Analysis of Elemental distribution in selected edible plants grown under different conditions: Quantification and imaging and catalytic activity of green synthesized nanoparticles

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By

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DECLARATION

I declare that the dissertation entitiled "**Analysis of Elemental distribution in selected edible plants grown under different conditions: Quantification and imaging and catalytic activity of green synthesized iron nanoparticle**" submitted by me for the **Degree of Master of Philosophy** (M.Phil) is the record of the work carried out by me during the period from 2018 to 2019 under the guidance of **Dr.P.Lalitha, M.Sc., M.Phil., Ph.D.,** Associate professor, Department of Chemistry, Avinashilingam Institute For Home Science and Higher Education for Women, Coimbatore and has not formed the basis for the award of any Degree, Diploma, Associateship, Fellowship Titles in this university or any other University or other similar institution of Higher Learning.

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Signature of the Candidate

CERTIFICATE FROM THE SUPERVISOR

I certify that the dissertation entitled entitled "**Analysis of Elemental distribution in selected edible plants grown under different conditions: Quantification and imaging and catalytic activity of green synthesized nanoparticle**" submitted by me for the **Degree of Master of Philosophy** (M.Phil) is record of research work carried out by her during the period from 2018 to 2019 mu guidance and supervision and that this work not formed the basis for the award of any Degree, Diploma, Associateship, Fellowship, Titles in this university or any other University or other similar institution of Higher Learning.

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designation

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1.Introduction

The edible plants have good dietary factor for human health. We eat those plants so that we have nutrients.The edible plants such as fenugreek (***Trigonellafoenumgraecum L.),*** mustard ***(Brassica juncea L.),*** coriander ***(Coriander sativum L.),***Greens ***(Amaranthuscruentus L.,)***Pea ***(Vignaradiate L.)*** have many medicinal properties. Medicinal benefits of fenugreek includesuse in diabetes, anaemia, wounds, inflammation etc. Its leaves are used for cooking as an ingredient. Mustard seeds are used for cooking purpose and are also used for the production of oil. Health benefits of mustard include use in asthma, high anti-inflammatory effect and for reducing blood pressure. Coriander is the most common ingredient in cooking and1 gives good flavour. The medicinal propertiesinclude antioxidant, antifungal and antiseptic. It has good digestive properties, relief from acne and pimple. *Amaranthuscruentus* **(lajollamom.com)**seed and oil which contains fiber can lower cholesterol and risk of cardiovascular diseases. It was commonly known as red amaranth. *Vigna radiate L.* can reduce chronic diseases (**riskhealthline.com)**.

These five plants are hence chosen for study in the present research work.The growth of plants is affected by several factors. We are affected by eating affected plants. Among the various factors affecting plant growth radiation is the one of the factors which may affect the plant growth. The growth of the plants differsin polluted and non-polluted areas. The plants which are grown under polluted areas like heavy traffic areas or in parking areas of residential places may take up heavy metalsfrom exhaust. On consumption, these metals are accumulated in our body.***This metal hazard is the impetus behind choosing this study***. The aforesaid plants would be grown in different growth conditions and metal accumulated in leaves would be analyzed.

Radiations may cause damages to plants DNA. The COMET ASSAY is the one of the method to analyse the changes in DNA of plant tissue. It is also call single cell gel electrophoresis.DNA integrity of *Nicotianatabacum L.* and*Viciafaba L.* with different stages of the leaf were analysed using single cell gel electrophoresis (comet) it is also called alkaline assay by which decrease in DNA integrity with ageing of the leaf was concluded. The lesion of DNA was observed by using three different protocols**(Koppen*et al, 1999*).** The comet assay or single cell gel electrophoresis are used to detect genotoxity of plants at the level of single cell. Comet assay aimed to provide an over view of evolution of measurement of DNA damage level and to summariseand critically analysed the advantages and disadvantages of different approach currently being adopted whilst using this assay **(Kumaravel*et al, 2007*)**.

The single cell gel electrophoresis was preformed for the radish sprouts which is exposed to the varied of light condition. The DNA damage was found to be restored to an appreciable extent when the plants were fed with antioxidants such as ascorbic acid and green tea extract, suggesting that DNA damage from strong light can be caused by photo oxidative stress generated by the excess energy over a scavenging capacity of antioxidative defence mechanisms in the plant cell**(Ojima,*et all,* 2009).**

Single cell gel electrophoresis has the ability to measure the DNA damage level. The repair insingle cell prepared fromyeast, protozoa, plants, invertebrates and mammalscan also be studied using this assay their application is now ranging from human and sentinel animal bio monitoring**(Peggy *et al,* 2006).**

Heterogeneity in radiation induced DNA damage and its repair in normal and tumor cell with in the mouse was assessed. Heterogeneity change induced to DNA damage level by ionization radiation. Most of the cell repaired the damage in 30 min following exposure to 15Gy. The heterogeneity was in response through the cell cycle**(Peggy *et al,* 1990).**

TheDNA damage in sperm of 60 unselected grouping of men after IVN treatment was analysed using comet assay. The semen and treatment cycle are not different in men group according to the high and low sperm DNA damage. However, regression analysis showedthat DNA damage was positively associated with age (29-44 years), abnormal sperm and motility and negatively associated with sperm concentration. High loads of DNA damage measured by the comet assay were predictive of failure of embryo development after ICSI **(Morris *et al, 2002*)**. In this assay apart from image analysis, which greatly facilitates and enhances the possibilities of comet measurements, the cost of performing the assay is extremely low. The comet assay has already been used in many studies to assess DNA damage and repair induced by various agents in a variety of cells *in vitro* and *in vivo***(Gunter *et al*, 1999)**

Single cell gel electrophoresis is also used to detect the DNA damage in aquatic animals. It is an inexpensive method to measure the DNA strand breaks.The comet assay to determine DNA strand breaks in aquatic animals exposed to genotoxicants both *in vitro* and *in vivo*, including assessment of DNA damage in aquatic animals collected from contaminated sites. One difficulty in using the comet assay in environmental work is that of comparing results from studies that used different methods, such as empirical scoring or comet tail lengths. There seems to be a consensus in more recent studies to use both the intensity of the tail and the length of the tail, i.e. DNA tail moment, percentage of DNA in the tail (**Richard et al, 2003).**

The comet assay is the simple, rapid and inexpensive method to detect the DNA damage level. The existing protocol of comet assay is used to analyse the DNA damage in mammalian cell (**Martin et al, 1993**).

The genetoxity of fish and their aquatic animals can be studied by using comet assay. The DNA strand breakages can be achieved by alkaline elution, alkaline unwinding by single cell gel electrophoresis technique comet assay. The analysis of organism exposed to polluted water or sediment have implicated DNA strand breakages as arelatively sensitive, rapid and specificity indicator of genetoxity pollutants exposure **(Metchelmore*et al, 1998*).**

The single cell gelelectrophoresis has gained wide spread acceptance as cheap and simple genetoxity test, but it requires a computer- assisted image analysis system **(Helma*et al, 2000*).** The alkaline single cell gel electrophoresis wasadopted for detecting DNA damage. Increase in DNA damage level for the workers who are exposed to the lead. Their DNA damage was analysed by using comet assay**(Danadevi*et al, 2003*).*The aforesaid review of literature prompted us to take up Comet assay as a tool in establishing the DNA damage of the leaves.***

Nanomaterials have played a wide role in application as a catalyst. Nano technology is ability to measure, see, manipulate and manufacture the things in atomic or microscale level, usually between one and 100 nanometers. Physical and chemical methods have been extensively used for the preparation of nanoparticles**(Saif*et al, 2016*)** chemical or physical method requires very toxic reagents for the preparation of nanoparticle. In turn the green synthesis does not require such toxic reagents.

Iron belongs to D block, period 4 in periodic table. It is the fourth most abundant element. It is found in minerals such as hematite and magnetite. It is a strong, ductile and malleable metal. Nano-iron particle are sub-micrometer particles of iron metal. Iron is high reactive to both air (oxygen) and water, and in nanoparticles it is even more rapid than the bulk material. This characteristic limits its use to inert environments**(azonano.com).**

Iron nano particle are non toxic in nature they are readily react to form iron oxides. Fe nanoparticle possess high magnetic nature, high surface area, electrical and thermal conductivity**(nanoshell .com).** There are conventional method to approach the preparation of iron nanoparticlei) top down method ii) bottom up approach. The top down approaches such as physical method thermal decomposition, sonochemical synthesis, vacuum sputtering. The bottom up method is a production of nano materials by green synthesis some of traditional methods are co precipitation, hydrothermal method and hydrolysis.Preparation of nanoparticle using chemical reagents which are toxic to the ecosystem. Plant extract plays an

important role in green synthesis of iron nanoparticles **(Devatha*et al, 2016*)**because of eco friendliness.

Methods of Preparationof iron nanoparticle include Coprecipitation, Thermal decomposition**,** Microemulsion, Hydrothermal synthesis,Sonochemical synthesis etc.(**Kammari*et al, 2017*). ***Of these co-precipitation method has been chosen in the present study. Considering the green aspects of use of plant extracts, aqueous extract of Amarathus has been chosen as reducing and capping agents for preparation of iron nanoparticles.***

The phytochemical screening is more important for the leaf extract. Different plants have different phytochemical constitution. Different parts such as leaf, bark, flowers have different phytochemical constituents.

Iron oxide nanoparticle are used in diagnostic fields, biomedical and drug delivery, magnetic iron oxide nanoparticles have been observed to accumulate in liver, spleen, lungs and brain after in halation showing its ability to cross the BBB **(Formenti*et al, 2014*)**

Their super paramagneticproperties are used in a rapidly expanding number of applications, such as for cell labeling, separation, and tracking; for therapeutic agents, cancer therapy and for diagnostic agents. It was synthesized by co precipitating ferrous (Fe^{2+}) and ferric (Fe^{3+}) ions in aqueous solution which is simplest pathway to obtain large quantities of magnetite nanoparticles **(Young Hoe *et al, 2014*).**

The two biocompatible forms of iron oxide are magnetite (Fe3O4) and the oxide form maghemite (γ-Fe3O4) magnetic fluids, data storage, catalysis and bio medical applications are some of the key applications **(Acharya*et al, 2017*).** Nanoparticles of metal, with a wide range of dimensions, are anticipated to yield size-dependent optical, electronic, magnetic and chemical properties suitable for applications in optoelectronic devices, catalysts and chemical and biosensors. In view of these bright application prospects of metal nanoparticles, many investigations have already been carried out to examine heterogeneous catalysis by, and magnetic properties of, these nanoscale species**(Lin Guo*et al, 2001*).**

The green synthesis of zero valent iron nanoparticle has been recently proposed as a cost effective,Environmental friendly alternative to chemical and physical methods.Since a variety ofmaterials from bio-renewable natural sources can be employed**(Lanlan Huang *et al,2014*).**

In view of the several applications of iron nanoaprticle the catalytic activity is the one we aimed to do. The catalytic activity was tested in hydrogenation of aldehyde to ketones

The reduction of carbonyl compounds to the corresponding alcohols is an important transformation in organic synthesis1,2and an important step in the synthesis of biologically active compounds.A variety of reducing systems are available to carry out reductions reaction including Raney nickel **(MazaahirKidwai*et al, 2006***).

Reduction reactions of carbonyl compounds to primary and secondary alcohols possess one of the important classes oforganic reactions that are well used in synthetic chemistry. Such reactions find immense applications in chemicalindustries related to fine chemicals, pharmaceuticals,perfumes, and agrochemicals. Transition metal catalyzedreduction reactions are considered as popular substitutesof platinum metal based catalysts. Cost effectiveness, abundance,stability, recyclability, environmentally benign, andrelatively nontoxic are some of the reasons for the importantrole of transition metals in catalysis.**(Parimala*et al, 2014*).** Iron nanoparticleshave beenreported to be effective catalysts inmany reduction reactions.The reduction of carbonyl compounds is a fundamental transformation in synthetic organic chemistry. Selectivity of hydrogenation reaction is important in both homogeneous and heterogeneous catalytic process. The specific target in hydrogenation process is unsaturated bonds, such as C=C, C=C, or C=O, leaving other unsaturated bonds within the molecule (or in other molecules) unaffected.1 The selective hydrogenation of organic compound also having different functional groups to be hydrogenated is not an easy goal in synthesis of fine chemical.2 Catalytic hydrogenation is the most convenient, versatile, and environment friendly and adequate methods for organic synthesis.**(Muhammad Tariq Shah *et al, 2015*).**

Natte*et al (2015*) reported a novel, general, convenient and inexpensive method for the reduction ofaromatic aldehydes to the corresponding benzylic alcohols. Various aromatic aldehydes werereduced in good to excellent yields by using well-defined iron-complex as the catalyst precursorand using paraformaldehyde and water as the hydrogen source.

Surface functionalized magnetic iron oxidenanoparticles (NPs) are a kind of novel functional materials,which have been widely used in the biotechnology andcatalysis **(Wei Wu *et al, 2008*)**

Hence in the present work the catalytic activity of green synthesized iron nanoparticles were used as a nanocatalyst in the hydrogenation of aldehyde to alcohol.

The characterization of nanoparticle is always a challenge to nanochemists. In the current era, technology development aids the process and has largely simplified the techniques and methods. Iron oxide nanoparticlehave been characterized by several techniques like UV-visible, FT-IR, FESEM etc.

UV/Vis absorption showed a characteristic absorption peak of iron oxide nanoparticles in the expected range of 250-350 nm. Fourier Transform Infrared Spectroscopy measurement was carried out to identify the possible molecules like carbonyl, -CH and -OH band.

Field Emission Scanning Electron Microscopy (FESEM) was used to analyse the size and shape of the nano particle.

Present study is focused on growing five edible plants and analysis of its selected physical characteristics and elemental composition . The growth of the plants is maintained in both polluted and non- polluted area. DNA damage analysis for radiation assisted plants has been carried out by COMET assay. Out of five plants Amaranthusis comparatively rich in iron content. Hence this extract has been chosen owing to its non- toxic nature . The applications of iron nanoparticles has been reviewed and selectively tested for its catalytic activity in hydrogenation reaction.

OBJECTIVES OF THE STUDY

The following study has been conducted in two phases:

Main objectives

Phase I

Assessing the impact of growing plants in polluted and non-polluted atmosphere and determining the metal content of leaves of plants grown in polluted atmosphere

Phase II

Synthesis of Iron nanoparticles using aqueous extract from the leaves of greens grown in non-polluted atmosphere *viz*.green house.

Specific Objectives

Phase I

- To grow the plants *Trigonellafoenumgraecum L., Brassica juncea L., Coriander sativum L. , Amaranthuscruentus L., Vigna radiate L. in potted plants under different study conditions- viz. polluted area and in green house*
- To observe the growth of the plants in both polluted and non polluted area for a selected period of time
- To assess the impact of the pollution on the growth of plants
- To assess the impact of mobile radiation on the growth of plants
- To determine the growth characteristics of plants grown inside green house
- To analyse the DNA damage in radiation assisted plants using Comet assay
- To analysis their elemental composition of leaves of all the plant samples used in the study using Energy dispersive X-Ray.

Phase II

- To synthesize iron nanoparticles using aqueous leaves extractof *Amaranthuscruentus L.*
- To explore the catalytic activity of the aforesaid synthesized nanoparticles in the reduction of aldehyde to alcohol.
- To characterize the product alcohol formed by FTIR and analyze for –OH peak and absence of carbonyl peak.

2. Review of literature

2.1. Review on DNA damage studies

OLIVE, P. L *et al,* (1990) measured the DNA damage using comet assay, produced by the ionization radiation. Cells embedded in agarose are lysed, subjected briefly to an electric field, stained with a fluorescent DNA binding stain, and viewed using a fluorescence microscope. Broken DNA migrates farther in the electric field, and the cell then resembles a "comet" with a brightly fluorescent head and a tail region which increases as damage increases. We have used video image analysis to define appropriate "features" of the comet as a measure of DNA damage, and have quantified damage and repair by ionizing radiation. The assay was optimized for lysing solution, lysing time, electrophoresis time, and propidium iodide concentration using Chinese hamster V79 cells. To assess heterogeneity of response of normal versus malignant cells, damage to both tumor cells and normal cells within mouse SCCVII tumors was assessed. Tumor cells were separated from macrophages using a cell-sorting method based on differential binding of FITC-conjugated goat anti-mouse IgG. The "tail moment", the product of the amount of DNA in the tail and the mean distance of migration in the tail, was the most informative feature of the comet image. Tumor and normal cells showed significant heterogeneity in damage produced by ionizing radiation, although the average amount of damage increased linearly with dose (0-15 Gy) and suggested similar net radiosensitivities for the two cell types. Similarly, DNA repair rate was not significantly different for tumor and normal cells, and most of the cells had repaired the damage by 30 min following exposure to 15 Gy. The heterogeneity in response did not appear to be a result of differences in response through the cell cycle.

McKelvey-Martin *et al,* (1993) used comet assay technique for measuringDNA breakage in individual mammalian cells. Here we review the development of SCGE assay (with particular reference to the alkaline version), existing protocols for the detection and analysis of comets, the relevant underlying principles determining the behaviour of DNA, and the potential applications of the technique.

ChristophHelma*et al,* (1999) decided to develop an image-analysis system based on public domain programs and make it publicly available for the scientific community. Comet Assay requires a computer-assisted image-analysis system. The system is based on the scientific image-processing program NIH Image, and was written in its Pascal-like macro

language. User interaction was kept as simple as possible, to enable the measurement of a large number of cells with a few keystrokes. Therefore, the time for image analysis is very low, even on slow computers. The comet macro can be obtained from NIH Image is available at http:rrrsb.info.nih.govrnih-imager. Both programs are free of charge.

Koppen*et al,* (1999)analysed DNA integrity of *Nicotianatabacum*L. and *Viciafaba*L. leaves in different stages of growth with the single cell gel electrophoresis (comet) assay. With this test DNA of individual cells is stretched by electrophoresis and the migration is measured, which gives an image of the nuclear DNA organisation. Nuclei were sampled when the plants had developed an apical bud, five true leaves and cotyledons. To get an idea of the kind of lesions observed, three different comet protocols were used. The neutral protocol with electrophoresis in a neutral buffer and the semi-alkaline or alkaline assay with alkaline unwinding followed by electrophoresis in neutral alkaline buffer, respectively. For *V. faba* there was a successive increased cellular DNA mobility with age of the leaves. The percentage DNA migration in control cells of fully developed leaves from *N. tabacum*almost reached the same level than after irradiation of not fully developed leaves with 50 Gy X-rays. The increased stretching of DNA with leaf age was most obvious if the DNA duplex was converted to single strands by alkali treatment before electrophoresis. Therefore, it could be concluded that with the ageing of leaves there is a decrease in DNA integrity, which could be the result.

Morris *et al,* (2002) measured the DNA damage within sperms of unselected groups of mens.This study contributes to the evidence of DNA damage within the sperm.high loads of DNA damage measured by the comet assay were predictive of the failure of embryo development after ICSI. As it is likely that sperm with DNA damage contributed to successful fertilization and in-vitro development, potential adverse effects remain to be clarified.

Günter Speit*et al,* (2006)was studied DNA damage by using comet assay (single-cell gel electrophoresis). In this microgel electrophoresis technique, a small number of cells suspended in a thin agarose gel on a microscope slide is lysed, electrophoresed, and stained with a fluorescent DNA-binding dye. Cells with increased DNA damage display increased migration of chromosomal DNA from the nucleus toward the anode, which resembles the shape of a comet. The assay has manifold applications in fundamental research for DNA damage and repair, in genotoxicity testing of novel chemicals and pharmaceuticals,

environmental biomonitoring, and human population monitoring. This chapter describes a standard protocol of the alkaline comet assay and points to some useful modifications.

Olive *et al,* (2006) presented a procedure for the comet assay, a gel electrophoresis–based method that can be used to measure DNA damage in individual eukaryotic cells. It is versatile, relatively simple to perform and sensitive. Although most investigations make use of its ability to measure DNA single-strand breaks, modifications to the method allow detection of DNA double-strand breaks, crosslinks, base damage and apoptotic nuclei. The limit of sensitivity is approximately 50 strand breaks per diploid mammalian cell. DNA damage and its repair in single-cell suspensions prepared from yeast, protozoa, plants, invertebrates and mammals can also be studied using this assay. Originally developed to measure variation in DNA damage and repair capacity within a population of mammalian cells, applications of the comet assay now range from human and sentinel animal biomonitoring (e.g., DNA damage in earthworms crawling through toxic waste sites) to measurement of DNA damage in specific genomic sequences. This protocol can be completed in fewer than 24 h.

Kumaravel*et al,* (2007) suggested that judicious selection of different parameters, staining methods along with inter-laboratory validation and harmonization of methodologies will further help in making this assay more robust and widely acceptable for scientific as well as regulatory studies. In this assay, the shape, size and amount of DNA within the 'comet' play important roles in the determination of the level of damage. The use of a software in particular also provides a range of different parameters, many of which might not be relevant in determining the extent of DNA damage. As a large number of factors could influence the shape, size, identification and determination of induced damage, which includes the scoring criteria, staining techniques, selection of parameters (whilst using the software packages) and appearance of 'hedgehog' or 'clouds', this article aims (a) to provide an overview of evolution of measurements of DNA damage using the Comet Assay and (b) to summarise and critically analyse the advantages and disadvantages of different approaches currently being adopted whilst using this assay.

Yoshihiro Ojima*et al,* (2009) adapted the comet assay for quantifying the degree of photo-induced DNA damage by using radish sprouts exposed to varied light conditions. An index, *IN*D, was defined to express the DNA intactness, based on image-analyzing of nuclei in protoplasts prepared from the plant leaves. The *IN*D value gradually decreased with

increasing light intensity (22– 30Wm−2) and exposure time (0–6 h), and ultimately fell to 21% at 6 h under a light intensity of 430Wm−2, as compared to a reference level in the plants virgin of the exposure. Furthermore, the DNA damage was found to be restored to an appreciable extent when the plants were fed with antioxidants such as ascorbic acid and green tea extract, suggesting that DNA damage from strong light can be caused by photo-oxidative stress generated by the excess energy over a scavenging capacity of antioxidative defense mechanisms in the plant cells.

Andrew Collins *et al,* (2011) have said DNA repair plays a major role in maintaining genetic stability, and so measurement of individual DNA repair capacity should be a valued tool in molecular epidemiology studies. The comet assay (single cell gel electrophoresis), in different versions, is commonly used to measure the repair pathways represented by strand break rejoining, removal of 8-oxoguanine, and repair of bulky adducts or UV-induced damage. Repair enzyme activity generally does not reflect the level of gene expression; but there is evidence – albeit piecemeal – that it is affected by polymorphisms in repair genes. There are mixed reports concerning the regulation of repair by environmental factors; several nutritional supplementation trials with phytochemical-rich foods have demonstrated increases in base excision repair of oxidation damage, while others have shown no effect. Exposure to genotoxic agents has in general not been found to stimulate repair. Crucial questions concerning the factors regulating repair and the causes of individual variation are as yet unanswered.

JustynaGuzy*et al,* (2012) aimed to optimize comet assay on the basis of already published protocols using *Allium cepa*meristematic root cells as a good indicator for hospital waste water ecotoxicological potential estimation.

2.2. REVIEW ON PLANT GROWTH ANALYSIS

Becker*et al,* (1981) determined the chemical composition of ten amaranth seed samples. The saccharide content was determined using gas chromatography and high performance liquid chromatography. Sucrose was the major sugar followed by raffinose. Inositol, stachyose, and maltose were found in small amounts in most of the samples. Autolysis for 16 hr at pH 5.0 and 6.5 resulted in decreased sucrose and raffinose concentrations. Maltose was liberated by autolysis at pH 6.5 but not at pH 5.0. Inositol increased after autolysis. It was concluded that invertase, amylase, and phytase occur in the grain. Physico-chemical properties of isolated amaranthus starch were measured and compared with analogous values reported for wheat starch. The lipids from representative

amaranth grain varieties were analyzed for fatty acid composition. Squalene was present in the oil in large amounts, compared to other grains. The amino acid composition of the grain was used to calculate the chemical score (73) and the nitrogen to protein conversion factor (5.85). Leucine was found to be the limiting amino acid. Tannin and vitamin levels typical of other grains were detected. Mineral and proximate compositions were similar to previously reported values.

Beadle *et al,* (1985) said that the techniques of growth analysis are most suited to following the effects of long-lasting treatments. They are particularly useful for studies of dry matter production in relation to varietal differences of crop plants or agronomic practice (e.g. mineral nutrition, spacing and irrigation), and the study of the effects of environmental factors in controlled environments. The limitations in accuracy which the technique offers precludes its use in the investigation of subtle changes in climate which occur in the field, as the variance attributable to sampling will exceed that of the factor investigated. E and R may also change systematically in such a way as to obscure correlations with light and other environmental factors, except during the very early growth phase.

