

SYNTHESIS OF METAL NANOPARTICLES FOR WASTE WATER TREATMENT

PROJECT WORK

**Submitted in partial fulfillment of the requirements for the award of Bachelor of
science degree in Biotechnology**

by

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DEPARTMENT OF BIOTECHNOLOGY

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

**Accredited with Grade "A++" by NAAC | 12B Status by UGC | Approved by AICTE
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **YEDIDHA SRI ALEKHYA (41770037)** who carried out the project entitled "**SYNTHESIS OF METAL NANO PARTICLES FOR WASTEWATER TREATMENT**" under our supervision from December 2023 to April 2024


Internal Guide

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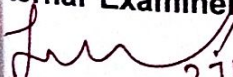


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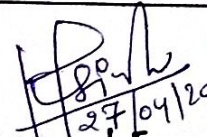
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DECLARATION

I am YEDIDHA SRI ALEKHYA (41770037) hereby declare that the Project Report entitled " **SYNTHESIS OF METAL NANO PARTICLES FOR WASTE WATER TREATMENT** " done under the guidance of DR.DEVI, assistant professor at Department of Biotechnology at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

DATE: 27/04/2024

PLACE: CHENNAI

A handwritten signature in black ink, appearing to read 'Sri Alekha', with a horizontal line underneath.

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Nanoparticles, tiny structures with dimensions typically less than 100 nanometers, are revolutionizing various fields due to their unique properties. These minuscule entities possess extraordinary characteristics, distinct from their bulk counterparts, owing to their size and high surface area-to-volume ratio. Graphene oxide is a derivative of graphene, a two-dimensional material consisting of a single layer of carbon atoms arranged in a hexagonal lattice. Graphene oxide is produced from graphene through a chemical oxidation process, which introduces oxygen-containing functional groups such as epoxides, hydroxyls, and carboxyls onto its surface. Graphene oxide serves as a precursor for the production of reduced graphene oxide (rGO), which involves the removal of oxygen functional groups, resulting in a material with properties more similar to pristine graphene. This reduction process restores some of the electrical and mechanical properties lost during oxidation, further expanding the applications of graphene-based materials. The nanosheets are formed by the pineapple peel powder and fresh such as the pineapple peel is act as a rGO. Then synthesis the rgo with FESEM, EDAX, UV from the chracterization techniques. But the fresh peel nanosheets are formed better. Then first rGO reduced and used for dye degradation of crystal violet. Then the graphene sheets are reduced Degration of nanosheets.

KEY WORDS – GO, Pineapple peel , FESEM, EDAX, UV

TABLE OF CONTENTS

CHAPTER NO.	TITTLE	PAGE NO.
	Abstract	v
	List of figures	x
	List of tables	xi
1.	Introduction	1
	1.1 Nanoparticles	1
	1.2 Dye degradation	1
	1.2.1 Chemical reactions	1
	1.2.2 Biological processes	1
	1.2.3 Physical processes	2
	1.2.4 Photodegradation	2
	1. 2.5 Combination approaches	2
	1.3 Types of dye degradation	2
	1.3.1 Photodegradation	2
	1.3.2 Oxidative degradation	2
	1.3.3 Thermal degradation	2
	1.3.4 Chemical degradation	3
	1.3.5 Biodegradation	3
	1.3.6 Hydrolytic degradation	3
	1.3.7 Mechanical degradation	3
	1.4 waste water treatment	3
2.	Literature survey	5
	2.1 Green Reduction of Graphene Oxide Involving Extracts of Plants from different	5

Taxonomy Groups

2.2 Biological Reduction of Graphene Oxide
Using Plant Leaf Extracts 5

2.3 Synthesis and Toxicity of Graphene Oxide
Nanoparticles 7

2.4 Challenges of using natural extracts as
green reducing agents in the synthesis of rGO 8

2.5 Chemical reduction of graphene oxide
using green reductants 9

2.6 Synthesis and Characterization of Reduced
Graphene Oxide (rGO) Started from Graphene
Oxide (GO) Using the Tour Method with
Different Parameters 9

3. Aim and scope 10

3.1 Aim 10

3.2 Objectives 10

4. Experimental 11

4.1 Materials and methods 11

4.2 Synthesis of GO 11

	4.3 Preparation of rGO	11
	4.4 Dye degradation	12
5.	Results and discussion and performance analysis	13
6.	Sumarry and conculsion	22
	References	25

ABBREVIATIONS

NPs - Nanoparticles

GO - Graphene oxide

rGO - Reduced Graphene Oxide

CHAPTER NO	LIST OF FIGURES	PAGE NO
5.1	Before the stirrer	13
5.2	After the stirrer	13
5.3	Centrifuge	14
5.4	Collection of pellet	15
5.5	Preparation of rGO	16
5.6	FESEM results	17
5.7	FESEM results	18
5.8	EDAX	19
5.11	Dye Degradation	21

TABLE NO

LIST OF TABLES

PAGE NO

5.10

Map sum of spectrum

20

CHAPTER-1

INTRODUCTION

1.1 NANOPARICLES

Nanoparticles are incredibly tiny particles, usually around one and one hundred nanometers in size, having dimensions on the nanometer scale. One billionth of a meter is equal to one nanometer, to put that into perspective. Metals, metal oxides, polymers, and carbon-based materials are just a few of the materials that can be used to create these particles.

