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Water Treatment Using Zinc Nanoparticles and Apricot Plant Extracts from Organic and Inorganic Pollution

Suzan Muslim Abdullah[1*] ***Abbas Ali Salih AL-Hamdani[1]***
Labeeb Ahmed Al-Zubaidi[2]

[1] Department of Chemistry, College of Science for Women, University of Baghdad, Baghdad, Iraq.
[2] Environment and Water Directorate, Ministry of Science and Technology.
*Corresponding author: nsuzaneiaz@gmail.com
E-mail addresses: Abbas_alhamadani@yahoo.co.uk, Labeebbio1996@yahoo.com

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Abstract:

The apricot plant was washed, dried, and powdered after harvesting to produce a fine powder that was used in water treatment. created an alcoholic extract from the apricot plant using ethanol, which was then analysed using GC-MS, Fourier transform infrared spectroscopy, and ultraviolet-visible spectroscopy to identify the active components. Zinc nanoparticles were created using an alcoholic extract. FTIR, UV-Vis, SEM, EDX, and TEM are used to characterize zinc nanoparticles. Using a continuous processing procedure, zinc nanoparticles with apricot extract and powder were employed to clean polluted water. Firstly, 2 g of zinc nanoparticles were used with 20 ml of polluted water, and the results were Tetra 44% and Levo 32%; after that, we used 4 g (Tetra 100% and Levo 100%). Secondly, an apricot plant was used to treat water (Tetro 100%, Levo 100%). When apricot powder and zinc nanoparticles were compared in treatment water, apricot-zinc nanoparticles were preferred. Thirdly, we treated the water from some heavy metals (2 g after 25 min; Fe 99.50%, 88.75%, Cr 99.10%, Pb 100%, Sb 95%, Cd 95%, Cu 100%), and added 4 g of nanoFe 98.75%, 96.40%, Cr 83.40%, Pb 100%, Sb 77.50%, Cd 95.80%, and Cu 100%.

Keywords: Antibiotic pollutant, Apricot plant, Inorganic pollutant, Organic pollutant, Pollutant water treatment, Zinc nanoparticle

Introduction:

Pollution is the introduction of substances that cause a negative change to the environment. Pollution may be solid, liquid, or gaseous. Environmental pollution is no longer a local problem, but has become a global problem due to the accumulation of its impact and the delay in implementing solutions[1].Pollutant concentration is affected by the social, cultural, and physical environment[2]. Organic and inorganic pollution are the two types of chemical pollution; organic pollution includes carbon and hydrogen.[3] Because of the high percentage of toxic substances and low element concentrations, inorganic pollution, which includes all elements except C-H, is more dangerous[4]. We discuss this in our research on water pollution. Any chemical or physical change caused by human consumption, whether direct or indirect, is not suitable for use by humanitarians, animals, or vegetarians[5]. We employ treatments such as plant extract assisted biogenesis. Merging plants with chemical materials is one of the most effective and non-toxic methods for preparing nanomaterials because it is a good way and includes many uses for plants[6]. Another definition for "green nano" is a method used to integrate plants with chemicals. It is one of the most effective, fast, ineffective, and environmentally friendly modalities. It is common for usefulness methods to be a very important way that includes multiple plants using the plant in the nut and nanotechnology prevention prepared to benefit the environment. [7-9]. In this work, we will investigate the treatment of heavy metals, antibiotics, and pesticides polluting water using zinc nanoparticles in combination with alcoholic apricot extract processed using customised columns. In order to cleanse water tainted with phenols and aromatic chemicals, silver nanoparticles have already won the use of extracts utilisingspecialised capsules[10]. In other studies, ZnNPs were combined with alcoholic cumin leaf extract to clean water of inorganic pollutants. [11].

Materials and Method:

1. Materials and instrumentation

A Shimadzu-3800 Spectrometer equipped with a FTIR in the range of 4000-400 cm1 was used as a detector, and the following chemical substances were used: ethanol (20%), methanol (65%), zinc sulfate, ascorbic acid, sodium hydroxide, and polyvinyl alcohol. A Shimadzu 160 spectrophotometer was used to find the electronic spectrum data. Compounds were analysed for mass indication using a Shimadzu Mass 100P. This study used scanning electron microscopy (SEM) to manage the analysis and describe the size and surface of the nanoparticles. The best technique for determining the NPs' morphology is TEM. A sample is passed through an intense electron beam during this technique for microscopy, and the outcome of the electrons' interactions with the material is the creation of a picture. A little drop of nanoparticles was applied to a copper grid that had a carbon coating, and it was left to dry under a mercury lamp for five minutes. Finally, readings were taken under stable voltage conditions at magnifications of 5000x, 10000x, 20000x, and 50000x. To validate the presence of the zinc nanoparticles, EDX measurements were performed using a high-resolution chemical composition in a sample.

