Al-Mukhtar Journal of Sciences 37 (2): 113-119, 2022
ISSN: online 2617-2186 print 2617-2178
Journal Homepage https://omu.edu.ly/journals/index.php/mjsc/index

Water Quality Assessment of Lakes (Ain Al-Ghazala and Umm-Hufayn) for Fish Culture in the Eastern Coast of Libya

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Received: 12 August 2021/ Accepted: 14 March 2022
Doi: https://doi.org/10.54172/mjsc.v37i2.527

Abstract: Assessments of some physical and chemical properties were conducted for two Libyan water bodies (Ain Al- Ghazala and Umm-Hufayn). Of each ecosystem, ten water samples were taken from ten points for analysis. The results showed that the electric conductivity in Ain Al-Ghazala Bay waters is higher than that in the waters of Umm-Hufayn Lake. In the two areas, the hydrogen ion concentration pH recorded the highest value with a value of 8.3, with mean values of chloride (Cl) exceeding the internationally recorded limits. Furthermore, nitrites (NO_2), nitrate (NO_3), sulphate (SO_4), phosphate (PO_4), silicates (SiO_2), carbonate (CO_3), calcium (Ca), magnesium (Mg), sodium (Na), and potassium (K) were all greater in Ain Al-Ghazala Bay waters than in Umm-Hufayn Lake waters. In conclusion, more attention should be directed to the preservation of such natural resources.

Keywords: Water Quality, Physical and Chemical Properties, Ain Al-Ghazala Lagoon, Umm-Hufayn Lagoon.

INTRODUCTION

Water properties and quality are defined by specific physical, chemical, and biological properties and how these properties impact the survival, reproduction, growth, and management of aquatic life (Aduwo & Adeniyi, 2019). Water quality is the major limiting factor in the productivity of aquatic ecosystems, including fish resources. The health of an aquatic ecosystem depends on its physico-chemical and biological characteristics (Watson & Lawrence, 2003). The Libyan coast and lagoons are important for Mediterranean marine life biodiversity and productivity.(Haddoud & Rawag, 1995). The lakes may be used for recreation, and/or used as a component of hydropower generating systems. In developing countries, lakes are primarily used by the local inhabitants for transportation, fishing, washing, cooking, and irrigation practices (Okoro et al., 2014). Ain Al-Ghazala, is a long inlet with mainly rocky shores, lacking relevant tidal movements, but with characteristic extensive shallows occupied by Zosterabeds and mudflats (Team, 2010). The Umm-Hufayn lagoon is around 2 km2 in size and has a water depth of 0.5 to 3.0 m (Abdalhamid et al., 2018). It has a short passage connecting it to the sea, which is subject to tidal intrusions. Algal blooms,

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anoxic conditions, and ocean acidification are caused by too much nitrogen and phosphorus, resulting in dead zones, fish kills, toxin generation, and changed plant species (Ngatia et al., 2019). About 75% of surface water may be contaminated by different kinds of pollutants. Pollutants may include heavy metals (Awoyemi et al., 2014), nutrients from industrial discharges (Mahananda et al., 2005), or agricultural activities. Higher concentrations of nutrients, e.g., phosphorus and nitrogen, may cause hypoxia and algal bloom (Garg et al., 2009); which may cause low light penetration, obstruction of oxygen levels, and loss of aquatic life and biodiversity (e.g., fish mortality) (Parashar et al., 2006).

The constant monitoring of water quality in lakes is essential and can be conducted by quantifying the level of physical and chemical parameters (Ademoroti, 1996). This paper's objective is to compare water quality between the two studied areas.

MATERIALS AND METHODS

Study area Ain Al- Ghazala Bay (Fig.1) is located west of Tobruk, about 60 km along the eastern extension of the Libyan coast in the Mediterranean Sea, with coordinates 32° 10' 42.49334" N**,** 23° 18' 37.80131" E. The shore is rocky, with sandy beaches interspersed. It is about 6 km long and 1.5 km wide, with depths ranging from 3.5 to 5 m and an area of 180 hectares. Almarakeb (Ulbah) island, located in front of the entrance, protects the bay from wave action and northern winds.

Lake Umm-Hufayn (Fig.1) originated from Bomba Bay 32° 33' 47.96503", 23° 5' 29.10995", about 80 km east of the city of Derna towards Tobruk, covers an area of about 2 km^2 and a depth of 0.5-3 m. During high tides, seawater enters the lake through the bay. Underground springs on the lake's inner shore provide fresh water, which helps to lessen its salinity.