The small size and high surface area-to-volume ratio of nanoparticles make them different from their bulk counterparts in terms of special features. Because of these properties, nanoparticles are extremely adaptive and helpful in a variety of sectors, such as energy, environmental cleanup, electronics, and medicine. Nanoparticles, with their minute size and remarkable properties, find applications across diverse fields, propelled by their unique characteristics. One notable feature is their size-dependent properties, where as dimensions shrink to the nanoscale, distinct physical and chemical attributes emerge. In biomedicine, nanoparticles play a pivotal role in drug delivery systems, owing to their ability to penetrate tissues and cells efficiently. They enable targeted therapy, reducing side effects while enhancing treatment efficacy. Additionally, in diagnostic imaging, nanoparticles serve as contrast agents, aiding in the detection of diseases like cancer with heightened precision. The field of electronics benefits immensely from nanoparticles, particularly in the fabrication of conductive inks and transparent conductive films. Moreover, nanoparticles are integral to the development of optoelectronic devices such as LEDs and solar cells, leveraging their tunable optical and electronic properties. In environmental applications, nanoparticles contribute to pollution detection and remediation efforts, showcasing their catalytic prowess in breaking down contaminants and purifying water sources. Furthermore, the food industry utilizes nanoparticles for enhancing packaging materials and food additives, bolstering food safety and quality. Despite their myriad applications, concerns surrounding nanoparticle toxicity and environmental impact necessitate ongoing research to ensure their safe utilization across various sectors. Thus, while nanoparticles offer unparalleled versatility and promise, their responsible integration demands a nuanced understanding of their properties and implications.

1.2 DYE DEGRADATION:

The principle of dye degradation revolves around breaking down complex dye molecules into simpler, less harmful substances. This can be achieved through various processes, including

1. 2.1 *Chemical reactions*

Chemical agents or catalysts can be used to facilitate the breakdown of dye molecules into smaller fragments through processes such as oxidation, reduction, or hydrolysis.

1.2.2 *Biological processes*

Microorganisms such as bacteria, fungi, or algae can metabolize dye molecules as a source of energy or carbon, converting them into simpler compounds through enzymatic reactions.

1.2.3 *Physical processes*

Mechanical agitation, such as mixing or ultrasonic treatment, can help disperse dyes and increase their contact with other degrading agents, facilitating their breakdown.

Overall, the principle of dye degradation aims to mitigate the environmental and health risks associated with dye pollution by reducing the persistence and toxicity of dye molecules in the environment.

1.3 WASTE WATER TREATMENT

Wastewater treatment is an essential process that keeps the environment and human health safe by eliminating impurities and pollutants from industrial and sewage effluents before they are released into natural water bodies. The procedure consists of several steps, each of which targets a different type of contamination using physical, chemical, and biological treatments. Larger particles and solids are first removed by physical techniques like screening and sedimentation; suspended solids and organic debris are then removed by later chemical processes like flocculation and coagulation. By using techniques like biological filters or activated sludge, biological treatment uses microorganisms to break down organic contaminants into simpler, less hazardous chemicals. The treated water is further refined using cutting-edge methods including membrane filtering and UV disinfection to guarantee that its quality satisfies legal requirements. Furthermore, Before being safely disposed of or reused, the sludge produced during treatment is subjected to additional processing, such as digestion and dewatering. There are still issues with wastewater treatment technologies, such as the need to remove newly discovered pollutants and the energy-intensive nature of some treatment techniques. In order to solve these issues and create long-term solutions for efficient wastewater treatment, which encourage prudent water resource management and environmental preservation, more research and innovation are needed. Wastewater treatment is a collective term for an array of treatments intended to efficiently extract impurities and pollutants from sewage and industrial effluents. These procedures fall into three general categories: chemical, biological, and physical. Mechanical methods are used in physical treatment methods including screening and sedimentation to remove big particles and waste. Chemicals are added during chemical treatments, including in oxidation, flocculation, and coagulation, to help in the precipitation or breakdown of suspended and dissolved pollutants. Through aerobic or anaerobic digestion, microbes are used in biological treatment methods to break down organic contaminants into less toxic, less complicated molecules. Based on the physical characteristics of the wastewater and the intended treatment results, specific methods, such as membrane bioreactors, trickling filters, and activated sludge, are

used within these categories. Furthermore, advanced Reverse osmosis, membrane filtration, and UV disinfection are a few treatment techniques that can be used to further purify the treated water while maintaining compliance with strict legal requirements. In order to produce treated effluent that is safe for discharge or reuse and so reduce environmental pollution and safeguard public health, the right treatment methods must be chosen based on a number of factors, including the wastewater's composition, treatment objectives, and available resources.

CHAPTER-2

LITERATURE SURVEY

2.1 GREEN REDUCTION OF GRAPHENE OXIDE INVOLVING EXTRACTS OF PLANTS FROM DIFFERENT TAXONOMY GROUPS

Graphene, a remarkable material, is ideal for numerous applications due to its thin and environmentally friendly manner continues to be a significant challenge. Chemical reduction is considered the most advantageous method for preparing reduced graphene oxide (rGO). However, this process necessitates the use of toxic and harmful substances, which can have a detrimental effect on the environment and human health. Thus, to accomplish the objective, the green synthesis principle has prompted researchers worldwide to develop a simple method for the green reduction of graphene oxide (GO), which is readily accessible, sustainable, economical, renewable, and environmentally friendly. For example, the use of natural materials such as plants is generally considered safe. Furthermore, plants contain reducing and capping agents. The current review focuses on the discovery and application of rGO synthesis using extracts from different plant parts. The review aims to aid current and future researchers in searching for a novel plant extract that acts as a reductant in the green synthesis of rGO, as well as its potential application in a variety of industries. (Dharshini Perumal *et al.*,)

