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Antimicrobial Activity of *Cladophora Glomerata* and *Chara Vulgaris* Against Pathogenic Bacteria and Fungi

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Abstract

There are several significant secondary metabolites found in freshwater macroalgae, which remain an unexplored source of therapeutic substances. The present study investigated the antimicrobial activity of two different species of macroalgae, *Cladophora glomerata* and *Chara vulgaris*. These were extracted using acetonitrile and tested against one Gram-positive bacterium, one Gram-negative bacterium, and one type of fungus using the well diffusion technique. Eleven different concentrations of the algal extract (2, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 mg/mL) were prepared for the study. Additionally, gas chromatography-mass spectrometry (GC-MS) was used to analyse the components of the extracts. The results showed that the extract of *Cladophora glomerata* and *Chara vulgaris* prepared with acetonitrile was most effective against the pathogenic fungus *Candida albicans* (ATCC: 10231) at a concentration of 15 mg/mL, followed by *Staphylococcus aureus* (ATCC: 25923) at 25 mg/mL, and *Escherichia coli* (ATCC: 35218) at 30 mg/mL. Furthermore, the extract of *Cladophora glomerata* was more effective against the Gram-positive bacterium *Staphylococcus aureus*. Numerous chemical components with antibacterial and antifungal properties were identified in the extracts. These included alkaloids, alcohols, carboxylic acids, ketones, benzenes, amines, fatty acids, alkenes, furans, heterocycles, and other natural compounds. The antimicrobial investigation of *Cladophora glomerata* and *Chara vulgaris* demonstrated a significant effect in inhibiting or killing bacteria and fungi.

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1. Introduction

In aquatic ecology, algae are the most significant primary producers [1]. Algae are aquatic photosynthetic creatures that have been ascribed exceptional ecological significance and a place in the animal food chain [2]. Macro-algae may create a wide range of secondary metabolites with a wide range of biological functions and they are regarded as a source of bioactive compounds. It has been demonstrated that brown, red, and green algae contain compounds with antioxidant, antiviral, antifungal, and antibacterial qualities [3]. Polysaccharides, indoles, terpenes, phenolic acids, and fatty acids are among the bioactive components of algae antibiotics [4]. Green algae, one of the most prevalent types of algae worldwide, can grow rapidly in salty water, which accounts for about 10% of all communities, or they can be attached to plants (epiphytic), epileptic (rocks), edaphic moist soil, or both. It is well known that green algae have antibacterial properties that enable them to combat microorganisms that are both Gram positive and Gram negative [5]. For instance, more than 183 species of *Cladophora* contain a variety of

compounds having therapeutic uses [6]. The term "macrophytes" is used to refer to all green algae. From an ecological perspective, algae are abundant and found in fresh and marine environments, where they absorb carbon dioxide and carry out photosynthesis [2]. The multipurpose biochemical found in algae demonstrated several therapeutic qualities, such as antibacterial, antioxidant, anti-inflammatory, and anticancer bioactivities [7]. Numerous diseases in humans and animals are caused by fungi as agents of superficial mycoses, which affect the outer layer of skin in the stratum corneum and frequently result in chronic infections [8]. Algae are a natural treasure, due to several studies on their chemical makeup and growing public consciousness of the benefits of using them [9]. Interest in products made from natural ingredients is continuously rising. Thus, it is essential to harvest algae correctly and create techniques that allow the biomass to be examined for the presence of physiologically active substances with a variety of uses [9]. The aims of this study are determine phytochemical compounds of *Cladophora glomerata* and *Chara vulgaris* by using GC-MASS and estimation antimicrobial activities of *Cladophora glomerata* and *Chara vulgaris* against some pathogenic bacteria and fungi.

2. Research Method

2.1. Algal Collection

This work was done from April to July in 2023. After being gathered from freshwater sources, *Cladophora glomerata* and *Chara vulgaris* were carefully cleaned of sand, mud, and other weeds were removed from the collected freshwater macroalgae were first washed with tap water and then with distilled water. After being spread out on plain paper and allowed to dry for roughly ten days at room temperature, the clean freshwater macroalgae plants were manually crumbled into a fine powder. These algal samples were stored in the refrigerator [10] .

2.2. Location and Sampling Site Description

Between latitudes 35° 40' and 30° 30' N and longitudes 43° 20' and 44° 20' E is the province of Erbil, where this work was conducted. Numerous writers describe the climate, water resources, and geology of the Erbil Province area under study [11].

