

CONTROLLED RELEASED OF PESTICIDAL FORMULATION USING NATURAL POLYMERS

(Project-Report)

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Science degree in Biochemistry.

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
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

March - 2021



SATHYABAMA

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DEPARTMENT OF BIOTECHNOLOGY

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of M SANTHOSH SARAIVANAN (38070004) who carried out the project entitled "**CONTROLLED RELEASE OF PESTICIDAL FORMULATION USING NATURAL POLYMERS**" under our supervision from October 2020 to March 2021.

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DECLARATION

I **M SANTHOSH SARAVANAN (38070004)** hereby declare that the Project Report entitled “**CONTROLLED RELEASE OF PESTICIDAL FORMULATION USING NATURAL POLYMERS**” done by me under the guidance of **Dr. S KARTHICK RAJA NAMSIVAYAM** at **Sathyabama Institute of Science and Technology, Chennai** is submitted in partial fulfillment of the requirements for the award of Bachelor of Science degree in Biochemistry.

DATE: 04.04.2021

PLACE: CHENNAI



SIGNATURE OF THE CANDIDATE

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ABSTRACT

Organic based pesticides mainly biopesticides or now being extensively used to controls economic important in diverse plants. uccessful formulation techniques are required for the effectiveness of the pesticides. Formulation of agro active compounds using bio-compatible materials play a major role. In this analysis formulation of biopesticidal product “Zaena Bio” sucking pest controller using cow dung, groundnut pressed cake and rice husk. Various analytical techniques such as **FTIR(Fourier Transform Infrared Spectroscopy), XRD (X-RAY DIFFRACTION), AFM (ATOMIC FORCE MICROSCOPY), FESEM (FIELD EMISSION SCANNIING ELECTRON MICROSCOPE)** reveals highly stable , crystalline , microparticles with specially interacting functional groups. Biocompatability of the combined pesticidal formulation, mortality, no diverse effect on development stages and histopathological parameters. Furthur study will be helpful to utilize the formulation as an effective pesticidal agent with high safety and efficiency.

CHAPTER NO.	TABLE OF CONTENTS	PAGE NO.
	TITLE	
	ABSTRACT	
1	INTRODUCTION	1
1.1	TYPES OF FARMERS IN INDIA	1
1.1.1	SUBSISTENCE AND COMMERCIAL FARMING	1
1.1.2	COMMERCIAL FARMING	2
1.1.3	INTENSIVE AND EXTENSIVE FARMING	2
1.1.4	PLANTATION FARMING	2
1.1.5	MIXED FARMING	3
1.2	SALIENT FEATURES OF INDIAN AGRICULTURE	3
1.2.1	SUBSISTENCE AGRICULTURE	3
1.2.2	PRESSURE OF POPULATION OF AGRICULTURE	3
1.2.3	MECHANIZATION OF FARMING	3
1.2.4	DEPENDENCE UPON MONSOON	3
1.2.5	VARIETY OF CROPS	4
1.2.6	PREDOMINANCE OF FOOD CROPS	4
1.2.7	SEASONAL PATTERNS	4
1.3	CROP PRODUCTION IN INDIA	4
2	REVIEW OF LITERATURE	5

2.1	CONTROLLED RELEASE IN AGRICULTURE AND ITS ADVANTAGES	6
3	AIM & OBJECTIVE	8
4	MATERIALS & METHODS	9
4.1	DESCRIPTION OF PESTICIDAL FORMULATION	9
4.2	PREPERATION OF CONTROLLED RELEASE PESTICIDAL FORMULATION	9
4.2.1	SELECTION OF RAW MATERIALS	9
4.2.2	CHARACTERIZATION	12
4.3	ZEBRA FISH TOXICITY ANALYSIS	12
5	RESULT & DISCUSSION	13
5.1	ZEBRA FISH ANALYSIS	13
5.2	EMBRYONIC STUDY	13
5.3	RESULT & INTERPRETATIONS	15
5.3.1	OBSERVATION OF EGGS IN DIFFERENT HOURS	15
5.3.2	INTERPRETATION ABOUT THE OBSERVATIONS	23
6	HISTOPATHOLOGY	26
6.1	INTESTINE	26
6.2	LIVER	27

7	XRD	28
8	EB COMPOSITE	31
9	FTIR	32
10	AFM	37
11	FESEM	45
12	EDAX	47
13	REFERENCE	48

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1	Biopesticide	10
2	Groundnut Pressed Oil Cake	10
3	Cow Dung Manure	11
4	Rice Husk	11
5	Microscope	12
6	Sample taken in eppendorf tube	12
7	Zebrafish	13

8	Zebrafish at differernt containers	13
9 a	Percentage graph of hatching rate 4to96hrs	24
9b	Percentage graph of hatching rate 25-48 hrs	24
10	2D images of AFM at 4x4um	38
11	3D images of AFM at 4x4um	38
12	X Section@2430nm	39
13	X Section @3040nm	40
14	2D images of AFM at 10x10um	40
15	3D images of AFM at 10x10um	41
16	X Section@2820nm	42
17	X Section@3040nm	42
18	2D images of AFM at 40x40um	43
19	3D images of AFM at 40x40um	43
20	X Section@6400nm	44
21	X Section@ 28700nm	45
22	FESEM result at X250	45
23	FESEM result at X500	46

24	FESEM result at X1000	46
25	FESEM result at X2000s	47

1.INTRODUCTION

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors for forestry and fisheries accounted for 16.6% of GDP in 2009, about 50% of total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadcast economic sector and plays a significant role in the overall socio-economic fabrics of India. In India around 70% of the population earns its livelihood from agriculture. It still provides a livelihood from agriculture. It fulfills the basic need of human beings and animals. It is an important source of raw materials for many agrobased industries. India's geographical condition is unique for agriculture because it provides many favourable conditions. There are plain areas, fertile soil, long growing seasons and wide variations in climatic conditions etc. Apart from unique geographical conditions, India has been constantly making innovative efforts by using science and technology to increase production.

1.1. TYPES OF FARMING IN INDIA

Apart from variation in landform, the country has varieties of climatic conditions and soil types. These variations along with other factors like availability of irrigation, use of machinery, modern agriculture inputs like high yielding varieties (HYV) seeds, insecticides and pesticides have played their respective role in evolution of different farming practices in India. Some of the major types of farming are discussed below.

1.1.1 Subsistence and commercial farming:

Major of farmers in India practices subsistence farming. This means Farming for own consumption and soil types. The entire production is largely consumed by the farmers and their family and they do not have any surplus to sell in market. In this type of farming, landholdings are small and fragmented.

Cultivation techniques are primitive and simple . In other words there is a total absence of modern equipment like tractor and farm inputs like chemical fertilizer, insecticides and pesticides . In the farming, farmers mostly cultivate cereals along with oil seeds, pulses, vegetables and sugarcane.

1.1.2. Commercial Farming

It is just the opposite to subsistence farming. In this case, most of the produce is sold in the market for earning money. In this system, farmers use inputs like irrigation, chemical fertilizers, insecticides, pesticides and High Yielding Varieties of seeds etc. Some of the major commercial crops grown in different parts of India are cotton, jute, sugarcane, groundnut etc. Rice farming in Haryana is mainly for commercial purpose as people of this area are predominantly wheat eaters. However in East and North-Eastern states of India, rice cultivation would be largely of subsistence type.

1.1.3. Intensive and Extensive Farming:

The basic difference between these two types of farming is the amount of production per unit of land. In comparison with temperate areas of USA, Canada, and former USSR, India does not practice extensive cultivation. When we use large patch of land for cultivation then we call it extensive farming. Here, total production may be high due to larger area but per unit production is low. In India extensive cultivation can be observed in Punjab, Haryana and Western Uttar Pradesh. **Intensive Farming** records high production per unit of land. Best example of intensive cultivation is in Japan where availability of land for cultivation is very limited. Similar kind of situation can be observed in the state of Kerala in India.

1.1.4. Plantation Farming:

Plantation farming is an artificial and established form. It is an estate where a single cash crop is grown for sale. This type of agriculture involves growing and processing of a single cash crop purely meant for sale. Tea, coffee, rubber, banana

and spices are all examples of plantation crops. Most of these crops were introduced in India by the Britishers in the 19th Century.

1.1.5. Mixed Farming:

It is a situation in which both raising crops and rearing animals are carried on simultaneously. Here farmers engaged in mixed farming are economically better off than others. All classifications are based on nature and purpose of farming. It may overlap.

For example: Banana is a plantation type of farming. It can also be classified as commercial farming.

1.2. SALIENT FEATURES OF INDIAN AGRICULTURE

1.2.1. Subsistence Agriculture:

As mentioned earlier, most parts of India have subsistence agriculture. This type of agriculture has been practised in India for several hundreds of years and still prevails in a larger part of India in spite of the large scale change in agricultural practices after independence.

1.2.2 Pressure of population on Agriculture:

Despite increase in urbanization and industrialization, about 70% of population is still directly or indirectly dependent on agriculture.

1.2.3. Mechanization of farming:

Green revolution took place in India in the late sixties and early seventies. After more than forty years of Green Revolution and revolution in agricultural machinery and equipments, complete mechanization is still a distant dream.

1.2.4. Dependence upon monsoon:

Since independence, there has been a rapid expansion of irrigation infrastructure. Despite the large scale expansion, only about one third of total

cropped area is irrigated today. As a consequence, two third of cropped areas is still dependent upon monsoon. As you know, monsoon in India is uncertain and unreliable. This has become even more unreliable due to change in climate.

1.2.5. Variety of crops:

Can you guess why India has a variety of crops? As mentioned in the beginning of the lesson, India has diversity of topography, climate and soil. Since India has both tropical and temperate climate, crops of both the climate are found in India. There are very few countries in the world that have variety comparable to that of India. You would realize that when we would discuss the different type of crops in detail. Look at the table No.1 to get an idea.

1.2.6. Predominance of food crops:

Since Indian agriculture has to feed a large population, production of food crops is the first priority of the farmers almost everywhere in the country. However, in recent years, there has been a decline in the share of land used for food crops due to various other commercially most advantageous uses of these land.

1.2.7. Seasonal patterns:

India has three distinct agricultural/cropping seasons. You might have heard about kharif, rabi and zaid. In India there are specific crops grown in these three seasons. For example rice is a kharif crop whereas wheat is a rabi crop.

1.3. Crop production in India:

Agriculture has a vital role in the economy of many developing as well as developed countries. In India, over twenty two percent of the rural households depend on agriculture as the principal means of livelihood (Sahayaraj, 2004).

reported that the total annual crop loss due to insect pests alone exceeded Rs. 6000 crores during 1973 and it was further increased to about 25,000 crores in 2001 - 2002 .Among the various biotic and abiotic constraints in agriculture production, the insect pests, disease causing pathogens, weeds and nematodes as biotic stress play a vital role reported that the biotic stress were estimated to cause an annual loss of about 33 - 35 percent of the potential food production worldwide. Further more, the pest related damages resulted in an estimated Rs. 50,000 crore annually in agricultural production in the field as well as storage in India .The rapid increase in the area under intensive cultivation of crops, lack of natural enemy of pests, pests resurgence, climatic condition and the spread of pests from one place to another are largely responsible for the serious pest deprivation in any agro-ecosystem .The key challenge today is to adopt strategies that will address the concern of maintaining and enhancing the integrity of natural resources and improved productivity (Sunita and Abrol, 2006).

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 16.6% of the GDP in 2009, about 50% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. In India around 70% of the population earns its livelihood from agriculture. It still provides livelihood to the people in our country. It fulfills the basic need of human beings and animals. It is an important source of raw material for many agrobased industries. India's geographical condition is unique for agriculture because it provides many favourable conditions.

2. REVIEW OF LITERATURE

Polymers are been mostly grounded in agriculture sectors for usage including controlled release of pesticides and o active factors. The capability to see their delivery helps us to keep away form environmental risks. Macromolecular are used as transpoter in controlled release of agricultural active medium , especially in pesticides which are reviewed. This review focus on the superiority and process of

controlled release pesticidal formulation. It includes biodegradable polymers in agriculture, their manufacturing procedures, and their degradation methods and kinetics. This article also presents an account of present studies and upcoming challenges.

2.1 Controlled release in agriculture and its advantages

The process was first used in 1930, synthetic pesticides became common after World War II and agriculture has grown depending on them. Only 0.1% of the chemicals used for safety of crop to reach the targeted pest while the remaining will enter the environment and may effect the non-target organisms, which includes humans. Controlled release sciences has appeared as a adaptable equipment to reduce problems. Controlled release is a regulated transfer of an active elements from the targeted surface to regulate the pre-maintained concentration level for a specific time . Comparative release of conventional and controlled release assists the final results. Normal Utilization gives a high initial measures which quickly drops below the actual level. The controlled release formulation can keep an actual level for over a long period of time. Controlled release has been used in the agricultural, biomedical, food, and pharmaceutical industries for delivering pesticides, herbicides, fertilizers, and drugs . Controlled release sciences has been used where crop protection is required for a long period of time. Some of the advantages are constant for active medium for an overlanged period, smaller quantity, reduction in evaporating losses, reduction of phytotoxicity, reduce in environmental pollution, and ease in handling. The main aim are more effectual treatment, decrease side effects, extended efficacy, and increased protection and dependant . An pesticide formulation would keep an active sufficient level for pest control but it leave least crop and environmental remaining . Encapsulation in a polymeric network which can help to reach the goals. Polymer encapsulated methods are higher to non-encapsulated commercial methods in enlarged activity as well as decreased evaporation and degradation losses, leaching, and toxicity. When the normal half life of a strong pesticide is short, then these methods are really advantageous.

Natural plant products like essential oils has hold to use in pest control because of low environmental collisions. This can be sucessful in controlling parasitic mites takeover honeybee colony, but sucessful encapsulates required to provide sustained targeted carraige to reduce active ingredient used. Glenn described essential oil encapsulation in easily dispersible porous microspheres comparable in size to pollen. The microsphere was prepared by pushing a gelatinous aqueous 8% high-amylose starch melting through atomizing nozzle. The oils emerged to be largely cut off within the pore structure, since the spheres hold out a freeflowing powder and exhibits little if any agglomeration in spite of their high loading. Further, SEM micrographs verify that pore structure is solid, as the pores perserved in spheres had first loaded and have the oil removed by solvent extraction.

Developed nanospheres improves a insecticide for plants. Solid polymeric nanospheres contain 3.5% insecticide, with size of 135 nm were acquired with S100 polymer. Using a reference, infested plants were used to evaluate contact with insects and ingredients to the plant. The action of sustained release were not good but the formulate improved plant perforation. This concluded that nanospheres don'tt control release but its small size enhance perforation.