2.2 BIOLOGICAL REDUCTION OF GRAPHENE OXIDE USING PLANT LEAF EXTRACTS

Two-dimensional graphene has attracted significant attention due to its unique mechanical, electrical, thermal, and optical properties. Most commonly employed methods to chemically reduce graphene oxide to graphene use hydrazine or its derivatives as the reducing agent. However, they are highly hazardous and explosive. Various phytochemicals obtained from different natural sources such as leaves and peels of a plant are used as reducing agents in the preparation of different gold, silver, copper, and platinum nanoparticles. In this study, seven plant leaf extracts (Cherry, Magnolia, Platanus, Persimmon, Pine, Maple, and Ginkgo) were compared for their abilities to reduce graphene oxide. The optimized reaction conditions for the reduction of graphene oxide were determined as follows. Type of plant: Cherry (*Prunus*

serrulata), reaction time: 12 h, composition of the reaction mixture: 16.7% v/v of plant leaf extract in total suspension, and temperature: 95 °C. The degree of reduction caused by Cherry leaf extract was analyzed by elemental analysis and X-ray photoelectron spectroscopy. The reduction of graphene oxide was also confirmed by ultraviolet-visible spectroscopy, Fourier transform-infrared spectroscopy, Raman spectroscopy, X-ray diffraction, transmission electron microscopy, and thermogravimetric analysis. (Geummi Lee , Beom Soo Kim, 2013)

2.3 SYNTHESIS AND TOXICITY OF GRAPHENE OXIDE NANOPARTICLES: A LITERATURE REVIEW OF IN VITRO AND IN VIVO STUDIES

Nanomaterials have been widely used in many fields in the last decades, including electronics, biomedicine, cosmetics, food processing, buildings, and aeronautics. The application of these nanomaterials in the medical field could improve diagnosis, treatment, and prevention techniques. Graphene oxide (GO), an oxidized derivative of graphene, is currently used in biotechnology and medicine for cancer treatment, drug delivery, and cellular imaging. Also, GO is characterized by various physicochemical properties, including nanoscale size, high surface area, and electrical charge. However, the toxic effect of GO on living cells and organs is a limiting factor that limits its use in the medical field. Recently, numerous studies have evaluated the biocompatibility and toxicity of GO in vivo and in vitro. In general, the severity of this nanomaterial's toxic effects varies according to the administration route, the dose to be administered, the method of GO synthesis, and its physicochemical properties. This review brings together studies on the method of synthesis and structure of GO, characterization techniques, and physicochemical properties. Also, we rely on the toxicity of GO in cellular models and biological systems. Moreover, we mention the general mechanism of its toxicity. (Asmaa Rhazouani *et al.*,)

2.4 CHALLENGES OF USING NATURAL EXTRACTS AS GREEN REDUCING AGENTS IN THE SYNTHESIS OF RGO: A BRIEF REVIEW

Reduced graphene oxide (rGO) has attracted much attention because of its high thermal conductivity, electrical properties, Young's modulus, mechanical strength, optical transmittance as well as theoretical areas. This material is widely used for various applications and normally produced by the reduction of graphene oxide (GO). Currently, the reducing agents used in the rGO synthesis such as hydrazine are harmful to the environment. Therefore, multiple searches for eco-friendly reducing agents have been conducted to replace the toxic ones. This brief review discusses the challenge of using natural extracts as reducing agents and several techniques commonly utilized in the synthesis of rGO from GO. Furthermore, the chemical components and mechanism involved in the reduction process are reviewed and compared. Some mechanisms involved in the GO reduction are discussed from the view point of the chemical contents in the plant extracts. Several fundamental characterization techniques, such as UV-Vis, FTIR, XRD, and Raman spectroscopies are also described. These main characterizations are utilized to justify the success of the reduction process with the hope that it can be used as an initial screening before a complete characterization of the synthesized rGO is conducted. Moreover, the developing use of natural reducing agents faces some challenges, including the complexity of the compounds in the natural extracts and the reproducibility of the synthesis method. This review summarizes the strategy for applying natural agents to reduce GO to rGO so that it can help researchers finding the novel green extracts and use it effectively in the rGO synthesis process.

(Lia Destiarti *et al.*,)

2.5 SYNTHESIS AND CHARACTERIZATION OF REDUCED GRAPHENE OXIDE (RGO) STARTED FROM GRAPHENE OXIDE (GO) USING THE TOUR METHOD WITH DIFFERENT PARAMETERS

A new approach to synthesize graphene is oxidizing graphite powder with a mixture of $\text{H}_2\text{SO}_4/\text{H}_3\text{PO}_4$ acids and potassium permanganate. Parameters such as reaction time, reaction temperature, and amount of concentration were varied to study the degree of oxidation of graphite to graphene oxide. Currently, an improved method for the preparation of graphene oxide was the most common one. A mixture of $\text{H}_2\text{SO}_4/\text{H}_3\text{PO}_4$ (9 : 1 volume ratio) instead of only H_2SO_4 resulted in increased hydrophilic and oxidized GO without the emission of toxic gas, which differs from the traditional Hummers' method. The graphene oxide (GO) was converted to reduced graphene oxide (rGO) by chemical reduction using ascorbic acid as the reducing agent. The GO and rGO were characterized by UV-visible spectroscopy, FTIR spectroscopy, and X-ray diffraction patterns. The result showed that treating graphite powder with potassium permanganate (1 : 9) and a mixture of concentrated $\text{H}_2\text{SO}_4/\text{H}_3\text{PO}_4$ acids at 50°C for 12 hours resulted in a better oxidation degree. The designed synthesis strategy could be easily controlled and is an alternative green approach for the production of graphene oxide and reduced graphene oxide.

