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GC-MS assay of hexane and ethanol extracts of spirulina algae and detecting their antibacterial activity against uropathogenic *S.aureus* and *E.coli*

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Abstract. ***Background.*** *This study aims to assess the antimicrobial activity of spirulina hexane and ethanol extracts. The task is to discover standardized analytical methods for isolating original bioactive compounds from algae for fighting harmful bacteria such as E.coli and Staphylococcus aureus that cause urinary tract infections.* ***Materials and methods.*** *The study included the collection and preparation of spirulina algae from Nasiriyah, Iraq. The algae were cleaned, dried, and minced into powder. Twenty grams of the dried powder were mixed with 200 ml of ethanol and hexane solvents and subjected to ultrasonic extraction. The extracts were filtered and stored in sterile conditions. Antimicrobial activity was evaluated using varying concentrations (25, 50, 75, and 100 mg/ml) against bacterial strains Staphylococcus aureus and E.coli by the Kirby-Bauer disk diffusion method.* ***Results.*** *The ethanol extract showed the highest inhibitory effect against E.coli, with a zone of inhibition measuring 20.00 ± 2.00 mm at 100 mg/ml. It also showed inhibitory effect against S.aureus, with a zone of inhibition measuring 15.60 ± 1.51 mm at 100 mg/ml. The hexane extract showed significant activity against E.coli, with an inhibition zone of 17.60 ± 1.15 mm at 100 mg/ml, and exhibited inhibitory effect against S.aureus, with a zone of inhibition measuring 14.80 ± 1.30 mm at 100 mg/ml. Then the activity decreased for both extracts with a reduction in concentration. Comparative analysis demonstrated that both extracts outperformed several tested antibiotics in terms of efficiency against the respective bacterial strains.* ***Conclusions.*** *The findings indicate that algae extracts have significant antimicrobial properties, making them potential alternatives to conservative antibiotics in treating urinary tract infections. The study highlights the importance of these extracts in emerging specific preparations from algae for antimicrobial applications, contributing to the field of alternative medicine.*

Keywords: *spirulina algae; hexane; ethanol; E.coli; S.aureus; DMSO; GC-MC*

Introduction

In recent years, there has been a growing tendency in using algae extracts to treat various illnesses. This is predominantly due to the rise in resistance of pathogenic bacteria, which pose a significant health anxiety for individuals in both developed and developing countries [1]. The presence of this resistance presents a significant danger to the comfort of individuals, irrespective of their residence in either industrial or developing nations. To counter these disorders, a variety of antibacterial agents are employed. However, the consistent and unselective long-term use of these medications has led to damaging adverse effects for individuals [2]. In addition, presently available synthetic medicines do not inhibit the action of certain pathogens. The use of synthetic chemicals for the control of pathogenic microorganisms, and the treatment is imperfect because of their potential oncogenic effect, acute toxicity and potential hazard to the environment. In this respect, use of extract for the control and suppression of resistant pathogenic microorganisms can be of great advantage in the fight against many diseases [3]. Algae-derived chemicals possess characteristic pharmacological characteristics, including cost-effectiveness, reduced toxicity, reduced side effects, and a lower probability of resistance development [4].

Algae primarily need three major components for growth counting sunlight, water, and carbon source [5]. They obtain nutrients from the aquatic habitats, absorb sunlight, capture CO_2 from the air, and produce about 50 % of the at-

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mospheric oxygen, algae own an efficient biological system capable of utilizing sunlight for the production of organic compounds [6].

