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Original article

Study of the Physicochemical and Bacteriological quality of surface water in the Oran Region

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Abstract

Water is an essential resource. Its use for food, body hygiene or recreational requires a high level of physico-chemical, chemical and microbiological quality. The substances they transport are in fact likely to be ingested, inhaled, or to come into contact with the skin. Therefore, the analysis of eight parameters in addition to pH and which are the electrical conductivity, total phosphorus, chloride, Ammonium, Sulfate, Nitrate, Chemical Oxygen Demand (COD) and Matter in suspension (MES) as well as the analysis of total coliforms, faecal streptococci and clostridium were carried out on the waters of three lakes, Dayat Morsli, Telamine, and Gharabas, located in Northwestern Algeria in the Oran region. The results show that the three lakes are saline wetlands where total phosphorus is found at lower concentrations while chlorides, Ammonium and Sulfate are found at concentrations above standards. The pH of Lake Dayat Morsli, the Nitrate of Lake Telamine, the COD and the MES of Lakes Dayat Morsli and Telamine exceed international standards. These results could be used as a basis for the rehabilitation project of this wetland.

Keywords: Bacteriology, Physico-chemical parameters, Pollution, Wetland.

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INTRODUCTION

The water that makes up 65% of the human body, between 75 and 100% of plants and covers 70% of the earth's surface is essential for life and its availability in strictly fixed quantities is dictated by the laws of conservation and water cycle. As a result, it becomes a coveted resource more than any other and its scarcity keeps entire populations in poverty traps and fuels political conflicts that can eventually lead to armed conflict (Baechler, 2012). Due to rapid population growth, economic development and other challenges that affect natural resources, water has become a precious commodity and global development trends suggest that the cost of water is expected to exceed that of the oil, gas, coal as well as other natural resources essential to the sustainable future of each country and region (Emomali, 2018). There are many sources of water, among which are lakes. In Algeria, there are many lakes some of which are used in agricultural activities or are considered as a place of entertainment. These uses are not without danger because these lakes are considered polluted with varying degrees of pollution from one lake to another due to various factors (industrial, agricultural, domestic or accidental ...) which can influence human health and environmental. Continuous monitoring and control of the waters of these lakes is essential and is proving to be important in order to guarantee better protection of both human and environmental health. This study is part of this framework with the objective of carrying out physicochemical and bacteriological analyzes of three lakes in the Oran region located in western Algeria.

MATERIAL and METHODS

Study area presentation

The Wilaya of Oran contains eight important natural wetlands which represent the best examples of wet ecosystems in Algeria, by their geographical, strategic position, ecological and hydrological function, their biodiversity and their socio-economic importance. Currently, only 4 sites are inscribed on the Ramsar list of international importance among them the lake of "Telamine" located in the municipality of Gdyel (Aibeche et al., 2017). The latter was the subject of this study as well as the "Dayat Morsli" lake located in the town of Es-Sénia, classified as a protected area by the Ministry in charge of the Environment (Sidhoum, 2019) and the Gharabas lake located in the commune of Boufatis (Fig.1 and 2).

Figure1. Geographical location of study sites

(MAPS, consulted on 03/09/2020)

Figure 2. Overviews of Dayat Morsli Lake, Telamine Lake and Gharabas Lake (taken on 03/09/2020)

Water samples were taken aseptically using an intermediate vessel submerged at a distance of approximately 15 cm from the water surface.

Bacteriological Analyzes

The microbiological analyzes were carried out at the central microbiology laboratory of the Oran Water and Sanitation Company (SEOR), During these analyzes, the hygiene and sterilization conditions were respected in order to " avoid any possible contamination. The bacteriological analysis focused on pollution indicator germs which include bacteria, total coliforms, faecal enterococci and clostrodia.

Total coliforms

100 ml of the sample are used. After filtration (0,45 µm), the filter paper is recovered and placed in a petri dish containing TTC CHAPMAN and then the dishes are incubated in the oven at 36 ° C for 24 h.

Confirmation test

Half of a colony was subcultured in TSA culture medium and incubated at 36 ° C for 24 h. At the same time, the second part of the colony is transplanted into tubes containing 3ml of tryptophan and then incubated at 44 ° C for 24 hours to detect E. Coli.

Oxidase test

After incubating the petri dishes for 24 hours, the oxidase (mixture of 0.025g powder oxidase and 2.5 ml of distilled water) is prepared to detect total coliforms.

