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SAKER Soussen and CHEBAANI Fatima

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Study of the effect of the addition of Zamzam water on physico-chemical characteristics of El-Kantara water

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Jury :

Mme.	Imene MERZOUGUI	MCB	University of Biskra	President
Mme.	Nadjat BEBBA	MCB	University of Biskra	Supervisor
M.	Mohammed TITAOUINE	MCA	University of Biskra	Examiner

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Dedication

It is with the help and grace of God that I have completed this modest work that I dedicate:

To my dear mother

The source of tenderness and the example of dedication who never stopped encouraging me and praying for me. Your prayer and blessing have been a great help to me in my studies. Dedication cannot be eloquent enough to express what I deserve for all the sacrifices you have made for me from my birth to my arrival to this day.

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To my husband Sid Ahmed and my second family.

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To my dear partner *"Sokar " my sweet short, it was a pleasure to work with you and to share all the details of this work. Thank you for being by my side, may God guide you in your life and grant you all the best.*

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To my parents,

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My dear uncle"Hafa", my support after my father, **my aunt"Malika"** the beloved of the soul after my mother, for all the encouragement, support and love, may God protect them and take care of them

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………**Sousen**

Table of contents

Second part: Experimental part

Chapter 3: Material and methods

Chapter 4: Results and discussions

List of Tables

List of Figures

List of abbreviations

CO_2: Carbon dioxide.

WHO: World Health Organisation.

ITDAS: Institut Technique de Développement de l'Agronomie Saharienne.

EDTA: Ethylene Diamine TetraAcetic.

$CaCO_3$: Calcium Carbonate.

H_2SO_4: Sulfuric Acid.

Cond: Conductivity.

TDS: Total Dissolved Solids.

Introduction

Water is the essential element for life. It represents a very important percentage in the concentration of all living beings. The body of an adult human being is made up of 60% water and a minimum consumption of 1.5 liters of water per day is necessary (Cherif, 2006).

Water intended for human consumption is drinkable when it is exempt from chemical and biological elements that are likely to the more or less long term to the health of individuals. According to (OMS, 2005), each year 1.8 million people, 90% of whom are children under five, mostly living in developing countries, die from diarrheal diseases (including cholera); 88% of diarrheal diseases are attributable to poor water quality, poor sanitation and poor hygiene .

It is estimated that there is about 1.4 billion m3 of water on the planet. However, most 97% of this water represents in the form of salt water in the seas and oceans, it is difficult to recover for human activities of the remaining 3% (36 million km3), more than 3/4 constituting the very glaciers. Not very accessible. The remaining 1/4 mainly comprises groundwater less than 1% of the total water of the globe) is a small part in the form of surface water contained in lakes and rivers (i.e. 0.01% of the water in the planet (Remini, 2007).

The analysis for verifying the source water is particularly important in the absence of water treatment. It is also useful after a failure in the treatment process or as part of the investigation of an outbreak of water-borne diseases. The frequency of testing will depend on the reason for the withdrawals (OMS, 2017).

Water is used for many essential uses: drinking, preparing meals, hygiene, home maintenance, recreation, manufacturing in industry, crop irrigation and watering. livestock (Leemans *et al*., 2008)

The origins of drinking water are multiple, but those that meet drinking water standards are very few. The water supplied to consumers must meet national standards for drinkability and all other conditions imposed by the health administration (Bouziani, 2000).

So the nature of the drinking water accessible is a long way from fulfilling request of purchasers. Man has consistently experienced issues in liking the nature of the water in Consume.

With this major importance, this work aims to focus on aspect determination of the physicochemical quality of bottled water (El-Kantara) and Zamzam in order to evaluate the effect of adding Zamzam water on the characteristic physicochemical quality of normal water (El-Kantara) for healthier and ideal consumption.

This study was structured by an approach in two interdependent parts:

- Through the first part, we present the bibliographical study which is composed of two chapters: The first chapter is a general reminder of water. The second chapter presents the physical and chemical properties of drinking water.
- In the second part devoted to the experimental study, we find two chapters:

The first chapter is titled Materials and Methods, and it is devoted to the methods and techniques used in this study: physico-chemical analysis of water (Zamzam, Al-Kantara), and the second chapter is discussed in the form of graphic representations. The different results obtained during this practical study with their discussion.

Bibliographic parts

Chapter 1: Generalities

1.1 Introduction

Water is the internal medium for almost all the organism, and principal external medium for several organisms. A large proportion of about 70% of the body of most organisms including Man is constituted of water. Water is also an important substance in directing the energy flow in the living systems since it is one of the constituents in the reaction of photosynthesis which captures energy from the sun. In fact, life on this planet could have been possible only because of the presence of abundant water (Goel, 2006).

1.2 Raw water

1.2.1 Water cycle

The hydrosphere is part of the general ecosystem. The water cycle is a very complex self-regulating system. The modification of a single factor (pressure, temperature, hygrometry, composition of the air in gas or particles, etc.) causes changes that can be very serious in the long term, or even irreversible (Bourrouillou *et al.*, 2010).

Water constantly evaporates over oceans, lakes and forests, condensed into clouds and then carried across the sky by wind. In the sky, the clouds condense in the form of water vapor around the dust particles, then fall in precipitation in the form of rain or snow, under the action of complex meteorological phenomena in which mainly winds and differences in temperature (Ayad, 2016/2017).

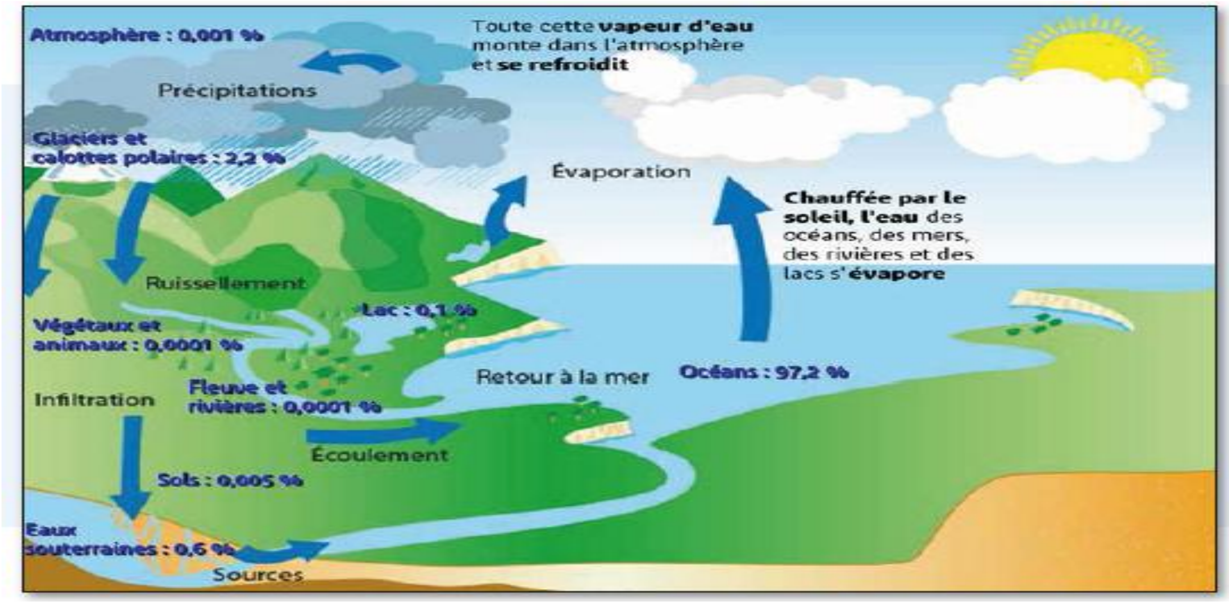


Figure 1. Cycle de l'eau (l'environnement en Poitou-Charentes , 2015)

1.2.2 Water intended for human consumption

Fresh water is a rather rare element on the earth's surface since it represents only 3% of the total volume of hydrosphere. Water intended for human consumption has a dual origin (Rejsek, 2002).

1.2.2.1 Surface water

Water contains mineral salts and trace elements, the contents depending on its origin: source, groundwater, rainwater, etc (Holst, 2004). Surface or superficial water for 40% of the volume produced. These waters which are on the earth's surface can be running water (river) or stagnant water (lake and natural or artificial reservoir) (Rejsek, 2002).

1.2.2.2 Groundwater

Groundwater, buried in the ground, is usually safe from sources of pollution. Since the characteristics of these water varies very little over time. Its main characteristics: constant temperature, low color index, high hardness, high concentration of iron and manganese (Henri et Patrick, 2018). Groundwater for 60% of the volume produced (Rejsek, 2002).

1.2.3 Freshwater category

According to (Maiga et Alpha, 2005) , drinking water suitable for consumption, therefore devoid of all harmful elements. Drinking water is understood to mean natural or treated water suitable for consumption, for cooking food, for preparing food and for cleaning objects that came into contact with food.

1.2.3.1 Springs water

According to (Coreil, 1896), the spring waters considered to be the best drinking water. The passage through successive layers of permeable soil produces a real filtration which rids these waters of all suspended matter, in particular microbes and a part of that which is in solution. On the other hand, water, as it travels through its layers of land, takes charge of certain soluble mineral principles which cause the composition of these waters to vary with the nature of the land from which they emerge.

1.2.3.2 Mineral water

Mineral waters are mature waters. They came, by definition, from a water source containing a minimum of mineral salts. The name "mineral water" implies in principle that this water contains at least 1g of mineral substances: iron, potassium, magnesium, etc (Holst, 2004).

1.3 Drinking water

Water intended for human consumption must therefore meet general hygiene rules and all measures to protect human health. The portability of water is essentially based on notions of world health organization (Rejsek, 2002).

1.3.1 El-Kantara water

The water of El-Kantara source, the symbol of vitality and recovery, comes from the foothills of the Metlili Mountains, the municipality of Kantara, the wilaya of Biskra, Algeria (Site web 1).They are water originating underground, microbiologically sound, protected from pollution hazards and suitable for consumption Human, it is without treatment.

1.3.2 The origin of El-Kantara

El-Kantara's natural spring water has long been renowned for its purity and exceptional lightness and mineral balance, comes from the foothills of the Metlili Mountains, the municipality of Kantara, the wilaya of Biskra, Algeria (Site web 1).They are water originating underground, microbiologically sound, protected from pollution hazards and suitable for consumption Human, it is without treatment.

1.3.3 Zamzam water

1.3.3.1 Location and description of the Zamzam well

The Well of Zamzam water is located in the holy mosque (Haram) at about 20m east of Ka'abah in Makah, which is known as western province of the Kingdom of Saudi Arabia (Sharif *et al*., 2016). This city is located in the western part of Saudi Arabia about 70 km south of the city of Jeddah on the coast of the Red Sea. Geographically it can be located at latitudes 21° 26` 48`` N, longitude 39° 53` 46``E, with an elevation of about 1399 ft, above mean sea level (Husnah, 2020).

The Zamzam well is about 30.5 m deep with diameter ranges from 1.08 to 2.66 m. The well is now located in ground floor surrounded by glass plates permitting a clear vision of the inside. The water is withdrawn by electrical pumps to become available in the taps distributed in specific areas in the mosque (Ahmed *et al*., 2021).

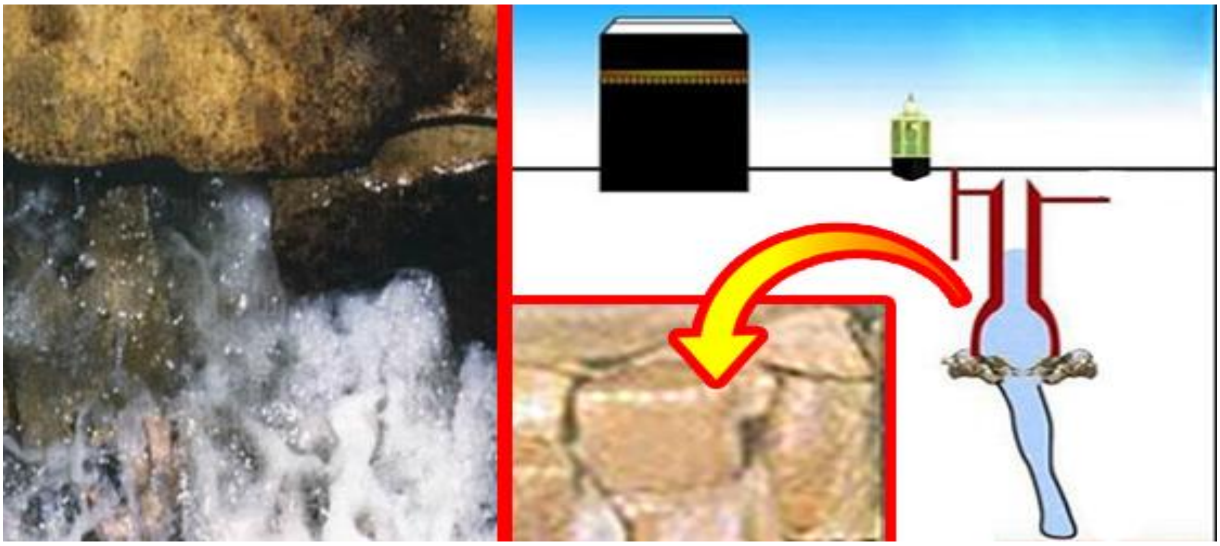


Figure 2. Zamzam well, (Husnah, 2020).

1.3.3.2 Qualities of Zamzam water:

Zamzam water is different from other water in many ways: first no bacteria can form at its source, second it doesn't go moldy nor does it change color, taste or smell.4F5 Biological growth and vegetation usually take place in the most wells. This makes water unpalatable owing to the growth of algae leading to changes in taste and odor. However, in Zamzam water well, there isn't any sign of biological growth (Husnah, 2020).