The algae are commercially used as human nutrition, animal and aquatic feed, in cosmetics products, pigments, bio-fertilizer for removing high-value molecules, stable isotope bio-chemicals, and for the synthesis of antimicrobial drugs [7]. Algae species are capable of producing different kinds of antioxidant, enzyme polymer, peptide carotenoid, lipid, natural dye, polyunsaturated fatty acid, toxin and sterols [8]. Some of the high-value bioactive compounds produced by algae are acetylic acids, β-carotene agars, agarose, keto-carotenoid astaxanthin, alginates, polyunsaturated fatty acids carrageenan's, vitamin B, and lutein that can using in synthesis of antimicrobial, antiviral, antibacterial and anticancer drugs [6]. The chemical composition of algae includes lipid at 20–30 %, protein around (50 %), carbohydrate (20–30 %) and other compounds account for approximately (5 %), the market value depends on the concentration and amount of the vital amino acids, polysaccharides, polyunsaturated fatty acid and amount of essential vitamins, also, the value depends upon the application, or what is the purpose of the using of algae and compared to similar other sources of this product [9]. A number of dry algal products are used for feed and food, pharmaceuticals and aquaculture [10].

Spirulina is one of the greatest well-known microalgae genera. *Spirulina* spp. is a filamentous cyanobacterium, multicellular. *Sprulina* spp. is live in fresh water and have bioactive compounds similar protein, vitamins, pigments, long chain polyunsaturated fatty acids, sterols and other compounds that make these microalgae very stimulating from the health benefits point of view [11]. The name Spirulina was based on its spiral shaped. However, linear shaped arthrospira microalgae have been identified, spirulina is commonly called blue green algae cyanobacteria [12]. Spirulina is well known in credited to their rich medical and nutritional values as antioxidant, antimicrobial and anticancer compounds. Further, it contains many nutrients and vitamins like vitamin C, iron, calcium, potassium, etc., and several carotenoids such as carotenes, xanthophylls, and chlorophyll A. It is used in burn infection, anti-oxidant, and anti-microbial drugs [13, 14]. The United Nations says about spirulina algae (the world's savior from hunger) because it contains important nutrients for malnutrition and complements the lack of vitamins and proteins in the body. *Spirulina* spp. has drawn more care because it shows a high nutritional content characterized by a 70% protein content and by the presence of minerals, vitamins, amino acids, essential fatty acids etc. [15]. Many studies of algal extract have been established its significant anti-inflammatory, antioxidant, and antimicrobial activity [16].

Spirulina is identified to produce a wide range of secondary metabolites with various biological actions and produce intracellular and extracellular metabolites with diverse biological activities such as antifungal, antiviral, and antibacterial activities due to the increase in drug-resistant bacteria, there is a requirement for standardized contemporary analytical methods to separate novel bioactive chemicals from algae. Compounds obtained from algae have the possible to offer a new and groundbreaking method for fighting harmful microorganisms. This study investigates the antibacterial properties of algae-derived compounds, including their potential styles of action and chemical properties.

Materials and methods

Study design

1. Preparation of hexane and ethanol extracts.
2. Identification of bioactive compounds by GC-MS.
3. Preparation of stock solution by adding 10 ml from DMSO solvent to 1 g from extract.
4. Preparation of all extract concentrations.
5. Isolation of pathogenic bacteria from UTI patients.
6. Bacterial test to antibiotics susceptibility.
7. Evaluation of antibacterial activity of algal extract.

Collection and classification of study stations

The algal specimens used in this study were obtained from Nasiriyah, located in the Thi-Qar Province in southern Iraq, province for the period from October to February, 2023–2024. Specifically, spirulina algae were collected. Dr. Roaa Jafar Khudhayer, a professor at the University of Thi-Qar, College of Science, identified the algae. The impurities were completely removed from them, and they were transformed into a fine powder using an electric mill. After that, they were kept in sterile glass bottles until they were ready to be used [17].

Preparation of algal extract, hexane and ethanol extract

The chemical components were qualitatively screened by subjecting a mixture of 20 grams of algal powder and 200 milliliters of hexane for hexane extract, as well as 200 milliliters of ethanol for ethanol extract, to an ultrasonic bath. The resulting solution was filtered using multiple layers of Whatman (0.22) filter paper and then concentrated at 50 °C under reduced pressure using a rotary evaporator. Afterwards, it was subjected to a drying procedure at a temperature of 25 °C. The extract was ultimately gathered in sterilized glass tubes that are now prepared for utilization [18]. Preparation concentration to obtain different concentrations, we dilute the stock solution (100 %) with DMSO dissolving solution as in Table 1.

