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The Biological Effect of Synthesized Zinc Oxide Nanoparticles on Organic Pollutions in Drinking Water

H.M. Hussain[1*], M.B. Mahmood[1], L. A. Yaaqoob[2]
[1]*Department of Biology, College of Science, University of Baghdad, Baghdad, Iraq*
[2]*Department of Biotechnology, College of Science, University of Baghdad, Baghdad, Iraq*

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ABSTRACT

This study aimed to demonstrate the biosynthesis procedure of zinc oxide nanoparticles (Zn-O NPs) by using extracellular components from environmental isolates of *Escherichia coli* as reducing and stabilizing agent by adding 1 g of zinc sulfate to 10 ml of bacterial extract to prepare of zinc oxide nanoparticles. These organic pollutants are considered one of the most important causes of poisoning that have great health risks to humans and are also considered one of the most dangerous environmental pollutants as they are toxic and harmful to the environment. The optimum condition for Zn-O biosynthesis was characterized through several devices and techniques such as ultraviolet- visible (UV-Vis) Atomic force microscope (AFM) X-Ray diffractometer (XRD) Fourier Transform Infrared spectroscopy (FT-IR) and field emission scanning electron microscopy (FE-SEM). In particular, a cut-off phenomenon of the biological synthesized Zn-O was found at around 325 nm using UV-Vis, while spherical shape particles were noticed using FE-SEM techniques. Also, the results of the AFM analysis revealed that Zn-O NPs have an average diameter of 37.15 nm. Determining the FTIR spectrum of the biosynthesized Zn-O nanoparticles showed Zn-O at the broad peak at 694.33 cm.

Keywords: Biosynthesis, Nanoparticles, Organic pollutants, Zinc oxide.

التأثيرالبيولوجي لجسيمات اوكسيد الزنك المصنعة على الملوثات العضوية في مياه الشرب

هديل محمد حسين [1] , محمود باسل محمود [1] , ليث احمد يعقوب [2]
[1] قسم علوم الحياة، كليه العلوم، جامعة بغداد، العراق
[2] قسم التقنيات الاحيائية، كليه العلوم، جامعة بغداد، العراق

الخلاصه

هدفت هذه الدراسة إلى توضيح إجراء التخليق الحيوي لجسيمات أكسيد الزنك النانوية باستخدام مكونات خارج الخلية من العزلة البيئية الاشيريشية القولونية كعامل مختزل ومثبت. من إضافة 1 جرام من كبريتات الزنك إلى 10 مل من المستخلص البكتيري في تحضير جزيئات أكسيد الزنك النانوية حيث تعتبر هذه الملوثات العضوية من أهم حالات التسمم التي تسبب مخاطر صحية كبيرة للإنسان كما تعتبر من أخطرها. تم تمييز الحالة المثلى لتخليق جسيمات اوكسيد الزنك الحيوي من خلال العديد من الاجهزة و التقنيات مثل

*Email: hadeel.mohammed1102a@sc.uobaghdad.edu.iq

مقياس الطيف الضوئي بالأشعة المرئية فوق البنفسجية UV/Vis ، مجهر القوة الذرية AFM ، ،حيود الاشعة السينية XRD، مطيافية الأشعة تحت الحمراء FT-IR و المجهر الإلكتروني الماسح FE-SEM ، تم العثور على ظاهرة الانقطاع لجسيمات اوكسيد الزنك المركب البيولوجي عند حوالي 325 نانومتر باستخدام الطيف الضوئي، بينما لوحظت جزيئات الشكل الكروية باستخدام تقنيات الماسح الالكتروني. أيضًا ، أظهرت نتائج دراسة مجهر القوة الذرية أن متوسط قطر جسيمات اوكسيد الزنك هو 37.15 نانومتر. كشفت نتائج مطياف الاشعة تحت الحمراء لجسيمات الزنك النانوية المُصنَّعة حيوياً عن ذروتها الواسعة عند 694.33 سم.

