European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 10, 2020

GREEN SYNTHESIS OF NANOSTRUCTURED ALUMINUM: ANTIBACTERIAL ACTIVITY AND DYE DEGRADATION.

Shubhada S. Nayak[1], Gurumeet C Wadhawa [1] , Vitthal S. Shivankar[2], Inamadar R F [3]Maryappa C. Sonawale[3]

[1]Rayat Shikshan Sansthas, Karmaveer Bhaurao Patil College, Vashi sector 15 A Navi Mumbai, 400703, Maharashtra, India.,[2]Rayat Shikshan Sansthas, Chhatrapati Shivaji College, Satara, Maharashtra, India.,

[3] Department of Chemistry, Veer Wajekar A.S.C. College, Phunde, Raigad, Maharashtra.

Email: wadhava.gurumeet@gmail.com

*Email: wadhava.gurumeet@gmail.com

ABSTRACT

In the world the industrialization is increased very fastly. Most of time various dyes are used in industries like textile, plastic, food, colour etc. Most of these industries put their waste in water like river, lakes. This is responsible for the water pollution. Due to large discharge of such dyes there is increase in water pollution, significantly these can be removed by the traditional method. There is need to develop the simple method for the dye degradation before discharging into environment. To eliminate environmental pollution, we have synthesized the green nanoparticles using waste rind of jackfruit (Artocarpus heterophyllus). We develop simple method for synthesis of green aluminum oxide nanoparticles. The formation of various nanoparticles is confirmed by the various spectral analyses. These nanoparticles used for degradation of Methyl red and Congo red in sunlight. The green aluminum oxide nanoparticles show the excellent rate of the degradation. These green aluminum oxide nanoparticles also show the excellent antimicrobial activity by zone of inhibition method.

Keywords: Artocarpus heterophyllus, aluminum oxide nanoparticles, green, dye, jackfruit.

Introduction

Nanotechnology has gained importance due to their remarkable properties of nanoscale materials different from bulk material. These are wide applications in science such as catalysis, textiles and optics cosmetics, pharmaceutics [1-3]. Among these silver, gold and aluminum nanoparticles are widely used due to their properties. There are various methods for the synthesis of these nanoparticles such as electrochemical, photochemical, physical, and many other.

Most of the time reducing of the corresponding metal ion takes place for this type of reduction. We have to use various chemicals or reducing agent's sodium sulfide, sodium borohydride, hydrazine and use of the surfactants, certain polymers or the capping agents. These reactions have drastic condition, they might generate the toxic byproducts causes the pollution. Due to this we have to develop the green ecofriendly approach in which the simple green synthesis of the nanoparticle involves the use of the bio agent like plant [4-6]. In certain cases, the fungi, bacteria and different virus [7-10], to obtain nanoparticles by the biological means the advantage of the being eco-friendly, one step, low cost and energy. The plant material includes the phytochemical like poplyphenolic, amino acids, proteins, polysaccharides, vitamins, and terpenoids. They play an important role in green synthesis of various silver nanoparticles as reducing and stabilizing agent [11-12]. In the non-biodegradable organic dyes resulting from plastic, paper, food industries are usual are widely released in water without previous treatment leading to significant environmental pollution. Many of these dyes can substantially damage the aquatic organism. Also, they are toxic to human life and responsible for mutagenic and carcinogenic [13-14] various techniques such as photochemical chemical, absorption, biodegradative methods various methods are used [15].

Dye pollutants are rather resistant to the physical and chemical stability. The removal of this toxic material is very necessary but removal of this material is very difficult [16-18]. Reduction of these dye compounds are very dangerous, may toxic and affect the health of the human being [19]. Among these reductive degradation of the hazardous dyes with metal nanomaterial is very convenient for the degradation [20-23]. Metal nanomaterials are highly versatile material that can be used in envoirmental application medical technology, energy and water treatment [24-29]. Gold, silver and aluminum oxide act as good catalyst and catalyzes many reduction reactions. The aluminum oxide nanoparticles are used in current study. We have used the waste jackfruit rind for plant assisted synthesis of the nanoparticles. This jackfruit plant grows in the Konkan region it is medium sized evergreen tree and having the typical 8-25 m in height the tree grows rapidly in early years up 1.5 m/year in height, slowing it has very high. This jackfruit rind which is fiber. Rich in fiber and pectin. They are largely used. [30-33]

1. Material and methods

Plant and chemicals

The plant used for the study was *Artocarpus heterophyllus*. We have used the rind of the *Artocarpus heterophyllus*. This was collected from APMC market Vashi, Navi Mumbai, MH, India.