Indole test

After incubating the tubes for 24 hours, four drops of kovacs reagent are added to the tubes.

Enterococci

100 ml of the sample are used and filtered (0.45 µm), the filter paper is collected and placed in a petri dish containing the SLANETZ and BARTLEY culture medium and then incubated at 36 ° C for 48 hours.

Confirmation test

The filter paper is recovered from the SLANETZ and BARTLEY medium and is placed in a petri dish containing the BEA medium and then the dishes are incubated in the oven at 44 ° C for 2 h.

Clostrodiums

The samples are placed in a water bath at 75 ° C. for 15 min. They are then rapidly cooled to 47 ° C. (thermal shock). 100 ml of the sample are used. After filtration (0.22 µm), the filter paper is recovered which is deposited so that the squared face adheres to the bottom of the petri dish containing the TSC culture medium and then incubated in an oven at 37 ° C for 48 h.

Physico-chemical parameter

Hydrogen Potential (pH)

The pH is carried out by measuring the difference between the measuring electrode and a reference electrode with known potential (calomel electrode with a saturated KCI concentration), it is less than or greater than 7 knowing that the water can be acidic or basic.

Electrical conductivity

Electrical Conductivity (EC) reflects the ability of an aqueous solution to conduct electric current. it is measured by a condictimeter.

Color measurement

The presence of color in the sample is considered to be a negative indicator of water quality. This analysis is carried out by a spectrophotometer

Odor measurement

25 ml of sample are placed in a beaker and you can smell if there is an odor, dilutions are made when the odor is strong until it disappears.

Sulfate measurement

Sulfate ions are precipitated and determined as Barium Sulfate. The homogeneous suspensions are measured with a spectrophotometer. Introduce 25ml of water to be analyzed in a beaker, 1.25 ml of the precipitating solution RO2 SO4-3 and a little Barium Chloride are added, stirred before reading

Ammonium

The hypochlorite ions are generated in situ by alkaline hydrolysis of the sodium salt of sodium Dichoroisocyanurate. In a 50 ml volumetric flask, 40 ml of water to be analyzed are taken, 4 ml of reagent I (Dichloroisocyanurate) are added then 4 ml of colored reagent and made up with distilled water. After stirring, it is placed in a water bath for 1 hour at 25 ° C. The results of the spectrophotometric measurement are displayed directly in mg / l.

Suspended matter

The weight of the filters is weighed before filtration (P1) and the latter is carried out. The filters are then incubated at 105 ° C. for eight hours, allowed to cool in a desiccator and then the weight of the filters after filtration is weighed a second time (P2).

Nitrates

Nitrates give sodium paranitro-salicylate in the presence of sodium salicylate, are colored yellow and susceptible to colorimetric determination. We enter the wavelengths in software for the calculation of the concentration in mg / l.

Total phosphorus

The total phosphorus is determined after mineralization of the sample by passage through a plasma emission spectrophotometer with inductive coupling. Place 10ml of water to be analyzed in a test tube, add 2 drops of 35% sulfuric acid and 0.1g of ammonium persulfate, then stir and place in the thermoreactor at 120 ° C for 30 minutes. After cooling add 2 ml of combined reagent. The spectrophotometer readings are taken after standing for 20 min.

Chlorides

Reaction of insoluble silver chloride with silver ions and chromate formation of chromate ions which were added as an indicator. This reaction is used for the indication of the turn. During the titration, the formation of a white precipitate of AgCl is observed**.** 100ml of water to be analyzed are introduced into a beaker on the Metrohm apparatus, the specific probe for chlorides is placed in the middle of the beaker. Launch the device and wait until it rings, a white precipitate of silver chlorides forms. Read the value of the titrated volume of silver nitrate and then calculate the: [cl-] = v (ml) x 235.45 in mg / l.

Chemical oxygen demand (COD)

The principle is based on oxidation by potassium dichromate ($K_2Cr_2O_7$) in an acidic medium and in the presence of silver catalyst and mercury sulfate. Take 2.5 ml of samples and add 1.5 ml of high level digestion solution (Mercury sulfate Potassium dichromate, distilled water). After 3.5 ml of reactive, sulfuric acid and mercury sulfate are added and then the mixture is stirred before leaving everything in the thermoreactor at 150 ° C. for 2 h. The reading is done using a spectrophotometer.

Statistical analysis

All measurements were made in triplicates. The repeatability of the values obtained was verified by a simple linear model. The result showed that all measurements were highly repeatable (F83-168 > 120 and $p < 10^{-3}$). The means of the three measurements were used thereafter.