Introduction:

The type of common contamination in water is determined by the characteristics of the normal matter itself if it is biodegradable or not and if it is far too rotted. Characteristic matters inside the water are classified into the taking after materials: The carbonaceous characteristics of carbohydrates. fats are typical materials that are difficult to decompose, proteins are frequently found nitrogenous compounds. Compounds of sulfur and organophosphorus [1]. Other normal materials such as urea has influence of characteristic defilement. Normal defilement has various impacts on the biological system. The following are the most significant negative effects of common matter on water. Nanoparticles affect the exchange and alter broken-down oxygen in water[2]. affecting the physical and chemical characteristics of conduits. Influence on progress and destructive outcomes [3] Influence on the differences in marine lifeforms and influence on marine life. The drinking water fragment perseveres from various issues, which are due to erosion of pipeline frameworks transporting consumable water, in development of bacteriological contamination in treated water organization centers (water capacity tanks and taps) and defilement that happens inside the drinking water is the result of a number of variables[4]. In 2020, 74% of the world's people (5.8 billion people) utilized safely managed drinking water organizations, i.e., water organizations that are open where required and not sullied[5]. At scarcest two billion people inside the world utilize drinking water sources sullied with feces[6]. The debasement of drinking water with life forms as a result of its debasement with feces is the foremost noticeable peril to the safety of drinking water and causes the transmission of contaminations such as the runs, cholera, free bowels, typhoid and polio[7]. Nanoparticles and nano-biomedicine It has the power to create things appear on a nuclear scale, repetitively between (1 – 100) nanometer. Effectiveness and minimization of modern electronic devices is now absolutely crucial. compared to other parameters in which nanomaterials play an awfully vital part. Nanotechnology has become widely used as it is extremely small in size due to its endless applications in nearly all sorts of businesses from materials to pharmaceutical including its action as antibacterial, the foremost critical viewpoint of which is the wide utilization of nanostructures in mechanics, optics, hardware, biotechnology, microbiology, natural remediation, pharmaceutical, different designing and fabric sciences[8]. The environmentally friendly method is the method by which zinc oxide nanoparticles are manufactured in a safe, non-toxic, cheap, and available in large quantities and in a short time. Zinc oxide nanoparticles have received great interest for their applications in magnetic resonance, in the manufacture of solar cells, in environmental treatments, in the medical fields, in photocatalysts, and others. frameworks, such as microscopic organisms, contain macromolecules, most of them are within the nanometer run[9]and[10]. Cellular extraction from these bacterial species is utilized to create nanoparticles of different sizes and biological compositions[11]and [12].

Zinc oxide nanoparticles have attracted special attention because they are among the most easily oxidizable metals when exposed to air and show a range of useful physical properties such as hyperthermia, superconductivity, magnetism, strong interaction and bonding due to the large surface area, biodegradable, biocompatible and low toxicity to human life [13]. Organic nanotechnology includes an extraordinary of intrigued and includes a wide assortment of forms that minimize or expel destructive substances.to protect the environment. Natural generation supplies more focal points than chemical strategies and physical strategies since it is straight forward to prepare, exceptionally cost-effective and versatile for large-scale generation [14]and[15]. Because of their biocompatibility, superparamagnetic properties, and chemical stability, appealing zinc oxide nanoparticles are the preferred choice for natural applications [16].

Materials and Methods:

The microbes displayed within the drinking water, by separating from water and then growing them on media (MacConkey agar, eosin methylene blue, supplement agar) to get pure culture [17]. Bacteria were grown in a liquid medium (nutrient broth) and placed in a shaking incubator at a temperature of 37°C and at a speed of 120 cycles/min for three days (72 hours), after which the filtrate was isolated then separated. This filtrate contained the extracellular enzymes of bacteria, and was used to prepare nanoparticles. The zinc sulfate was added to the bacterial extract in a ratio of 1 gram of the metal salts to 10 ml of the extract and placed in a shaking incubator at room temperature for a full day at a speed of 120 cycles/min. The filtrate, then deionized water was added to the precipitate and placed in a centrifuge for 10 minutes. This process was repeated twice to ensure that the particles were washed from any remaining extract and sulfate. The precipitate was taken and placed in a petri dish and placed in an incubator at 37°C to dry. This way zinc oxide nanomaterials were extracted [18], [21], [22]and [23].

2. *Study of the Structural and Optical Properties:*

Utilizing obvious and bright beams the auxiliary properties of nano-zinc oxide were examined employing a spectrophotometer. It was also inspected by a nuclear constrain magnifying instrument to determine the sizes of the shaped nanoparticles. The X-ray diffraction of the nanoparticles was inspected to guarantee the immaculateness of the shaped nanoparticles which were free of pollutions[24]. infrared spectroscopy was also examined to further confirm the formation of nanoparticles that are free of impurities. It was inspected by a checking electron magnifying lens to identify the external morphology of the nanoparticles and their arrangement [25].

