



**Universitatea
Transilvania
din Braşov**

OFICIUL DE RELAȚII INTERNAȚIONALE | Biroul ERASMUS+
Bulevardul Eroilor 29
500036 – Braşov, ROMÂNIA
Tel./fax: +40 268.473.473
incoming@unitbv.ro | erasmus@unitbv.ro | www.unitbv.ro

Erasmus+ Staff Mobility for Training

CERTIFICATE OF ATTENDANCE

Name of the host Institution: **TRANSILVANIA UNIVERSITY OF BRAŞOV, Romania**

IT IS HEREBY CERTIFIED THAT:

Mrs. **Chitra Devi ARANGANATHAN**

From **Sathyabama Institute of Science and Technology, Republic of India**

has developed a **virtual TRAINING ACTIVITY**

between **15 / 06 / 2022** (day, month, year)

and **17 / 06 / 2022** (day, month, year)

At the **UNITBV Worldwide Talks: Reshaping internationalization in the "new normal"**

Date, **17 / 06 / 2022** (day, month, year)

Stamp and Signature



Name of the signatory: **Prof. dr. ing. Simona LACHE**

Function: **Erasmus Institutional Coordinator**





**Universitatea
Transilvania
din Braşov**

OFICIUL DE RELAȚII INTERNAȚIONALE | Biroul ERASMUS+
Bulevardul Eroilor 29
500036 – Braşov, ROMÂNIA
Tel./fax: +40 268.473.473
incoming@unitbv.ro | erasmus@unitbv.ro | www.unitbv.ro

Erasmus+ Staff Mobility for Training

CERTIFICATE OF ATTENDANCE

Name of the host Institution: TRANSILVANIA UNIVERSITY OF BRAŞOV, Romania

IT IS HEREBY CERTIFIED THAT:

Mrs. **Preethi SHESHADRI**

From **Sathyabama Institute of Science and Technology, Republic of India**

has developed a **virtual TRAINING ACTIVITY**

between **15 / 06 / 2022** (day, month, year)

and **17 / 06 / 2022** (day, month, year)

At the **UNITBV Worldwide Talks: Reshaping internationalization in the "new normal"**

Date, **17 / 06 / 2022** (day, month, year)

Stamp and Signature



Name of the signatory: Prof. dr. ing. Simona LACHE

Function: Erasmus Institutional Coordinator



UTM.J.01.34/14.17/1/51 Jld.48 (33)
 21 March 2022

Jayaraman Vanjinathan

 Sathayabama Institute of Science and Technology,
 India.

Dear Mr,

OFFER FOR MOBILITY PROGRAM AT UNIVERSITI TEKNOLOGI MALAYSIA, JOHOR BAHRU, MALAYSIA

We are pleased to offer you admission in the following program:-

Program	:	UTM Research Internship
Status	:	Postgraduate
Duration	:	06 July 2022 - 06 December 2022 (6 Months)
Host Faculty	:	Faculty of Engineering
School	:	School of Civil Engineering
Program	:	PKAW3 - Doctor of Philosophy (Civil Engineering)
Academic Advisor/ Supervisor	:	Assoc. Prof. Ts. Dr. Abdul Rahman Bin Mohd. Sam
Fees	:	Refer to Annex 2
Additional Information	:	1. Due to Covid19, all international students are required to obtain a Visa Approval Letter (eVAL) by the Malaysian Immigration Department. To obtain the approval, students must apply via EMGS portal: https://visa.educationmalaysia.gov.my/customer/account/login/. 2. In regards to the 'Payment Method for the Student Pass Application Form (IM14) for Mobility and eVAL application', students are instructed to choose the Paid by student method. Any selection of payment methods other than those instructed may result in your application not being supported or rejected. 3. You must adhere to regulations including quarantine period at your own costs prior entering UTM. Permission to enter Malaysia remains strictly at the discretion of the Malaysian Immigration Department. 4. Quarantine location will be either at the designated quarantine station (by NADMA) or home quarantine, subject to Home Quarantine Application (HQA) status. Visit the link for detailed instructions on HQA. https://hso.moh.gov.my/outbreak-portal-hqa/index 5. Undergo an RT-PCR COVID-19 test at least two (2) days prior to the departure date.

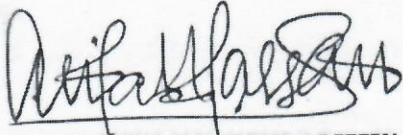
We look forward to welcome you to UTM!

Thank you.

"WAWASAN KEMAKMURAN BERSAMA 2030"

"BERKHIDMAT UNTUK NEGARA"

I, who uphold trust,



ASSOC. PROF. DR. MOHD ARIFFIN BIN ABU HASSAN

Associate Director

Global Education & Experience

UTM International

Universiti Teknologi Malaysia

81310 Johor Bahru, Johor, Malaysia

Tel: +607-553 6850

Fax: +607-553 6847

Email: mariffin@utm.my

C.C - **Prof. Ir. Dr. Shuhaimi Bin Mansor (Asistant Dean, External & Global Engagement)**
- **Assoc. Prof. Ts. Dr. Abdul Rahman Bin Mohd. Sam (Academic Advisor/Supervisor)**
School of Civil Engineering, Faculty of Engineering (SKA, FK)



WSZECHNICA POLSKA
AKADEMIA NAUK STOSOWANYCH W WARSZAWIE



Erasmus+

CONFIRMATION OF STAY

ERASMUS+ PROGRAMME

This is to confirm that

Ms. Velumoni Dharumaraj

was participating in a **Staff Mobility for Teaching (STA)**
at Wszechnica Polska Academy of Applied Sciences in Warsaw
from **25.07.2022** to **29.07.2022**.

The stay has been carried out in accordance with the plan
set in the Staff Mobility Agreement for Training.

29.07.2022

Date

Head of International Cooperation Office
Erasmus Coordinator

Katarzyna Gajewska
Katarzyna Gajewska, Ph.D.

Signature of the Receiving Institution

PALAC KULTURY I NAUKI, VIII PIĘTRO, 00-901 WARSZAWA, PL. DEFILAD 1 SEKRETARIAT POK. 822,
TEL./FAKS 22 624 88 35, TEL. 22 656 6192
E-MAIL: WSZECHNICA@WSZECHNICAPOLSKA.EDU.PL WWW.WSZECHNICAPOLSKA.EDU.PL



Certificate of Appreciation

Number : 267/KGKP.10/STIKI/III/2023

THIS IS TO CERTIFY THAT

Tharun Raju

Has earned 3 (three) credits in the International Credit Transfer Program
in Bachelor of Informatics Management at Sekolah Tinggi Informatika & Komputer Indonesia
(STIKI) Malang during the period of odd semester, a.y. 2022/2023

Rector of STIKI Malang,



A handwritten signature in black ink, appearing to read 'Eva Handriyantini', is written over the STIKI logo.

Dr. Eva Handriyantini, S.Kom., M.MT.



WSZECHNICA POLSKA
AKADEMIA NAUK STOSOWANYCH W WARSZAWIE



Erasmus+

CONFIRMATION OF STAY

ERASMUS+ PROGRAMME

This is to confirm that

Ms. Rani Jayaraj

was participating in a **Staff Mobility for Teaching (STA)**
at Wszechnica Polska Academy of Applied Sciences in Warsaw
from **25.07.2022** to **29.07.2022**.

The stay has been carried out in accordance with the plan
set in the Staff Mobility Agreement for Training.

Head of International Cooperation Office
Erasmus Coordinator

Katarzyna Gajewska
Katarzyna Gajewska, Ph.D.

29.07.2022

Date

Signature of the Receiving Institution



MAHSA
UNIVERSITY

MAHSA
UNIVERSITY
BE MORE

5th July 2022

To

AP Dr. Muthiah Bavanilatha
Associate Professor
School of Bio and Chemical Engineering
Sathyabama Institute of Science and Technology
India.

Dear AP Dr. Muthiah Bavanilatha,

We invite you, Dr. Muthiah Bavanilatha, Associate Professor from the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, Chennai, India with Passport No.V3872734 on Staff mobility programme at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, India. During the visit, MAHSA University will provide for her stay in the campus.

Regards,

Professor Dr Srikumar Chakravarthi

Director of Research, Innovation & Postgraduate Studies

MAHSA University

Prof. Dr. Srikumar Chakravarthi
Director
Research, Innovation & Postgraduate Studies
MAHSA University
Level 10, Unity Building,
Jalan SP2, Bandar Saujana Putra,
42610 Jenjarom, Kuala Langat, Selangor

SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.

Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my

To

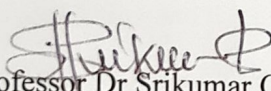
5th July 2022

Dr. S.Usha Nandhini, Assistant Professor,
School of Bio and Chemical Engineering,
Sathyabama Institute of Science and Technology,
Chennai,
India

Dear Dr. S. Usha Nandhini

We invite Dr. S.Usha Nandhini, Assistant Professor from the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, Chennai, India with Passport No.W1315786 on Staff mobility programme at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, India. During the visit, MAHSA University will provide for her stay in the campus.

Regards,



Professor Dr Srikumar Chakravarthi

Director of Research & Postgraduate Studies Centre

MAHSA University

Prof. Dr. Srikumar Chakravarthi
Director
Research, Innovation & Postgraduate Studies
MAHSA University
Level 10, Unity Building,
Jalan SP2, Bandar Saujana Putra,
42610 Jenjarom, Kuala Langat, Selangor

SAUJANA PUTRA CAMPUS

Level 11, Administrative Block, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.

MAHSA AVENUE CAMPUS

Block A, Level 1, MAHSA Avenue, Jalan Ilmu off Jalan Universiti, 59100 Kuala Lumpur, Malaysia.
Tel: +603-7965 2639 (DL) +603-7965 2555 (GL) . Fax: +603-7931 7119 . Toll Free: 1800 88 0300 . Website: www.mahsa.edu.my

PRIVATE AND CONFIDENTIAL

Date: 21 April 2022

Mr. Manigandan Sekar
Address : India

Telephone no.: +919791025158
Email: manisek87@gmail.com

Dear Mr. Manigandan

RE: EMPLOYMENT OFFER

We are pleased to inform you that we would like to offer you employment with the United Arab Emirates University to hold the position pursuant to the terms and conditions set out below:

1. **EMPLOYMENT**

Position Title / Grade : Research Assistant / 19
Department / Work Place: College of Engineering
Commencing Date : To Be Confirmed
Reporting To: Dr. Mahmoud Moustafa Elgendi

2. **TERM**

Your employment shall be for a period of Seven months starting on the commencing date mentioned above. Employment may be renewed by mutual agreement between the parties and is subject to on-going funding.

3. **COMPENSATION**

You will be employed on a temporary grant hire basis and you will receive a monthly Gross Payment of Eight thousand Dirhams (AED 8,000.00).

4. **PROBATIONARY PERIOD**

The Probation Period of the Employees appointed for the first time, shall be for three (3) months only, starting from the actual Commencement Date of Work, renewable for other similar terms. The service of the new Employee may be terminated during the Probation Period if the Employee proves not to be fit for the job

5. **WORKING HOURS**

The Second Party will normally work eight hours (8:00) per day from Monday to Thursday and Four hours and thirty minutes in the Friday.

6. **ANNUAL LEAVE**

You are entitled to an annual leave at the rate of one working day per month. The timing of your leave will be subject to the University's approval. Your annual leave should be applied within your contract period. Any unused leaves at the end of your contract will not be paid as cash in lieu.

7. **SICK LEAVE**

You are entitled to sick leave with full pay for up to Five (5) working days. Any continuous or otherwise, and any extra days shall be without salary.

8. **NATIONAL HOLIDAYS**

You will be entitled to a paid leave on national holidays and as decreed by the appropriate authority.

9. **INSURANCE**

The University will provide you with free health insurance based on the University's insurance scheme.

10. **TERMINATION**

This is a temporary grant funded position. The University may terminate your employment by giving you One (1) month prior written notice (or cash-in lieu of notice). The University may terminate your employment without any notice for disciplinary reasons. You may terminate your employment by giving one (1) month prior written notice to the University.

11. **END OF SERVICE**

This position is not eligible for any end-of-service gratuity payment.

12. **QUALIFICATIONS/EXPERIENCE**

You warrant the University that all qualifications and statements of experience presented in any application, resume or other documents submitted in connection with this appointment are true, and you acknowledge that any fraudulent misrepresentation of qualifications or experience shall be sufficient grounds for your dismissal without notice or compensation.

13. **UNIVERSITY POLICIES**

Terms and conditions of your employment shall be applied in accordance with regulations set out in the UAE University HR Policies a copy of which is available on the HR Department web page with benefits being limited to those stated in this offer .

14. **GOVERNING LAW AND DISPUTE**

This offer of employment is subject to the laws of the UAE. In the event the parties fail to resolve any dispute amicably, the matter shall be referred to the competent courts in the UAE.

15. **LANGUAGE**

Where this offer or subsequent contract is in Arabic and English, the Arabic version shall prevail.

16. **CONDITIONS**

This offer of employment is subject to you passing the health and medical tests required by the competent UAE authorities, signing this employment offer letter with the University, and the University obtaining relevant security clearances and visas. Please note that the medical screening process includes tests for HIV, Hepatitis, Leprosy and TB. You may wish to review these categories with your family physician prior to moving to the UAE.

Additionally: Soon after commencing date of your employment contract, you must provide HR within Six months, an equivalency of your degree from the Ministry of Education, UAE.
Please browse the following side:

<https://www.moe.gov.ae/en/eservices/servicecard/pages/universiycertificateequilization.aspx>

Please indicate your acceptance of our offer by signing and returning to us a scanned copy of this letter within one week of receiving the same. Alternatively, you may communicate your acceptance via an email message

Yours sincerely,

Aisha Al Dhaheri
Director, Human Resources Dept.

I hereby confirm my acceptance of the offer of employment on the terms detailed above and those contained in the HR Policies.

Mr. Manigandan Sekar





Powiślański University

11 Listopada 29, 82-500 Kwidzyn
Heweliusza 11, 80-890 Gdańsk
Prosta 4, 87-100 Toruń
W. Sikorskiego 1, 83-400 Kościerzyna
e-mail: erasmusplus@psw.kwidzyn.edu.pl
www.powislanska.edu.pl

Kwidzyn, 15.02.2023

LETTER OF INVITATION

I confirm that Assoc. Prof. **Dr. Dhivya Sathish** (Passport No.W1005867) from Sathyabama Institute of Science and Technology from India, is invited for a teaching exchange within the framework of the Erasmus+ Teaching Staff Mobility Programme (STA) combined with Training Staff Mobility, in the academic year 2022/2023 to provide teaching of 4 hours and receive 4 hours of training during her stay at Powiślański University, Poland between 16.05.2023-20.05.2023 at 5th edition of International Week 2023 "Cultural Diversity".

I hereby declare that our University has signed a bilateral agreement with the Sathyabama Institute of Science and Technology from India, for the above mentioned academic year including teaching staff mobility. The overall costs for this STA Erasmus+ exchange will be covered by Powiślański University, Poland and will be in the amount of max. 1800 euro from 2020-1-PL01-KA107-080041 project, which will cover the travel cost and stay during mobility.

Erasmus + Programme Coordinator

Paulina Osuch

POWIŚLAŃSKI UNIVERSITY

ul. 11 Listopada 29
82-500 Kwidzyn
tel. 55 261 31 39 / 55 615 13 71
NIP 581-17-22-066 REGON 19187117



Powiślański University

11 Listopada 29, 82-500 Kwidzyn
Heweliusza 11, 80-890 Gdańsk
Prosta 4, 87-100 Toruń
W. Sikorskiego 1, 83-400 Kościerzyna
e-mail: erasmusplus@psw.kwidzyn.edu.pl
www.powislanska.edu.pl

Kwidzyn, 15.02.2023

LETTER OF INVITATION

I confirm that Assoc. **Prof. Dr. Lavanya Murugesan** (Passport No. W1001380) Sathyabama Institute of Science and Technology from India, is invited for a teaching exchange within the framework of the Erasmus+ Teaching Staff Mobility Programme (STA) combined with Training Staff Mobility, in the academic year 2022/2023 to provide teaching of 4 hours as well as receive 4 hours of training during her stay at Powiślański University, Poland between 16.05.2023-20.05.2023 at 5th edition of International Week 2023 "Cultural Diversity".

I hereby declare that our University has signed a bilateral agreement with the Sathyabama Institute of Science and Technology from India, for the above mentioned academic year including teaching staff mobility. The overall costs for this STA Erasmus+ exchange will be covered by the home university of the teaching staff.

Erasmus + Programme Coordinator

Paulina Osuch

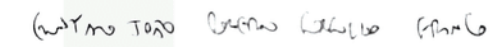
POWIŚLAŃSKI UNIVERSITY

ul. 11 Listopada 29
82-500 Kwidzyn
tel. 55 261 31 39 / 55 615 13 71
NIP 581-17-22-066 REGON 191871175

Certificamos que **Dr. Preethi Sheshadri**, participou, na qualidade de **Palestrante**, do evento III International Conference U.Experience e IV Seminário Internacional sobre Cooperación Universitaria Creces, realizado de 26 a 29 de setembro de 2022, ministrando a atividade **Opportunities for international cooperation at the Sathyabama Institute of Science & Technology** e contabilizando carga horária total de 1 hora(s).

Varginha, 30 de setembro de 2022


Daniel Vaz Freire
Coordenador do Núcleo Brasil do CRECES


Gustavo João Roberto Gorgulho Franco
CEO da U.Experience

REALIZAÇÃO:



APOIO:



PARCEIROS:



Certificamos que **Dr. Preethi Sheshadri**, participó como **Palestrante**, en el evento III International Conference U.Experience y IV Seminário Internacional sobre Cooperación Universitaria Creces, celebrado del 26 al 29 de septiembre de 2022, impartiendo la actividad **Opportunities for international cooperation at the Sathyabama Institute of Science & Technology** y contabilizando una carga horaria total de 1 hora(s).

Varginha, 30 de septiembre de 2022


Daniel Vaz Freire
Coordinador del Núcleo Brasil del CRECES

Gustavo João Roberto Gorgulho Franco
CEO de U.Experience

REALIZACIÓN:



APOYO:

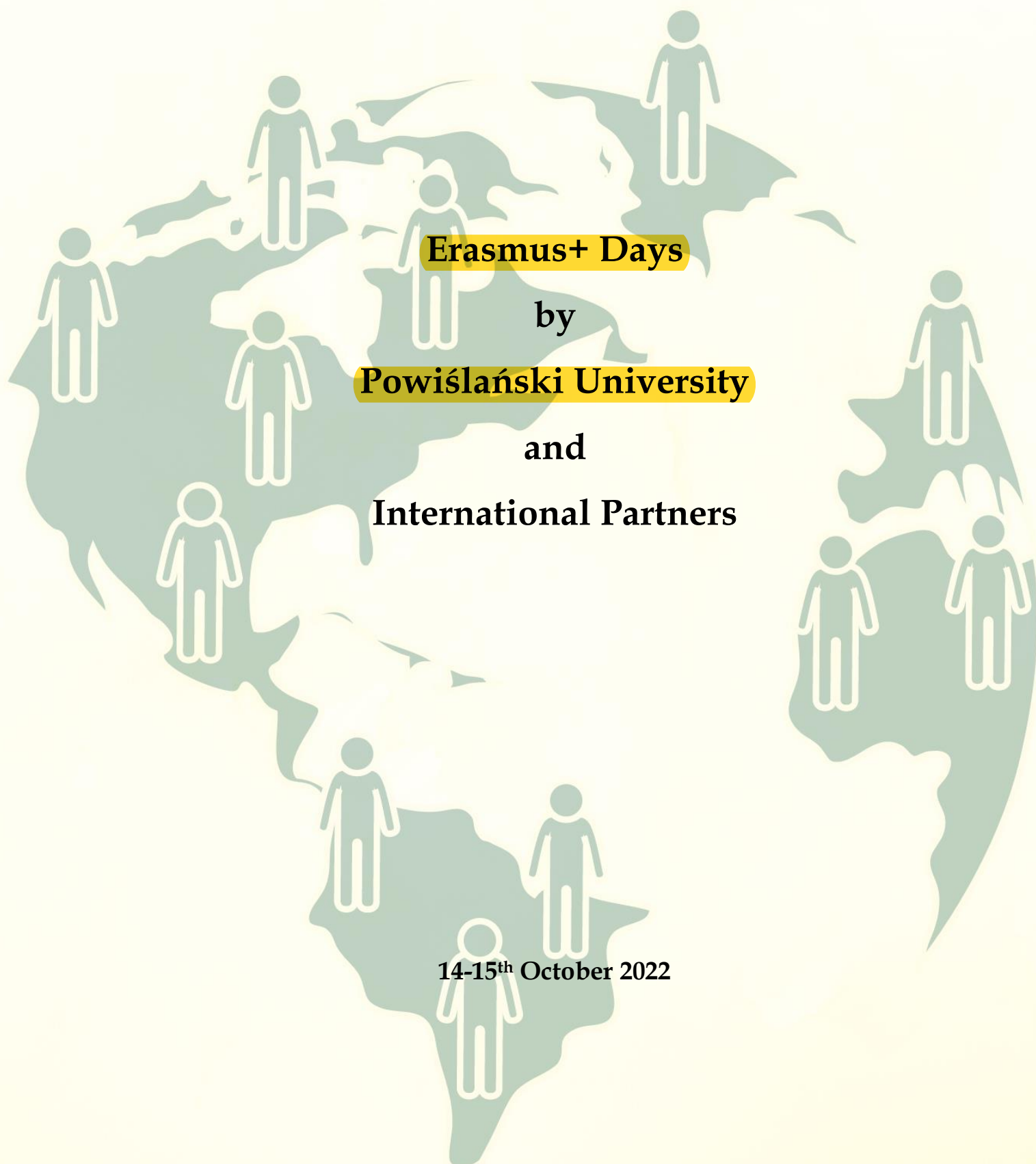


SOCIOS:





International Office
Powiślański University
11 Listopada 29 Street
82-500 Kwidzyn
Tel. +48 615 13 71



Erasmus+ Days



International Office
Powiślański University
11 Listopada 29 Street
82-500 Kwidzyn
Tel. +48 615 13 71

Day 1 – 14/10/22

Polish Time (CEST)

10:00 am

**“Presentation of Powiślański University, Poland and the Erasmus+ programme.
Opportunities within Erasmus+ Programme for Powiślański University’s partners.
Incoming students and staff mobilities – result of KA171 project application.**

Presenter: Paulina Osuch, Powiślański University

11:00 am

Student’s Panel – Mobility experience in the framework of Erasmus+ Programme.

Moderator: Paulina Osuch, Powiślański University

12:00pm

Virtual Coffee break

12:15pm

Staff’s Panel – Mobility experience in framework of Erasmus+ Programme.

Moderator: Paulina Osuch, Powiślański University

**Panelists: Vikas Kumar, Management Development Institute Gurgaon, India
Erjona Deshati, PhD, Canadian Institute of Technology, Albania
Sami Hochlaf and Ammar Azouzi, University of Sousse, Tunisia
Corina Gribincea, PhD, Free International University of Moldova, Moldova
Kamal Ahmed, University of Raparin, Iraq**

13:15 pm

Medical Tourism Panel

Moderator: Paulina Osuch, Powiślański University



**Institute of Research
and Development
of Medical Tourism**



Erasmus+ Days



International Office
Powiślański University
11 Listopada 29 Street
82-500 Kwidzyn
Tel. +48 615 13 71

Day 2 – 15/10/22

12:00 am

Opportunities for academic community of Powiślański University from International Partners in the framework of Erasmus+ programme:

Where can our student and staff realize a mobility in an academic year 2022/2023?

- ❖ ADEN University, Panama
- ❖ Aleksandër Moisiu University Durrës, Albania
- ❖ Anadolu University, Turkey
- ❖ College of Applied Sciences “Lavoslav Ružička”, Croatia
- ❖ Polytechnic of Rijeka, Croatia
- ❖ International Daffodil University, Bangladesh
- ❖ Kyrgyz State Medical Academy, Kyrgistan
- ❖ Mbarara University of Science & Technology, Uganda
- ❖ International Burch University, Bośnia and Hercegovina
- ❖ Sathyabama Institute of Science & Technology, India
- ❖ Tarlac Agricultural University, Philippines
- ❖ Technological University of Tajikistan
- ❖ Birzeit University, Palestine



Erasmus+ Days



International Office
Powiślański University
11 Listopada 29 Street
82-500 Kwidzyn
Tel. +48 615 13 71

Links (MS Teams) to the Erasmus+ Days:

14.10.2022 – Day 1: <https://teams.microsoft.com/>

15.10.2022 – Day 2: <https://teams.microsoft.com/>

Website of the event: <https://powislanska.edu.pl/wspolpraca/international-week/erasmus-days-2022/>



Erasmus+ Days



The 1st International Student Conference 2022

“ CREATIVITY OF INITIATIVE OF YOUNG GENERATION IN AN UNCERTAINTY FUTURE : OPPORTUNITIES AND CHALLENGES “

Tuesday, December 6th 2022 | 09.00 AM - 03.00 PM (GMT +7)

Welcoming Speech:



Dr. Eva Handriyanti, S.Kom, M.MT
Rector STIKI Malang
Indonesia



Raul F. Muyong, Ed.D
President ISAT University
Philippines



Dr. T. Sasipraba
Vice Chancellor
Sathyabama Institute of Science
and Technology
India



Dr. Rasmuna Hussain
Director
Selayang Community College
Malaysia

Keynote Speakers:



Dr. Jozua F. Palandi, S.Kom.,
STIKI Malang
Indonesia



Dr. Corazon C. Corbal
ISAT University
Philippines



Dr. B. Bharathi
Dean Academics
Sathyabama Institute of Science
and Technology
India



Dr. Rasmuna Hussain
Director
Selayang Community College
Malaysia



Hilmiyah Mawaddah

Master of Ceremony:

Program:

- Call for Paper
- International Conference

Topics:

- Management Information System
- Software Engineering
- Data & Information Dissemination
- IT Security
- Enterprise System
- Data Science
- Visual Communication Design
- And Other Related Topics

Submission Deadline	December 1 st , 2022
● Paper Presentation ● Keynote Speaker ● Best Paper Award	December 6 th , 2022
Official Website	conference.stiki.ac.id
Registration Link	bit.ly/IC-ITECH2022

- **Participant Requirement Undergraduate Students Enrolled in any recognized college or university**
- **Free Submission Fee & E-Eertificate** for all student participants



CP: (+62) 857-4632-3091 (Datik)



kui@stiki.ac.id

Ref. SC: 015/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite Ms/Mr. **AADHITYA SRIDHAR** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W0998644** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between **MAHSA UNIVERSITY, MALAYSIA** and **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA**. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wt Yong@mahsa.edu.my



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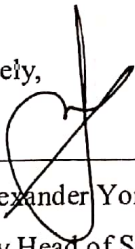
Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **FAZILA ALI AHMED** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V3502176** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between **MAHSA UNIVERSITY, MALAYSIA** and **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA**. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.





MAHSA
UNIVERSITY

MAHSA
BE MORE

Ref. SC: 006/22

Date: 9th June 2022

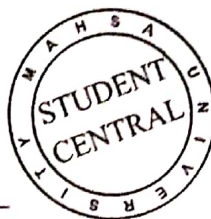
LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **NAJEEBA MOHAMED YUSUFF ALI** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V1305874** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between **MAHSA UNIVERSITY, MALAYSIA** and **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA**. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,

Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my

Ref. SC: 016/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. PONNI SIVANANTHAM student** from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W0996183** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between **MAHSA UNIVERSITY, MALAYSIA** and **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA**. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wt Yong@mahsa.edu.my



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Ref. SC: 003/22

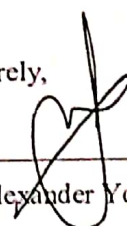
Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **SARASWATHI BALAJI** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V3509267** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between **MAHSA UNIVERSITY, MALAYSIA** and **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA**. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my

Ref. SC: 017/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. SRIVARI MUKUNTH** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W0993148** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wt Yong@mahsa.edu.my

Ref. SC: 018/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. TEJASWINI SUNDARGANESH student** from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V8870664** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wtjong@mahsa.edu.my

Ref. SC: 020/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. ANGELIN WINSLET student** from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W1005435** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wt Yong@mahsa.edu.my



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Ref. SC: 002/22

Date: 9th June 2022

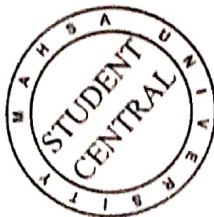
LETTER OF INVITATION

To whomsoever It may concern

We invite Ms/Mr **MANASA VINOTHIKUMAR** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **Z6045228** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,

Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my

Ref. SC: 022/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. MATHANGI BALASUBRAMANIAN** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W1003620** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wtjong@mahsa.edu.my



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Ref. SC: 009/22

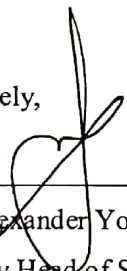
Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **PRAKKRITH VIJEYAKUMAR** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **U3615090** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my



Ref. SC: 013/22

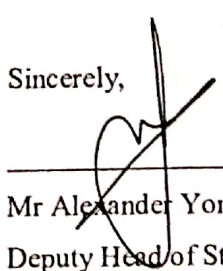
Date: 9th June 2022

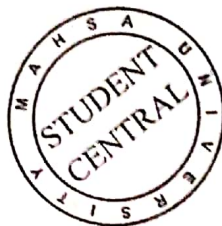
LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **RAGHUL ANANDAN** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W0989017** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.





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Ref. SC: 004/22

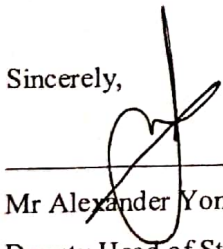
Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **RENNY VALENTINA NIXON RAJAKUMAR** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W0993456** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my



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Ref. SC: 012/22

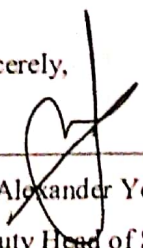
Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite **Ms/Mr JANANITHA KARNAN** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **T8810189** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my



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Ref. SC: 008/22

Date: 9th June 2022

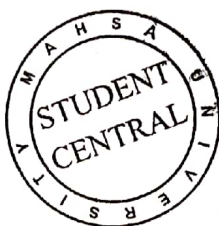
LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **NOEL RICHARD PRAKASH** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V2186581** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,

Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my



Ref. SC: 010/22

Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **RAJALAKSHMI DEENADHAYALAN** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V1820705** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,



Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my



Ref. SC: 007/22

Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **SANJAY PREETH** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V1307653** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,



Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



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Ref. SC: 011/22

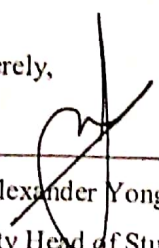
Date: 9th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **SATHIYA SREE MAHENDRAN** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V1812581** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,


Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my

Ref. SC: 019/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. WILFRED JEROME WINNIE PRAHELIKA** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W1003283** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wtjong@mahsa.edu.my

Ref. SC: 021/22

Date: 20th June 2022

LETTER OF INVITATION

To whomsoever it may concern

We heartily invite **Ms/Mr. HARITHA SIVAKUMAR** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W1005068** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wt Yong@mahsa.edu.my



Ref. SC: 014/22

Date: 9th June 2022

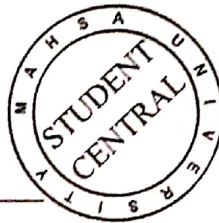
LETTER OF INVITATION

To whomsoever it may concern

We invite Ms/Mr **RIZWAN AHAMED NAJIMUDEEN** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **V3574438** for the Two Week Summer Internship Programme on "Recent Trends in Biomedical Sciences" at MAHSA University, Malaysia between 18th July and 31st July 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor, Malaysia.

Sincerely,

Mr Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.



SAUJANA PUTRA CAMPUS

Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Kuala Langat, Selangor, Malaysia.
Tel: +603-5102 2200 Toll Free: 1800 88 0300 Website: www.mahsa.edu.my

Ref. SC: 023/22

Date: 23rd June 2022**LETTER OF INVITATION****To whomsoever it may concern**

We heartily invite **Ms/Mr. HARSHAA RAJABALAKUMAR** student from the School of Bio and Chemical Engineering of Sathyabama Institute of Science and Technology, Chennai, India with Passport No. **W1280648** for the Two Week Summer Internship Programme on “Recent Trends in Biomedical Sciences” at MAHSA University, Malaysia between 25th July and 7th August 2022, within the framework of the Memorandum of Understanding for Academic Cooperation, entered between MAHSA UNIVERSITY, MALAYSIA and SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, INDIA. The student will be provided accommodation on campus located at MAHSA UNIVERSITY, Jalan SP2, Bandar Saujana Putra, 42610 Jenjarom, Selangor. Malaysia.

Sincerely,



Mr. Alexander Yong,
Deputy Head of Student Central,
MAHSA UNIVERSITY.

MAHSA UNIVERSITY

Office of Registry, Level 1, UNITY Building, Bandar Saujana Putra, 42610 Jenjarom, Selangor.
Malaysia. Tel: +6016-6225662 | Email: wt Yong@mahsa.edu.my

Feb 6, 2022

NAGANJAN KUMAR GOBBURU

16-2-738/a/1and 2f tycoon residency
flat no 202
Asmangadh
Malakpet Hyderabad-500036
INDIA

Hello Intern Applicant:

It is my pleasure to invite you to join the Computer Science department at The University of Texas at Dallas as a J-1 Exchange Visitor, Student Intern.

Nature of Student Internship Activities:

This internship will include lessons & projects on advanced Computer Science concepts like Big Data, Machine Learning & Programming Contests. There will be lectures in the mornings and hands-on projects in the afternoons. Internship will end with project presentations during the final 2 days. You will also get to experience U.S. cultural activities in Dallas in the weekends.

Duration of Student Internship: June 6 – July 29, 2022

Funding: You will be required to pay for all your expenses related to internship. UT Dallas will provide you with access to the required facilities to fulfill the requirements of your internship.

We are delighted that you will come to our university as J-1 Student Intern and look forward to meeting you.

Sincerely,



Dr. Jey Veerasamy

Associate Professor of Instruction

T: (972)883-4241

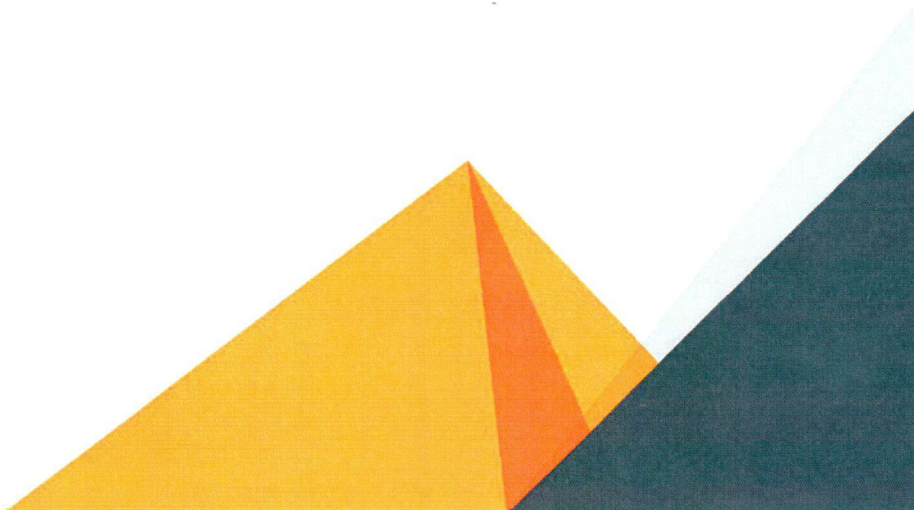
E: jeyv@UTDallas.edu

W: UTDALLAS.EDU/~JEYV

THE UNIVERSITY OF TEXAS AT DALLAS

800 W. Campbell Road
Richardson, Texas 75080-3021

CS.UTDALLAS.EDU





Department of
**COMPUTER
SCIENCE**
THE UNIVERSITY OF TEXAS AT DALLAS



NAGANJAN KUMAR GOBBURU

is recognized for completing Summer Internship
**ARTIFICIAL INTELLIGENCE, MACHINE LEARNING
& DEEP LEARNING**

June 6 – July 29, 2022

A handwritten signature in black ink, appearing to read 'John Cole'.

Prof. John Cole
Assoc. Director,
CS Outreach

A handwritten signature in black ink, appearing to read 'Jey'.

Dr. Jey Veerasamy
Director, CS Outreach

A handwritten signature in black ink, appearing to read 'O Daescu'.

Dr. Ovidiu Daescu
CS Dept. head

Feb 6, 2022

KARTHIKHEYAA KURRA

House No. 1-7-1321,
Road No. 4, Advocates Colony,
Balasamudram,
Hanamkonda, Warangal
INDIA

Hello Intern Applicant:

It is my pleasure to invite you to join the Computer Science department at The University of Texas at Dallas as a J-1 Exchange Visitor, Student Intern.

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This internship will include lessons & projects on advanced Computer Science concepts like Big Data, Machine Learning & Programming Contests. There will be lectures in the mornings and hands-on projects in the afternoons. Internship will end with project presentations during the final 2 days. You will also get to experience U.S. cultural activities in Dallas in the weekends.

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Sincerely,



Dr. Jey Veerasamy

Associate Professor of Instruction

T: (972)883-4241

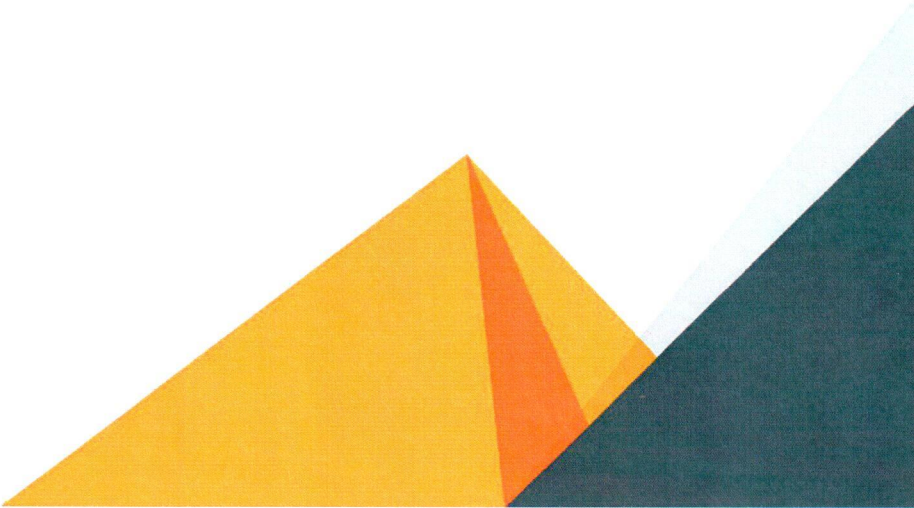
E: jeyv@UTDallas.edu

W: UTDALLAS.EDU/~JEYV

THE UNIVERSITY OF TEXAS AT DALLAS

800 W. Campbell Road
Richardson, Texas 75080-3021

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Department of
**COMPUTER
SCIENCE**
THE UNIVERSITY OF TEXAS AT DALLAS



KARTHIKHEYAA KURRA

is recognized for completing Summer Internship
**ARTIFICIAL INTELLIGENCE, MACHINE LEARNING
& DEEP LEARNING**

June 6 – July 29, 2022

A handwritten signature in black ink, reading 'John Cole'.

Prof. John Cole
Assoc. Director,
CS Outreach

A handwritten signature in black ink, reading 'Jey Veerasamy'.

Dr. Jey Veerasamy
Director, CS Outreach

A handwritten signature in black ink, reading 'Ovidiu Daescu'.

Dr. Ovidiu Daescu
CS Dept. head

Feb 6, 2022

NETHRA BALARAMAN

24/25 Saraswathi Illam first floor
Appu street 2nd lane,
Mylapore,
Chennai-600004
INDIA

Hello Intern Applicant:

It is my pleasure to invite you to join the Computer Science department at The University of Texas at Dallas as a J-1 Exchange Visitor, Student Intern.

Nature of Student Internship Activities:

This internship will include lessons & projects on advanced Computer Science concepts like Big Data, Machine Learning & Programming Contests. There will be lectures in the mornings and hands-on projects in the afternoons. Internship will end with project presentations during the final 2 days. You will also get to experience U.S. cultural activities in Dallas in the weekends.

Duration of Student Internship: June 6 – July 29, 2022

Funding: You will be required to pay for all your expenses related to internship. UT Dallas will provide you with access to the required facilities to fulfill the requirements of your internship.

We are delighted that you will come to our university as J-1 Student Intern and look forward to meeting you.

Sincerely,



Dr. Jey Veerasamy

Associate Professor of Instruction

T: (972)883-4241

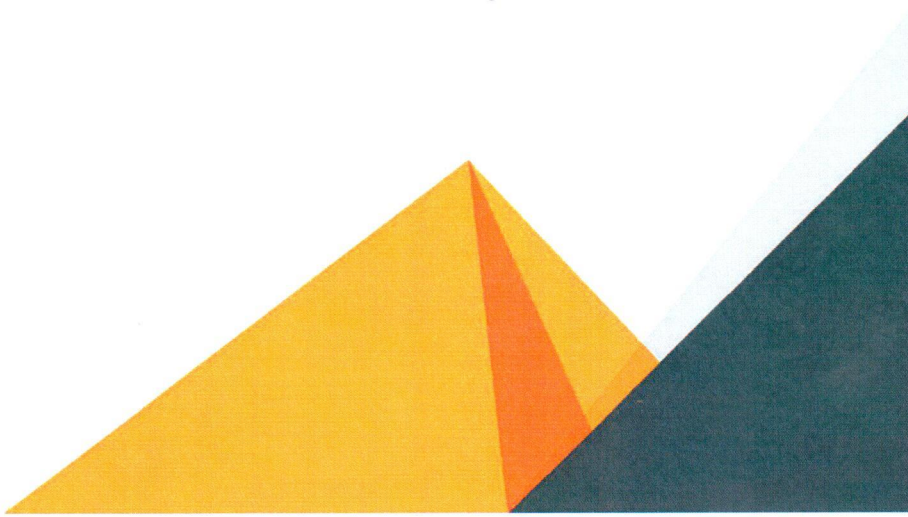
E: jeyv@UTDallas.edu

W: UTDALLAS.EDU/~JEYV

THE UNIVERSITY OF TEXAS AT DALLAS

800 W. Campbell Road
Richardson, Texas 75080-3021

CS.UTDALLAS.EDU





Department of
**COMPUTER
SCIENCE**
THE UNIVERSITY OF TEXAS AT DALLAS



NETHRA BALARAMAN

is recognized for completing Summer Internship
**ARTIFICIAL INTELLIGENCE, MACHINE LEARNING
& DEEP LEARNING**

June 6 - July 29, 2022

John Cole

Prof. John Cole
Assoc. Director,
CS Outreach

Jey Veerasamy

Dr. Jey Veerasamy
Director, CS Outreach

Ovidiu Daescu

Dr. Ovidiu Daescu
CS Dept. head

Feb 6, 2022

KAILASH SUMUTRAM VISWANATHAN

43-C Police Officers Road
St Thomas Mount Butt Road
Chennai- 600016
INDIA

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It is my pleasure to invite you to join the Computer Science department at The University of Texas at Dallas as a J-1 Exchange Visitor, Student Intern.

Nature of Student Internship Activities:

This internship will include lessons & projects on advanced Computer Science concepts like Big Data, Machine Learning & Programming Contests. There will be lectures in the mornings and hands-on projects in the afternoons. Internship will end with project presentations during the final 2 days. You will also get to experience U.S. cultural activities in Dallas in the weekends.

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Sincerely,



Dr. Jey Veerasamy

Associate Professor of Instruction

T: (972)883-4241

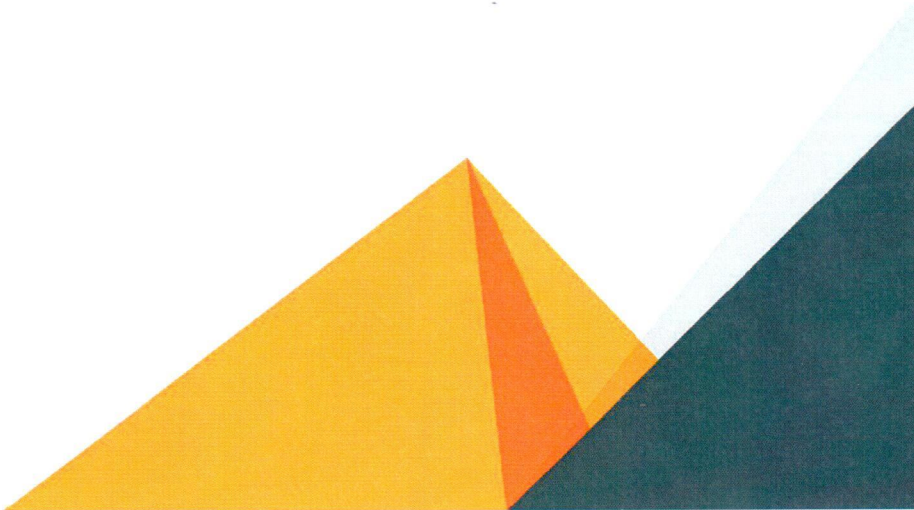
E: jeyv@UTDallas.edu

W: UTDALLAS.EDU/~JEYV

THE UNIVERSITY OF TEXAS AT DALLAS

800 W. Campbell Road
Richardson, Texas 75080-3021

CS.UTDALLAS.EDU





Department of
**COMPUTER
SCIENCE**
THE UNIVERSITY OF TEXAS AT DALLAS



KAILASH VISWANATHAN

is recognized for completing Summer Internship
**ARTIFICIAL INTELLIGENCE, MACHINE LEARNING
& DEEP LEARNING**

June 6 – July 29, 2022

Prof. John Cole
Assoc. Director,
CS Outreach

Dr. Jey Veerasamy
Director, CS Outreach

Dr. Ovidiu Daescu
CS Dept. head



CERTIFICATE OF PARTICIPATION

This is to certify that

Hashika Vishvini

(Sathyabama Institutions Of Science And Technology)

has participated in

VIRTUAL PUTRA EXPERIENCE:
UNIVERSITI PUTRA MALAYSIA X
SOEGIJAPRANATA CATHOLIC UNIVERSITY

on
30th June 2022

via  zoom

Prof. Dr. Suhaimi Ab Rahman
Director
PUTRA International Centre
Universiti Putra Malaysia

PUTRA
EXPERIENCE

   [iputraupm](https://www.youtube.com/channel/UCputraupm) | intl.upm.edu.my



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BERSEKUTUHAN MELAKSANAKAN TRANSFORMASI

CERTIFICATE OF PARTICIPATION

This is to certify that

Sneha Murali

(Sathyabama Institutions Of Science And Technology)

has participated in

VIRTUAL PUTRA EXPERIENCE:
UNIVERSITI PUTRA MALAYSIA X
SOEGIJAPRANATA CATHOLIC UNIVERSITY

on

30th June 2022

via  zoom



Prof. Dr. Suhaimi Ab Rahman
Director
PUTRA International Centre
Universiti Putra Malaysia

PUTRA
EXPERIENCE

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WITH KNOWLEDGE WE SERVE

CERTIFICATE OF PARTICIPATION

This is to certify that

G.R.Jayasree

(Sathyabama Institutions Of Science And Technology)

has participated in

VIRTUAL PUTRA EXPERIENCE:
UNIVERSITI PUTRA MALAYSIA X
SOEGIJAPRANATA CATHOLIC UNIVERSITY

on

30th June 2022

via  zoom



Prof. Dr. Suhaimi Ab Rahman
Director
PUTRA International Centre
Universiti Putra Malaysia

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WITH KNOWLEDGE WE SERVE

CERTIFICATE OF PARTICIPATION

This is to certify that

Hema Darshine. A

(Sathyabama Institutions Of Science And Technology)

has participated in

VIRTUAL PUTRA EXPERIENCE:

UNIVERSITI PUTRA MALAYSIA X

SOEGIJAPRANATA CATHOLIC UNIVERSITY

on

30th June 2022

via  zoom



Prof. Dr. Suhaimi Ab Rahman
Director
PUTRA International Centre
Universiti Putra Malaysia

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WITH KNOWLEDGE WE SERVE



Certificate of Appreciation

Number : 267/KGKP.10/STIKI/III/2023

THIS IS TO CERTIFY THAT

A Lokeshwari

Has earned 3 (three) credits in the International Credit Transfer Program
in Bachelor of Informatics Management at Sekolah Tinggi Informatika & Komputer Indonesia
(STIKI) Malang during the period of odd semester, a.y. 2022/2023

Rector of STIKI Malang,



Dr. Eva Handriyantini, S.Kom., M.MT.



Certificate of Appreciation

Number : 267/KGKP.10/STIKI/III/2023

THIS IS TO CERTIFY THAT

Gopu Lekha G

Has earned 3 (three) credits in the International Credit Transfer Program
in Bachelor of Informatics Management at Sekolah Tinggi Informatika & Komputer Indonesia
(STIKI) Malang during the period of odd semester, a.y. 2022/2023

Rector of STIKI Malang,



A handwritten signature in black ink, appearing to read 'Eva Handriyantini', is written over the STIKI logo.

Dr. Eva Handriyantini, S.Kom., M.MT.



Certificate of Appreciation

Number : 267/KGKP.10/STIKI/III/2023

THIS IS TO CERTIFY THAT

Munusamy Munish

Has earned 3 (three) credits in the International Credit Transfer Program
in Bachelor of Informatics Management at Sekolah Tinggi Informatika & Komputer Indonesia
(STIKI) Malang during the period of odd semester, a.y. 2022/2023

Rector of STIKI Malang,



A handwritten signature in blue ink, likely belonging to Dr. Eva Handriyantini.

Dr. Eva Handriyantini, S.Kom., M.MT.



Certificate of Appreciation

Number : 267/KGKP.10/STIKI/III/2023

THIS IS TO CERTIFY THAT

Ravi Karthik

Has earned 3 (three) credits in the International Credit Transfer Program
in Bachelor of Informatics Management at Sekolah Tinggi Informatika & Komputer Indonesia
(STIKI) Malang during the period of odd semester, a.y. 2022/2023

Rector of STIKI Malang,



A handwritten signature in blue ink, likely belonging to Dr. Eva Handriyantini.

Dr. Eva Handriyantini, S.Kom., M.MT.



Certificate of Appreciation

Number : 267/KGKP.10/STIKI/III/2023

THIS IS TO CERTIFY THAT

Tharun Raju

Has earned 3 (three) credits in the International Credit Transfer Program
in Bachelor of Informatics Management at Sekolah Tinggi Informatika & Komputer Indonesia
(STIKI) Malang during the period of odd semester, a.y. 2022/2023

Rector of STIKI Malang,



A handwritten signature in black ink, appearing to read 'Eva Handriyantini', is written over the seal.

Dr. Eva Handriyantini, S.Kom., M.MT.



اونيورسيتي ملايسيا فاهڠ
UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

PRASEMA FEMI GRACE PRABUDHAS WILSAL
(STUDENT ID: CA22002)

from

**SATHYABAMA INSTITUTE OF SCIENCE
AND TECHNOLOGY, INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

26th SEPTEMBER 2022 – 21st FEBRUARY 2023

at

UNIVERSITI MALAYSIA PAHANG

ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director

Centre for International Relations

Universiti Malaysia Pahang





اونيورسيتي مليسيا قهڻ
UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

SHANMUKA SREE PATCHIGOLLA
(STUDENT ID: CA22003)

from

**SATHYABAMA INSTITUTE OF SCIENCE
AND TECHNOLOGY, INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

26th SEPTEMBER 2022 – 21st FEBRUARY 2023

at

UNIVERSITI MALAYSIA PAHANG

ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director

Centre for International Relations
Universiti Malaysia Pahang





اونيورسيتي مليسيا قهڻ
UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

LAWRENCE GILBERT
(STUDENT ID: MA22006)

from

**SATHYABAMA INSTITUTE OF SCIENCE
AND TECHNOLOGY, INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

26th SEPTEMBER 2022 – 21st FEBRUARY 2023

at

UNIVERSITI MALAYSIA PAHANG

ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director

Centre for International Relations
Universiti Malaysia Pahang



Pusat Antarabangsa PUTRA

PUTRA International Centre

Our reference : UPM.INTL.600-4/17/2

Date : 14 October 2022

Mr. Sanjay Preeth Ramsingh

Sathyabama Institute of Science & Technology, India

E-mail address: sanjaypreeth@gmail.com

Dear Mr. Sanjay Preeth Ramsingh,

Research Attachment Application at Universiti Putra Malaysia

We are pleased to inform you that your application for the Research Attachment Programme at UPM has been approved. The details of the programme are as follows:

Faculty/ Institute : Faculty of Medicine and Health Sciences
Department : Biomedical Sciences
Programme : Bachelor
Academic Advisor : Assoc. Prof. Dr. Rachel Mok Pooi Ling
Matric No. : ES03951
Study Period : 1 November 2022 – 15 April 2023
Study Fees : You are required to pay the fees listed below.

No	Compulsory Fees	Amount (MYR)	Remarks
I.	Tuition fee*	-	Payment can be made at UPM Bursar's Office or deposited to the following CIMB account at the CIMB Counter/ via online payment during the registration.
II.	Bench fee	-	
III.	Mobility fee	532.50	
IV.	UPM Student Pass Processing Fee	270.00	Bank Name : CIMB BANK BERHAD Account Name: UPM COLLECTION Bank Account No: 8002155042 Bank Branch : UPM, SERDANG Swift Code: CIBBMYKL
V.	Health Screening	250.00	Payment to be made at University Health Centre.
Optional Fees			
VI.	UPM Shuttle Bus (per/month)	15.00	Payment can be made to: Bank Account No: 8002155042 Account Name: UPM COLLECTION
VII.	Health Services <i>Subscribing to the health services will enable student to get medical treatment and have access to various services provided by University Health Centre for the whole semester.</i>	200.00	Payment to be made at University Health Centre.

Disclaimer: Programme fees may differ from what is displayed based on each student's specific course level and needs of study facilities provided by the university and the faculty

2. Be informed that you are required to apply for the Student Visa Approval Letter (VAL) as well as the Single Entry Visa (SEV) before coming to Malaysia and to follow Malaysian Government SOP on COVID-19. The application procedure for the student mobility visa can be found at the Education Malaysia Global Services (EMGS) website at <https://educationmalaysia.gov.my>. If there are any changes, on the international entry to Malaysia entry, the teaching medium for the mobility program will be conducted virtually, however, this will depend on the faculty decision on converting the program to virtual mode.

3. All information and terms above are subject to change due to the evolving circumstances of Covid-19. Students are advised to check with the relevant authorities' websites for updated information. Please note that there is no possibility for extension of the student mobility period beyond the number of months stated in this offer letter. Please confirm your participatory intent for this program by 30th October 2022 via email if you wish to join or withdraw from the program.

4. For matters relating to your mobility programme at UPM, kindly contact our Inbound Officers at Ms. Rahayu, at +603 9769 3598 (tel), or email to rahayu.ridzuan@upm.edu.my / mobility@upm.edu.my for any further updates/details. Be informed too that UPM will not be held responsible for any reliance and decision-making based on the information provided herein.

We look forward to welcoming you to Universiti Putra Malaysia, either physically or virtually. We hope that your experience at UPM will be one of the most exciting periods of your life.

Thank you.

WITH KNOWLEDGE WE SERVE

Yours sincerely,



NORAIHAN NOORDIN

Chief Assistant Registrar

Putra International Centre

- c.c. 1. Director, PUTRA International Centre
2. Deputy Director, PUTRA International Centre
3. Dean, Faculty of Medicine and Health Sciences

Pusat Antarabangsa PUTRA
PUTRA International Centre

Our reference : UPM.INTL.600-4/17/2
Date : 14 October 2022

Mr. Noel Richard Prakash

Sathyabama Institute of Science & Technology, India
E-mail address: noelrichardp@gmail.com

Dear Mr. Noel Richard Prakash,

Research Attachment Application at Universiti Putra Malaysia

We are pleased to inform you that your application for the Research Attachment Programme at UPM has been approved. The details of the programme are as follows:

Faculty/ Institute : Faculty of Medicine and Health Sciences
Department : Biomedical Sciences
Programme : Bachelor
Academic Advisor : Assoc. Prof. Dr. Rachel Mok Pooi Ling
Matric No. : ES03950
Study Period : 1 November 2022 – 15 April 2023
Study Fees : You are required to pay the fees listed below.

No	Compulsory Fees	Amount (MYR)	Remarks
I.	Tuition fee*	-	Payment can be made at UPM Bursar's Office or deposited to the following CIMB account at the CIMB Counter/ via online payment during the registration.
I.	Bench fee	-	
II.	Mobility fee	532.50	
III.	UPM Student Pass Processing Fee	270.00	Bank Name : CIMB BANK BERHAD Account Name: UPM COLLECTION Bank Account No: 8002155042 Bank Branch : UPM, SERDANG Swift Code: CIBBMYKL
IV.	Health Screening	250.00	Payment to be made at University Health Centre.
	Optional Fees		
V.	UPM Shuttle Bus (per/month)	15.00	Payment can be made to: Bank Account No: 8002155042 Account Name: UPM COLLECTION
VI.	Health Services <i>Subscribing to the health services will enable student to get medical treatment and have access to various services provided by University Health Centre for the whole semester.</i>	200.00	Payment to be made at University Health Centre.

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Thank you.

WITH KNOWLEDGE WE SERVE

Yours sincerely,



NORAIHAN NOORDIN

Chief Assistant Registrar

Putra International Centre

- c.c. 1. Director, PUTRA International Centre
2. Deputy Director, PUTRA International Centre
3. Dean, Faculty of Medicine and Health Sciences



SEKOLAH TINGGI INFORMATIKA & KOMPUTER INDONESIA

STIKI MALANG

Jl. Raya Tidar 100, Malang 65146, Telp. (0341) 560823, Fax. (0341) 562525

Website: www.stiki.ac.id Email: stiki@stiki.ac.id

Ref. No.: 180/KGKP.14/STIKI/II/2023

Date: February 28th, 2023

Dr. Mariazeena Johnson

University President

Sathyabama Institute Of Science And Technology

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600119.

India

Letter of Acceptance: International Transfer Credit Program

Within the framework of Memorandum of Understanding for Academic Cooperation entered between Sekolah Tinggi Informatika & Komputer Indonesia (STIKI), Indonesia and Sathyabama Institute Of Science And Technology, India, we are pleased to inform that the following student of your institution is accepted by our institution to have the credit transfer which are arranged by our institution.

Name of Student:	L. Priyadharshini
Education Level:	Bachelor
Study Area:	Visual Communication
Student's Institution:	Sathyabama Institute Of Science And Technology
From Country:	India
Academic Year:	2022-2023
Semester:	2
Venue:	Sekolah Tinggi Informatika & Komputer Indonesia
Appointment:	Regular Student

For further coordination and inquiries regarding the International Credit Transfer arrangement, the coordinating teachers and students can contact Mr. Arif Tirtana, S.Kom., M.Kom, Head Office of International Affairs by email to kui@stiki.ac.id or mobile number +62822 1888 8259.

We look forward to welcoming your students and developing a fruitful partnership with your institution in the future.



Dr. Eva Handriyantini, S.Kom M.MT.

Rector



SEKOLAH TINGGI INFORMATIKA & KOMPUTER INDONESIA

STIKI MALANG

Jl. Raya Tidar 100, Malang 65146, Telp. (0341) 560823, Fax. (0341) 562525
Website: www.stiki.ac.id Email: stiki@stiki.ac.id

Ref. No.: 180/KGKP.14/STIKI/II/2023

Date: February 28th, 2023

Dr. Mariazeena Johnson

University President

Sathyabama Institute Of Science And Technology

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600119.

India

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Name of Student:	R. Deva Amirtha Priya
Education Level:	Bachelor
Study Area:	Visual Communication
Student's Institution:	Sathyabama Institute Of Science And Technology
From Country:	India
Academic Year:	2022-2023
Semester:	2
Venue:	Sekolah Tinggi Informatika & Komputer Indonesia
Appointment:	Regular Student

For further coordination and inquiries regarding the International Credit Transfer arrangement, the coordinating teachers and students can contact Mr. Arif Tirtana, S.Kom., M.Kom, Head Office of International Affairs by email to kui@stiki.ac.id or mobile number +62822 1888 8259.

We look forward to welcoming your students and developing a fruitful partnership with your institution in the future.

Sincerely,



Dr. Eva Handriyantini, S.Kom M.MT.

Rector



SEKOLAH TINGGI INFORMATIKA & KOMPUTER INDONESIA

STIKI MALANG

Jl. Raya Tidar 100, Malang 65146, Telp. (0341) 560823, Fax. (0341) 562525

Website: www.stiki.ac.id Email: stiki@stiki.ac.id

Ref. No.: 180/KGKP.14/STIKI/II/2023

Date: February 28th, 2023

Dr. Mariazeena Johnson

University President

Sathyabama Institute Of Science And Technology

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600119.

India

Letter of Acceptance: International Transfer Credit Program

Within the framework of Memorandum of Understanding for Academic Cooperation entered between Sekolah Tinggi Informatika & Komputer Indonesia (STIKI), Indonesia and Sathyabama Institute Of Science And Technology, India, we are pleased to inform that the following student of your institution is accepted by our institution to have the credit transfer which are arranged by our institution.

Name of Student:	Teffina Daniel
Education Level:	Bachelor
Study Area:	Visual Communication
Student's Institution:	Sathyabama Institute Of Science And Technology
From Country:	India
Academic Year:	2022-2023
Semester:	2
Venue:	Sekolah Tinggi Informatika & Komputer Indonesia
Appointment:	Regular Student

For further coordination and inquiries regarding the International Credit Transfer arrangement, the coordinating teachers and students can contact Mr. Arif Tirtana, S.Kom., M.Kom, Head Office of International Affairs by email to kui@stiki.ac.id or mobile number +62822 1888 8259.

We look forward to welcoming your students and developing a fruitful partnership with your institution in the future.



Dr. Eva Handriyantini, S.Kom M.MT.
Rector



SEKOLAH TINGGI INFORMATIKA & KOMPUTER INDONESIA

STIKI MALANG

Jl. Raya Tidar 100, Malang 65146, Telp. (0341) 560823, Fax. (0341) 562525

Website: www.stiki.ac.id Email: stiki@stiki.ac.id

Ref. No.: 180/KGKP.14/STIKI/II/2023

Date: February 28th, 2023

Dr. Mariazeena Johnson

University President

Sathyabama Institute Of Science And Technology

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600119.

India

Letter of Acceptance: International Transfer Credit Program

Within the framework of Memorandum of Understanding for Academic Cooperation entered between Sekolah Tinggi Informatika & Komputer Indonesia (STIKI), Indonesia and Sathyabama Institute Of Science And Technology, India, we are pleased to inform that the following student of your institution is accepted by our institution to have the credit transfer which are arranged by our institution.

Name of Student:	Swathi Nirmal Kumar
Education Level:	Bachelor
Study Area:	Visual Communication
Student's Institution:	Sathyabama Institute Of Science And Technology
From Country:	India
Academic Year:	2022-2023
Semester:	2
Venue:	Sekolah Tinggi Informatika & Komputer Indonesia
Appointment:	Regular Student

For further coordination and inquiries regarding the International Credit Transfer arrangement, the coordinating teachers and students can contact Mr. Arif Tirtana, S.Kom., M.Kom, Head Office of International Affairs by email to kui@stiki.ac.id or mobile number +62822 1888 8259.

We look forward to welcoming your students and developing a fruitful partnership with your institution in the future.

Sincerely,



Dr. Eva Handriyantini, S.Kom M.MT.

Rector



SEKOLAH TINGGI INFORMATIKA & KOMPUTER INDONESIA

STIKI MALANG

Jl. Raya Tidar 100, Malang 65146, Telp. (0341) 560823, Fax. (0341) 562525
Website: www.stiki.ac.id Email: stiki@stiki.ac.id

Ref. No.: 180/KGKP.14/STIKI/II/2023

Date: February 28th, 2023

Dr. Mariazeena Johnson

University President

Sathyabama Institute Of Science And Technology

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600119.

India

Letter of Acceptance: International Transfer Credit Program

Within the framework of Memorandum of Understanding for Academic Cooperation entered between Sekolah Tinggi Informatika & Komputer Indonesia (STIKI), Indonesia and Sathyabama Institute Of Science And Technology, India, we are pleased to inform that the following student of your institution is accepted by our institution to have the credit transfer which are arranged by our institution.

Name of Student:	Avvai Krithika Harini. VA
Education Level:	Bachelor
Study Area:	Visual Communication
Student's Institution:	Sathyabama Institute Of Science And Technology
From Country:	India
Academic Year:	2022-2023
Semester:	2
Venue:	Sekolah Tinggi Informatika & Komputer Indonesia
Appointment:	Regular Student

For further coordination and inquiries regarding the International Credit Transfer arrangement, the coordinating teachers and students can contact Mr. Arif Tirtana, S.Kom., M.Kom, Head Office of International Affairs by email to kui@stiki.ac.id or mobile number +62822 1888 8259.

We look forward to welcoming your students and developing a fruitful partnership with your institution in the future.

Sincerely,



Dr. Eva Handriyantini, S.Kom M.MT.
Rector



Serial No.: UMP.21-2023 (18)

اونيورسيتي مليسيا قهڠ
UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

PANEERSELVAM DHIVAKARAN
(STUDENT ID: KBB23006)

from

**SATHYABAMA INSTITUTE OF SCIENCE & TECHNOLOGY,
INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

27th FEBRUARY 2023 – 18th JULY 2023

at

UNIVERSITI MALAYSIA PAHANG

ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director

Centre for International Relations
Universiti Malaysia Pahang





Serial No.: UMP.21-2023 (17)

اونيورسيتي مليسيا قهڻ
UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

DHANALAKSHMI RAMESH PRABHU ARVINDHA SW
(STUDENT ID: KBB23001)

from

**SATHYABAMA INSTITUTE OF SCIENCE & TECHNOLOGY,
INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

27th FEBRUARY 2023 – 18th JULY 2023

at

UNIVERSITI MALAYSIA PAHANG


ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director
Centre for International Relations
Universiti Malaysia Pahang





Serial No.: UMP.21-2023 (16)

اونيورسيتي مليسيا قهڻ
UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

JANARTHAN ARTHY
(STUDENT ID: PC22155)

from

**SATHYABAMA INSTITUTE OF SCIENCE & TECHNOLOGY,
INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

27th FEBRUARY 2023 – 18th JULY 2023

at

UNIVERSITI MALAYSIA PAHANG

ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director

Centre for International Relations
Universiti Malaysia Pahang





Serial No.: UMP.21-2023 (19)

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UNIVERSITI MALAYSIA PAHANG

CERTIFICATE OF COMPLETION

This is to certify that

KORLEPARA ADITYA NAGA LAKSHMI VENKAT
(STUDENT ID: MA22159)

from

**SATHYABAMA INSTITUTE OF SCIENCE & TECHNOLOGY,
INDIA**

has successfully completed

STUDENT MOBILITY PROGRAM

on

27th FEBRUARY 2023 – 18th JULY 2023

at

UNIVERSITI MALAYSIA PAHANG

ASSOC. PROF. DR. MOHD AZMIR BIN MOHD AZHARI

Director

Centre for International Relations
Universiti Malaysia Pahang





Our Reference : 100-UiTM (DIA 1/1)
Date : 10th February 2023

SATHYA NARAYANAN RAMSAI

SATHBAYAMA INSTITUTE OF SCIENCE AND TECHNOLOGY

Jeppiaar Nagar, Rajiv Gandhi Salai
Chennai - 600 119. Tamilnadu
INDIA

Dear student,

LETTER OF OFFER

Congratulations! You have been accepted by Universiti Teknologi MARA (UiTM) to enroll in the following Mobility Programme:

Programme	: Bachelor in Architecture, Planning and Surveying (Mobility Programme)
Course level	: Degree
Faculty	: Architecture, Planning and Surveying
Academic session	: Semester 2 2022/2023
Duration	: March 2023 – August 2023 (1 Semester/ 6 months)
Student ID No.	: 2023552593
Campus	: Universiti Teknologi MARA (UiTM), Shah Alam Campus
Registration date	: 20 th March 2023

Payable Fees:

1. Service Charge

Amount	: MYR200.00
Payment method	: FPX Online Payment via iStudent Portal
Payment deadline	: 10 th April 2023

*Please send the proof of payment to nurhidayahelias@uitm.edu.my / wahida058@uitm.edu.my

2. Tuition Fee : Waived** (depends on whether partner University has any MoU/MoA with UiTM)

Kindly please contact the faculty for course registration purposes. For more information, please email us at isd.oia@uitm.edu.my.

We look forward to receiving you as our student soon. We wish you all the best with your studies at UiTM.

