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RESEARCH ARTICLE

Green synthesis of the plant assisted nanoparticles from *Euphorbia neriifolia* L. and its application in the degradation of dyes from industrial waste

Shubhada S. Nayak[1], Gurumeet C. Wadhawa[1], K. B. Pathade[2], Vitthal S. Shivankar[3], & Nitin A. Mirgane[*4]

[1]Rayat Shikshan Sansthas, Karmaveer Bhaurao Patil College, Vashi sector, 15 A Navi Mumbai, 400 703, Maharashtra, India
[2]Maharaja Jivajirao Shinde Arts, Science, Commerce College, Shrigonda, Dist. Ahmednagar 413 701, Maharashtra, India
[3]Rayat Shikshan Sansthas, Chhatrapati Shivaji College, Satara, Maharashtra, India
[4]Department of Chemistry, SIES College of ASC, Sion (West), Mumbai 400 022, Maharashtra, India
**Email: mirgane@gmail.com*

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ABSTRACT

In the world industries are growing very rapidly resulting in fast development. Various industries are coming up such as that of dyes, paints, pharmaceuticals etc. Dyes are used in various industries and release pollutants in the environment. It is necessary to remove such pollutants from the environment. *Euphorbia neriifolia* L. grow as the weed in the forests of the konkan region in waste land area. This weed is a typical latex bearing plant. This latex can be converted into the powder under sun drying process. This powder can be used for the preparation of Fe nanoparticles. The plant assisted synthesized nanoparticles have good particle size, morphology and band gap. These nanoparticles used for the degradation of the dye like Methylene Blue and Methylene Red from the industrial waste. It gives very good results. We can develop new catalyst for the degradation of the dyes from the industrial waste. It act as good catalyst by the simple non form of the catalyst. This catalyst is derived from the plant *Euphorbia neriifolia* L. latex.

Introduction

Industrial development occurs all over the world rapidly. This industrial development is possible with the use of lot of chemicals and different chemical products. As a result, a lot of the wastes are thrown out in the environment. This waste includes solid, liquid and many times gases (1). Most of the time solid and liquid wastes causes lot of pollution in water bodies. It became necessary to remove these toxic materials from water. The contemporary toxic removing techniques are costly. So, there is a need to develop cost (1-2) effective techniques such as adsorption, advanced biochemical treatment, photocatalysis etc. (2). Amongst these techniques photocatalyst is very common. Most of the time photocatalyst become inexpensive method for degradation of waste water (3). The photocatalyst are used due their band gap and activity. Use of application of nanoparticle depend upon on the size and band gap to overcome this (4). It became necessary to develop visible light or sunlight active photocatalyst, the most commonly used metal oxide photo catalyst such as Zinc oxide, Titanium dioxide, Ferrous oxide (5-6).

In this era, Nanotechnology is used in all the fields of science including healthcare to industry work (7-8). The nanoparticles are synthesized by various ways which involves, the use of hazardous chemicals. It is need of time to develop the environmentally friendly protocols with non-toxic by-products, mild reaction conditions, safety natural material as capping agent as part of the reducing agent (9-11). It has been observed that the nanomaterial prepared from the plant part as the capping agent are safer, best with good particle morphology and stable (12). Using plant material in

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the synthesis of the nanoparticles increase safety and decrease the pollution gives the eco-friendly way for the synthesis (13). Using plant material in synthesis of the biological nanomaterial gives rise to new branch known as nanobiotechnology (14). This study mainly deal with use of seeds, fruits, microbes, fungi, algae and other plant materials. This synthesized nanomaterial used in the medicine, pharma, plastic and other industry (15). These plant materials work as reducing agent and capping agent due to various neutral metabolites present in them (16). The nanomaterials are the use in field of biochemistry, environmental sciences, synthetic chemistry piezoelectric, catalytic piezoelectric, optoelectronics and semiconducting capacity (17). Most of metals used are Zinc, Ferrous, Cobalt, Manganese etc., that have very good band-gap and binding energy. The plant assisted nanoparticles are used the various applications vapor–liquid–solid (VLS) (18), hydrothermal synthesis (19), vapor phase deposition (20), chemical vapor deposition (21), metallo-organic deposition of chemical vapors (22). The variety of the nanomaterial are synthesized, they have various shapes such as nanoparticle, nanorod, nanoparticles, nanoflowers (23).

