International Journal of Global Science Research **ISSN: 2348-8344 (Online)**
Vol. 10, Issue. 1, April 2023, pp. 1976-1927 **DOI: 10.26540/ijgsr.v10.i1.2023.230**
***Available Online* at www.ijgsr.com**

Research paper

Biodegradation of a polluant: Petroleum by microorganisms isolated from Sidi M'Hamed Bentiba dam at water treatment plant of Arib (Algeria)

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Received: 03/12/2022
Revised: 15/12/2022
Accepted: 21/12/2022

Abstract : The Sidi M'Hamed Ben Taïba dam is located near the town of Arib. It is used both for drinking water supply and for irrigation. The objective of the study which done in two locations : Sidi M'Hamed Ben Taïba dam and Water Treatment Plant of Arib is to enhance the physicochemical and bacteriological quality of water. As well as, to evaluate the biodegradation capacities of the microbial strains isolated from the water of the Sidi M' Hamed Ben Taïba dam. Our work consists first of all in determining the physicochemical parameters of the raw water of the Sidi M'Hamed Ben Taïba dam on three levels (surface, 15 m and 30 m) mainly: temperature, pH, nitrate, nitrite, organic matter, etc. Then the bacteriological quality by accounting total coliforms, faecal coliforms, faecal streptococci and sulphite-reducing *Clostridium*. In the second part, we based on the biodegradation of an oil sample on solid medium Mineral Salts Medium by the use of microorganisms isolated from the water of the dam. Twenty-seven cells grouped into five genera: *Pseudomonas*, *Staphylococcus*, *Vibrio*, *Stenotrophomonas* and *Chryseobacter* are identified. The stumps assimilate oil as a carbon source giving degradation zones of different diameters. *Pseudomonas flurescens* species showed significant degradative activity among other isolated bacterial species.

Keywords: Sidi M'Hamed Ben Taïba Dam, Water Treatment Plant, Arib, Physicochemical parameters, Bacteriological quality, Water, Oil, MSM, Biodegradation.

1. Introduction

The Middle East and North Africa are the regions of the world with the least water and the situation is worsening due to the impacts of conflict, climate change and economic recession. The water crisis threatens stability, human development and sustainable growth in the region (FAO, 2018).

Algeria like other Mediterranean countries which face the problem of water. The overloading of the coast, the disparities between rural and urban areas, periods of drought and above all the increase in pollution, are all factors that destabilize the

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balance of the environment (Tahraoui *et al*., 2022).

Polluted water is of great concern to the aquatic organism, plants, humans, and climate and indeed alters the ecosystem. The preservation of our water environment, which is embedded in sustainable development, must be well driven by all sectors (Inyinbor Adejumoke *et al.*, 2018). For this modern technology has allowed us to design water treatment plants to overcome pollution problems that threaten the potability of water that has been preserved for centuries (Henri, 2012) using physical, chemical and biological processes.

Hydrocarbon pollution poses a major problem for aquatic ecosystems, particularly at the level of the coastal fringe, exposed to these insoluble pollutants in a chronic or accidental manner. Microorganisms play a key role in the fate of these hydrocarbons. Indeed, the microbial communities present in marine sediments have a significant potential for biodegradation; this key process of natural pollution mitigation is increasingly considered as an alternative to the current aggressive processes of remediation of contaminated sites (Ben Said *et al*., 2007).

The objective of this work consists in carrying out physicochemical and bacteriological analysis to determine the quality of the raw water of Sidi M'Hamed Ben Taïba dam on the one hand, and to try to find biological procedures for the remediation of certain pollutions on the other hand.

2. Material and methods

2.1. Presentation of the study area

The Sidi M'Hamed Ben Taïba (SMBT) dam is located in the wilaya of Ain Defla, about 15 km northwest of the city of Ain Defla. The SMBT dam site is located on oued Ebda immediately south of the confluence of two oued located to the north: oued Ferhat and oued El-Had which go into the watershed and extend to the mountains of Djebel Boumaad and Djebel Zaccar Gharbi (http://197.112.0.211/soudoud-dzair/).

The SMBT dam is located in an agricultural region, whose housing is located outside the dam basin. The construction of the dam makes it possible to mobilize a volume of 75 million m³, the purpose of development is essentially the regularization of contributions from the Ebda oued, in order to meet the needs for the irrigation of the perimeter of El Amra-Abadia, whose area is 8500 hectares, as well as the reinforcement of the drinking water supply of the localities of Ain Defla, Khemis Miliana and Sidi Lakhdar (http://197.112.0.211/soudoud-dzair/).