Yours sincerely,

DR. HAJAH ZAINAB HAJI MOHD NOOR, A.N.S.
Director
Department of International Affairs

Universiti Teknologi MARA
Kompleks Antarabangsa
40450 Shah Alam, Selangor, MALAYSIA
Tel: (+603) 5521 1441
Faks: (+603) 5544 2042





Our Reference : 100-UiTM (DIA 1/1)
Date : 10th February 2023

VELMURUGAN DHARUN RAJ

SATHBAYAMA INSTITUTE OF SCIENCE AND TECHNOLOGY

Jeppiaar Nagar, Rajiv Gandhi Salai
Chennai - 600 119. Tamilnadu
INDIA

Dear student,

LETTER OF OFFER

Congratulations! You have been accepted by Universiti Teknologi MARA (UiTM) to enroll in the following Mobility Programme:

Programme	: Bachelor in Architecture, Planning and Surveying (Mobility Programme)
Course level	: Degree
Faculty	: Architecture, Planning and Surveying
Academic session	: Semester 2 2022/2023
Duration	: March 2023 – August 2023 (1 Semester/ 6 months)
Student ID No.	: 2023396601
Campus	: Universiti Teknologi MARA (UiTM), Shah Alam Campus
Registration date	: 20 th March 2023

Payable Fees:

1. Service Charge

Amount	: MYR200.00
Payment method	: FPX Online Payment via iStudent Portal
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2. Tuition Fee : Waived** (depends on whether partner University has any MoU/MoA with UiTM)

Kindly please contact the faculty for course registration purposes. For more information, please email us at isd.oia@uitm.edu.my.

We look forward to receiving you as our student soon. We wish you all the best with your studies at UiTM.

Yours sincerely,

DR. HAJAH ZAINAB HAJI MOHD NOOR, A.N.S.
Director
Department of International Affairs

Universiti Teknologi MARA
Kompleks Antarabangsa
40450 Shah Alam, Selangor, MALAYSIA
Tel: (+603) 5521 1441
Faks: (+603) 5544 2042





WSZECHNICA POLSKA
AKADEMIA NAUK STOSOWANYCH W WARSZAWIE

CERTIFICATE OF PARTICIPATION
ERASMUS PLUS PROGRAMME

Warsaw, 7 July 2023

I, the undersigned, hereby certify that **Ms. Sandra Chandran** was a student of the Institute of Pedagogy and Philology, Wszechnica Polska Academy of Applied Sciences in Warsaw under the Erasmus Plus Programme from 27.02.2023 until 2.07.2023.

WSZECHNICA POLSKA
Akademia Nauk Stosowanych w Warszawie
Pałac Kultury i Nauki
00-901 Warszawa, Pl. Defilad 1

Head of International Cooperation Office

Erasmus Coordinator
Katarzyna Gajewska
Katarzyna Gajewska

Katarzyna Gajewska, Ph.D.
Erasmus Coordinator



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **DARSHAYANI A/P GANESAN**, III Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

Dr. T. Sasipraba
VICE CHANCELLOR



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **CHRISTOPHER ANTHONY NIXON RAMESH**, III Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

Dr. T. Sasipraba
VICE CHANCELLOR



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **FATHIMATH MAEE ASLAM**, II Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

Dr. T. Sasipraba
VICE CHANCELLOR



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **MAHEISHINII GRACE A/P M SEBASTIAN,**
II Year, Bachelors in Biomedical Science (Hons), MAHSA
University, Malaysia has successfully completed a Two Week
Internship Programme in the School of Bio and Chemical
Engineering, Sathyabama Institute of Science and Technology,
India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **MEILARSHNY A/P KALAI SELVAN**, II Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

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Dr. A. Chitra Devi
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Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **RUBAIYAT SIDDIQUE DIBA**, II Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **SULTANA SHIRIN**, II Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **FATHIMATH HISHMA HASSAN**, II Year, Bachelors in Biomedical Science (Hons), MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

Dr. T. Sasipraba
VICE CHANCELLOR



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Rajiv Gandhi Salai, Jeppiaar Nagar, Tamilnadu, India

CERTIFICATE OF PARTICIPATION

This is to certify that **YOGESWARY A/P MAIYALAGAN**, I Year, Diploma in Medical Laboratory Technology, MAHSA University, Malaysia has successfully completed a Two Week Internship Programme in the School of Bio and Chemical Engineering, Sathyabama Institute of Science and Technology, India, from 25th July to 07th August 2022.

Dr. V. Ramesh Kumar
HEAD

DEPARTMENT OF BIOTECHNOLOGY

Dr. A. Chitra Devi
HEAD

INTERNATIONAL RELATIONS

Dr. T. Sasipraba
VICE CHANCELLOR



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Ref: SU/CAPIR/2022/0009

25/05/2022

LETTER OF INVITATION

To whomsoever it may concern

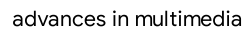
We hereby confirm that **Mr MD.AKTARUZZAMAN SIDDIQUEI**, born on **10/08/2000** at Jhenaidah, Bangladesh, student at Daffodil International University with **PASSPORT No. A01184843** has been invited for International Student Mobility, for one semester, within the framework of Memorandum of Understanding for Academic cooperation, entered between **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** and **Daffodil International University (DIU)**, in the Department of Computer Science and Engineering, starting from **15th June 2022 to 30th November 2022** for the **Academic Year 2022-2023**

The student will be provided accommodation on campus, located at SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, St. Antony's Hostel, Rajiv Gandhi Road, Jeppiaar Nagar Chennai - 600119, Tamilnadu, India.


Dr T Sasipraba

Vice Chancellor





Compose

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Kristen Russell <kristen.russell@kwglobal.com>
to me, nagarajangovidan@gmail.com, Laura

Hi, Dr. Nagarajan,

Thank you for suggesting and guest-editing this special issue for TALLIP.

Please select relevant the ACM Computing Classification Terms (attached ACMCSS Taxonomy file). We use the lists from the ACM Digital Library database.

Please include a short version of this CfP's background for the eblast? We need something straightforward to le goals.

In the eblast we will also link to the complete text for further information.

After we receive this information, we can add the call to our webpage and send a marketing notice to prospective Issue.

Please let me know if you have any questions.

All the best,
Kristen



ACM Transactions on Asian and Low-Resource Language Information Processing

*Special Issue on **Multimodal low resource language information processing in Visual Detection, Restoration and Fusion for Game Human Interaction***

Guest Editors:

- **Dr. G. Nagarajan**, Sathyabama Institute of Science and Technology, India, gnagarajan.cse@sathyabama.ac.in; nagarajangovidan@gmail.com
- **Dr. Mingli Song**, Zhejiang University, China, brooksong@ieee.org
- **Dr. Xavier Baró**, Universitat Oberta de Catalunya, Spain, xbaro@uoc.edu
- **Dr. Lin Ma**, Researcher, Meituan, China, forest.linma@gmail.com

Multimodal low resource language information processing (MLRLIP) has grown in prominence in recent years, notably in the field of computer vision. Deep multimodal low resource language information processing is becoming increasingly prevalent as multimodal data streams and deep learning algorithms evolve. It is required to model multimodal information so that it may be uniformly evaluated and processed. The unstructured data that we encounter in the real world often includes visuals and textual content, which are also known as modalities. Deep learning researchers are still drawn to the challenge of identifying significant patterns from large amounts of data. Multimodal interaction systems (MIS) integrate visible information (which include photos, text, and drawings) with voice, gestures, and different modalities to provide versatile and effective communication tactics, permitting individuals to pick out from loads of interplay modalities. With the help of multiple input modes integrated into mobile devices, they enable users to benefit from the natural approach used in human communication, overcoming barriers to adopting mobile devices for value-added services.

Game environments are applications that can be used in a collaborative and participatory way to increase user engagement. Gaming settings provide a lot of potential in terms of improving people's engagement and cooperation. Players engage with games in a number of ways, with the content, format, and modality of the game changing depending on the player's preferences. Multimodal learning makes use of information fusion techniques based on feature-level fusion or score-level fusion. Deep learning has been used in games for a wide range of purposes, including agent decision-making based on an abstraction of the game state or utilizing the pixels of the real screen as input. When the depth of a deep convolutional neural network is great enough, it may be used to estimate any continuous function to an arbitrarily high level of accuracy.

List of potential topics include but are not limited to the following:

- Multimodal low resource language information processing and techniques for real-world game-interactions development
- Multimodal low resource language information processing and algorithms in game-human interaction for accurate recognition and analysis in real-time multi-target applications
- Intelligent algorithms for pattern recognition and data processing in game-human interaction
- Algorithms to optimize multi-modal visual restoration, visual fusion, and visual control for game human interactions
- Multimodal low resource language learning analytics in the game system to analyze complex processes
- Applications and limitations of multimodal low resource language information processing in human-game interaction
- Multimodal deep learning-based models for enhancing interactions in gaming

- Advances in multimodal low resource language information processing in games for managing complex interactions
- Deep convolutional networks and low resource language information processing methods for efficient image filtering

Important Dates

- Submissions deadline: November 30, 2022
- First-round review decisions: January 25, 2023
- Deadline for revision submissions: March 25, 2023
- Notification of final decisions: May 01, 2023
- Tentative publication: Late 2023

Submission Information

Please refer <https://dl.acm.org/journal/tallip/author-guidelines> and select “Special Issue on Multimodal low resource language information processing in Visual Detection, Restoration and Fusion for Game Human Interaction” in the TALLIP submission site.

For questions and further information, please contact **Dr. G. Nagarajan**, nagarajangovidan@gmail.com.

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www.nbu.ac.in

Ref. No: NBU/BI/2022-23/

Date: March 30, 2023

The Finance Officer
University of North Bengal
Rajarammohunpur, Siliguri

Sub: Remuneration for Visiting Lecturer Dr. P. Asha

Dear Sir,

I have attached a statement showing the remuneration paid to the visiting lecturer, **Dr. P. Asha**, who handled the lecture to MSc Bioinformatics students of the Department of Bioinformatics. The event is duly approved by the Honourable Vice-Chancellor (Copy enclosed). The remuneration should be paid from the departmental budget head "Visiting Faculty/Expert." in the financial year of 2022-23.

Total Number of Lectures: 22. Remuneration Rs 750/- Per Lecture

Total amount payable: Rs. 16, 500/- (Sixteen Thousand and five hundred only)

Name: **Dr. P. Asha**
Account No.: 482915587
IFSC Code: IDIB000S201
Bank Name: Indian Bank
Branch Name: Sholingnallur -Sathyabama Extension Branch
PAN No: AJDPA1597L

Therefore, I request you to take the necessary action in this regard.

Thanking you,

Yours faithfully

Dr. John J. George
Associate Professor & Head
Mob: 9898609230 Email: george@nbu.ac.in

Enclosure: 1) Copy of the approval letter from the Honourable Vice-Chancellor.
2) Detailed list of the topics covered, along with the dates.



CERTIFICATE

No. 22969/IJAI/R1/2/2023

IAES International Journal of Artificial Intelligence

is hereby awarding this certificate to

V. R. Niveditha

in recognition of his/her contribution as **Reviewer** in this scientific journal



ISSN 2089-4872
<http://ijai.iaescore.com>

Yogyakarta: February 7, 2023


Tole Sutikno
Managing Director, Journals

Reviewer for CIEMA 2022:

Title: Productive Inference of Convolutional Neural Networks using Filter Pruning Framework

No: 55

https://login.easychair.org/conferences/review_requests?a=27662856

The screenshot shows a web browser window with multiple tabs open. The active tab is 'login.easychair.org/conferences/review_requests?a=27662856'. The page header includes the EasyChair logo and 'CIEMA 2022 (subreviewer)'. A navigation bar contains links for 'Review requests', 'CIEMA 2022', 'Conference', 'News', 'Alerts', and 'EasyChair'. The main heading is 'My Review Requests for CIEMA 2022'. Below it, a message states: 'The table below shows all your review requests. To work with a request, click on a submission number.' A table with 5 columns is displayed: '#', 'Title', 'PC member', 'Status', and 'Status Date'. The table contains one row with the following data: '# 55', 'Title: Productive Inference of Convolutional Neural Networks using Filter Pruning Framework', 'PC member: Dragan Pamucar', 'Status: review added to EasyChair', and 'Status Date: Dec 07'. The footer of the page shows 'Copyright © 2002 – 2022 EasyChair'. The browser's taskbar at the bottom shows various open applications and the system clock indicating 12:55 on 17-02-2022.

#	Title	PC member	Status	Status Date
55	Productive Inference of Convolutional Neural Networks using Filter Pruning Framework	Dragan Pamucar	review added to EasyChair	Dec 07

Reviewer for “Cyber Security and Applications”, Manuscript Number: CSA-D-22-00005R1, “An Advanced and Secure Framework for Conducting Online Examination Using Blockchain Method”, Md. Rahat Ibne Sattar; Md Thowhid Bin Hossain Efty; Taiyaba Shadaka Rafa; Tusar Das; Md Sharif Samad; Abhijit Pathak; Mayeen Khandaker; Md. Habib Ullah.

First Co... x How can... x Invitation... x Editorial... x CSA-D... x Inbox (6... x FDP_WC... x 2022_20... x certica... x New Ta... x +

editorialmanager.com/csa/default1.aspx

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Role: Reviewer Username: AshaP

Reviewer Recommendation and Comments for Manuscript Number CSA-D-22-00005R1

An Advanced and Secure Framework for Conducting Online Examination Using Blockchain Method

Revision Number 1
Asha P

Back Edit Review Print Submit Review to Editorial Office

Recommendation: Accept

Reviewer Comments to Author

Dear Author,
Good Work. I appreciate your sincerity in upgrading and incorporating the suggestions given.

Reviewer Confidential Comments to Editor:

Dear Sir,
The authors have incorporated the major revisions stated. Therefore, I Completely Recommend the Paper for Further processing and Publication.

Back Edit Review Print Submit Review to Editorial Office

Dr. P. Asha_15 Day....pdf Show all x

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Cyber Security and Applications

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Role: Reviewer Username: AshaP

Reviewer Recommendation and Comments for Manuscript Number CSA-D-22-00005R1

An Advanced and Secure Framework for Conducting Online Examination Using Blockchain Method

Revision Number 1
Asha P

Back Edit Review Print Submit Review to Editorial Office

Recommendation: Accept

Reviewer Comments to Author

Dear Author,
Good Work. I appreciate your sincerity in upgrading and incorporating the suggestions given.

Reviewer Confidential Comments to Editor:

Dear Sir,
The authors have incorporated the major revisions stated. Therefore, I Completely Recommend the Paper for Further processing and Publication.

Journal of Engineering Research and Reports

(Indexing: Ebsco, Proquest, Index Copernicus, Google Scholar)

2022

Certificate No: SDI/HQ/PR/Cert/88910/DRP

Certificate of Excellence in Reviewing

awarded to

Dr. P. Asha

Sathyabama Institute of Science and Technology, India

in recognition of an outstanding contribution to the quality of the journal.

Date: 22-Aug-2022

**Dr. M Basumondal
Chief Managing Editor**

Reg. Offices:

India: Guest House Road, Street no - 1/6, Hooghly, West Bengal, India, Tele: +91 8617752708, UK: Third Floor, 207 Regent Street, London, W1B 3HH, UK, Fax: +44 20-3031-1429

Journal: CMC-Computers, Materials & Continua

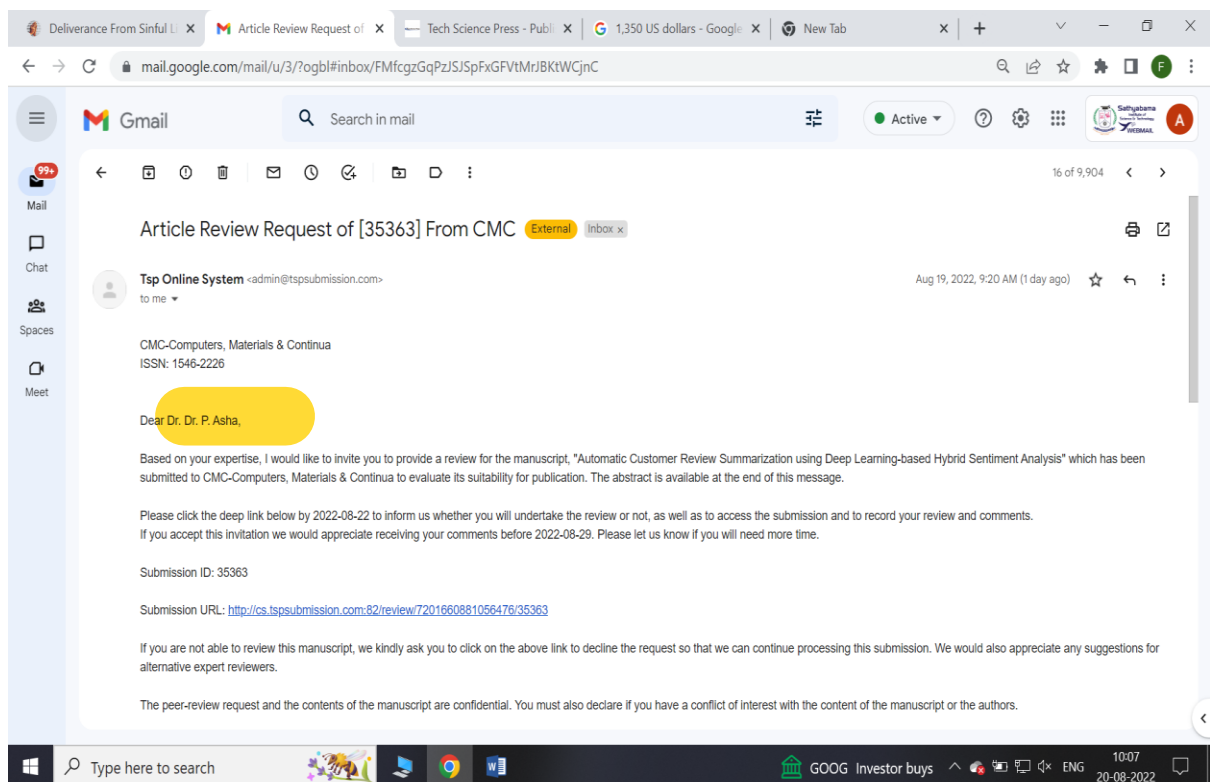
Indexed: WoS and Scopus

ISSN: 1546-2218 (print) Impact Factor: 3.860

ISSN: 1546-2226 (online)

Submission ID: 35363

Submission URL: <http://cs.tpsubmission.com:82/review/7201660881056476/35363>



Current Journal of Applied Science and Technology

(Indexing: Ebsco, Proquest, Index Copernicus, Google Scholar, NAAS - 4.71 (2022))

2022

Certificate No: SDI/HQ/PR/Cert/92167/DRP

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Dr. P. Asha

Sathyabama Institute of Science and Technology, India

in recognition of an outstanding contribution to the quality of the journal.

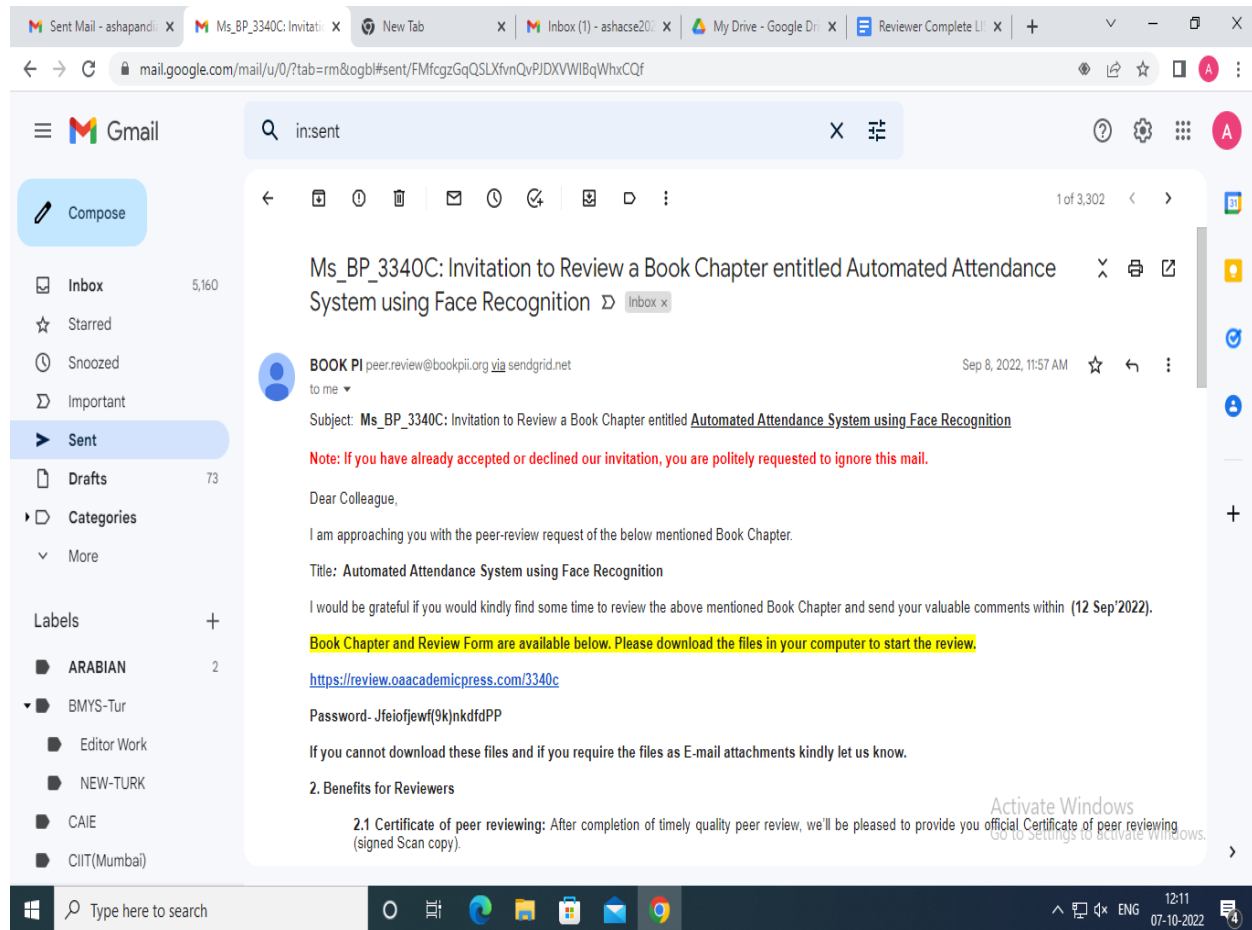
Date: 19-Sep-2022

Dr. M Basumondal
Chief Managing Editor

Reg. Offices:

India: Guest House Road, Street no - 1/6, Hooghly, West Bengal, India, Tele: +91 8617752708, UK: Third Floor, 207 Regent Street, London, W1B 3HH, UK, Fax: +44 20-3031-1429

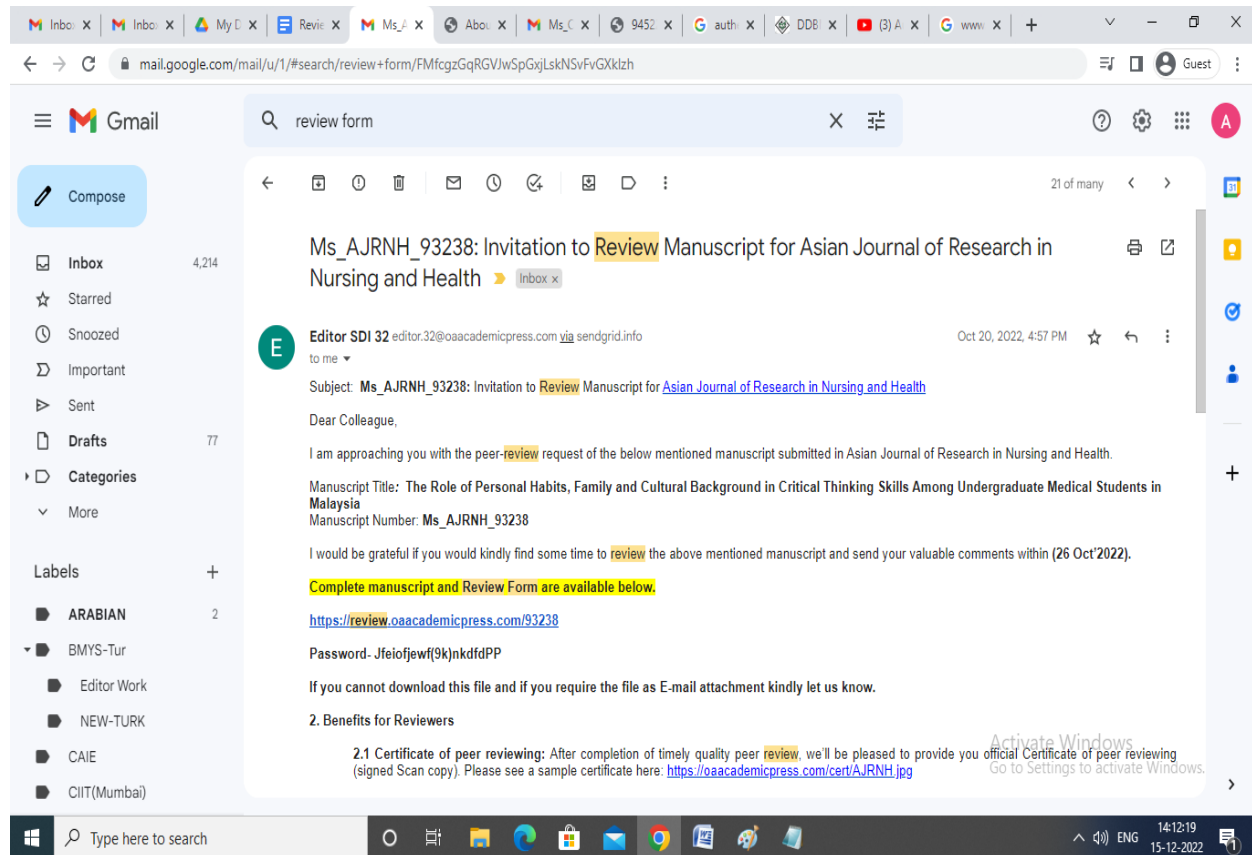
Reviewer: Ms_BP_3340C: Invitation to Review a Book Chapter entitled Automated Attendance System using Face Recognition, Sep 8, 2022.



Reviewer for Asian Journal of Research in Nursing and Health, 20 October 2022. (indexed by Publons, Mendeley)

Manuscript Title: **The Role of Personal Habits, Family and Cultural Background in Critical Thinking Skills Among Undergraduate Medical Students in Malaysia**

Manuscript Number: **Ms_AJRNH_93238**



Journal of Pharmaceutical Research International

(Indexing: Ebsco, Proquest, Index Copernicus, Google Scholar, NAAS - 5.51 (2020))

2022

Certificate No: SDI/HQ/PR/Cert/94522/DRP

Certificate of Excellence in Reviewing

awarded to

Dr. P. Asha

Sathyabama Institute of Science and Technology, India

in recognition of an outstanding contribution to the quality of the journal.

Date: 16-Dec-2022

Dr. M Basumondal
Chief Managing Editor

Reg. Offices:

India: Guest House Road, Street no - 1/6, Hooghly, West Bengal, India, Tele: +91 8617752708, UK: Third Floor, 207 Regent Street, London, W1B 3HH, UK, Fax: +44 20-3031-1429

Reviewer : [Diagnostics \(ISSN 2075-4418\) \(WoS & Scopus\)](#)

Manuscript ID: diagnostics-2000678

Type of manuscript: Article

Title: Applicability of American College of Radiology Appropriateness

Criteria Decision-making model for acute appendicitis diagnosis in children

Authors: Ozum Tuncyurek, Koray Kadam, Berna Uzun, Dilber Uzun Ozsahin *

Submitted to section: Machine Learning and Artificial Intelligence in
Diagnostics,

https://www.mdpi.com/journal/diagnostics/sections/artificial_Intelligence

Application of Artificial Intelligence to Advance Individualized Diagnosis
and Treatment in Emergency and Critical Care Medicine

https://www.mdpi.com/journal/diagnostics/special_issues/AI_Emergency

The screenshot shows a web browser window displaying the MDPI Review Report Form for manuscript diagnostics-2000678. The browser's address bar shows the URL: susy.mdpi.com/user/review/review/31826460/g7QTLn9. The page has a dark blue header with navigation links: Journals, Topics, Information, Author Services, Initiatives, About, Login, Register, and Submit. On the left, there is a sidebar with 'Information' links: Guidelines for Reviewers, Instructions for Authors, Editorial Process, and Journal Homepage, along with a Publons logo and a note about the median time (5 days) and last 6 months for Diagnostics. The main content area is titled 'Review Report Form' and contains the following details:

- Journal: [Diagnostics \(ISSN 2075-4418\)](#)
- Manuscript ID: diagnostics-2000678
- Type: Article
- Title: Applicability of American College of Radiology Appropriateness Criteria Decision-making model for acute appendicitis diagnosis in children
- Authors: Ozum Tuncyurek , Koray Kadam , Berna Uzun , Dilber Uzun Ozsahin *
- Section: [Machine Learning and Artificial Intelligence in Diagnostics](#)
- Special Issue: [Application of Artificial Intelligence to Advance Individualized Diagnosis and Treatment in Emergency and Critical Care Medicine](#)
- Abstract: Acute appendicitis is one of the most common causes of abdominal pain in the emergency department and also the most common surgical emergency reason for children younger than 15 years of age, which could be enormously dangerous when ruptured. The choice of radiological approach is very important for the diagnosis. In this way, unnecessary surgery is avoided. The aim of this study was to examine the validity of the American College of Radiology appropriateness criteria for radiological imaging in diagnosing acute appendicitis with multivariate decision criteria. In our study, paediatric patients who presented to the emergency department with abdominal pain were grouped according to the AIR score and the choice of radiological examinations was evaluated with fuzzy based Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) and with the fuzzy based Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) model for the validation of the results. While non-contrast CT was recommended as the first choice in patients with low and high AIR scores, the US examination was ranked third in patients with high scores. While computed tomography is at the forefront with many criteria used in the study, it is still a remarkable practice that US examination is in the first place in daily routine.

The bottom of the screenshot shows a Windows taskbar with several open files: 'diagnostics-20006...pdf', 'P.Asha_Arnab (2).docx', and 'P.Asha_Arnab (1).d...pdf'. The system clock indicates 09:47:27 on 20-10-2022.

Have Faith in you x [Diagnostics] Ma x MDPI | Peer Revie x Inbox (3) - asha x My Drive - Goog x Reviewer Compli x Diagnostics | Ind x +

mail.google.com/mail/u/0/#inbox/FMfcgzGqRGTCBJTWTtHCFhFTgtfsFDz Guest

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Labels

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Editor Work

NEW-TURK

[Diagnostics] Manuscript ID: diagnostics-2000678 - Review Request Accepted

Inbox x

🖨

🔗

diagnostics@mdpi.com

to me, Freida

Dear Dr. Asha,

9:40 AM (7 minutes ago)

☆

↶

⋮

Thank you very much for agreeing to review this manuscript:

Manuscript ID: diagnostics-2000678

Type of manuscript: Article

Title: Applicability of American College of Radiology Appropriateness Criteria Decision-making model for acute appendicitis diagnosis in children

Authors: Ozum Tuncyurek, Koray Kadam, Bema Uzun, Dilber Uzun Ozsahin *

Submitted to section: Machine Learning and Artificial Intelligence in Diagnostics,

https://www.mdpi.com/journal/diagnostics/sections/artificial_intelligence

Application of Artificial Intelligence to Advance Individualized Diagnosis and Treatment in Emergency and Critical Care Medicine

https://www.mdpi.com/journal/diagnostics/special_issues/AI_Emergency

The review report form can be found here:

<https://susv.mdpi.com/user/review/review/31826460/q7QTLin9>

1 of 8,641

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⏩

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diagnostics-20006....pdf

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P.Asha_Arnab (1).d....pdf

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09:48:02

20-10-2022

ENG

🔊

Reviewer: Journal: Security and Communication Networks

ID 2419749: A novel approach to Android permission filtering that preserves malicious behavior patterns

Zhibo Zhang, Can Gui, Jiyun Yang, Tao Xiang

The screenshot shows a web browser window with multiple tabs open. The active tab is 'Hindawi', displaying the article details for 'A novel approach to Android permission filtering that preserves malicious behavior patterns'. The article is by Zhibo Zhang¹, Can Gui^{SA CA}¹, Jiyun Yang¹, and Tao Xiang¹, with a link to 'Show Affiliations'. The article type is 'Research Article' and the journal is 'Security and Communication Networks'. The article ID is 2419749. The page shows the Associate Editor David Megias, Academic Editor Deborah Jegatha, and the submission date of 2022-09-25 (6 days ago). The abstract, author declaration, and files section are visible. The files section shows a 'Main manuscript' file named 'paper.pdf' (418 kB). The browser's address bar shows the URL 'review.hindawi.com/details/ec0dfe6e-1222-499c-aa98-5d57116c0160/d86ba3c6-da55-4798-a244-438725d26713'. The Windows taskbar at the bottom shows the search bar and several open applications, including a PDF viewer with 'paper.pdf' and 'Dr Asha.pdf', and a document titled 'Reviewer Comple...docx'.

Mothe X Search X Confir X Hinda X paper X Inbox X My Dr X Review X Young X Comp X New T X +

review.hindawi.com/details/ec0dfe6e-1222-499c-aa98-5d57116c0160/d86ba3c6-da55-4798-a244-438725d26713

Hindawi asha

← BACK DASHBOARD / ARTICLE DETAILS Updated on 2022-09-25 Version 1

A novel approach to Android permission filtering that preserves malicious behavior patterns COMPLETE REVIEW

Zhibo Zhang¹, Can Gui^{SA CA}¹, Jiyun Yang¹, Tao Xiang¹ + Show Affiliations ID 2419749

Article Type
Research Article

Journal
Security and Communication Networks

Associate Editor David Megias Academic Editor Deborah Jegatha Submitted on 2022-09-25 (6 days ago)

> Abstract

> Author Declaration

▼ Files 1

Main manuscript

paper.pdf 418 kB

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paper.pdf Dr Asha.pdf DC Member s Det...pdf Reviewer Comple...docx Staff admission de...doc Show all X

Type here to search 12:43 01-10-2022

paper.pdf

418 kB



Your Report

1 submitted

Recommendation

Minor Revision

asha p - Reviewer 2 | 01.10.2022

Report

1. Language improvisation is required.
2. Figures are of very poor clarity.
3. Refer Page 5, Check E. Recursive Feature Elimination based on Logistic Recursion(Logistic Regression or Recursion?)
4. SVM, Random Forest, Decision Tree also provides good accuracy, then why only Logistic Regression is employed in your proposed work?
5. State the purpose of Cross Validation.
6. The proposed approach shows very negligible performance enhancement when compared to existing Apriori Algorithm(Fig. 5 and 6). Justify.
7. Please mention your proposed methodology name instead of mentioning as OURS/OURS method.

paper.pdf

Dr Asha.pdf

DC Member s Det....pdf

Reviewer Comple....docx

Staff admission de....doc

Show all X

Reviewer - Intelligent Systems with Applications (Scopus) - Elsevier

Manuscript Number: ISWA-D-22-00576

Temporal Contrast Sets Mining

Mariam Orabi; Zaher Al Aghbari

The screenshot shows a Gmail interface on a Windows desktop. The browser tabs at the top include 'Inbox (4,863) - asha.co', 'Review for Intelligent', 'authentication in dist', 'DDBMS - Security in', '(3) Authentication in', and 'www.google.com'. The address bar shows 'mail.google.com/mail/u/1/#inbox/FMfcgzGrbRdRcBgLXJbhZJCdqSjvtqKr'. The Gmail sidebar on the left shows the 'Compose' button and a list of folders: 'Inbox' (4,216), 'Starred', 'Snoozed', 'Important', 'Sent', 'Drafts' (77), 'Categories', and 'More'. Under 'Labels', there are 'ARABIAN' (2), 'BMYS-Tur', 'Editor Work', 'NEW-TURK', 'CAIE', and 'CIIT(Mumbai)'. The main email view shows an email from 'Wooju Kim <em@editorialmanager.com>' received on 'Mon, Dec 12, 11:24 AM (3 days ago)'. The subject line is 'Review for Intelligent Systems with Applications - due soon'. The email body contains the following text: 'This is an automated message.*', 'Manuscript Number: ISWA-D-22-00576', 'Temporal Contrast Sets Mining', 'Mariam Orabi; Zaher Al Aghbari', 'Dear Asha,', 'You kindly agreed to review the above referenced manuscript on Dec 03, 2022. This message is to remind you that your review is due by Dec 14, 2022.', 'To view the manuscript, please click here: <https://www.editorialmanager.com/iswa/asp?i=724030&I=SPIPEC5W>.', 'When you are ready to submit your review, you may access the submission record here <https://www.editorialmanager.com/iswa/asp?i=724037&I=PQ6PMHFF>. Please click on the "Submit Recommendation" link to enter your comments.', 'If, for any reason, the above link does not work, please log in as a reviewer at <https://www.editorialmanager.com/ISWA/>.', 'Since timely reviews are of utmost importance to authors, we look forward to receiving your review soon. If your review will be delayed for any reason, please let us know.', and 'Thank you in advance for your contribution and time.' The Windows taskbar at the bottom shows the search bar, task view, and several application icons. The system clock indicates '13:42:09' on '15-12-2022'.

Thank you for agreeing to review Inbox x

Wooju Kim <em@editorialmanager.com>

Sat, Dec 3, 7:12 PM (12 days ago)

to me

Dec 14 Wed	Review Due When Wed Dec 14, 2022 (IST) Who Intelligent Systems with Applications* Add to calendar »	Agenda Wed Dec 14, 2022 No earlier events All day Review Due No later events
--	---	---

Ms. Ref. No.: ISWA-D-22-00576
Title: Temporal Contrast Sets Mining
Intelligent Systems with Applications

Dear P. Asha,

Thank you for agreeing to review manuscript number ISWA-D-22-00576 for Intelligent Systems with Applications.

If possible, I would appreciate receiving your review by Dec 14, 2022.

Activate Windows

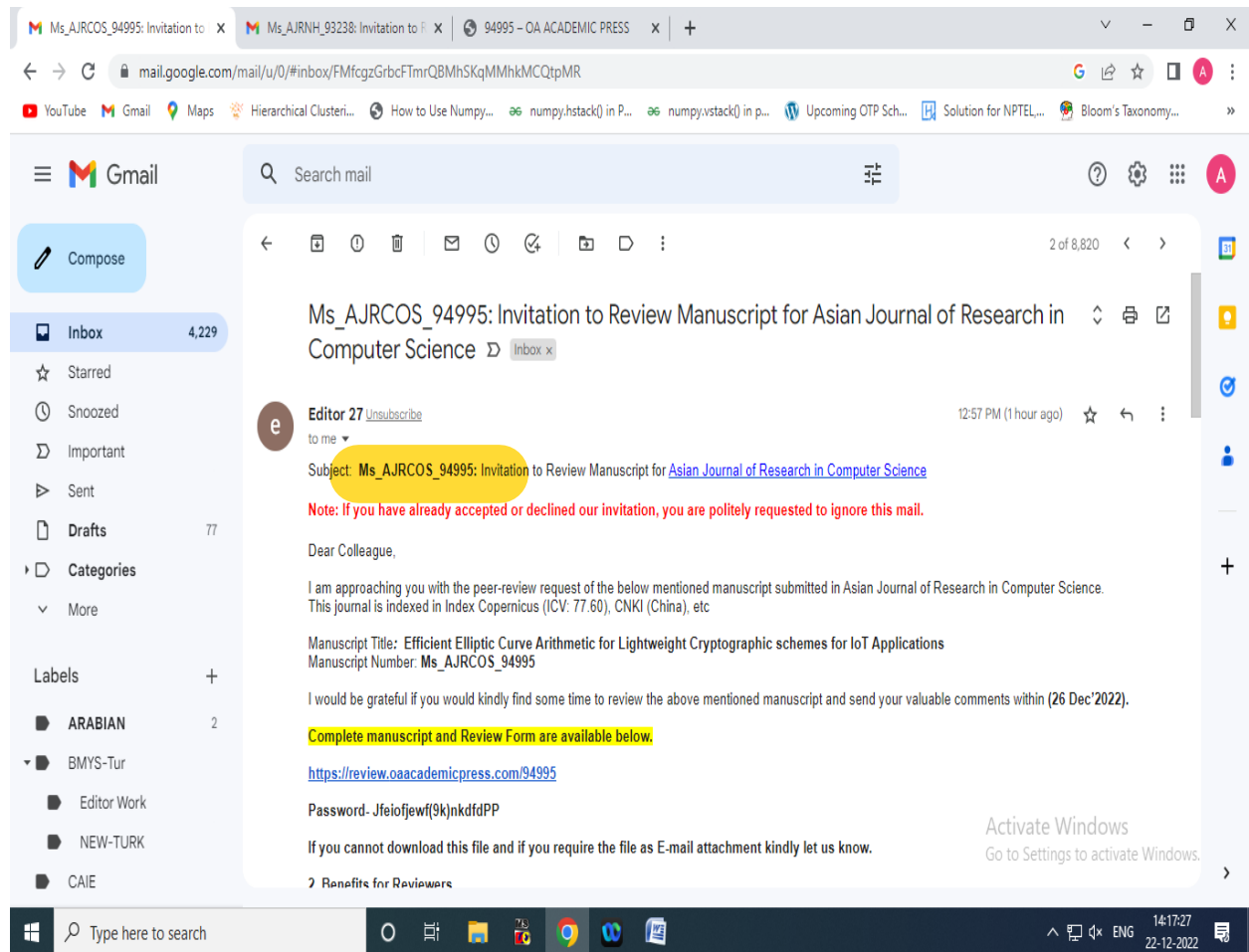
The screenshot shows a Gmail interface with a sidebar on the left containing folders like 'Compose', 'Inbox' (4,216), 'Starred', 'Snoozed', 'Important', 'Sent', 'Drafts' (77), 'Categories', 'More', 'Labels', 'ARABIAN' (2), 'BMYS-Tur', 'Editor Work', 'NEW-TURK', 'CAIE', and 'CIIT(Mumbai)'. The main content area displays an email from 'Ravi ChandraMouli <r.chandramouli@elsevier.com>' dated 'Fri, Dec 2, 2:19 PM (13 days ago)'. The email subject is 'Outstanding review invitation for ISWA-D-22-00576' with a tag 'Inbox x'. The email body contains the Elsevier logo and text: 'Dear Asha, We recently invited you to review the manuscript on 30.11.2022, and are awaiting your response. To accept this review invitation, please login in to Editorial Manager (EM) (<https://www.editorialmanager.com/ISWA/default.asp>) and Accept the invitation there. If you are unable to review at this moment, or have a conflict of interest, please login to EM and decline the invitation there. We appreciate your suggestion for potential reviewers for this manuscript. Note: If you have taken action on this paper within the last 24 hours, please disregard this email.'

Reviewer - Asian Journal of Research in Computer Science_ ISSN:
2581-8260_22 Dec 2022

- Indexed by Publons, SSRN, Mendeley

Manuscript Title: **Efficient Elliptic Curve Arithmetic for Lightweight Cryptographic schemes for IoT Applications**

Manuscript Number: **Ms_AJRCOS_94995**

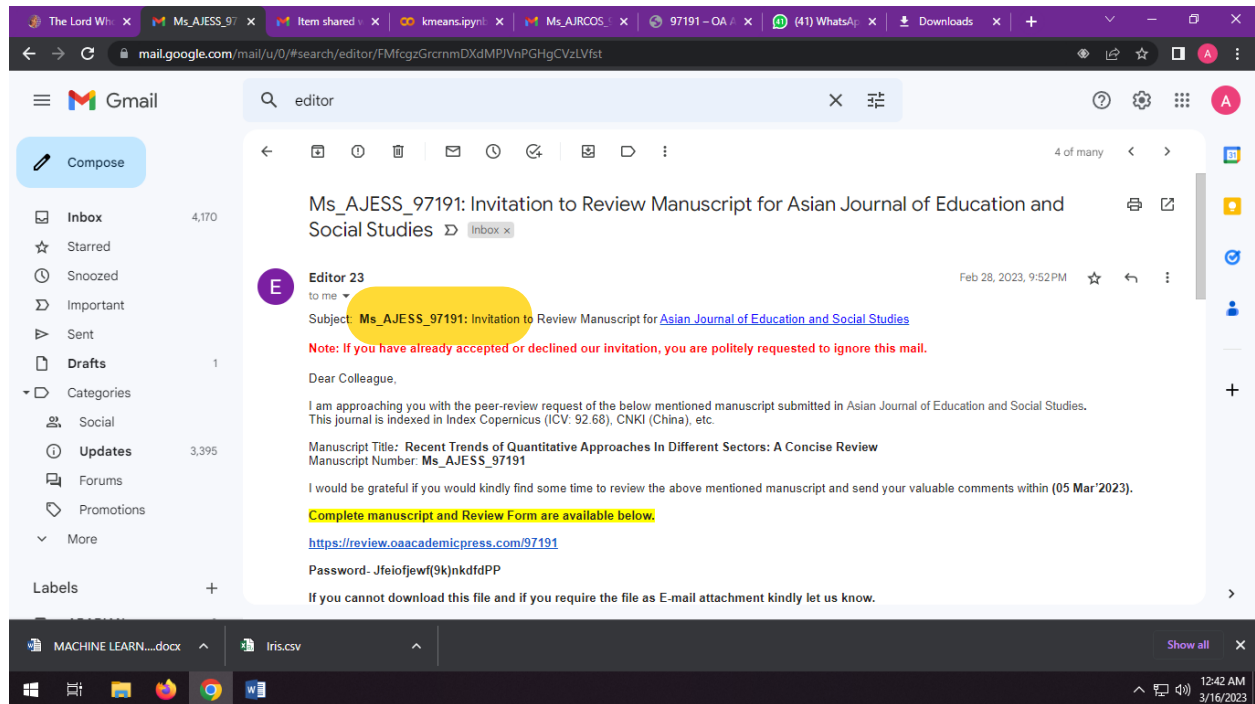


Reviewer 15 March 2023 : Ms AJESS 97191: Asian Journal of Education and Social Studies

Manuscript Title: **Recent Trends of Quantitative Approaches In Different Sectors: A Concise Review**

Manuscript Number: **Ms_AJESS_97191**

Indexed: Publons, SSRN, Google Scholar, Mendeley.

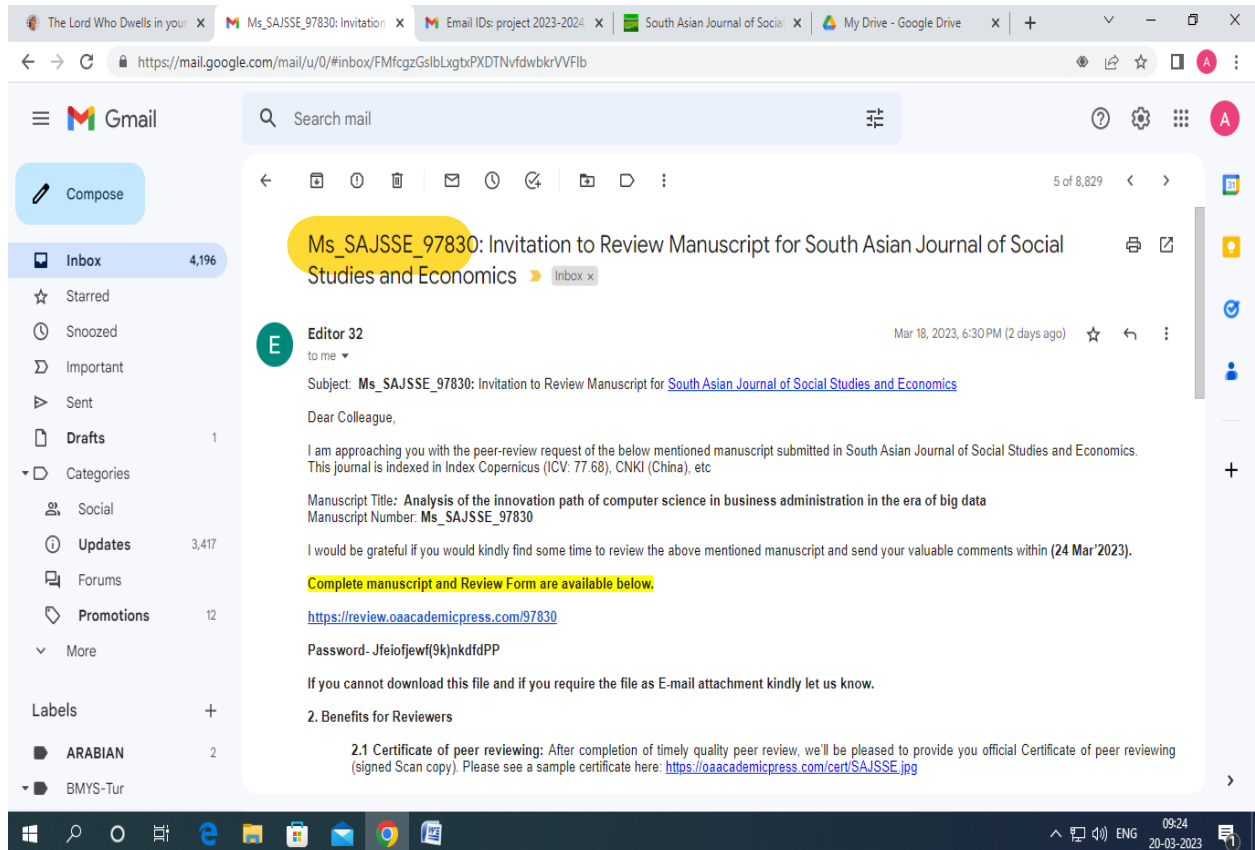


Reviewer 20 March 2023 : Ms_SAJ SSE 97830: South Asian Journal of Social Studies and Economics, ISSN: 2581-821X

Manuscript Title: **Analysis of the innovation path of computer science in business administration in the era of big data**

Manuscript Number: **Ms_SAJ SSE_97830**

Indexed: Publons, SSRN, Google Scholar, Mendeley.



Ms_SAJ SSE_97830: Invitation to Review Manuscript for South Asian Journal of Social Studies and Economics

Editor 32 to me Mar 18, 2023, 6:30 PM (2 days ago)

Subject: **Ms_SAJ SSE_97830: Invitation to Review Manuscript for South Asian Journal of Social Studies and Economics**

Dear Colleague,

I am approaching you with the peer-review request of the below mentioned manuscript submitted in South Asian Journal of Social Studies and Economics. This journal is indexed in Index Copernicus (ICV: 77.68), CNKI (China), etc

Manuscript Title: **Analysis of the innovation path of computer science in business administration in the era of big data**
Manuscript Number: **Ms_SAJ SSE_97830**

I would be grateful if you would kindly find some time to review the above mentioned manuscript and send your valuable comments within (24 Mar'2023).

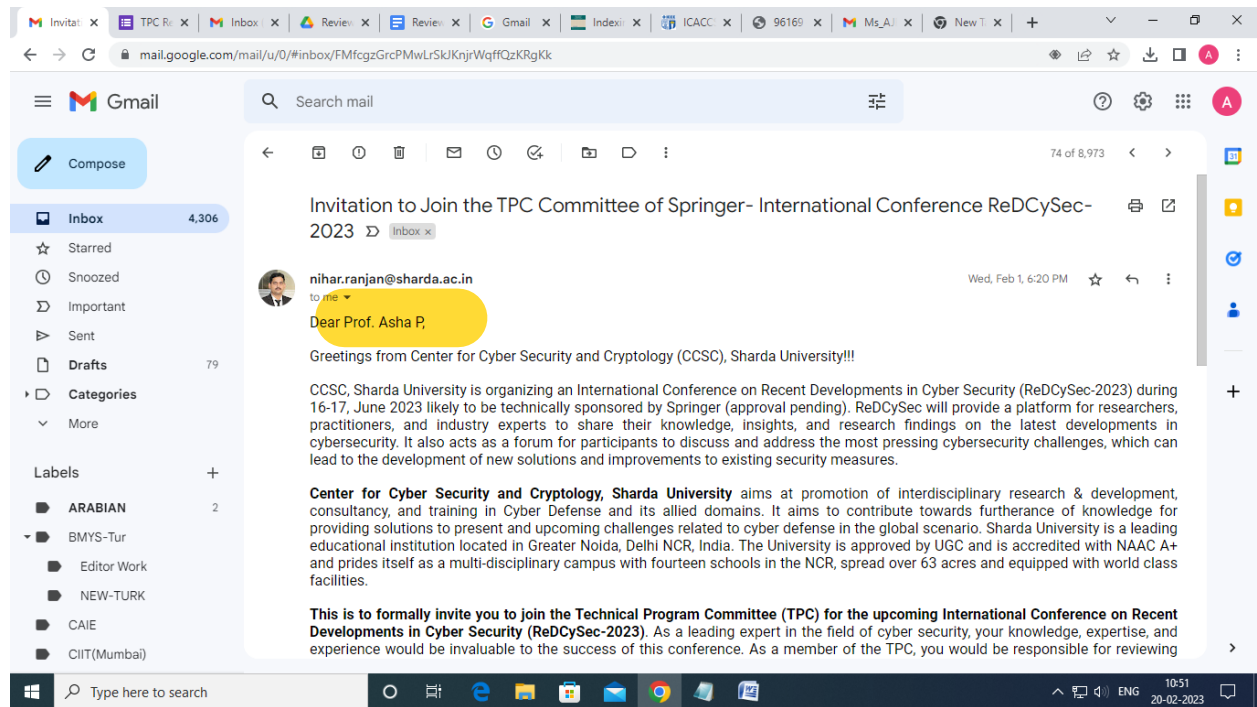
Complete manuscript and Review Form are available below.

<https://review.oacademicpress.com/97830>

Password- Jfeiofewf(9k)nkdfPP

1 Feb 2023_TPC Committee of Springer- International Conference ReDCySec-2023

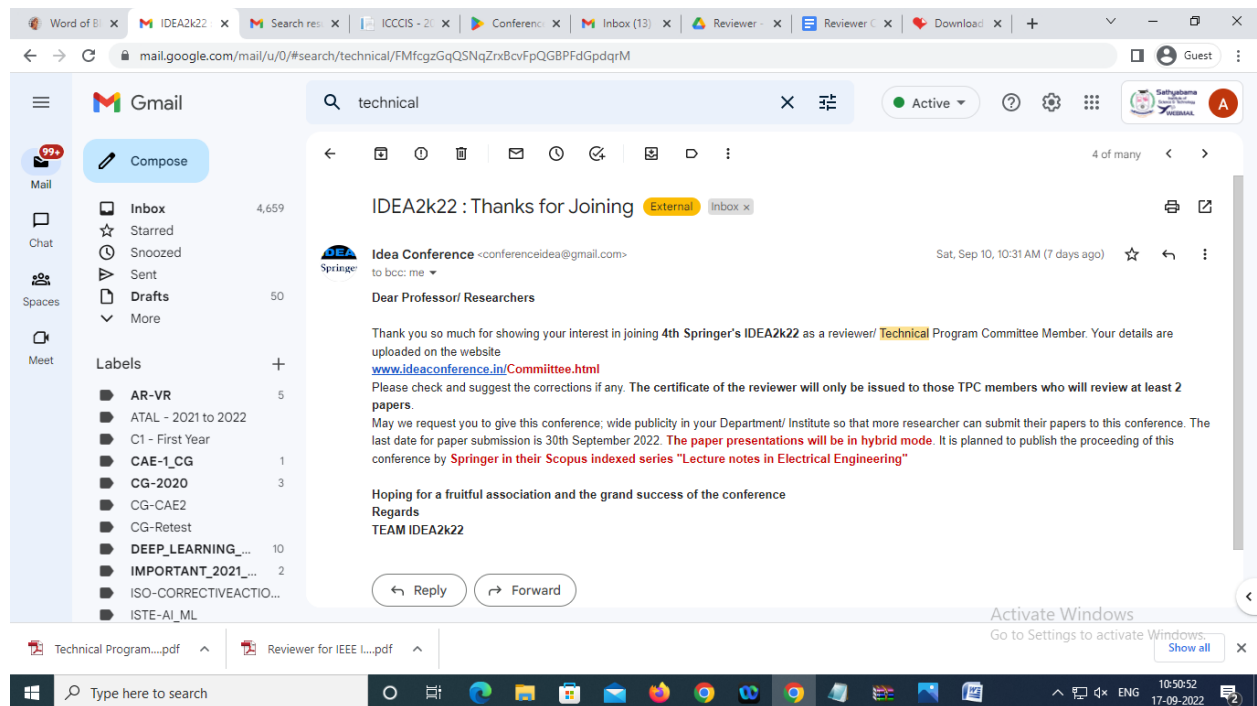
Greetings from Center for Cyber Security and Cryptology (CCSC), Sharda University!!!



Technical Program Committee – IDEA – 2k22, Sep 10, 2022

4th International Conference on Data, Engineering and Applications 2022 (IDEA-2k22) is being organized during Dec 23-24, 2022 in Bhopal.

<http://www.ideaconference.in/Commiittee.html>



IDEA2k22 : Thanks for Joining



Idea Conference <conferenceidea@gmail.com>
to bcc: me

Sat, Sep 10, 10:31 AM (7 days ago)

Dear Professor/ Researchers

Thank you so much for showing your interest in joining 4th Springer's IDEA2k22 as a reviewer/ **Technical** Program Committee Member. Your details are uploaded on the website

www.ideaconference.in/Commiittee.html

Please check and suggest the corrections if any. The certificate of the reviewer will only be issued to those TPC members who will review at least 2 papers.

May we request you to give this conference; wide publicity in your Department/ Institute so that more researcher can submit their papers to this conference. The last date for paper submission is 30th September 2022. **The paper presentations will be in hybrid mode.** It is planned to publish the proceeding of this conference by **Springer in their Scopus indexed series "Lecture notes in Electrical Engineering"**

Hoping for a fruitful association and the grand success of the conference

Regards

TEAM IDEA2k22

UNIT IV-----MACHINE | Course: SCSA1601-Machine | SCSA1601: CAE- RE EXAM-2 | IDEA2k22 : Thanks for Joinin | 4th IDEA-2K22

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4th IDEA-2K22 HOME CALL FOR PAPERS COMMITTEES KEYNOTES VENUE CONTACT US CALL FOR SPECIAL SESSION PREVIOUS IDEA CONFERENCE

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Springer

4th International Conference
on
Data, Engineering & Applications
(IDEA - 2K22)

23-24, December, 2022

School of Information Technology
Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Oriental Institute of Science & Technology,
Bhopal

IMPORTANT ANNOUNCEMENT : It is planned to publish the peer reviewed and selected papers of conference

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December 23-24, 2022
BHOPAL

IDEA
Data Engineering Application

School of Information Technology
Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Oriental Institute of Science & Technology,
Bhopal

planned to publish the peer reviewed and selected papers of conference 4th IDEA-2k22(23-24 Dec2022, Bhopal) as proceedings with Springer

OVERVIEW OF THE CONFERENCE

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SCIENCE

Rashmi Lad MIT Arts Commerce and Science College, Alandi(D), Pune	Shweta Gupta Sri Aurobindo Institute of technology, Indore	Dr NAGENDRA H PDA College of Engineering Kalaburagi (Gulbarga)	Dr. Amit Grover Shaheed Bhagat Singh State University Ferozepur Punjab	Mrs. Preethi Sallian K NMAM Institute of Technology, Nitte, Karkala Taluk, Karnataka	Dr. Sanjay Tejasvee Govt. Engineering College Bikaner
KAMJULA LAKSHMI KANTH REDDY JNTU-K	Varsha N Vidya Vikas Institute of Engineering and Technology	Hitesh Ekanath Chaudhari Savitribai Phule University, Pune	Dr.Balvir Singh Thakur University Institute of Technology, H.P. University Shimla	Yashaswini A R VTU	Dipesh Vaya Jodhpur Institute of Engineering and Technology, Jodhpur
Vivek Sharma School of Information Technology, RGPV, Bhopal	Dr. Mahesh Shyamsunder Darak School of Computational Sciences, S. R. T. M. University, Nanded	Aditi Srivastava Noida International University	Dr. chandrajit M MIT Mysore	Dr. Ramesh Kumar Yadav ICFAI , University Raipur Chhattisgarh	VINAMRA BHUSHAN SHARMA Rajiv Gandhi Institute of Petroleum Technology, Amethi
Prajna .s JSS Science and Technology University, Mysuru	Dr. P. Asha Sathyabama Institute of Science and Technology	Dr.Mukul Shrivastava BIST Bhopal	Dr Varsha Sharma School of Information Technology, RGPV, Bhopal	Dr.S.P.Shiva Prakash JSS Science and Technology University	Amos R Maharaja Institute of Technology Mysore
Pramod Rajaram Suryavanshi Bharati Vidyapeeth College of Engineering Navi Mumbai	Dr. Vanishri Arun JSS Science and Technology University	Shilpa Mehta Auckland University of Technology, Auckland, New Zealand	Dr D RAVINDRAN Kristu Jayanti College(Autonomous), Bengaluru	S.Jayachitra PSNA College of Engineering and Technology	Dr.G.RAJAVIKRAM VIGNAN INSTITUTE OF TECHNOLOGY AND SCIENCE
Dr.A.Velayudham JANSONS Institute of Technology Coimbatore	Swaroop S VTU Belagaum Karnataka	Dr.N.Kalpana Anna University	Ranjitha P Presidency University	Dr. Kirti jain Sage University, Bhopal	Gagneet Punjab technical University
Priyanka dixit UIT RGPV Bhopal	Lawanyashri VIT	Dr. Manisha Shankarrao Deshmukh Central University of	Dr.Monisha Awasthi Uttaranchal University	MANOJ KUMAR D P Kalpataru Institute of Technology	Dr. Prashant Madhukar Yawalkar ActivME's Institute of

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15:37:17
16-09-2022

7th International Conference on Engineering Research and Innovations - (ICERI-2022)

22nd & 23rd September 2022 | Virtual Conference

IFERP - TEC express its gratitude to

Asha P

from.....
Sathyabama Institute of Science and Technology

for being the **ORGANIZING COMMITTEE MEMBER** at the

“7th International Conference on Engineering Research and Innovations (ICERI-2022)”

organized by Terna Engineering College (TEC), Nerul, Navi Mumbai,

in association with Institute For Engineering Research and Publication (IFERP)

held on 22nd & 23rd September 2022 (Virtual Conference).



Dr. L. K. Ragha
Convenor | ICERI 2022
Principal | TEC



Dr. Rajiv Gupta
Co - Convenor | ICERI 2022
Professor (E & T) | TEC



Mr. Rudra Bhanu Satpathy
CEO & Founder
Institute For Engineering Research and
Publication (IFERP)



Ashokkumar Kulandasamy <ashokkumark.cse@gmail.com>

Thank you for submitting your review of Manuscript ID TIIS-WC-2022-Oct-1071 for the KSII Transactions on Internet and Information Systems

1 message

KSII Transactions on Internet and Information SystemsTue, Feb 21, 2023 at
2:43 PM

<onbehalf@manuscriptcentral.com>

Reply-To: hongdk@smu.ac.kr

To: ashokkumar.cse@sathyabamauniversity.ac.in, kumar.kashok@gmail.com

Cc: hongdk@smu.ac.kr

21-Feb-2023

Dear **Mr. Ashokkumar K:**

Thank you for reviewing manuscript # TIIS-WC-2022-Oct-1071 entitled "Investigation of Long Range Seamless Communication using Adaptive Zero Configuration Algorithm in Dynamic SPAN" for the KSII Transactions on Internet and Information Systems.

On behalf of the Editors of the KSII Transactions on Internet and Information Systems, we appreciate the voluntary contribution that each reviewer gives to the Journal. We thank you for your participation in the online review process and hope that we may call upon you again to review future manuscripts.

Sincerely,

Prof. Dae-Ki Hong

Editor,

KSII Transactions on Internet and Information Systems

hongdk@smu.ac.kr



ashok kumar <ashokkumar.cse@sathyabama.ac.in>

Journal of Control and Decision Reviewer notification of decision on Manuscript TJCD-2022-0299

1 message

Journal of Control and Decision <onbehalf@manuscriptcentral.com>

Mon, Oct 24, 2022 at 1:38 PM

Reply-To: tengrong@ise.neu.edu.cn

To: tengrong@ise.neu.edu.cn

24-Oct-2022

Dear Reviewers,

Thank you for reviewing the manuscript TJCD-2022-0299 entitled "Super resolved maize plant leaves disease detection using optimal generative adversarial network" for Journal of Control and Decision. We greatly appreciate the voluntary contribution that each reviewer gives to the Journal and hope that we may continue to seek your assistance with the refereeing process for Journal of Control and Decision.

The decision that we arrived at for this article was: Major Revision, basing the decision on your review and those of the other referees.

A copy of your comments to the author, along with those of any other referees, follows at the end of this letter for your information. Any files that referees uploaded for the attention of the author are attached as a PDF proof.

Yours sincerely,

Professor Changyun Wen
Editor-in-Chief, Journal of Control and Decision
ecywen@ntu.edu.sg

Referee comments to the author:

Reviewer: 1

Recommendation: Major Revision

Comments:

how CSPOA-based GAN shows efficiency?

how much time required for input maize leaf image pre-processing? how many images you have taken?

couldnt see the data set and sample images of affected leaf's.

in figure 4.3 a,d shows actual image. D showing maize leaf along with weeds. so you cannot find maize plant leaves disease detection.

kindly justify

Additional Questions:

As a thank you and to acknowledge the contribution of our reviewers, the journal may publish a list of the names of those who have reviewed at the end of the year. This will not be linked to any specific paper and will only be done if the list of reviewers is long enough to protect the anonymity of the review process for individual papers. If you would prefer for your name not to be included in a published list of reviewers, please indicate this below.: No

Reviewer: 2

Recommendation: Major Revision

Comments:

This paper combines Cat Swarm Optimization and Political optimizer, which is used to train GAN. The authors perform disease detection using GAN. They have used maize leaf images. The authors perform preprocessing, super resolution, and salient map extraction before disease detection. The manuscript is lacking in many aspects.

* It is not clear that challenges mentioned in 2.2 are for who?

* The authors need to connect 2.1 with the authors' work presented in this manuscript.

* 2.2 presents challenges or limitations of the existing work? If they are challenges, then the authors need to prove

which part of their manuscript addresses which challenge(s).

- * Before presenting the proposal, they should discuss important background information, in section 2, Background and Related Work.

- * Section 3 directly starts the proposal; however, it is not clear why the authors need to use GAN? Why do they need to use optimization?

- * The following article should be studied and cited, "Detection and classification of rice plant diseases", Intelligent Decision Technologies, Volume 11, Issue 3, 2017, pp 357–373; which shows how to represent results of intermediate steps.

- * Figure 1 shows disease detected output; but in the image, nowhere disease is visible. Actually, the image shows both the green part of a leaf and dark-brown soil. Where is disease?

- * Region of interest (ROI) based on pixel intensity: how is it guaranteed to provide disease portion? Need to show results on few images. It creates doubt as the image is color and thresholding does not discuss it.

- * It is not clear whether the authors have tried Region of interest (ROI) and Anisotropic filtering one after another or they are two alternatives the authors are evaluating.

- * Why has Anisotropic filtering been used? What problem does it solve? What problem the authors are facing so that they need to use Anisotropic filtering? For what kind of noise, it has been used? Is it used on color images or gray color images?

- * Why do authors need to perform superresolution? How much does it affect the result? What will happen if it has not been done?

- * Disease classification and disease detection are two different things. Authors need to use appropriate terms.

- * The authors need to discuss and justify the need for optimization for training of GAN. Architecture of GAN in Figure 2 is vague. The authors need to show and discuss their derived architecture with full details.

- * Results presented in Figure 4.3 are not proper. Figure d also contains soil portions. Furthermore, on watching (b) and (d), it appears that (d) is not matching with (b) in terms of region. Why?

- * The authors need to discuss the dataset.

- * How has accuracy been derived based on Figure 4.d?

- * The authors need to pay much attention to what they claim as their claims: GAN and optimization. Should write specific to what they have done and should present all relevant results.

***** Presentation:

- * It is not clear, why the authors use subscripts s and h ? What do they represent?

- * The authors need to correct grammar errors.

- * At many places, there are sentences discussing different concepts/keypoints.

Additional Questions:

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ashok kumar <ashokkumar.cse@sathyabama.ac.in>

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Sat, Sep 10, 2022 at 11:57 AM

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To: "K.Ashok Kumar" <ashokkumar.cse@sathyabamauniversity.ac.in>

Ref.: Ms. No. ECTI-EEC-D-22-00165

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Ying Chen; Lei Quan; Xiaoqiang Zhang; Kun Zhou; Caicong Wu

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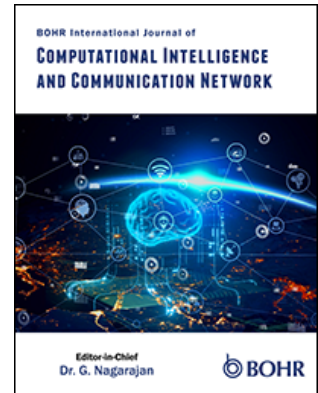
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Thank you for your support of *Computational Intelligence and Neuroscience* and I look forward to working with you in your role as Lead Guest Editor.

Best wishes,

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More articles will be published in the near future.