1.3.3.3 Healing properties of Zamzam water

Zamzam is unique in its natural characteristics because it is "hard carbonated type water" in nature. It has been proven that there is no microbial growth in the water from the Zamzam well (Nauman *et al*., 2013).

Chapter 2: Physicochemical properties of water

2.1 Physicochemical properties of water

2.1.1 The Temperature

Water temperature is an important factor in organic production. This comes from the fact that it affects the physical and chemical properties of it, in particular its density, its viscosity, the solubility of its gases (in particular that of oxygen) and the speed of chemical and biochemical reactions (Belghit *et al*., 2013). Water intended for human consumption must have a temperature below or equal to 25°C (except in the overseas). In nature, it is 10 to 15 °C for spring water, 4 °C for very deep water, variable for surface water (Henri et Patrick, 2018).

2.1.2 The hydrogen potential (pH)

The pH of the water is the measure of the concentration of hydrogen ions [H^+] continues in the water. The pH depends on the origin of the water, the geological nature of the substrate and the watershed crossed. It is sensitive to temperature, salinity, and to the gases below in the water (O_2, CO_2, SO_2, NO…).The pH is corrected as appropriate by removing excess dissolved CO2 or by correcting the carbonate hardness (Al-Qawti *et al*., 2015).the values of the hydrogen potential are between 6 and 8,5 in natural waters (Ghazali et Zaid, 2013).

2.1.3 The hydrotimetric title (HT)

The hardness or hydrotimetric strength of water corresponds to the sum of the concentrations of metal cations with the exception of those of alkali metals and of the hydrogen ion. It most cases the hardness and especially due to calcium and magnesium added iron, aluminum, manganese, strontium ions. Hardness is also called calcium and magnesium hardness or soap consumption.. It is expressed in milliequivalents of concentration of $CaCO_3$. It is also very often given in French degrees (Rodier *et al*., 2009).

2.1.4 Conductivity (σ)

The electrical conductivity of water is a measure of the ability of water to conduct an electric current (the ability of water to allow an electric current to flow) the electrical conductivity of water is an indirect measure of the ion content of the water (Ca^{2+}, Mg^{2+}, Na^+, K^+, HCO^{3-},SO_4^{2-},Cl^-, NO^{3-},..) which are formed by the solution of mineral salts in water (Al-Qawti *et al.*, 2015). According to (Zohra, 2006) a high conductivity translates to be a little ordinary be with a salinity is raised it should be noted that the power suooly has an electrical conductivity 2800µS/cm.

2.1.5 Salinity

It is defined as the sum of solids in continuous solution in water, after conversion of carbonates to oxide, after oxidation of any organic matter and after replacement of garbage and bromides by an equivalent quantity of chlorides. This salinity is lower than the filterable dry residue in g/kg (either partly per millies or ‰) it is linked to the conductivity of the water, to its density and to the equivalent content of chlorides, i.e. the sum of the Cl^-, Bi^- et I^- expressed in g/kg of Cl^- (Henry et Monique).

2.1.6 Total dissolved solids (TDS)

Total dissolves solids (TDS) are naturally present in water or are the result of mining or some industrial treatment of water. TDS contain minerals and organic molecules that provide benefits such as nutrients or contaminants such as toxic metals and organic pollutants. Current regulations require the periodic monitoring of TDS, which is a measurement of inorganic salts, organic matter and other dissolved materials in water. The amount of TDS in a water sample is measured by filtering the sample through a 2.0 µm pore size filter, evaporating the remaining filtrate and then drying what is left to a constant weight at 180ºC.The concentration and composition of TDS in natural waters is determined by the geology of the drainage, atmospheric precipitation and the water balance (evaporation-precipitation) (Weber-Scannell et Duffy, 2007).

2.1.7 The complete alkalimetric title (CAT)

The complete alkalimetric strength of water is the measure of the alkaline power of the solution. The TAC is mainly explained by the pH and the concentration of carbonate ions. This titration is carried out automatically at the CARRTEL joint research unit of Inra in Thonon-les-Bains (Lazzarotto, 2010). Water with a TAC above 20 °f are generally scaled, water with TAC below 10 °f are generally corrosive (Henri et Patrick, 2018).

2.2 The cations and anions containing in water

2.2.1 The cations

2.2.1.1 The calcium [Ca^{2+}]

Is an alkaline earth metal extremely prevalent in nature and especially in limestone rocks under carbonates. Its salts are found in almost all natural waters. Their water content, which can vary from 1 to 150mg/l, is directly linked to the nature and geological nature of the terrain crossed. Calcium is the main element in water hardness (Potelon *et al*., 1998).

2.2.1.2 The magnesium [Mg^{2+}]

Magnesium is a very common element in nature, in many minerals and in limestone (2.1% of the earth's crust).most natural waters have contents between 5 and 10 mg/l. this concentration is directly related to the terrain crossed. The magnesium in the water comes back from the attack by carbonic acid of the magnesium rocks and the dissolution of magnesium forms $MgCO_3$ and of Mg $2HCO^{3-}$. In the waters of the old massifs, the contents are less than 5 mg/l or even mg/l (Potelon *et al*., 1998).

2.2.1.3 The potassium [K^+]

Potassium is a natural element in water where its almost constant concentration usually does not exceed 10 to 15 mg/l, except in certain specific geological contexts where it reaches 20 to 25 mg/l (Potelon *et al*., 1998).

2.2.1.4 The sodium [Na^+]

Sodium is a constant element in water, however, the concentration can be extremely variable ranging from a few tens of milligrams to 500mg/l (Bouchemal, 2017).sodium comes from the decomposition of marine fallout and saltwater infiltration (Bernard, 2015).

2.2.2 The anions

2.2.2.1 The Chloride [Cl^-]

The chloride content in freshwater is very generally well bellow the quality benchmark. However, for certain groundwater or surface water undergoing maritime impact or industrial pollutions (mines, chemicals) the concentrations may be higher, it should be noted that the presence of bromides is often linked to those of chlorides (in a ratio Cl^-/Br of around 103). (Bernard, 2015).

2.2.2.2 The alkalinity [HCO_3^-]

The alkalinity of water corresponds to the presence of hydroxides ions (OH^-), of carbonate and silicate ions or even water, molecular species of weak acids. Closely related to hardness, this value is generally close to it is due to the presence of carbonate and bicarbonates HCO^{3-} . In natural waters, the alkalinity expressed in HCO^{3-} vary from 10 to 350 mg/l they are increased by inputs of urban origin (phosphates, ammonia, organic matter) or industrial (basic or acid product) (Potelon *et al*., 1998).

2.3 Drinking water standards

Table 1. Physic-chemical parameter of water quality from human consumption

Parameter	Unites	Norm of Algerian waters	Norme of WHO
Temperature	°C	25	/
Salinity	/	/	/
TDS	mg/l		1000
Conductivity	us/cm	2400	2000
Ph		6.5-8.5	6.5 - 9.5
Chloride	mg/l	500	250
CAT	°F	500	/
HCO_3^-	mg/l	/	400
TH	°F	/	/
Calcium	mg/l	200	70-200
Magnesium	mg/l	150	50-150
Sodium	mg/l	200	200
Potassium	mg/l	12	12

2.4 Conclusion

This party was illustrated with generalities on water and physic-chemical characteristics through which we can evaluate the effect of the addition of Zamzam water on El-Kantara water as water bottled for human consumption.

Experimental part

Chapter 3: Material and methods

3.1 Introduction

This chapter deals with analysis of physicochemical characteristics which presents a very important role in the control of water quality. The objective is to identify their characterization in order to assess the influence of Zamzam water on selected bottled water.

The analyzes were carried out on the following samples:

- Drinking water brand registered at the market: Elkantra is manifested during April 2021.
- Zamzam water from the period of 2019.

3.2 Physicochemical analysis

3.2.1 Analysis equipment and devices

Table 2. Types of equipment used for the different analyzes

Parameters measured	Types of devices
Temperature	- Multi parameter (Cond level L)
Conductivity	
Salinity	
TDS	
pH	- pH meter (pH 7110)
Na^+	- Flame photometer (PFP7)
K^+	
Turbidity	- Turbid meters (TL 2300)

Table 3. Types of solution and reagents used for the different analyzes

Parameters measured	Types of solutions and reagents
Cl^-	- Silver nitrate solution ($AgNO_3$) 0,01 N - Potassium chromate indicator solution (K_2CrO_4) 5%
Ca^+	- 0.02N calcium solution - EDTA solution; sodium salt - Tampon solution pH 10 - 2.5 N sodium hydroxide solution (NaOH) - Murexide - Erichrome black T
TH	- EDTA, standard solution (0.01mol/l) - Buffer solution (pH 10) - Mordant noir 11, indicator
TAC	- Sulfuric acide (0.02N) - Methylorange solution (0.5%)

3.3 Physico-chemical analysis methods

3.3.1 Ultraviolet-Visible Spectrophotometer analysais

Ultraviolet-Visible spectrophotometer is a qualitative and quantitative analysis technique where a light beam of monochromatic wavelength passes through the solution to be analyzed.

It is by this method that we were able to measure the following parameters.

3.3.1.1 Simultaneous determination of sodium [Na^+] and potassium [K^+]

- **Principle**

Atomic absorption spectrometry with or without flame has greatly extended the possibilities of the previous methods, both for the predominant elements in water such as sodium and potassium (Rodier *et al*., 2009).

- **Operating mode**

Nebulize the sample in an air-acetylene flame by interposing permuted water between each solution. Read the flame spectrophotometer at a wavelength of 589 nm for sodium and 766.5 nm for potassium.

3.3.2 Electrochemical methods

Is a class of techniques in analytical chemistry which study an analyse by measuring the potential (volts) and/or current (amperes) in an electrochemical cell containing the analyse.

It is by this method that we were able to measure the following parameters:

3.3.2.1 Temperature measurement (°C)

The temperature measurement is to be carried out in the field. It is necessary to determine the temperature of the area in the same place and at the same time (Rodier, 2005).

- **Operating mode**

The water temperature is measured either with an electrometric device (multi parameter of type Cond level L) or with an accurate thermometer, the reading is made after a 10-minute immersion and expressed in degrees Celsius.

3.3.2.2 Hydrogen potential measurement (pH)

- **Principe**

The potential difference existing between a glass electrode and a reference electrode (saturated calomel-KCl) immersed in the same solution is a linear function of the pH thereof. According to the expression of NERNST, the potential of the electrode is related to the activity of the H^+ ions (Rodier *et al*., 2009).

- **Operating mode**

A pH measurement involves two electrodes: the indicator electrode (also called the glass electrode) and the reference electrode. These two electrodes are often grouped together in the same body and give rise to a single electrode called the combined electrode.

When a glass electrode and a reference electrode are immersed in a solution, a galvanic cell is created. The potential difference depends on the two electrodes.

Ideally, the potential of the reference electrode remains constant while the potential of the indicator electrode will vary depending on variations in the pH to be measured.

The results are read directly.

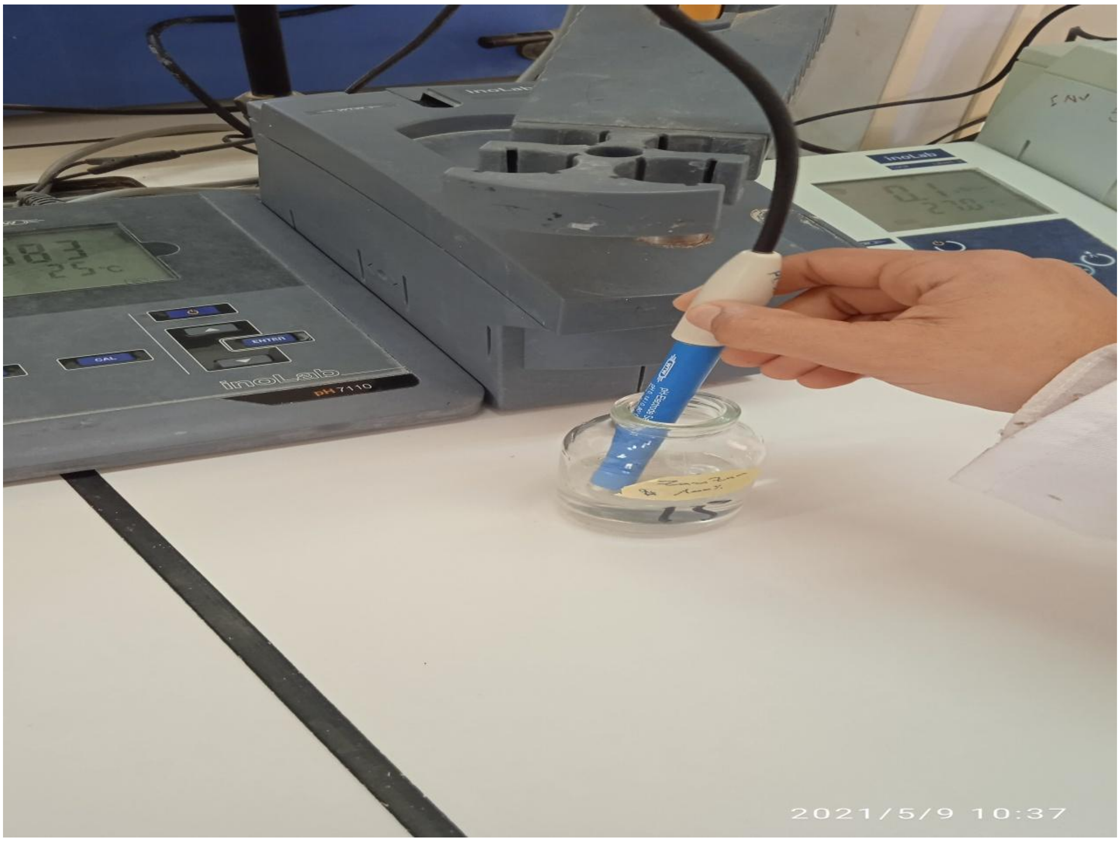


Figure 3. pH meter (pH 7110) (original photo)

3.3.2.3 Conductivity measurement (σ)

- **Principle**

Conductivity is measured by applying an alternating electric current to two electrodes submerged in a solution and measuring the resulting voltage. In this experiment, the cations migrate towards the negative electrode, the anions move towards the positive electrode, and the solution behaves like an electrical conductor (ITDAS-laboratory).