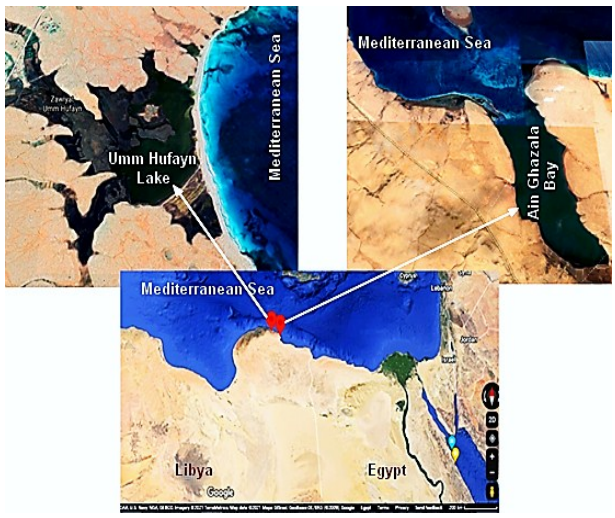

Figure (1).. Map showing the two studied areas, Umm Hufayn and Ain Al- Ghazala.

Water sampling: For chemical analysis, water samples were collected in polyvinyl chloride Van Dorn bottles at the two selected sites (10 points for each site). Some physicochemical parameters of water bodies at all studied sites were measured, including pH, by a multi-portable device (HACH, USA). Other Water samples were kept in a one-litre polyethylene bottle in an icebox and analyzed in the laboratory, Total dissolved salts TDS (mg/l), Conductivity EC (mS/cm), Total hardness TH (mg/l), Total Alkalinity TA (mg/l), Chloride Cl (mg/l), Nitrite NO_2 (mg/l), Nitrate NO_3 (mg/l), Sulfate SO_4 (mg/l), Phosphate PO_4 (mg/l), Silicate SiO_2 (mg/l) Carbonate CO_3 (mg/l), Bicarbonate, HCO_3 (mg/l), Calcium Ca (mg/l) Magnesium Mg (mg/l), Sodium Na (mg/l), Potassium K (mg/l) are measured according to the traditional manual methods (Beutler et al., 2014).

RESULTS

Table (1) shows the physicochemical parameters derived from the study of water samples. The results showed that the mean values of the water electric conductivity were higher in Ain Al- Ghazala water (62.500±1.141 mS/cm) than in those of Umm-Hufayn Lake (28.620±0.993 mS/cm). Total dissolved solids in Ain Al- Ghazala water (41.511 ±0.760mg/l) were more than twice as high as

in Umm-Hufayn (19.157±0.665 mg/l). TDS in this study were over the international permitted limit of 1mg/L. The pH values in Umm-Hufayn and Ain Al- Ghazala, respectively, were (8.14±.023) and (8.210±0.7), indicating that the water in Ain Al- Ghazala Lake is on the alkaline side. The greatest values of total alkalinity (6.822±0.190) and chloride (3.253±0.210) were found in Ain Al-Ghazala water, while these values were (1.576±0.054) and (3.185±0.110) in Umm-Hufayn respectively. In both areas, the mean chloride percentage exceeded the international standards. The findings also revealed that Lake Ain Al- Ghazala had higher nutrient levels of NO_3, NO_2, and PO_4 than Lake Umm-Hufayn. Phosphorus, like nitrogen, is a necessary component of all living organisms. Ain Ghazala Lake had greater SO_4, Ca, K, mg, Na, SiO_2, CO_3, and HCO_3 concentrations than Lake Umm-Hufayn. On the other hand, a T-test was used to demonstrate the differences in physicochemical parameters between the two assessed wetlands (Table 2). The T-test demonstrated the presence of greater and significant (Table 2) differences in the means of all parameters ($P<0.01$), except for pH (insignificant, $P> 0.05$).

Table: (1). Mean ±SD Water criteria sampled from the two investigated areas.

Water parameter	Ain AlGhazala	Umm Hufayn
Conductivity(mS/cm)	62.500±1.141	28.620±0.993
TDS (mg/l)	41.511±0.760	19.157±0.665
pH	8.21±0.07	8.14±.23
Hardness(mg/l)	7.302±0.132	3.427±0.118
Alkalinity (mg/l)	3.253±0.210	1.576±0.054
Chlorides (mg/l)	6.822±0.190	3.185±0.110
NO_2(mg/l)	0.223±0.004	0.112±0.003
NO_3(mg/l)	2.285±0.314	1.209±0.053
SO_4(mg/l)	2.341±0.340	1.485±0.050
PO_4(mg/l)	0.410±0.008	0.185±0.006
SiO_2(mg/l)	0.008±000	0.002±000
CO_3(mg/l)	0.064±0.001	0.017±0.008
HCO_3(mg/l)	3.085±0.067	1.547±0.053
Ca(mg/l)	6.116±0.114	2.89±0.100
Mg (mg/l)	1.042±0.370	0.543±0.018
Na(mg/l)	5.681±0.109	2.705±0.093
K(mg/l)	0.3007±0.024	0.173±0.006