Multimodal learning in computer vision is vital in the design of modern communication systems. Computer vision uses machine learning with image classification, face detection, and pose estimation to understand, identify, and react to the user in real time. Human-game interaction is the meaningful interaction between gaming consoles or computers and humans, or vice versa. Human interaction is complex as it revolves around the movements, actions, and commands of the user. One crucial aspect of such interactions is that each user has their own form of perceptions or opinions about interactions. Multimodal frameworks aim to integrate acoustic, visual, and textual information, however, most of the available fusion strategies perform poorly in real-time applications.

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We are fully satisfied with his services and wish him good luck for all his future endeavours.

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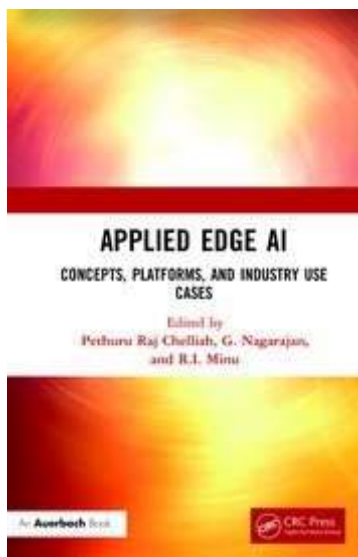


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Applied Edge AI: Concepts, Platforms, and Industry Use Cases focuses on the technologies, processes, systems, and applications that are driving this evolution. It examines the implementation technologies; the products, processes, platforms, patterns, and practices; and use cases. AI-enabled chips are exclusively used in edge devices to accelerate intelligent processing at the edge. This book examines AI toolkits and platforms for facilitating edge intelligence. It also covers chips, algorithms, and tools to implement Edge AI, as well as use cases.

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- Case studies presenting the potential of leveraging AI in 5G wireless communication

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Biography

Dr. Pethuru Raj Chelliah is the chief architect in the Site Reliability Engineering (SRE) division of Reliance Jio Infocomm Ltd. (RJIL), Bangalore, India.

Dr. G. Nagarajan is a professor at the Department of Computer Science and Engineering, School of Computing, Sathyabama Institute of Science and Technology, Chennai, India.

Dr. R. I. Minu is an associate professor at the Department of Computer Science and Engineering, SRM Institute of Science and Technology, Kattankulathur, India.

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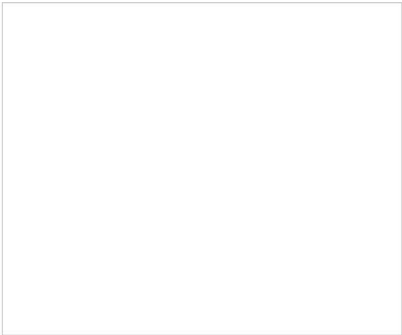


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Description



Medical diagnosis is necessary to identify a disease or injury through the signs and symptoms presented. Accurate diagnoses collect data from sources such as medical history and physical examination and tests like blood, CT or MRI scans, and biopsies, among others. Technological advances aid the medical industry and are transforming healthcare by reducing the complexity of diagnosis. Artificial intelligence (AI) supports specialists in the diagnosis of patients precisely with advanced methods that can recognize in-depth knowledge from multimedia information on the patient.

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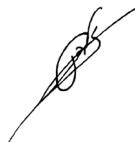
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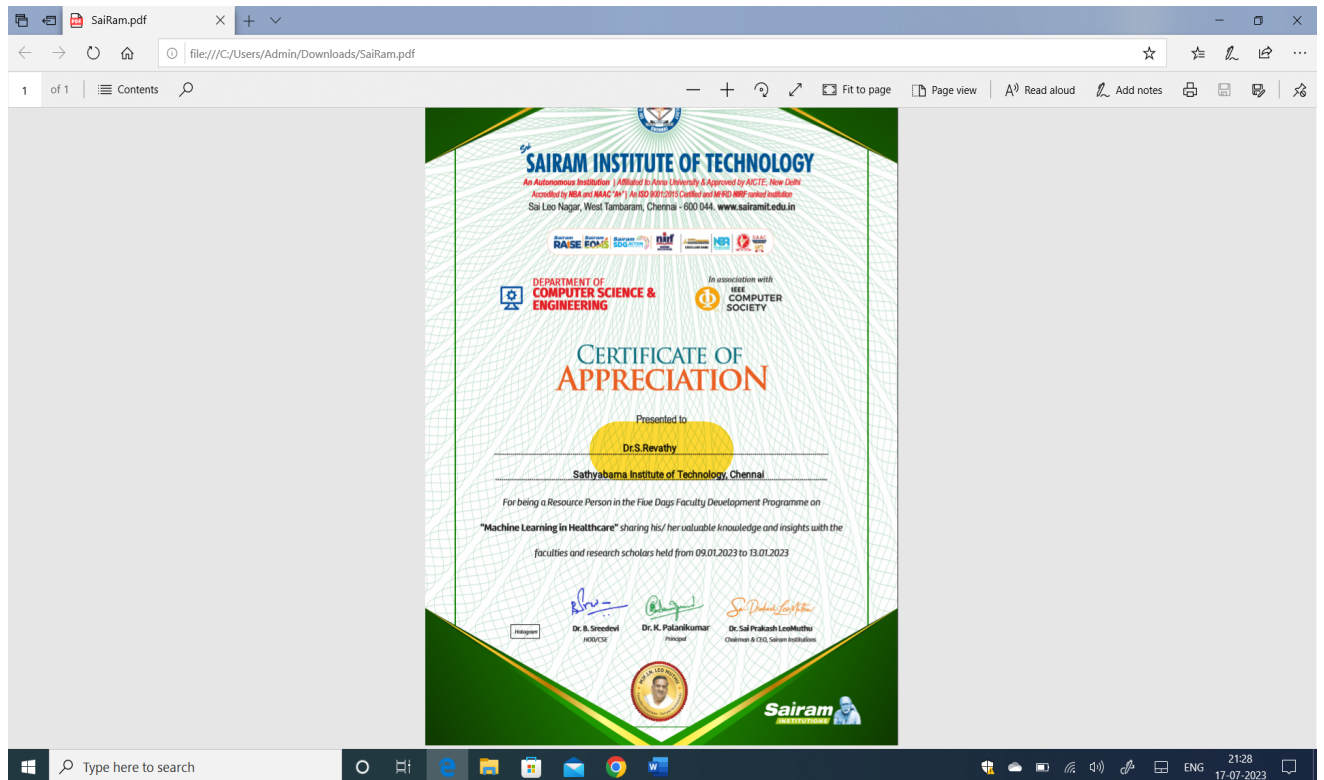
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1	Hands on Training for Inverter Fabrication	Sri Sivasubramaniya Nadar College of Engineering	Abhay Verma	2023	3 days	Short term Training Programme	https://drive.google.com/
2	Hands on Training for Inverter Fabrication	Sri Sivasubramaniya Nadar College of Engineering	Abhay Koushal	2023	3 days	Short term Training Programme	https://drive.google.com/
3	Hands on Training for Inverter Fabrication	Sri Sivasubramaniya Nadar College of Engineering	Satya Prakash	2023	3 days	Short term Training Programme	https://drive.google.com/
4	Hands on Training for Inverter Fabrication	Sri Sivasubramaniya Nadar College of Engineering	B.Reddy Chandra Sekhar	2023	3 days	Short term Training Programme	https://drive.google.com/



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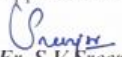
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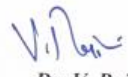
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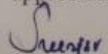
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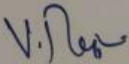
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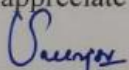
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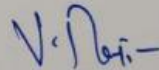
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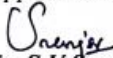
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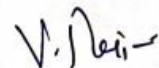


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Functionalized Nanoparticles: A Paradigm Shift in Regenerative Endodontic Procedures

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Abstract

Clinical treatment of inflamed tooth pulp mostly involves the removal of the entire pulp tissue. Because the vitality of the tooth is important for its ability to function, optimal regenerative biomaterials must be developed to maintain the vitality. Despite vast advances in the field of endodontics, the clinical translation of regenerative endodontic procedures and materials remains challenging. Patient-specific, tissue-derived stem cells play a major role in regeneration and revascularization, and these stem cells require an infection-free environment for a successful outcome. However, the high doses of antibiotics currently used to maintain an infection-free environment for tissue regeneration can be toxic for the stem cells. The introduction of nanotechnology in the field of regenerative procedures has overcome these issues and demonstrated promising results. Nanoparticles can be used to deliver antibiotics at very low doses owing to their small size, thereby enhancing antimicrobial activity and reducing the cytotoxic effect. Additionally, nanofibrous scaffolds provide an environment that is favorable for stem-cell migration and proliferation, thereby favoring the regeneration of the pulp-dentin complex. Nanotechnology can be used in the construction of nanofibrous scaffolds incorporated with different bioactive nanoparticles for favorable clinical outcomes. Nonetheless, the role of nanotechnology and the controlled release of various bioactive nanomolecules enhancing stem cell proliferation and regeneration of true pulp-dentin complex remains poorly understood. Given the importance of nanotechnology in tissue regeneration, this review provides an overview of the potential applications of nanotechnology in tooth pulp-dentin regeneration.

Categories: Healthcare Technology, Dentistry

Keywords: nanoscaffolds, regenerative endodontics, nanofiber, nanoparticles, nanotechnology

Introduction And Background

A newly erupted immature permanent tooth with incomplete root apex formation usually takes a few years for complete root development after the tooth emerges in the mouth. Pulpal necrosis due to dental caries or traumatic injuries of immature permanent teeth can often affect root end development. Post-emergent root development consists of an increase in root length and root wall thickness as well as a narrowing of root canals in the apical region. A wide range of treatment protocols has previously been suggested to treat immature permanent teeth with necrotic pulps [1,2]. The apexification procedure is commonly used to treat immature necrotic permanent teeth with open root apices to induce the formation of the hard tissue barrier at the root apex. However, tissue vitality and root maturation along with apical closure cannot be achieved by this procedure. Consequently, the regenerative endodontic procedure, which aims to biologically and functionally regenerate the pulp-dentin complex in immature permanent teeth damaged by infection or trauma, was introduced by Nygaard-Ostby et al. in the 1960s [1]. This procedure involves crucial steps, such as disinfection of the root canal space, control of inflammation, and pulp tissue regeneration, to obtain the desired outcomes, which include complete tooth root maturation with signs of neurogenesis and resolution of the clinical signs and symptoms. However, true regeneration of the pulp-dentin complex is difficult to achieve, and factors such as the stage of root development, severity and duration of apical periodontitis, follow-up time, and trauma influence the treatment outcomes [3]. Several studies have been conducted in the field of regenerative endodontic procedures based on biological tissue engineering concepts that involve the triad of stem cells, scaffolds, and signaling molecules [1].

Various stem cells, such as dental pulp stem cells (DPSC) from permanent teeth, stem cells from the apical papilla (SCAP), immature dental stem cells from primary teeth, stem cells of human exfoliated teeth (SHED), and periodontal ligament stem cells (PDLSC), have been investigated for pulp-dentin regeneration [4,5]. The key element in regenerative endodontics is the proper disinfection of the canal system without damage to the endogenous stem cells in the apical papilla. The stem cells are introduced into the root canal space from the periapical region by inducing intracanal bleeding. Huang et al. used human DPSCs and SCAP, synthetic scaffolds, and human root segments to demonstrate the regeneration of pulp-like tissue and the formation of dentin-like mineral structures in immunocompromised mice [6].

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Bioactive molecules are signaling molecules that initiate and maintain cellular interactions and aid in the regeneration of injured pulp tissues. They require a favorable microenvironment and a proper scaffold to aid in tissue regeneration. Scaffolds are designed to resemble the structure and complexity of the extracellular matrix (ECM) in the pulp. They provide mechanical support, promote cell adhesion, and enhance the growth and differentiation of stem cells. Scaffolds are biocompatible and can act as carriers of bioactive molecules and undergo biodegradation over time. Scaffolds can be classified as natural (collagen, fibrin, blood clot, platelet-rich fibrin, chitosan, silk, alginate, hyaluronic acid) or synthetic (polylactic acid, polyglycolic acid, polylactic-polyglycolic acid, polycaprolactone, poly (L-lactic acid)) based on the material used [7]. In a study conducted by Gangolli et al., DPSCs seeded onto a bi-layered poly (lactic-co-glycolic acid) scaffold fabricated with different pore diameters on each side penetrated through the entire thickness of the scaffold on the side with the large pores, whereas limited penetration was observed on the side with small pores. Nonetheless, penetration and differential odontoblastic differentiation of the DPSCs was observed on both sides of the scaffold [8].

Nanotechnology allows for the construction of nanofibrous scaffolds incorporated with different bioactive nanoparticles that possess the mechanical strength and properties required for the controlled release of bioactive agents. Owing to the unique characteristics of nanoparticles, which include their nano size, high surface area-to-volume ratio, enhanced solubility, heightened antibacterial activity, increased reactivity, and capacity to be functionalized with other reactive compounds, their use in regenerative endodontics has gained significant interest. Polymeric nanoparticles are used during the different stages of regenerative endodontics for dentin and pulp connective tissue formation, revascularization, re-innervation, and root end completion [9].

Various derivatives of nanoscale technology, including nanofibers, nanoshells, and nanotubes, have been used in endodontic tissue regeneration. Although several in vitro and in vivo studies on pulp-dentin regeneration have been conducted, the role of nanoparticles in the controlled release of various loaded bioactive molecules and the enhancement of stem cell proliferation remains to be understood for the proper application of nanotechnology in endodontic regeneration. This review outlines the role of nanomaterials in different areas of regenerative endodontics.

Review

Methods

A review of the literature was performed by an electronic search of PubMed and Google Scholar for publications related to the evaluation of pulp-dentin tissue regeneration. The literature search was done using the keywords “nanoparticles,” “polymeric nanoparticles,” “nanofibers,” and “regenerative medicine.” Articles were chosen using the following inclusion criteria: articles published in the English language over the last 20 years, as well as studies related to the role of nanomaterials in regenerative endodontics. A total of 59 articles related to the field of endodontics and studying the role of tissue regeneration were considered. Articles related to the role of nanotechnology in other dental treatment procedures were not considered.

Nanoparticles and their role in endodontic regeneration

Nanoparticles and other products of nanoscale technology, such as nanofibers and nanopatterned surfaces, are employed in regenerative procedures. They are widely used for various functions such as drug delivery, gene delivery, antimicrobial action, and tissue regeneration. Based on the type of material used, nanoparticles can be classified as follows: polymeric-based (natural or synthetic polymer-based nanoparticles), inorganic-based metallic (silver nanoparticles, gold nanoparticles), carbon-based (hydroxyapatite-based nanoparticles or mesoporous silica nanoparticles), and biological protein peptide-based. Figure 1 represents the various types of nanomaterials used in endodontic regeneration.

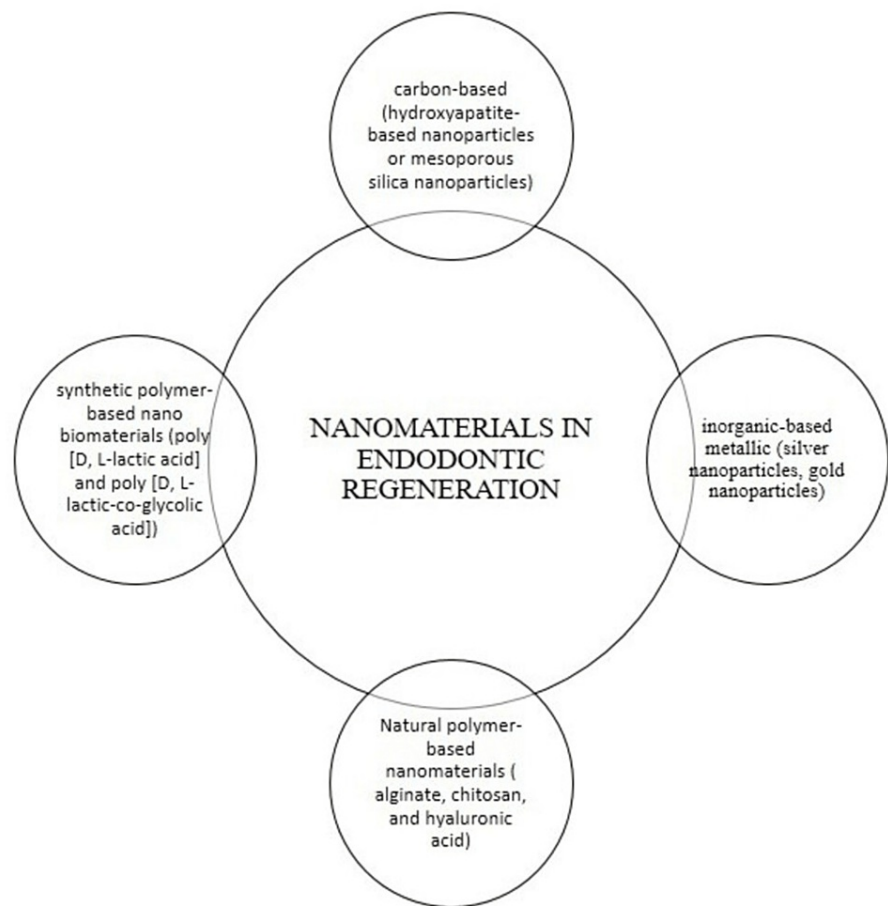


FIGURE 1: Schematic representation of nanoparticles in regenerative endodontics.

Authors' own work.

Metallic nanoparticles such as silver nanoparticles have superior antimicrobial and anti-inflammatory properties and can be used to combat infections at much lower doses. Natural polymer-based nanomaterials (such as alginate, chitosan, and hyaluronic acid) are highly biocompatible and beneficial for cell adhesion and tissue regeneration but have low mechanical properties, which can result in the instability of the polymer-based nanobiomaterial leading to a burst release of the drug [10]. In contrast, synthetic polymer-based nanobiomaterials (such as poly (D, L-lactic acid) and poly (D, L-lactic-co-glycolic acid)) have greater mechanical strength and structural integrity. Thus, both natural and synthetic polymer-based nanobiomaterials can be used together to meet biological and physical requirements. By modifying the hollow interior microstructures, mesoporous materials can be used as carriers with adjustable release kinetics. Inorganic mesoporous silica nanoparticles are widely used in regenerative medicine for drug and gene delivery owing to their good biocompatibility and highly porous framework [11].

The presentation and local delivery of bioactive agents (such as growth factors, chemokines, and cytokines) in a controlled manner are essential for tissue engineering. Investigations on the use of polymeric nanoparticles as a carrier system for bioactive molecules have shown promising biomechanics and sustained release potential, thereby favoring tissue regeneration [12]. Incorporating bioactive materials, such as drugs or proteins, into a biodegradable nanopolymer increases the efficacy, bioavailability, and target tissue delivery potential of the bioactive molecule. Nanospheres (matrix system) and nanocapsules (reservoir system) are the two main types of polymeric nanoparticles used as drug carriers [12]. Nanocapsules consist of an inner oily core, where the drug is dissolved, and an outer polymeric shell, which controls the release profile of the drug. On the other hand, nanospheres are composed of continuous polymeric networks, wherein the drug is dissolved within the polymeric matrix or adsorbed onto the polymer [13].

Bioactive molecules can be incorporated into polymeric nanoparticles via chemical conjugation or physical encapsulation. A bioactive substance is enclosed within an inert material by the process of nanoencapsulation, which increases the stability and rate of release of bioactive substances at physiologically active sites [14]. For instance, core-shell structured lipid nanoparticles facilitate the

encapsulation of hydrophobic drugs and exhibit a sustained drug release potential [15]. Lipid nanoformulations encapsulate hydrophilic and lipophilic regenerative agents that improve their bioavailability. Lipid nanoparticles may be considered alternative carriers for numerous other colloidal drug delivery systems owing to their size (50-1000 nm), the lack of need for an organic solvent, and the economic fabrication processes [16].

Nanofibers evaluated in endodontic regeneration

Nanofibers serve as nanoscale carriers for bioactive molecules and have been used during the various stages of regenerative endodontics. When used as a scaffold, the flexible nanofiber matrix meets several requirements, including those for three-dimensional (3D) matrix creation, drug delivery, attachment of growth factors, and adhesion of bioactive molecules, which encourages cell homing behavior for the regenerative process [17]. The surface texture, composition, network structure (random or aligned), and molecular orientation of the nanofiber must be optimized to improve its bioactivity. Nanofibers are available in different morphological forms, such as uniaxially aligned, biaxially oriented, porous fibers, ribbon-shaped, necklace-like, nanowebs, hollow tubes, and nanowire-in-microtubes [18]. A nanofibrous architecture enhances the adsorption of the cell adhesion protein when compared to a smooth-walled architecture scaffold. The nanofibrous architecture of poly (L) lactic acid scaffold is similar to the physical architecture of natural collagen fibers. It provides a favorable extracellular matrix-like environment for the attachment and proliferation of human DPSCs [19]. Nanofibers, used for the seeding of regenerative cells (such as dental pulp cells, mesenchymal cells, odontoblasts, and growth factors), act as a scaffold and provide a porous 3D surface that promotes the attachment of cells. Polymeric nanofibers can be fabricated by various methods such as self-assembly, electrospinning, and thermal-induced phase separation. These methods can be utilized to create 3D nanofibrous scaffolds with linked pore architectures that enable nutrition delivery, cell infiltration, and proliferation [20].

Electrospinning technology is commonly used to fabricate highly porous nanofibers with structures and mechanical properties similar to the extracellular matrix of native tissues. The image of an electrospun poly(vinyl alcohol) (PVA)/chitosan nanofiber mimicking the extracellular matrix is shown in Figure 2.

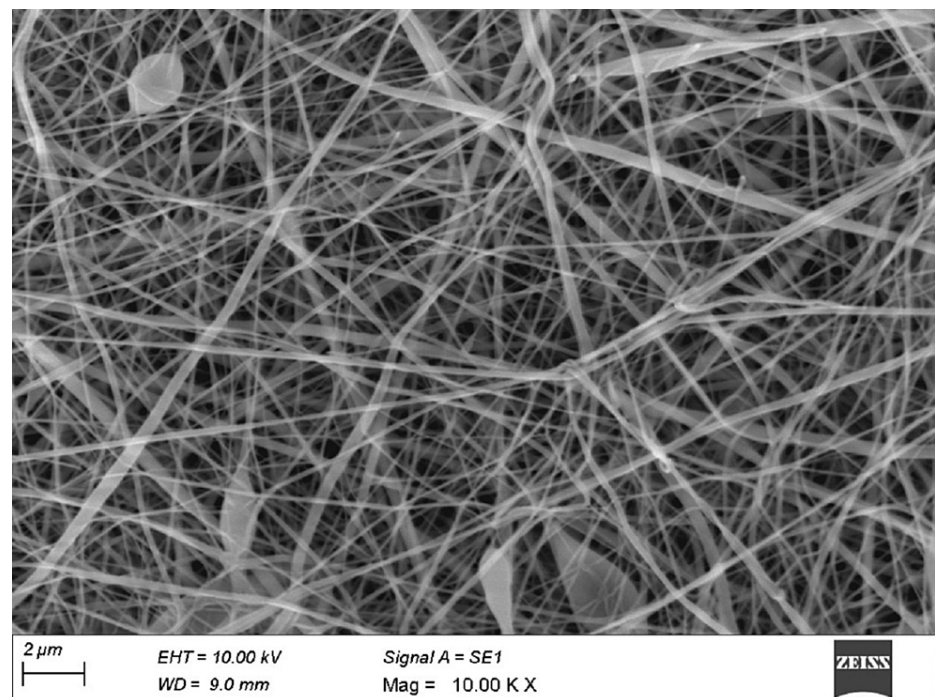


FIGURE 2: Scanning electron microscope observation: the electrospun nanofibrous poly(vinyl alcohol)/chitosan network membrane.

Authors' own work.

The electrospun nanofiber can be used as a carrier of active molecules, and this functionalization of nanofibers can be performed using various techniques such as surface graft polymerization and wet chemical treatment [21]. Antibiotics incorporated into electrospun nanofibrous membranes can exhibit more pronounced disinfection at a relatively lower dosage, thereby minimizing the adverse toxic effects of currently used high-concentration antibiotics. Studies have shown that electrospinning does not jeopardize the therapeutic properties of the incorporated material [22]. A nanopolycaprolactone-gelatin matrix

incorporated with mesoporous bioactive nanoparticles can enhance the odontogenic differentiation of human DPSCs.

Low-dose simvastatin incorporated in a poly (L) lactic acid nano scaffold was reported to promote dentin regeneration by reducing inflammatory reactions and increasing stem cell regenerative capacity in inflamed dental pulp tissue [23]. Scaffold-mediated angiogenesis from the surrounding tissue is desirable. Moreover, the presence of blood vessels inside the scaffold improves the supply of nutrients/oxygen and the removal of metabolic waste, thereby creating a favorable environment for the growth of DPSCs. Endothelial cells cultured on simvastatin/nanofibrous-poly (L) lactic acid scaffolds are reported to form highly connected vascular-like structures, which demonstrates the angiogenesis-promoting properties of dental pulp cells [23]. Eap et al. reported that nanofibrous polycaprolactone scaffolds functionalized by a neural growth factor can induce pulp innervation and exhibit signs of tissue homeostasis [24]. In another study, dentin regeneration by human pulp stem cells is enhanced using 3D nanofibrous gelatin/magnesium phosphate scaffolds, resulting in a controlled release of metallic ions [25]. An injectable scaffold is more beneficial than an implantable bulk scaffold for dental regenerative procedures. Kuang et al. used poly (L) lactic acid-block-poly (L-lysine) copolymers to fabricate nanofibrous spongy microspheres as an injectable cell carrier by employing self-assembly and thermally induced phase separation techniques [26]. The nanofibrous spongy microspheres with interconnected pores improve the proliferation and odontogenic differentiation of human DPSCs compared to the nanofibrous microspheres without pore structures, thus serving as a potential injectable cell carrier system for dentin regeneration. In another study, the vascular endothelial growth factor is bonded with heparin and encapsulated into gelatin nanospheres, which are then entrapped within nanofibrous-poly (L) lactic acid microspheres and used as injectable growth factor carriers. Successful regeneration of pulp-like tissue, which filled the entire root canal space, is observed [27]. Table 1 shows the different nanofibers evaluated in the field of regenerative endodontics.

Nanofiber	Targeted tissue	Result
Poly (L-lactic acid) (PLLA) nanoscaffold loaded with low-dose simvastatin [23]	Dental pulp stem cells	Increased stem cell regenerative capacity. Good angiogenic promoting property of dental pulp cells
Polycaprolactone scaffolds [24]	Neural growth factor	Innervation of the pulp
Nanofibrous gelatin/magnesium phosphate scaffolds [25]	Human pulp stem cells	Dentin regeneration
Poly (L-lactic acid)-block-poly (L-lysine) nanofiber [26]	Human dental pulp stem cells	Enhanced proliferation and odontogenic differentiation
Nanofibrous, poly (L-lactic acid) microspheres [27]	Vascular endothelial growth factor	Pulp-like tissues regeneration in entire root canal space
Polycaprolactone/gelatin and nano-hydroxyapatite composite scaffold [28]	Dental pulp stem cells	Enhanced proliferation and odontogenic differentiation
Apatite-mineralized polycaprolactone nanofibrous scaffold [29]	Human dental pulp cells	Enhanced odontogenic differentiation
Composite biopolymer nanofiber loaded with bioactive glass nanoparticles [30]	Human dental pulp cells	Promoted odontogenic differentiation
Triple antibiotic-eluting nanofiber [31,32]	Multispecies biofilm cytotoxic effect on stem cell	Better antibacterial action at low concentration, and no significant cytotoxic effect
Carboxymethyl chitosan-based scaffold [33]	Transforming growth factor-β1	Enhanced differentiation and migration of stem cells
Alginate/nano-hydroxyapatite scaffold [34]	Dental pulp stem cells	Enhanced osteogenic differentiation. Promoted calcium deposition and biomineralization

TABLE 1: Role of different nanofibers used during the various stages of endodontic regeneration.

Different materials used in endodontic tissue regeneration in nanoscale form

Chitosan

Chitosan nanoparticles have shown promising results in the local delivery of bioactive molecules due to

their nano size, large surface area, increased chemical reactivity, and potential to be conjugated with other molecules [35]. It is a bioactive biopolymer with alterable porosity to permit the transport of nutrients, biomolecules, and toxic cellular products. The complexation of recombinant keratinocyte growth factor with mucoadhesive low-molecular-weight chitosan is reported to enhance the stability and biological function of the growth factor [36]. Likewise, a carboxymethyl chitosan-based scaffold incorporated with transforming growth factor (TGF)- β 1-loaded chitosan nanoparticles are found to enhance the differentiation and migration of stem cells [33]. In another study, alkaline phosphatase, an early marker of odontoblast-like differentiation, exhibited improved activity in SCAP due to the slow and continuous release of bovine serum albumin from chitosan nanoparticles [37]. Shrestha et al. reported that the odontogenic stimulant dexamethasone improves the odontogenic differentiation of SCAP when loaded onto chitosan nanoparticles [38]. The harmful effects of using sodium hypochlorite as an endodontic irrigant are found to be reduced when the dentin surface is conditioned with either chitosan nanoparticles or dexamethasone-modified chitosan nanoparticles; conditioning with chitosan nanoparticles stimulated the adherence, viability, and differentiation of SCAP [39].

Hydroxyapatite

Biodegradable synthetic polymers such as polycaprolactone, polyglycolide, and polylactide exhibit inadequate cell adherence and proliferation due to the lack of biological recognition sites. These polymer material scaffolds can be supplemented by hydroxyapatite crystals, which provide inorganic reinforcement and simulate the natural dentin extracellular matrix. A previous study showed that the addition of nanohydroxyapatite to polymer scaffolds enhances the cellular adherence and proliferation of osteoblast-like cells [40]. Nanohydroxyapatite increases protein absorption, cell adhesion, and cell proliferation; additionally, it has a high solubility, which promotes an increase in the bioactivity of the polymer. Alginate can be fabricated into 3D porous biodegradable networks. DPSCs seeded on alginate and nanohydroxyapatite scaffold are found to express osteogenic differentiation-related markers and promote calcium deposition and biomineralization [34]. Electrospun composite scaffolds made of polycaprolactone/gelatin and nanohydroxyapatite enhanced the proliferation and odontogenic differentiation of DPSCs [28]. According to Kim et al., apatite-mineralized polycaprolactone nanofibrous scaffolds favor the development and odontogenic differentiation of human dental pulp cells via the integrin-mediated signaling pathway when compared to the plain polycaprolactone fibers [29].

Cellulose Nanocrystals

A scaffold architecture with high porosity and interconnected pores allowing for adequate nutrient diffusion, cell migration, and vascularization may have poor mechanical properties. Silva et al. reported that injectable hyaluronic acid hydrogels reinforced with cellulose nanocrystals have higher scaffold network stiffness and stability due to their action as effective junctional elements, thereby favoring cell adhesion, migration, and proliferation [41]. The incorporation of a platelet lysate, which is rich in proangiogenic and chemotactic factors, into reinforced hydrogel enhanced the revascularization and regeneration of pulpal tissue [41].

Bioactive Glass

Lim et al. incorporated dexamethasone molecules loaded with bioactive glass nanoparticles within the biopolymer nanofiber matrix through electrospinning and found that this nanofiber composite exhibits a sustained, controlled release of dexamethasone for 14 days. Additionally, it enhances the odontogenic differentiation of human dental pulp cells via the activation of integrins, bone morphogenetic protein, and the mammalian target of rapamycin (mTOR) signaling pathway [30]. The mechanical properties of scaffolds can be improved by the incorporation of bioactive glass nanoparticles. These nanoparticles have better biocompatibility, promote cell adhesion and migration, and demonstrate stronger osteogenic abilities than microscale bioactive glass. Kim et al. showed that a composite nanofibrous scaffold of polycaprolactone/gelatin and mesoporous bioactive glass nanoparticles promoted the odontogenic differentiation of human dental pulp cells by activating integrins, bone morphogenetic proteins (BMP), and the mitogen-activated protein kinase signaling pathway [42]. Bae et al. reported similar results, wherein the nanocomposite collagen/nano bioglass scaffold matrix induced the growth and odontogenic differentiation of stem cells more effectively than collagen alone [43].

Metal Ions

Biomaterials that promote osteogenic and angiogenic activity and exhibit antimicrobial potential are ideally chosen for regenerative procedures. Metal ions such as magnesium, strontium, zinc, and copper ions are involved in tissue development and repair. Graphene oxide copper nanocomposite has been shown to enhance the odontogenic and neurovascularization activities of DPSCs [44]. Low-concentration copper ions have antimicrobial, osteogenic, and angiogenic effects when administered in controlled-releases dosage form [45]. El-Fiqi et al. evaluated the use of a mesoporous bioactive glass nano-delivery system incorporating silicate, calcium, copper, and epidermal growth factors and report excellent antibacterial, angiogenic, and odontogenic effects [46]. The copper ions and epidermal growth factors released from glass

nanospheres suppressed the growth of *Enterococcus faecalis* and stimulate the angiogenic potential of endothelial cells.

Calcium Silicate Nanoparticles

Calcium silicate-based materials promote hard tissue regeneration and stimulate odontogenic and osteogenic differentiation in various types of cells. Huang et al. fabricated an injectable paste of mesoporous calcium silicate nanoparticles with organized mesoporous channels that exhibited high surface areas and pore volumes. These nanoparticles demonstrated a sustained release pattern of calcium and silicate ions, thus indicating their potential as a novel material in regenerative endodontics [47]. In another study, a unique, ready-to-use calcium silicate-based nanoparticulate bioceramic paste demonstrates excellent apatite formation; enhances the adhesion, migration, and attachment of DPSCs; and induces the formation of a dentin bridge for pulp repair [48].

Gold Nanoparticles

To study and visualize the interactions between stem cells and scaffolds and to know how the cells are spatially distributed after seeding, Biz et al. combined gold nanoparticles with poly-L-lysine and incorporated them into dental pulp stem cells as gold nanoparticles have a higher coefficient of X-ray absorption and provide a superior contrast. The authors stated that an increase in cell radiopacity allows for the identification of viable cell distribution in scaffolds, and the functions of the stem cells remained unaffected [49]. A previous study has shown that gold nanoparticle-incorporated calcium phosphate cement significantly enhanced the osteogenic functions of hDPSCs [50]. In another study, gold nanoparticles are reported to inhibit pathogenic *Candida albicans* biofilm formation and invasion into DPSCs [51].

Antimicrobials

Sodium hypochlorite irrigation of the root canal system and the use of double or triple antibiotic paste (TAP) can result in maximum bacterial eradication, but when used in high concentrations, they can negatively impact the survival of dental-derived stem cells [52]. To overcome this cytotoxic challenge, novel antibiotic-containing polymer nanofibers are developed as a 3D tubular drug delivery construct that can be placed inside the root canals of the necrotic teeth [53]. This allows for the use of antibiotics at lower concentrations with a sustained release rate, which facilitates regeneration. Antimicrobial nanoparticles can infiltrate bacterial biofilms and interact electrostatically with bacterial cell walls leading to cell membrane disruption, increased cell permeability, protein breakdown, and DNA damage, ultimately resulting in cell death.

TAP, which contains metronidazole, ciprofloxacin, and minocycline, has been recommended for canal disinfection during regenerative procedures. However, the drawbacks of TAP include notable tooth discoloration and significant dental stem cell death when used at considerably high concentrations. Albuquerque et al. reported that the antimicrobial properties of 3D tubular-shaped triple antibiotic-eluting nanofiber constructs containing significantly low concentrations of metronidazole, ciprofloxacin, and minocycline against multispecies biofilm are similar to those observed with high concentrations of TAP [31]. Similar results were also reported by Palasuk et al. wherein nanocomposite scaffolds containing metronidazole or ciprofloxacin and polydioxanone exhibited good antimicrobial activity against *Enterococcus faecalis* and *Porphyromonas gingivalis* with no toxic effects on human DPSCs [53]. The kinetics of antibiotic release from polydioxanone nanofibers in the work by Kamocki et al. shows an initial burst release, followed by a sustained release for up to 14 days, providing a long-lasting antibacterial impact [54]. In a recent study, clindamycin-modified triple antibiotic (minocycline-free) polydioxanone (PDS) polymer nanofibers exhibit significant antimicrobial effects and low cytotoxicity. Scanning electron microscopy shows that clindamycin-containing nanofibers have smaller diameters than antibiotic-free PDS nanofibers, providing more surface area for drug release over time [32]. Silver nanoparticles exert significant antibacterial effects at low concentrations [55]. Compared to other micro- or macro-sized materials, nanoscale materials are more substantial and can penetrate the dentinal tubules and lateral canals with ease [56]. Additionally, oxidative stress and mitochondrial dysfunction can be brought on by silver nanoparticles in human cells. Alternatively, low concentrations of silver nanoparticles do not appear to be detrimental to mammalian cells, and the green synthesis of low concentrations of silver nanoparticles does not affect human dermal fibroblasts in a recent study by Oncu et al. [57]. In another study using DPSCs, carboxymethyl cellulose-silver nanoparticles exhibit good antimicrobial properties and low toxicity at a concentration of 16%; however, cytotoxic effects are observed at concentrations of >50% [58].

Biodegradable poly (D, L) lactic acid nanoparticles, which have low immunogenicity, can be used to deliver antifungal and antibacterial drugs. Bekhouche et al. evaluated the antibacterial efficacy of clindamycin-loaded poly (D, L) lactic acid nanoparticles incorporated into fibrin hydrogel and reported better antibacterial and antibiofilm activities without any effect on the cell viability, thereby creating an aseptic environment that is favorable for tissue regeneration [59].

Conclusions

Nanodentistry is the application of nanotechnology for diagnosing, treating, and preventing oral and dental diseases. Nanotechnology has demonstrated promise as a carrier of bioactive molecules and for the controlled delivery of drugs and growth factors. In this review, we have addressed the research conducted in the field of nanotechnology that can be used in the fabrication of various functionalized nanoparticles for their use in regenerative endodontics. These functionalized nanoparticles can be employed as novel materials to enhance antimicrobial drug activity at a relatively smaller dose and improve regenerative outcomes. The combination of stem cells and bioactive nanostructured scaffolds creates a better environment for the reconstruction of the dental pulp. Within the limitations of this review which does not include a literature search that considers the chances of potential adverse effects of nanomaterial use in regenerative endodontics, it can be stated that studies on long-term clinical trials are needed to evaluate the successful clinical application of nanomaterials in regenerative endodontics.

Additional Information

Disclosures

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Assessment of Oxidative Stress by the Estimation of Lipid Peroxidation Marker Malondialdehyde (MDA) in Patients with Chronic Periodontitis: A Systematic Review and Meta-Analysis

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Abstract

Objective. The present systematic review and meta-analysis aimed to assess the oxidative stress-mediated lipid peroxidation end product malondialdehyde (MDA) in periodontitis using the available literature. **Materials and Methods.** An electronic literature search was performed for the published articles from 2000 to 2022 in PubMed (MeSH), Science Direct, Wiley Online library, and cross-reference using specific keywords. **Results.** The literature search identified 1,166 articles. After analyzing the abstracts of the obtained

Assessment of the anti-oxidant reduced glutathione in oral squamous cell carcinoma – Systematic review and meta-analysis

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Abstract

Background: The excess reactive oxygen species or free radicals reaction leads to oxidative injury to the biological components such as cells and tissues, which would result in the initiation and progression of carcinogenesis. The magnitude of oxidative damage depends primarily on the balance between free radicals (pro-oxidants) and antioxidant system activity.

Aim: To assess antioxidant status by evaluating the reduced glutathione (GSH) levels in various biological samples of patients with oral squamous cell carcinoma (OSCC) using available literature.

Materials and Methods: An electronic literature search was carried out in PubMed (MeSH), Science Direct, Scopus and Cross Reference by using specific keywords.

Results: The systematic electronic search identified 704 articles. After studying the articles' titles and abstracts, 657 articles were excluded for the following reasons; duplicated articles, animal studies, studies of low quality and not relevant to the research question. The remaining 47 articles were selected for full-text assessment. After eliminating the articles that did not match the objectives, the present qualitative synthesis finally included 27 articles for evaluation. The ten studies, which showed coherent data, were included in quantitative analysis. The GSH levels in OSCC groups are significantly decreased ($P < 0.001$) in plasma and erythrocyte samples compared to healthy controls.

Conclusion: The selected studies showed significantly lower levels of GSH in various biological samples of OSCC. Hence, future studies are required to validate the expression of GSH as a prognostic biomarker in oral cancer.

Keywords: An antioxidant enzyme, oral cancer, oral squamous cell carcinoma, reduced glutathione

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INTRODUCTION

Along with pharyngeal cancer, oral cancer is considered the ninth-most common cause of malignancy globally^[1] and the third-leading cause of mortality in developing countries.^[2] The oxidative stress (OS) induced by free radicals has been implicated in the pathogenesis of several diseases, including oral cancer.^[3] Free radicals (Pro oxidants) are molecular species capable of independent existence with an unpaired electron in the outer shell. They are unstable and highly reactive oxygen species (ROS).^[4] Free radicals target biomolecules and induce irreparable DNA, Lipid and Protein change, causing cellular/tissue damage.^[5] The antioxidants defense system scavenges the free oxygen radicals, suppresses free radical chain reaction and lipid peroxidation. Thus, antioxidants play protects the human body from the harmful effects of ROS.^[6] Excessive production of ROS by oxidative phosphorylation or suppression of the antioxidant system resulting in an imbalance between the Pro-oxidants (ROS) and antioxidants in favor of pro-oxidants is called OS. These oxidative modifications may also lead to mutations in DNA and transfer the normal cell into a malignant cell.^[7]

Literature has expressed that antioxidants exert their protective effect by decreasing oxidative DNA damage and inhibiting the initiation and promotion of carcinogenesis. Reduced glutathione (GSH) is a ubiquitous tripeptide thiol compound that acts as a nonenzymatic antioxidant found in virtually all cells. GSH has a redox buffering capacity due to its ability to regenerate the essential antioxidants back to their active forms.^[8] It plays a critical role in protecting organisms against toxicity by detoxifying deleterious hydrogen peroxide and alleviating OS caused by enhanced free radical production and providing a reducing capacity for several reactions.^[9] GSH also maintains immune function by regulating mitogenic responses and cell proliferation.^[10] It is a valuable marker for assessing the antioxidant defense mechanism in malignancy.

MATERIALS AND METHODS

Protocol and registration

The present protocol has adhered strictly to the PRISMA guidelines. The systematic review has been registered in the PROSPERO database (CRD42021265189).

Focused question

Is there any significant difference in antioxidant GSH levels between oral squamous cell carcinoma (OSCC) patients and the control group?

Based on the focus of the present systematic review, the formulated research question includes the following components of the PECOS framework:

- i. Population: Patients with oral cancer
- ii. Exposure or Prognostic factor: Evaluation of GSH
- iii. Comparison: Between patients with oral cancer and healthy control group
- iv. Outcome: GSH standardized mean difference value in various biological samples of patients with OSCC
- v. Study: Identify prospective, cross-sectional and case-control studies investigating the oral cancer group's antioxidant GSH level.

Electronic search identification

The literature search was performed for published articles in electronic databases, including PubMed (MeSH), Science Direct, Scopus and Cross Reference. The articles that addressed the antioxidant defense status in OSCC using GSH levels from 1998 to 2020 were selected. The works only in English were selected, using the following keywords, "OSCC," "antioxidant status," and "GSH."

Screening for relevance

The articles that discussed antioxidant GSH levels in OSCC were collected and shortlisted. The titles and objectives of all the extracted materials were screened for applicability and duplication.

Inclusion criteria

- a. Papers assessed antioxidant status by GSH level in OSCC
- b. Studies evaluated different biological samples and expressed the GSH level in mean, standard deviation along with *P* value for freshly diagnosed OSCC patients and control group
- c. Papers delivered sufficient data for comparison of OSCC and control groups.

Exclusion criteria

- a. Articles displayed the unmatched objective and abstract
- b. Being animal studies, literature or systematic reviews and case reports
- c. The articles that had displayed Oral cancer under the Head-and-Neck Malignancy or oropharyngeal group had not provided specific data for OSCC
- d. Studies utilized other markers of nonenzymatic or enzymatic antioxidants for evaluation
- e. The works provided inadequate data for comparison between groups or articles expressed only pre- and post-treatment changes in OSCC without the control group evaluation.

Retrieval of full-text articles and evaluation

Three reviewers carried out an electronic search of the articles independently. If there is any disagreement, the consensus was reached based on the formulated criteria. The initial screening was accomplished by examining the titles and abstracts of the articles. The articles with matched objectives were carefully chosen for full-text review. Three observers independently assessed all the full-text papers against the New Castle Ottawa Scale and other specifications such as selection bias, missing and incomplete or imprecision data (e.g., inadequate sample size) and quality measures (e.g., ethics approval, informed consent, funding and conflicts of interest statement). After assessing all the particulars, the authors finally selected the eligible articles for the present systematic review.

Data extraction

The extracted data from full-text articles were author, publication year, sample size, GSH estimation method and measurements in specific units with statistical significance *P* value for OSCC and control groups. The segregated data were tabulated using the specified format.

Statistical analysis

The Forest plot was derived by the standard difference in the mean method by referring to the articles included in quantitative synthesis with the help of the comprehensive meta-analysis software. The overall standardized mean difference of GSH levels in OSCC was evaluated at a 95% confidence interval (CI). Due to significant heterogeneity between the articles, the random-effects model was used for quantitative synthesis.

RESULTS

From the methodology specified, we recovered 704 articles. Science Direct yielded 552 papers; Scopus search yielded 58 papers; PubMed search yielded 88 papers and Cross-reference yielded six papers. After fine-tuning, 657 articles were excluded because of irrelevant abstract and duplication. A full-text assessment was performed for 47 articles. After the final screening, the articles with inadequate data ($n = 4$) and reviews ($n = 16$) were excluded. After checking eligibility criteria, 27 articles with matched objectives were involved for qualitative synthesis. The articles containing incoherent data were not included for meta-analysis. Finally, 11 articles were included for quantitative synthesis [Figure 1]. We used the Newcastle-Ottawa quality assessment scale to weigh the selected studies [Table 1]. We tabulated all the derived data expressed in the eligible articles [Table 2].

Meta-analysis result

Compared to healthy tissues, GSH levels are significantly decreased ($P < 0.001$) in OSCC in plasma and erythrocyte samples. The plasma samples showed an overall standard mean difference of -7.191 with 95% CI (-9.45 to -4.94) [Figure 2 and Table 3]. The erythrocyte samples showed an overall standardized mean difference of -2.04 with 95% CI (-2.57 to -1.51) [Figure 3 and Table 4]. The meta-analysis in plasma samples exhibited high heterogeneity, reflected by the I^2 values 95.368 [Table 3]. In contrast, in erythrocyte samples, the I^2 value was 41.528, presented in Table 4. The diverse methodologies employed to assess the GSH levels could cause the high heterogeneity in plasma samples. Few studies compared the GSH level of OSCC for progressing clinical stages in various biological samples [Table 5]. The analysis of GSH levels between advancing histopathological grades is recorded in Table 6.

Publication bias

Studies included in the meta-analysis of erythrocyte samples were showed Begg and Mazumdar rank correlation; Kendall's tau without continuity correction gave a *Z* value for tau 0.522 with a two-tailed $P = 0.60$, indicating the absence of publication bias. Whereas studies included in the Meta-analysis of plasma samples were showed Begg and Mazumdar rank correlation, Kendall's tau without continuity correction gave a *Z* value for tau 2.47 with a two-tailed $P = 0.01$, which indicates a risk of publication bias.

DISCUSSION

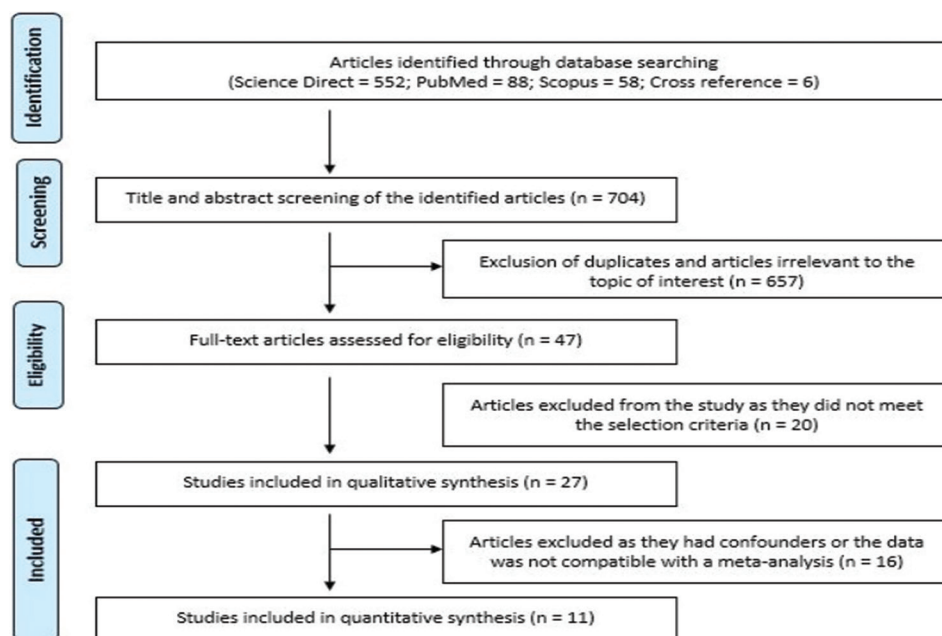
The free radicals (Oxidants) responsible for important diseases are Superoxide anion radical ($O_2^{\bullet-}$), Singlet oxygen (O_2), Hydroxyl radical ($\bullet OH$), Hydroperoxyl radical ($HOO\bullet$), Hydrogen peroxide (H_2O_2), Lipid peroxide radical ($ROO\bullet$), hypochlorite, nitric oxide ($NO\bullet$) and Peroxynitrite ($ONOO-\bullet$).^[44] In a healthy human, the balance is maintained between oxidants and antioxidants. However, in an abnormal condition, it produces an excess of oxidizing species. It suppresses the antioxidant defense, which causes a shift in the ratio toward pro-oxidants and induces OS.^[45] OS is the situation, initiates biomolecular damage, stimulates abnormal cell division and results in a malignant change of the tissue.

Several antioxidant compounds and enzymes may function to protect cellular components from oxidative damages.^[5] Some research has indicated that OSCC people tend to

Table 1: New castle ottawa scale for studies included in the systematic review

Study (reference number)	Selection	Comparability	Exposure	Total score
Nagini <i>et al.</i> , 1998 ^[11]	4	1	2	7
Saroja <i>et al.</i> , 1999 ^[12]	4	1	3	8
Balasenthil <i>et al.</i> , 2000 ^[13]	4	1	2	7
Subapriya <i>et al.</i> , 2002 ^[14]	4	2	2	8
Subapriya <i>et al.</i> , 2003 ^[15]	4	1	2	7
Kolanjiappan <i>et al.</i> , 2003 ^[16]	4	1	2	7
Beevi <i>et al.</i> , 2004 ^[17]	4	2	2	8
Manoharan <i>et al.</i> , 2005 ^[18]	4	2	3	9
Fiaschi <i>et al.</i> , 2005 ^[19]	4	1	2	7
Elango <i>et al.</i> , 2006 ^[20]	4	2	3	9
Rasheed <i>et al.</i> , 2007 ^[21]	4	1	3	8
Sharma <i>et al.</i> , 2009 ^[22]	4	2	2	8
Bathi <i>et al.</i> , 2009 ^[23]	4	2	3	9
Raghavendra <i>et al.</i> , 2010 ^[24]	4	1	3	8
Srivastava K <i>et al.</i> , 2012 ^[8]	4	1	2	7
Rasool <i>et al.</i> , 2014 ^[25]	4	1	2	7
Shetty <i>et al.</i> , 2014 ^[26]	4	1	3	8
Metgud <i>et al.</i> , 2014 ^[9]	4	1	3	8
Bhat <i>et al.</i> , 2015 ^[27]	4	1	2	7
Thomas and Sethupathy 2015 ^[28]	4	1	2	7
Srivastava K <i>et al.</i> , 2016 ^[3]	4	2	3	9
Banerjee <i>et al.</i> , 2017 ^[29]	4	2	3	9
Madhulatha <i>et al.</i> , 2017 ^[30]	4	1	2	7
Khan <i>et al.</i> , 2017 ^[31]	4	2	3	9
Basu <i>et al.</i> , 2018 ^[32]	4	1	1	6
Babiuch <i>et al.</i> , 2019 ^[33]	4	2	3	9
Shahi <i>et al.</i> , 2020 ^[34]	4	2	3	9

Selection - Case definition, case selection, control definition and selection, Comparability - Consideration of Matching known and potential confounding factors, Exposure - Securing patient records, interviewer blindness to groups, similarity ascertainment between groups and nonresponse rate

**Figure 1: Prisma flow chart – study selection**

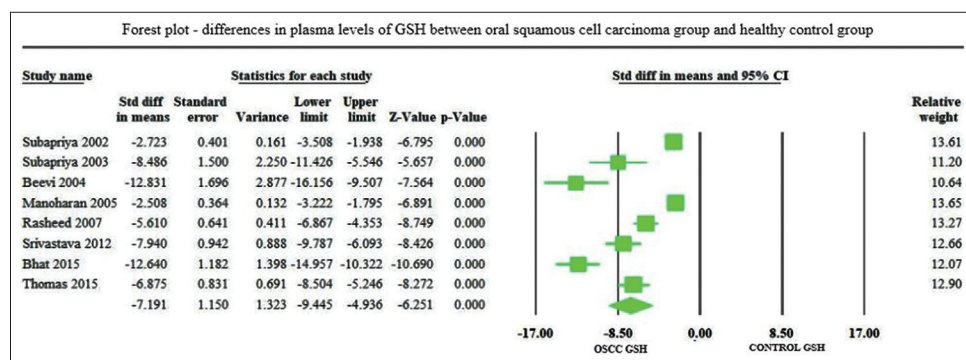
have decreased serum levels of antioxidant-GSH than healthy individuals.^[46] Earlier studies have reported a strong correlation between decreased risks of oral cancer with increasing blood glutathione levels.^[10]

Glutathione is an essential water-soluble antioxidant synthesized from the amino acids glycine, g-glutamate and cysteine. GSH has a total electron-donating capacity. Due to its high redox potential, GSH functions as a potent

Table 2: The levels of reduced glutathione in various biological samples between healthy controls and patients with oral squamous cell carcinoma

Study	Sample type	Measurement unit	Mean	SD	Sample size	Mean	SD	Sample size	P	Method of assessment
			OSCC			Control				
Nagini <i>et al.</i> ^[11]	Ti	moles/mg protein	17.406	4.27	24	6.326	1.82	24	<0.001	Beutler <i>et al.</i> ^[35]
Saroja <i>et al.</i> ^[12]	Ti	mg/100 g tissue	29.56	3.87	33	21.36	3.46	33	<0.001	Beutler <i>et al.</i> ^[35]
Balasenthil <i>et al.</i> ^[13]	Ti	mg/100 g tissue	26.5	2.6	10	20.4	2.3	10	<0.001	Beutler <i>et al.</i> ^[35]
Subapriya <i>et al.</i> ^[14]	Pl	mg/dl	26.4	2.72	24	35.32	3.75	24	<0.05	Ellman ^[36]
Subapriya <i>et al.</i> ^[14]	Ti	mg/100 g tissue	29.51	2.93	24	20.5		24	<0.05	Ellman ^[36]
Subapriya <i>et al.</i> ^[15]	Pl	mg/dl	24.72	2.45	6	36.6	0.35	12	<0.05	Anderson ^[37]
Kolanjiappan <i>et al.</i> ^[16]	Ti	nmol/mg protein	15.87	2.27	16	6.8	0.91	16	<0.001	Beutler <i>et al.</i> ^[35]
Beevi <i>et al.</i> ^[17]	Pl	mg/dl	3.09	0.53	15	10.02	0.55	15	<0.001	Thomas and Skrinska ^[38]
Manoharan <i>et al.</i> ^[18]	Pl	mg/dl	37.71	5.15	48	50.64	5.17	16	<0.001	Beutler <i>et al.</i> ^[35]
Manoharan <i>et al.</i> ^[18]	Er	mg/dl	41.1	3.32	48	50.15	4.12	16	<0.001	Lowry <i>et al.</i> ^[39]
Fiaschi <i>et al.</i> ^[19]	Ti	nmol/mg protein	25.71	4.976	18	4.39	0.899	20	<0.001	Tietze ^[40]
Fiaschi <i>et al.</i> ^[19]	Bl	μmol/ml	0.69	0.109	18	2.54	0.331	20	<0.001	Tietze ^[40]
Elango <i>et al.</i> ^[20]	Bl	nmol/dl	26.4	3.1	63	44.3	4.8	45	<0.001	Moron <i>et al.</i> ^[41]
Rasheed <i>et al.</i> ^[21]	Pl	mg/dl	3.01	0.57	24	8.28	1.2	24	<0.001	Thomas and Skrinska ^[38]
Sharma <i>et al.</i> ^[22]	Er	mg/dl	7.8401	0.7048	30	9.0873	0.51078	15	<0.001	Beutler <i>et al.</i> ^[35]
Sharma <i>et al.</i> ^[22]	Er	ug/ml	78.401	7.0478	30	90.873	5.1078	15	<0.001	Beutler <i>et al.</i> ^[35]
Bathi <i>et al.</i> ^[23]	Pl		8.8149		30	2.2367		30	<0.001	Beutler <i>et al.</i> ^[35]
Raghavendra <i>et al.</i> ^[24]	Er	mg/dl	40.69	7.04	25	53.06	7.79	25	<0.001	Beutler <i>et al.</i> ^[35]
Srivastava <i>et al.</i> ^[8]	Pl	mg/dl	32.43	2.8	20	48.93	0.893	20	<0.001	Ellman ^[36]
Rasool <i>et al.</i> ^[25]	Sa	mg/dl	0.88	0.25	30	2.09	0.24	10	<0.001	Spectrophotometric method
Rasool <i>et al.</i> ^[25]	Bl	mg/dl	2.4	0.77	30	9.82	1.32	10	<0.001	Spectrophotometric method
Shetty <i>et al.</i> ^[26]	Se	mg/dl	0.09479	0.02706	50	0.18804	0.03656	65	<0.001	DTNB method
Shetty <i>et al.</i> ^[26]	Sa	mg/dl	0.04787	0.02317	35	0.094.67	0.03659	35	<0.001	DTNB method
Shetty <i>et al.</i> ^[26]	Se	μg/dl	94.79	27.06	50	188.04	36.56	65	<0.001	DTNB method
Shetty <i>et al.</i> ^[26]	Sa	μg/dl	47.87	23.17	35	94.67	36.59	35	<0.001	DTNB method
Metgud and Bajaj ^[9]	Sa	nmol/dl	7.04	0.67	30	9.74	0.53	30	<0.001	Beutler <i>et al.</i> ^[35]
Metgud and Bajaj ^[9]	Se	nmol/dl	17.31	1.55	30	32.18	5.53	30	<0.001	Beutler <i>et al.</i> ^[35]
Bhat <i>et al.</i> ^[27]	Pl	mg/dl	2.89	0.65	30	10.5	0.55	30	<0.001	Thomas and Skrinska ^[38]
Thomas and Sethupathy ^[28]	Pl	mg/dl	26.3	2.4	20	41.15	1.89	20	<0.05	Ellman ^[36]
Srivastava <i>et al.</i> ^[3]	Ti	mg/dl	33.6	4.65	20	22.9	1.1	20	<0.001	Ellman ^[36]
Banerjee <i>et al.</i> ^[29]	Mi	mM	15.225	3.02	60	11.1	2.38	20	<0.001	Akerboom and Sies ^[42]
Madhulatha <i>et al.</i> ^[30]	Se		5.55	0.91	25	4.46	0.39	25	<0.001	
Khan <i>et al.</i> ^[31]	Se	mg/dl	2.58	0.031	50	9.77	1.37	20	<0.05	Tietze ^[40] and Moron <i>et al.</i> ^[41]
Basu <i>et al.</i> ^[32]	Ly	nmol/mg of protein	35.52	7.65	30	56.7	8.85	50	<0.001	Beutler ^[43]
Babiuch <i>et al.</i> ^[33]	Sa	mmol/l	0.01	0.01	20	0.02	0.01	20	<0.001	Beutler <i>et al.</i> ^[35]
Shahi <i>et al.</i> ^[34]	Pl	μmol/l	11.7	5.4	25	6.2	1.5	45	0.004	Moron <i>et al.</i> ^[41]

Ti: Tissue, Pl: Plasma, Er: Erythrocyte, Bl: Blood, Sa: Saliva, Se: Serum, Mi: Mitochondria, Ly: Lymphocyte, SD: Standard deviation, OSCC: Oral squamous cell carcinoma, DTNB: Ellman's Reagent (5,5-dithio-bis-2-nitrobenzoic acid)

**Figure 2:** Forest plot shows standardized mean difference estimates with 95% confidence intervals representing differences in plasma levels of reduced glutathione between oral squamous cell carcinoma group and healthy controls

antioxidant and a convenient cofactor for the enzymatic reaction. It also maintains the redox state of protein

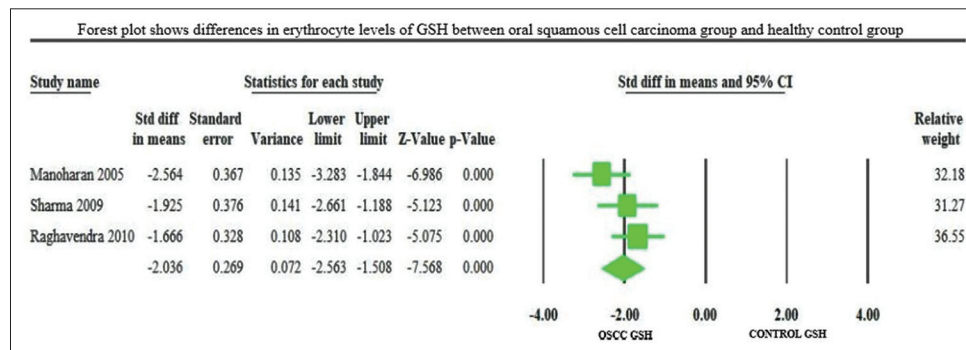
sulfhydryls necessary for DNA repair.^[47] This molecule is also involved in conjugation with electrophilic carcinogens

Table 3: Test for overall effect size and Heterogeneity values for studies included in meta-analysis - plasma samples.

Model	Effect size and 95% confidence interval				Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model (no of studies)	Point Estimate	SE	Variance	CI Values Lower/Upper	Z - value	P-value	Q-value	Df (Q)	P-value	I-Squared	Tau Squared	SE	Variance	Tau
Fixed (8)	-4.224	0.222	0.049	-4.659/-3.789	-19.026	0.000	151.118	7	0.000	95.368	9.563	7.411	54.926	3.092
Random (8)	-7.191	1.150	1.323	-9.445/-4.936	-6.251	0.000								

Table 4: Test for overall effect size and Heterogeneity values for studies included in meta-analysis - erythrocyte samples.

Model	Effect size and 95% confidence interval				Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model (no of studies)	Point Estimate	SE	Variance	CI Values Lower/Upper	Z - value	P-value	Q-value	Df (Q)	P-value	I-Squared	Tau Squared	SE	Variance	Tau
Fixed (3)	-2.023	0.205	0.042	-2.425/-1.621	-9.868	0.000	3.420	2	0.181	41.528	0.090	0.217	0.047	0.300
Random (3)	-2.036	0.269	0.072	-2.563/-1.508	-7.568	0.000								

**Figure 3:** Forest plot shows standardized mean difference estimates with 95% confidence intervals representing differences in erythrocyte levels of reduced glutathione between oral squamous cell carcinoma group and healthy controls

and catalyzes the decomposition and detoxification of ROS. Thus, it prevents accumulation, protects the cells against oxidative damage and limits cell injury, preventing carcinogenesis.^[9] It regenerates the essential antioxidants, Vitamins C and E, back to their active forms. Glutathione includes a reduced form (or GSH) and an oxidized form (or glutathione disulfide [GSSG]). The regenerating capacity of Glutathione is linked with the Redox state of the GSSG-glutathione couple (GSSG/2GSH). Therefore, the intracellular “Redox homeostasis” or “Redox buffering” capacity is substantiated primarily by GSH.^[48] GSH and its precursors prevent the arecoline-induced cytotoxicity of tobacco and betel quid chewers. When exposed to excessive xenobiotics, including carcinogens, more Glutathione is utilized for conjugation (detoxification). It decreases the GSH/GSSG ratio, making it less available, decreasing body defense against free radicals.^[18] GSH depletion is sufficient to sensitize cancer cells to oxidative and nitrative stress, which leads to DNA damage.^[49] DNA degeneration that may result in the activation of carcinogens leads to cancer initiation and progression.^[8] Thus, assessing antioxidant thiol levels is a valuable biomarker to predict oral cancer

patients’ risk of progression of carcinogenesis and overall survival.^[50]

There has been a report of decreased antioxidants and increased protein-and DNA oxidation products in the saliva of OSCC patients.^[51]

The present systematic review included 1052 patients diagnosed with OSCC and 910 healthy volunteers for GSH analysis. The present work evaluated the literature to analyze antioxidant enzyme GSH in various biological samples of patients diagnosed with OSCC and healthy controls. The authors used various laboratory methods to assess GSH levels.^[35-42]

The present systematic review displayed a significant decrease of mean GSH level in various biological samples of OSCC patients as compared with the control ($P < 0.001$).^[8,9,17-27,32,33] A similar diminishing trend was reported in plasma level of GSH in oral cancer patients compared to controls with statistical significance $P < 0.05$.^[14,15,28,31] Antioxidant depletion in the blood may be due to increased utilization in lipid peroxides scavenging

Table 5: The levels of reduced glutathione in various samples of patients with different clinical stages of oral squamous cell carcinoma

Study	Sample type	Measurement unit	Clinical stages								Statistical significance	Criteria
			Stage I		Stage II		Stage III		Stage IV			
			Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Manoharan <i>et al.</i> ^[18]	Pl	mg/dl	-	-	44.09	5.62	37.56	4.98	31.48	4.86	<0.01	UICC
Manoharan <i>et al.</i> ^[18]	Er	mg/dl	-	-	45.24	3.86	40.92	2.93	37.14	3.16	<0.01	UICC
Srivastava <i>et al.</i> ^[8]	Pl	mg/dl	-	-	34.58	2.01	32.8	2.5	30.76	2.64	Nonsignificant	TNM
Srivastava <i>et al.</i> ^[3]	Ti	mg/dl	-	-	28.3	0.91	32.8	2.83	37.56	3.65		<0.01
Kolanjiappan <i>et al.</i> ^[16]	Ti	nmol/mg protein	-	-	10.9	1.3	15.8	1.3	20.9	4.2	<0.001	AJCC
Banerjee <i>et al.</i> ^[29]	Mi	mM	15.2	3.87	13.2	2.36	15.3	2.63	17.2	3.25	<0.001	TNM

Pl: Plasma, Er: Erythrocyte, Ti: Tissue, Mi: Mitochondria, SD: Standard deviation, UICC: Union for International Cancer Control, TNM: Tumor Node Metastasis, AJCC: American Joint Committee on Cancer

Table 6: The levels of reduced glutathione in various samples of patients with different histopathological grades of oral squamous cell carcinoma

Study	Sample	Unit	WD		MD		PD		Statistical significance <i>P</i>
			Mean	SD	Mean	SD	Mean	SD	
Sharma <i>et al.</i> ^[22]	Er	ug/ml	80.554		77.63072		76.55867		>0.05
Metgud and Bajaj ^[9]	Sa	nmol/dl	6.9	0.75	7.18	0.59	-		>0.05
Metgud and Bajaj ^[9]	Se	nmol/dl	16.84	1.48	17.78	1.62	-		>0.05

Er: Erythrocyte, Sa: Saliva, Se: Serum, SD: Standard Deviation, WD: Well-differentiated, MD: Moderately differentiated, PD: Poorly differentiated

and the counter-reaction of oxidative conditions induced by pro-oxidants.^[9] The decrease in GSH levels is from the repression of synthesizing enzymes and increased conjugation with arecoline,^[52] and increased sequestration by the tumor cells to meet a growing tumor's demands.^[14] Depletion of GSH may sensitize tumors to chemotherapy and radiotherapy.^[53] Thus concerning these facts, assessing antioxidant status both in tumor tissue and adjacent normal tissue might prove beneficial for cancer patients before radiotherapy and chemotherapy.