These nanoparticles have potential applications in the removal of pollutants from environment, in production of active oxygen species, in hydrogen peroxide preparation (24), also used in the production of the solar cell or other materials (25). These nanoparticles used widely in the industry such as cosmetic industries, pharmaceutical, solar cell industries, bio-sensors, photo-catalysis (26). The large number of the plant material has been used such as *Aloe vera* (27), *Calotropis gigantea* (28), *Citrus aurantifolia* (29), *Coriandrum sativum* (30), *Parthenium hysterophorus* L. (31). the plant has the botanical classification the kingdom plantae, subkingdom Tracheobionta having division Magnoliophyta, subdivision Spermatophyte (32) *Euphorbia neriifolia* L. in plant belonging to the family Euphorbiaceae. (33, 34) This is the latex bearing family, contains the many active ingredients and used in many ayurvedic formulations like citrakadi taila, avittoladi bhasma, jatyadi varti, Snu highrta, abhaya lavana, jalodarariras, snuhidugdhadi varti used in various formulations vatavyadhi, gulma, udara sula, sotha, arsas (35) and the ayurvedic study (36) of India. This plant grows in India, Burma, Baluchistan mostly cultivated (37, 38). This type of plant secretes the latex. The plant is a large branched shrub occur in dry, rocky and hilly area. This is 3-5-meter-tall, leaves are alternate, clustered around 2-3mm, over the area with the good developing the flowers and having good latex bearing property Female flowers rarely developed. In this research paper we have developed the simple plant assisted Fe nanoparticles from the latex of plant *Euphorbia neriifolia* L. this plant is very rare and it occur through the This plant *Euphorbia neriifolia* L. coated nanoparticles are used for the degradation of dyes. The mostly we are using dyes like Methylene blue and Methyl red dyes. This synthesized nanoparticle worked best photocatalyst for the degradation of the dyes.

Materials and Methods

Plant material was collected from the Dhutpapeshwar mandir with Latitude: 16° 40' 12.00" N, Longitude: 73° 31' 12.00" E and identified by Dr. Arun Chandore Abasaheb Marathe Arts & New Commerce Science College, Rajapur.

Chemicals

All chemicals were used of S.D. FINE and Loba companies. These chemicals used are highly pure and analytical grade and required further no purification.

Characterization

The UV Spectra of the synthesized nanoparticle characterized by the Shimadzu UV 1800. The IR Spectra was recorded by the Shimadzu IR infinity. The SEM was carried out by the Bruker D8 ADVANCE (Germany) diffractometer. TEM or the Transmission electron microscopy was carried using the Carbon coated grid FEI Technai G2 F20 instrument for such case ethanol was used as diluent. Scanning Electron Microscopy was studied using the Philips CM120 and LEO 1430VP instruments, X-ray diffraction was carried on Bruker D8 ADVANCE (Germany) diffractometer.

Euphorbia neriifolia **L.** ***latex powder preparation***

Euphorbia neriifolia L. is the latex bearing plant, mostly maximum latex present in the plant in the morning time. The latex was collected in to the clean beaker using knife for making cut on the plant. This plant grows on the rocky region as weed. The latex collected in beaker then some amount of alcohol was added. This latex was dried with 1:3 amyl alcohol in light specially sun light and converted to the powder. This powder dried in oven at 30 ^{0}C-40 ^{0}C at above this temperature it get evaporated till constant weight was obtained. This latex contains various active biomaterial such as terpenes, flavonoids, alkaloids or other shikimates as the secondary metabolites. This was stored in the air tight container and kept in refrigerator at 20 ^{0}C.