KalyaniAbhimanyuKedar*et al,* (2018) presented this article which are related to the scanning electron microscope and elemental studies in the four species of Bignoniaceae namely Tecomagaudichaudi DC (Sample1), Tecomacapensis (Thunb.) Lindl.(Sample2), Tecomastans (L.) Juss.ExKunth (Sample 3), Tabebuiarosea (Bertol.)(Sample4). The SEM images were obtained for permanent record. The abaxial and adaxial surfaces of each species were carefully studied. In addition to this, the consistent occurrence of anomocytic stomata in all four species of this family shows that morphological and taxonomically all the species are very close and intimate. The elemental data on leaf samples of all four species were performed and total eight important components were present such as C, O, Mg, Al, Si, Cl, K, Ca. These elements are useful, so identification of inorganic components of these species defiantly helps to promote as dietary elements.

Michael P. Dzakovich*et al,* (2018) to our knowledge, these studies represent the first reported use of environmentally relevant doses of UV radiation throughout the reproductive portion of the tomato plant life cycle to positively enhance the sensory and chemical properties of fruits.Fruits harvested from off-season, greenhouse-grown tomato plants have a poor reputation compared to their in season, garden-grown counterparts. Presently, there is a gap in knowledge with regard to the role of UV-B radiation (280−315nm) in determining greenhouse tomato quality. Knowing that UV-B is a powerful elicitor of secondary

metabolism and not transmitted through greenhouse glass and some greenhouse plastics, we tested the hypothesis that supplemental UV-B radiation in the greenhouse will impart quality attributes typically associated with garden-grown tomatoes. Environmentally relevant doses of supplemental UV-B radiation did not strongly affect antioxidant compounds of fruits, although the flavonol quercetin-3-Orutinoside (rutin) significantly increased in response to UV-B. Physicochemical metrics of fruit quality attributes and consumer sensory panels were used to determine if any such differences altered consumer perception of tomato quality. Supplemental UVA radiation (315−400 nm) pre-harvest treatments enhanced sensory perception of aroma, acidity, and overall approval, suggesting a compelling opportunity to environmentally enhance the flavor of greenhouse-grown tomatoes. The expression of the genes COP1 and HY5 were indicative of adaptation to UV radiation, which explains the lack of marked effects reported in these studies.

Sajad Ahmad Wani*et al,* (2018) presented this paper about nutraceutical properties of fenugreek and its utilization in various product developments. Fenugreek (Trigonellafoenum-graecum) is a legume and it has been used as a spice throughout the world to enhance the sensory quality of foods. It is known for its medicinal qualities such as antidiabetic, anticarcinogenic, hypocholesterolemic, antioxidant, and immunological activities. Beside its medicinal value, it is also used as a part of various food product developments as food stabilizer, adhesive, and emulsifying agent. More importantly it is used for the development of healthy and nutritious extruded and bakery product.

Anubhuti Sharma et al, (2018)investigated the detection and determination of the chemical components from polar extract of the seeds and leaves of Indian Mustard i.e. *Brassica juncea L.* genotypes using gas chromatography-mass spectrometry (GC-MS). Many of the components in *Brassica juncea*L. seeds and leaves are essential for proper human nutrition as primary and secondary metabolites. The main phytochemicals identified in seeds were 2-butyl isothiocyanate (32.46%), phenylethylisothiocyanate (28.01%), α-D-galactopyranoside (25.19%), linolenic acid (16.05%), tetradecanoic acid (11.32%) and oleic acid (15.30 %). The GC-MS results clearly show that the major compounds identified in the leaves were α-methyl-D-mannopyranoside (27.18%),2-butyl isothiocyanate (24.24%), β–Dglucopyranoside (24.54%), furaldehyde (15.96%), 1-phenyl ethanol (23.33%), ethyl benzoate (14.50%), linolenic acid (13.99%) and oleic acid (12.75 %).The study confirmed that the glucosinolates with allyl and phenylethyl groups as side chain are predominant

compounds in *Brassica juncea L.* Due to variable patterns of bioactive compounds *Brassica* extract could be used as natural antioxidant and source for various medicinal purposes.

2.3. REVIEW ON RADIATION ASSISTED PLANTS

Helen Behn *et al,* (2010) said thatsolar radiation is a key environmental signal in regulation of plant secondary metabolism. Since metabolic responses to light and ultraviolet (UV) radiation exposure are known to depend on the ratio of spectral ranges (e.g., UV-B/PAR), we examined effects of different UV-B radiation (280-315 nm) and photosynthetically active radiation (PAR, 400-700 nm) levels and ratios on yield and pattern of monoterpenoid essential oil of peppermint. Experiments were performed in exposure chambers, technically equipped for realistic simulation of natural climate and radiation. The experimental design comprised four irradiation regimes created by the combination of two PAR levels including or excluding UV-B radiation. During flowering, the highest essential oil yield was achieved at high PAR (1150 μmol m-2 s-1) and approximate ambient UV-B radiation (0.6 W m-2). Regarding the monoterpene pattern, low PAR (550 μmol m-2 s-1) and the absence of UV-B radiation led to reduced menthol and increased menthone contents and thereby to a substantial decrease in oil quality. Essential oil yield could not be correlated with density or diameter of peltatelandulartrichomes, the epidermal structures specialized on biosynthesis, and the accumulation of monoterpenes. The present results lead to the conclusion that production of high quality oils (fulfilling the requirements of the Pharmacopoeia Europaea) requires highlevels of natural sunlight. In protected cultivation, the use of UV-B transmitting covering materials is therefore highly recommended**.**

2.4. REVIEW ON IRON NANOPARTICLE

Lin Guo*et al,* (2001) employed the microemulsion method to synthesize iron nanoparticles with an average size of 3 nm using trioctyl phosphine oxide (TOPO) as a stabilizing agent. The morphology, structure, and composition of the nanoparticles are studied by transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS) and UVÈVIS spectroscopy. The iron nanoparticles show a remarkable surface-enhanced Raman scattering (SERS) activity, and the scheme of iron nanoparticle-on-electrode is successfully used in the in situ SERS study of adsorbed molecules. Electrocatalysis over the iron nanoparticles is demonstrated in the highly efficient and selective reduction of H2O2 in the presence of oxygen.

. **Wei Wu *et al,* (2008)**have found that theSurface functionalized magnetic iron oxide nanoparticles (NPs) are a kind of novel functional materials, which have been widely used in the biotechnology and catalysis. This review focuses on the recent development and various strategies in preparation, structure, and magnetic properties of naked and surface functionalized iron oxide NPs and their corresponding application briefly. In order to implement the practical application, the particles must have combined properties of high magnetic saturation, stability, biocompatibility, and interactive functions at the surface. Moreover, the surface of iron oxide NPs could be modified by organic materials or inorganic materials, such as polymers, biomolecules, silica, metals, etc. The problems and major challenges, along with the directions for the synthesis and surface functionalization of iron oxide NPs, are considered. Finally, some future trends and prospective in these research areas are also discussed. There are various methods of nanoparticle synthesis. The most common methods are discussed below:

i) Coprecipitation

In this method, Fe_3O_4 or γFe_2O_3 is synthesized by mixing ferrous ions and ferric ions (usually in a 2:1 molar ratio) in basic solutions either at room temperature or at elevated temperatures. The size and shape of the nanoparticles produced by this method depend on the type of ferrous or ferric salt that has been used, the ratio of ferrous/ferric ions, temperature, etc. This method produces nanoparticles with a wide size distribution. As the process requires high-pH solutions, the by-products of this process require further purification.

ii) Thermal Decomposition

This process involves the thermal decomposition of organic compounds such as $Fe(CO)_5$, $Fe(N\text{-nitrosophenylhydroxylamine})_3$, or $Fe(acetylacetonate)_3$. The decomposition is followed by oxidation, which produces high-quality monodispersed iron oxide nanoparticles. The disadvantages of this method include high-temperature requirements and the production of nanoparticles that disperse and dissolve only in nonpolar solvents .

iii) Microemulsion

In this method, first the micro emulsion in aqueous phase is prepared with ferric and/or ferrous ions in the presence of 0.1 M HCl to avoid oxidation of the ions. The microemulsion is then precipitated by injecting organic precipitating agents such ascyclohexylamine or oleylamine. The disadvantages of this method include aggregation and stability issues with the nanoparticles.

iv) Hydrothermal Synthesis

This method involves the production of nanoparticles by crystallization from an aqueous solution of ions at a high temperature under high vapor pressure. The crystallization can be facilitated by using various wet chemical technologies and this method produces nanoparticles with good monodispersity.

v) Sonochemical Synthesis

This method involves the usage of sonochemical techniques such as sonication of an aqueous solution of ions to produce nanoparticles. For example, magnetite nanoparticlescan be obtained by sonicating an iron (II) acetate aqueous solution.

Other methods of iron oxide nanoparticle preparation include electrochemical synthesis, laser pyrolysis technique, and microorganism or bacterial synthesis. Magnetic responsive properties vary based on the method of preparation and surface properties.

Amyn S. Teja*et al,* (2009) have found that magnetic nanoparticles exhibit many interesting properties that can be exploited in a variety of applications such as catalysis and in biomedicine. This review discusses the properties, applications, and syntheses of three magnetic iron oxides e hematite, magnetite, and maghemite e and outlines methods of preparation that allow control over the size, morphology, surface treatment and magnetic properties of their nanoparticles. Some challenges to further development of these materials and methods are also presented.

SiavashIravani*et al,* (2011) have investigated in order to find an eco-friendly technique for production of well-characterized nanoparticles. One of the most considered methods is production of metal nanoparticles using organisms. Among these organisms plants seem to be the best candidates and they are suitable for large-scale biosynthesis of nanoparticles. Nanoparticles produced by plants are more stable and the rate of synthesis is faster than in the case of microorganisms. Moreover, the nanoparticles are more various in shape and size in comparison with those produced by other organisms. The advantages of using plant and plant-derived materials for biosynthesis of metal nanoparticles have interested researchers to investigate mechanisms of metal ions uptake and bioreduction by plants, and to understand the possible mechanism of metal nanoparticle formation in plants. In this review, most of the plants used in metal nanoparticle synthesis are shown.

Jau-Rung Chiou*et al,* (2013) have been synthesized Silver/iron oxide composite nanoparticles via a facile one-pot green route by the use of l-arginine, which created an aqueous solution of about pH 10 and acted as a reducing agent for the successive formation of iron oxide and Ag nanoparticles. The product was characterized to be silver-coated iron oxide and iron oxide hydroxide composite nanoparticles with a mean diameter of about 13.8 ± 3.0 nm and 8.53% of Ag in weight. It exhibited good catalytic activity for the reduction of 4-nitrophenol to 4-aminophenol with sodium borohydride. The reduction reaction followed the pseudo first-order kinetics. The corresponding rate constants increased with the increases of temperature and catalyst amount but decreased with the increase of initial 4-NP concentration, revealing activation energy of 28.2 kJ/mol and a diffusion controlled mechanism. In addition, this product had quite good stability. No significant activity loss was observed after reuse for 5 cycles**.**

Kishore Natte*et al,* (2014) reported a novel, general, convenient and inexpensive method for the reduction of aromatic aldehydes to the corresponding benzylic alcohols. Various aromatic aldehydes were reduced in good to excellent yields by using well-defined iron-complex as the catalyst precursor and using para formaldehyde and water as the hydrogen source.

Lanlan Huang *et al,* (2014)synthesized Iron nanoparticles (Fe NPs) using sodium borohydride with aggregation, which is a high cost process and environmentally toxic. To address these issues, Fe NPs were synthesized using green methods based on tea extracts, including green, oolong and black teas. The best method for degrading malachite green (MG) was Fe NPs synthesized by green tea extracts because it contains a high concentration of caffeine/polyphenols which act as both reducing and capping agents in the synthesis of Fe NPs. These characteristics were confirmed by a scanning electron microscope (SEM), UV-visible (UV-vis) and specific surface area (BET). To understand the formation of Fe NPs using various tea extracts, the synthesized Fe NPs were characterized by SEM, X-ray energy-dispersive spectrometer (EDS), and X-ray diffraction (XRD). What emerged were different sizes and concentrations of Fe NPs being synthesized by tea extracts, leading to various degradations of MG. Furthermore, kinetics for the degradation of MG using these Fe NPs fitted well to the pseudo first-order reaction kinetics model with more than 20 kJ/mol activation energy, suggesting a chemically diffusion-controlled reaction. The degradation

mechanism using these Fe NPs included adsorption of MG to Fe NPs, oxidation of iron, and cleaving the bond that was connected to the benzene ring.

Parimala*et al,* (2014) synthesized Iron nanoparticles and size characterized using HRTEM, FESEM, and XRD. Polyethylene glycol(PEG), carboxymethyl cellulose (CMC), and poly N-vinyl pyrrolidone (PVP) are used as nanoparticle stabilizers. The sizes of Fe nps are found to be 9 nm, 14 nm, and 17 nm± 1 nm corresponding to PEG, CMC, and PVP stabilizers, respectively. The three different iron nanoparticles (Fe nps) prepared are used as catalysts in the hydrogenation reaction of various substituted aromatic ketones to alcohols with NaBH4.The progress of the reaction wasmonitored using time variance UV spectra. Kinetic plots are made from the absorbance values and the pseudo first order rate coefficient values are determined. Catalytic efficiency of the Fe nps is obtained by comparing the pseudo first order rate coefficient values, times of reaction, and % yield. Fe-PEG nps was found to act as better catalyst than Fe-CMC nps and Fe-PVP nps. Also, effects of substituents in the aromatic ring of ketones reveal that +I substituents are better catalysed than –I substituents.

Ting Wang *et al,* (2014)focused on synthesis of iron nanoparticles using*Aspilliaplorizeta*aqueous extracts its characterization and antimicrobial activities against gram positive and gram negative bacteria. Preliminary phytochemical screening was carried out to test for the presence of secondary metabolites; phenol, flavonoid, phytosterol, carbohydrate, tannin, saponin, glycoside and terpenoid resulting in a positive test for all the metabolites. Folin-Ciocalteu method and aluminium chloride method respectively were used in determination of total phenolic content 31.45 ±0.017 mg/g and total flavonoid content 7.223 ±0.081 mg/g. Characterization of zero valent iron oxide NPs was achieved using UV-visible spectrophotometer, FT-IR, XRD and XRF. UV-Vis spectrophotometer displayed a peak at 346 nm. FT-IR spectra portrayed existence of functional groups such as OH, C-O and C-C that aid in formation of NPs. XRD indicated the presence of peaks of peaks at 16.06° and 43.73°.XRF data showed the NPs containing Fe 31.58%, MgO 12.02%, Al2O3 1.883%, SiO2 13.84%, P2O5 11.14%, K2O 4.699% and CaO 1.522% of respective oxides. Thus presence of secondary metabolites in the plant extracts are responsible for the synthesis of iron nanoparticles. Finally the antimicrobial activity was determined against *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Candida albicans*which exhibited significant zones of inhibition.

Devatha, C.P. *et al,* (2016) aimed to prepare leaf extracts, precursor, and synthesis of iron nanoparticles and to evaluate its efficacy in treating domestic waste water. Synthesis of iron nanoparticles is done using various leaf extracts viz. *Mangiferaindica, MurrayaKoenigii, Azadiractaindica, Magnolia champaca,* and to check its potential for treating domestic waste water. Characterization of the synthesized iron nanoparticles is done by UVVisible spectrophotometer, Scanning Electron Microscopy equipped with X-ray energy dispersive spectroscopy and Fourier Transform Infrared spectroscopy. The characterization results confirm the formation and presence of iron nanoparticles and biomolecules which could help in capping the nanoparticles. The effect of iron nanoparticles thus obtained is evaluated for simultaneous removal of total phosphates, ammonia nitrogen, and chemical oxygen demand. Among the different plant mediated synthesized iron nanoparticles, *Azadiractaindica*showed 98.08% of phosphate, 84.32% of ammonia nitrogen and 82.35% of chemical oxygen demand removal. Overall performance of *Azadiractaindica*synthesized iron nanoparticles showed satisfactory results compared to other leaf extracts for treating domestic waste water.

SadiaSaif*et al,* (2016)reported green synthesised zero valent metallic iron (ZVMI) and iron oxide (Fe2O3/Fe3O4) nanoparticles (NPs) and highlights their substantial applications in environmental pollution control. This review also summarizes the ecotoxicological impacts of green synthesized iron nanoparticles opposed to non-green synthesised iron nanoparticles.Finally, applications of these as-prepared green Fe NPs in swine wastewater demonstrated a promising environmental pollution management option for large scale eutrophic wastewater treatment.

Yongsheng Chen*et al*, (2016) Interested to develope environmentally benign procedures for the synthesis of metallic nanoparticles has been increased. The purpose is to minimize the negative impacts of synthetic procedures, their accompanying chemicals and derivative compounds. The exploitation of different biomaterials for the synthesis of nanoparticles is considered a valuable approach in green nanotechnology. Biological resources such as bacteria, algae fungi and plants have been used for the production of low-cost, energy-efficient, and nontoxic environmental friendly metallic nanoparticles.

Santhoshkumar*et al,* (2017) synthesized Nanoparticles using *Passifloracaerulea*fresh leaf extract and were characterized by UV-visible spectroscopy (UV–vis), X-ray diffractometer (XRD), Fourier transform infrared spectroscopy (FT-IR),

Scanning electron microscopy (SEM), Energy dispersive analysis of x-ray (EDAX), Atomic force microscopy (AFM). Therefore, the study reveals an efficient, eco-friendly and simple method for the green synthesis of multifunctional ZnO NPs using *P. caerulea*. Urinary tract infection causing microbes were isolated from the disease affected patient urine sample. The synthesized nanoparticles have been tested against the pathogenic culture showed a very good zone of inhibition compared with plant extract. It indicates the biomedical capability of ZnO NPs.

Vijayaraghavan*et al,* (2017) highlights the application of biosynthesized nanoparticles in different fields such as medicine, agriculture, catalytic, cosmetic and food Nanoparticles exhibit unique properties that enable them to find potential applications in various fields. Accordingly, significant research attention is being given to the development of novel strategies for the synthesis of nanoparticles. Among these, biological route of nanoparticle synthesis has been portrayed as an efficient, low-cost and environmental friendly technique. Biological materials such as bacteria, fungi, yeast, algae and plant have been reported to possess high bioreduction ability to synthesize various size and shape of metallic nanoparticles. Of these biomaterials, this review focuses on plant-mediated biosynthesis of metallic nanoparticles. The biomolecules present in the plants such as terpenoids, flavones, ketones, aldehydes, proteins, amino acids, vitamins, alkaloids, tannins, phenolics, saponins, and polysaccharides play a vital role in reduction of metals. A systematic comparison of literature, based on the bioreduction capacity of various plant biomass/extract towards various metals under different experimental conditions, is also provided. Various instrumental techniques utilized to characterize nanoparticles are also discussed.Thus, this article reviews the achievements and current status of plant-mediated biosynthesis, and hopes to provide insights into this exciting research frontier**.**

AbdollahGholami*etal,* (2018) havecarried out the research to investigate the use and efficacy of Barberry leaf, Elaeagnusangustifolia leaf, Saffronsepal, and Ziziphus jujube leaf extracts as agents for the synthesis of green iron nanoparticles(GINPs). The studied plants are among the native plants abundantly found in South Khorasan, Iran. The data also show the effect and role of important variables in green synthesis process including Fe to extract ratio, extract heating time, and length of time when Fe- extract solution was mixed under ultrasonic waves. The effects of the mentioned variables were measured by weighing the produced nanoparticle and determining the yield of the prepared nano- particles. Based on the data,

with decreasing Fe to extract ratio, the amount of produced GINPs was increased but the yield of the process decreased . Additionally, extract heating time and ultrasonic mixing time had a significant effect on GINPs yield. Based on the results of transmission electron microscopy (TEM) test, the size of GINPs in all of the plant extracts was about 40nm and smaller.

Muthuvinothini*et al,* (2018) demonstrated a green synthesis of Metal Oxide nanoparticles using the freshly prepared aqueous extract of the immature fruit of *Cocosnucifera*and the MO nanoparticles were characterized by the analytical techniques such as UV-Vis, FT-IR, XRD, SEM, TEM and EDAX. Characterization techniques confirmed that the biomolecules involved in the formation of nanoparticles and also they stabilized the nanoparticles. The synthesized MO nanoparticles were used as catalysts for the reduction of aromatic aldehydes. The reduction was done at mild reaction conditions using ammonium formate as a green hydrogen donor andthe corresponding alcohols were obtained in 2-24 h with excellent yields. The reduction reaction was optimized using various solvents, loading of catalyst and at different temperatures.

Shegavi*et al* (2018)reported Fe2O3-nanoparticle catalysed hydroboration of aromatic and aliphatic aldehydes and ketones with HBpin (pin = OCMe2CMe2O). The reaction proceeds under mild conditions (room temperature) and is moderately sensitive to air. This process is applicable to a broad range of substrates with high functional group compatibility. Moreover, aldehydes are selectively hydroborated over other reducible functional groups, such as ketone, nitrile, hydroxide, alkene, amide, ester, nitro and halide groups.

2.5. REVIEW ON REDUCTION REACTION

Saadi*et al,* (2006) presented the work which deals with the acid–base properties of alkaline earth metal oxide catalysts (MgO, CaO, BaO, SrO) and benzaldehyde reduction was used as probe reaction for characterizing the surface properties.

MazaahirKidwai*et al,* (2006) have found a novel method for reduction of aromatic and heteroaromatic aldehydes with ammonium formate using Ni-nanoparticles is described. The Ni-nanoparticles act as a green catalyst for selective reduction of the aldehydic group in the presence of other functional groups, viz.: –NO2, –CN and alkenes to give the corresponding alcohols in excellent yields.

Hannah C. Maytum*et al,* (2007) observed Chemoselective 1,2-reduction of a, b-unsaturated carbonyl compounds to the corresponding allylic alcohols are also.
1,4-Butanediol has been used as the hydrogen donor in transfer hydrogenation reactions. The equilibrium is driven by the formation of *ç*-butyrolactone, and the diol is therefore not required in excess.

Shalbaf*et al,* (2010) reducesAldehydes and ketones to their corresponding alcohol using NaBH4 supported onto alumina under solvent free conditions. It was found that the presence of small amount of methanol in reaction media is essential.

DavoodSetamdideh*et al,* (2012) carried a reaction usingSodium borohydride (0.4–1.5 equivalents) in the presence of ammonium oxalate (0.2 equivalents) reduces varieties of organic carbonyl compounds such as aldehydes, ketones, acyloins, -diketones and -unsaturated carbonyl compounds to their corresponding alcohols. Reduction reactions were carried out in acetonitrile in high to excellent yields of products. The chemoselective reduction of aldehydes over ketones was accomplished successfully with this reducing system. In addition, regioselectivity and exclusive 1,2-reduction of conjugated carbonyl compounds to their corresponding allylic alcohols in high to excellent yields was achieved successfully with this reducing system

Jayesh T. Bhanushali*et al,* (2016) focused on catalytic hydrogenation and their parameters associated with supports, methods of preparation, solvents involved, reaction conditions in converting benzaldehyde to benzyl alcohol. Critical aspect of review is to evaluate activities of various heterogeneous catalysts that can selectively reduce benzaldehyde to benzyl alcohol. The catalysts include various transition (Ni, Cu, Co) and noble metals (Au, Pt, Pd, Ru), monoliths and metal oxides (MgO, CaO, BaO, Al2O3, CeO2, ZrO2, etc.,), which are all active in the reaction. Among the transition metals, cobalt- based catalysts depicted promising activity, while ruthenium-based systems demonstrated spectacular activity among noble metal series. Hydrogenation by electrochemical reduction using platinum, palladium, nickel has also been reviewed.

MaulidanFirdaus*et al,* (2016) presenteda simple, energy efficient, and relatively quick synthetic procedure for the reduction of aldehydes under ultrasonic irradiation is

reported. Satisfactorily isolated yields (71-96%) were achieved confirming that the preparation of alcohol by aldehyde reduction is possible in green and sustainable fashion.

Vijai K. Rai*et al,* (2019) reportedReduced graphene oxide (rGO)–NaBH4 is as mild and efficient catalyst-system for chemo-/ regioselective reduction of structurally different aliphatic, aromatic as well as a,b-unsaturated aldehydes and ketones in water. The rGO was prepared by reducing graphene oxide using Tulsi leaf extract as bioreductant. Operational simplicity, ambient reaction condition, high yield of pure products (80–97%), no by-product formation, no use of column chromatography for purification are the salient features of the envisaged protocol. Furthermore, the recovered TRGO was recycled and reused for subsequent reductions up to five times without any loss in activity.