DISCUSSION

Along the Libyan coast and offshore, there are a variety of natural aquatic environments. Despite their importance as natural resources, they have received little attention. Effective conservation and management are the most pressing issues facing marine biotopes. Recently, Elshakh et al. (2020) conducted an assessment to the fish *Liza aurata* collected from Umm Hufayn lagoon. The lagoon is a major artisanal fishing ground, an important wetland with high biodiversity, a refuge and breeding place for fish and turtles, as well as a nesting and resting location for local and migratory sea birds (Elshakh et al., 2020). In addition, *Chelonlabrosus* was recorded for the first time in Umm-Hufayn Lagoon (Elmor et al., 2020). This finding indicates that these species are highly adaptive to changing environmental conditions, implying that their presence is tied directly to their euryhaline character, a wide range of water parameters, and a diverse food menu. Umm-Hufayn is almost entirely exposed to juvenile eel migration, making it suitable for tilapias and mullets. It's vital to perform a thorough examination of the newly discovered critter, which could represent a threat to the fish population in the lagoon (Abdalhamid et al., 2018). When comparing the two water bodies, Ain Al-Ghazala waters were found to be slightly contaminated and of average quality, whereas Umm-Hufaynn waters were found to be slightly polluted and of average quality. In terms of statistical analysis (Table 2), T-tests revealed significant differences in water parameters between the two investigated areas ($p<0.01$), except for water pH ($p>0.5$). Ain Al-Ghazala has conductivity and total dissolved solids more than twice as high as Umm Hufayn. In fact, TDS are indicative of conductivity, namely, the higher TDS, the higher conductivity of water. Furthermore, hardness, alkalinity, chlorides, nitrates, sulphates, and bicarbonates were also dramatically higher at Ain Al-Ghazala when compared to Umm Hufayn.

The primary factors influencing lake water quality evaluation that should be managed are nitrate, phosphate, alkalinity, and total sus-

pended solids. The main reason for the difference in the physical, chemical, and biological properties between the two lakes is due to the increasing urbanization. The consequent discharge of harmful effluents from large cities is continually altering the water quality and productivity of Lakes Adverse changes in water quality of aquatic ecosystems in Ain Al-Ghazala and Umm-Hufayn Lake are reflected in the biotic community structure, and the most sensitive species often act as sentinels of water quality. Therefore, water quality monitoring is vital for the conservation of water resources and their sustainable use for irrigation and fish farming. The quality of surface water is mainly affected by natural processes (weathering and soil erosion) as well as anthropogenic inputs (municipal and industrial wastewater discharge). The anthropogenic discharges represent a constant polluting source, whereas surface runoff is a seasonal phenomenon, mainly affected by climatic conditions (Singh et al., 2004). The lagoon of Ain Al-Ghazala hosts a breeding site for the loggerhead sea turtle *Caretta caretta*. Mating occurs inside the lagoon (Pergent et al., 2007), while the egg deposition takes place outside along the sandy coastal region located to the east (Laurent et al., 1999). Lake Umm-Hufayn is home to a diverse range of fish, including mullet, sea bass, and tilapia, as well as being an important turtle hatching location and a haven for migratory birds (Abdalhamid et al., 2018).

Table (2). Differences in the means of water parameters, Independent Samples Test**,** T-test for Equality of Means