CHAPTER -3

AIM AND SCOPE

3.1 AIM

To synthesis metal nanoparticles for waste water treatment

3.2 OBJECTIVES

- To optimize the synthesis of metal nanoparticles.
- To characterize the synthesized metal nanoparticles using UV, SEM and EDAX.
- To treat the wastewater using, synthesized metal nanoparticles.

CHAPTER-4

EXPERIMENTAL

4.1 MATERIALS AND METHODS

As graphite powder purity maker by SRL 99.9%, deionized water we are purchased further purification and sulfuric acid, phosphoric acid by SRL, potassium permanganate by SRL, Hydrochloric acid we are getting these are in chemical laboratory without purification.

4.2 SYNTHESIS OF GO

To a solution of 27ml of sulfuric acid, 3ml of phosphoric acid (9:1 ratio) these solution are mixed and stirred for 30 minutes. And 0.255g of graphite powder and add slowly 1.32g of potassium permanganate, then stirred for 6 hours (figure:4.2.1). Then after 6 hours stirred it forms dark green color (figure:4.2.2)

4.3 PREPARATION OF rGO

To reduce graphite oxide (GO), two different reducing agents were employed: pineapple peel powder and pineapple peel juice. Initially, the pineapple peels were separated from the fruit and left to dry under sunlight. Once dried, they were ground to obtain a fine powder. For the pineapple peel powder method, 0.025g of the powder was mixed with 0.05g of GO in 50ml of deionized water. The mixture was stirred for 2 hours and then subjected to centrifugation at 5000rpm for 15 minutes. The resulting pellet was collected and treated in a hot air oven at 1000°C for 1 hour to produce reduced graphene oxide (rGO).

As for the pineapple peel juice method, 20ml of juice was extracted from the pineapple peels using a mortar and pestle. Separately, 0.05g of GO was dispersed in 50ml of deionized water and stirred for 1 hour. The mixture was then centrifuged at 5000rpm for 15 minutes to obtain a pellet, which underwent the same treatment in the hot air oven at 1000°C for 1 hour to obtain rGO.

Following the reduction process, characterization of the rGO was performed using field-emission scanning electron microscopy (FESEM).

4.4 DYE DEGRADATION

Dye solution was measured and for every 30 minutes the observants value was measured from the observants value the percentage of dye degradation was calculated and plotted.

CHAPTER 5

RESULTS AND DISCUSSION



Fig:5.1 before the stirrer

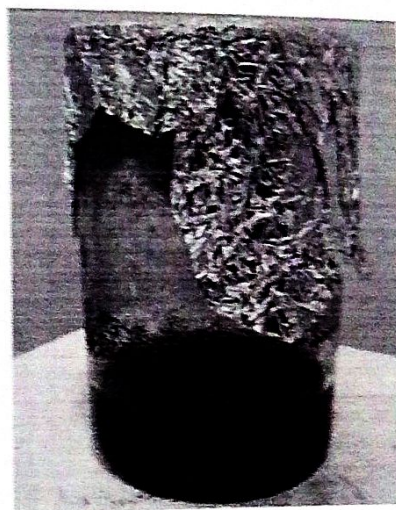


Fig:5.2 after thr stirrer

The before and after stir we use the 27 ml Sulfuric acid and 3ml phosphoric acid (9:1) ratio Mixed and magnetic stir for 30 minutes and after add 0.255 g of graphite powder and add 1.32 g potassium permanganate add slowly and Stirred for 6 hours then the dark green colour was produced and 0.675 ml Hydrogen peroxide add slowly because the exothermic reaction is produced because the volume of temperature is produced Stir for 20 minutes.

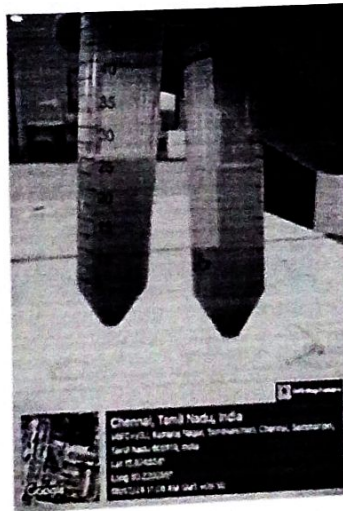
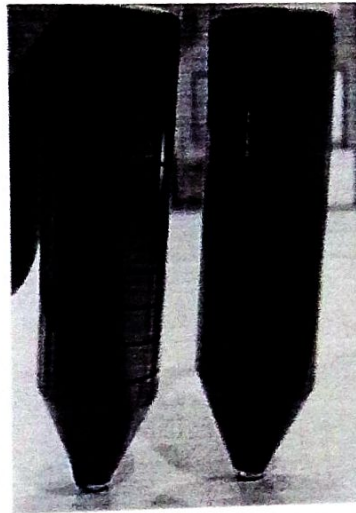


Fig:5.3 centrifuge

10 ml Hydrochloric acid and add 30 ml Deionized H₂O and Centrifuge @ 5000 rpm for 7 minutes this process should be 3 times doing for the purification of sample.