2. Plant harvest and preparation for grinding and extraction

The apricot plants used in this study came from the Kadhimiya District in Iraq's Baghdad Governorate. It was thoroughly cleaned with deionized water many times to get rid of any impurities, dried at room temperature, and then ground into a very fine powder using a special laboratory grinder for 15 seconds. Alcoholic apricot extract was produced by mixing a solution of 65% methanol, 20% ethanol, and 15% free ionised water, allowing it to sit for a while, and then heating it to 50C. It was condensed simultaneously for eight hours using a laboratory condenser. At 50 °C, the extraction procedure is carried out, and then evaporation and condensation are used to boost enrichment the aim of this paper treatment pollutant water included some inorganic metals (Fe, Pb, Sb, Cd, Cu, Cr) and antibiotic (Tetro, Levo) by using firstly zinc nanoparticle with apricot plant extract, secondly apricot plant powder.

3. Preparation of zinc nanoparticles

The following steps were used to manufacture zinc nanoparticles with apricot extract, using a modified version of Elumalai's method: Placing 10 ml (20%) of apricot extract and 1000 ml of pure water in a round flask, the flask was left to be heated and stirred at different temperatures. After one minute, 17.5 g of zinc sulphate was added gradually while being continuously stirred [12]. The mixture's acidity was then equalised by adding pure sodium hydroxide. The mixture was then put into a glass container and heated to 200°C for two hours. The filtered solution separates from the precipitate to complete the separation, and the precipitate is then collected and dried from the remaining water in A furnace set to 70°C will be used to do the drying; after it has been crashed, 17.5g of zinc sulphate will be gradually added to finish the mixing of the components. The green powder that was produced is kept in a container for characterization. [13]. The aim of study treatment pollutant water included (antibiotic and heavy metals) by using two ways zinc nanoparticles with alcoholic apricot extract and apricot powder by continuous technique.

4. Determining the most important compounds of apricot plant extract

Gas chromatography-mass spectroscopy (GC-Mass) technology, which is pure, quicker, and cheaper than conventional extraction methods, was used to identify the activated compounds in the alcoholic apricot plant extract. GC-MS is a technique for analyzing a qualitative and quantitative group of compounds [14,15]. Substances found in the apricot extract by GC-Mass are shown in Fig. 1 and Table 1.

Table 1. Organic and inorganic compounds detected in the apricot alcoholic extract by GasChromatography

Peak No.	R.T	Area %	Comp. Name	Classification	
1	25.145	6.60	Benzoic acid	Organic acid	Soapycompounds
2	25.817	2.14	Benzoic acid	Organic acid	
3	33.075	0.92	Cyclopentane-1-thione, 2,3,4,4-2-tetramethyl	Thiophen compounds	
4	34.898	1.22	Tetradecane	Aliphatic compounds	
5	39.871	1.53	Durohydroquinone	Glycol	Soapy compounds
6	43.116	4.28	Hexadecane	Aliphatic compounds	
7	50.336	1.89	Furazan 2-(dimethyl amino methylene amino)-4-(1,2,4-trizol-2-yl)	Triazol	
8	50.518	2.62	Hexadecanal, 2-methyl	Aliphatic compounds	
9	51.770	13.37	Oxiraneundecanoic acid, 3-pentyl methyl ester, trans	Alcohol	
10	53.999	3.30	n-hexadecanoic acid	Alcohol	
11	54.759	1.13	Epoxy-1-vinylcyclododecene-1,2	Fatty acid methyl esters	Soapy compounds
12	56.062	16.52	Methyl (furan-2-yl)-6-hydroxy x-2-ynoate	Fatty acid	Soapy compounds
13	57.171	5.23	4-(4-chlorophenyl)-2-diethyl amino-2-cyclo buten-1,2-dione	Epoxy compounds	Soapy compounds
14	57.451	3.41	Oleic Acid	Methyl esters	
15	57.654	2.50	1-cyclohexylnonene	Amino acid methyl esters	Soapy compounds
16	58.731	1.67	(Octadecanoic acid (Z-1)	Fatty acid	
17	59.709	5.16	Iron, tricarbonyl (2,3,4,5-tetrahydroxy-2,4-cyclopentadien-1-one)	Aliphatic compounds	
18	60.332	1.48	1,3-cyclopentadiene, 5-(1-methylpropylidene)	Fatty acid	Soapy compounds
19	60.526	1.26	Octadic-9-enoic acid		
20	61.183	1.49	1,3-cyclopentadiene,5-(1-methylpropyldene)-	Cyclic compounds	Soapy compounds
21	61.606	17.77	Octadic-9-enoic acid	Fatty acid methyl esters	
22	62.326	6.41	Thiosulfunic acid ($H_2S_2O_2$), S-(minoethyl) ester		
23	62.778	1.83	9-Octadecenoic acid, (E)-	Fatty acid methyl esters	Soapy compounds