2.6. REVIEW ON PHYTOCHEMICAL SCREENING

Edeoga*et al,* (2005) assessed phytochemical compound such as Alkaloids, tannins, saponins, steroid, terpenoid, flavonoids, phlobatannin and cardic glycoside distributed in ten medicinal plants belonging to different families. The medicinal plants investigated were *Cleome nutidosperma, Emilia coccinea, Euphorbia heterophylla, Physalisangulata, Richardiabransitensis, Scopaniadulcis, Sidaacuta, Spigeliaanthelmia, Stachytarphetacayennensis*and *Tridaxprocumbens*. All the plants were found to contain alkaloids, tannins and flavonoids except for the absence of tannins in *S. acuta*and flavonoids in *S. cayennsis*respectively. The significance of the plants in traditional medicine and the importance of the distribution of these chemical constituents were discussed with respect to the role of these plants in ethnomedicine in Nigeria**.**

Falodun. A *et al,* (2006) used*Euphobiaheterophylla* a local medicinal plant in ethnomedicine for the treatment of constipation, bronchitis and asthma. The aqueous decoction and the methanolic extracts were subjected to anti-inflammatory activity using experimental animal model, in the presence of the positive control drugs. The inflammation was induced by carraegenean. From the results obtained the aqueous extract showed significant activity ($P < 0.001$) comparable to the reference drug used. At the different dose range used (50, 100 and 150 mg/kg), there was no significant differences in their anti-inflammatory activity hence they were not dose- dependent. However, the methanolic extract did not show any appreciable activity (20-24% inhibition) and were also not dose-dependent. The results of the study showed the justification of the use of the plant in the treatment of

inflammatory disease conditions, and the active chemical constituents when isolated will be added to the present anti-inflammatory agents.

AbeerM.Ismail*et al,* (2016) wereanalysed thePhytochemicals of the methanolic and aqueous extracts of *Faidherbiaalbida* legumes which indicated the presence of terpenes, cardiac glycosides, monosaccharides and carbohydrates type of compounds in both extracts. While alkaloids and saponins were found in aqueous extract only, flavonoids were found to be absent in both extracts. The aqueous and methanolic extracts exhibited a potent growth stimulation effect. Inhibition of both the rootlet and shoot showed a dose dependent response. Aqueous extract has a greater inhibitory effect on rootlet growth than shoot growth. The methanolic extract has a greater inhibitory effect than the aqueous extract. Both extracts and some fractions were tested against three pathogenic bacterial species; *Staphylococcus aureus*, *Escherichia coli* and *Shigelladysenteriae*, also tested against three pathogenic fungal species; *Fusariumoxysporum*, *Alternaria alternate*, and *Aspergillus niger*. Most of the plant extracts stimulate the studied fungal growth specially the aqueous extract. Meanwhile it shows interesting results by inhibiting the growth of the studied pathogenic bacterial species with most extracts and fractions.

3. Materials and methods

The present study entitled "Analysis of Elemental distribution in selected edible plants grown under different conditions: Quantification and imaging and catalytic activity of green synthesized nanoparticle" was carried out in two phases. The detailed methodology adopted for the study is given below.

Phases of Study: 2 phases

Phase I: Assessing the impact of growing plants in polluted and non-polluted atmosphere and determining the metal content of leaves of plants grown in polluted atmosphere

Phase II: Green nano synthesis of iron oxide nano particle using *Amaranthuscruentus L.* aqueous leaf extract and its catalytic activity

3.1 General

All apparatus used were washed with soap solution and then with doubly distilled water. Plants were watered using drinking water at the morning time and double distilled water was used for nano synthesis. All chemicals used were of A.R grade.

3.2.Collection of plants

The seeds of ***Trigonellafoenumgraecum L., Brassica juncea L. , Coriander sativum L., Amaranthuscruentus L., VignaradiataL.***were collected from a local market in Coimbatore district.

3.3. Germination of Seedsunder different conditions

The seeds of the plants were purchased from Ganapathy market. At morning Around 50 seeds of each plant were sown in 15 pots containing 371g of soil which is get from nearer agricultural farm house and 36g of natural fertilizer were added. One set of five pots were placed in green house, another set was placed in polluted area and the last five set were placed in radiation exposure. The plants were watered daily at two time one at morning and other at evening.

3.3.1. Growing plants in Polluted areas-Exhaust exposed plants

The planted seeds were grown under polluted area in residential area prone to more vehicle exhaust from parking area and also from vehicles in roads adjoining residential areas.

The climatic conditions during growth period were recorded regularly using whether forecasting application which updates daily climatic conditions such as temperature, humidity and wind. The seeds were watered regularly and monitored for their physical growth characteristics. The period of shoot (25 days) , growth of leaves, numbers of leaves, nature of leaves, wilting of leaves were observed. The plants were shooted by using Samsung galaxy A5 having 13-megapixel, the growth of the leaves was observed daily, the number of leaves was counted manually. The changes in colour of the leaves were observed by monitoring daily, the length of the leaves was measured by using short size scale.

3.3.2. Growing plants exposed to mobile radiation

The planted seeds were kept under mobile radiation (MOTO TURBO G)for 6 hours daily. The leaves are watered regularly. The radiation exposed to the plant in the morning three hours and evening three hours. The periods of shoot was 25 days by using above mentioned mobile with 13-megapixel. As both exhaust plant and radiation exposed leaves were planted simultaneously their climatic conditions also same. The number of leaves was counted manually, the colour changes of the leaves under radiation exposure were monitored manually.

3.3.3. Growing plants in non-polluted area-Green house plants

Green house facility available in the place of research (Institution) was used for growing five sets of pots with seeds of 5 different plants. The seeds were watered regularly two time per day in morning and in evening and monitored for its growth characteristics.

3.4. Physical characteristics studied

Table.1.Plants details:

S.No	Types	Plant name
1	Plant 1	*Trigonellafoeumgraecum.L*
2	Plant 2	*Vigna radiate*
3	Plant 3	*Brassica juncea*
4	Plant 4	*Coriandumsativum*
5	Plant 5	*Amaranthuscruentus*

The samples codes for three sets of plants are:

Set I: 5 pots grown in polluted atmosphere (exhaust)

POT 1: EEF

POT 2: EEG

POT 3: EEM

POT 4: EEC

POT 5: EEA

Set II: 5 pots grown in Radiation exposure

POT 1: REF

POT 2: REG

POT 3: REM

POT 4: REC

POT 5: REA

Set III: 5 pots grown in Green house

POT 1: GF

POT 2: GG

POT 3: GM

POT 4: GC

POT 5: GA

3.5 Comparative study of metal composition of leaves of samples taken in the study using EDS

Various elements may be present in the plants grown in different conditions. The planted seeds were allowed to grow, simultaneously their physical characteristics were monitored. There may be the presence of toxic element in the exhaust exposed plants or some organic matters may be lost after exposure to the radiation. In order to see how it has affected, on the 26th day of the growing plants, three matured leaves were plucked manually, shade dried and powdered in a mortar and pestle. The powder samples were analyzed for morphology and elemental composition.

3.6. Analysis of morphology of leaves

The morphology of the leaves were analysed by using Tescan MIRA3 FESEM with EDS STUW-SAPPHIRE. The leaves were powdered using mortar pestle mixed well and representative samples were used for analysis. Prior to analysis in EDS , gold sputtering was carried out to make the non-conducting particles conducting. A spec of sample was coated onto a 5x5mm double-sided adhesive carbon tape placed on an aluminium stub. The stubs were then placed in a gold coater and sputtered at 10mv for 60s. The sputtered samples were then loaded to FESEM for analysis.

3.7. Imaging of germination by photographic recording of its growth

The germination of seeds was photographed daily in the morning. The photograph was taken in the Samsung mobile with model number A5 having 13-mega pixel. During the monitoring period of germination of seeds and plant the images of the plant were recorded from 1st day to 26th day in the morning time.

3.8. Analysis of DNA damage in radiation assisted plants using Comet assay

Assessment of genotoxicity of radiation assisted plants adopting alkaline single cell gelelectrophoresis and DNA laddering assay

The comet assay or single cell gel electrophoresis (SCGE) is a rapid, sensitive and relatively simple method for detecting DNA damage at the level of individual cells.

3.8.1.Reagents

1) 1 % Normal agarose

2) 1 % Low melting agarose

3) Electrophoresis buffer (pH 13-14)

NaOH (AR)	12 g
Na_2EDTA	372 mg

Made up the volume to 1 litre with distilled water.

4) Neutralization buffer (pH 7.2)

Dissolve 12.11 g Tris-Base in 250 ml distilled water.

5) Lysis solution (pH 10)

NaCl	146.1g
Na_2 EDTA	37.2 g
Tris	1.2 g

Added the above ingredients to 700 ml distilled water and dissolved. About 12 g pelletized NaOH in small quantities were added and stirred until the salts dissolve completely into solution The pH of the solution was adjusted to 10.0 using 0.1N HCl or NaOH and made up to 990 ml with distilled water, filtered and sterilized and stored at room temperature. Added 10 ml of Triton X -100 (1%) to the above solution and refrigerated for 30-60 min prior to use.

3.8.2. Dyes used

Ethidium bromide

Added 5 µl ethidium bromide stock (10 mg/ml) per 100 ml gel solution for a final concentration of 0.5 ug/ml.

3.8.3. Method

Processing of cells

Trypsinize the cells in T_{25} flaskand pellet it. Wash the pellet thrice in PBS.

3.8.4. Electrophoresis apparatus

The apparatus used for electrophoresis is of the conventional type. However, the gels used for the assay are different. Since the comet assay involves the microgel electrophoresis system, gels are loaded in 18 x 18 mm area on a fully frosted microslide. Two samples, each containing about 1000 -2000 cells, could be conveniently cast on each slide. 8 to 12 such slides could be placed on the platform of the electrophoresis apparatus as shown in the figure 1 and 2 below.

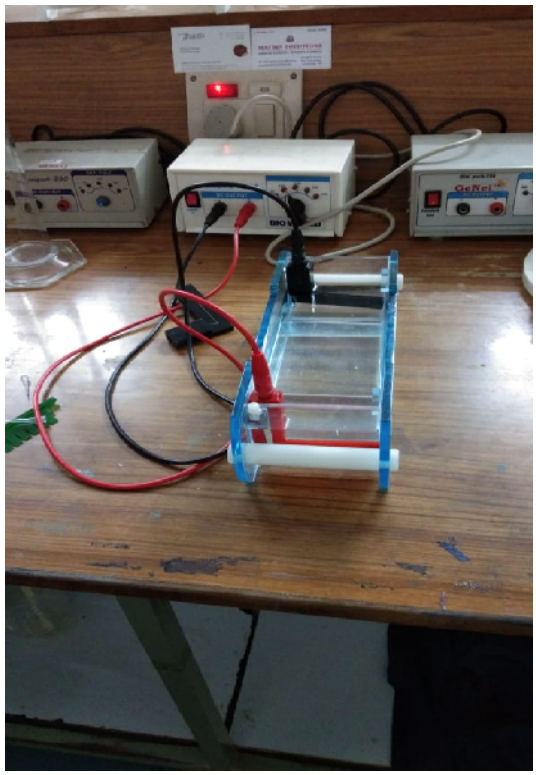


Fig. 1. Electrophoresis apparatus

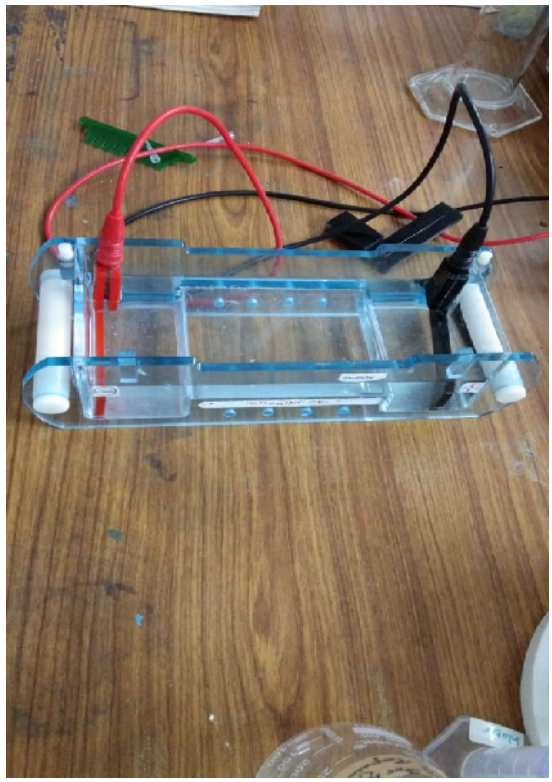


Fig. 2.Electrophoresis apparatus

3.7.5. Preparation of slides

- Dropped gently the 200µl of 1% normal agarose in PBS at 65ºC on to a fully frosted micro-slide, covered immediately with a cover slip and place over a frozen ice pack for about 5min.
- Removed the cover slip after the gel had set. Mixed the cell suspension from one fraction with 1% low melting agarose at 37ºC in 1:3 ratio.
- Applied 100µl of this mixture quickly on top of the gel, coated over the micro-slide and allowed to solidify as before.
- Given a third coating of 100µl of 1% low melting agarose on the gel containing the cell suspension and allowed to solidify.
- Similar preparation was followed for the slides for each cell fraction.

3.8.6. Cell lysis

- After solidification of the agarose, removed the cover slips and immersed the slides in ice-cold lysis solution at 4ºC for 16h.

* Performed all the above operations in low lighting conditions in order to avoid any additional DNA damage.

3.8.7. Electrophoresis

* The slides were placed horizontally in an electrophoresis tank after being removing them from the lysis solution.
* Filled the reservoirs with electrophoresis buffer until the slides just immersed in it.
* Allowed the slides to stand in the buffer for about 20 min (to allow DNA unwinding) after which carry out the electrophoresis at 0.8v/cm for 15 min.
* After electrophoresis, removed the slides, washed thrice in neutralization buffer and gently dabed to dry.
* Few drop of the working solution of ethidiumbromide on to the gel and covered the slide with a cover slip.
* Examined the stained DNA in the cells at 200x and 400x magnifications using a fluorescent microscope equipped with a 365nm excitation filter and a 435nm barrier filter.

3.9. Collection of *Amaranthuscruentus*leaves

The mature leaves of *Amaranthuscruentus*grown in green house were washed and shade dried. The dried leaves were powdered and used for phytochemical screening and preparation of iron nanoparticles.

3.10.Preparation ofaqueous extract of*Amaranthuscruentus*

To prepare extract, dried leaves were powdered using mortar and pestle. 20g leaf powder was treated with 250 ml water in a 500ml beaker. The solution was heated inBunsen burner for 20 minutes. The solution was allow to cool and then filtered by using wattman filter paper. The aqueous extractof amaranth was store in to the sample tube for the further analysis.

3.11. Preliminary analysis of Phytochemical compounds in aqueous plant extract

The aqueous extract obtained in the aforesaid procedure was used for phytochemical screening.

3.11.1.Test for alkaloids

I. **Wager's test**: To the extract wagers reagent was added formation of brown precipitate indicates the presence of alkaloids
(Preparation of reagent: add 2g KI and 1.27g I_2 in 5ml distilled water).

II. **Dragendroff's test:** To the extract 1ml Dragendroff's reagent was added formation of red orange precipitate indicates the presence of alkaloids.

3.11.2. Test for flavonoids

I. **NaOH test**: To the extract aqueous NaOH and dilute HCl was added formation of yellow orange precipitate indicates the presence of flavonoids.

II. **H_2SO_4 test**: To the extract concentrated H_2SO_4 was added orange colouration indicates the presence of flavonoids.

III. **Aqueous. NH_3 test**: To the extract aq.NH_3 was added yellow orange coloration indicates the presence of alkaloids.

IV. To the extract concentrated H_2SO_4 was added development of red colour indicates the presence of flavonoids.

V. To the extract 1ml alcohol, magnesium turning and con.HCl along the side of the test tube was added formation of pink solution indicates the presence of flavonoids.

3.11.3. Test for steroids

I. **Libermann-Burchard test**: To the extract add 1ml chloroform, 1ml acetic anhydride and a drop of concentrated H_2SO_4 is added formation of light red colour indicates the presence of steroids.**Alternate test**: Chloroform was added to 200mg plant material and then filtered. To the filtrate 2ml acetic anhydride and concentrated sulphuric acid was added formation of green ring indicates the presence of steroids.

II. **Salkowski test**: To the extract 2ml chloroform, 2ml concentrated H_2SO_4 was added reddish brown colour indicates the presence of steroids.

3.11.4. Test for Terpenoids

To the extract chloroform, acetic anhydride and a drop of concentrated H_2SO_4 was added no formation of dark green colour indicated the absence of terpenoids.

3.11.5. Test for Anthraquinones

I. **Borntrager'stest:** to the 50mg of plant powder 10% $FeCl_3$ and 1ml concentrated HCl was added, cooled and filtered. The filtrate was shaken with diethyl ether further treated with strong ammonia formation of deep red colour indicates the presence of anthraquinones.

II. **Test for carbohydrate:** The extract was shaken with 2 drops α-napthol in alcohol solution con.H_2SO_4 was added along the side of the test tube there is no formation of violet ring absence of carbohydrate.

3.11.6. Test for reducing sugar (carbohydrates)

I. **Fehling test**: 1ml Fehling's A and Fehling's B were boiled for 1 minute, equal amount of extract was added and heated for 5 to 10 minutes in the water bath and cooled no brick red precipitate was formed absence of reducing sugar.

II. **Benedict's test**: the extract was boiled with 2ml Benedict's reagent no formation of reddish brown precipitate indicates the absence of carbohydrates.

3.11.7. Test for saponins

The extract was shaken with few drops of distilled water formation of foam indicates the presence of saponins.

3.11.8. Test for phenols

To the extract lead acetate solution was added formation of yellow precipitate indicates the presence of phenols.

3.11.9. Test for test for Tannins and Phenols

I. To the extract 0.1% $FeCl_3$ solution was added formation of bluish black precipitate indicates the presence of tannins and phenols.

II. To the extract acetic acid solution was added formation of red colouration indicates the presence of tannins and phenols.

3.11.10. Test for phlobatannins:

The extract was boiled with 2ml 1% HCl no deposition of red colour solution indicates the absence of phlobatannins.

3.11.11. Test for proteins:

Biuret test: The extract was treated with 2% $CuSO_4$ solution, 95% ethanol and KOH no formation of pink ethanolic layer indicates the absence of proteins.

3.11.12. Test for Quinones:

To the extract concentrated HCl was added formation of yellow colour precipitate indicates the presence of quinines.

3.11.13. Test for cardiac glycosides:

To the extract 1ml glacial acetic acid, few drops $FeCl_3$ and 1ml of concentrated H_2SO_4 along the side of the test tube no formation of brown ring indicates the absence of cardiac glycosides.

3.11.14. Test for amino acids:

Ninhydrine test: to the extract 5-6 drops of ninhydrin was added and boiled in water bath for about 5minutes no formation of purple colouration indicates the absence of amino acids.

3.11.15. Test for coumarins:

To the extract chloroform and sodium hydroxide solution was added yellow colouration indicates presence of coumarins.

3.11.16. Test for Tannins:

To the extract lead acetate and sodium hydroxide solution was added formation of white precipitate indicating the presence of tannins.

3.11.17. Test for Anthocyanins:

To the extract dilute HCl and NH_3 solution was added no pink-red colour indicates the absence of anthocyanins.

3.11.18. Test for Xanthoproteins:

To the extract concentrated HNO_3 was added no reddish orange precipitate indicates absence of xanthoproteins.

Phase II: Green nano synthesis of iron oxide nano particle using *Amaranthu scruentus L.* aqueous leaf extract and its catalytic activity

3.11. Preparation of iron oxide nanoparticle I using Amaranthus cruentus extract

0.1M $FeSO_4.7H_2O$ was prepared by adding 2.780g of salt in 100ml distilled water. The iron nano particle was prepared by adding 0.1M $FeSO_4.7H_2O$ solution to the extract in 1:2 ratios. The appearance of black precipitate indicates the formation of iron nano particle. The formed nanoparticle was filtered using wattman filter paperand airdried.

3.12. Preparation of iron oxide nanoparticle II using Amaranthus cruentus extract

$FeCl_3.6H_2O$ solutionof 0.1Mconcentration was prepared by adding 2.703g $FeCl_3.6H_2O$ in 100ml distilled water. The iron nanoparticle was prepared by adding 0.1 M $FeCl_3.6H_2O$ solution to the plant extract immediate appearance of black precipitate indicates the formation of iron nanoparticle. The formed nanoparticle was filtered and dried.

3.13. Characterization of iron nanoparticle

The iron oxide nanoparticles were characterized using UV-SYSTRONICS AR 2701 UV-Vis spectrophotometer, Shimadzu FT-IR (4000-400) FT-IR spectrometer and Tescan MIRA3 FESEM with EDS STUW-SAPPHIRE.

3.13.1. UV-Visible spectroscopy

The iron oxide nanoparticle were characterized by using UV-SYSTRONICS AR 2701 double beam

3.13.2. Fourier Transform Infrared Spectroscopy

The FT-IR spectrum of iron nanoparticle was recorded in a Shimadzu FT-IR (4000-400) spectrophotometer.

3.13.3. Field emissionScanning Electron Microscopy

The Scanning Electron Microscopy of iron nanoparticle was recorded inTescan MIRA3 FESEM with EDS STUW-SAPPHIRE.

3.14. Catalytic activity of iron nanoparticle in reduction of -CHO to-CH_2OH

The procedure of **Muthuvinothini et al, (2018)** was adopted for the reduction reaction. Modifications in the procedure was made based on the procedure of **Shaha et al, (2015**).

Method-1

1mg iron nano catalyst was taken in 50 ml RB flask and fitted with water condenser to that add 100µlBenzaldehyde in 2ml ethanol. 5ml 0.5mM $NaBH_4$ was added to the solution. The reaction mixture was maintained at 40^0C.The formation of the product was monitored by using TLC (solvent 1:6 ratio of ethyl acetate and hexane). The product formed was extracted using dichloromethane. Formation of the product was confirmed by absorption maximum in UV spectra.

Method-2

1mg iron nano catalyst was taken in 50 ml RB flask fitted with water condenser to that 100µl benzaldehyde in 2ml ethanol is added. 0.5mM Ammonium formate and 0.3mM NaOH was dissolved in water and added to the solution. The reaction mixture was maintained at 40^0C.Formation of the product was monitored by TLC (solvent 1:6 ratio of ethyl acetate and hexane). The product formed was extracted using dichloromethane. Formation of the product was confirmed by absorption maximum in UV spectra.

4. Results and Discussion

The results of the study entitled "Analysis of Elemental distribution in selected edible plants grown under different conditions: Quantification and imaging and catalytic activity of green synthesized nanoparticle" along with the relevant discussions is given in the following pages.

4.1. Plant sample codes

The following table is the sample code assigned to the leaf powder of various test plants grown in different conditions. Hitherto in the thesis the samples would be represented by the designated sample codes.