3. Gas Chromatographic-mass Spectrometric (GC):

Gas and mass spectrometry was used to recognize organic compounds present in drinking water. The bioactivity of the zinc oxide particles that was synthesized against organic pollutants was inspected by GC-MASS technique [26].

Results and Discussion:

The microbes that showed up on the dishes were analyzed with the Vitek system, in Fig.1 it was found that the foremost frequent sort of microbes that showed up was *Escherichia coli*. Fig. 2 shows the percentage of bacteria in drinking water.

bioMérieux Customer: Microbiology Chart Report Printed December 26, 2021 10:35:48 PM CST

Patient Name: Patient ID: Location: Physician: Lab ID: 28 Isolate Number: 1

Organism Quantity:

Selected Organism : Escherichia coli

Source: **Collected:**

Comments:	
Identification Information	**Analysis Time:** 4.83 hours — **Status:** Final
Selected Organism	96% Probability **Escherichia coli** **Bionumber:** 0405610554524610
ID Analysis Messages	

Biochemical Details

2	APPA	-	3	ADO	-	4	PyrA	-	5	lARL	-	7	dCEL	-	9	BGAL	+
10	H2S	-	11	BNAG	-	12	AGLTp	-	13	dGLU	+	14	GGT	-	15	OFF	+
17	BGLU	-	18	dMAL	+	19	dMAN	+	20	dMNE	+	21	BXYL	-	22	BAlap	-
23	ProA	-	26	LIP	-	27	PLE	-	29	TyrA	+	31	URE	-	32	dSOR	+
33	SAC	+	34	dTAG	-	35	dTRE	+	36	CIT	-	37	MNT	-	39	5KG	+
40	lLATk	+	41	AGLU	-	42	SUCT	+	43	NAGA	-	44	AGAL	+	45	PHOS	-
46	GlyA	-	47	ODC	-	48	LDC	+	53	lHISa	-	56	CMT	+	57	BGUR	+
58	O129R	+	59	GGAA	-	61	lMLTa	-	62	ELLM	-	64	lLATa	-			

Page 1 of 1

Figure 1: Vitek-2-system for *Escherichia coli*

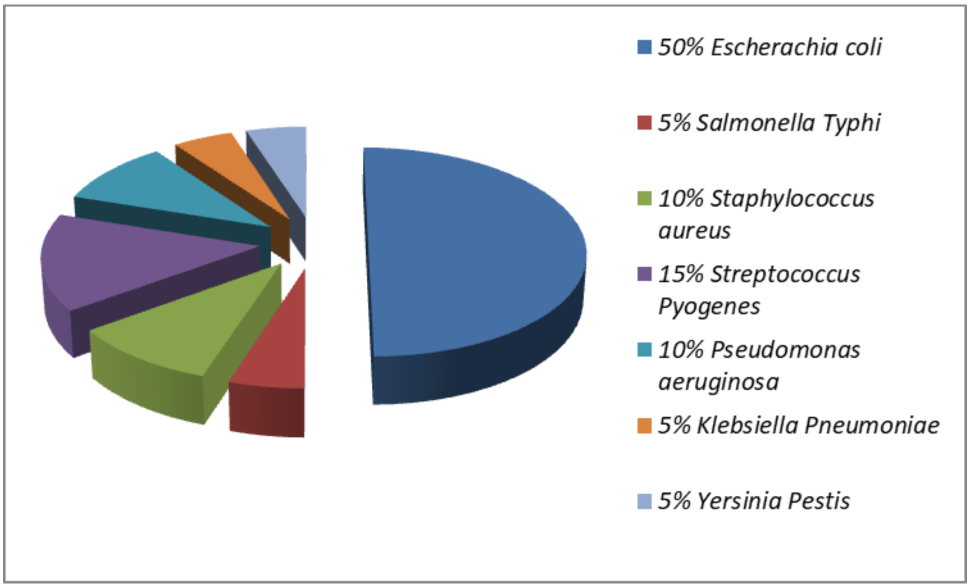


Figure 2: Percentage of bacteria appearance in drinking water

4. *UV-Vis Spectrophotometer:*

The optical properties of the nanoparticles were studied using a UV-visible spectrometer (200 to 800) nm. Figure 3 shows the absorbance of zinc oxide nanoparticles. Fig. 4 shows the absorbance of bacterial extract of *E. coli* with the absorption peak being 325 nm. This result agrees with Al Awadh *et al*. [3] in terms of UV results. The acquired UV-Vi peak indicates direct electron recombination between the valence and conduction bands.