2.2. Sidi M'Hamed Ben Taïba dam technical sheet

The characteristics of the Sidi M'Hamed Ben Taïba dam and those of its watershed are presented in Tab. 1.

Table 1: SMBT dam data sheet (ONID, 2016; ADE, 2016; ANBT, 2016).

Date put into service	2005
Catchment area	194 Km^2
Average interannual contribution of the catchment area	49 Hm^3 against 29 Hm^3 Estimated by the Hydrographic Basin Agency (HBA)
Dam capacity	75 Hm^3
Regulated volume	56 Hm^3 /year
Average annual intake	76 Hm^3
Average annual precipitation	938 mm
Annual Volume of Solid Inputs	330000 m
Probable design flood	2647

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2.4. Presentation of the treatment station

The Sidi M'Hamed Ben Taïba station is designed to handle an average flow of 1800 m³/h (Fig. 1). The quality of the treated water must meet the Official Journal of the Algerian Republic (2000 and 2014).

Figure 1: Satellite image of Sidi M'Hamed Ben Taïba dam and the water treatment plant (Google Earth, 2019).

The main processing steps are (Fig.2) (ONID, 2016; ADE, 2016; ANBT, 2016):

- Admission of raw water into the structure equipped with a safety valve.
- Aeration of raw water and injection of aluminum sulphate (AL_2 $(SO_4)_3$), potassium permanganate ($KMnO_4$) and sulfuric acid (H_2SO_4).
-Dosage of polyelectrolyte.
- Coagulation by external energy supply.
- Flocculation by external energy input.
-Decantation.
-Filtration by 04 sand filters.
-Chlorine disinfection.

2.5. Climatological situation

The climate in Sidi M'Hamed is warm and temperate. In summer, the rains are less important than they are in winter. The climate map of Köppen-Geiger classifies the climate there as being of type Csa. The average annual temperature in Sidi M'Hamed is 17.7 °C. It falls on average 615 mm of rain per year. The Sidi M'Hamed are in the northern hemisphere. June is the beginning of summer and September is the end of summer. The summer months are: June, July, August, September. The most pleasant months for a trip are June, July, August and September (https://fr.climate-data.org/afrique/algerie/algiers/sidi-m-hamed-59582/).

2.6. Description of the laboratory

The analysis laboratory is located in the building of the Drinking Water Treatment Plant (DWTP) of Arib. It is composed of two chambers, one for physicochemical

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analyzes and the other for carrying out bacteriological analysis.

2.6.1. Sampling technique and mode of collection

Our study was carried out during the year 2019. It consists of carrying out physicochemical and bacteriological analyzes of the water taking from SMBT dam of Arib.

The sampling points were chosen so that the sample must be representative, sampling was done at three levels.

The first step in ensuring that the sampling techniques employed is appropriate was to train staff in the sampling conditions they are likely to encounter.

A. Surface sampling

Surface samples can be collected by holding the sample bottle and immersing it in water until fully submerged, following standard procedures. This manual sampling method is the easiest way to collect a water sample (RESE-Nord, 2005).

B. Deep sampling

This was done by a 1.7 liter sample bottle (KC DenmarkA/S) only for sampling sites deeper than 2 m (ISO, 2008a).

C. Sampling mode

The water sample was collected in well-cleaned 250 ml plastic bottles for physicochemical analysis and glass bottles rinsed with distilled water, tightly capped and sterilized in an autoclave at 120°C for 1 hour for bacteriological analysis.

The main information to provide for a water analysis were:

1) Date and time of collection.
2) Origin of the water (source, well, borehole, river, lake, dam, cistern, etc.).
3) Type of analysis (physicochemical or bacteriological).
4) Depth.
5) Current weather (precipitation, wind, atmospheric pressure) (Rodier *et al.*, 2009).

D. Transport and storage of samples

To ensure the reliability of the results, the transport of samples from the moment of sampling until their arrival at the laboratory must not exceed 24 hours, the transport was carried out in a cooler at 4°C (Rodier *et al.*, 2009).

2.6.2. Analysis and operating methods

The analyzes must be carried out as soon as possible after sampling to allow more reliable results, drinking water must present certain physicochemical characteristics and meet certain essential criteria (colorless, odorless, etc.) (Khadraoui & Taleb, 2012).

2.6.2.1. Organoleptic Parameters

The analysis of the organoleptic characters that were carried out for the water samples allowed to examine:

a- Color: Drinking water should be clear and colorless, the change in color of water can be the first sign of a quality problem. In a water sample, the relative intensity of a color was analyzed using an arbitrary scale composed of true color units (Khadraoui & Taleb, 2012).

b-Taste and odor: Drinking water must have a non-unpleasant taste and odor (Rodier *et al.*, 2005).

