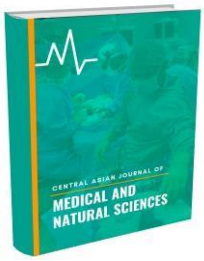

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Article

Treating Soil Contamination with Household Cleaners Using Bio-Prepared Nano-Iron Oxide

Khalisa Ahmed Qahtan Ahmed[1], Ahmed Jassim Mohammed[2*]

1. Department of Biology, College of Science, Baghdad University, Baghdad, Iraq
* Correspondence: ahmed.jasim@sc.uobaghdad.edu.iq

Abstract: Everyday life involves the use of laundry detergents. They are essential in maintaining hygienic conditions. Water and plant-based cleaning solutions were used in the past to clean clothing. But as living conditions have improved and technology has advanced quickly, there has been a rise in the demand for and use of laundry detergents, which have gradually supplanted the long-standing practice of using plant species to clean clothing and textiles. This review's main goal was to investigate how the growing manufacturing and use of contemporary laundry detergents has affected the environment. This was accomplished by employing qualitative content analysis to examine the numerous research studies on laundry detergents that were published in scientific journal articles, the environmental regulations for laundry detergents in different nations, and other published scientific publications on the topic. The conclusion is that while technical developments in detergent and soap formulas have improved the washing of clothing, they are having a negative impact on the environment and human health. The release of laundry detergents and/or their prepared solutions into the environment presents a serious risk in terms of loading wastewater, treating it later, using resources, and getting rid of packaging debris. The findings presented in these research, despite their limited dissemination, offer important insights for the creation of laundry detergents that take into account environmental and economic factors while utilizing a variety of botanical resources. The most significant studies' and reports' findings are utilized to suggest crucial new lines of inquiry for upcoming investigations into the systems and technologies needed to create environmentally friendly laundry detergents for residential usage.

Keywords: pollution, soil pollution, locally manufactured detergents, lemon peels

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1. Introduction

Pollution also called environmental pollution, the addition of any substance [solid, liquid, or gas] or any form energy [such as heat, sound, or radio activity] to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form. The major kinds of pollution usually classified by environment air [air pollution, water pollution, and land pollution] [1], [2], [3], [4].

Modern society is also concerned about specific types of pollutants such as [Noise pollution, light pollution and plastic pollution of all kinds can be have negative effects on the environment and wildlife and often inmacts human health and well – being.

2. Materials and Methods

This study was conducted during the period from January to March / 2023 at University of Baghdad. The study soil samples were selected from the garden of the College of Science / Baghdad University, the soil type was mixed. The samples were taken on January / 2023. Each soil samples were weighted 100 gram with 30cm depth under soil surface almost.

2.1. Materials

The general instruments and equipment used in this study are listed in Table 1:

Table 1. Strouhal number for different geometric cases

Equipment	Company	Country
Sensitive balance	VIBRA SJ	Japan
Centrifuge	Hattich	German
Shaker	Precisterm	England
Laboratory incubator	Memert	German
Oven	Memert	Japan
HPLC	SYKAM	German
Soil Probe	Hunter	German
FTIR	Shimadzu	Japan
UV	Shanghai	China

2.2. Methods

2.2.1. Nanotechnology Methods:

2.2.1.1. Preparation Iron Oxide Nanoparticles from lemon Peels:

This preparation study It lasted for 3 months start at 1/12/ 2022. African yellow lemon peels were used in the study and took the yellow part only from the shell almost, (100) g were used, a liter of water (tap water) was added to lemon peels and mixed in the electric blender and continue mixing until become like juice, then filtered by a piece of gauze or a piece of cloths, liquid permeable, then filtered it anther time with filter papers with diameter (0.2) mm, and filtered again until we have clear solution without of any impurities.

Trancenfed the solution in tubes with capacity (10) ml in the centrifuge at speed 60 cycle/ second for 30 minutes, to separate the resin material formed at the top of the tube, then filtered with filter papers to have clear solution. By adding (1) g from Aqueous ferrous Sulfate ($FeSO_4.7H_2O$) for each (10) ml from extracted lemon solution and put it in the Shaker for (24) hour to ensure salt and solution miscible.

