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Magneto recyclable, green fabricated Fe_3O_4 nanorods on photo responsive of textile dye degradation and identification products by LC-MS

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Highlights

- To development of Fe_3O_4 nanorods by phytonutrients using punica grantum leaf (PGL).
- The degradation of the methyl violet color has been acknowledged by the depletion of the UV light (UV) absorption.
- The significant color expulsion of the Fe_3O_4 nanorods was proved to really be 97% after 60 min.
- Degradation products was determined by LC-MS spectra.
- Ecologically responsible Fe_3O_4 nanorods are immensely beneficial in the photocatalytic reaction of harmful pollutants.

Abstract

Prior to being released towards water sources such as rivers, lakes, and groundwater, the efficient technique of removing color out textile effluents seems to have become widely used. Such contaminants are extremely difficult for traditional wastewater treatment methods to completely eliminate. This innovative development of phytonutrients uses Fe_3O_4 nanorods, that have been employed as photocatalytic to change substrate colors in the aqueous layer when exposed to light. Given prominence was adopted to incorporate phytonutrients with Fe3O4 nanorods. The degradation of the methyl violet colour has been acknowledged by the depletion of the UV light (UV) absorption edge that also originated at 581 nm. The significant colour expulsion of the Fe3O4 nanorod was proved to really be 97% after 60 min. The findings demonstrate that ecologically responsible Fe_3O_4 nanorods are immensely beneficial in the photocatalytic reaction of harmful pollutants.

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Keywords

X-ray techniques; Nanocrystalline materials; FTIR; Electron microscopy; Photo catalysis; Textile dyes

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Introduction

In this materialistic society, first most highly toxic modern toxins are assimilated in the raw material to considerable extent being used nutrition, skincare, textiles, paper and cardboard sectors for purely aesthetic reasons. The vast numbers of them are outright dangerous that also embodies a remarkable threat to the current condition of the ecosphere. The dyes also were extensively employed in dye manufacturing [1] so upon intravenous mixture that leads to serious carcinogenicity and melanoma ailments [2]. Primarily, there seem to be various physicochemical strategies like as membrane filtration, bio-sorption on functionalized but also layer separation process. Magnetic nanoparticles (MNPs) are the foremost nanoscale materials with many practical applications such as ferrofluids, biosensors, catalysts, separation processes and environmental remediation. Especially, Fe_3O_4 (ferric oxide) belonging to the class of metal oxides was very well known for its unanimous photo catalytic and photo-oxidizing capacities. In Great Plains appealing iron oxide nanoparticles (Fe_3O_4 NRs) have indeed been adhered in distinctive sectors, such as validation and detachment of amino acids to continue improving the sensitivity of magnetic resonance imaging. (MRI), immunoassay and targeted drug delivery [3,4]. In part due to this, the consumption of the nanostructures has indeed adhered in a good deal with the consideration in the domain of Photocatalysts [5], polymer electrolyte membrane fuel membrane but also biosensor [6]. Likewise, a few really iron oxides and their matrix have revealed as a great tool for colour corruption by adsorbent [7,8] because of their substantial surface area to the volume ratio and diverse nanostructure materials.

Up to this point, various approaches have really been developed for the fabrication of Fe_3O_4 NRs, for solvothermal, ultrasonication, micro-emulsion, electrochemical, sol-gel and co-precipitation approaches [9,10]. The sustainable green encapsulation has been used to fabricate Fe3O4 NRs because of its numerous advantages over biological and physicochemical strategies, such as the feature in that it doesn't use conceivably hazardous materials as well as being renewable, environmentally friendly, and cost-effective [9,10]. It uses readily accessible bioactive compounds from plants. One-

dimensional Fe_3O_4 nanostructures have been high-lighted for many applications due to unique properties such as high specific surface area, single-crystal structure, high transparency, high electron mobility, large exciton binding energy (~ 60 meV), piezoelectricity and biocompatibility. In addition that Fe3O4 nanostructures-like nanowires, nanotubes and nanorods possess high surface-to-volume ratio and high areal density which can supply an electron transportation path. Particularly, Nanorod materials possess great anisotropic with exceptional magnetic behavior, which increase substrate combustion efficiency for waste water treatment compare to various metal oxide compounds like as ZnO NRs, CeO2 NRs and grpahene oxide doped ZnO NRs and so on [[11], [12], [13], [14]].

Punica grantum leaves of the plant have been used as they would be widely obtainable. The pomegranate (Punica granatum) seems to be the prevailing hybrid of multiple species comprising the Punicaceae relatives. The phytoconstituents reveal in this plant extract of leaves encompasses triterpenic acids, alkaloids, tannins, flavonoids [15]. These phytochemical constituents play a role as stabilizing and capping agents and refine metal oxide nanoparticles by chemical reduction. According to our expertise, none research upon that usage of P. granatum leaves in the production of Fe_3O_4 NPs has been done so far.

The proposed approach has used a promising strategy for perhaps the first time; it places an emphasis on incorporating as well as employing flavonoid @ Fe_3O_4 NRs and highlighting one's photocatalytic investigation, synergist action upon methyl violet (MV) colour eviction in a watery medium.