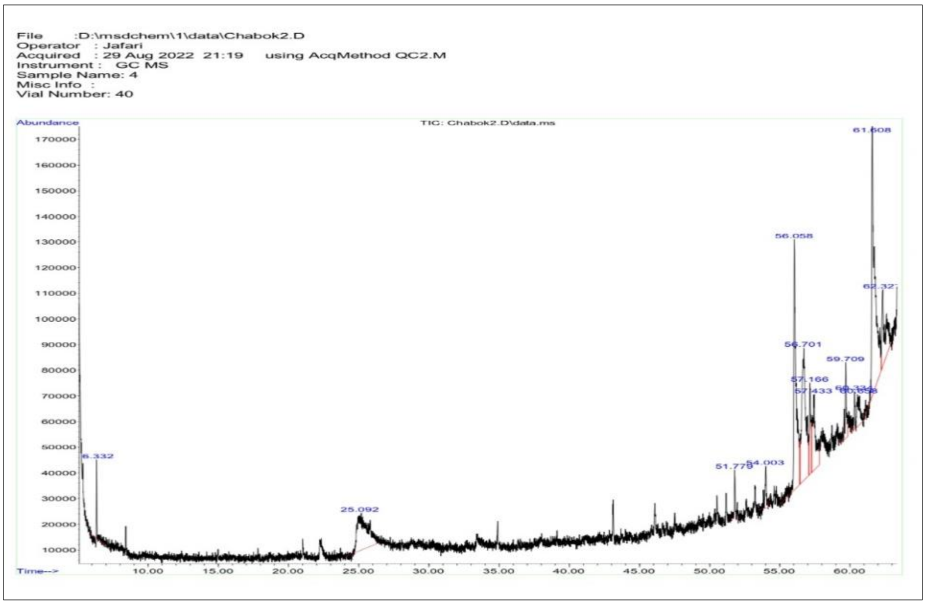

Figure 1. GC-Mass spectroscopy for apricot extract

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Results and Discussion:

This section describes the results of treating water that has been contaminated with antibiotic pollutants and inorganic elements including Cd, Sb, Fe, Cr, and Cu either using apricot plants or with zinc nanoparticles and evaluates the effectiveness of the treatment. The water treatment technique that was used was the result of processing research. Contrasting the standards for standard water adopted by the WHO and treated water.

1. Ultraviolet Visible (UV-Vis)

The main part of identifying active compounds in apricot plants is determining the absorptions caused by the visible spectrum to the colors of the apricot plant, which has been screened as an alcoholic extract and ZnNP with apricot extract. The absorbing peaks in the first one are at 307 and 676 nm, and in ZnNP, at 292 nm. These peaks refer to n → π* and π → π* in the UV, and 676 nm refers to an apricot plant with organic and inorganic compounds. When comparing between two samples, the alcoholic extract peak shifted towards a shorter, longer wavelength 10 nm red shift, and another peak in the visible area refers to ZnNP[17,18], as shown in Fig 2.