The solution was trancefed in the centrifuge at speed 60 cycle/ second for 30 minutes, to get a deposit at the bottom of the tube and only the deposit is taken and wash it for (10) second at the centrifuge by added (5) ml deionized water to the deposit, then pour into Petri dishes and incubated for (2-3) days at 37 °C, then scraped off it after drying with spatula and it placed in a shaded incubator away from humidity and light .

2.2.1.2. Atomic force microscopy (AFM)

To observe the surface roughness and topography of the sedimentary thin films, they are examined with a Scanning Probe Microscope (NT- MTD), which was examined at Al Nahrain University / College of Science.

Advantages of Atomic Force Microscope [5]:

1. Easy to prepare samples for observation
2. It can be used in vacuums, air, and liquids
3. Measurement of sample sizes is accurate
4. It has a 3D imaging
5. It can be used to study living and nonliving elements
6. It can be used to quantify the roughness of surfaces
7. It is used in dynamic environments.

2.3. Principle of Operation

A field-emission cathode in the electron gun of a scanning electron microscope provides narrower probing beams at low as well as high electron energy, resulting in both improved spatial resolution and minimized sample charging and damage.

Morphological analysis of the iron oxide nanoparticles was performed by (FESEM). Dried sample of iron oxide NPs solution was sonicated with distilled water, then placed small drop of this solution on microscope slide and let the sample dry, then a thin layer of platinum was coated so that to make the samples conductive.

3. Results

3.1. Preparation of nanomaterial from lemon peels

Researchers have increased their interest in preparing and studying nanoscale metal oxides in the past years due to their increasing applications. It was found that the various properties of these oxides change significantly at nanoscale measurement compared to traditional measurement, where it reaches a complete change in properties. As for the nanoscale, super magnetic iron oxide is widely used in important medical and biological applications such as the restoration of Tissues and detoxification of body fluids, in sensors, electronic circuits, and fuel cells [6].

3.2. Forms of the presence of iron oxide

Iron oxide is found in nature in various forms, including magnetite (Fe_3O_4), hematite (Fe_2O_3), and macahematite (Fe_2O_3). It was found that the surface area of iron oxide particles significantly effects on their magnetic properties. Hematite is considered the most widely used form of iron oxide and has several names (Among them is ferric oxide). It is obtained from the soil of sedimentary rocks; it is black or gray if it is coarsely crystalline and is more stable because it is the end product of other iron transformations. Magnetite in the form of Fe shows the most vital magnetic properties [7].

3.3. Methods for preparing Nano-iron oxide

There are several methods for preparing and identifying nanoscale iron oxide, including reaction methods in a liquid medium, especially water or organic liquids, the sol-gel method, the method used to prepare iron oxide nanoparticles in this study is a simple, relatively inexpensive, and environmentally friendly method to produce nanoparticles with a large surface area, using lemon plant extract, as this plant is rich in citric acid [8] which reacts with iron(III) nitrate to give iron oxide nanoparticles [9].

3.4. Preparation

Lemon peels are used and filtered, then placed in a centrifuge at speed 60 for half an hour. Then the resinous material is separated and re-filtered again to obtain a pure lemon solution, and aqueous ferrous sulfate salts are added at a rate of (1 gm) for every (10 ml) of extract. Then put it in the MX-S shaker for (24) hours to ensure that the salt mixes with the solution. Then it is placed again in the centrifuge for half an hour to obtain sediment at the bottom of the tube. It is taken and washed for 10 seconds in the centrifuge with (5 ml) added of non-ionic water with the substance, pour it into petri dishes, place it in the incubator for (2-3) days, scrape it, weigh it, and keep it in a shaded container.

First, take the yellow part only from lemon peels and put them in a blender with (500 ml) of sterilized water and beat in the blender for (15 minutes), then filter with a liquid-permeable cloth, then filter three times with filter paper to obtain a clear, impurities-free liquid.