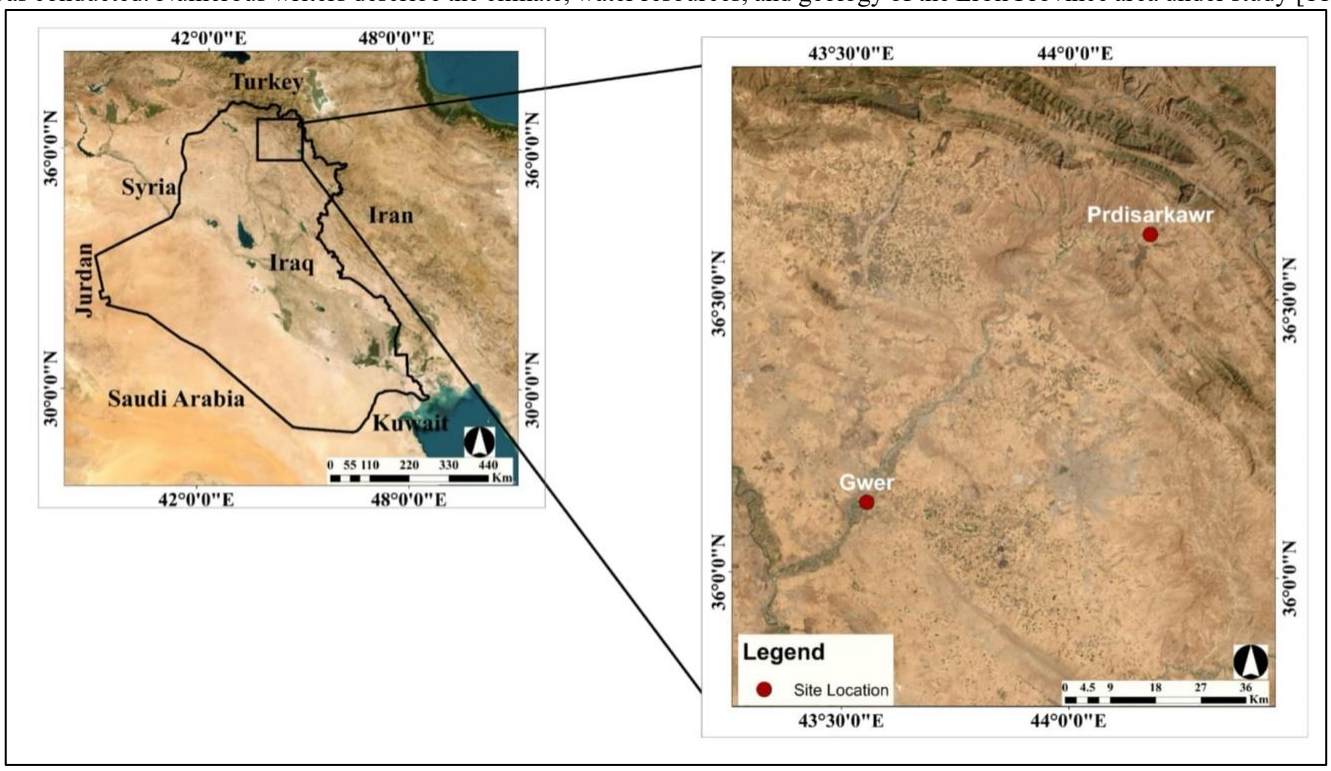

Figure 1. Map of the A. North part of Iraq, B. Sampling sites (ArcGIS)