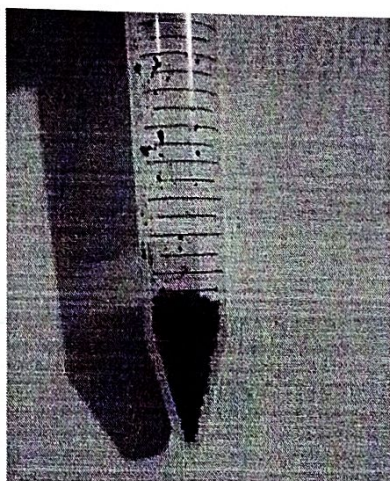
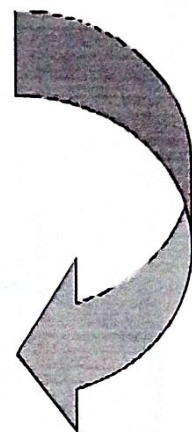
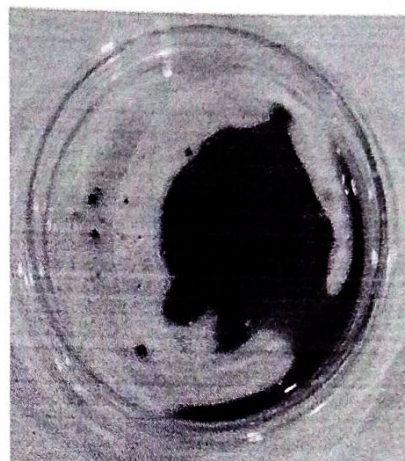
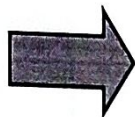
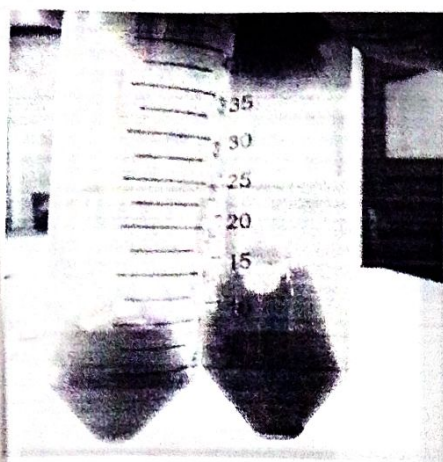


Fig:5.4 collection of pellet

Then finally the pellet was formed and collect the pellet into the petridish and dired 100⁰c for 24 hours in hot air oven. After the 24 hours the GO as been formed and collect the GO with help of spatula and collect in the centrifuge tube .

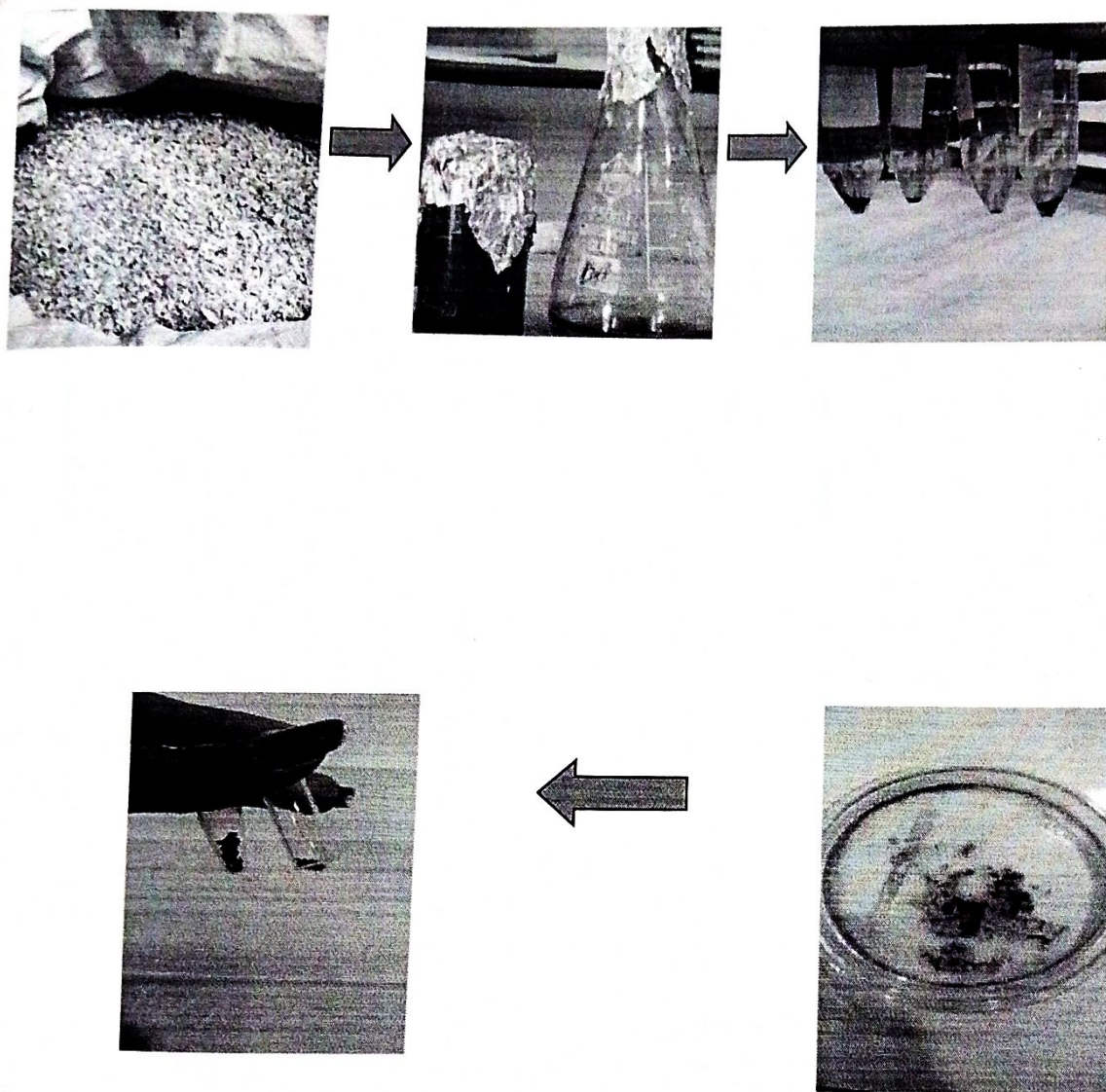


Fig:5.5: preparation of rGO

in this I have use the pineapple peel dried powder and pineapple peel juice mix with deionized water and centrifuge and hot air oven then finally collect the rGO the pineapple peel was using for the reducing aget

