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Theme

Assessment of the raw water quality at the dam of Keddara before and after the filling

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Dedication

It is with great pleasure that I dedicate this modest work to

My dear father, who never spared me anything, my bless and my best partner.

My dear mother, she has always been by my side, she witnessed the hardest and best moments of my preparation for this job.

My brother, my sister Amira and her son Haitham, may the merciful protect them for me.

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To all my classmates, especially Soria, Miral, and Saada

To everyone I found whenever I needed him. Thank you

Yasmine

Summary

Summary

List of abbreviations

SEAAL: Société des Eaux d'Assainissement d'Alger.

ANBT : Agence National des Barrages et Transferts.

SPIK: Isser-Keddara Production System.

m^3: Cubic meter.

Km: Kilometers.

Hm^3: Cubic hectometer.

WHO: World Health Organisation.

O.G.A.R: Official Gazette of the Algerian Republic.

mg/Pt: Milligram per platinum.

T: Temperature.

pH: Hydrogen potential.

EC: Electrical conductivity.

TDS: Total dissolved solids.

SM: Suspended matter.

DR: Dry residues.

OM: Organic matter.

BOD_5: Biochemical oxygen demand for 5days.

COD: Chemical oxygen demand.

TOC: Total organic carbon.

H: Hours.

mg: Milligram.

DO: Dissolved oxygen.

AT: Alkalemetric title.

CAT: Complete alkalemetric title.

mol /L: Mole per liter.

mL: Milliliter.

TH: Total hardness.

ºF: French degree.

°C: Degree Celsius.

µS/cm: Micro Siemens per centimeter.

NTU: Nephelometric of turbidity unity.

mg /L: Milligram per litter.

List of abbreviations

µg/L: Microgram per litter.

TC: *Total coliforms.*

E-Coli: *Escherichia coli.*

Entero: *Enterococci bacteria.*

ONPG: Ortho-nitrophenyl ß-D-galactopyranoside: identification of coliform bacteria.

MUG: 4-Methyl-umbellifery: ß-D-glucuronide: identification of Escherichia coli.

MUD: 4-Methyl-umbelliferyl: ß-D-glucoside: Identification of intestinal enterococci.

MPN: Most Probable Number.

UV: Ultraviolet radiation.

CFU: Colony forming units.

m: Meter.

mL: Milliliter.

cm^2: Square centimeter.

cm: Centimeter.

min: Minutes.

nm: Nanometer.

g/mol: Gram per mole N.

M: Molarity, mol/L.

N: Normality.

EDTA: Ethylene Diamine Tetra-Acetic Acid.

Q-T: Quanty-tray.

g/day: Gram per day.

List of tables

List of figures

General introduction

General introduction

Water is essential and inseparable for life and functioning of eco-system and humans activities also. It interferes in the composition of cells and cover about 70% of the surface of the earth divided between oceans and surface waters that's why it is called the blue planet. Water, which is chemically the association of an oxygen atom and two hydrogen atoms, visually the colorless, odourless and tasteless sample is considered as one of renewable energies, but not like other energies. It must be protected and defended because of its great Importance. It’s a rich heritage that we really have to take advantages of but without degrading it. This matter which is destined for human’s supplies such as cooking or hygiene or whatever its use, need a good quality both physicochemical and bacteriological; it mustn’t contains either bacterizes or chemical compound like nitrate and heavy metals. But, unfortunately its quality will be affected and reduces as those supplies increase over the time. In Algeria, water is increasingly a precious source but also rare and missed used and we even experienced periods of drought. The habitants consume drinking water which comes from surface water but in an uncontrollable way. This forced us to control our habits on the part of the people and to build sources that reserve surface water such as dams on the part of the state.

For our knowledge, in our days, dams are a primary source that the state favors to provide the inhabitants with their drinking water needs and several initiatives have been implemented to build these dams such as the Keddara dam. Keddara dam which is located in the wilaya of boumerdes: the main source of drinking water for the wilaya and a part of the capital Algiers; treated in SEAAL treatment center in Boudouaou. Any changes of its characteristics means a reduction of its quality that we will evaluate through this work.

This thesis entitled ‘assessment of the raw water quality at the dam of keddara before and after the filling” its purpose is to assess the quality of the keddara dam through the realization of different analyzes. Consists of three chapters: First chapter relating to the bibliographic study, consisting of defining the place of internship (SEAAL), and the water from keddara dam which we carry out our analyses. Other notions are to insert such organoleptic, physicochemical and bacteriological parameters.

A second chapter, material and methods is related to the methods of analyzes carried out and material used in this context.

The last chapter brings together all the results, focusing on our analyses.

This thesis ends with a general conclusion, which summarizes the results obtained with some perspective.

Chapter I: Bibliographic synthesis

I.1. Introduction

Surface water in raw nature (dam, river and lacks) forms a basis for drinking water. Population growth, the development of industry and agriculture and domestic needs affect the quality of this important source; they degrade it. This is why it is necessary to treat in order to evaluate its quality by operating and distinguishing different parameters whether organoleptic, physicochemical or bacteriological ones.

I.2. Keddara dam

Keddara dam is the main source of raw water situated in Boumerdes with a capacity of 142 million m^3 [1].

Keddara dam is filled with water in 1985, it is located in the coastal chain of the Tell Atlas, 8 km south of Boudouaou and 35 km east of Algiers. The dam closes the valley of the Boudouaou wadi at the end of the mountainous course of the Keddara wadi, a little before its outlet into the Mitidja plain and immediately after the confluence with the El Haad wadi. The Keddara dam is fed from three sources:

- Transfers excess water by gravity from the Hamiz dam through a diversion gallery (Hamiz Keddara of 3.2 km). Allow a volume of 15 hm^3/year be diverted towards the Keddara dam.
- Transfers pumped from the Beni-Amrane dam, using a discharge station with a capacity of 06 hm^3/day, which allow the transfer to Keddara of an average annual volume of 110 hm^3.
- The watershed is 93 km^2 fed by the tributaries of the Keddara, El Haad and Isser wadis [2].

The main goal of Keddara dam is to provide water needs for drinking and irrigation in Boumerdes and a large part of Algiers.

Figure I.1: Keddara dam.

I.3. General Information about raw water

I.3.1. Definitions and notions

I.3.1.1. Surface water

Surface water is water stored on the surface of continents [3]. This storage can be in a natural reserve (rivers and lakes) or artificial (reservoir and dams). They often turn out to be unfit for consumption due to the pollution generated by our urban, industrial and agricultural activities [4]. Their challenge, even they are easily reachable, allowable to be more easily polluted: The quality of these waters varies depending on the case, they are naturally rich in organic matter. As a result, surface water requires substantial treatment facilities [4]. For surface water we find raw water and potable water.

I.3.1.2. Raw water

Raw water is that water taken directly from its source with no treatments.

Natural water such as rain water, ground and surface water (dams, lakes and rivers) are considered as raw water until they will be treated through drinking water treatment process. Even thought, raw water is cheaper than treated one, but it is more risky. It contains numerous contaminants in the form of dissolved or particles of industrial origin and even microorganism like bacteria and viruses [3].

Due to these contaminants, raw water must be treated for many purposes: cooking water, irrigation, production and drinking water.

There are three initial categories of raw water destined for treatment for drinking water which are:

- Class A: Consider as good and require only simple physical treatment and disinfection.
- Class B: medium quality requires physical, chemical treatment and disinfection.
- Class C: medium quality requires a very thorough physical and chemical treatment, coupled with refining and disinfection operations [3].

a) Dams

The word dam returns to Middle English and Middle Dutch, where the name of many cities contains the word dam like Amsterdam.

A dam is a barrier build across a surface water flow to stop it and to control water level, which create an artificial source of water called reservoir can be used to store water for irrigation, industry, hygiene purposes, fishing, boating and the most important use is to provide drinking water supplies.

Even dams are ancient or modern, but they still present an important source of water and people have used in order to help prevent flooding.

The act of damming and impounding a river imposes a fundamental physical change upon the river continuum. The river velocity slows as it approaches the dam wall and the created reservoir becomes a lacustrine system. The physical change of damming leads to chemical changes within the reservoir, which alters the physical and chemical water quality, which in turn leads to ecological impacts on downstream rivers and associated wetlands [5].

I.3.1.3. Potable water

According to WHO, "Potable water is safe for health, we are able to consume it with no risks". As the demand for good potable water quality increase by the time. It will pass by a series of treatments process, it mustn't contains pathogenic agents or undesirable chemical elements, which turns it suitable and pleasant water to drink, clear and odorless.

There is many sources for drinking water especially raw water what explains the increasing of demand on it.

I.3.2. Water cycle

Earth's water is always in movement, changing states from solid to gas to liquid in a continuous process including four stages:

The first state is liquid water which is stored in raw water, ground water and the soil. As the sun shines, liquid water start heating by the time and the effect of heat warm make it rises into the atmosphere to water vapor; this stage is called evaporation.

After this step, the vapour cools forming droplets and bands of droplets which form by its turn clouds so the state changes again from vapor to liquid; this transition named condensation. Water is always in the air even in the absence of clouds.

More droplets condenses in the form of clouds, more they will be heavy; so they falls to the earth, returns to the first state liquid ; this is the precipitation. The hydrological cycle is really interesting to the earth, thanks to him it keep its amount of water.

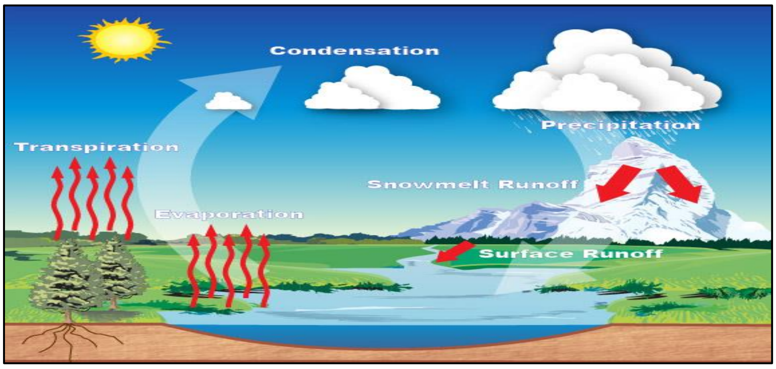

Figure I.2: Water cycle.

I.3.3. Assessment of the raw water quality

Assessment of water quality is the entire process of assessing the physical, chemical and bacteriological composition in relation to natural quality, human impacts and intended uses, especially uses which may affect human health and the health of the aquatic system itself [6]. This is why raw water quality assessment are often used to classify degree of contamination and provide information about its quality. The main aspects are the interpretation and reporting of monitoring results and recommendation for future action.

I.4. Parameters and quality

I.4.1. Organoleptic parameters

I.4.1.1. Smell

The smell of water is generally a sign of pollution or the presence of decomposing organic matter in quantities that are often so small that they cannot be detected by analytical methods. The olfactory sense alone can, to a certain extent, detect them [7].

I.4.1.2. Color

The color of water is one of its quality parameters; more water is clear more it is conducive to consumption.

The coloration due to the existence of chemical or mineral substances in water or industrial discharge.

I.4.1.3.Taste

All water has a certain taste of its own which is due to dissolved salts and gases. If it contains too much chlorine, the water will have a brackish taste, if it contains a large amount of magnesium salts, the water will taste bitter [7].

Table I.1: Organoleptic parameters according to O.G.A.R 2011 standards.

Parameters	O.G.A.R	Unity
Color	15	mg/pt
Smell at 12˚C	4	Dilution rate
Taste at 25˚C	4	Dilution rate

I.4.2. Physicochemical parameters

I.4.2.1. Temperature

Water’s temperature plays a major role while it regulates and control all of physical, chemical and biological processes in water and, therefore, the concentration of many variables. As water temperature increases, the rate of chemical reactions generally increases together with the evaporation and volatilisation of substances from the water [8]. Temperature also acts as a physiological factor influencing the growth metabolism of micro-organisms living in water; it increases (this is most noticeable for bacteria and phytoplankton which double their populations in very short time periods) leading to increased water turbidity [7].

I.4.2.2. pH

pH is an important property which indicated the acidity or basicity of water. Determined by the concentration of hydrogen. Its scale ranges from 1 to 14: water is considered neutral if pH =7, acidic if pH is more than 7 and basic if pH is less than 7.

pH can be measured using pH paper, pH meter or by calculating with this relation:

$$pH = -\log [H_3O^+] \qquad (1)$$

$[H_3O^+]$: Hydronium ion concentration.

I.4.2.3. Electrical conductivity

The salinity of water can be identified based on electrical conductivity (EC) or the total dissolved solids (TDS). The EC of water is an expression of the ability of water to carry an electric current and directly related to the amount of TDS and major ions. The TDS expresses the presence of inorganic salts and small amounts of organic matter in water. The EC value in water depends on the presence of ions, temperature, and pH. The possible sources of salinity in the surface water come from the nature and geological condition of the catchment area surrounding the water body (i.e. weathering and erosion of rocks); urban and agricultural runoff; industrial and wastewater discharges [8].

I.4.2.4. Turbidity and suspended matter

This is the first parameter perceived by consumer. Turbidity is reduction of water transparency [9]. It is caused, in water, by the presence of fine suspended matter (SM), such as clays, silts, silica grains and microorganisms. A small part of the turbidity may also be due to the presence of colloidal matter of organic or mineral origin [10].

I.4.2.5. Dry residues DR

The determination of dry residues provides information on the content of non-volatile dissolved and suspended substances. Water whose dry residues content is extremely high or low might be unacceptable because of its tasteless [11].

