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Iron oxide nanoparticles were preparation by mixing iron chloride salt with garlic extract

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***Abstract*---**Using a straightforward chemical process and a temperature of 200 °C, iron oxide nanoparticles (IONPs) (Fe_2O_3) were produced from ferric chloride ($FeCl_3$) with garlic peels as the source material. (X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), ultraviolet (UV-Vis), and Fourier transformed infrared (FTIR) spectroscopy were utilized in the process of diagnosing (Fe_2O_3) NPS. XRD tests indicated a crystallite size of 50 nanometers and a cubic structure (magnetite) for the Fe_2O_3 NPs that were generated at a temperature of 200 °C using garlic peel extract. FESEM explained particle size for Fe_2O_3 NPs was 18.61 to 27.91 nm. The UV-Visible data indicated that there was a blue shift in the band energy gap, which came out to 3.1 eV for the Fe_2O_3 NPs. FTIR shows the absorption band strategy is 681 cm^{-1} for Fe_2O_3 NPs at 200 °C.

***Keywords*---**iron oxide nanoparticles, garlic peels extract, simple chemical method.

Introduction

Nano-technology is a subfield of nanoscience that incorporates the most recent breakthroughs in science and is responsible for the advancement of a variety of domains, including the industrial, economic, and social sectors [1-5]. The establishment of nanotechnology that is less harmful to the environment will be a step forward that is applauded in the present scientific period. NPS, on the other

hand, represents significant leaps forward in nanotechnology. IONPs (Fe_3O_4 and -Fe_2O_3) are significant materials and have great future advantages compared to other materials [6], due to their unique physicochemical properties, low toxicity, and high catalytic activity, small sizes, and high surface area to volume ratio, physical and magnetic properties. (Fe_3O_4 and -Fe_2O_3) NPs are also significant materials and have great future advantages compared to other materials [7-10]. IONPs involve a wide range of applications containing in magnetic targeting [11], drug delivery [11], hyperthermia [12], gene therapy [13], environmental remediation [14-15], antimicrobial agent [16-17], negative MRI contrast enhancement [18]. A quantum-confined structure means a strong spatial localization of carriers (electron and hole) [19]. A structure is said to have quantum confinement if one or more of its directions are prevented from moving in the same direction by the presence of potential barriers. A structure that is quantum-confined and whose properties are determined by the direction in which the confinement is applied [20]. There are a number of chemical and physical mechanisms that can result in the creation of IONPs. These strategies can be classified as either "bottom-up" or "top-down," respectively. Hehe. It (begins with a cockroach and works its way up in the material growth process so that nanoscale structures can be accessed directly through the process) (etching, mechanical milling, microwave, and sputtering). Cockroaches build their nanoscale structures from the top down, beginning with a with or molecules (aerosol process, atomic condensation, co-precipitation) [21]. IONPs can be generated using chemical and physical methods, as was previously indicated. These procedures, however, necessitate the employment of very toxic reaction reducing agents such sodium borohydride and sodium hydrazine, both of which provide a range of undesirable dangers to human health and other biological systems. Over the past decade, numerous specialists have developed a method that is gentle on the planet. Biosynthesis is the term for this method [22-23It's a way to eliminate potentially harmful chemicals in production without resorting to a cumbersome clocatedcated purifying process. As a way to synthesis materials of a higher purity level, the IONPs chemical process was developed and implemented [24-25]. Nurul H. A., et al. (2018) [26]. The prepared iron oxide nanocomposites for degradation of dyes from water. Hala Y. El-Kansas, et al. [27]. The IONPs (Fe_3O_4) were prepared by the green synthetic method by mixing ferric chloride with plant extract. In addition, Iohannis Anatropous et al. [28]

In this paper, by chemical method to synthesize of IONPs (Fe_2O_3) by mixing garlic peels extract within chloride salt ($fecl_3$) under normal conditions at 200 ^oC for 2 hours. The determination of structural and optical properties for IONPs (Fe_2O_3) by X-ray diffraction (XRD) by using "(XRD6000 Shimadzu, Company/ Japan), scanning electron microscopy (FESEM) using (Tescan Mira3 FESEM-Czechia)". Additionally, ultraviolet (UV-Vis) radiation by (Double Beam Li-1800) (Double Beam Li-1800). In the g use FTIR spectrum, the mode vibrations and function groups are studied and determined (Spectrum GX FT-IR, Perkin-Elmer) (Spectrum GX FT-IR, Perkin-Elmer).

Materials

A peels of garlic extract and Ferric chloride ($FeCl_3$) (Baghdad, Iraq) were bought from the market (Baghdad/Iraq). All solutions prepared in this experiment are from distilled water.