- **Operating mode**

- Pour about 60 ml of sample into a container.

- Place the containers on the sampler carousel and start the analyzer by using Multiparameters with a cell to measure conductivity.

- The results are read directly and are expressed in µS / cm.

Figure 4. Multi parameter (Cond level L) original photo

3.3.2.4 Salinity measurement *(S)*

- **Indirect salinity measurements**

By this method :

$$(\boldsymbol{S}) = CE * 0.64$$

3.3.2.5 Total Dissolved Solids measurement

The standard method for determining the TDS is to evaporate a known amount of a sample of water by heating it to 180 ° C. It then suffices to weigh the solid residue obtained. Of course, all these operations are carried out under rigorous conditions. The accuracy of the standard method depends on the nature of the dissolved species (IGZ, 2004).

The TDS method built into the conductivity meters or TDS meters provides a quick and easy way to determine the TDS based on a conductivity measurement by the following equation (ITDAS-laboratory).

3.3.3 Volumetric methods

The volumetric method is an operation which consists in determining the title of a solution, that is to say its concentration. Indeed, the solution of known concentration is poured drop by drop into the dosing solution in which a few drops of colored indicator have been previously put to detect the equivalent point.

It is by this method that we were able to measure the following parameters.

3.3.3.1 Determination of chloride [Cl^-]

- **Principle**

The chloride ions are precipitated to the state of chloride by a standard solution of silver nitrate ($AgNo^3$). The end-of-reaction indicator is the potassium chromate (K_2CrO), which in the presence of silver ion execs a red precipitate (Rejsek, 2002).

- **Operating mode**

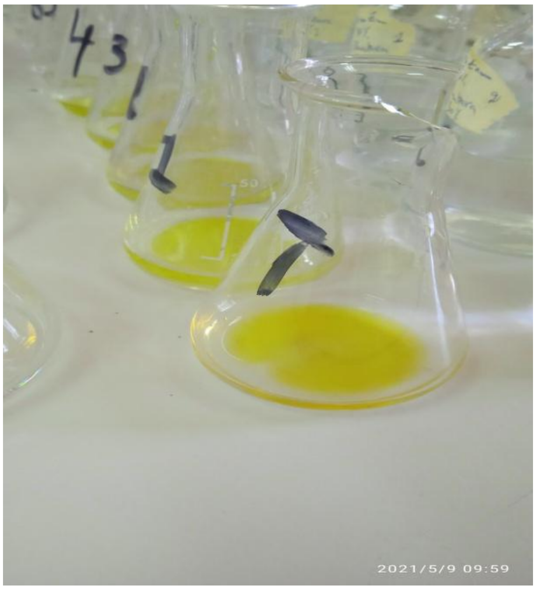
- 5 ml of the diluted sample is taken from a 250 ml Erlenmeyer flask.
- Add 3 drops of potassium chromate (see annex).
- Titrate with silver nitrate until (see annex) the red brick colour is loaded.
- A sodium chloride control (see annex) is used to determine the normality of $AgNO^3$ exactly while taking 5ml of 0.01 N sodium chloride and putting it into a 250ml Erlenmeyer.
- 3 drops of the potassium chromate indicator are added.
- Titration is done with silver nitrate. if 5 ml of sodium chloride is assumed 5.2 ml of silver nitrate:

$$5 * 0.01 = 5.2 * N$$

$$N = 0.01 * \frac{5}{5.2} = 0.0096$$

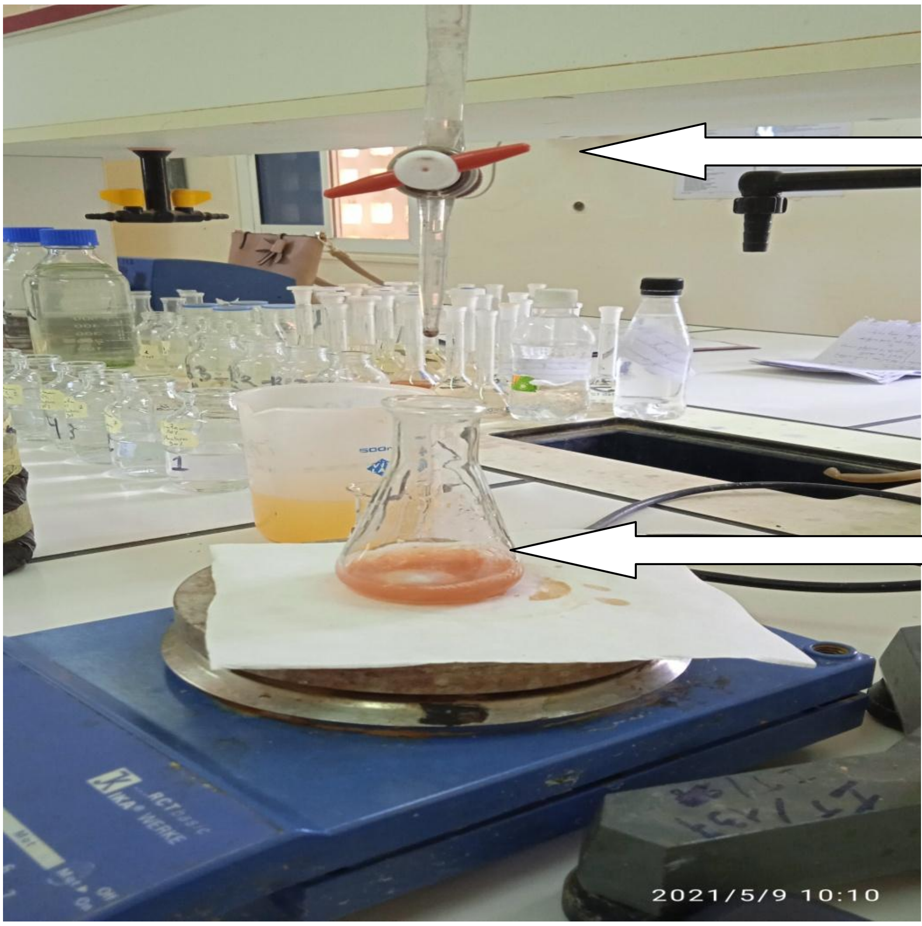
- **Calculations**

$$\mathbf{Cl}(\mathrm{meq/l}) = \mathrm{V1} * \mathrm{N\ AgNO3} * 1000/\mathrm{V2}$$



5 ml of the diluted sample

3 drops of potassium chromate



$AgNO^3$ 0.01N

We titrate until the appearance of brick red color.

Figure 5. Determination of Chloride by Titration

- **Expression of results**

The concentration of chloride Cl expressed in milliequivalent per litre, is given by formula:

$$\boldsymbol{Cl(meq/l)} = V1 * N_{AgNO3} * 1000/V2$$

V1: Volume of $AgNO_3$ that responded.

V2: Volume of the test sample.

N: $AgNO_3$ normality.

3.3.3.2 Calcium dosage [Ca^{+2}]

- **Principle**

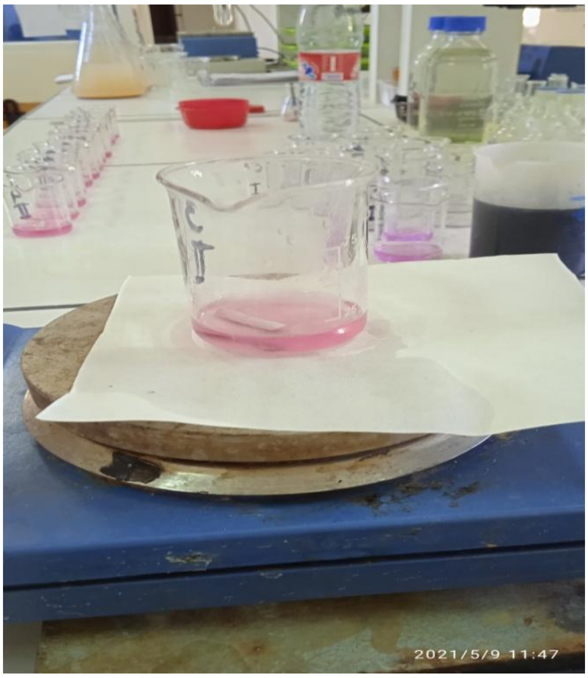
Titration of calcium ions with an aqueous solution of EDTA (see annex) at a pH between 12 and 13. The indicator used is Murexide (see annex), which forms a pink complex with calcium .

During the titration, the EDTA reacts with calcium ions, the indicator then changes from pink to purple (ITDAS-laboratory).

- **Operating mode**

In 50 ml beakers take:

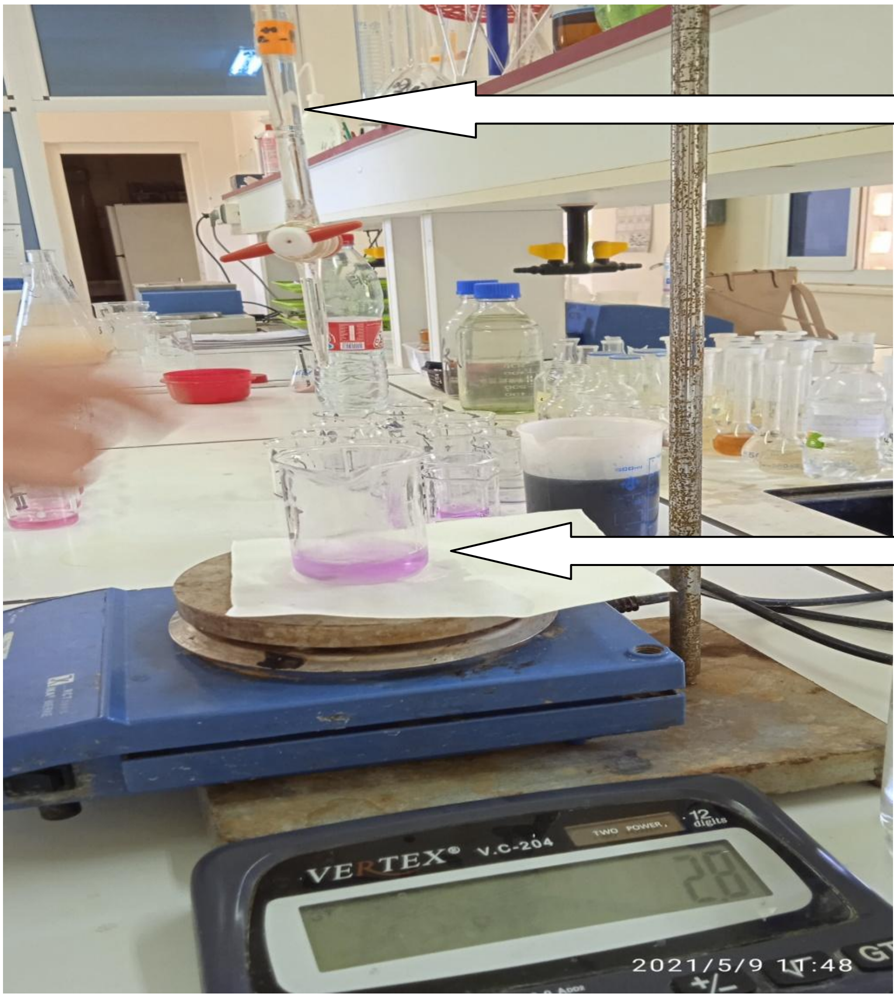
- 10ml of sample solution.
- 1ml of the solution (NaOH) at 2.5 N.
- A Murexide mixing forceps.
- Title with the EDTA solution until a purple colour noted the volume V of EDTA.



10ml of sample solution.

1ml of the solution (NaOH) at 2.5 N.

a murexide mixing forceps.



EDTA solution

We titrate until the appearance of purple color

Figure 6. Determination of Calcium by Titration

3.3.3.3 Magnesium dosage [Mg^{+2}]

- **Calculation method**

We analyzed calcium and magnesium together in the studied sample, then we calibrated calcium in the same sample and from it we deduce the value of magnesium (ITDAS-laboratory).

- **Expression of the results**

General formula: X meq / l = N * V EDTA * 1000 / test sample

Ca + Mg = N * V EDTA* 1000 / test sample = X1 meq / l

Ca = N * V EDTA * 1000 / test sample = X2 meq / l

Mg = X1-X2 (meq / l)

In mg / l: **Ca** meq / l * 20; **Mg** meq / l * 12

N: normality

V: volume

3.3.3.4 Determination of total hardness (TH)

- **Principle**

The hardness of a water results from the presence of bivalent cations especially calcium (Ca^{2+}), and magnesium (Mg^{2+}). From an ecological point of view, fresh water is more sensitive to biological and chemical phenomena likely to alter its pH (Cortuvo, 2010; Derwich *et al.*, 2010).

The hardness calculation is carried out according to the following equation:

$$\boldsymbol{TH}\ meq/l = 1000 * C * V\mathrm{a}/\mathrm{Vb}$$

Va: volume of EDTA solution

Vb : sample volume

3.3.3.5 Complete Alkalimetric Titel measurement

- **Principle**

These determinations are based on the neutralization of a certain volume of water with a dilute mineral acid, in the presence of a colored indicator (Rodier, 2005).