3.5. Properties analysis of iron oxide nanoparticles

The X-ray diffraction (XRD) analysis method, the scanning electron microscope (SEM) method, the infrared spectroscopy (FTIR) method, and the ultraviolet-visible spectroscopy method (UV-Vis) and (AFM) method are all used to evaluate the properties of soil after nano addition.

3.5.1. Ultra-violate visible light (UV-Vis):

This study conducted on lemon peels found that when exposed to visible ultraviolet rays, its absorption rate for radiation waves whose length ranges between approximately (190-280 nm) fluctuates between positive values close to 2 and negative values up to approximately -4, that is, relatively high, while waves that range Its length is between(281-400 nm), we notice that the absorption rate decreases significantly with increasing wavelength until it reaches a wavelength of about (964 nm), at which the absorption is approximately 0.0011, in Figure 1, value is very low, meaning that only a very small part of the wave is absorbed, and with increasing wavelength more, the closer the absorption value is to zero, meaning that lemon peels at relatively high wavelengths do not absorb these rays.

Therefore, affect the crusts with ultraviolet rays, the wavelength must be at low values between (190 - 280 nm) [10]. Studied using the method of visible ultraviolet spectroscopy, and the results appeared as shown in Figure 2 to reveal the maximum absorption, it was found that there was a clear absorption of "3.376" of rays at a wavelength of about (285 nm) [11].

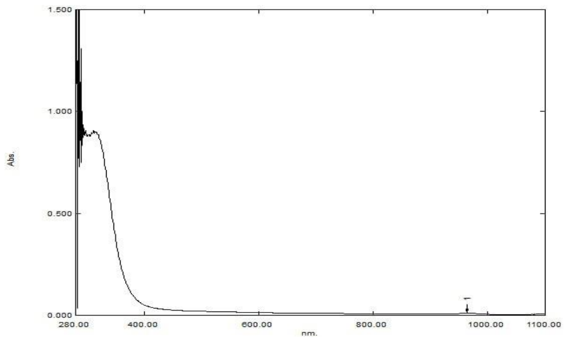

Figure 1. The absorption of UV radiation by lemon peel

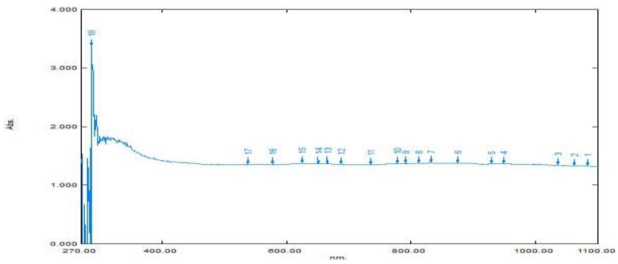

Figure 2. The absorbance properties of the iron nanoparticles

3.5.2. Atomic force microscopy (AFM) investigation

The surface shape formation of the iron oxide nanoparticles was studied by atomic force microscopy to show that iron oxide nanoparticles, AFM images show that the bio-synthesized iron oxide nanoparticles are spherical. The average Diameter of 50.66 nm. We note that the Diameter of the core-shell is (50.66). This increase in Diameter indicates the amount of iron, and this was evident from their quantity in the EDX examination, as shown in Figure 3, 4 and Table 2.

Table 2. Strouhal number for different geometric cases (size 10)

Avg.	**Diameter:50.66 nm**	**<=10%**	**Diameter:20.00 nm**
<=50%	Diameter:45.00 nm	<=90%	Diameter:80.00 nm