Extract from garlic peels is being prepared

A summed garlic peels specimen was scared for remove impurities for little parts. After that, dried specimens were crushed for soft powder by trade an electric mixer (steel blender). Garlic peels extract was synthesized from a mixture of 10 g powdered in 200 ml (DW). On a hotplate stirrer, the solution was heated to 70 ^{o}C and kept there for two hours. The consequence solution is vefrozenreeze and purified during the Whatman filter sheet. Figure (1) explain the steps of converting the fresh animal into the o extract. Figure (2) show images of garlic peels by the FE-SEM analysis [29].

Figure (1): Phases of converting plant into extract (garlic), A) garlic peels tree, B) garlic peels powder, C) garlic peels extract

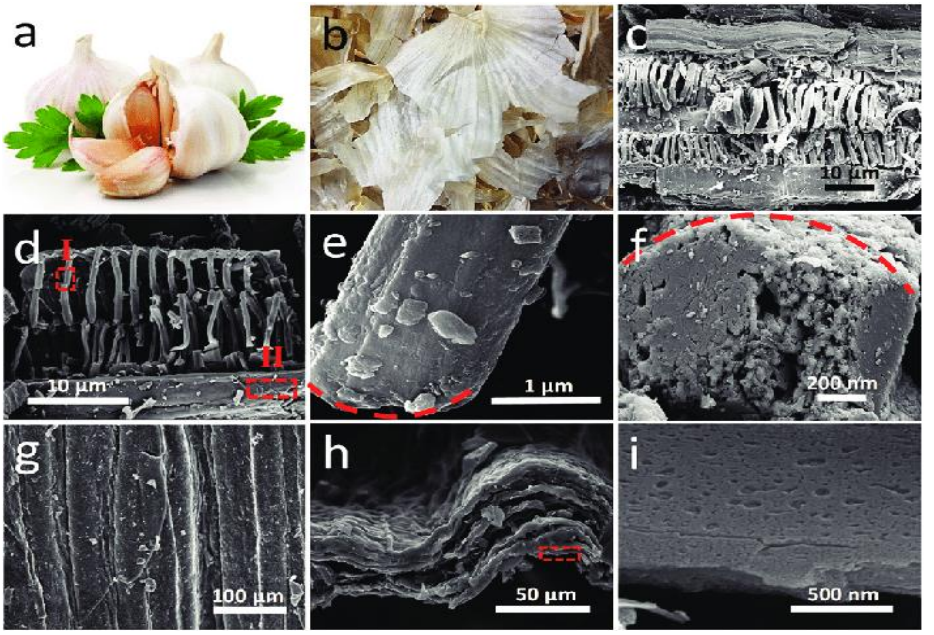

Figure (2) show images of garlic peels by the FE-SEM analysis [29].

Preparation of IONPs using Garlic peels extract

In order to prepare the synthesized IONPs (Fe_2O_3), 100 ml of ferric chloride ($FeCl_3$) at a concentration of 1 M was added to 200 ml of garlic peel extract. After that, the sol ware was left on a hot plate stirrer at a temperature of 80 ^oC for a period of thirty minutes. Through this method, the color of the reaction so changed refers to the formation of IONPs (Fe_2O_3). Then, the solution left cooled under at room temperature. After that, the solution of IONPs (Fe_2O_3) takes 20 is ml and put in a ceramic eyelid in the oven at (200) ^oC for 2 hours to obtain-nano powder der Then, stored the powder of IONPs (Fe_2O_3) unsealedealed serum tubes for further characterization. Methods for making IONPs (Fe_2O_3) from garlic peel extracts are shown in Figure (3).

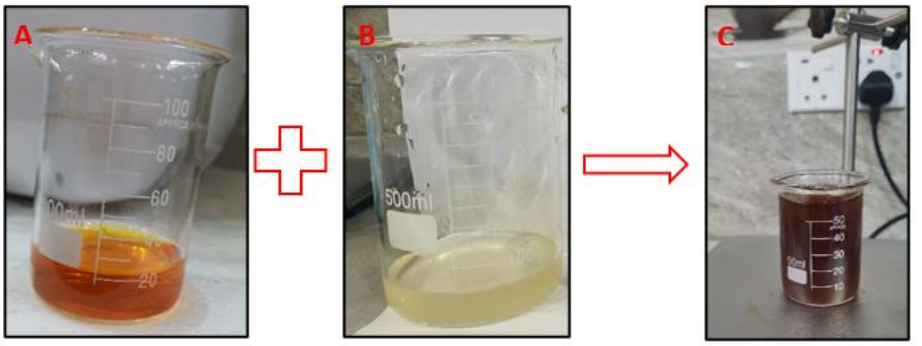

Figure (3): A phases of prepared from IONPs (A) Ferric ($FeCl_3$) solution (B) garlic peels extract, (C) IONPs