Results

Bacteriological analyzes of the water in the three lakes studied show variations in terms of concentrations. All the results were compared to international standards authorized for human use set by the World Health Organization, WHO (OMS) and those set by FAO for irrigation water.

Total coliforms

The (Figure.3) shows the presence of yellow-orange colonies with different densities of the three lakes. This expresses the presence of total coliforms at extremely variable concentrations. Telamine Lake and Gharabas Lake present values above the international value of drinking water (10 CFU / 100 ml according to WHO) while Dayat Morsli Lake has values below this value. However, these values remain lower than the guide value for water intended for irrigation (1000 CFU / 100 ml according to FAO).

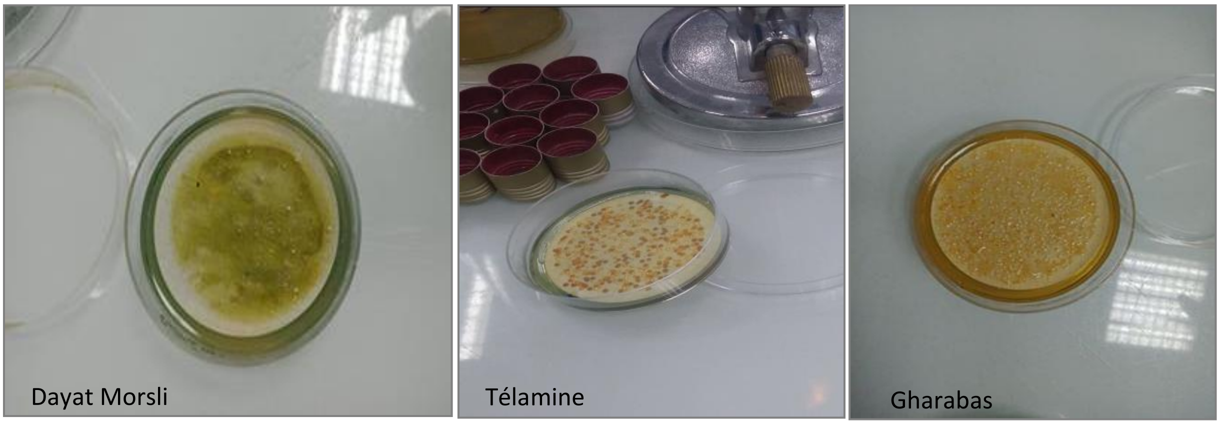

Figure 3. Orange-yellow colonies of total coliforms

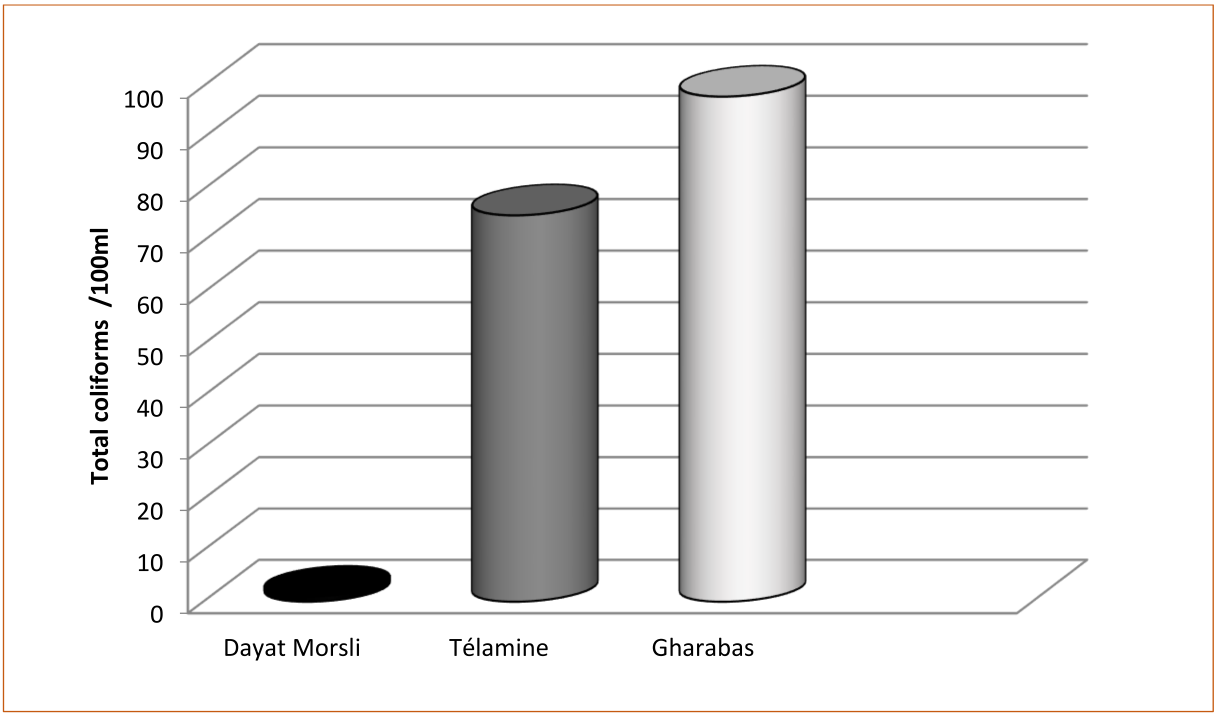

Figure 4. Total coliforms

The presence of E. coli was shown in the two sites, Telamine Lake and Gharabas Lake. The highest concentrations of total coliforms are recorded at Gharabas Lake with a maximum of 98 CFU / 100ml. Then the Telamine lake which occupies the second position with a concentration of 75 CFU / 100ml, and Dayat Morsli lake with a low concentration of 1 CFU / 100ml. According to Mehanned et al., (2014), total coliforms are naturally present on plants and in soils. This could be the reason for the high rate recorded in Gharabas Lake due to the presence of surrounding agricultural land or vegetation inside the lake, where they can accumulate as the temperature of the lake increases.

Enterococci

Figure 5 and 6 shows the presence of brick red colonies for the three lakes. which explains the presence of streptococci at extremely variable concentrations from one lake to another, they are expressed by the graph shown in Figure 7. The values are higher than the guide value for drinking water and they are lower than the guide value for water intended for irrigation (1000 SF / 100 ml).