On the contrary, another reported study in plasma and serum samples displayed an increase in GSH level with statistical significance ($P < 0.001$)^[23,30] and ($P < 0.01$) in OSCC patients than in the control group.^[34] Glutathione levels were significantly increased in all groups compared to controls. The increased levels of GSH in erythrocytes may be in response to the toxins released by cytologically altered cells. It is believed that these erythrocytes are resistant to oxidative hemolysis. They were adequately protected against any free radical damage even if serum levels of other antioxidants were suppressed.^[23] The increased levels of GSH in these patients reflect the increased detoxification capacity and resistance in response to the cytotoxic substances released by carcinogen-altered cells.^[23]

Similarly, few authors reported significantly increased tissue levels of GSH in the OSCC group ($P < 0.001$).^[3,11-13,16,19] and ($P < 0.05$).^[14] Another study also expressed a statistically significant GSH level increase in mitochondria samples of OSCC patients compared to the control group ($P < 0.001$).^[29]

Prolonged direct contact of the quid with the oral mucosa leads to the seepage of the carcinogens. Finally, it gets concentrated in high volumes in the local environment of the tissue. These carcinogens from tobacco smoke or quid are predominantly detoxified by enhanced glutathione-dependent enzymes in the tumor tissue. GSH offers cell protection against ROS's cytotoxic effect and makes them more resistant to OS.^[3] It can also be suggested that tumor tissue and plasma are two different compartments regarding behavior toward OS.^[3]

Some of the studies compared the levels of GSH in each of the clinical stages of OSCC. The mean GSH level of one study in plasma and erythrocyte samples showed a significant gradual reduction ($P < 0.01$) when the clinical grade of OSCC advances.^[18] One study in plasma displayed that the reduction of GSH levels was insignificant when the clinical-stage OSCC advanced.^[8] Moreover, the decrease in antioxidant enzyme levels showed no significant relation with the tumor stage in the patients.^[8] The GSH levels were gradually decreased from stage II to stage IV of oral cancer patients.^[8,18] Few studies documented that the mean GSH level showed a significant gradual rise ($P < 0.001$)^[16,29] and ($P < 0.01$) when the clinical grade of OSCC advances.^[3] In Sharma *et al.*'s study, a significantly lower level of GSH was observed in patients with tongue SCC (Stage III/IV) compared to control individuals. Early stages of tongue SCC were not evaluated in their study since all of their patients were in advanced stages.^[22]

Sharma *et al.* had observed that GSH levels were mainly reduced in poorly differentiated tumors than in well and moderately differentiated tumors. On statistical analysis, the comparison is found to be insignificant.^[22] On the contrary, Metgud and Bajaj reported a statistically insignificant rise in serum and salivary GSH levels in moderately differentiated tumors compared to well-differentiated tumors ($P > 0.05$).^[9]

Limitation

The apparent discrepancies could be partly due to different laboratory techniques used to measure the GSH level. Only a few studies had expressed the clinical stage-wise and histopathological grade-wise analysis. Hence, there is no definitive GSH level change prediction according to varying clinical stages and histopathological grades.

CONCLUSION

The ROS in the blood is supposed to play a vital role in mutations in the cell; thus, normalization of oxidant-antioxidant status might improve the prognosis of patients.

Hence, antioxidants play a vital role as valuable markers in the prognosis of oral cancer. Further elaborative studies with a larger sample size could ratify the value of GSH as a prognostic marker of OS to determine the progression of various stages of cancer.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Sathyabama College of Nursing
Sathyabama Institute of Science and Technology

(DEEMED TO BE UNIVERSITY)

Accredited with "A" grade NAAC

Jeppiar Nagar, Rajiv Gandhi Salai, Chennai – 600119



Ref.No.063/Dean/PHC/2022

06/06/2022

To

The Managing Director,
Public Health Centre,
West Mambalam,
Chennai-600033

Sub: Clinical training in your Esteemed Organization -regarding

Respected Sir/Madam,

Greetings from Sathyabama College of Nursing, Sathyabama Institute of Science & Technology!

We Sathyabama College of Nursing, a constituent College of Sathyabama Institute of Science & Technology, offers four year B.Sc Nursing course from 2019.

As per the clinical requirements, Nursing students have to undergo Clinical training in Various wards, ICU, OPD, CSSD, Blood Bank & OT. Hence we request you to kindly permit our Second (60) & Third Year (28) B.Sc Nursing Students to have their clinical experience in your esteemed organization from June 2022 to August 2022.

Kindly grant us permission and do the needful.

Thanking You,



6/6/22

L. Lakshmi
Yours truly,

Dean



DEAN
SATHYABAMA
COLLEGE OF NURSING
Jeppiar Nagar, Rajiv Gandhi Salai,
Chennai – 600 119.

PUBLIC HEALTH CENTER- 9From 1-Apr-2017)

174, LAKE VIEW ROAD,
WEST MAMBALAM,
CHENNAI-600033
STATE NAME: Tamilnadu, Code: 33
E-mail: mdphc2012@yahoo.com

Receipt Voucher

Dated : 19-Jul-22

Sl.No: 1555

Particulars	Amount
-------------	--------

Account:

Miscellaneous –clinical training for sixty students

1,80,000/-

Account of:

Being received from Sathyabama College of Nursing for
training 60 students BSc Nursing

Rs.1,80,000/-

[Signature]
19/7/22

Authorised Signatory





ABSTRACT

Para Medical Education - **Sathyabama College of Nursing**, Chennai - Tie-up arrangements with Thiruporur, Government Hospital, Chengalpattu District for their B.Sc (Nursing) Course students from the academic year 2020-2021 to 2023-2024 - Permission- Granted – Orders – Issued.

HEALTH AND FAMILY WELFARE (PME-2) DEPARTMENT

G.O.(Rt) No.188

Dated:18.02.2021
Saarvari, Maasi-06
Thiruvalluvar Aandu 2052

Read again:

1. G.O. (Ms) No.323, Health and Family Welfare (PME.2) Department, Dated: 31.07.2019.

Read also:

2. From the Director of Medical and Rural Health Services, letter Ref.041609/N1/1/2020, dated 07.01.2021.

ORDER:

In the circumstances reported by the Director of Medical and Rural Health Services in his letter second read above, permission is accorded to the Principal, Sathyabama College of Nursing, Chennai to have tie-up arrangements with Thiruporur, Government Hospital, Chengalpattu District for their 60 students of 4 years B.Sc (Nursing) course from the academic year 2020-2021 to 2023-2024, subject to the following conditions:-

- i. Students should be deputed in small batches;
- ii. Clinical training should be given without any hindrance to the normal functioning of Thiruporur, Government Hospital, Chengalpattu District and without any financial implications to the Government.
- iii. The Hospital should maintain 1:3 student: patients ratio every day of clinical training based on rotation.
- iv. The institution should pay the prescribed fees for the students who are deputed for training as per G.O (D) No.738, Health and Family Welfare (PME.1) Department, dated 20.08.2020 and obey the conditions stipulated in G. O. (D) No.1258, Health and Family Welfare (MCA.2) Department, dated: 20.11.2014.

2. The Director of Medical and Rural Health Services is directed to take necessary action accordingly.

(BY ORDER OF THE GOVERNOR)

J. RADHAKRISHNAN
PRINCIPAL SECRETARY TO GOVERNMENT

To

The Director of Medical and Rural Health Services, Chennai - 600 006.

✓ The Principal, **Sathyabama College of Nursing**, Jeppiar Nagar, Rajiv Gandhi Salai, Chennai - 600 119.

The Joint Director of Health Services, Kancheepuram.

Copy to:

The Special Personal Assistant to Hon'ble Minister (Health and Family Welfare), Chennai - 600 009.

The Health and Family Welfare (Data Cell) Department, Chennai - 600 009.

Stock File / Spare Copy.

//FORWARDED / BY ORDER //

P. Senthikumar

SECTION OFFICER

13/12/2021

112



ABSTRACT

Para Medical Education - Sathyabama College of Nursing, Chennai - Tie-up arrangements with Chengalpattu Medical College Hospital, Chengalpattu for their B.Sc(N) Course students from the academic year 2022-2023 to 2025-2026 – Permission - Granted – Orders – Issued.

HEALTH AND FAMILY WELFARE (PME-2) DEPARTMENT

G.O.(Rt)No.204

Dated: 27.02.2023
Subakiruthu, Maasi-15
Thiruvalluvar Aandu 2054

Read again:

1. G.O. (Ms) No.323, Health and Family Welfare (PME.2) Department, Dated: 31.7.2019.
2. G.O. (Rt.) No.188, Health and Family Welfare (PME.2) Department, Dated: 18.2.2021.

Read also:

3. From the Director of Medical Education, letter Ref. No. 59704/NE3/2022, dated: 20.01.2023.

ORDER:

In the circumstances reported by the Director of Medical Education in her letter second read above, permission is accorded to the Dean, Sathyabama College of Nursing, Chennai run by Sathyabama Institute of Science and Technology, Chennai to have tie-up arrangements with Chengalpattu Medical College Hospital, Chengalpattu for availing clinical training of their 60 students of 4 years B.Sc(N) course students from the academic year 2022-2023 to 2025-2026, subject to the following conditions:-

- i. Students should be deputed in small batches;
- ii. Clinical training should be given without any hindrance to the normal functioning of the Chengalpattu Medical College Hospital, Chengalpattu without any financial implications to the Government;
- iii. The Hospital should maintain 1:3 student: patients ratio every day of clinical training based on rotation;
- iv. The institution should pay the prescribed fees for the students who are deputed for training as per G.O (D) No.738, Health and Family Welfare (PME.1) Department, dated 20.08.2020 and obey

the conditions stipulated in G.O.(D) No.1258, Health and Family Welfare (MCA.2) Department, dated: 20.11.2014.

2. The Director of Medical Education is directed to take necessary action accordingly.

(BY ORDER OF THE GOVERNOR)

**P. SENTHILKUMAR
PRINCIPAL SECRETARY TO GOVERNMENT**

To

The Director of Medical Education, Chennai - 600 010.

✓ The Dean, Sathyabama College of Nursing, Jeppiar Nagar,
Rajiv Gandhi Salai, Chennai – 600119.

The Dean, Chengalpattu Medical College, Chengalpattu.

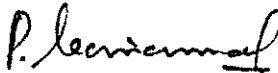
Copy to:

The Special Personal Assistant to Hon'ble Minister (Health and Family Welfare),
Chennai-600 009.

The Health and Family Welfare (Data Cell) Department, Chennai 600 009.

Stock File / Spare Copy.

//FORWARDED/ BY ORDER //


SECTION OFFICER

From
City Medical Officer (i/c)
Medical Services Department
Greater Chennai Corporation
Ripon Building
Chennai - 3

To
The Principal
Sathyabama College of Nursing
Jeppair Nagar,
Rajiv Gandhi Salai,
Chennai -600119.

M.S.D / Trg/F20/1856/2022

Date: 27.03.2023

Respected Sir/Madam,

Sub: Medical Services - Programme – Training- Greater Chennai Corporation -
Permission accorded- Sathyabama College of Nursing- 28 Nos of IVth year
BSc (N) Students at Preungudi UCHC from 01.04.2023 to 30.06.2023 –
Midwifery Experience – Orders issued - Regarding.

Ref: 1. Your letter dated: 07.11.2022.
2. Corporation Treasury Challan No.HD/2022-23/0052189
Dated : 27.03.2023.

With reference to your letter cited , permission is accorded to 28 Nos of IVth year
BSc (N) students of your College of Nursing to gain Midwifery Experience at Perungudi
UCHC from 01.04.2023 to 30.06.2023 as detailed below.

SL. No.	Name of the students	No.of students	Location	Duration	Course content.
1	List Enclosed	28 Nos of IVth Year BSc (N) Students	Perungudi UCHC 14 Students (Day-11, Night-3)	01.04.2023 to 15.05.2023	Midwifery Experience
			Perungudi UCHC - 14 Students (Day-11, Night-3)	16.05.2023 to 30.06.2023	

Terms & Conditions

1. Night Duty is a must
2. Should be posted in rotation to Antenatal OP, Labour Room, Postnatal Ward, NBSU, Operation Theatre, Post Operative Ward.
3. Health Education to be given on Antenatal Care, High risk Pregnancy, Family Welfare Methods, Perineal Care, Postnatal Exercises, Breast Feeding, New born care, Immunization, Warning Signals of complication in New Born and Postnatal care.

Time :- Day :- 8 AM to 4 PM , Night : 8 PM to 8 AM.

Note: Timing to be strictly maintained.

City Medical Officer(i/c)

07.02
20/3/2023
City Medical officer /
Additional Director
Medical Services Department
Greater Chennai Corporation

PROFORMA
Midwifery Experience

S. No.	PARTICULARS	DETAILS
1	Name of the Student	
2	Period of Posting	
3	Place of Posting	
4	No. of AN given care	
5	No. of Deliveries conducted	
6	No. of Postnatal care given	
7	No. of 0 – 1 years given care	
8	No. of FW method Motivated	
9	No. of Special Campaigns attended	
10	No. of Days to be attended	
11	No. of OT session attended	
12	No. of Days actually attended	
13	General remarks	

Study Off/ Week Off/ Leave should be informed to the UCHC Medical Officer concerned. To maintain decorum. After completion of training the Principal of College of Nursing has to submit a report of the above details in the Proforma enclosed.

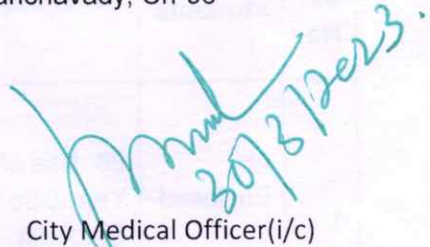
The Principal of College of Nursing, Sathyabama College of Nursing is requested to contact the Zonal Medical Officer of Perungudi Zone for necessary arrangements.

Address & Contact No.:

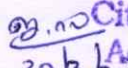
Perungudi UCHC : No.1, School Road, Ramappa Nagar, Kandhanchavady, Ch-96

ZMO- Dr.Thendral :9790925192

MCHO- Gowri Mohan - Ms. 9600028583


City Medical Officer(i/c)

Copy to : The Zonal Medical Officer, Perungudi Zone.


City Medical officer /
Additional Director
Medical Services Department
Greater Chennai Corporation

M.S.D / Trg/F20/1011/2023

Date: 30.03.2023

Respected Sir/Madam,

Sub: Medical Services - Programme - Training- Greater Chennai Corporation -
Permission accorded- Sathyabama College of Nursing- 28 Nos of IVth year BSc
(N) Students at Palavakkam UPHC from 01.04.2023 to 30.06.2023 - Urban
Community Health Experience - Orders issued - Regarding.

Ref: 1. Your letter dated: 27.03.2023.
2. Corporation Treasury Challan No.HD/2022-23/0052559
Dated : 30.03.2023.

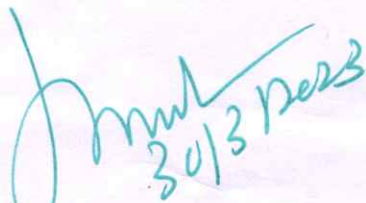
With reference to your letter cited , permission is accorded to 28 Nos of IVth year BSc
(N) students of your College of Nursing to gain Urban Community Health Experience at
Palavakkam UPHC from 01.04.2023 to 30.06.2023 as detailed below.

SL. No.	Name of the students.	No.of students.	Location	Duration	Course content.
1	List Enclosed	28 Nos of IVth Year BSc (N) Students	Palavakkam UPHC 14 Students	01.04.2023 to 15.05.2023	Urban CommunityHealth Experience
			Palavakkam UPHC - 14 Students	16.05.2023 to 30.06.2023	

Terms & Conditions

- 1.Each Student Nurse should visit 25 Families per day Students should go along with UHNs only for family visit (Approximately 125 – 150 Population per day)
- 2.During the Family visit, the Student Staff Nurses should
 - Update enumeration
 - Motivate unprotected couples for Family Welfare Methods
 - Collect Data of delivery of Babies
 - Register Antenatal if any
3. - New Born Babies follow up & monthly follow up of all postnatal babies after discharge till 42 days.
4. Health education to the family on – RCH, NCD activities, Anemia prevention, WIFS etc.
5. Participate in Special Campaign (i.e) Intensified Pulse Polio Programme , Outbreak response, Measles Camp, Vit . A Camp , National Deworming Day Camp , Ante Diarrhoea Camp etc
6. Observing / Assisting in outreach sessions .

Time :- 8 AM to 3 PM


City Medical Officer(i/c)
Additional Director

PROFORMA
Community Health Experience

S. No.	PARTICULARS	DETAILS
1	Name of the Student	
2	Period of Posting	
3	Place of Posting	
4	No. of Families Visited	
5	No. of AN given care	
6	No. of 0 – 1 years given care	
7	No. of PN Care given	
8	No. of fever cases attended	
9	No. of NCD Cases Motivated	
10	No. of UPC Motivated	
11	No. of Special Campaigns attended	
12	No. of Outreach sessions attended	
13	No. of Days to be attended	
14	No. of Days actually attended	
15	General remarks	

Note: Timing to be strictly maintained. Study Off/ Week Off/ Leave should be informed to the UPHC/UCHC Medical Officer concerned. To maintain decorum. After completion of training the Principal has to submit a report of the above details in a Proforma enclosed.

The Principal of College of Nursing , **Sathyabama College** is requested to contact the Zonal Medical Officer of Sholinganallur Zone for necessary arrangements.

Address & Contact No.:

- Palavakkam UPHC: East coast road, Palavakkam, Ch-41

ZMO- Dr.Thendral :9790925192

MCHO- Gowri Mohan - Ms. 9600028583

City Medical Officer (I/c)

City Medical officer

Additional Director

Medical Services Department
Greater Chennai Corporation

Copy to : The Zonal Medical Officer, Perungudi Zone.



Sathyabama College of Nursing
**Sathyabama Institute of Science and
Technology**

(DEEMED TO BE UNIVERSITY)

Accredited with "A" grade NAAC

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600119



RefNo: 058/Dean/BOAZ/2023

04.01.2023

To

The Medical Superintendent,
Dr.G.D.Boaz Memorial Hospital,
Santhoshapuram,
Chennai

Sub: Grant of permission for clinical training-for B.Sc Nursing III year Students –request-reg.,

Respected Sir,

Greetings from Sathyabama College of Nursing, Sathyabama Institute of Science & Technology!

We wish to kindly inform you that III year Bsc (N) students (60 in No.) of our institution have to undergo clinical training in the area of psychiatry as per their curricular requirements.

Hence requesting you to kindly grant us permission to post our III year students in various clinical areas of your hospital from Jun'23 to July'23 tentatively.

Kindly do the needful.

Thanking You

Yours Sincerely

(Dr.L Lakshmi)

Dean
DEAN

SATHYABAMA
COLLEGE OF NURSING
Jeppiaar Nagar, Rajiv Gandhi Salai,
Chennai – 600 119.

Request has been accepted.

Dr.G.D. BOAZ MEMORIAL HOSPITAL SCHOOL
#2/234, Velachery Main Road,
Santhoshapuram, Chennai - 600 073.



Co-funded by the
Erasmus+ Programme
of the European Union

ESTABLISHED OF CENTRE FOR TEACHING EXCELLENCE


SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
www.sathyabama.ac.in

Ref.no:SIST/R/FRACTION/12 Date: 24.03.2022

ORDER

Establishing Centre of Teaching Excellence (CTE) as a part of EU Project – Proposal from Dr.N.KANNAN - Professor, School of Management Studies - Resolution of the Syndicate – Communicated – Orders issued

The management / syndicate of Sathyabama Institute of Science and technology along with the recommendation of the Committee members of the institution accepts the proposal from Dr.N. Kannan, Professor, School of Management Studies for the implementation of EU project in the institution.

The following activities are to be initiated are to be implemented as a part of project implementation

- Establishment of the Centre for Teaching Excellence in CTE in Sathyabama Institute of Science and Technology
- Nomination of a Head of the Centre / Director for the established CTE.
- Authorizing the Head / Director of CTE to provide adequate space for setting up the facilities for CTE from the space available in Sathyabama Institute of Science and Technology.
- Permission to the Head / Director of CTE to select teachers for giving training in a systematic manner based on the norms provided by the project coordinator and with the approval given by the institution

The Syndicate endorses for the establishment of Centre of Teaching Excellence (CTE) as a part of EU project in Sathyabama Institute of Science and technology, Chennai with the Director as Coordinator without any financial commitment to the institution. The management also resolves that the selection of teachers for training under the project "Fraction" shall be done with the approval of the Institution.


Dr.T.SASIPRABA
Vice – Chancellor

Copy to:-
The Registrar, SIST
Director – Research


SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Jepplaar Nagar, Rajiv Gandhi Salai, Chennai, Tamilnadu, India
RIDE - 2023
Royal Enfield Inter Department Extravaganza

ROYAL ENFIELD

Certificate of appreciation

This is to certify that

Mr./Ms _____

is the **WINNER** of the event **MINUTE TO FAME** in "RIDE-2023"

an interdepartmental event competition organized by Sathyabama Institute of Science and Technology in association with **ROYAL ENFIELD** on 21st March 2023.

DR. BHUVANESWARI .G
DEAN -SCHOOL OF MGT. STUDIES
SATHYABAMA

DR. G. SUNDARI
Director(Administration)



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI, TAMILNADU, INDIA

CENTRE OF TEACHING EXCELLENCE (CTE)

Invites you for the Inauguration
of

POST GRADUATE PROGRAM IN TEACHING EDUCATION (PgPTE)

Future - Oriented Teacher Education Program with Innovative Methodologies
Certified by the European Agency ACQUIN and funded by Erasmus+ FRACTION Project

on

6th March 2023 at 11.00 a.m.

Venue : Sathyabama Campus -Block 12

Co-funded by the
Erasmus+ Programme
of the European Union



FILE NO. TAR/2021/000041
SCIENCE & ENGINEERING RESEARCH BOARD(SERB)
(A statutory body of the Department of Science & Technology, government of India)

Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 07-Jan-2022

ORDER

Subject: Financial Sanction **under Teachers Associateship** for Research Excellence (TARE) to Dr. Karthikeyan J, **Sathyabama Institute Of Science And Technology , Sathyabama University, Jeppiar Nagar, Rajiv Gandhi Road, Chennai, Chennai, Tamil Nadu- 600119-** under the mentorship of Dr. Md. Mahiuddin Baidya, at **Indian Institute of Technology Madras I.I.T. Post Office Chennai - 600036-** Release of 1st grant.

Sanction of **Science and Engineering Research Board (SERB)** is hereby accorded to the above mentioned grant at a total cost of **Rs. 18,30,000/- (Rs. Rupees Eighteen Lakh Thirty Thousand only Only)** for a duration of 36 months.

The date of start of the project will be 17 December, 2021 .The items of expenditure for which the total allocation of **Rs. 18,30,000/-** has been approved are given below:

The following budget is proposed for

Sathyabama Institute Of Science And Technology , Sathyabama University, Jeppiar Nagar, Rajiv Gandhi Road, Chennai, Chennai, Tamil Nadu-600119 (Parent)

Sl. No.	Budget Head	Amount
1.	Fellowship	Rs. 0 (@0/- per month (consolidated))
2.	Research Grant	Rs. 2,50,000/- per annum
3.	Overheads	Rs. 25,000/- per annum

Indian Institute of Technology Madras I.I.T. Post Office Chennai - 600036 (Host)

Sl. No.	Budget Head	Amount
1.	Fellowship	Rs. 60,000 (on completion of 90 days mandatory attendance in the host institute every year)
2.	Research Grant	Rs. 2,50,000/- per annum
3.	Overheads	Rs. 25,000/- per annum

2. Sanction of the **SERB** is also accorded to the payment of **Rs. 2,75,000/-** (Rupees Two Lakh Seventy Five Thousand only) to **Sathyabama Institute Of Science And Technology , Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai , Rs. 3,35,000/-** (Rupees Three Lakh Thirty Five Thousand only) to **Indian Institute of Technology Madras I.I.T. Post Office Chennai - 600036** being the first installment of the grant for the year 2021-2022 for implementation of the said research project.

3. The expenditure involved is debitable to

Fund for Science & Engineering Research (FSER)

This release is being made under Teachers Associateship For Research Excellence (TARE). (Organic Chemistry)

4. The Sanction has been issued to with the approval of the competent authority vide Diary No. **SERB/F/6762/2021-2022** dated **05 January, 2022**

5. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at website (www.serb.gov.in).

6. Overhead expenses are meant for the host Institute towards the cost for providing infrastructural facilities and general administrative support etc. including benefits to the staff employed in the project.

7. As per rule 211 of GFR, the accounts of project shall be open to inspection by sanctioning authority/audit whenever the institute is called upon to do so.

8. The release amount of **Rs. 2,75,000/-** (Rupees Two Lakh Seventy Five Thousand only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

Sathyabama Institute of Science and Technology , Sathyabama university, jeppiar nagar, rajiv gandhi road, chennai, Chennai, Tamil nadu-600119 (Parent) :

PFMS Unique Code	SU
Account Name	SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY - RESEARCH
Account Number	6089858032
Bank Name & Branch	INDIAN BANK INDIAN BANK, SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, RAJIV GANDHI SALAI, CHENNAI 600119.
IFSC/RTGS Code	IDIB000S201
Email address of PI	dr.j.karthikeyan@gmail.com
Email id of A/C Holder	provcs@sathyabama.ac.in
Email address of concerned officer	ms_tare@serbonline.in

The release amount of **Rs. 3,35,000/-** (Rupees Three Lakh Thirty Five Thousand only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

Indian Institute of Technology Madras I.I.T. Post Office Chennai - 600036 (Host) :

PFMS Unique Code	IITM
Account Name	THE REGISTRAR, INDIAN INSTITUTE OF TECHNOLOGY MADRAS
Account Number	2722101016150
Bank Name & Branch	CANARA BANK CANARA BANK, IITM BRANCH, IITM CAMPUS POST OFFICE, SARDAR PATEL ROAD, ADYAR, CHENNAI 600036
IFSC/RTGS Code	CNRB0002722
Email address of PI	dr.j.karthikeyan@gmail.com
Email id of A/C Holder	deanicsr@iitm.ac.in
Email id of Mentor	Dr. Md. Mahiuddin Baidya

9. Both the institutes will furnish Utilization certificate(UCs) financial year wise to the SERB and an audited statement of accounts pertaining to the grant immediately after the end of each financial year.

10. The institute will maintain separate audited accounts for the fellowship. A part or whole of the grant must be kept in an interest earning bank account which is to be reported to SERB. The interest thus earned will be treated as credit to the institute to be adjusted towards further installment of the grant.

11. The File no. **TAR/2021/000041** may also be mentioned in all research communications arising from the above project with due acknowledgement of **SERB**.

12. As this is the first grant for the fellowship, no previous U/C is required.

13. The institute may refund any unspent balance to SERB by means of a Demand Draft favoring "**FUND FOR SCIENCE AND ENGINEERING RESEARCH**" payable at New Delhi.

14. The organization/institute/university should ensure that the technical support/financial assistance provided to them by the Science & Engineering Research Board, a statutory body of the Department of Science & Technology (DST), Government of India should invariably be highlighted/ acknowledged in their media releases as well as in bold letters in the opening paragraphs of their Annual Report.

15. In addition, the investigator/host institute must also acknowledge the support provided to them in all publications, patents and any other output emanating out of the project/program funded by the Science & Engineering Research Board, a statutory body of Department of Science & Technology (DST), Government of India.


(Dr. T Thangaradjou)
Scientist F
msls@serb.gov.in

To,
Under Secretary
SERB, New Delhi

Copy forwarded for information and necessary action to:-

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
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3.	File Copy
4.	(i) Dr. Karthikeyan J CHEMISTRY Sathyabama Institute of Science and Technology, Sathyabama university, jeppiar nagar, rajiv gandhi road, chennai, Chennai, Tamil nadu-600119 Email: dr.j.karthikeyan@gmail.com Mobile: 919443029048 (ii) Dr. Md. Mahiuddin Baidya Indian Institute of Technology Madras I.I.T. Post Office Chennai - 600036 (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	(i) pro vice chancellor, Sathyabama Institute Of Science And Technology, Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai (ii) DEAN ICSR Indian Institute of Technology Madras I.I.T. Post Office Chennai - 600036 (Receipt of Grant may be intimated by name to the undersigned)


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सी.एस.आई.आर राष्ट्रीय धातुकर्म प्रयोगशाला

मद्रास केन्द्र वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद (भारत सरकार)

सी.एस.आई.आर मद्रास कॉम्प्लेक्स तारमणी चेन्नै 600 113.

CSIR - National Metallurgical Laboratory Madras Centre

Council of Scientific and Industrial Research, Govt. of India
CSIR Madras Complex, Taramani, Chennai - 600 113. INDIA



CERTIFICATE

This is to certify that **Ms. Ashwini R (Register No. 41910004)** pursuing her degree, M.Sc. Chemistry (Final year), in Sathyabama Institute of Science & Technology, Chennai has carried out her project work in our laboratory under the guidance of Mrs. N. Vasumathi, Principal Scientist, CSIR-NML Madras Centre, Chennai on the topic **“DESIGN AND OPTIMIZATION PROCESS PARAMETERS FOR PLANT SEED BASED OIL EXTRACTION BY DESIGN OF EXPERIMENTS (DoE)”**, as partial fulfillment of her degree from 4th January, 2023 to 5th May, 2023.

I wish success in all her future endeavors.



T. V. Vijaya Kumar
(Dr. T.V. Vijaya Kumar)

Scientist In-Charge, NML



सी.एस.आई.आर राष्ट्रीय धातुकर्म प्रयोगशाला

मद्रास केन्द्र वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद (भारत सरकार)

सी.एस.आई.आर मद्रास कॉम्प्लेक्स तारामणी चेन्नै 600 113.

CSIR - National Metallurgical Laboratory Madras Centre

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CSIR Madras Complex, Taramani, Chennai - 600 113. INDIA.



CERTIFICATE

This is to certify that **Mr. Santhosh Kumar N** (Register No. 41910017) pursuing his degree in M.Sc. Chemistry (Final year) in Sathyabama Institute of Science & Technology, Chennai has carried out his project work in our laboratory under the guidance of Mrs. N. Vasumathi, Principal Scientist, CSIR-NML Madras Centre, Chennai on the topic “**DESIGN AND OPTIMIZATION OF PROCESS PARAMETERS FOR PLANT BASED OIL EXTRACTION BY DESIGN OF EXPERIMENTS (DoE)**”, as partial fulfillment of his degree from 4th January, 2023 to 5th May, 2023.

I wish success in all his future endeavors.



P. V. Vijaya Kumar
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Review Article

A Review on Cassava Residues as Adsorbents for Removal of Organic and Inorganic Contaminants in Water and Wastewater

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An increase in water demand for drinking, agriculture, and industries necessitates the treatment of water and wastewater. Among various conventional treatment techniques available, adsorption is found to be one of the most economical and feasible methods. Adsorbents from plant biomass are effective for the removal of organic and inorganic pollutants. Cassava has gained attention among researchers during the past decades due to its plentiful availability and resilient characteristics. Even though cassava contains cyanogenic glucosides as toxins, it is used in industries for development of various products. Cassava stem, rhizome, peel, and bagasse are industrial residues that are generated in abundance. The present review focusses on factors affecting adsorption using cassava residues, adsorbent preparation and activation methods, equilibrium, mass transfer, kinetics, and thermodynamic studies of adsorption.

1. Introduction

According to the Food and Agricultural Organization (FAO), cassava is considered to be one of the significant crops in the tropical region of the world [1]. The cassava plant consists of leaves and tubers as feed and food, respectively, and stem and rhizome being nonedible parts [2]. Cassava-producing industries generate peel and bagasse as residues and utilize the pulp to produce starch, flour, chips, and bioethanol [3]. The production statistics of cassava tubers reveal an average production of 268, 283.8, and 293.5 MMT during 2011–13, 2014–16, and 2018–20, respectively, with a sharp decline in 2017 at 277 million tons (Figure 1). As production increased during the mentioned periods, cassava-producing industries emerged as a promising sector for economic growth [4]. Hence, the waste generated from cassava-producing industries requires a suitable alternate

option for waste to wealth conversion. Adsorbents could be the potential route for utilization of cassava peel, bagasse, stem, and rhizome.

Adsorption is an exothermic process in which liquid, dissolved solid, or gas atoms, ions, or molecules (adsorbate) accumulate inside the top surface of another solid substance (adsorbent) [5]. Adsorption is caused by an imbalance of forces forming hydrogen, Van der Waals, covalent, and ionic bonds among the two species, the adsorbent and the adsorbate [6]. Adsorption is used in chemical process industries for sugar refining, wastewater treatment, chromatography, gas purification, moisture removal, metallurgy, etc. [7]. The advantages of adsorption include operating in mild conditions and having simpler designs. Conventional methods are available to treat wastewater, but adsorption creates interest among researchers due to its economics [8, 9].



Surface treated *Phoenix sylvestris* for bioadsorption of oil from aqueous solution: Isotherms and kinetic studies

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Use of activated *Chromolaena odorata* biomass for the removal of crystal violet from aqueous solution: kinetic, equilibrium, and thermodynamic study

Michael Rahul Soosai^{1,8} · Innasi Muthu Ganesh Moorthy¹ · Perumal Varalakshmi² · Asad Syed³ · Abdallah Mohamed Elgorban³ · Sean Patrick Rigby⁴ · Sivrajasekar Natesan⁵ · Sathaiah Gunaseelan² · Yonas Camy Joshya⁶ · Rajoo Baskar⁷ · Rajaram Shyam Kumar¹ · Sankar Karthikumar¹

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Abstract

In the present study, biomass from the *Chromolaena odorata* plant's stem was activated using sulfuric acid to adsorb crystal violet (CV) dye. The adsorption operation of CV dye was studied considering the effect of variables like pH, initial dye concentration, time, adsorbent dosage, and temperature. The pseudo-second-order equation best fitted the kinetic study. The thermodynamic parameters such as activation energy (9.56 kJ/mol), change in Gibbs energy (81.43 to 96.7 kJ/mol), enthalpy change (6.89 kJ/mol), and entropy change (-254.4 J/mol K) were calculated. Response surface methodology estimated that at pH (4.902), adsorbent dosage (8.33 g/L), dye concentration (82.30 ppm), and temperature (300.13 K) dye removal of 97.53% is possible. FTIR, SEM, XRD, BJH, and BET confirmed adsorption operation. The adsorbent can be reused for 3 cycles effectively. Langmuir isotherm which best fitted the adsorption operation was used for designing a theoretical single-stage batch adsorber for large-scale operation.

Keywords Adsorption · *Chromolaena odorata* biomass · Crystal violet dye · Kinetic model · Single-stage batch adsorber design

Introduction

Mauveine was the first synthetic dye invented in 1856; since various synthetic dyes were created, the use and development of other synthetic dyes in textile industries

have continuously increased. Synthetic dye meets nearly 65 to 70% of the dyeing industry's needs. They possess a large variant of color available at a relatively low price than natural dye and could colorize the target molecules easily with greater stability (Zhang et al. 2016b). Around

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Review

Progress and Prospective of the Industrial Development and Applications of Eco-Friendly Colorants: An Insight into Environmental Impact and Sustainability Issues

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Abstract: Color is the prime feature directly associated with the consumer's attraction and choice of their food. The flavor, safety, and nutritional value of any food product are directly associated with the food color. Natural and synthetic colorants (dyes and pigments) have diversified applications in various sectors such as food, feed, pharmaceutical, textiles, cosmetics, and others. Concerning the food industry, different types of natural and synthetic colorants are available in the market. Synthetic food colorants have gained popularity as they are highly stable and cheaply available. Consumers worldwide prefer delightful foodstuffs but are more concerned about the safety of the food. After its disposal, the colloidal particles present in the synthetic colorants do not allow sunlight to penetrate aquatic bodies. This causes a foul smell and turbidity formation and gives a bad appearance. Furthermore, different studies carried out previously have presented the toxicological, carcinogenic effects, hypersensitivity reactions, and behavioral changes linked to the usage of synthetic colorants. Natural food colorings, however, have nutraceutical qualities that are valuable to human health such as curcumin extracted from turmeric and beta-carotene extracted from carrots. In addition, natural colorants have beneficial properties such as excellent antioxidant properties, antimutagenic, anti-inflammatory, antineoplastic, and antiarthritic effects. This review summarizes the sources of natural and synthetic colorants, their production rate, demand, extraction, and characterization of food colorants, their industrial applications, environmental impact, challenges in the sustainable utilization of natural colorants, and their prospects.

Keywords: natural colorants; extraction techniques; technological applications; environmental sustainability; colorant stability; nutraceuticals



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1. Introduction

Colorants are key to the acceptance of various commodity materials as they provide wider perspectives from sensory perceptions. They have diverse roles during the lifespan of mankind, ranging from textiles to the colors of contact lenses. The significance of colorants has an immense impact on commodity markets. Hence, understanding the sources of colorants is highly significant in a few areas, such as the textile and food industries. It brings paramount importance to the study of biochemistry, processing, and characterization of colorants, irrespective of their sources; natural or synthetic. Based on their solubility, they can be classified as soluble colorants, i.e., dyes, and insoluble colorants, i.e., pigments. Dyes are often believed to have a synthetic origin. Despite their natural origin, pigments have limited utilization as a colorant in many industries; the details are summarized in the



Enhanced photocatalytic degradation of caffeine using Co–Zn/ Al_2O_3 nanocomposite

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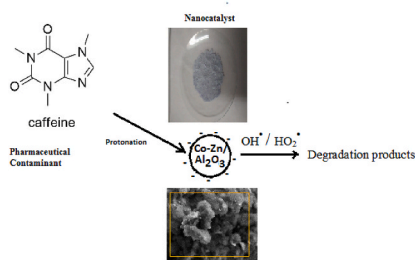
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HIGHLIGHTS

- The Co–Zn/ Al_2O_3 was synthesized using the wet impregnation process in this investigation.
- A maximum caffeine removal of 92% was achieved under the optimum conditions.
- Optimal condition, 0.5 g/L catalytic dose, 50 min contact duration, 50 mg/L initial concentration, and pH of 9.5.
- Caffeine is an attractive potential photocatalyst for removing caffeine from its aqueous mixture.
- The catalyst was successfully regenerated to clean caffeine effluent from the pharmaceutical sector.

GRAPHICAL ABSTRACT



ARTICLE INFO

Handling editor: Pau-Loke SHOW

Keywords:

Co–Zn/ Al_2O_3

Photo-catalyst

Caffeine

Pharmaceutical pollutant

ABSTRACT

This work focuses on the synthesis and characterization of photocatalytic activity of Co–Zn/ Al_2O_3 nanocomposite obtained by calcination of Co-loaded Zn/aluminum layered double hydroxide by wet impregnation method. The catalyst was characterized by X-ray diffraction (XRD), Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), BET and UV-DRS. The evaluation of catalytic activity was investigated for the degradation of emerging pharmaceutical pollutant caffeine in aqueous solutions under UV irradiation. The process parameters were optimized for the maximum removal of caffeine. A maximum caffeine removal of 92% was obtained with the optimal conditions at the catalytic dosage of 0.5 g/L, contact time of 50 min, initial concentration of 50 mg/L, and pH of 9.5. The batch experimental data coincide well with the pseudo first order kinetic model, the rate constant of 0.012 min^{-1} , with the R^2 value of 0.875–0.938. The regeneration study

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Synthesis and characterization of barium doped CaO heterogeneous nanocatalyst for the production of biodiesel from *Catharanthus roseus* seeds: Kinetics, optimization and performance evaluation

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ARTICLE INFO

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Biodiesel,
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Transesterification
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Catalyst

ABSTRACT

The exploitation of petroleum derivatives to meet the energy demands of the cutting edge is thought of as impractical because of asset shortage. The current necessitates that the world community improves future energy sources by developing sustainable, ecofriendly alternatives. In this work, biodiesel is produced through the transesterification of *Catharanthus roseus* seed oil with a barium-doped CaO heterogeneous nanocatalyst. The catalyst characterization is assessed using FTIR, GC-FID, EDAX, XRD, and SEM. The optimum conditions of time (70 min), temperature (58 °C), the molar ratio of methanol: oil is 15:1, and catalyst load (4% w/w) resulted in a conversion of the maximum biodiesel yield of 91.83%. Finally, by using *Catharanthus roseus* as a feedstock, the low optimal reaction conditions contribute to the development of the economic impact of biodiesel synthesis. Biodiesel blend (B20) containing barium-doped CaO nanoparticles showed better combustion engine performance and lower emissions than fossil fuels.

1. Introduction

The aim of the circular economy is to reduce modern and human contamination by creating eco-friendly items from waste and by-products. The demand in the energy sector has increased, especially for petrochemicals (Alsohaimi et al., 2020). In such a situation, biodiesel is a viable option as it is an ecological, renewable, harmless and perishable resource based on bio-oils derived mainly from plants and their derivatives (Chaveanghong et al., 2018). It is acquired from oils, creature fats, green growth and non-palatable oils and contains mono-alkyl esters of long-chain greasy substances (Asikin-mijan et al., 2015). Biodiesel has brought about the change of fatty substances into vegetable oils, for example, soybean oil, palm oil, canola oil and sunflower oil. Other inedible sources such as Pongamia, Castor oil, Jatropha oil, Camelina, Neem oil and cottonseed oil can be used (Du et al., 2019). Late examination on the making cost of biodiesel utilizing *Catharanthus roseus* as feedstock uncovers that the general formation cost of biodiesel might be brought down by the greater part when contrasted with

non-consumable sources effectively diminishes the feedstock cost to generally 60%–70% (Almasi et al., 2019). Subsequently, on the off chance that a *Catharanthus roseus* is utilized for biodiesel production, the huge cost of feedstock may be reduced. *Catharanthus roseus* significantly works on the monetary practicality of biodiesel production (Erchamo et al., 2021). The expense of the catalyst additionally affects the whole expense of biodiesel process. Several types of research have been conducted to prepare low-cost catalysts for the development of acceptable biodiesel manufacturing systems using waste materials (Degfie et al., 2019). Homogeneous catalysts face several challenges in purification and separation, and their exceptionally destructive and non-recyclable nature builds support and creation costs (Boey et al., 2011). Homogeneous catalysts face a few difficulties in decontamination and partition, and their exceptionally destructive and non-recyclable nature builds support and creation costs (Xuejun et al., 2007). The heterogeneous catalyst (Chaveanghong et al., 2018) and photocatalysts lessens the division cycle and creation cost, and dismisses the saponification interaction (Ratul Paul et al., 2022). Solid form of heterogeneous catalyst is

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Synthesis and characterization of barium doped CaO heterogeneous nanocatalyst for the production of biodiesel from *Catharanthus roseus* seeds: Kinetics, optimization and performance evaluation

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ABSTRACT

The exploitation of petroleum derivatives to meet the energy demands of the cutting edge is thought of as impractical because of asset shortage. The current necessitates that the world community improves future energy sources by developing sustainable, ecofriendly alternatives. In this work, biodiesel is produced through the transesterification of *Catharanthus roseus* seed oil with a barium-doped CaO heterogeneous nanocatalyst. The catalyst characterization is assessed using FTIR, GC-FID, EDAX, XRD, and SEM. The optimum conditions of time (70 min), temperature (58 °C), the molar ratio of methanol: oil is 15:1, and catalyst load (4% w/w) resulted in a conversion of the maximum biodiesel yield of 91.83%. Finally, by using *Catharanthus roseus* as a feedstock, the low optimal reaction conditions contribute to the development of the economic impact of biodiesel synthesis. Biodiesel blend (B20) containing barium-doped CaO nanoparticles showed better combustion engine performance and lower emissions than fossil fuels.

1. Introduction

The aim of the circular economy is to reduce modern and human contamination by creating eco-friendly items from waste and by-products. The demand in the energy sector has increased, especially for petrochemicals (Alsohaimi et al., 2020). In such a situation, biodiesel is a viable option as it is an ecological, renewable, harmless and perishable resource based on bio-oils derived mainly from plants and their derivatives (Chaveanghong et al., 2018). It is acquired from oils, creature fats, green growth and non-palatable oils and contains mono-alkyl esters of long-chain greasy substances (Asikin-mijan et al., 2015). Biodiesel has brought about the change of fatty substances into vegetable oils, for example, soybean oil, palm oil, canola oil and sunflower oil. Other inedible sources such as Pongamia, Castor oil, Jatropha oil, Camelina, Neem oil and cottonseed oil can be used (Du et al., 2019). Late examination on the making cost of biodiesel utilizing *Catharanthus roseus* as feedstock uncovers that the general formation cost of biodiesel might be brought down by the greater part when contrasted with

non-consumable sources effectively diminishes the feedstock cost to generally 60%–70% (Almasi et al., 2019). Subsequently, on the off chance that a *Catharanthus roseus* is utilized for biodiesel production, the huge cost of feedstock may be reduced. *Catharanthus roseus* significantly works on the monetary practicality of biodiesel production (Erchamo et al., 2021). The expense of the catalyst additionally affects the whole expense of biodiesel process. Several types of research have been conducted to prepare low-cost catalysts for the development of acceptable biodiesel manufacturing systems using waste materials (Degfie et al., 2019). Homogeneous catalysts face several challenges in purification and separation, and their exceptionally destructive and non-recyclable nature builds support and creation costs (Boey et al., 2011). Homogeneous catalysts face a few difficulties in decontamination and partition, and their exceptionally destructive and non-recyclable nature builds support and creation costs (Xuejun et al., 2007). The heterogeneous catalyst (Chaveanghong et al., 2018) and photocatalysts lessens the division cycle and creation cost, and dismisses the saponification interaction (Ratul Paul et al., 2022). Solid form of heterogeneous catalyst is

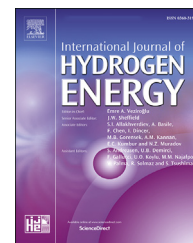
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Influence of nanopores volumes in hydrogen absorption properties of B₄C and WC carbide-derived carbon nanomaterials

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HIGHLIGHTS

- CDC nP Nanomaterials suggested hydrogen generation towards sustainable environment.
- A-B₄C-CDC nP, B₄C CDC nP and WC-CDC nP Nanomaterials tested in N₂ & H₂ absorption.
- BET surface area of A-B₄C-CDC nP material after treated was 2240 m²/g.
- Total pore volume is a highly influencing factor in absorption of Hydrogen.
- All CDC nP Nanomaterials characterized by SAXS, NLDFT, XRD, TEM, FTIR, EDS & SEM.

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ABSTRACT

Sustainable energy development is needed to meet rising energy demands and reduce fossil fuel risks. Hydrogen generation is a crucial study area for sustainable energy. This study examines hydrogen adsorption on carbide-derived carbon nano-porous (CDC nP) nanomaterials. B₄C CDC nP and WC-CDC nP Nanomaterials were produced by reacting chlorine gas with boron carbide (B₄C) and tungsten carbide (WC) at 1200 °C and 980 °C in a high-pressure quartz stationary bed reactor. A CDC nP Nanomaterials was activated by heating it to 900 °C for 1 h in hydrogen to produce A-B₄C-CDC nP Nanomaterials, which

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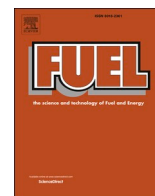
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Effective utilization of azolla filiculoides for biodiesel generation using graphene oxide nano catalyst derived from agro-waste

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ABSTRACT

A circular bioeconomy is concerned with environmental sustainability and waste valorization. Utilization of leftovers and trashes while elevating the value of biomass through the cascade is receiving greater attention in recent years. Biomass is expected to play a significant role in fixing global alternative fuel ambitions. Azolla, a type of macroalgae which grows very quickly, is employed to develop a self-sustaining Azolla biorefinery model. Tannery effluents are treated using the phytoremediation approach, and the algal oil extracted from the cultivated Azolla is employed to produce bio-diesel as an alternative energy source. Biodiesel is produced via the transesterification technique. N₂ sorption isotherms, scanning electron microscopy (SEM), FT-IR, and X-ray diffraction studies are used to evaluate the catalyst. The IR spectral analysis with the absorption bands corresponding to alkyl and ester stretching and bending modes of vibrations confirm biodiesel production. The reaction mechanism involved in the conversion process is proposed, and the process parameters such as the reaction temperature, oil-to-methanol molar ratio, and catalyst quantity are optimized. The results show that a catalyst loading of 2 % (by weight) and a molar ratio of 1:9 produce a high biodiesel yield with GO as the catalyst at temperatures between 60 and 65 °C. Its ability to catalyze allowed for numerous cycles of repetitive use. The results show that employing GO as a catalyst to trans esterify Azolla oil to biodiesel is cost-effective and reliable.

1. Introduction

One of the most important aspects of economic progress is energy. As per the Global Energy Perspectives 2022, the global primary energy consumption is expected to triple by 2050 as the standard of living is growing. Renewable sources for energy is expected to become the new baseload, accounting for 50 % of the power mix by 2030 and 85 % by 2050. Fossil fuels are non-renewable resources on the verge of depletion and are in crisis. Because of the environmental impact of fossil fuels, the development of renewable liquid biodiesel has received a lot of interest as a possible replacement for petroleum-based fuels [1]. More studies

are available for converting fossil fuels to bioethanol [2]. Liquid bio-diesel is renewable and sustainable, similar to other renewable energy sources such as solar and wind. Biodiesel is the best alternative fuel for diesel engines [3]. In contrast, fossil fuels are not only non-renewable, but they also have other environmental negative impacts. Greenhouse gases such as CO and CO₂ are released during their burning. When ethanol is burnt, it produces CO₂. It is, nonetheless, considered carbon neutral [4]. This is because non-ethanol biomass feedstock absorbs CO₂. This indicates that burning biofuels does not contribute to greenhouse gas emissions. The conversion of residue of agrowaste to a valuable product is a budding opportunity for all researchers [5]. Azolla filiculoides is the only member of the genus and family Azollaceae in Africa

Abbreviations: GO, Graphene Oxide; SEM, Scanning Electron Microscopy; FT-IR, Fourier transform infrared; XRD, X-ray diffraction; EDAX, Energy dispersive X-ray analysis; FAME, Fatty Acid Methyl Ester; GCMS, Gas chromatography–mass spectrometry; GC-FID, Gas Chromatography With Flame Ionization Detection; TGA, Thermogravimetric analysis; BET, Brunauer–Emmett–Teller.

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Analysis of phytochemical composition of a leaf extract of sacred fig (*Ficus religiosa* L.) by UPLC-QqQ-MS and assessment of its hepatocurative potential in mouse model

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Shanmugam Achiraman^g  

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Highlights

- UPLC-QqQ-MS was used to analyse the phytochemicals in leaf extract of *F. religiosa*
- Phytochemicals in the leaf extract were identified, confirmed and quantified



Short communication

First report on molecular characterization and *in silico* analysis of caprine TCIM gene

Venkatesh K.M.^{a, c} , Chinmoy Mishra^a  , Sukanta Kumar Pradhan^b 

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Highlights

- The TCIM gene was highly expressed in thyroid cancer.
- The specific signaling pathways are regulated by TC1 protein.
- The role of caprine TC1 protein in carcinogenesis, cell stress, and heat shock

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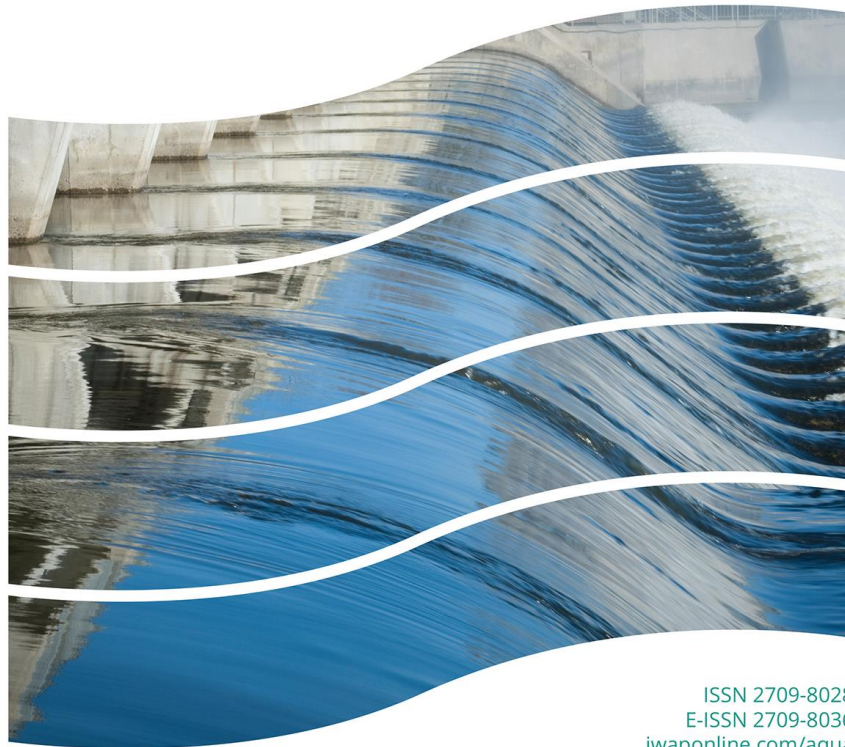
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Simulation of chain of tanks to augment water supply: a case study from Tamil Nadu

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ABSTRACT

The application of system dynamics techniques is gaining significance and is much needed for an effective management of the depleting water resources in a dynamically complex region and considers it as the feedback from the system. The present study deals with the application of a system dynamic approach to simulate a chain of four tanks in the Guduvanchery watershed, Tamil Nadu, India. Standard data-driven models cannot be effectively used due to a lack of quality data for ungauged basins. VENSIM was used for the system dynamic simulation to assess water availability for the sustainable management of water resources. Inflow into the four tanks, net losses in each tank, and crop water requirement were given as inputs into VENSIM. Along with different models, an extensive field survey was carried out to quantify each input component. Based on system dynamics simulation, only 28% of the total available water is used for irrigation and the rest is wasted due to evaporation, transition loss, and spill from the tanks. It was found that there was approximately 5.46 MCM of surface water available in the watershed, and it will be able to supply the domestic demand of the watershed of 0.672 MCM in addition to the irrigation requirement.

Key words: chain of tanks, hydrological modelling, NRCS model, runoff, simulation, VENSIM

HIGHLIGHTS

- Hydrological modelling and simulation are essential for the effective management of water resources in semi-arid regions.
- The present study deals with the application of a system dynamic approach to simulate a chain of four tanks.
- The water balance study for the chain of tanks indicates that only 28% of the total available water is used for irrigation, with the remainder lost due to evaporation, transition loss, and spill.

1. INTRODUCTION

South India has a rich tradition of tanks. Tank irrigation is a storage-based irrigation scheme widely practised in south India; and hence, the terminology ‘tank’ is limited to India only. The area under tank irrigation declined drastically from the 1970s and has led to an increased extraction of groundwater. Also, India is rapidly urbanizing; consequently, the demand for water is increasing in most cities as every urban citizen requires almost double the amount of water than a rural citizen requires. Furthermore, since India’s cities face water shortages, groundwater abstraction has become unavoidable, resulting in a decline in the groundwater table. There is an urgent need to improve the groundwater table in cities in order to sustain the groundwater resource. This research pertains to a scientific approach to accessing the available surface water potential from a chain of four tanks in the Guduvanchery watershed. The land-use changes in the peri-urban areas modify the drainage pattern, thereby changing the catchment area of the tanks leading to water stagnation and flooding consequently reducing the inflow into the tanks. A scientific approach is needed to assess the present status of existing water bodies and surface water budgeting to identify the opportunities for sustainable surface water use.

The water requirement is increasing to meet the demand of the growing population due to urbanization. The assessment of the water availability in a watershed is essential for an efficient water management. The Natural Resource Conservation Service (NRCS) model (SCS 1956) is widely accepted for runoff computation for small watersheds. The NRCS runoff curve number method was extensively used by researchers for runoff computation (Meher & Jha 2011; Tedela *et al.* 2012;

Panahi 2013; Raji *et al.* 2021). For a long time, the model has been used to simulate the hydrology of minor watersheds all over the world. Several researchers in Tamil Nadu used the NRCS curve number approach and found it to be beneficial for estimating surface runoff in several basins. (Mohan & Abraham 2010; Viji *et al.* 2015; Santhanam & Abraham 2018). An elaborative study on the Soil Conservation Service-curve number (SCS-CN) method was conducted by Mishra & Singh (2004). Runoff computation by CN Nomograph for watersheds was demonstrated by Srinivas *et al.* (1997). Soulis *et al.* (2009) applied the Soil Conservation Service (SCS) method for a forest watershed and found it very effective in runoff computation. The NRCS runoff curve number approach can be utilized for runoff estimation in small ungauged watersheds, according to Krisnayanti *et al.* (2021). Remote sensing and GIS technique were found to be very effective in the SCS-CN model with spatial and temporal variabilities in soil and land use (Zhan & Huang 2004; Geetha *et al.* 2007; Satheeshkumar *et al.* 2017).

Modelling of ungauged catchments using catchment runoff response similarity was worked by Tegegne & Kim (2018). The robustness of agricultural reservoirs in ungauged catchments under climate change was studied using a Ratio Correction Factors-Based Calibration and Run theory (Lee *et al.* 2020). Jun *et al.* (2020) used flood vulnerability as a criterion for prioritizing and assessing the reservoir study. The flood indicators created in the study were shown to be beneficial in determining the impact of hydraulic structure repair. The SWAT model was used by Ramabrahmam *et al.* (2021) to study the hydrological processes and flow routing in the Salivagu watershed tank cascade system in Telangana, which improved the knowledge of hydrological processes in ungauged cascading tank systems in tropical semi-arid environments. Hamzah *et al.* (2021) examined the performance of three imputation approaches in predicting the recurrence in streamflow datasets: robust random regression imputation (RRRI), k-nearest neighbours (k-NN), and classification and regression tree (CART). Furthermore, the whole historical daily streamflow data from 2012 to 2014 (as training dataset) were used to assess and validate the effectiveness of the imputation methods in addressing missing streamflow data. Following that, streamflow rates in Malaysia's Langat River Basin were restored using all three methods combined with multiple linear regressions (MLRs).

There are various studies related to the use of VENSIM in the simulation of reservoirs in water resources. Based on long-term aquifer responses to hydrological variability, Niazi *et al.* (2014) evaluated the recharge and outflow dynamics within the Sirik area of the Iran aquifer system. A regional modelling framework that includes aquifer storage and recovery (ASR) as well as a dam design was constructed utilizing VENSIM's system dynamics (SD) modelling. ASR was found to be a beneficial technique for farmers and the groundwater system using the SD model of the groundwater flow and the complete SD model developed in the study. Mandal *et al.* (2019) studied the impact of climate change on hydropower production from a multi-reservoir system using a VENSIM model and demonstrated the robustness of SD modelling. Ganji & Nasser (2021) developed an SD model using Vensim to simulate the effects of climate change on the water quality and quantity of the Karoun River, Iran. It was reported that SD is the best tool for assessing various scenarios because of its feedback loops. Nozari *et al.* (2021) assessed the performance of Dez Reservoir using the SD method in VENSIM. The simulation was carried out after assessing the effective parameters and their relationships. It was reported that SD-simulated releases met downstream demands and the method is very accurate in simulating the performance of the surface tank system.

It is very important to plan how to utilize the existing water and create a balance between the requirement and availability. The main objective of the study is to assess the surface water availability through the simulation of the chain of tanks. The uniqueness of the study is that the watershed is ungauged. Due to urbanization and depleting water supplies, the irrigated areas of the tanks have been drastically decreasing at an alarming rate. Standard data-driven models cannot be effectively used due to a lack of quality data for ungauged basins. Many hydrological models are at the basin scale, which have only limited regional and local applications. A micro-level simulation study with adequate field observations was carried out to solve the problem. Uncertainties in data and modelling are reduced by doing field verification. The results from the study can be used to derive the strategies to increase utilizable water in ungauged watersheds.

2. STUDY AREA AND DATABASE

The Guduvanchery watershed covering an area of 50 km² is a part of the Adyar basin, in the Kancheepuram district of Tamil Nadu. The region lies between the latitudes of 12°50'N and 12°47'N, and the longitudes of 80°02'E and 80°06'E. The elevation ranges from 0.5 to 230 m above sea level. The district's temperatures range from 37.1 to 20.5 °C. Figure 1 shows an index map of the study area. The peculiar problems faced by the watershed include the following: (i) watershed lying in the over-exploited block; (ii) large-scale development in this area due to fast urbanization; and (iii) continuous reduction

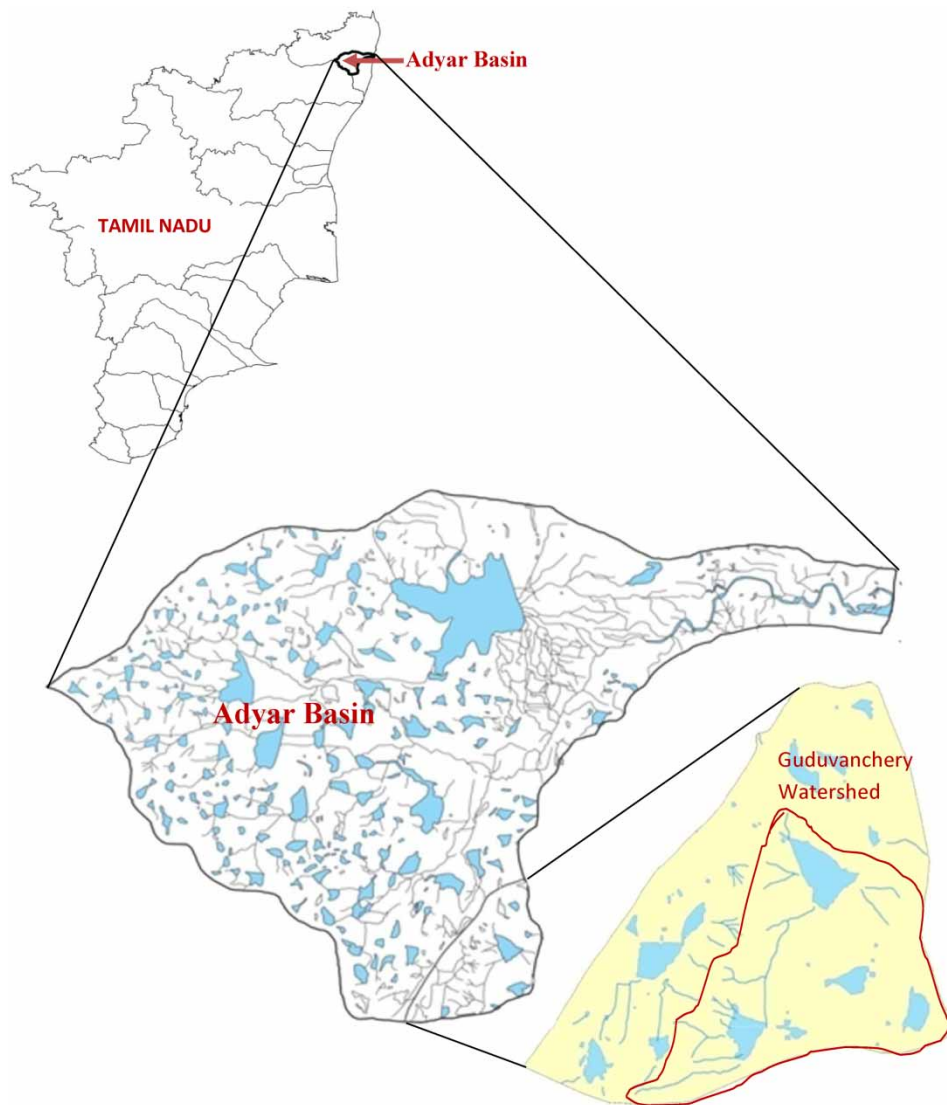


Figure 1 | An index map of the study area.

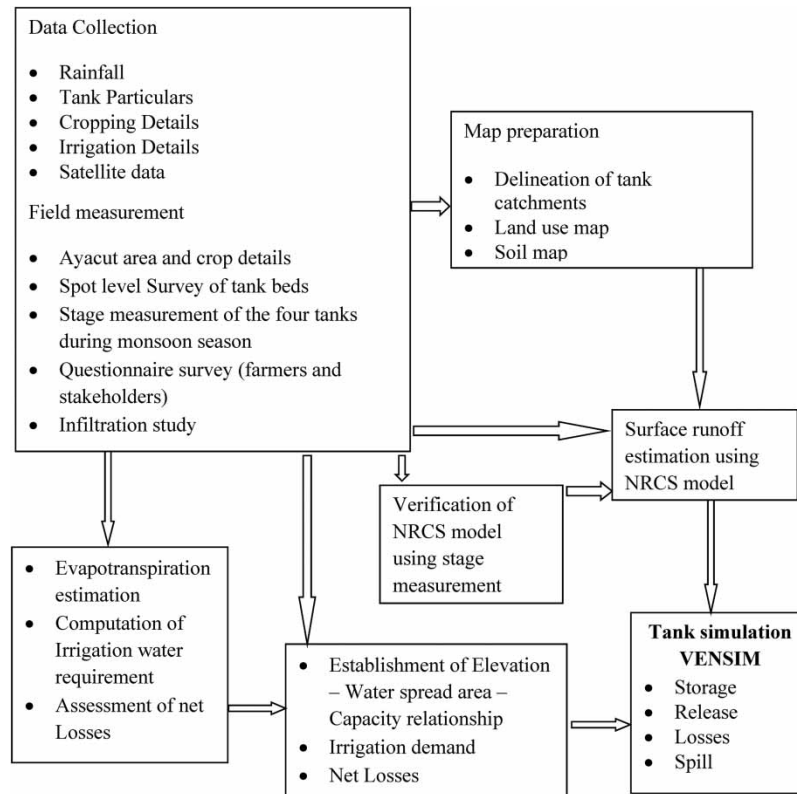
in cropping area. The North-East monsoon brings rain to the study region mostly in October and November. The yearly average rainfall is 1,150 mm. The chain of tanks in Guduvanchery consists of four tanks, namely Kayarambedu tank, Kannivakkam tank, Perumattunallur tank, and Nandhivaram tank. A spill from the Kayarambedu tank is flowing to the Nandhivaram tank, one from the Kannivakkam tank is flowing to the Perumattunallur tank, and then finally reaches the Nandhivaram tank. Hydraulic particulars of the tanks and crop and irrigation details were collected from the Public Works Department (Table 1). The available daily rainfall data during the period 2000–2014 for Chengalpeta were collected from the India Meteorological Department (IMD), Pune, India.

3. METHODOLOGY

The methodology consists of data collection and field survey, net loss calculation, irrigation demand computation, inflow estimation, and tank simulation. The methodology adopted is given in Figure 2. An extensive field data collection and questionnaire survey were necessary during each stage, especially to check the inflow calculated from hydrological modelling and to get the net losses. Toumi & Remini (2021) did an extensive field survey to determine the phenomenon of water leakage at the Hammam Grouz dam in Algeria. Eberlein & Peterson (1992), Vensim (2014) was used for the tank simulation. The

Table 1 | Tank particulars of the watershed

Description	Kayarambedu tank	Kannivakkam tank	Perumattunallur tank	Nandhivaram tank
Bund length (m)	1,000	700	1,300	1,000
Original ayacut (ha)	172.80	57	58.68	339.50
Present ayacut (ha)	136.07	7.44	Nil	136.50
Capacity (MCM)	1.33	0.39	2.06	1.69
No. of sluice	2	2	2	5
No. of weir	1	1	2	2
Water spread area (km ²)	0.98	0.28	0.93	4.58

**Figure 2** | Flow charts explaining the methodology.

inflow is computed using the NRCS model and is verified using the change in storage computed using the tank water levels. The net loss is calculated using the reduction in water level during the periods of no rainfall. The simulation model was run with monthly time step.

3.1. Inflow estimation

Using a daily time step, the United States Department of Agriculture (USDA), NRCS–Hydrologic model was used to assess surface runoff from rainfall (Chow *et al.* 1988).

$$Q = \frac{(P - I_a)^2}{(P - I_a + S)} \quad (1)$$

$$S = \frac{25,400}{CN} - 254 \quad (2)$$

where P is the rainfall, in mm, CN is the curve number which ranges between 0 and 100, S is the potential maximum retention, I_a is the initial abstraction, ($I_a = 0.2 S$), and Q is the runoff, in mm.

Curve numbers take care of the surface condition of the watershed. Dry condition (Antecedent Moisture Condition (AMC) I) and wet condition (AMC III) are assessed using 5-day antecedent rainfall. Less than 13, 13–28, and above 28 mm rainfall during the antecedent 5-day period gives rise to AMC I, II, and III status, respectively (Chow *et al.* 1988). The curve numbers for each land use can be obtained for average AMC II and can be converted for other conditions using the following relationships (Chow *et al.* 1988).

$$CN_I = \frac{4.2CN_{II}}{10 - 0.0584CN_{II}} \quad (3)$$

$$CN_{III} = \frac{23CN_{II}}{10 + 0.13CN_{II}} \quad (4)$$

where CN_I is the CN for AMC I, CN_{II} is the CN for AMC II, and CN_{III} is the CN for AMC III.

The NRCS model was employed with a daily time step to estimate runoff from 2000–2001 to 2013–2014. The inflow estimated is verified by estimating the change in storage by conducting the field study.

3.2. Irrigation demand computation

The area under tank irrigation is called ayacuts. Irrigation is practised only in the ayacuts of Nandhivaram and Kayarambedu tanks. A questionnaire survey was carried out to learn about the cropping season and crops cultivated. Brouwer & Heibloem's approach (1986) for calculating irrigation water demand was used. The Blaney–Criddle equation was used to compute potential evapotranspiration. Potential evapotranspiration (ET_o) by the Blaney–Criddle method (Doorenbos & Pruitt 1977) is given by

$$ET_o = p(0.46T_{\text{mean}} + 8) \quad (5)$$

where T_{mean} is the average daily temperature ($^{\circ}\text{C}$) and p is the average daily percentage of annual daylight hours.