Interest of intoxic biodegradable polymers such as amylose, cellulose, carboxymethyl, polylactic acid, polycaprolactone, etc. have been growing . Decomposition of soil can take place both chemically or microbiologically. Basically one or more chemical steps can take place followed by microbiological failure. The chemical process ends and controls the biological processes of decomposition rate. Over a decade efforts has focused on plastics discaeding but polymers have been used in countless applications with little consideration attracts alternatives when waste polymer increase causes pollution. Polymers like polyethylene and polypropylene looks insuitable for short-lived applications followed by disposal; their impenetrable to bio-degradation is difficult. Biodegradable polymers are increasingly used in agricultural sectors.

3.AIM AND OBJECTIVE

Formulation of the agroactive compounds using green science principle plays a vital role in organic agriculture . Biocompatible materials based agro wastes are utilized in this formulation. The objectives of present study is as follows:

- To prepare controlled release of pesticidal formulation using agro wastes.
- To evaluate biocompatibility of synthesized CRP using zebra fish model.

4.MATERIALS AND METHODS

4.1 Description of pesticidal product

Pesticides used in this study was Zaena Bio

4.2 Preparation Of Controlled Release Pesticide Formulation

4.2.1 Selection Of Raw Materials

Cow Dung, Groundnut pressed oil cake and rice husk were selected in this study. Known value of respective material as dried powder was finely suspended in 100ML of distilled water followed by addition of field concentration of pesticide (0.01%). Contents were mixed gently and spread as thin film on plastic sheets, incubated at room temperature after the incubation period , the finished product was dried at 40 degree celcius for 48 hours. Materials used are:-



FIG.1



FIG.2



FIG.3



FIG.4

4.2.2 Characterisation

Characterisation of dried materials thus obtained was analyzed FTIR,SEM,AFM and XRD to evaluate functional group groups interactions , particle morphology, topography and crystallinity .

4.3 Zebra Fish Toxicity Analysis

Equipment used for zebra fish toxicity are :

1.3.1



FIG.5

1.3.2



FIG.6

1.3.3



FIG.7

1.3.4



FIG.8

5.RESULT & DISCUSSION

5.1 Zebra Fish Analysis

1. Methods :

1.1 Collection and maintenance:

Zebrafish (*Danio rerio*), it was purchased from aquarium. They were acclimatized under laboratory conditions in a 35 L glass aquaria containing dechlorinated water, aerated continuously through stone diffusers connected to a mechanical air compressor. The zebrafish is a hardy fish and can withstand a pH ranging between 7.2 and 7.5. The temperature of the water was maintained at $26 \pm 1^{\circ}\text{C}$ throughout the study. During the acclimation period, the adult fish was fed twice per day with readily available fish food. The care and husbandry of the zebrafish used in this study was in conformity with the guidelines that regulate the care and use of laboratory animals by humans for research purposes.

5.2. Embryonic study

1.2 Breeding setup:

The zebrafish we used as spawners had a length of 3.05 ± 0.04 cm and a weight of 1.00 ± 0.5 g. Prior to spawning, the male and female fish were housed separately for a minimum of 1 day. For breeding, male and female fish were taken in the ratio of 2:1 (male: female) to get the maximum number of embryos. Care was taken in collecting the eggs that Nylon net was placed between the fish and the bottom of the aquarium; the spawned eggs fell through the net, thus, preventing the adult fish from eating the eggs. Breeding kept for overnight or 16 hours in dark environment. After 16 hours the dark closure was removed and left the fishes as it to lay the eggs. Then, the eggs were transferred to a petri dish containing E3 medium and checked for fertilization under a microscope, only the fertilized eggs taken for the studies.

1.3 Sample preparation and Treatment:

Samples was weigh mg/ml concentration this sample was boiled for 2 hours then the extract were filtered then used in this study .

The concentration of sample used was $0.25 \mu\text{g/ml}$, $0.5 \mu\text{g/ml}$, $0.75 \mu\text{g/ml}$, $1 \mu\text{g/ml}$ and $1.25 \mu\text{g/ml}$. The fertilized eggs (12/concentration) were taken for the treatment in 96 well plate. Without closing the lid fully covered,

gap was created for aeration and at the same time evaporation also avoided. The eggs were observed for 0, 2, 4, 6, 24, 48, 72 and 96 hours.

1.4 Survival Rate and Hatching Rate:

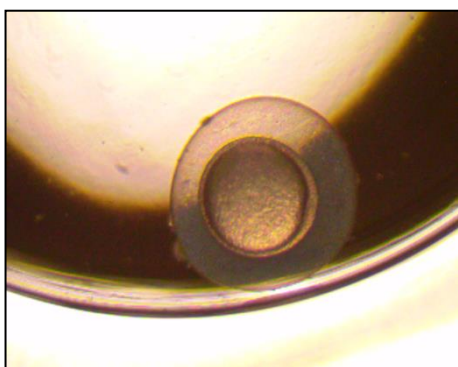
Percentage of survival rate was calculated as a ratio of number of healthy (fertilized) developing embryos at various time of exposure divided by total number of incubated embryos initially x 100.

Percentage of hatched embryos (HR) was calculated as a ratio of number of hatched embryos divided by total number of incubated embryos x 100. HR at each exposure-duration was separately considered as an individual variable. Therefore HR between 48 hrs to 72 hrs were considered as separated variable, presented as HR-48, HR-54, HR-60 and HR-66 as graphs.

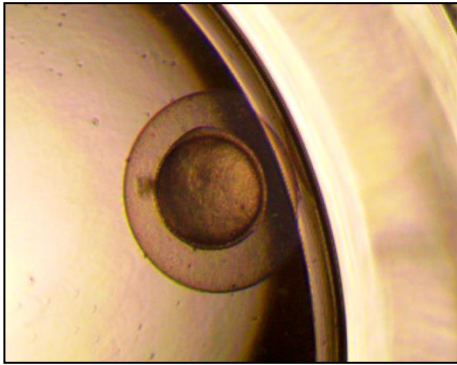
5.3.Results and Interpretation:

5.3.1.Observation of eggs in different hours :

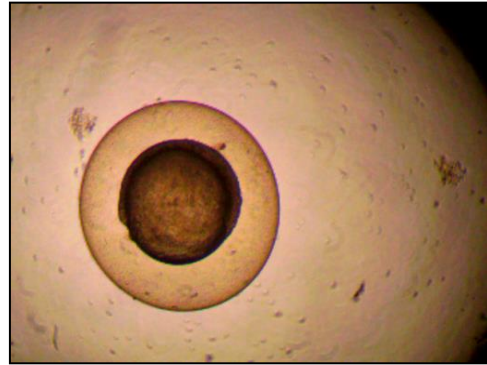
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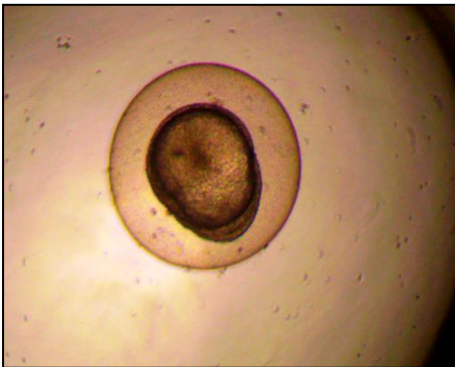
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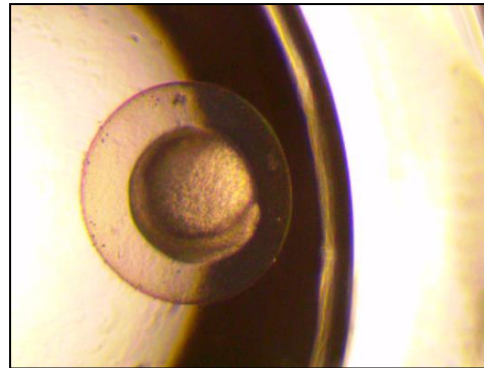
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0.75µg/ml

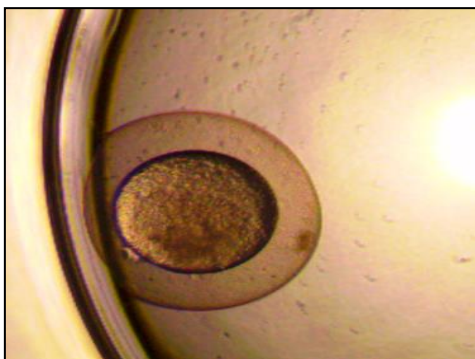


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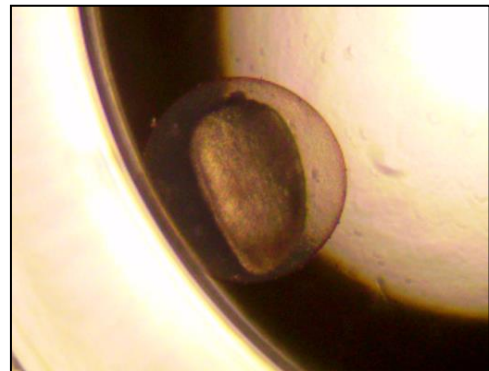


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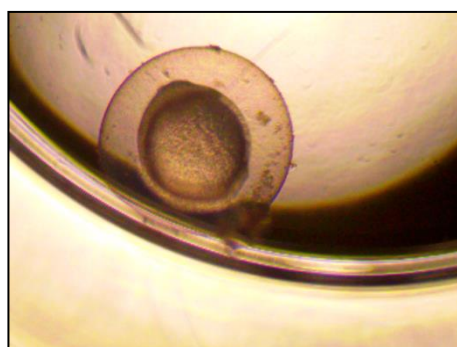
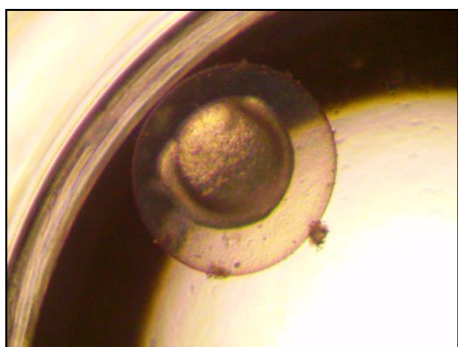
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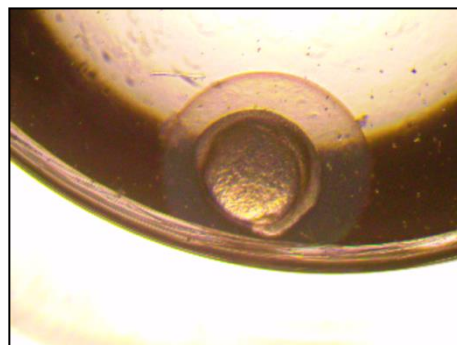
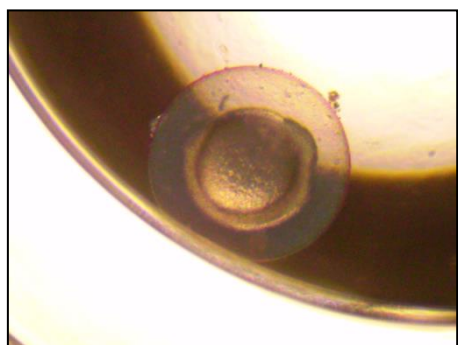


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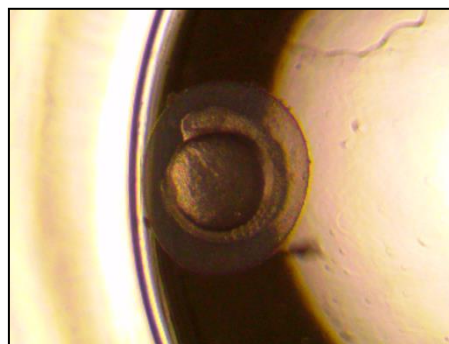
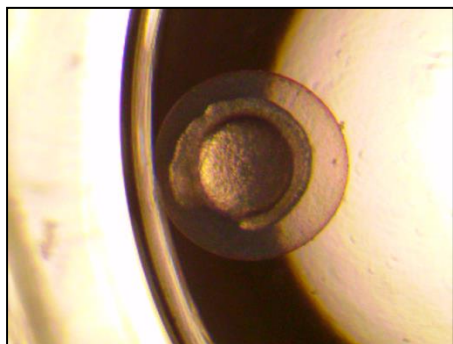
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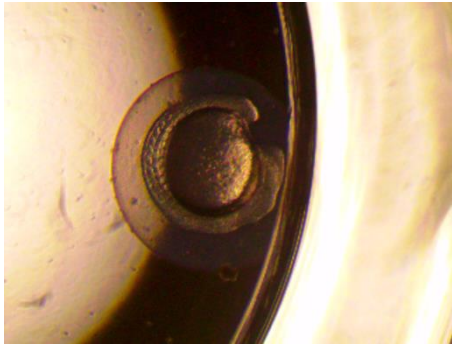
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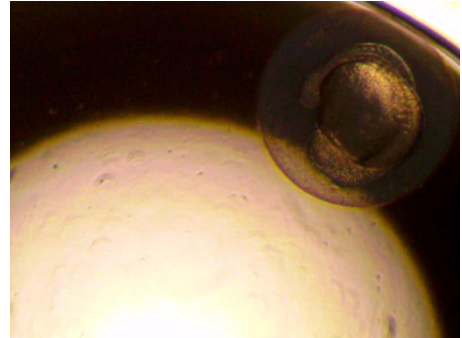
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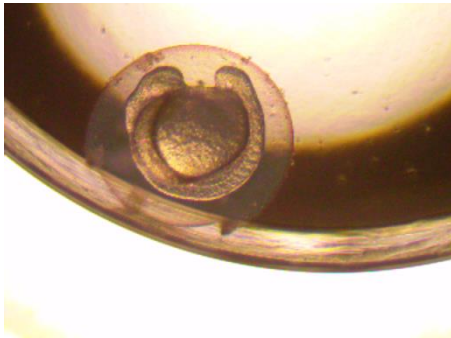
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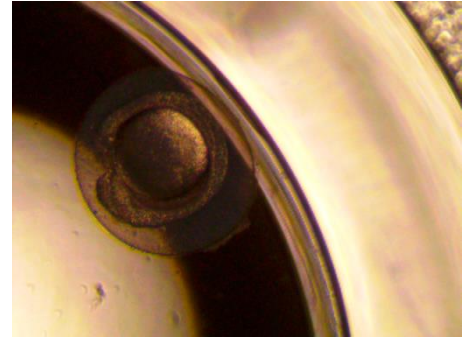
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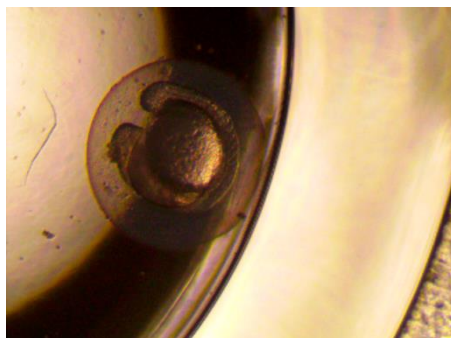
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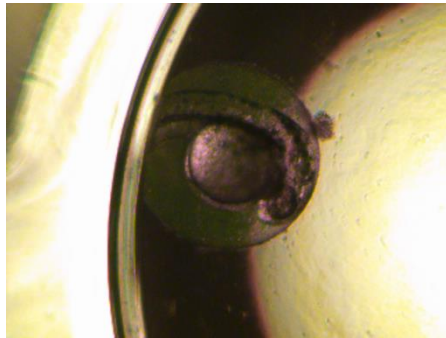


