Phytochemical Investigation, Synthesis and Characterization of Iron Oxide Nanoparticles by Peel Extract of Punica Granatum

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ABSTRACT

Iron oxide nanoparticles are gradually being studied for many applications in the field of medicine, photonics, laser, and biophysics. In this experiment, dark synthesis is used for obtaining iron oxide nanoparticles from *Punica granatum* fruit peel extract. Results confirmed that all synthesized iron oxide nanoparticles have a purity and high degree of crystallinity. The size of the nanoparticles which is synthesized by this root has a high degree of crystalline structure with a crystalline size of 37.71 nm. The highest peaks angle is 33.24^0, and 35.71^0 with the interplanar spacing (hkl) at (104), and (112) respectively and the index hkl based on ICSD no. 01-079-0007. UV–vis absorption recorded a characteristic peak at 653.9 nm for iron oxide nanoparticles. The bandgap analysis at 1.81 eV.

Keywords: Punica granatum, Nanoparticles, Dark synthesis, Phytochemical.

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INTRODUCTION

Nanotechnologies and Nanoscience are included in a large number of fields such as physical, chemical, medical, biological, electronics, and engineering. The subdivisions of nanoscience are nanometrology, nanomaterials, optoelectronics, and bionanotechnology for communication and information (Taylor, 2002).

Nanomaterials are placed or bound on many supports, but many kinds of nanoparticles are used in commercial sunscreen. The particles of nanomaterial device have a configuration that enables to absorb the ultraviolet rays from the sunlight to save the skin from diseases that can experience sunlight. The precision and the skill of the construction of nanomaterials with the size of <100 nm are very high to transport benefits in the making of apparatuses in different fields i.e the automobile, aerospace industry, and information technology (Kumar 2007).

Superparamagnetic iron oxides Fe_2O_3 nanoparticles have developed with a lot of applications for medical imaging tools. For a change in properties, characterize them. Iron oxide Fe_2O_3 nanoparticles are many kinds such as a diagnostic tool for diseases and application for clinical of cancer. Recently, Researcher found applications in the field of stem cell in which both cardiologic and neurological. The most interesting field of research is the contrast agents' production for magnetic resonance imaging MRI which is very effective in Superparamagnetic agents which are proton relaxation enhancers. There are different types of iron oxides such as maghemite (γ-Fe_2O_3), maghemite (Fe_3O_4), or other ferrites that are insoluble in water (Jahangirian, et al., 2021). Magnetite Fe_3O_4 NPs were greenly prepared using *Punica granatum L.* fruit peel extract as a reducing and capping agent. The Fe_3O_4 crystalline with an average crystallite size range from 21 to 23 nm and was mostly cubical (Bouafia, et al., 2021).

The dark Phytochemical synthesized of Iron oxide nanoparticles have different properties such as biocompatible, polyphenols, and phytochemicals which is more efficient than other different metal oxide nanoparticles. These all properties are also included in the plant extracts which is increase the therapeutic more efficiency for the synthesis of iron oxide nanoparticles. In recent, many research works were published to identify the applications of biological for the synthesis of iron oxide nanoparticles in different diseases such as microbial infections, wound healing, cancer, inflammatory, neurodegenerative diseases, etc. (Biswas et al., 2021; Bharathi et al., 2020; Pravallika et al., 2019). The same research was also done by Radoslaw Przenioslo (Hu et al., 2014; K. Supattarasakda (Przeniosło et al., 2020), Mufid (Supattarasakda et al, 2013), X. Yao (Bharathi et al, 2020), etc.

Nowadays, several techniques for the synthesis of nanoparticles are used, but the problems with all of these methods are they become less efficient and also not cost-effective. Besides these problems also impurities are present in these synthesized nanoparticles. The most suitable method for synthesizing nanoparticles is Phytochemical. The uniqueness of this paper is the synthesis technique of Fe_2O_3 nanoparticles by dark reactions.

MATERIAL AND METHOD

Salt of Iron chloride $FeCl_3.6H_2O$ (99% pure) was purchased from Islamabad, Pakistan, and manufactured by Merck Millipore. All solutions of aqueous were prepared by using distilled de-ionized water. The extract of *Punica Granatum* was prepared from the fresh *Punica Granatum* that was collected from Multan, Pakistan.

Preparation of P. Granatum Fruit Peel Aqueous Extract

To eliminate the dust and dirt from the Peel of *Punica Granatum*, washed it at room temperature. The dried peel is grounded by using an electric blender. 12g of peel extract powder, 100 ml water is added and stirred at 90 ^{0}C with rpm of 200. A filter all this solution by using a cotton cloth and store it at 4 ^{0}C in a dark environment.

Dark Phytochemical Reaction

The dark Phytochemical method is used for obtaining Fe_2O_3 NPs. Iron salt $FeCl_36H_2O$ is used with peel extract solution and stirred for 5 hours at room temperature. Store all the solutions for 5 days in a dark environment. Obtained nanoparticles which settle down in a beaker and washed by distilled water with the centrifuge of 15,000 rpm. In the end, annealing at 400 ^{0}C.