The crop coefficient (K_c) for paddy was estimated for various stages and crop water need was determined as

$$ET_{\text{crop}} = ET_o \times K_c \quad (6)$$

Other water requirements are taken into account, such as the amount of water required for saturating the soil for land preparation (SAT), percolation and seepage losses (PSL), and the amount of water required to establish a water layer (WL).

The effective rainfall (P_e) is calculated using the formulae

$$P_e = 0.8 P - 25 \text{ when } P > 75 \text{ mm/month, and}$$

$$P_e = 0.6 P - 10 \text{ when } P < 75 \text{ mm/month where } P \text{ is rainfall in mm/month.}$$

Irrigation water demand was calculated as

$$IN = ET_{\text{crop}} + SAT + PSL + WL - P_e \quad (7)$$

3.3. Tank simulation

The tank simulation was carried out using the VENSIM (Eberlein & Peterson 1992) software.

Figure 3 shows the stock and flow diagram of the tank system developed in VENSIM. In Figure 3, the stock variables (tank) are rectangles, fluxes (flow rates) are arrows as seen in the figure (inflow, outflow, and losses), the interdependency of the variables is represented by arrows, and other parameters are represented as auxiliary variables.

The mass balance equation is

$$\Delta S = I - O \quad (8)$$

where ΔS is the change in storage, I is the inflow, and O is the outflow.

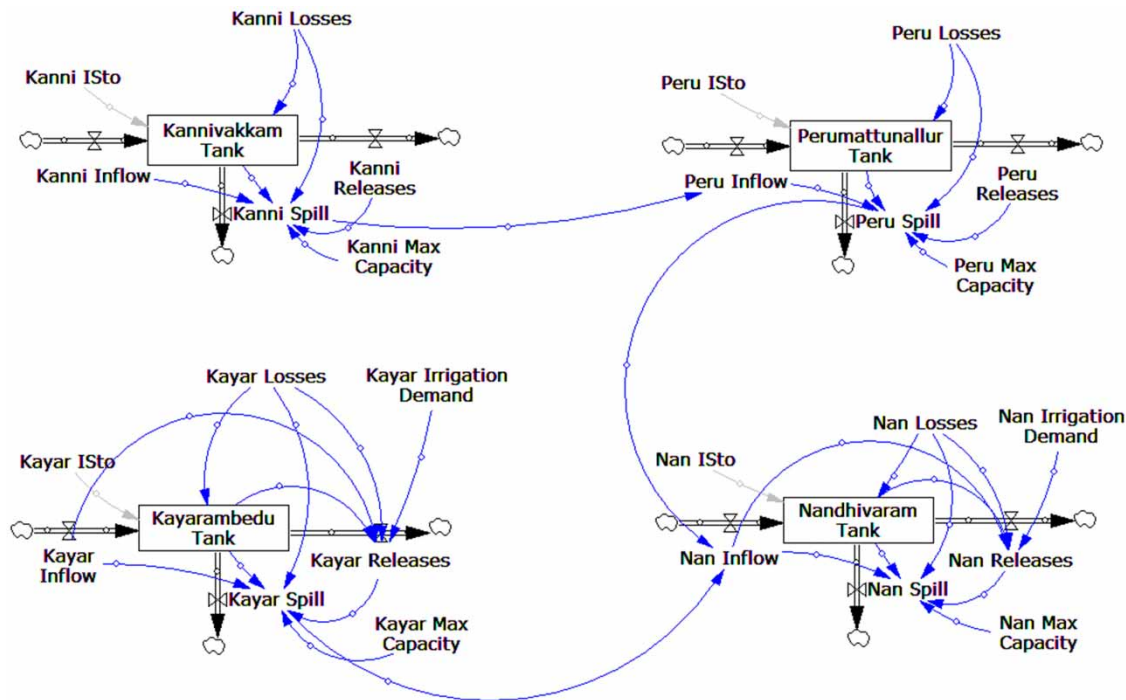


Figure 3 | Indicator diagram—VENSIM.

Inflow is from the rainfall and outflow is the release for irrigation through sluice and/or spills.

Evaporation and infiltration from the tank together are accounted as net losses.

The equation becomes

$$\text{End storage} = \text{Beginning storage} + \text{Inflow} - \text{Release} - \text{Net losses} - \text{Spill} \quad (9)$$

The following details were given as input for the tank simulation:

- The monthly inflow
- Water depth–water spread area–storage capacity relationship
- Monthly net loss in the depth unit
- Full tank capacity
- Tank storage at the start of the simulation

The net loss due to both evaporation and infiltration estimated in the depth unit is multiplied by the average water spread area (water spread area at the beginning and end of the period). The water spread area corresponding to given storage is determined by interpolating the storage capacity–water spread area relationship.

For a given period, the inflow is added to the beginning storage to determine the total storage (TS). The demand for irrigation (DI) and the net losses (NL) requirement is to be met from TS. If TS is very high, then the tank gets filled up reaching its full capacity (FC) and spill (SPL) occurs. The cases that arise are:

- Case (A) $TS < NL$
- Case (B) $TS < NL + DI$
- Case (C) $TS > NL + DI$, and
 $TS(NL + DI) < FC$
- Case (D) $TS > NL + DI$, and
 $TS(NL + DI) > FC$

The procedure followed in each case is as follows:

- Case (A) NL is equal to TS, No water is released to meet DI.
End storage is zero.

- Case (B) Release to irrigation is equal to (TS-NL). DI is met partially. End storage is zero.
 Case (C) DI is met in full, NL is met, End storage = TS (DI + NL)
 Case (D) DI is met in full, NL is met, End storage = FC,
 $SPL = TS(DI + NL + FC)$

4. RESULTS AND DISCUSSION

The satellite imagery Resourcesat-2, LISS IV FMX dated 12 June 2014 obtained from NRSC, Hyderabad, toposheet and Google map were used to create a base map of the Guduvanchery watershed. The watershed boundary was taken from Watershed Atlas (AIS and LUS 1990) and verified with satellite imagery. The drainage area/catchment area for Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram tanks were demarcated utilizing satellite imagery, toposheet, and Google Earth map. A contour map was drawn for the watershed of tanks in order to identify low-lying areas and also to identify the tank connectivity (Figure 4). Land-use maps of the watersheds of all four tanks are prepared with satellite imagery using ArcGIS software and the area under each land-use category was determined. Details of the land-use category and the areal extent under each category for the free catchment area of the four tank watersheds are given in Figure 5.

Water levels were measured for the period 18 September–30 November 2014 for all four tanks using scales prepared especially for that purpose. Figure 6 shows the daily rainfall and the water level in all four tanks during the year 2014. During periods when there was no rain, the water level dropped. The average water level decline per day for no rainfall periods is used to compute the net loss from the tank due to evaporation and infiltration from the tank bed. The daily net losses were computed for Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram tanks and are 0.94, 0.79, 0.91, and 0.63 cm, respectively. A spot level survey was conducted for all four tanks to determine the elevation–water spread area–

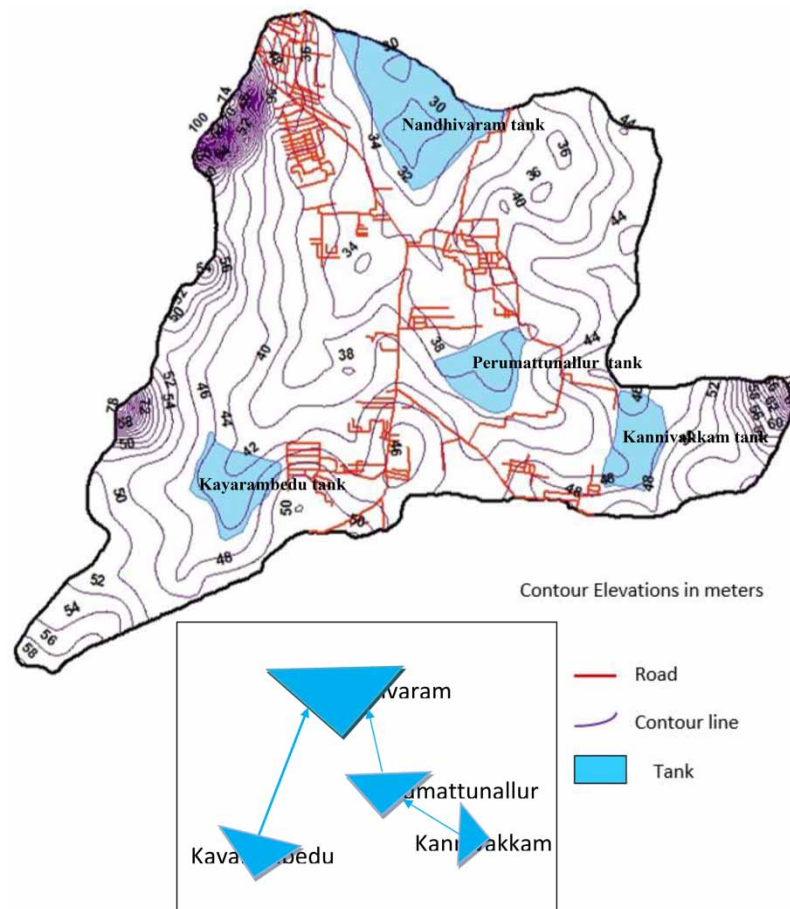


Figure 4 | Elevation contours and flow directions for the tank watershed.

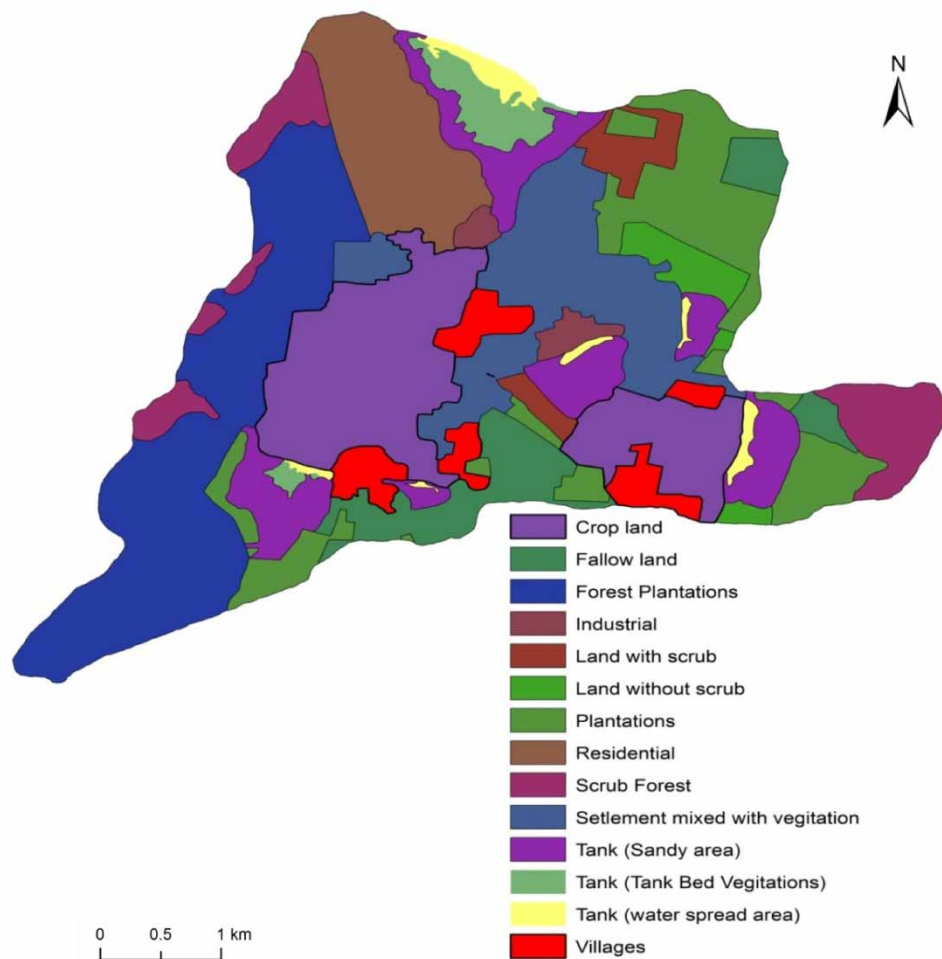


Figure 5 | A land-use map of the watershed of the Guduvanchery chain of tanks.

storage capacity relationship. The water spread areas for various depths were calculated using the elevation contours. The difference in contour height and average water spread area of the contours is used to calculate the storage capacity between the consecutive contours. Utilizing the water level in the tank, actual tank storage was computed. The water level in the tank is measured from a scale (Gauge) painted in posts fixed specially for that purpose. The spill level of the deepest sluice is taken as the datum and the depth of water in the tank is measured considering the datum as zero. By measuring the change in water level in the tank, the change in storage and, thus, the inflow into the tanks were determined.

4.1. Hydrological modelling of tanks

Water potential assessment for the four tank watersheds namely Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram tanks were carried out by applying USDA–NRCS model using the inputs daily rainfall, land use, and hydrological soil group for the watershed (NRCS 2007). These watersheds fall under the Hydrologic soil group ‘D’. Hydrological modelling employs a daily time step and assumes the water year to be July–June of the ensuing year. For Kayarambedu and Kannivakkam tanks, only free catchment exists, whereas for Perumattunallur and Nandhivaram tanks, both free catchment and intercepted catchment are present. The catchment area which drains only into the tank under consideration is the free catchment. The free catchment areas of Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram tanks are 3.375, 1.675, 2.721, and 12.882 km², respectively. Hydrological modelling for all four tanks is carried out only with free catchment. From the land-use category, the weighted curve number for Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram tank catchment areas was found to be 80.52, 81.48, 83.21, and 82.56, respectively. The hydrological model is then used to

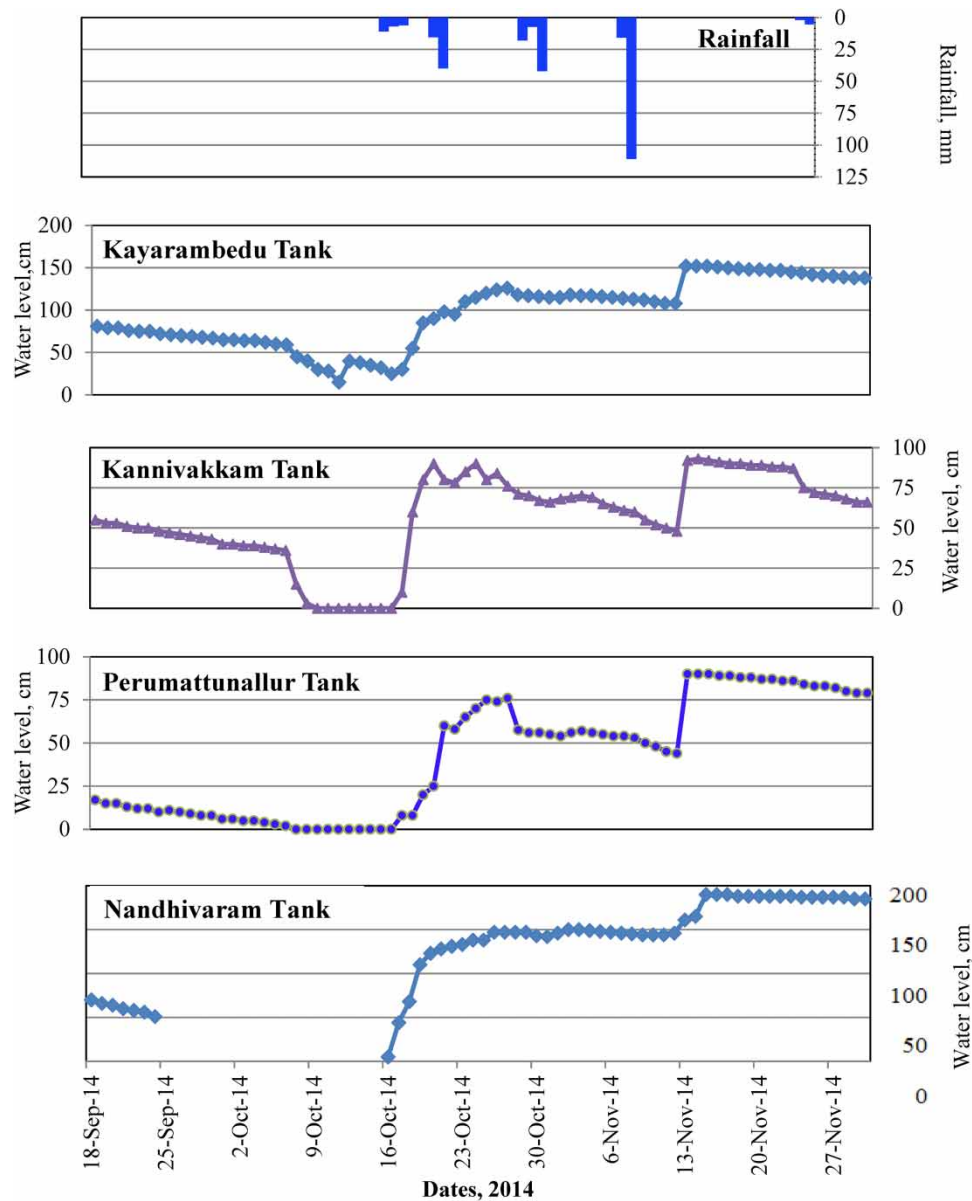


Figure 6 | Daily rainfall and water level in tanks during the year 2014.

determine runoff for the 14 years, namely from 2000–2001 to 2013–2014 on daily basis. Water levels in the tanks were monitored daily during September–November 2014. The runoff calculated using the NRCS model for the same time period was compared to the amount of water collected in the tank by actual daily tank stage measurement during the rainy season, thus field verifying the NRCS model. Monthly runoff was determined by summing up the daily runoff (Table 2). These monthly runoffs are used as input for simulation.

Table 2 shows annual rainfall and runoff estimates from the NRCS model for the four tanks from 2000–2001 to 2013–2014. Fifty per cent dependable flow of 1.567, 0.804, 1.384, and 6.411 MCM is observed during 2008–2009 for Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram watersheds, respectively.

4.2. Irrigation water demand computation

Of the four tanks, Kannivakkam and Perumattunallur tanks have no ayacut area (irrigated area) under cropping. Hence, irrigation demand is computed only for the ayacuts of two tanks, namely Kayarambedu and Nandhivaram tanks. Kayarambedu

Table 2 | Estimated rainfall and runoff from the NRCS model for the study period

Water year	Rainfall		Runoff from tank catchments							
	No. of days	Depth mm	Kayarambedu		Kannivakkam		Perumattunallur		Nandhivaram	
			Depth mm	% of Rainfall	Depth mm	% of Rainfall	Depth mm	% of Rainfall	Depth mm	% of Rainfall
2000–2001	39	1,092.3	247.81	22.69	262.91	24.07	292.36	26.77	280.92	25.72
2001–2002	49	1,211.1	290.20	23.96	303.02	25.02	328.01	27.08	318.29	26.28
2002–2003	28	575.7	67.79	11.78	72.91	12.66	83.30	14.47	79.20	13.76
2003–2004	65	1,765.8	423.48	23.98	446.16	25.27	490.31	27.77	473.16	26.80
2004–2005	44	1,648.0	653.76	39.67	677.49	41.11	722.30	43.83	705.12	42.79
2005–2006	59	3,608.0	2,110.84	58.50	2,156.32	59.76	2,240.11	62.09	2,208.29	61.21
2006–2007	38	1,379.0	624.76	45.31	640.69	46.46	670.45	48.62	659.10	47.80
2007–2008	71	1,899.5	668.71	35.20	691.46	36.40	734.79	38.68	718.11	37.81
2008–2009	44	1,238.8	464.20	37.47	479.68	38.72	508.76	41.07	497.65	40.17
2009–2010	55	1,439.0	489.95	34.05	508.76	35.36	544.62	37.85	530.82	36.89
2010–2011	67	1,489.0	410.98	27.60	428.94	28.81	463.17	31.11	449.98	30.22
2011–2012	52	1,810.0	597.66	33.02	625.41	34.55	678.42	37.48	658.00	36.35
2012–2013	60	1,435.4	397.87	27.72	415.07	28.92	448.35	31.24	435.43	30.34
2013–2014	64	769.3	111.55	14.50	117.33	15.25	129.06	16.78	124.42	16.17
Minimum	28	575.7	67.79	11.78	72.91	12.66	83.30	14.47	79.20	13.76
Maximum	71	3,608.0	2,110.84	58.50	2,156.32	59.76	2,240.11	62.09	2,208.29	61.21

tank has an ayacut of 136.07 ha. Paddy is cultivated from September to February of the ensuing year using water from the Kayarambedu tank as per the existing practices. Nandhivaram tank has an ayacut of 136.50 ha. Paddy crop is cultivated from October to March of the ensuing year with water supply from Nandhivaram tank as per the existing practices. Irrigation water demand was calculated for the representative year 2008–2009. A representative computation of irrigation demand for paddy for Kayarambedu tank ayacut is given in Table 3. The crop coefficient was adopted based on the type of crop and stages of the crop. The irrigation demand for paddy crop in the Kayarambedu and Nandhivaram ayacut areas works out to around 1,211 and 1,184 mm, respectively (Table 4). For Kayarambedu and Nandhivaram ayacuts, the actual irrigation water requirements calculated are 1,730.80 and 1,629.60 mm, respectively, assuming 70% efficiency. A questionnaire survey was conducted with 73 farmers in Kayarambedu tank ayacut and 76 farmers in Nandhivaram tank ayacut. This is to assess the

Table 3 | Details of computation of irrigation demand for paddy for the year 2008–2009 for the Kayarambedu tank ayacut

Item	Month						
	September	October	November	December	January	February	Season
Percentage of annual daytime hours, p	0.28	0.27	0.26	0.26	0.26	0.27	
Average temperature T_{mean} (°C)	29.55	28.00	26.00	24.80	24.60	25.80	
Potential evapotranspiration, ET_o (mm/day)		5.64	5.19	4.95	5.02	5.27	
Crop coefficient, K_c		1.10	1.10	1.20	1.30	1.00	
Crop water requirement	ET_{crop} (mm/day)	6.20	5.71	5.94	6.53	5.27	
		ET_{crop} (mm/month)	192.24	171.26	184.10	202.39	147.42
SAT, mm	200.00						
PSL, mm/month @4 mm/day		124.00	120.00	124.00	124.00	112.00	
WL, mm		100.00					
P_e , mm		78.20	178.20	402.20	42.20	0.00	0.00
Irrigation demand, mm		121.80	238.04	0.00	265.90	326.51	259.42
							1,211.67

Table 4 | Irrigation demand for paddy crop in the tank ayacuts

Sl. No.	Month	Irrigation demand in mm	
		Kayarambedu tank ayacut	Nandhivaram tank ayacut
1	September	174.00	–
2	October	340.06	31.14
3	November	0.00	0.00
4	December	379.86	357.94
5	January	466.28	444.03
6	February	370.60	433.78
7	March	–	425.71

status of the ayacut area. The area irrigated is around 70 ha as against 136.50 ha furnished by the Public Works Department, Government of Tamil Nadu.

4.3. Simulation of tanks

The simulation was carried out for all four tanks namely Kayarambedu, Kannivakkam, Perumattunallur, and Nandhivaram tanks, for a period of 14 years from 2000–2001 to 2013–2014 using VENSIM. The output from VENSIM includes the monthly tank storage, release to meet the agriculture demand, if any, and the spill if any for the known inflow for the entire period of simulation. From these data, the period for which the tank contains water, the total release, the total net losses, and the maximum storage reached in the tank can be obtained. The simulation results in essence will be used to look at the adequacy of the inflow to the tank for meeting the irrigation requirements of the tank ayacut and the amount of water available for further utilization. The simulation model runs on a monthly time step. To start with the live storage in the tank was taken as zero as on 1 July 2000. The inflow for simulation was arrived at by aggregating the daily runoff from the NRCS model. Demand for irrigation is present for Kayarambedu and Nandhivaram tanks only. Figure 7 shows the end month storage obtained from VENSIM for all four tanks.

Irrigation release made from Kayarambedu tank and the spill from each tank and year-wise spill quantity are shown in Figure 8. Simulation findings revealed that the Kayarambedu tank, with an ayacut size of 136.07 ha, could not supply the irrigation requirement for a paddy crop cultivated between September and February for 13 years out of 14 years of study. Even though the area presently under irrigation is assessed to be only around 80 ha, the farmers are growing 2–3 crops in a year, so the tank water is fully utilized by the farmers. There is no scope to utilize Kayarambedu tank water for other purposes.

Kannivakkam tank presently has no ayacut and hence the tank water is fully available for utilization. The full tank capacity is 0.39 MCM. Simulation results indicate that the tank gets filled up for 9 years out of 14 years and there is a spill. The spill reaches the Perumattunallur tank and Figure 8 shows the quantities of annual spill. As the tank gets filled up for more than 50% of the time, the entire storage of 0.39 MCM of water per annum on an average is available for utilization.

Perumattunallur tank has no ayacut and the tank water is fully available for utilization. The full tank capacity is 1.07 MCM. Simulation results indicate that the tank gets filled up for 7 years out of 14 years and there is spill. The spill reaches the Nandhivaram tank and Figure 8 shows the quantities of the annual spill. As the tank gets filled up 50% of the time, the entire storage of 1.07 MCM of water per annum on an average is available for utilization.

With an ayacut area of 136.50 ha, the Nandhivaram tank can provide the irrigation needs of a single crop of paddy cultivated from October to March. The full tank capacity is 1.69 MCM. Table 5 gives summary of simulation results year wise. Simulation results indicate that the tank gets filled up for 12 years out of 14 years and there is a considerable spill. The percentage of Nandhivaram tank's irrigation demand that was satisfied each year is shown in Figure 9. It can be seen that more than 50% of the demand is met for 12 years and more than 75% of the demand is met for 9 years. Figure 10 shows the annual spill from the tank in a semi log plot. Also, the area presently under irrigation is assessed to be only around 70 ha. On average, there is scope to utilize 4.0 MCM of water per annum.

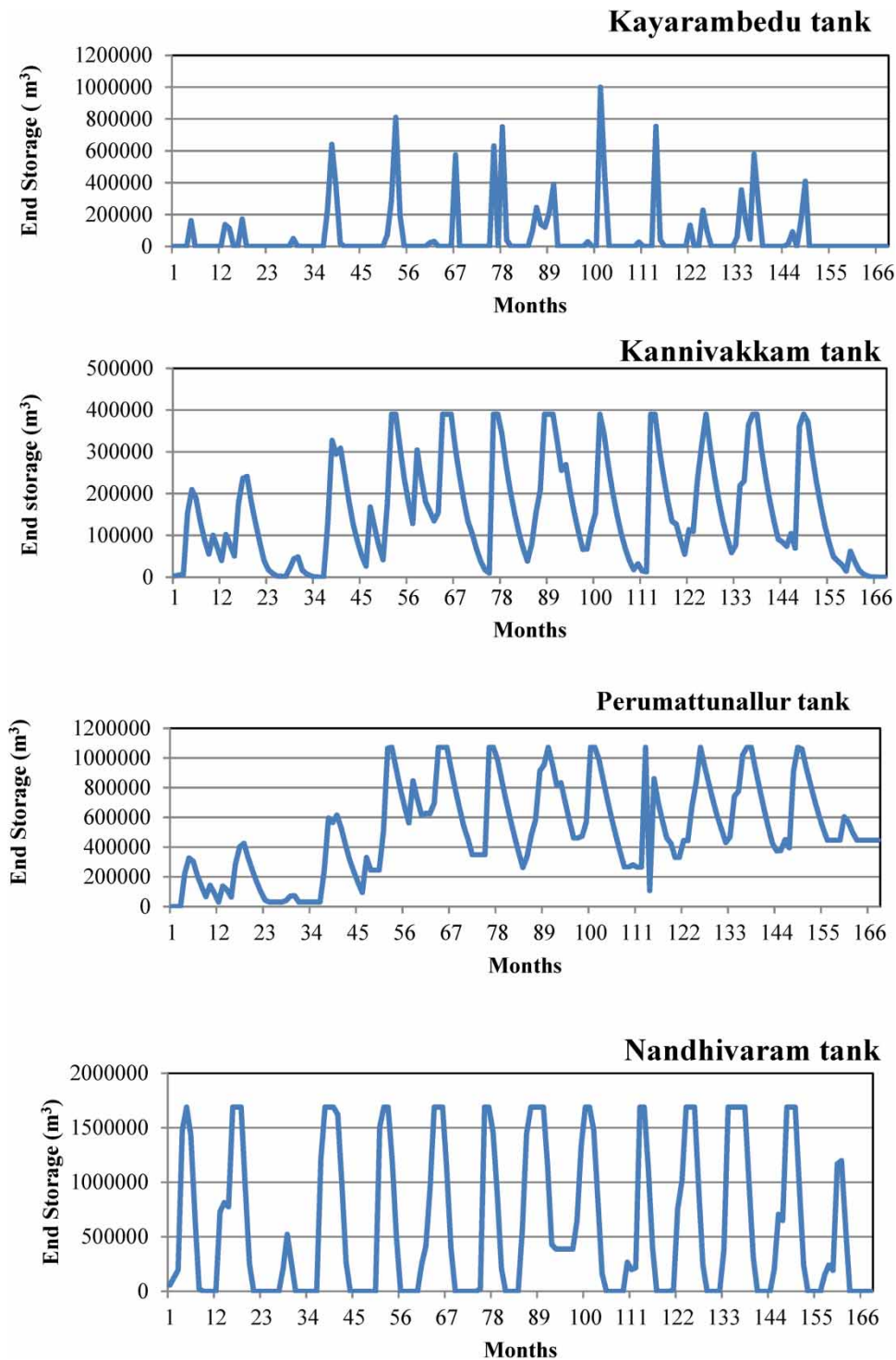


Figure 7 | The end month storage for the tanks.

4.4. Surface water budgeting of chain of tanks

Water budgeting for the watershed of a chain of tanks for 50% dependable year, 2008–2009 indicates that the total quantum of water available is 10.77 MCM. The available water is from three components, namely (i) the free catchment inflow into each of the tanks put together comes to 10.16 MCM (94.3%), (ii) irrigation return flow from Kayarambedu tank ayacut

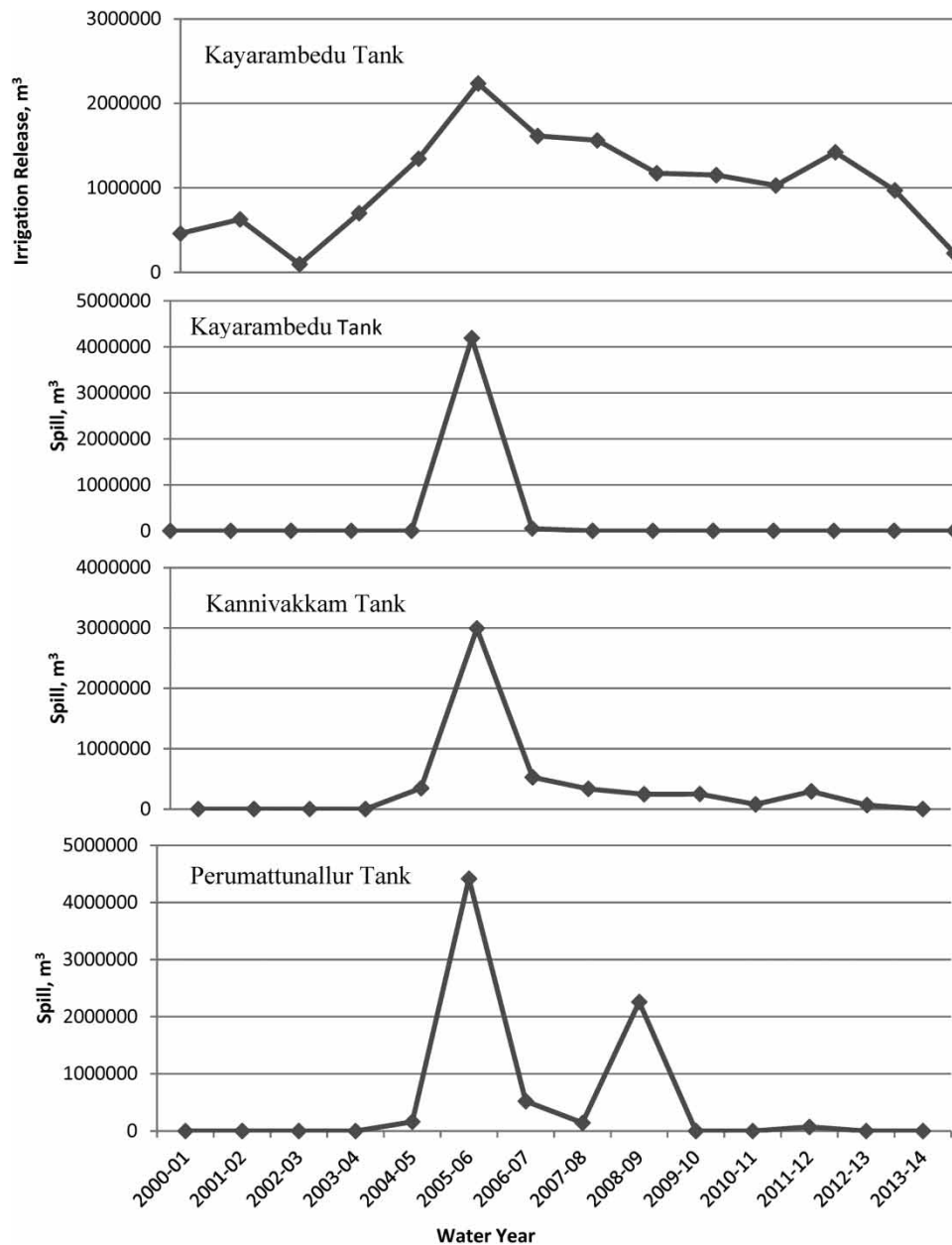


Figure 8 | Irrigation release made from the Kayarambedu tank and the spill from each tank.

reaching Nandhivaram tank comes to 0.35 MCM (3.2%), and (iii) the net water available from carryover storage from the previous year namely 2007–2008 and carryover storage to the ensuing year namely 2009–10 for both Kannivakkam and Perumattunallur tanks comes to 0.26 MCM (2.5%).

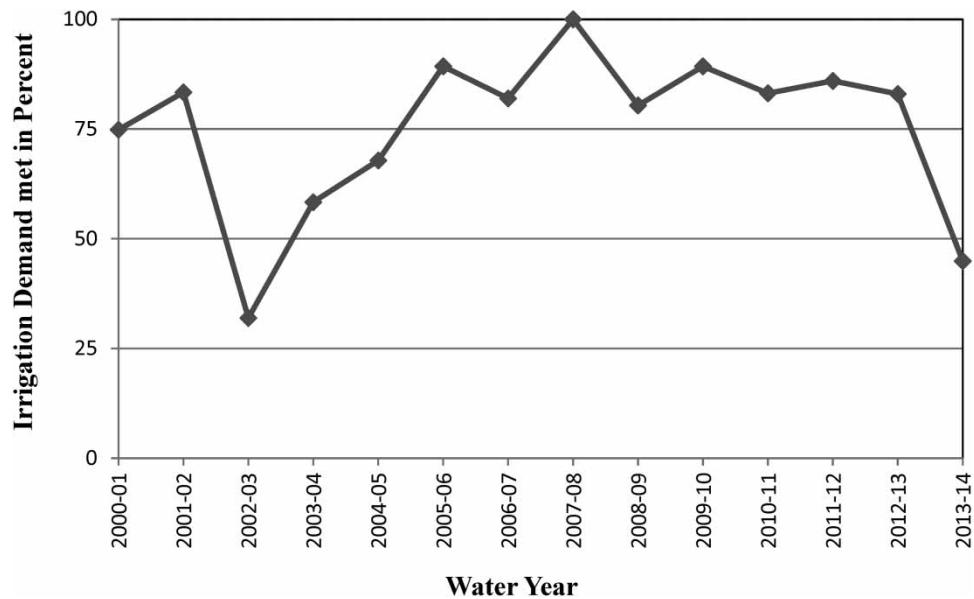
The total utilization which comes to 10.77 MCM is assessed under four components, namely (i) irrigation release from Kayarambedu and Nandhivaram tanks is 3.02 MCM (28.0%), (ii) the net losses from all the four tanks is 3.37 MCM (31.3%), (iii) the spill from Nandhivaram tank is 4.23 MCM (39.3%) as it is the terminal tank, the spill from which leaves the watershed; and (iv) the transmission loss from the spill of Kannivakkam and Perumattunallur tanks is 0.15 MCM (1.4%). The present water availability and utilization from the watershed are shown in Figure 11.

Kancheepuram district's population density is 892/km² (Census of India 2011). The domestic water consumption of the watershed with an aerial extent of 20.625 km² is 1,840 m³/day or 0.672 MCM per year, assuming a per capita water requirement of 100 L/day.

Table 5 | Summary of simulation of the Nandhivaram tank

Year ^a	Inflow, m ³	Release for irrigation		Net losses, m ³	Spill, m ³	Maximum storage reached, m ³
		m ³	% of demand			
Tank capacity = 1,690,000 m ⁵		Irrigation demand = 2,310,415 m ⁵				
2000–2001	3,025,214	1,729,324	74.85	764,102	531,787	1,690,000
2001–2002	4,268,663	1,925,960	83.36	1,153,476	1,189,227	1,690,000
2002–2003	1,046,845	738,187	31.95	308,658	0	988,549
2003–2004	4,860,385	1,348,051	58.35	1,089,824	2,422,510	1,690,000
2004–2005	7,960,945	1,566,936	67.82	806,296	5,587,714	1,690,000
2005–2006	35,960,665	2,062,617	89.27	1,123,235	32,774,812	1,690,000
2006–2007	9,453,985	1,893,995	81.98	783,690	6,776,300	1,690,000
2007–2008	10,110,472	2,310,415	100.00	1,305,440	6,107,384	1,690,000
2008–2009	7,004,030	1,856,896	80.37	918,707	4,451,351	1,690,000
2009–2010	6,963,809	2,062,617	89.27	841,097	309,298	1,690,000
2010–2011	6,071,919	1,920,836	83.14	1,052,757	3,098,326	1,690,000
2011–2012	9,004,315	1,985,914	85.95	1,197,938	5,820,463	1,690,000
2012–2013	5,900,009	1,917,366	82.99	1,072,682	2,909,960	1,690,000
2013–2014	1,659,397	1,037,890	44.92	621,507	0	1,198,087

Note: ^aJuly–June of ensuing year.

**Figure 9** | Irrigation demand met from the Nandhivaram tank.

5. CONCLUSIONS

In the present study, a scientific methodology is developed to examine the adequacy of the inflow to the tank for meeting the irrigation requirements of the tank ayacut and the amount of water available for further utilization. Hydrologic modelling along with simulation modelling can effectively be utilized for irrigation scheduling of small watersheds for sustainable management of available water resources. The study indicates that in total there is scope to utilize around 5.46 MCM water after

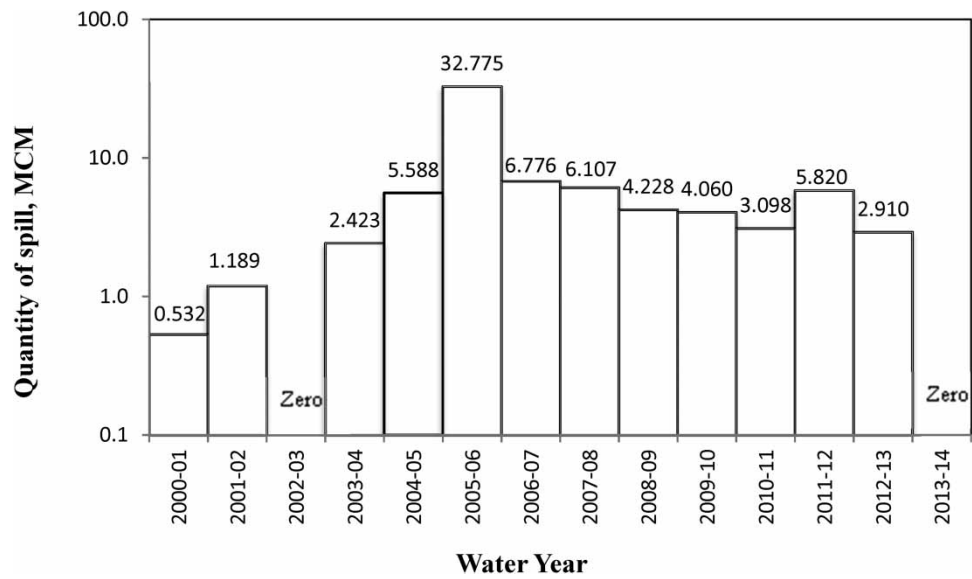


Figure 10 | A semi log plot of spill from the Nandhivaram tank.

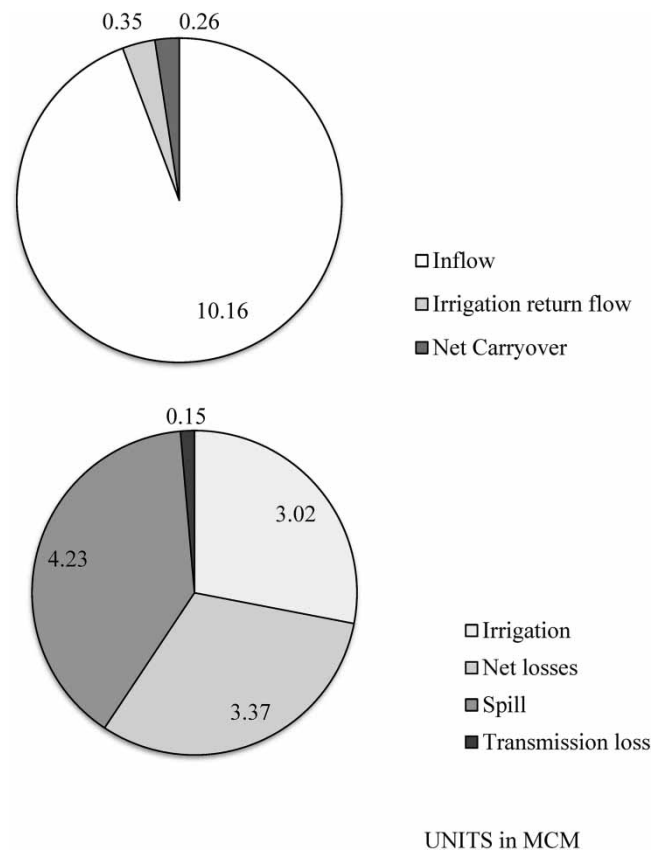


Figure 11 | Water availability and water utilization in the watershed of chain of tanks.

meeting the irrigation requirement of its ayacut area. Even if half of the available water can be effectively utilized, around 2.73 MCM is available for further use in the watershed. According to the study for the chain of tanks, only 28% of the total available water is used for irrigation, with the remainder wasted due to evaporation, transition loss, and spill from

the tanks. As the minimum available water is estimated to be around 2.73 MCM, demand from future development and demand from neighbouring regions, in addition to the watershed's present domestic demand of 0.672 MCM, may also be met if the available water is adequately captured. It is suggested that the authorities have to take necessary initiatives for the frequent maintenance of the tank to avoid a reduction in storage due to silting. One of the advantages of system dynamic study is that the changes in the system can be simulated easily using the developed VENSIM model. Future research can be oriented to study the effect of land-use/land-cover change and climate change effect on water resources in these tanks catchment.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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Dept. of Civil Engineering, NIT Patna

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Groundwater Modeling using MODFLOW

Dr. S. K. Pramada, Assistant Professor

Dept. of Civil Engineering, NIT Calicut, Kerala

Date: 17.02.2023: Time 5.30 - 7 PM



Application of Open Source GIS Software in Water Resources

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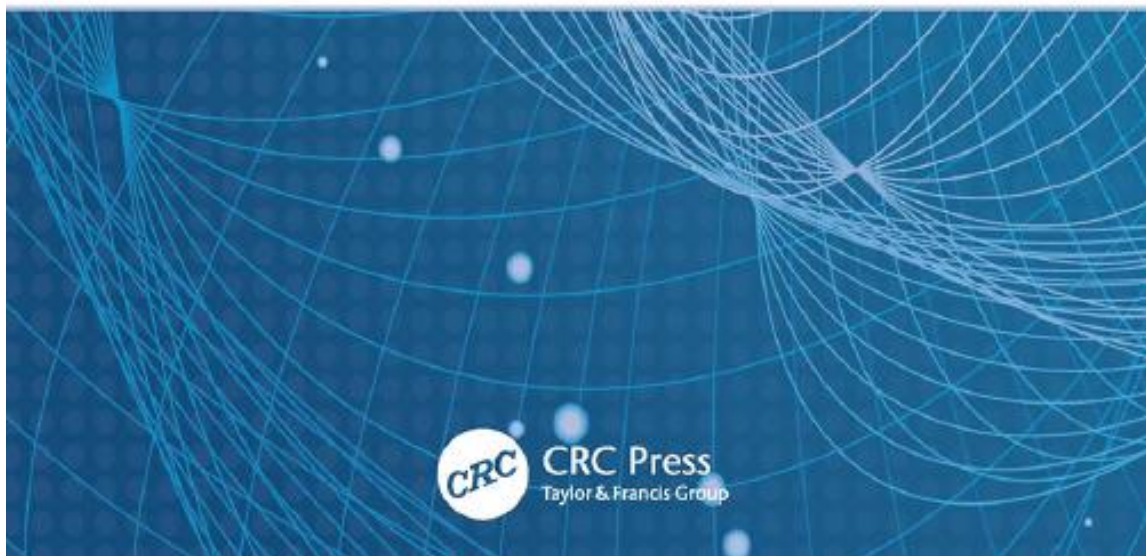


MODELING AND SIMULATION OF ENVIRONMENTAL SYSTEMS

A COMPUTATION APPROACH

Edited by

**Satya Prakash Maurya, Akhilesh Kumar Yadav,
and Ramesh Singh**



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4 Computational and Field Approach to Assess Artificial Recharge of Groundwater

*Marykutty Abraham and
Sankaralingam Mohan*

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4.1 INTRODUCTION

Pumping requirements from aquifers are increasing due to an increase in water demand because of population growth and higher standard of living. An indiscriminate extraction of aquifers can cause decline in physical and chemical quality of water, saline water intrusion in coastal aquifers, and land subsidence.



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Water and climate change from the regional, national, and international perspective

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22.1 Introduction

The natural occurrence of water is known as a meteorological event. It accumulates in rivers, streams, creeks, wadis, and depressions, as well as groundwater storage, and is influenced by atmospheric climatology and morphological features on the Earth's surface. Global water scarcity will increase along with climate change and socioeconomic development in the future at the local, regional, and national level. Due to the geographical location, available water resources are unevenly distributed at the upstream and downstream regions in most river basins. According to various researchers (Arnell, 1999; Döll, 2002; IPCC, 2007, 2013, 2014), socioeconomic development is dependent on water availability and adaptation to natural hazards (droughts and floods) as well as anthropogenically induced variations (including climate change and variability). Future climate change and socioeconomic development would aggravate global water scarcity. Zhongwei Huang et al. conducted research on adaptive inner-basin water allocation measures (AIWAM) that incorporated into future global water scarcity assessment. The results show that future water scarcity would mainly occur in arid and semiarid areas with either large irrigated cropland (e.g., the High Plain in the United States and north coast of Africa) or dense population (e.g., large cities in the Western United States and Bulgaria), or both of them (e.g., India, the North China Plain, Central Asia, and the Arabian Peninsula). The global water deficit is likely to increase by 48.3% during 2020–50, and the number of absolute population and irrigated cropland area exposed to water scarcity in 2050 are projected to increase by 82.5% and 42.9%, respectively, in comparison to those in 2020. They also found that the adaptive measures that reallocate water resources in the river basin would mitigate water scarcity for nonagricultural sectors, particularly in the downstream areas with intensive population. Their study emphasized the importance of considering AIWAM in water scarcity assessment under future climate change, which would be helpful in developing policies to reduce population exposure to water scarcity and achieve the goals of sustainable water management (Huang et al.). Water resource planners must take into account the effects of global warming and climate change on water supply options due to changes, necessitating the design of water structural systems (Hitz and Smith, 2004). Existing water resource structures are based on past climate events, with the assumption that there will be no significant changes in the future. This assumption considers the historical records' stationarity, which are regarded as indistinguishable reflections of future conditions. Future risks of extreme events such as droughts and floods, which are triggered intensively and frequently as a result of climate change impacts, should be factored into the water structures. The engineering structures' robustness and reliability are thus guaranteed to a maximum safety level with practically reduced risks. Hydroelectricity generation units may be knocked offline as a result of flood damage, resulting in a cascade of unwelcome subsequent

Sustainable and Circular Management of Resources and Waste Towards a Green Deal



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Sustainable and Circular Management of Resources and Waste Towards a Green Deal

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Preface

The United Nations established 17 sustainable development objectives in 2015 (see *Transforming Our World: The 2030 Agenda for Sustainable Development*, United Nations, 2015). This program currently spans the globe with 169 Targets, 3108 Events, 1307 Publications, and 5487 Actions. There are various references to global sustainable development in these goals. The Green Deal (European Commission, 2019) is a crucial component of the European Union's (EU) strategy to implement the Sustainable Development Goals (SDGs) of the United Nations (UN General Assembly, 2015), which are important for minimizing the impact of climate change, biodiversity loss, air, water, and soil pollution, as well as ensuring the sustainable use of energy and natural resources and the well-being of citizens.

EU initiative of the Green Deal in 2019 was aimed at transforming the EU's economy for a sustainable future. It is mainly meant for tackling "climate change," emphasizing the following:

- A zero pollution ambition for a toxic-free environment
- Climate neutrality switching from fossil fuels to nontraditional energy sources, by increasing the EU's climate ambition for 2030 and 2050
- Limiting greenhouse gas emissions in the context of combating global warming
- Mobilizing industry for a clean and circular economy (CE)
- Supplying clean, affordable, and secure energy
- Large-scale job creation in the field of clean energy
- Circular management of resources and waste (cash from trash) Building and renovating in an energy- and resource-efficient way
- Accelerating the shift to sustainable and smart mobility
- From "Farm to Fork": designing a fair, healthy, and environment-friendly food system
- Preserving and restoring ecosystems and biodiversity
- Soil–agricultural innovations

The European Green Deal strategy's central agenda is the CE. The EU has emerged as a leader in the fight against climate change. The ambitious program's milestones are displayed in tabular style. Ursula von der Leyen, President of the European Commission, dubbed it the "Man on the Moon Moment" because the European Green Deal aims to offer a comprehensive framework to make Europe the first continent to achieve net zero emissions by 2050. Consequently, an important strategy for implementing the UN SDGs is the EU Green Deal (EUGD) The planned EGD comprises a number of components that will move the continent closer to its ultimate objective of climate neutrality. In this book 29 chapters are dealt in the following sections:

1. Strategies for implementation of Green Deal—Chapters 1–3
2. Circular economy—Chapters 4–10
3. Sludge management—resource recovery—Chapters 11–14
4. Phosphorus management—Chapters 15–20
5. Climate action—Chapters 21–25
6. Clean energy transition—Chapters 26 and 27
7. Sustainable management and global agenda—Chapters 28 and 29

The goal of this work is to examine climate change–related challenges and prevention strategies, such as the Green Deal's creative technological, environmental, and social solutions. This work also presents recent developments and research findings in the area of sustainable science. The idea of environmental concerns and its remediation, which tries to reduce waste production while maximizing the use of resources such as energy, water, and human capital.

The world is threatened at an existential level by climate change and environmental deterioration. Taking steps to protect the environment is a top priority in light of the expanding human population and the ecosystem's ongoing

degradation brought on by human activity. In order to combat climate change, it is crucial that the Green Deal strategies are put into action. They are essential in the quest for sustainability, which integrates environmental, economic, and social factors to guarantee the survival of current and future generations.

The concurrent crises of climate change, biodiversity loss (also known as the Sixth Mass Extinction), material waste, pollution of land, freshwater, and oceans, while social cohesion and inequality are being exacerbated by the COVID-19 pandemic, present an opportunity for new jobs, values, and equal opportunities. The planet is in peril from environmental deterioration, climate change, and natural calamities. Action plans for environmental conservation and sustainability are a top concern due to the planet's population boom to approximately 7.8 billion people and environmental deterioration brought on by the overuse of natural resources and waste generation.

Implementing the Green Deal strategies, which aim to update knowledge among the affected stakeholders, is therefore urgently needed. The suggested work is essential for the pursuit of sustainability, in which social, economic, and environmental factors are combined to assure the existence of the present and future generations. Consequently, the goal is to showcase cutting-edge areas in the selected fields, such as creative (technological, environmental, economic, and social) solutions that may be used within the Green Deal strategies.



Word cloud generated using the keywords and titles of the contributory chapters

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Water and climate change from the regional, national, and international perspective

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22.1 Introduction

The natural occurrence of water is known as a meteorological event. It accumulates in rivers, streams, creeks, wadis, and depressions, as well as groundwater storage, and is influenced by atmospheric climatology and morphological features on the Earth's surface. Global water scarcity will increase along with climate change and socioeconomic development in the future at the local, regional, and national level. Due to the geographical location, available water resources are unevenly distributed at the upstream and downstream regions in most river basins. According to various researchers (Arnell, 1999; Döll, 2002; IPCC, 2007, 2013, 2014), socioeconomic development is dependent on water availability and adaptation to natural hazards (droughts and floods) as well as anthropogenically induced variations (including climate change and variability). Future climate change and socioeconomic development would aggravate global water scarcity. Zhongwei Huang et al. conducted research on adaptive inner-basin water allocation measures (AIWAM) that incorporated into future global water scarcity assessment. The results show that future water scarcity would mainly occur in arid and semiarid areas with either large irrigated cropland (e.g., the High Plain in the United States and north coast of Africa) or dense population (e.g., large cities in the Western United States and Bulgaria), or both of them (e.g., India, the North China Plain, Central Asia, and the Arabian Peninsula). The global water deficit is likely to increase by 48.3% during 2020–50, and the number of absolute population and irrigated cropland area exposed to water scarcity in 2050 are projected to increase by 82.5% and 42.9%, respectively, in comparison to those in 2020. They also found that the adaptive measures that reallocate water resources in the river basin would mitigate water scarcity for nonagricultural sectors, particularly in the downstream areas with intensive population. Their study emphasized the importance of considering AIWAM in water scarcity assessment under future climate change, which would be helpful in developing policies to reduce population exposure to water scarcity and achieve the goals of sustainable water management (Huang et al.). Water resource planners must take into account the effects of global warming and climate change on water supply options due to changes, necessitating the design of water structural systems (Hitz and Smith, 2004). Existing water resource structures are based on past climate events, with the assumption that there will be no significant changes in the future. This assumption considers the historical records' stationarity, which are regarded as indistinguishable reflections of future conditions. Future risks of extreme events such as droughts and floods, which are triggered intensively and frequently as a result of climate change impacts, should be factored into the water structures. The engineering structures' robustness and reliability are thus guaranteed to a maximum safety level with practically reduced risks. Hydroelectricity generation units may be knocked offline as a result of flood damage, resulting in a cascade of unwelcomed subsequent

services for societal life support (RAE Royal Academy of Engineering, 2011). Engineering water structures must be built in such a way that they can anticipate, absorb, accommodate, and recover from any hazard. In this vein, water resource management through engineering structures is best accomplished when combined with hard modeling procedures based on previous experiences and expert opinions. To scale these further, national governments should ensure that every city has a transformative, locally appropriate climate-resilient water management plan that encourages the integration of nature-based solutions, such as green infrastructure (Oates et al., 2020). The main attention of this chapter is to define the role of climate change on the national and regional level and its impact on the hydrometeorological parameters and ground-based water engineering structure.

22.2 Water and climate change: case study in Asian countries

Due to the geographical location, water resources are distributed unequally all over the world. In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality (IPCC a., 2014). In 2014, the Intergovernmental Panel on Climate Change (IPCC) reported that the surface temperature is projected to rise through the 21st century under all assessed emission scenarios. The increase in temperature will continue to increase heat waves that will occur more often and last longer. According to the projected climate change, people who live in dry lands will be affected by the severe water stress in the coming decades. The increase of temperature will mean that a higher proportion of the water falling on the Earth's surface will evaporate. The amount of rainfall will change in some parts of the world, while the frequency of the intensive rainfall events will increase in other parts of the world. The combined effect of less rainfall and more evaporation means less soil moisture available for crop growth. Moreover, the amount of runoff is highly sensitive to changes in climate; even small changes in the amount of precipitation or in temperature can have a big influence on the hydrological cycle mostly in arid and semiarid regions. The surface runoff is expected to decrease drastically in arid and semiarid regions of Asia, which will affect the volume of water available for irrigation and other purposes. Climate change affects the water balance and ecosystems. As faced by many countries, floods, landslides, and droughts often occur in many cities in Indonesia. The annual temperature in Indonesia has been rising by about 0.3°C since 1990 (Sulistiyawati et al., 2018). In some published reports, flood frequency is projected to increase with the rising warming in a particular area (Merten et al., 2021; Yamamoto et al., 2021). According to the National Statistical Agency (*Badan Pusat Statistik*; BPS) of Indonesia, floods are the most significant disasters that strike many subdistricts in Indonesia (see Fig. 22.1). They are followed by landslides, earthquakes, and drought, which can also be associated with drastic climate change. The number of subdistricts impacted by the disasters increased from 2011 to 2018. This situation shows that Indonesia is vulnerable to climate change and water security (Sulistiyawati et al., 2018). The detailed environmental and socioeconomic impact will be explained further in the following subsections.

22.2.1 The physical or environmental impact of climate change

The capital city of Indonesia, Jakarta, has become the most crowded and populous city in Indonesia. Jakarta also has the most rapid urbanization rate compared to other cities in Indonesia. Therefore, Jakarta poses many risks to water resources due to climate change. The temporal issue occurring, especially in the rainy season, is the biggest challenge the local and central governments must face (Dwirahmadi and Phung, 2019). Muis et al. (2015) stated that the risk of flood would increase with the rise of urban expansion. It was also predicted that the coastal flood would have a higher risk than the river flood since the urban expansion mainly exists in the coastal areas (Muis et al., 2015). This urban

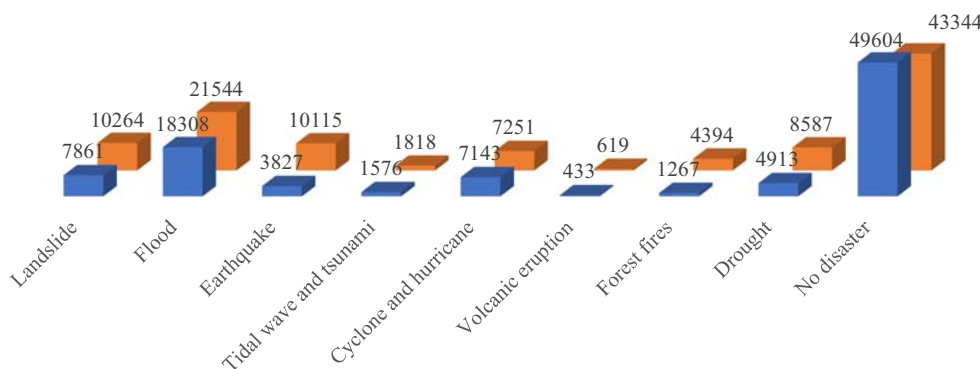


FIGURE 22.1 Number of subdistricts that were subject to disasters in Indonesia: blue color indicates the year 2011–14 and the yellow color year 2015–18.

development should be controlled, and local regulation should be enforced to reduce the probability of local disasters (Jin et al., 2018). Jakarta also poses groundwater depletion because of rapid anthropogenic activity development. Climate change influences the stability of groundwater recharge. Therefore, the rapid development is an imbalance in the groundwater recharge rate (Amanambu et al., 2020). Climate change also influences the availability and supply of water resources, reducing crop yield (Akpoti et al., 2019) and harming human health (Sulistyawati et al., 2018). Notably, the increase in average annual temperature by 1°C reduces the grain irrigated rice yield by 10% (Akpoti et al., 2019). As the largest archipelagic nation, Indonesia also faces challenges providing sufficient water services on the small islands that spread over many provinces in Indonesia. Many small islands are vulnerable to water scarcity and droughts (Tallar and Dhian, 2021). Some factors that drive this condition include coastal erosion, precipitation changes, and overwash. Therefore, mismanagement of freshwater use in the islands can increase the possibility of unsustainable freshwater resources. Freshwater use in many small islands in Indonesia is regulated by traditional rules by the elders that restrict the use of water extraction (Schwerdtner Máñez et al., 2012).

22.2.2 The socioeconomic impact of climate change

Climate change is significantly negatively impact warmer countries such as Indonesia. The increasing poverty is in line with the increasing number of carbon dioxide (CO₂) emissions. Therefore, the poorer regions will be more vulnerable to climate change (Chen et al., 2020). This condition should be treated well by the local government. Slums in a city are another problem that the local government must face. These informal settlements are mostly impacted because of the inequality of basic sanitary services. This problem has become a challenge in many rapidly expanding cities in Indonesia since the slums should be improved (Rahmasary et al., 2019). Some health risks associated with water resources and climate change are also emerging. For instance, vector-borne diseases and waterborne diseases have increased since 2001 (Sulistyawati et al., 2018). This situation may be due to the high level of rainfall, puddles, and poor sanitation systems in many cities in Indonesia. Some abnormal floods were also reported by Merten et al. (2021) in Jambi District. These floods have uncertain patterns that affect the food crop timing for cultivation, thus influencing the economic value of crop production. Due to this flood, farmers are the most impacted stakeholder, especially in rural areas, which also increases the risk of conflict due to social injustice and inequalities (Merten et al., 2021).

22.3 Recent practices to adapt and mitigate the climate change

Climate change is affecting the urban water systems, which are already stressed by the aggravating challenges of water scarcity and water quality deterioration. Changes in precipitation have varied in terms of frequency and intensity in many Asian regions in recent years, which potentially leads to intensive flood and drought that could have strong socio-economic and environmental impacts in many urban cities. Additionally, increasing human activities, such as changes of land cover and emission of greenhouse gases, are also causing extreme rainfall and raising issues in terms of water demand and water supply systems. As seen, there is a need to manage and improve the urban water supply systems based on the positive effect of the current climate change. Due to the rapid population growth and lack of freshwater resources, both the developing and developed countries will face challenges to urban water supply. Therefore, it's important to implement climate change mitigation and adaptation measures on urban water supply systems. In urban areas, climate change is projected to increase risks for people, assets, economies, and ecosystems, including risks from heat stress, storms, extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rises, and storm surges (very high confidence).

According to the IPCC report (2014) climate change is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions, intensifying competition for water among sectors IPCC a (2014). These risks are amplified for those lacking essential infrastructure and services or living in exposed areas (IPCC a., 2014). The intensity of heavy rainfall has sometimes exceeded the limits of the design of rainfall drainage systems and causes rainwater to run over the road (Nakasaka and Ishigaki, 2021) in urban areas, which causes several problems for underground construction. The other main causes of water problems in the cities are the destruction of wetlands and green spaces. In order to adapt to such large-scale floods, it is necessary to implement a safe and prompt evacuation plan that anticipates future increases in rainfall due to climate change (Nakasaka and Ishigaki, 2021). Mostly, rainwater infiltrates into the ground or is reserved in paddy fields; in that case the flow downstream is controlled effectively. However, due to the development of urban cities in most countries, the surface has been covered by concrete or asphalt, and forests and paddy fields have disappeared, that has resulted in the increase of water flow downstream. The urban drainage system is also still not improved or designed to be suitable for a rapidly increasing settlement. Several Asian countries

have experienced rapid urbanization in recent decades. Such a rapid process of urbanization has increased the changes of land use and land cover, green spaces, vegetation areas into constructions, and road networks with and without suitable drainage systems. Due to the high intensity of flooding, many cities in Asian countries have faced major problems in recent years. Extreme weather events will become more intense and frequent in many regions. In recent years, extreme rainfall events have caused severe distribution with wide spread socioeconomic impacts all over the world. Such severe weather and rising sea levels are affecting people and their property in developed and developing countries. In most urban cities, water engineering structures have been developed without consideration of climate change. However, the impact of climate change has shown its footprints in recent years. Thus additional consideration and planning is required for these water structures. Therefore, it becomes more important to consider water structures with reference to the climate change scenarios to reduce the risk of extreme hydrometeorological events. The common form was structured in such a way that the construction of the new buildings should take into account climate change and be environmentally friendly.

China has introduced the Sponge City program in 2015 that is one of the flood mitigation systems instead of building dams and floodwalls. This program has five main concepts: (1) retaining water on site, (2) eliminating water logging and urban flooding, (3) improving urban water quality, (4) mitigating impacts on ecosystems, and (5) alleviating urban heat island impacts (Hadhinata et al., 2021; Li et al., 2017), and its aim is to build a green infrastructure, like wetland areas, rooftop plants, and rain gardens in order to absorb the rainwater as much as possible. This environmental design holds, cleans, and drains water in a natural way and it can reduce the urban flooding damage. Under the environment-friendly urban development, like the sponge city program implemented in China and Germany, the rainwater can be used in more efficient way. The sponge city concept, initiated in China, has also become a hot topic in reducing floods in Jakarta City, Indonesia. Other countries, like India, the United States, and Russia are also looking at the sponge city concept as a potential solution for flooding and water scarcity. To alleviate the urban flooding problems, 30 cities in China were selected to initiate a pilot project to build a sponge city in 2015 (Gong et al., 2019). However, there are several challenges faced by the Sponge City Program. Some researchers (Li and Zhang, 2022) conducted a review of the progress in the Chinese Sponge City program. Exploring internal interaction among climate change, human activities, and terrestrial hydrological cycles will help to improve the management of water resources in Central Asia. Despite the exciting concept of sponge cities, the Indonesian Government is currently more interested in developing reservoirs and dams to conserve water resources rather than implementing sponge cities as China's Government does (Fulazzaky, 2014). The Indonesian Government has been committed to improving the urban sanitation system (Kerstens et al., 2016). Incentives structures from the central Government through Special Allocation Funds (*Dana Alokasi Khusus*; DAK) and the international donor assistance from many nongovernment organizations (NGO) have improved sanitation services (Winters et al., 2014). Those incentives can improve water conservation, increase sustainable water resource resilience, and benefit people and the environment (Garlick et al., 2020). However, the policy has many constraints at the local or municipal level. Educational campaigns have removed gaps in the people's knowledge of basic sanitation services. Collaborative action between the local Government and community-based organizations (CBO) has been proven to engage people in sustainable water use and improving the sanitation system (Winters et al., 2014). Kirono et al. (2014) stated that the stakeholder engagements through the sustainable urban development project could improve adaptation capability for sustainable use of the urban water system in Mamminasata region, Makassar City. The involvement and collaboration of multidiscipline stakeholders produced a good adaptation practice for the water management system. This project consisted of several activities which were done through intensive collaborative workshops, including stakeholder engagement, project development, and system design. Other collaborative workshop projects were also reported to successfully engage stakeholders to develop some mitigation and adaptation actions related to sustainable freshwater usage (Bohensky et al., 2016; Butler et al., 2014; Larsen et al., 2012).

The Indonesian Government has a multilevel governance structure that can synchronize local and national policy strategies. The decentralization system can give appropriate policy, but at the same time, this "flexibility" and "decentralized" organizational system also produces multilevel problems and a lengthy decision-making process (Ward et al., 2013). The slow progress of urban sanitation development is the other problem that has hindered the improvement of the sanitation system. Therefore, community-based sanitation and decentralized wastewater treatment system (DEWATS) have become attractive for investment. Since Indonesia has a broad range of diversity in local culture, community involvement is the best approach to improve the urban sanitation system (Rahmasary et al., 2019). The establishment of such DEWATS, community-based material recovery facility (CdMRF) or waste bank, Family Welfare Empowerment (*Pemberdayaan Kesejahteraan Keluarga*; PKK), and other CBO has a higher impact on the successful implementation of a local policy related to climate change adaptation (Budihardjo et al., 2022). Currently, PAMSIMAS, a community-based rural drinking water supply program that allows the extraction of deep-well water

resources, helps to ensure freshwater availability, especially in rural and remote areas. This program could be effective if the community, as the beneficiaries and management at the same time, can appropriately manage the resource (Daniel et al., 2021).

Building community resilience toward climate change-related disasters is being promoted nowadays. This concept involves a collaborative governance approach to reduce the possibility of risk and vulnerability in a specific area. However, building community resilience in Indonesian cities is challenging since many barriers include lack of financial capacity, technology, leadership, community involvement, coordination across stakeholders, and information. Besides, the poor habit of communities and social sensitivity, unclear roles and responsibilities, overgenerous disaster relief to the disaster survivors, and high dependency on government relief become barriers to achieving community resilience (Dwirahmadi and Phung, 2019). Moreover, some factors that drive the building process of community resilience in a city include (1) motivation and initiative of the municipal government, (2) support from the central Government, (3) capacity building, (4) partner assistance, (5) availability of guidelines/rules, (6) strong collaboration and coordination, (7) policy directives, (8) active participation of the related stakeholders, and (9) political will and decision-makers' commitment. Therefore, among those factors, municipal government initiative and motivation become the highest factors driving the integration of adaptation strategies (Wijaya et al., 2020). Community-based movement in the local decision-making process is also essential to mitigate the effects of global warming in densely populated cities (Rachman et al., 2022).