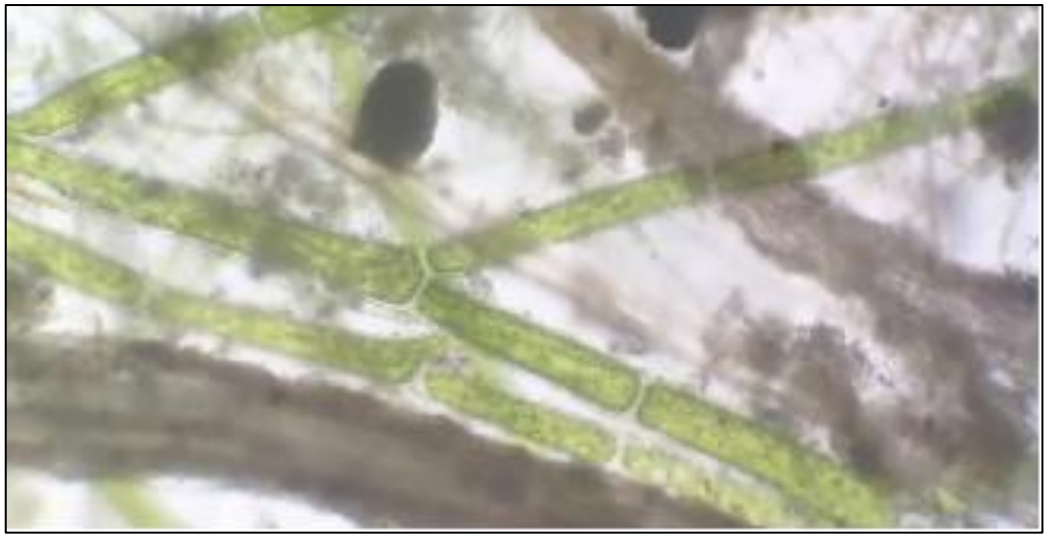

Figure 2. Microscopic picture of *Cladophora glomerata* at 40x

Figure 3. Microscopic picture of *Chara vulgaris* at 40x

Site one: (Prdisarkawr spring) (Figure 4)

This location is at an elevation of 386 meters above sea level, latitude N 38S425862, longitude E 4052589, and roughly 6 kilometers north of Qandil Bridge. The discharge was used for irrigation, and the soil here is grayish brown in color. There is mud at this location.

Figure 4. Site 1(Prdisarkawr spring)

Site two: (Gwer pond) (Figure 5)

It is situated at an elevation of 221.3 meters above sea level in Kapran village, Gwer district, at latitude N 38S369444 and longitude E 3999202. The soil colour ranged from brown to grayish-brown. Near this location, agricultural activities predominate. Man-made ponds, this pond contains both stone and mud.

Figure 5. Site 2 (Gwer pond)

2.3. Algal Identification

After the collection of macroalgae, each sample was labelled and then brought to the laboratory for identification. The morphological identification of *Cladophora glomerata* and *Chara vulgaris* was done using the references of [12] and [13]. A digital microscope camera (Model Number: SCMOS05100KPB) was used to capture images of both species.

2.4. Antimicrobial activity

The bacteria *Staphylococcus aureus* (ATCC:25923), *Escherichia coli* (ATCC:35218), and fungi *Candida albicans* (ATCC:10231) were acquired from the Media Diagnostic Centre, Erbil and utilised in the current study. The bacterial culture was incubated for 24 hours at 37°C on Muller Hinton agar, while the fungal culture incubation lasted between 24 and 72 hours at 37°C on Sabouraud Dextrose Broth. The media used for the activation and growth of bacteria were Sheep Blood Agar(SBA) for *Staphylococcus aureus,* MacConkey Agar for *Escherichia coli* and Sabouraud Dextrose Agar (SDA) for *Candida albicans* [14]. *Cladophora glomerata* and *Chara vulgaris* algal extracts (0, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 mg/mL) were used as antibiotic and antifungal activity.

2.5. Phytochemical examination of the algal species

According to [15], 100 ml of 97% acetonitrile was used to extract 10 grams of powdered *Cladophora glomerata* and *Chara vulgaris* separately. Soxhlet extracts these solvents at 76°C for three to four hours until they are insoluble. The algal extract was dried at 40°C using a rotary evaporator. The extracts were used for gas chromatography-mass spectrometry (GC-MS) phytochemical screening. Filtration was used to sterilise the algae crude extracts, which were then diluted in dimethyl sulfoxide until they reached a final concentration of 300 mg/mL and kept at 4°C [16].

2.6. Determining Minimum Inhibitory Concentration (MIC) of algal extraction

The antimicrobial activity and separation of different concentrations of algal extracts (0, 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 mg/mL) were tested in 96-well microliter plates by mixing them with nutritional broth for bacteria and SDB for fungi. This technique helped separate antimicrobial compounds and evaluate algae for antimicrobial activity. All wells were inoculated with 10µl of the activated culture of *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*, then incubated overnight at 37 °C. Before and after incubation, the absorbency was determined using a wavelength of 490 nm. ELISA apparatus (EL 800 Biotek, Epison LQ-300+II) was then used to determine the MIC [17].