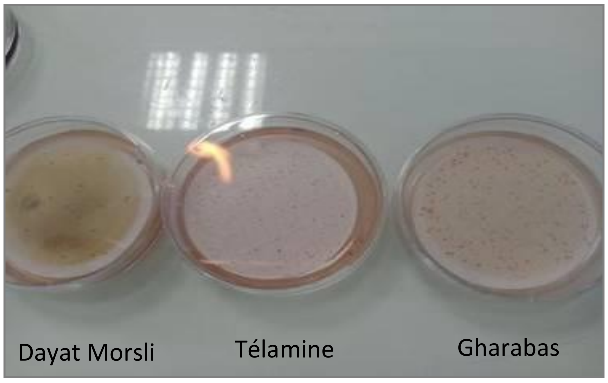

Figure 5. Red brick colonies of Streptococci

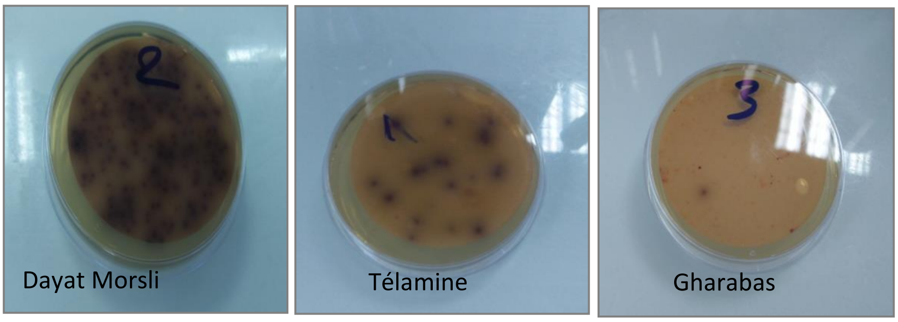

Figure 6. Black colonies after 2 hours incubation in BEA medium

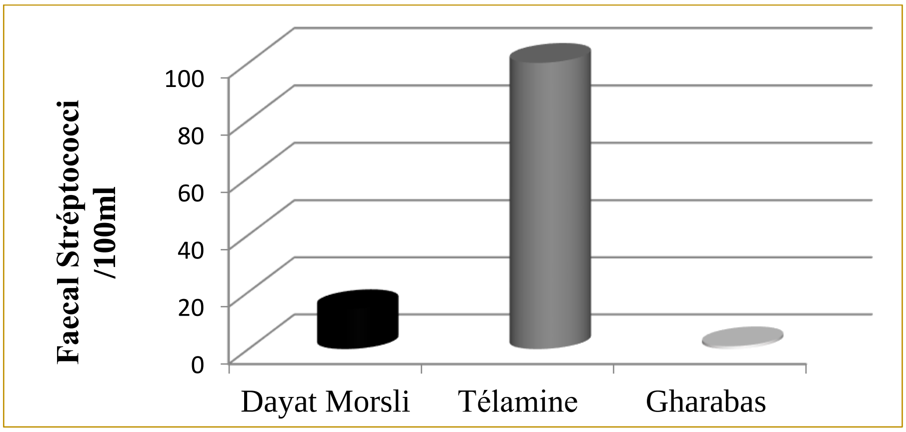

Figure 7. Number of faecal streptococci

Variations in physico-chemical parameters

Hydrogen Potential (pH)

The pH gives an indication of the acidity or alkalinity of water. Figure 8 shows us that the pH of the waters of Telamine Lake and Gharabas Lake varies from 7.6 to 8.48 which complies with drinking standards (6.5 <pH <8.5). The pH of Dayat Morsli Lake shows a high value, 9.40 thus exceeding the standards of drinkability.

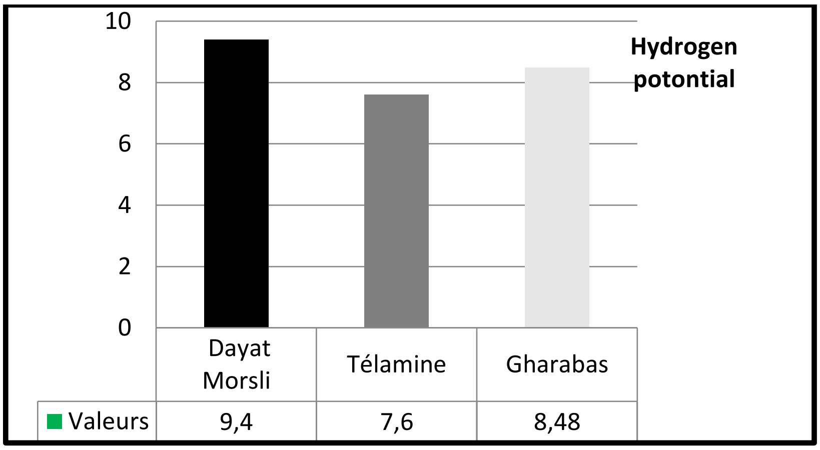

Figure 8. The pH of lake water

Conductivité électronique