I.4.2.6. Organic matter

Organic matter present in water is generally made up of a mixture of organic compounds resulting from the decomposition of materials of plant, animal and microbial origin present in the water. The decomposition of these substances produces different complex organic molecules that range from macromolecules to low molecular weight compounds present in different concentrations and compositions. The composition of the organic matter present in the surface waters strongly depends on the composition of the soil and the vegetation surrounding the flow and the reservoir as well as the characteristics of the industrial effluents discharged. The content of organic matter is also affected by certain seasonal variations and by agricultural activity. So organic matter has no unique structure or composition [4].

$$OM= (2BOD_5+COD)/3 \qquad (2)$$

a) Chemical oxygen demand COD

Chemical oxygen demand is defined as the amount of oxygen needed to oxidize dissolved organic matter in water. This parameter represents the majority of organic compounds as well as oxidizable mineral salts. Its value must be reduced as much as possible so that the water is suitable for consumption [12].

b) Biochemical oxygen demand BOD_5

Biochemical oxygen demand is the quantity of oxygen needed to degrade the biodegradable organic matter by the development of micro-organisms for 5 days at 20ºC [10].

Table I.2: BOD_5classification of water according to Rodier.

Values (mg/L)	**Quality**
$BOD_5 < 3$	Very good
$3 < BOD_5 < 5$	Good
$5 < BOD_5 < 8$	medium
$BOD_5 > 8$	Poor, even very poor

c) Total organic carbon TOC

Carbon might be found in organic and inorganic form while the organic represent the lowest concentration. This parameter is the measure of organic matter in water [7].

$$\text{Total carbon} = \text{TOC} + \text{mineral carbon} \qquad (3)$$

I.4.2.7. Dissolved oxygen

Dissolved oxygen is an essential component in evaluating of water quality: it allows wildlife to live. It comes in surface waters mainly from the atmosphere and the photosynthetic activity of algae. Its variation can be estimated every 24H or seasonally depend on temperature, salinity, photosynthetic activity of algae and atmospheric pressure, respiration and composition process [13].

Water with a content of 3 to 7 mg of O_2 per liter is good quality water.

Dissolved oxygen has an inverse relationship with temperature and salinity: its solubility decrease as temperature and salinity increase.

I.4.2.8. Alkalinity

Alkalinity of water refers to the existence of bases and weak acid salts.it is the result of the presence of hydrogen carbonate HCO_3^-, carbonate CO_3^{2-} and hydroxide OH^-. Alkalinity is necessary to determine the risks of scaling (tendency to precipitate salts in the pipe and reduce its useful diameter) and corrosion (tendency to react with the metal of the pipes and corrode it) of the grids. We distinguish

a) Alkalimetric title AT

Corresponds to the concentration of water in hydroxide ions OH^- and the half of the concentration in carbonate ions CO_3^{2-}.

$$AT= [OH^-] + [CO_3^{2-}] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (4)$$

b) Complete alkalimetric title CAT

CAT giving the total alkalinity of water, it measures the basic species in the water (hydroxide ions OH-, carbonate ions CO_3^{2-} and hydrogen carbonate ions HCO_3^-). CAT is an indicator of the buffering capacity of water against acidic substances. There is a relationship between the pH and the TAC. In practice for water whose pH is less than 8.3, it corresponds to the concentration of bicarbonate ions HCO_3^-. For human consumption the optimum is between 10 and 20°F [4].

$$CAT= [OH^-] + 2[CO_3^{2-}] + [HCO_3^-] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The unit of both AT and CAT is French degree.

c) Total Hardness TH

Hydrometric title TH or hardness is a particular quality of water which indicates its mineralisation. Mainly due to the calcium and magnesium ions. High water hardness leads to scaling (accumulation of white solids of calcium and magnesium) and even deterioration of the fittings. This is why its domestic and industrial use is limited.

$$HT= 10^4 ([Ca^{2+}] + [Mg^{2+}]) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (6)$$

The unit of TH is French degree.

Table I.3: Classification of water according to total hardness.

The value	From 0˚f to 8˚f	From 8˚f to 15˚f	From15˚f to 30˚f	More than 30˚f
Classification	Very soft water	Soft water	Moderately hard water	Very hard water

I.4.2.9. Ammonium NH_4^+

The presence of ammonium in surface water can be estimated as an indicator of pollution. It can have a natural origin through the decomposition of plant and animal waste [11], industrial waste and fertilizers. Mineral nitrogen presents the major part of the nitrogenous material found in water, of which ammonium is its reduced form; actually, ammonium itself it is not harmful. When pH increases, ammonia (NH_3^+) is found, which is a gas soluble in water and toxic to aquatic life [12].

Ammonium undergoes nitration by the action of nitrifying bacteria transforming into nitrite and nitrate thereafter.

I.4.2.10. Nitrite NO_2^-

Nitrite is an intermediate stage between incomplete oxidation of ammonia (nitrification), nitrate reduction (denitrification) under the influence of a denitrifying action [10]. Their presence in water is often associated with deterioration in microbiological quality, which turns water considered suspect [7] also it is considered as a harmful element for aquatic life and even for pregnant and nursing women and for babies to.

I.4.2.11. Nitrate NO_3^-

The nitrate ion (NO_3^-) is the common form of combined nitrogen found in natural waters. It may be biochemically reduced to nitrite (NO_2^-) by denitrification processes, usually under anaerobic conditions. The nitrite ion is rapidly oxidised to nitrate. Natural sources of nitrate to surface waters include igneous rocks, land drainage and plant and animal debris. Nitrate is an essential nutrient for aquatic plants and seasonal fluctuations can be caused by plant growth and decay [6].

I.4.2.12. Orthophosphate PO_4^{3-}

Phosphorus is one of the essential components of living matter. Phosphorus compounds have two origins: decomposition of organic matter; leaching of minerals, or also due to industrial discharges (agri-food, etc.), domestic (poly-phosphate from detergents), fertilizers (pesticides, etc.)

I.4.2.13. Chloride Cl^-

Most waters contains chloride, but at varying concentration. They are widely distributed in nature, usually in form of salts of sodium (NaCl) and potassium (KCl) and often used as pollution indicators [9].The existence of chloride in water in very high concentration gives it a salty taste.

I.4.2.14. Sulfate SO_4^{2-}

Sulfate are least toxic ions, however in large concentration causes gastro-intestinal irritation and give to drinking water an unpleasant taste. Natural waters practically contain sulphates, in very variable proportions. Their presence results from calcium sulphate solubility in gypsum rocks and from oxidation of sulphides spread in rocks [10].

I.4.2.15. Hydrogen carbonate HCO_3^-

They are found in water when pH varies between 7 and8; their dosage is carried out in order to determine the alkalinity of water (AT, CAT, and TH).

I.4.2.16. Manganese Mn^{2+}

Manganese is very common in nature and especially in water. It constitutes for man an essential element for its growth and the good functioning of its metabolism (glucose and lipids), further it plays the role of a catalyst in certain enzymatic reactions [7]. All these advantages constitute a real cause so that its concentration is well regulated and does not affect human health on the one hand and the quality of the water: an undesirable taste and reduction in quality; on the other hand.

I.4.2.17. Iron Fe^{2+}

Iron is of heavy metals which are found in water especially as it is very widespread in rocks, dissolved iron precipitates in oxidizing medium. Its presence in water can promote the proliferation of certain strains of bacteria. Iron remains a safe metal, it allows oxygen to be fixed to human cells [9].

Table I.4: Physicochemical parameters according to the O.G.A.R 2011 standards.

Parameters	**O.G.A.R**	**Unity**
pH	>6,5 and <9	
Temperature	25	˚C
EC	2800	µS/cm
Turbidity	5	NTU
COD	30	mg /L
BOD_5	7	mg /L
TOC	/	
DO	/	
Alkalinity	500	mg/L in $CaCO_3$
Hardness	200	mg/L in $CaCO_3$
DR	1500	mg/L
Ammonium NH^{4+}	0,5	mg/L
Nitrite NO_2^-	0,2	mg/L
Nitrate NO_3^-	50	mg/L
Phosphate PO_4^{3-}	/	
Chloride Cl^-	500	mg/L
Sulfate SO_4^{2-}	400	mg/L
Manganese Mn^{2+}	50	µg/L
Iron fe^{2+}	0,2	mg/L

I.4.3. Bacteriological parameters

I.4.3.1.Total coliforms

Coliforms are micro-organisms belonging to the *Enterobacteriaceae* family-one of the most studied bacteria-that we find everywhere in our environment, in our body, as well as in that of all living beings. All of those coliforms are called *total coliforms*. Among these bacteria, we mainly find *TC, E-Coli, Enterobacter* and *Citrobacter* and other types such as *Salmonella.*

The term *"coliform"* refers to rod-shaped, non-spore forming, gram negative, and oxidase negative, facultatively anaerobic organisms, capable of growing aerobically at 36°C and in a liquid medium and of hydrolysing by a specific enzyme the ß-galactosidase the ONPG into a yellow colored compound [14], in the presence of bile salts or other surfactants possessing similar growth inhibitory activities, and able to fermenting lactose (and mannitol) with gas, acid and aldehyde production in 24H to 48H at a temperature between 36°C-37 ºC [7].

I.4.3.2. Escherichia-coli

Escherichia-coli is a bacterium of the coliform group and an indicator of an exclusive contamination of raw water by human waste [9].Its presence indicates that probability that faecal waterborne pathogen have entered the water. [3]

This kind of bacteria is gram-negative bacillus micro-organism capable of growing aerobically at 36°C and in liquid medium and of hydrolyzing the MUG by a specific enzyme ß glucuronidase into a fluorescent compound under UV [14].

I.4.3.3. Intestinal Enterococci

Formerly the legislation speaks of (*faecal streptococci*), while it generalizes all the *streptococci*, which have the D antigen. Among them we have "*Intestinal Enterococci*".

Intestinal Enterococci are a microorganisms of group streptococci capable of growing aerobically at 36°C and in liquid medium, spherical in shape, possessing the antigen D, gram-positive, forming chains, catalase negative, able to hydrolyzing insulin and cultivating at 44ºC and pH=9.6.

Those microorganisms are able to hydrolyse by a specific enzyme the ß-glucosidase the MUD into a fluorescent compound under UV [15]. They testify to an old faecal contamination.

Table I.5: Bacteriological parameters according to O.G.A.R 2011 standards.

Parameters	O.G.A.R	Unity
TC	/	
E-coli	0	n/100mL
Entero	/	

I.5. Conclusion

Water, the major component in life which covers human needs and interferes in all activities, remains a source which must be reserved and preserved before, during and after its use.

Any degradation of its quality causes negative impacts on both of human health and environment.

Chapter II: Material and method

II.1. Introduction

The purpose of this study is to use the example of the Keddara Dam to assess the quality of raw water. Using different methods, to obtain the main results on physicochemical quality and bacteriological one.

The work took place at the SEEAL laboratory for three months and covered one season: spring. This work allows to notice any changes in parameters and thus quality.

About COD and BOD_5 analyzes, have been done in faculty of technology INGM University in Boumerdes.

II.2. Study area and samples collection

The study area is located in keddara dam, focus on three sites: surface water (1m), intermediate water (26m) and the depth one (54m).

A total of nine water sample were collected; three samples on each collection. Were taken in polyethylene bottles of 5L (have already been washed by the sample) to be taken in ice box and transported to the laboratory.

Those samples have to be labeled, homogeneous and ensuring the non-modification of their characteristics till they arrive at the laboratory.

Figure II.1: The sampler used.

II.3. Physicochemical parameters

II.3.1. Temperature measurement

Temperature measurement is very important; it is based on the use of a thermometer.

Mode of operating

- Rinse the thermometer with the sample.
- Pour the water into a beaker previously rinsed with the same sample.
- Add the thermometer to the beaker.
- Note the temperature value.

II.3.2. pH measurement [16]

pH is an indicator of the alkalinity of water. Its potentiometric measurement is based on the potential difference that exists between a glass electrode and a reference electrode (saturated calomel KCl) immersed in the same solution, which is a linear function of the pH of the latter.

Mode of operating

- Take 50 mL of raw water using graduated cylinder and pour into a beaker.
- Rinse the electrode with distilled water.
- Introduce the electrode into the beaker.
- Turn ON the pH meter.
- Read the pH value for each sample.

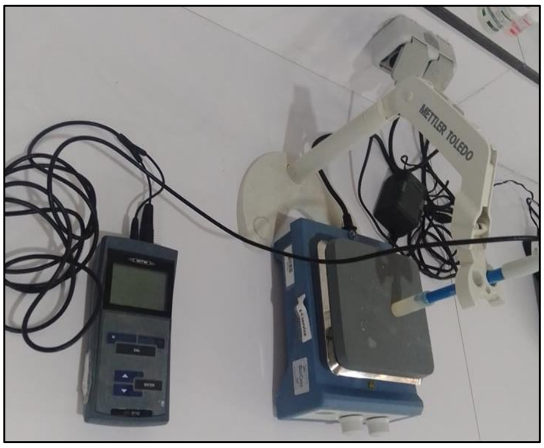

Figure II.2: pH meter METTLER TOLEDO.

II.3.3. EC measurement [17]

The electrical conductivity of water (γ) is the capacity of the water column between two metal electrodes with a surface area of 1 cm^2 and a distance of 1 cm from each other to carry the electric current. It allows to measure variations (consumption or production) of charged species produced during the reactions.

Mode of operating

- Take 50 mL of raw water using a graduated cylinder and pour into a beaker.
- Rinse the probe with distilled water.
- Introduce the probe into the beaker.
- Turn the conductimeter ON, press cond for conductivity.
- Wait until stabilization and read the displayed value.

Figure II.3: Conductimeter.

II.3.4. Turbidity measurement [18]

The determination of turbidity measures an optical property of the water sample which results from the scattering and absorption of light by particles of suspended matter present in the sample.

Mode of operating

- Take 25mL of raw water using a graduated cylinder and pour into a glass cell.
- Turn the turbidimeter ON.
- Place the cell in the turbidimeter and close the lid.
- Read the displayed value.

Figure II.4: Turbidimeter (HACH 2100N).

II.3.5. Dosage of organic matter OM [19]

Heating of a sample in the presence of a known quantity of potassium permanganate and sulfuric acid for a given period (10min).

Reduction of part of the permanganate by the oxidizable matter present in the sample.

Determination of excess permanganate by adding an oxalate solution, monitoring titrating the excess oxalate with permanganate.