Table 1. Preparation concentration in this study

Concentration	Extract (ml)	Solvent DMSO (ml)
75	750	250
50	500	500
25	250	750

GC-MS analysis of extracts

Gas chromatography-mass spectrometry (GC-MS) conditions the GC-MS examination was performed using the GCMS-QP2010 plus instrument (Shimadzu, Kyoto, Japan), equipped with an auto injector and a 5 ms capillary column of 30 × 0.25 mm with a film thickness of 0.25 μm. The carrier gas used is helium, with a flow rate of

1.15 ml/min. The 70 eV ionized charge system was used to do mass spectroscopic scanning. The temperature was initially set at 80 °C for 2 minutes and then increased progressively at a pace of 10 °C per minute until it reached 280 °C for 5 minutes. The samples that were injected were exposed to excruciating mode at a temperature of 250 °C. Two files contain mass spectral data. The National Institute of Standards and Technology (NIST14) and Wiley 10th/NIST 2014 mass spectral library (W10N14) was utilized to characterize the isolated components grounded on them.

Therapeutic effect of the extract

To accurately evaluate the therapeutic effects of algae extracts, it is necessary to distinguish between the biologically active compounds derived from the algae and any potential effects of the alcohol used in the extraction process by the following steps:

1. After the extraction process, the alcohol is evaporated from the extract by drying it. It is spread in special open containers and exposed to air at a suitable temperature. It is ensured that all the alcohol used has evaporated, leaving only the extract and collecting in special tubes.

2. Minimum inhibitory concentration (MIC) tests. Performed MIC tests using both the algal extract and the alcohol control to compare their effects on bacterial growth. A significant difference in MIC values would suggest that the algal extract contains active antibacterial compounds independent of the alcohol.

3. Performed investigated the mechanism of action of the algal extract on bacterial cells (e.g., disruption of cell membranes, inhibition of cell wall synthesis) to confirm that the observed effects are due to algal components rather than the solvent.

4. Utilize techniques such as GC-MS to analyze the composition of the algal extract. This analysis can identify bioactive compounds and their concentrations, allowing correlation with antibacterial activity.

5. Control experiment. Solvent control. Used the same concentration of alcohol as in the extraction but without the algal material. This control helps determine if the alcohol alone exhibits antibacterial properties.

After these steps, it was confirmed that the antibacterial effect was caused by the algae extract and not the alcoholic solvent.

Culturing of samples and antibiotic susceptibility

Bacterial cultures of *E.coli* and *S.aureus* were maintained at 4 °C in Brain Heart Infusion agar (BHIA) with glycerol and subculture on blood and MacConkey and then on Mueller Hinton agar were used disc diffusion methods to determine the sensitivity of isolates to antibiotics [19].

Antimicrobial activity of algal extracts against bacteria

The researchers working the Kirby-Bauer disk diffusion susceptibility test to measure the sensitivity and resistance of algal extracts to bacteria healthier from UTI patients [20]. To achieve this, they consistently distributed 100 µL of the bacterial inoculum obtained from an 18–24 hour broth culture onto the surface of Mueller Hinton agar media plates. Subsequently, the researchers placed antibiotic discs on the inoculated plates, followed by the algal extract at concentrations of 25, 50, 75, and 100 mg/ml. Also, several antibiotics were examined in this investigation. The plates were placed in an incubator at a temperature of 37 °C for a period of 18–24 hours, following a chilling period of 2 hours at 4 °C. The inhibitory zones on each plate were then unhurried in terms of their diameter.

Analytical profile index

To identify the isolated bacteria, a fully automated system called VITEK, which performs bacterial identification and antibiotic susceptibility testing, was used.

Statistical analysis

The data was analyzed by using SPSS (Statistical Package of Socio Science) by using one-way ANOVA for variation and LSD at p-value < 0.05 [21].