Figure 9 shows that the conductivity values at the three water sites exceed the recommended standard for drinking water (400 µs / cm). However, for irrigation water, the Dayat Morsli and Gharabas lakes show values below the standard (20,000 µs / cm). On the other hand, Lake Telamine exceeds the standards.

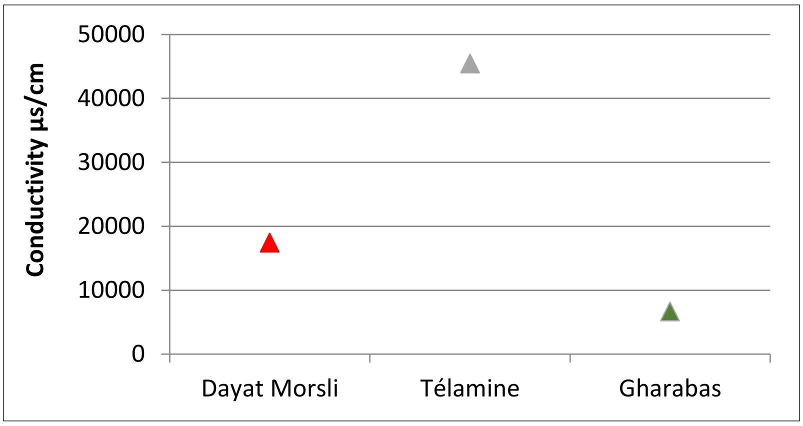

Figure 9. Electrical conductivity (EC) in lake waters

The lowest value is observed at Gharabas Lake with 6992µs / cm. while the maximum value is recorded at Telamine Lake with 45,500 µs / cm. Dayat Morsli Lake records 17440µs / cm. These high EC values necessarily indicate high mineralization (Table 1), which is explained by the nature of the terrain and the depth. However, waters at shallow depths are the most exposed to evaporation and therefore to an increase in their dissolved salt load (Aibeche et al., 2017).