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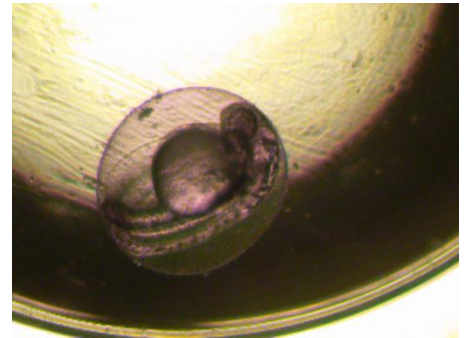


1.25µg/ml

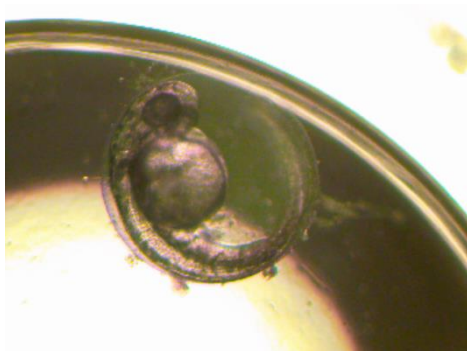
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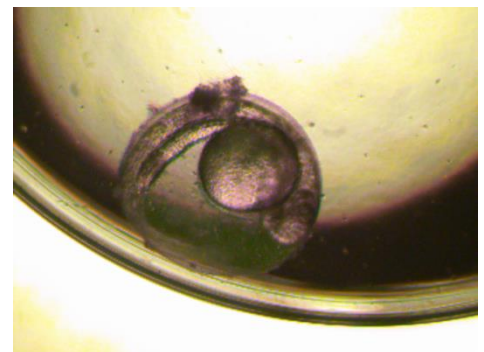
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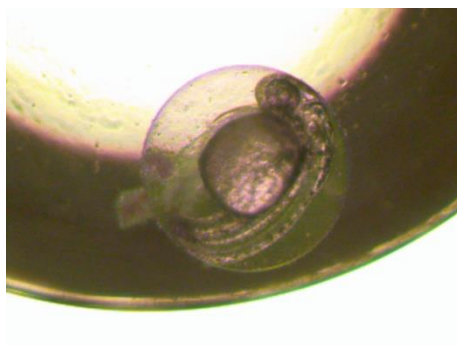
0.25µg/ml



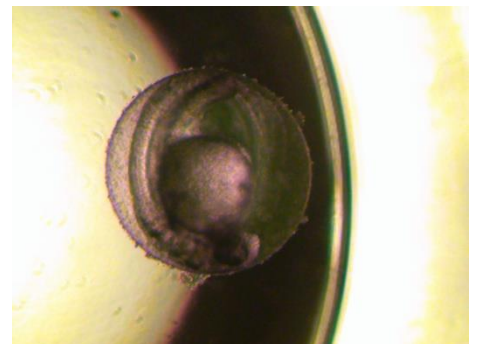
0.5µg/ml



0.75µg/ml



1µg/ml



1.25µg/ml

48th Hour:



1

0.25 μ g/ml



1

0.75 μ g/ml

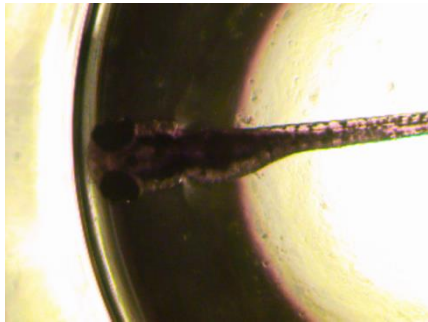


1 μ g/ml

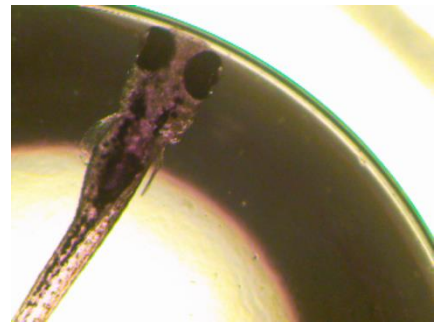


1.25 μ g/ml

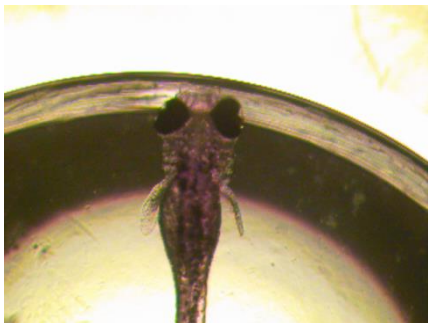
72nd Hour:



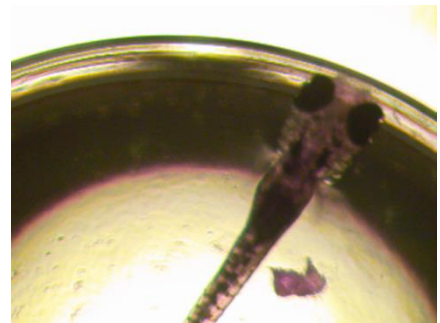
Control



0.25µg/ml



0.5µg/ml



0.75µg/ml

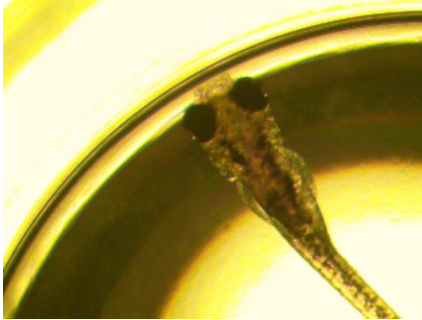


1µg/ml

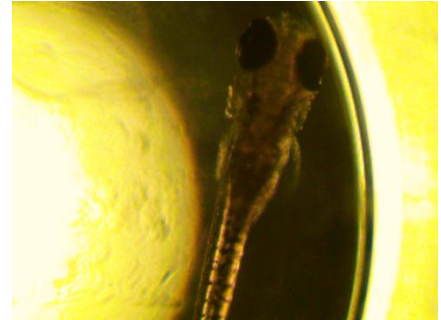


1.25µg/ml

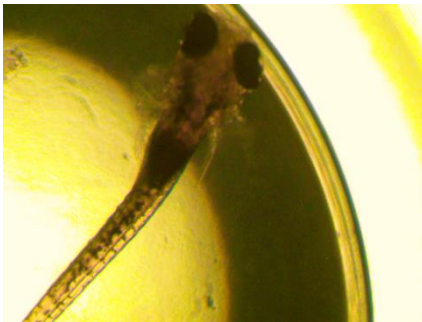
96th Hour:



Control

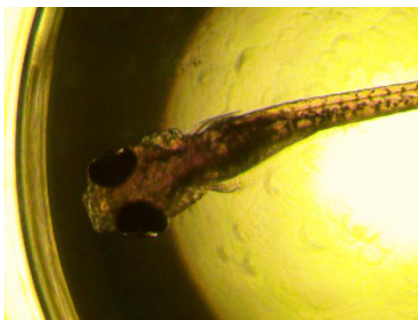
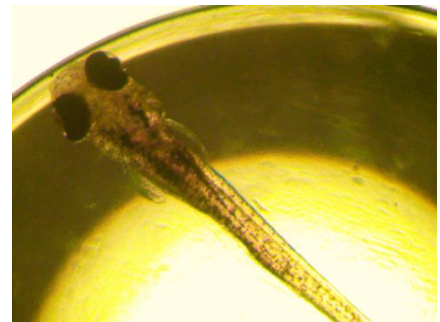


0.25µg/ml



g/ml

0.75µg/ml



1µg/ml



1.25µg/ml

5.3.2. Interpretation about the observation:

The eggs were collected and subjected to treatment with the given sample and observed at 2,4,6,24,48,72 and 96 hours.

Upto 24 hours: At 2 hours the embryos were in cell division (Oblong) stage and few eggs are at epiboly stage. Further embryos were at somite development stage in 4 hrs. The spinal cord appeared thick at 20 somite stage during 6th hour with initiation of eye lids and ear buds at the spaces.

24 hours: The development of growth of tail region and heart region with pigmentation.

48 hours: Hatching was observed with exact breakage of chorion sac and starts swimming.

72 hours-96 hours : Within 96 hours embryo developed into larvae and the swimming was normal.

The treatment with sample upto 1.25 µg/ml concentration does not show any abnormal effect in embryonic development. The embryonic development was normal in treated group similar to control.

6.3 Survival rate and Hatching Rate :

The survival and hatching rates of zebrafish embryos from the control and sample exposed (0.25 µg/ml, 0.5 µg/ml, 0.75 µg/ml, 1.0 µg/ml and 1.25 µg/ml, from 4 hrs to 96 hrs) groups are shown in the graphs. From graph A, it is clear that the survival rate of all the fishes were high and that only 10-15 % of the embryos failed to survive beyond 48 hrs post fertilization (hpf) including control. This is the typical survival rate for zebrafish under normal lab conditions. The results subjected to two way analysis using Graphpad prism software where it is showed non-significant with p value <0.0001. So it is indicated that the sample does not affect the embryonic development and function.

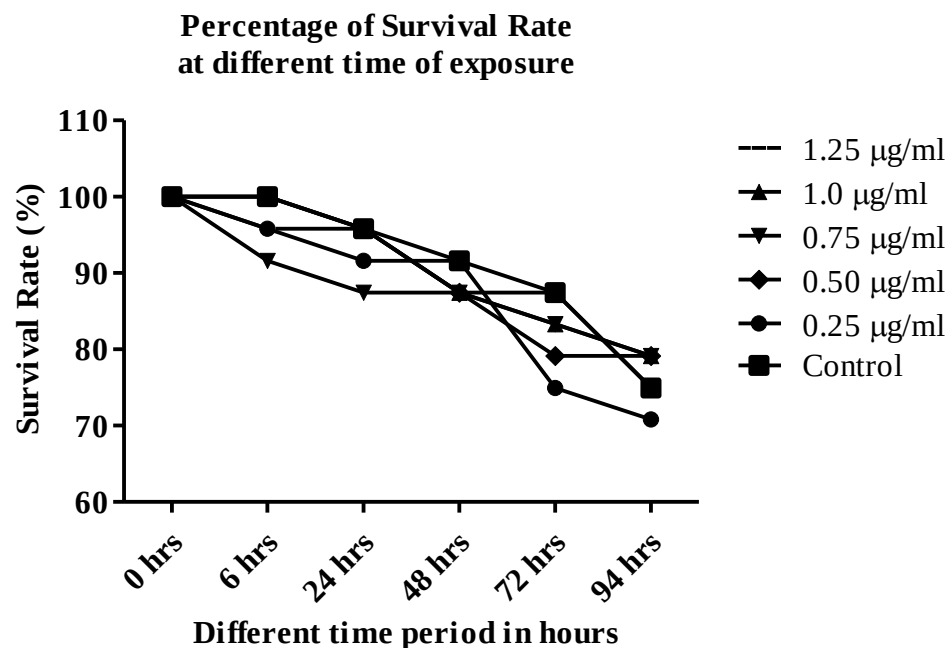


FIG.9 A

The graph B shows that the success of hatching rate of the eggs were approximately same in all doses. All the surviving eggs hatched from 24-48 hours post fertilization.

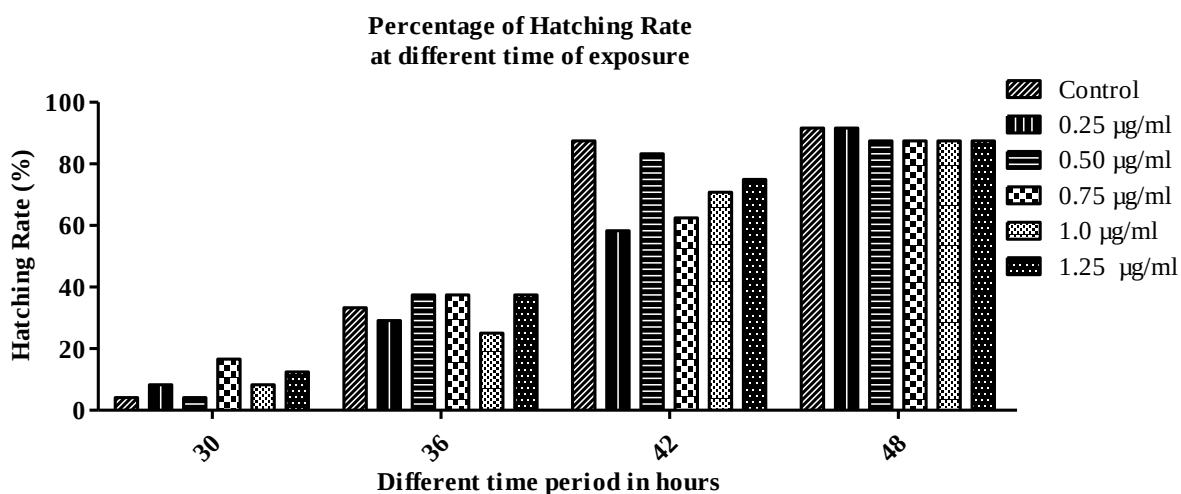


FIG.9 B

Heartbeat Count: (Heartbeat in counts/minute)

Conc. / Hour s	Contro l	0.25µg/ ml	0.5µg/ ml	0.75µg/ ml	1.0µg/ ml	1.25µg/ ml
48	137	140	134	133	142	135
72	143	138	139	131	149	142
96	136	146	145	142	132	138

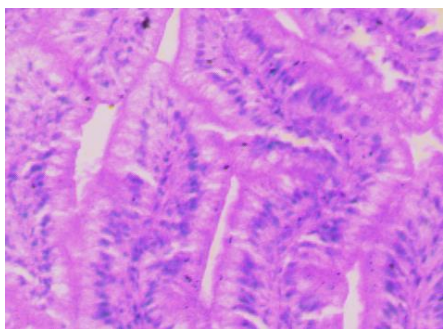
The results indicated showed that the sample doesn't have considerable effect on the embryonic development in Zebra fish embryo between 0.25µg/ml and 1.25µg/ml concentration. At this level the product doesn't have toxicity effect.