Mode of operating

- Pour 100 mL of water into a 150 mL beaker using a graduated cylinder.
- Add 20mL of sulphuric acid (2mol).
- Heat under the hood for 5min.
- Add 20 mL of potassium permanganate using graduated pipette.
- Reheat the samples 10 min after boiling.
- After cooling add 20 mL of sodium oxalate using graduated pipette and a magnetic bar.
- Titrate with potassium permanganate.
- Note the volumes and calculate the permanganate index.

$$I_{Mn} = (V_1\text{-}V_0)/V_2 * f \ldots\ldots\ldots\ldots\ldots\ldots.. (7)$$

I_{Mn}: permanganate index.

V_0 = the volume in (mL), of the permanganate solution consumed in the white titration, before re-warm.

V_1= the volume in (mL), of the permanganate solution consumed in the samples titration.

V_2 = the volume in (mL), of the permanganate solution consumed in the white titration, after re-warm.

f = the corrective factor used, taking into account the units, to express the results in mg of O_2/L. equal to 16.

II.3.6. COD [20]

It is a chemical oxidation (presence of a strong oxidant $K_2Cr_2O_7$) and in a strongly acid medium (H_2SO_4 cc). The reaction takes place in a digester at a stable temperature (140°C).

Mode of operating

- Dilute the standard solutions of 10, 30, and 70 mL.
- Take 2.5 mL of each of the diluted solutions and the samples to be analyzed.
- Pour into glass tubes.
- Add 1.5mL of digestion solution.
- Add 3.5mL of acid reagent.
- Stir with a vertex stirrer.
- Bring to reflux in a heating block at a temperature of 148°C for 2 H.
- Cool to room temperature.
- Note the absorbance by the spectrophotometer at 420 nm.

II.3.7. BDO$_5$ [21]

A quantity of water is poured into a 300 mL incubation bottle, closed with a cap fitted with a pressure sensor (oxytop). Connected to a control head and placed thereafter in a refrigerator kept at 20°C. Then follow the oxygen consumption, which results in a decrease in air pressure.

The oxidation of organic matter causes the formation of CO_2 which will be trapped by a NaOH solution. Thus it develops a depression in the bottle.

Mode of operating

- Pour 250 mL of the samples in the incubation bottle.
- Insert the magnetic bar into each bottle.
- In the boat to be placed on the bottle, we introduce 2 to 3 grains of potassium hydroxide on which we add 1 to 2 drops of water.
- Screw on without closing the cap hermetically.
- Incubate the flask is incubated at 20°C for 5 days with constant shaking.

II.3.8. Dosage of dissolved oxygen by iodometry [22]

The dosage of dissolved oxygen by iodometry is applicable for any type of water having a dissolved oxygen concentration greater than 0.2mg/L is based on:

- ➢ The reaction of dissolved oxygen with manganese sulphate (II).
- ➢ Acidification and oxidation of iodide.
- ➢ Titration of the amount of iodine released by sodium thiosulfate.

Mode of operating

- Fill the vials with water until it overflows, ensuring the elimination of air bubbles on the walls.
- Add 1mL of manganese sulphate (II).
- Add 2 mL of alkaline reagent.
- Both reagents are added below the surface.
- Put the cap of the vial and turn it upside down to homogenize.
- Leave to stand for 5 min and homogenize again for the decantation of the precipitate.
- Add 1.5mL of sulphuric acid (1/2).
- Recap the vial and shake to dissolve the precipitate formed.
- Pour into a 250 mL beaker.
- Titrate with sodium thiosulfate (10mmol/L) in the presence of Thiodene.

We calculate $[O_2]$ using these relations: $[O_2] = V_{thio}$ ……………………… (8)

$[O_2]$: concentration in mg/L of DO.

V_{thio}: volume in mg/L of sodium thiosulphate.

II.3.9. TDS measurement

Mode of operating

- Take 50 mL of water using a graduated cylinder and pour into a beaker.
- Rinse the probe with distilled water.
- Introduce the probe into the beaker.
- Turn the conductimiter ON, press TDS.
- Read the displayed value.
- Note the volumes.

II.3.10. Alkalinity [23]

As pH<8.5 we we'll not be able to measure AT, just CAT.

a) CAT dosage

The determination of alkalinity is applicable for any type of water where the pH is greater than 4.5.

The determination of the concentrations of hydrogen carbonate (HCO_3^-), carbonate (CO_3^{2-}) and hydroxide (OH^-) ions is carried out using hydrochloric acid to bring the samples to pH4.5 and 8.3.

Mode of operating

- Pour 50 mL of water into a 100 mL Erlenmeyer using graduated cylinder.
- Add 5 drops of methyl orange.
- Complete with water up to the judge mark.
- Titrate with H_2SO_4 (0.04N).
- Note the volumes.

$$CAT=V_{H2SO4}*4 \qquad (9)$$

V_{H2SO4}: volume of sulphuric acid in mL to titrate CAT.

II.3.11. Total hardness TH

Mode of operating

- Pour 50 mL of water into a 100 mL Erlenmeyer using graduated cylinder.
- Add 2 mL of buffer solution.
- Add a pinch of eriochrome black.
- Complete with water up to the judge mark.
- Titrate with EDTA (0.01M).

- Note the volumes.

$$TH=V_{EDTA}*2 \ldots\ldots (10)$$

V_{EDTA}: volume of EDTA in mL to titrate TH.

II.3.12. Dosage of calcium Ca^{2+} [24]

It is a complexometric titration of calcium ions with an EDTA solution at pH 10.The indicator used is murexide, which gives a pink color in the presence of calcium ions. When titrating with EDTA the solution turns to purple.

Mode of operating

- Pour 50mL of water into a 100 mL Erlenmeyer using graduated cylinder.
- Add 2 mL of sodium hydroxide NaOH (2N).
- Add a pinch of murexide.
- Complete with water up to the judge mark.
- Titrate with EDTA (0.01M).
- Note the volumes.

$$[Ca^{2+}]= V_{EDTA}*8 \ldots\ldots (11)$$

V_{EDTA}: volume of EDTA in mL to titrate Ca^{2+}.

$[Mg^{2+}]= (V_{TH}-V_{Ca2+})*4.8$

V_{TH}: volume in (mL) of EDTA solution used to obtain TH.

V_{Ca2+}: volume in (mL) of EDTA solution used to obtain calcium concentration.

II.3.13. Dosage of ammonium NH_4^+ [25]

The ammonium determination method by molecular spectrophotometry is suitable for drinking water and raw water. The principle is to determine the compounds formed by the reaction of ammonium with salicylic acid and hypochlorite ions in the presence of sodium nitroprusside.

Mode of operating

- Pour 40 mL of water into 50 mL Erlenmeyer flasks using graduated cylinder.
- Add 4 mL of sodium dichlorocyanurate.
- Add 4 mL of colored reagent.
- Fill with distilled water up to the judge mark.
- Wait up to 60 min in the darkness.
- Read the concentrations by the spectrophotometer at λ= 655 nm.

II.3.14. Dosage of nitrite NO_2^- [26]

In the presence of colored reagent at pH 1.9, a diazotization reaction by nitrites occurs. The pink complex formed is measured by spectrophotometry at a wavelength of 540 nm.

Mode of operating

- Pour 40 mL of water into a 50 mL Erlenmeyer using graduated cylinder.
- Add 1 mL of colored reagent.
- Complete with distilled water.
- Wait 20 min and read concentrations by a spectrophotometer at λ = 540 nm.

II.3.15. Dosage of nitrate NO_3^-[27]

Determination of nitrate by sodium salicylate method, suitable for drinking water, residual water and raw water. Where nitrate in the presence of sodium salicylate produces yellow paranitrosalicylate sodium.

Mode of operating

- Pour 10 mL of water into crucibles using graduated cylinder.
- Pour 1mL of sodium salicylate.
- Place in an oven (75˚C-80˚C) until completely dry (formation of a white precipitate).
- Remove and let cool.
- Add 2 mL of sulphuric acid.
- Shake and let stand 5min.
- Pour the container into a 50 mL Erlenmeyer flask by adding 15 mL of distilled water and 15 mL of the double sodium and potassium tartrate solution.
- Complete with distilled water up to 50 mL.
- Read the concentrations with the spectrophotometer at λ= 420 nm.

II.3.16. Dosage of orthophosphates PO_4^{3-} [28]

The ammonium molybdate method is suitable for the determination of orthophosphate, which is suitable for drinking water, waste water, raw water and even seawater. The orthophosphate reacts with molybdate and antimony to form an antimony phosphomolybdate complex, which is reduced by ascorbic acid forming a second complex and measure its absorbance to determine orthophosphate concentration.

Mode of operating

- Pour 40 mL of water into a 50 mL Erlenmeyer flask using graduated cylinder.
- Add 1 mL of ascorbic acid.
- Add 2 mL of acid molybdate.
- Complete with distilled water up to 50 mL.
- Wait 20 min.
- Read the concentrations with the spectrophotometer at λ= 880 nm.

II.3.17. Chloride dosage Cl^{-}[29]

The determination of chlorides is carried out by titration with silver nitrate ($AgNO_3$) -which results from the reaction of chloride with silver ions- using potassium chromate (K_2CrO_7) as an indicator.

Mode of operating

- Pour 20 mL of water into a 50 mL Erlenmeyer using graduated cylinder.
- Add 1mL potassium chromate K_2CrO_4.
- Complete with water up to the judge mark.
- Titrate with silver nitrate $AgNO_3$ (0.02M).
- Note the volumes.

$$[Cl^{-}] = (V_{AgNO3}-0.5) * 0.02*35453/ 100 * \ldots\ldots\ldots\ldots\ldots\ (12)$$

V_{AgNO3}: volume in (mL) of the silver nitrate solution used for the samples titration.

0.5: volume in (mL) of the silver nitrate solution used for the white titration.

0.02: the normality of $AgNO_3$.

35453 and 5: factors.

II.3.18. Sulphate dosage SO_4^{2-}[30]

Ions sulphate, in the presence of barium chloride (BaCl), precipitates as barium sulphate.

Mode of operating

- Pour 20 mL of water into a 50 mL Erlenmeyer using graduated cylinder.
- Add 5 mL of stabilizing solution.
- Add 2 mL of barium chloride.
- Complete with distilled water up to 50 mL.
- Let stand 1min.
- Read the concentrations by the spectrophotometer at λ= 530 nm.

III.19. Manganese Mn^{2+} determination [31]

The method is suitable for the determination of manganese in drinking, waste and raw water Manganese is oxidized to permanganate by ammonium per sulfate in the presence of silver nitrate.

Mode of operating

- Take in beakers of 250 mL, 100 mL of distilled water and samples**.**
- Add 5 mL of nitric acid.
- Add 5 mL of mercury nitrate (II).
- Add 0.5 mL of silver nitrate ($AgNO_3$).

- Heat on a hot plate.
- Let cool at room temperature for 5 min.
- Add 1mL of orthophosphoric acid and 10 mL of 10 % ammonium per sulphate solution.
- Re-heat for 10 min.
- Let cool.
- Read the concentration by spectrophotometer at λ= 525 nm.

II.3.20. Dosage of iron Fe^{2+} [32]

The phenanthroline spectrometric method for the determination of iron is applicable to drinking water and raw water. This method is based on an addition of phenanthroline to the sample to form a red-orange complex and measure its absorbance.

Mode of operating

- Pour 50 mL of water into a 100 mL Erlenmeyer flask using graduated cylinder.
- Add 1 mL of hydrochloric acid (10%).
- Heat on a hot plate under the hood for 40 min.
- Allow to cool and add 1 mL of hydroxylamine hydrochloride.
- Add 2 mL of the acetate buffer solution.
- Add 2 mL of phenanthroline solution.
- Leave to stand in the darkness for 15 min.
- Read the concentrations by the spectrophotometer at λ=510 nm.

II.4. Bacteriological parameters

II.4.1. Searching and enumeration of *TC* and *E-Coli* [14]

Colilert-18 either simultaneously detects *TC* and *E-Coli* or *FC*. It is based on IDEXX's proprietary defined substrate technology. When TC metabolizes colilert-18's DST nutrient-indicator: ONPG, the sample turns yellow. When *E-Coli* metabolize colilert-18 DST nutrient-indicator, MUG; the sample also fluorescence. Colilert-18 can simultaneously detect those bacteria at 1CFU/100mL within 18H even with as many 2 million heterophic bacteria per 100mL present.

Mode of operating

- Add content of one pack to 100 mL room temperature water sample in a sterile, transparent, non-fluorescing vessel.
- Cap vessel and shake until dissolved.
- Pour sample/ reagent mixture into a quanty-tray on Q-T/2000 and seal in an IDEXX Q-T sealer.

- Place the sealed tray in 35±0.5˚C incubator for 18H. For incubation in a water bath, submerge the quanty-tray, as is, below the water level using a weighted ring.
- Count the number of positive wells and refer to MPN table provided with the trays to obtain the MPN. (annexe 10)

II.4.2. Searching and enumeration of *Entero* [15]

Enterolert-E detects *Entero* in fresh and marine water. It's based on IDEXX's proprietary defined substrate technology (DST). When *Entero* uses then ß-glycosidase enzyme to metabolize Enterolert-E's nutrient-indicator, 4-methy-umbelliferyl ß-D- glucodise; the sample fluorescence. Enterolert-E detects *enterococci* at 1CFU/100mL sample within 24H.

Mode of operating

- Add content of one pack to 100 mL room temperature water sample in a sterile, transparent, non-fluorescing vessel.
- Cap vessel and shake until dissolved.
- Pour sample/ reagent mixture into a quanty-tray on Q-T/2000 and seal in an IDEXX Q-T sealer.
- Place the sealed tray in 41±0.5˚C incubator for 24H.
- Count the number of positive wells and refer to MPN table provided with the trays to obtain the MPN. (annexe 10)

II.5. Conclusion

At the end of our work, we've got the ability of analyzing the different parameters of quality; to knowing their principles, their work methods and the interaction between the reagents of each analyze.

Notice that those analyze has been done at the laboratory with a high attention and control in order to get the most accurate results.

Chapter III: Results and discussion

III.1. Introduction

The analyzes have been done, thereafter, they present many differences of parameters on each collection and on parameters themselves; which conduct to interpret their results so to discuss the quality of water at the end.