22.4 Climate change variability and water harvesting and management

The availability of water resources varies in different areas of the globe due to the unpredictable distribution of precipitation and runoff. The global population demand is significantly influenced by population growth and urbanization. With the development of the society and economy, croplands and urban areas have gradually increased, resulting in a rising demand for water withdrawal for agriculture irrigation and industry. The unreasonable utilization and exploitation of water resources has led to vegetation degradation and ecosystem deterioration, which worsens the shortage of water resources in the arid regions of Central Asia (Chen et al.). Water resources are necessary, especially for some crops that require a continuous irrigation system. Due to population growth, the availability of water sources is affected. Therefore, it is critical to collect water for further use. Rainfall pattern and water availability will have a significant impact on agricultural production. The modification of rainfall and evaporation rates to increase crop production in an arid area is an example of adaptive practices related to the drastic changes of the microclimate. However, this practice comes at a higher cost than other repressive measures. A good cropping plan is also necessary to achieve a better result in crop production. Land suitability analysis can determine where the suitable agroecological regions are located. Then, crop relocation and better land management become another solution to adapting and mitigating the impact of climate change (Akpoti et al., 2019). Other examples of climate change adaptation include intermittent irrigation and rainwater harvesting technology to ensure the availability of water resources for agricultural purposes. The rain harvesting system is widely used and a standard technology to conserve water in the rainy season and use it in the dry season. Irrigation technology, such as drip, capillary, rotating, and intermittent irrigation systems, is commonly used in areas with limited water availability (Twidyawati et al., 2021). Water harvesting in the form of rainfall and runoff provides the opportunity to increase water resources through appropriate structures. These structures not only reduce downstream runoff, but also contribute to surface and groundwater storage. The traditional method of collecting rainwater on the surface is to dig large ditches, but more advanced techniques include arches, small dams, weirs, underground tanks, and ponds. The principles of runoff harvesting for groundwater recharge have been explained by Sen (2020). The following water structural units can be used for harvesting in general.

1. These are designed for shallow groundwater storage recharges and have a length of 2 m, a width of 1 m, and a depth of about 3 m. Boulders, gravels, and coarse sand are used to fill these pits.
2. When the stream is permeable at shallow depths, this is a good harvesting structure. Their dimensions can range from 0.5 to 1 m in width, 1 to 1.5 m in depth, and 10 to 20 m in length, depending on water availability. Filter materials are used to refill them.
3. Hand-pumps: Simple hand pumps can recharge shallow and deep aquifers. Water must pass through a filter before it can be used in hand pumps.
4. Recharge wells: Recharge wells have a diameter of 100–300 mm and are used to recharge deep aquifers. Water must pass through an effective filter to avoid clogging the well's periphery.

5. Recharge shafts: These are useful for recharging shallow aquifers beneath clayey surfaces. They can range in size from 0.5 to 3 m in diameter, with depths of 10 to 15 m. Backfilled with boulders, gravels, and coarse sand, they are similar to pits.
6. Lateral shafts: These are used in conjunction with one or two bore wells to recharge shallow or deep aquifers with groundwater. Their width ranges from 1.5 to 2 m, and their length ranges from 10 to 30 m. Boulders, gravels, and coarse sand are also used to backfill them.
7. Spreading technique: This technique is appropriate for starting a permeable layer from the surface. Small dams, gabion structures, percolation ponds, and cement plugs can be used to spread water from streams.

22.5 Impact of climate change on hydrological processes

Climate change has a tremendous impact on the hydrological process by disrupting the temperature pattern. The frequent occurrence of extreme weather events and depletion of water resources are projected in several studies. [Zaz et al. \(2018\)](#) analyzed temperature and precipitation in the Indian regions of Jammu and Kashmir for the period 1980–2016. According to the study, a decrease in precipitation has been accompanied by an increase in temperature. This decrease in precipitation has affected the water supply for the growth and development of the study area. [Mishra \(2015\)](#) studied the occurrence of floods in Jammu and Kashmir in September 2014 using satellite remote sensing. According to a study, the main cause of flooding in Jammu and Kashmir was an increase in rainfall from September 2 to 6 due to regional temperature variations. This increase in rainfall was influenced by the change in rainfall pattern over the study area. Most of these districts experienced continuous frequent heavy rainfall in the range of 15–22 mm/h during the first week of September 2014, which caused an increase in rainfall and contributed to major flooding in Jammu and Kashmir. In Japan, a heavy rainfall event occurred on July 5–6, 2017 in the Northern Kyushu area, resulting in flash floods and landslides in Fukuoka and Oita prefectures. The Automated Meteorological Data Acquisition System (AMeDAS) at Asakura city in Fukuoka prefecture recorded 129.5 mm of rainfall in 1 hour and 261.0 mm in 3 hours ([Kato et al., 2018](#)). The governments of urban cities in Asian countries have been implementing different kinds of flood protection measures. Japan has been implementing nationwide hydro meteorological observation through a dense network of rain gauges ([Shibuo and Furumai, 2021](#)). In recent decades, ground radars have been used to observe heavy rainfall with high spatial and temporal resolution as a countermeasure. The number of occurrences of heavy rainfall that exceeds 50 mm/h has increased by 1.4 times in the recent decade compared to the earliest decade in the observation records of AMeDAS in Japan ([Shibuo and Furumai, 2021](#)). Due to the impact of climate change and increased water demand, the hydrological regime of water resources has changed over the years.

Groundwater is an essential life-sustaining resource for billions of people worldwide. It is also a critical backstop during drought when surface water supplies are reduced. But unsustainable depletion of groundwater is now documented on both local and global scales. Climate change will exacerbate these problems. Higher temperatures and more extreme droughts will alter the timing and availability of surface water, thus increasing reliance on groundwater. At the same time groundwater recharge will be reduced limiting supplies for consumptive use and for ecosystems. The net effect of climate change on groundwater depends not only on changing climatic conditions or the physical attributes of a region, but also on human actions and management decisions. As most of the runoff resulting from snow-ice melt is related to climate change factors in the arid region of northwest China, the risk to water resource systems threatens the socioeconomic and ecological environment and is becoming increasingly prevalent ([Yang and Zhang, 2022](#)). Literature ([Yang and Zhang, 2022](#)) explored the risks of water resources shortages for different periods (2010, 2020, and 2030) in the Aksu River basin (ARB) in the northwest arid region of China by reconstructing a risk model based on the framework proposed by the IPCC with an improved vulnerability (V) module and a more suitable hazard probability in the cost module. The conclusion derived from the model was that the vulnerability of the water resource system in the ARB was medium in 2010, and dropped to a medium-low to nonvulnerable level in 2020 before increasing in 2030 under different representative concentration pathways (RCP) (RCP2.6, RCP4.5, and RCP8.5). The risk level of water resource shortages in the ARB in 2010 was medium–low and although the risk decreased in 2020 due to the increasing water supply from mountainous areas, the risk was predicted to increase significantly in 2030, to a medium to high risk level.

Due to the increase in carbon dioxide and methane emissions, global warming occurs eventually which results with more thawing of the permafrost. The impacts of climate change on permafrost vary at the regional and local scales. The permafrost thawing has been observed in many locations all over the world, causing unequaled shifts in freezing and thawing degree days from local to regional scales ([Frauenfeld et al., 2006](#); [Wu and Zhang, 2010](#); [Luo and Jin, 2014](#); [Peng and Zhang, 2018](#); [Shi and Niu, 2019](#)). [Rafiq and Mishra \(2016\)](#) investigated the changes in Himalayan glaciers in

a warming environment in a case study of the Kolahai glacier. The interannual difference technique (Mishra and Rafiq, 2017) was adopted to analyze the impact of regional climate change on the snow depth over the Kolahai glacier. The results reveal that an increase in temperature at the global and regional levels enhanced the rate of glacier melt. That increase in temperature impacted the environment and causing flooding and droughts. The permanently frozen ground could have severe consequences for climate change in Mongolia. Also, permafrost thaw has been creeping in the Northern Mountains of Mongolia. A few studies have evaluated freezing and thawing indices over Mongolia. Some of the results highlighted that Mongolia experienced more pronounced decreases in the freezing index and increases in thawing index than Alaska, Russia, Canada, and the Tibetan Plateau between 1901 and 2015 (Shi and Niu, 2019; Avirmed and Khurelbaatar, 2021). The decrease of the freezing index and increase in the thawing index over Mongolia has likely led to permafrost thawing and the formation of taliks, which has been recorded at the southern permafrost boundary in Mongolia (Ishikawa and Jambaljav, 2018). Avirmed and Khurelbaatar (2021) highlighted that the decrease in the freezing index is usually higher in mountain regions and the north of Mongolia featuring permafrost, compared to steppes and the Gobi-desert dominated by seasonally frozen ground. The opposite occurred for the thawing index (Avirmed and Khurelbaatar, 2021). Then, they concluded that the latitude and altitude play the dominant roles in the spatial patterns of freezing and thawing indices over Mongolia. In Mongolia, the freezing index has decreased with the range from $-0.3^{\circ}\text{C}\cdot\text{day}$ per year to $-10.1^{\circ}\text{C}\cdot\text{day}$ per year, while the thawing index has increased between $5.8^{\circ}\text{C}\cdot\text{day}$ per year and $14.4^{\circ}\text{C}\cdot\text{day}$ per year. The highest values for both the thawing index and the freezing index (i.e., the least negative values) have occurred during the last two decades. However, the largest changes of thawing and freezing indices occurred between 1981 and 2000. Permafrost in Mongolia, which lies on the southern edge of the Siberian permafrost is the most vulnerable to climate change. Permafrost change over Mongolia between 1974 and 2016 is shown in Fig. 22.2A and B, respectively. As shown in Fig. 22.2A, the northern side of Mongolia was covered by continuous and sporadic permafrost in 1974, while the southern side was only sparsely covered with patches. Within four decades, the continuous permafrost area has changed into discontinuous and sporadic permafrost area, which is a consequence of climate change at the regional level Fig. 22.2B.

Khentii, Khuvsgul, Khangai, and Altai mountains are the largest permafrost in Mongolia, and are the main water sources of surface water in the country. High surface temperature associated with climate change would result in changes of permafrost conditions, and thus would impact the surface water availability in these regions (Zorigt et al., 2020). Thawing permafrost would increase the surface water runoff as well as ground water resources for short period of time. Both permafrost thaw and ground ice-melt can be related to groundwater discharges (i.e., spring discharges), and spring water is an important local water resource; accordingly, changes in these processes can have large impacts on local people and their subsistence activities Hiyama and Avirmed, (2021). Guo et al. (2017) investigated the contribution of climate change on water resources in permafrost region of Northern Hemisphere between 1901 and 2014. The results show that yearly air temperature in permafrost region of the Northern Hemisphere experienced a statistically significant warming with trends of 0.13°C per decade for 1901–2014 and 0.40°C per decade for 1979–2014. Winter air temperatures showed the greatest increase during 1901–2014, while autumn air temperatures increased the most during 1979–2014 (Hiyama and Avirmed, 2021). In addition, increases in air temperature in the high-latitude permafrost sub-region are greater than those in the high-elevation permafrost subregion, and air temperatures in the permafrost subregion of Mongolia have the largest trend from 1901 to 2014, followed by those in Russia, Alaska, Canada, and China. Air temperatures in the permafrost region increased 1.7 times more than temperatures globally from 1901 to 2014 (Hiyama and Avirmed, 2021; Guo et al., 2017). Recently, Hiyama and Avirmed (2021) also studied the contribution of climate change on permafrost thaw melting around the Khangai Mountains in central Mongolia through analysis of an atmospheric water budget and a groundwater age of seven spring water samples including two thermokarst sites during 2015 and 2019 using two transient tracers (^3H and chlorofluorocarbons CFCs). The results show that the net groundwater recharge by modern and recent precipitation to the active layer in the summer season was almost zero at the northern part of the Khangai Mountains, which means that the ground ice meltwater is the main contribution to the spring water of the thermokarst sites in this region. The highest distribution of cold and warm permafrost is found in river basins of northern Mongolia, an area that has a high density of river networks and provides a major part of the surface water resources of the country. According to the literature (Zorigt et al., 2020), the cold permafrost (mean annual ground temperature is below -2°C) is found abundantly in the Khuvsgul and Altai mountain ranges and in some rivers in the Khangai mountain range. The warm permafrost (mean annual ground temperature is above -2°C) dominates in the Khentii mountain range. The active layer thickness in the permafrost area is 2–3 m in clay soil and 4–5 m in gravelly sand materials in the basins. The average mean annual ground temperature and active layer thickness for the permafrost regions is -1.6°C and 3.1 m, respectively. The climate change projections, based on several global models, suggest

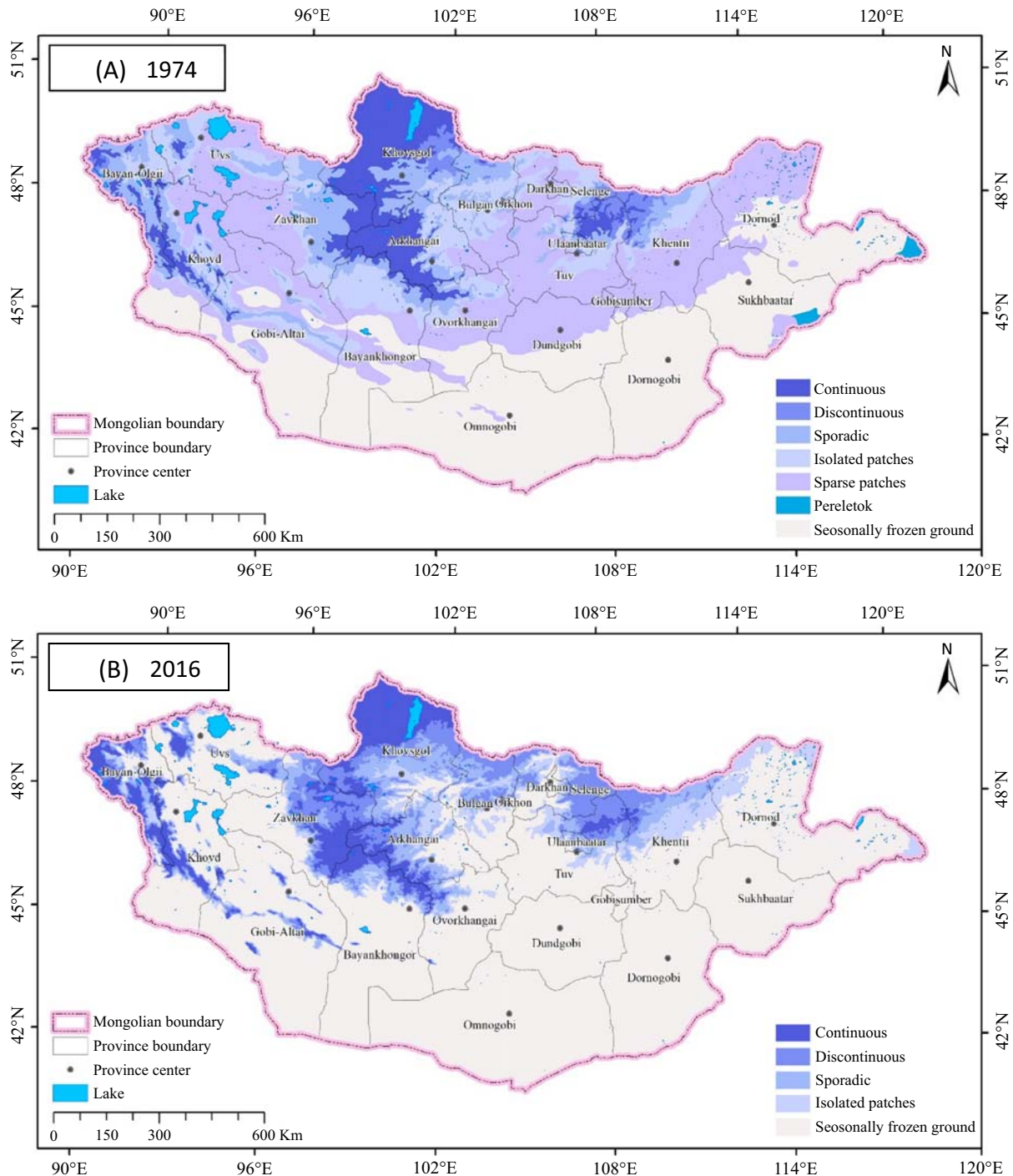


FIGURE 22.2 Permafrost change over Mongolia between 1974 and 2016: (A) 1974; (B) 2016.

the highest warming corresponds to the high-latitude regions, with some models predicting as high as a 7°C–8°C warming over land in those regions by the end of the 21st century.

22.6 Impact of regional land use land cover (LULC) change on hydrological process

The changes in regional precipitation and temperature pattern is attributed to land surface changes. The most important natural force for conversion of land use land cover is the decline in precipitation with the change in precipitation

patterns. This change in land use land cover impacts the food security over the study area. Lone and Mayer (2017) studied the assessment of the impact of land use and land cover change on the food security of Ananthnag district of Kashmir valley. By using times series satellite data different land use and land cover classes were generated to define the food security areas. Results revealed that over 10 years, a decrease has taken place in agriculture and forest at a change rate of 3.7% and 2.26% respectively. On the other hand, horticulture has increased at a rate of 2.17% and 1.13% respectively. This change in the land use land cover has impacted the economy and the development of the study area.

22.7 Climate change and education for environmental sustainability

Environmental sustainability can only be achieved with the help of education. Climate change education is a complicated topic in which a variety of factors come into play. One such factor, the ongoing debate over whether or not climate change is real, makes delivering a climate change curriculum difficult. This and other factors point to the need to revisit the issue of education for long-term social sustainability. The goal of this part is to build on previous research and consider how sustainability education is envisioned in culturally diverse settings around the world. Distinguished scholars from Brazil, China, Germany, Mexico, Saudi Arabia, and the United States presented detailed analyses of the social context of climate change and their visions for a sustainable education based on survey and interview data. The United States' withdrawal from the Paris Climate Change Agreement, political and economic barriers to climate change, sustainability initiatives, and university–industry linkages were all noted contextual features of climate change pedagogy in the countries studied, according to the survey data. Furthermore, the scholars' visions of a sustainable education revolved around five main visions: teaching all forms of scientific knowledge as rooted in some level of uncertainty, complexity, and nuance; comprehensive empirical knowledge of climate change, including its main principles, myths, and debates; critical inquiry, integration, and engagement with global and cross-disciplinary perspectives; transformative and learner-centered pedagogies conducive to sustainable education; and student-learner authentic participation in the study and mitigation of climate change (Krystal and Nora, 2018). The implications of climate change for educational practice are discussed. It is argued that global perspectives have the potential to enrich climate change education and lead to a more sustainable future. Regarding the awareness of the local community about climate change adaptation and mitigation, environmental-based education is needed to increase the knowledge. However, there is a gap in the knowledge transfer and inconsistent curricula for environmental education at the formal education level. This problem can be solved by building awareness through impressive and attractive social media assimilation (Sulistyawati et al., 2018).

22.8 Conclusion

Climate change will have significant impact on the sustainability of water supplies in the coming decades. The RCP and the common socioeconomic pathway consider the impact of both climate change and socioeconomic development in a changing environment and have been used extensively for projections of future water scarcity. Arid and semi-arid regions will be at extremely high risk of water sustainability and water shortages under continues global warming. On the other hand, as a result of heavy rainfall during the rainy season due to climate change, there are many urban cities facing water issues such as water scarcity and flooding. Due to extreme floods and landslides, thousands of people have lost their homes and left their devastated towns. There are still many gaps and uncertainties in meteorological, climatological, and hydrological assessments for vulnerability, mitigation, adaptability, and capacity enhancement, while there are many studies that provide comprehensive explanations for climate change and variability. Some socioeconomic and technical indicators that influence the implementation of adaptation and mitigation measures in response to climate change in terms of crop production and urban water management practices have already been summarized in the literature. The literature has simulated irrigation water demands based on future climate change. For instance, irrigation water demand would increase from 0.6% to 3.7% while temperature would increase from 0.5°C to 3.0°C respectively (Surendran and Raja, 2021). Therefore, climate change adaptation planning should be implemented in order to manage water resources in a proper way in the future. One of the main goals of this chapter is to provide a systematic source of information on water engineering aspects and causes for their future behavior or new planning, design, operation, maintenance, education, and management.

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About the Editors



Dr. R. Santhi Devi is an Associate Professor of Geography, at Bharathi Women's College (A), Chennai 108. She received her Ph.D. in Coastal Geomorphology how to control Land Use / Land cover with Remote Sensing & GIS, M.Phil in Geomorphological Evolution, and her M.Sc., in Geography. She has more than 22 years of experience in the field of research and more than 15 years of experience in Teaching. She has published around 21 Papers in Journals, has attended and presented 8 international conferences, 10 national conferences around 53 workshops, and conducted many workshops, training programs, and seminars & webinars. She published a Book on Soil Science. Peer Reviewer of Multi-Disciplinary Journal.



Durairaj Rajasugunasekar a senior Scientist conducts genetics and tree improvement research at the Institute of Forest Genetics and Tree Breeding in Coimbatore. His doctorate focused on the molecular characterization of *Allanthurus excelsa* and its genetics. His research career spans more than 30 years, and he has published about 35 publications in a variety of national and International Journals. The scientist is working to develop long rotation species like *Myrtagyna parvifolia* native tree, which is highly valued by the construction industries, as well as short rotation species like *Allanthurus excelsa*, *A. triplhyssa* Sps for the safety matches industry. He received an Invitation to take part in a three-month training course on ecology and the forest ecosystem at the University of Florida in the United States. Well versed in the tree improvement of native genetic resources.



Dr. A. Sivakumar holds the degrees include M.Sc., M.S. W., M.Ed., M.Phil.(Education), Ph.D.(Education), NET& TNSSET.(Education). His area of specialization includes Teacher Education, Educational Psychology, Educational Technology and Research Methodology & Statistics. He has published nearly 50 papers, 15 books and he has organized more than 10 Web Seminars at National and State level. He has participated and presented 10 International and 26 National papers in Conferences, Seminars & Workshops. He is an International Peer Reviewer of Papua New Guinea Journal of Teacher Education, International Journal of School & Educational Psychology and Asian Journal of Education and Social Studies.

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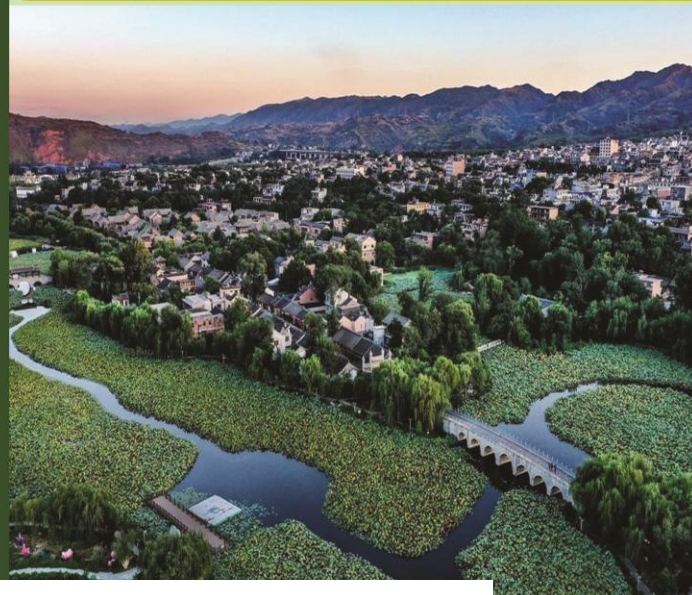


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INTRODUCTION TO CLIMATE CHANGE AND CURRENT TRENDS IN INDIA

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ABSTRACT

Climate change is continuous shift in weather parameters are temperature, humidity, precipitation and atmospheric pressure or long term weather changes cause by natural phenomenon such as heat variation from sun, earth orbit and rotational change, volcanic eruption, and human activities. 1800s onwards temperature getting increases mainly caused by fossil fuel burning, releasing of greenhouse gases (GHG) like Water vapor, Carbon dioxide, Methane, Nitrous oxide, Hydrofluorocarbons, Perfluorocarbons, chlorofluorocarbons, and deforestation which increases the global average temperature about 1.5°C from last century, this induce frequent cyclones, sea level rise, ice melting, flood, water scarcity, forest fire, heat waves and health impacts. This book chapter discuss the proxies of climate change for evidence, impacts of climate change, introduction about Intergovernmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC) and current trends in Indian context with development of various climate change mitigation measures and adaptation. India is one of the developing countries and has high population around 1.39 billion in 2021. India's average temperature increases 0.7°C from 1900s due to increasing



Balloon-borne aerosol–cloud interaction studies (BACIS): field campaigns to understand and quantify aerosol effects on clouds

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Abstract. A better understanding of aerosol–cloud interaction processes is important to quantify the role of clouds and aerosols on the climate system. There have been significant efforts to explain the ways aerosols modulate cloud properties. However, from the observational point of view, it is indeed challenging to observe and/or verify some of these processes because no single instrument or platform has been proven to be sufficient. Discrimination between aerosol and cloud is vital for the quantification of aerosol–cloud interaction. With this motivation, a set of observational field campaigns named balloon-borne aerosol–cloud interaction studies (BACIS) is proposed and conducted using balloon-borne in situ measurements in addition to the ground-based (lidar; mesosphere, stratosphere and troposphere (MST) radar; lower atmospheric wind profiler; microwave radiometer; ceilometer) and space-borne (CALIPSO) remote sensing instruments from Gadanki (13.45° N, 79.2° E), India. So far, 15 campaigns have been conducted as a part of BACIS campaigns from 2017 to 2020. This paper presents the concept of the observational approach, lists the major objectives of the campaigns, describes the instruments deployed, and discusses results from selected campaigns. Balloon-borne measurements of aerosol and cloud backscatter ratio and cloud particle count are qualitatively assessed using the range-

corrected data from simultaneous observations of ground-based and space-borne lidars. Aerosol and cloud vertical profiles obtained in multi-instrumental observations are found to reasonably agree. Apart from this, balloon-borne profiling is found to provide information on clouds missed by ground-based and/or space-borne lidar. A combination of the Compact Optical Backscatter Aerosol Detector (COBALD) and Cloud Particle Sensor (CPS) sonde is employed for the first time in this study to discriminate cloud and aerosol in an in situ profile. A threshold value of the COBALD colour index (CI) for ice clouds is found to be between 18 and 20, and CI values for coarse-mode aerosol particles range between 11 and 15. Using the data from balloon measurements, the relationship between cloud and aerosol is quantified for the liquid clouds. A statistically significant slope (aerosol–cloud interaction index) of 0.77 found between aerosol backscatter and cloud particle count reveals the role of aerosol in the cloud activation process. In a nutshell, the results presented here demonstrate the observational approach to quantifying aerosol–cloud interactions.

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Vertical Ozone Profiles observed by Ozonesone at Pengjia Islet, Taiwan during ACCLIP 2022

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From Aug. 1st to Aug. 29th, 2022, 8 ozonesondes were successfully launched at Pengjia Islet, Taiwan (122°04'17" E, 25°37'46" N) to measure vertical ozone profiles up to 35 km. An ozone DIAL lidar was operated at Academia Sinica in Taipei City, Taiwan (25.040°N, 121.614°E, about 80 km southwest of Pengjia Islet) to continuously measure ozone profile up to 12 km. Ozonesondes launched by the CWB, Taiwan during 1992-2011 are also presented for comparison. The lowest ozone concentration usually occurred around cold point tropopause around 17.5km. The ozone concentration observed in Aug. 2022 in general was in the range of ozone observed during 1992-2011. And there is no significant ozone abundance observed in the UT/LS region. On Aug. 1st and 12th, significant low ozone episodes (about 0.5mPa and 0.8mPa) were found at 10km-16km and 9km-12km, respectively. These two ozone deficiencies might be owing to ozone quenching processes and HYSPLIT back-trajectory analysis indicated the air parcels passed northeast of the Philippines on 7/31 and south of Japan on 8/10, respectively. On the other hand, several weak ozone abundant/deficient episodes were noticed by ozonesonde and ozone DIAL measurements in the UTLS and the low troposphere regions. Ozone concentrations are also noticed to tend to be weakly negatively correlated with RH. HYSPLIT analysis shows most of the back-trajectory of air parcels nearby the south of Japan or northeast of the Philippines.

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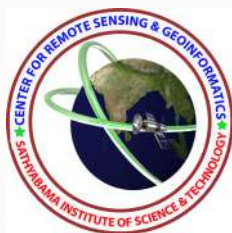
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THREE DAYS INTERNATIONAL WORKSHOP ON TECHNICAL AND SCIENTIFIC ASPECTS OF LIDAR REMOTE SENSING OF THE ATMOSPHERE (ITSLRA-2022)

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About the workshop

Laser Radar also named Light Detection and Ranging (LIDAR) remote sensing has been a versatile active remote sensing tool to measure and monitor the atmospheric structure and composition with high time and vertical resolutions. This international workshop is aimed to bring the lidar community together right from the expert system developer to the end user, and exchange both technological and scientific knowledge base among all. This workshop mainly covers technological developments and applications of different types of lidars probing the atmospheric structure and composition right from the surface up to about 100km of the atmospheric column. The operational challenges during different weather conditions and geographical locations and remedies to face the challenges will also be discussed. This workshop is aimed to ignite the young professionals to start working on indigenous Lidar system development as a part of Make in India initiative.

Topics to be covered in the workshop but not limited to:

- Overview of Lidar Remote sensing - Technological advancements and Applications
- Technological aspects of Elastic and inelastic Lidars
- Doppler wind lidar
- Metallic Lidars (Na, K, Fe Lidar ..)
- DIAL ozone lidar
- Pure Rotational Raman temperature Lidar
- Airborne and Shipborne Lidar observations
- CALIPSO technical details and scientific applications
- AEOLUS technical details and scientific applications
- Operational challenges and technological considerations in lidar measurements at different environments.
- Lidar inversion algorithms.
- Aerosol and cloud observations using lidar
- Application of Lidar Remote sensing for weather and climate monitoring.

Eminent Speakers

Dr. Jean Paul Vernier, Sr. Scientist, NASA, USA.

Dr Wei Nai Chen, Assoc.Res.Engg, RCEC, Academia Sinica, Taiwan.

Prof Alexander Konoshonkin, Professor, National Research Tomsk State University, Tomsk, Russia.

Dr Viktor Zharkov, Sr.Scientist, Inst. of Atm. Optics, Tomsk, Russia

Dr Guangyao Dai, Assoc.Prof, Ocean University of China, China.

Prof Sivakumar Venkatraman, Professor, Univ. of KwaZulu-Natal, South Africa.

Prof A Jayaraman, Former Director, NARL, Gadanki, India.

Dr M Venkat Ratnam, Scientist-SG, NARL, India.

Dr Pandithurai, Scientist-F, IITM, Pune, India.

Prof Som Kumar Sharma, Professor, PRL, Ahmadabad, India.

Dr Harish Gadhavi, Assoc. Professor, PRL, Ahmadabad, India.

Dr Veerabuthiran, Scientist, CHESS, DRDO, Hyderabad, India.

Dr K Raghunath, Scientist-SG, NARL, India.

Dr Ravi Kiran, Scientist-SF, NARL, India.

Dr B L Madhavan, Scientist-SD, NARL, India.

Dr Puna Ram Sinha, Assoc.Prof, IIST, Thiruvananthapuram, India.

Dr P Vishnu Prasanth, Assoc. Prof, Mohan Babu University, India.

Dr Sanjay K Mehta, Assoc.Prof (Research), SRM IST, India.

Expected participants:

This workshop is aimed for students of Engineering Bachelors, Masters in Science and Technology, Ph.D Scholars, Faculty and Scientists who are all interested to learn or existing users of lidar technology for atmospheric profiling. Foreign delegates can attend online and Indian delegates can attend offline or online as per their convenience.

Important Dates

Registration / Abstract deadline	: 25 June 2022
Acceptance of Abstract	: 28 June 2022
Payment of fee on or before.	: 01 July 2022
Dates of the program	: 13-15 July, 2022

Registration Fee

Students/Ph.D Scholars (Proof required)	: Rs. 800
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Certificates will be given to all registered participants at the end of the workshop.

Abstract submission:

Participants are invited to submit the abstract of their original work on any related topic exclusively using Lidar remote sensing of the atmospheric structure and composition, including assimilation of lidar data in to weather and climate models. The abstract (12pt, Times New Roman) should not exceed 350 words including title, authors, affiliation and 5 keywords with presenting author underlined. **Please download the abstract templet available at shorturl.at/oqBDI .**

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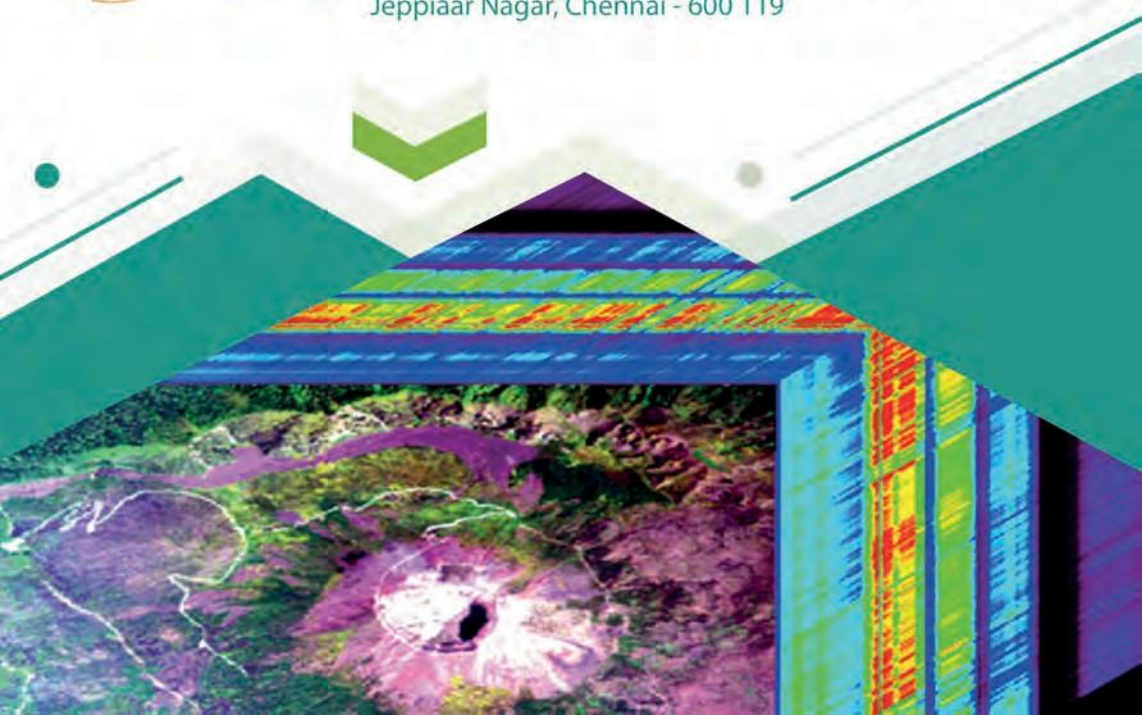
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Indian Institute of Technology Tirupati (IIT Tirupati) is incorporated under the Institutes of Technology Act, 1961 and has its campus at Yerpedu-Venkatagiri Road, Yerpedu Post, Tirupati District, Andhra Pradesh-517619. It is the first among the 3rd phase of Indian Institutes of Technology, announced in 2014, to have its foundation stone laid in March 2015. IIT Tirupati started functioning with the support of its mentoring institute, IIT Madras, from the academic year of 2015-16. IIT Tirupati is currently offering the programmes – B.Tech, M.Tech, M.Sc, MPP, M.S (Research) and Ph.D. IIT Tirupati has nine departments – Civil & Environmental Engineering, Computer Science & Engineering, Electrical Engineering, Mechanical Engineering, Chemical Engineering, Mathematics & Statistics, Physics, Chemistry and Humanities & Social Science. The pedagogy is aimed at nurturing innovation, creativity, quality, teamwork, communication skills, ethics, and societal interaction.

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About the Workshop

Hyperspectral Remote Sensing deals with measurements in a large number of narrow spectral bands over a contiguous spectral range. Because of its ability to detect narrow absorption features hyperspectral data are related to specific vegetation physico-chemical characteristics, soil physical and chemical properties, mineral composition and snow characteristics, mapping tree species, recognizing invasive plants and identifying key geologic features. However, because of presence of a large number of bands, hyperspectral data needs different analysis approach including feature reduction, feature selection, removal of noise, detection of absorption features, advance classification techniques. This course will make the participants aware about hyperspectral remote sensing, hyperspectral data processing and its applications. This workshop will have eight session. This workshop will cover the basics of hyperspectral remote sensing, ground spectra-radiometer and processing techniques: and its various applications.

This workshop targets the young minds to excel in Hyperspectral Remote Sensing and its various applications. Lecture sessions will be handled by eminent speakers.

Lecture Sessions

- Hyperspectral Remote Sensing an Overview, Sensors and Satellite data, Data Processing
- Applications of Hyperspectral Remote Sensing for Urban Studies, Water Resources Studies, Agriculture and Soil Studies, Environmental Studies.

Expected Participants

The workshop is designed for Scientists, faculty members, Research scholars and students from academic institutions, Industrialists, officials from Government/ Public sector organizations.

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EVENT SCHEDULE



DAY 1 - Sep 16, 2022		
Time (hrs)	Session	Details
10:00-10:30		Inaugural Session Overview, Remarks by the Guest of Honour, About TIH
10:30 - 11:45	Session 1	<i>Hyperspectral Remote Sensing: An overview</i> Dr. Rabi Narayan Sahoo Indian Agricultural Research Institute, New Delhi Email: rabi.sahoo@icar.gov.in
11:45 - 13:00	Session 2	<i>Hyperspectral Remote Sensing Data processing</i> Mr. Vinay Kumar Indian Institute of Remote Sensing, ISRO, Dehradun Email: vinaykumar@iirs.gov.in
Lunch Break		
15:00 - 16:15	Session 3	<i>Hyperspectral Remote Sensing Sensors and Satellite data</i> Prof. Giovanni Laneve SIA (Scuola di Ingegneria Aerospaziale) Earth Observation Satellite Images Applications Lab (EOSIAL), Italy Email: giovanni.laneve@uniroma1.it
DAY 2 - Sep 17, 2022		
10:00 - 11:15	Session 4	<i>Hyper spectral Remote Sensing for Urban Studies</i> Ms. Asfa Siddiqui Urban & Regional Studies Department Indian Institute of Remote Sensing, ISRO, Dehradun Email: asfa@iirs.gov.in
11:15 - 12:30	Session 5	<i>Hyper spectral Remote Sensing for Water Resources Studies</i> Dr. Vaibhav Garg Water Resources Department Indian Institute of Remote Sensing, ISRO, Dehradun Email: vaibhav@iirs.gov.in
Lunch Break		
13:30 - 14:45	Session 6	<i>Hyper spectral Remote Sensing for Agriculture and Soil Studies</i> Mr. Justin George. K Scientist/ Engineer - SD, Agriculture and Soils Department Indian Institute of Remote Sensing, ISRO, Dehradun Email: justinagri@gmail.com
14:45 - 16:00	Session 7	<i>Hyper spectral Remote Sensing for Environmental Studies</i> Prof. M. Anji Reddy Professor of Environment, Director, R&D, JNTU, Hyderabad Email: mareddyanjireddi@gmail.com
16:00 - 16:30		Valedictory Feedback



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Workshop (online)

on

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Organized by

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DEPARTMENT OF CIVIL ENGINEERING**

SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY

In Association with

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Scientist C, CRSG, SIST
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Registration Fee: Rs.500/-

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Contact:

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Dr. S.K. Pramada - pramada@nitc.ac.in 09061029952



Programme Schedule for the Workshop

Dates: 15th to 22nd February, 2023



Machine Learning and Deep Learning Applications in Water Resources

Prof. S. Mohan

Institute Chair Professor

Environmental and Water Resources Engineering Division

Dept. of Civil Engineering, IIT Madras, Chennai

Date: 15.02.2023: Time 10 AM -12 Noon



Application of WEAP model for water resources management

Dr. T. Roshni, Associate Professor

Dept. of Civil Engineering, NIT Patna

Date: 16.02.2023: Time 5.30 - 7 PM



Groundwater Modeling using MODFLOW

Dr. S. K. Pramada, Assistant Professor

Dept. of Civil Engineering, NIT Calicut, Kerala

Date: 17.02.2023: Time 5.30 - 7 PM



Application of Open Source GIS Software in Water Resources

Dr. P. Mohana, Scientist

CRSG, SIST, Chennai

Date: 18.02.2023: Time 5.30 - 7 PM



Application of Soft Computing Techniques in Water Resources

Dr. R. Arunkumar, Assistant Professor

Dept. of Civil Engineering, NIT Calicut, Kerala

Date: 20.02.2023: Time 10 AM -12 Noon



Groundwater Flow and Quality Modeling using FEFLOW

M. Shreya, Scientist

DHI (India) Water & Environment Private Limited, Chennai

Date: 21.02.2023: Time 3 - 5 PM



SWAT Modeling and its Applications in Water Resources

Dr. P. Jegathambal, Professor

Water Institute - A Centre of Excellence, Karunya Institute of

Technology and Sciences (KITS), Coimbatore

Date: 22.02.2023: Time 5.30 - 7 PM



Antagonistic activity of a novel chitosan-selenium nanoflower against common aquaculture pathogen *Aeromonas caviae*

Prasad Sowmiya¹ · Tharmathass Stalin Dhas¹ · Dhinakaranasamy Inbakandan¹ · Ravi Mani¹ · Anandakumar Natarajan² · Gopal Dharani³ · Kasivelu Govindaraju¹ · Malaichamy Kannan⁴ · Karthick Velu¹ · Chirayil Meethalepurayil Vineeth Kumar¹

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Abstract

Aquatic pathogens contribute to the most severe economic loss in fishes. Nanoparticles are being developed as potent antimicrobial agents against various pathogens. The bacteria *Aeromonas caviae* is one of the most common aquatic pathogens that infects the majority of economically important fishes causing significant losses to the aquaculture industry. This study involved synthesizing and characterizing of a novel chitosan-selenium nanoflower employing multiple spectroscopic and microscopic approaches. The UV-vis spectra obtained at 265 nm indicated the formation of the Chitosan-selenium nanoflower. The particle size analysis revealed the size of the nanoflowers to be 186.3 nm. The transmission electron micrographs revealed a unique nanoflower-like morphology. XRD spectrum revealed amorphous nature. The Raman spectrum showed a strong resonance peak at 254 cm⁻¹ which is a characteristic absorption band for monoclinic Se and α -Se. Cytotoxicity analysis of the synthesized nanoflowers against isolated fish pathogen *Aeromonas caviae* showed increasing toxicity in a dose-dependent manner with maximum cytotoxicity of 75.06% at 1000 μ g/mL. The DCFDA assay was conducted to estimate the increase in reactive oxygen species (ROS) production, and the highest percentage increase in ROS of 96.02% was observed at 1000 μ g/mL. The lipid peroxidation assay was performed by quantification of the lipid oxidation product malondialdehyde (MDA). The highest percentage of lipid peroxidation was found to occur at a dose of 500 μ g/mL. As a result, the synthesized chitosan-selenium nanoflowers can be exploited as a promising antibacterial treatment against the fish pathogen *Aeromonas caviae*.

Keywords Antimicrobial · Chitosan-selenium · *A. caviae* · Fish pathogen · ROS

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Extended author information available on the last page of the article

Introduction

The main barrier to sustainable aquaculture development is the rise of several diseases. One of the leading causes of most fish fatalities worldwide is bacterial infections in farmed fish (Rathore et al. 2021). Around the world, *Aeromonas species* is frequently found in aquatic environments and is the primary cause of serious fish infections (Baldiissera et al. 2018a). With a 1–2% prevalence compared to other *Aeromonas species*, *Aeromonas caviae* has attracted attention as a significant fish pathogen (Vega-Sánchez et al. 2014). A large variety of economically important fish, including *Clarias gariepinus* (African catfish), *Colossoma macropomum* (tambaqui), *Oncorhynchus mykiss* (rainbow trout), *Clarias batrachus* (Indian walking catfish), and *Rhamdia quelen* (silver catfish) (Thomas et al. 2013; Vega-Sánchez et al. 2014; Marques et al. 2016; Sarjito et al. 2017; Baldiissera et al. 2018b), are susceptible to infection by *Aeromonas caviae*. This bacterium has been recognized in fish as one of the most common causes of hemorrhagic septicemia in fish. It affects fish and is associated with hepatosplenomegaly, ulcerative skin lesions (Sharma et al. 2022; Thomas et al. 2013), and disruption of the hepatic energy metabolism (Baldiissera et al. 2018b). Surface swimming, listlessness, inappetence, and stomach distention are typical clinical signs of *A. caviae* infection (Xue et al. 2022). Several reports associate significant fish mortality with pathogenic *A. caviae* (Munro et al. 1993; Ringo and Vadstein 1998). High percentages of *A. caviae* were linked to low fish larval survival rates. In the intestines of turbot fish larvae with high *A. caviae* infection, 100% mortality was observed (Ringo and Vadstein 1998). Numerous examples of *A. caviae* being isolated from other fish, including mullet, carp, catfish, goldfish, and tilapia (Sharma et al. 2022; Sugita et al. 1994). This causes mass mortality in fishes and brings about significant economic losses for the aquaculture industries.

Numerous innovative nanomaterials have drawn much of attention lately because of their enormous potential in engineering, agriculture, food safety, and biological sciences. The overuse of antibiotics has led to the evolution of many antibiotic-resistant pathogens (Schmidt et al. 2000). To overcome the effects of antibiotics and antibiotic-resistant pathogens, various innovative nanomaterials have been used in the fields of aquaculture. Among these, selenium (Se) nanoparticles demonstrate promise as a nanomaterial with diverse potential uses. In various living creatures, including humans, animals, bacteria, and archaea, the element Se is recognized as an essential micronutrient. Selenium (Se) is an essential trace element for the health of both humans and animals. The daily dietary need for Se in humans is 55 mg, with a maximum of 400 mg. Adult Se levels are usually about 81 mg. Many living organisms, such as humans, animals, microbes, and archaea, require Se as a micronutrient for various vital cellular processes (Novoselov et al. 2002; Rayman 2012; Mangiapane et al. 2014). Additionally, it is necessary for many species' metabolic processes and growth. Due to its chemical similarity to sulphur (S), Se can be metabolized via S metabolic pathways. However, Se can serve as a pro-oxidant at high doses and can be hazardous to living organisms because of its ability to substitute S in proteins, which causes the proteins to lose their proper folding. Furthermore, excess Se can cause ROS formation by depleting the intracellular glutathione (GSH) pool (Hoewyk et al. 2008; Grant et al. 2011; Schiavon et al. 2012). Thus, Se nanoparticles have been commonly used in aquaculture feeds as dietary supplements to ameliorate infections and improve disease resistance in aquaculture industries for economically important species like carp and catfish (Tawwab et al. 2007; Han et al. 2011). High resistance to *Aeromonas sobria* infection was found in Nile tilapia fed with dietary Se nanoparticles (1–2 mg/kg) (Ayoub et al. 2021). Another

study reported Nile tilapia fishes treated with Se nanoparticles showed increased resistance to *A. hydrophyla* infection (Rathore et al. 2021). *Pangasianodon hypophthalmus* exhibited high resistance to *A. veronii* biovar *sobria* when administered dietary Se nanoparticles (1–2 mg/kg) (Kumar and Singh 2019). Additionally, it has been reported that *Labeo rohita* (Hamilton) exposed to 0.3 mg Se nanoparticles/kg demonstrated significantly enhanced resistance to *A. hydrophila* infection (Swain et al. 2019). In this study, the synthesis of a novel chitosan-selenium nanoflower (CS-SeNF) was evaluated against *A. caviae* isolated from contaminated aquaculture water (Fig. 1).

Materials and methods

Synthesis of CS-SeNF

Ascorbic acid was used to reduce sodium selenite in a chitosan solution to synthesize CS-SeNF. Initially, 0.01 M Na_2SeO_3 solution was prepared by homogeneously dissolving Na_2SeO_3 in distilled water, and a 0.5% w/v chitosan solution was prepared by dissolving chitosan in 1% v/v acetic acid. The prepared Na_2SeO_3 and chitosan solutions were mixed in equal volumes and stirred until homogeneity under dark conditions. Furthermore, 0.01 M ascorbic acid solution was added in dark condition under constant stirring at room temperature. Color change from clear to bright orange indicates the reduction of Se salt to Se nanoparticles. The solution was centrifuged at 9300 G for 10 min and dried in a vacuum oven at 50 °C. The resulting nanoparticle powder was used for further analysis.

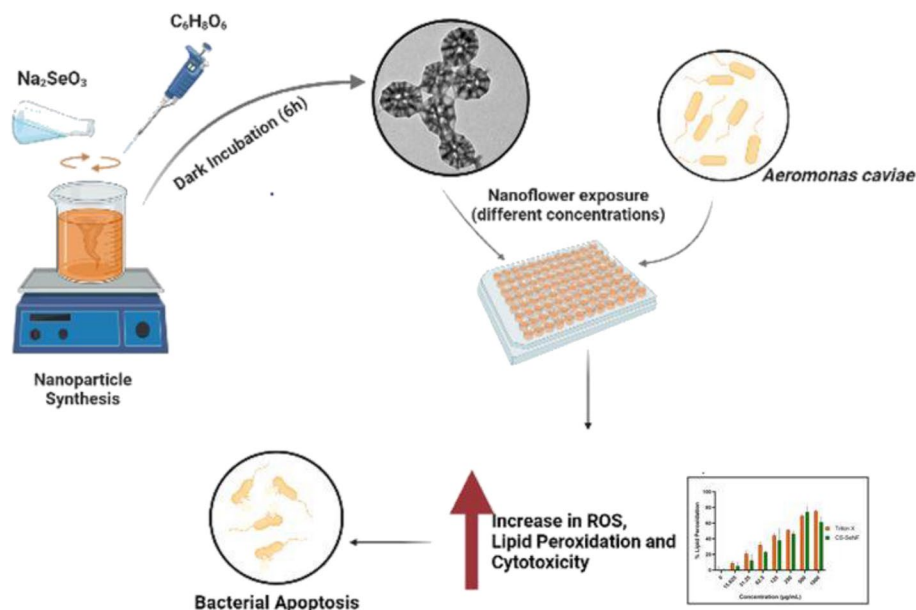


Fig. 1 Graphical abstract

Characterization of CS-SeNF

Different spectroscopic and microscopic methods were used to characterize the synthesized CS-SeNF. The maximum absorbance of the synthesized CS-SeNF was assessed using a UV-vis spectrophotometer (UV-1800 Shimadzu, Japan). The CS-SeNF were ground with KBr to obtain the FTIR spectrum, which was then measured with an FTIR spectrophotometer (IR Affinity Shimadzu, Japan). Particle size distribution and zeta potential of the synthesized CS-SeNF were analyzed by dynamic light scattering with a particle size analyzer (nanopartica SZ-100V2, HORIBA Japan). Post-drop coating the sample onto copper grids, the grids were visualized with a high-resolution transmission electron microscope (120 kV TEM, JEOL Japan). The Bruker D8 Advanced apparatus was used to study the X-ray diffraction pattern. Using a confocal Raman microscope (inViaTM, Reinshaw, UK) equipped with an argon-ion laser at an excitation wavelength of 535 nm, the fabricated CS-SeNF were subjected to spectroscopic Raman examination.

Bacterial culture and maintenance

Bacteria were isolated from contaminated aquaculture water collected from Mandapam (Latitude: 9° 16' 48.00" N; Longitude: 79° 07' 12.00" E). The study area map has been illustrated (in Fig. 2). The sample was diluted serially and then plated on Zobell Marine Agar (ZMA). A single colony was isolated, and plating was done on ZMA by quadrant streaking method and incubated at 25 °C. Further morphological and biochemical identification was made to identify the bacteria. DNA was extracted, and 16S rDNA partial sequencing was performed in Barcode Bio Sciences Karnataka, India. To amplify the 16S

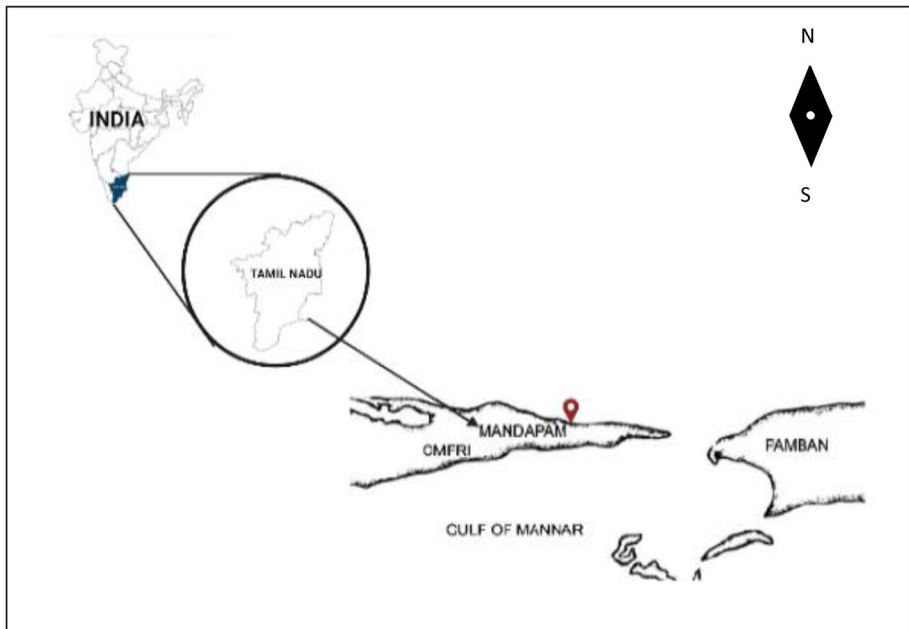


Fig. 2 Study area map: sampling site

rDNA gene using a universal primer, about 50 ng aliquot of the extracted DNA was used. The 16S rDNA sequence was acquired and submitted to the NCBI database.

Cytotoxicity of CS-SeNF on *A. caviae*

To investigate the cytotoxicity of CS-SeNF, a 3-(4,5-dimethylthiazol-2-yl) 2,5-diphenyl tetrazolium bromide dye (MTT) reduction experiment was carried out. The conversion of yellow-colored MTT dye to a purple-colored formazan by the mitochondrial dehydrogenase enzyme, which is present in the mitochondria of living cells, serves as a marker for cell viability (Mosmann, 1983). MTT Assay was done to determine the percentage cytotoxicity of the synthesized CS-SeNF on *A. caviae*. Essentially, the bacteria were incubated with various concentrations of the CS-SeNF (0, 15.625, 31.25, 62.5, 125, 250, 500, and 1000 µg/mL) for 6 h. A volume (200 µL) of CS-SeNF treated cell suspension was taken, and about 10 µL of MTT solution was added, and the mixture was then left to incubate for 4 h in the dark. The suspension was centrifuged and washed twice with PBS, and the formazan crystals developed during the procedure were dissolved by adding 200 µL of dimethyl sulfoxide. With the use of a multimode microplate reader (Synergy™ H1, Biotek, USA), the absorbance was recorded at 570 nm. All the experiments were performed in triplicates; the data presented are mean ± s.d.

Lipid peroxidation in *A. caviae* by exposure to CS-SeNF

Following the method of Sayeed et al., malondialdehyde (MDA), a significant indicator of lipid peroxidation, was quantified. *A. caviae* bacteria were exposed to various CS-SeNF concentrations (Sayeed et al. 2003). Briefly, 200 µL of bacterial cells treated with SeNPs were added to 700 µL of HCl (0.1 M), and the mixture was then let to sit at room temperature for 20 min. Additionally, 900 µL of thiobarbituric acid (TBA) (0.025 M) was added, and the solution was allowed to stand for 65 min at 37 °C. Post incubation, 400 µL of 10 mM PBS was added, and using a hybrid multimode microplate reader (Synergy™ H1 (Biotek, USA), the fluorescence was measured at 520 nm (excitation) and 549 nm (emission). The percentage of lipid peroxidation was evaluated by calculating MDA values, and the data was expressed in terms of concentration of CS-SeNF (in µg/mL) vs percentage of lipid peroxidation.

Estimation of ROS production by DCFDA assay

Spectrophotometric analysis of ROS production was performed using the fluorescent probe 2,7-dichlorofluorescein diacetate (DCFH-DA). The non-fluorescent chemical 2',7'-dichlorofluorescein is produced when cellular esterase hydrolyzes DCFH-DA, which then diffuses easily through the cell membrane (Wang and James 1999). It rapidly oxidizes to extremely fluorescent 2',7'-dichlorofluorescein in the presence of ROS. The bacterial cells of *A. caviae* were exposed to various concentrations of CS-SeNF (0, 15.625, 31.25, 62.5, 125, 250, 500, and 1000 µg/mL). Briefly, the bacterial culture treated with different concentrations of CS-SeNF was incubated in dark conditions with DCFH-DA (200 µM). The multimode hybrid microplate reader (Synergy™ H1 Biotek, USA) was used to detect the fluorescence. A maximum excitation of 490 nm was applied, and the emission was recorded at 523 nm.

Results and discussion

Synthesis and characterization of CS-SeNF

The visual observation of the change in color from colorless to bright orange indicated the complete reduction and formation of the CS-SeNF. The UV-vis spectrum (Fig. 3A)

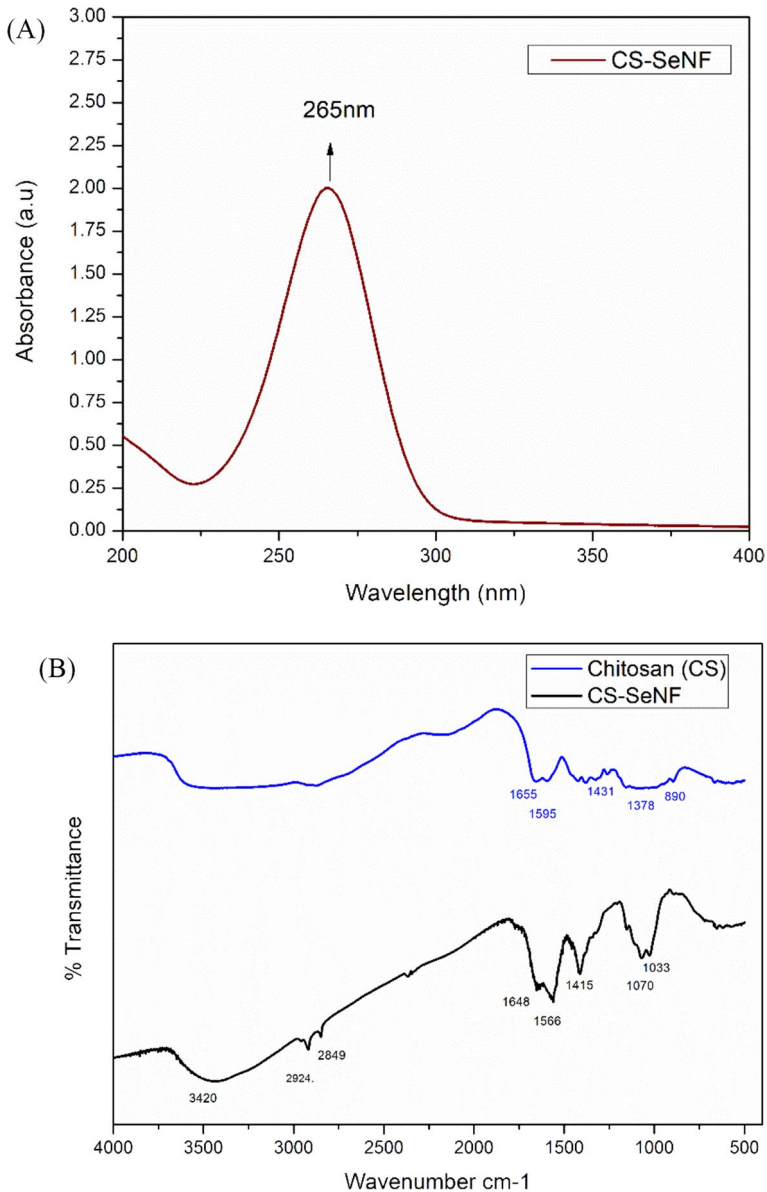
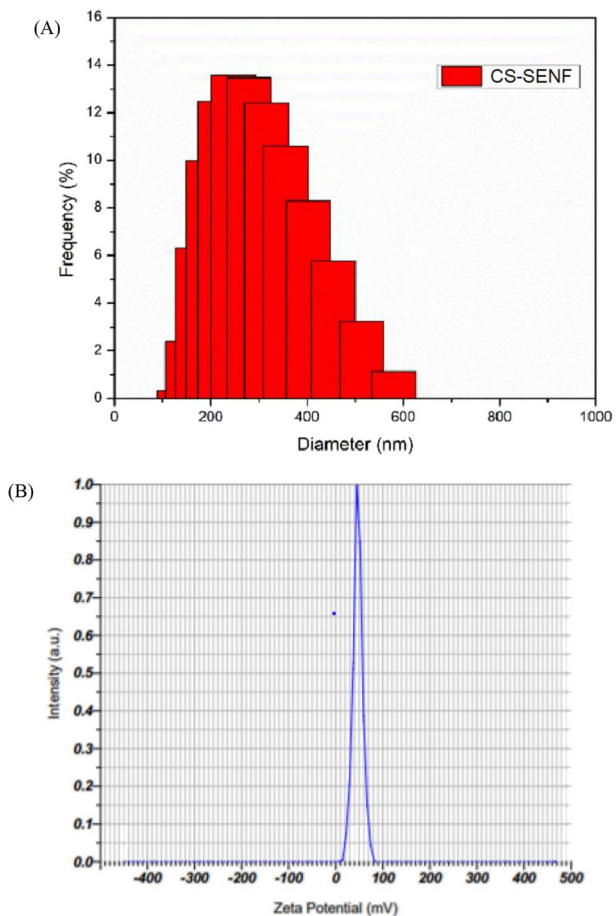


Fig. 3 **A** UV absorption spectrum of CS-SeNFs showing absorbance maxima at 265 nm; **B** FTIR spectrum of chitosan and synthesized CS-SeNFs

revealed an absorbance maximum of 265 nm, characteristic of the reduction of selenium salt to CS-SeNF. According to published research, the absorbance maxima of Se nanoparticles fabricated with reducing agents, including carboxylic groups, are predicted to be in the 200–300 nm range (Tran et al. 2016).

In the FTIR spectrum (Fig. 3B), peaks at 1648 cm^{-1} and 1655 cm^{-1} correspond to asymmetrical and symmetric stretching vibrations of COO^- . The peak obtained at 1378 cm^{-1} indicates the symmetric stretch of COO^- in chitosan. The shift in peak to 1415 cm^{-1} indicated the involvement of COO^- groups in the synthesis of CS-SeNF. The band at 3420 cm^{-1} corresponds to the O-H stretching. The IR band obtained at 2849 cm^{-1} indicates the presence of aliphatic C-H vibrations. The band at 890 cm^{-1} corresponds to $=\text{C-H}$ out of plane bending and $-(\text{CH}_2)_n$. It was found that the prepared CS-SeNF were polydisperse in nature and found to have a unique and novel nanoflower morphology. Particle size measurement (Fig. 4A) resulted in an average size of the particle with 186.3 nm. Zeta potential (Fig. 4B) of the synthesized CS-SeNF was found to be 49.1 mV, indicating significantly stable colloidal nanoparticles. Electrostatic and electro-steric forces prevent particles from sticking to other components in the medium, such as organic compounds. Therefore, their stability and capacity to aggregate largely depend on their surface charge (Dutta et al. 2011). The

Fig. 4 **A** Particle size measurement of CS-SeNFs. **B** Zeta potential in mV of the synthesized CS-SeNFs



presence of hydrophobic groups on the surface can successfully reduce the toxicity to considerable levels with the usage of amphiphile coatings (Simoes et al. 2021).

The transmission electron microscopic imaging of the synthesized CS-SeNF revealed a unique nanoflower-like morphology (Fig. 5A–D). XRD analysis was used to examine the phase of the synthesized CS-SeNF. The XRD pattern obtained of the synthesized CS-SeNF seen in (Fig. 6A) clearly revealed that the nanoparticles were amorphous. Using the Raman spectroscopic technique, the nature and bonding nature of synthesized CS-SeNF were assessed. The Raman scattering spectra acquired for CS-SeNF (Fig. 6B) showed a sharp resonance peak at 254 cm^{-1} , a characteristic absorption band for monoclinic Se and α -Se (Lucovsky et al. 1967). The obtained resonance peak is indicative of the Se_8 absorption band in the amorphous material (Baganinch et al. 1991).

Bacterial isolation and identification

Bacteria were isolated by serial dilution from contaminated aquaculture water. The isolated bacteria were subjected to morphological and biochemical characterizations. In addition to fundamental biochemical tests, PCR-based molecular methods that amplify conserved sections of the 16S rDNA gene have also shown promise for phylogenetic discrimination.

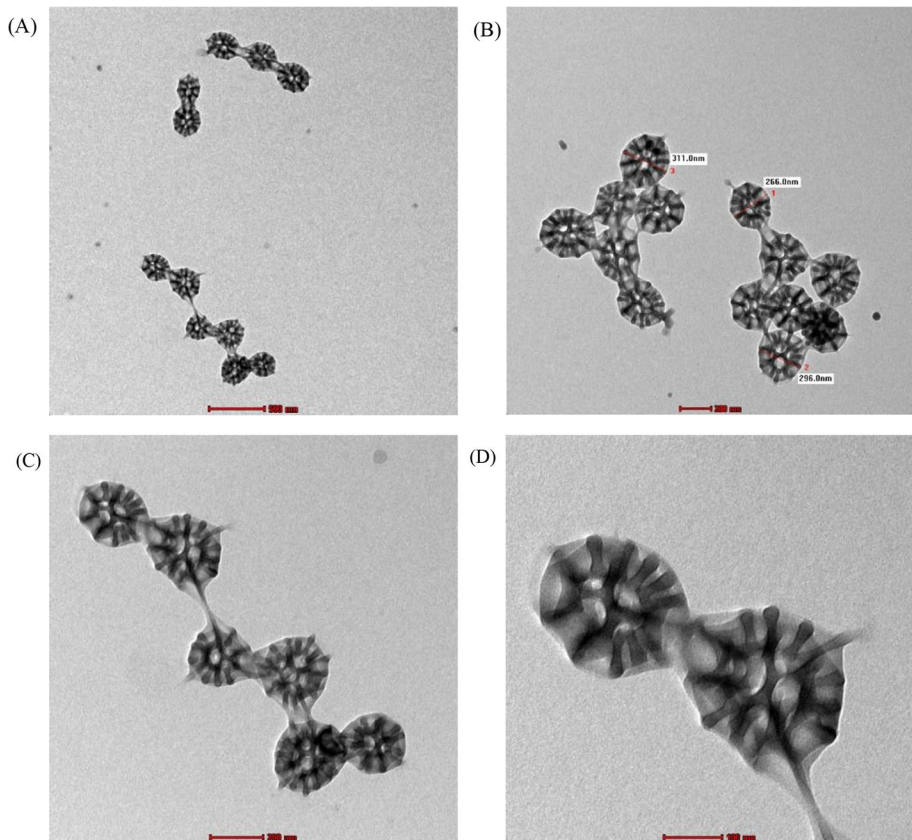
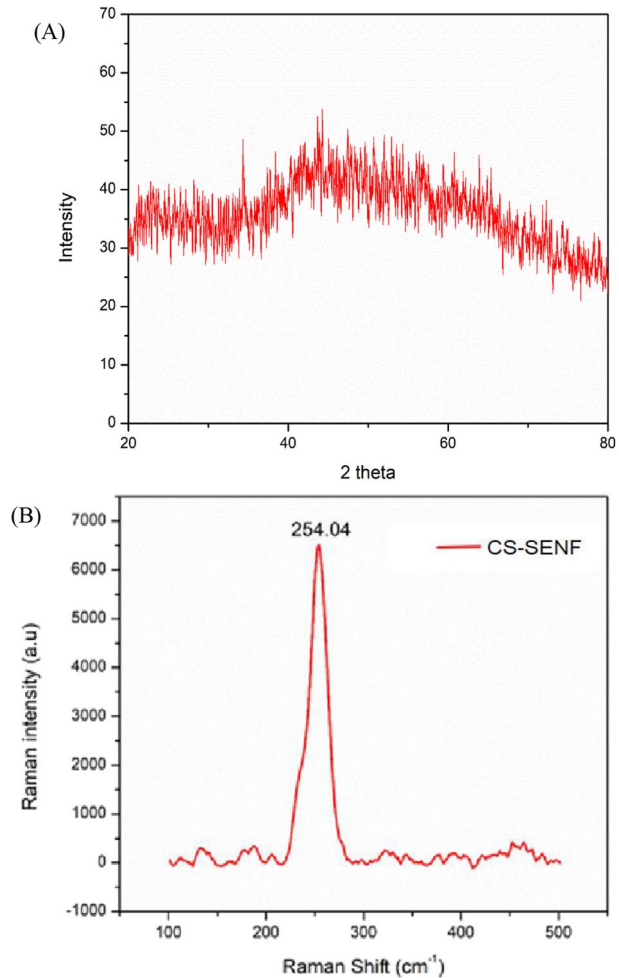


Fig. 5 Transmission electron micrographs of CS-SeNFs showing unique nanoflower morphology (A–D)

Fig. 6 **A** X-ray diffraction spectrum of synthesized CS-SeNFs. **B** Raman scattering spectrum of CS-SeNFs



Small amounts of DNA isolated from laboratory cultures or natural habitats can be used in PCR to recover the 16S rDNA gene sequences, which can be used to characterize the strain. These sequences are independent of cultivation or growth conditions (Giovannoni 1991). Bacterial relationships can be determined since the 16S rDNA gene is present in every bacterial species. In general, identifying strains at various levels, including what we currently refer to as the species and subspecies level, is made possible by comparing the 16S rDNA gene sequences, which allows discrimination among organisms at the genus level across all major phyla of bacteria. The 16S rDNA partial sequence was acquired and submitted to the NCBI database with an accession number (ON203034). A nucleotide BLAST analysis was performed to find potentially related sequences by comparing them to non-redundant BLAST databases. The results clearly indicated similarity with *Aeromonas caviae*. The bacteria were identified as *Aeromonas caviae* after comparison with the 16S rDNA sequence data from strains available at EMBL, GenBank, and DDBJ. A Phylogenetic tree was constructed using closely related and highly similar sequences to arrive at the evolutionary relationship using the Mega X software (Fig. 7).