LC 50 Determination:

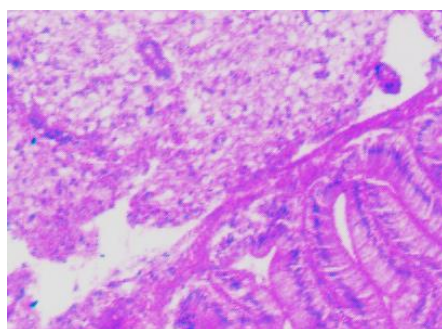
The sample was subjected to LC50 analysis in the range of 2, 4, 6,8 and 10 µg/ml for 7 days. For each group 12 fishes were taken and duplicated which includes treatment group with different concentration of sample and control. There were no mortality and behavioural changes observed upto 10 µg/ml. The dosage range was increased to 10, 20, 30, 40 and 50 µg/ml and observed for 7 days. In all dosages, fishes showed normal behaviors and no mortality was observed between 10 – 50 µg/ml. The dosage level further increased to 20, 40, 60, 80 and 100 µg/ml and kept under treatment for 7 days. There was no evident effect in the entire dosage range upto 100 µg/ml. The sample did not show any prominent toxic effect and abnormal behaviors throughout the treatment period in acute phase. Fishes from control group and treated group (various concentration of sample such as 20, 60 and 100 µg/ml) were sacrificed after 7 days of exposure. The collected Liver and intestine tissues were stored for histopathology analysis.

6. Histopathology:

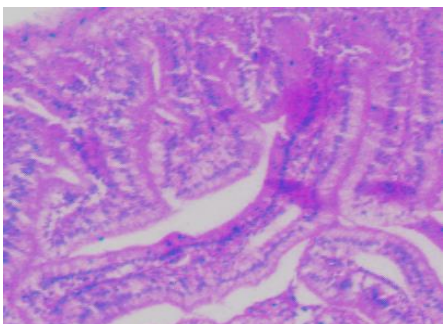
6.1.Intestine:



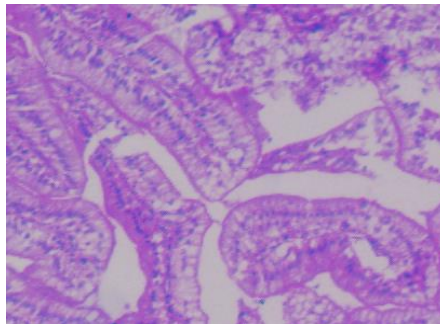
(a)



(b)



(c)

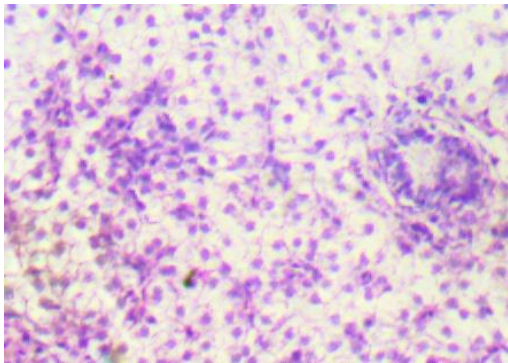


(d)

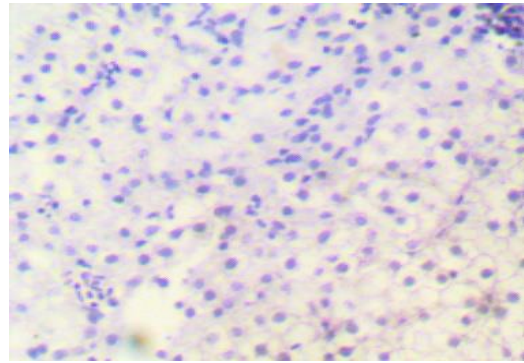
The histological results observed in the intestinal tissue of zebrafish in the present study indicate that there was no alteration in tissue architecture of intestine when treated with different concentrations of given sample. There was no accumulation of neutrophils observed, neutrophils were present in a

scattered manner. Intestine tissues in the Zebrafish control and treated group exhibited normal histology.

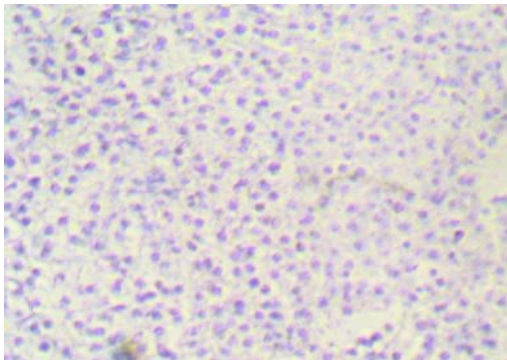
6.2.Liver:



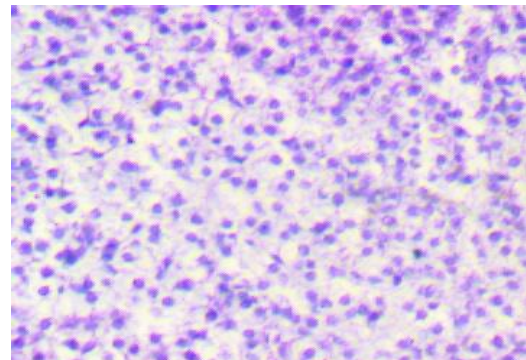
(a)



(b)



(c)



(d)

The histological results observed in the intestinal tissue of zebrafish in the present study indicate that there was no alteration in tissue architecture of Liver

when treated with different concentrations of given sample. There was no accumulation of neutrophils observed, neutrophils were present in a scattered manner. Liver tissues in the Zebrafish control and treated group exhibited normal histology.

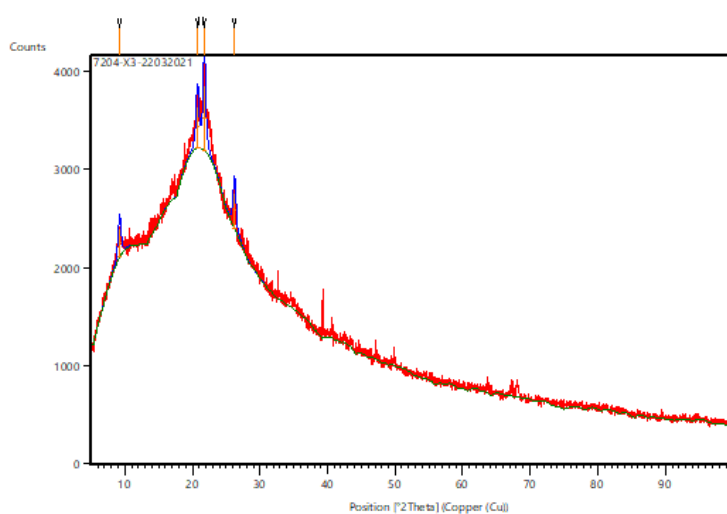
7. XRD

Anchor Scan Parameters

Dataset Name:	7204-X3-22032021
File name:	H:\XRD data\7204\7204-X3-22032021.xrdml
Sample Identification:	7204-X3-22032021
Measurement Date / Time:	22-03-2021 15:00:14
Operator:	Instrument
Raw Data Origin:	XRD measurement (*.XRDML)
Scan Axis:	Gonio
Start Position [$^{\circ}2\theta$.]:	5.0109
End Position [$^{\circ}2\theta$.]:	99.9849
Step Size [$^{\circ}2\theta$.]:	0.0220
Scan Step Time [s]:	58.3950
Scan Type:	Continuous
PSD Mode:	Scanning
PSD Length [$^{\circ}2\theta$.]:	5.54
Offset [$^{\circ}2\theta$.]:	0.0000
Divergence Slit Type:	Fixed
Divergence Slit Size [$^{\circ}$.]:	0.9167
Specimen Length [mm]:	10.00
Measurement Temperature [$^{\circ}\text{C}$.]:	25.00
Anode Material:	Cu
K-Alpha1 [$\text{\AA}$.]:	1.54060
K-Alpha2 [$\text{\AA}$.]:	1.54443
K-Beta [$\text{\AA}$.]:	1.39225
K-A2 / K-A1 Ratio:	0.50000
Generator Settings:	15 mA, 40 kV

Diffractometer Type: 207756
 Diffractometer Number: 0
 Goniometer Radius [mm]: 145.00
 Dist. Focus-Diverg. Slit [mm]: 95.00
 Incident Beam Monochromator: No
 Spinning: No

Graphics



Peak List

Pos.[°2Th.]	Height [cts]	FWHMLeft[°2Th.]	d-spacing [Å]	Rel. Int. [%]
9.2136	295.94	0.5196	9.59865	45.58
20.7417	421.55	0.5196	4.28253	64.92
21.7489	649.31	0.5196	4.08644	100.00
26.2229	365.88	0.5196	3.39851	56.35

Document History

Insert Measurement:

- File name = "7204-X3-22032021.xrdml"
- Modification time = "23-03-2021 11:54:31"
- Modification editor = "Dell"

Default properties:

- Measurement step axis = "None"
- Internal wavelengths used from anode material: Copper (Cu)
- Original K-Alpha1 wavelength = "1.54060"
- Used K-Alpha1 wavelength = "1.54060"
- Original K-Alpha2 wavelength = "1.54443"
- Used K-Alpha2 wavelength = "1.54443"
- Original K-Beta wavelength = "1.39225"
- Used K-Beta wavelength = "1.39225"
- Irradiated length = "10.00000"
- Spinner used = "No"
- Receiving slit size = "0.10000"
- Step axis value = "0.00000"
- Offset = "0.00000"
- Sample length = "10.00000"
- Modification time = "23-03-2021 11:54:31"
- Modification editor = "Dell"

Interpolate Step Size:

- Derived = "Yes"
- Step Size = "0.01"
- Modification time = "23-03-2021 11:54:31"
- Modification editor = "PANalytical"

Determine Background:

- Add to net scan = "Nothing"
- User defined intensity = "-5"
- Correction method = "Automatic"
- Bending factor = "12"

- Minimum significance = "0"
- Minimum tip width = "0"
- Maximum tip width = "1"
- Peak base width = "2"
- Use smoothed input data = "No"
- Granularity = "10"
- Modification time = "20-10-2020 14:44:29"
- Modification editor = "Dell"

Search Peaks:

- Minimum significance = "2.5"
- Minimum tip width = "0.3"
- Maximum tip width = "1"
- Peak base width = "2"
- Method = "Top of smoothed peak"
- Modification time = "25-08-2020 11:46:43"
- Modification editor = "Dell"

8. EB COMPOSITE

2021.02.20 14:47:26



HORIBA SZ-100 for Windows [Z
Type] Ver2.40

Undersize (%)

SZ-100

202102201424003.nsz

Measurement Results

Date : 20 February 2021
 14:24:47
 Measurement Type : Particle Size
 Sample Name : Si Ve6
 Scattering Angle : 90
 Temperature of the Holder : 25.1 °C
 Dispersion Medium Viscosity : 0.893 mPa·s
 Transmission Intensity before Meas. : 19347 Distribution
 Form : Standard
 Distribution Form(Dispersity) : Monodisperse
 Representation of Result : Scattering Light
 Intensity
 Count Rate : 140 kCPS

S.P.Area Ratio Mean S. D. Mode

Calculation Results

Frequency (%)

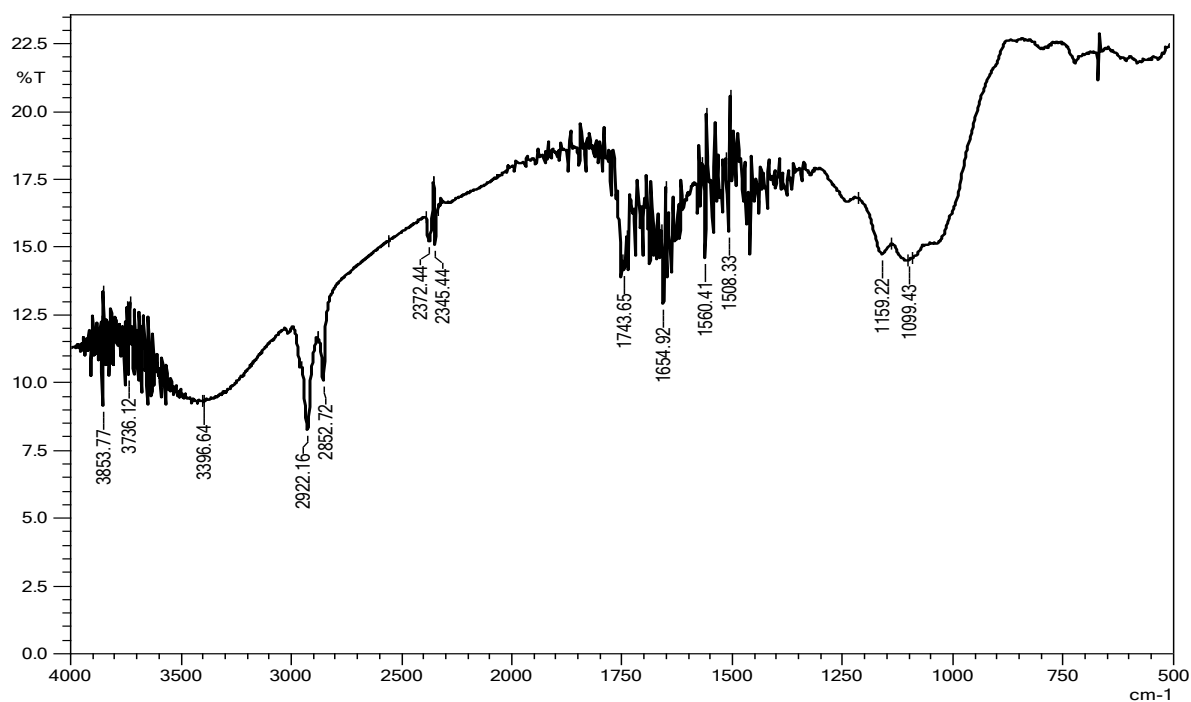
Peak No.	S.P.Area Ratio	Mean	S. D.	Mode
1	1.00	1130.6 nm	261.6 nm	1015.1 nm
2	---	--- nm	--- nm	--- nm
3	---	--- nm	--- nm	--- nm
Total	1.00	1130.6 nm	261.6 nm	1015.1 nm