2.7. Chemical composition of algae extracts

A single quadrupole detector and an HP-5 capillary column (30 m×0.25 mm I.D., 1 µm film thickness) were utilised in the GC-MS analytical method (Agilent Technologies, USA) to determine the biochemical components of the algal extract. After two minutes at 40 degrees, the oven was heated for five minutes to 150 degrees and then for fifteen minutes to 300 degrees. At 280°C, the injector port's temperature was maintained. One microliter of the sample (dissolved in 100% dimethyl sulfoxide) was delivered into the system using helium as a carrier gas [15].

3. Results And Discussion

Freshwater macro-algae are a rich source of bioactive substances with a variety of advantageous biological functions [18]. *Chara vulgaris* is a coarse and brittle plant that is typically heavily lime-encrusted, varying widely depending on its habitat, varying in height from 4 cm in shallow water and on sandbars to 40 cm in deep water bottoms. Stems with cortication, the node cells of the primary cortical series are produced into spines that may vary from mere papillae to very long and prominent cells, giving a distinctly spiny appearance to the plant as a whole, nodes of the stem bearing a whorl of 6-11 leaves, leaves are uncorticated for 3-4 cell lengths at the tip, and sex organs are monoecious, borne on the same leaf node [12]. *Cladophora glomerata* filaments are branched, the individual cells are very large and cylindrical, the chloroplast is dense and net-like (reticulated), and it forms dense mats attached to substrates (epiphytic) [13].

3.1. Antimicrobial activities

The antibacterial activity of *Cladophora glomerata* and *Chara vulgaris* was evaluated in this study using the diffusion technique against two Gram positive and Gram negative bacteria, *Staphylococcus aureus* (ATCC:25923), *Escherichia coli* (ATCC:35218), and the fungus *Candida albicans* (ATCC:10231). Eleven different algal extract concentrations were used, including 2, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 mg/mL. The extracts were tested by determining their minimum inhibitory concentrations (MIC) against certain bacteria and fungi at different doses (Tables 1 and 2). In reaction to biotic and abiotic stressors, algae produce and accumulate a variety of chemicals. These substances have a variety of biological activities, such as antiviral, antibacterial, cardioprotective, antioxidant, anti-inflammatory, and anticancer qualities [19] and [20]. Different inhibitory activities against different harmful bacterial species are indicated by *Cladophora glomerata*. In the present study, the results showed that *Cladophora glomerata* extract has greater antifungal and antibacterial activity against *Staphylococcus aureus* and *Candida albicans*, with concentrations of 15 mg/mL for *Candida albicans*, 25 mg/mL for *Staphylococcus aureus*, and 40 mg/mL for *Escherichia coli* (Table 2). This result comes in accordance with [21]. Antimicrobial activity of *Chara vulgaris* was more effective against *Candida albicans* by 20 mg/mL (Table 1). Fungal infections in humans have been related to serious problems, particularly in rural and impoverished areas with limited access to diagnosis and treatment [22]. *Cladophora glomerata* showed the highest antibacterial activity against *Staphylococcus aureus;* this result agreed with [23]. The findings of

this investigation revealed that the two isolated algal acetonitrile extracts had the most potent antifungal efficacy. With an antibacterial action of 25 mg/mL against *Staphylococcus aureus*, *Cladophora glomerata* demonstrated greater efficacy against Gram positive bacteria. This result was consistent with two types of macroalgae extracts demonstrating moderate antibacterial activity against Gram negative bacteria. This result agreed with [10]. The antimicrobial mechanisms of action attributed to compounds extracted from algae are diverse. These encompass alterations in membrane permeability due to interactions with proteins and lipids, as well as enzyme inhibition. Different compounds might be incorporated into the membrane of microbial cells, leading to a loss of selective permeability and leakage of solutes, distorting their shape, size, and constituents [19]. Moreover, *Cladophora glomerata* showed the most promising antibacterial and antifungal capacity since they were able to inhibit *Escherichia coli* growth in the intermediate or susceptible category [23]. In this study, the algae contain phytochemicals comprised of alcohol, alkane, and alkaloids, indicate antimicrobial activity against *Escherichia coli* and *Staphylococcus aureus.* This outcome was consistent with [24].