Results

GC-MS

The GC-MS analysis of hexane and ethanol extracts showed the presence of bioactive chemicals. GC-MS analysis of chemical compounds in hexane extract of spirulina algae, shows 15 compounds. The hexadecenoic acid, methyl ester ($C_{18}H_{36}O_2$) compound is the most abundant with 81.92 % of the total area, while the cyclohexanespiro-5-(2,4,4-trimethyl-2-oxazoline) compound is the least area with 0.01 % (Table 2). Whereas the GC-MS analysis of chemical compounds in the ethanolic extract of spirulina algae, showed 10 compounds. The 9-octadecenoic acid, (Z)-,2,3-dihydroxypropyl ester ($C_{21}H_{40}O_4$) compound is the most abundant with 68.48 % of the total area, while the propanoic acid, anhydride compound is the least area with 0.05 % (Table 3).

Antibiotic susceptibility test

The results were read by observing the inhibiting zones formed by the disk and explained that the bacteria, sensitive, media, or resistant according to standard specifications. the result for *E.coli* shows in Table 4, Fig. 1, *S.aureus* in Table 5, Fig. 2.

Activity of spirulina ethanol extract with different concentrations against E.coli and S.aureus

The present study was investigated a significant difference at p-value < 0.05, in the activity of spirulina ethanol extract according to extract concentration, was showed the high activity of spirulina ethanol against both *E.coli* and *S.aureus* in 100% concentrations, then the activity decreased with decrease concentration. In the other hand, the study showed a non-significant difference between *E.coli* and *S.aureus* in 25% concentration, while the other concentration the activity increased against *E.coli* compared with *S.aureus*, furthermore the study noted a non-significant difference between concentration of 75 and 50 % against both *E.coli* and *S.aureus* and as in Table 6.

Table 2. Chemical compounds in the hexane extract of spirulina

Seq	R. time	Area, %	Common name	Formula
1	2.038	0.05	Decane, 2,2,3-trimethyl-	$C_{13}H_{28}$
2	4.279	0.04	Dimethylsulfoxonium formylmethylide	$C_4H_8O_2S$
3	9.188	0.02	5H-tetrazole-5-thione, 1-[2-(dimethylamino)ethyl]-1,2-dihydro-	$C_5H_{11}N_5S$
4	14.928	0.54	Octadecane, 1-chloro-	$C_{18}H_{37}Cl$
5	15.821	0.07	2(4H)-benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-	$C_{11}H_{16}O_2$
6	16.247	0.35	Hexadecane	$C_{16}H_{34}$
7	17.582	0.04	Tetracosane, 2,6,10,15,19,23-hexamethyl-	$C_{30}H_{62}$
8	20.790	81.92	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$
9	20.873	0.44	n-hexadecanoic acid	$C_{16}H_{32}O_2$
10	22.108	0.96	Phytol	$C_{20}H_{40}O$
11	22.500	0.22	Methyl 4,7,10,13,16-docosapentaenoate	$C_{23}H_{36}O_2$
12	22.625	0.39	2(1H)-benzocyclooctenone, decahydro-10a-methyl-, trans-	$C_{13}H_{22}O$
13	22.625	14.62	9,12-octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$
14	22.850	0.33	trans-2-undecen-1-ol	$C_{11}H_{22}O$
15	22.975	0.01	Cyclohexanespiro-5'-(2',4',4'-trimethyl-2'-oxazoline)	$C_{11}H_{19}NO$
Total		100		

Table 3. Chemical compounds in the ethanol extract of spirulina

Seq	R. time	Area, %	Common name	Formula
1	16.221	0.05	Propanoic acid, anhydride	$C_6H_{10}O_3$
2	16.333	0.08	Ethylformanilide	$C_9H_{11}NO$
3	17.487	15.3	Heptadecane	$C_{21}H_{44}$
4	18.482	2.97	Benzenamine	$C_9H_{13}NO$
5	19.133	0.13	Hexanedinitrile	$C_6H_8N_2$
6	19.133	8.99	Hexadecanoic acid	$C_{16}H_{32}O_2$
7	22.132	0.45	1-pentene	C_5H_{10}
8	22.697	68.48	9-octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester	$C_{21}H_{40}O_4$
9	22.826	2.68	Pentadecanoic acid, 14-bromo-	$C_{15}H_{29}BrO_2$
10	23.383	0.87	1-pentyn-3-ol	C_5H_8O
Total		100		