FESEM RESULTS

Pineapple peel powder of rGO

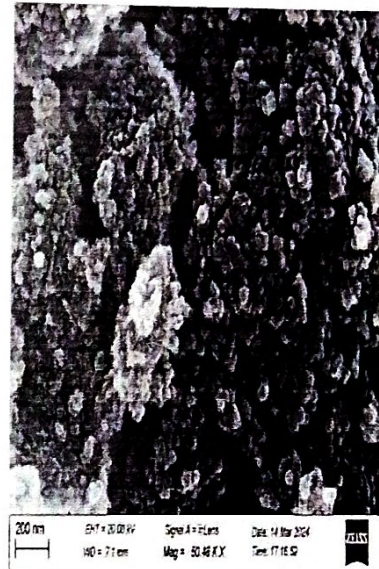


Fig:5.6 FESEM results

FESEM results of reduced graphene oxide using pineapple peel powder. In this the grafine sheets are forming then the graphene is reduced.

In 40μm- Mag = 250x,WD=7.3mm

In 200nm- Mag=50.48xx,WD=7.1mm

pineapple peel juice rGO



Fig:5.7 FESEM RESULTS

FESEM results of reduced graphene oxide using pineapple peel juice. In this the graphene sheets are forming then the graphene is reduced.

In 100μm -Mag=150X, WD=7.1 mm

In 10μm -Mag=1.50 KX, WD=7.1mm

EDAX

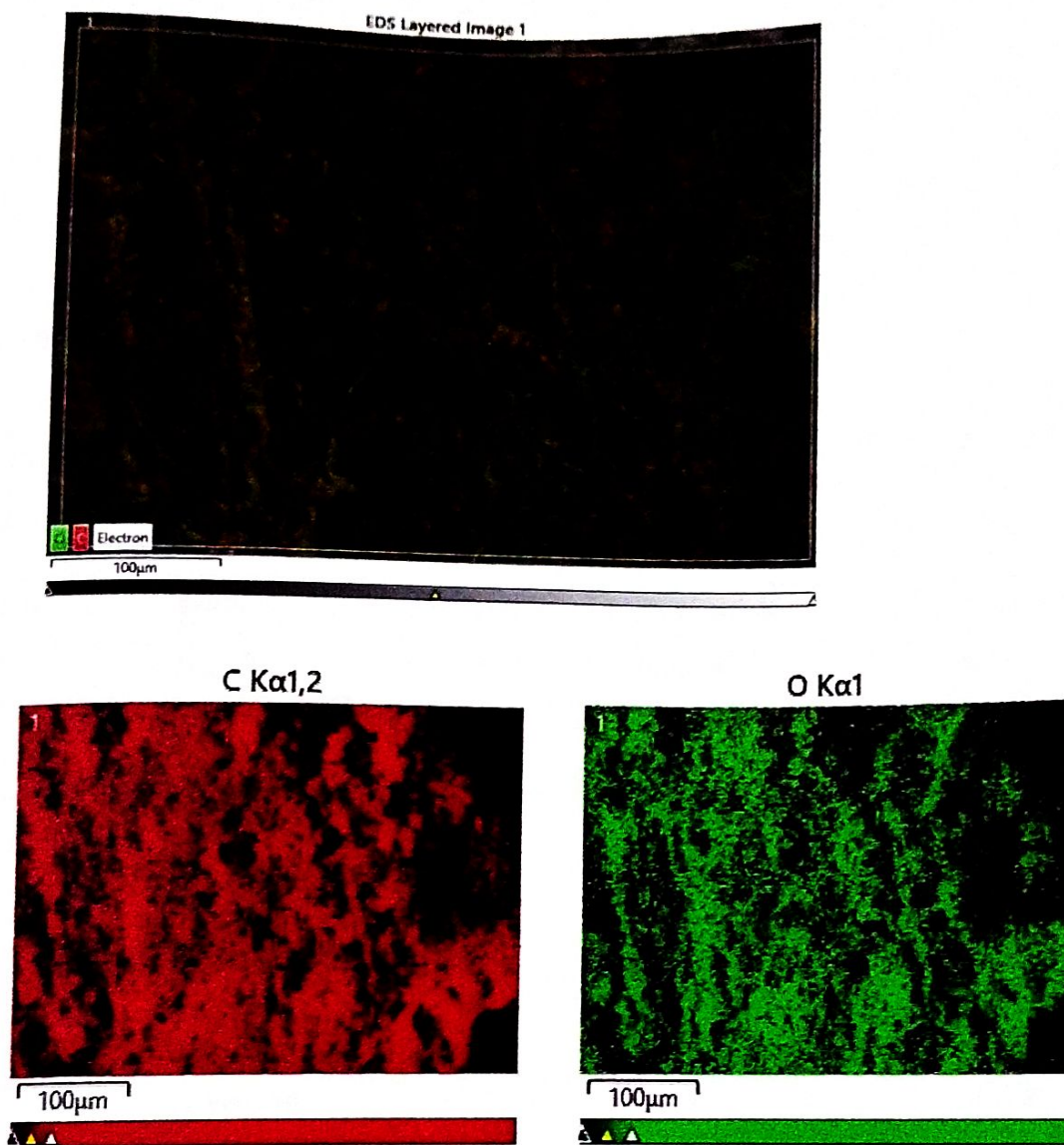


Fig:5.8 EDAX

This is edax results of rGO in this the carbon and oxygen particles are presence.