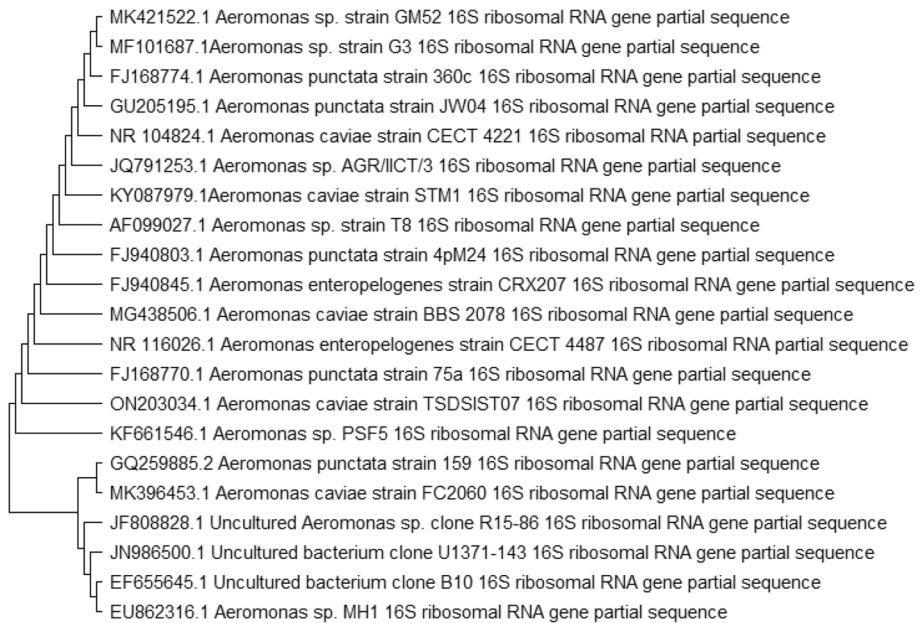


Fig. 7 Phylogenetic tree by neighbor-joining method showing evolutionary relationships of *A. caviae* drawn using MEGA X software (Accession number: ON203034 *Aeromonas caviae* Strain TSDSIST07)

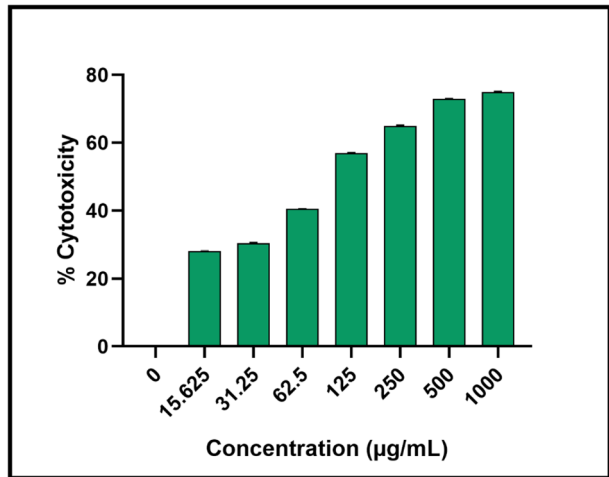
Cytotoxicity of CS-SeNF on *A. caviae*

Cell viability is determined by mitochondrial dehydrogenase, an enzyme found in the mitochondria of living cells, which reduces MTT to purple-colored formazan. (Mosmann, 1983). The cytotoxicity was found to increase in a dose-dependent manner. The maximum cytotoxicity of 75.06% was observed at 1000 µg/mL. At the lowest concentration, 15.625 µg/mL cytotoxicity of 28.09% was observed, which was significantly higher than untreated *A. caviae* (Fig. 8). This indicates that the synthesized CS-SeNF has significant cytotoxicity against pathogenic *A. caviae*.

Lipid peroxidation in *A. caviae* on exposure to CS-SeNF

Malondialdehyde (MDA), the result of lipid peroxidation based on interaction with thio-barbituric acid, was quantified to determine the degree of lipid peroxidation of the CS-SeNF (Sayeed et al. 2003). The induction of the lipid peroxidation process in an organism is attributed to the presence of free radicals. Lipid peroxidation is a sign of oxidative stress in living organisms as it damages the lipids in cell membranes. As a result, it serves as a biomarker for oxidative stress. The percentage of lipid peroxidation was assessed by the amount of MDA. The lipid peroxidation was found to increase with an increase in the dose (Fig. 9A). The maximum lipid peroxidation of 74.22% was observed at 500 µg/mL. This indicated the production of ROS-induced damage in the bacteria. Increased MDA synthesis could result in the development of mutagenic substances that can interact with DNA

Fig. 8 Cytotoxicity of CS-SeNFs on *A. caviae*



to create various DNA addition products, including deoxyguanosine adducts (Saieva et al. 2016).

ROS production in *A. caviae*

Using the DCFH-DA test on *A. caviae*, the contribution of SeNPs to ROS induction has been shown. The intensity of fluorescence of 2',7'-dichlorofluorescein determines the quantity of ROS produced. All live cells generate ROS as a by-product of metabolism. Bacteria produce elevated ROS in stress condition. Superoxide dismutase and other ROS-scavenging enzymes found in bacteria work to reduce the ROS produced under non-stressful conditions (Arakha et al. 2015). Due to the significant involvement of reduced oxygen intermediates in signal transduction and the production of transcription factors, these ROS are essential for cellular function (Martindale and Holbrook 2002). Excess ROS interacts with proteins, lipids, and DNA to disrupt or destroy their intended functions, which can cause significant damage. ROS production in CS-SeNF-treated *A. caviae* was concentration dependant (Fig. 9B). Increase in the concentration of CS-SeNF resulted in a significant increase in the fluorescence intensity. The maximum ROS generation of 96.02% was observed at 1000 µg/mL. This was similar to the trend observed in positive control Triton-X which showed a 96.49% increase in ROS production. The increase in ROS generation is directly associated with the change in fluorescence intensity. As far as biological processes such as the stress response are concerned, ROS serve as secondary messengers. ROS is exceedingly harmful in high quantities and triggers oxidative damage. The inactivation or modification of biomolecules by ROS can lead to cellular dysfunction, alterations in cellular structure, and mutagenesis (Rezayian et al. 2019). The treatment and exposure of *A. caviae* with increasing concentrations of the CS-SeNF induced ROS production. At higher concentrations, the ROS damages the cellular function by degradation of lipids proteins and causes cellular dysfunction. Thus, the antimicrobial activity of CS-SeNF could be attributed to cell damage due to excessive ROS production.

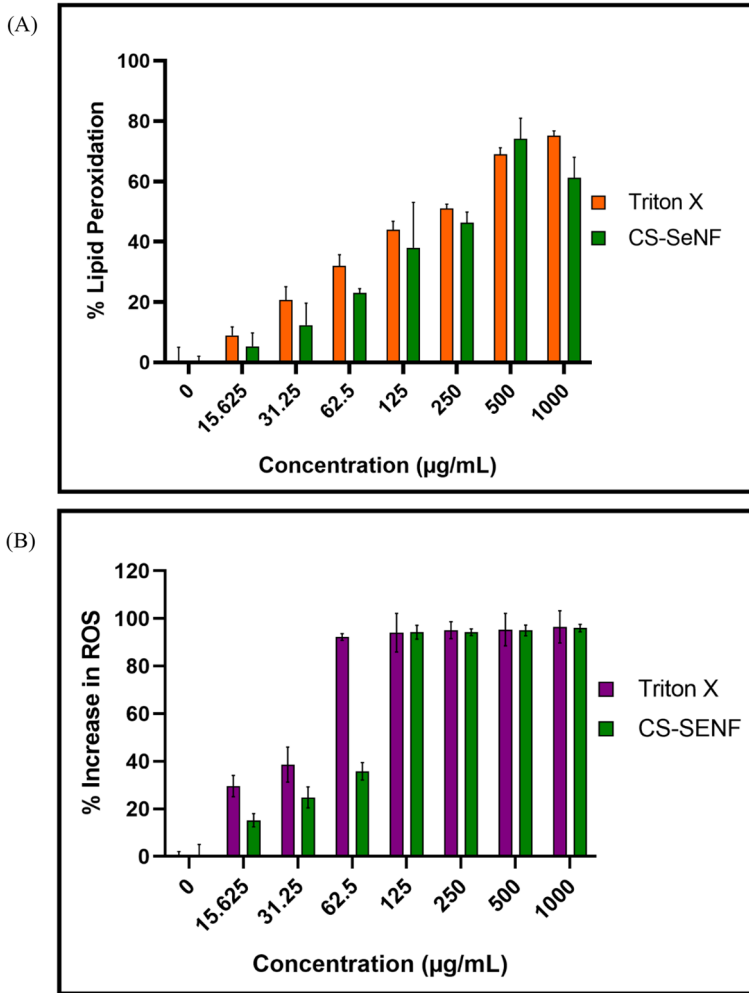


Fig. 9 **A** Lipid peroxidation (%) of CS-SeNFs by MDA assay. **B** Increase in ROS production in *A. caviae* upon treatment with CS-SeNFs

Conclusion

Antibiotics have been used to reduce bacterial infections in aquaculture. However, due to the potential negative effects of antibiotics, such as the development of resistant strains, environmental contamination and posing a threat to food safety, and reduction in intestinal microbial diversity of fishes, this relative practice has been avoided and has become increasingly controversial around the world (Xue et al. 2022). Since most *Aeromonas* species are resistant to common antibiotics (Chen et al. 2021), the use of novel nanomaterials to control *Aeromonas* infections has been in trend (Khanh and Cu 2019; Márquez et al. 2018). Our study involved the synthesis of a novel chitosan-selenium nanoflower against common aquatic pathogen *A. caviae*. In summary, the toxicity of CS-SeNF on pathogenic

A. caviae strain was found to be significant, as demonstrated by in vitro assays. CS-SeNF can be used as an antimicrobial agent to inhibit the growth of *A. caviae* and can potentially be used in aquaculture industries. Similar toxicity experiments with selenium nanoparticles were performed on the food pathogen *Staphylococcus aureus*, and it was demonstrated that Se nanoparticles have significant inhibitory effects. Significant inhibitory effects of selenium nanoparticles were observed on *S. aureus* at concentrations of 20–50 µg/mL (Nguyen et al. 2017). However, more research is necessary to completely comprehend the mechanisms of the cytotoxicity and antibacterial properties of CS-SeNF and to investigate their potential application.

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Author contribution Prasad Sowmiya: experimental analysis, writing original draft, review, and editing; Tharmathass Stalin Dhas: conceptualization, visualization, supervision, review, and editing; Dhinakarasamy Inbakandan: review and editing; Ravi Mani: review and editing; Anandakumar Natarajan: review; Gopal Dharani: consultation, review, and editing; Kasivelu Govindaraju: review and editing; Malaichamy Kannan: transmission electron microscopy analysis; Karthick Velu: review and editing; Chirayil Meethalepurayil Vineeth Kumar: review.

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Declarations

Ethical approval Not applicable.

Competing interests The authors declare no competing interests.

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Optically active organic and inorganic nanomaterials for biological imaging applications: A review

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ABSTRACT

Recent advancements in the field of nanotechnology have enabled targeted delivery of drug agents in vivo with minimal side effects. The use of nanoparticles for bio–imaging has revolutionized the field of nanomedicine by enabling non-invasive targeting and selective delivery of active drug moieties in vivo. Various inorganic nanomaterials like mesoporous silica nanoparticles, gold nanoparticles, magnetite nanoparticles graphene–based nanomaterials etc., have been created for multimodal therapies with varied multi–imaging modalities. These nanomaterials enable us to overcome the disadvantages of conventional imaging contrast agents (organic dyes) such as lack of stability in vitro and in vivo, high reactivity, low–quantum yield and poor photo stability. Inorganic nanomaterials can be easily fabricated, functionalised and modified as per requirements. Recently, advancements in synthesis techniques, such as the ability to generate molecules and construct supramolecular structures for specific functionalities, have boosted the usage of engineered nanomaterials. Their intrinsic physicochemical properties are unique and they possess excellent biocompatibility. Inorganic nanomaterial research has developed as the most actively booming research fields in biotechnology and biomedicine. Inorganic nanomaterials like gold nanoparticles, magnetic nanoparticles, mesoporous silica nanoparticles, graphene–based nanomaterials and quantum dots have shown excellent use in bioimaging, targeted drug delivery and cancer therapies. Biocompatibility of nanomaterials is an important aspect for the evolution of nanomaterials in the bench to bedside transition. The conduction of thorough and meticulous study for safety and efficacy in well–designed clinical trials is absolutely necessary to determine the functional and structural relationship between the engineered nanomaterial and its toxicity. In this article an attempt is made to throw some light on the current scenario and developments made in the field of nanomaterials in bioimaging.

1. Introduction

The advancements of imaging modalities are constantly being pushed by the compelling and desperate need for early detection and diagnosis. Detailed and faster results in imaging of tissue lesions and microstructures using nontoxic contrast agents with elongated retention/circulation time is a major challenge in the current scenario (Han et al., 2019). Nanotechnology plays a major role in offering possibilities for enhanced imaging. Nanoparticles as imaging contrast agents are one of the most promising and highly beneficial to clinical practice. The first

and crucial step in clinical practice is the early disease diagnostics and detection (Ryvolova et al., 2012). Medical imaging technology time and again plays the most significant role in the early diagnosis, detection and therapeutic response assessment of various diseases. Since the origination of X-ray technology various other non-intrusive methodologies have been originated. These techniques have been successfully adapted to various fields ranging from clinical diagnosis, drug discovery and cell biology. Significant advancements in the fields of information technology, electronics, image processing and nanotechnology have benefitted the biomedical imaging research to a great extent (Murray et al., 2000).

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The use of fluorescent probes has rendered feasibility to view specific biological in viable and nonviable specimen. The synthesis of fluorescing luminescent engineered nanoparticles is contemplated to be constitutive to the evolution of next set of theranostic imaging technologies (Mahmood, 2004).

Ultrasound imaging (USI), magnetic resonance imaging (MRI), positron emission tomography (PET), Computed tomography (CT), optical imaging (OI), and emission of a single photon CT (SPECT) are non-intrusive optical imaging techniques that have been developed and are currently in use (Högemann and Basilion, 2002; Pomper MG, 2004). Each of these techniques differs in terms of various factors like resolution, sensitivity, and time for data accession, complexity and monetary cost. In general, various techniques in imaging are only supplementary and the choice of technique depends on the sample in question. Light microscopy (luminescence and fluorescence imaging) has been the go-to technique for imaging of biological specimens and is at present inviting significant interest as various technological advancements provide significantly improved capabilities. MRI has seen a remarkable growth in medical diagnostics specifically for soft tissues. Multifunctional nanoparticles are a step forward in MRI-based soft tissue imaging. Multimodal nanoparticles are created by incorporating a paramagnetic ion and a luminescent core into the same interface (Kircher et al., 2003; Santra et al., 2005). Thus, the multimodal nanoparticles can be detected by MRI and OI in a simultaneous manner. The advantage of using such particles is the increased sensitivity due to optical detection and ability to obtain a 3-D image of biological micro and nanostructures and processes at cellular level (Faiz Kayyem et al., 1995; Moats et al., 1997).

Light is arguably one of the most versatile radiation used in imaging due to its nonintrusive nature and ability to bring about a contrast by interference, coherence, intensity, polarization, wavelength, (Dunn et al., 2001; Tearney et al., 1997) nonlinear effects and lifetime. Various optics based imaging techniques have utilized interaction of various physical parameters of light with tissues (Alivisatos, 2004; Licha and Olbrich, 2005; Ntziachristos et al., 2005; Rudin and Weissleder, 2003; Weissleder and Ntziachristos, 2003). Fluorescence microscopy has evolved as one of the most significantly relevant imaging techniques among the many accessible optical imaging techniques. The intrinsic fluorescing capacity of the fluorophore determines optical fluorescence which is depicted in Fig. 1.

When a quantum of specific energy hits the fluorophore, it excites electrons and pushes them to a higher energy level (S_1 , S_2), from the ground state. Since various electrons possess various vibrational and rotational energies, the shift to a singlet state necessitates a move to a higher electrical state with a corresponding rotational or vibrational energy. During this process, a part of the electrons energy is lost, most typically through a nonradioactive thermal decay as a result of which a photon at lower energy is emitted. The Stokes shift is the difference in wavelength between the excitation wavelength and the wavelength of the emitted light. In fluorescence imaging technique, an external light

source emits the energy which is captured and absorbed by the imaging dyes introduced by injection near the tissue or tumour site. This light energy is instantaneously reemitted with a lesser energy and longer wavelength, which is then captured by the detector. Auto fluorescence, scattering of light and high absorption by tissue haemoglobin in the mid-visible band are all common constraints to optical imaging of any tissue. Varied penetration depths can be attained by altering the wavelength of light employed and the fluorophore used (Graves et al., 2004; Licha et al., 2001; Ntziachristos et al., 2004). For example, tissue chromophores i.e., deoxy- and oxyhaemoglobin, strongly absorb photons in the UV-vis spectral range within the first few micrometres of tissue thickness, thus limiting the penetration of the photons. On the other hand, due to minimal surface tissue absorbcency in the specific spectral region, near-IR light of 650–900 nm, achieves the greatest tissue penetration (Graves et al., 2005, 2003).

2. Conventional contrast agents for Imaging and their limitations

The most frequently used fluorophores are organic fluorescent dyes. Carboxyfluorescein–diacetatesuccinimidyl ester and fluorescein isothiocyanate dyes have been commonly used in various biological applications. These dyes are commonly used to tag antibodies and molecules used in the staining of cells or organelles (Lyons and Parish, 1994; Weston and Parish, 1990). The problem with using these organic dyes however outweighs the benefits. The main limitation to using conventional contrast agents are,

- They are extremely vulnerable to photobleaching, which can occur rapidly (Fig. 2). They are unable to emit fluorescence over extended periods of time. This makes them unfit for bioimaging investigations over long periods of time (Chan et al., 2002; Walker et al., 1998).
- Organic fluorescing molecules are unsuitable for concurrent multicolour imaging because most organic dyes have a broad emission spectrum that can interfere and overlap with other fluorophores' emission spectrum. The excitation wavelength of each fluorophore is different. As a result, using multiple excitation sources becomes important.
- Local chemical environment and factors such as pH, interacting ions, etc can alter and interfere with the Emission or excitation.
- Overlapping of emission from dyes can occur over auto fluorescence from tissues. Low quantities of fluorophores such as nicotinamide (NAD [H]), collagen, flavins and elastin cause auto fluorescence in tissues. These molecules give a background fluorescence which occurs in the same region as the fluorescence of organic dyes. Most dyes that fluoresce in the visible area suffer from this limitation. Externally administered fluorochromes that fluoresce in the near-infrared range, such as the cyanine class of dyes, are increasingly being employed in fluorescence imaging to bypass this constraint (Lin et al., 2003). Nevertheless, most common dyes that possess fluorescence emission beyond ~850 nm suffer from low quantum yield, low brightness and insufficient photostability (Frangioni, 2003; Kim et al., 2004).

3. Optically active nanomaterials

Many nanoprobes have been engineered and used in bioimaging of tissues and treatment of diseases ranging from cancer to cardiovascular and inflammatory illnesses (Lim et al., 2012). Functionality of optically active nanoparticles depends on reliable and precise fabrication techniques. Various methods of synthesis of nanomaterials are discussed in Table 1. Optics-responsive inorganic and organic nanoparticles (Fig. 3) as imaging contrast agents for bioimaging applications have been elaborated below.

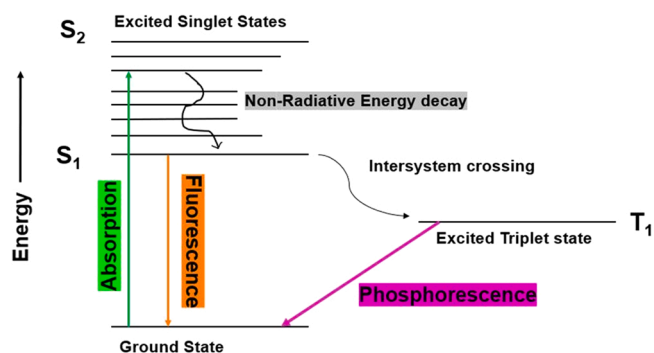


Fig. 1. The Jablonski diagram.

Photobleaching

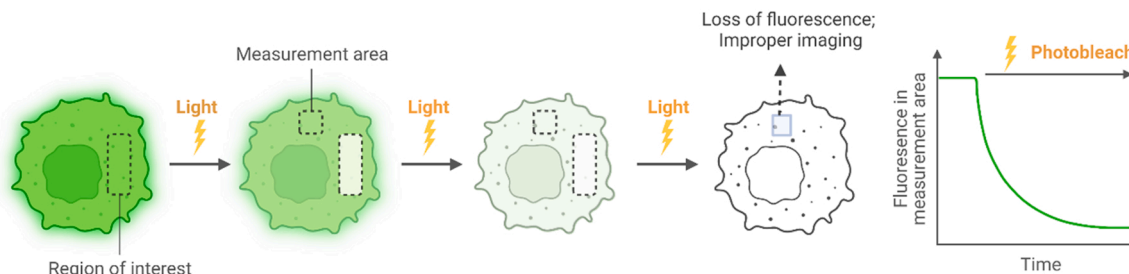


Fig. 2. Fluorescence loss due to photobleaching.

3.1. Inorganic nanoparticles as imaging contrast agents

Inorganic nanoparticles which are optically active are those which are capable of producing fluorescence or light dispersed under appropriate optical excitation by means of an inorganic material. Several optically active inorganic nanoparticles are used in optical bioimaging.

3.1.1. Magnetic nanoparticles

Magnetic nanoparticles have achieved considerable reactivity due to their imminent application in optical, magnetic and electronic mechanisms (Thorek and Tsourkas, 2008). They were extensively used to extend the platforms to target molecular imaging and theranostic purposes which take advantage of magnetic nanomaterial characteristics. Because of certain unique properties such as biocompatibility, less toxicity, distinct surface chemistry and other promising pharmacokinetic properties in blood and persistent tissue retention times. Generally, Magnetic have been used in single or multimodal imaging techniques (Huang et al., 2016; Lee et al., 2015). Besides the new expansions in molecular imaging and the growing demand for specific and effective imaging for identification and treatment, there is a revitalised advantage in emerging Iron oxide nanoparticles aimed at utilization in biomedical imaging.

There are various methods of preparing magnetic nanoparticles like physical, chemical and biological methods and each synthetic pathway has advantages and disadvantages. Physical synthetic methods such as ball milling, gas/aerosol deposition, electron beam lithography, laser-induced pyrolysis and pulsed laser ablation were simple to implement, it's difficult to control the size of the particles that may leads to various shapes. Chemical methods are efficient and simple which includes coprecipitation, thermal decomposition, hydrothermal, sol-gel, and micro emulsion. The synthesized nanoparticles have irregular shapes and they depend on the reagents used, temperature and pH. The biological means such as the use of magnetotactic bacteria are depicted by suitable reproducibility and scalability, which are also cost effective and produces great yield (Crețu et al., 2021).

There are few works reported that surface modification or functionalization of magnetic nanoparticles which are referred to as iron oxide core magnetite shells consists of Iron oxide (Fe_3O_4), Superparamagnetic iron oxide nanoparticles, Iron oxide nanoparticles, and Ultrasmall Superparamagnetic Iron oxide nanoparticles along with biologically compatible materials that has been used for imaging purposes (Ansari et al., 2019; Zhu et al., 2018). There are various shell coatings (Radhakrishnan et al., 2016) that have been used as encapsulation materials of proteins such as albumin (Vismara et al., 2017), gelatin (Murata et al., 2017), collagen (Belkahlia et al., 2020) or polysaccharides like chitosan (Balan et al., 2015), alginate (Castelló et al., 2015), dextran (Naha et al., 2015), starch (Tudorachi et al., 2018), etc. This has been used for different imaging applications of MRI, PET, CT, SPECT and optical imaging (Fig. 4). In addition, the research is quite necessary to expose their ability as a potential candidate for the

ingenious functionalization of metallic oxide nanomaterials to bioimaging.

3.1.2. Gold nanoparticles

Among metallic nanoparticles, silver and gold nanoparticles are most often investigated for biomedical applications. In the case of silver nanoparticles (SNPs), the area of application is restricted due to its toxic effects (Asharani et al., 2011, 2008). The unique features such as biocompatibility, optical property which is size dependent and stability were identified as the extraordinary benefits of gold nanoparticle (GNPs) to focus towards bioimaging (Bansal et al., 2020). There are various optical bioimaging techniques that are based on GNPs such as Localized Surface Plasmon Resonance (LSPR) imaging, Surface-Enhanced Raman Spectroscopy (SERS) imaging and Luminescence imaging (Kang et al., 2020).

Apart from the above characteristics, the use of GNPs in biomedical imaging techniques such as X-ray CT, dark field microscopic imaging, photoacoustic imaging, magnetic resonance imaging, and fluorescence imaging are widely accepted (Cole et al., 2015). The functionalization or the modification of GNPs with chemicals or biomolecules are useful for the diagnosis of diseases as imaging in the mode of probe (De Juan-Franco et al., 2013). Several studies have investigated the exploitation of GNPs as theranostic cancer probes, because of their exceptional optical characteristics which are not perceived in massive gold formulations. GNPs have incredible prospective for use as convenient fluorescent, probes that are non-bleaching as well as contrast agents for both *in-vitro* and *in-vivo* bioimaging (Aydogan et al., 2010; Cheng et al., 2015).

The GNPs possess unique optical properties and ease surface alteration ability makes GNPs ideal for bioimaging applications (Meir and Popovtzer, 2018; Repenko et al., 2018). In recent years, GNPs have drawn attention among the researchers due to their unique physicochemical features. GNPs are optically and electronically active, chemically stable, biologically compatible and adaptable to all functionality that depends on their size and shape. These unique properties of gold nanoparticles have immense possibilities to be used in various biomedical applications. A new approach focused on CT as an imaging technique and GNPs as contrast agent, has gained significant attention in its potential therapeutic application (Meir and Popovtzer, 2018).

Photoacoustics imaging is a versatile biomedical imaging (BI) tool for deep tissue imaging with immense significance for clinical visualization application. Repenko et al. (2018) demonstrated the melanin shells around the GNPs geometrics (from spheres to star and rods) improved the Photoacoustic (PA) competence. The melanin coatings reduced the cell toxicity as bioidentical surface coating (Repenko et al., 2018). The melanin coated GNPs display the powerful particles for *in vivo* PA imaging, particularly to be used as gastrointestinal PA imaging probes. The presence of the melanin coating completely avoided the cell death in case of gold rods. The cell viability improved over 90 % (melanin coating) and considerably improved cell proliferation in case

Table 1

Various methods of nanomaterial synthesis in Top Down and Bottom Up Approaches (Biswas et al., 2012)(Khan et al., 2017).

Approach to Synthesis	Techniques Used	Salient Features
Top-Down Approach	Optical Lithography	Dependable degree of resolution at high throughputs, long-established micro/nanofabrication tool specifically for chip manufacture.
	E beam Lithography	A widely used technique and equipment for nanofabrication that produces desired shapes for < 20 nm nanostructures in research environments.
	Block Co-polymer Lithography	A low-cost, high-throughput approach that works well for large-scale, densely packed nanostructures that allows for the fabrication of a variety of nanostructure shapes, including spheres, cylinders, and lamellae by parallel assembly.
	Soft and nanoimprint Lithography	Making ultra-small features (<10 nm) with a simple, efficient tool for nanofabrication based on pattern transfer.
	Scanning Probe Lithography	High resolution chemical, mechanical, and molecular nanopatterning capabilities, precisely controlled nanopatterns in resists for transfer to silicon, and the capacity to handle large molecules and individual atoms.
Bottom-Up Approach	Atomic layer deposition	By depositing one atomic layer at a time, it is possible to achieve atomic level accuracy, pinhole-free nanostructured films over broad surfaces, high reproducibility, and adhesion since chemical bonds are formed at the first atomic layer.
	Molecular Self assembly	Allows for the self-assembly of atomically precise nano systems by producing deep molecular nanopatterns with a width of less than 20 nm.
	Sol-gel nano synthesis	A low-cost approach for creating a wide range of nanomaterials, including multicomponent materials (glass, ceramic, film, fibre, and composite materials). Usually difficult to regulate synthesis, not easily scalable, and the subsequent drying procedures.
	Vapour deposition (Physical and Chemical)	Adaptable nanofabrication tool for the creation of nanostructured materials, like complex multicomponent nano systems (such as nanocomposites), controlled simultaneous deposition of a variety of materials, such as metal, ceramics, semiconductors, insulators, and polymers, high purity nanofilms, a scalable process, and the potential to deposit porous nanofilms

of silica-core gold-shell particles (SiAuMel) and Gold nano stars (AustarsMel). The surface modification of melanin coatings with biomedical identification motifs may contribute to targeted imaging probes for accurate detection and localization in order to acquire biomedically pertinent molecular data. Kang et al. (2020) synthesised nano porous GNPs by implementing pulsed electrochemical deposition procedure utilizing an anodic aluminium oxide template for repeated Ag-Ag-Au nano segments and succeeding selective Ag phase etching. The internal porous structure of nano porous GNPs displayed a 15 nm gap size. The surface of nano porous GNPs was altered with mercaptosuccinic acid and mercaptopropionic. The mercaptosuccinic acid altered nano porous GNPs displayed light triggered drug releasing for doxorubicin (Kang et al., 2020). Their study suggested that light irradiation on the nano porous GNPs induce local photothermal heating to cause the

Table 2

Inorganic nanomaterials and organic nanomaterials with optical activities and their applications in biological imaging.

Type of Nanomaterial	Application in Imaging	Reference
Lanthanide nanoparticles	Fluorescence Imaging Contrast Agents	(Ren et al., 2020)
TADF dye doped silica NPs		(Crucho et al., 2020)
NaTb (WO ₄) ₂ nanomaterials		(Munirathnappa et al., 2020)
Gold nanoparticles	Computed Tomography	(Wen et al., 2013)
Bismuth nanoparticles		(Kinsella et al., 2011)
CaP nanomaterials		(Kollenda et al., 2020)
Magnetite iron oxide nanoparticles	Magnetic Resonance Imaging	(Arsalani et al., 2019); (Maity and Agrawal, 2007)
Chitosan derived glycolipid nanoparticles		(Zhao et al., 2020)
Hyaluronic acid nanoparticles	Positron Emission Tomography and Single Photon Emission Computed Tomography	(Lee et al., 2015)
Aluminium oxide nanoparticles		(Pérez-Campaña et al., 2012)

doxorubicin to be released from the nano porous GNPs. The in-vivo fluorescence imaging study showed that mercaptopropionic altered nano porous GNPs effectively functioned for controlled release of doxorubicin in mouse during light irradiation. The light triggered releasing may be useful for drug delivery and in vivo photothermal therapy.

In recent times, different coatings of GNPs have been developed for targeting the macrophages due to their unique optical properties, biocompatibility and less cytotoxicity. One of the important parameters in macrophage targeting is the nanorod brightness, choosing of nanorods aspect ratio and determines the sensitivity of an imaging system. Two photon luminescence microscopy is another common bio-imaging approach that overcomes the challenges posed by certain optical imaging techniques like auto-fluorescence of living tissues. The high spatial resolution with 3D images can be obtained from luminescence microscopy. Wang et al., 2013 used a laser scanning Two-photon luminescence (TPL) microscope to study the TPL characterization of nanorods with four different aspect ratio of nanorods with surface plasmon resonance at 700, 756, 844 and 1060 nm, respectively (Wang et al., 2013). Among the four wavelengths studied the nanorods with surface plasmon resonance at 756 nm were observed to be strongest TPL signal. Their study suggested that GNPs are the promising imaging contrast agent for Two-photon luminescence and the brightness of the nanorods for specific application can be known by comparison of TPL brightness, Two photon action cross section and TPL emission spectrum. The gold nanostructures with various morphologies functions as contrast agents and are also suitable for photoacoustic imaging (Xi et al., 2012). Gold nanocages have been used in variety of nanomedicine applications due to their unique properties. Photoacoustic tomography (PAT) is a powerful bio-imaging technique and Au nanocages are known to improve the PAT efficacy (Xia and Xia, 2014). PAT represents a unique and low cost approach to determine the angiogenic status of cancers such as head, neck, breast, skin etc before or during the therapy specifically antiangiogenic treatment, using angiogenesis as the origin of treatment, as an indication of disease recurrence (Pan et al., 2011). PAT contrast agents have been documented based on dyes (Wang et al., 2005; Xie et al., 2005); GNPs, nanocages (Pan et al., 2010; Yavuz et al., 2009).

Yang et al., 2007 reported Au nanorods as contrast agent (intravascular) for Photoacoustic tomography imaging in rat model (imaging of cerebral cortex and sentinel lymph nodes) (Yang et al., 2007). Kim et al., 2010 demonstrated the use of [Ni⁴⁺, D-Phe⁷] -α-melanoma stimulating hormone conjugated Au nanocages as contrast agent for in-vivo

Optically Active Nanomaterials

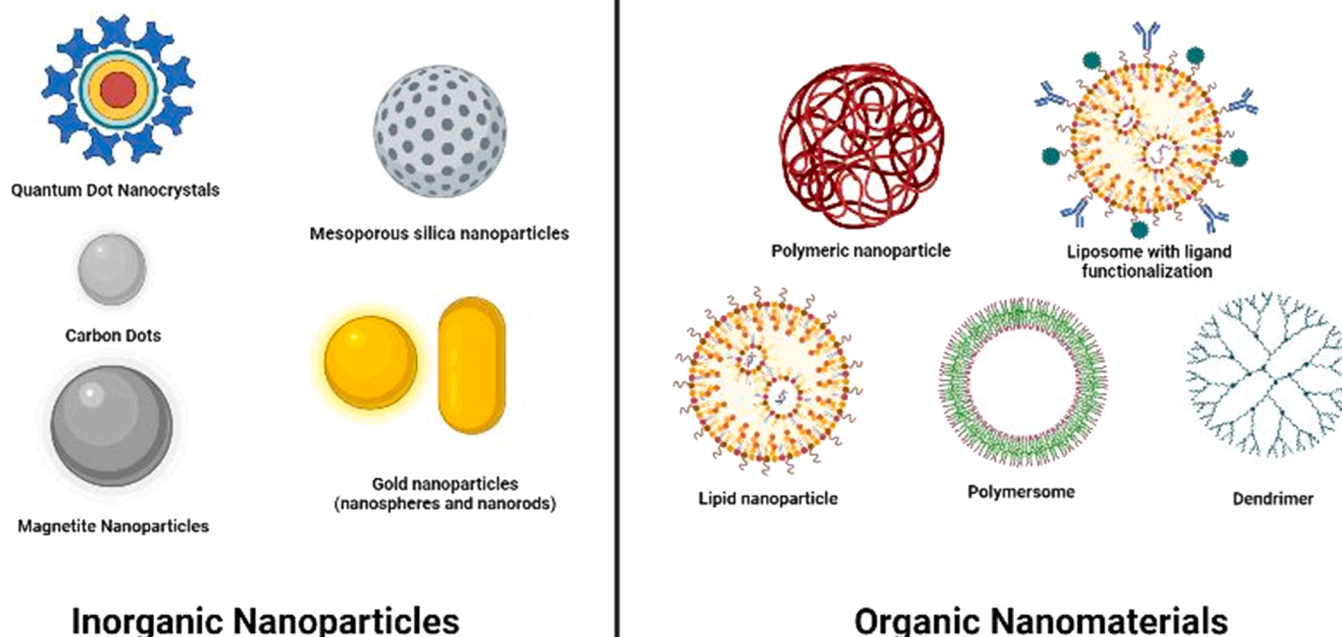


Fig. 3. Inorganic and organic optically active nanomaterials.

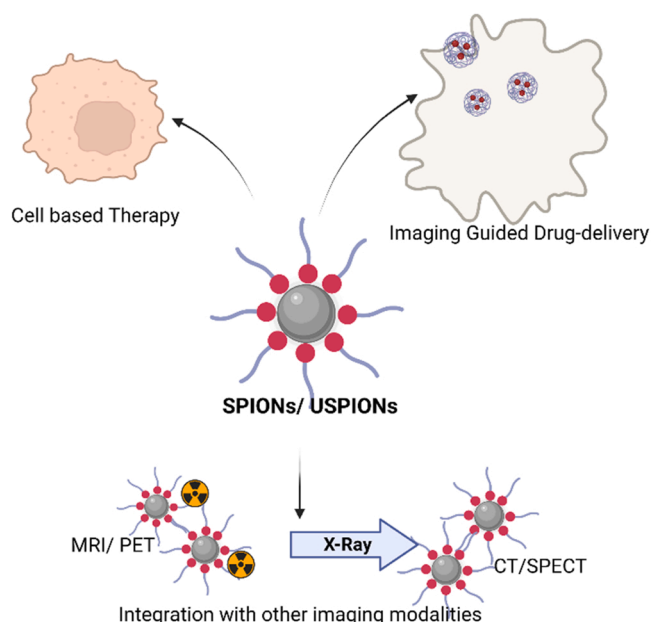


Fig. 4. Applications of super paramagnetic and ultrasmall super paramagnetic iron oxide nanoparticles (SPIONs/USPIONs).

Photoacoustic tomography imaging of melanomas (Kim et al., 2010).

Immunoelectron microscopy is one of the finest techniques for identifying and localizing the proteins in the cells and tissues (De Paul et al., 2012). In immunoelectron microscopy technique GNPs labelled antibodies are used to detect the particular antigens within the samples.

Recently, biomedical investigators used GNPs for optical microscopic imaging. Wang et al. (2014) reported the Rose Bengal conjugated gold nanorods in-vivo for internalization of GNPs in oral cancer cells (Wang et al., 2014).

Another popular bio-imaging technique is magnetic resonance imaging (MRI). The 3D anatomical images with high resolution are obtained. The drawbacks from old MPI machine were long duration for scanning. The modern MRI machines have significantly reduced the time of scanning and the scanning of whole body is done in few minutes. Gadolinium based contrast agents have been extensively used to acquire magnetic resonance images. Gadolinium chelates based magnetic resonance imaging have been reported promising for improving MRI imaging (Perry et al., 2020).

3.1.3. Mesoporous silica nanoparticles

As previously stated, one of the most pressing issues with organic fluorescent agents is quick and rapid photobleaching. Various photochemical reactions happening in the cellular environment can lead to the degradation of the dye (Jaiswal et al., 2003; Song et al., 1995). A method that is in use and is the most effective in maximising the stability in-vitro and in vivo is the encapsulation of the dye in a ceramic matrix. This method minimizes exposure to oxygen thereby increasing chemical stability thereby allowing modification of shell surface to enhance hydrophilicity and cellular uptake. Currently various methods that are being used for encapsulation comprise incorporation of the dye in PNA oligomers nucleic acid, lipid micelles (Zheng et al., 2002), and encapsulation in polymer or silica matrices (Bagwe et al., 2004).

Colloidal mesoporous silica nanoparticles (MSNPs) are a group of inorganic vehicles that are of high significance in dye/drug delivery. They possess controllable morphologies and mesostructures that can be readily functionalised and are highly biocompatible, thus making them

suitable candidates for bio-therapeutic and biomedical applications (Popat et al., 2011; Wu et al., 2011) (Fig. 5). MSNPs possess more silanol groups on their surface making them hydrophilic; the ease of functionalization by various chemical moieties/groups enables in achieving sustained holding/release of the loaded molecules. The high pore capacity and huge internal surface area of mesoporous materials facilitate an increased loading of molecules. They also prevent the escape of molecules by rapid dissolution in an aqueous environment. This ensures efficiency and effective loading of drugs into the delivery system and increases the chances of drug reaching their specific therapeutic target. In addition, the large pore size of the MSNPs is advantageous in improving the delivery of hydrophobic anti-cancer molecules. This is of great importance because the effectiveness and efficiency of such drug molecules may be limited by their poor solubility in water (Li et al., 2012). The MSNPs can be functionalised on both the interior and exterior surfaces, improving the drug delivery and a plethora of functionalities. One of the primary aspects that contribute to MSNPs' wide functionalization capacities is their increased surface area-to-volume ratio and mesoporosity. Organic molecules such as dyes, drugs etc. can be bound to the silanol group on the exterior surface by means of electrostatic or covalent interactions. Also, the MSNP surface can be reinforced with vectors that are active targeting to increase the targeted nature of drug delivery and reduce tissue damage. Furthermore, research has been carried out on functionalization of the interior surface with specific load molecules such as drugs, dyes, proteins and nucleic acids for theranostic purposes (Li et al., 2012; Margolese et al., 2000; Solberg and Landry, 2006).

Before the effective application of MSNPs in drug delivery systems,

investigating their cellular uptake and cytotoxicity becomes ultimately necessary. The uptake of MSNPs and their significant biocompatibility were confirmed using both healthy cell lines and cancer cell lines (Lu et al., 2007; Radu et al., 2004). Many researchers have proven that cellular uptake and cytotoxicity of MSNPs depend upon factors like surface charge, particle shape, size and functional groups present (Vivero-Escoto et al., 2010; Wu et al., 2011). Non modified 100 nm MSNPs showed no cytotoxicity up to 100 mg mL^{-1} . Therefore, therapeutic treatments can be safely done with a lower concentration range (Lu et al., 2010; Meng et al., 2010; Thomas et al., 2010).

3.1.4. Quantum dots

Quantum Dots (QDs) have become a major group of imaging probes in addition to general multi-purpose nanodevice platforms for engineering (Zrazhevskiy et al., 2010). There are several routes of synthesis of QDs out of which top-down which include molecular beam epitaxy, ion implantation, and lithography and bottom-up that includes wet-chemical and vapor-phase methods are generally preferred (Bera et al., 2010). They have discrete benefits compared to conventional luminous natural dyes in both chemical and biological studies with respect to integrate emission spectrum, indicate brightness, and photostability (Liu et al., 2011; Liu et al., 2011). Hence, due to the adaptable luminescence property, its influence on numerous fields of advanced biology with QDs extensively applied as tags and diverge agents in vitro and in vivo bioimaging (Jeong et al., 2016). Quantum dots, especially semiconductor quantum dots, are one of the most intriguing photoluminescent nanomaterials with a lot of potential in cancer nanomedicine (Yao et al., 2018). ZnS quantum dots appear intriguing,

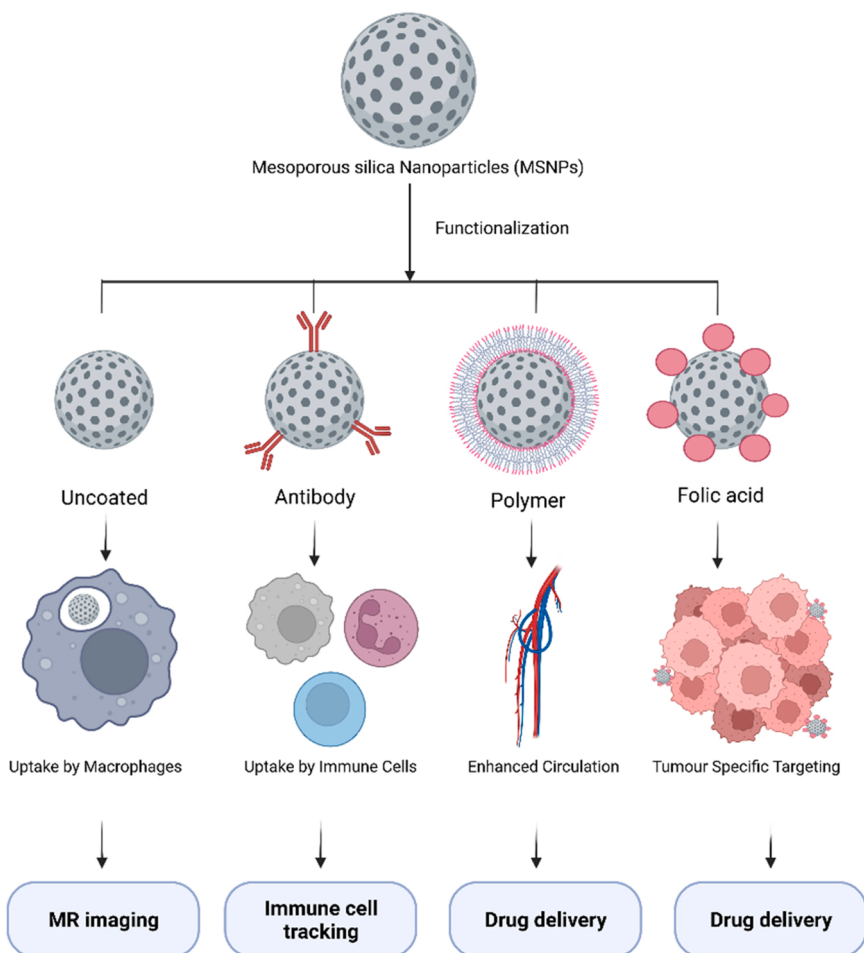


Fig. 5. Functionalization of mesoporous silica nanoparticles and their uses.

because of its visible light emission, biocompatibility, and ability to be synthesized using a variety of surface capping agents (Ramanery et al., 2014). Pure or doped ZnS nanoparticles are employed in a number of applications, including biomedical luminous nanoprobes, nano-photocatalysts, optical nano-sensors, and fluorescence resonance energy transfer processes (Caires et al., 2020). In a study, green synthesized ZnS quantum dots were used as photoluminescent nanoprobes for bioimaging brain cancer cells (Caires et al., 2020). Bioconjugates made of Ag-In-S@ZnS coupled with ZIKA virus was designed and developed for the first time which gives insights on the interaction profile of the ZIKA virus-nanoparticle conjugates with VERO cells and serves as a nanoplatfrom to elucidate the infection mechanisms and host cell response (Carvalho et al., 2020). Quantum dots are also presumed to be a leading tool in the fluorescent diagnostics of cancer and other acute conditions.

3.1.5. Black phosphorous nanomaterials

Black phosphorus (BP) nanosheets and nanodots make up the majority of BP nanomaterials. Among them, phosphorene, a two-dimensional BP nanosheet with just a few layers, has garnered a lot of interest lately. Over decades of research and development, a variety of approaches have been developed for the synthesis of BP nanosheets, including the top-down method and the bottom-up method. These techniques include mechanical cleavage and liquid-phase exfoliation procedures (such as chemical vapour deposition and wet-chemistry techniques) (Qiu et al., 2018). In recent years, a new 2D substance called BP, each layer of which is also known as phosphorene, has appeared. High anisotropy due to its wrinkled structure along the zigzag and armchair directions, a direct and layer-dependent band gap (E_p) from 0.2 eV (bulk state) to 3.2 eV (monolayer), in contrast to semi-metallic graphene, and, in particular, a strong sensitivity to oxygen and water in conjunction with visible light, which leads to poor stability under ambient conditions, are just a few of the key differences between BP and graphene (Xing et al., 2018). BP's weak environmental stability is its greatest shortcoming. The fascinating physical properties of it under ambient conditions are deteriorating mostly as a result of its degradation. As a result, numerous efforts have been made to shield BP against airborne deterioration. Recent studies, however, have shown that this trait of quick degradation is a significant benefit when using BP as a photothermal agent for photothermal therapy (PTT) against cancer (Xie et al., 2020; Zhou et al., 2016). In the field of biomedicine, accurate tumour identification and successful therapy are crucial and essential. Metal phosphide/phosphate nanomaterials were demonstrated to be appropriate for tumour imaging, including MRI, fluorescence imaging (FI), photo acoustic imaging (PAI), and tumour treatments (CDT, PTT, and PDT). BP nanoparticles, phosphorus-containing dendrimers, and metal phosphide/phosphate nanomaterials have all been used in the treatment of tumours, tumour imaging, and neurological disorders (Tang et al., 2020).

4. Organic nanomaterials

In recent years, there is an exponentially increasing interest in the development of organic nanomaterials for biomedical applications. Engineered nanoparticles have gained significant interest due to their versatile medical applications in vaccination, cancer therapy, diagnostic imaging procedures and drug delivery (Virlan et al., 2016). Polymer dots have been identified as an intriguing class of fluorescence probes in bioimaging and biosensing. Polymer dots are advanced nanomaterials that generally display enhanced fluorescence brightness and photo stability. These type of fluorescent nanoparticles are commonly used in sub fluorophore groups such as C $\frac{1}{4}$ N, C $\frac{1}{4}$ O, N $\frac{1}{4}$ O instead of fluorophore groups and have a promising potential as new fluorescent material (Zhong et al., 2018). The main advantage of these polymer dots can be low or minimal toxicity, non-degradable, rapid emission rate and high fluorescence brightness and so they possess explicated potential for vast

applications in biomedical fields like cell labelling, bioimaging, cancer phototherapy, lymph node mapping, drug delivery and biosensing (Solhi and Hasanzadeh, 2019).

One of the most recent advancements in the creation of value-added goods from bioenergy and biochar production is the fabrication of carbon-based nanomaterials (Plácido et al., 2019a). The synthesis and purification of carbon containing nanomaterials from biochar or microalgae by employing chemical depolymerisation and solvent extraction methods has been reported too (Plácido et al., 2019b). These nanomaterials were investigated as a transducer for the detection of heavy metal ions in aqueous systems and cellular imaging. The fluorescence emitted by microalgal biochar-derived carbon nanomaterials was found to be quenched by four heavy metal ions: Ni (II), Pb (II), Cd (II), and Cu (II). The results suggest that the biochar-derived carbonaceous nanomaterials were suitable as a bioimaging probe for yeast cell bioimaging and had varied fluorescence intensity and the localisation depending on the yeast cells. The intensity of the signals and absence of toxicity make them most suitable for bioimaging applications (Plácido et al., 2019a). Graphene, a two-dimensional substance with a sheet-like faveolated structure, has sparked a tremendous amount of interest in both basic and applied research. Due to its distinctive optical and electrical features, as well as a tunable band gap, 2D black phosphorus has recently gained popularity. Black phosphorus nanodots of size < 20 nm was reported to serve as a candidate for bioimaging. The so formed nanodots were found to be stable in aqueous solution and degraded in phosphate buffered saline. They showed little or minimal cytotoxicity *in-vitro*, making them a suitable candidate for drug delivery or intracellular tracking systems as bioimaging agents using blue and green fluorescence (Lee et al., 2016).

Self-assembled organic molecules made of paclitaxel conjugated near-infrared brominated boron-dipyrromethenes synthesized via nanoprecipitation method was used as an efficient bioimaging agent for cervical tumours and showed no systemic toxicity (Zhang et al., 2018). Emission tunable probes via one step hydrothermal reaction using terbium (III) doped self-activated luminescent hydroxyapatite were synthesized with the assistance of trisodium citrate which holds significant promise in luminescence and bioimaging (Wang et al., 2021).

In comparison to the traditional natural fluorophores and semiconductor QDs, the recently developed carbon quantum dots, which belongs to nanocarbon family, are exclusive in terms of facile surface functionalization, chemical inertness, resistance to photobleaching, etc. (Xu et al., 2004). CDs can be synthesised from a wide variety of precursors such as chemical and eco-friendly resources such as glucose, ascorbic acid, gelatin, chitosan, sugarcane juice, watermelon peel, etc. Surface modification of CDs by functionalisation that are obtained using polyethylene glycol, thiols, etc., for bioimaging application (Dong et al., 2012).

Carbon dots were also assessed for optical bioimaging applications, including their cellular absorption and fluorescence luminosity within the cell (Li et al., 2012). Fluorescence imaging of the *in vivo* mouse model using commercially available CdSe-ZnS QDs was compared (Cao et al., 2012). Additional research on uses such as combining carbon dots with bioactive substances for exclusive *in vivo* targeting and their applications in cancer diagnosis and angiography could be envisaged.

Organic-inorganic hybrid NPs of PANI@W₁₈O₄₉ with uniform morphology and PANI@W₁₈O₄₉@Fe₃O₄ with magnetic targeting were synthesized by hydrothermal method in a study for combined synergistic photothermal therapy and chemotherapy for cancer. It was found that the hybrid NPs not only did not affect the photothermal properties of W₁₈O₄₉, but also improve its antioxidant properties, which made the synthesized NPs more suitable for PTT as a photothermal agent than W₁₈O₄₉ itself (Yang et al., 2021).

5. Bioimaging using nanomaterials

5.1. Nanoparticles in fluorescence imaging

Fluorescent nanoparticles are potential devices in biochemical, bio-analytical, and medicinal fields for optical data storage and other technical applications. Fluorescent imaging with engineered nanoparticles has become widely used in a variety of clinical and biological applications, including gene therapy, drug delivery, and also in bio sensing, to investigate cellular dynamics and interactions (Grunert et al., 2018). The majority of current medical and biological fluorescence imaging technologies rely on dye markers, which have limitations in terms of light emission per molecule and photostability. These drawbacks are solved by nanoparticles, which provide strong and stable fluorescence. In a study, engineered NIR-IIb fluorescence of Er-based lanthanide nanoparticles were reported for through-skull targeted imaging of orthotopic glioma which demonstrated to possess greater potential in imaging-guided surgery of tumour (Ren et al., 2020). The field of organic light emitting diodes that provide a long-lived delayed fluorescence component for sensing oxygen content, measuring local temperature, or imaging has been revolutionised by thermally activated delayed fluorescence (TADF). A facile method demonstrated the synthesis of TADF dye doped silica nanoparticles that are effectively internalized by human cells even at low incubation concentrations, localized in the cytosol and enabled fluorescence live cell imaging (Crucho et al., 2020). An electrostatic complex nanoparticle has been designed to serve as a fluorescence switch for selective cell imaging. The fluorescence of the complex nanoparticle can be modulated by light irradiation and those with good fluorescence performance were employed for selective cell marking and imaging applications (Peng et al., 2020). Scheelite like NaTb (WO₄)₂ nanoparticles has been reported to exhibit particle size dependent optical properties which emit green fluorescence. The nanoparticles synthesized showed excellent biocompatibility in HeLa cells and it is reported to be a promising candidate for its role as a biomarker for cell imaging applications (Munirathnappa et al., 2020).

5.2. Nanoparticles for CT imaging applications

The structural and morphological qualities of the sample under investigation can be determined using X-ray CT in 3-D. It is essentially used in clinical and medical applications to diagnose the diseases that occur in different parts of the body (Aslan et al., 2020). Contrast agents based on tiny molecular molecules are frequently employed for better CT imaging; however, they have significant drawbacks such as a short half-life, renal toxicity at relatively high concentrations, and non-specificity. Recent advances in nanotechnology have paved way for various nano systems for numerous applications. In a study,

multifunctional gadolinium-loaded dendrimer-entrapped GNPs were synthesized and were reported to show excellent dual mode MRI-CT imaging performance in-vivo. These complexes were anticipated to show promising results in cancer diagnosis at an early stage with high accuracy and sensitivity (Wen et al., 2013).

Bismuth, due to its high atomic number, density and good X-ray attenuation, is a suitable candidate to be a contrast agent. Polyvinyl pyrrolidone (PVP) coated chemically synthesized bismuth nanoparticles provided excellent contrast amplification which was reported to be significantly greater than commercial iodine based products in the market. Internal organ visibility was improved without causing any significant cytotoxicity (Rabin et al., 2006). In addition, functionalization of bismuth nanoparticles with antibody possessed tissue targeted drug delivery applications (Kinsella et al., 2011). Intravenous injection of radiolabelled/tagged nanoparticles enhanced the contrast of the tumorous tissue and was found to be cleared up in renal pathway (Fig. 6).

Calcium phosphate nanoparticles were fabricated to visualize its biodistribution in-vivo by quantitative small animal positron emission tomography for several application routes. The results revealed that post intra-venous injection; the nanoparticles entered the lungs rapidly and gradually were redistributed into the spleen and liver. However, while following the intra muscular route of injection the nanoparticles remained mostly at the injection site which provides a new insight for the persistent activity of the nanoparticle in treatment (Kollenda et al., 2020).

5.3. Nanomaterials for MRI imaging

MRI has become one of the most extensively used and powerful tools for non-invasive clinical diagnosis. Nanomaterials have been extensively studied in the biomedical field to improve imaging tools for the diagnosis of tumours, tissue damage, and neurological problems (Wang et al., 2020; Yoo, 2012). MRI contrast agents available at present are commonly in the form of T1 positive agents of paramagnetic particles and T2 negative agents of superparamagnetic particles (Yang et al., 2011). Though the mostly used contrast agents are Gd-complexes, they pose a high risk of serious effects including systemic fibrosis of kidneys (Todd et al., 2007) and its accumulation in the brain (McDonald et al., 2015). To counteract this, lately, magnetic nanoparticles, in particular magnetite iron oxide nanoparticles are used as MRI contrast agents owing to their magnetism, insignificant toxicity and enhanced biocompatibility when compared to other magnetic nanoparticles (Arsalani et al., 2019). In addition, surface modification of these magnetite iron oxide nanoparticles can enhance the properties of biocompatibility and stability for medical applications (Maity and Agrawal, 2007).

In another study, chitosan derived glycolipid nanoparticles were reported as contrast agents for MRI imaging for the photodynamic

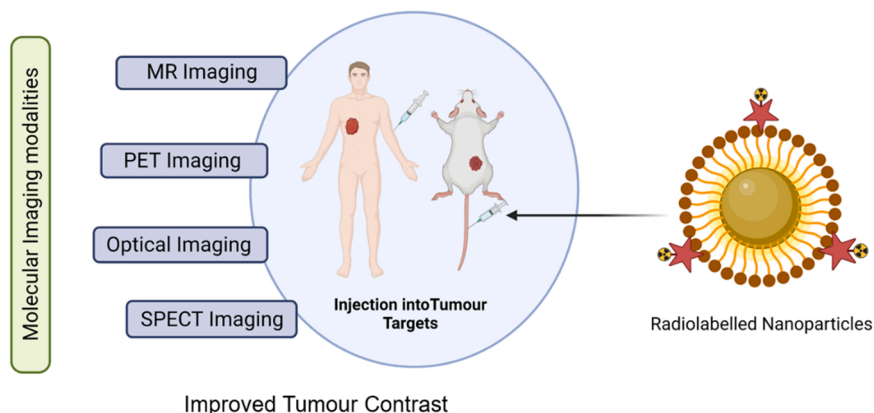


Fig. 6. Radiolabelled nanoparticles for molecular Imaging modalities.

therapy of cancer (Zhao et al., 2020). Among the polysaccharides, chitosan being a naturally occurring one has been widely reported for its high biocompatibility, flexibility and clinical efficacy (Esfandiarpour-Boroujeni et al., 2017). The chemical conjugation of octadecanoic acid and gadopentetic acid with chitosan gave rise to a polymer that self-assemble into glycolipid nanoparticles increased the MRI sensitivity as compared to the common gadolinium diethylenetriaminepentaacetic acid candidate. Moreover, it was reported that the nanoparticles showed negligible haemolysis and stability in physiological environments in addition to powerful MRI guided tumour ablation through photodynamic therapy (Kamkaew et al., 2016; Zhao et al., 2020).

5.4. PET/SPECT imaging using nanoparticles

Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) are the two major imaging modalities in nuclear medicine. A radioisotope is generally used as the imaging signal in both the methods. PET and SPECT are most commonly used for imaging or diagnosis of cancer and cardiovascular diseases respectively. PET has become the clinical method of choice for grading and restaging a variety of cancers, requiring the intravenous delivery of tracer amounts (typically nanomolar) of a radioactively labelled medication that is selective and specific for the target of interest. Nanoparticles can operate as signal amplifiers, leading in improved sensitivity and greater contrast indices. Their enormous surface area allows them to be functionalized with various targeting moieties, resulting in a multifunctional nanoplatform for disease detection (Goel et al., 2017). The capability for multimodality is a significant benefit of nanoprobe over standard biological moieties. Generally, nanoparticles-based functional imaging has the potential to enable early detection and prevention, and to essentially improve diagnosis, treatment and follow-up of diseases.

Hyaluronic acid nanoparticles labelled with fluorescent dyes have the potential to effectively target the atherosclerotic lesions (Lee et al., 2015). In a study, GNPs based imaging for cardiovascular diseases using SPECT proved to be promising due to their easy uptake and high X-ray sensitivity. It was also reported that the GNPs based imaging agents increased the specificity for apoptotic macrophages and reflects the exact pathologic condition of the examined specimen (Li et al., 2016). In another study, dual-functional quantum dot nanoprobe were utilized for quantitative evaluation of *in-vivo* pharmacokinetics and tumour-targeting efficacy studies using both PET and NIRF imaging (Cai et al., 2007).

Radionuclides emitting positrons can be conjugated or even inserted into carbon nanotubes for PET imaging. For instance, it was reported that ^{86}Y -Carbon nanotubes were synthesized from amine-functionalized and water-soluble carbon nanotubes by covalently attaching multiple copies of DOTA chelates and then radiolabelling with the positron-emitting metal-ion, yttrium-86 (McDevitt et al., 2007). Nahrendorf et al. developed a dextranated 20-nm nanoparticle labelled with ^{64}Cu to yield a PET, MR, and optically detectable imaging agent (Nahrendorf et al., 2008). Recently, ^{18}O -enriched aluminium oxide (Al_2O_3) NPs were developed by irradiation with protons to yield ^{18}F -labeled NPs via the $^{18}\text{O}(\text{p},\text{n})^{18}\text{F}$ nuclear reaction (Pérez-Campaña et al., 2012).

5.5. Multimodal imaging using nanoparticles

Multifunctional nanoplatforms with multimodal imaging and cancer therapeutic abilities have gained attention in biomedical applications. Molecular imaging techniques such as OI, MRI and CT play a vital role for diagnosis in medical field (Gao et al., 2010). Nevertheless, unimodal molecular imaging techniques provide inadequate information in clinical diagnosis and scientific research (Dai et al., 2013). OI with increased sensitivity is limited owing to their relatively unsatisfactory spatial resolution (Ma et al., 2012). Also, as a non-invasive imaging method, MRI possess high spatial resolution and soft tissue contrast without any

damage due to radiation; however, it sometimes shows insufficient sensitivity resulting in false images (Zhou et al., 2012). To counteract these difficulties, multimodal imaging methods have gained attention as they prove to be more efficient and provide exact information about physical and biological structures and their physiological functions (Lv et al., 2015).

The fabrication of imaging probes is crucial to the advancement of multimodal imaging. Many multimodal imaging nanoprobe have coupled optical and MR imaging such as in Gd/Fe-based QDs (Liu et al., 2011; Liu et al., 2011), Gd-based carbon dots (Chen et al., 2016) etc. The ideal candidate for optical and MR multimodal probe is Gd^{3+} ions, due to their minimal quenching efficiency and strong MRI signals. Due to the exceptional optical imaging properties, luminescent nanoprobe based on near infrared luminescence have proved to be one of the best candidates. In a study, a novel multimodal imaging nanoprobe based on near infrared luminescence nanoparticles functionalised with gadolinium complex for *in-vivo* MRI and NIR persistent luminescence imaging (Abdukayum et al., 2014). In another study, Maldiney et al., 2015 synthesized a multimodal bioimaging nanoprobe via Gd^{3+} co-doping into near infrared luminescence nanoparticles for MR Imaging (Maldiney et al., 2015). Apart from these near infrared luminescence nanoprobe, metallic nanoparticles like fluorescent copper sulphide nanoparticles enable both non-invasive multimodality imaging and targeting photothermal therapy of metastatic gastric cancer cells in lymph nodes examined in mice models (Shi et al., 2018).

5.6. Nanoparticles in ultrasound imaging

USI is one among the most often used diagnostic modalities in clinics, with various advantages over other imaging techniques, including quick and real-time imaging, excellent temporal and spatial resolution, low cost, no radiation risk, and easy patient access (Kang et al., 2010; Son et al., 2014). USI is most commonly utilised to perform morphological and functional examinations of soft tissues and the abdomen without the need for contrast agents. However, the assistance of contrast agents proves to provide more exact and clear USI of organs in various disease diagnosis.

The ketalized maltodextrin nanoparticles for contrast enhanced USI and therapy of acute liver failure. The synthesized nanoparticles were capable of delivering therapeutic and imaging functions simultaneously to the acidic conditions found in the site of inflammation (Go et al., 2018). In another study, Min et al., 2015 developed gas generating pH-controlled calcium carbonate (CaCO_3) nanoparticles as diagnostic and therapeutic agents for USI and cancer therapy. The mechanism of action of mineralized nanoparticles involved acid triggered dissolution of CaCO_3 and subsequent CO_2 generation. The hybrid nanoparticles were reported to quicken drug release at the acidic tumour site, leading to targeted drug delivery (Min et al., 2015). Magnetic nanoparticles also play a vital role in medical diagnosis where they mostly served as imaging contrast agents. Magneto-motive ultrasound is one such imaging technique where superparamagnetic NPs are used as contrast agent. A facile and economical coprecipitation method for the synthesis of Zn-substituted magnetite nanoparticles was reported. The study showed a marked increase in magnetic properties of magnetite nanoparticles by zinc which makes it a good candidate not only as contrast agent in USI but also as a therapeutic agent in magnetic hyperthermia. GNPs that have been explored widely in biomedical research also proved to have a profound efficacy in USI. In a study, nanomolecular probe encapsulating liquid perfluoro hexane and gold nanorods targeted towards melanoma associated antigens were found to enhance USI at tumour sites (Hadadian et al., 2018).

6. Biocompatibility of nanomaterials

Biocompatibility of nanomaterials is an important aspect for the evolution of nanomaterials from laboratory to medicinal use.

Nanotoxicology is a growing paradigm that attempts to evaluate the effects of nanoparticles in order to determine out the structure and functional link between nanomaterials and toxicity. Toxicology testing and assessment are, nonetheless, a significant aspect of pre-clinical safety testing of novel medications, which is required before beginning human Phase I/II clinical trials (Ashokan et al., 2017).

Nanomaterials, particularly gold is known to be highly compatible with the human body and is regarded as safe. However, there exist various concerns on its repeated and long-term exposure. In a study, Suganya et al., 2017 reported the biocompatibility of pectin derived GNPs in-vivo at acute and sub-acute level. The results proved the biocompatibility of GNPs with no lethal effects on tested animals (Suganya et al., 2017). Various reports have reported the use of graphene-based nanomaterials for medical applications. Covalent functionalization of graphene oxide with amino acids based on amidation has proved to be biocompatible on *in-vitro* evaluation on human embryonic kidney cells. The fabricated graphene-L-methionine nanomaterial has also shown to be a potential target for drug delivery upon binding with human serum albumin (Abdelhalim et al., 2020). Carbon nanomaterials have been used in a vast array and it was of interest to investigate its biocompatibility to be used for medical applications. The importance of particle shape in toxicity was demonstrated in a study where multi-walled carbon nanotube were found to be more toxic compared to multi-walled nano-onions to human skin fibroblasts (Ding et al., 2005). In a study, where the role of dimension of carbon nanotubes were considered in dermal toxicity, the results suggested that considering multiple physicochemical parameters when evaluating cellular toxicity of carbon nanomaterials will provide accurate results on its biocompatibility (Grabinski et al., 2007). Among various nanomaterials, biodegradable polymeric nanoparticles serve as a possible alternative for drug delivery (Mattu et al., 2013), to deliver drugs, genes and proteins (Hu et al., 2013). Commonly used polymeric nanoparticles include PLGA and PLA nanoparticles which were approved by US Food and Drug Administration (FDA). It is well established that several nanomaterials are able to cross blood-brain barrier reaching several regions in the central nervous system. While some nanomaterials possess the ability to cause neuronal toxicity, inflammation and cognitive deficits, there are reports on the biocompatibility of polymeric nanoparticles to the CNS and biodegradable properties which are the important characteristics when developing efficient nanocarriers for drug delivery (Leite et al., 2015).

