Libyan Journal of Ecological & Environmental Sciences and Technology
(LJEEST)
ISSN: 2710-5237
www.srcest.org.ly/jou

DOI: https://doi.org/10.63359/74r08x24

Seasonal Variation of Water Physico Chemical Properties and Nutrients of Farwa Lagoon, Libya

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ARTICLE INFO

Vol. 7 No. 1 April., 2025
Pages (39-43)

Article history:
Revised form 2 Feb. 2025
Accepted 3 March 2025

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Keywords:
Farwa lagoon , permissible limits,, Libya

ABSTRACT

Some physico-chemical properties, namely temperature, pH, salinity, dissolved oxygen, and major nutrients, namely NH_3, NO_2, NO_3, and PO_4, were studied for water samples from ten stations in the Farwa Lagoon on the western coast of Libya during July 2010 to January 2011.The study revealed that the water temperature of the lagoon varied between 16.0-33.0°C; pH 7.24-8.26; salinity 37.9-52.8 ppt; D.O. 5.182-8.375 mg/l; ammonia 0.002-0.0415; nitrate 0.0033-0.0555 mg/l; nitrite 0.001-0.0132; and phosphate 0.0002-0.0087 mg/l. Salinity showed high levels during the dry season. Rainfall, distance from seawater, and high temperature play a major role in the variation of the lagoon's salinity. Low salinity of water was observed at stations 7 and 8 located near seawater during the rainy season. It was noted that the concentrations of nutrients measured in Farwa Lagoon water for all stations during the sampling seasons were within the normal range and did not indicate any nutrient pollution inside the lagoon. The results are important in understanding the pattern of variation of water quality parameters so as to assist relevant agencies to plan, protect, and aid in the management of the lagoon water for different uses.

التباين الموسمى للخصائص الفيزيائية والكيميائية والمغذيات في بحيرة فروة بليبيا

محمود عبد المطلب باره، ازدهار على التلوثى، عائشه محمد المجدوب

تمت دراسة بعض الخصائص الفيزيائية والكيميائية مثل درجة الحرارة والرقم الهيدروجيني والملوحة والأكسجين الذائب والعناصر الغذائية الرئيسية مثل الأمونيا (NH_3) و والنتريت(NO_2) والنتراث (NO_3) والفوسفات (PO_4) لعينات مياه بحيرة فروه الشاطئية تم تجميعها من عشر محطات خلال الفترة من يوليو 2010 إلى يناير 2011. بينت نتائج الدراسة أن درجة حرارة مياه البحيرة تراوحت من 16.0 إلى 33.0 درجة مئوية ودرجة الحموضة من 7.24 إلى 8.26 والملوحة من 37.9 إلى 52.8 جزء في البليون وتركيز الأكسجين الذائب من 5.182 إلى 8.375 ملجم / لتر والأمونيا 0.002من إلى 0.0415 والنترات من 0.003 إلى 0.0555 ملجم / لتر والنتريت من0.001 إلى 0.0132 والفوسفات من 0.0002 إلى 0.0087 ملغم/لتر. أظهرت الملوحة مستويات عالية خلال موسم الجفاف؛ ولوحظ أن هطول الأمطار والبعد عن مياه البحر وارتفاع درجة الحرارة لعبت دورًا رئيسيًا في تباين ملوحة البحيرة، حيث وجد انخفاض في ملوحة المياه في المحطتين 7 و8 الواقعتين بالقرب من مياه البحر خلال موسم الأمطار. كانت تراكيز المغذيات المقاسة في مياه بحيرة فروة لجميع المحطات خلال مواسم أخذ العينات ضمن المعدا الطبيعي لها ولا تشير إلى أي تلوث بهذه المغذيات داخل البحيرة. النتائج مهمة في فهم نمط التباين في معايير جودة المياه لمساعدة الهيئات ذات الصلة على التخطيط والحماية والمساعدة فى إدارة مياه البحيرة للاستخدامات المختلفة.