- **Operating mode**

- Take a 100 ml test portion of the sample
- add 2 drops of methylorange solution
- Mix well, the solution should be colored orange.
- Titrate immediately with HCL_4, pouring slowly until the color turns brick red.

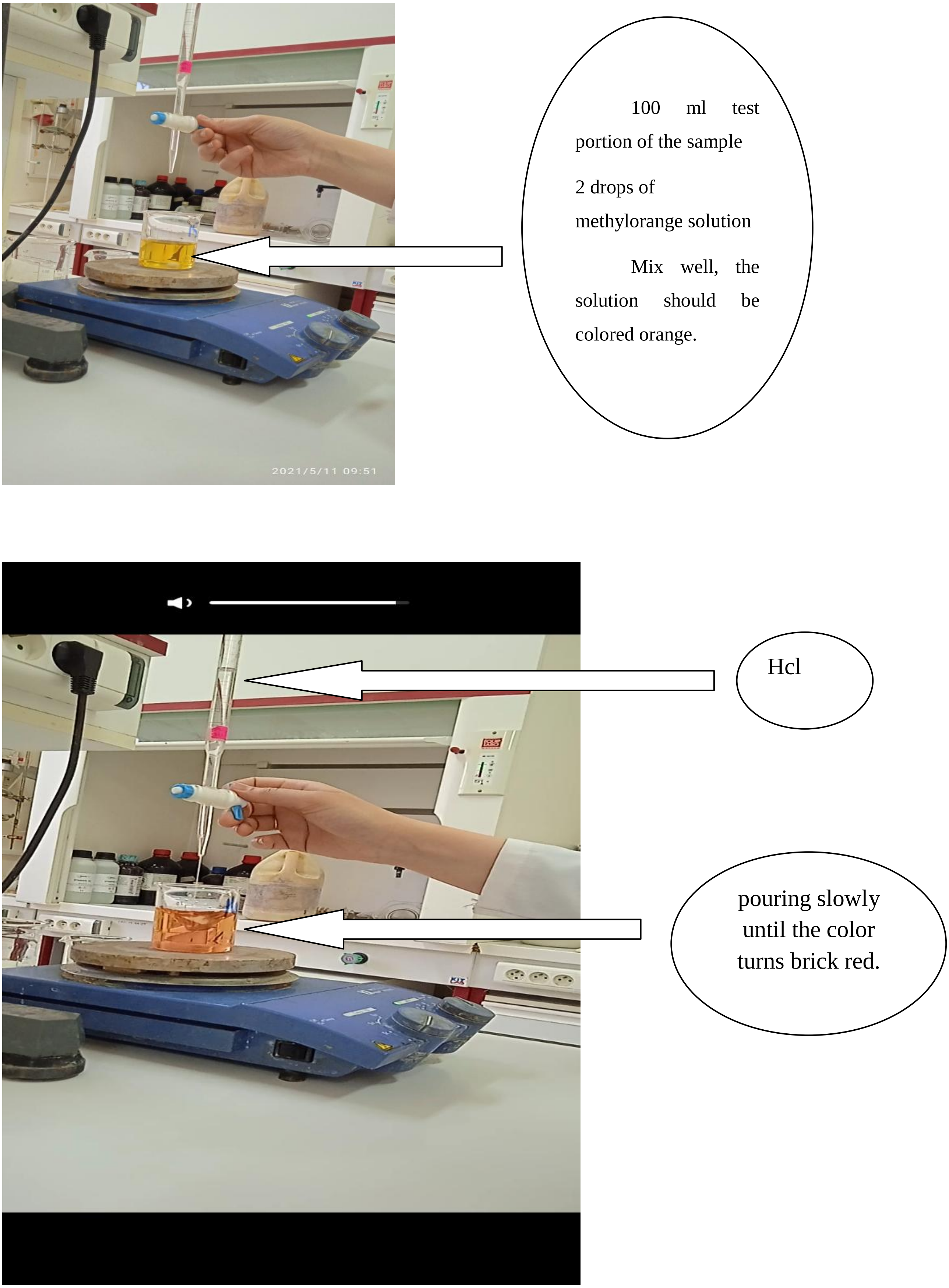


Figure 7. Determination of Complete Alkalimetric Titel

3.3.3.6 Determination of alkalinity [HCO_3^-]

- **Operating mode**

- 10 ml of the sample are taken in a 250 ml volumetric flask add 4 to 5 drops of phenolphthalein; if there is a light pink color, this confirms the presence of carbonates
- Then we do the titration with sulphuric acid (0.02N) (see annex) or hydrochloric acid (see annex) until the pink color disappears and the volume of H_2SO_4 (see annex) will be (x) (see annex).
- The bicarbonate is assayed in the same sample; 4 to 5 drops of orange methyl are added.
- The titration is carried out with sulfuric acid until the color changes to orange and the volume of H_2SO_4 will be (y).

- **Calculations**

$$\boldsymbol{HCO}\mathbf{3} - (meq/l) = (y - x) * 0.02 * 1000/10 = (y - x) * 2$$

3.4 Statistical Analysis:

The data tables were entered by Excel 2010. Statistical analysis by the software "*IBM-SPSS version 23"* was used in the kruskal-walis test application to compare between the averages of the physicochemical parameters measured for each dilution.

The pearson and spearman correlation tests were used to study the strength and direction of the link between dilution on the measured physicochemical parameters. If the correlation coefficient (r) is close to +1 or -1 this means a very strong correlation where the sign + means a proportional relation and the sign – means a inversely proportional relation.

The significance threshold considered in our study is 0.05 (or 5%).

Table 4. Comparison of Physicochemical Parameter Averages.

	Mixture at 0%	Mixture at 10%	Mixture at 25%	Mixture at 50%	Mixture at 75%	100% blend	p.k value
Values of physico-chemical parameters (mean the standard deviation)							
Calcium	110.00 0.00	56.00 4.61	45,33 8,74	37.33 0.81	41.33 2.67	36.00 4.00	**0.045** *
Magnesium	16,41 0,00	204.12 9.19	204.93 7.72	183.87 15.39	164.60 14.22	129.60 11.76	**0.018** *
TH_f	34,20 0,00	47.01 1.53	45.90 1.76	41.60 3.20	37.13 2.15	29.90 1.85	**0.014** *
CE	766,80 0,00	812.66 0.88	812.00 1.00	807.00 1.15	810.00 13.01	807.00 23.64	0.511
Salinity	0,37 0,00	0,51 0,00	0,51 0,00	0,51 0,00	0,51 0,00	0,51 0,01	0.086
TDS_mgl	382.80 0.00	567.00 3.78	595.66 6.74	617.33 4.91	635.00 13.01	635.00 16.09	**0.01** *
TCA_f	25,20 0,00	15,80 0,41	17,46 0,54	19,06 0 ,53	21,00 0,52	21,26 0,17	**0.007** *
HCO3	252.00 0.00	292.80 0.00	333.46 14.66	292.80 7.04	313.13 10.75	268.4 7.04	**0.011** *
Chlorine	62,50 0,00	73,84 5,68	66.26 3.78	75.73 1.89	73.84 3.27	75.73 3.78	0.201
Sodium	34,00 0,00	43.16 0.30	51.36 0.30	64,55 0,94	76.28 1.88	86.32 2.24	**0.005** *
Potassium	3,10 0,00	7,00 0,00	15,00 0,00	25,33 0,33	35.00 0.57	42.00 0.57	**0.05** *

4.5 Conclusion

In this chapter we have tried to present the material and the methods used to determine the physicochemical parameters of our samples according to the techniques of the laboratory of the technical institute for the development of Saharan agriculture.

Chapter 4: Results and discussions

4.1 Introduction

The experimental study carried out on the different samples allowed us to determine the Physico-chemical parameters of Zamzam water with different concentrations on the quality of El-Kantara water.

The interpretation of the results of each parameter is carried out according to Algerian standards relating to the quality of water for human consumption and the WHO guideline values.

4.2 Parameters physico-chimique

Table 5. Sample analysis result study

	10% (10 ml zemzem+ 90ml El-Kantara)	25% (25 ml Zamzam+ 75ml El-Kantara)	50% (50 ml Zamzam + 50ml El-Kantara)	75% (75ml Zamzam+ 25ml El-Kantara)	100% (100 ml Zamzam)	100% (100ml El-Kantara)	ALG	WHO
Cl^- (mg/l)	79,52	62,48	73,84	79,52	79,52	62,5	500	/
	79,52	73,84	73,84	68,16	79,52	62,5		
	62,48	62,48	79,52	73,84	68,16	62,5		
HCO_3^- (mg/l)	292,8	305	305	329,4	280,6	252	250	/
	292,8	353,8	292,8	317,2	2684	252		
	292,8	341,6	280,6	292,8	256,2	252		
Ca^{2+}(mg/l)	48	56	24	44	40	110	200	1000
	64	52	52	44	40	110		
	56	28	36	36	28	110		
Mg^{2+}(mg/l)	221.13	191.97	213.84	145.8	116.64	16.41	150	2000
	201.69	218.7	174.96	155.52	119.07	16.41		
	189.54	204.12	162.81	192.5	153.09	16.41		
K^+ (mg/l)	7	15	25	36	41	3.1	12	6.5 - 9.5
	7	15	26	34	43	3.1		
	7	15	25	35	42	3.1		
Na^+ (mg/l)	42.55	51.98	66.01	75.67	83.03	34	200	250
	43.47	51.06	62.79	73.37	90.62	34		
	43.47	51.06	64.86	79.81	85.33	34		
TAC (°f)	16.4	18.2	19.6	20.2	21	25.2	/	/
	16	17.8	19.6	20.8	21.6	25.2		
	15	16.4	18	22	21.2	25.2		
TH (°F)	49.4	44.6	47.5	34.1	27.8	34.2	500	400
	47.5	49.4	40.8	36	28.3	34.2		
	44.15	43.7	36.5	41.3	33.6	34.2		

TDS (mg/l)	560	583	614	661	666	382.8	/	/
	573	606	611	619	627	382.8		
	568	598	627	625	612	382.8		
T°	24.4	24.3	24.4	24.3	24.2	25	25	70-200
	24.4	24.3	24.4	24.3	24.2	25		
	24.4	24.3	24.4	24.3	24.2	25		
PH	7.98	7.98	7.96	7.80	7.74	7.68	6.5/8.5	50-150
	7.98	8.02	8.06	8.14	8.24	7.68		
	7.98	8	8.01	7.97	7.99	7.68		
CE (us/cm)	814	811	809	824	835	766.8	2800	200
	811	814	805	822	826	766.8		
	813	811	807	784	760	766.8		
Sal	0.52	0.51	0.52	0.53	0.53	0.37	/	12
	0.52	0.52	0.51	0.53	0.52	0.37		
	0.52	0.52	0.51	0.50	0.48	0.37		

4.3 Physical parameters

4.3.1 The Temperature

The water temperature is a comfort parameter for users, it also allows correct the analysis parameters whose values are related to temperature (conductivity and hydrogen potential (pH in particular) (Rodier *et al.*, 2009).

For the temperature of the analyzed water, the temperature values are almost constant 24 and 25°C. Hence, we can say from it that Zamzam water has the same effect on the temperature of El-Kantara water regardless of the difference in its concentration.

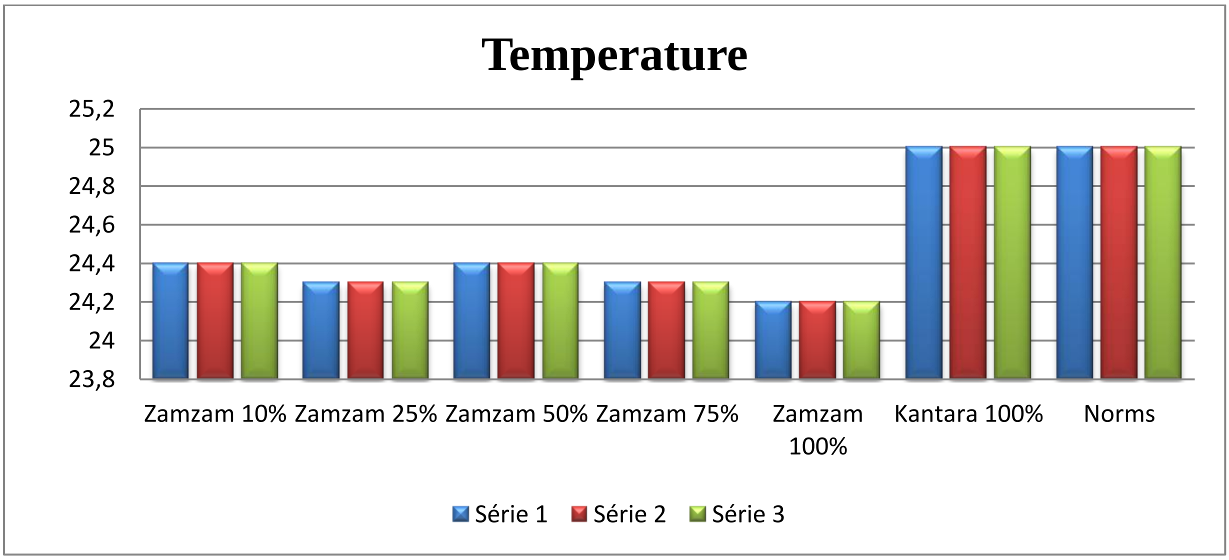


Figure 8. Temperature measurement

3.3.1 PH

The pH of natural water depends on its origin and the nature of the land Crossings (Ayad, 2016/2017). According to WHO standards for drinking water, the optimum pH values are between 6.5 and 9.5 (Al-Qawti et al., 2015) .The pH obtained from the water studied is 7.08 to 7.25 this complies with Algerian standards which set pH values between 6.5 and 8.5.WHO specifies that low pH can cause corrosion problems and high pH can lead to taste problems and increased soap consumption; she recommends a pH less than 8 for good chlorine disinfection (Rodier *et al*., 2009).