Table 1. Minimum Inhibitory Concentration (MIC) of *Chara vulgaris* toward harmful bacteria and fungi

Name of solvent and bacteria	Bacterial culture absorbency (Concentration of extract mg/mL)											
	Control	2	5	10	15	20	25	30	35	40	45	50
Staphylococcus aureus (acetonitrile)	1.060	0.501	0.559	0.367	0.506	0.323	0.472	0	0	0	0	0
Escherichia coli (acetonitrile)	0.664	0.442	0.411	0.407	0.433	0.189	0.331	0	0	0	0	0
Candida albicans (acetonitrile)	0.422	0.236	0.048	0.074	0.033	0	0	0	0	0	0	0

0: It means no growth detected

Table 2. Minimum Inhibitory Concentration (MIC) of *Cladophora glomerata* toward harmful bacteria and fungi

Name of solvent and bacteria	Bacterial culture absorbency (Concentration of extract mg/mL)											
	Control	2	5	10	15	20	25	30	35	40	45	50
Staphylococcus aureus (acetonitrile)	0.623	0.479	0.369	0.297	0.252	0.309	0	0	0	0	0	0
Escherichia coli (acetonitrile)	0.723	0.644	0.465	0.599	0.47	0.179	0.092	0.074	0.111	0	0	0
Candida albicans (acetonitrile)	0.462	0.322	0.208	0.134	0	0	0	0	0	0	0	0

0: It means no growth detected

3.2. Natural compounds

The kind of algae being studied, the efficiency of the extraction method, the active components, and the host type all affect the inhibitory activity. The extract of two algae taxa in the current study contained a number of chemical components linked to human health (Tables 3 and 4). Acetonitrile, an organic solvent, was used in the current study for the preparation of extracts from *Cladophora glomerata* and *Chara vulgaris* as well as for the GC-MS diagnosis of several chemicals. Throughout the solvent extract GC-MS screening process, *Cladophora glomerata* and *Chara vulgaris* showed sixteen and eleven substances, respectively (Tables 3 and 4). The polarity of the extraction solvent determines the phytochemical makeup of the crude extract [25]. In actuality, the test microorganism's inhibitory activity varied according to how susceptible they were to antimicrobial compounds found in algae extracts, compared to Gram negative bacteria; Gram positive bacteria were less susceptible. Different cell wall transparency is the cause of the sensitivity differences between bacteria and fungi [8]. These results show the presence of various ketones, alkenes, amines, and fatty acids extracted from *Chara vulgaris,* these compounds having various antibiotic actions. Similar results were conducted by [10]. In the present study, fatty acids detected from *Cladophora glomerata* and *Chara*

vulgaris significantly contribute to their bioactive capacity [9]. Furan compounds, which were isolated from algae for this study, contain compounds that are effective antibiotics with antibacterial and anti-inflammatory properties; this outcome was in agreement with [26]. Moreover, palmitoleic acid has also demonstrated antimicrobial activities and appears to have potent antibiotic activity against pathogenic bacteria and fungi [27].

Table 3. GC-MS analysis of different compounds in an acetonitrile extract of *Cladophora glomerata*

Peak	R.Time	No.	Compounds	Chemical formula
1	29.605	1	Chloroacetic acid	$C_{20}H_{39}ClO_2$
2	30.700	2	3,7,11,15-Tetramethylhexadec-2-ene	$C_{20}H_{40}$
		3	2-Hexadecene, 3,7,11,15-tetramethyl-	$C_{20}H_{40}$
3	30.265	4	Hexadec-9-enoic acid, Palmitoleic acid	$C_{16}H_{30}O_2$
4	33.310	5	Hexadecanoic acid	$C_{16}H_{32}O_2$
5	34.145	6	Carbonic acid, eicosyl vinyl ester	$C_{23}H_{44}O_3$
6	35.470	7	3,4-Dihydroxymandelic acid	$C_{20}H_{40}O_5Si_4$
		8	Hexasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11-dodecamethyl-	$C_{12}H_{38}O_5Si_6$
7	36.035	9	2(3H)-Furanone	$C_{16}H_{30}O_2$
8	38.525	10	1-Naphthalenamine, N-phenyl-	$C_{16}H_{13}N$
		11	Quinoline	$C_{16}H_{13}N$
9	39.605	12	17-Pentatriacontene	$C_{35}H_{70}$
10	40.340	13	2H-Pyran-2-one	$C_{14}H_{26}O_2$
11	46.095	14	beta.-Glyceryl monostearate	$C_{21}H_{42}O_4$
12	47.340	15	Squalene	$C_{30}H_{50}$
13	48.210	16	Benzoic acid	$C_{16}H_{30}O_4Si_3$