Table 4. Antibiotic susceptibility of E.coli against different antibiotics

Antibiotics	Inhibition zone, mean ± SD	
Imipenem	24.60 ± 1.52	p-value < 0.001 LSD = 2.21
Meropenem	22.10 ± 1.00	
Amikacin	16.60 ± 1.52	
Levofloxacin	2.33 ± 0.57	
Ciprofloxacin	3.33 ± 0.57	
Gentamycin	14.00 ± 2.64	
Azithromycin	5.42 ± 0.57	

Table 5. Antibiotic susceptibility of S.aureus against different antibiotics

Antibiotics	Inhibition zone, mean ± SD
Imipenem	16.31
Meropenem	12.66
Amikacin	2.11
Levofloxacin	9.33
Ciprofloxacin	1.24
Gentamycin	2.13
Azithromycin	10.4

Activity of spirulina hexane extract with different concentrations against E.coli and S.aureus

The present study was showed a significant difference at p-value < 0.05, in the activity of spirulina hexane extract according to extract concentration, was showed the high activity of spirulina hexane against both *E.coli* and *S.aureus* in 100% concentrations, then the activity decreased with decrease concentration. In the other hand, the study showed a non-significant difference between *E.coli* and *S.aureus* in 50% concentration, while the other concentration the activity increased against *E.coli* compared with *S.aureus*, furthermore the study noted a non-significant difference between concentration of 75 and 50 % against both *E.coli* and *S.aureus* as in Table 7.

Discussion

It is well known that if a chemical has antimicrobial activity, this indicates its ability to kill and inhibit the growth of bacteria and other microorganisms. Recently, bacterial resistance to currently available antibiotics has increased. According to the World Health Organization, antimicrobial resistance is one of the top ten global threats to public health facing humanity [22]. Therefore, finding new antibacterial chemicals as alternatives to existing drugs has become extremely important [23].

The diversity of secondary receptors found in algae makes them attractive candidates, as many of these metabolites exhibit antibacterial effects [24]. These metabolites can inhibit the metabolic activity of microbes and damage

Table 6. Activity of spirulina ethanol extract with different concentrations against E.coli and S.aureus (mean ± SD)

Concentration	*E.coli*	*S.aureus*	p-value
25 %	11.40 ± 0.89	10.00 ± 1.22	0.073
50 %	15.20 ± 2.68	10.80 ± 0.83	< 0.01
75 %	16.00 ± 2.00	11.80 ± 0.83	< 0.01
100 %	20.00 ± 2.00	15.60 ± 1.51	< 0.01
p-value	< 0.01	< 0.01	
LSD	2.65	1.51	