We conclude that there is a proportional relationship between the different concentrations of Zamzam water added to El-Kantara water and the pH of El-Kantara water.

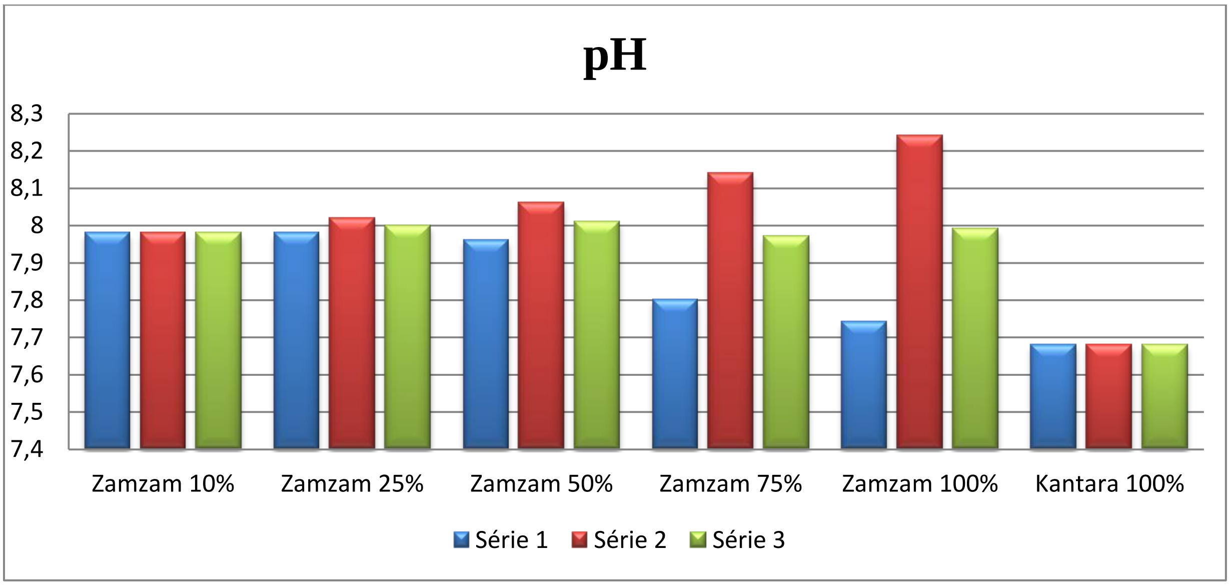


Figure 9. PH measurement

3.3.2 Conductivity

The conductivity of water is an indicator of changes in material composition and their overall concentration. It is proportional to the quality of dissolved ionisable salts. It provides information on the degree of global mineralization of surface water. High temperatures act on the electrical conductivity by acting on the mobility of salts (Bouchemal, 2017).

The results of the measurements made it possible to observe the variation in electrical conductivity (Fig.10), showing that it varied between 760 µS /cm and 835 µS /cm. All the values do not exceed the Algerian standard of potability set at 2800 µS / cm.

In this way, we can say that, the variation of concentration of Zamzam water adding to El-Kantara water effect on the conductivity of El-Kantara water by increasing or decreasing, because the conductivity relies upon various variables: Concentration, mobility and valence of ions and Temperature.

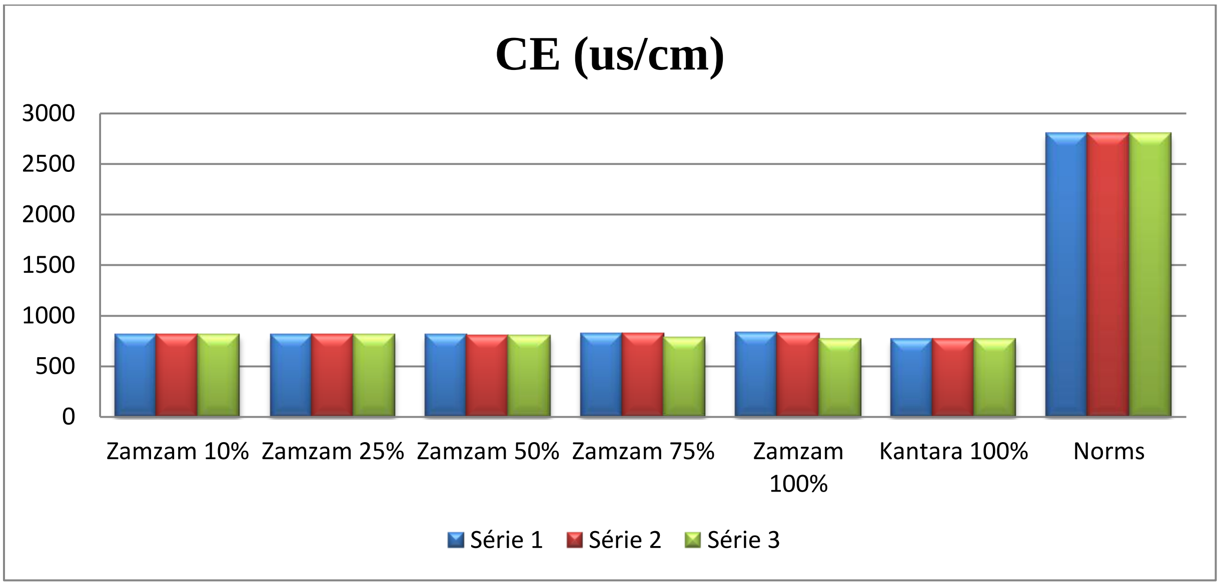


Figure 10. Conductivity measurement

3.3.3 Salinity ‰

The results obtained are: Salinity of El-Kantara is 0.35, and the Salinity of different concentration of Zamzam water is between 0.48 and 0.53.

From the results, we find that the different concentrations of Zamzam water added to El-Kantara water have no effect on the salinity of this latter.

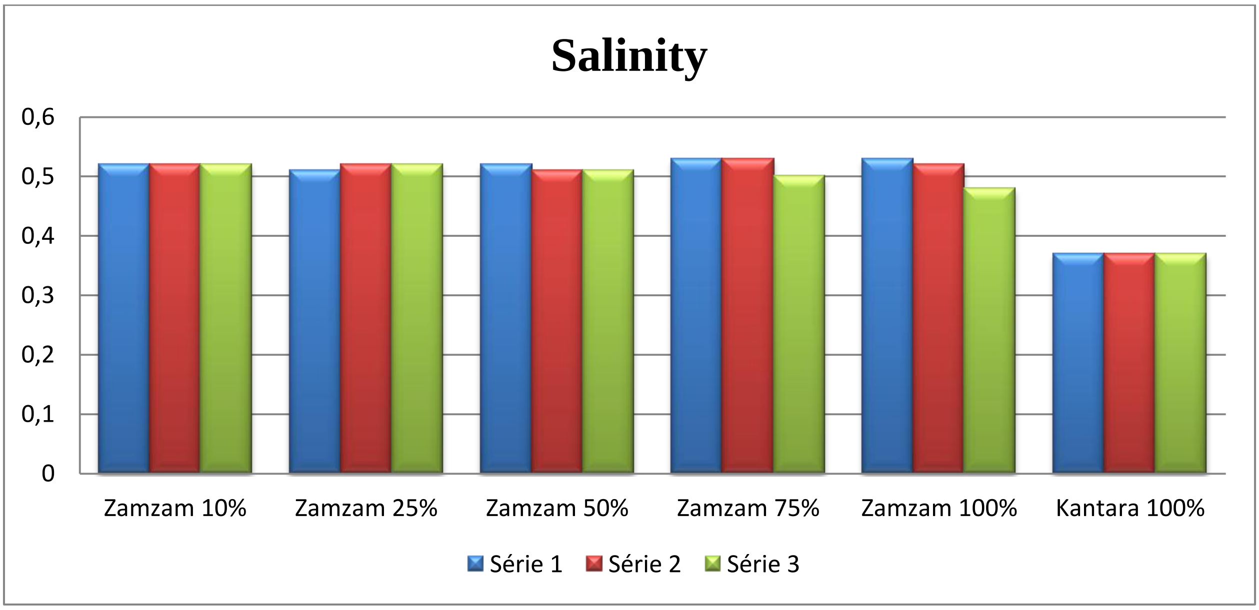


Figure 11. Salinity measurement

3.3.4 TDS

The results of the analyzes obtained determine a variation between 383.8 and 666 mg /l, the maximum value of which is recorded at 100% concentration of Zamzam water and the minimum value is recorded in El-Kantara water.

Thus, it can be said that varying the concentrations of Zamzam water in addition to El-Kantara water affects the dissolved solids of El-Kantara water in the same way on its conductivity.

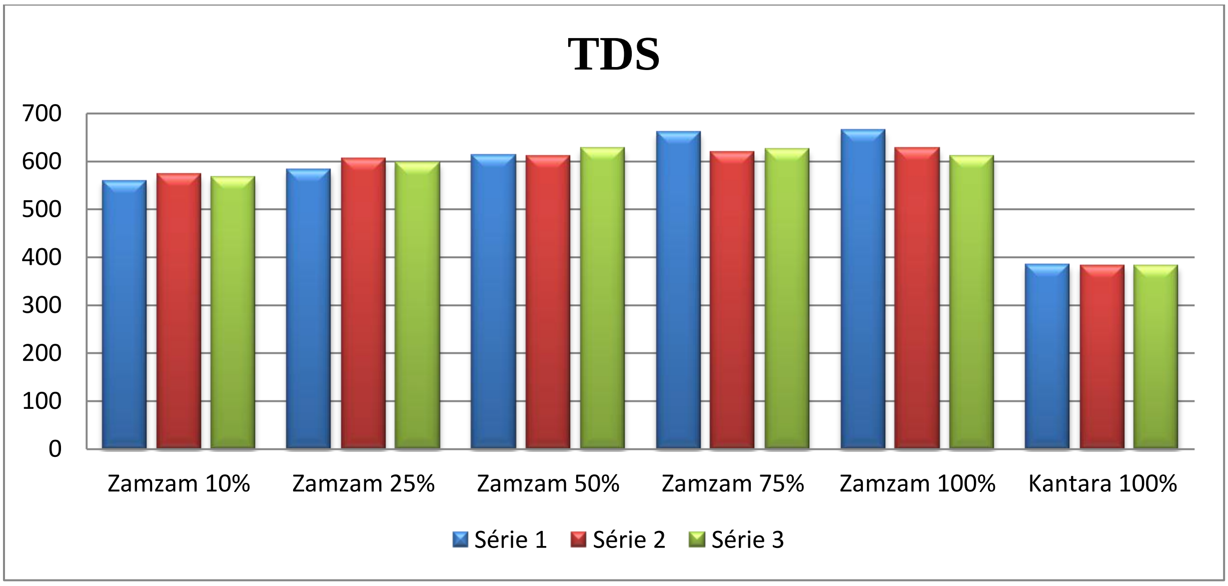


Figure 12. TDS measurement

4.4 Chemical parameter

4.4.1 Hydrotimetric title

The total hardness has a natural character linked to the leaching of the land crossed and corresponds to calcium and magnesium content (Ayad, 2016/2017).

Indeed, the recorded levels vary between 27.8 mg/L to 49.4 mg/L, the maximum value of which is 10% Zamzam water and the minimum value of El-Kantara. We can observe that increasing the concentrations of Zamzam water in addition to El-Kantara water has a positive effect on TH in El-Kantara water.

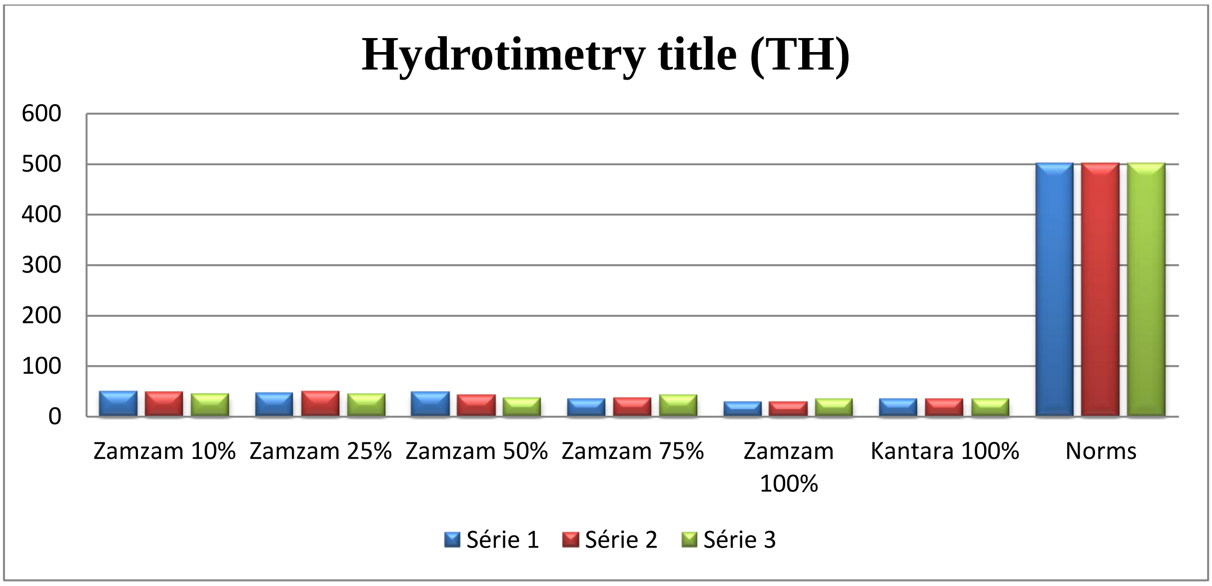


Figure 13. TH measurement

4.4.2 Complete Alkali metric title

We obtained TAC values in Zamzam water (100%) lower than the TAC in El-Kantara water. And after adding different concentrations of Zamzam water to El-Kantara water, we recorded an increase in the TAC of the mixed water according to the concentrations of Zamzam water

Therefore, we can say that there is a proportional relationship between the concentrations of Zamzam water added to El-Kantara water and TAC from El-Kantara water.