Table 4. GC-MS analysis of different compounds in an acetonitrile extract of *Chara vulgaris*

Peak	R.Time	No.	Compounds	Chemical formula
1	11.635	1	d-Glycero-d-ido-heptose	$C_7H_{14}O_7$
2	27.970	2	2-Butenedioic acid (Z)-, monododecyl ester	$C_{16}H_{28}O_4$
3	29.375	3	6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-tetrahydrobenzofuran-2(4H)-one	$C_{11}H_16O_3$
4	32.705	4	Oxacycloheptadec-8-en-2-one, (8Z)-	$C_{16}H_{28}O_2$
5	32.810	5	1,8,11,14-Heptadecatetraene, (Z,Z,Z)-	$C_{17}H_{28}$
6	33.045	6	9-Pentadecen-1-ol	$C_{15}H_{30}O$
7	33.300	7	n-Hexadecanoic acid, Hexadecanoic acid	$C_{16}H_{32}O_2$
8	43.655	8	Hexadec-9-enoic acid, Palmitoleic acid	$C_{16}H_{30}O_2$
9	43.940	9	2-Dodecenoic acid	$C_{12}H_{22}O_2$
10	45.085	10	trans-13-Octadecenoic acid	$C_{18}H_{34}O_2$
11	51.100	11	6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-tetrahydrobenzofuran-2(4H)-one	$C_{11}H_{16}O_3$

4. Conclusion

The extraction of *Cladophora glomerata* was found to be more effective against all pathogenic bacteria, including *Escherichia coli* and *Staphylococcus aureus*. Both *Cladophora glomerata* and *Chara vulgaris* exhibited higher minimum inhibitory concentrations (MICs) against the fungus *Candida albicans*. Using gas chromatography–mass spectrometry (GC-MS) to analyses the two algae species, this study identified several chemical compounds with antimicrobial properties that either inhibit or kill pathogens. Among the substances found in the acetonitrile extracts of these algae genera were alkaloids, alcohols, carboxylic acids, ketones, benzenes, amines, fatty acids, alkenes, furans, heterocycles, and other natural compounds. Acetonitrile was used to extract compounds from the algae species, and the results showed that several algal taxa exhibit potent antibacterial activity against both fungi and harmful bacteria.

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6. Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication.

7. Funding

The authors declare that they have no known competing financial interests in this paper

8. References

[1] B. Saengsawang, P. Bhuyar, N. Manmai, V. K. Ponnusamy, R. Ramaraj, and Y. Unpaprom, "The optimization of oil extraction from macroalgae, Rhizoclonium sp. by chemical methods for efficient conversion into biodiesel," *Fuel,* vol. 274, p. 117841, 2020, doi: 10.1016/j.fuel.2020.117841.

[2] R. Ramaraj, D. D.-W. Tsai, and P. H. Chen, "Freshwater microalgae niche of air carbon dioxide mitigation," *Ecol. Eng.,* vol. 68, pp. 47-52, 2014, doi: 10.1016/j.ecoleng.2014.03.058.

[3] Y. L. Chew, Y. Y. Lim, M. Omar, and K. S. Khoo, "Antioxidant activity of three edible seaweeds from two areas in South East Asia," *Lebenson. Wiss. Technol.,* vol. 41, no. 6, pp. 1067-1072, 2008, doi: 10.1016/j.lwt.2007.06.013.

[4] J. Zhao *et al.*, "Extraction, analysis, and antifungal activity study of algae antibiotic active substances in plateau lakes," *PloS one.,* vol. 20, no. 5, p. e0319853, 2025, doi: 10.1371/ journal.pone.0319853.

[5] N. D. Salman, A. S. Dwaish, and S. M. Kareem, "Evaluation the Antibacterial Activity of some Macro Algae Isolated from Baghdad-Iraq," *IOP Conf. Ser. Earth Environ. Sci*., vol. 1371, no. 5, p. 052039, 2024, doi:10.1088/1755-1315/1371/5/052039.

[6] M. Munir, R. Qureshi, M. Bibi, and A. M. Khan, "Pharmaceutical aptitude of Cladophora: A comprehensive review," *Algal Res.,* vol. 39, p. 101476, 2019, doi: 10.1016/j.algal.2019.101476.