III.2. Physicochemical parameters

III.2.1. Temperature measurement

Water temperature plays an important role in an aquatic life: in migration, growth, incubation and the metabolism of aquatic organisms. It also influences the concentration of dissolved oxygen and pH determination. Therefore, temperature conditions all the species and compounds.

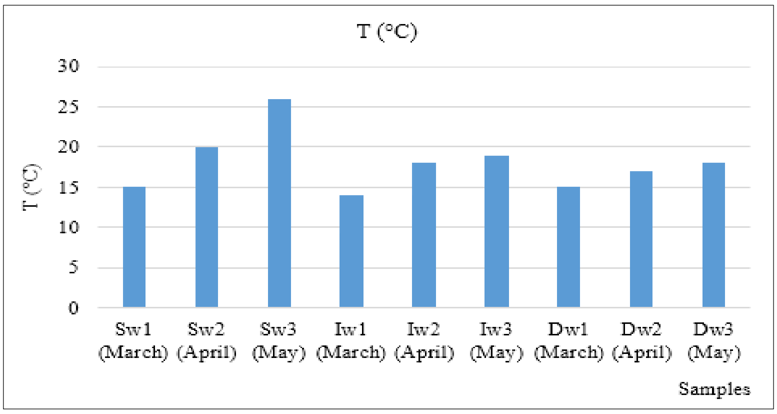

Figure III.1: Variation in temperature of raw water from keddara dam.

The lowest values of temperature have been notices at Dw (15°C-18°C), the highest ones are those of Sw (15°C-26°C): from March to May for all collections (figure III.1); they meet the standards [33, 34].

In addition to that, an increase of temperature of water has been detected: many parameters caused it. Such as season, time of day (of collection), air circulation, cloud cover, the flow and depth of the dam [6].

III.2.2. pH measurement

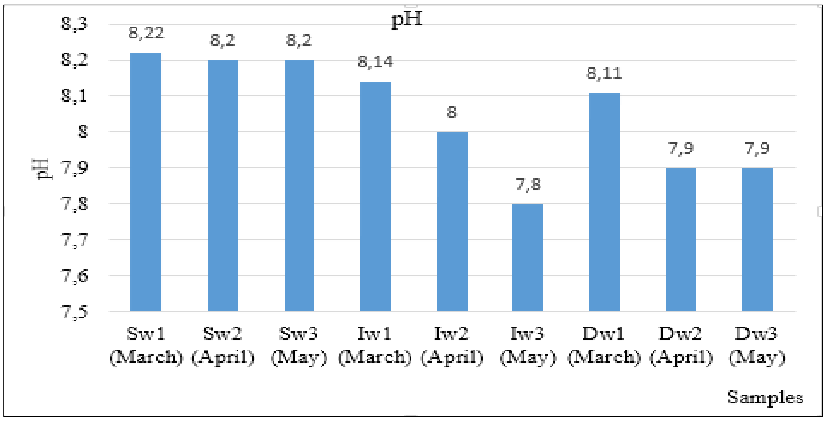

Figure III.2: Variation in pH of raw water from keddara dam.

pH values (figure III.2) are almost constant (7.8 to 8.22): the highest value is of Dw for the first collection, and the lowest one is of Dw so for the last collection. Similar results found in 2015 [3] and 2020 [10]. Those values are at Algerian national standard (6.5-9.5) [33]; which means that water has alkaline propriety. According to Chambet-Hezerdja Faiza [3], it decreases in the presence of high levels of organic matter and increases during low water periods, when evaporation is high.

The slight change might be attributed to the presence of pollutants, activity of bacteria in surface water compared to the depth using dissolved carbon dioxide CO_2 in their photosynthetic process and precipitation of calcium and magnesium.

III.2.3. Electrical conductivity

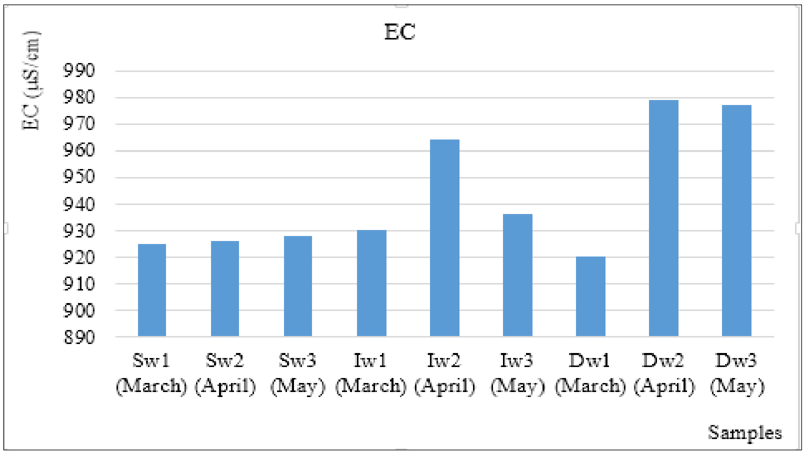

Figure III.3: Variation in EC of raw water from keddara dam.

The importance of EC is related to the presence of positive ions, which greatly affect the taste of water and its acceptability for drinking uses [35].

From 920µs/cm for Iw of the first collection up to 979µs/cm for Dw of the second one, the water has got deferent values of EC (figure III.3). Nevertheless, they steel according to the national and international standards [33, 34].

The increase or decrease of EC probably due to the use of artificial fertilizers or salts carried out by irrigation water. The electrical conductivity depends on the charges of organic matter, generating salts after decomposition and mineralization and with the phenomena of evaporation, which concentrates these salts in the water [36].

III.2.4. Turbidity measurement

The turbidity of water can affect water acceptability by consumers leading to consumer complaints from appearance and it is utility in some industries [36].

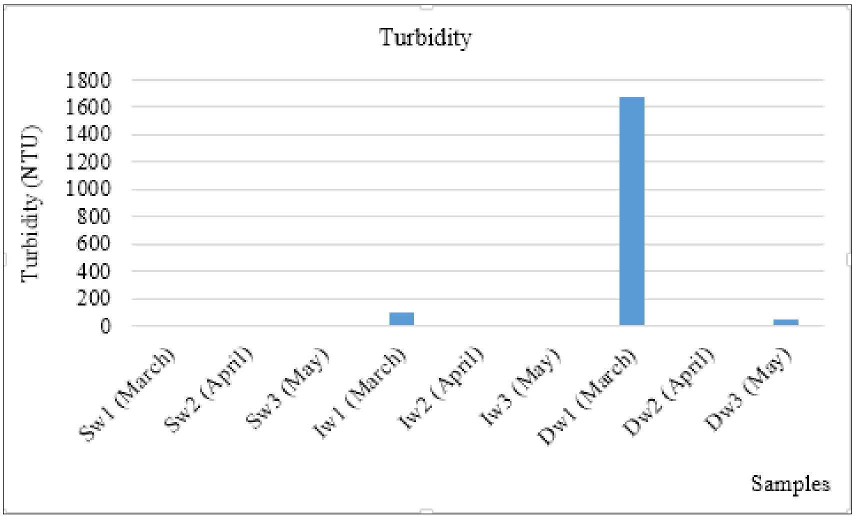

Figure III.4: Variation in turbidity of raw water from keddara dam.

As it is mentioned in (figure III.4) and (Annexe 02), turbidity fluctuates between 3.6 NTU for Sw of the second collection and 1637 NTU for Dw of the first one, which was much more turbid than the others.

For the three collections, a remarkable increase of turbidity has been noticed, but most of them are extremely higher than the standards [33, 34].Turbidity is linked to the presence of various organic matters, clay, colloids… [7].

III.2.5. OM

Permanganate index (OM) of water is the mass concentration of oxygen in relation to the quantity of permanganate ions consumed by a sample of water, under defined conditions. Expressed in mg/L of oxygen, it corresponds to a conventional measurement for evaluating the contamination of a water sample with low organic matter content [7].

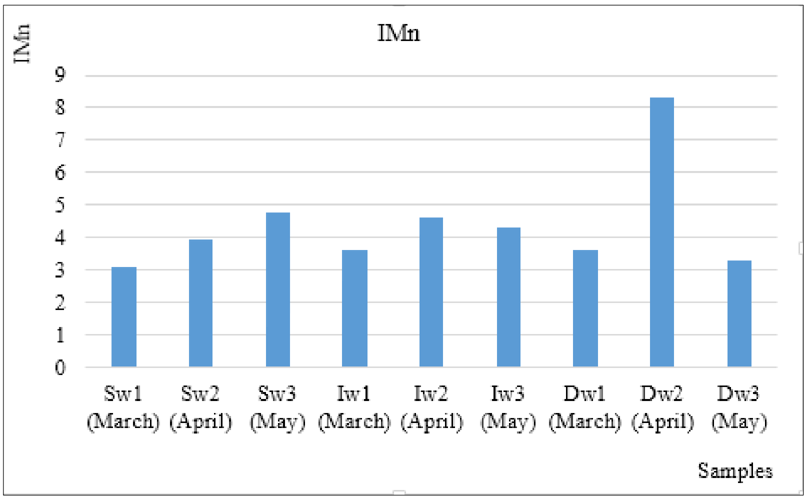

Figure III.5: Variation in OM of raw water from Keddara dam.

The range of samples is between 3.07 mg/L O_2 for Sw of the first collection and 8.33 mg/L O_2 for Dw of the second, where it changes by increasing its value than it decreases on the third collection with a remarkable values (figure III.5). Indeed, even if it is an increase or decrease of IMn and therefore of OM, but these entire results meet the standard [33]. Except for Dw of the second collection which exceeds it: it is an index of organic contamination. This explains the activity of microorganisms, which decompose organically consuming a large amount of oxygen and even the deposition of waste at the bottom.

III.2.6. COD

The COD is widely used as a measure of the susceptibility to oxidation of the organic and inorganic materials present in water.

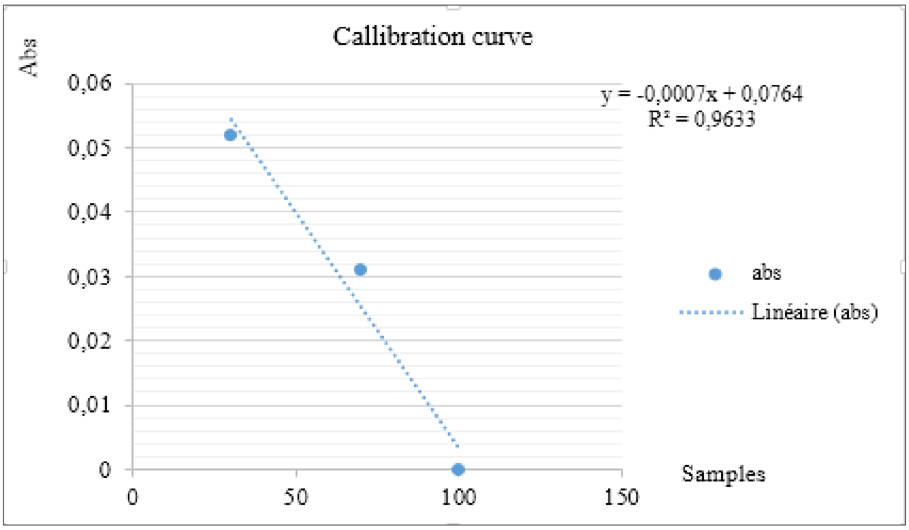

Figure III.6: COD calibration curve.

Amount of COD, of this study (Annexe 02), fluctuates between very high values (96.28 mg/L) and other low values (3.42 mg/L). For surface water intended for the production of drinking water, a guide value of 30 mg/L O_2 is fixed [7, 33, and 34]. Most of sites have exceeded it .According to Lebea N. Nthunya et *all* [37]; those levels arise generally from the material loads brought into the dam from surface runoff and subsequent settling, and even from the presence of a fraction of non-biodegradable OM.

The negative COD values were obtained just by calculation and not experimentally since, it means the non-biodegradability of organic matter. (Annexe 02).

III.2.7. BOD_5

BOD_5 is a parameter used to classify water and define the alteration of the environment by biodegradable organic matter.

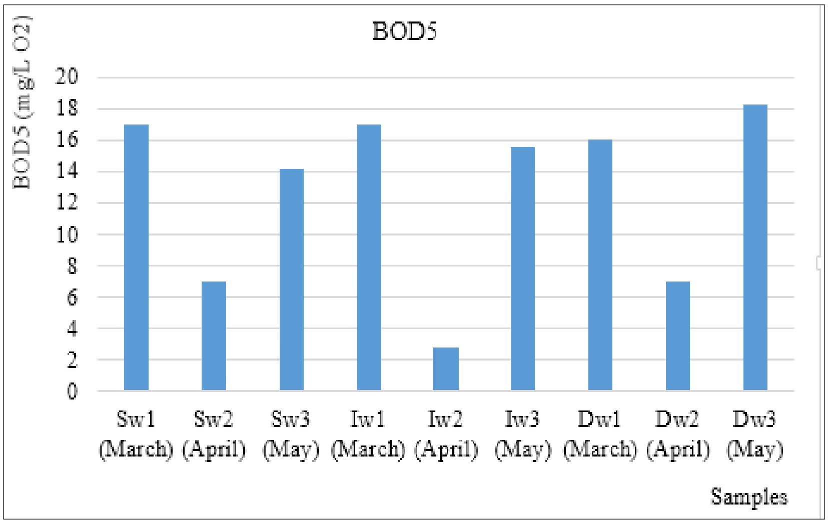

Figure III.7: Variation in BOD_5 of raw water from keddara dam.

The variation of the BOD_5 (figure III.7) oscillating from (2.8 mg/L O_2) up to (18.3 mg/L O_2), appreciates that its value does not meet the Algerian standard 7 mg/L O_2 [33]. the lower values than BOD_5 is 2.8 mg/L mean that it is good quality water and highly oxygenated, that of 7 mg/L is of average quality, and this was found at the level of the second collection. While, those that exceed 7mg/L are of very poor quality.

Table III.1: COD/BOD_5 report.