INTRODUCTION

A coastal lagoon is an inland body of water that typically runs parallel to the coast and is surrounded by a barrier separating it from the ocean. It is connected to the ocean by one or more inlets and is usually only a few meters deep. The lagoon may or may not be affected by the tides from the sea, and the salinity of the water in it may vary from a fresh coastal lake to one with very high salinity, depending on the hydrological balance of the area. Lagoons are usually adjacent to the seashore with their largest diameters. There are two main types of lagoons according to their connection to the sea: closed lagoons and open lagoons. The physical, chemical, and biological diversity of lakes is greatly influenced by three interrelated properties: the amount of ocean water inflow, the degree of enclosure, and salinity. Mediterranean coastal lagoons are highly productive shallow ecosystems between marine water bodies and watersheds, which, due to climatic and hydrological influence, exhibit high variability in their environmental parameters. Coastal lagoons are important as a supply of fisheries products, nursery areas for marine fish, and habitats for a wide variety of aquatic flora and fauna. Coastal lagoons are subject to widely fluctuating physical and chemical regimes that place enormous stress on the organisms that inhabit them. Therefore, a deep understanding of the physical and chemical systems present in a coastal lake is essential to effectively appreciate and manage its environment (Armah and Ababio, 2005; Al-Asadi, 2012; Onyema, 2009; Orfanidis *et al*., 2005). Water quality is defined by its chemical, physical, and biological properties. Even in the absence of pollution, the nature of river and lake water varies according to seasons and geographical locations. Temperature, rainfall, pH, salinity, and dissolved oxygen are the basic physical and chemical properties that affect an aquatic ecosystem. These conditions are very important to the continuity of aquatic life (flora and fauna). Poor water quality can be caused by inadequate water flow, municipal effluents, or industrial discharges. The most significant environmental factor is most likely the temperature of the water. It impacts aquatic organisms' development, eating, reproduction, distribution, metabolic processes, and migratory patterns. A major environmental factor that plays a role in the survival of aquatic species, as well as in metabolism, physiology, and growth, is hydrogen ion concentration, also known as pH.

Salinity is an important environmental parameter in its own right, and it plays a vital role in some chemical processes. Dissolved oxygen (DO) impacts the availability and solubility of nutrients, low concentrations can damage the oxidation state of substances, causing them to shift from an oxidized state to a reduced state, thus raising levels of harmful metabolites (Lawson,2011). Nutrients are naturally occurring substances that are found in low concentrations in aquatic ecosystems (Nartey *et al*.,2011), While excessive inputs of nutrients and organic matter are having an increasing impact on coastal lagoons, often as a direct a consequence of human activity, like (fish farming and sewage discharge) or as an indirect result (such as eutrophication). Excess nutrients in a coastal lake may lead to pollution (Magni, 2008).

MATERIALS AND METHODS.

Samples of water were collected from the study area, Farwa Lagoon, which is located 150 km west of Tripoli and has an area of about 310 hectares. The lagoon is divided from the sea by a narrow strip 11 km long. The lake communicates with the sea through two openings, one of which is located west of the lake and is relatively wide, 3.5 km wide, and the other is located east of the lake and is 10 meters wide. The depth of the lake ranges from 0.5 to 2.5 meters. Figure (1) shows the studied area (Farwa lagoon) and the sample collection stations.