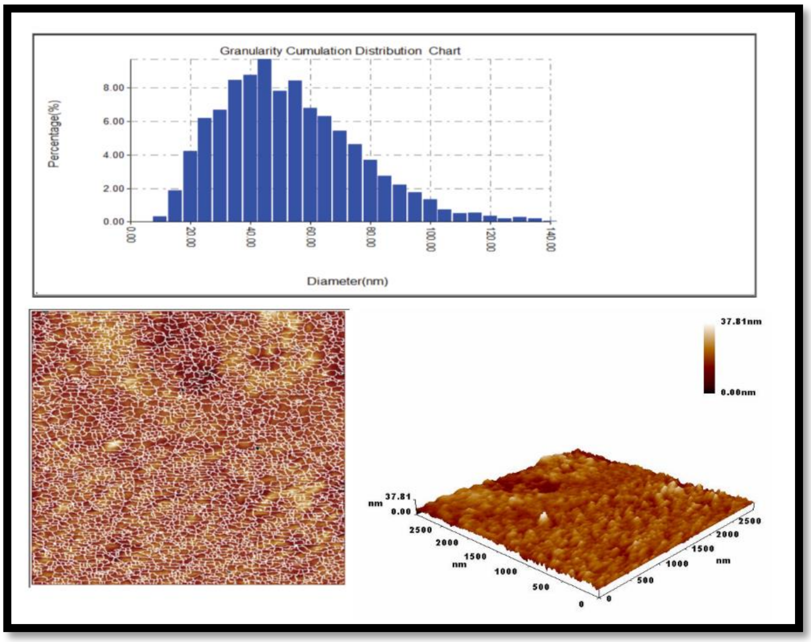

Figure 3. Atomic Force Microscopy (Fe_2O_3) NPs (A: Histogram of (Fe_2O_3) NPs, B: 2D and C: 3D of (Fe_2O_3) nanoparticles

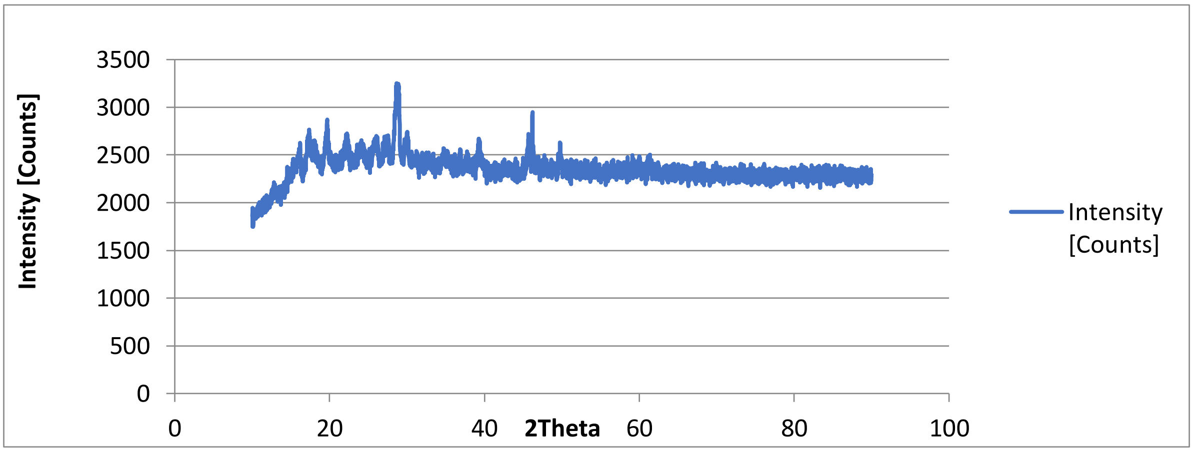

Figure 4. The highest value for Intensity

From the results of the graph in Figure 4, it was found that the peak was at an intensity value of 3221,483, with theta (2theta) = 28.574, and this indicates the effectiveness of the samples included in the study prepared in the research. The curve in Figure 5 shows the crystallite size of the iron oxide particles that the peak was at a size of 30342 and 2theta = 46.1891.