	Samples	COD (mg/L O_2)	BOD_5(mg/LO_2)	COD/BOD_5
First collection	Sw	-78	16,9	-4,61538462
	Iw	70,5714286	16,9	4,17582418
	Dw	/	16	/
Second collection	Sw	3,42857143	7	0,48979592
	Iw	-116,571429	2,8	-41,6326532
	Dw	96,2857143	7	13,755102
Third collection	Sw	-143,714286	14,1	-10,1925026
	Iw	-120,857143	15,5	-7,79723503
	Dw	-149,428571	18,3	-8,16549568

According to the COD/BOD_5 report and Rodier's classification [7], the water quality of the keddara dam is easily to moderately biodegradable, which explains the rising rate of OM.

III.2.8. Dissolved oxygen

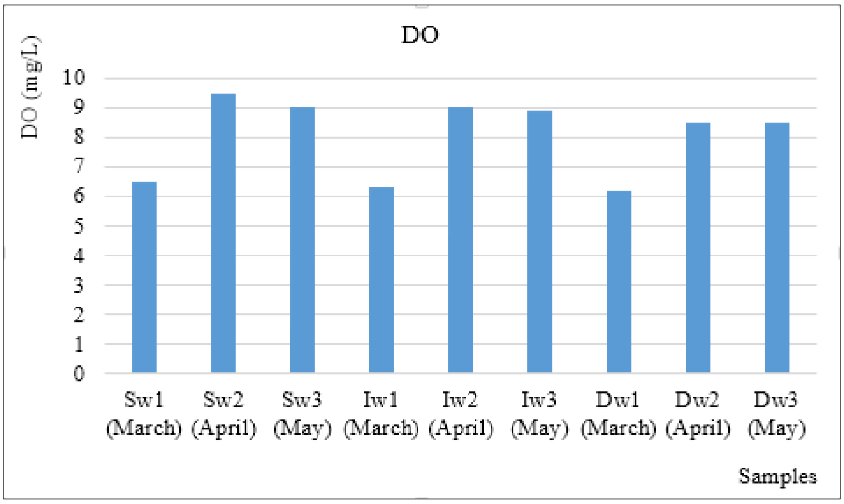

Figure III.8: Variation in DO of raw water from keddara dam.

The evolution of dissolved oxygen displayed in the figure above (figure III.8), informs that not all these concentrations accepts the Algerian standard fixed at 5 mg/L; oscillating from (6.2 mg/L): the lower value to (9.5 mg/L): the higher value.

There is also a decrease in concentration along depth: waste discharges high in organic matter and nutrients can lead to decreases in DO concentrations because of the increased microbial activity (respiration) occurring during the degradation of the organic matter [6].

III.2.9. TDS

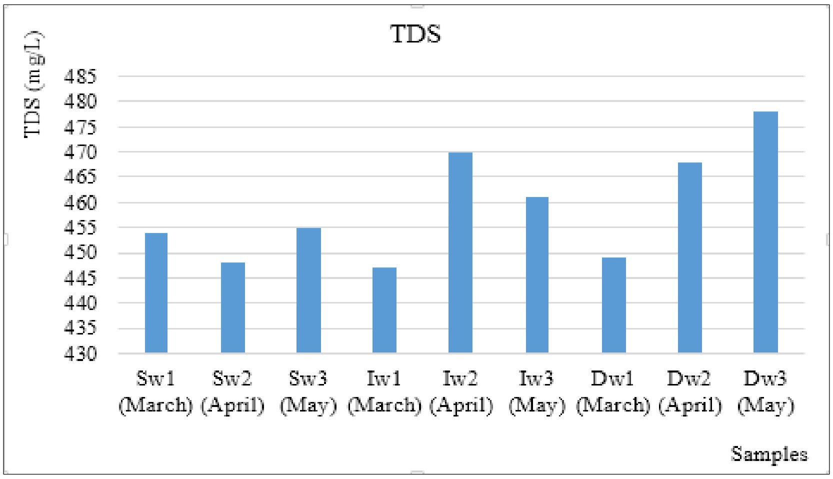

Figure III.9: Variation in TDS of raw water from keddara dam.

All of Iw and Sw of the first collection, and Sw of the second take the lowest values (447 mg/L-449 mg/L), but Dw of third collection is much more higher than the other samples (478 mg/L) (annexe 02). All of them are under the standard [33], which means it is suitable for domestic use. TDS variation during the study period, due to a lot of parameters such as temperature, pH, EC and activity of OM too: TDS are comprised of inorganic matter such as mineral, salts, metals as well as dissolved organic matter present in the water [37]. Rainfall (period of first collection) diluted the dam water and the TDS concentrations decreased, while evaporation caused the TDS to increase during dry season [36].

III.2.10. Alkalinity

a) CAT

The relative values of the complete alkalimetric title (CAT) make it possible to know the quantities of hydroxides, carbonates or hydrogen carbonates present in the water.

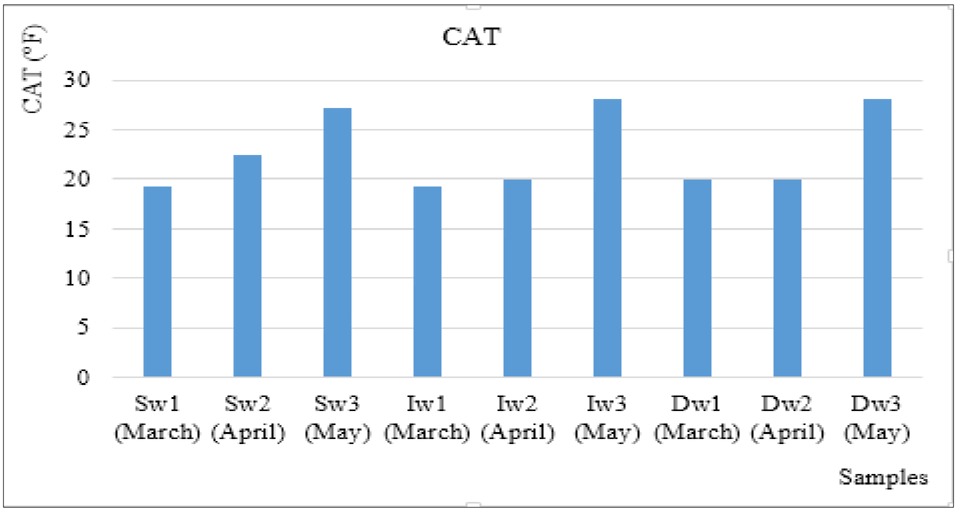

Figure III.10: Variation in CAT of raw water from keddara dam.

High TAC results were obtained for all three collections (19.2°F up to 28°F),and even an increase from winter to early summer was marked; which means the water was rich with hydrogen carbonate(HCO_3^-), carbonate (CO_3^{2-}) and hydroxide (OH^-): they present high concentration [9].

III.2.11. TH

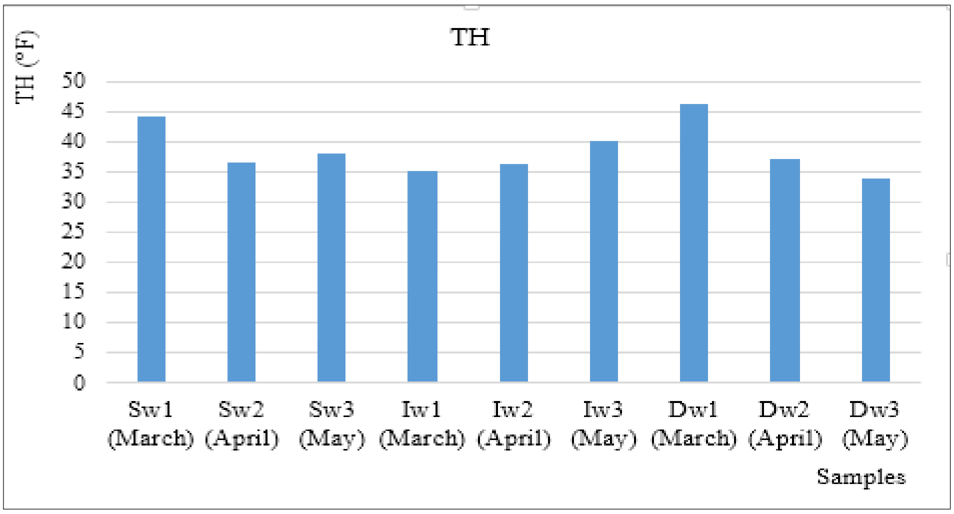

Figure III.11: Variation in TH of raw water from keddara dam.

Total hardness is the measure of the sum of positively charged ions, as its equation indicates, primarily comes down to Ca^{2+} and Mg^{2+} ions.

According to O.G.A.R regulations [33] TH meet the standard, this parameter increases in March : where the highest value (Dw = 46.4°F) has been recorded, while it decreases in May: the lowest value in summer (Dw = 34°F); this change is mainly related to the increase and decrease of calcium Ca^{2+} and magnesium Mg^{2+} ions, respectively.

To refer at classification of water according to TH, its values means that water is very hard.

III.2.12. Calcium Ca^{2+}

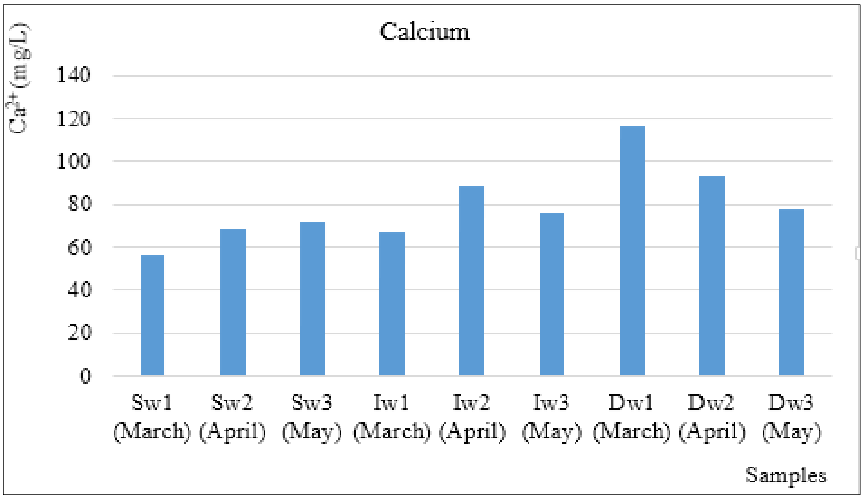

Figure III.12: Variation in calcium of raw water from keddara dam.

The values of calcium increase in all collections as it is mentioned in figure III.12.

Calcium is essential element (99% in the skeleton); it must be supplied to the human body at a rate of 0.7 to 2 g/day. High concentration in water poses no health hazard. It is important for water quality: it plays with magnesium Mg^{2+} an indisputable role of hardening.

The Calcium contents of the waters analyzed are all lower than the maximum admissible concentration that is 200 mg/L enacted by national and international standards [33, 34] for drinking water. With maximum and minimum of (116 mg/L) and (56 mg/L), respectively. This content presents an increase on the same collection. It decreases during the time study, this variation is due to climate change (temperature increase), according to Aouadi Ibtihel [4]: calcium concentrations can fall when calcium carbonate precipitates due to increased water temperature. The nature of the soil crossed and the limestone deposit at the bottom of the dam [9] lead to change its content so.

III.2.13. Magnesium Mg^{2+}

Magnesium is common in natural waters as Mg^{2+}, and along with calcium, is a main contributor to water hardness.

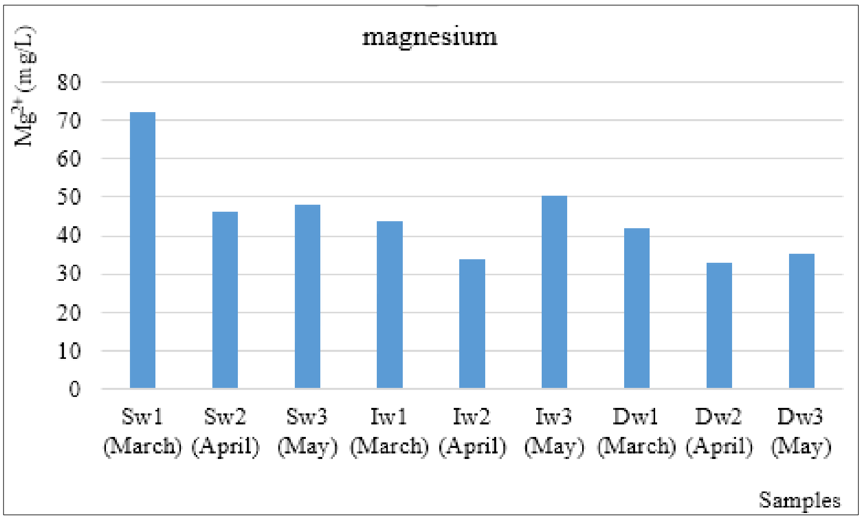

Figure III.13: Variation in magnesium of raw water from keddara dam.

Figure III.13 represents the magnesium values which oscillate from (33.12mg/L) in April and (72mg/L) at the end of March; as a minimum and maximum value, successively.

The values recorded meet the Algerian standard [33]; in addition, they mark a reduction from Sw to Dw for the three collections, and even from winter to early summer. This decrease can be attributed to the weathering and leaching of the rocks during the winter, whereas it is not the case for the last collection where a precipitation of calcium carbonate and magnesium exists [8].

III.2.14. Ammonium NH_4^+

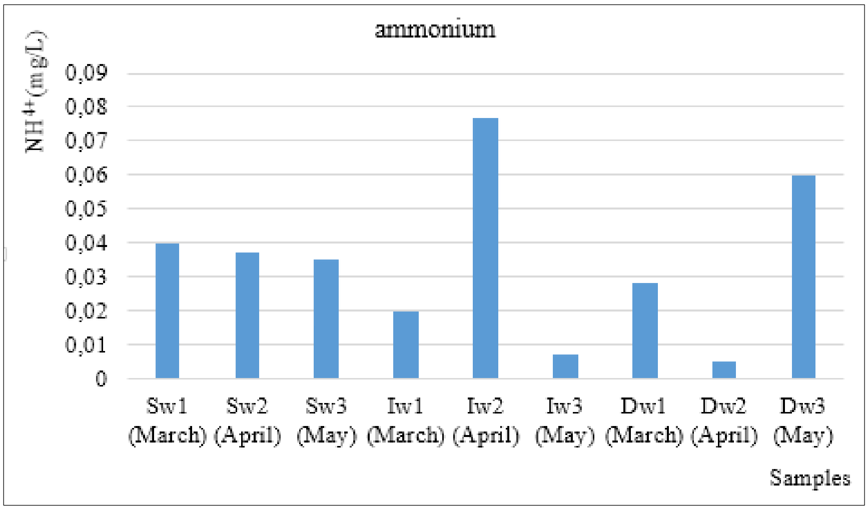

Figure III.14: Variation in ammonium of raw water from keddara dam.