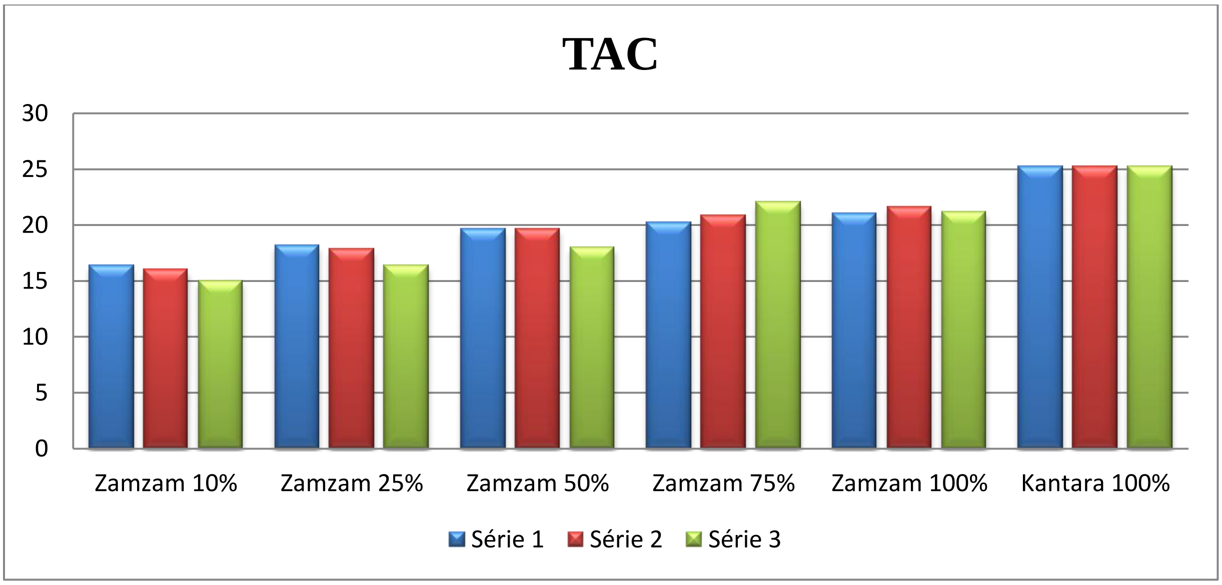


Figure 14. TAC measurement

4.4.3 Calcium

The average concentration of calcium in our samples varies between 24 and 110 mg/l, our results comply with the Algerian standard which sets a maximum value of 200 mg/l.

By adding Zamzam water of various concentrations to El-Kantara water, we notice a decrease in the calcium concentration in El-Kantara water to 44 mg/l, and this value is very close/equal to the value of calcium concentration in Zamzam water (100%).

Accordingly, we conclude that Zamzam water has the same effect on the calcium concentration value in El-Kantara water, regardless of the difference in its concentration.

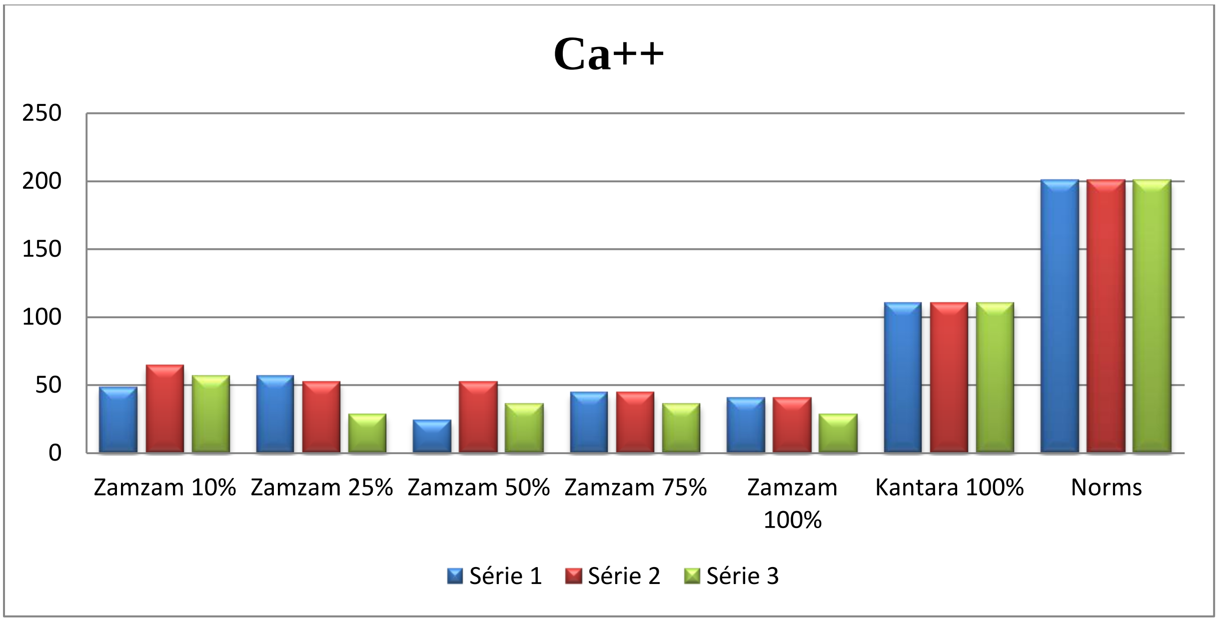


Figure 15. Calcium measurement

4.4.4 Magnesium

Magnesium is an essential element for growth (50% in the bones) and for the production of certain hormones (Potelon *et al*., 1998).

The measurements of our samples gave a magnesium concentration varying between 16.41 and 221.13 mg /l, where the highest value was recorded for Zamzam water (10%), and the lowest value recorded for El-Kantara water.

And by adding different concentrations of Zamzam water to El-Kantara water, we notice a decrease in the [Mg^{+2}] of the mixed water according to the concentrations of Zamzam water.

We can conclude after this result there is a positive effect of the concentrations of Zamzam water added to El-Kantara water and [Mg^{+2}] of El-Kantara water.

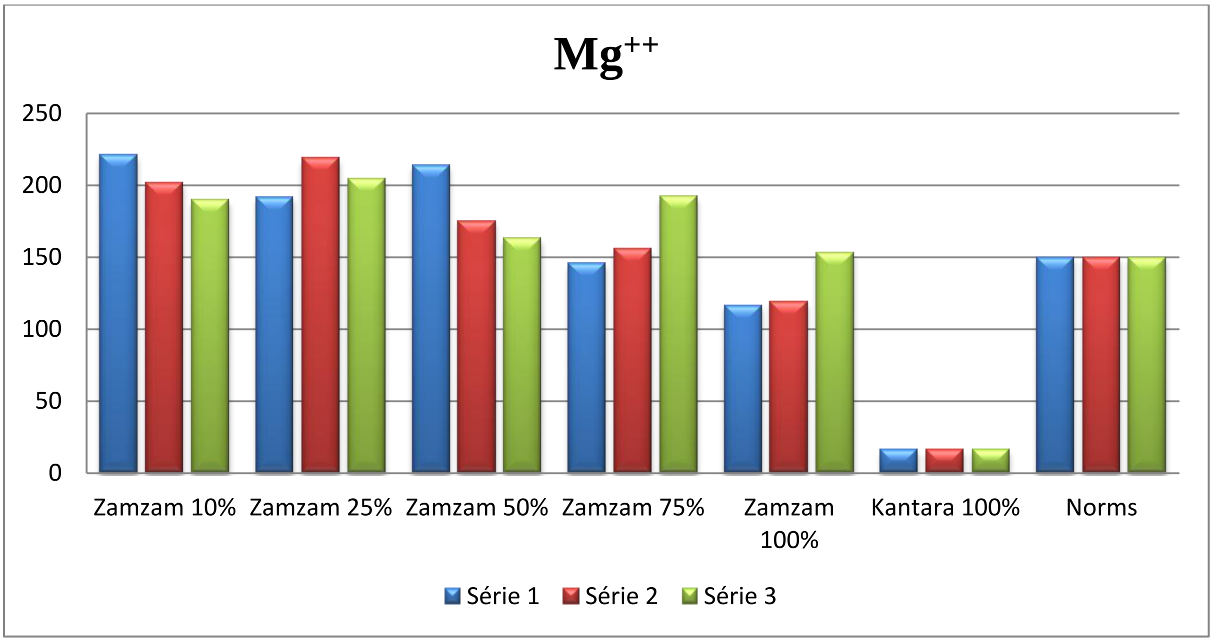


Figure 16. Magnesium measurement

4.4.5 Chloride

Chloride occurs naturally in groundwater due to weathering and leaching from sedimentary rocks and soils. According to WHO standards for drinking water, the maximum recommended concentration is 250 mg/l (Al-Qawti *et al.*, 2015), and the results obtained vary between 62.5 and 79.5 mg/l.

By adding Zamzam water at a different concentration to El-Kantara water, there is an increase in the chloride concentration of El-Kantara water, this value is very close / equal to the value of the chloride concentration in Zamzam water (100%).

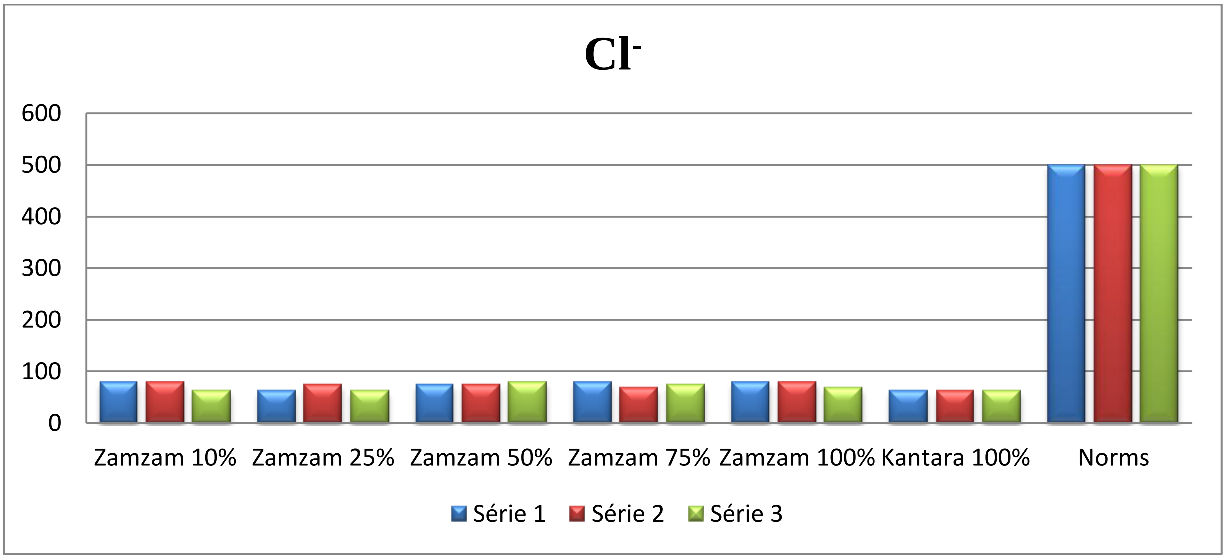


Figure 17. Chloride measurement

4.4.6 Sodium

Sodium is a vital element which participates in essential functions. It is necessary to provide an adult and a child organism respectively with 2000 and 200 mg / day, which is confirmed by (Potelon *et al*., 1998).

According to the results obtained, the concentration of Sodium is 34 to 90.62 mg/L, a value which complies with the limit values determined by the 200mg / l standards.

The sodium value of El-Kantara water changes by adding different concentrations of Zamzam water either by increasing or decreasing, according to these concentrations added.