Green Synthesis of the FeNPs

The green FeNPs (39) were produced taking 10 ml of the iron precursor ($FeCl_3{\cdot}6H_2O$, 0.1M), 2 gm of the plant *Euphorbia neriifolia* L. latex powder and 10 ml of water and sonicated in special sonicator this reaction mixture for 2 hrs at room temperature. Initially color was light brown after nanomaterial formation it changes to black indicating in this case the reduction of Fe ions to FeNPs. Then this material was subjected to the rotation for 3000 rpm using special sonicator, supernatant liquid was collected kept in another beaker. Upper Liquid obtained was kept in the muffle furnace for 6 hrs till constant weight was obtained, weight will change and decreases. The solution kept in desiccators to remove water and they are kept in the air tight container.

Photo catalytic dye degradation using sun light (Methylene Blue dye)

Photo catalytic dye degradation experiment was carried by modified procedure (40) in the 250 ml conical flask. The 50 ml of Methylene Blue (MB) dye solution prepared by taking 10 mg of MB dye per litre was added to 250 ml conical flask. The 25 mg of our biocatalyst was added to it. The suspension formed stirred in the sunlight. This can be done by keeping this under stirring for the given time interval at every 30 min. UV spectra was recorded using the UV Spectrophotometer Shimadzu 1800. All samples from the industrial dye degradation carried out is reported in Table 1-3.

Results and Discussion

UV–Vis data analysis of FeNP using Euphorbia neriifolia L. *Latex Powder*

Reduction of iron using plant *Euphorbia neriifolia* L. latex powder was studied using making reaction solution by measuring the UV absorption. This can be done using Shimadzu UV 1800 from wavelength 200-600 nm. The maximum absorption was observed at 370 nm, indicate the formation of the nanoparticles (Fig. 1).

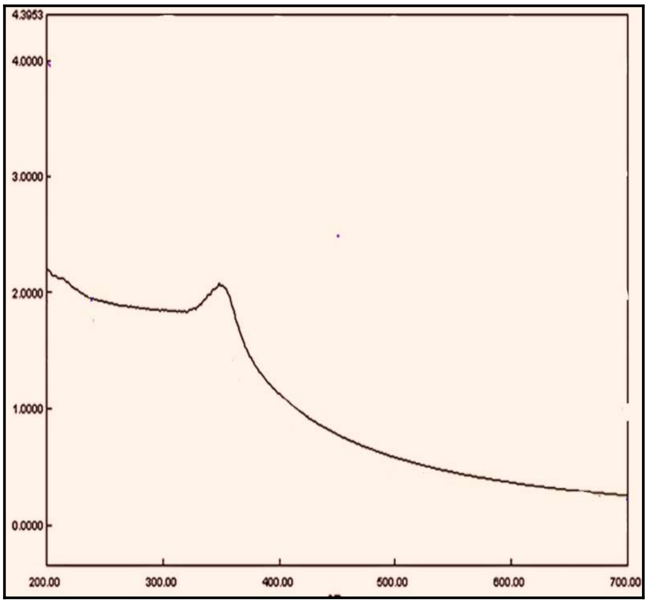

Fig. 1. UV Spectra obtained shows that FeNP coated with biomaterial.

Fourier Transform-Infrared data analysis of FeNPs

FTIR spectroscopy was used to identify the functional groups. We have scanned at 500-4000 cm^{-1}. The peak got at 3400-3500 cm^{-1} shows for the –OH group, 2900-300 cm^{-1} band for C-H Stretching, while certain band at 1600-1800 cm^{-1} show the C=C and C=O stretching at 600 to 700 cm^{-1} for the iron and oxygen bond (Fig. 2).

X-ray diffraction data analysis of FeNPs

Plant *Euphorbia neriifolia* L. latex powder was used for the preparation used for the coating of FeNPs. The FeNPs particles was confirmed using the XRD (Fig. 3). The structural composition of the synthesized nanoparticles from the plant *Euphorbia neriifolia* L. The nanoparticles formed by using the XRD analysis Fig. 3 shows the formation of nanoparticles using the angle and planes 2theta values of 20.2°, 34.5°, 37.2°, 40.91°, 48.8°, 56.3° and 64.21°, 70.21.