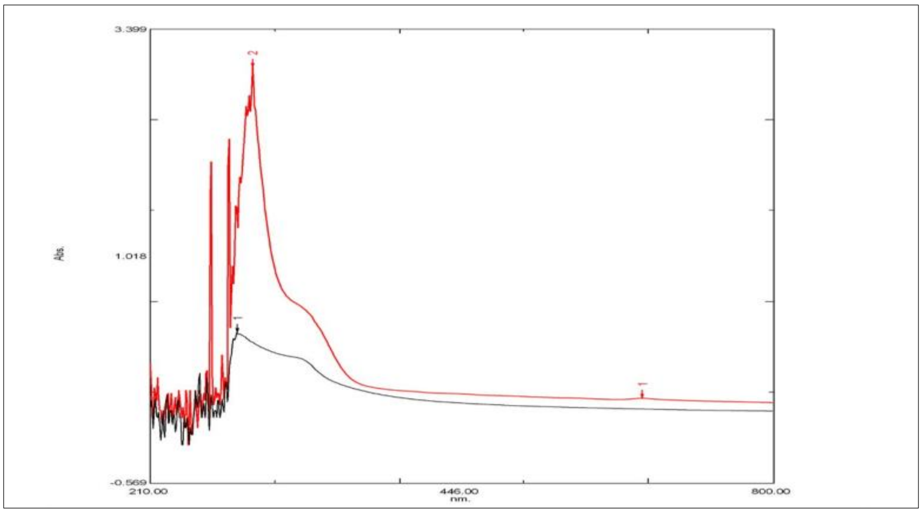

Figure 2. Ultraviolet -Visible for both of apricot extract and zinc nanoparticles with Alcoholic extract

2.Fourier Transform-Infrared (FTIR)

The infrared Fourier transform is a key method. When comparing alcoholic extract with an apricot plant and alcoholic extract with a nanocomposite, the method for defining organic components in alcoholic extract refers to the creation of nanoparticles. It is employed to identify active chemicals and test whether they can be joined with another element to create new complexes. A peak may be seen at 3371 cm^{-1}, and at 3417 cm^{-1} zinc nanoparticles can be seen. The (O-H) group has altered two compounds at around 46cm^{-1} in these peaks, which are then followed by further peaks on 2929 cm^{-1} in the extract and 2926cm^{-1}refer to ZnNPs. These peaks correspond to the (CH) aliphatic group (1612 cm^{-1}), the carbonyl group (1552 cm^{-1}), the (CH) group (1037 cm^{-1} in the apricot alcohol extract), and the (CH) group (1116 cm^{-1} in the nanoparticle)[19,20]asshown in Figs 3, 4.

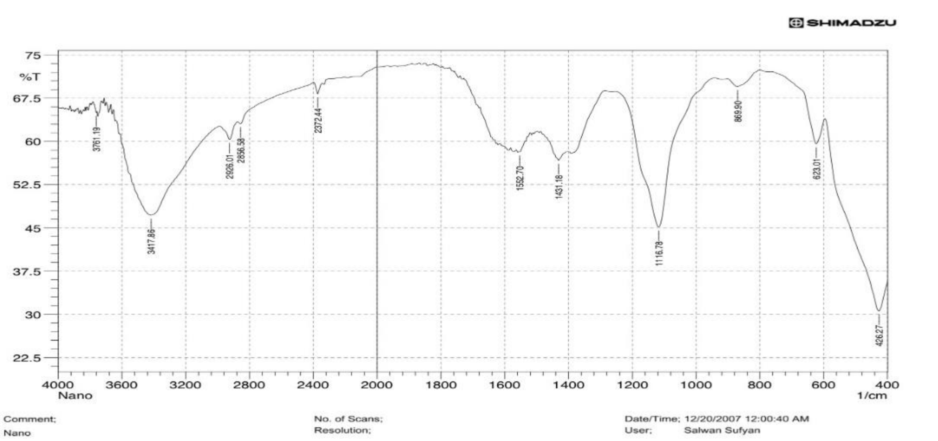

Figure 3. FT-IR Spectrum of zinc nanoparticles with alcoholic apricot

3. Scanning Electron Microscope (SEM)

The scanning electron microscope for zinc nanoparticles reveals a spherical crystal shape in average particles (122.8 nm), indicating that its granule size includes a range of nano, and this result is significant. [21] Other nanoparticles can be found at 55.96, 63.93, 60.66, 85.32, 97.20, 100.1, and 122.8 nm, which correspond to the hydrocarbon group range of nano except for hydrogen due to its small size[22] as shown in Fig. 5.