Table 1. Water conductivity-mineralization relationship. (HADJADJ, 2018)

Conductivity (µs/cm)	Reviews
Conductivity < 100	Very low mineralization
100 < Conductivity< 200	Minéralisation faible
200 < Conductivity < 333	Low mineralization
333 < Conductivity < 666	Average mineralization
666 < Conductivity< 1000	Medium accentuated mineralization
Conductivity> 1000	Significant mineralization
	High mineralization

Color

Figure10 shows that the color values of the three water sites exceed the recommended standard for drinking water (15 UCV) according to the WHO. The maximum value is recorded at Lake Dayat Morsli with 427 mg / l. successively followed by the value of Lake Telamine estimated at 344 mg / l and the value of Gharabas estimated at 48 mg / l. These high values are probably due to the water pollution caused by the diversity of wastewater and industrial water as well as the illegal discharges that are dumped in these lakes. Animal fasces and soil quality may also play a role in increasing these values.

Odor

The smell of water is strong for all three study sites. Several dilutions were necessary as shown in Table 2. These odors come from wastewater and industrial water and wild dumps which are discharged into these lakes as well as from animal faeces.

Sulfate

The presence of sulfates in water can give it a noticeable taste at very high levels which can have a laxative effect in unaccustomed consumers. The maximum concentration is 250 mg / l according to the WHO (WHO, 2017). Table 2 shows that the sulfate concentrations in the three sites exceed the recommended standard for drinking water (250 mg / l), The maximum value is recorded at the level of the Telamine Lake, i.e. 4411 mg / l.

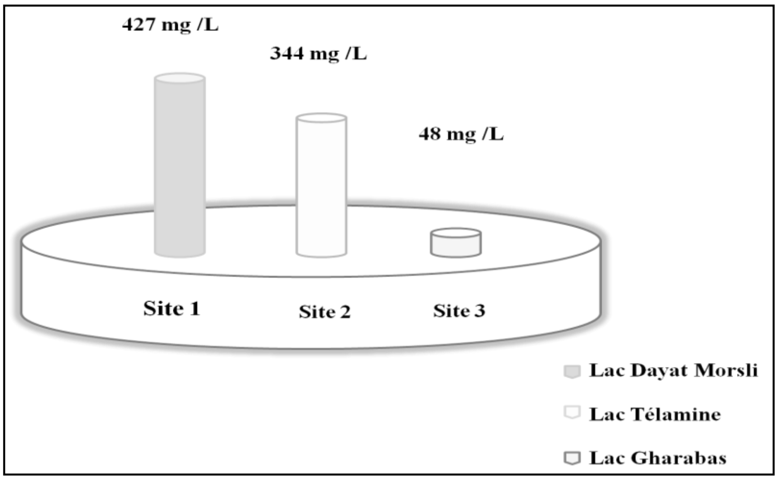

Figure 10. Color in lake waters

The minimum value at the level of the Gharabas Lake with 862.55 mg / l. Dayat Morsli Lake records the value of 3922.25 mg / l. These high values are probably due to the gypsum dissolution of the various water discharges as well as to the quality of the soil.

Nitrogen cycle

Nitrates

Their presence in water is generally linked to agriculture (spreading fertilizer or raising livestock). They also come from the mineralization of organic nitrogen and the oxidation of ammonium (Bennana, 2013). The highest concentration of nitrates is recorded at Lake Telamine (61,127 mg / l). This is higher than the WHO standards (2017) or 50 mg / l. On the other hand, the concentrations recorded at Lake Gharabas and Lake Dayat Morsli are successively 26.962 mg / l and 31.467 mg / l and which remain below the standard of 50 mg / l (Table 2).

Ammonium

In surface water, it comes from nitrogenous organic matter and gas exchange between water and the atmosphere (Boualla et al., 2011). The standard described by WHO is 0.50 mg / l while the values recorded for the three sites are higher than this standard (Table 2). The values are successively 4.65, 4.70 and 4.09 mg / l

Chloride

Water contains varying concentrations of chlorides, but in high proportions they give water and drinks a salty taste. (WHO, 2017). The contents obtained are greater than the drinkability standard (500 mg / l) in the three sampling sites (Table 2).