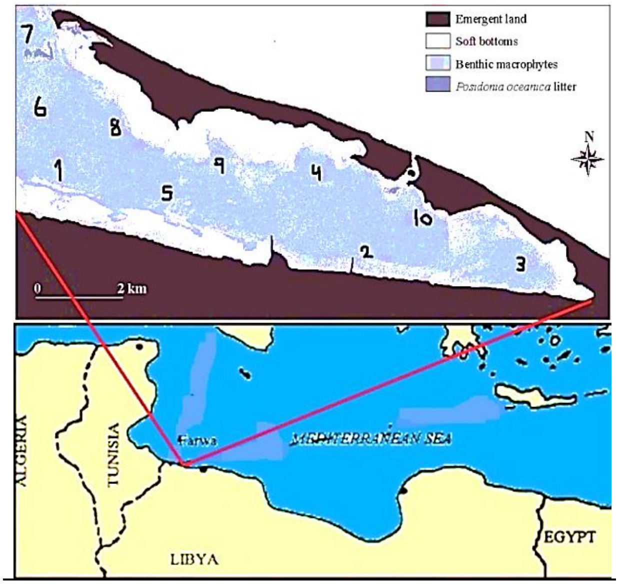

Figure 1:- Sampling sites in Farwa lagoon

Surface water was collected from 10 stations (Fig. 1) three times to determine environmental changes during the winter season, the dry season, and the rainy season (July 2010, October 2010, and January 2011).

Water temperature was measured by a mercury thermometer; samples were taken in glass and polyethylene bottles and stored at 4°C for transport to the laboratory. Analysis was performed in our laboratory in Tajoura, about 170 km from the sampling site. The dissolved oxygen and pH were measured in situ using Hanna HI-9145 and HI-9025, respectively. The Mohr-Knudsen method was used to measure the salinity of filtered lake water; ammonia, nitrate, nitrite, and phosphate were quantified using the colorimetric techniques with the AutoAnalyzer 3HR. one-way ANOVA used to examine the statistical variations between the physico-chemical parameters' means and nutrients of the study sites using SPSS software.

RESULTS AND DISCUSSION

a. Results

Physicochemical Parameters:

The temperature of the water ranged from 16 to 33°C. The lowest temperature was recorded in January at 16°C, while the greatest temperature was observed in July at 33°C. The average temperature values during the collection periods were 23 °C±0.652. The pH was found to range between a minimum of 7.24 in January and a maximum of 8.26 in July. The average pH value for the sampling seasons was 7.76±0.0378. Salinity varied during the sampling period due to the effect of rainfall, with the lowest salinity value being 37.9‰ in January, while the highest salinity value was 52.80‰ in July. The average salinity value through the sampling period was 44.16‰ ± 0.364. Dissolved oxygen concentrations ranged from 5.18 mg/l to 8.38 mg/l, with the lowest concentration of 5.18 mg/l recorded in July, while the greatest concentration of 8.38 mg/l was recorded in January, and the average dissolved oxygen concentration was 6.78 mg/l ±0.1249.

Nutrients:

Ammonia concentrations varied from a low of 0.002 mg/l in January to a high of 0.0415 mg/l in July. The average ammonia concentration through the sampling period was 0.0181 mg/l ± 0.0008.The lowest nitrite level was 0.001 mg/l in July, while the greatest was 0.0132 mg/l in October. The average nitrite content throughout sampling was 0.0059 mg/l ± 0.0012. Nitrate showed the lowest level of 0.0007 mg/l in January, while the greatest level of 0.0125 mg/l was found in July. The average nitrate values throughout the sampling period were 0.0051 mg/l ± 0.0004. Phosphate recorded its lowest concentration of 0.0002 mg/l in January, while its maximum level of 0.0056 mg/l was recorded in July. The average phosphate values throughout the sampling period were 0.0024 mg/l ± 0.0004.

Table (1). Physicochemical parameters in Farwa Lagoon water (summer, autumn, winter) 2010-2011.

Seasons	°C water	pH	S‰	D.O **mg/l**
Summer 2010	27 – 33 30.03±1.803	7.70 – 8.26 7.89 ± 0.187	41.2 – 52.8 46.64±3.24	5.18 – 7.05 6.22±0.691
Autumn 2010	22 – 23.9 22.59±0.677	7.57 – 7.95 7.78±0.113	40.15 – 46.75 43.31±2.52	5.68 – 7.77 6.95±0.653
Winter 2011	16 – 18 17.65±0.668	7.24 – 7.71 7.59±0.139	37.9 – 47.35 42.52±2.81	5.79 – 8.38 7.18±0.886
Annual average	23.4±0.652	7.75 ± 0.0378	44.15± 0.3639	6.78±0.1249

b. Discussion

The variation of the water physicochemical parameters and nutrient concentrations in the present study was significantly different across the seasons ($p<0.05$).