2.6.2.2. Physicochemical parameter

In situ parameters

A certain number of physicochemical parameters of water can only be measured in the field because the values can change very quickly in the samples taken. These are mainly: Temperature; pH; Conductivity; Dissolved Oxygen and Turbidity (CPEPESC, 2015).

Parameters measured in the laboratory

The samples was subjected to a series of analyzes which make it possible to assess the quality of the raw water and to measure their degree of pollution. We were mainly interested in water treatment plant in the determination of pollution by estimating parameters: biological oxygen demand for 5 days (BOD5), Calcium and Magnesium, Chlorides (Cl^-), Sulphates (SO_4^{2-}), Alkalinity (HCO_3^-), Ammonia nitrogen (NH_4^+), Nitrates (NO_3^-), Nitrites (NO^{2-}), Phosphates (PO_4^{3-}), organic matter, etc. (CPEPESC, 2015).

2.6.2.3. Bacteriological parameters

ISSN: 2348-8344 (Online)
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The bacteriological parameters consisted of the search for contamination indicators mainly which were:

Ø Total mesophilic aerobic germs at 22°C and 37°C, total coliforms at 37°C, faecal coliforms at 44°C, faecal streptococci at 37°C and sulphite-reducing aerobic spores at 37°C (Larif *et al.*, 2013).

Ø Pathogenic Staphylococci (Rodier *et al.*, 2009).

The isolation was done on three culture media: Chapman agar, Hektoen agar and nutrient agar. In order to confirm the purity of the strains, we performed successive subcultures using the streak method (Martineau, 1996).

Depending on the desired storage time, pure strains are stored for short or long term (Bio-Rad, 2011).

The identification of bacteria was done according to a dichotomous key which goes from the broadest characters to the most pointed to lead to a given bacterial species.

2.6.2.4.Biodegradation of petroleum on solid medium MSM agar (modified)

A procedure has been established on a solid medium (MSM + Agar) for the detection of microorganisms capable of degrading non-volatile hydrocarbons. We took the previously selected strains (Martin, 2011).

The method for inoculating strains on MSM is according to the following steps:

- Start a culture of the isolated strains in nutrient broth and incubate for 24 hours.
- Centrifuge the culture at 3000rpm for 10 minutes, recover the pellet and wash with liquid MSM 5 times.
-Prepare the solid MSM medium + crude oil (modified protocol), pour into Petri dishes then create wells.
-After solidification of the agar from the different pellets, take a drop with a sterile loop and place the culture concentrate in the appropriate wells for each strain.
-Let dry in front of the bunzen beak then incubate away from light at 30°C for 2 to 5 days and the reading must be done daily (see appearance of clear zones).

3. Results

3.1. Organoleptic parameters of water

In the three water samples taken from Sidi M'Hamed Ben Taïba dam: surface, 15m and 30m, the water is colorless, odorless and tasteless.

3.2. Physicochemical analysis

From the results obtained (Fig. 2), it is noted that the temperature recorded for the surface sample is 19.6°C, the sample taken at 15m is 15.2°C and for the 30m sample is 16.3°C. We observe a variation in the degree of temperature between the three samples, these values are in accordance with Algerian standards (do not exceed 25°C), so they are very acceptable.

The pH measurements of our water samples gave a values equals to 8.36 for the sample taken from the surface, 8.05 for the sample of 15 and 7.60 for the sample of 30 m. The official journal of the Algerian Republic indicates that the pH must be between 6.5 and 9. So the dam water is alkaline, and the analysis results are in accordance with the standardization. The quality of the water in the study area is acceptable.

Lower values were measured in water samples taken from Sidi M'Hamed Ben Taïba dam. They are classified as follows: 494 µs/cm, 505 µs/cm and 509 µs/cm, respectively for the three sampling levels. In comparison with the Algerian standard which accepts a limited value of 2800 µs / cm, our samples comply with water quality standards.

The conductivity results obtained show an accentuated average mineralization (333 < conductivity < 666µs/cm). Lower values are noted during the cold period.

Raw water turbidity values are estimated between 3.32 NTU and 4.14 NTU for surface sampling and those from 15 m and 30 m, respectively. The turbidity values are less than 5 NTU, which indicates that these samples have a turbidity in accordance

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with Algerian standards. On the other hand, the sample taken from the depth has a high turbidity that exceeds 17.5 NTU (not in accordance with standardization).