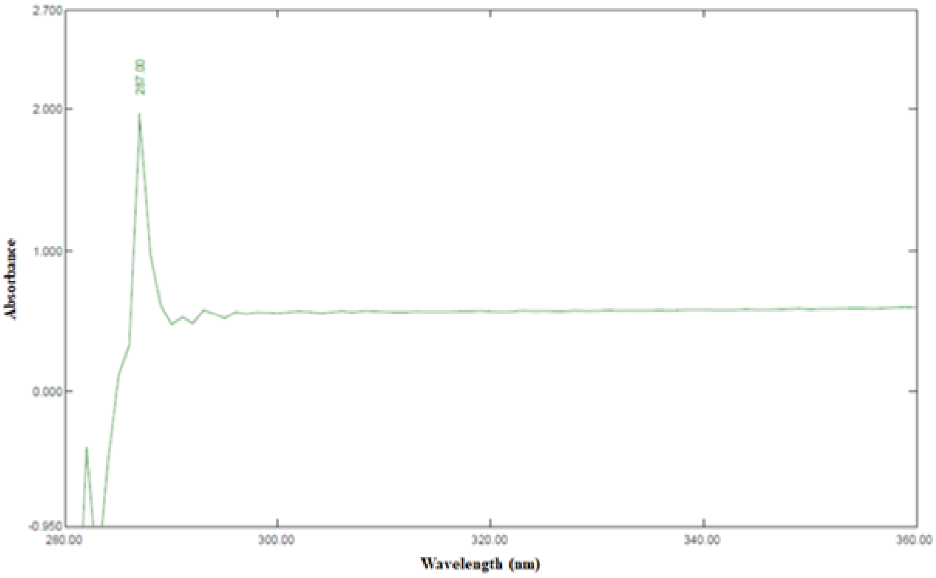


Figure 3: UV-Vi spectrum of the biosynthesized Zn-O.

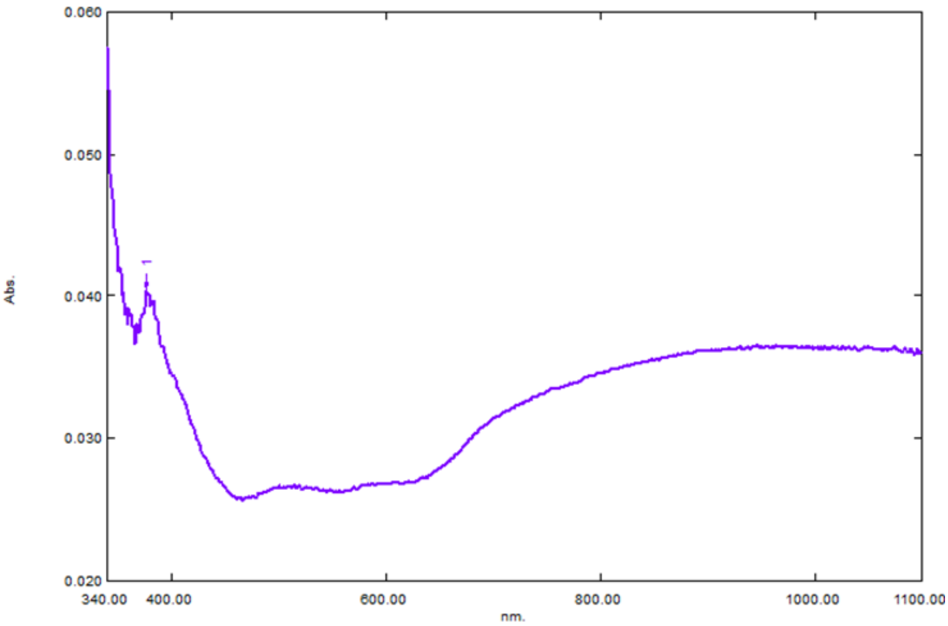
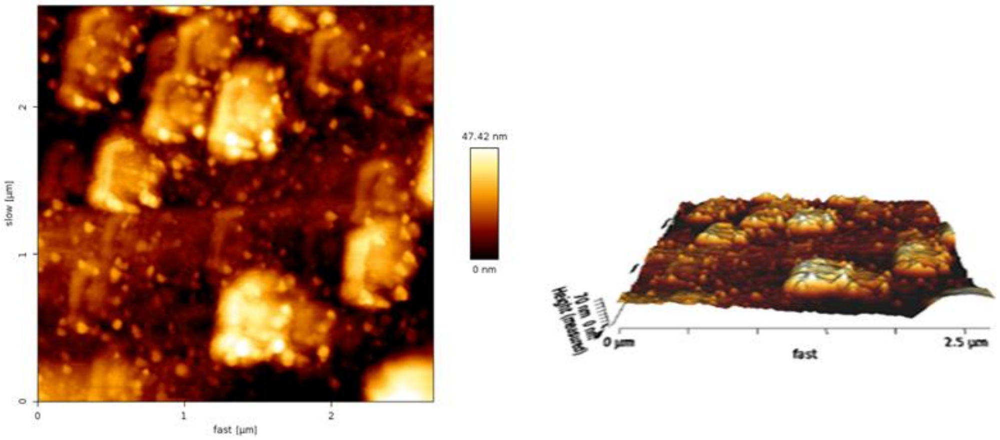