Cumulant Operations

Z-Average : 2917.5 nm
 PI : 0.693

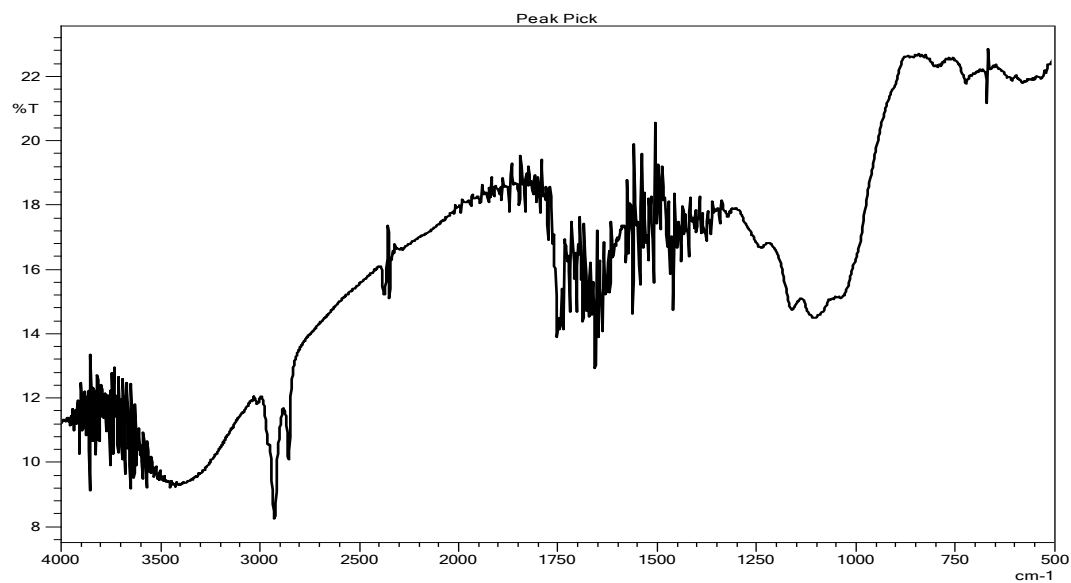
9.FTIR

9.1

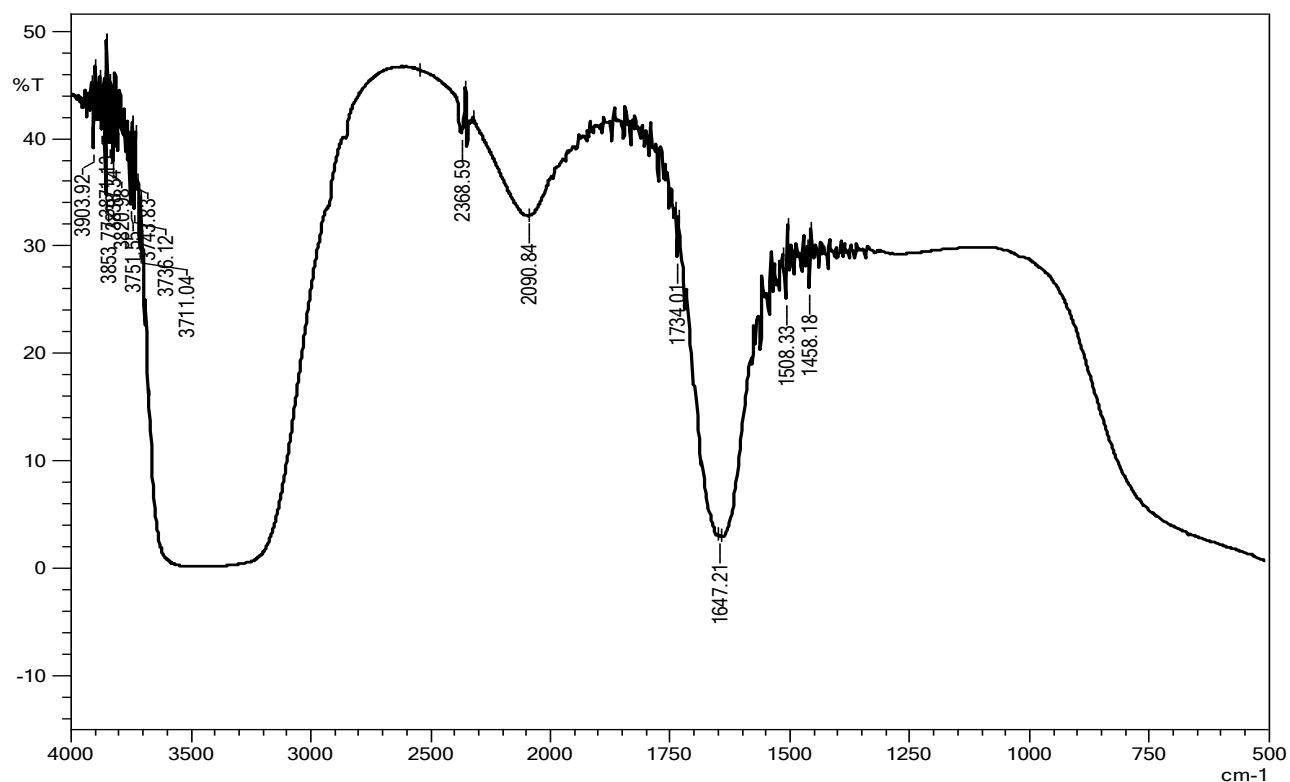


WAVELENGTH	FUNCTIONAL GROUP
3853.77	O-H (Alcohol Group)
3736.12	O-H (Carboxylic Group)
3396.64	Bonded N-H/C-H/O-H Stretching from amines and amides
2922.16	C-H
2852.72	Carboxylic Acid
2372.44	C-N
2345.44	C-N
1743.66	Ketones
1654.92	Diketones
1560.41	Diketones
1508.33	C=N
1159.22	Polysaccharides
1099.43	Polysaccharides

9.2



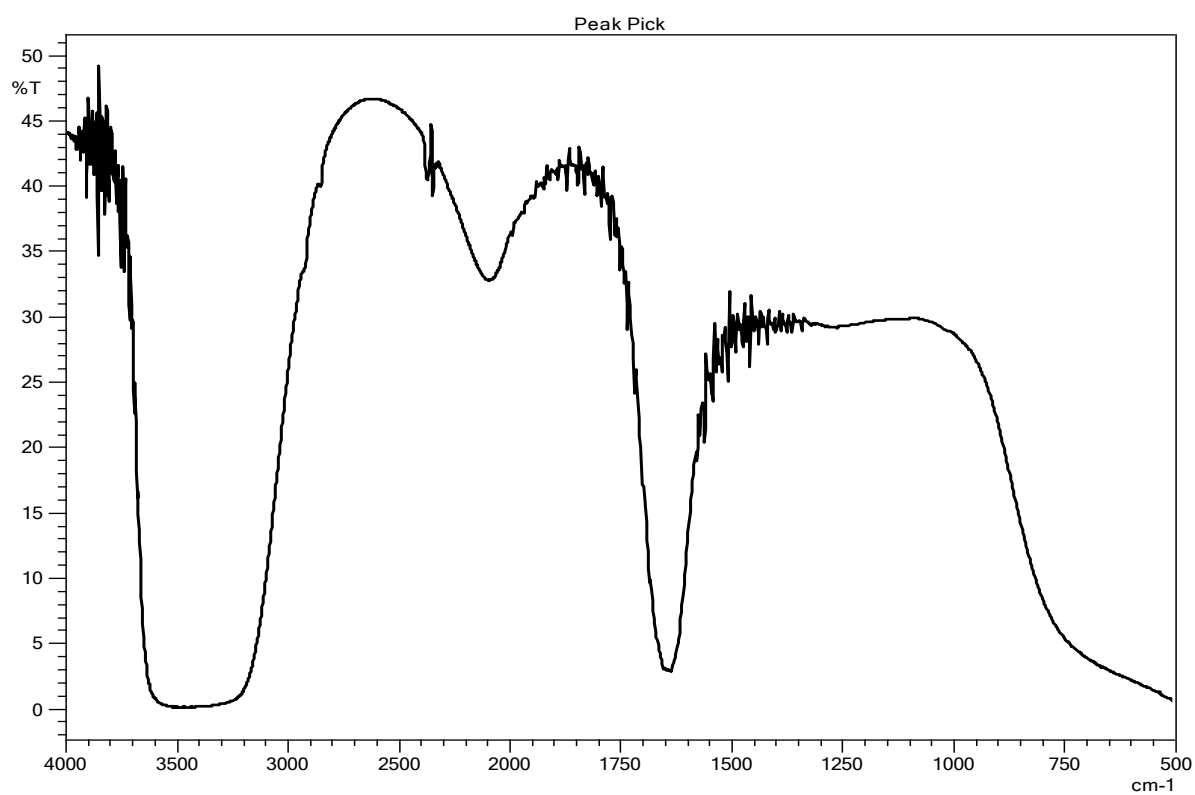
9.3



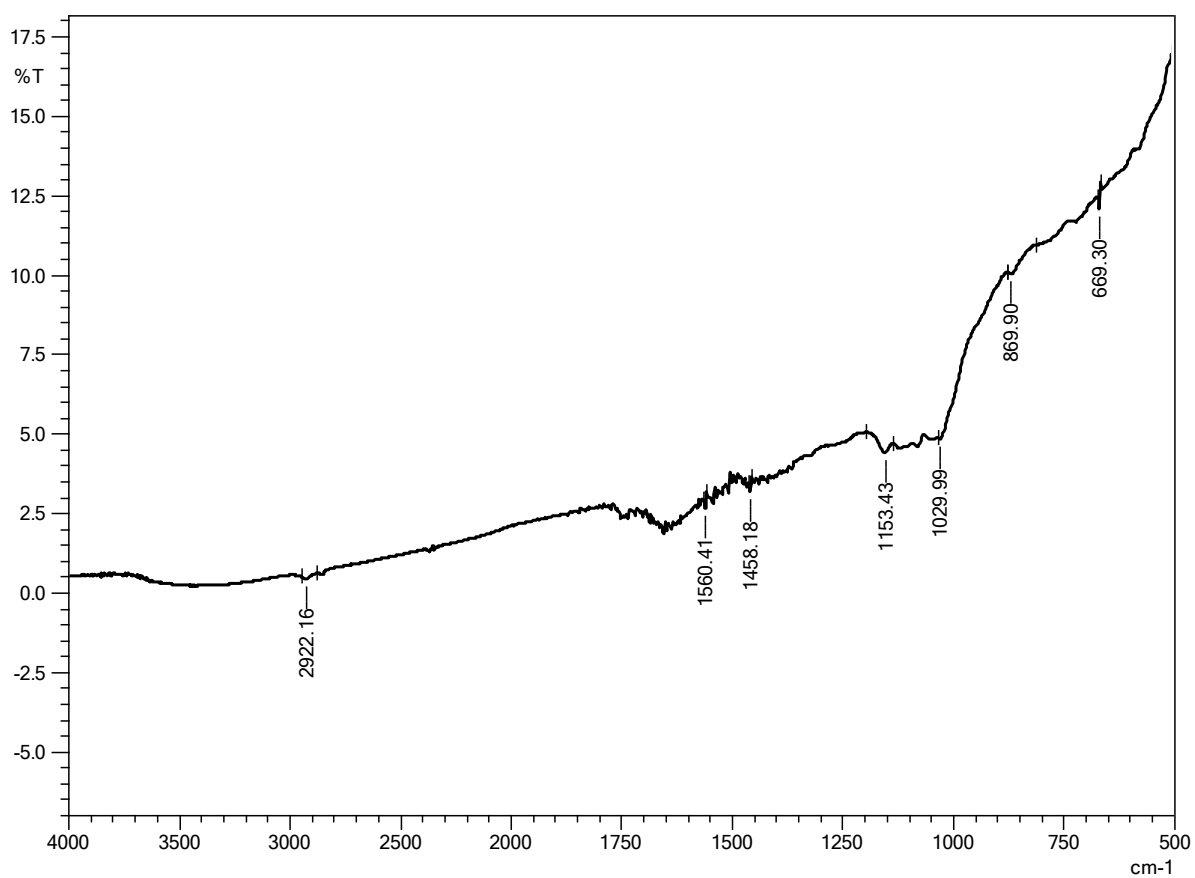
WAVELENGTH	FUNCTIONAL GROUP
------------	------------------

3803.93	O-H
3853.34	O-H
3751.55	Amides
3743.83	Amides
3736.12	Amides
3711.04	Amides
2368.59	C-O bonds
2090.84	C=C stretching bonds of alkynes molecules
1734.01	Ketones
1647.21	Diketones
1508.33	Phenol rings
1458.18	Phenol rings

9.4

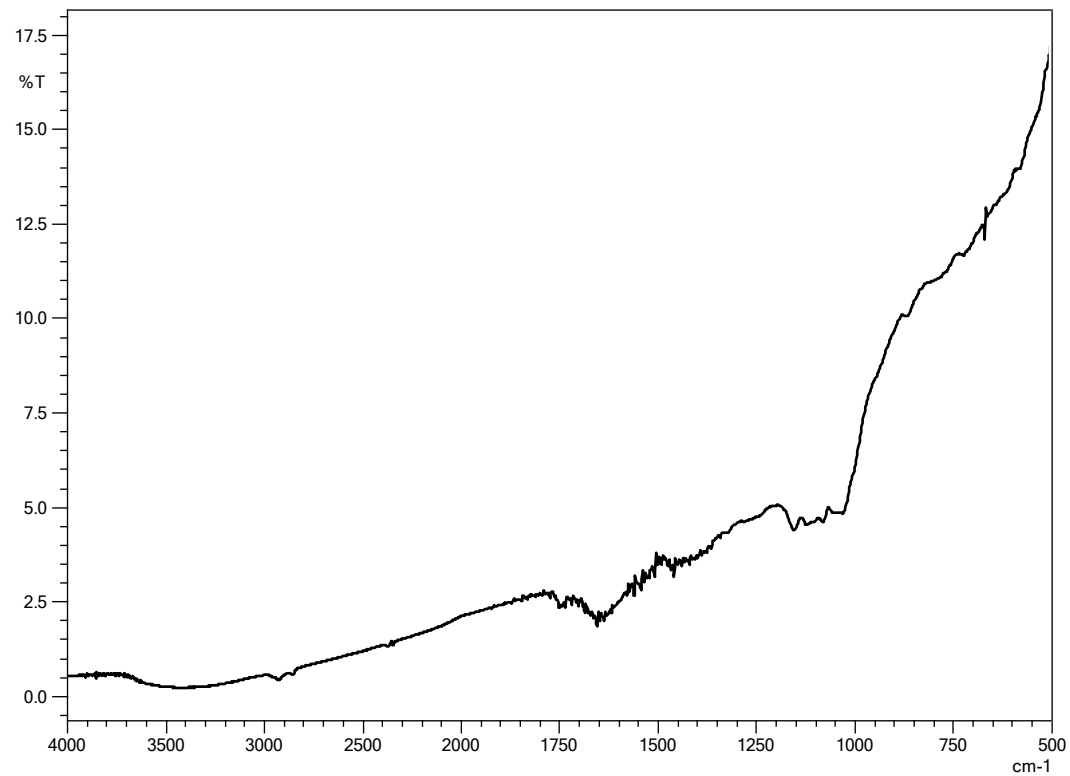


9.5



WAVELENGTH	FUNCTIONAL GROUP
2922.16	Methyl Group
1560.41	Phenol Ring
1458.18	Phenol Ring
1153.43	Alkyl Amines
1029.99	Alkyl Amines
869.90	C-H
669.30	C-S linkage