Dissolved oxygen concentrations are one of the most important water quality parameters for aquatic life. Dissolved oxygen values of raw water samples range from: 10.60 mg/l, 10.13 mg/l and 8.76mg/l. There is a gradual decrease with depth.

The Biochemical Oxygen Demand (BOD) result was 3 mg/l indicating that the bacterial load is very low.

The BOD5 value was low due to the low rate of biodegradable organic matter that exists in our samples.

The results obtained from our samples comply with Algerian standards. They vary between 0.63mg/l and 1.16mg/l.

The quantity of nitrate in the three samples is acceptable compared to the Algerian standard. The presence of nitrates in surface and underground waters results from the natural decomposition, by microorganisms, of nitrogenous organic matter such as vegetable and animal (proteins and excrement).

Nitrite analysis of water samples gives values below 0.2mg/l.

Sulfate values were obtained in surface, 15m and 30m samples (39.5 mg/L, 33.85 mg/L and 50 mg/L) respectively. In comparison with the Algerian regulations, the water samples contain a lower amount of sulphate than the mentioned amount of which it is equal to 400mg/l.

The measurements obtained from the different samples are: 35.358 mg/l for the surface water, 41.251 mg/l for the water taken from 15 m and for the sample from 30m is 58.93 mg/l. The quantities of chloride recorded are low (500 mg/l in Algerian regulations).

The raw water samples contain ammonium, the values are within the standards and estimated at 0.01 mg/l, 0.13mg/l and 0.006 mg/l for the samples taken from the surface, 15m and 30m, respectively.

The raw water from Sidi M'Hamad Ben Taïba dam contains calcium in ionized form. The values recorded during the analysis of this ion vary from 84mg/l for surface water, 52mg/l for the water sample taken from 15m and 64mg/l for 30m.

The magnesium results obtained for the surface sample is 57.67 mg/l, the 15 m sample is 62.48 mg/l and for the 30 m sample is 60.07 mg/l.

A main alkaline constituent of most tap water the bicarbonate ion was assayed in our water samples taken, we found an increase in this ion estimated at 183mg/l, 195.2mg/l for the sample taken from 15m and 256.2mg/l for the 30m sample.

The results obtained from our samples comply with Algerian standards. They vary between 0.028mg/l and 0.072mg/l.

The three raw water samples contain varying values of organic matter estimated at 0.65mg/l, 0.57mg/l and 4.37mg/l for the samples taken from the surface, 15m and 30m, respectively.

Water rich in organic matter should always be suspected of bacteriological or chemical contamination. Their disadvantage is to promote the appearance of bad taste which can be increased by chlorination.

The analysis of iron in the water samples taken shows that the water contains only 0.01mg/l of iron for the 3 samples. The results obtained comply with Algerian standards (0.3 mg/l).