Aqueous *Artocarpus heterophyllus* exterior rind extracts preparation

The exterior rind of the jackfruit was collected from the APMC market Vashi, Navi

Mumbai MH, India. These were washed 3-4 times by the water, then dried in shade for 3-4 weeks. Then dried at 30^0C till constant weight obtained. The dried rind of the jackfruit was ground into fine powder. This fine powder was dried in oven at 30^0C for six hours. Finally, pack in the bottle under nitrogen atmosphere. 10 g of the powder was taken in the Erlenmeyer flask. 100 mL water added in it and reflux it for 2 h, cool it at room temperature, then filter it through the Whatman filter paper number 1. Finally, evaporate the filtrate to half using the Rota evaporator.

Photosynthesis of Aluminum oxide nanoparticles

Aluminum nitrate was used for the synthesis of aluminum oxide nanoparticles with a molecular weight of 375.23 g/mol, 2 molar concentration of aluminum nitrate was mixed with distilled water, extract prepared above was added in 3:2 ratio. Add 10 % sodium hydroxide 5 mL then subjected for sonication for 40 min. Then it was subjected to the rotation at 1290 rpm for 6 hrs. It forms the yellow brown precipitate, indicate the formation of the aluminum oxide nanoparticles, then supernatant layer was removed. Finally, brown precipitated was dried in muffle furnace at particular temperature to get product.

Characterization of Aluminum oxide nanoparticles

Ultraviolet–visible spectral analysis of the sample was performed for all samples in 300 -700 nm using the UV –VISIBLE spectrophotometer UV 1800. Infrared Spectroscopy (FTIR) was used for the determination of various functional groups present. Surface morphology of the synthesized nanoparticles was studied using the scanning electron microscopy (SEM) on NOVA- 450 instrument. The crystanality and chemical composition were examined by the transmission electron microscopy (TEM), X-ray diffraction (XRD) and energy dispersive spectroscopy (EDS)

measurements

Catalytic experiments

The catalytic activity of the green synthesized aluminum oxide nanoparticles was studied for the degradation of the hazardous dye such as Methyl red and Congo red. In this 10 mg of the dye was added to 1 liter and make this as the stock solution. Take 10 mL of the above stock solution add 10 mg of the synthesized nanoparticles green aluminum oxide nanoparticles. The resulting mixture was sonicated at 30 min. The progress of the dye degradation was monitored by the UV- Visible spectrophotometer. This was measured at 0.5hr, 1 hr, 1.5 hr, 2.0 hr, 2.5hr, up to 24 hrs.

2. Results and discussion

UV–visible absorption

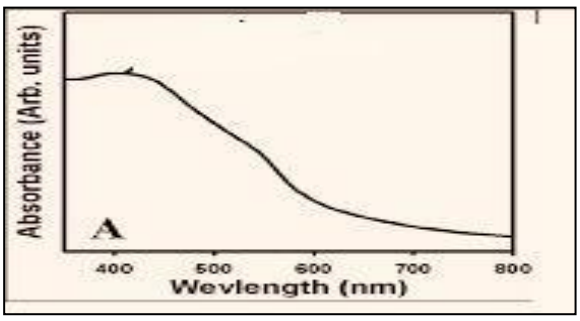

Fig. 1. UV visible spectra of Plant assisted aluminum oxide nanoparticles

The formation of the aluminum oxide nanoparticles was monitored by the UV visible spectroscopy Fig. 1. This shows the absorption at the 404 nm which is characteristic

absorbance of the nanoparticles.