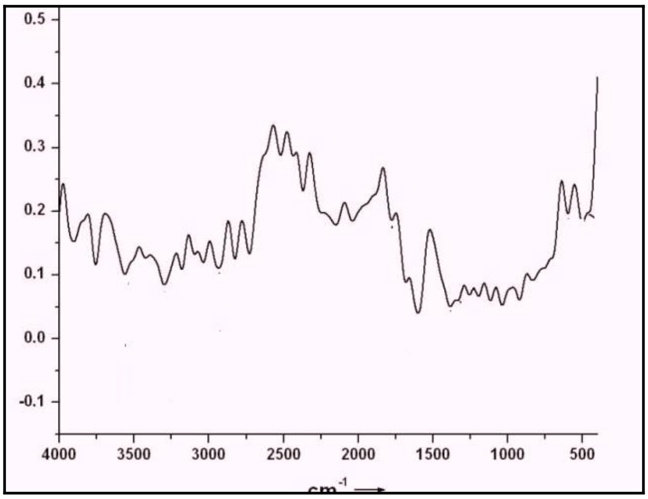

Fig. 2. FTIR Spectrum indicate the formation of the Fe nanoparticles. x axis Cm^{-1}(Frequency) and Y axis transmittance.

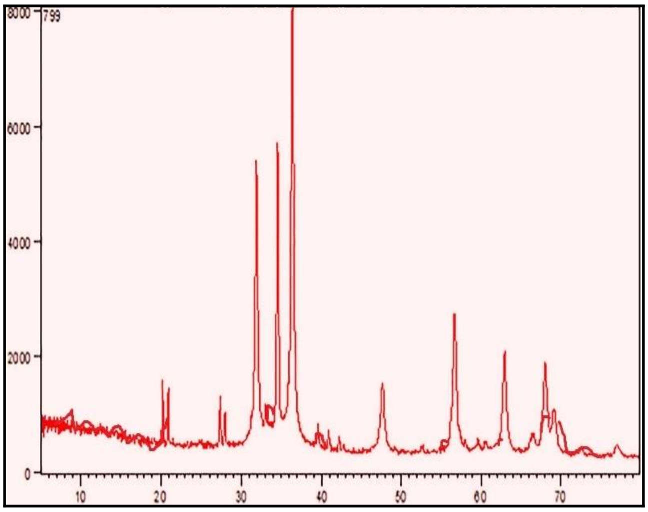

Fig. 3. X-ray diffraction
x axis as angle diffraction and y axis intensity.

Scanning electron microscopy

Euphorbia neriifolia L. latex powder was used for the preparation used for the coating of FeNPs. The FeNPs nanoparticles was confirmed using the SEM (Fig. 4). The data analysis of FeNPs got by plant *Euphorbia*

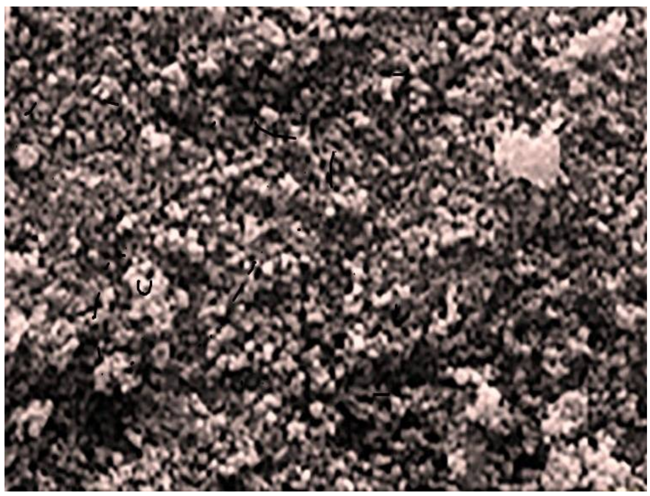

Fig. 4. Scanning electron microscopy.

neriifolia L. latex powder studied using the scanning electron microscopy (SEM). The SEM result show that the bio-nanoparticle was prepared having very good particle size around 40-50 nm.