Table.2. Assignment of sample codes to leaf powder of various plant samples

Description	Sample code	Description	Sample code
Radiation exposed fenugreek leaves	REF	Radiation exposed mustard	REM
Radiation exposed fenugreek – discoloured	REFD	Radiation exposed mustard-discoloured	REMD
Exhaust exposed fenugreek leaves	EEF	Exhaust exposed mustard	EEM
Exhaust exposed fenugreek– discoloured	EEFD	Exhaust exposed mustard-discoloured	EEMD
Green house fenugreek	GF	Green house mustard	GM
Green house fenugreek- discoloured	GFD	Green house mustard - discoloured	GMD
Radiation exposed green gram	REG	Radiation exposed coriander	REC
Radiation exposed green gram – discoloured	REGD	Radiation exposed coriander discoloured	RECD
Exhaust exposed green gram	EEG	Exhaust exposed coriander	EEC
Exhaust exposed green gram – discoloured	EEGD	Exhaust exposed coriander-discoloured	EECD
Green house green gram	GG	Green house coriander	GC
Radiation exposed amaramth	REA	Exhaust exposed amaranth – discoloured	EEAD
Radiation exposed amaranth – discoloured	READ	Green house amaranth	GA
Exhaust exposed amaranth	EEA	Green house green gram discoloured	GGD
Green house amaranth discoloured	GAD	Green house coriander discoloured	GCD

4.2 Germination of seeds of 5 different plants – Day 1-3

The potted plants – 3 sets (green house, under mobile radiation, under exhaust exposure) were observed for results after sowing. From day 1-3 these 15 pots were sprinkled with water regularly and monitored for growth. No changes were observed **(Fig.3, 4, and 5)**

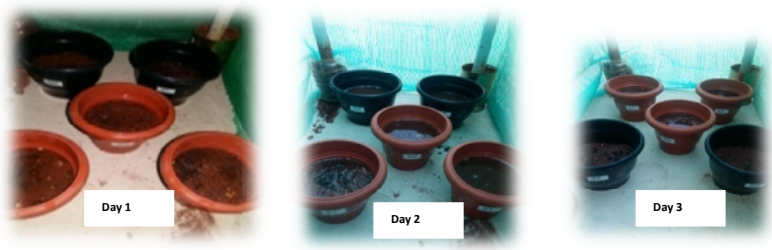
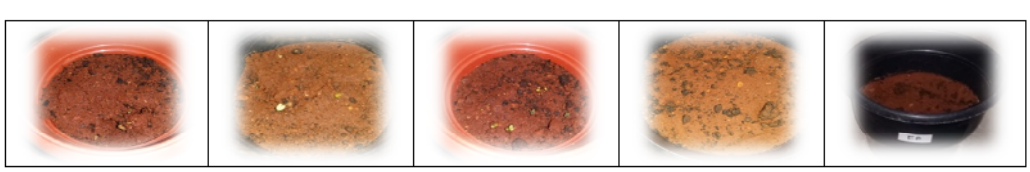


Fig.3. Germination of plants in green house atmosphere – day 1-3

Day 1

Day 2



Day 3

Fig.4.Germination of plants under exhaust exposure– day 1-3

Day 1

Day 2

Day 3

Fig.5.Germination of plants in mobile radiation atmosphere– day 1-3

Table.3. Measurement of physical characteristics of germinated seeds of 5 different plants exposed to mobile radiation- Day-1-7

Day 1-3: No visible changes

Day	Observation	Plant 1		Plant 2		Plant 3		Plant 4		Plant 5	
		X	Y_1	X	Y_1	X	Y_1	X	Y_1	X	Y_1
4	**Length of leaves(cm) leaves(cm)(cm)**	sprouted	0.5-0.6	N/C	Sprouted	N/C	0.1-0.2	N/C	N/C	N/C	N/C
	No of leaves	3	18	N/C	18	N/C	26	N/C	N/C	N/C	N/C
	Colour of leaves	Green	Green	N/C	Dirty white	N/C	Light green	N/C	N/C	N/C	N/C
5	**Length of**	0.7	0.7-1.2	N/C	1.2	0.3	0.1-0.2	N/C	N/C	N/C	0.4-0.6
	No of leaves	24	56	N/C	68	2	26	N/C	N/C	N/C	24
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pink
6	**Length of leaves(cm)**	0.5-0.9	0.9-1.5	N/C	1.5-2.5	0.2-0.4	0.2-0.6	N/C	N/C	N/C	0.2-0.6
	No of leaves	68	66	N/C	70	14	72	N/C	N/C	N/C	49
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pinkish green
7	**Length of leaves(cm)**	0.7-1.5	1-1.5	N/C	2-3	0.3-0.6	0.3-0.6	N/C	N/C	N/C	0.2-0.9
	No of leaves	70	83	N/C	73	22	74	N/C	N/C	N/C	59
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pinkish green

Table.4. Measurement of physical characteristics of germinated seeds of 5 different plants exposed to mobile radiation- Day-8-18

Day	Observation	Plant 1		Plant 2		Plant 3		Plant 4		Plant 5	
		X	Y_1	X	Y_1	X	Y_1	X	Y_1	X	Y_1
8	**Length of leaves(cm)**	0.6-1.6	0.7-1.8	N/C	2-3.6	0.2-0.6	0.3-0.7	N/C	N/C	N/C	0.2-1.1
	No of leaves	75	96	N/C	76	24	76	N/C	N/C	N/C	70
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pinkish green
9	**Length of leaves(cm)**	0.6-1.9	0.3-1.9	N/C	1.5-4	0.2-0.5	0.3-0.7	N/C	N/C	N/C	0.3-1.2
	No of leaves	76	96	N/C	82	26	82	N/C	N/C	N/C	74
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pinkish green
10	**Length of leaves(cm)**	0.9-2	0.3-2.1	N/C	1.8-4	0.2-0.6	0.3-0.8	N/C	N/C	N/C	0.2-1.3
	No of leaves	78	96	N/C	84	26	86	N/C	N/C	N/C	74
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pinkish green
11	**Length of leaves(cm)**	1-2.1	0.4-2.3	N/C	0.8-4.7	0.2-0.5	0.3-0.9	N/C	N/C	N/C	0.3-1.5
	No of leaves	78	96	N/C	85	26	91	N/C	N/C	N/C	74
	Colour of leaves	Green	Green	N/C	Green	Light green	Light Green	N/C	N/C	N/C	Pinkish green
12	**Length of leaves(cm)**	0.5-2.4	0.5-2.3	N/C	1.8-4.7	0.3-0.5	0.2-0.9	N/C	0.8	N/C	0.4-1.5
	No of leaves	78	96	N/C	86	26	93	N/C	3	N/C	74
	No of wilting leaves	Nil	2	N/C	6	Nil	Nil	N/C	Nil	N/C	Nil
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pinkish green
13	**Length of leaves(cm)**	0.5-2.5	0.6-2.5	N/C	1.9-4.8	0.3-0.5	0.1-1	N/C	0.8-1	N/C	0.2-1.5
	No of leaves	78	110	N/C	86	25	95	N/C	12	N/C	75
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pinkish green
14	**Length of leaves(cm)**	0.5-2.5	0.7-2.5	N/C	2-4.8	0.4-0.5	0.2-1	N/C	0.3-	N/C	0.2-1.5
	No of leaves	80	122	N/C	86	22	95	N/C	14	N/C	77
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pinkish green
	No of wilting leaves	Nil	1	N/C	Nil	3	Nil	N/C	Nil	N/C	Nil
15	**Length of leaves(cm)**	0.3-2.5	0.7-2.5	N/C	2.1-4.8	0.2-0.5	0.3-1	N/C	0.8-2	N/C	0.2-1.5
	No of leaves	88	125	N/C	86	22	97	N/C	21	N/C	80
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pinkish green
	No of wilting leaves	Nil	1	N/C	Nil	2	Nil	N/C	Nil	N/C	Nil
16	**Length of leaves(cm)**	0.5-2.6cm	0.5-2.6	N/C	2.3-4.8	0.3-0.6	0.3-1.3	N/C	1-2	N/C	0.2-1.5
	No of leaves	95	132	N/C	86	22	102	N/C	30	N/C	81
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	No of wilting leaves	Nil	Nil	N/C	2	2	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	4	N/C	7	Nil	Nil	N/C	Nil	N/C	Nil
17	**Length of leaves(cm)**	0.5-2.6	0.4-	N/C	2.5-4.8	0.3-0.6	0.3-1.5	N/C	0.5-2	N/C	0.3-1.5
	No of leaves	95	137	N/C	86	24	118	N/C	38	N/C	82
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	No of wilting leaves	Nil	Nil	N/C	3	2	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	5	N/C	10		1	N/C	Nil	N/C	Nil
18	**Length of leaves(cm)**	0.5-2.7	0.6-	N/C	2.6-5	0.5-0.7	0.3-1.6	N/C	0.5-	N/C	0.3-1.5
	No of leaves	101	146	N/C	90	26	122	N/C	42	N/C	82
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	Decolourised leaves	Nil	8	N/C	10	Nil	Nil	N/C	Nil	N/C	Nil

Table.5. Measurement of physical characteristics of germinated seeds of 5 different plants exposed to mobile radiation- Day-19-26

Day	Observation	Plant 1		Plant 2		Plant 3		Plant 4		Plant 5	
		X	Y_1	X	Y_1	X	Y_1	X	Y_1	X	Y_1
19	**Length of leaves(cm)**	0.6-2.7	0.7-2.5	N/C	0.2-5.1	0.4-0.7	0.2-1.7	N/C	0.5-2.1	N/C	0.3-1.5
	No of leaves	102	163	N/C	93	29	129	N/C	42	N/C	82
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	Decolourised	Nil	10	N/C	15	Nil	Nil	N/C	Nil	N/C	Nil
20	**Length of leaves(cm)**	0.1-2.7	0.8-2.5	N/C	0.5-2.5	0.5-0.8	0.3-1.8	N/C	0.32.	N/C	0.3-1.5
	No of leaves	105	178	N/C	97	33	133	N/C	45	N/C	82
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	Decolourised leaves	Nil	11	N/C	16	Nil	Nil	N/C	Nil	N/C	Nil
21	**Length of leaves(cm)**	0.2-2.8	0.2-2.7	N/C	0.5-5.3	0.1-0.8	0.3-1.9	N/C	0.6-2.1	N/C	0.3-1.5
	No of leaves	106	180	N/C	90	38	139	N/C	46	N/C	83
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	No of wilting leaves	Nil	Nil	N/C	12	2	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	11	N/C	10	Nil	Nil	N/C	Nil	N/C	Nil
22	**Length of leaves(cm)**	0.3-2.8	0.2-2.7	N/C	0.9-5.3	0.2-0.8	0.3-1.9	N/C	0.4-1	N/C	0.3-1.5
	No of leaves	109	171	N/C	48	45	142	N/C	48	N/C	83
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	No of wilting leaves	Nil	Nil	N/C	42	2	Nil	N/C	Nil	N/C	Nil
	Decolourised	Nil	11	N/C	3	Nil	Nil	N/C	Nil	N/C	Nil
23	**Length of leaves(cm)**	0.3-2.8	0.2-2.5	N/C	4	0.2-0.9	2.5	N/C	0.2-1	N/C	1.5
	No of leaves	109	155	N/C	58	52	144	N/C	49	N/C	83
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	No of wilting leaves	Nil	16	N/C	Nil	2	Nil	N/C	Nil	N/C	Nil
	Decolourised	Nil	7	N/C	9	Nil	1	N/C	Nil	N/C	Nil
24	**Length of leaves(cm)**	0.8-2.8	0.2-2.5	N/C	4-4.8	0.4-1.4	1.7-2.2	N/C	0.5-1	N/C	1-1.5
	No of leaves	111	153	N/C	62	52	145	N/C	49	N/C	84
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Greenish pink
	No of wilting leaves	Nil	14	N/C	14	2	2	N/C	Nil	N/C	Nil
	Decolourised	Nil	11	N/C	10	Nil	1	N/C	Nil	N/C	Nil
25	**Length of leaves(cm)**	0.2-2.8	0.6-2	N/C	0.6-5.3	0.4-1.4	0.2-1.8	1.1	0.3-1	N/C	0.4-1.5
	No of leaves	113	149	N/C	68	52	147	5	49	N/C	83
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	Light	Light	N/C	Greenish pink
	No of wilting leaves	Nil	4	N/C	14	2	2	Nil	Nil	N/C	Nil
	Decolourised	Nil	7	N/C	4	Nil	1	Nil	Nil	N/C	Nil
26	**Length of leaves(cm)**	0.6-2.8	0.5-2.1	N/C	0.4-5.3	0.2-1.4	0.5-2.2	1-1.8	0.4-1	N/C	0.3-1.6
	No of leaves	166	143	N/C	72	58	149	6	50	N/C	84
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	Light	Light	N/C	Greenish pink
	No of wilting leaves	Nil	12	N/C	Nil	2	9	Nil	9	N/C	Nil
	Decolourised leaves	Nil	7	N/C	2	Nil	2	Nil	Nil	N/C	1

(X=Plants without radiation, Y=Plants with radiation, N/C= No significant changes

Table.6. Measurement of physical characteristics of germinated seeds of 5 different plants exposed to exhaust- Day-4-15

Day 1-3: No visible changes

Day	Observation	Plant 1		Plant 2		Plant 3		Plant 4		Plant 5	
		X	Y_2	X	Y_2	X	Y_2	X	Y_2	X	Y_2
4	**Length of**	Start	0.5-0.6	N/C	0.3	N/C	0.2	N/C	N/C	N/C	
	No of leaves	3	10	N/C	6	N/C	4	N/C	N/C	N/C	
	Colour of leaves	Green	Light	N/C	Dirty white	N/C	Light green	N/C	N/C	N/C	
5	**Length of leaves(cm)**	0.7	0.6-0.7	N/C	1.4-2	0.3	0.2-0.5	N/C	N/C	N/C	0.3-0.4
	No of leaves	24	68	N/C	58	2	67	N/C	N/C	N/C	4
	Colour of leaves	Green	Green	N/C	Light green	Light green	Light green	N/C	N/C	N/C	Pink
6	**Length of leaves(cm)**	0.5-0.9	0.5-1.4	N/C	2-2.9	0.2-0.4	0.2-0.6	N/C	N/C	N/C	0.3-0.6
	No of leaves	68	68	N/C	60	14	76	N/C	N/C	N/C	18
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	N/C	N/C	Pink
7	**Length of leaves(cm)**	0.7-1.5	0.6-1.6	N/C	0.5-3	0.3-0.6	0.4-0.9	N/C	N/C	N/C	0.3-0.7
	No of leaves	70	80	N/C	60	22	80	N/C	N/C	N/C	20
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	N/C	N/C	Pink
8	**Length of leaves(cm)**	0.6-1.6	0.9-1.9	N/C	0.6-3.4	0.2-0.6	0.4-0.9	N/C	N/C	N/C	0.3-0.7
	No of leaves	75	92	N/C	62	24	80	N/C	N/C	N/C	26
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	N/C	N/C	Pink
9	**Length of leaves(cm)**	0.6-1.9	0.3-1.9	N/C	0.6-3.4	0.2-0.5	0.5-0.9	N/C	N/C	N/C	0.3-0.8
	No of leaves	76	97	N/C	62	26	83	N/C	N/C	N/C	28
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	N/C	N/C	Pink
10	**Length of leaves(cm)**	0.9-2	0.5-1.9	N/C	0.3-3.6	0.2-0.6	0.2-0.9	N/C	0.6	N/C	0.5-0.9
	No of leaves	78	103	N/C	68	26	91	N/C	3	N/C	30
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
11	**Length of leaves(cm)**	1-2.1	0.8-1.9	N/C	1.5-4.1	0.2-0.5	0.5-0.9	N/C	0.5-1.3	N/C	0.3-1.1
	No of leaves	78	112	N/C	68	26	97	N/C	17	N/C	34
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	3	Nil	Nil	N/C	Nil	N/C	Nil
12	**Length of leaves(cm)**	0.5-2.4	1-1.9	N/C	2-4.5	0.3-0.5	0.3-0.9	N/C	0.3-1.5	N/C	0.3-1.2
	No of leaves	78	120	N/C	68	26	102	N/C	38	N/C	37
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
13	**Length of leaves(cm)**	0.5-2.5	0.3-2	N/C	0.3-4.5	0.3-0.5	0.2-0.9	N/C	0.3-1.5	N/C	0.4-1.3
	No of leaves	78	120	N/C	76	25	120	N/C	46	N/C	40
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
14	**Length of leaves(cm)**	0.5-2.5	0.5-2.2	N/C	0.7-4.7	0.4-0.5	0.2-1	N/C	0.3-1.5	N/C	0.5-1.5
	No of leaves	80	122	N/C	85	22	131	N/C	54	N/C	45
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	No of wilting leaves	Nil	Nil	N/C	Nil	3	Nil	N/C	Nil	N/C	Nil
15	**Length of leaves(cm)**	0.3-2.5	0.5-2.2	N/C	0.8-4.7	0.2-0.5	0.5-2.2	N/C	0.6-1.5	N/C	0.4-1.5
	No of leaves	88	126	N/C	87	22	134	N/C	54	N/C	48
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	No of wilting leaves	Nil	Nil	N/C	Nil	2	Nil	N/C	Nil	N/C	Nil

Table.7. Measurement of physical characteristics of germinated seeds of 5 different plants exposed to mobile radiation- Day 16-22

Day	Observation	Plant 1		Plant 2		Plant 3		Plant 4		Plant 5	
		X	Y_2	X	Y_2	X	Y_2	X	Y_2	X	Y_2
16	**Length of leaves(cm)**	0.5-2.6	0.5-2.2	N/C	1-4.7	0.3-0.6	0.5-2.3	N/C	0.5-1.8	N/C	0.5-1.5
	No of leaves	95	128	N/C	91	22	145	N/C	62	N/C	51
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	No of wilting leaves	Nil	Nil	N/C	Nil	2	Nil	N/C	Nil	N/C	Nil
17	**Length of leaves(cm)**	0.5-2.6	0.5-2.2	N/C	1.5-4.7	0.3-0.6	0.5-2.4	N/C	0.5-1.8	N/C	0.2-1.5
	No of leaves	95	128	N/C	91	24	148	N/C	73	N/C	54
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	No of wilting leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
18	**Length of leaves(cm)**	0.5-2.7	0.6-2.2	N/C	1.6-4.8	0.5-0.7	0.5-2.6	N/C	0.5-1.9	N/C	0.2-1.5
	No of leaves	101	131	N/C	91	26	151	N/C	75	N/C	57
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	No of wilting leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
19	**Length of leaves(cm)**	0.6-2.7	0.6-2.2	N/C	0.5-5	0.4-0.7	0.6-2.6	N/C	0.5-2	N/C	0.3-1.5
	No of leaves	102	133	N/C	93	29	153	N/C	80	N/C	57
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	No of wilting leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
20	**Length of leaves(cm)**	0.1-2.7	0.7-2.2	N/C	1-5.1	0.5-0.8	0.7-2.9	N/C	0.5-2.2	N/C	0.4-1.5
	No of leaves	105	136	N/C	106	33	153	N/C	86	N/C	57
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	No of wilting leaves	Nil	Nil	N/C	2	Nil	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	Nil	N/C	2	Nil	4	N/C	Nil	N/C	Nil
21	**Length of leaves(cm)**	0.2-2.8	0.7-2.2	N/C	0.6-5.1	0.1-0.8	0.5-2.9	N/C	0.3-1.1	N/C	0.4-1.6
	No of leaves	106	136	N/C	109	38	154	N/C	92	N/C	57
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	1	2	Nil	N/C	Nil	N/C	Nil
	No of wilting leaves	Nil	Nil	N/C	5	Nil	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	Nil	N/C	3	Nil	6	N/C	Nil	N/C	Nil
22	**Length of leaves(cm)**	0.3-2.8	0.6-2.2	N/C	0.7-5.2	0.2-0.8	0.5-3	N/C	0.3-1.1	N/C	0.3-1.6
	No of leaves	109	138	N/C	107	45	155	N/C	97	N/C	89
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	Holes in leaves	Nil	Nil	N/C	1	2	Nil	N/C	Nil	N/C	Nil
	No of wilting leaves	Nil	Nil	N/C	6	Nil	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	Nil	N/C	3	Nil	6	N/C	Nil	N/C	Nil

Table.8. Measurement of physical characteristics of germinated seeds of 5 different plants exposed to mobile radiation- Day 23-26

Day	Observation	Plant 1		Plant 2		Plant 3		Plant 4		Plant 5	
		X	Y_2	X	Y_2	X	Y_2	X	Y_2	X	Y_2
23	**Length of leaves(cm)**	0.3-2.8	0.6-2.2	N/C	0.8-4.5	0.2-0.9	0.6-3	N/C	0.4-1.2	N/C	0.4-1.8
	No of leaves	109	140	N/C	110	52	170	N/C	98	N/C	58
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	No of wilting leaves	Nil	Nil	N/C	7	2	Nil	N/C	Nil	N/C	Nil
	Decolourisedleaves	Nil	Nil	N/C	5	Nil	Nil	N/C	Nil	N/C	Nil
24	**Length of leaves(cm)**	0.8-2.8	0.7-2	N/C	0.8-4.5	0.4-1.4	0.7-3	N/C	0.4-1.3	N/C	0.4-1.9
	No of leaves	111	160	N/C	112	52	182	N/C	98	N/C	58
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	N/C	Light	N/C	Pink
	No of wilting leaves	Nil	Nil	N/C	10	2	Nil	N/C	Nil	N/C	Nil
	Decolourised leaves	Nil	3	N/C	8	Nil	19	N/C	Nil	N/C	Nil
25	**Length of leaves(cm)**	0.2-2.8	0.2-1.9	N/C	0.5-4.5	0.4-1.4	0.4-3.2	1.1	0.6-1.3	N/C	0.5-2
	No of leaves	113	188	N/C	116	52	192	5	98	N/C	58
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	Light	Light	N/C	Pink
	No of wilting leaves	Nil	5	N/C	8	2	11	Nil	Nil	N/C	Nil
	Decolourised leaves	Nil	8	N/C	17	Nil	3	Nil	Nil	N/C	Nil
26	**Length of leaves(cm)**	0.6-2.8	0.3-2.2	N/C	1.7-3.2	0.2-1.4	0.5-3.4	1-1.8	0.4-1.2	N/C	0.5-2
	No of leaves	166	215	N/C	120	58	115	6	99	N/C	61
	Colour of leaves	Green	Green	N/C	Green	Light green	Light green	Light	Light	N/C	Pink
	No of wilting leaves	Nil	4	N/C	13	2	24	Nil	Nil	N/C	2
	Decolourised leaves	Nil	8	N/C	23	Nil	Nil	Nil	Nil	N/C	Nil

(X=Plants without radiation, Y=Plants with radiation, N/C= No significant changes

The results of the plant growth have been analyzed in three different headings:

- **Impact of growth of plants exposed to exhaust**
- **Impact of growth of plants exposed to mobile radiation**
- **Impact of growth of plants in green house**

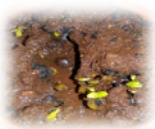
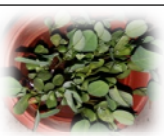
4.3.Impact of growth of plants exposed to exhaust

The results of growth of 5 plants exposed to polluted atmosphere from day 4 to 26 is given as observations and relevant discussions. Table .9.shows the growth of plants on day 4

Observations- EEF

- The leaves of EEF was start sprouts at 4th day with 0.5cm in length.
- The leaves were light green in colour.
- There is no wilting and discoloration of leaves was observed until the day 23.
- After that three leaves were discoloured on 24th day it may be due to the plants grow under polluted environment.
- On 26th day 8 leaves were wilted. The discoloured leaves were coded as EEFD.

Table.9. Germination of EEF from day 4 to day 25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 166 leaves were only healthy and survived. 8 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were discoloured. The results of the study vividly portray the impact of exhaust on the growth of plants taken up in the study.

Observations- EEG

- The leaves of the EEG were start sprouts at 4th day it was dirty white in colour. The length of the leaf at 4th day was 1.4cm their length was increased with their growth.
- On 5th day the colour of the leaves were light green in colour. There is no changes was observed until day 9.
- On 10th day the holes were observed in the leaves of EEG. It may be due to insects in polluted areas. Number of holes increased by three on 11th day.
- On 17th day 2 leaves of the EEG were wilted, and the 2 leaves were discoloured. The discoloured leaves were coded as EEGD. On 18th day two leaves contains holes, two leaves were discoloured and tow leaves were wilting this may be due the polluted environment of plant.
- On 21st day number of wilting leaves and discoloured leaves were increased by 5 and 3 respectively, then one leaf containing holes.
- On 26th day 13 wilting leaves 23 discoloured leaves were observed.
- The length of the EEG leaves was increased from 0.3cm to 3.2cm and the number of leaves in the plant was increased from 6 to 120.

A wide range of effects were detected, including growth stimulation and inhibition. **(J.N.B. Bell et al,2011)**

Table.10. Germination of EEG from day 4 to day 25

Day 4-8					
Day 9-13					
Day 14-18					

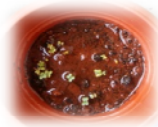
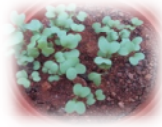
Day 19-23					
Day 24-25					

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 120 plants were only healthy and survived. 13 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were discoloured. The results of the study vividly portray the impact of exhaust on the growth of plants taken up in the study.

Observations- EEM

- The leaves of EEM were start sprouts at 4th day their length was 0.2cm.
- The leaves of the EEM were light green in colour. On 20th day the 4 leaves of EEM were discoloured.
- On 24th day 19 leaves of were discoloured. The discoloured leaves were coded as EEMD eleven leaves were wilted on 25th day and it was increased by 24 on 26th day.
- The significant changes induced in the EEM may be due the exhaust environment.
- The length of the leaves was increased from 0.1cm to 3.4cm, number of leaves also increased from 26 to 115.

Table.11. Germination of EEM from day 4 to day 25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 115 leaves were only healthy and survived. 11 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were discoloured. The results of the study vividly portray the impact of exhaust on the growth of plants taken up in the study.

Observations- EEC

- There are no significant changes from day 1 to day 9. On 10th day three leaves of the coriander were starts to sprouts.
- The length of the leaf was 0.6 and it was light green in colour.

- The no wilting of leaves until day 25, but on day 26 nine leaves of the coriander was wilted it may be because of polluted environment.
- The number of leaves increased from 3 to 99.
- The length of the leaves was increased from to 0.6cm to 1.2cm.
- The discoloration was observed on 29th day and it was coded as EECD.

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 99 leaves were only healthy and survived. 9 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were discoloured. The results of the study vividly portray the impact of exhaust on the growth of plants taken up in the study.

Table.12. Germination of EEC from day 4 - 26

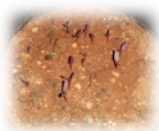
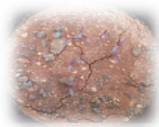
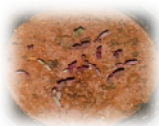
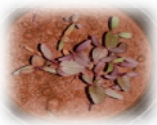
Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

Observations- EEA

- EEA was abbreviated as exhaust exposure amaranthus.
- The four leaves of the amaranth were start sprouts at 5th day and their length were 0.3cm.
- It was pink in colour. There is no wilting of leaves were observed until the day 25, on 26th day 2 leaves were wilted it may be because of polluted environment of plant.
- The length of the leaves was increased from 0.3cm to 2cm. Number of leaves was increased from 4 to 61.
- Discoloration of leaves was observed at 30th day and it is coded as EEAD (exhaust exposure amaranth discoloured).

