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Comparative Study on the Hardness of Mechroha Water Springs

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ABSTRACT

$\mathbf{T}$he vacancy of natural resources is undoubtedly limited by time. The sustainable development principle recommends modern technology for its protection and renewal. This project conducted analyses on two underground water sources in the north of Algeria (Mechroha Province). Besides, the use of the hardness factor and the adoption of the titration method, which is the determining the concentration of an unknown solution using a known solution concentration, have permitted the characterization of the examples taken and to verify their conformity to the standard required, the results found showed $H_T = 6.66$ French degrees (°F) for Ain Guilloume water spring in comparison to Ain Messai water spring $H_T = 7$ French degrees (°F). Those data conduct us to select the drinking water source of Ain Guilloume due to its attractive composition and value.

Keywords: Ain Guilloume, Ain Messai, comparative, hardness, titration.

دراسة مقارنة حول عسرة منابع المياه لمقاطعة المشروحة

عيسى بن سلهوب	علي بوعمران	* عصام روايقية
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مركز البحث في البيئة	قسم الري	جامعة سوق اهراس / الجزائر
عنابة / الجزائر	جامعة ورقلة / الجزائر	

الخلاصة

وفرة الموارد الطبيعية من المؤكد أن تكون محدودة بوقت، مبدأ التنمية المستدامة يوصي بالتكنولوجيا الحديثة لحمايتها وتجديدها. في هذا المشروع، أجريت دراسة تحليلية على مصدرين للمياه الجوفية يقعان كلاهما في شمال الجزائر (مقاطعة المشروحة). إلى جانب ذلك، سمح باستخدام عامل العسرة واعتماد طريقة المعايرة والتي تتمثل في حساب تركيز مجهول لمحلول بواسطة محلول آخر تركيزه معروف، سمح لنا هذا بتشخيص الأمثلة المأخوذة والتحقق من مطابقتها للمعايير المطلوبة، النتائج المحصل عليها

تظهر H_T = 6,66 درجة فرنسية لمنبع مياه عين قيلوم بالمقارنة مع منبع مياه عين مسعي H_T = 7 درجة فرنسية. تقودنا

هذه البيانات إلى اختيار مصدر مياه الشرب عين قيلوم بالنظر إلى تركيبته الجذابة وقيمته.

الكلمات الرئيسية: عين قيلوم، عين مسعي، مقارنة، صلابة، معايرة.

1. INTRODUCTION

Natural resources can be materials or energies from the earth intended to optimize the quality of human life **(Cherepovitsyn and Ilinova, 2018).** One of them is mineral water. This later has recently been the subject of several studies due to its importance. Knowing that water is an essential component of life, which is the most basic need of humans as well as other living organisms and an engine of numerous sectors; the main drink of citizens, agriculture, industry, etc. **(Nasier and Abdulrazzaq, 2022); (Mathew and Krishnamurthy, 2014), and (Naser and Abdulrazzaq, 2022)**. Water resources can be significantly affected by human action (industry, overconsumption, overexploitation), anthropogenic factors, and more rarely by severe climatic conditions.

This work is more interested in applying the classical method for determining hidden concentrations, lime salts (Ca^{2+}), and magnesia (Mg^{2+}) recognized by the name titration. Moreover, the method is reliable and proven with convincing results, and it has been used previously to measure the energy required to separate the bonded atoms **(Velázquez-Campoy et al., 2014)**. In the same context, hydrotimetric titration is the only traditional titrimetric process applied for metal ions' instantaneous and quantitative chemical analysis **(Zhai and Bakker, 2016).** By the way, the total hardness of water index is often calculated from the sum of calcium and magnesium ions concentration. Hard water can cause many complications, scaling on water pipes, boilers, eczema, and odd-tasting drinking water **(AHN et al., 2018 KECHIDA et al., 2021)**.

1.1 Experimental setup

1.1.1 Cases of the study

The study areas are located in the Northeast of Algeria (Souk Ahras City); it has moderately rugged relief with an average altitude of 1000 m in the North **(BOUKEHILI et al., 2018)**. It is made up of 26 municipalities, Mechroha is one of them, and it is located 21 km Northwest of the mentioned City and 58 km Southeast of Guelma City **(BELHOUCHET, 2018)**. It is a small village previously called greenery, **Fig. 1**, with several springs like; Ain Guilloume, Ain Rogti, Ain Garsa, Ain Messai, Ain Kahwa, etc.

Figure 1. The geographical location of Mechroha village (**TLIDJANE et al., 2019**).

The objective of this study is to measure the hardness of water from two underground springs (Ain Guilloume and Ain Messai, **Fig.2**, and Then measure their hardness (H_T) by the appropriate equipment.

**Figure 2.** Mechroha water springs 1—Ain Guilloume; 2—Ain Messai

2. MATERIALS AND METHODS

The product used during the tests can be summarized in **Fig. 3**. The equipment used during the test were: graduated burette with stand, hot plate magnetic stirrer, beaker, Erlenmeyer flask, graduated cylinder, funnel, dropper, graduated pipette and pear, volumetric flask and spatula.

The assay procedure begins with filling the graduated burette with ethylenediaminetetra acetic acid (EDTA) solution up to scale 0. 100ml of mineral water to be analyzed is poured into the beaker and heated at 60°C. At that time, 5 ml of the buffer solution are added with 10 drops of eriochrome Black T (NET).