Water temperature:

Temperature significantly affects the rate of biological and chemical processes in water; no other factor influences fish growth and development as much as water temperature (Babalola and Agbebi, 2013).

Table (2). Nutrients in Farwa Lagoon water (summer, autumn, winter) 2010-2011

Seasons	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	PO_4 mg/l
Summer 2010	0.018 – 0.0415 0.029±0.008	0.001–0.003 0.0015±0.0007	0.02–0.0555 0.0318±0.012	0.0055–0.0087 0.0060±0.0009
Autumn 2010	0.0045–0.027 0.0136±0.008	0.0078–0.0132 0.0101±0.0016	0.0061–0.0449 0.0195±0.0146	0.00016–0.00065 0.00034±0.0002
Winter 2011	0.002–0.018 0.011±0.006	0.0012–0.0103 0.0059±0.0032	0.0033–0.0354 0.0162±0.0116	0.00015–0.0011 0.00074±0.0003
Annual average	0.0181±0.0008	0.0059±0.0012	0.0225±0.0016	0.0024±0.0004

The seasonal temperatures recorded during the study period at the Farwa lagoon indicate that the temperature was high in July and started to decrease from October to January, resulting from the increased ambient temperature during the dry season (July) and the low ambient temperature during the rainy season (January). The surface runoff during the rainy season from the interior can also be responsible for the low temperature of the lake water from July to January. Saif (1987), during the summer, it was observed that the water temperature was elevated due to low water levels, high ambient temperatures, and clear weather conditions.

pH

Figure 2 shows the seasonal variation of pH in Farwa lagoon. From the present study, the pH values indicate a slightly alkaline nature during the sampling seasons. According to Murhekar (2011), the samples are slightly alkaline due to the presence of carbonates and bicarbonates. The pH values of the water samples ranged from 7.24 to 8.26, and thus all pH values fall within the WHO 2008 standards of 6.5-8.5. pH higher than 7.0 but lower than 8.5 is ideal for biological productivity, but pH values below 4.0 are harmful to aquatic life (Abowei, 2010).

Salinity

In the present study, seasonal variation was significant ($P < 0.05$). Figur. 2 shows the pattern of salinity distribution over the three seasons tested, with salinity values being higher in summer than in autumn and winter, indicating that the prevailing weather conditions supported a higher evaporation rate in hot seasons (Al-Farawati,2008). As reported in Abdo,(2005), the lowest salinity values were recorded during winter and the highest values were recorded during summer. This is mainly due to the increased evaporation rate, as temperature affects the rate of evaporation and precipitation,(Abd ellah and Hussein,2009) especially in the isolated areas. The increment in salinity is compensated during the winter season by rainfall and seawater entrance through the inlets.

Dissolved oxygen

The variation in D.O. concentration in the lake was statistically significant across different sampling seasons ($p < 0.05$). The rainy period observed a D.O. range between 5.8 mg/l (at 9) and 8.4 mg/l (at 1), The rainy period observed a D.O. range between 5.8 mg/l (at 9) and 8.4 mg/l (at 1), while the dry season observed concentrations within 5.2 mg/l (at 2) and 7.1 mg/l (Table 1, Fig. 2). Many scientific studies indicate that 4–9 mg/l of D.O is the optimum range that will support a wide variety of fish (Abdus-Salam *et al*, 2010). If dissolved oxygen levels fall below 3.9 mg/l, some fish and other aquatic organisms may become stressed, and if they fall below 2.0 mg/l, many species may die. Variation in dissolved oxygen levels may be affected by the presence of aquatic weeds and their decaying plant material, domestic waste, and human/animal waste that has found its way into the lake. The concentration of D.O. in water is influenced by the water temperature, the salt content of the water, and the partial pressure of oxygen in the atmosphere (Lawson, 2011).

Nutrients:

Ammonia: The WHO and USEPA permissible limits for ammonia are 0.3 and 0.5 mg/l, respectively, so all values obtained during the sampling seasons are within the normal range. In the present study, the highest value for ammonia was recorded during the dry season (July) in Stations 2 and 8 as shown in Fig. 2. According to (Nartey *et al*., 2011), the high value in the dry season may be attributed to local pollutants from wastewater from points.