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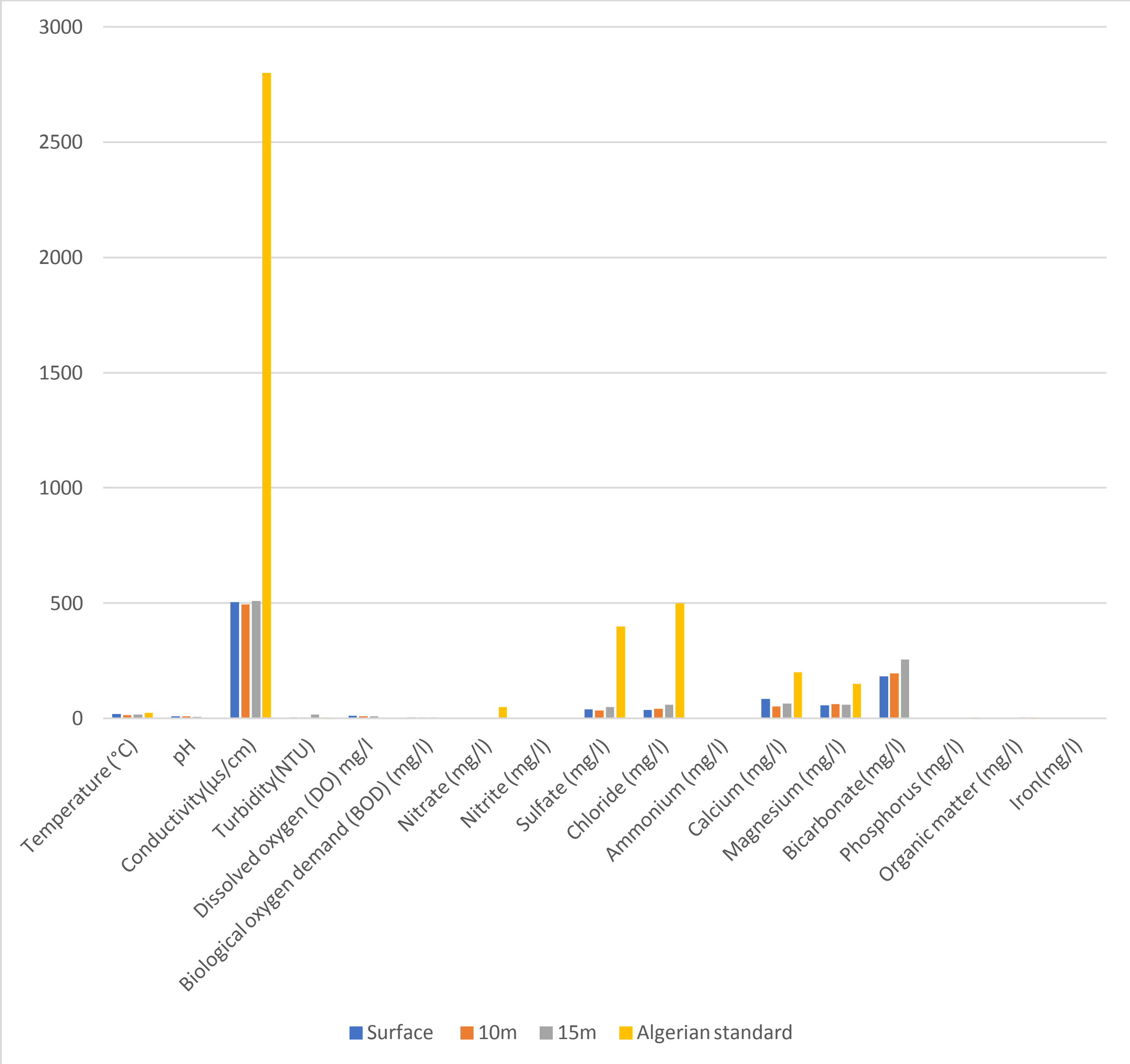

Figure 2 : Physicochemical analyzes of water samples taken from the surface, 15 m and 30 m from the Sidi M'Hamed Ben Taïba dam.

3.2. Microbiological analysis

3.2.1. Indicators of contamination in water

Total coliforms are less abundant in the two water samples (surface and 15m). Their concentration in the third sample (30m) is considerable, reaching up to 54 CFU/100ml. While the concentration of faecal coliforms is zero.

The count of the bacterial load of the genus *Streptococcus* showed the presence of 14 CFU/100ml for the surface sample and 4 CFU/100ml for the 30 m sample.

In the liver meat tubes inoculated with the water samples, no colony surrounded by the black halo was observed.

Staphylococci count results give a bacterial load of 6 colonies for the surface sample and 13 colonies for the 30 m sample.

3.2.2. Search for total mesophiles

The results of the total mesophilic obtained in our study at 22°C are 161 CFU/1ml for the 10^{-2} dilution, 148

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CFU/1ml for the 10^{-3} dilution, and 90 CFU/1ml for the 10^{-4} dilution.

The total germ count at 37°C is 100 CFU/1ml for the 10^{-2} dilution of the 30m sample,

The total germ count is considered a much more general type of indicator for any microbial pollution: it is the total bacteria count. In the 30m sample, the concentration of total germs is high compared to the first and second samples.

3.2.3. Search for coliforms in BCPL medium

The results obtained on the BCPL medium indicate the absence of bacteria in the single concentrations, and bacterial growth in the tubes with double concentrations of the stock solution, the dilutions 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} . After inoculation in Schubert medium and the addition of Kovacs, the tubes are considered negative because there is no *Escherichia coli*.

3.2.4. Characterization of purified strains

We isolated and purified 27 strains belonging to the different genera. From the results obtained from microscopic observation, we can deduce that the strains isolated from our samples are divided into two forms: Gram- bacillus and Gram+ cocci. For the water samples taken, the strains isolated are Gram - bacilli in isolated form. The S2 strain of the sample taken from 15m is a Gram positive cluster shell.

From colony observation, catalase enzyme is present in all strains except S4 and S1 (surface), S4 (15m) and S2, S11 (30m) strains. The oxidase test carried out on the strains isolated for the three water samples showed that most of the strains contain oxidase except the strains S2, S4, S7, S9 and S11 for the sample taken from the surface, S2 for the 15m sample and S1, S3 for 30m sample was oxidase negative. The strains isolated from the samples were identified using the API 20E micro gallery, reading the galleries allowed us to obtain the following results (Table 2).