[7] Z. Wu *et al.*, "Antibacterial and cytotoxic new napyradiomycins from the marine-derived Streptomyces sp. SCSIO 10428," *Mar. Drugs,* vol. 11, no. 6, pp. 2113-2125, 2013, doi: 10.3390/md11062113.

[8] M. S. Dwaish, "Anti-dermatophytes activity of some algal extracts isolated From Baghdad City-Iraq," *Res J Pharm Technol.,* vol. 11, no. 12, pp. 5449-5454, 2018, doi: 10.5958/0974-360X.2018.00993.9.

[9] K. Korzeniowska, B. Łęska, and P. P. Wieczorek, "Isolation and determination of phenolic compounds from freshwater Cladophora glomerata," *Algal Res.,* vol. 48, p. 101912, 2020, doi: 10.1016/j.algal.2020.101912.

[10] Z. Shah, S. L. Badshah, A. Iqbal, Z. Shah, A.-H. Emwas, and M. Jaremko, "Investigation of important biochemical compounds from selected freshwater macroalgae and their role in agriculture," *Chem Biol Technol Agric.,* vol. 9, no. 1, p. 9, 2022, doi: 10.1186/s40538-021-00273-0.

[11] C. M. Shareef and F. H. Aziz, "Assessment of Some Physico-Chemical Parameters and Heavy Metals in The Greater Zab River Path from Bekhma to Al Guwayr District in Erbil Province-KRI," *Zanco J Pure Appl Sci.,* vol. 35, no. 2, pp. 94-110, 2023, doi: 10.21271/ZJPAS.35.2.11.

[12] G. W. Prescott. Algae of the western Great Lakes area. United states of America: 4th ed. WM. C. Brown Company Publisher;. p. 292, 1970.

[13] R. A. Matthews. Freshwater Algae in Northwest Washington, Volume II, Chlorophyta and Rhodophyta. Western Washington University: Western CEDER; p. 786, 2016, doi: 10.25710/fctx-n773.

[14] M. Hombach, G. V. Bloemberg, and E. C. Böttger, "Effects of clinical breakpoint changes in CLSI guidelines 2010/2011 and EUCAST guidelines 2011 on antibiotic susceptibility test reporting of Gram-negative bacilli," *J Antimicrob Chemother.,* vol. 67, no. 3, pp. 622-632, 2012, doi: 10.1093/jac/dkr524

[15] H. A. Alghanmi and A. S. Omran, "Antibacterial activity of ethanol extracts of two algae species against some pathogenic bacteria isolated from hospital patients," *Eurasian J Biosci.,* vol. 14, no. 1, 2020.

[16] Y. Li *et al.*, "A comparative study: the impact of different lipid extraction methods on current microalgal lipid research," *Microb Cell Fact.,* vol. 13, no. 14, pp. 1-9, 2014, doi: 10.1186/1475-2859-13-14.

[17] A. S. Ismaeil and F. A. Saleh, "Sumac (Rhus coriaria L) as quorum sensing inhibitors in Staphylococcus aureus," *J Pure Appl Microbiol.,* vol. 13, no. 4, pp. 2397-2404, 2019, doi: 10.22207/JPAM.13.4.56.

[18] O. D. Stefanović, A. B. Rakonjac, D. D. Nikodijević, S. D. Milojević, A. Dinić, and S. B. Simić, "Freshwater algae Cladophora glomerata and Vaucheria sp. from Serbia as sources of bioactive compounds: chemical analysis and biological activities," *Arch Biol Sci.*, vol. 76, no. 2, pp. 175-189, 2024, doi: 10.2298/ABS240215012S.

[19] A. Silva *et al.*, "Antibacterial use of macroalgae compounds against foodborne pathogens," *Antibiotics.,* vol. 9, no. 10, p. 712, 2020, doi: 10.3390/antibiotics9100712.

[20] A. M. Abo-Shady, S. F. Gheda, G. A. Ismail, J. Cotas, L. Pereira, and O. H. Abdel-Karim, "Antioxidant and antidiabetic activity of algae," *Life.,* vol. 13, no. 2, p. 460, 2023, doi: 10.3390/life13020460.

[21] J. Toma. Response of Algal Distribution to Environmental Condition of Shaqlawa District and their Antibiotic Activities [PH. D. dissertaion]. Univ. of Salahaddin. Erbil; 2022. 225 p.