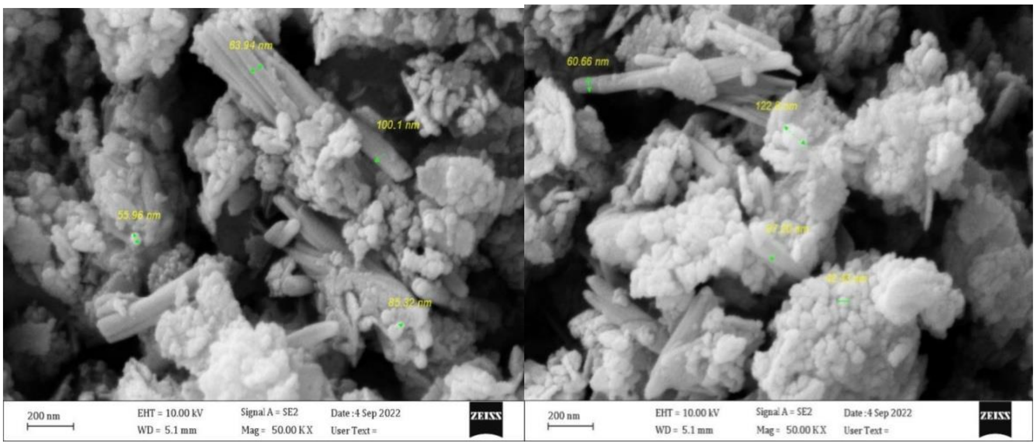

Figure 4. Show SEM for zinc nanoparticles with alcoholic extract of apricot

4. X-Ray diffraction spectroscopy

It is a technique used to identify the arrangement of the crystal atoms, where the X-ray hits the crystal to show certain directions according to the angles and strengths of reflected rays, and where 3D images are formed for the electron density inside the crystal. To measure the diffraction of X-rays, the nano-crystals are inserted on the angle meter and transformed while targeting the X-rays on it, which results in random diffraction called measurements. All directions are taken as images in 2D dimensions in order to be transformed into 3D images representing the electronic density inside the crystal. The X-ray diffraction study used for identifying the crystal molecular weight is the result of X-ray testing, where the three readings between 30 and 40 were due to the presence of zinc elements in more readings due to the size of nano-molecules with zinc elements, while the remaining values show the presence of hydrocarbon compounds except for hydrogen, which does not appear due to its small size[23], as shown in Fig 6.

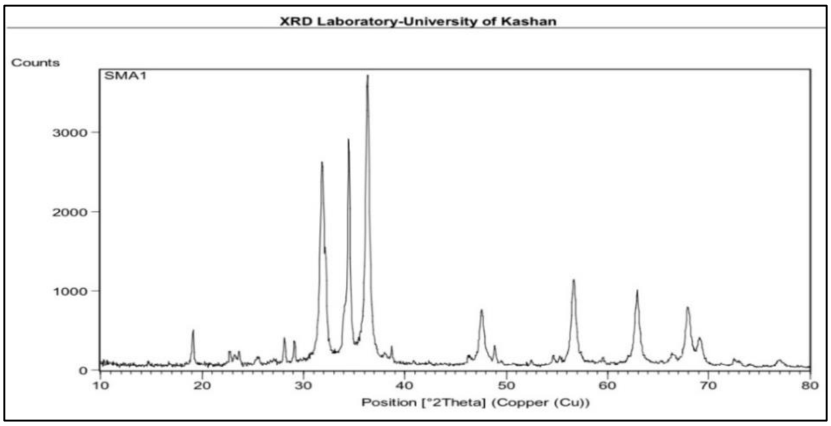

Figure 5. XRD-diffraction of Zinc nanoparticles with alcoholic apricot extract

5. Energy dispersive X-Ray spectroscopy

EDX is a type of X-ray emission used to identify the chemical properties of the samples, which offers information about the location of atomic distribution on the surface and the chemical compounds of the samples; on another note, each element has an atomic structure and determined values in x-ray spectroscopy. When examining a nanoparticle, three peaks (1, 8.6, and 9.8) keV was determined, and they had a crystalline spherical structure[24]. Show Fig7.

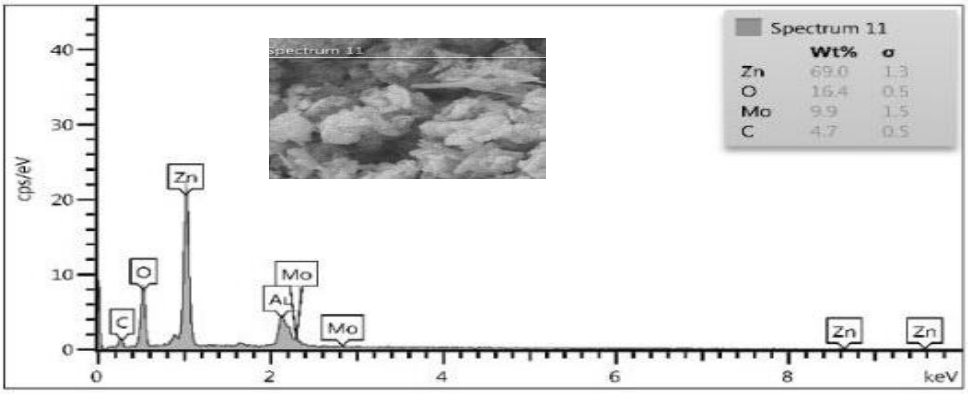

Figure 6. Energy dispersive X. Ray spectroscopy (EDX) of Zinc nanoparticles with alcoholic apricot extract