9.6



10.AFM

The following are the results of AFM shown at different μm :

10.1

At 4x4 μm

10.1.1

2D Images

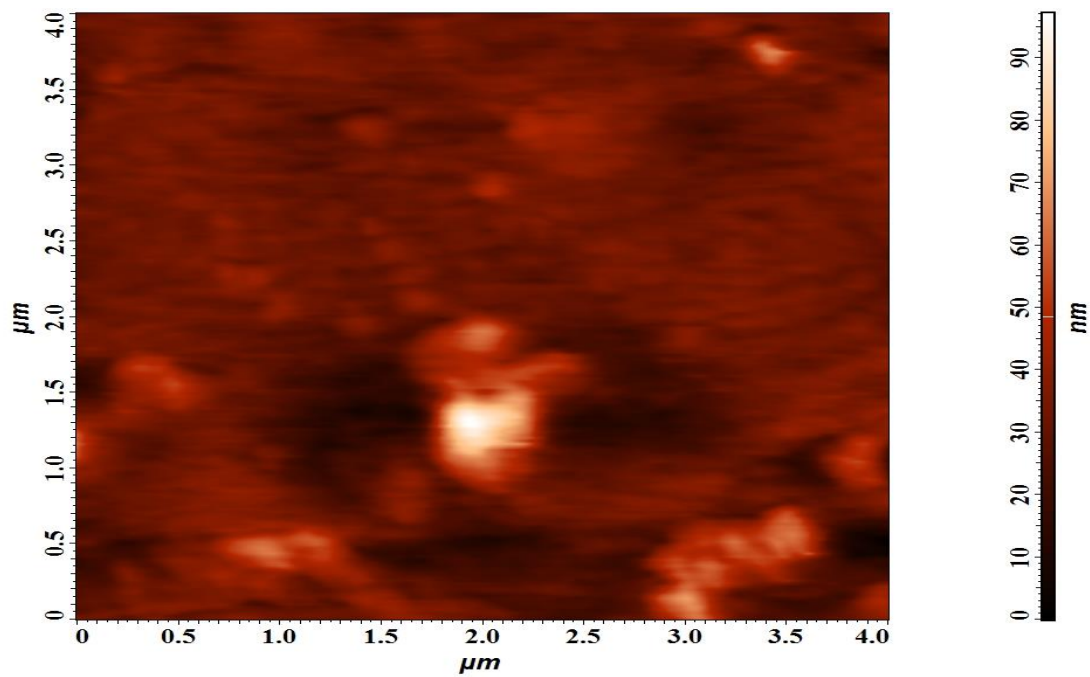


FIG.10

10.1.2

3D Images

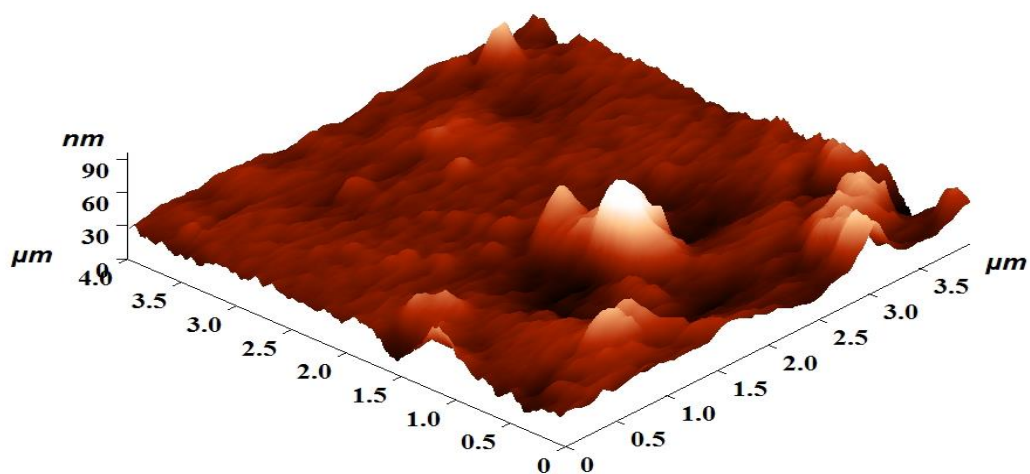
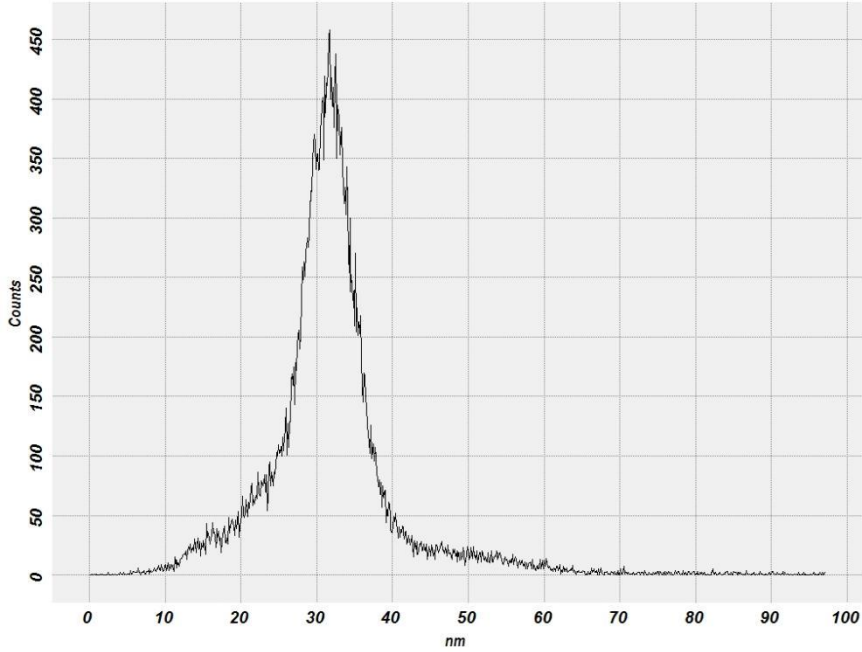