Fourier transforms infrared (FTIR) spectroscopy

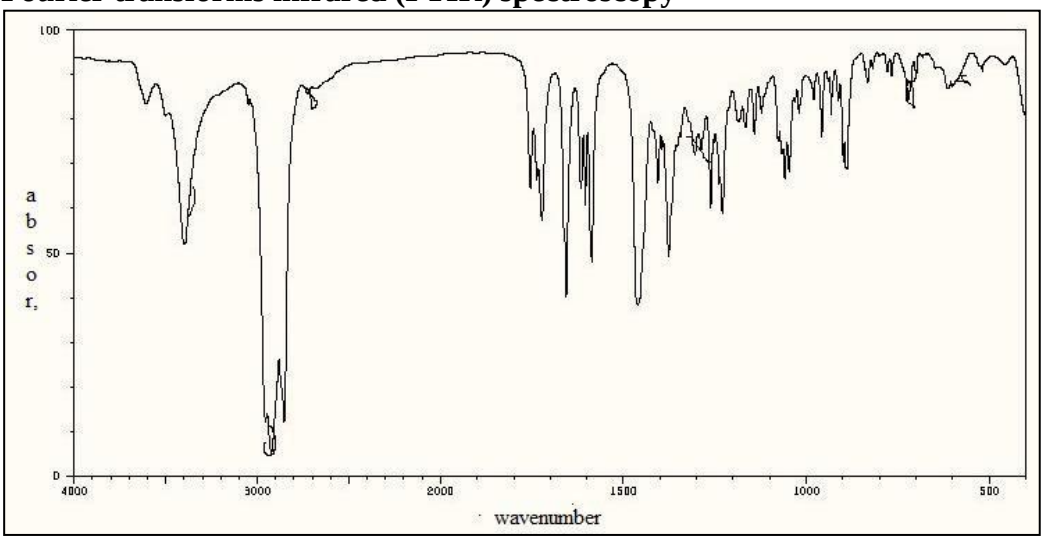

Fig. 2. Fourier transforms infrared (FTIR) spectra of Plant assisted aluminum oxide nanoparticles.

These infrared spectra used to determine the functional groups present in the nanomaterial synthesized using the rind of jackfruit. This Fig. 2 shows 3440 cm^{-1}, 3000 cm^{-1},1740 cm^{-1}, 1620cm^{-1}, 1380 cm^{-1}, 1250 cm^{-1}, 1030 cm^{-1}, 3440 cm^{-1}, indicate the presence of hydroxyl group, 3000 for the C-H stretching, 1740 cm^{-1}, for the carbonyl group stretching , 1620 cm^{-1}, indicate the formation of the NAH. 880 cm^{-1} 780 cm^{-1}, 600 cm^{-1}, indicate the formation of various aluminum oxide nanoparticles.

SEM analysis

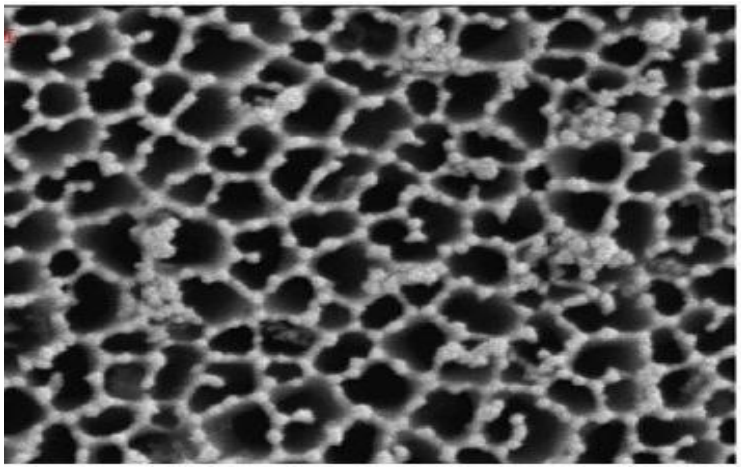

Fig. 3. Image of SEM of Plant assisted aluminum oxide nanoparticles

The SEM analysis Fig. 3 of the synthesized nanoparticles shows the Plant assisted aluminum oxide nanoparticles have good size and shape.