The plants were injured by the direct impact of the vehicle exhaust on the plants **(Smit et al, 1970)**

Table .13.Germination of EEA from day 4 - 26

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 61 leaves were only healthy and survived. 2 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were discoloured. The results of the study vividly portray the impact of exhaust on the growth of plants taken up in the study.

4.2. Impact of growth of plants exposed to mobile radiation

The results of growth of 5 plants exposed to mobile radiation from day 4 to 26 is given as observations and relevant discussions.

Observations- REF

- The REF plants sprouted on the 4th day.
- The leaves were light green in colour.
- Their growth was gradually increased with number of leaves.
- The wilting of leaves was not observed until the day 11, but in the day 12 two leaves were start wilting

  The wilting of leaves may be because of radiation exposurefrom mobile phone that would have interfered with both morphological and the biochemical processes affecting the growth and nodule formation in the plants as was observed by earlier workers**(Sharma et al, 2014).**
- The two leaves fell off day 13. Again the leafs of REF started wilting now the number of wilting leaves were 1, it was gradually increased to 4on day16. The wilted leaves were simultaneously fell off from the plant.
- There was no discolouration observed until the 15, but on the next day, 4 leaves were discoloured. Their actual colour was green it was decoloured as light green. There is no wilting leaves were observed on the day 17.the decolouration of REF leaves were increased by 5 and 8 on the 17th and 18th day respectively.
- There is no wilting of leaves were observed form 16th day to 22nd day. Sudden wilting of 16 leaves on 23rd day. The discoloration of leaves was observed as 10, 11, 11, 11, 16 in numbers from 19th to 23rd day respectively. 5 discoloured leaves were wilted on 24th day. The leaves were fell off after discolouration and wilting. On 25th day number of leaves in REF plant was decreased form 171 to 143.

To conclude in 26 days not all 50 seeds germinated. Among the germinated seeds 143 leaves were only healthy and survived. 28 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the

study vividly portray the impact of mobile radiation on the growth of plants taken up in the study.

Table.14.shows the germination of REF seeds from day 4-26

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

Observations- REG

- The green gram which was grown under the radiation exposure may cause some changes to the plant growth.
- The leaves of the green gram were start sprouts at 4th day there are 18 numbers of leaves were starts sprouts.
- The leaves were dirty white in colour.
- The length of the leaves was increased with their growth.
- On 5th day, 68 leaves were grown and it was green in colour. The 6 leaves of the REG were start wilting at 12th day; this may be due to the radiation.
- On 13th day it was fell off. There is no wilting of leaves were observer from 13th to 15th day.

- The 7 leaves of the REG were started discoloured and it is named as REGD (radiation exposure green gram discoloured). The discoloured leaves were light green in colour.

  The radiation emitted from mobile phones show effect on the early growth and biochemical changes in the emerging seedlings **(SAPNA SHARMA ET AL, 2014)**.

- The wilting leaves were fallen off from the plant.
- On 16th day the leaves were again started to wilting.
- On 18th day wilted 3 leaves were fell off from plants. The discolouration of leaves was increased gradually from 16th day to 20th day.

Table.15. Germination of REG seeds from day 4 to day25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

- On 21st and 22nd day 11 leaves of discoloured leaves were fell off from plant. On 24th day again 10 leaves were discoloured. On 25th day 6 discoloured leaves were fell off from the plant.

- On 22nd day 42 leaves were wilted. The sudden wilting of large number of leaves may be due to the radiation exposure of REG. The length of the leaves was increased from 1.2cm to 5.3cm. Wilted and discolouration of leaves were finally fell off from plant.

To conclude in 26 days not all 50 seeds germinated. Among the germinated seeds 72 leaves were only healthy and survived. 14 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study.

Observations- REM

- The leaves of the plant were starts sprouts at 4th day. The colour of the leaf was light green in colour.
- The number leaves in the plant were increased day by day. There is no discoloration and wilting of leaves was observed until day 16.
- On 17th day the leaves of the REM was start to wilting. On 18th day the wilted leaves were fell off from the plant.
- The growth and the number of leaves were increased.
- After 17th day the wilting of leaves were observed at 24th and 25th day. The discolouration of the leaf was observed at 23rd day. The discoloration and wilting may be due to radiation exposure.
- The length of the leaves was increased from 0.1cm to 1.8cm and the number of leaves also increased from 26 to 149.

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 155 plants were only healthy and survived. 24 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study.

Table.16. Germination of REM seeds from day 4 to day 25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

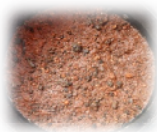
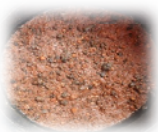
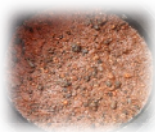
Observations- REC

- The leaves of the coriander were not sprouts until day 11.
- On 12th day the 3 leaves were starts sprouts with 0.8cm in length.
- The leaves were light green in colour.
- The number of leaves was increased from 12th day to 25th day.
- The leaves of the REC started wilting at 26th day.
- The discoloration of the leaves was observed at day 27th and it was coded as RECD, it may be due to radiation exposure.

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 99 leaves were only healthy and survived. 2 leaves wilted and fell off in the aforesaid period of study.

In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study.

Table.17. Germination of REM from day 4 to day25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

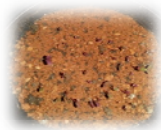
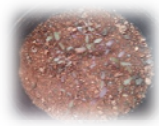
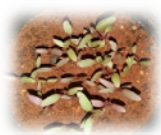
Observations- REA

- The leaves of the plant were start sprouts at 5th day.
- The length of the leaf at 5th day was 0.4cm to 0.6cm.
- And it was pink in colour.
- On next day it was pinkish green in colour.
- The number of leaves was gradually increased with their growth.
- Later on 16th day the leaves with the length 0.2cm-1.5cm were greenish pink in colour.
- There is no discoloration and wilting of leaves were observed until the day 25, on day 26 the lines with pale pink colour was observed it was discoloured and it is coded as

READ. The observed effect was significantly depends on the induced mobile radiation.

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 61 leaves were only healthy and survived. 2 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study.

Table.18. Germination of REA from day 4 to day25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

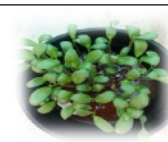
IMPACT OF GREEN HOUSE ASSISTED PLANTS

Observations- GF

- The leaves of the fenugreek were start sprouts at 4th day.
- 3 leaves were sprouts and their colour was green. There is no wilting and discolouration of leaves was observed until day 23.

- On day 24 the leaves of GF start decolouration it may be because of sunlight inside the green house was low. The decoloured leaves were start wilting on 26th day. The decoloured leaves were coded as GFD.
- The number of leaves and their length were increased with their growth.

Table.19. Germination of GM from day 4 to day25

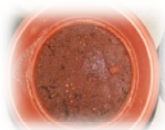
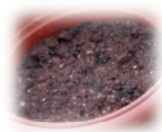
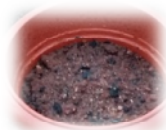
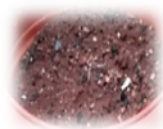
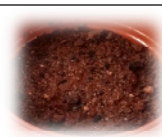
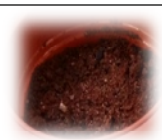
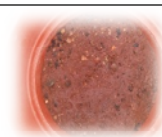
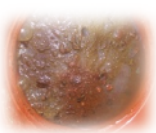
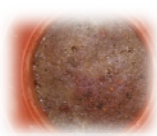
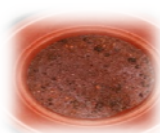
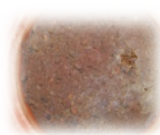
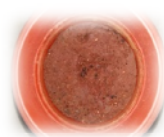
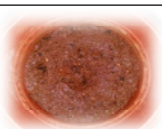
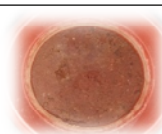
Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 215 Leaves were only healthy and survived. 4 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study

Observations- GG

- Because of less sunlight it was not grown during February month. Another plant with the sample code GG were grown on march month.
- In that decolouration and wilting were observed.
- The decolourised green gram in green house was coded as GGD.

Table.20. Germination of GG from day 4 to day25

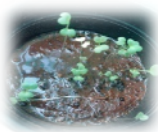
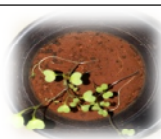
Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

To conclude in 25 days all 50 seeds was not germinated.. The results of the study vividly portray the impact of less amount of sunlight inside thegreen house affects the growth of plants taken up in the study

Observations- GM

- There are no significant changes in the plant.
- The leaves of GM were start sprouts at 4th day, their length is 0.1cm and its was green in colour.
- There is no decolourisation was observed until on the day 16.
- The decolourisation was observed on 17th day, it may because of less sunlight inside the green house. The plant may be affected by not getting proper amount of sunlight. The decolourised leaf was coded as GMD.

Table.21.Germination of GM from day 4 to day25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

- On 25th day there are 2 wilting leaves were observed. There is continuous wilting of leaves until the day 26. The decolourisation and wilting was observed may be because of less amount of sunlight inside the green house.

- The length of the leaf was gradually increased with their growth.
- Their length was increased from 0.3cm to 1.4cm.
- The number of leaves increased from 2 to58.

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 58 Leaves were only healthy and survived. 2 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study

Observations- GC

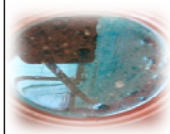
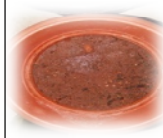
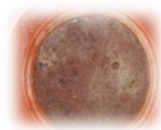
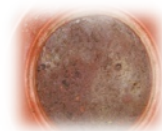
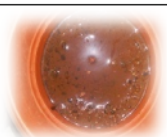
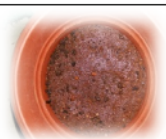
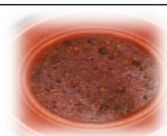
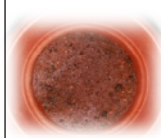
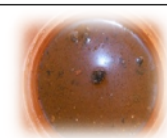
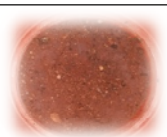
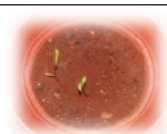
- There is no significant changes were observed until on the day 26. The sunlight inside the green house was less, the less amount of the sunlight may affect the plant growth.

  The plants get energy from the sunlight for their growth the process is called the photosynthesis. The plants can get the energy from the sunlight only if there is proper amount of sunlight. Without sunlight the plants would not be able to produce energy. **(Beverley Burgess Bel, 2017).**

- The same plant was grown on March the wilting and decolourisation was observed. The decolourised leaves were coded as GCD green house coriander decolourised.

To conclude in 25 days not all 50 seeds germinated. Among the germinated seeds 215 Leaves were only healthy and survived. 4 leaves wilted and fell off in the aforesaid period of study. In general the leaves of these plants were highly discoloured. The results of the study vividly portray the impact of mobile radiation on the growth of plants taken up in the study.

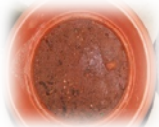
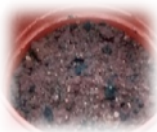
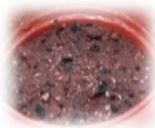
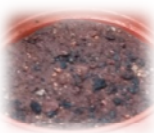
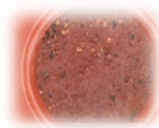
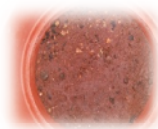
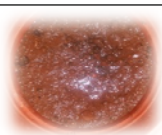
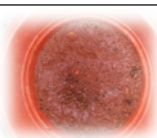
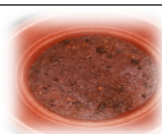
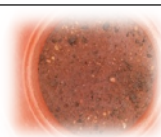
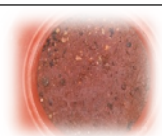
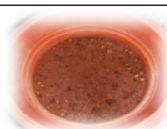
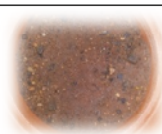
Table.22. Germination of GC from day 4 to day25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

Observations- GA

- There is no significant changes were observed on the plant until the day 26.
- The plants were start sprouts at 29th day, it was pink in colour.
- The willing and decolourisation was observed. The decolourised leaves were coded as GAD, this may be because of not getting proper amount of sunlight.

Table.23. Germination of GA from day 4 to day25

Day 4-8					
Day 9-13					
Day 14-18					
Day 19-23					
Day 24-25					

4.4. Analysis of morphology of leaves surface

Surface morphology of radiation exposed plants

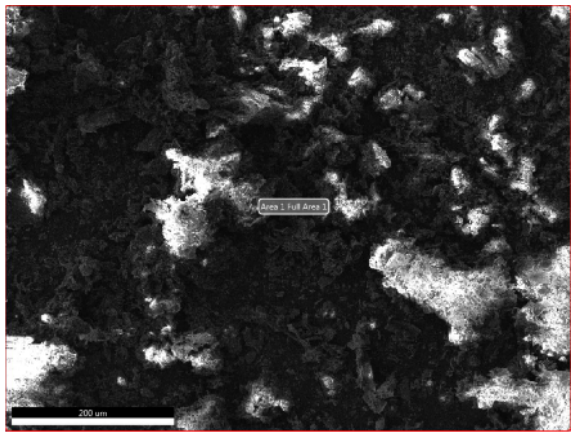


Fig. 6.REF

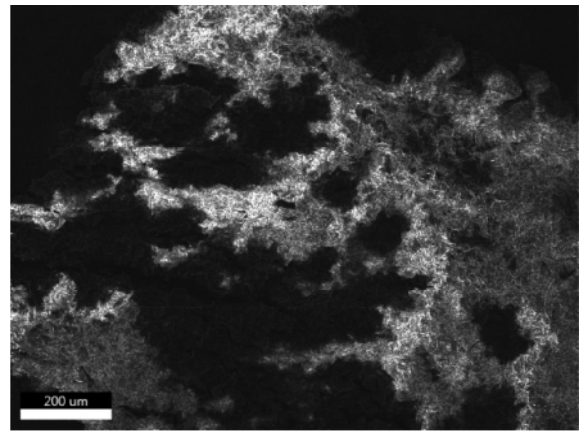


Fig.7 . REG

Fig.8 .REM

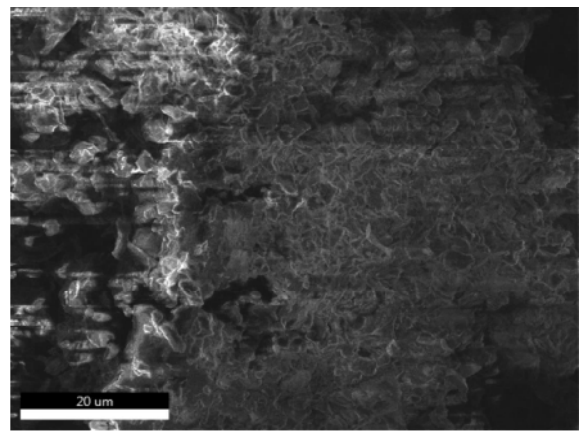


Fig. 9.REC

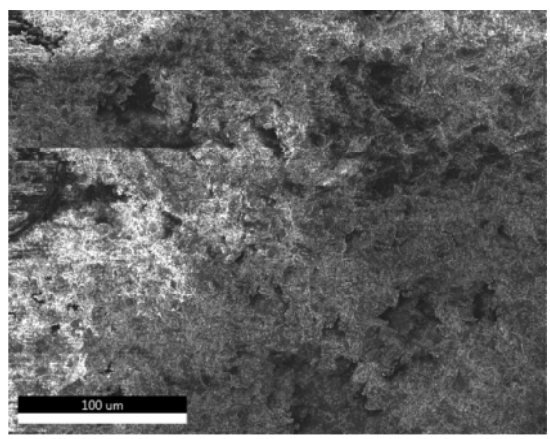


Fig.10 .REA

Surface morphology of green house plants

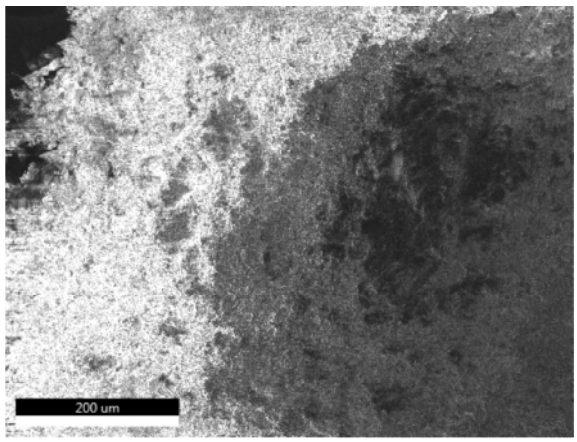


Fig.11.GF

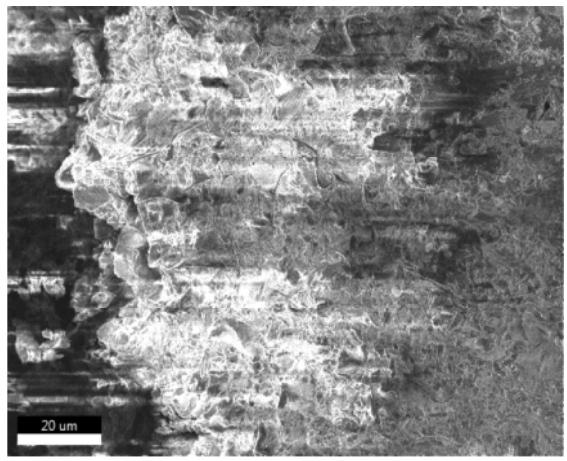


Fig.12.GM

Fig.13.GA

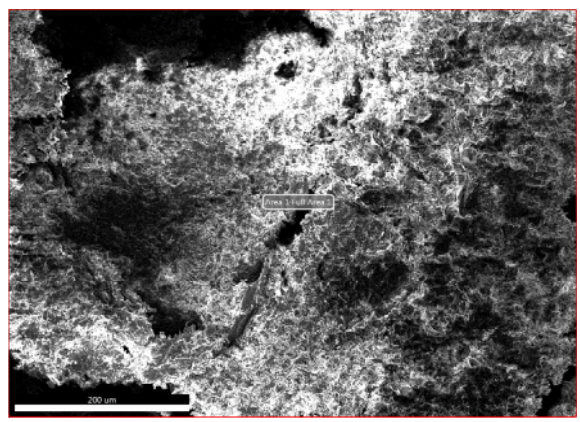


Fig.14.GG

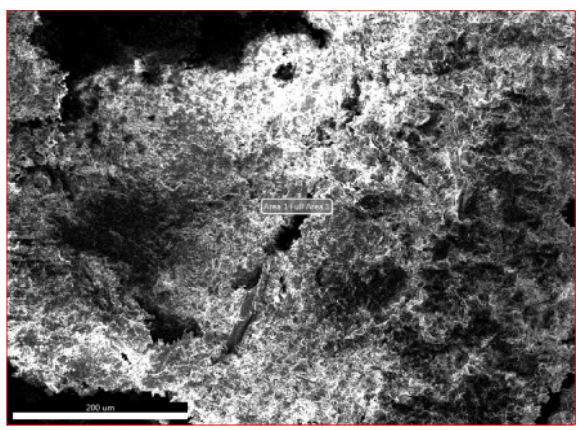


Fig. .GC

Surface morphology of exhaust exposed plants

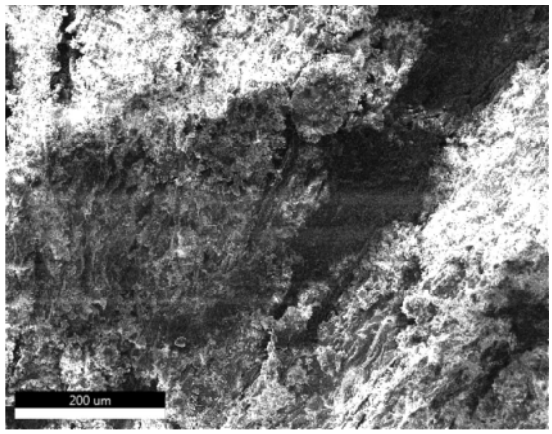


Fig .16. EEF

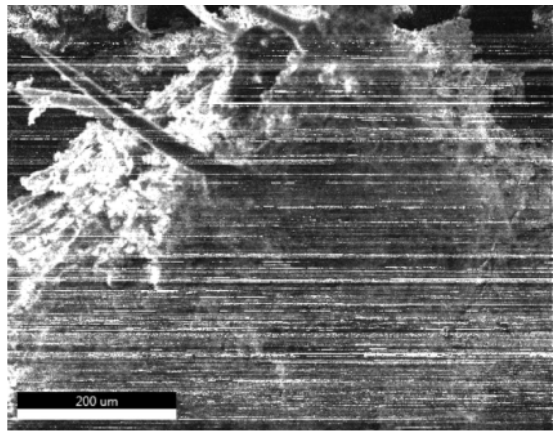


Fig.17.EEG

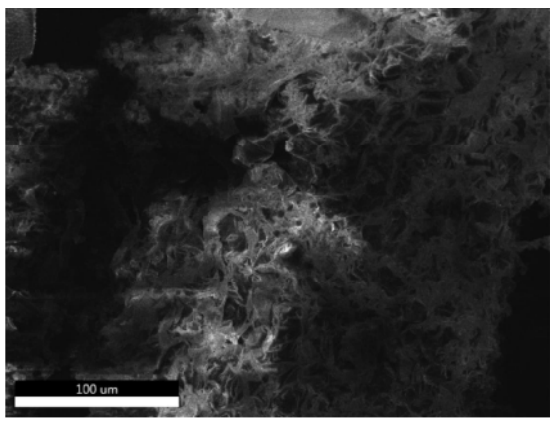


Fig.18. EEM

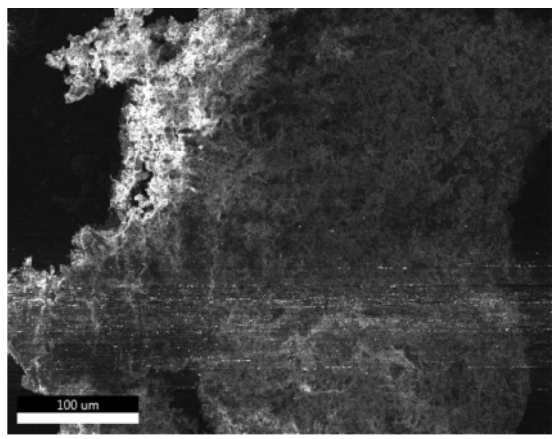


Fig.19. EEC

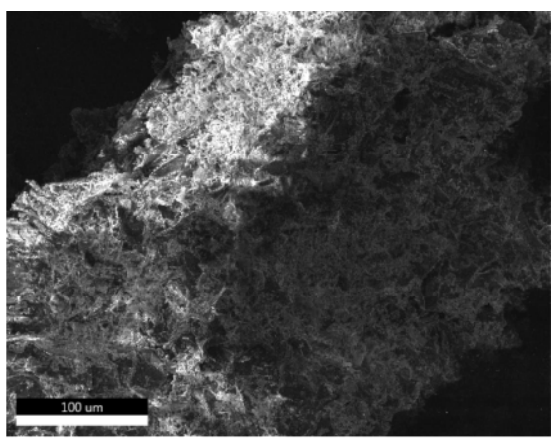


Fig.20 .EEA

The results of the surface morphology of plants under three different conditions shows the comparatively less amount of charging occurs for the exhaust exposed plant this indicates the absence of organic matter. There is rich is organic matters in green house plants. Radiation exposed plants do not have much organic matters but the image shows the presence of less amount of organic matter.

4.5. Comparative study of metal composition of leaves of samples taken in the study using EDS

The results of the comparative study of metal composition of leaf samples in three different exposure.