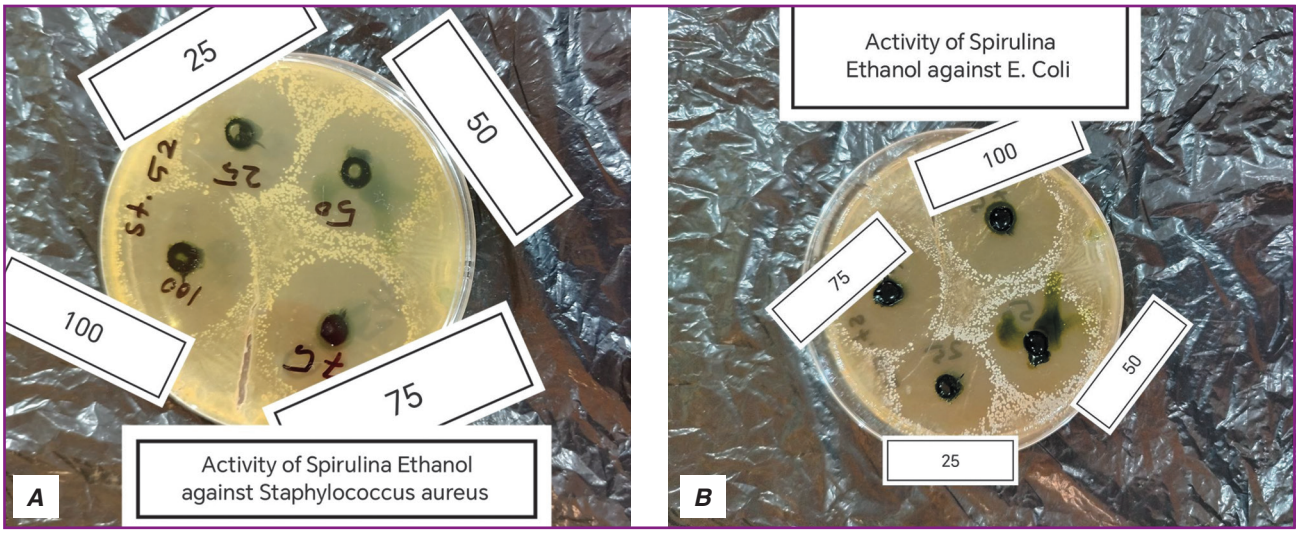

Figure 1. Activity of spirulina ethanol extract with different concentrations against S.aureus (A) and E.coli (B)

Table 7. Activity of spirulina hexane extract with different concentrations against E.coli and S.aureus (mean ± SD)

Concentration	*E.coli*	*S.aureus*	p-value
25 %	12.40 ± 1.14	9.20 ± 0.83	< 0.01
50 %	14.20 ± 1.78	12.00 ± 1.41	0.065
75 %	16.80 ± 1.78	13.00 ± 1.00	< 0.01
100 %	17.60 ± 1.15	14.80 ± 1.30	0.014
p-value	< 0.01	< 0.01	
LSD	2.10	1.54	

their membranes and cell walls. According to the results, spirulina algae has antibacterial effects against some of the bacteria that were tested. This study was showed the highly activity of ethanol and hexane extracts from spirulina algae against both *E.coli* and *S.aureus* in 100% concentrations then the activity decreased for both with decrease concentration. The high activity of spirulina ethanol extract *E.coli* (20.00 ± 2.00) in 100 mg/ml concentration, then against *S.aureus* (15.60 ± 1.51 mm) in 100 mg/ml concentration. While the high active of spirulina hexane extract *E.coli* (17.60 ± 1.15 mm) in 100 mg/ml concentration, then against *S.aureus* (14.8 ± 1.30 mm) in 100 mg/ml concentration. The ethanol extract showed highly activity against *E.coli* and *S.aureus* at all concentrations, but with less activity than the 100% concentration. The activity of the ethanol extract against *E.coli* reached 11.40 ± 0.89, 15.20 ± 2.68, and 16.00 ± 2.00 in concentrations 25, 50, and 75, respectively. The activity of the ethanol extract against *S.aureus* reached 10.00 ± 1.22, 10.80 ± 0.83, and 11.80 ± 0.83 in concentrations 25, 50, and 75, respectively. On the other hand, the hexane extract showed clear activity against *E.coli* and *S.aureus* at all concentrations, but with less activity than the ethanol extract. The activity of the hexane extract against *E.coli* reached 12.40 ± 1.14, 14.20 ± 1.78, and 16.80 ± 1.78 in concentrations 25, 50, and 75, respectively. The activity of the hexane extract against *S.aureus* reached 9.20 ± 0.83, 12.00 ± 1.41, and 13.00 ± 1.00 in concentrations 25, 50, and 75, respectively. The effectiveness of the spirulina algae can be attributed to its content of active compounds such as hexadecanoic acid methyl ester has antioxidant, hypocholesterolemic, nematicide, pesticide, antiandrogenic flavor, hemolytic, alpha reductase inhibitor [25]. In addition, 9-octadecenoic acid (z)-, 2,3-dihydroxypropyl ester has (antibacterial, anticandidal, anti-inflammatory, hypocholesterolemia, cancer preventive, hepatoprotective, nematicide, insecticide, antihistaminic, antiarthritic, ant coronary, antieczemic, antiacne, 5-alpha reductase inhibitor and antiandrogenic activities) [26, 27].