Water parameters		Sig.	t	Sig.	MD	Std. Error	95% CID	
							Lower	Upper
EC	EVA	.40	69.84	.00	33.42	.47	32.42	34.43
	EVNA		69.84	.00	33.42	.47	32.42	34.43
TDS	EVA	.43	70.01	.00	22.38	.31	21.71	23.06
	EVNA		70.01	.00	22.38	.31	21.71	23.06
pH	EVA	.18	.91	.37	.07	.07	-.09	.23
	EVNA		.91	.38	.07	.07	-.09	.23
Hrds.	EVA	.41	68.22	.00	3.87	.05	3.75	3.99
	EVNA		68.22	.00	3.87	.05	3.75	3.99
Alk.	EVA	.00	23.82	.00	1.67	.07	1.52	1.82
	EVNA		23.82	.00	1.67	.07	1.52	1.83
Cl	EVA	.12	51.54	.00	3.63	.07	3.49	3.78
	EVNA		51.54	.00	3.63	.07	3.48	3.78
NO_2	EVA	.51	61.63	.00	.10	.00	.10	.11
	EVNA		61.63	.00	.10	.00	.10	.11
NO_3	EVA	.07	10.65	.00	1.06	.10	.85	1.27
	EVNA		10.65	.00	1.06	.10	.84	1.29
SO_4	EVA	.39	52.41	.00	1.27	.02	1.24	1.32
	EVNA		52.41	.00	1.27	.02	1.24	1.32
PO_4	EVA	.37	68.25	.00	.22	.00	.21	.23
	EVNA		68.25	.00	.22	.00	.21	.23
SiO_2	EVA	.30	15.25	.00	.00	.00	.00	.00
	EVNA		15.25	.00	.00	.00	.00	.00
CO_3	EVA	.39	80.12	.00	.04	.00	.04	.04
	EVNA		80.12	.00	.04	.00	.04	.04
HCO_3	EVA	.21	57.10	.00	1.53	.02	1.48	1.59
	EVNA		57.10	.00	1.53	.02	1.48	1.59
Ca	EVA	.40	68.19	.00	3.28	.04	3.18	3.38
	EVNA		68.19	.00	3.28	.04	3.18	3.38
Mg	EVA	.11	23.93	.00	.60	.02	.55	.66
	EVNA		23.93	.00	.60	.02	.55	.66
Na	EVA	.39	65.30	.00	2.97	.04	2.87	3.07
	EVNA		65.30	.00	2.97	.04	2.87	3.07
K	EVA	.36	41.80	.00	.13	.00	.13	.14
	EVNA		41.80	.00	.13	.00	.13	.14

EC: electric conductivity, TDS: total dissolved solids, Hrds.: hardness, Alk.: alkalinity, EVA: Equal variances assumed, EVNA: Equal variances not assumed, LTEV: Levene's Test for Equality of Variances, 95%, MD: Mean Difference, CID: Confidence Interval of the Difference

CONCLUSION

The study found that the ecological characteristics of these lakes vary greatly. Some elements are over the allowable limits based on the standard limitations of the aquatic ecosystem. As a result, further research is needed to assess the anthropogenic activities that degrade water quality, and special care should be given to water management and the protection of the environment all around the lakes. The dumping of garbage and other urban waste products around the site must be strictly avoided, given the highly sensitive ecological balances that should be maintained. Urgent action should be taken to protect the lakes. Now that there is a definite underway to develop a hatchery and aquafarming complex at Ain Al- Ghazala and Umm-Hufayn lagoon, careful consideration should be given to the need for embarking on any additional large-scale capacity building for the national aquaculture sector in the near term.

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تقييم جودة مياه البحيرات (بحيرة عين الغزالة وبحيرة أم حفين)، لاستزراع الأسماك بالساحل الشرقي، ليبيا

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تاريخ الاستلام: 12 أغسطس 2021 / تاريخ القبول: 14 مارس 2022
Doi:https://doi.org/10.54172/mjsc.v37i2.527

المستخلص : أجريت تقييمات لبعض الخصائص الفيزيائية والكيمائية في اثنين من المسطحات المائية الليبية (عين الغزالة وأم حفين). لكل نظام بيئي، تم اخذ عشر عينات مائية من عشر نقاط لغرض التحليل. وأظهرت النتائج أن الموصلية الكهربائية في مياه خليج عين الغزالة أعلى منها في مياه بحيرة أم حفين. في كلا المنطقتين، سجل الأس الهيدروجيني لتركيز أيون الهيدروجين أعلى قيم بقيمة 8.3 مع قيم متوسطة للكلوريد (Cl) تجاوزت الحدود المسجلة دوليًا. علاوة على ذلك، فإن النتريتات (NO2)، والنترات (NO3)، والكبريتات SO4، والفوسفات (PO4)، والسيليكات (SiO2)، والكربونات (CO3)، والكالسيوم (Ca)، والمغنيسيوم (Mg)، والصوديوم (Na)، والبوتاسيوم (K) كانت جميعها أعلى في مياه خليج عين الغزالة عنها في مياه بحيرة أم حفين. اخيرا، ينبغي اعطاء المزيد من الاهتمام إلى الحفاظ على هذه الموارد الطبيعية.

الكلمات المفتاحية : جودة المياه، الخصائص الفيزيائية والكيمائية، بحيرة عين الغزالة، بحيرة أم حفين.

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