The EDS spectra of leaves from radiation exposed plant

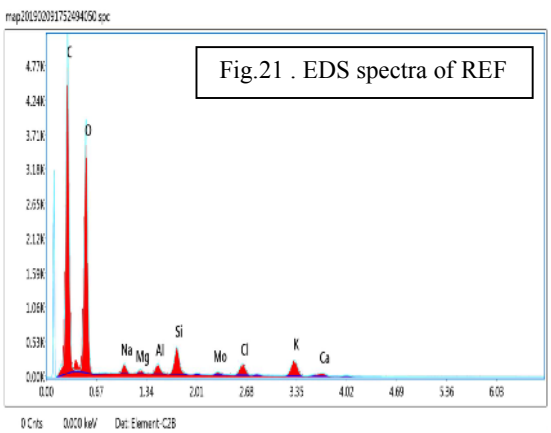


Fig.21 . EDS spectra of REF

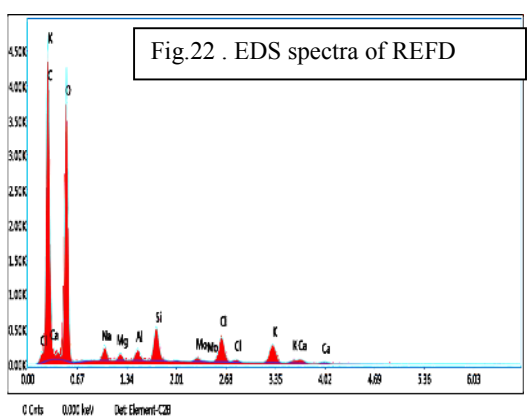


Fig.22 . EDS spectra of REFD

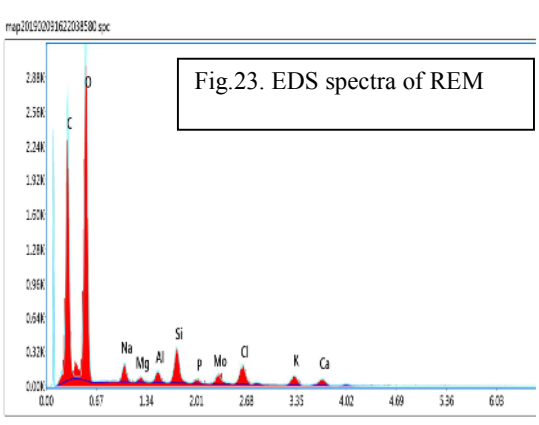


Fig.23. EDS spectra of REM

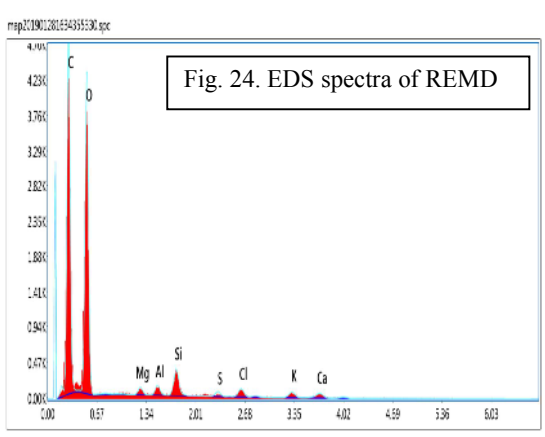


Fig. 24. EDS spectra of REMD

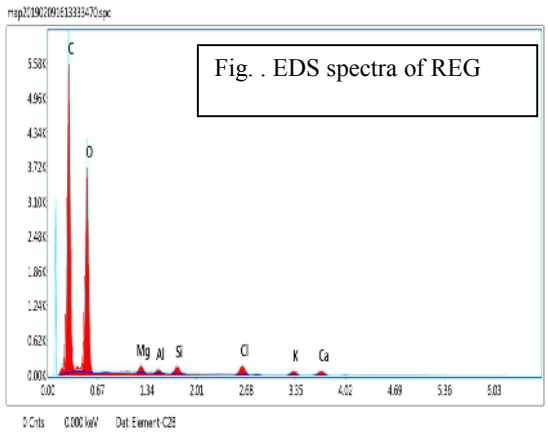


Fig. . EDS spectra of REG

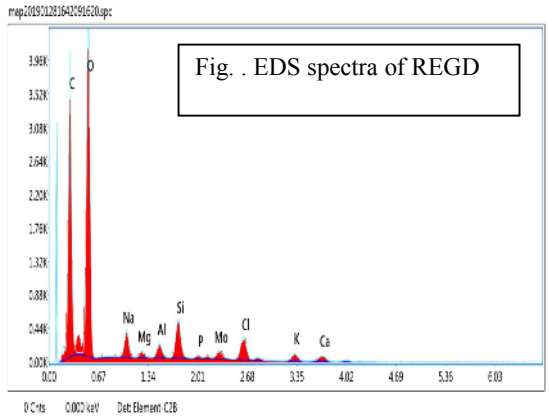


Fig. . EDS spectra of REGD

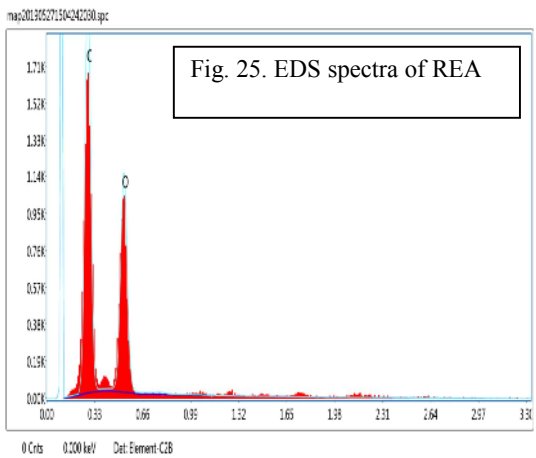


Fig. 25. EDS spectra of REA

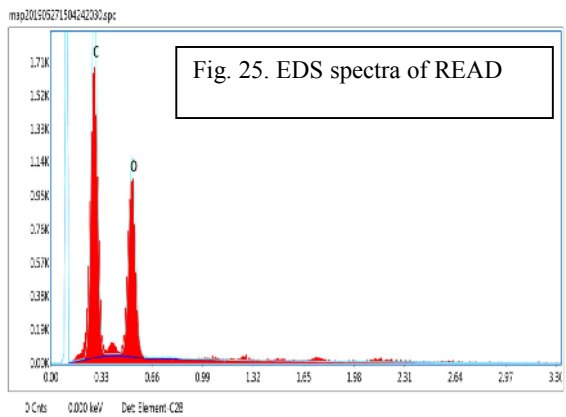


Fig. 25. EDS spectra of READ

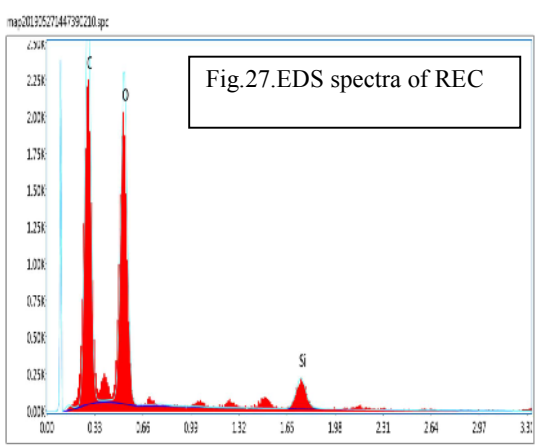


Fig.27.EDS spectra of REC

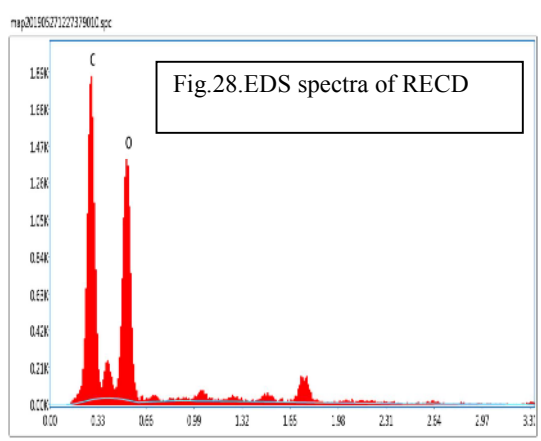


Fig.28.EDS spectra of RECD

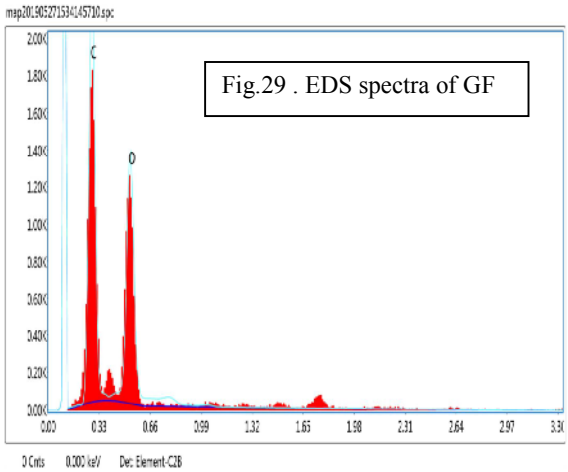


Fig.29 . EDS spectra of GF

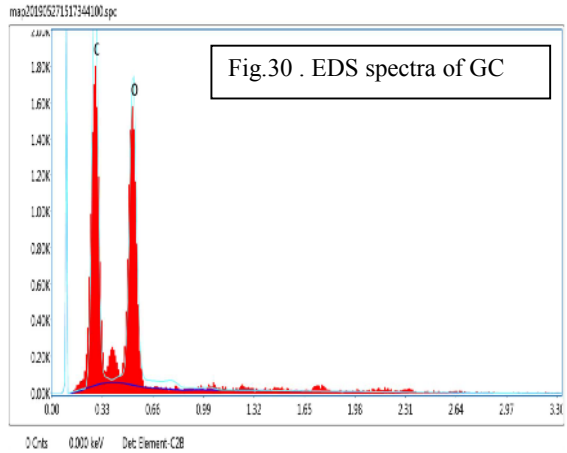


Fig.30 . EDS spectra of GC

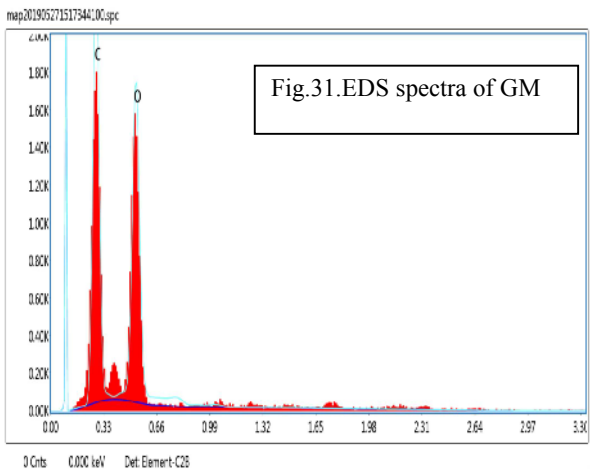


Fig.31.EDS spectra of GM

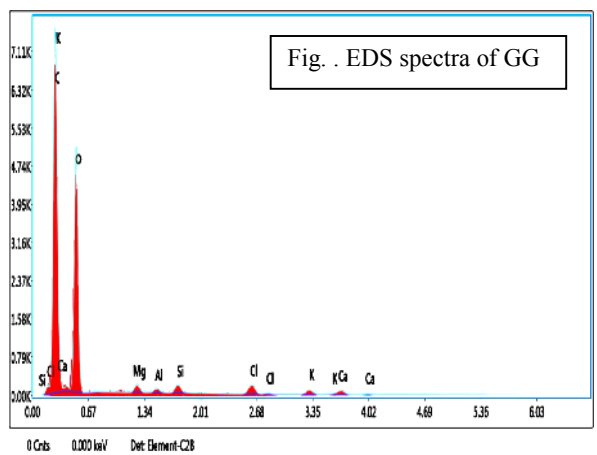


Fig. . EDS spectra of GG

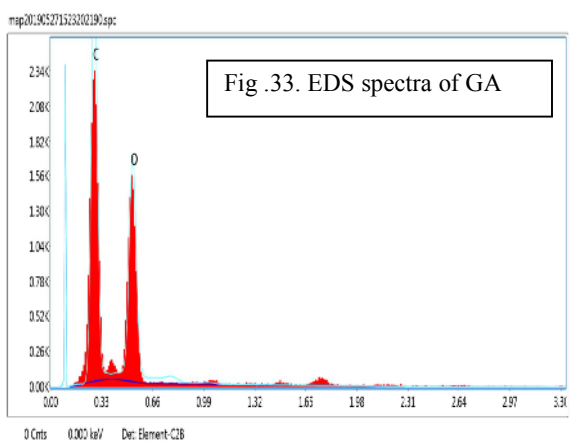


Fig .33. EDS spectra of GA

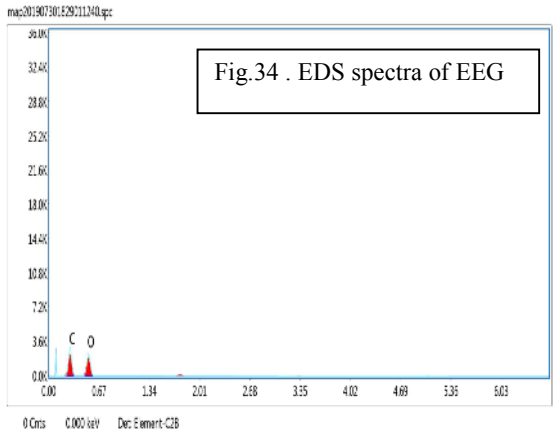


Fig.34 . EDS spectra of EEG

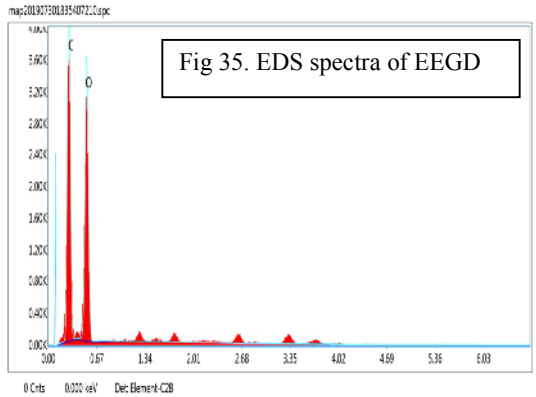


Fig 35. EDS spectra of EEGD

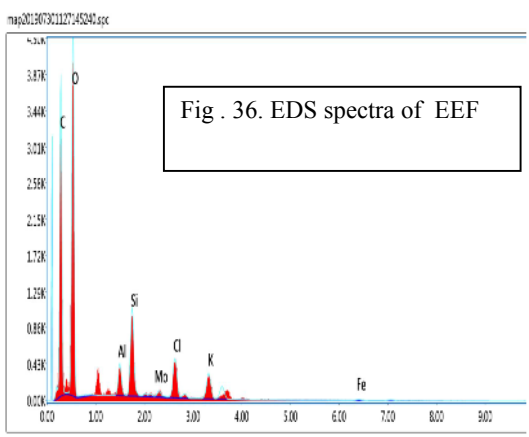


Fig . 36. EDS spectra of EEF

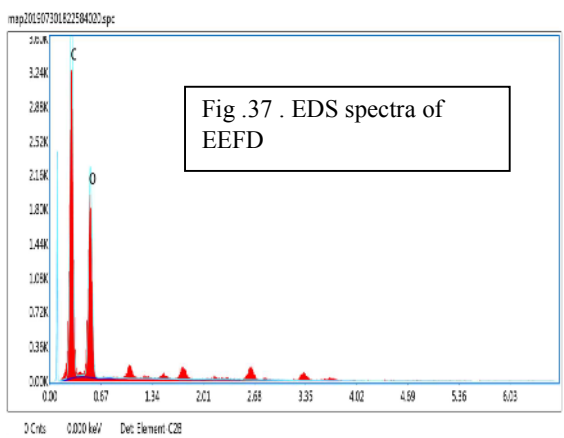


Fig .37 . EDS spectra of EEFD

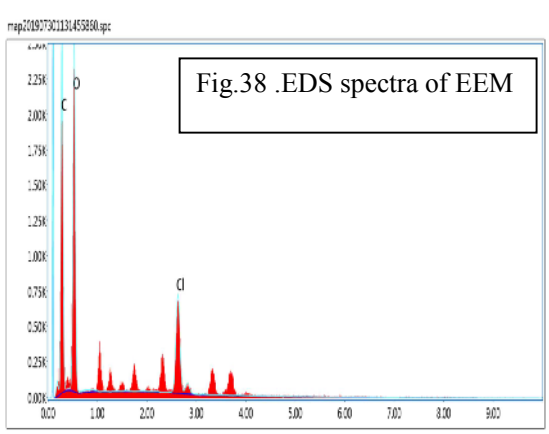


Fig.38 .EDS spectra of EEM

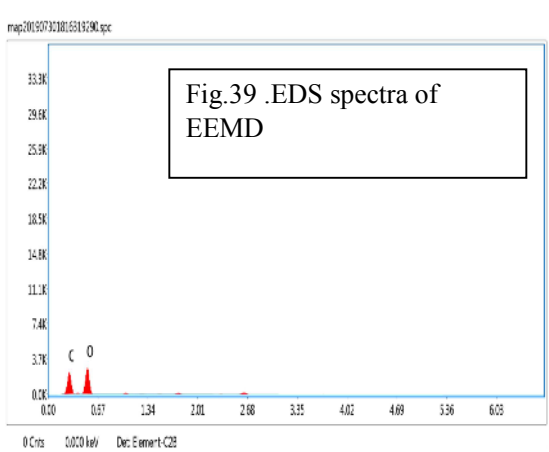


Fig.39 .EDS spectra of EEMD

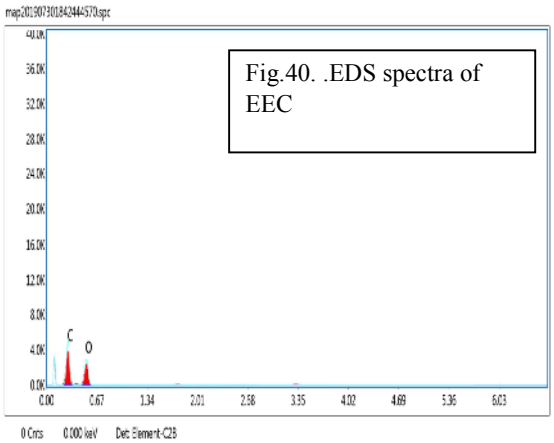


Fig.40. .EDS spectra of EEC

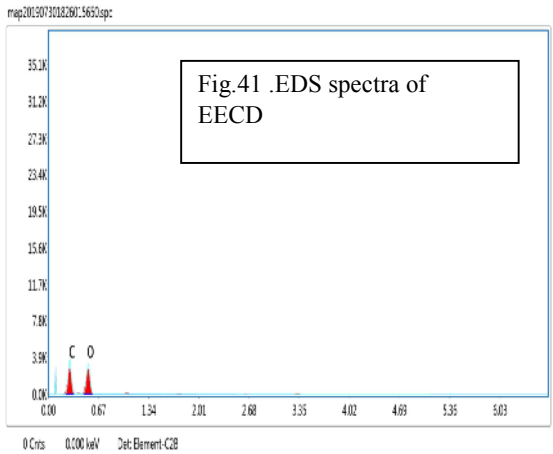


Fig.41 .EDS spectra of EECD

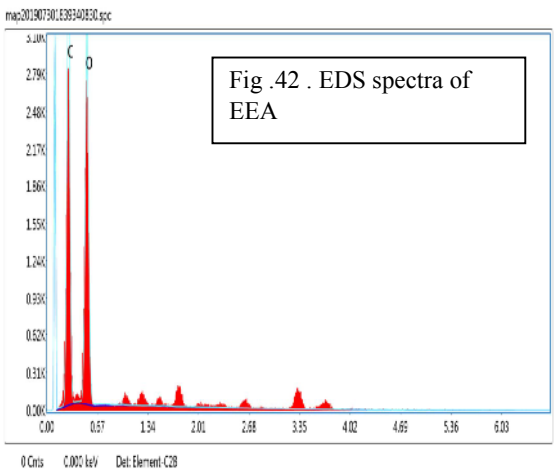


Fig .42 . EDS spectra of EEA

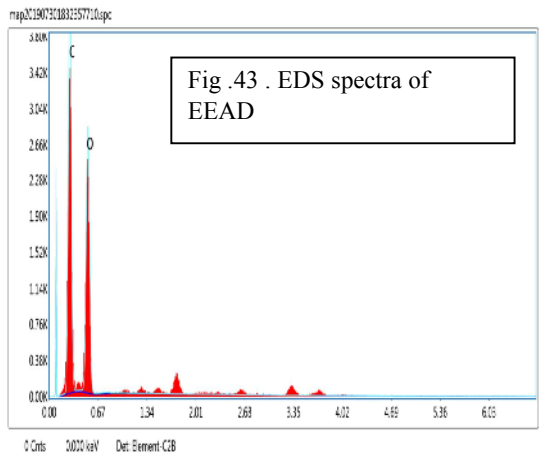


Fig .43 . EDS spectra of EEAD

Table. 24.Elemental composition of plants in polluted and non polluted area

Elements	C	O	Si	Na	Mg	Mo	Cl	K	Ca	Al
REF	41	34	6	3	2	2	4	5	1	3
REG	33	40	4	3.2	0.75	3.53	5.53	2.76	3.1	-
REM	29	49	7	2.3	0.66	3.32	4.74	3.32	3.41	1.20
REC	62	38	-	-	-	-	-	-	-	-
REA	58	42	-	-	-	-	-	-	-	-
REFD	35	34	7	3	2	2	7	5	2	3
REGD	29	39	7	5	2	3	6	2	2	3
REMD	29	39	7	5	2	3	6	2	2	3
RECD	50	49	-	-	-	-	-	-	-	-
READ	32	43	3	2	0.66	3	4	3	3	1
GF	58	42	-	-	-	-	-	-	-	-
GG	48	37	-	-	-	-	-	-	-	-
GM	49	51	-	-	-	-	-	-	-	-
GC	46	47	-	-	-	-	-	-	-	-
GA	50	50	-	-	-	--	-	-	-	-

EEF	38.36%	45.15	5.15	-	-	1.06	4.02	3.68	-	-
EEG	45	54	-	-	-	-	-	-	-	-
EEM	45	44	-	-	-	-	9.63	-	-	-
EEC	51	48	-	-	-	-	-	-	-	-
EEA	43	56	-	-	-	-	-	-	-	-
EEFD	52	47	-	-	-	-	-	-	-	-
EEGD	45	54	-	-	-	-	-	-	-	-
EEMD	40	59	-	-	-	-	-	-	-	-
EECD	43	56	-	-	-	-	-	-	-	-
EEAD	49	50	-	-	-	-	-	-	-	-

The EDS spectra of the plants show that presence of carbon and oxygen this indicates the presence of organic compound. all the plants containing three elements such as carbon, oxygen and silica. The elements identified from the leaf powder of the plant such as carbon, oxygen, sodium, magnesium, aluminium, silica, molybdenum, chlorine, potassium, calcium. Oxyegen and carbon shows high concentration this indicates presence of organic compounds. This type of sudy for the *Trigonella foenum graecum L. , Brassica juncea L. , Coriander sativum L. ,Amaranthus cruentus L., Vigna radiataL* was reported first time this is used to identify the above edible plants. The carbon and oxygen content in the polluted areas were low when compared to the non polluted area (green house). To conclude that plants grow in non polluted area have comparatively rich in organic content.

4.6. Analysis of DNA damage in radiation assisted plants using Comet assay

Results of the DNA damage analysis was discussed

The alkaline version of comet assay is used to detect directly induced DNA single strand breaks(**Günter Speit et al,**). DNA of the radiation assisted plants may exhibits significant migration. Therefore it was confirm that the DNA damage caused to the radiation induced plants. During electrophoresis the damaged DNA was migrated towards the anode. It was visualised in fluorescent microscope by staining in the ethidium bromide dye. The fragmentation was appeared in the all the five plants.