Furthermore, this current study's identification of octadecenoic acid (oleic acid) in spirulina extract is corroborated by the prior work of Al-Khafaji and Al-Saedi [28], where they found that octadecenoic acid is one of the active compounds present in spirulina extract. Stabile et al. [29] also noted in their study that since oleic acid is the most abundant among the fatty acids of spirulina extract, it is likely responsible for the antibacterial activity.

Conclusions

Given the numerous side effects associated with most antibiotics employed in the medical profession, our current study aimed to investigate the effects of ethanol and hexane extracts of spirulina algae on pathogenic bacteria that cause UTI, demonstrating superior inhibition compared to some medicines. The ethanol and hexane extracts exhibit antimicrobial properties due to their chemical composition, which includes compounds such as hexadecanoic acid, ethyl ester, 9,12-octadecadienoic acid (z,z),9-octadecenoic acid (z)-, 2,3-dihydroxypropyl ester, heptadecane pentadecanoic acid, 14-bromo, positioning them as potential alternative medicinal treatments.

Staphylococcus aureus is not considered the primary cause of uncomplicated urinary tract infections, but rather a secondary cause. However, it is involved in complicated cases, especially in patients suffering from urinary tract obstruction, catheterization, and immunodeficiency. Its presence associated with compromised host factors (patients with structural abnormalities of the urinary tract, prolonged catheter use, or those undergoing urologic procedures), polymicrobial infections (in complicated UTIs, *S.aureus* may co-occur with other pathogens, complicating the clinical picture), increased morbidity (infections caused by *S.aureus* in the urinary tract can lead to more severe clinical outcomes, necessitating more aggressive treatment strategies), and especially since my thesis samples were collected from patients hospitalized for long periods and suffering from chronic urinary tract infections, who took medications