[22] S. A. Cochrane and C. T. Lohans, "Breaking down the cell wall: Strategies for antibiotic discovery targeting bacterial transpeptidases," *Eur J Med Chem.,* vol. 194, p. 112262, 2020, doi: 10.1016/j.ejmech.2020.112262.

[23] O. Erturk and B. TAB, "Antibacterial and antifungal effects of some marine algae," Kafkas Univ Vet Fak Derg., vol. 17, no. 1, pp. 122-124, 2011, doi:10.9775/kvfd.2010.2539.

[24] D. Marimuthu and A. Jayaraman, "Isolation and growth characterization of the fresh water algae Chlorosarcinopsis eremi on different growth media," *J. Pure Appl. Microbiol.,* vol. 12, no. 1, pp. 389-392, 2018, doi.org/10.22207/JPAM.12.1.46.

[25] O. Awotedu, U. Okeke, P. Ogunbamowo, O. Ariwoola, and T. Omolola, "Extraction of phytochemical compounds of Leea guineensis (g. Don) leaves using non-polar and polar solvents," *European J Med Plants.,* vol. 31, no. 2, pp. 24-31, 2020, doi: 10.9734/EJMP/2020/v31i230213.

[26] M. Alizadeh *et al.*, "Recent updates on anti-inflammatory and antimicrobial effects of furan natural derivatives," *J Inflamm Res.,* vol. 13, pp. 451-463, 2020, doi: 10.2147/JIR.S262132.

[27] M. Desnoyers, K. Gilbert, and G. Rousseau, "Cardioprotective effects of omega-3 polyunsaturated fatty acids: dichotomy between experimental and clinical studies," *Mar drugs.,* vol. 16, no. 7, p. 234, 2018, doi: 10.3390/md16070234.

النشاط المضاد للميكروبات لـ *Cdophora glomerat*و *Chara vulga* ضد البكتيريا المسببة للأمراض والفطريات

جياي معروف شريف

قسم العلوم البيئية والصحة، كلية العلوم، جامعة صلاح الدين، أربيل، العراق

المستخلص:

توجد العديد من المستقلبات الثانوية المهمة في الطحالب الكبيرة في المياه العذبة، وهي مصدر غير مستكشف للمواد العلاجية. استهدفت هذه الدراسة النشاط المضاد للميكروبات لنوعين مختلفين من الطحالب الكبيرة، هما *Cladophora glomerata* و *Chara vulgaris* تم استخلاص هذه الطحالب باستخدام الأسيتونتريل ضد نوع واحد من البكتيريا موجبة الجرام، ونوع واحد من البكتيريا سالبة الجرام، ونوع واحد من الفطريات باستخدام تقنيات انتشار الآبار. تم تحضير أحد عشر تركيزًا مختلفًا من مستخلص النشاط الطحلبي (2، 5، 10، 15، 20، 25، 30، 35، 40، 45، و50 ملغ/مل). كما استُخدمت تقنية كروماتوغرافيا الغاز-مطياف الكتلة-GC) (MSلتحليل المكونات الكيميائية في المستخلصات.

أظهرت النتائج في هذه الدراسة أن مستخلص *Cladophora glomerata* و *Chara vulgaris* باستخدام الأسيتونتريل كان أكثر فعالية ضد الفطريات المسببة للأمراض، مثل المبيضات البيضاء (ATCC: 10231) بتركيز 15 ملغم/مل، تليها المكورات العنقودية الذهبية (ATCC: 25923) بتركيز 25 ملغم/مل، ثم الإشريكية القولونية (ATCC: 35218) بتركيز 30 ملغم/مل. بالإضافة إلى ذلك، كان مستخلص *Cladophora glomerata*أكثر فعالية تجاه البكتيريا موجبة الجرام(*Staphylococcus aureus*)

تم العثور على العديد من المكونات الكيميائية ذات الخصائص المضادة للبكتيريا والفطريات، حيث يحتوي مستخلص نوعي الطحالب في الدراسة الحالية على مجموعة من المركبات الكيميائية المرتبطة بصحة الإنسان، بما في ذلك القلويدات، الكحول، حمض الكربوكسيل، الكيتون، البنزين، الأمين، الأحماض الدهنية، الألكين، الفوران، المركبات غير المتجانسة، ومركبات طبيعية أخرى. أظهرت الدراسات المضادة للميكروبات لـ *Cladophora glomerata* و *Chara vulgaris* تأثيرًا كبيرًا في تثبيط نمو أو قتل البكتيريا والفطريات.