Transmission electron microscopy

TEM was used to determine the shape and size of the nanoparticles. The TEM Spectra (Fig. 5) show that the nanoparticle formed with good shape and size. They have size around 40-50 nanometer. Photocatalytic

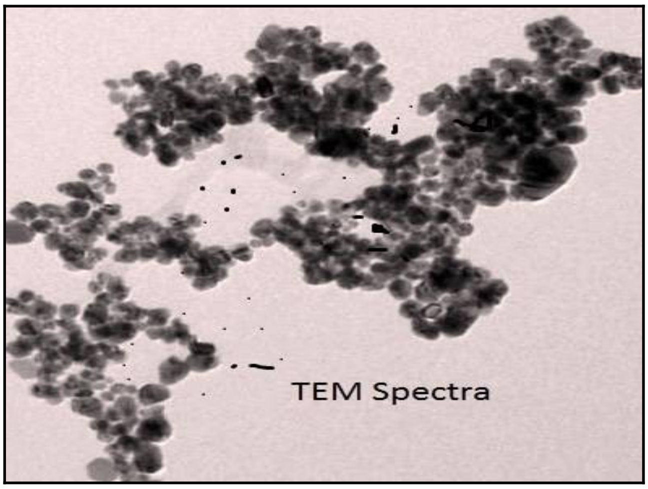

Fig. 5. Transmission electron microscopy spectra.

dye degradation using sun light (Methylene Blue). The photocatalytic methylene blue dye degradation using sun light studied carried out by measuring absorption with time. The results obtained are tabulated in Table 1. From the graph (Fig. 6), we have observed that dye degradation takes place as time proceed methylene blue dye gets degraded in the

Table 1. Time and absorption obtained for MB dye.

Time	Absorption	Time in min	Absorption innm
0	690	390	540
30	685	450	530
60	680	480	525
90	675	510	510
120	670	540	490
150	650	570	480
180	640	600	470
210	630	630	460
240	620	660	450
270	600	690	445
300	590	720	430
330	565	750	420
360	550	780	400

sunlight. Photocatalytic dye degradation using sun light (Methyl Red).

Similar experiment was carried out with Methyl Red (MR) by taking the same quantity. The results obtained are tabulated in Table 2. From above the graph (Fig. 7), it has been observed that the degradation of the MR takes place into simpler chemical with moderate rate photo catalytic dye degradation using sun light of various dye industry.

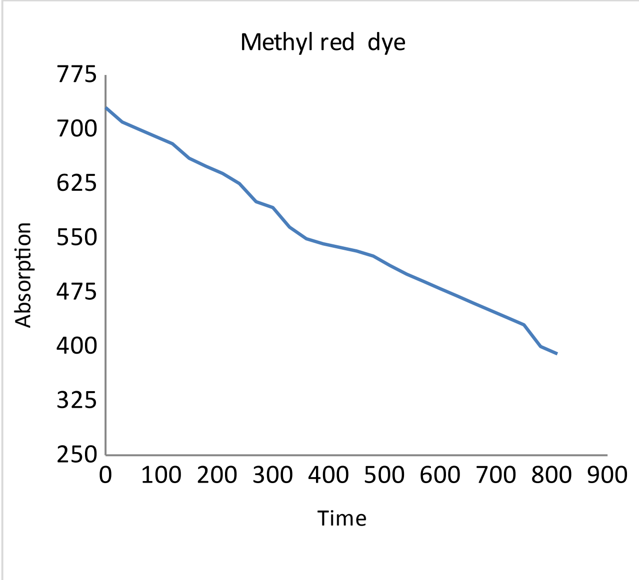

Fig. 6. Time in Min Vs absorption for Methylene Blue dye.

Table 2. Time and absorption obtained for MR dye.