Figure III.14 represents the ammonium values of the three dam sites. An increase in the ammonium concentration was recorded during the sampling and especially at the level of Dw , ammonium in surface waters can originate from plant matter in watercourses, animal or human organic matter (man eliminates 15 to 30 g of urea per day), industrial discharges and fertilizers [7]. Almost, similar results have been recorded in 2015 [3].

Note that the highest and lowest values are (0.035 mg/L) and (0.077 mg/L), successively. There more, all the concentrations respect the value fixed by the standards [33, 34] they are extremely lower.

III.2.15. Nitrite NO_2^-

Nitrites are important for the development of algae. However, its presence in very large concentrations destroys the quality of water and human health thereafter.

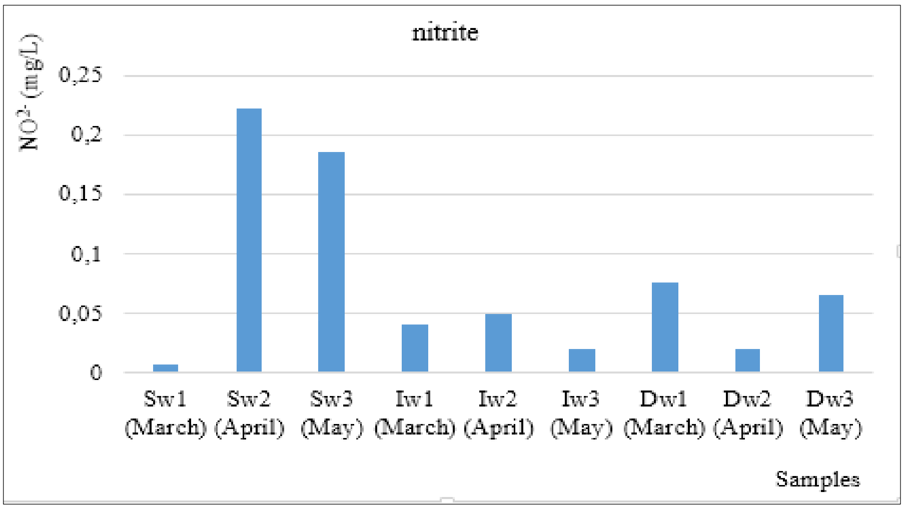

Figure III.15: Variation in nitrite of raw water from keddara dam.

As shown in the figure above (figure III.15), the nitrite concentration decreases from 0.222 mg/L down to 0.006 mg/L. whose lowest values were noted at the bottom of the dam, except for the first collection. Unlike the 2021 results [9], our results are a little weak. This is due to the oxidation phenomena of nitrate in the presence of DO and even the high values are due to the temperature: Nitrites are likely to form under the action of bacteria and at high temperatures [7]. All results meet [33, 34] standards that is (0.2 mg/L).

III.2.16. Nitrate NO_3^-

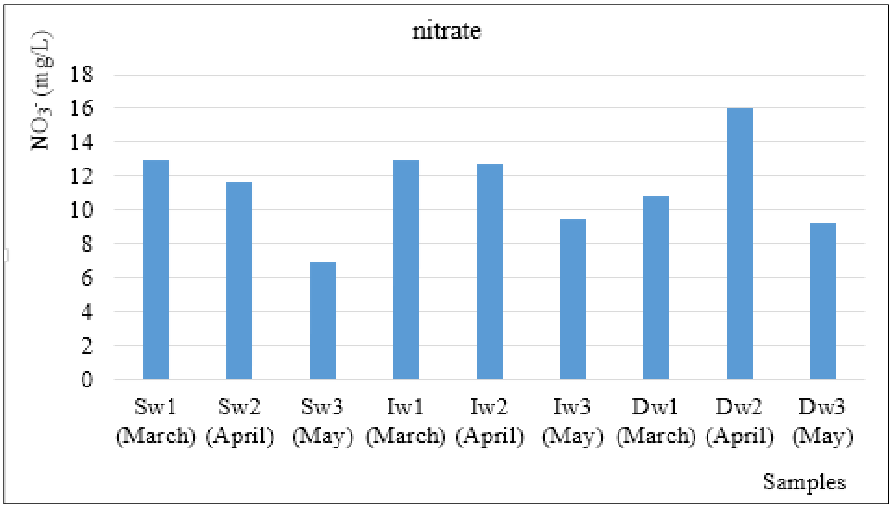

Figure III.16: Variation in nitrate of raw water from keddara dam

Nitrate concentrations are summarized in figure III.16.

The deep of dam was found to have the highest nitrate concentration. This can be explained by the action of nitrification, which took place especially in reduction of the temperature at the level of bottom of dam, and thereafter an increase in the solubility of DO, therefore the solubility of nitrate. This allows its easy movement and settling.

A concentration of (6.9 mg/L) and (16.04 mg/L) are recorded as the maximum and minimum, respectively (annexe 02). Moreover, even all the other values remain below the national and international standard [33, 34].

The decrease in nitrate concentration at the level of collection amounts to the increase in temperature (an inversely proportional relationship).

III.2.17. Orthophosphate PO_4^{3-}

The figure III.17 shows the concentrations of ortho-phosphates, which are well below the standard set by the O.G.A.R and even by the WHO (0.4mg/L) [33, 34].

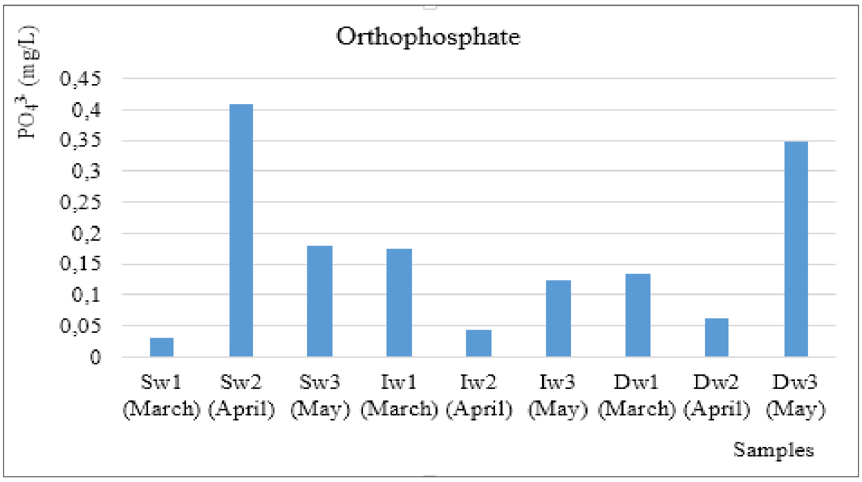

Figure III.17: Variation in ortho-phosphate of raw water from keddara dam.

The higher and lower concentrations are noted at the Sw of the second collection and Sw of the first collection which are 0.41mg/L and 0.031mg/L, successively; an increase in concentration has also been noted due to human activities which are the main cause of eutrophication. The latter (eutrophication) is characterized by the multiplication of microorganisms, which reduces the passage of light, increases the consumption of oxygen (explains the DO content) [7].

Overall, our water is not loaded with orthophosphate, which limits the phenomena of eutrophication. Because all its values conform to the standards.

III.2.18. Chloride Cl^-

Chlorides are widely distributed in water, especially in the form of salt (NaCl).

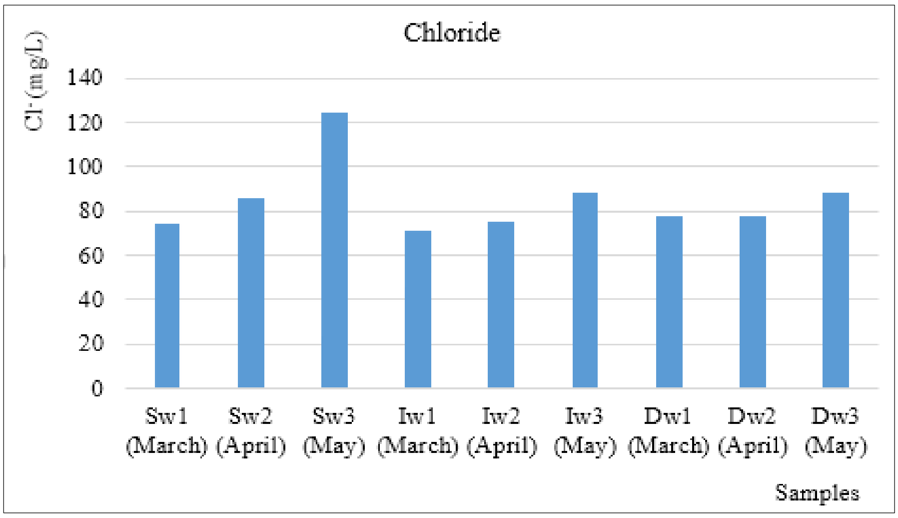

Figure III.18: Variation in chloride of raw water from keddara dam.

Monitoring the concentration of chlorides, make it possible to detect high and low levels, but which always remain in accordance with the national standard and the standard recommended by WHO [33,34]: (70.9mg/L) for winter and (124.08mg/L) in early summer and even it increases from first to last collection.

These values and this increase is a result of the dissolution of the different minerals existing in the dam.

III.2.19. Sulphate SO_4^{2-}

Natural waters practically contain sulphates, in very variable proportions. Their presence results from calcium sulphate solubility in gypsum rocks and from oxidation of sulphides spread in rocks [9].

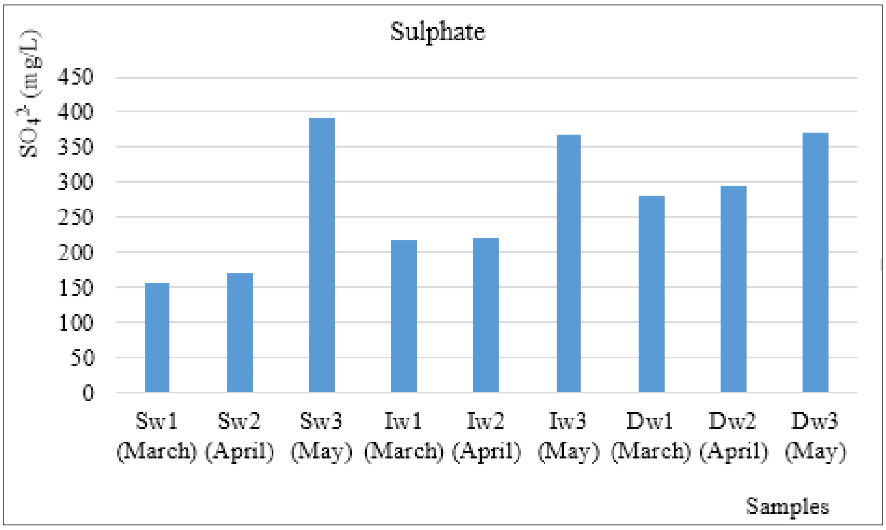

Figure III.19: Variation in sulphate of raw water from keddara dam.

The Algerian regulation and the WHO have admitted a value of (400mg/L) as a maximum admissible concentration of sulphate. Therefore, all values are in agreement with. The lowest is that of Sw of first collection (156.44 mg/L) and the highest is Sw of third collection (393.2 mg/L) as figure III.19 shows. An increase was observed during this study: can be explained by the dilution caused by rain during winter to soluble calcium sulphate in rocks also industrial discharges and atmospheric precipitation can add significant amounts of sulphate to surface waters. [6].

III.2.20. ManganeseMn^{2+}

Manganese is one of the heavy metals found in water. Fortunately, it is less toxic than others are such as cobalt and cadmium...

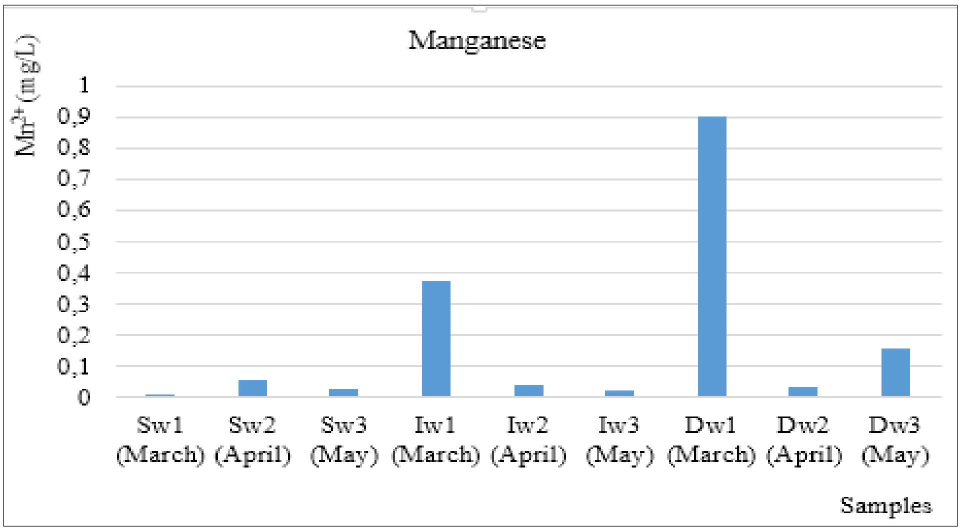

Figure III.20: Variation in manganese of raw water from Keddara dam.

Manganese content increases from winter to early summer with a maximum and minimum value equal (0.375 mg/L) and (0.005 mg/L) during winter and summer, respectively.