Punica grantum leaves, which act as functionalization agents, being gathered from the botanical herbal garden at Annamalai University in Tamil Nadu, India. All of the metal precursors, including $NaCOOCH_3$ > 99.9%, $FeCl_3.6H_20$>99%, NaOH > 99.9% and methyl violet fabric dye, were received from Sigma Aldrich. Without additional sanitization, the prescribed chemicals were used in deionized water.

5 g of powdered punica grantum leaf (PGL) were extracted solublely in a Soxhlet apparatus using a mixture of 50% methanol and 35% HCl. The acquired methanolic extracts subsequently neutralised with 0.3 mol of Sodium carbonate provisions, and so when petroleum ether and ethyl acetate were being separated, they have been triple-emptied and also the upper part disappeared. Punica grantum leaf extract (PGL), which has been fractionalized, has been eluted by proclivity. Five partitions was fractionalized using column chromatography from the 30 ml portion of the collected component. The acquired flavonoids isolates was evaluated by adding 0.5 ml hydroxide, and the extricated assays was homogenized at temperatures. It was evident that the PGL isolate used to have a yellow colour, indicating confirms the existence of flavonoids [16].

A cheap and ecologically responsible strategy has been employed to construct Fe_3O_4 MNRs. The traditional method has been employed but probably adapted [17]. The construction of 3 g of $FeCl_3.6H_20$ with 5.56 g of sodium acetate was inserted as a bio-catalytic agent (flavonoid 50 ml) then vigorously agitated by 2 h at 80 °C. As an outcome, the homogeneous slurry assumed on such a block color, as well as the block products was subsequently obtained & separated as seen in Scheme 1.

The photo catalysis platform has examined the effects of flavonoid@Fe_3O_4 NRs on textile dye removal. 50 ml of 0.1 M MV dye combined with 10 mg of Fe_3O_4 NRs were used in the experiment, which was then exposed to UV light. A control (MV) set was

also employed in the absence of a catalyst. The essence of the reaction medium was to offer desorption stability for repetitive exposure. Eventually, the chromphoric group started splitting by UV light. While also exposed to an accelerator (a mercury lamp of 120W) for various periods of time [18]. Decomposition of the color was represented by a sharp reduction in the absorption maximum at (max=581 nm), as illustrated in Fig. 6. (a).

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Results and discussion

Electronic absorption bands of embedded Fe_3O_4NRs have been obviously two shoulder bands were noticed like band I (Flavonoid) at 248 nm. The characteristic peaks for flavonoids and other phenolic compounds traditionally are located in the range of 210–290 nm and band II (Fe–O) at 402 nm was immobilised flavonoid @ Fe_3O_4 NRs was identified in Fig. 1 (a). Identical findings also backed up [19,20]. This is as an outcome of Fe_3O_4 NR development seeming to be dependent on the nucleation and growth …

Conclusion

In accordance with the plan, the flavonoids @Fe_3O_4 NRs have been successfully obtained employing PG leaves extract in a more environmentally friendly manner. In this way, various logical representations of the reusable and photo endurance of Fe_3O_4 NRs have been established. The strong dis-area thickness of 8.75×10^{15}, crystal field fascination, and adaptable oxygen species (AOS) constituent were also delivered to as fast response rates and simple to attain quickly in the color removal process, …

Declaration of competing interest

The authors declare that there is no conflict of interest regarding the research work reported in this manuscript. …

Acknowledgment

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Guan H., ..., Xue Y.

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> *Citation Excerpt:*

> …Nanoparticles can function as peroxidase mimetics, facilitating the catalysis of H2O2 to generate •OH, which in turn can destroy organic contaminants [19,20]. Fe3O4 magnetic nanoparticles (MNPs) possess robust magnetism, high surface redox activity, excellent electron transmission capability, favorable compatibility with diverse substrates, and economical cost [21]. As a result, they find extensive applications in medical diagnosis (e.g., drug delivery systems, magnetic resonance imaging), catalysis, environmental monitoring, and more [22,23]….

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From rust to robust disinfectants: How do iron oxides and inorganic oxidants synergize with UVA light towards bacterial inactivation?

Jia J., …, Giannakis S.

Science of the Total Environment • Volume 931 • 2024 • Article 172740

> *Citation Excerpt:*
>
> …Fig. 1d shows the FT-IR spectra of the two iron oxides. For hematite, the absorption peaks at 577 cm−1 and 635 cm−1 can mainly be ascribed to the typical stretching vibration of the FeO bond (Sundaresan et al., 2023). In addition, the absorption peaks at approximately 1047 cm−1 and 1124 cm−1 are attributed to the vibration of crystalline FeO modes, which can be classified as the characteristic peaks of Fe2O3 (Maji et al., 2012; Hao et al., 2015)….

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Catalytic degradation of antibiotic sludge to produce formic acid by acidified red mud

Yang R., …, Liu Z.

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> …The lattice width was analyzed and measured by Digital Micrograph software, which yielded that the spacing of each lattice is 2.53 Å (0.253 nm), which corresponds exactly to the crystalline surface of (3 1 1) in Fe3O4. Combined with the analysis of the test results in Fig. 6, it can be assumed that the active substance on the ARM surface is Fe3O4(Sundaresan et al., 2023). To verify the speculation, XRD analysis was performed on RM and ARM, and the results are shown in Fig. 8(a)….

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