Time	Absorption	Time min	Absorption in nm
0	730	450	532
30	710	480	525
60	700	510	512
90	690	540	500
120	680	570	490
150	660	600	480
180	649	630	470
210	639	660	460
240	625	690	450
270	600	720	440
300	592	750	430
330	565	780	400
360	549	810	390
390	542	-	-

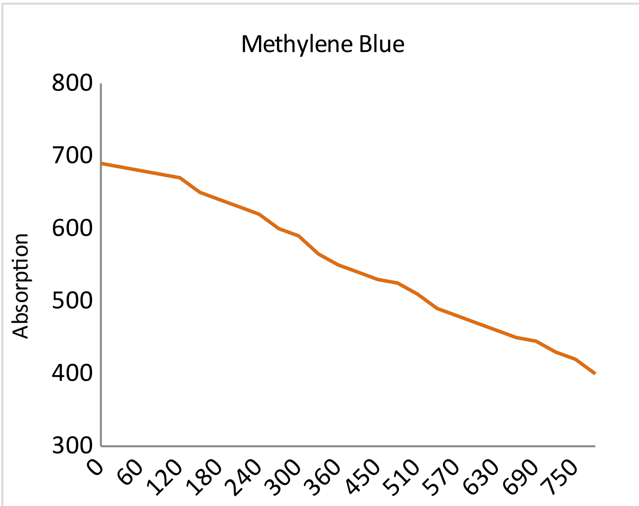

Fig. 7. Time in Min Vs absorption for MR dye.

The photocatalytic dye degradation of various dye industries studied using sun light. The results obtained are tabulated in Table 3. From the graph (Fig. 8), it has been observed that as we increase the time of exposure to sunlight the degradation takes place and dye get degraded to simple chemicals.

Table 3. Photocatalytic dye degradation of various dye industry Time Vs absorption.

Time	Industry I	Industry II	Industry III	Industry IV
0	780	760	800	770
30	770	750	790	740
60	760	740	780	730
90	750	730	770	710
120	740	720	760	690
150	730	710	750	670
180	700	700	740	650
210	690	690	730	635
240	670	680	720	620
270	660	670	710	605
300	654	660	700	595
330	645	650	685	580
360	630	630	670	565
390	610	610	660	550
450	590	590	640	545
480	576	570	620	530
510	560	560	600	514
540	540	550	585	500
570	520	540	570	485
600	500	510	560	400
630	490	490	540	385
660	480	470	525	370
690	470	460	500	360
720	460	450	485	-
750	430	420	470	-
780	410	400	450	-
810	400	380	430	-
840	390	350	420	-

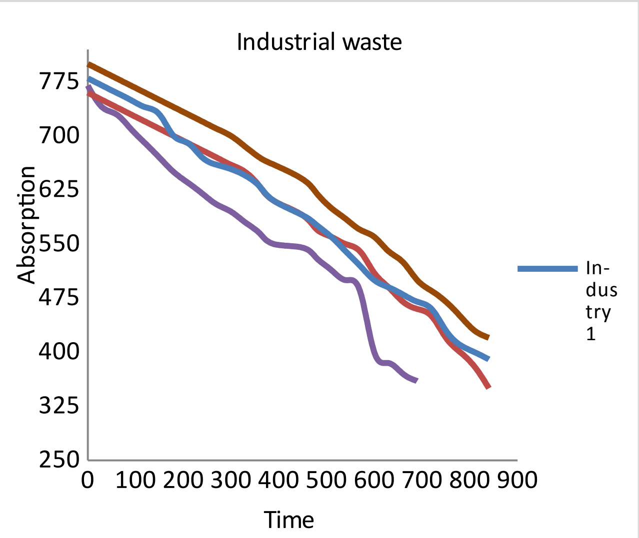

Fig. 8. Time and absorption obtained for various industry.

Conclusion

FeNP using plant *Euphorbia neriifolia* L. latex powder were successfully synthesized and characterized by XRD, IR, SEM, EDX and TEM. These synthesized nanomaterials were successfully applied for the degradation of both dyes. It gives very good degradation of the MB and MR under solar irradiation. These are successfully applied to the various dye industries. We have studied waste of four dye industries. This catalyst is reusable and green. This coating plant *Euphorbia neriifolia* L. material was waste latex used as capping and reducing agent, this may be useful for the industrial application.

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Authors' contributions

Concept and work plan were supervised by SN and GW. All the analytical experiment was performed by KP, SN and GW. The manuscript writing and statistical calculation were done by GW. Necessary and final correction done by NM and VS. All authors read and approved the final manuscript.

Conflict of interests

Authors do not have any conflict of interests to declare.

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