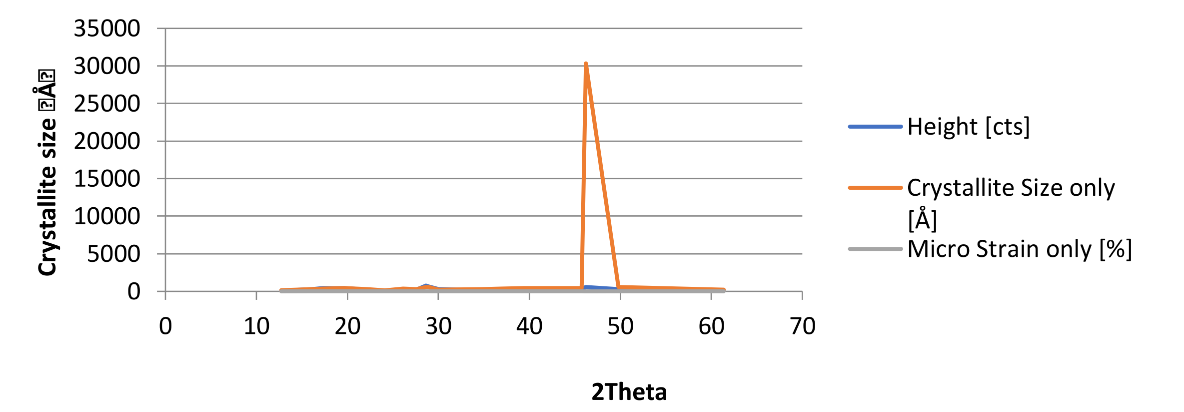

Figure 5. The highest Crystallite value for iron oxide nanoparticles

4. Discussion

The result of the (UV-VIS) Ultra-violate visible light analysis showed the greatest effectiveness for the highest absorption value of 3.376 at wavelengths between 285-400 nm [11]. The inability of nano-iron oxide to significantly absorb long-wave ultraviolet rays and its ability to absorb relatively short-wavelengths is due to the characteristics of its structure and composition, as the nano-iron oxide extract is characterized by the size of its small particles and its large surface area compared to its size, as its surface provides a surface being great for absorbing light and rays.

It also found in the study of lemon peel that its absorption of ultraviolet rays with wavelengths higher than 400 is almost non-existent, so their inability to absorb ultraviolet rays with higher wavelengths can be due to:

1. The composition of the outer peel of the fruit, which may contain materials that act as a barrier to transmit long-wave ultraviolet rays, and these materials are present in a certain proportion to give the peel its special color.
2. The microscopic structure of plant tissues plays a role in not absorbing high wave-lengths. Lemon peels may contain specific cells, such as the cell wall and the iron vessels of chitinous deposits, which lead to visible wavelength interference that does not exceed the limits of high-wavelength ultraviolet rays.
3. Taking into account the ultraviolet rays of high wavelength produce high intensity that may be able to break down and demolish small or nanoparticles such as iron oxide nanoparticles, leading to a loss of structural stability, which in turn leads to a loss of the properties of the extracted nano iron oxide.

In summary, the main reasons why lemon peels, from which nano-iron oxide was extracted, do not absorb high lengths of ultraviolet rays are:

1. Composition of the peel.
2. Microstructure of plant tissues.
3. The effect of high intensity ultraviolet radiation on the stability of nanoparticles.

5. Conclusion

To maintain the health of soil, plants, and the environment in general, the environ-mental and negative impacts of nano-iron oxide must be taken into consideration when used in agricultural and environmental applications. The use of nano-iron oxide should be regulated, and the potential environmental risks of this compound should be assessed.

In conclusion,

1. This work highlights the creative use of nanomaterials generated from lemon peel, namely iron oxide nanoparticles, in tackling environmental and agricultural difficulties.
2. The distinct attributes of these nanoparticles, including their dimensions, light absorption capabilities, and magnetism, show substantial promise in soil remediation, namely in the absorption of pollutants and interaction with soil microbes.
3. These nanoparticles have the potential to improve plant development, while their possible environmental effects need to be taken into account.
4. The use of nano-iron oxide extracted from lemon peels shows great promise for soil remediation and environmentally friendly manufacturing techniques.
5. In addition, exploring the potential of nanoscale iron oxide in conjunction with other organic amendments could further enhance its effectiveness as a soil remediation method.

In today's rapidly changing world, the importance of accurate weather forecasts cannot be overstated. By incorporating innovative approaches such as using nano-iron oxide extracted from lemon peels in soil remediation, we can contribute to sustainable farming practices and address the challenges of soil pollution and nutrient depletion in a more sustainable and environmentally friendly way. These potential benefits in improving soil health make it an attractive option for farmers because it provides a cost-effective solution to soil remediation.

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