The manganese variations presented in (figure III.20) show that the latter complies with the standards [33, 34]. On the other hand, there is a site that does not accept it (Dw of first collection): its value greatly exceeds it. This is explained by the variations in pH and DO which are high at the same level. According to Rodier [7], manganese solubility depends on pH, dissolved oxygen. Some groundwater has levels of around 1 mg/L, particularly when water is under the action of certain bacteria.

II.21. Iron Fe^{2+}

No health risks can be caused by iron, but not in high concentrations; even if the body can get rid of it easily.

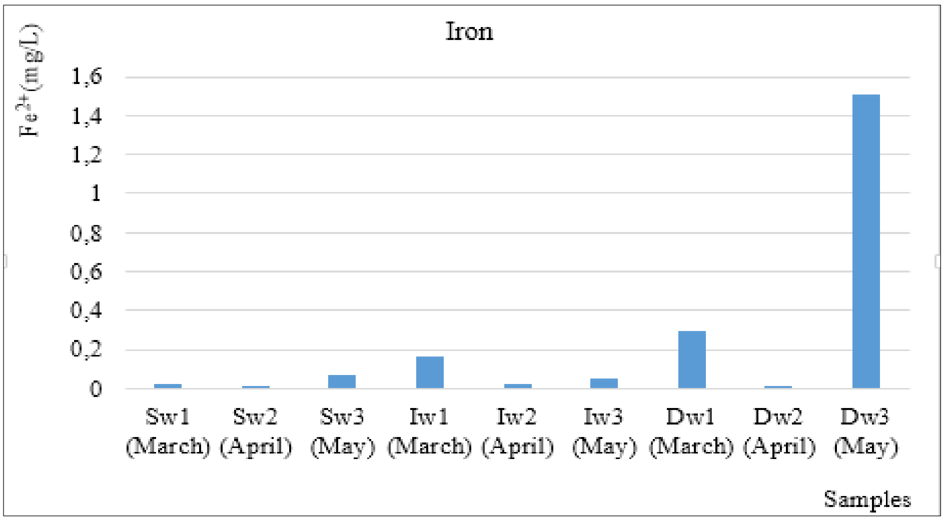

Figure III.21: Variation in iron of raw water from keddara dam.

Iron values shown in (figure III.21), allows us to note the existence of an increase in concentration from Sw to Dw during the collection or a maximum value of 1.51 mg/L was obtained for the third collection and the minimum of 0.015 mg/L in the second sample. This increase can be attributed to a decrease in dissolved oxygen at the bottom of the dam, which allows the development of this heavy metal.

All iron concentrations meet national and WHO standard [33, 34], except for Dw of the last collection which presents a high concentration (1.51 mg/L) which is already explained above.

III.3. Bacteriological parameters

III.3.1. Searching and enumeration of *TC* and *E-Coli*

The presence of *TC* and *E-Coli* bacteria in the water is an indication of its hygienic quality: they come mainly from human faeces, warm-blooded animals and sometimes from household water. That is why they are considered as the source of different diseases, either the infections that they cause or the diarrhea and the fever in the body of the human.

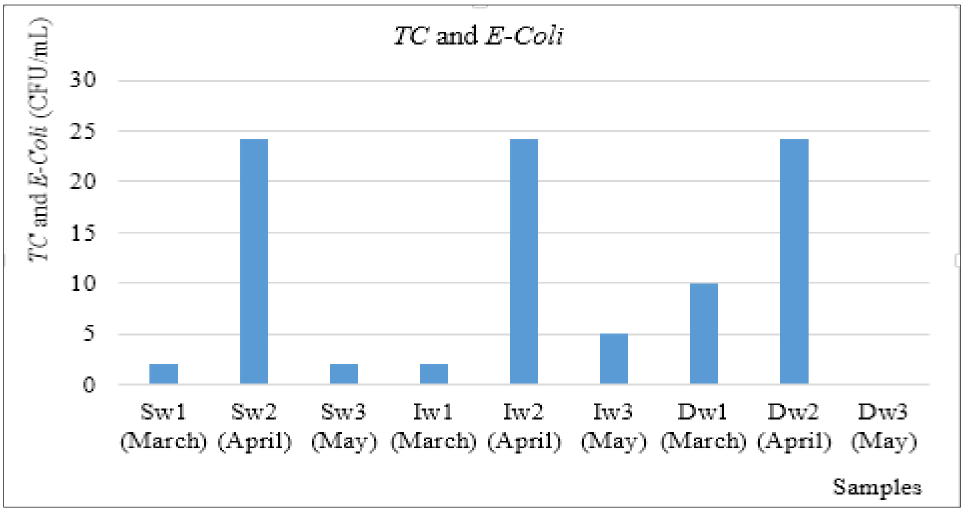

Figure III.22: Variation in *TC* and *E-Coli* of raw water from keddara dam.

Due to the aforementioned causes, the Algerian and WHO regulations [33, 34] prohibit the presence of *TC* and *E-Coli* in the water. Now, that our results, summarized in the figure III.22 indicate their high content especially at the second collection: when the temperature was higher. The presence of *TC* and *E-Coli* is an important indicator of faecal contamination and especially for the surface water that it is evaluated (faecal contamination). The results of T, OM and dissolved oxygen mean the bacterial activity existing in this water and can be coming from urban wastewater discharges [7].

III.3.2. Searching and enumeration of *Intestinal Enterococci*

Entero marks a significant defence to disinfectant agents. Such as *EC* and *T-Coli*, *Entero* are an index of faecal contamination and even of the effectiveness of treatment thereafter.

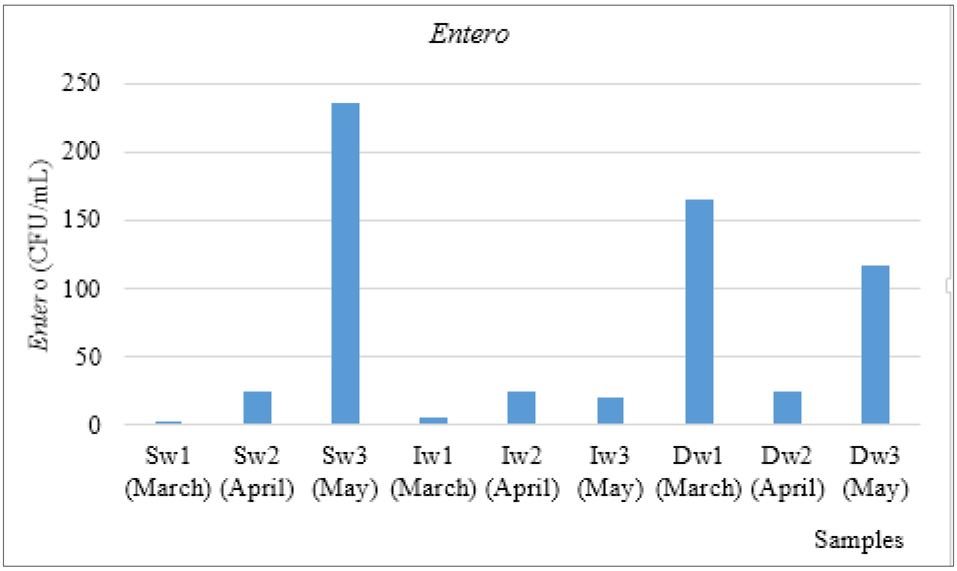

Figure III.23: Variation in *Entero* of raw water from keddara dam.

As for *EC* and *E-Coli*, the regulations immediately rule out the existence of *Entero* in water. While they are present in very large numbers from 0 CFU/mL as a minimum value up to 235.2 CFU/mL as a maximum value.

III.4. Conclusion

At the end of the monitoring of the physicochemical and bacteriological parameters of raw water from keddara dam, we have identified a certain number of observations such as the physicochemical analyzes obtained revealed that the temperature, pH and EC are very satisfactory to the standards but turbidity is much higher than the standards, due to the presence of SM.

OM shows that living microorganisms in water decompose remarkable organic matter, especially by the COD and BOD_5 values, therefore by the high oxygen consumption explained by the excessively high DO value.

The mineralization of the dam water also meet standards while nitrogenous compounds (nitrite and nitrate), iron and manganese even if they respect the standards, but they exceed them in some sites and present significant values which are always due to the activity of microorganisms using oxygen during their decomposition. About other physicochemical parameters, they are always in accordance with the standards. Microbiological analyzes show the strong growth and existence of bacteria at the dam level. In this case, a biological treatment is necessary.

General conclusion

General conclusion

Either for humans, or animals, Or for nature, water presents a real source of functioning for all their organisms. However, any contamination of water is a cause of destruction for them. Therefore, a quality assessment is necessary.

The study carried out during this modest work was focused on the evaluation of the raw water quality at the keddara dam before and after filling.

The results obtained during our internship, allowed us to draw the following result:

- For physicochemical analyses, most of them are in the standards except the turbidity which surpassed it significantly; this comes down to the degradability and biodegradability of organic matter. Although, for the other parameters, they remain within the standards, except for a few, especially for the bottom of the dam which is caused to the activity of microorganisms therefore to organic matter.
- For bacteriological analyses, a search and enumeration of *total coliforms*, *Escherichia coli* and *Entero* was carried out and it shows us the presence of bacteria for the three samples, especially when it comes to a high temperature. Therefore, faecal contamination was obtained at the dam.

In the light of the results found, we discovered that the keddara dam is of a good quality; just a biological treatment is enough to minimize bacterial activity.

As a perspective, taking into account the results, a biological treatment must be implemented before the water is distributed as drinkable. The latter targets microorganisms and bacteria.

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Annexes

Annexe 01

SEAAL

The treatment center is located hlaymiya city between the communes of Boudouaou and Ouled Moussa wilaya of Boumerdes, about 46km from Keddara dam. With an essential, mission which is to produce and serve drinking water.

Historically the station is the largest water production infrastructure, is missioned in 1986 and constitutes a part of SPIK (system de production ISSER-KEDDARA). Treats raw water from Keddara, Beni-Amrane and el-Hamiz; but its main source for drinking water is Keddara dam with a capacity of 142 million m^3. The station produces 300000 m^3 daily, which provides the needs of habitants, and half of the habitants of the capital Algiers.

SEAAL.

Annexes 02

Tables

Physical parameters results.

	Date	Samples	T (°C)	pH	EC (µs/cm)	Turbidity (NTU)
First collection	30/03/2022	Sw	15	8,22	925	6,1
		Iw	14	8,14	930	95
		Pw	15	8,11	920	1637
Second collection	26/04/2022	Sw	20	8,2	926	3,6
		Iw	18	8	964	6,6
		Pw	17	7,9	979	9,31
Third collection	24/05/2022	Sw	26	8,2	928	4,9
		Iw	19	7,8	936	8,5
		Pw	18	7,9	977	48

Annexes

OM values.

			V $kmNO_4$ (mL)			
	Date	**Samples**	**V0**	**V1**	**V2**	**IMn**
First collection	31/03/2022	The white	0,7	/	19,8	0
		Sw	/	4,5	/	3,07
		Iw	/	5,2	/	3,63
		Dw	/	5,2	/	3,63
Second collection	27/04/2022	The white	0,6	/	19	0
		Sw	/	5,3	/	3,95
		Iw	/	6,1	/	4,63
		Dw	/	10,5	/	8,33
Third collection	24/05/2022	The white	0,6	/	19	0
		SW	/	6,3	/	4,8
		Iw	/	5,7	/	4,29
		Dw	/	4,5	/	3,28

COD results.

	Date	**Samples**	**Abs**	**COD (mg/L O_2)**
Standard solutions	11/05/2022	100	0	109,142857
		30	0,052	34,8571429
		70	0,031	64,8571429
First collection	11/05/2022	Sw	0,131	-78
		Iw	0,027	70,5714286
Second collection	11/05/2022	Sw	0,074	3,42857143
		Iw	0,158	-116,571429
		Dw	0,009	96,2857143
Third collection	25/06/2022	Sw	0,177	-143,714286
		Iw	0,161	-120,857143
		Dw	0,181	-149,428571

BOD_5 results.

	Date	Samples	BOD_5 (mg/L O_2)
First collection	11/05/2022	Sw	16,9
		Iw	16,9
		Dw	16
Second collection	11/05/2022	Sw	7
		Iw	2,8
		Dw	7
Third collection	25/05/2022	Sw	14,1
		Iw	15,5
		Dw	18,3

DO values.

	Samples	[O_2] (mg/L)
First collection	Sw	6,5
	Iw	6,3
	Dw	6,2
Second collection	Sw	9,5
	Iw	9
	Dw	8,5
Third collection	Sw	9
	Iw	8,9
	Dw	8,5

TDS values.

	Date	Samples	TDS (mg/L)
First collection	07/04/2022	Sw	454
		Iw	447
		Dw	449
Second collection	27/04/2022	Sw	448
		Iw	470
		Dw	468
Third collection	24/05/2022	Sw	455
		Iw	461
		Dw	478

CAT results.

	Date	Samples	VH_2SO_4 (mL)	CAT (°F)
First collection	11/04/2022	Sw	4,8	19,2
		Iw	4,8	19,2
		Dw	5	20
Second collection	10/05/2022	Sw	5,6	22,4
		Iw	5	20
		Dw	5	20
Third collection	29/05/2022	Sw	6,8	27,2
		Iw	7	28
		Dw	7	28

TH, Ca^{2+} and Mg^{2+} results.

	Date	Samples	V EDTA (mL)	TH (°F)	V EDTA (mL)	[Ca^{2+}] (mg/L)	[Mg^{2+}] (mg/L)
First collection	11/04/2022	Sw	22	44	7	56	72
		Iw	17,5	35	8,4	67,2	43,68
		Dw	23,2	46,4	14,5	116	41,76
Second collection	10/05/2022	Sw	18,2	36,4	8,6	68,8	46,08
		Iw	18,1	36,2	11	88	34,08
		Dw	18,5	37	11,6	92,8	33,12
Third collection	29/05/2022	Sw	19	38	9	72	48
		Iw	20	40	9,5	76	50,4
		Dw	17	34	9,7	77,6	35,04

NH_4^+, NO_2^-, NO_3^- and PO_4^{3-} results.