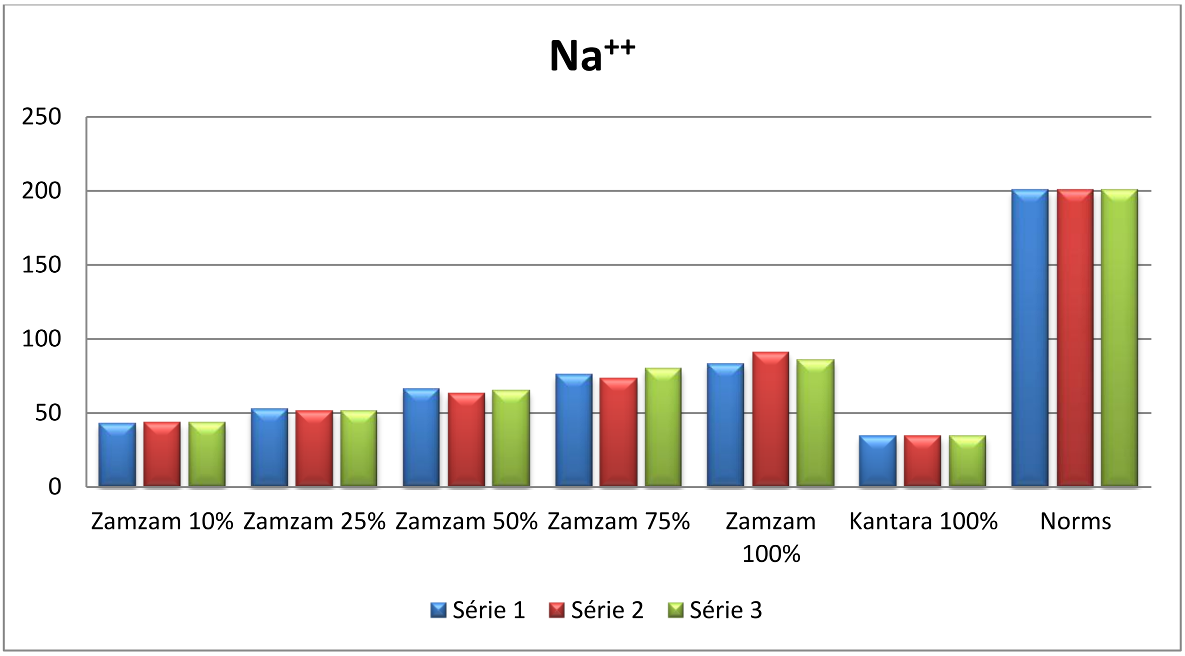


Figure 18. Sodium measurement

4.4.7 Potassium

From the results obtained we notice that the potassium concentration of 100% Zamzam water is higher than that of El-Kantara water.

So, the difference in the concentration of Zamzam water effect on [K^+] of the El-Kantara water, whether it decrease or increase as a result of the instability of Zamzam water

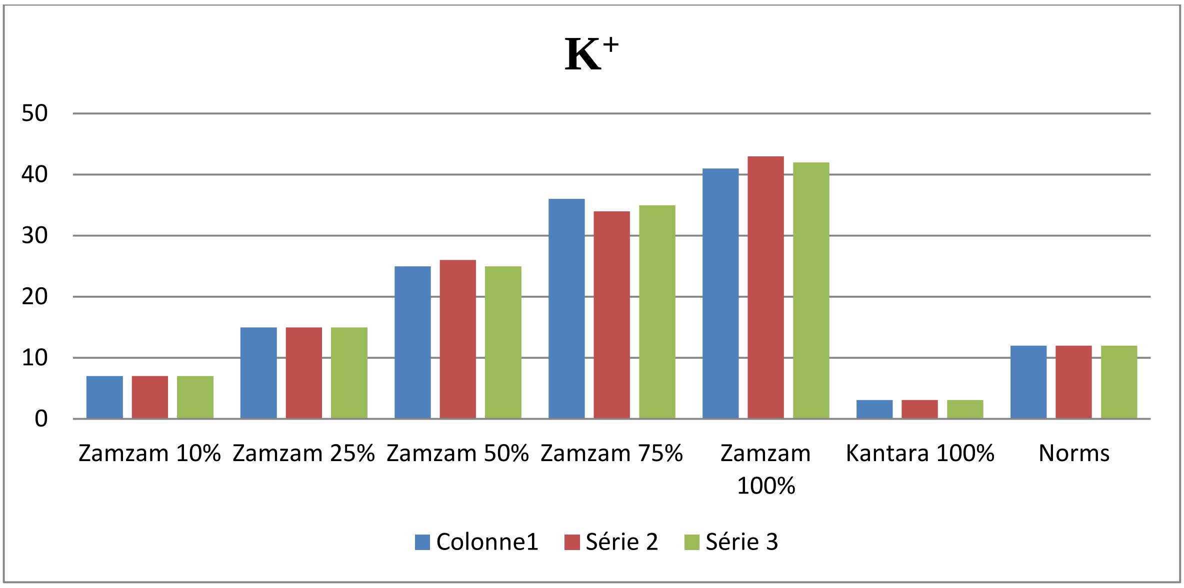


Figure 19: Potassium measurement

4.4.7 Alkalinity

We obtained results vary between 250 and 353 which agree with the WHO which sets 500 mg / l as the maximum value.

Thus, the different concentrations of Zamzam water have a positive effect on the $[HCO_3^-]$ of El-Kantara water by raising its value.

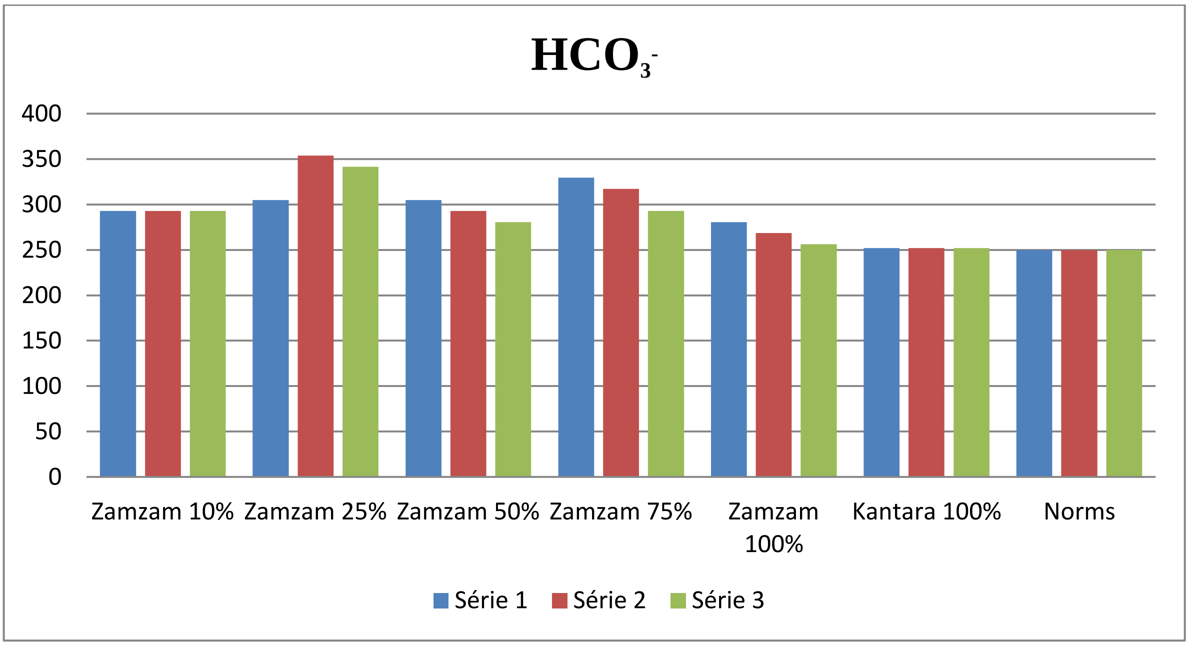


Figure 20. Alkalinity measurement

4.5 Results interpretation

4.5.1 Physical parameters

4.5.1.1 Temperature

It is important to know the temperature of the water with good precision. Indeed, it plays an important role in the solubility of gases, in the dissociation of salts and in the determination of the pH, for understanding the origin of water and possible mixtures. In addition, this measurement is very useful for immunological studies (Rodier, 2005). High temperature promotes the growth of microorganisms, can accentuate taste, odor and color (WHO, 1994). On the other hand, a temperature below 10 ° C slows down the chemical reactions in the various water treatments (Rodier *et al*., 2009).

The results recorded over the period studied indicate that the tested water (Zamzam, new, Zamzam 50% and 75%) is of good quality and corresponds to Algerian and European studies.

4.5.1.2 PH

The pH (hydrogen potential) measures the concentration of H^+ ions in the water. It thus translates the balance between acid and base on a scale of 0 to 14, 7 being the pH of neutrality. This parameter conditions a large number of physicochemical equilibrium, and depends on multiple factors, including the temperature and the origin of the water, it represents an important indication as regards the aggressiveness of the water (ability to dissolve limestone) (Ghazali et Zaid, 2013)

The pH is between 7.68 and 8. According to WHO (2004), the pH of drinking water must be between 6.5 and 8.5, so Biskra waters have a pH close to neutrality (Guergazi *et al.*, 2005).

4.5.1.3 Electrical conductivity

Electrical conductivity reflects the ability of an aqueous solution to conduct electric current; it determines the overall content of minerals present in a solution: soft water will generally show low conductivity and on the contrary so-called hard water will display high conductivity. It is also a function of the water temperature, and proportional to the mineralization (Bremaude *et al*., 2006).

The results we obtained through the analyzes are less than the Algerian and European standards 2800 µS / cm

4.5.1.4 TDS

According to the Center of Expertise in Environmental Analysis of Quebec, total dissolved solids (TDS) consist mainly of inorganic substances dissolved in water. The main constituents of dissolved solids are chlorides, sulfates, bicarbonates, calcium, magnesium and sodium. They mainly lead to the alteration of the taste of water (Iounes *et al*., 2016).

The global mineralization is proportional to the conductivity. Therefore, the values obtained in the results of the analysis are relative to the results of conductivity.

4.5.1.5 Salinity

Because salinity is proportional to the conductivity, following the same rate of variation and being affected by the geological structure of the origin of the water, we obtained similar results.

4.6 Chemical parameters

4.6.1 TH

The total hardness of water is produced by the calcium and magnesium salts it contains. We distinguish: a carbonate hardness which corresponds to the content of carbonates and bicarbonates of Ca^{2+} and Mg^{2+} and non-carbonate hardness produced by the other salts. It mainly results from the contact of groundwater with rock formations (Belghit *et al*., 2013)

The water hardness values of the studied water are in accordance with the Algerian standards.

4.6.2 Calcium

Calcium is the most abundant and the most important mineral in the body, yet it is the most difficult to get absorbed and utilized by the cells. It raises the body's resistance to viruses, parasites, cancer as well as bacteria which causes tooth decay (Husnah, 2020).

Calcium salts are obtained mainly during the attack of limestone rocks by dissolved carbon dioxide (CO_2) it constitutes the dominant cationic element of surface water (Potelon *et al*., 1998).

Our results for all the studied water are less than the Algerian specifications.

4.6.3 Sodium

Sodium is a constant component of water, however concentrations can vary widely. Apart from the leaching of geological formations containing sodium chloride, salt can come from the decomposition of mineral salts (Belghit *et al*., 2013). Water that is very high in sodium becomes brackish, takes on an unpleasant taste and cannot be consumed (Rodier, 2005).

The values of the different concentrations of Zamzam water are greater than those of El-Kantara water, but in general they are less than the Algerian specifications.

4.6.4 Chloride

Water too rich in chlorides is laxative and corrosive, the concentration of chlorides in the water also depends on the terrain crossed (Belghit *et al*., 2013).

The chloride contents of extremely varied waters are mainly linked to the nature of the terrain crossed. The big disadvantage of chlorides is the unpleasant flavor that they impart to water from 250 mg / L especially when it is sodium chloride (Rodier, 2005).

Chloride concentrations in the studied water are generally lower than Algerian standards.

4.6.5 Magnesium

It is a significant element of water hardness along with calcium ions; it is one of the most common elements in nature (Rodier *et al*., 2009). Magnesium contributes to the hardness of water without being the essential element (Potelon *et al*., 1998).

The results obtained for the different concentrations of Zamzam water are greater than the results of El- Kantara water. In general, all the studied water is less than the Algerian standards.

4.6.6 Potassium

Potassium is so closely related to sodium that it is rarely analyzed as a separate constituent in water analyzes. Its presence is widespread in nature in the form of salts. It plays an important role in the body's electrolyte balance and regulates the water content inside cells (Merceier, 2000).

The results obtained are different compared to the Algerian standards for drinking water, as we find that the values of Zamzam water (100%) are greater than the values of El-

Kantara water and drinking water standards. We also note that the higher the percentage of Zamzam water added to El-Kantara water, the higher the potassium value.

4.6.7 Bicarbonate (HCO_3^-)

Most of the bicarbonate content in natural waters comes from the dissolution of carbon dioxide (CO_2) in the water. They also come from the dissolution of calcium or magnesium carbonates in the presence of carbon dioxide in water (Al-Qawti *et al*., 2015).

According to Algerian standards, the results obtained for El-Kantara water are close to them, while the results of Zamzam water (100%) are greater than the standards, and the higher the concentration of Zamzam water added to El-Kantara water, the higher the bicarbonate value.

4.7 Statistical analysis

Comparison of the values of the physicochemical parameters of the different mixing series of Zamzam water and tap water in Table I showed the existence of a statistically significant difference in the means of calcium, magnesium, TH, TDS, TCA, HCO_3, sodium and potassium.

Tables II and III showed a very strong positive relationship between the percentage of the Zamzam-water mixture El-Kantara and the values of TDS, Potassium, sodium (correlation coefficient close to +1) while low and negative laison was observed with calcium and especially TH.

Table 6. Spearman correlation between Zamzam-water mixture El-Kantara and Physicochemical parameters.

		Calcium	salinity	CE	Chloride	TDS_ mgl
Percentage of Zamzam-water mixture El-Kantara	r de Spearman	**-0.753**	0.339	0.39	0.455	**0.921**
	Value of p.	**0.000***	0.168	0.109	0.058	**0.000***

r: correlation coefficient, p-value*: statistically significant test at 5%.

Table 7. Pearson correlation between Zamzam-water mixture El-Kantara and physicochemical parameters.