Table 2: Summary of the tests studied by the API 20 gallery.

S	ONPG	ADH	LDC	ODC	CIT	H2S	URE	TDA	IND	VP	GEL	GLU	MAN	INO	SOR	RHA	SAC	MEL	AMY	ARA
S1 s1	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S1 s2	+	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-
S1 s3	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S1 s4	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
S1 s5	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S1 s6	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S1 s7	+	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-

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S1 s8	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S1 s9	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S1 s10	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S1 s11	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
S2 s1	+		-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S2 s3	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S2 s4	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S3 s1	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
S3 s2	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s3	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
S3 s4	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s5	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s6	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s7	+	+	-	-	-	-	-	-	+	-	+	+	+	-	-	-	+	-	-	+
S3 s8	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s9	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
S3 s10	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s11	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-
S3 s12	-	+	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-

S: Sample s: strain

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The results of the final identification of the isolated strains are presented in the Table 3.

Table 3: Final identification of the isolates strains.

Bacillus Gram^{-}	*Pseudomonas*	*Pseudomonas flurescens*
		Pseudomonas luteola
	Vibrio	*Vibrio fluviatis*
	Stenotrophomonas	*Stenotrophomonas maltophilia*
	Chryseobacter	*Chryseobacter meningosepitium*
Cocci Gram^{+}	*Staphylocoque*	*Staphylococcus aureus*

According to the results obtained, the genus *Pseudomonas* is the most frequent in the water samples with two species: *Pseudomonas flurescens* in the surface sample (S1,S3,S6,S8 and S10), the 15m sample (S4) and the 30m sample (S2,S5,S6,S10,S11 and S12), a second species of the same genus *Pseudomonas luteola* was determined in the surface sample (S3,S5), the sample of 15m (S1,S3) and S9 for the 30m sample.

The S7 strain of the sample taken from 30m is attached to the genus *Vibrio*. The strains S1s4, S1s9, S1s11, S3s1 and S3s3 belong to the species *Stenotrophomonas maltophilia*. The strains S1s2, S2s7 are *Chryseobacter meningosepitium*.

Observation of the S2s2 strain in Chapman's medium gives golden colonies with a change from medium to yellow. These specificities plus the Gram staining and the morphology of the colonies which shows clustered Gram+ cocci do not mean the presence of *Staphylococcus aureus* species.

3.3. Result of petroleum biodegradation

The oil biodegradation test by the strains isolated from the water samples taken from the SMBT dam gave degradation zones observed after 2 days and 5 days (Fig. 3; Fig. 4).

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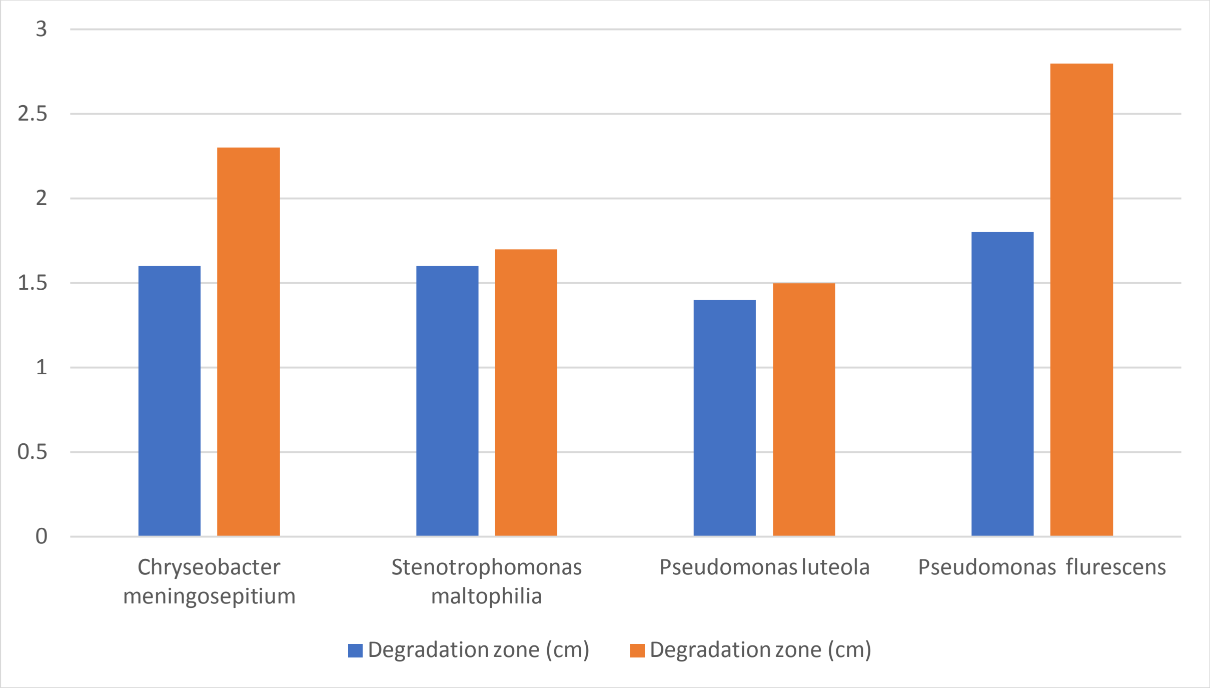