	Date	Samples	$[NH_4^+]$ (mg/L)	$[NO_2^-]$ (mg/L)	$[NO_3^-]$ (mg/L)	$[PO_4^{3-}]$ (mg/L)
First collection	31/03/2022	Sw	0,04	0,006	12,98	0,031
		Iw	0,02	0,04	12,92	0,175
		Pw	0,028	0,076	10,81	0,135
Second collection	27/04/2022	Sw	0,037	0,222	11,711	0,41
		Iw	0,077	0,049	12,754	0,043
		Pw	0,005	0,02	16,046	0,063
Third collection	24/05/2022	Sw	0,035	0,186	6,89	0,179
		Iw	0,007	0,02	9,47	0,124
		Pw	0,06	0,065	9,21	0,348

Cl^- results.

	Date	Samples	V $AgNO_3$ (mL)	$[Cl^-]$ (mg/L)
First collection	11/04/2022	Sw	2,6	74,45
		Iw	2,5	70,9
		Dw	2,7	78
Second collection	10/05/2022	Sw	11	86,06
		Iw	12	75,16
		Dw	12,4	77,99
Third collection	29/05/2022	Sw	4	124,08
		Iw	3	88,68
		Dw	3	88,63

SO_4^{2-} results.

	Date	Samples	$[SO_4^{2-}]$ (mg/L)
First collection	10/04/2022	The white	0
		Sw	156,44
		Iw	217,64
		Dw	280,46
Second collection	09/05/2022	The white	0
		Sw	170,99
		Iw	221,4
		Dw	294,05
Third collection	29/05/2022	The white	0
		Sw	393,2
		Iw	386
		Dw	371

Mn^{2+} results.

	Date	Samples	$[Mn^{2+}]$ (mg/L)
First collection	30/03/2022	Sw	0,005
		Iw	0,375
		Dw	0,9
Second collection	09/05/2022	Sw	0.056
		Iw	0.039
		Dw	0.032
Third collection	26/05/2022	Sw	0,026
		Iw	0,021
		Dw	0,158

Fe^{2+} results.

	Date	Samples	$[Fe^{2+}]$ (mg/L)
First collection	03/04/2022	The white	0
		Sw	0,02
		Iw	0,16
		Dw	0,3
Second collection	09/05/2022	The white	0
		Sw	0,015
		Iw	0,02
		Dw	0,017
Third collection	26/05/2022	The white	0
		Sw	0,07
		Iw	0,053
		Dw	1,51

Bacteriological parameters results.

	Date	Samples	*TC and E-Coli*	*Entero*
First collection	30/03/2022	Sw	2CFU/mL	2 CFU/mL
		Iw	2FCFU/mL	5,3 CFU/mL
		Dw	10CFU/mL	165,2CFU/mL
Second collection	26/04/2022	Sw	>24,19CFU/mL	>24,19CFU/mL
		Iw	>24,19CFU/mL	>24,19CFU/mL
		Dw	>24,19CFU/mL	>24,19CFU/mL
Third collection	24/05/2022	Sw	2 CFU/mL	235,2CFU/mL
		Iw	5CFU/mL	19,6CFU/mL
		Dw	0CFU/mL	116,6CFU/mL

Annexe 03

Figures

Figure II.5: Vertex stirrer and Deciometer.

Figure II.6: Dosage of DO.

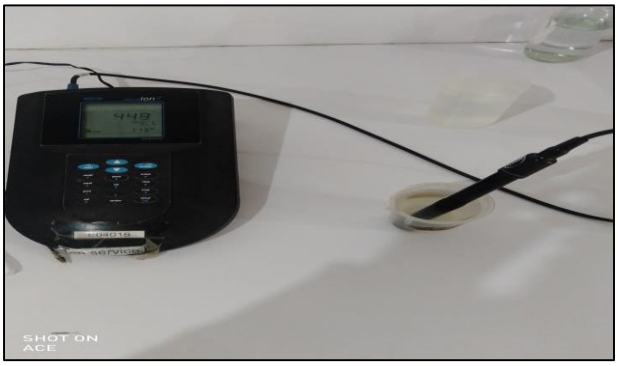


Figure II.7: TDS measurement.

Figure II.8: CAT before and after dosage.

Figure II.9: TH before and after dosage.

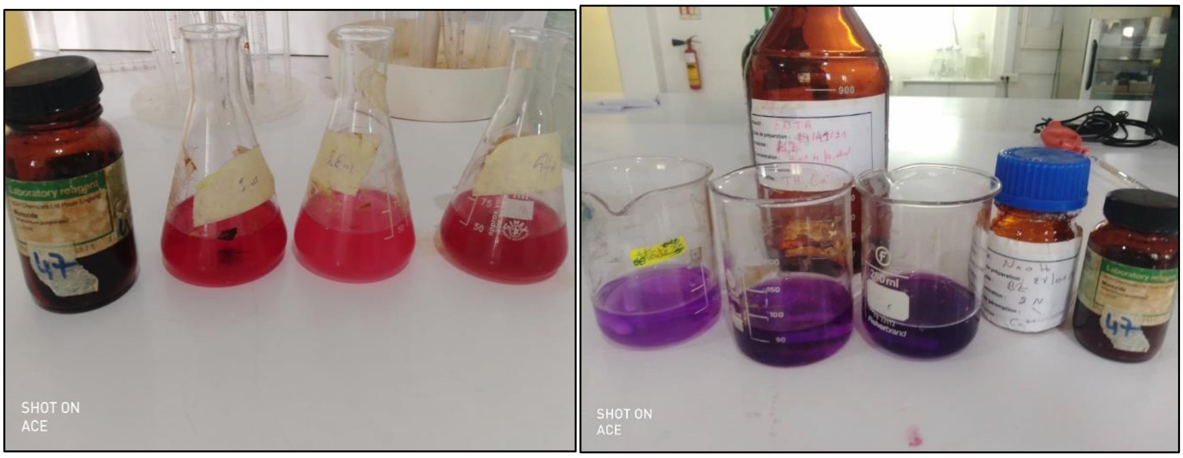


Figure II.10: Calcium before and after dosage.

Figure II.11: Dosage of NH_4^+.

Figure II.12: Dosage of NO_2^-.

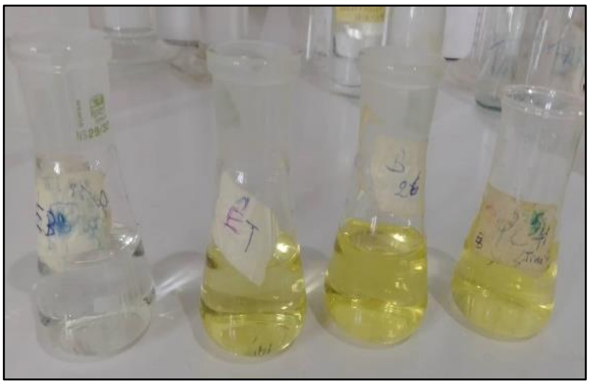


Figure II.13: Dosage of NO_3^-.

Figure II.14: Dosage of PO_4^{3-}.

Figure II.15: Dosage of Cl^-.

Quanti-Tray*

English

Introduction

IDEXX Quanti-Tray* is designed to give quantitated bacterial counts of 100 mL samples using IDEXX reagent products. Add the reagent/sample mixture to a Quanti-Tray, seal it in a Quanti-Tray* Sealer and incubate per the reagent instructions. Count the number of positive wells and use the Most Probable Number (MPN) Table attached to determine the MPN.

Contents

This package contains sterile 51-well Quanti-Trays.

User Instructions

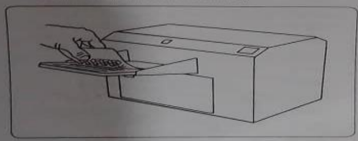
1. Use one hand to hold a Quanti-Tray upright with the well side facing the palm.

2. Squeeze the upper part of the Quanti-Tray so that the Quanti-Tray bends toward the palm.

3. Open the Quanti-Tray by pulling the foil tab away from the well side. Avoid touching the inside of the foil or tray.

Pour the reagent/sample mixture directly into the Quanti-Tray, avoiding contact with the foil tab. Allow foam to settle.

5. Place the sample-filled Quanti-Tray onto the rubber tray carrier of the Quanti-Tray Sealer with the well side (plastic) of the Quanti-Tray facing down to fit into the carrier.



6. Seal according to the Quanti-Tray Sealer instructions.
7. Incubate according to reagent instructions.
8. Count positive wells and refer to the MPN table on the back of this instruction sheet to find the MPN.*
9. Dispose of media in accordance with good laboratory practices.

For technical support, please call:
North/South America: +1 207 556 4496 or +1 800 321 0207
Europe: +00800 4339 9111
UK: +44 01638 676800
China: +86 21 61279528
Japan: +81 422 71 5921
Australia: +1300 44 33 99
idexx.com/water

*Download the IDEXX MPN generator software for automated Quanti-Tray results at idexx.com/mpngenerator

IDEXX
One IDEXX Driv
Westbrook, Maine 04092 US

Table NPP du Quanti-Tray a "51 Cupules"

Nombre de cupules donnant une réaction positive par échantillon de 100 ml	Nombre le plus probable	Limites de confiance à 95%	
		Minimum	Maximum
0	<1	0,0	3,7
1	1,0	0,3	5,6
2	2,0	0,6	7,3
3	3,1	1,1	9,0
4	4,2	1,7	10,7
5	5,3	2,3	12,3
6	6,4	3,0	13,9
7	7,5	3,7	15,5
8	8,7	4,5	17,1
9	9,9	5,3	18,8
10	11,1	6,1	20,5
11	12,4	7,0	22,1
12	13,7	7,9	23,9
13	15,0	8,8	25,7
14	16,4	9,8	27,5
15	17,8	10,8	29,4
16	19,2	11,9	31,3
17	20,7	13,0	33,3
18	22,2	14,1	35,2
19	23,8	15,3	37,3
20	25,4	16,5	39,4
21	27,1	17,7	41,6
22	28,8	19,0	43,9
23	30,6	20,4	46,3
24	32,4	21,8	48,7
25	34,4	23,3	51,2
26	36,4	24,7	53,9
27	38,4	26,4	56,6
28	40,6	28,0	59,5
29	42,9	29,7	62,5
30	45,3	31,5	65,6
31	47,8	33,4	69,0
32	50,4	35,4	72,5
33	53,1	37,5	76,2
34	56,0	39,7	80,1
35	59,1	42,0	84,4
36	62,4	44,6	88,8
37	65,9	47,2	93,7
38	69,7	50,0	99,0
39	73,8	53,1	104,8
40	78,2	56,4	111,2
41	83,1	59,9	118,3
42	88,5	63,9	126,2
43	94,5	68,2	135,4
44	101,3	73,1	146,0
45	109,1	78,6	158,7
46	118,4	85,0	174,5
47	129,8	92,7	195,0
48	144,5	102,3	224,1
49	165,2	115,2	272,2
50	200,5	135,8	387,6
51	> 200,5	146,1	infinite

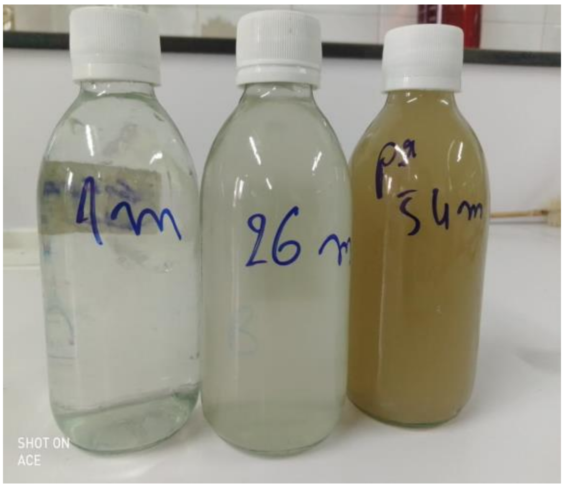
Bacteriological processes.

Annexes

Materials photos

DR6000 Spectrophotometer(original photo).

Oven (original photo).



Bottles for bacteriological analyzes (original photo).

Abstract:

Raw water is an important source of drinking water after it has been treated. For that; states always aim to preserve it by building dams.

The keddara dam supplies the province of Boumerdes and part of the capital Algiers while the purpose of this study is to assess its quality, whose physic-chemical results are satisfactory with the exception of organic matter in which the microorganisms decompose. And the same observation for bacteriological analyzes which show the strong presence of bacteria.

Key words: assessment, keddara dam, physicochemical parameters, organic matter, bacteriological parameters.

Résumé

L'eau brute est une source importante de l'eau potable après qu'elle soit traitée. C'est pour cela; les états visent toujours à la préservée en construirons des barrages.

La wilaya de Boumerdes et une partie de la capitale Alger, s'alimente principalement de barrage de keddara alors que cette étude a pour but d'évaluer sa qualité, dont ses résultat physicochimiques sont satisfaisantes à l'exception de la matière organique de fait que les microorganismes se décomposent. Et la même note pour les analyses bactériologique qui montrent la forte existence des bactéries.

Les mots clés : évaluation, barrage de keddara, paramètres physicochimiques, matière organique, paramètres bactériologiques.

ملخص

تعد المياه الخام مصدرًا مهمًا لمياه الشرب بعد معالجتها. لهذا؛ تهدف الدول دائمًا إلى الحفاظ عليها من خلال بناء السدود

تتغذى ولاية بومرداس وجزء من العاصمة الجزائر بشكل رئيسي من سد قدارة، بينما تهدف هذه الدراسة إلى تقييم جودتها، والتي تعتبر نتائجها الفيزيائية والكيميائية مرضية باستثناء المادة العضوية التي تتحلل فيها الكائنات الحية الدقيقة. ونفس الملاحظة للتحاليل البكتريولوجية التي تبين الوجود القوي للبكتيريا

الكلمات المفتاحيةتقييم، سد قدارة، المعلمات الفيزيائية والكيميائية، مادة عضوية، المعلمات البكتريولوجية