Nitrite concentrations ranged from 0.001 to 0.0132 mg/l, with the lowest and highest values observed at all sampling stations (Table 2, Fig. 2). The annual average value is 0.0059 mg/l (Table 2). Since nitrite is an intermediary in the oxidation of ammonia into nitrate, wastewater is a rich source of ammonia nitrogen, and water showing any significant amounts of nitrite is considered to be of highly questionable quality (Omeru *et al*., 2018). Levels in unpolluted waters are usually low, below 0.03 mg/l (EPA, 2001). The high nitrite values > 0.2 mg/l are an indication of possible sewage discharge into the lagoon.

Nitrate: The results of the analysis of variance (ANOVA) regarding seasonal variations in nitrates indicate significant seasonal variation ($p < 0.05$ $p=0.027$). The results indicated that the highest concentration of nitrates was observed during the dry season, 0.005 mg/l, while the stations close to seawater recorded the lowest values due to the dilution of nitrate levels as a result of mixing with seawater (Green *et al*., 2019). Nitrate values varied across sampling sites but did not above the USEPA limit of 0.1 mg/l for wastewater discharged into an aquatic ecosystem, indicating that all sampling sites were free of nitrate contamination (Nartey *et al*., 2011). High concentrations of nitrates in lagoon water are usually located near cultivated land, where wastewater from nearby land reaches the lagoon (Sugirtharan *et al*., 2017).

Phosphate: The results of the analysis of variance (ANOVA) regarding seasonal variations in phosphate indicate highly significant seasonal variation ($p < 0.05$, $p = 0.000$).The monthly average values of phosphate in lake water ranged from 0.0002 to 0.0086mg/l. Table (2) shows the phosphate concentrations in Farwa Lagoon at various locations through the sampling seasons. The greatest level was observed through the dry season of 2010 at Station (2). According to the CEA water quality standards for Sri Lanka as quoted by Green Tech Consultants (2009), the maximum allowable phosphate concentration for aquatic life is 0.4 mg/l, while the critical threshold to prevent accelerated eutrophication is 0.1 mg/l (Sugirtharan *et al*., 2017). The values obtained during the sampling seasons did not exceed the maximum value for total phosphorus set by the EPA, which is 2.0 mg/l, indicating that Lake Farwa is not contaminated with phosphate (Nartey *et al*., 2011).

In Conclusion this study, the physicochemical parameters of Farwa Lagoon were evaluated. Lake water salinity was high during the dry season and in certain locations during the rainy season. The difference is primarily attributed to the rainfall pattern and high temperature in the area, in addition to the blockage of the water renewal and circulation hole inside the lagoon with sand. The results showed that the dissolved oxygen level in the lagoon water was within the normal range and suitable for aquatic species. Nutrient concentrations in the lagoon near urban areas and anthropogenic activities did not exceed the maximum limit considered for aquatic species. Through the results obtained in this study, the pattern of difference in water quality parameters within the lagoon can be understood. This information can be utilized to plan, safeguard, and manage lake water for diverse purposes. Due to the high salinity of the lagoon water, this study recommends the need to remove sand from the water renewal and circulation hole located to the northeast of the lagoon.

REFERENCES

Abd Ellah, Radwan. G.and Hussein, Maged. M.,2009. Physical limnology of Bardawil Lagoon, Egypt.

American-Eurasian J. Agric. & Environ. Sci., 5 (3): 331-336.

Abdo, Mohamed. H.,2005. Physico-chemical characteristics of Abu Za'baal ponds, Egypt. Egyptian journal of aquatic research, vol. 31 no. 2, 2005: 1-15.

Abdus-Salam. N; Adekola, F.A.and Apata,A.O.,2010. A Physicochemical Assessment of Water Quality of Oil Producing Areas of Ilaje, Nigeria. Advances in Natural and Applied Sciences, 4(3): 333-344.