Figure 3: The diameter of the oil degradation zone on MSM medium

Figure 4: Oil degradation by the different strains after 5 days of incubation at 30°C.

After incubation of the dishes for 2 days up to 5 days, the inoculated colonies are surrounded by a clear zone of different diameters on the surface of the MSM medium (degradation zone). The diameter of the zones is gradually increased over time, all depends on the strain used, in particular the *Pseudomonas* genus gives a larger degradation zone than the other genera estimated at 2.8 cm recorded after 5 days of incubation at 30°C.

4. Discussion

The physicochemical parameter is very important to get exact idea about the quality of water and then we compare the

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obtained results with standard values. Water quality analysis is important to protect the natural ecosystem (Dirican, 2015). The coloring of the waters may have a natural origin (presence of iron and manganese in deep waters, humic substances in surface waters), or may be one of the consequences of the eutrophication phenomenon. It is therefore very often synonymous with the presence of dissolved compounds (Thomas, 1995). The rise in temperature can strongly disturb the environment (thermal pollution). It can also be a factor in increasing biological productivity, which can be enhanced by aquaculture (Gaujouse, 1995). The conductivity is due to the concentration of ionized species, mainly mineral matter (Gaagai, 2017). According to Abdoulaye *et al.* (2022), the turbidity of water is due to the presence of finely divided suspended solids. The abundance of these materials indicates the degree of turbidity. Turbidity measurements are therefore of great interest in water quality control. Dissolved oxygen measures the concentration of dissolved oxygen in water, it participates in the majority of chemical and biological processes in the aquatic environment (Ghazali *et al*., 2013). Its concentration varies according to water temperature, depth and concentration of organic matter (Bozorg-Haddada *et al*., 2021). The biochemical oxygen demand (BOD) represents the quantity of oxygen used by bacteria to partially decompose or totally oxidize the oxidizable biochemical materials present in the water in 5 days. The higher the BOD5, the greater the quantity of biodegradable organic matter present in the sample (Rodier *et al*., 2009). The presence of nitrates in the environment is a natural consequence of the nitrogen cycle (Schuddeboom, 1993). The presence of nitrite ions in water comes either from an incomplete oxidation of ammonia, or from a reduction of nitrates (Rejseck, 2002). Water containing a high quantity of nitrite greater than 1 mg/l is considered chemically impure "pollution index" (Dan *et al.*, 2018). The origin of sulphate comes from certain minerals in particular Gypsum, where it appears from the oxidation of sulphurous minerals (Kemmer, 1984). In surface waters, the chloride ion is present in low concentration. While in groundwater, the chloride ion content can reach a few grams per liter in contact with certain geological formations (Mullaney *et al.*, 2009). With regard to ammonia toxicity, it is recognized that it is not the ionized ammoniacal form that is toxic but the non-ionized form, the proportion of which depends on pH and temperature (Rodier, 1996). Calcium ions found in water due to geological criteria. Lechaari (1990), shows that the origin of calcium is generally linked to the terrain crossed and the water supply. Calcium can in no way cause potability problems, the only domestic inconvenience linked to high hardness is scaling. On the other hand, fresh water can lead to corrosion problems in pipes (Gaujous, 1995). The calcium value must not exceed 200 mg/l according to Algerian standards. Magnesium is a significant component of water hardness (gives a bitter taste to water). We found values lower than those published by the official journal (150 mg/l) (Rodier *et al.*, 2005).The presence of bicarbonate ions in water is due to the action of bacteria which provide CO_2 from minerals containing carbonates (Rodier *et al.*, 2005). Phosphate ions found in waters can be a natural decomposition of organic matter; leaching of minerals, or also due to industrial discharges (agrifood, etc.), domestic (polyphosphate from detergents), fertilizers (pesticides, etc.) (Tardat-Henry, 1992). According to the classification of Rodier (1996), water is very pure when the MO values are less than 1mg/l which corresponds to the values of the first and second sample. Water is of poor quality when the MO values are greater than 4mg/l. l (the case of the third sample),