Characterization of IONPs prepared using Garlic peels extract

Using (CuK) radiation at 1.5418 A^o as an XRD source, the IO (Fe_2O_3) NPs were detected using XRD JCPDS (Joint Committee on Powder Diffraction Standards). Above the range (10o-80o), intensity data was acquired in a step scan mode (XRD-6000). XRD measurements were used to examine the orientation of IONPs generated samples in the Iraqi Ministry of Science and Technology's nanotechnology facility and Advanced Materials/Materials Research Department. In Iran-Mashhad, FESEM was used to determine the IONPs' particle size and shape using the (Tescan Mira3 FESEM-Czech Republic). To create the UV-Visible transmittance spectrum from an IONP liquid solution, we used a twin beam spectrophotometer (UV-1800, Shimadzu) covering the wavelength range of (200 to 900) nm. To accomplish the polarized IR reflectance, we employ an FTIR spectrometer (specifically, a Spectrum GX FT-IR, Perkin-Elmer) equipped with a potassium bromide (KBr) beam splitter and a mid-IRIR triglycine sulfate (TGC) detector to identify the vibrational modes and functional groups.

Results and Discussion

XRD data of IONPs using garlic peels extract

In Figure (3) the X-ray diffraction patterns of nanoparticles prepared by simple chemical method using garlic extract showed the characteristic peaks of Fe_2O_3 nanoparticles with a faceted cubic crystal structure (2θ = 16°, 21°, 31.71°, 33.74°, 38.71°, 42.74°, 43.1°) for the Crystal Planes (102), (012), (104), (113), (202), (024) and (214) In addition, it is noted that there is an effect of the plant extract on the cubic crystal structure of iron oxide nanoparticles. From the X-ray diffraction patterns, we notice that the peaks are shifted towards higher (2θ) angles. With an increase in the iron oxide content, this phenomenon is mainly due to the elastic deformation of the lattice [30]. The crystallite sizes (D) are estimated by the following Scherrer's equation [30].

$$D\ (nm) = \frac{K\lambda}{\beta \cos\theta} \qquad (1)$$

Diffraction angles are calculated using the formula: where is the wavelength, k is the shape factor, is the full width at half maximum (FWHM), and is the diffraction angle.

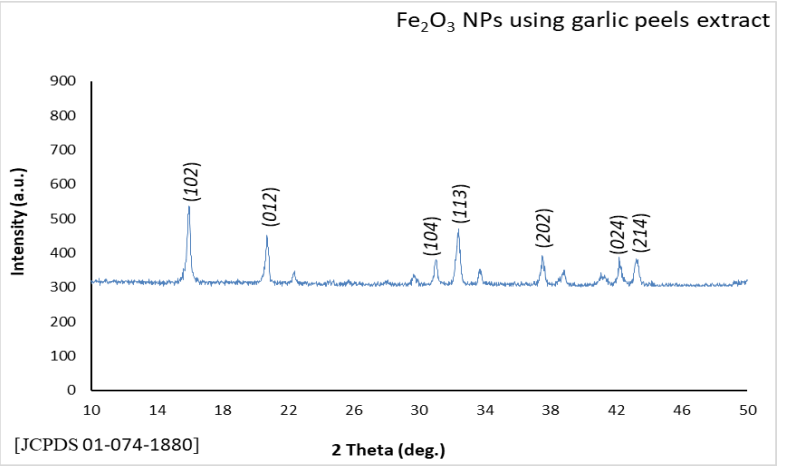

Figure (3) X-ray diffraction (XRD) patterns of iron oxide nanoparticles (Fe_2O_3 NPs) prepared using garlic extract

Table (1): show of some crystalline parameters of iron oxide nanoparticles

Plant extract	materials	FWHM (deg.)	2θ Exp. (deg.)	(hkl)	2θ JCPDS (deg.)	Crystallite D(nm)
Garlic peels	Fe_2O_3	0.69	16.2	(102)	17.5	10
		0.20	21.2	(012)	22.0	40
		0.15	31.3	(104)	24.1	53
		0.21	33.7	(113)	29.9	38
		0.14	38.1	(202)	32.2	58

		0.20	42.6	(024)	33	41
		0.29	43.7	(214)	33.9	28

FESEM of IONPs using garlic peels extract

The morphology and average size of the grain size of iron oxide (Fe_2O_3) NPs were analyzed using FE-SEM images using garlic peel extract by simple chemical method at 200°C. Figure (4) shows a microscopic image of the prominent nanoparticle structures observed with average grain sizes ranging from (41.68 nm to 59.12 nm), the results show that the nanoparticles are spherical in shape [30]. FE-SEM analysis reveals the following shapes for samples a, b, c and d: They are shown in Fig. 4. The samples have a spherical shape with minimal aggregation [30].