Figure 4: UV-Vi spectrum of the bacterial extract of *E. coli.*

Atomic Force Microscopy (AFM) Analysis:

The AFM was presented to explore the Zn-O nanoparticles' surface highlights employing a 2D and 3D imaging approach Fig. 5. Particularly, the AFM results uncovered that the Zn-O nanoparticles display a circular shape with a normal distance across measuring of 37.15 nm. The result was identical to Al Awadh *et al*. [3] in the value of an average diameter of 45.02 nm.



2D 3D

Figure 5: Atomic force microscopy of the bio-synthesized Zn-O.

6. X-ray Diffraction (XRD) Examination:

The XRD patterns obtained from the bio-synthesized Zn-O nanoparticles are elucidated in Figure 6 showing the XRD spectrum of the synthesized zinc oxide nanoparticles. The result revealed the presence of diffraction peaks which were 202, 004, 201, 112, 200, 103, 110, 102, 101, 002 and 100 at the values of θ = 2, which correspond to the characteristics of the diffraction pattern of Fe3O4 nanoparticles according to the data of the JCPDS standard. The deviation angles were 76.64°, 71.70°, 68.87°, 67.84°, 66.11°, 62.69°, 56.45°, 47.35°, 36.11°, 34.22°and 31.60° degrees. The result was identical to Al Awadh *et al*. [3] where their results uncovered the existence of eight-strong diverse diffraction crests compared to the Zn-O NPs observed at 2θ (θ=diffraction point) values of (30-40).

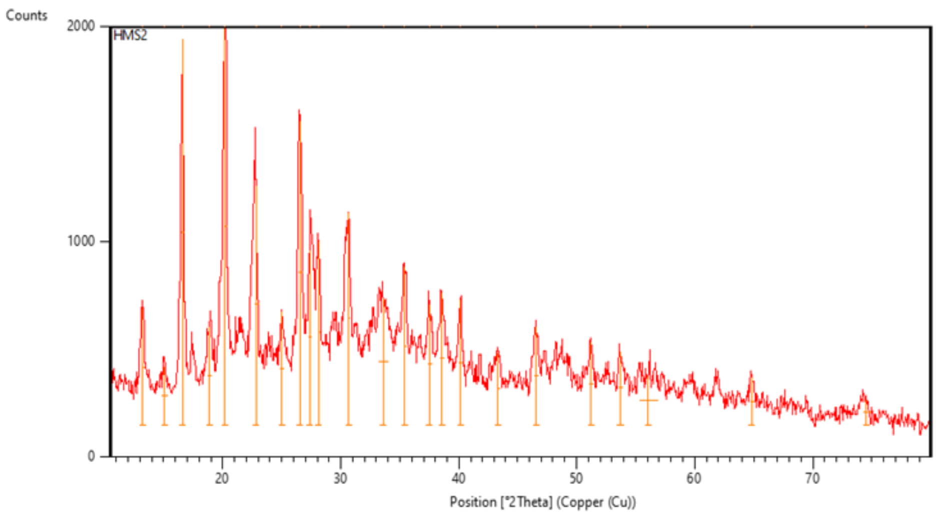


Figure 6: XRD patterns of the bio-synthesized Zn-O nanoparticles

Fourier Transforms Infrared (FTIR) Spectroscopy Analysis:

The FT-IR results for the bio-synthesized Zn-O nanoparticles are demonstrated in Fig. 7. The biosynthetic Zn-O nanoparticles appeared in the wide peak at 694.33 /cm^{-1}. The result agrees with Yaqoob [15].

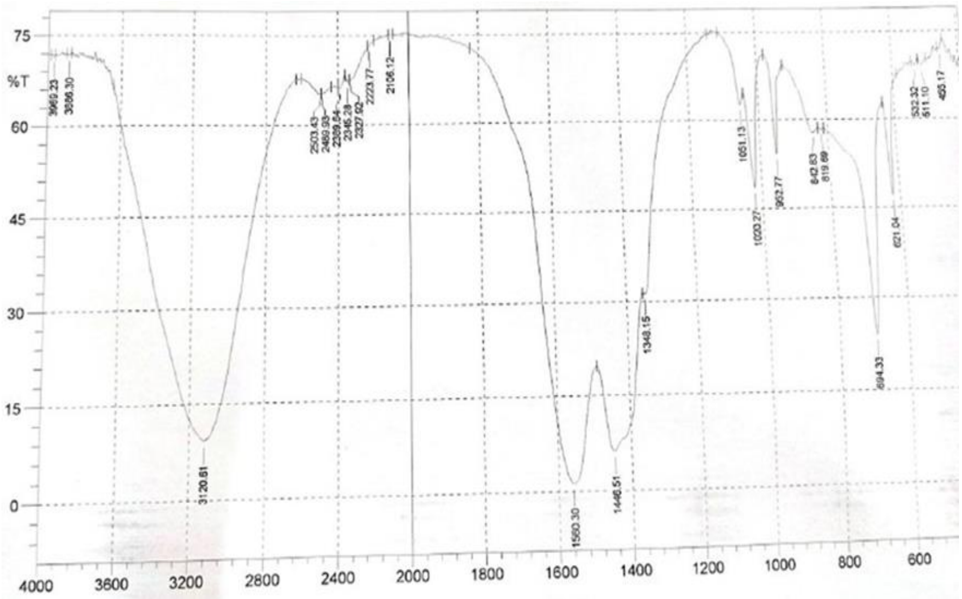


Figure 7: FTIR spectrum of the biosynthesized Zn-O.

Field Emission Scanning Electron Microscopy (FE-SEM) Analysis:
The morphological properties of the bio-synthesized Zn-O NPs were inspected utilizing the FE-SEM technique. As outlined in Figure 8, the arranged Zn-O NPs test displayed circular particles as well as plate-like structures. It is worth specifying that the normal nanoparticles breadth was found to be around 44 nm utilizing ImageJ computer program. The result was identical to Al Awadh *et al*. [3] concerning the of shape Zn-O spherical particles as well as their plate-like structures.