FIG.11

10.1.3

HISTOGRAM



10.1.4

X SECTION @ 2430nm

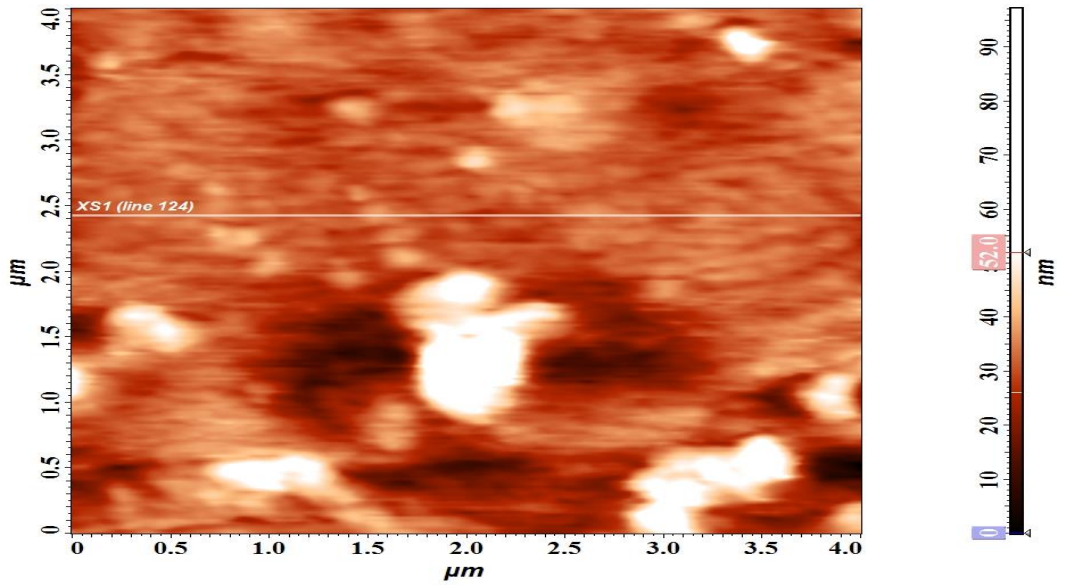


FIG.12

10.1.5

X SECTION @ 3040NM

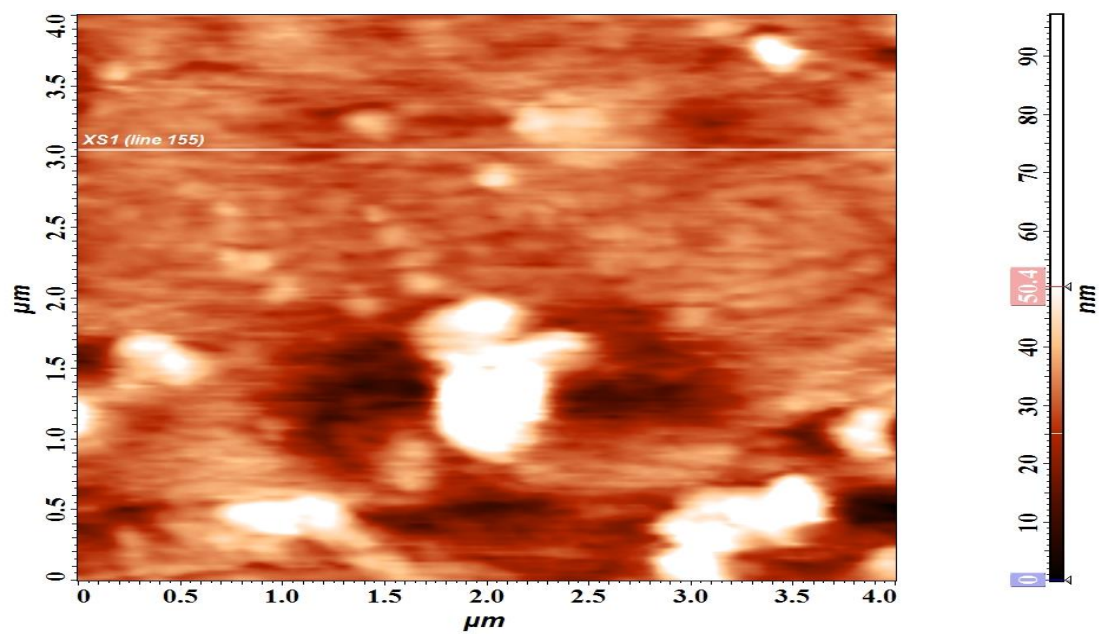


FIG.13

10.2

At 10x10 μm

10.2.1

2D Images

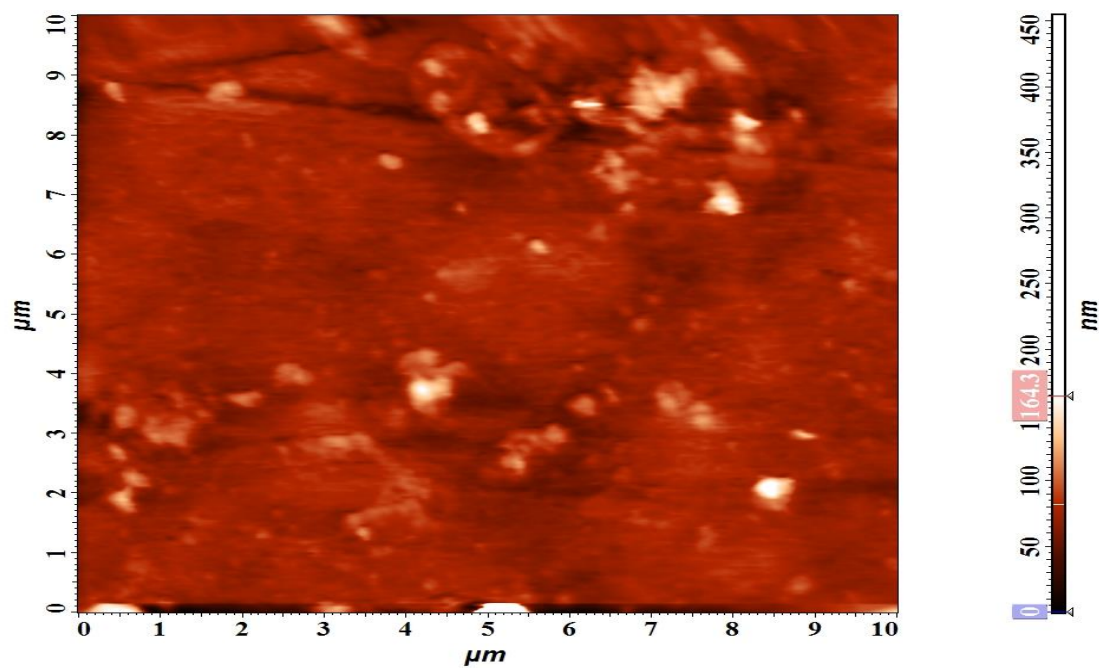


FIG.14

10.2.2

3D Images

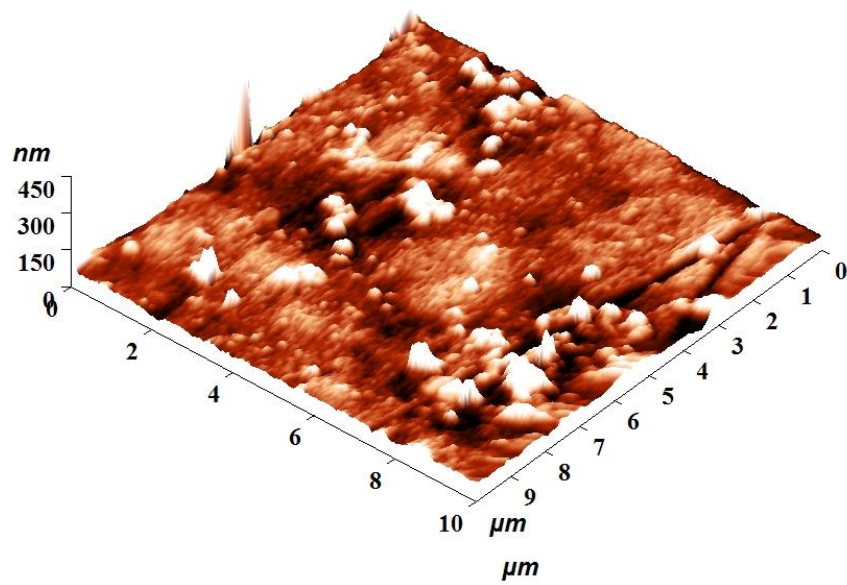
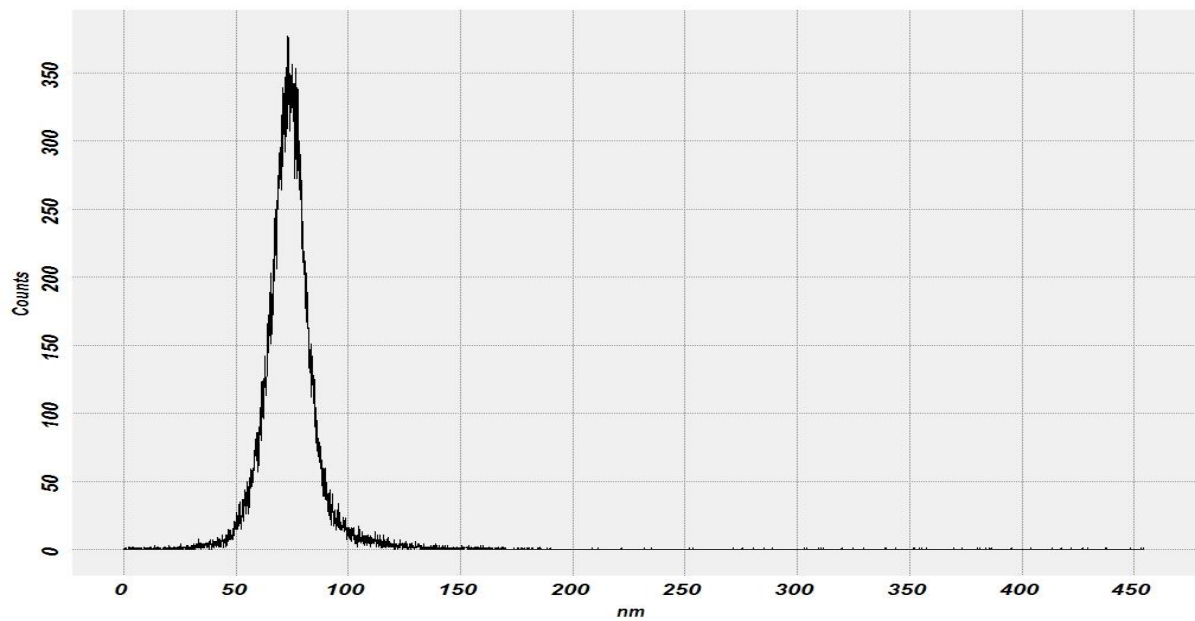


FIG.15

10.2.3

HISTOGRAM



10.2.4

X SECTION@2820nm

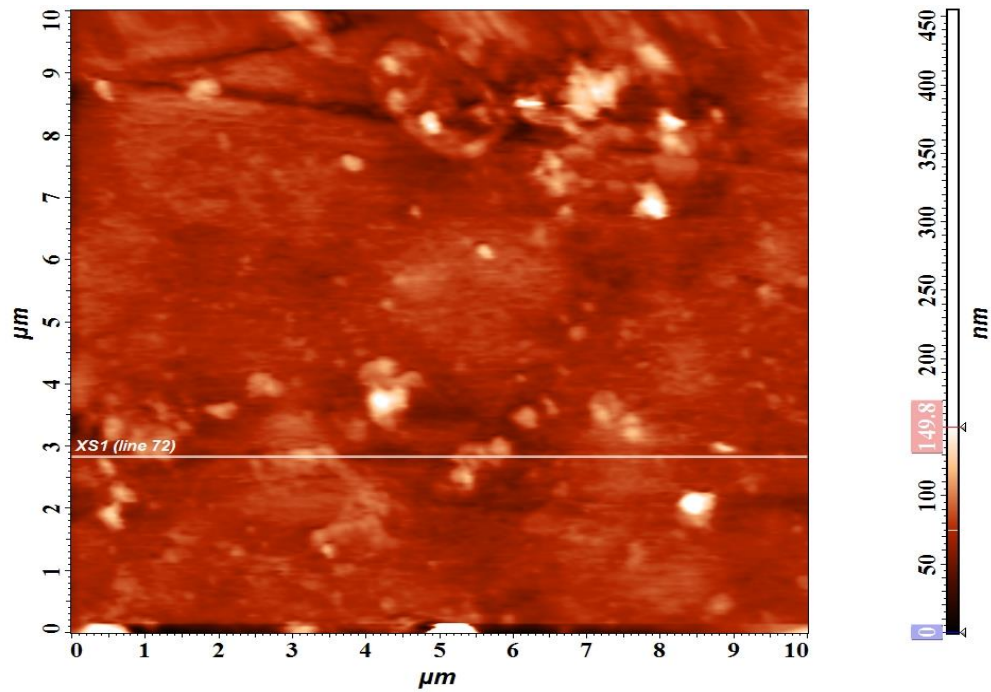


FIG.16

10.2.5

X SECTION@5450nm

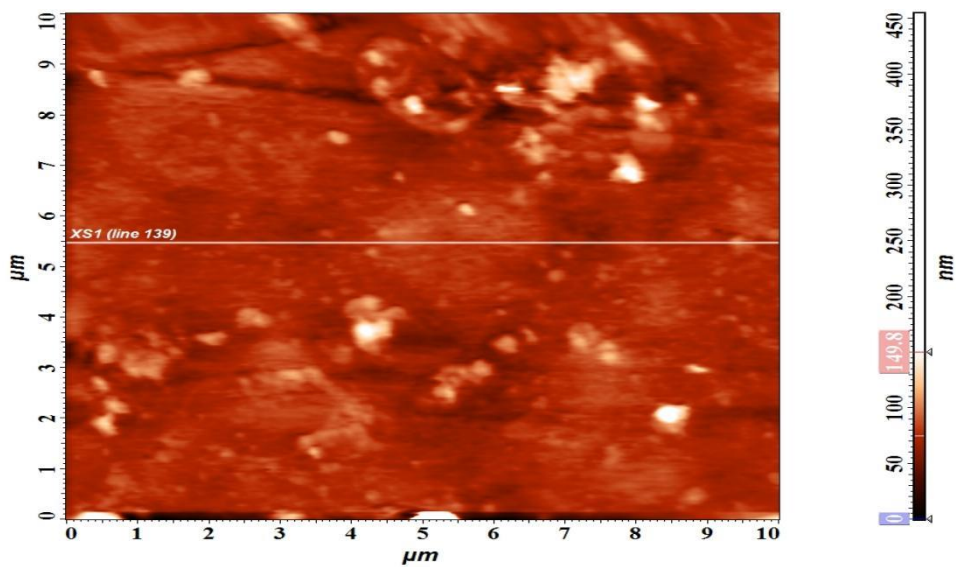


FIG.17

10.3

At 40x40um

10.3.1

2D Images

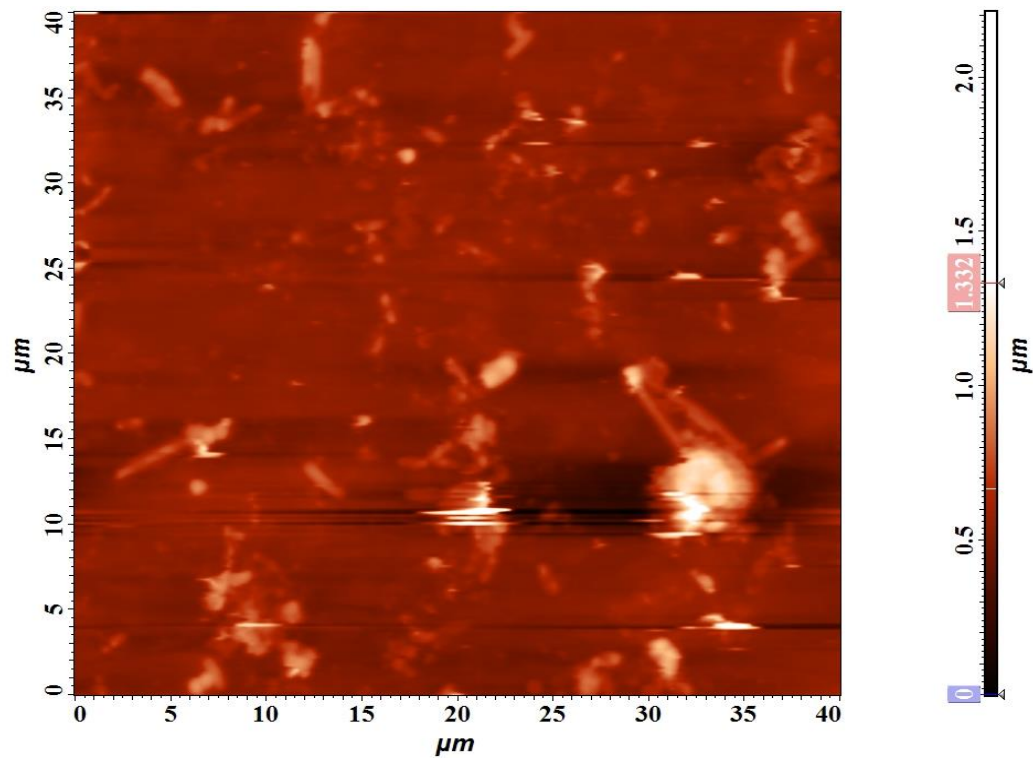


FIG.18

10.3.2

3D Images

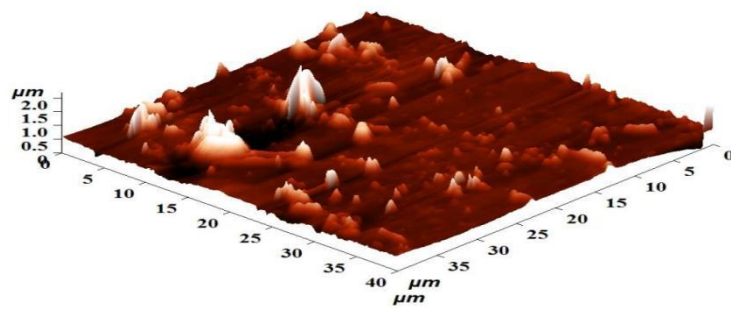
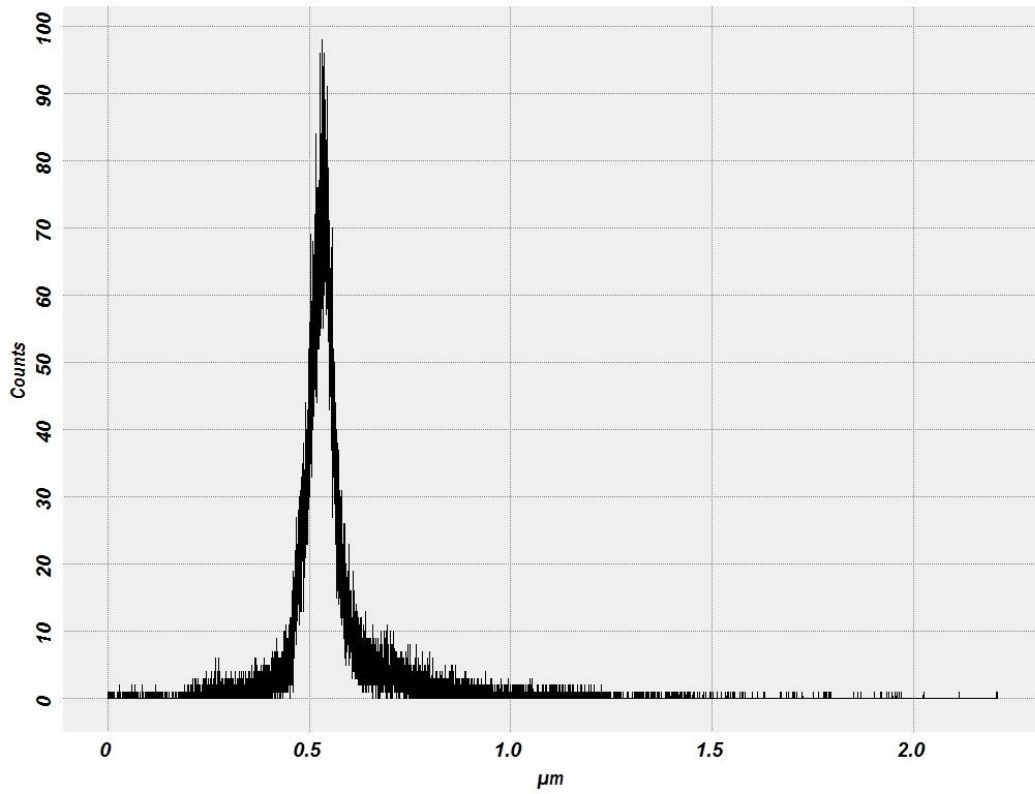