6. Transmission electron microscopy (TEM)

TEM is the greatest method for figuring out how nanoparticles are shaped. In this sort of microscopy, a sample is run through a powerful electron beam, and the outcome of the electrons' interactions with the material is the creation of an image. After that, the image is magnified and focused onto an imaging medium, such as a charge-coupled device, a fluorescent screen, or a sheet of photographic film[25], smaller magnification. Because of differences in the material's composition or thickness, contrast can be seen in TEM pictures of that substance. When using a sample of zinc nanoparticles with apricot extract, high-resolution transmission electron microscopy (HRTEM) revealed that the sample was smooth and spherical on the outside[26] Shown in Fig. 8.

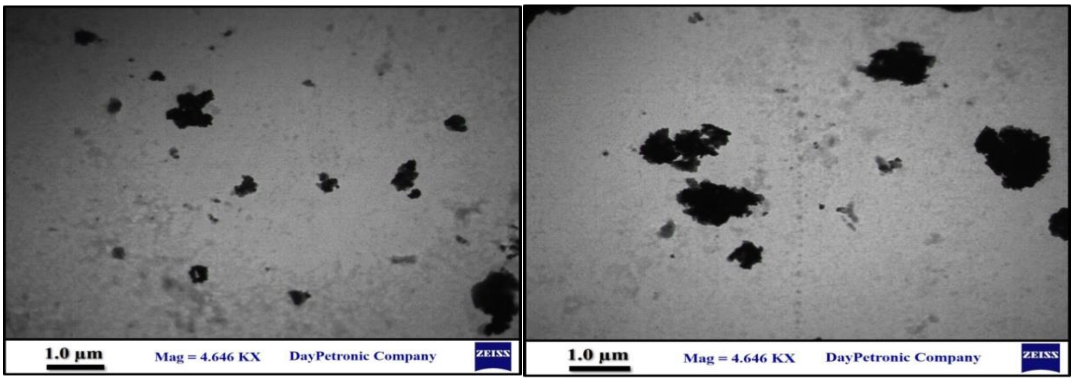

Figure 7. Transmission Electron Microscope of zinc nanoparticles (TEM)

4. Treatment of organic compounds

The polluted water was identified using a specific ratio of Tetra 100%- Levo 100%, and 2g for each sample. After that, a continuous technique of treatment was used. Ten milliliters of polluted water were added, two grams of apricot powder, and the same method with zinc nanoparticles. After that, the shaking and mixing process was completed by placing the ingredients onto a magnetic stirrer. After the end flow rate, a portion of the sample was pulled out, and the treatment percentage was calculated. The following apricot powder percentages are 100%. Comparatively, the components were found. Because found some free active plant groups as in GC -Mass in plants comparison with zinc as there are some copulative which involving nano zinc or a layer of nanoparticles of zinc there for it reduce their activity as in the following result [27, 28.] The results are shown in tables 2, 3, 4, 5, 6and scheme 1,2,3,4 respectively.

Table 2. Treatment percentages by continuous process by use zinc nanoparticles with extract apricot plant with heavy metals

25min	Metal (ppm)				34 min	Metal (ppm)			
	2 gm	Before	After	Percentage		4 gm	Before	After	Percentage
1.	Fe	10	0.05	99.50%	1.	Fe	10	0.125	98.75%
2.	Cr	10	0.09	99.10%	2.	Cr	10	0.36	96.40%
3.	Pb	10	B.D.L	100%	3.	Pb	10	1.66	83.40%
4.	Sb	10	0.5	95%	4.	Sb	10	B.D.L	100%
5.	Cd	10	B.D.L	100%	5.	Cd	10	2.25	77.50%
6.	Cu	10	1.125	88.75%	6.	Cu	10	0.42	95.80%