RESULT AND DISCUSSION

X-RAY Diffraction

Figure 1 shows the XRD graph of the Dark Phytochemical of iron oxide nanoparticles.

The graph shows that the nanoparticles have a single rhombohedral phase such as αFe_2O_3. The index hkl is based on ICSD no. 01-079-0007. It was also confirmed that synthesized iron oxide nanoparticle α-Fe_2O_3 has no impurity phase. The average crystalline size was 37.71 nm and it was analyzed by X'pert High Score Software. The highest peaks were analyzed at 33.24^0, and 35.71^0 with the interplanar spacing (hkl) at (104), and (112) respectively as shown in table 1.

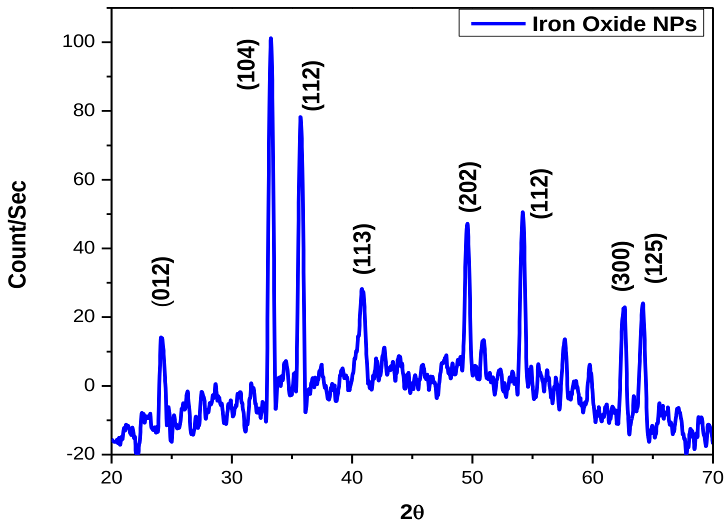

Figure 1: XRD Graph of Iron Oxide nanoparticles

Table1: Table of XRD Data

Peaks No	2θ	d	hkl	D(nm)
01	33.24	0.269	(104)	37.84 nm
02	35.71	0.251	(112)	37.58 nm

UV-Visible Spectroscopy

The Ultraviolent absorption spectroscopy was used for analyzing the optical properties of the sample being synthesized iron oxide nanoparticles. The absorption effects of different peaks are shown in Figure 2. The absorption of iron oxide in the visible range is 653.9 eV.

Tauc gap rule is used for studying the optical properties of the amorphous solid materials. The Tauc graph shows the absorption of light energy (hv) and this energy bandgap is measured by using equation

$$(\alpha hv)^2 = A(hv - E_g).$$

In which 'hv' shows the energy of photons, 'v' shows the frequency of photon and 'E_g" is the energy of bandgap.

$$A = \frac{4\pi k}{\lambda}$$

It shows the absorption coefficient. 'λ' and 'k' are wavelength and absorbency and 'h' is Planck's constant. For direct transition, we chose the square of 'αhv'. It gives us the best-fitting linear curve for the region of the band edge. The relation between hv and $(\alpha hv)^2$ is shown in Figure 3. We can find the E_g values by extrapolating the linear region near onset in the plot of hv verses $(\alpha hv)^2$. The value of bandgap E_g is 1.81 eV.

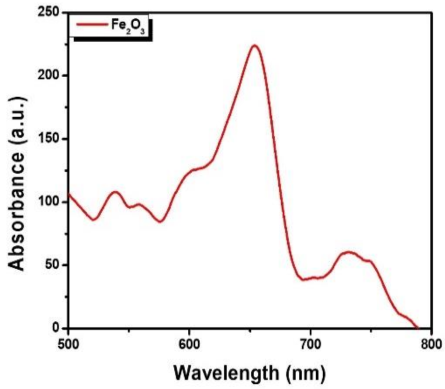

Figure 2: Graph of Absorption of Iron Oxide Nanoparticles

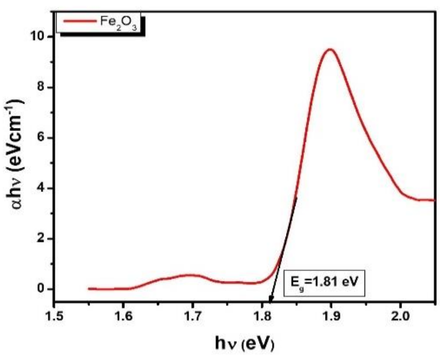

Figure 3: Graph of Band Gap of Iron Oxide Nanoparticles

CONCLUSION

In this novel study, a dark phytochemical procedure was used to synthesize the iron oxide nanoparticles. The XRD data showed that the iron oxide nanoparticles have crystallinity and high purity. The size of the nanoparticles which is synthesized by this root has a high degree of crystalline structure with a crystalline size of 37.71 nm. The highest peaks angle is 33.24^0, and 35.71^0 with the interplanar spacing (hkl) at

(104), and (112) respectively and the index hkl based on ICSD no. 01-079-0007. UV–vis absorption recorded a characteristic peak at 653.9 nm for iron oxide nanoparticles. The bandgap analysis at 1.81 eV.

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