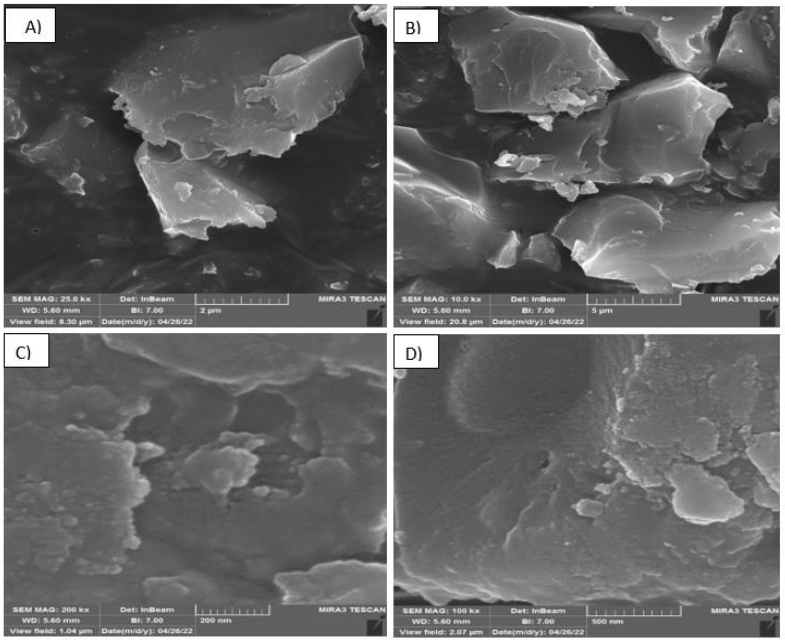

Figure (4) shows scanning tunneling electron microscope images of iron oxide nanoparticles (Fe_2O_3 NPs) prepared using garlic extract.

Analysis of the UV-Visible Spectrum of IONPs Prepared from garlic peel extract

Iron oxide nanoparticles (Fe_2O_3 NPs) were synthesized using a simple chemical technique employing garlic peel extract at 200°C, and UV-Vis analysis was used to measure the absorption and transmission band. Figure 5 show the absorption band for Fe_2O_3 using garlic extract. It showed strong absorption in (230 nm) and an absorbance of (3.33 a.u.). Figure 6 shows the optical transmittance spectra for iron oxide nanoparticles (IONPs) produced using a straightforward chemical technique. An increase in the absorption of Fe_2O_3 NPs hematite is seen above 400 nm, as demonstrated in Figure 6 [31].

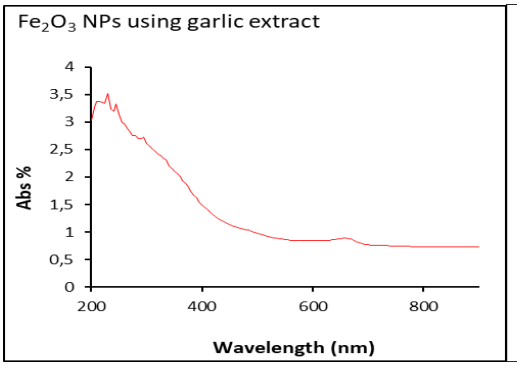

Figure 5 UV-visible absorbance of Fe_2O_3 NPs using garlic extract at (200 ˚C).

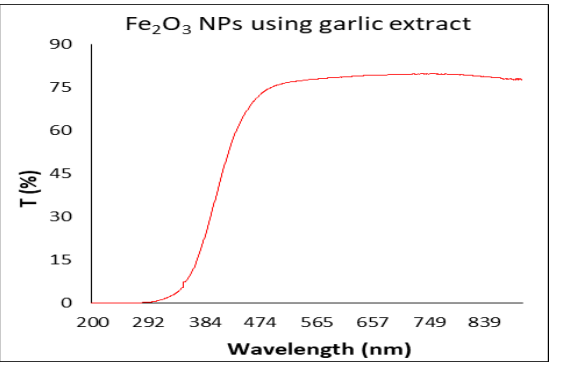

Figure 6 UV-visible transmittance of Fe_2O_3 NPs using garlic extract at (200 ˚

In order to determine the energy gap of (Fe_2O_3) that were synthesized utilizing plant extract (garlic), we plotted the square of 2 (h) against (h). As a result of the decreased attractive force between the particle's conduction electrons and metal ions, the band gap widens for NPs of smaller size, and the energy gap widens if the particles are concentrated enough to split their level into secondary levels. In Figure (7), the energy gap for (Fe_2O_3) values ranged from (3.1) electron volts.