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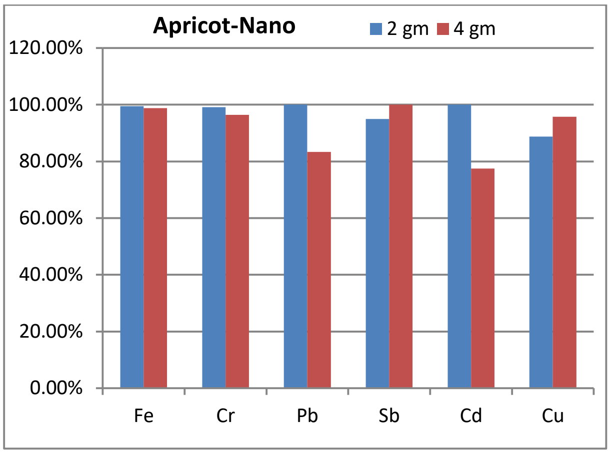
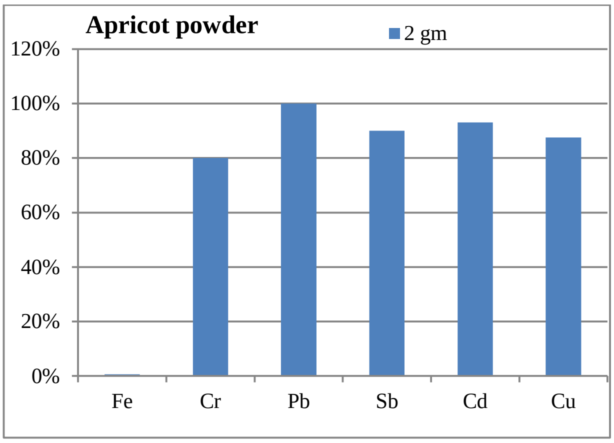


Scheme 1. Treatment of heavy metals by using zinc nanoparticles with apricot extract

Table 3. Treatment percentages by continuous process by using zinc nanoparticle with apricot plant extracts

	Metal (ppm)			
	2 gm	**Before**	**After**	**Percentage**
1.	**Fe**	**10**	**9.94**	**1%**
2.	**Cr**	**10**	**2**	**80%**
3.	**Pb**	**10**	**B.D.L**	**100%**
4.	**Sb**	**10**	**1**	**90%**
5.	**Cd**	**10**	**0.69**	**93%**
6.	**Cu**	**10**	**1.24**	**88%**



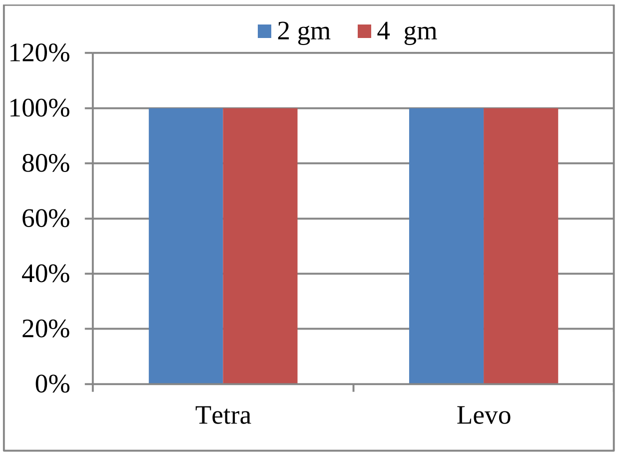
Scheme 2. Treatment heavy metals by using apricot powder

Table 4. Treatment percentages by continuous process by use nano particle

2 gm	Antibiotic (ppm)			
		Before	**After**	**Percentage**
1.	**Tetra**	**5**	**B.D.L**	**100%**
2.	**Levo**	**5**	**B.D.L**	**100%**

Table 5. Treatment percentages by continuous process by using nanoparticle

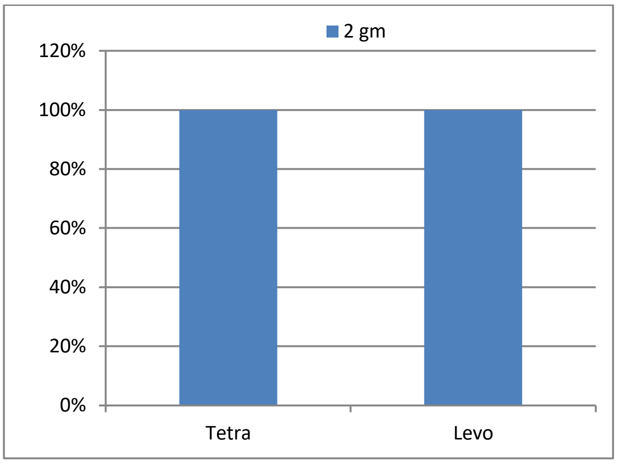
4 gm	Antibiotic (ppm)			
		Before	**After**	**Percentage**
1.	**Tetra**	**5**	**B.D.L**	**100%**
2.	**Levo**	**5**	**B.D.L**	**100%**