EDAX

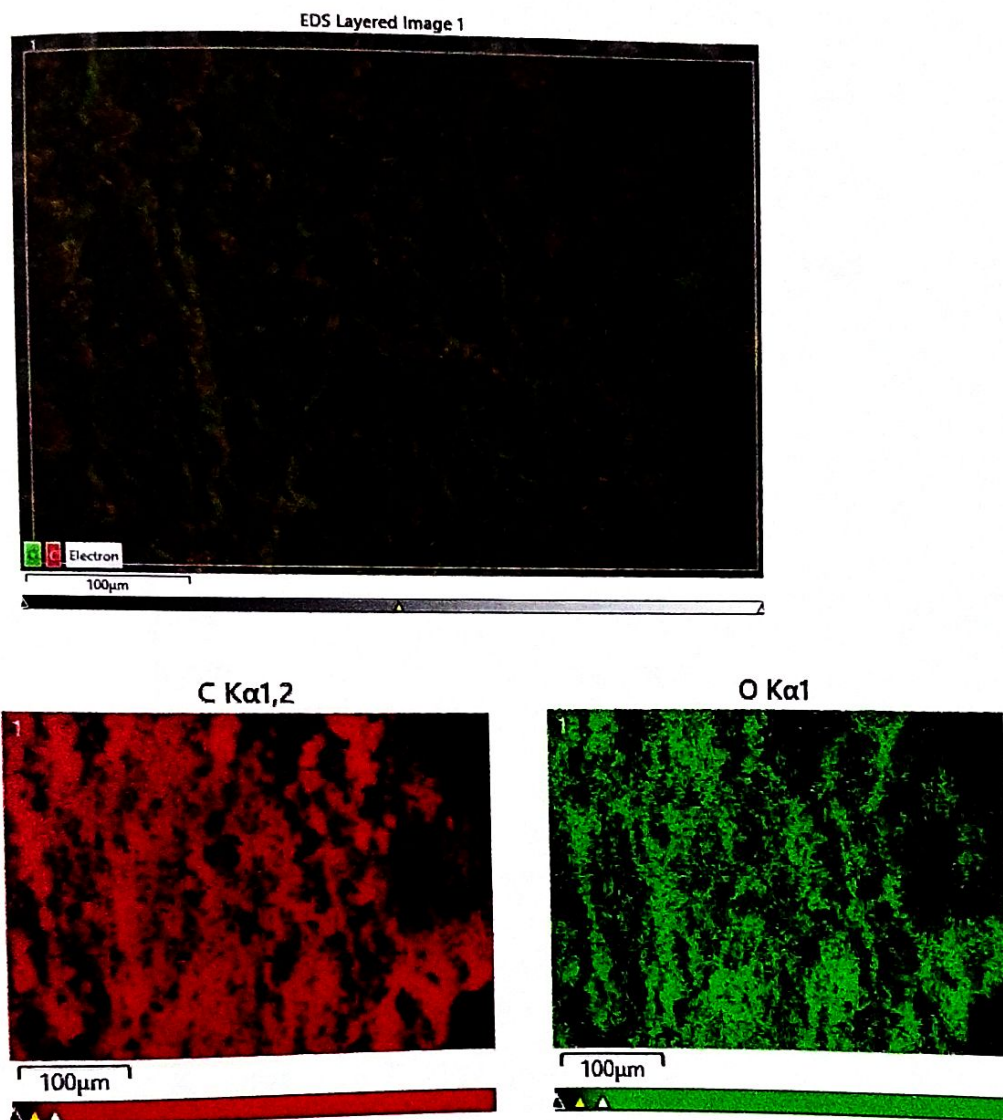


Fig:5.8 EDAX

This is edax results of rGO in this the carbon and oxygen particles are presence.

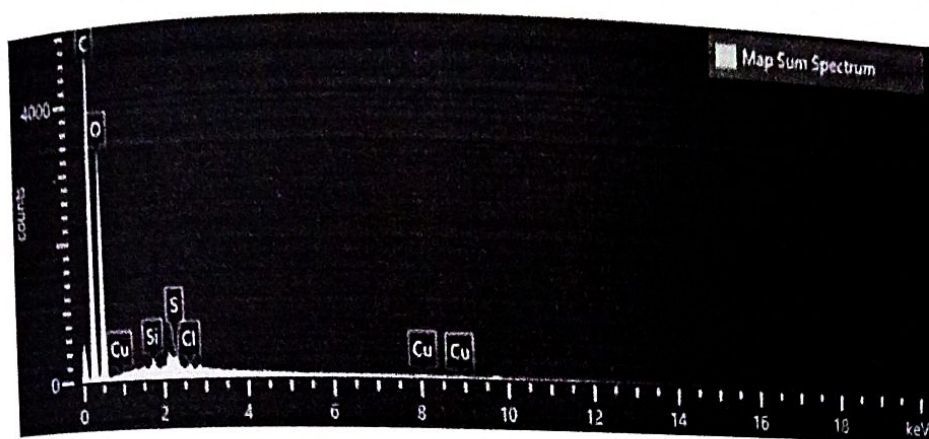


Fig:5.9:map of spectrum

Map sum spectrum				
Element	Line Type	Weight%	Weight % Sigma	Atomic%
C	K series	58.06	0.36	65.12
O	K series	41.05	0.35	34.56
Si	K series	0.20	0.03	0.10
S	K series	0.21	0.03	0.09
Cl	K series	0.20	0.03	0.08
Cu	K series	0.28	0.08	0.06
Total		100.00		100.00