Abowei,J.F.N.,2010. Salinity, Dissolved Oxygen, pH and Surface Water Temperature Conditions in Nkoro River, Niger Delta, Nigeria. Adv. J. Food Sci. Technol., 2(1): 36-40.

Al-Asadi,M.K.,2012. Levels of oil residues in some coastal lagoons, east of Libya. Mesopot. J. Mar. Sci., 2012, 27 (1): 67 – 77.

Al-Farawati,R; Al-Maradni,A.and Niaz,R.G.,2008. Chemical Characteristics (Nutrients, Fecal Sterols and Polyaromatic Hydrocarbons) of the Surface Waters for Sharm Obhur, Jeddah, Eastern Coast of the Red Sea. JKAU: Mar. Sci., Vol. 19, pp: 95-119.

Armah,A.K and Ababio,S.D., 2005. Spatial and temporal variations in water physicochemical parameters in the south-western sector of the KETA LAGOON, GHANA. Proceedings of the 14th Biennial Coastal Zone Conference New Orleans, Louisiana July 17 to 21, 2005

Babalola, O.A.and Agbebi, F.O.,2013. PHYSICO-CHEMICAL CHARACTERISTICS AND WATER QUALITY ASSESSMENT FROM KURAMO LAGOON, LAGOS, NIGERIA. International Journal of Advanced Biotechnology and Research,3(1)2013.

Environmental protection agency (EPA), 2001.Interpretetion and standards ISBN 1-84096-015-3.

Green. Rebecca,H; Jones. Nicole,L; Rayson. Matthew,D; Lowe. Ryan,J; Bluteau. Cynthia,E.and Ivey. Gregory,N.,2019. Nutrient fluxes into an isolated coral reef atoll by tidally driven internal Bores. Limnology and Oceanography,vol 6,461-473.

Green Tech Consultants. (2009). An assessment of the change in shoreline location along thecoast of the Eastern Province of Sri Lanka, using remote sensing technology. Revised Final Report. Pp. 49. North East Coastal Community Development Project (NECCDEP).

Lawson,E.O.,2011. Physico-Chemical Parameters and Heavy Metal Contents of Water from the Mangrove Swamps of Lagos Lagoon, Lagos, Nigeria. Advan. Biol. Res, 5 (1): 08-21

Magni,P; Rajagopal,S; van der Velde.G; Fenzi,G; Kassenberg,J; Vizzini,S; Mazzola,A and Giordani,G.,2008. Sediment features, macrozoobenthic assemblages and trophic relationships (d13C and d15N analysis) following a dystrophic event with anoxia and sulphide development in the Santa Giusta lagoon (western Sardinia, Italy). Marine Pollution Bulletin, 57(1-5):125-36.

Murhekar,G.H.,2011. Assessment of Physico-Chemical Status of Ground Water Samples in Akot city. Res.J.Chem.Sci, Vol. 1(4), 117-124.

Nartey,V.K; Edor,K.A; Doamekpor,L.K and Bobobee,L.H.,2011. Nutrient Load of the Sakumo Lagoon at the Sakumo Ramsar Site in Tema, Ghana. West African Journal of Applied Ecology, vol. 19,2011.

Orfanidis,S;Stamatis,N;Ragias,V and Schramm,W.,2005.Eutrophication patterns in an eastern mediterranean coastal lagoon Vassova: delta nestos ,Macedonia ,Greece.Medit.Mar.Sci,6/2,2005,17-30.

Onyema,I.C.,2009. Notes on the existence of an additional lagoon in South-western Nigeria: Apẹṣẹ Lagoon. Journal of American Science 2009;5(4):151-156.

Safe, S.H. (1987) “Polychlorinated Biphynels (PCBs) Mammalian and Environmental Toxicology. Springer-Verlag, NY: pp 1-52.

.

Sugirtharan, M ;Pathmarajah, S. and Mowjood, M.I.,2017. Spatial and Temporal Dynamics of Water Quality in Batticaloa Lagoon in Sri Lanka. Tropical Agricultural Research, Vol. 28 (3): 281–297.