Total phosphorus

Concentrations of total phosphorus (table 2) are below the 5 mg / l standard described by WHO for drinking water. The maximum concentration is recorded at Lake Telamine with 0.508 mg / l. Dayat Morsli Lake shows a value of 0.242mg / l. On the other hand, we note the total absence of Phosphorus at the level of Gharabas Lake. According to El ouali lalami et al. (2010), the Phosphorus comes largely from domestic activities then from agricultural and industrial activities but also, from the fact that, the Phosphorus is linked to the transport of sediments in the aquatic environments which sediment in the funds following the leaching of neighboring rocks1

Suspended matter

The results (table 2) obtained in Dayat Morsli Lake and Telamine Lake (198mg / l and 316mg / l) are higher than the WHO (2017) standard for surface water (50 mg / l). On the other hand, the value obtained at Gharabas Lake is lower than this standard (39mg / l). This value confirms that Gharabas Lake is not very loaded with suspended matter compared to the other two.

Chemical oxygen demand (COD)

The COD is indicative of the level of global water pollution (Aibeche et al., 2017).

The WHO COD standard for surface water is less than 30 mg / L. The results (table 2) show varying metal concentrations from one site to another, the minimum value being recorded at Gharabas Lake 25.53 mg / l. The other two values are above the standards, ie 123.93 mg / l at Dayat Morsli Lake and 522.4 mg / l at Telamine Lake. These values are interpreted by the presence of industrial material that is more or less difficult to biodegrade (Aibeche et al., 2017).

Table 2. Water parameters of the stations studied

Lakes	**Odeur (dilution) %**	**Sulfate mg/l**	**Chlorure mg/l**	**Nitrate mg/l**	**Ammonium mg/l**	**Phosphore total mg/l**	**MES mg/l**	**DCO mg/l**
Dayat Morsli	20	3922,25	10283,46	31,467	4,65	0,242	198	123,93
Lac Télamine	50	4411	26829,40	61,127	4,7	0,508	316	522.4
Lac Gharabas	10	862,55	4122,83	26,962	4,09	0 mg/l	39	25,53

Discussion

This study reveals a variation in the bacteriological and physicochemical parameters of surface water in the Oran region. The results show a strong bacteriological contamination at the level of the study areas which exceeds the international and Algerian standards of drinkability. These results present lower values compared to those of the waters of Lake Tonga located in northeast Algeria (Bouchiar and Benalia, 2015) and those of the waters of Lake Témacine de Touggourt located in southeast Algeria (Bouchelaghem and Hafi, 2014). However, compared to Lake Annecy, one of the purest lakes and the second largest natural lake in France (Frossard et al., 2018), the values obtained remain higher. The results of the bacteriological parameters vary in the three sites, this is due to the nature of the soil and the plants it contains since total coliforms are naturally present on plants and in soils (Mehanned et al., 2014) and also to temperature which is one of the most important factors that act on the growth of microorganisms (Aibeche et al., 2017). The results of the physicochemical parameters vary in the three sites; the high values obtained may be due to the nature of the terrain (gypsum, limestone), the degree of its mineralization and salinity. They can also be the result of the presence of wastewater, industrial water, illegal dumping and animal and human faeces. The pH values obtained in Lake Telamine and Lake Gharabas are in international standards according to WHO 2017 and Algerian (OFFICIAL JOURNAL DE LA REPUBLIQUE ALGERIENNE N ° 18, 2011). But for Lake Dayat Morsli, its pH is higher than the standards. This increase is related to the large number of phytoplankton cells, in particular with the appearance of flowering (Ben Bayer et al., 2019). According to Aibeche et al. (2017), this indicates that the pH is strongly influenced by photosynthesis and mainly by the physical environment of a lake, the pH is related to the presence or absence of carbon dioxide, it can then reach higher values during the day and lower at night (Ben bayer et al., 2019). The color values exceed the standards because of wastewater and industrial discharges as well as wild dumps, while for Telamine Lake, it is rather due to the gray to black color of the ground (Sidhoum, 2019), according to Aibeche et al. (2017), the main source of color are microorganisms and particularly those that have the ability to degrade organic matter in the presence of oxygen. Due to this phenomenon, which is added to the problem of excessive discharges of pollutants, strong odors are released, making the place very unpleasant. According to the EC values obtained, the degree of mineralization is very high in the three sites studied. According to Hade (2003), conductivity is influenced by various natural and anthropogenic factors such as the geology of the watershed, temperature, water evaporation, variations in the flow of inputs that feed the lakes and water inputs from domestic origin. According to Ben Bayer et al. (2019), Nitrate and an essential element for the development of photosynthetic organisms. In wetlands, it is used by microorganisms and plants as mineral sources, but at high concentrations it causes eutrophication of the ecosystem. In our case, the values of nitrate and sulfate obtained exceed the standards of drinkability, the highest value is recorded at Lake Telamine. According to the study by the maximum and minimum values of Nitrates are linked to a low algal biomass and consequently to a low algal proliferation (Gouasmia et al., 2016), this is mainly due also to agricultural and urban waste containing high concentrations of Nitrates and Phosphates. These two elements are also linked to the decomposition of organic matter and bacteria, in particular nitrifying bacteria in water, which also increase the production of NO3 (Ben Bayer et al., 2019), the reduction of nitrates in an anoxic environment a as a stimulant for Sulfates (Gouasmia et al., 2016), according to the same authors, the nitrate contained in excess in surface water constitutes a source of environmental degradation. Regarding Ammonium, it constitutes the product of the final reduction of nitrogenous organic substances and inorganic matter in water and soils (Boualla et al., 2011). This explains the very high values recorded at the level of the three lakes with similar values, according to the same author, it also comes from the excretion of living organisms and the reduction and biodegradation of waste without neglecting contributions from domestic, industrial and agricultural sources. It also comes from gas exchange between water and the atmosphere. It is a good indicator of the pollution of rivers by urban effluents. According to Hadjadj (2018), Chlorides come from the permanent contact of water with ponds, from the presence of clayey levels in the alluvium, from intense evaporation (arid to semi-arid climate) but also from the dissolution of fertilizers and pesticides. used in agriculture as well as wastewater discharges (urban and animal discharges). This explains the high values of Chlorides recorded at the levels of the three lakes. The results obtained for total phosphorus for the three sites are lower than international standards in Telamine and Dayat Morsli lakes and total absence at Gharabas lake. While the MES values exceed the standards at Telamine and Dayat Morsli Lake these results are linked to various factors, among others, human activities. The most important values of COD of the analyzed waters are recorded in Telamine Lake and Dayat Morsli Lake thus exceeding the standards. This can be linked to the presence of industrial materials present in the soil and in illegal and industrial landfills. While Gharabas Lake which recorded a value below international standards, this is probably due to its location which is far from industrial areas.