FIG.19

10.3.3

HISTOGRAM



10.3.4

X SECTION@6400nm

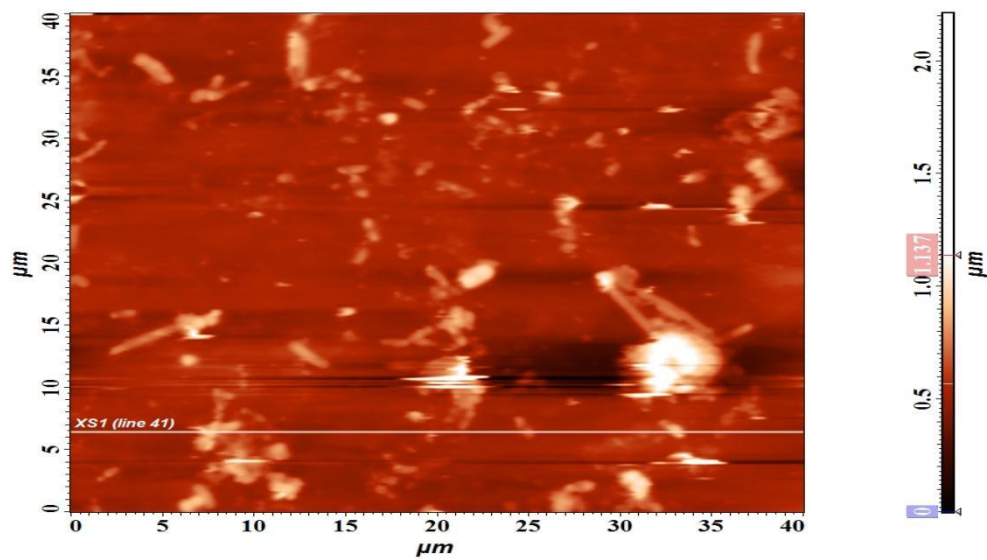


FIG.20

10.3.5

X SECTION@28700nm

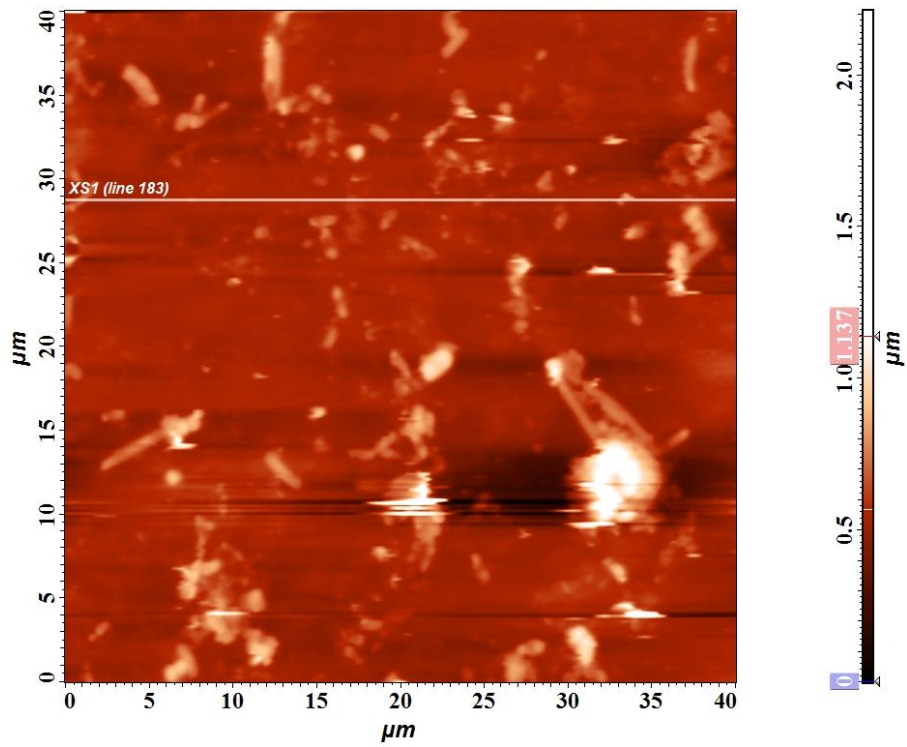


FIG.21

11 FESEM

11.1

At X250

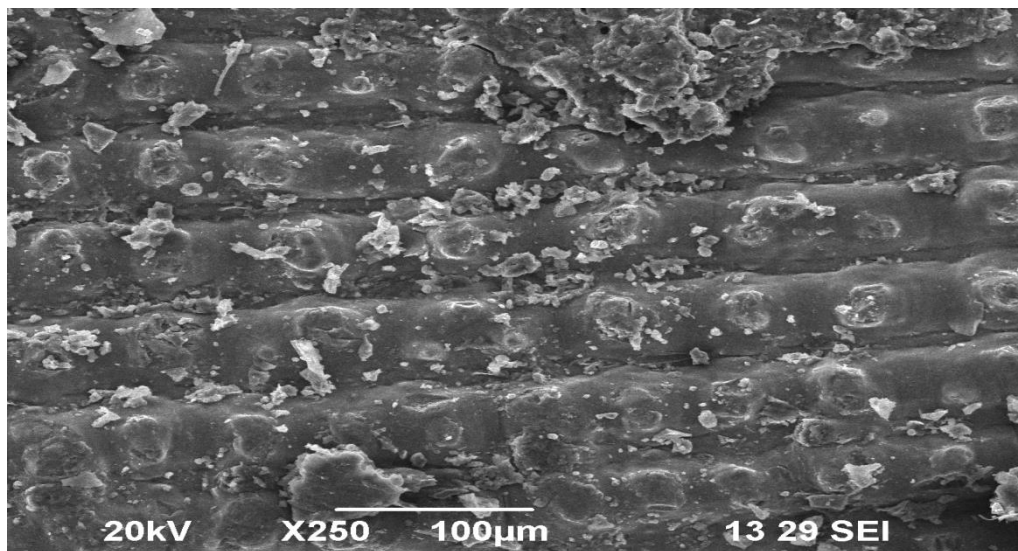


FIG.22

11.2

At X500

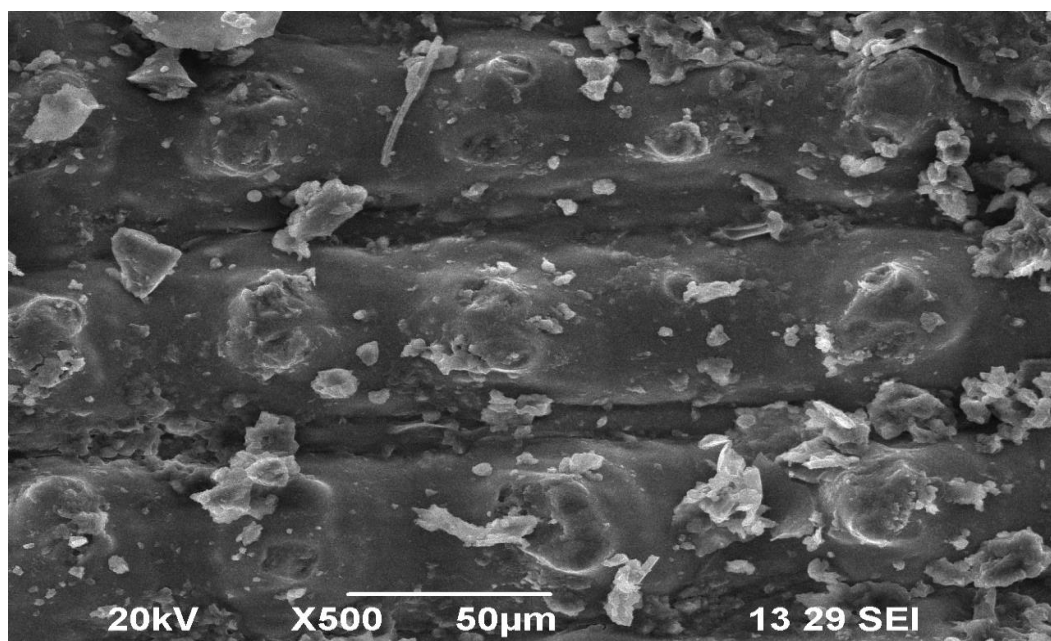


FIG.23

11.3

At X1000

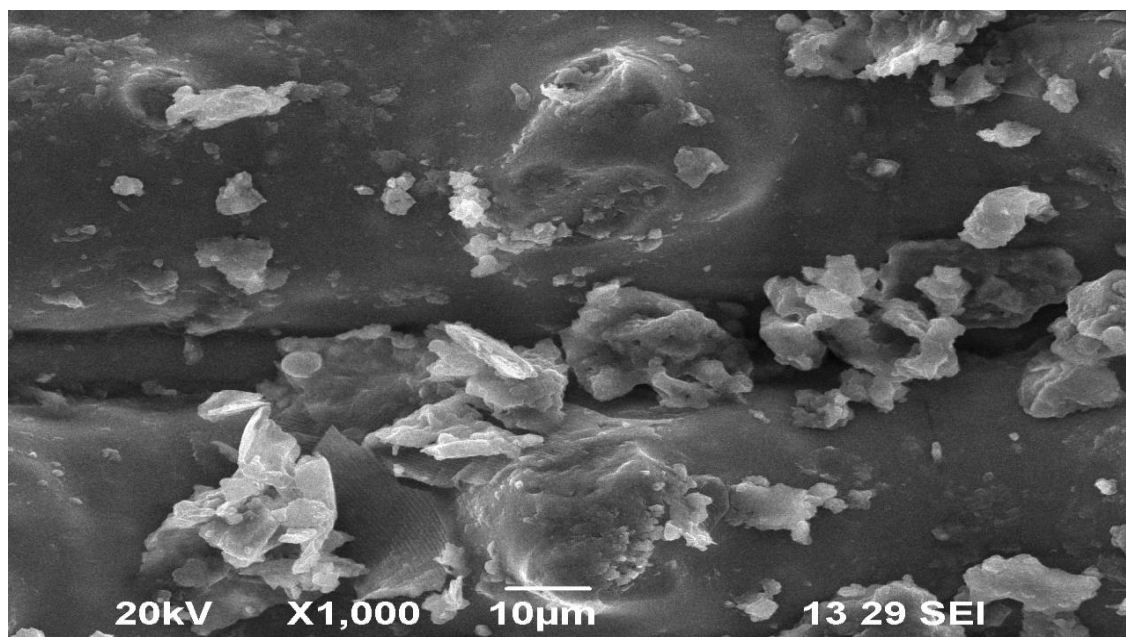


FIG.24

11.4

At X2000

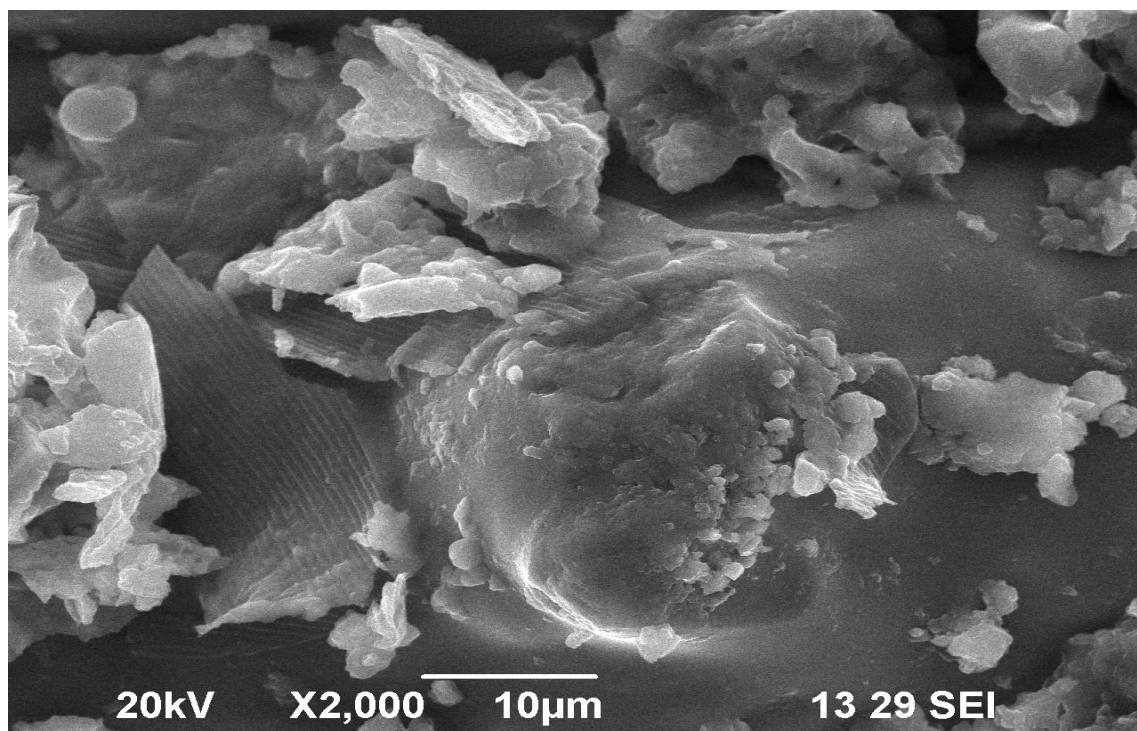
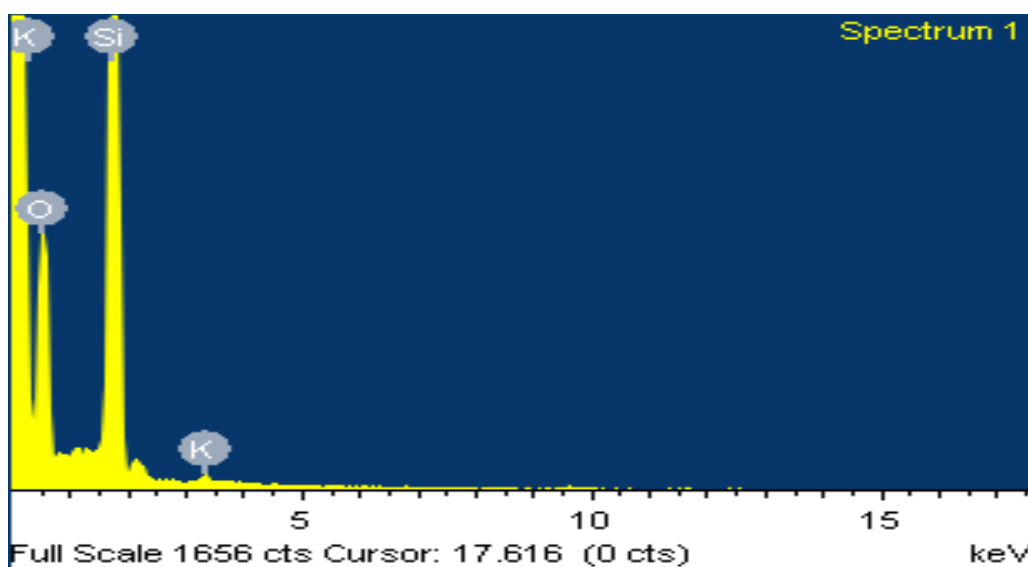


FIG.25

12 EDAX

12.1

GRAPH



13. REFERENCE

- **Sarkar, D. J., Majumder, S., Kaushik, P., Shakil, N. A., & Kumar, J. (2019). Controlled Release of Pesticide Formulations. Applications of Encapsulation and Controlled Release, 229.**
- **Roy, A., Singh, S., Bajpai, J., & Bajpai, A. (2014). Controlled pesticide release from biodegradable polymers. Open Chemistry, 12(4), 453-469.**
- **Singh, A., Dhiman, N., Kar, A. K., Singh, D., Purohit, M. P., Ghosh, D., & Patnaik, S. (2020). Advances in controlled release pesticide formulations: Prospects to safer integrated pest management and sustainable agriculture. Journal of hazardous materials, 385, 121525.**
- **Allan, G. G., Chopra, C. S., Neogi, A. N., & Wilkins, R. M. (1971). Design and synthesis of controlled release pesticide-polymer combinations. Nature, 234(5328), 349-351**