TEM analysis of the Aluminum oxide nanoparticles

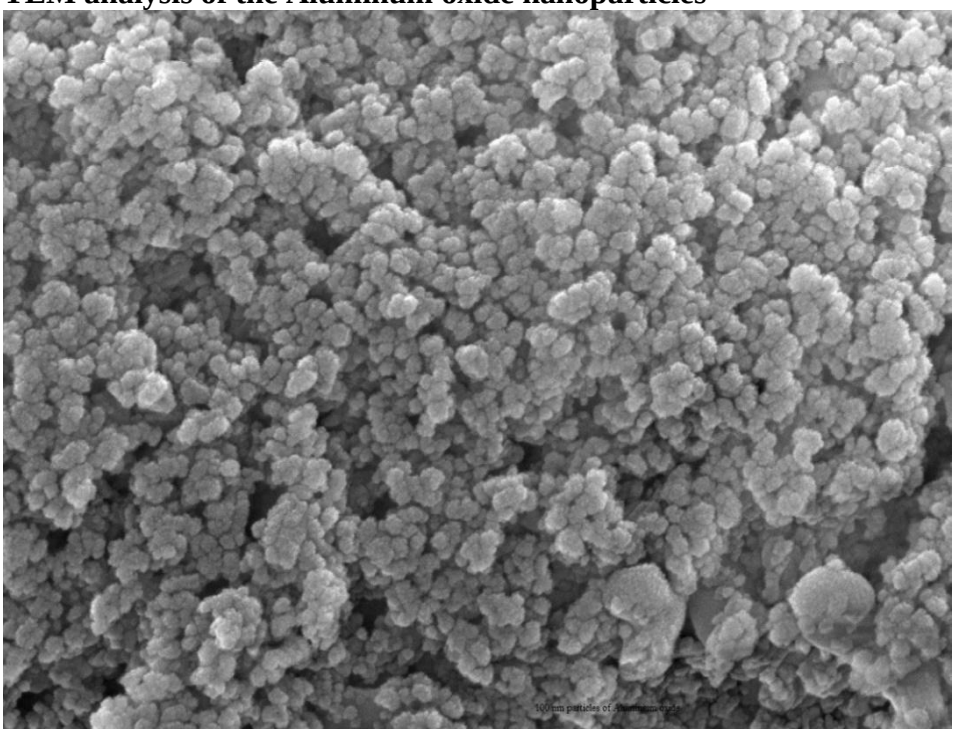

Fig. 4. TEM analysis of Plant assisted aluminum oxide nanoparticles.

TEM analysis Fig. 4 of the plant assisted aluminum oxide nanoparticles indicates that the plant assisted nanoparticles have good shape and morphology.

XRD Analysis of the plant assisted aluminum oxide nanoparticles

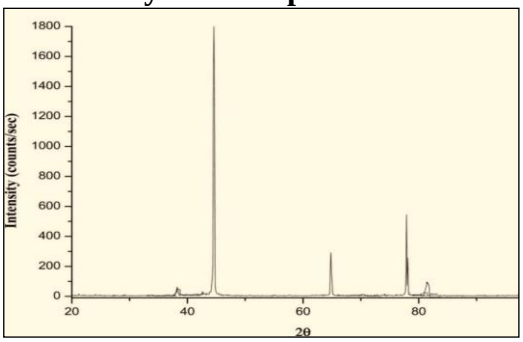

Fig. 5. XRD Analysis of Plant assisted aluminum oxide nanoparticles.

XRD analysis Fig. 5 of the plant assisted nanoparticles indicate that synthesized nanoparticle has semi crystalline nature.

Degradation of Congo red dye

The Congo red dye was degraded using the green nanoparticles. These particles can slowly degrade the Congo red dye. This Congo red dye is mainly responsible for the pollution. This dye degraded over the period of 24 h in the sunlight, as time goes the concentration of the dye goes on decreasing Fig. 6.

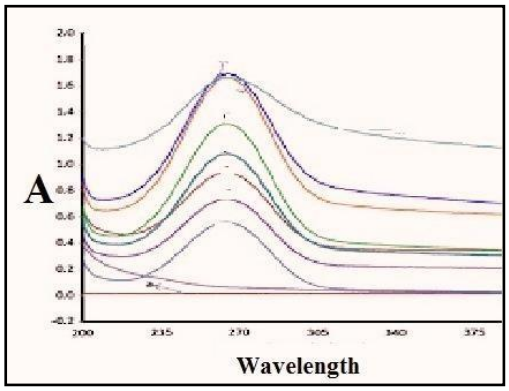

Fig. 6. UV visible spectra Degradation of Congo red dye using Plant assisted aluminum oxide nanoparticles.