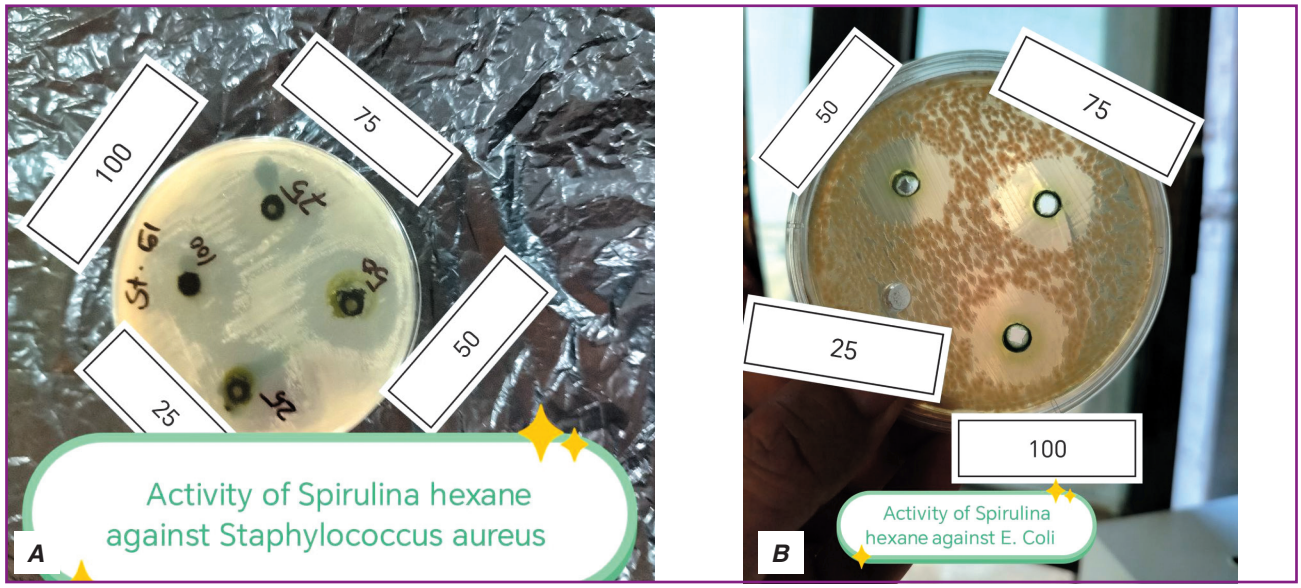

Figure 2. Activity of spirulina hexane extract with different concentrations against S.aureus (A) and E.coli (B)

for long periods and who used urinary catheters. Therefore, we find that *Staphylococcus aureus* bacteria are one of the causes of urinary tract infections in our samples, in addition to many other types of bacteria and fungi, especially *Candida albicans*. Highlighting these aspects in my thesis would provide a clearer understanding of when *S.aureus* might be a concern in UTIs. This clarification can help guide clinicians in their diagnostic and therapeutic approaches.

Practical relevance. The current study identified natural compounds from algae with both ant-bacteria properties, it can be applied in the medical field.

Research limitations. No limitation in this study.

Prospects for further research. Applying the current extract to other types of bacteria and extracting other compounds from the same algae and proving their effectiveness.

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ГХ-МС гексанових та етанольних екстрактів водоростей спіруліни з виявленням їхньої антибактеріальної активності проти уропатогенних *S.aureus* та *E.coli*

Резюме. Актуальність. Метою цього дослідження є оцінка антимікробної активності гексанових та етанольних екстрактів спіруліни. Завданням є пошук стандартизованих аналітичних методів для виділення оригінальних біологічно активних сполук із водоростей для боротьби зі шкідливими бактеріями, як-от *E.coli* та *Staphylococcus aureus*, що викликають інфекції сечовивідних шляхів. **Матеріали та методи.** Дослідження включало збір та підготовку водоростей спіруліни з м. Насірія (Ірак). Водорості були очищені, висушені та подрібнені в порошок. Двадцять грамів сухого порошку змішували з 200 мл етанолу та гексанових розчинників і піддавали ультразвуковій екстракції. Отримані екстракти фільтрували та зберігали в стерильних умовах. Антимікробну активність оцінювали за різних концентрацій (25, 50, 75 та 100 мг/мл) проти бактеріальних штамів *Staphylococcus aureus* та *E.coli* методом дискової дифузії Кірбі — Бауера. **Результати.** Етанольний екстракт продемонстрував найвищий інгібуючий ефект проти *E.coli*, із зоною пригнічення 20,00 ± 2,00 мм при концентрації 100 мг/мл. Також він мав інгібуючу дію проти *S.aureus*, із зоною пригнічення 15,60 ± 1,51 мм при концентрації 100 мг/мл. Гексановий екстракт продемонстрував значну активність проти *E.coli*, із зоною пригнічення 17,60 ± 1,15 мм при концентрації 100 мг/мл, а також інгібуючий ефект проти *S.aureus*, із зоною пригнічення 14,80 ± 1,30 мм при концентрації 100 мг/мл. При зменшенні концентрації активність обох екстрактів знижувалась. Порівняльний аналіз показав, що обидва екстракти перевищували кілька протестованих антибіотиків щодо ефективності проти відповідних бактеріальних штамів. **Висновки.** Отримані результати свідчать про те, що екстракти водоростей мають значні антимікробні властивості. Це робить їх потенційною альтернативою консервативним антибіотикам у лікуванні інфекцій сечовивідних шляхів. Дослідження підкреслює важливість цих екстрактів у розробці специфічних препаратів із водоростей для антимікробного застосування, що сприятиме розвитку альтернативної медицини.

Ключові слова: водорості спіруліни; гексан; етанол; *E.coli*; *S.aureus*; ДМСО; ГХ-МС