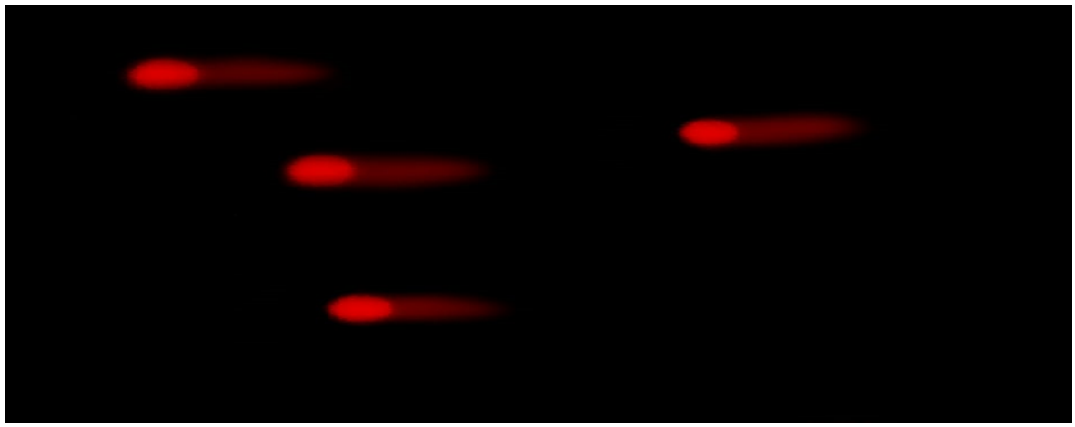


Fig.42 .Fluoresences microscopy visualization of DNA damage of Amaranthus leaf

The radiation exposure plant may affected by the radiation. Their DNA may get damaged. The comet is the simple method to detect the DNA damage induced by the radiation. The comet assay was preformed for the radiation assisted plants after two months. The migration of DNA towards the anode indicates that the plant may affected by the DNA damage. The DNA damage was analysed with the ageing of leaves **(Collins et al, 2011).** From the above image the fragmentation was observed because of damage in DNA of amaranth. The DNA damage was identified in the radish sprouts which is exposed to variety of light. The DNA damage may cause by the photo oxidative stress generated by the excess of energy. **(Collins, et al 2009)**

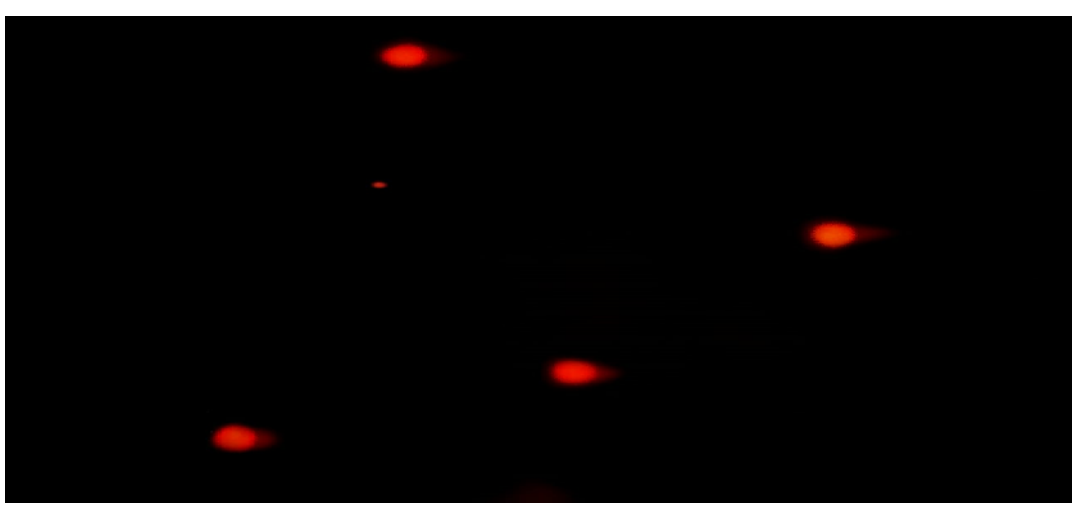


Fig. 43.Fluoresences microscopy visualization of DNA damage of coriander leaf

DNA of coriander may affected by the radiation. There is small amount of the migration was observed. The percentage of DNA damage was analysed by using tail length it requires the special software.**(Kumaravel, et al 2009).** The tail length of the coriander was looking quit

small this may indicates the radiation not that much affect the coriander, but the damage in DNA may induced due to the mobile radiation. Daily six hours radiation for the coriander didn't affect that much.

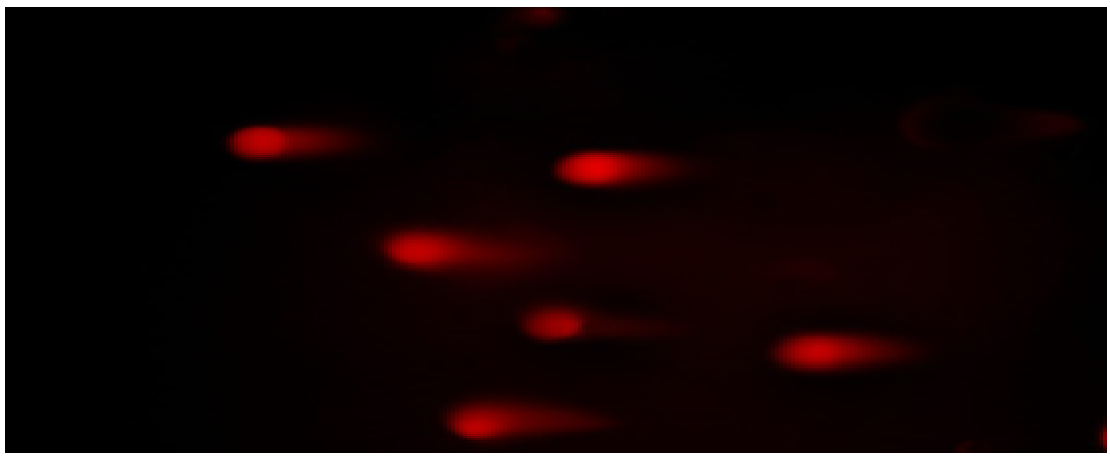


Fig.44 .Fluoresences microscopy visualization of DNA damage fenugreek leaf

The fenugreek was affected by the radiation. There is strike was observed in the comet image. The length of tail indicates that during electrophoresis the DNA migrated toward the anode. Tumor and normal cells showed significant heterogeneity in damage produced by ionizing radiation, although the average amount of damage increased linearly with dose**(OLIVE et al, 1990)**small amount of the fragmentation indicates only small amount of radiation induced on the coriander plant.

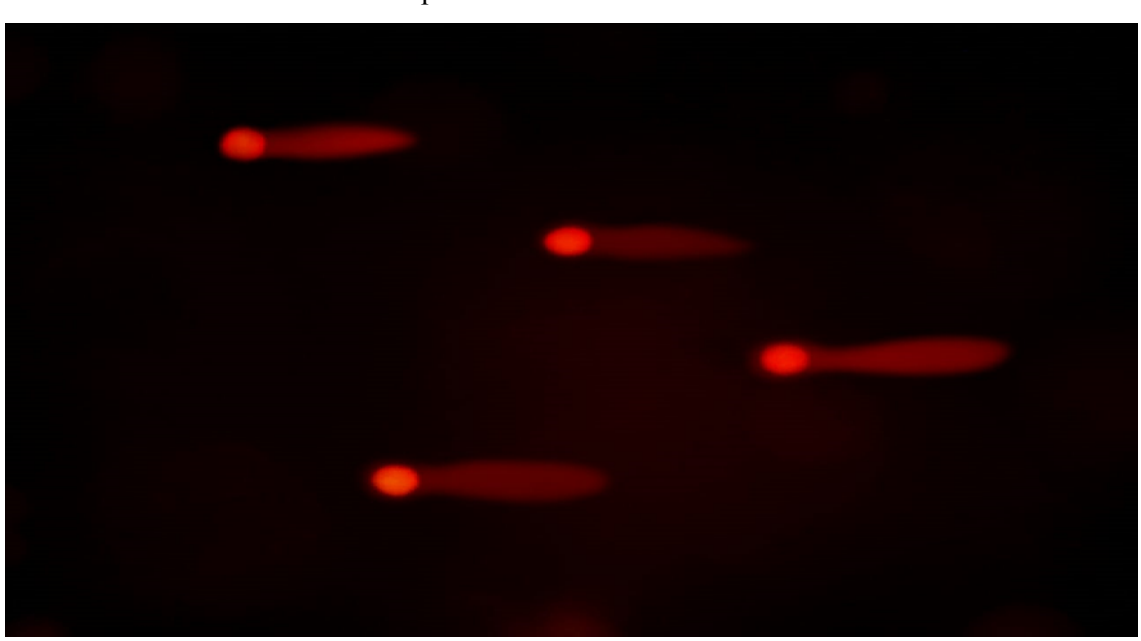


Fig.45 .Fluoresences microscopy visualization of DNA damage of green gram leaf

The comet results of the plant green gram shows there is large fragmentation when compared to the other plants. The plant DNA was migrated towards the anode during electrophoresis indicates damage in DNA of plant may induce due the mobile radiation. The length of the tail also shows the damage in DNA of green gram.

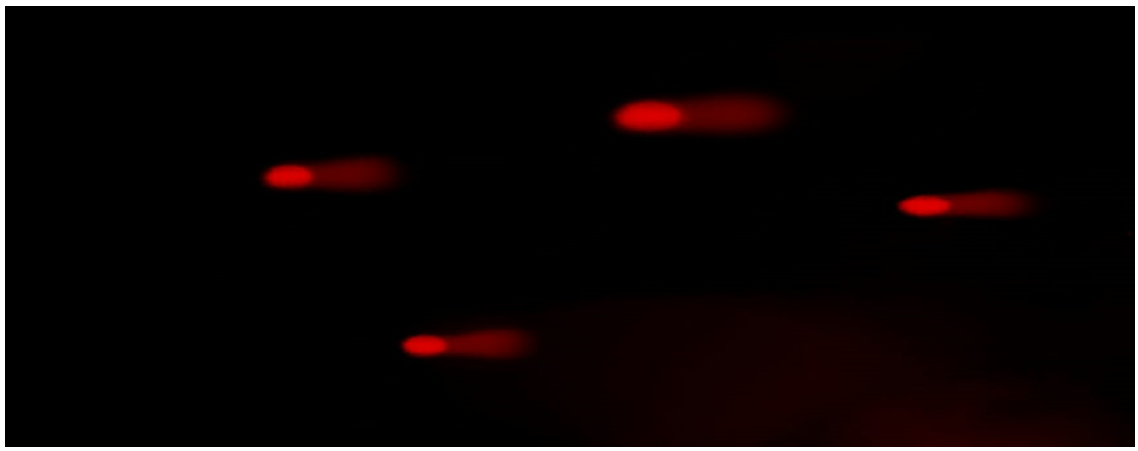


Fig.46 .Fluoresences microscopy visualization of DNA damage of mustard leaf

The fragmentation was observed on the comet image of mustard which is exposed to six hours daily radiation for two months. The strikes observed in the comet image may caused by the radiation induced to the plant. The strikes in the images indicates migration in DNA due to the damage induced DNA of mustard plant.

To conclude that the comet was used to analyse the DNA damage in all the five plants. The above results of the comet assay may suggested that the plants may injured by the mobile radiation. The results may rise from the plants exposed to the radiation.

4.6.Phytochemical screening of aqueous extract of amaranth

Table.25.Results of phytochemical screening of amaranth extract

Phytochemicals	Observation
Alkaloids	+
Flavonoids	+
Steroids	+
Terpenoids	-
Anthraquinones	+
Reducing sugar(carbohydrates)	-
Saponins	+

Phenols	+
Tannins	+
Phlobatannins	-
Proteins	-
Quinones	+
Cardiac glycosides	-
Amino acids	-
Coumarins	+
Anthocyanins	-
Xanthoproteins	-

+=presence ; -=absence

The phytochemical chemical compounds of amaranth investigated are summarized in the above table. Alkaloid, Flavonoids, steroids, anthraquinones, saponins, phenols, tannins, quinones , coumarins, anthocyanins were present in aqueous extract of amaranth. Terpenoids, anthraquinones, carbohydrates, phlobatannins, proteins, cardiac glycosides, amino acids, anthocyanins, xanthoproteins were absent in the aqueous extract of amaranth. The presence of alkaloids, flavonoids, tannins and saponins were known to show medicinal activity **(Sofowara, et al 1993).**The presence of secondary metabolites in amaranth plant extract was shown in the table.The presence of different metabolites like terpenoid, phenols, or carbohydrates are directly responsible of the extract capacity to carry out the NPs biosynthesis hence the leaves were boiled with the aim of rupturing and releasing intracellular materials into the solution.

4.7. Preparation of iron nanoparticle

The synthesis of the iron nanoparticle using FeCl3 and FeSO4 was carried out with the slight modification in the previous work done by (Wang et al, 2014). There is immediate formation of black precipitate was observed after the addition of extract to the 0.1M FeCl3 solution and 0.1M FeSO4separately. The formation of black precipitate was due to the reduction of Fe2+ ions **(Ting Wang et al, 2014)**. Terpinoids and flavonoids present in the plant extract have the capacity to carry out green synthesis of iron nanoparticle.

4.8. Characterisation of iron nanoparticle

4.8.1. UV-vis spectroscopy:

The UV spectrum of iron nanoparticle was taken in UV-SYSTRONICS AR 2701 DOUBLE BEAM. The absorption band seen at 220 nm arising due to the $\pi - \pi^*$ transition associated with –C- O group is attributed to the oligomer (Lu et al., 2006) originating from the degradation of product. The uv spectrum of iron nano particle I shows the absorption peak at 260 nm. The uv spectrum of iron nanoparticle II shows the peak at 270nm .

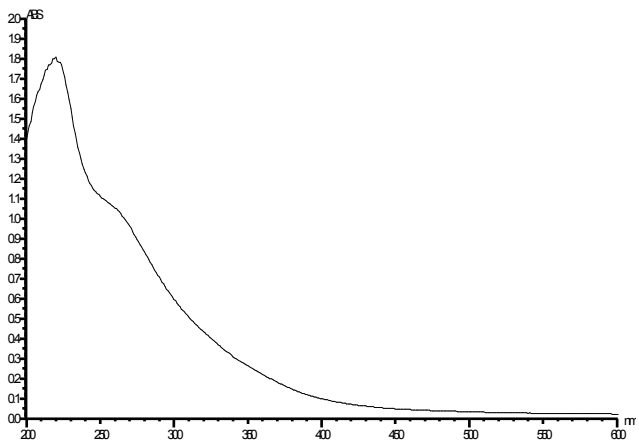


Fig.47.UV spectrum of INP I

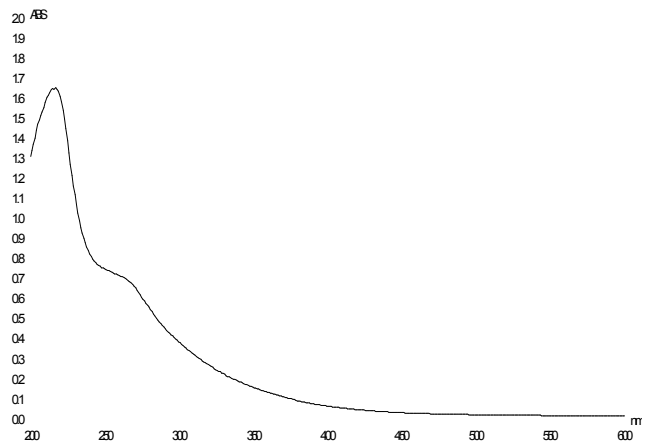
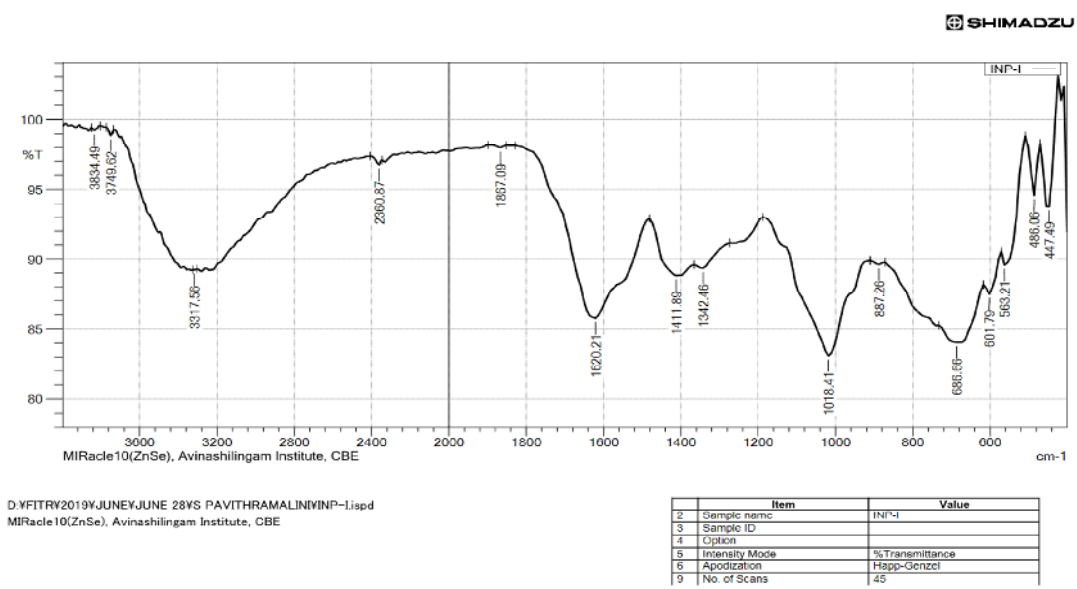


Fig.48 .UV spectrum of INP II

4.8.2. FT-IR spectroscopy

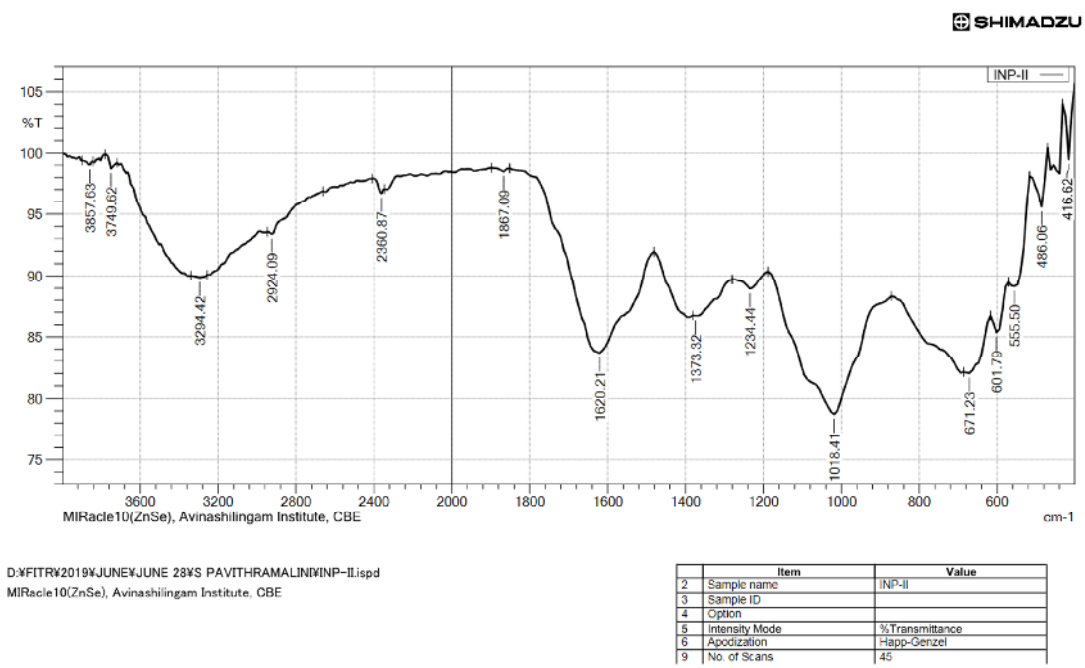
Fig .49 .FT-IR spectrum of iron nanoparticle I



FT-IR spectrum of iron nano particle was recorded in Shimadzu FT-IR (4000-400) spectrophotometer. The iron nanoparticle -I shows the absorption peak at 1620 and 1411cm-1 corresponding to the C=C stretching frequency. OH stretching vibration was observed in 3317cm-1

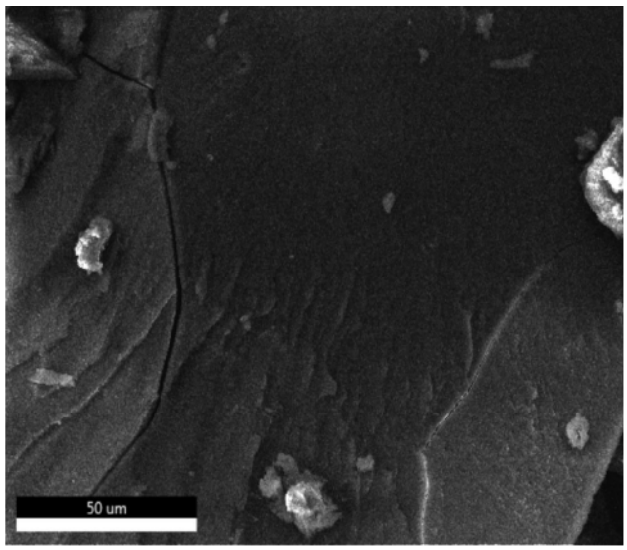
The iron nanoparticle II shows the obsorption od broad band at 3294cm-1 corresponding to the stretching frequency of O-H. The obsorption band at 2924 cm-1 shows the presence of C-H bond.The C-H bending frequency was observed at 1373cm-1. C=C stretching frequency was observed at 1620 The iron nano particle appears at 601cm-11 belonging to the stretching vibration mode and the torsional vibration mode of Fe–O bonds in the tetrahedral sites and in the octahedral sites. The involvement of –OH, –CO in binding and confirming theinvolvement of hydroxyl and carbonyl groups of amaranth plant extract for the synthesis of nanoparticles. **(Brajesh kumar et al, 2014)**

Fig. 50. FT-IR spectrum of Iron nanoparticle II



	Item	Value
2	Sample name	INP-II
3	Sample ID	
4	Option	
5	Intensity Mode	%Transmittance
6	Apodization	Happ-Genzel
9	No. of Scans	45

4.8.3. SCANNING ELECTRON MICROSCOPY OF IRON NANO PARTICLE



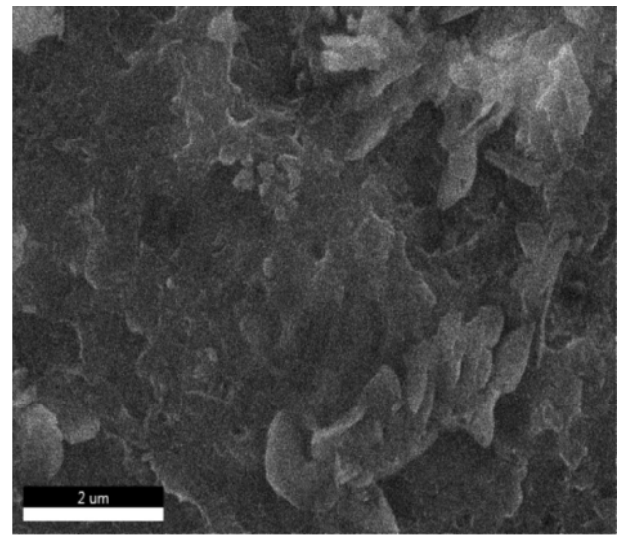


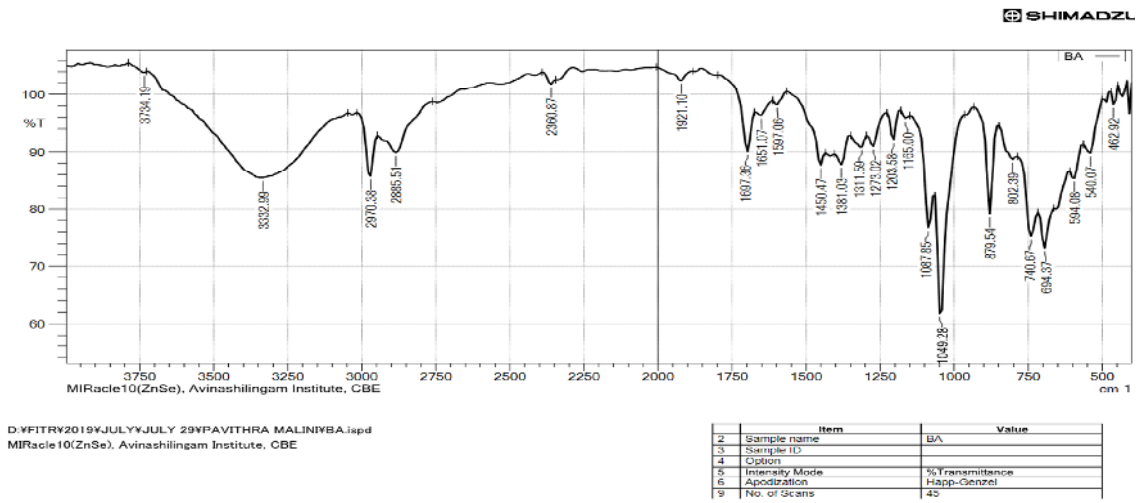
Fig.50 .FE-SEM of iron nanoparticle- I **Fig.51.FE-SEM of iron nanoparticle-II**

The scanning electron microscopy of iron nano particle I was 50nm in size and iron nanoparticle II show like presence of flakes much bigger size than INP I.

4.8.4. Catalytic activity of iron nanoparticle

The catalytic activity of iron nanoparticle was performed in the reduction of aldehyde to the ketones. The two type of nanoparticle form the product but the reaction was quit slow. The reaction was monitored by TLC, the product formation was confirmed by appearance of the 2 spots on the TLC plate. The formed product was benzyl alcohol it was confirmed by taking IR for extracted product**.**

Fig. 52.FT-IR of formed product



FT-IR spectrum of shows the formation of benzyl alcohol. the peak obtained in tha range of 2700-3200 corresponding to the O-H streching of alcohol.