Degradation of Methyl Red

We have studied the dye degradation. We have used the methyl red dye. We have prepared the standard solution this dye degradation carried in the sun light from 0 to 24 hr. For each half hour the UV absorption was recorded up to the dye degradation. This graph indicate that degradation of the dye takes place, concentration of the dye from the solution goes on decreasing Fig. 7.

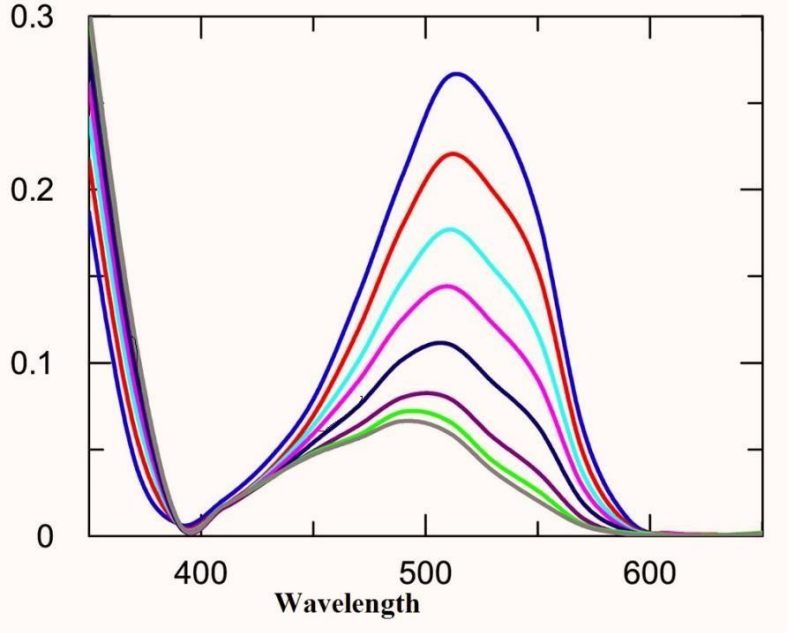

Fig. 7. UV visible spectra Degradation of Methyl red dye using Plant assisted aluminum oxide nanoparticles.

Table 1 Antibacterial Activity of the Green Aluminum oxide Nanoparticles

Sr. No	Name of the Organism	Activity in MM
1	Standard Penicillin's	28
2	E. coli	18
3	Staphylococcus aureus	17
4	Proteus vulgaris	21
5	Streptococcus mutans	25

The synthesized green nanoparticles were used to studied the antibacterial activity (Table 1) by using the zone of the inhibition method. It shows the comparable antibacterial activity with the standard. Jackfruit is commonly occurring in India. Jack fruit is edible food. Only inner part is edible and outer part is waste. In this we have use waste rind of jackfruit which contain the various phytochemicals. This phytochemical includes terpenoids, flavonoids, certain lignin and lignin. These can act as coating agent for the nanoparticles. The green nanoparticles are synthesized using aluminum nitrate on hydrolysis it forms the green aluminum oxide

nanoparticles. The formation of green nanoparticles was indicated by the UV-Visible spectra, IR Spectra, SEM, TEM and XRD Spectra. These spectra indicate that nanoparticle have good particle size and good morphology and structures. Synthesized nanoparticle was used for degradation of various dyes such as Methyl red and Congo red. This nanoparticle can effectively degrade the various dyes. The microbial activity of these nanoparticles was carried. These nanoparticles show excellent activity. We have synthesized the green nanoparticles from waste fruit rind, it shows the excellent result for the dye degradation and the antimicrobial activity.

3. Conclusion

In this study we have synthesized the green nanoparticles using the waste rind of the jack fruit. We use waste bark this is green route. We avoided the high cost and toxic chemicals. The synthesized nanoparticles are confirmed using the UV-Visible, IR, SEM, TEM and XRD. All these analysis shows that the nanoparticles are formed. These are green nanoparticles. They show the good stability. The synthesized nanoparticles used to study the dye degradation such as Methyl red and Congo red. It has shown the excellent dye degradation activity. These green nanoparticles are showing the excellent antibacterial activity.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are thankful to Principal Dr. V. S. Shivankar, Reasearch Promotion and ethics committee Dr. Keshav Shinde, Rayat Shikshan Sansthas, Satara.

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