Conclusion

The Wilaya of Oran includes eight important natural wetlands which represent the best examples of wet ecosystems in Algeria. This, by their strategic geographical position and their ecological and hydrological function. Telamine Lake which is inscribed on the Ramsar List of International Importance is one of them. The study is carried out with the aim of assessing the physicochemical and microbiological quality of the surface water of three lakes in the Oran region of western Algeria, namely Telamine Lake, Dayat Morsli Lake and Gharabas Lake. The results obtained from the three lakes through the microbiology analyzes carried out on the samples clearly show bacterial contamination to varying degrees depending on the lakes. Indeed, the results of Telamine Lake are marked by high bacterial concentrations largely exceeding the standards established by the WHO for drinking water making it unfits for human consumption. This water contamination is probably due to the poor protection of surface water, the non-application of basic hygiene measures, the discharge of uncensored hazardous waste and the poor evacuation and management of wastewater. Added to this are natural causes such as rain and the nature of the soil. The physicochemical parameters highlight the heterogeneity of the results. The latter depends on the parameter analyzed and the lake concerned. For the majority of cases, these results exceed international standards. These have often been linked to many factors, among others, sewage and domestic water, discharges of untreated industrial water and industrial agricultural practice disrespectful of the environment. In the light of these results, the water resources of the lakes of the Oran region are vulnerable to pollution generated by urban and agricultural development. Improving the quality of surface water and specifically that of lakes necessarily involves:

- A broad awareness campaign to reduce pollution of surface water;
- The suggestion of halophytic plants to reduce salinity;
- Maintenance by ensuring the circulation of lake water periodically;
- Installation of saltwater fish cultures;
- Permanent physico-chemical and bacteriological control;
- Establishment of an adequate drainage system for wastewater;
- On-site treatment or storage of industrial waste and discharges;
- Elimination of infiltration of domestic and industrial waste,
- Mechanical and biological filtering of wastewater for reuse.
- Creation of a safety belt around the lakes to protect the water surface from encroachment;
- Intensification of inspections of industrial establishments responsible for pollution and finally,

- Thoughtful management of these lakes to transform these places into tourist areas while ensuring their protection

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