		Magnesium	sodium	potassium	HCO3	TCA_ f	TH
Percentage of Zamzam-water mixture El-Kantara	r de Pearson	0.175	**0.990**	**0.995**	0.045	0.089	**-0.515**
	Value of p	0.486	**0.000***	**0.000***	0.859	0.726	**0.029***

r: correlation coefficient, p-value*: statistically significant test at 5%

4.8 Discussion

Table 8. Compared the our values of Zamzam water with the previous results of other works

	01	02		03			
Parametres	Zamzam (100%)	Directly-collected Zamzam water 2021	Bottled Zamzam water	Zamzam water collected from big container#1 in the Haram mosque2011	Zamzam water collected from big container#2 in the Haram mosque	Piped Zamzam water collected from taps outside the Haram mosque	Commercial Zamzam water available small plastic bottles in Riyadh
T C^{O}	24.2	-	-	-	-	-	-
Salinité ‰	0.51	-	-	-	-	-	-
TDS mg/l	635	814	812	810	798	812	818
Cond µS/cm	807	-	-	1280	1270	1270	1250
pH	7.99	7.65	7.6	7.5	7.5	7.6	7.7
Cl^{-}	75.64	158.7	149.5	164.5	164.7	164.9	161.9
TAC	21.26	-	-	-	-	-	-
HCO_3^{-}	268.4	177.2	184	-	-	-	-
TH	29.9	-	-	303.84	303.84	315.01	324.56
Ca^{+2}	36	71.5	74	92	92	94	97
Mg^{+2}	129.6	20.5	18.5	18	18	19.5	20
Turbidité	-	-	-	0.11	0.10	0.11	0.12
Na^{+}	86.33	119.6	72.5	129.5	129.2	130	133.6
K^{+}	42	37.5	30.8	44.5	44.8	44,6	43.6

Through the results listed in Table 01, which represent the values obtained from our analysis of Zamzam water, and previous results from other work, we note good agreement between the results with very small differences due to several reasons, including:

- Source of used Zamzam water

- Directly-collected Zamzam water (Ahmed *et al*., 2021).

- Bottled Zamzam water (Ahmed *et al*., 2021).

- Samples collected from big container#1 in the Haram mosque (Alfadul et Khan, 2011).

- Samples collected from big container#2 in the Haram mosque (Alfadul et Khan, 2011).

- Piped samples collected from taps outside the Haram mosque (Alfadul et Khan, 2011).

- Preservation period

The samples used in our study are from two different years

-2011 (Alfadul et Khan, 2011).

- 2021 (Ahmed *et al*., 2021).

The table clearly shows the variations of each parameter, this could be attributed to the geological and hydro geological sources, the geochemistry of the rock, the case of alteration, the geochemical behavior of elements in Zamzam water.

According to the Saudi Geological Survey, granite represents the major rock of the aquifer rocks in the study area (Site web 2). The alkaline nature of the Zamzam water most likely stems from alkaline waters being associated with granitic environments (Shomar, 2012).

The alkalinity of the water and relatively low total dissolved solids (TDS) could explain the high concentrations of Ca^{+2}, K^{+}, and HCO_3^{-}, as this environment enhances the dissolution of silicate minerals in the surrounding rocks (Shomar, 2012).

The alkaline nature of the Zamzam water could explain its healing properties. Several studies have discussed the mechanism by which alkaline water promotes healing. For example (Kellas et Dworkin, 1996) stated that alkaline drinking water plays an important part in ridding the body of mercury and other toxins. The more acidic the body is the more it holds onto (heavy) metals. Heavy metals in turn create a high oxidative stress that acidifies the body. Consequently, alkaline water has been used for improving bone density and healing (Wynn *et al.*, 2009); controlling gastric functions (Bertoni *et al.*, 2002); improving capacity for aerobic activities and flushing toxins and acidic waste.

Thus, Zamzam water can be a powerful tool for the treatment of many diseases because of its holiness and sanctity.

Zamzam water well located in Saudi Arabia, which means a factor of dry climate cause water to evaporate by capillary action and lead to increase the concentration of ion in Zamzam water (Halim, 2018).

A direct relationship between Zamzam water salinity and rainfall is recorded.

The long residence time with aquifer materials of basic lava origin (basalt) can account for the origin of the Ferro-magnesium minerals of the calcium and magnesium. The enrichment of Zamzam water with calcium reflects its asserted ability to satisfy both thirst and hunger, while the slightly enriched values of potassium and sodium reflects its alleged ability to affect the human nervous system. Most of the cations and anions in the Zamzam water are relatively higher in concentrations, but all of them are in agreement with the maximum contaminant limits set by different regulatory agencies (Al-Gamal, 2009).

The water quality may also be affected by treatment type, container type and length of storage. Most groundwater sources have natural variations that are seasonal or related to recharge events. Man made contamination can also affect such sources and quality (Alfadul et Khan, 2011).

The variation in the composition of the mixture (water Zamzam-water El-Kantara) had a statistically significant influence on the following physicochemical parameters calcium, magnesium, TH, TDS, TCA, HCO_3, sodium and potassium. This influence was very strongly proportional between the percentage of the Zamzam-water mixture El-Kantara and the values of TDS, Potassium, sodium however it was low and negative with calcium and TH that is That is, the higher the Zamzam water content of the mixture, the higher the TDS, Potassium, Sodium values increase while the calcium and TH values decrease.

4.9 Conclusion

In this chapter, we are interested in presenting our results and comparing them with the Algerian standard and the World Health Organization. We can conclude that our tested water is of good physico-chemical quality. The comparison of the results of Zamzam water with the results of other previous works confirms:

Firstly, Zamzam water has rich basic mineral properties, which means that very significant reactions occur in some inorganic elements, including Na^+, Ca^{2+}, Mg^{2+}, K^+, HCO_3^-

and Cl^-. The levels of these elements in the Zamzam water have a strong influence on the El-Kantara water and enrich it.

Secondly, the instability of the concentrations of the studied parameters of Zamzam water (large changes in different years) plays a fundamental role in influencing other types of water (El-Kantara). The notable effect on the arc makes a different contrast.

Therefore, the water of Kantara changes at the physico-chemical level according to the richness and change of the water of Zamzam.

Conclusion

Good quality water for human consumption is an important factor in protecting public health. The subject of this work is the evaluation of the physical and chemical quality of the addition of Zamzam water to bottled water (El-Kantara).

This work was carried out in the laboratory of the Technical Institute for Agriculture and Desert Development, in this work, we determined some physical and chemical variables for the studied water samples, this allowed us to learn the analytical techniques used and to acquire knowledge about the study of water. The results we obtained through this study allowed us to prove the following:

- The studied parameters of Zamzam water vary considerably from year to year.
- The results obtained for the studied samples are of good quality because almost all the analyzed physical parameters are in conformity with the national regulations.

According to the cations as well as the major anions found that:

Zamzam water at these different concentrations has few values for these compositions (Cl^-, Na^+, K^+, T°, PH, TH and salinity). Zamzam water contains more bicarbonate and magnesium than El-Kantara water. Zamzam water 10% contains little of calcium, dissolved solids and potassium, and 25% Zamzam contains a small amount of calcium. El-Kantara water contains little of EC, TDS and potassium. Our 100% Zamzam water and 100% El-Kantara water samples, contain good levels of EC and calcium, respectively.

So, Zamzam water has a positive effect on El-Kantara bottled water by raising its level on the biological and energy levels.

Hence, the suggested perspectives on the unit are as follows:

✓ Repeating physical and chemical analyzes three or more times to obtain reliable and confirmed results, after displaying these results using a program that gives a statistical presentation to facilitate comparison and save time.

✓ Women are in great need of minerals during pregnancy and lactation, as well as during and after menopause, so the water in question that contains magnesium and calcium is very important for them, as is the case for vegetarians and lactose intolerant people.

✓ Water consisting of magnesium and sodium helps in cases of muscle tension, fatigue, difficulty concentrating and low blood pressure.

✓ Water with a high content of minerals benefits a lot of those who sweat heavily at work, or during leisure time, so it is necessary to drink mineral water with a high content of minerals. It is also important for the elderly to drink plenty of minerals, since the need for them increases with age. Mineral water with a high mineral content contains at least 1,500 mg of minerals per liter.

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Annex

1. Reagents used in physico-chemical analyzes

1.1 Calcium and magnesium dosage

- **Calcium solution at (0.02 N)**

Dissolve 1g of $CaCo_3$ (previously oven-dried) in 25 ml of 30% HCL and make up to 1L with distilled water.

- **EDTA solution: sodium salt**

➢ **Solution A**: dissolve 3.720 g of EDTA and 0.5 g of sodium hydroxide (NAOH) in 500 ml of distilled water.

➢ **Solution B**: dissolve 0.1 g of magnesium chloride ($MgCl_2$; $6H_2O$) in 500 ml of distilled water

Mix the two solutions and shake well.

- **pH 10 buffer solution**

➢ **Solution A**: dissolve 33.5 g of ammonium chloride (NH_4CL) in approximately 200ml with distilled water: add 180 ml of ammonia (NH_4OHL) then make up with distilled water.

Mix the two solutions and shake well.

- **Sodium hydroxide solution (NaOH) at 2.5 N**

Dissolve 100g of NaOH in 1L of distilled water.

- **Murexide**

19.9 g of well ground sodium chloride (NaCL) mortar add 0.1 g of Murexide well mix with a spatula the two products in order to obtain a very homogeneous final product.

- **Eriochrome black T**

20 g of NaCL (well ground mortar) add a certain amount of Eriochrome black T while mixing everything well until a shade is obtained (mauve gray).

1.2 Determination of chlorides

- **Silver nitrate (0.01 N)**

Dissolve 1.7 g of silver nitrate in 1l of distilled water and keep in a smoked bottle.

- **Sodium chloride (0.01 N)**

Dissolve 0.585 g of dried sodium chloride at 110 ° C for 2-3 hours. in a volumetric flask is made up to 1L of distilled water.

- **Potassium chromate 5%**

Dissolve 5g of potassium chromate in 100ml of distilled water.

1.3. Potassium determination

- **1 N ammonium acetate**

place 77.08 g of ammonium acetate in a 1000ml flask and make up to the mark with distilled water adjusted to pH 7 with acid at the base.

- **KCL stock solution at 1000 ppm**

place 1.907g of KCL in a 1000 ml volumetric flask added with distilled water to the mark.

1.4 Determination of carbonates and bicarbonates

- **Sulfuric acid or hydrochloric acid (0.02 N)**

Dilute 0.5 ml of H_2SO_4 in 1 L of distilled water.

Dilute 1.64 ml of HCL in 1 L of distilled water.

- **Colored indicator: phenolphthalein (KHC_8H_4O)**

Weigh 1 g of phenolphthalein and dissolve in 100 ml of 70% ethyl alcohol

- **Methyl orange indicator**

Dissolve 0.1 g of methyl orange in 100 ml of distilled water.

Abstract

الملخص:

الهدف من الدراسة التي أجريت هو تقييم الجودة الفيزيائية والكيميائية للمياه المعبأة (القنطرة) وماء زمزم ، وكذلك تأثير إضافة الأخير بتركيزات مختلفة على جودة مياه القنطرة في إشارة إلى معايير مياه الشرب (الجزائرية ومنظمة الصحة العالمية). أجريت التحليلات على عينات مختلفة بقياس 13 عامل درجة الحرارة درجة الحموضة، الملوحة، الناقلية الكهربائية،مجموع المواد الصلبة المذابة، القلوية الكاملة، عيار هيدروتيمتري، الكالسيوم، البوتاسيوم، المغنزيوم، بيكاربونات، الصوديوم، الكلور ،. مع 3 التكرار لكل معلمة ولكل مختلط. بينت النتائج المتحصل عليها أن غالبية المعلمات الفيزيائية والكيميائية المدروسة تطابق المعايير وأن لماء زمزم تأثير إيجابي على مياه القنطرة من خلال إثرائها لتكون أقرب إلى نوعية المياه. ماء زمزم حسب الزيادة تخفيف الخليط.

الكلمات المفتاحية: مياه زمزم ، القنطرة ، المياه المعبأة ، التحليل الكيميائي الفيزيائي ، التأثير الإيجابي ، منظمة الصحة العالمية.

Résumé :

L’étude réalisée a pour objectif d’évaluer la qualité physico-chimique de l’eau embouteillée (El-Kantara) et l’eau de Zamzam, ainsi que l’effet de l’addition de ce dernier en différente concentrations sur la qualité physico- chimique de l’eau d’El-Kantara, on se référant aux normes de potabilité (algérienne et OMS). Les analyses ont été effectuées sur différents échantillons en mesurant 13 paramètres : T°, pH, CE, salinité, TAC, TH,TDS, Cl^-, Na^+, K^+, Ca^{2+}, Mg^{2+}, HCO_3^-, avec 3 répétitions pour chaque paramètres et chaque mélange . Les résultats obtenus montrent que la majorité des paramètres physico-chimiques étudiés répondent aux normes et l’eau de Zamzam exerce un effet positif sur l’eau d’El-Kantara en enrichissant celle-ci de façon à être plus proche de la qualité de l’eau de Zamzam selon les dilutions croissantes de mélange.

Mots clé : l’eau Zamzam, l’eau embouteillée El-Kantara, analyse physico-chimique, effet positif, OMS.

Abstract :

The objective of the study carried out is to assess the physico-chemical quality of bottled water (El-Kantara) and Zamzam water, as well as the effect of the addition of the latter in different concentrations on the quality physico-chemical of El-Kantara water, referring to drinking water standards (Algerian and WHO). The analyzes were carried out on different samples by measuring 13 parameters: T °, pH, EC, salinity, TAC, TH, TDS, Cl^-, Na^+, K^+, Ca^{2+}, Mg^{2+}, HCO_3^-, with 3 repetitions for each parameter and each mixed. The results obtained show that the majority of the physicochemical parameters studied meet the standards and Zamzam water has a positive effect on El-Kantara water by enriching it so as to be closer to the quality of the water. Zamzam water according to increasing dilutions of the mixture.

Keywords: Zamzam water, El-Kantara bottled water, physico-chemical analysis, positive effect, WHO