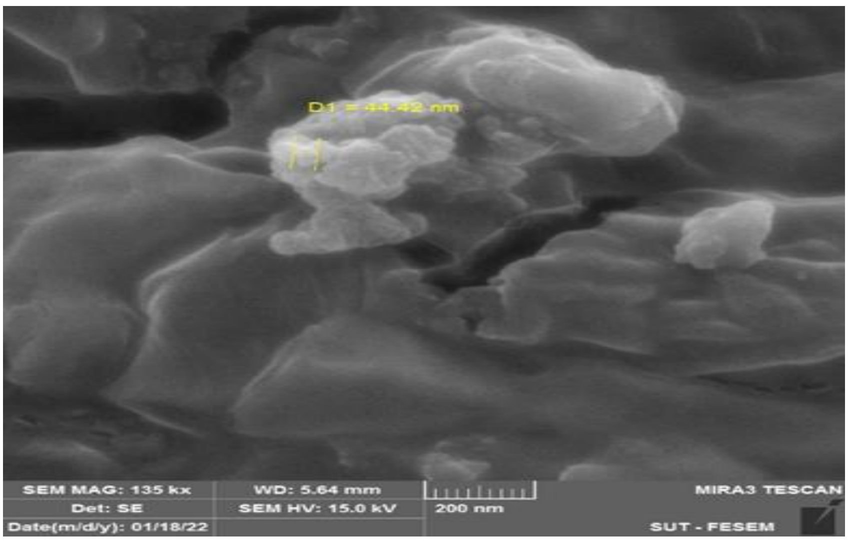


Figure 8: FE-SEM image of the bio-synthesized Zn-O nanoparticles

8. Gas Chromatographic-mass Spectrometric (GC):

Zinc oxide NPs was used was used against organic pollutants caused by *Escherichia coli* which was isolated from drinking water. The natural poisons were inspected utilizing the GC-Mass system. Figure 9 and Table 1 show drinking water before treatment with nanoparticles. As the first table shows the organic compounds that appeared in the drinking water before treatment, and Figure 10 and Table 2 show water tests after treatment with zinc oxide nanoparticles. While table.2 shows organic compounds in drinking water after treatment where the most noteworthy rate of natural toxin decrease was achieved. By using the GC-Mass system, the organic compounds present in the drinking water were identified. Tables 1 and 2 show the organic compounds that appeared in the drinking water, as well as the chemical formula of each compound, the molecular weight and the chemical composition.

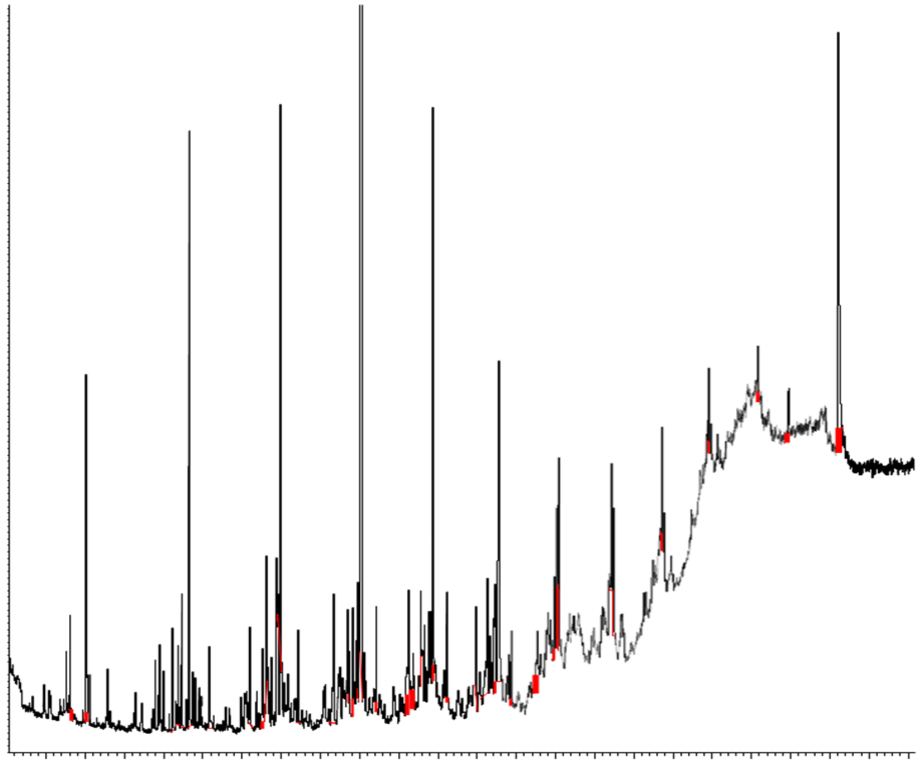
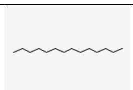
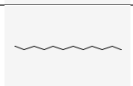
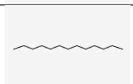
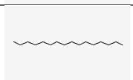
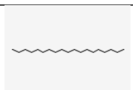
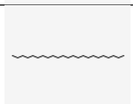
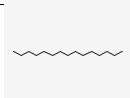