Scheme 3. Treatment of Tetra and Levo by using nanoparticle

Table 6. Treatment percentages for antibiotics by continuous process using apricot plant

2 gm	Antibiotics (ppm)			
		Before	**After**	**Percentage**
1.	**Tetra**	**5**	**B.D.L**	**100%**
2.	**Levo**	**5**	**B.D.L**	**100%**



Scheme 4. Treatment Tetra and Levo by using apricot powder

Conclusion:

By utilising zinc nanoparticles, which were in turn manufactured using $ZnSO_4$ as a starting material and whose creation was proven by the following methodology; we were able to successfully treat water in this study using ecologically acceptable techniques: FT-IR SEM, TEM, EDX, and UV-Visible. Then, using a continuous process of flowing polluted water with apricot powder and zinc nanoparticles extracted from an apricot plant, it was discovered that apricot powder with zinc nanoparticles was preferred to apricot powder.

Authors' Declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in University of Baghdad.

Authors' Contributions Statement:

A. presented the idea, analysis, discussion of the results and writing of the manuscript. S. M. A. and A.A.S.A. Contributed to the design and implementation of the research, laboratory work, L.A.A., verified the analytical methods and discussed the results and contributed to the final manuscript.

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معالجة المياه من الملوثات العضويةو اللاعضوية باستخدام دقائق الزنك النانوية مع مستخلص نبات المشمش

سوزان مسلم عبد الله[1] عباس علي صالح الحمداني[1] لبيب احمد الزبيدي[2]

[1] قسم الكيمياء، كلية العلوم للبنات، جامعة بغداد، بغداد، العراق.
[2] دائرة البيئة والمياه، وزارة العلوم والتكنلوجيا.

الخلاصة:
نبات المشمش تم غسلهُ، طحنه بعد حصاده للحصول على مسحوق جيد ليستخدم في معالجة المياه. تم استخدام نبات المشمش مع الايثانول للحصول على المستخلص الكحولي وتم تشخيصهُ بالتقنيات الطيفية كروموتوغرافيا الغاز، تقنية الاشعة تحت الحمراء، تقنية الاشعة فوق البنفسجية – المرئية، الطيفيةلتحديد المركبات الفعالة للمستخلص. مركب الزنك النانوي تم تحضيره باستخدام المستخلص الكحولي وتشخيصهُ بالتقنيات الطيفية (الاشعة تحت الحمراء، الاشعة فوق البنفسجية المرئية، فحص المجهر الالكتروني الماسح، مطيافية تشتت الاشعة السينية، المجهر الالكتروني النافذ)-)لتشخيص المركب الزنك النانوي. تم استخدام طريقة التدفق المستمر، مركب الزنك النانوي مع مستخلص المشمش الكحولي ومسحوق نبات الجت لمعالجة المياه الملوثة. أولا استخدمت 2 غرام من مركب الزنك النانوي مع 20 مل من المياه الملوثة وكانت النتيجة (Tetra 44% ، Levo 32%)، بعد ذلك استخدمت 4 غرام وكانت النتائج (Tetra 100%، Levo 100%). ثانياً، استخدم مسحوق نبات المشمش لمعالجة المياه وكانت النتيجة (Tetra 100%، Levo 100%). عند المقارنة بين مسحوق المشمش ومركب الزنك النانوي مع مستخلص المشمش وجد ان المعالجة باستخدام مركب الزنك النانوي افضل. ثالثاًاستخدم 2 غرام من مسحوق الزنك النانوي واظهرت نتائج المعالجة (Fe 99.50%، Cr 99.10%، Pb 100%، Sb 95%، Cd 95%، Cu 100%) وثم تم استخدام 4 غرام من مسحوق النانو (Fe 98.75%، Cr 83.40%، Pb 100%، Sb 77.50%، Cd 95.80%، Cu 100%).

الكلمات المفتاحية:المضادات الحيوية الملوثة، نبات المشمش،الملوثات اللاعضوية، الملوثات العضوية، معالجة المياه الملوثة، مركب الزنك النانوي.