The most worrying concerns with regard to phosphorus-based nanoparticles and possible clinical use are their biosafety and in vivo metabolism. The most widely utilised phosphorus-containing dendrimers, polyphosphazenes and polyphosphoesters, have the potential to breakdown into non-toxic compounds (Jing et al., 2019).

7. Toxicity of nanomaterials

Most nanomaterials used in biomedical applications for imaging diagnostics and theranostics are associated with toxic effects if not used with caution. Most nanomaterials enter the environment through air, water and soil. The benefits of NPs, such as their small size, strong reactivity, and great capacity, could turn into potential hazards by causing adverse toxicity in cells and thus leading to lethality. Studies have also shown that NPs can enter living organisms by inhalation or ingestion, and they possess the ability to translocate around the body to different organs and tissues where they may exert their reactivity and bioaccumulate (Khan et al., 2019). Also, the relatively small size of nanomaterials makes it easier for the smaller organisms to ingest or uptake the nanomaterials, which over time has detrimental consequences on the organisms. The increased manufacturing and application of nanomaterials, combined with a lack of a dedicated waste management infrastructure, cause them to become a discharge. Since nanoparticles are influenced by physicochemical and other elements including the pH of the surroundings, surface charge of the material,

biomass concentration, and chemical composition of the environment, environmental transformation is crucial for determining the toxicity of nanoparticles (Jadhav et al., 2021). Thus an ecotoxicological evaluation of the fate and persistence of nanoparticles becomes a crucial component of the toxicity assessments (Vineeth Kumar et al., 2022). Inorganic nanoparticles undergo a series of changes that significantly impact ecosystem's lower-level organisms. On rare instances, particle aggregation may be caused by increased surface area and charge. Metal oxide nanoparticles go through a number of transformation processes when they are discharged into an aqueous environment, including aggregation (including homogeneous and heterogeneous aggregation), adsorption, dissolution, and redox reactions. Linkages to macromolecules can happen due to numerous processes, including hydrophobic interaction, electrostatic interaction, van der Waals interaction, chelation, and ligand exchange (Wang et al., 2019).

8. Conclusion

Nano-imaging agents integrate diagnostics with therapeutics in the same platform, termed nano-theragnostic. Nanoparticles as carriers have humongous potential to incorporate various imaging and therapeutic agents to specific locations for biomedical imaging. Many categories of inorganic and organic nanoparticles have been used for biomedical imaging purposes. Most of these have been applied in tumour research. To ensure maximum bench to bedside translation of nanoparticle research, all aspects of nanoparticles, including shape, composition, surface area and charge, hydrodynamic diameter, composition, stability, solubility, delivery method, distribution, metabolism, clearance, accumulation, and potential hazardous effect, should be thoroughly studied (Choi and Frangioni, 2011). The conduct of thorough studies for efficacy and safety in well-designed clinical trials will be the most crucial and challenging component of this nanomaterial evolution. Improving target specificity with elongated fluorescence and minimal toxicity should be focussed on (Hua et al., 2018; Min et al., 2016). Moreover, the increasing significance of translational potential with relevant animal models cannot be exaggerated, without understanding the specific pharmacokinetic and pharmacodynamic profile of these agents in humans. Despite these challenges, nanoparticles possess remarkable capability as novel imaging agents for a variety of clinical applications (Sanna and Sechi, 2020; Van Norman, 2016). Further clinical translation is also hampered by the paucity of knowledge on the metabolism of nanomaterials in vivo. The current issues encourage future study of nanoparticles in imaging, PTT and PDT. For example, surface modification or the addition of liposome, erythroosome, and exosome for the encapsulation of phosphorus-based nanomaterials may significantly improve their biosafety and benefit their metabolism (Boorn et al., 2011; Fan et al., 2018). However, further research into the biosafety, cost-effectiveness, and controlled synthesis of high-quality few-layer nanomaterials with much increased efficiency, controlled size/thickness, and reduced adverse effects is imperative to finally realise clinical and translational applications of nanomaterials for therapeutic, diagnostic, or clinical applications.

CRedit authorship contribution statement

P. Sowmiya: Writing original draft, illustration, review & editing, visualization, conceptualization. **T. Stalin Dhas:** Conceptualization, writing original draft, review, editing, visualization and supervision, **D. Inbakandan & N. Anandakumar:** review & editing, **S. Nalini, K.S.U. Suganya, R.R. Remya:** Writing and review, **V. Karthick and C.M.V. Kumar:** Review & Editing.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Data availability

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INDIA WOOD EXPO 2022

Seminar & Study visit - June 2022

The III Year Interior Design students (Batch 2020-2024) attended a seminar / expo to get an insight into various interior materials and its applications. A team of 11 students along with 2 staff members visited this expo and interacted with different vendors and attended seminars by experts at different topics. The students were instructed to document materials specifications by collecting samples and details about the different materials they come across. They also had an exposure to various machineries for manufacturing and application of various interior finishes and accessories. Students spent the entire day in interaction, sketching, measuring and documenting the activities and seminars. They enjoyed the visit promised to come up with a good material study report for the material lab in the department.



ARCHITECT'S OFFICE VISIT

Live Case Study - July 2022

The III Year Interior Design students (Batch 2020-2024) are working on a design of an office space for a Designer. They have to select a designer of their choice and design a work space for them. In this regard they have to visit different office spaces for case study to get an in depth understanding about various office interiors. Two Architects office were selected in Chennai for their study. KSM Architects – Guindy and Triple O Studio in Adayar. A team of 11 students along with 2 staff members visited these offices on 8th July 2022. Detailed explanation was given and they were taken around the office which gave them a chance to explore each and every space inside the office. The students were instructed to document the spaces after having a discussion with the Architects and the employees in the office. Students spent the entire day in interaction, sketching, measuring and documenting the offices. This site visit gave them a better understanding about effective space planning, how to organize spaces and how to make every space functional. They enjoyed the visit promised to come up with a good case study report.



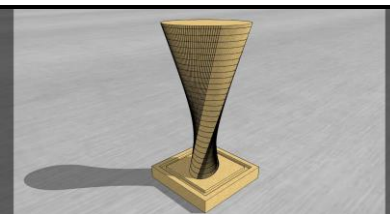
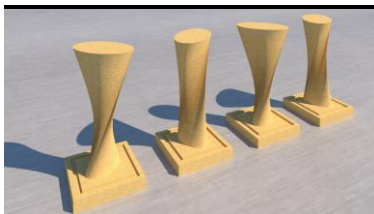
EBCO – INDUSTRIAL VISIT

Interactive workshop & Case Study - August 2022

The III Year Interior Design students (Batch 2020-2024) are working on a design of an office space for a Designer. In this aspect they are designing various office spaces and have to apply different finishes and materials for their interior spaces. In this regard a workshop and demonstration session was arranged in the experiential centre of EBCO in Kottivakkam, Chennai. Students were given a demo and instruction about Ebco's different product ranges as Office Furniture Fittings, Drawer Slides and Hinges, General Hardware, Joinery Fittings and Screws, Furniture Locks, Retail Display Systems, Window-Door Fittings, Window, Door & Glass Hardware, Kitchen Systems & Accessories, Aluminium Profiles & Handles, Bed & Wardrobe Fittings & Accessories, Furniture Lights - LED. The students were accompanied by 3 staff members for the visit on 6th August 2022. Detailed explanation was given and they were taken around the centre to explore various products. The students interacted with technicians and had detailed discussion. Students spent the entire day in interaction, measuring and documenting the range of products and its applications. This experiential centre gave them a better understanding about different products available in the market and its uses.

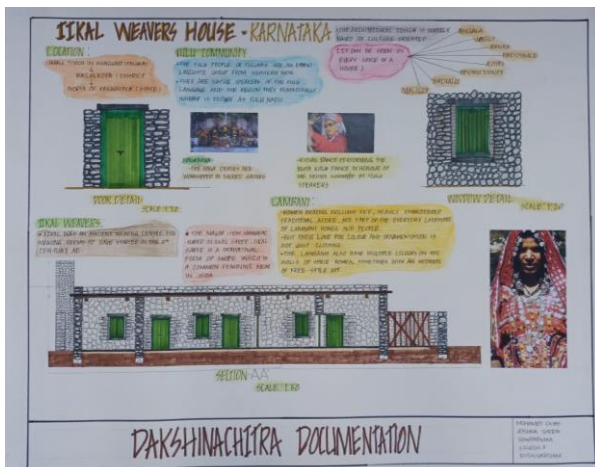
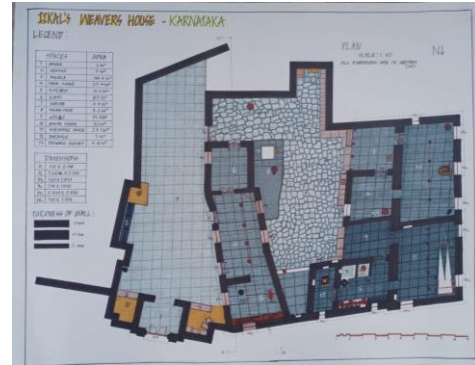


IIDCS workshop



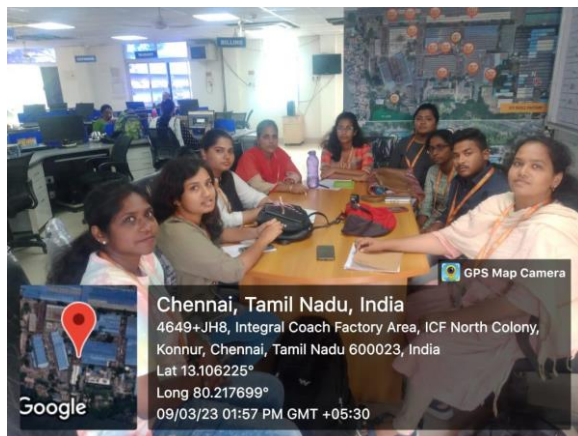
Dakshinchitra Visit

Workshop on Documentation and practices - 2023



Site Visit to ICF -Administrative Building.

A batch of 8 students pursuing 2nd semester M.Arch (Sustainable Architecture) visited the Administrative building, Integral Coach Factory(ICF) at Perambur, Chennai. The visit was mainly focused on understanding the evolution of energy-efficient strategies in buildings that contribute to energy conservation and thereby evaluate the energy performance of the Administrative building. Students were divided into 2 groups and they documented different energy consuming systems like HVAC, Firefighting pumps Lighting, Building Envelope. Observations made during the Visit.





First record of some crinoid and sponge associated crustacean decapods (Crustacea: Decapoda) from Lakshadweep Archipelago

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Abstract

Four additional records of crinoid associated crustacean decapods *Laomenes nudirostris* (AJ Bruce, 1968), *Periclimenes affinis* (Zehntner 1894), *Allogalathea babai* Cabezas et al. 2011 and *Aliaporcellana pygmaea* (de Man, 1902) have been documented from the selected Islands of the Lakshadweep archipelago. All four species were recorded for the first time. Information on the diagnosed material, host association, distribution was discussed in detail.

Keywords Crinoids · *Laomenes* · *Allogalathea* · Lakshadweep · India · First record

Introduction

Symbiotic relationships among various invertebrates and vertebrates are most common in the coral reef ecosystems (Bruce, 1976, Horka et al. 2016). Especially, the crustacean decapods associated with echinoderms possess astonishing diversity in terms of sexual biology, ecology and morphology in the tropical Indo-Pacific. Although, the symbiotic interactions among the animals are not well studied, the association of crustacean decapods with sponges and echinoderms are most common in the reef ecosystems (Bruce 1976, Williams 1984, Ng and Jeng 1999, Hayes 2007, Hayes et al. 2016). Surprisingly, out of all the decapod crustaceans that are symbiotic, more than 70% of diversity is dominated by Palaemonid shrimps that involve some form of relationship with other invertebrates and vertebrates (De Grave

2001). In India, the documentation of symbiotic crustaceans associated with echinoderms has started gaining attention in recent decades (Prakash et al. 2011, 2015; Prakash and Marimuthu 2020). An earlier study from the selected Islands of the Lakshadweep archipelago revealed seven species of crinoid associated crustacean decapods (Prakash and Marimuthu 2020). In this paper, we have documented four more species of crustacean decapods *Laomenes nudirostris*, *Periclimenes affinis*, *Allogalathea babai* and *Aliaporcellana pygmaea* are documented for the first time in Indian waters. It may increase the current state of knowledge in the crinoid associated communities from Lakshadweep archipelago. We have provided color photographs for the species for visual identification of crinoid associated shrimps.

The Lakshadweep archipelago is well known for its remarkable biodiversity that is located on the Laccadive-Chagos ridge. During our regular faunal exploration pertaining to the program entitled, “Fauna of Lakshadweep: Echinoderms” under Zoological Survey of India In-house activities funded by the Ministry of Environment, Forest and Climate Change, Government of India, crinoids, and their associated organisms were documented. Surveys have been carried out during October–November 2019 and February 2020. Crinoid hosts, as well as associated organisms, were collected at a depth between 10 and 40 m using SCUBA diving. The crustacean decapods identified were collected along with crinoids while doing line intercept transect (LIT) (English et al. 1997) as a part of biodiversity documentation. The crinoid host and the associated species collected

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and identified from the respective Islands were plotted in Fig. 1.

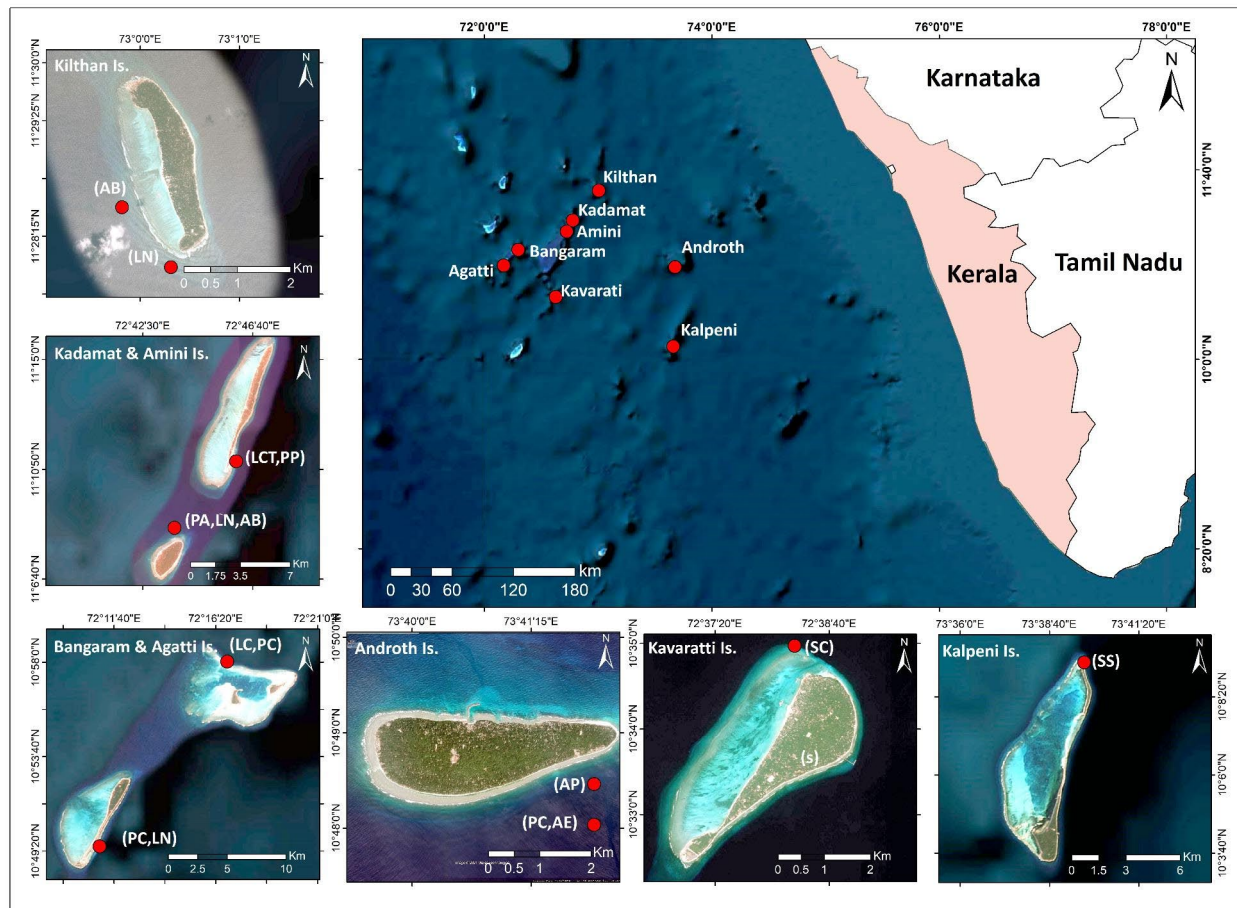


Fig. 1 Map showing the study area – selected Islands of Lakshadweep. Red spots indicate the sampling location corresponding to each Island

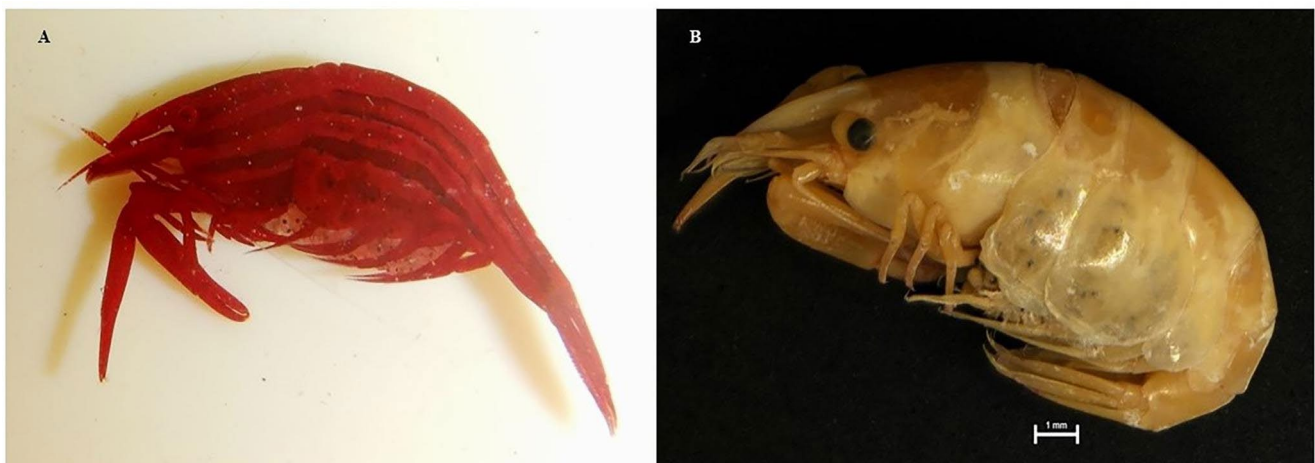


Fig. 2 *Laomenes nudirostris* (Bruce, 1968), ovigerous female, Agatti Island, Lakshadweep, ZSI/C9033/2. A, Coloration of live individual after collection; B, same in preserved condition

The host crinoids were collected manually picking from the benthic substrate or the rocks. The symbiotic decapods associated with the crinoids were separated manually using forceps without damaging the body parts of the host as well as the associate. Samples were stored in 95% ethanol and 5% seawater formalin for further identification. Underwater photographs of the hosts were taken using Nikon Coolpix W300 and the photos of the decapods were taken using Nikon SMZ25 microscope attached with Nikon DS-Fi3 camera, Japan. The morphometric measurements were done using NIS-Elements D software attached with the microscope. The crinoid hosts were identified using Clark and Rowe (1971) and Sastry et al. (2019). The crustacean decapods were identified as *L. nudirostris* (Bruce 1968, Marin 2009), *Periclimenes affinis* (Borradaile 1915), *Allogalathea babai* (Cabezas et al. 2011) and *Aliaporcellana pygmaea* (Osawa and Chan 2010). Lastly, the identified specimens have been deposited in the National Zoological Collections of the Crustacea Division, Zoological Survey of India, Kolkata.

Systematics

Order Decapoda Latreille 1802

Infraorder Caridea Dana, 1852

Family Palaemonidae Rafinesque 1815 Genus *Laomenes* A.H. Clark, 1919.

Laomenes nudirostris (Bruce, 1968) (Fig. 2).

Material examined. 1 Ovigerous female (cl 4.0 mm), Agatti Island, Lakshadweep, 10° 49.552' N 72° 10.996' E, 22 February 2020, Depth – 25 m, on *Himerometra robustipinna*, coll. N. Marimuthu (ZSI/C9033/2).

Short description. Rostrum long, straight and slender, compressed, well developed dorsal and ventral carina without dorsal and ventral teeth. Carapace smooth, swollen, presence of hepatic and antennal teeth; hepatic tooth triangular and slightly larger than antennal. Well-developed orbit, inferior margin rounded and produced. Antennule well developed and presence of acute distolateral tooth on the disto-lateral margin of antennule. Abdominal somites smooth, pleura of I – V rounded. First pereopod slender,



Fig. 3 *Periclimenes affinis* (Zehrtner 1894) (lateral view), Kadamat Island, Lakshadweep, ZSI/C9039/2

carpus without distolateral setae at carpo-propodal articulation; fixed finger and dactylus with numerous terminal setae. Second pereopod robust and equal in size and shape, fingers slender with 7 distinct triangular teeth with curved tips and palm cylindrical in shape. Third to fifth pereopod long and slender, propodus without distoventral spines, presence of plumose setae distally; dactylus robust, long, acute, and curved unguis and small accessory tooth facing downwards, presence of tuft of setae. Telson long with two pairs of small submarginal dorsal spines. Presence of single mobile distolateral spine on the exopod of uropod.

Coloration. Coloration agrees well with Marin (2009). Entire animal red in color with presence of dark red or brown longitudinal bands on carapace and abdomen dorso-laterally and laterally.

Host. In the present study it was associated with *Himerometra robustipinna*. Mainly associated with Himerometrid

crinoids such as *H. robustipinna* and *Amphimetra tessellata*, *Pontonimetra andersoni* and *Tropiometra arfa* (see Marin et al., 2009 for details).

Distribution: Previously known from Australia, New Caledonia, Japan and Indonesia (Marin 2009). Now from India.

Remarks. The description of present material of *L. nudirostris* agrees well with the description of Marin 2009. The *L. nudirostris* is closely related to *L. ceratophthalmus* however, can be easily distinguished from the later with the lack of teeth on the rostrum and the apical papilla is slightly smaller. The present material was collected from the same host found cohabiting with few individuals of *Pontoniopsis comanthi*.

Genus *Periclimenes* O.G. Costa 1844.

Periclimenes affinis (Zehrtner, 1894) (Fig. 3).



Fig. 4 *Allogalathea babai* Cabezas et al. 2011, Kiltan Island, Lakshadweep, ZSI/C9077/2. A, Coloration of live individual after collection; B, preserved specimen (dorsal view); C, same, ventral view



Fig. 5 *Aliaporcellana pygmaea* (de Man 1902), Androth Island, Lakshadweep, ZSI/C9052/2. A, dorsal view; B, ventral view

Material examined. Four individuals: 1 Male (cl 1.5 mm) and 3 Females (2 were ovigerous) (cl 2.1–2.4 mm), Kadamat Island, Lakshadweep, 11° 08.627' N 72° 43.691' E, Depth 20 m, 18 February 2020, coll. N. Marimuthu, (ZSI/C9039/2)

Short description. Rostrum straight and compressed, dorsal margin with 6 teeth and ventral with 1 tooth, overreaching the third article of the antennule. Eye cornea rounded and lack of papilla. Presence of supra orbital, antennal and hepatic spine. Presence of two distal spines on the first article of antennule. First pair of pereopods normal, mostly equal in size. Second pereopod slender and unarmed, having short wrist and simple fingers.

Host. In the present study it was associated with *Phanogenia gracilis*.

Distribution. Widely distributed throughout the Indo-Pacific including the closest locality Maldives (Borradaile 1915). Now from India.

Remarks. Previously under the name *P. brockettii* and has been considered as junior synonym of *P. affinis* (De Grave and Fransen 2011).

Family Galatheidæ Samouelle 1819

Genus *Allogalathea* Baba 1969.

Allogalathea babai Cabezas et al. 2011 (Fig. 4, 5).

Material examined. 1 Male (cl 3.7 mm) and 1 female (6.4 mm), Kiltan Island, Lakshadweep, 11° 28.538' N 72° 59.821' E, 19 February 2020, depth 12–15 m, on *Stephanometra* sp., coll. N. Marimuthu (ZSI/C9077/2).

Short description. Rostrum twice as long as broad, presence of 8 to 9 small spines on the lateral region. Dorsal surface of carapace slightly horizontal from anterior to posterior, cervical groove in the anterior region indistinct. Gastric region with 5–7 uninterrupted ridges, lateral margin of carapace with 8–9 spines. Pterygostomian flap possess setae with anterior margin bluntly produced. Abdominal somites II–IV with uninterrupted ridges. Eyestalk with short fine setae. First pereopod with dense, long setae with small spinules on the squamae, palm with row of spines and fixed finder with row of spines on lateral margin. Second to fourth pereopod long and slender, slightly compressed, squamous and scales with dense setae. Distodorsal spine on the dorsal margin of merus, carpus with dorsal spine and small distal spine on the flexor distal margin. Dactylus subequal with strong, curved sharp spine, triangular terminal tooth on the flexor margin.

Coloration. Body color usually brown with broad longitudinal whitish stripe flanked by narrow dark brown line on each side.

Host. In the present study it was associated with *Stephanometra* sp. Also associated with *Oxycomanthus bennetti* (Cabezas et al. 2011).

Distribution. Throughout Indo-Pacific from western Australia to Indonesia, Philippines, Japan, New Caledonia, South China Sea, Guam, Mariana Islands, Chesterfield and Loyalty Islands (Cabezas et al. 2011). Now from India.

Remarks. *Allogalathea babai* agrees well with the description of Cabezas et al. 2011 and can be clearly distinguished from *A. elegans* based on its coloration as well as other characters. The presence of broad longitudinal white stripe bordered with dark brown lines is distinct in *A. babai* compared to *A. elegans* that has alternate dark and light bands. The walking legs pereopod II–IV are shorter and slender in *A. babai* than *A. elegans*. The dorsal margin of meri on the pereopod II and III of *A. babai* have small spines compared well-developed spines in *A. elegans*.

Family Porcellanidae Haworth 1825

Genus *Aliaporcellana* Nakasone and Miyake 1969.

Aliaporcellana pygmaea (de Man 1902) (Fig. 4).

Material examined. One male, Androth Island, Lakshadweep, 10° 48.462' N 73° 41.906' E, depth 15 m, on *Phanogenia gracilis*, 23.10.2019, coll. N. Marimuthu (ZSI/C9052/2).

Short description. Rostrum terminating sub-acutely in the median lobe, lateral lobes serrated anteriorly. Carapace rounded, slightly broader with setae on transverse ridges. Larger cheliped without setae, smaller cheliped with setae on dorsal and dorsolateral margins, carpus armed with small spines and dactylus slender with acute spines on the dorsoflexor region. Second to fourth pereopod relative stout in the merus region, dactylus with slender extensor claw subequal in length.

Host. The present specimen was attached to the crinoids *Phanogenia gracilis*. However, it could have been possible that it has been collected from the sponge-covered site (M. Osawa, personal communication).

Distribution. Distributed throughout the Indo-Pacific region: Seychelles, Madagascar Thailand, HJava Sea, Moluccas, New Caledonia, Loyalty Islands, Taiwan including Red Sea, Gulf of Aden and Persian Gulf (Osawa and Chan 2010). Now from India.

Remarks. *Aliaporcellana pygmaea* is reported for the first time from India. It can be easily distinguished with its congener *A. kikuchii* Nakasone and Miyake 1969 by the shape of the rostrum and armature, shape of dactyli on ambulatory legs etc. (Osawa and Chan 2010).

Acknowledgements NM thank the Ministry of Environment, Forest and Climate Change, Government of India, the Director, Zoological

Survey of India and CF, Environment and Forest Department, UT Lakshadweep for the financial support and necessary entry permit to Lakshadweep archipelago. SP thank the authorities of Sathyabama Institute of Science and Technology, Chennai for the microscope facilities.

Author contributions Conceived, designed, and performed the surveys: NM, Identified the decapod crustacean specimens: SP, Wrote the paper: SP and NM.

Funding information Zoological Survey of India, Ministry of Environment, Forest and Climate Change, Government of India In-house program, “Fauna of Lakshadweep: Echinoderms (F.206 – 16/2019-20/Tech./13705/18.09.2019, F.206 – 17/2019-20/Tech./1096/20.01.2020)”.

Data Availability All data generated or analysed during this study are included in this article.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

Sampling and field studies All necessary permits (Administration of the UT Lakshadweep, Permit No. D/11/21/2019-COL/27.09.2019) for sampling and observational field studies have been obtained by the authors from the competent authorities and are mentioned in the acknowledgements, if applicable.

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Corallimorph sea anemone infestation in the coral reefs of Lakshadweep archipelago, India

Coral reefs have undergone a phase shift in several instances due to the dominance of soft corals, sea anemones or sponges^{1,2}. Such phase shifts could be triggered either by natural calamities or due to the anthropogenic disturbances that resulted in the reduction in coral cover and coral health³. One such instance has been documented recently (February 2021), during an intertidal survey along the reef edges (lagoon side) of Agatti Island, Lakshadweep, India. The dead corals, shells of giant clams and some live corals were infested by corallimorph sea anemone (Figure 1). These are invasive and naturally thrive in man-made or environmentally disturbed coral reef habitats⁴. They are considered as secondary colonizers that cover as a carpet the empty spaces of coral reefs. They are also resistant to pollutants and could be a po-

tential indicator for pollution studies⁵. The present corallimorph sea anemone species was identified as *Condylactis* sp. due to its typical brown colour, short tentacles with pink-coloured tips and oral disk diameter of 0.5–4 cm with mouth turned upside down, which are characteristic features of corallimorph sea anemones. Like other sea anemones, the corallimorph sea anemones also possess zooxanthellae inside their bodies to perform photosynthesis and provide nutrients to the host⁵. The present infestation of corallimorph sea anemones in Lakshadweep is only observational and subsequent damage to the coral reefs needs to be examined.

To the best of our knowledge, there are no reports on corallimorph sea anemone infestation in the Indian Ocean region. Previous reports on such infestations have

been observed only in Kenting National Park, southern Taiwan⁶ and Pacific Palmyra Atoll⁷. The outbreak of corallimorph sea anemones in Lakshadweep can be linked to the tropical cyclone 'Tauktae' that occurred in May 2021, affecting the entire west coast of India as well as Lakshadweep, Sri Lanka and the Maldives. Since the Lakshadweep reefs are more susceptible to increasing sea-surface temperature, coral bleaching events have been more prevalent in recent decades⁷. Further, the presence of several boats anchored in the nearby areas could be a reason for the increase in the leaching of iron from the propellers or anchors. The high density of corallimorph sea anemones found in the northwestern lagoon side of the Agatti Island indicates that they are rare or absent in the nearby coral areas of the lagoon as well as

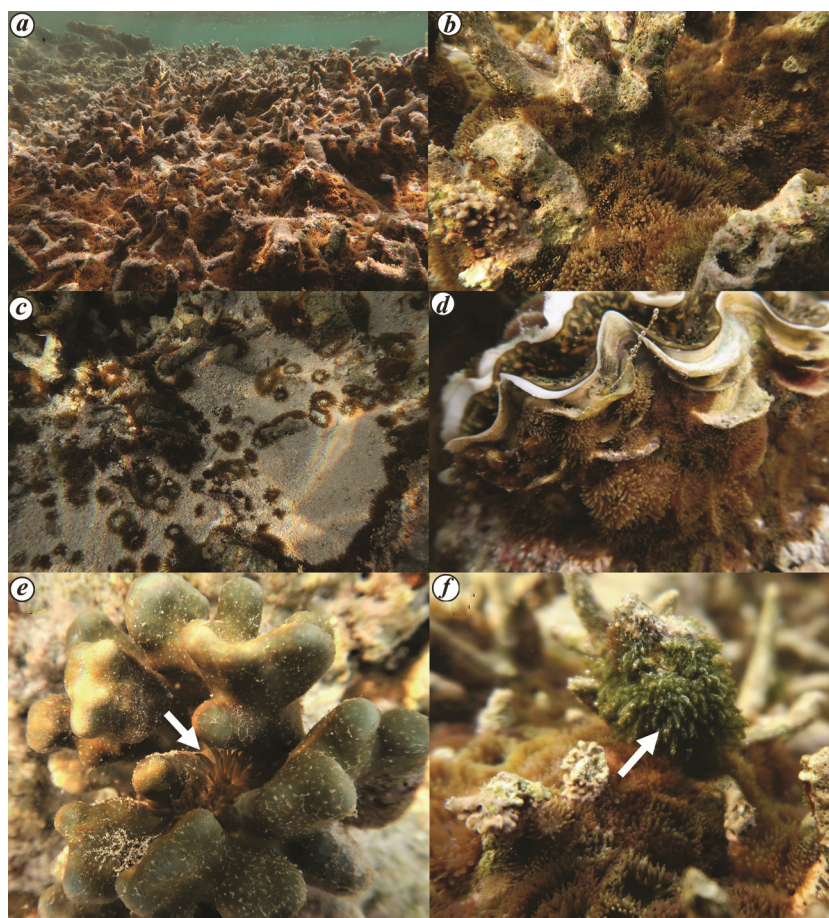


Figure 1. *a–c*, Corallimorph sea anemone (*Condylactis* sp.) infestation in the degraded coral reef areas in the northwestern lagoon side of Agatti Island, Lakshadweep, India. *d*, Sea anemone infesting the outer shells of live giant clam *Tridacna* sp. *e*, Corallimorph anemone (white arrow) thriving on the surface of live blue coral. *f*, Prevalence of green seaweed *Chaetomorpha* sp. (white arrow) adjacent to corallimorph sea anemone.

in outer reef slopes. *Condylactis* sp. infestation would lower the coral larval recruitment and eventually delay the recovery of associated communities⁶. In order to determine the risk of anemone infestation on the coral communities, conducting benthic surveys in the affected areas of Agatti Island is a prerequisite. Furthermore, a rapid survey needs to be undertaken in the other islands of Lakshadweep to better evaluate anemone infestation in the coral reef areas. Lastly, long-term ecological monitoring is warranted to ensure the recovery of coral and associated communities in the Lakshadweep archipelago.

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NEWS

Prof. A. K. Sood appointed Principal Scientific Advisor to the Government of India

Renowned physicist and Padma Shri awardee Ajay Kumar Sood has been appointed as the Principal Scientific Advisor (PSA) to the Government of India. He is currently a Distinguished Honorary Professor of Physics and Year of Science Professor at the Indian Institute of Science (IISc), Bengaluru, and is noted for his work on graphene and nanotechnology. He will take over as PSA from K. VijayRaghavan, the former director of the National Centre for Biological Sciences, who has been in the position since March 2018.

Since 2018, Sood has also been a member of the Prime Minister's Science, Technology, and Innovation Advisory Council (PM-STIAC). In November 1999, the government established the Office of the Principal Scientific Advisor. The office seeks to provide pragmatic and objective advice to the Prime Minister and his cabinet on matters related to science, technology, and innovation, with a focus on the application of science and technology in critical infrastructure, economic, and social sectors in collaboration with government departments, academia, and industry. The PM-STIAC is one of the catalysts for such activities and also oversees their implementation. The organization has nine key missions: Natural Language Translation, Quantum Fron-

tier, Artificial Intelligence, National Biodiversity Mission, Electric Vehicles, Bioscience for Human Health, Waste to Wealth, Deep Ocean Exploration, and Accelerating Growth of New India's Innovations (AGNI).

Sood is a holder of two US and five Indian patents and was awarded the Padma Shri in 2013 for his outstanding contributions to science. He has made extensive research in hard and soft condensed matter physics, focusing on Raman scattering and nanotechnology. He is recognized for several ground-breaking inventions and innovations that are considered to be of daily and scientific value. In 2003, he produced electrical impulses by passing liquids over solids or through nanotubes. This phenomenon is known as the 'Sood Effect' among the scientific community.

Sood was born on 26 June 1951 in Gwalior, Madhya Pradesh. He earned a Bachelor's degree in Physics from Panjab University, Chandigarh in 1971, and a Master's degree from the same university. He later went on to earn his Ph.D. from IISc in 1982. Between 1973 and 1988, he served as a scientist at the Indira Gandhi Centre for Atomic Research in Kalpakkam, Tamil Nadu, before undertaking post-doctoral research as a Max Planck Fellow at

the Max Planck Institute for FKF in Stuttgart, Germany. In 2015, Sood was elected a Fellow of the Royal Society (FRS). Since 2019, he has been on the Infosys Prize Physical Sciences jury. Sood has published over 450 peer-reviewed research articles and papers in national and international journals. He has earned over a dozen honours from various institutes for his numerous accomplishments. In 2000, the The World Academy of Sciences (TWAS) recognized Sood's contributions by awarding him the TWAS Prize in Physics. Among many other honours, he received the Shanti Swarup Bhatnagar Prize in 1990, the National Award in Nanoscience and Nanotechnology from the Government of India, the Nano Award from the Government of Karnataka, and the Vigyan Ratan Award from Punjab University. He is also one of the Executive Editors of an international journal, *Solid State Communications*. He was the President, Indian National Science Academy (2017–2019), Secretary General, The World Academy of Sciences (2013–2018) and President, Indian Academy of Sciences (2010–2012).

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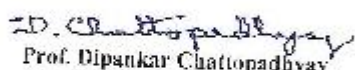
To Whom it may Concern

This is to certify that, Dr. Subhenjit Hazra, Scientist-C, Centre for Nanoscience and Nanotechnology, Sathyabama Institute of Science and Technology, Chennai-600119, has visited my Laboratory at Department of Polymer Science and Technology, University of Calcutta, 92, A.P.C. Road, Kolkata-700009 from 01-08-2022 to 28-10-2022 under INSA Visiting Scientist Scheme.

He performed joint research activity with my research group on Quantum dot based sensor for heavy metals. He also initiates molecularly imprinted polymer based sensor work which will be continuing in our active research collaboration.

The results obtained are promising and will be submitted for publication in near future. Apart from that, he discussed about concept of different sensors and device system for Environmental applications which will help to formulate joint collaborative R&D research proposal and publications.

We are looking forward to a long term productive research collaboration with Dr. Hazra and Sathyabama Institute of Science and Technology, Chennai in future.


Prof. Dipankar Chattopadhyay
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University of Calcutta,
92, A.P.C. Road, Kolkata- 700009,
West Bengal, India.

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Madhvendra Narayan
Assistant Executive Director – I

INSA/SP/VSF-36/2022-23/
12th May, 2022

Dr. Subhenjit Hazra,
Scientist C
Centre for Nanoscience and Nanotechnology,
SATHYABAMA Institute of Science and Technology,
Jopliar Nager, Rajiv Gandhi Salai,
Chennai-600119, Tamilnadu

Sub: INSA Visiting Scientist Programme, FY 2022-23.

Dear Dr. Hazra,

This is with reference to your application for INSA Visiting Scientist Programme 2022 for FY 2022-23. I am happy to inform you that you have been selected for this award under which you can visit the Institute as mentioned in your application for a period of 2 months on following terms conditions:

1. During the fellowship period you will be paid a consolidated amount of Rs. 30,000/- (maximum) per month to cover your expenses related to boarding, lodging, travel etc. At least one month of visit is required for claim.
2. Candidate selected as Visiting Scientist must avail this Fellowship on or before 31st January, 2023. The last date for submission of the Claim will be 15th March, 2023.
3. In case of any Change in Parent Institute, prior permission is to be obtained from INSA.
4. Grant will be release to Parent Institute on completion of the visit upon submission of Claim Bill (in duplicate) duly forwarded by Parent Institute along with UC/SOE as per enclosed proforma along with all supporting documents mentioned in the Claim Bill.
5. In case of on-line mode, no financial assistance will be provided by INSA.
6. The awardees are advised to avail Guest House/Hostel in any Institute/Govt. accommodation for boarding and lodging purpose.
7. A short report (2-3 typed pages) should be sent to the Academy immediately after completion of the visit along with a certificate of completion from the Host Institute.

Kindly communicate your acceptance.

With best wishes,

Yours sincerely,


(M Narayan)

Encl. Claim Bill & UC (also available on website)

Copy to:

1. Director, Department of Polymer Science & Technology, University of Calcutta, 92, A.P.C. Road, Kolkata- 700009, West Bengal, India



Construction of light-weight and flexible vanadium nitride coated graphite paper electrodes for supercapacitors

Ananthakumar Ramadoss^{1,2} · Ankita Mohanty² · K. Gobi Saravanan³ · Manab Kundu⁴ · Sohaila Z. Noby⁵ · K. Kirubavathi¹ · K. Selvaraju¹ · Lukas Schmidt Mende⁵

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Abstract

The energy storage devices for flexible/wearable and portable electronics are on immediate requirement demanding for high-performance flexible supercapacitors. Nevertheless, the real-time application of advanced electronics necessitates supercapacitors to own admirable mechanical properties to endure rigorous straining environments. Also, it is necessary to reduce the mass and volume of the whole device. Therefore, constructing a high-performance flexible supercapacitor based on better electrochemical and significant mechanical properties is still a formidable task. Herein, we have successfully fabricated a vanadium nitride thin film electrode onto the flexible, thin, and light-weight graphite paper substrate via reactive direct current (DC) magnetron sputtering method. The as-fabricated graphite sheets current collector is flexible, thin, light-weight, electrically conductive, cost-effective, and easy to fabricate. Furthermore, the as-prepared binder-free flexible negative electrode displayed better supercapacitor performance in terms of specific capacitance and cycle stability. The negative electrode exhibited an areal capacitance of 91 mF cm⁻² and better cycling stability with > 64% capacitance retention after 2000 cycles. Moreover, the flexible hybrid supercapacitor is fabricated with NiCo hydroxide and VN films and showed a maximum energy density of 1.80 μWh cm⁻² and power density of 387.5 μW cm⁻² and good stability. These results propose that the fabricated electrode has great prospective as a power source for flexible, wearable, and portable electronic devices.

Keywords Supercapacitor · Flexible · Light-weight · Thin · Vanadium nitride

Introduction

The excess use of highly advanced electronic devices has nearly utilized all the non-renewable energy sources in the modern generation. Therefore, renewable energies have become a reliable source of energy for the entire universe [1]. However, their unsymmetrical availability in nature is a major bottleneck in their use for real-time application. Thus, the realization of a sustainable energy storage device is of great interest to researchers in the present years. Electrochemical energy storage (EES) devices have been proved as very trustworthy in the past decades due to their tremendous energy and power density values. Among various EES devices, electrochemical capacitors or supercapacitors (SCs) have attracted much attention from researchers due to their ultrahigh power density and superior cyclic stability compared to batteries and capacitors [2, 3]. There are two kinds of materials for supercapacitor application and classified based on their energy storage mechanisms. Electric double-layer capacitors (EDLCs) include carbon-based

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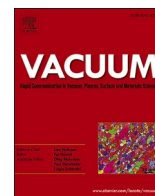
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Binder-free TiN/graphite based thin film negative electrode for flexible energy storage devices

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ABSTRACT

Transition metal nitrides are trustworthy electroactive materials due to their merits like good electrical conductivity, wettability, multi-oxidation state, and higher specific capacity than metal oxides and carbon materials. In the present work, titanium nitride is deposited over a highly flexible graphite substrate using physical vapour deposition process. The physiochemical studies confirmed the formation of TiN film over the graphite substrate and also exhibited flexible characteristics. The nitrogen content of the electrode provides considerable wettability to the electrode surface while having better conductivity. Noticeably, the as-fabricated negative electrode showed pseudocapacitive property with a good specific capacitance of 86 mF cm^{-2} at 1 mA cm^{-2} and stable cycling performance with 80% capacitance retention even after 3000 cycles at 3 mA cm^{-2} . The results of this study demonstrate that these metal nitrides can be considered as an alternative negative electrode for supercapacitor applications.

1. Introduction

With the fast development of the electronic world, flexible, lightweight, and portable electronic devices are essential for energy storage applications which instigated the researchers to shift their focus on energy storage devices like batteries and supercapacitors. This led to the development of supercapacitors which have better energy density, power density, and long-life durability than rechargeable batteries [1–4]. These supercapacitors are mostly fabricated with carbon cloth, metal foils, carbon papers, and graphite paper substrates, which are commonly used as wearable electronic devices [5–7].

Though supercapacitors are capable of storing more energy as compared to conventional capacitors, their energy density value is relatively lower, limiting their practical applications. So, the development of supercapacitors having good energy density and power density

is a major challenge in the present scenario. Therefore, in recent years, many such research works have been devoted to synthesize suitable electrode materials and couple them to fabricate high-performance asymmetric supercapacitors. In this regard, a wide choice of materials such, as MnO_2 [8], Co_3O_4 [9], CeO_2 [10], RuO_2 [11], and SnO_2 [12] has been utilized as positive electrodes. In contrast, the negative electrodes are mainly limited to carbon-based materials that exhibit low specific capacitance. On the other hand, transition metal oxides such as Bi_2O_3 [13], MoO_3 [14], and Fe_2O_3 [15] are some of the popular electrode materials used in supercapacitors that can effectively perform in a negative potential window, but they suffer from poor electronic conductivity and structural stability [16–18]. Thus, alternative electrode materials with higher capacitance and good conductivity should be developed. Transition metal nitrides (TMNs) have proved to be promising electrode materials in energy storage applications to fulfill this

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TAMIL NADU VETERINARY AND ANIMAL SCIENCES UNIVERSITY



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To

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Sub: Letter of Providing Advice and Expertise-Reg.

Dear Sir,

As I was requested by the **Dr. T. Sasipraba**, Vice Chancellor, Sathyabama Institute of Science and Technology, Chennai. I am willing to provide the advice based on my expertise to execute the proposed project entitled "**Sustainable Livelihood Development through Technology Assisted Indigenous Backyard Poultry Farming and Conversion of Value-Added Products**" DST/SEED/SCSP/STI/2021/882, in the field of poultry farming and food and nutrition to the Principal Investigator (Dr. Anandan Dayanandan) and its team.

Thanking you

With Regards

Dr. R. Richard Churchill

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3.7.1: RESEARCH

Journal of Cleaner Production

Volume 396, 10 April 2023, Article number 136386

Aquatic biomass cellulose fabrication into cellulose nanocomposite and its application in water purification(Review)

Namasivayam, S.K.R., Prakash, P., Babu, V., Paul, E.J., Bharani, R.S.A., Kumar, J.A., Kavisri, M., Moovendhan, M. 

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Abstract

The combination of nanotechnology principles and membrane technology has gained more attention in waste water remediation owing to the high efficiency of toxicants removal, unique physico chemical properties and biodegradability. This current work offers a wide and accurate overview of nanocellulose acetate membrane technology for waste water treatment efficacy. In this review, we described nanocellulose acetate membrane synthesis through electrospinning process and its potential role in waste water remediation. In particular, extraction of cellulose from lignocellulosic invasive aquatic weeds biomass wastes, conversion of extracted cellulose into cellulose acetate followed by fabrication with bio active metallic nanoparticles via electrospinning process were discussed. Most significantly, the factors influencing the electrospinning process, efficacy testing methods and the role of water treatment process were described. The present study suggests the sustainable approach of managing hazardous invasive aquatic weeds into composite membrane utilizing green nanotechnology principles with waste water treatment efficacy. In future, the nanocellulose composite that synthesised by the above described green nanotechnology principles can be used in waste water treatment process by showing higher separation or removal of organic and inorganic contaminants with eco-friendly and low operation costs. © 2023 Elsevier Ltd

Author keywords

Adsorption Aquatic biomass CA membrane Cellulose Nanocomposite Nanofiltration

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A Comprehensive Review on Nontronite-Chitosan Based Nanocomposites (A Review)

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Published: 11 July 2022

Green Synthesis of Chitosan–Selenium Bionanocomposite with High Biocompatibility and Its Marked Impact on Las B and RhII Genes Expression in *Pseudomonas aeruginosa*

S. Karthick Raja Namasivayam , Mohideen Nizar, K. Samrat, A. V. Sudarsan, C. Valli Nachiyar & R. S. Arvind Bharani

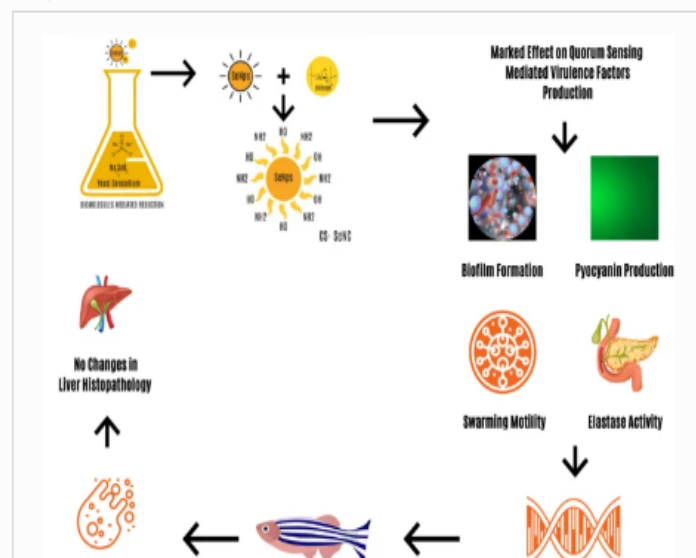
Journal of Inorganic and Organometallic Polymers and Materials 32, 4186–4203 (2022) | [Cite this article](#)

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Abstract

In this present study, quorum quenching activity (QQ) of chitosan–selenium bionanocomposite with high biocompatibility was investigated. QQ activity was studied in *Pseudomonas aeruginosa* by measuring the expression level of Las B and RhII genes. Impact of gene expression on the major virulence factors production was also evaluated. Relative gene expression of both the genes was significantly reduced in all the dosages of CS–SeNC treatment, with subsequent reduction in the production of all the tested virulence factors. Biocompatibility of the nanocomposite was checked in zebrafish model which reveals that the administrated nanocomposite was not shown any undesirable effect on apoptosis, oxidative stress gene expression and liver histology. The present study implies that CS–SeNC prepared by in situ green science principles is a promising antibacterial agent against multiple drug-resistant bacterial strains, which exhibit an antagonistic effect by inhibiting the molecular mechanism of pathogenesis with noteworthy biocompatibility.

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SN Applied Sciences



Article

Evaluation of the Toxic Effect of *Bauhinia purpurea* Mediated Synthesized Silver Nanoparticles against *In-vitro* and *In-vivo* Models

Nagarajan Shobana ¹, Pandurangan Prakash ^{1,*}, Antony V. Samrot ^{2,*}, Subramanian Saigeetha ³, Mahendran Sathiyasree ¹, Rajendran Thirugnanasambandam ⁴, Sridevi Visvanathan ⁵, Basanta Kumar Mohanty ⁶, Gokul Shankar Sabesan ⁶, Shanmugaboopathi Dhiva ⁷, Rajan Renuka Remya ⁸, Senthilkumar Pachiyappan ⁹ and Samraj Wilson ¹⁰

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Abstract: Metal nanoparticles, such as gold nanoparticles, silver nanoparticles, etc., have many benefits and have been in use for a very long time. Nevertheless, a number of concerns have been raised about the environmental impact and the possibility of exposure to various living systems at the moment. Thus, in this study, silver nanoparticles were synthesized by using plant gum from *Bauhinia purpurea* and characterization was done using UV—Visible Spectroscopy, Scanning Electron Microscopy, X—ray Diffraction, etc. To determine the accumulation and toxic effects caused by the nanoparticles, *Eudrilus eugeniae*, *Danio rerio*, and their embryos were exposed to the synthesized silver nanoparticles and evaluated using microscopic observation, histology, and Inductively Coupled Plasma Optical Emission Spectrometry (ICP—OES).

Keywords: metal nanoparticles; nanotoxicity; plant gum

1. Introduction

Nanotechnology has emerged as one of the most promising technologies in a variety of fields. Metal nanoparticles have higher electrical conductivity, roughness, and can strengthen metals and alloys which can be used in fields such as medicinal, agricultural, environmental, and physiochemical [1,2]. The antiviral or antibacterial effect of nanoparticles is influenced by their size, capping agent, and composition [3]. The large surface area and smaller particle size of the nanoparticles allow them to be employed in the techniques used for detecting viral infection, such as RT—PCR, ELISA, and RT—LAMP [4]. Chemical composition and reaction conditions (e.g., temperature and pH) can be adjusted to change



Nanotoxicity studies of *Azadirachta indica* mediated silver nanoparticles against *Eudrilus eugeniae*, *Danio rerio* and its embryos

N. Shobana^a, P. Prakash^a  , Antony V. Samrot^b  , S. Saigeetha^c, M. Sathiyasree^a, R. Thirugnanasambandam^d, Visvanathan Sridevi^e, Mohanty Basanta Kumar^f, Sabesan Gokul Shankar^g, S. Dhiva^g, R.R. Remya^h

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Abstract

Improper handling and discarding of metal nanoparticles into the ecosystem can lead to nano-pollution affecting the biota of the environment. This study was performed to understand the possible negative impacts of the silver nanoparticles for which silver nanoparticles were synthesized using plant gum from *Azadirachta indica*. The synthesized silver nanoparticles were characterized by UV–Visible Spectroscopy, Fourier-Transform Infrared Spectroscopy, X-ray powder Diffraction, Scanning Electron Microscopy, and Zeta Potential analysis. The silver nanoparticles were crystalline and spherical in shape and the size was found to be around 40–70nm. The toxic effects of *Azadirachta indica* gum based biogenic silver nanoparticles of different concentration (10µg and 20µg) *in vivo* against *Eudrilus eugeniae*, *Danio rerio* and its embryos were assessed, where it was found to damage the epidermis of gut and clitellum of the earthworm. It was found to cause gut erosion in zebrafishes depicting the toxicity. In the case of the embryos, it delayed the embryogenesis and organ deformities were observed. As the concentration of the nanoparticles, the damage in the organisms also increased indicating that it was concentration dependent impact.

Introduction

Nanoparticles have unique properties due to their size, shape, and morphology (Siddiqi et al., 2018). Noble metallic nanoparticles such as silver, gold, cadmium, platinum, zinc, etc have evolved in recent years and are considered to have many benefits (Bhattacharya and Mukherjee, 2008). Nanoparticles have been appreciated in the fields of pharmacy, medical science, energy, medicine, nutrition, etc (Jamkhande et al., 2019). Metal nanoparticles are used as an ingredient in daily-use product such as cosmetics, toothpaste, soaps, shampoos, detergents, medicines, and even pharmaceutical drugs (Bhattacharya and Mukherjee, 2008). Gold nanomaterials play a major part in drug

3.7.1: RESEARCH

Environmental Research

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Magnetic Co/CoOx@NCNT catalysts for activation of potassium peroxymonosulfate to deteriorate phenol from wastewater(Article)

Deena, S., Vedanayaki, S., Sathish, T., Dao, M.U., Rajasimman, M., Saravanan, R., Prakash, P.  

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Abstract

Phenols are of much toxicological and they must be effectively removed from the wastewater from industries as well as sewage treatment. Such removal demands a special and strong composite. So, this piece of research aims to activate Potassium peroxymonosulfate (PPMS) with the large surface area of magnetite nitrogen-fixed porous carbon nanotube composites (Co/CoOx@NCNT). Increases in the graphitization degree and structural control brought about by the incorporation of reduced Graphite oxide (rGO) significantly increased the catalyst activity of Co/CoOx@NCNT. It was found that PPMS activation for phenol removal by Co/CoOx@NCNT was nearly as effective as by homogeneous Co²⁺, with nearly 100% removal efficiency in 10 min. Both high reusability and high recycling of Co/CoOx@NCNT were accomplished simultaneously by proving the technology of viability in practical applications. The PPMS activation mechanism in the Co/CoOx@NCNT/PPMS system was driven by the electron transmission from contaminants to PPMS through the sp²-hybrid carbon nanotubes and nitrogen system. The selectivity of the Co/CoOx@NCNT/PPMS system to remove diverse organic compounds was determined by batch experiments. Due to the insignificant impact of radicals reactive on pollutant breakdown, the ability to inhibit species (such as Cl⁻ and natural organic materials) from a minor role was significantly decreased. These results not only shed light on the process of PPMS heterogeneous activation but also provided a framework for the balanced project of highly effective nanocarbon-based catalysts for PPMS activation. © 2022 Elsevier Inc.

Author keywords

Carbon nanotubes Catalysts Magnetite Phenol Potassium peroxymonosulfate

Indexed keywords

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carbon nanotube cobalt derivative composite nanoparticle graphite histidine
magnetic nanoparticle metal oxide nanoparticle nitrogen phenol potassium derivative
reactive oxygen metabolite organic compound peroxymonosulfate phenol
phenol derivative wastewater

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Research Article

Chitosan/Alginate Nanocomposite with Fe Nanoparticles for the Efficient Removal of Hexavalent Chromium Pollutant

Mahmoud Kandeel^{1,2}, S. Latha,³ Kumaran Subramanian^{3,4}, D. Rennita,³ Rajasekar Thirunavukkarasu,³ V. Ramesh,⁴ Guru Prasad Srinivasan,⁵ and Abdullah I. Al-Mubarak⁶

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Biopolymers and nanomaterials are an excellent choice for removing heavy metals and keeping the environment clean. The hexavalent chromium (Cr^{6+}) (or) chromium-6 is usually produced by various industrial processes, which can be a toxic liquid pollutant. In this study, a nanopolymeric compound supplemented with Fe nanoparticle was used in the extraction (removal) process of Cr^{6+} present in the aqueous solutions. Two biopolymers were blended and connected (using a microemulsion process) to produce nanoparticles (Chit/Alg NPs), and the nanoparticles have an average size of 311.2 nm with a negative charge of 23 and 2 mV. During synthesis, the red cabbage extract was also used to make iron nanoparticles (Fe-NPs), and these Fe-NPs had semispherical species with a diameter of 21.4 nm. The nanopolymeric compound was loaded and equally distributed with chitosan and alginate (Chit/Alg) NPs and synthesized Fe-NPs. The assessment using batch adsorption assays showed that both nanocomposites exhibited more ability than the Cr^{6+} adsorbents under various conditions (e.g., pH, initial ion concentration, adsorbent volume, and contact time (CT)). At the start, the initial Cr^{6+} concentration was 75 ppm, and the most effective adsorption condition was found at 5.0 pH, the adsorbent capacity was 4 g/L, and the CT was 210 min. These documented results show that Cr^{6+} may be completely removed from bulk testing. Therefore, the use of these composite nanopolymers (Chit/Alg NPs) combined with the synthesized Fe-NPs can be extrapolated for use in the aquatic milieu for the removal of Cr^{6+} .

1. Introduction

Nanotechnology is a remarkably new and rapidly evolving technology with a wide variety of processes, including the creation and use of objects of one or more sizes ranging from 1 to 100 nm. A series of physicochemical techniques are now used for the synthesis of nanoparticles (NPs) [1]. Nanoparticles (NPs) have a width of 1–100 nm function as a link between masses and atomic or molecular structures. Nanoparticles have a unique and attractive criterion of being small in size making them

easy to handle and have larger surface area with free hanging bonds and high performance [2]. Nanotechnology has been described as the scientific art of deciphering atoms and the atomic molecules. As a result, nanotechnology will bring a promising change of new and unique developments in the field of environmental protection. Nanotechnology, by far, has been developed as a very powerful tool in assisting researchers in the diagnosis, treatment, and prevention of life-threatening diseases, such as cancer, etc. However, the consequent potential for toxicity and the application of nanomaterials has been tightly

Research Article

Kumaravel Kaliaperumal, Kumaran Subramanian, Rajasekar Thirunavukkarasu, Ramesh Kumar Varadharajan, Reem Binsuwaidan, Nadiyah M. Alabdallah, Nawaf Alshammari, Mohd Saeed, Krishnan Anbarasu, and Rohini Karunakaran*

Antibacterial wound dressing with hydrogel from chitosan and polyvinyl alcohol from the red cabbage extract loaded with silver nanoparticles

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received February 27, 2023; accepted April 20, 2023

Abstract: The aim of the present study was the synthesis of hydrogel incorporated with chitosan blend with polyvinyl alcohol (PVA) from red cabbage *Brassica oleracea* and its application in wound healing and antibacterial activity. The chitosan/PVA hydrogel was synthesized by the combination of chitosan and PVA treated with acetic acid. The silver nanoparticles (AgNPs) were synthesized from the *B. oleracea* extract and its antibacterial efficacy was examined. The synthesized nanoparticles (NPs) were characterized using UV-spectroscopy and X-ray diffraction

methods. The synthesized NPs were purified and combined with the hydrogel. This combined hydrogel and AgNP mixture was then subjected to Fourier transform infrared analysis, and the results were observed to conclude the effectiveness of the hydrogel. This hydrogel would differ in the part of dressing the wound, that is it can last on the wound for a longer period, thus reducing the pain and frequency of dressing and in turn naturally healing the wound in less time.

Keywords: nanomaterials, silver nanoparticle, PVA, red cabbage, *Brassica oleracea*

1 Introduction

The first line of defense for the human body is the skin, which can be easily damaged by trauma, surgery, and burns [1]. The skin acts as a protective barrier which is vital in preventing wounds [2]. An ideal clinical wound covering should have mechanical strength, flexibility, and the ability for wound exudate absorbance, and should not stick onto the surface of wounds [3]. Traditional wound dressings are still the best sellers in the market because the use of novel wound coverings, including foams, nanofibers, and hydrogels, is in high demand as they provide anti-infective, anti-inflammatory, and pro-wound healing properties [4]. Hydrogels have been used successfully in numerous biomedical applications and act as a substitute extracellular matrix in creating a moist environment to promote the wound-healing process [5–8]. Several methods have been used to fabricate hydrogels, such as using gamma and UV rays and the freeze-thaw process [9]. Different biopolymers have been used in the synthesis of the hydrogel wound dressing. For instance, chitosan and polyvinyl alcohol (PVA) are mostly used in hydrogels because of their biocompatibility, low price, and non-toxicity [10].

Recently, the nanocomposites have been prepared by the incorporation of some NPs such as Ag and ZnO into

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3.7.1: RESEARCH

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Chapter 6

Extraction and Purification of Bioactive Ingredients from Natural Products

Swetha Sunkar, G. Ranimol, Jayshree Nellore, C. Valli Nachiyar, S. Karthick Raja Namasivayam, K. Renugadevi

Book Editor(s): Preetha Balakrishnan, Sreerag Gopi

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Summary

The role of bioactive compounds from natural sources such as plants, microbes, and animals in disease treatment is evident from time immemorial. Plants are known to act as saviors for a number of human health disorders as they house innumerable compounds as secondary metabolites that exhibit extraordinary potential in healing many diseases. These natural compounds belong to various classes and display unique properties structurally and functionally due to which they display numerous bioactivities. Their usage as a proper medicine demands their separation and purification with no contamination. A wide variety of methods exist to separate and purify the compounds and the current technological advancements led to categorizing them into conventional and modern methods. Conventional methods are simple, low cost, and use solvents for extraction while modern methods are complex, costly, and based on the properties of the compounds. This chapter focuses on the various techniques involved in extraction and purification of several bioactive compounds from natural products.



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3.7.1: RESEARCH



Chapter 1

Nutritional Supplements in Health Care

Iffath Badsha, C. Valli Nachiyar, S. Karthick Raja Namasivayam, K. Renugadevi, Swetha Sunkar, Jayashree Nellore

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Summary

Human body is composed of biomolecules, the building blocks of the body which come mainly from the food we take. Utmost care is needed in balancing the diet for the well-being of life. Tripping this balance will manifest as a diseased condition. Urbanization has led to a faster life style in which lesser importance is given for balanced diet. Another reason is poverty/nonavailability, which leads to malnutrition. These problems can be overcome with the knowledge of nutrient requirements for a healthy life. This review summarizes the nutrient supplements, global need, global market, effect of malnutrition, effect of nutritional supplements at different stages, and at different conditions of life.



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3.7.1: RESEARCH

Chapter 13

Polylysine

Natural Peptides as Antimicrobial Agents. A Recent Scenario in Food Preservation

Iffath Badsha, S. Karthick Raja Namasivayam, C. Jayaprakash, C. Valli Nachiyar, R. S. Arvind Bharani

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Summary

Consumers have been consistently concerned about possible adverse health effects from the presence of chemical additives in their foods. As a result, consumers are drawn to natural and fresher foods with no chemical preservatives added. This perception has stimulated research interest in finding natural but effective preservatives. Use of natural or controlled microbiota or antimicrobials as a way of preserving food and extending its shelf life is termed as biopreservation. The biopreservation of food, especially utilizing lactic acid bacteria (LAB) that are inhibitory to food spoilage microbes, has been practiced since early ages. Beneficial bacteria or the fermentation products produced by these bacteria are used in biopreservation to control spoilage and render pathogens inactive in food. Followed by bacteriocin, poly- L -lysine and its derivatives have gained recent attention in food sector and used as preservative in diverse food products. They are watersoluble, edible, and nontoxic with respect to the environment and humans. In



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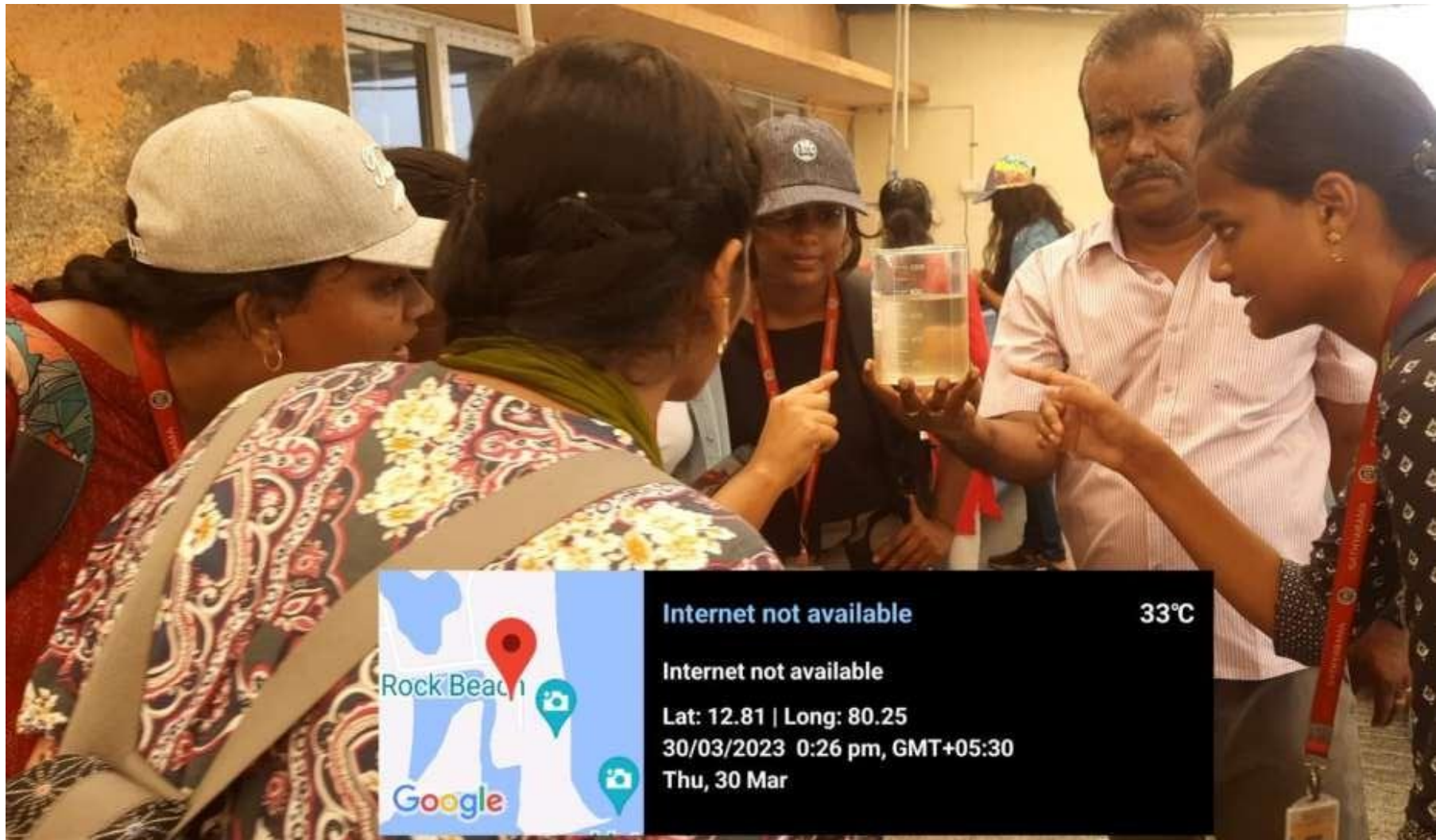
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In vitro and *in situ* growth characteristics and behaviour of spoilage organisms associated with anaerobically stored cooked meat products

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