Figure 9: Drinking water samples before treatment with Zn-O nanoparticles

Table 1: Drinking water samples before treatment

	Chemical name	Molecular formula	Molecular weight	The chemical composition
1	Tetradecane	CH3(CH2)12CH 3	198.39 g/mol	
2	Dodecane	CH3(CH2)10CH 3	170.33 g/mol	
3	Tridecane	CH3(CH2)11CH 3	184.36 g/mol	
4	Hexadecane	CH3(CH2)14CH 3	226.44 g/mol	
5	Nonadecane	CH3(CH2)17CH 3	268.518 g/mol	
6	Tricosane	C23H48	324.6g/mol	
7	Pentadecane	C15H32	212.421 g/mol	

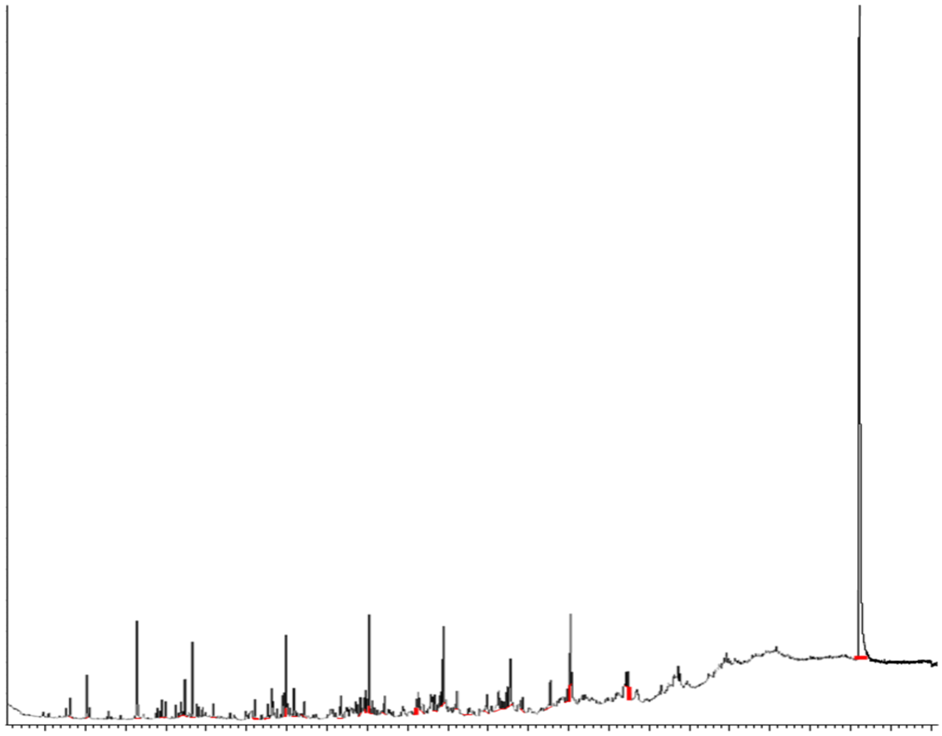
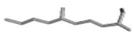
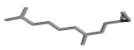


Figure 10: Drinking water samples after treatment with Zn-O nanoparticle**s**

Table 2: Drinking water samples after treatment with zinc nanoparticles

	Chemical name	Molecular formula	Molecular weight	The chemical composition
1	Nonane,3-methyl	C10H22	142.2817 g/mol	
2	Decane,3,8-dimethyl	C12H26	170.3348 g/mol	
3	Undecan,3,7-dimethyl	C13H28	184.3614 g/mol	
4	Dodecan,2,7,10-trimethyl	C15H32	212.4146 g/mol	
5	Tridecan,5-methyl	C14H30	198.3880 g/mol	
6	Dodecan,2,6,11-trimethyl	C15H32	212.4146 g/mol	
7	Octadecane,2-methyl	C19H40	268.5209 g/mol	

CONCLUSION:

In this study, the biosynthesis of Zn-O nanoparticles using extracellular enzyme of *Escherichia coli* as a reducing agent was demonstrated successfully. Additionally, the attained Zn-O NPs were characterized using UV-Vis, AFM, XRD, FT-IR and FE-SEM techniques. In particular, the XRD patterns showed the successful Zn-O NPs phase formation, while the FE-

SEM demonstrated that the prepared Zn-O NPs exhibited spherical particles as well as plate-like structures with an average diameter size ranging around44 nm. While the AFM revealed an average diameter of 37.15 nm. In the anti-organic pollutant activity test, it was found that the bio-synthesis has a strong effect activity against the organic pollutants in drinking water.

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