International Journal of Global Science Research **ISSN: 2348-8344 (Online)**
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these values encountered in water due to decomposition products of animal or vegetable origin, produced under the influence of microorganisms (Berne & Jean, 1991). The iron in the water does not present any disadvantage from a physiological point of view, but at very high levels, it influences the organoleptic quality (bad taste, color and flavor). The amount of iron that exists in SMBT dam water can come from ground crossing or corrosion of intake pipes (Rodier, 1996). Contamination can be of animal origin (fecal matter), agricultural activities in the period of the internship can be the origin of this increase in the number of coliforms in the dam water, especially that the people of the region use waste from the sheep as fertilizer for agricultural land. The explanation for the increase in coliforms in dam water was made by Patoine in 2011.

This means that there are no *Clostridium* spores (Rodier *et al.*, 2009). The bacteriological quality of water is based on the counting of microorganisms. They are found in the environment, whether water or soil, and their presence is not always synonymous with a health risk, but the pathogenic microorganisms (of polluted water) which are a danger to the health of the consumer of a polluted water. Indeed, contaminated water can cause an epidemic (Bengoumi *et al.*, 2004). This is due to the effect of water temperature which acts on the development of microorganisms (Bou Saab *et al.*, 2007). According to Rodier (1996) the presence of *Escherichia coli* in water indicates faecal contamination. In the 1974 edition of Bergey's Manual, *Pseudomonas* are included in the family Pseudomonadaceae. This genus occupies most natural environments. They are isolated from water, soil and plants (Franzetti & Scarpellini, 2007). They have a high potential for physiological and genetic adaptation and are able to use a wide variety of nutrients. From an ecological point of view, *Pseudomonas* include species beneficial to the environment and pathogenic species (Talon *et al.*, 2006). Microorganisms such as *Vibrio* are commonly transmitted to humans through ingestion of contaminated water, freshwater, marine water, and polluted water (Momba *et al.*, 2006), This genus can colonize the environment whether soil or water (Güngör *et al.*, 2003). Staphylococci have also been isolated from the natural environment (soil, fresh water and sea water, dust, air), the presence of this germ in the environment is due to contamination by humans or animals (Onoue & Mori, 1997). Hydrocarbons are organic pollutants that are very harmful to both humans and the environment. They have a mutagenic and/or carcinogenic power (Das & Chandran, 2011). Microbial degradation is a natural and essential mechanism for cleaning up sites contaminated by the spillage of petroleum hydrocarbons (Lal & Khanna, 1996). Microorganisms play a important role in the biodegradation of organic pollutants in terrestrial ecosystems. This degradation results from metabolic pathways that involve specific microbial populations (Tahri Joutey *et al.*, 2013). Oil-degrading bacteria called hydrocarbonoclasts use petroleum hydrocarbons as their sole carbon source. Most of these bacteria belong to α-proteobacteria. We can note a few major genera among *Flavobacterium*, *Pseudoalteromonas*, *Pseudomonas*, *Vibrio*, *Acinetobacter*, *Alcaligenes*, *Cycloclasticus*, *Marinobacter* (Reyes-Sosa *et al.*, 2018).

5. Conclusion

The Sidi M'Hamed Ben Taïba dam waters are important sources of water supply in the wilaya of Ain Defla. They are intended for various uses.

During our work, although short, we were able to deduce that the water from the Sidi M'Hamed Ben Taïba dam complies with Algerian standards, based on the results of the physicochemical and bacteriological analyzes that we have carried out.

We also isolated 27 microbial strains from the dam waters of Sidi M'hamed Ben Taïba and which belong to the genera: *Pseudomonas*, *Vibrio*, *Stenotrophomonas*, *Chryseobacter* and *Staphylococcus*. They are capable of degrading oil, of which *Pseudomonas* showed a very high degradation ability than the other strains studied. It can be used as a biodegradant of this type of hydrocarbons.

Acknowledgements:
The first author of this work thanks the director of the Algerian Direction of Water of Ain Defla as well as the managers and the staff of Sidi M'Hamed Ben Taïba dam and the Drinking Water Treatment Plant for their collaboration in order to carry out this work.

Conflict of interest:
No conflict.

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