DYE DEGRADATION:

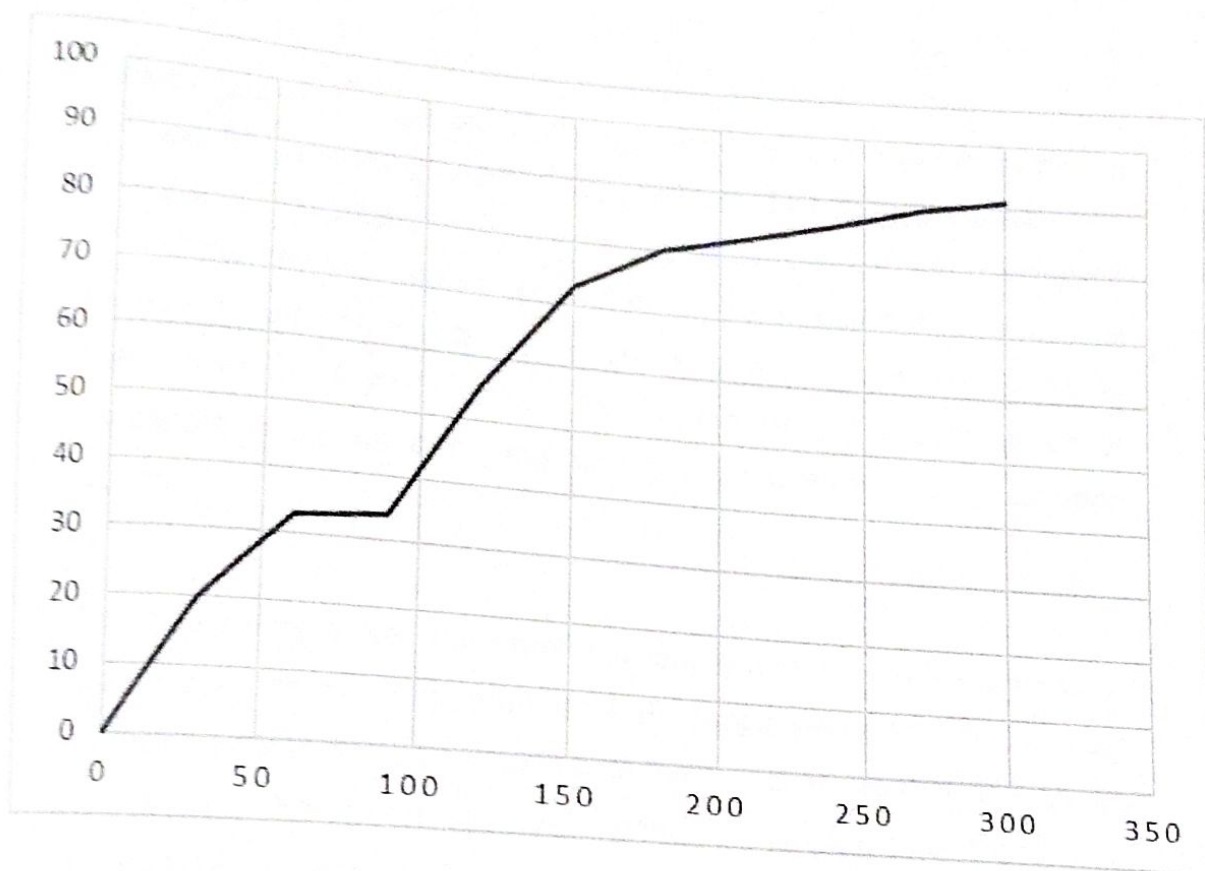


FIG:5.10: Dye degradation

Graphene oxide was successfully rGO nanosheets by the fresh pineapple peel. So thus prepared rGO nanosheets were studied for dye degradation of crystal violet. From the results it was found that 92% of dye degradation was achieved by the prepared rGO nanosheets hence we conclude that prepared rGO efficiently degrades the crystal violet dye.

SUMMARY AND CONCLUSION

The project undertook the challenge of developing a green synthesis method for producing reduced graphene oxide (rGO), a material with promising applications across various industries, including environmental remediation. Instead of relying on conventional chemical reduction methods, which often involve toxic substances harmful to both the environment and human health, the project sought to utilize pineapple peels as a natural and environmentally friendly reducing agent.

Graphite oxide, a precursor material readily available in the laboratory, was chosen as the starting material. Pineapple peels, known to contain reducing agents, were used to initiate the reduction process. This choice aligns with the green synthesis principle, emphasizing the use of renewable resources and minimizing environmental impact.

The synthesized rGO was subjected to thorough characterization using advanced techniques such as Field Emission Scanning Electron Microscopy (FESEM) and Energy Dispersive X-ray Analysis (EDAX). These analyses provided insights into the morphology, structure, and elemental composition of the produced rGO, confirming its successful synthesis and purity.

To demonstrate the practical application of the synthesized rGO, dye degradation experiments were conducted using crystal violet and graphene oxide as model pollutants. The degradation process was monitored using UV analysis, showcasing the effectiveness of rGO in environmental remediation.

Moreover, the project extended its impact beyond laboratory-scale experiments by incorporating the synthesized rGO into a nanofiber sheet. This innovative approach aimed to create a scalable and practical solution for water purification, leveraging the unique properties of rGO to efficiently remove contaminants from water sources.

Overall, the project's emphasis on green synthesis methodologies, utilization of natural resources, rigorous characterization techniques, and practical applications in environmental remediation underscores its significance in addressing contemporary challenges while promoting sustainability and environmental stewardship.

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