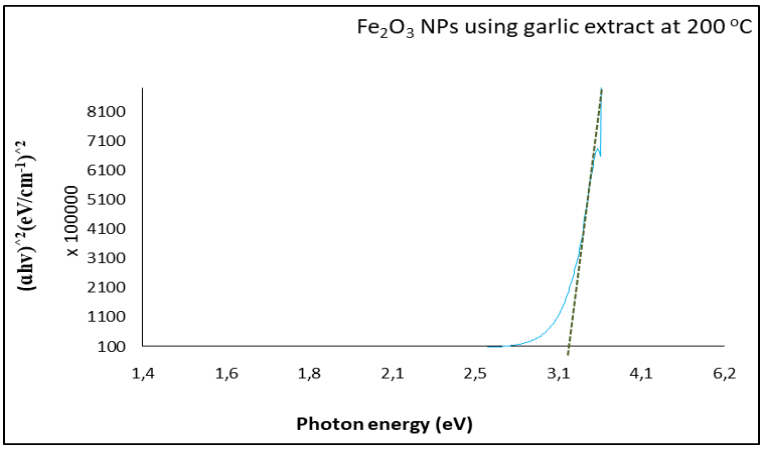

Figure (7): The energy band gap of (Fe_2O_3) chemically prepared using garlic.

FTIR spectrum from (Fe_2O_3) NPs by garlic peels extract

FTIR spectrum shows of results the vibrations mode and function groups of (Fe_2O_3) NPs produced via garlic. The band absorption strong is (726 cm^{-1}) of Fe_2O_3 NPs at 200 °C in figure 8, but the absorption band strong of Fe_2O_3 NPs at 400 °C from figure 7 (b) is (633 cm^{-1}). The FTIR spectrum results of (Fe_3O_4 and γ-Fe_2O_3) NPs prepared using egg peels (brown) extract in table (2) [34-35].

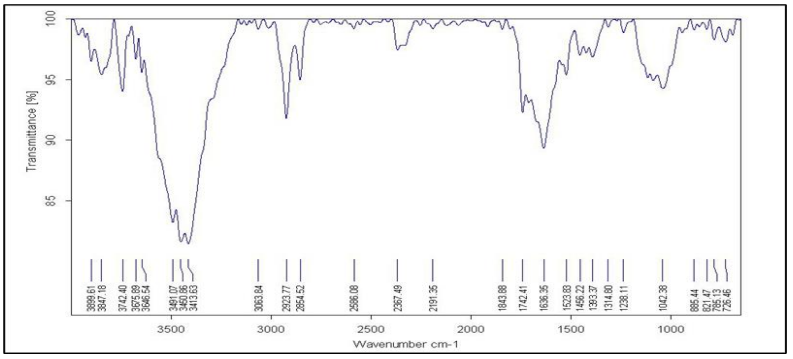

Figure (7): The FTIR spectrum of IONPs produced via garlic peels extract with $FeCl_3$ at 200 ^oC

Table (2): FTIR spectrum for (Fe_2O_3) NPs using garlic peels extract at (200) ^oC

Plant extract	Materials	The strong band (cm^{-1})	Compounds types	Function groups	Absorption regions
Garlic	Fe_2O_3	726	Fe-O	Finger print	band vibration
		1609	C=C	Aromatic	bending rocking
		3350	O-H	Hydroxyls	Stretching Asymmetric

Conclusion

The (Fe_2O_3) NPs were luckily produced by garlic peels extract mixed with iron chloride ($FeCl_3$) at (200) °C for two hours via chemical way, respectively. The XRD measurements explain the diffraction peaks showed cubic structure diagnostics of inverse cubic structure from Fe_2O_3 (hematite) NPs and 10 nm crystallite size at 200 °C, and the average grain size of 41.68 nm to 59.12 nm with nanostructure by the FESEM. The UV-VIS data indicated that the energy gap values for Fe_2O_3 NPs at 200 °C shifted to the blue from 3.1 eV. At a temperature of 200 ^oC, FTIR reveals a prominent absorption band at 726 cm^{-1} for Fe_2O_3 NPs.

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Declaration of Interest Statement

No Declaration of Interest Statement of the authors.

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