5. Summary and conclusion

The summary of the research work on "Analysis of Elemental distribution in selected edible plants grown under different conditions: Quantification and imaging and catalytic activity of green synthesized nanoparticle" is given below:

- Five plants *viz*. *Trigonella foenum graecum L. , Brassica juncea L. , Coriander sativum L. ,Amaranthus cruentus L., Vigna radiataL*were chosen for study in the present research work.
- The plant growth have been analyzed in three different headings:
    - Impact of growth of plants exposed to exhaust
    - Impact of growth of plants exposed to mobile radiation
    - Impact of growth of plants in green house
- Physical characteristics of three sets of the plants were studied for 26days
- Among the three sets of the germinated seeds more leaves were grown on exhaust exposed plants when compared to other two. Only considerable amount of leaves were grown on green house may be due to not getting proper amount of sunlight. The radiation exposure plant had more number of leaves when compared to green house plants.Apart from toxic metals also minerals from dust would have against anticipation lead to more leaves. More growth rate was expected in green house. But may be due to climatic conditions and less sunlight , this was not observed
- Analysis of elemental composition in three sets of plants. Comparatively the GG plants have large number of carbon and oxygen . The radiation exposed plants have less% of carbon and oxygen indicating more inorganic content compared to organic matter.
- The surface analysis of three sets of plants shows that radiation exposed plants have less number of organic matters, FE Scanning Electron Microcopy shows that the leaf powder of green house plants was charged indicated large amount of organic matters in the green house plants.
- Comet assay is used to analyse the DNA damage in radiation assisted plants, green house has comparatively rich in organic matters.

- Phytochemical screening of amaranth plant extract shows the presence of Alkaloid, Flavonoids, steroids, anthraquinones, saponins, phenols, tannins, quinones , coumarins, anthocyanins.
- Green synthesis of iron nano particle- I using $FeCl_3$ by co-precipitation method at room temperature gave good yields of nanoparticle of size varying between 40 and 100nm
- Green synthesis of iron nano particle- II using $FeSO_4$ by co-precipitation method at room temperature gave flakes of iron nanoparticles
- UV spectra of green synthesized INP I and INP II were in the range of 250-300nm comparable with the UV spectrum of green synthesized iron nanoparticle.
- The catalytic activity of iron nanoparticle using hydrogenation of aldehyde to alcohol at 40^0C.
- The present research work affords an economical, eco- friendly method of synthesis of iron nanoparticles which finds the application in catalytic activity.

References

- Collins Andrew R, AzquetaAmaya, 2012, "DNA repair as a biomarker in human biomonitoring studies; further applications of the comet assay", Mutation Research, **736** :122-129
- Speit Günter and Hartmann Andreas, "The Comet Assay (Single-Cell Gel Test) A Sensitive Genotoxicity Test for the Detection", Methods in Molecular Biology, **113** :203-212
- HelmaChristoph,Uhl Maria, 2000, "A public domain image-analysis program for the single-cell gel-electrophoresis (comet assay)", Mutation Research, **466** : 9–15.
- Koppen G, Toncelli L.M, Triest L, Verschaeve L, 1999, "The comet assay: a tool to study alteration of DNA integrity in developing plant leaves", Mechanisms of Ageing and Development, **110**:13–24
- KumaravelT. S, Vilhar Barbara, Faux Stephen P, JhaAwadhesh N, 2009, "Comet Assay measurements: a perspective", Cell BiolToxicol, **25**:53–64.
- Martin McKelveyV.J, Green M.H.L, Schmezer P., Pool-Zobel B.L., De Meo M.P. and Collins A, 1993, "The single gel electrophoresis assay (comet assay): A European review", Mutation Research, **288**: 47-63.
- Morris I.D., Ilott S., Dixon L and BrisonD.R, 2002, "The spectrum of DNA damage in human sperm assessed by single cell gel electrophoresis (Comet assay) and its relationship to fertilization and embryo development, human reproduction", **17**(4): 990-998.
- Ojima Yoshihiro, NishiokaMotomu, Matsumoto Masahiro, Taya Masahito, 2009, "Quantification of DNA damage by the comet assay in radish sprouts exposed to excess light irradiation", Biochemical Engineering Journal, **46**: 69–72.
- PEGGY L. OLIVE, JUDIT P. BANATH, RALPH E. DURAND, 1990,"Heterogeneity in Radiation-Induced DNA Damage and Repair in Tumor and Normal Cells Measured Using the "Comet" Assay", RADIATION RESEARCH **122**: 86-94.
- Peggy L Olive &Judit P Banáth., 2006, "The comet assay: a method to measure DNA damage in individual cells", NATURE PROTOCOLS,**1**: 23-29.

- DevathaC.P, Thalla Arun Kumar, Shweta Y. Katte, 2016, "Green synthesis of iron nanoparticles using different leaf extracts for treatment of domestic waste water", Journal of Cleaner Production, **139**: 1425-1435.
- VijayaraghavanK, AshokkumarT, 2017, "Plant-mediated biosynthesis of metallic nanoparticles: A review of literature, factors affecting synthesis, characterization techniques and applications", Journal of Environmental Chemical Engineering, **5**(5): 4866-4883.
- Huang Lanlan, WengXiulan,Chen Zuliang, MegharajMallavarapu, RavendraNaidu, 2014, "Green synthesis of iron nanoparticles by various tea extracts: Comparative study of the reactivity", Molecular and Biomolecular Spectroscopy, **130**: 275-301.
- IravaniSiavash, 2011, "Green synthesis of metal nanoparticles using plants", Green Chem,**13**(10): 2638–2650.
- Santhoshkumar J, Kumar VenkatS, Rajeshkumar S, 2017, "Synthesis of zinc oxide nanoparticles using plant leaf extract against urinary tract infection pathogen", Resource-Efficient Technologies, **3**: 459–465.
- KidwaiMazaahir, Bansal Vikas, Saxena Amit, Shankar Ravi and MozumdarSubho, "Ni-nanoparticles: an efficient green catalyst for chemoselective reduction of aldehydes", Tetrahedron Letters, **47**: 4161–4165.
- ParimalaL, SanthanalakshmiJ, 2014, "Studies on the Iron Nanoparticles Catalyzed Reduction of Substituted Aromatic Ketones to Alcohols", Journal of Nanoparticles, : 1- 10.
- Muthuvinothini, S. Stella, 2018, "Green synthesis of Metal Oxide nanoparticles and theircatalytic activity for the reduction of aldehydes", Process Biochemistry,**77**, 48-56.
- Natte Kishore, Li Wanfang, Zhou Shaolin, Neumann Helfried, Wu Xiao-Feng, 2015, "Iron-Catalyzed Reduction of Aromatic Aldehydes with Paraformaldehyde and H_2O as the Hydrogen Source", Tetrahedron Letter, **56**(9), 1118-1121.
- SaifSadia, Tahir Arifa, ChenYongsheng, 2016, "Green Synthesis of Iron Nanoparticles and Their Environmental Applications and Implications", Nanomaterials, **209**(6): 26 pages.
- FirdausMaulidan, HandayaniNestri,Marfu'ah Lina Tri, 2016,"Reduction of Aldehydes Using Sodium Borohydride under Ultrasonic Irradiation", Indones. J. Chem., **16** (2): 229 – 232.

- SetamdidehDavood, GhahremaniSahar, 2012, "Convenient Reduction of Carbonyl Compounds to their Corresponding Alcohols with NaBH4/(NH4)2C2O4 System", S. Afr. J. Chem., **65**: 91–97.
- GuzyJustyna,ZgorskaAleksandra, Ziembinska Aleksandra, 2012, "COMET ASSAY optimization with allium cepa as an indicator for ecotoxicological usage", Architecture civil engineering environment, **3**,109-116.
- Jayesh T. Bhanushali, KainthlaItika, Keri S. Rangappa, NagarajaBhariMallanna, 2016, "Catalytic Hydrogenation of Benzaldehyde for Selective Synthesis of Benzyl Alcohol: A Review", ChemistrySelect, **1**: 3839 – 3853.
- Silva da A.B, JordZoE, Mendes M.J, Fouilloux P,1997, "Effect of metal-support interaction during selective hydrogenation of cinnamaldehyde to cinnamyl alcohol on platinum based bimetallic catalysts", Applied Catalysis, **148**: 253-264.
- Falodun A, Okunrobo L.O. and Uzoamaka N, 2006, "Phytochemical screening and anti-inflammatory evaluation of methanolic and aqueous extracts of *Euphorbia heterophylla*Linn (Euphorbiaceae)", African Journal of Biotechnology, **5** (6): 529-531.
- Evaluation of the Anti-Microbial Activity of Zero valent iron nanoparticle synthesized using *Aspilliaplorizeta*extracts, under peer review.
- Feng Xue, LvPanpan, Sun Wei, Han Xinyu, GaoLingfeng, ZhengGengxiu, 2017, "Reduced graphene oxide-supported Cu nanoparticles for the selective oxidation of benzyl alcohol to aldehyde with molecular oxygen", Catalysis Communications, **99**:105-109.
- Shalbaf H, 2010, "Reduction of Aldehydes and Ketones with NaBH4/Al2O3 Under Solvent-Free Conditions", Asian Journal of Chemistry, **22**(9): 6761-6764.
- Edeogal H.O, Okwu D.E, baebie B.O, 2005, "Phytochemical constituents of some Nigerian medicinal Plants", African Journal of Biotechnology, **4** (7): 685-688.
- Huang Lanlan, WengXiulan, Chen Zuliang, MegharajMallavarapu, NaiduRavendra, 2014, "Green synthesis of iron nanoparticles by various tea extracts: Comparative study of the reactivity", Molecular and Biomolecular Spectroscopy, **130**: 295-301
- KidwaiMazaahir, Bansal Vikas, Saxena Amit, Shankar Ravi, MozumdarSubho, 2006, "Ni-nanoparticles an efficient green catalyst for chemoselective reduction of aldehydes", *Tetrahedron Letters*, **47**(25): 4161–4165

- Koppen G, Toncelli L.M, Triest.L, Verschaeve L,1999, "The comet assay: a tool to study alteration of DNA integrity in developing plant leaves", *Mechanisms of Ageing and Development*, **110**(1-2):13–24
- Hannah Maytum C., TavassoliBahareh, Jonathan Williams M.J, 2007, "Reduction of Aldehydes and Ketones by Transfer Hydrogenation with 1,4-Butanediol", *Organic letters*, **9**(21): 4387-4389.
- Ojima Yoshihiro, Nishioka1Motomu, Matsumoto Masahiro, Taya Masahito, 2009, "Quantification of DNA damage by the comet assay in radish sprouts exposed to excess light irradiation", *Biochemical Engineering* Journal, **46**(1): 69–72.
- RaiVijai.k, MahataSuhasini, BhardiyaSmita.R, Shukla Prashant, RaiAnkita, Singh Manorama, 2019, "A novel carbocatalytic hydride transfer strategy for efficient reduction of structurally different aldehydes and ketones in water", *Tetrahedron Letters*, **60**(7):524–529.
- Barn Siya and Spicer Leonard D, 1988, "Reduction of aldehyde and ketone to methylene derivatives using ammonium formate as a catalytic hydrogen transfer agent", *Tetrahedron Letters*, **29**(31): 3741-3744.
- RassoulSaadi Z, Bettahar M.M, 2006, "Reduction of benzaldehyde on alkaline earth metal oxides", *Journal of Molecular Catalysis,* **258**(1): 59–67.
- Schepersa J.S, Francisa D.D, Vigila M., Below F.E, 2015, "Comparison of corn leaf nitrogen concentration and chlorophyll meter readings", *Communications in Soil Science and Plant Analysis*, **23**(17-20), 2173-2187.
- Tariq Shah Muhammad, BalouchAamna, RajarKausar, Sirajuddin, Ali BrohiImdad, Ali Umar Akrajas,2015, "Selective Heterogeneous Catalytic Hydrogenation of Ketone (C=O) to Alcohol (OH) by Magnetite Nanoparticles Following Langmuir−Hinshelwood Kinetic Approach", *ACS Applied Materials and Interfaces,* **7**(1-12): 6480−6489.
- ShegaviMahadev L, BaishyaAshim, Geetharani.K, Kumar Bose Shubhankar, 2018, "Reusable Fe2O3-nanoparticle catalysed efficient and selective hydroboration of carbonyl compounds", *Organic chemistry frontiers*, **5**(24): 3520.
- Wang Ting, Lin Jiajiang, Chen Zuliang, MegharajMallavarapu, Naidu Ravendra, 2014, "Green synthesized iron nanoparticles by green tea and eucalyptus leaves extracts used for removal of nitrate in aqueous solution", *Journal of Cleaner Production*, **83**: 413-419.

- IsmailAbeer.M, Eman Mohamed A,.Abdel-MotaalFatma F, Ibrahim B.Abdel-Farid Ibrahim B., Magdi A. El-Sayed, 2016, "Preliminary phytochemical screening, plant growth inhibition and antimicrobial activity studies of *Faidherbiaalbida* legume extracts", *Journal of the Saudi Society of Agricultural Sciences,* **15**(2): 112-117.
- Wang Fan, Zhan Zehui, 2016, "Catalytic Transfer Hydrogenation of Furfural into Furfuryl Alcohol over Magnetic γ-Fe2O3@HAP Catalyst", *ACS sustainable chemistry and engineering*, **5**(1): 942-947.
- ShahidzadehHaleh, Labbeiki Ghazal, hossein Attar, 2017, "Enhanced fermentative production of Cephalosporin C by magnetite nanoparticles in culture of Acremoniumchrysogenum", *IET Nanobiotechnology,* **11**(6): 644-649.
- Sharma Swati, SaxenaVarun, BaranwalAnupriya, Chandra Pranjal, Mohan Pandey Lalit, 2018, "Engineered nanoporous materials mediated heterogeneous catalysts and their implications in biodiesel production", *Materials Science for Energy Technologies*, **1**(1): 11-21.
- Zhang Wei-xian, 2003, "Nanoscale iron particles for environmental remediation: An overview", *Journal of NanoparticleResearch*, **5**(3-4): 323–332.
- NaeimiAtena, HonarmandMoones, SedriAsmaa, 2019, "Ultrasonic assisted fabrication of first MoO3/copper complex bionanocomposite based on Sesbaniasesban plant for green oxidation of alcohols", *Ultrasonics – Sonochemistry,* **50**(1): 331–338.
- Beadle C.L., 1985, "Plant growth analysis", 21-25.
- MaríaRondon, Shirley Moncayo, Xavier Cornejo, Jaime Santos, David Villalta, Rosa Siguenica, Jodie Duche, 2017, "Preliminary Phytochemical Screening, Total Phenolic Content and Antibacterial Activity of Thirteen Native Species from Guayas Province Ecuador", *Journal of King Saud University – Science,* **30**(4):500-505
- Behn Helen, Albert Andreas, MarxFriendhlem, Noga Georg, Ulbrich Andreas, 2010, "Ultraviolet-B and Photosynthetically Active Radiation Interactively Affect Yield and Pattern of Monoterpenes in Leaves of Peppermint (Mentha ×piperita L.)", *Journal of agriculture and food chemistry*, **58**(12), 7361-7367.
- AbhimanyuKedarKalyani, RavindraChaudhariSanjay ,SrinivasaRaoAvanapu, 2018, "Dataset on leaf surface and elemental study of four species of Bignoniaceae family by SEM-EDAX", *Data in Brief*, **17**: 1188–1195.

- Lakshmanan G., Sathiyaseelan A., Kalaichelvan P.T., Murugesan K., 2018, "Plant-mediated synthesis of silver nanoparticles using fruit extract of Cleome viscosa L.: Assessment of their antibacterial and anticancer Activity", *Karbala International Journal of Modern Science*, **4**(1): 61-68.
- Dzakovich Michael .P,Ferruzzi Mario G., Mitchell Cary A, 2016, "Manipulating Sensory and Phytochemical Profiles of Greenhouse Tomatoes Using Environmentally Relevant Doses of Ultraviolet Radiation", *J. Agric. Food Chem*, **64**(36): 6801−6808.
- Zhang Peng,XieChangjian,Ma Yuhui,He Xiao, Zhang Zhiyong,Ding Yayun,
- ZhengLirong, Zhang Jing, 2017, "Shape-Dependent Transformation and translocation of Ceria Nanoparticles in Cucumber Plants", *Environ. Sci. Technol. Lett,* **4**(9): 380−385.
- Narayanan K. Badri, Sakthivel N., 2008, "Coriander leaf mediated biosynthesis of gold nanoparticles", *Materials Letters***, 62**(30):4588–4590.
- VargheseaRakesh, Mohammed A., Almalki c, SoundharrajanIlavenil B, Rebecca Jayanthi, Choi kiChoon, 2017," Silver nanopaticles synthesized using the seed extract of Trigonellafoenum-graecum L. and their antimicrobial mechanism and anticancer properties", *Saudi Journal of Biological Sciences,:***26**(1):148-154
- Leclair V, "Federal agencies battle over risks from low-level radiation exposure", 1997, *Environmental Science & Technology / News*, **31**(6):268
- Wani SajadAhamad, Kumar Pradyuman, 2018, "Fenugreek: A review on its nutraceutical properties and utilization in various food products", *Journal of the Saudi Society of Agricultural Sciences*, **17**(2): 97–106.
- WaniSajad Ahmad, KumarPradyuman, 2018, "Fenugreek: A review on its nutraceutical propertiesand utilization in various food products", Journal of the Saudi Society of Agricultural Sciences, **17**: 97–106
- SharmaAnubhuti, Rai P.K., Prasad Surendra, 2018, "GC–MS detection and determination of major volatile compounds in Brassica juncea L. leaves and seeds", Microchemical Journal,**138:**488-493
- FukuokaMasamichi, Tanaka Akira, and Nishimaki-Mogami Tomoko, 1987, "Deuterium and Tritium Labeling of (3-Xenyl)cyclohexane by Clemmensen and Wolff-Kishner Reduction", International journal of radiation application and instrumentation Part A, **39**(5): 391-396

- Lemieux Robert P, Beak Peter, 1989, "The cleavage of two carbon-carbon bonds in a wolff-kiselner reduction", Tetrahedron Letters, **30**(11): 1353-1356.
- Ilina I.V., Yu S,.Kurbakova, K.P. Volcho, Salakhutdinov N.F.,Anikeev V.I., 2011, "Meerwein–Ponndorf–Verley reduction of aldehydesformed in situ from a- and b-pinene epoxidesin a supercritical fluid in the presence of alumina", Journal of Saudi Chemical Society, **15**:313–317.
- MinambresJuan F., AramendiaMaria A., Marinas Alberto, Jose M. Marinas, Francisco J. Urbano., 2011, "Liquid and gas-phase Meerwein–Ponndorf–Verley reduction of crotonaldehyde on ZrO2 catalysts modified with Al2O3, Ga2O3 and In_2O_3", Journal of Molecular Catalysis A: Chemical, **338**:121–129.
- Shuai Liu, Xiaopeng Fan, XilongYan, Xiaobao Du, Ligong Chen., 2011, "Catalytic reduction of benzaldehyde to toluene over Ni-Al_2O_3 in the presence of aniline and H_2", Applied Catalysis A: General,**400**:99–103.
- AbbassiaRouzbeh, YadavaAsheeshKumar, Naresh Kumar, Shan Huanga, Jaffe Peter R, 2013, "Modeling and optimization of dye removal using green clay supported iron nano-particles", Ecological Engineering, **61**:366–370.
- Jiménez-SanchidriánCésar, Ruiz José Rafael., 2014, "Tin-containing hydrotalcite-like compounds as catalysts for theMeerwein–Ponndorf–Verley reaction", Applied Catalysis A: General**469**:367– 372.
- KoreniukAgnieszka,MareszKatarzyna, Mrowiec-BiałońJulita., 2015, "Supported zirconium-based continuous-flow microreactor for effective Meerwein–Ponndorf–Verley reduction of cyclohexanone", Catalysis Communications,**64**: 48–51.
- MandallShyamapada,MandalManisha., 2015, "Coriander (Coriandrumsativum L.) essential oil: Chemistry and biological activity", Asian Journal pacific of tropical biomedicine, **5**(6): 421–428.
- Ahmed Gulzar,Nickisch Klaus., 2016, "Thermodynamic Meerwein-Ponndorf-Verley reduction in the diastereoselective synthesis of 17a-estradiol", Steroids,**113**: 1–4.
- Zhang Bo, XieFang, YuanJian, Wang Le, Deng Bingxin., 2017, "Meerwein-Ponndorf-Verley reaction of acetophenone over ZrO_2-La_2O_3/ MCM-41: Influence of loading order of ZrO_2 and La_2O_3", Catalysis Communications,**92**: 46–50.
- OjhaNisha Kant, ZyryanovGrigory V., MajeeAdinath, CharushinValery N., ChupakhinOleg N.,SantraSougata, 2017, "Copper nanoparticles as inexpensive and

efficient catalyst: A valuable contribution in organic synthesis", Coordination Chemistry Reviews, **353**: 1–57.

- Xiao Zihui., 2017, "Insight into the Meerwein-Ponndorf-Verley reduction ofcinnamaldehyde over MgAl oxides catalysts", Molecular Catalysis,**436**: 1–9.
- Goldsmith Christian R.., 2018, "Aluminum and gallium complexes as homogeneous catalysts for reduction/oxidation reactions", Coordination Chemistry Reviews,**377**: 209–224.
- Song Chunsen , WuShikui, ShenXiaoping , Miao Xuli,JiZhenyuan, Yuan Aihua, LiuXuMiaomiao , XieXulan , Kong Lirong , Zhu Guoxing, Shah Sayyar Ali, 2018, "Metal-organic framework derived Fe/Fe_3C@N-doped-carbon porous hierarchical polyhedrons as bifunctionalelectrocatalysts for hydrogen evolution and oxygen-reduction reactions", Journal of Colloid and Interface Science,**524**: 93–101
- LiaHu, Yang Tingting, Fang Zhen, 2018, "Biomass-derived mesoporous Hf-containing hybrid for efficient Meerwein- Ponndorf-Verley reduction at low temperatures", Applied Catalysis B: Environmental,**227**: 79–89
- SudhakaraK., KumarAvvaru Praveen, Kumara, Raghavendera A., Ravia S., KeniecDunkanaNegussa, Lee Yong-Ill., 2018,"Synthesis of γ-Fe_2O_3 Nanoparticles and Catalytic activity of Azide-Alkyne Cycloaddition Reactions",Asian Journal ofNanoscience and Materials, **1**(4): 172-182
- AfsheenSumera, TahirMuhammad Bilal,IqbalTahir,LiaqatArslan,AbrarMuhammad ., 2018, "Green synthesis and characterization of novel iron particles by using different extracts", Journal of Alloys and Compounds,**732**: 935-944
- ZareaNahid, ZabardastiaAbedien, MohammadiAbdelnasser, AzarbaniFarideh., 2018, "Synthesis of spherical Fe_2O_3 nanoparticles from the thermal decomposition of iron (III) nano-structure complex: DFT studies and evaluation of the biological activity", Bioorganic Chemistry,**80**: 334–346
- Vijayaraghavan K., Ashokkumar T.,2017, "Plant-mediated biosynthesis of metallic nanoparticles: A review of literature, factors affecting synthesis, characterization techniques and applications", Journal of Environmental Chemical Engineering,**5**(5):4866-4883
- IravaniSiavash., 2011,"Green synthesis of metal nanoparticles using plants",Green Chem.,**13**: 2638

- GholamiAbdollah, KhosraviRasoul, KhosraviAfshin,Samadi Zahra.,2018, "Data on the optimization of the synthesis of green iron nanoparticles using plants indigenous to South Khorasan", Data inBrief, **21**: 1779–1783
- Becker R., Wheeler E. L., Lorenz K., Stafford A. E, Grosjean K., BetschartA. A., and Saunders R. M,1987, "A Compositional Study of Amaranth Grain", Journal of Food Science, **46**:1175-1180
- ChiouJau-Rung, Lai Bo-Hung, Hsu Kai-Chih, Chen Dong-Hwang., 2013, "One-pot green synthesis of silver/iron oxide composite nanoparticles for 4-nitrophenol reduction", Journal of Hazardous Materials, **248– 249**: 394– 400.
- Kauffman, C.S., and Weber. L.E., 1990, "Grain amaranth, Advances in new crops",Timber Press, Portland,127-139.
- Stella Muthuvinothini, S, 2018, "Green synthesis of Metal Oxide nanoparticles and theircatalytic activity for the reduction of aldehydes", Process Biochemistry,**77:**48-56
- TejaAmyn S., Koh Pei-Yoong., 2009, "Synthesis, properties, and applications of magneticiron oxide nanoparticles", Progress in Crystal Growth and Characterization of Materials,**55**:22-45
- Wei Wu, Quanguo He,ChangzhongJiang., 2008, "Magnetic Iron Oxide Nanoparticles: Synthesis and Surface Functionalization Strategies", Nanoscale Res Lett,**3**: 397–415
- Adkins, H., & Lazier, W. A. (1924). "Organic reactions at the surfaces of dehydrogenating catalysts",Journal of the American Chemical Society, **46**(10):2291–2305