The starting color is purple; the EDTA solution is poured drop by drop until the color of the beaker solution changes abruptly (blue turn), then the equivalence of volume (v_{eq}) is taken.
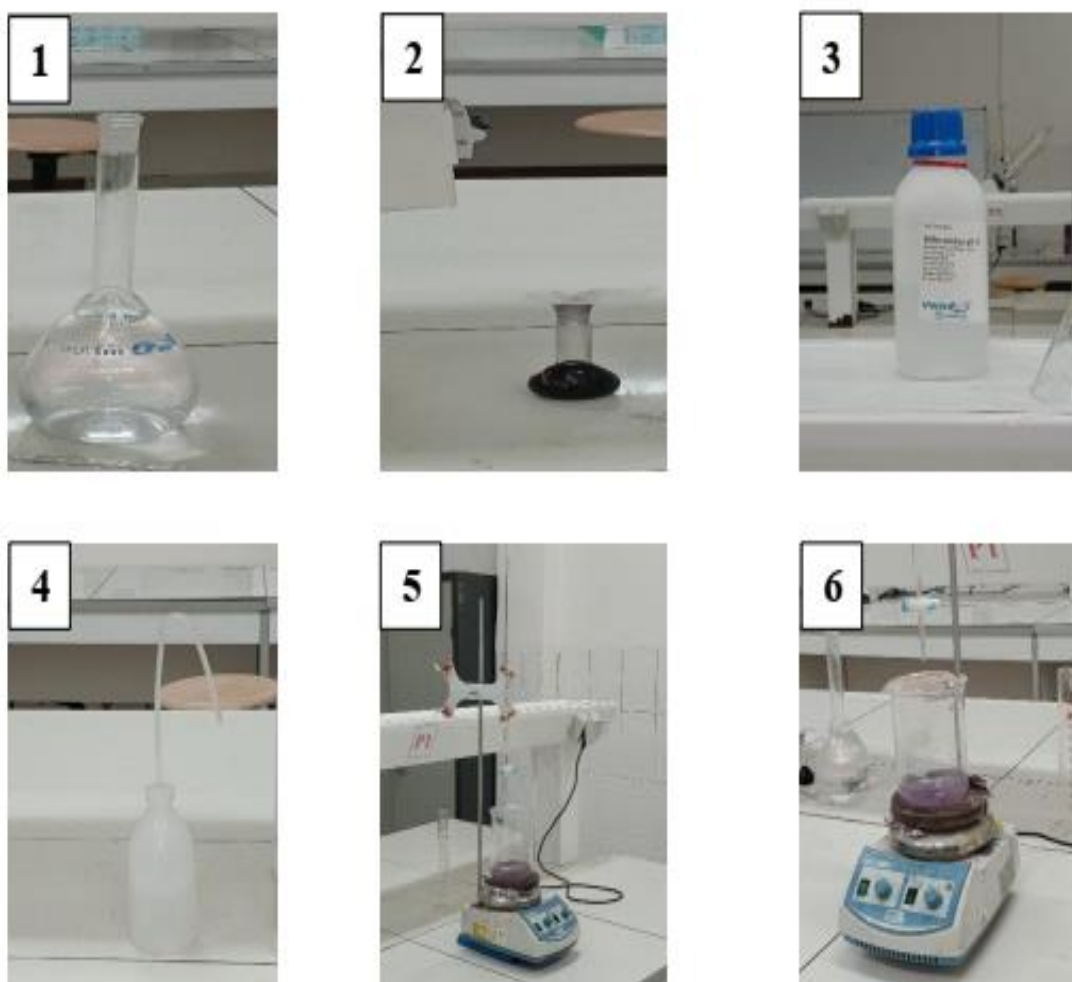
Figure 3. Experimental apparatus: 1—EDTA; 2—NET; 3— Buffer solution; 4—Distilled water; 5—Titrage process; 6—The solution to be assayed.

3. RESULTS AND DISCUSSION

Water is a crucial element of human life which is why all people should have an adequate supply of water; sufficient, safe, and accessible (**Directives de qualite pour l'eau de boisson, 2004**). Talking about the quality, this conducted the authors to the sampling process. To control spring waters, analysis is mostly recommended, especially in the absence of water treatment installation (**Directives de qualité pour l'eau de boisson, 2017**). **Table 1** recapitulates the World Health Organization (WHO) drinking water standard (**Normes de l'OMS sur l'eau potable, 2006**).

Table 1. WHO drinking water standards

Element/ substance	Symbol/ formula	Concentration normally found in surface water	Guidelines set by WHO
Aluminum	Al		0,2 mg/l
Ammonium	NH_4^+	< 0,2 mg/l (can go up to 0,3mg/l in anaerobic water)	No constraints
Antimony	Sb	< 4 µg/l	0.02 mg/l
Arsenic	As		0,01 mg/l
Asbestos			No guide value
Barium	Ba		0,7 mg/l
Beryllium	Be	< 1 µg/l	No guide value
Boron	B	< 1 mg/l	0.5mg/l
Cadmium	Cd	< 1 µg/l	0,003 mg/l
Chlorine	Cl		No value but a taste can be noted from 250 mg/l
Chromium	Cr^{+3}, Cr^{+6}	< 2 µg/l	Total Chromium : 0,05 mg/l
Coulor			No guide value
Copper	Cu^{2+}		2 mg/l
Cyanide	CN^-		0,07 mg/l
Dissolved oxygen	O_2		No guide value
Fluoride	F^-	< 1,5 mg/l (up to 10)	1,5 mg/l
Hardness	mg/l $CaCO_3$		200 ppm
Hydrogen sulfide	H_2S		0.05 à 1 mg/L
Iron	Fe	0,5 - 50 mg/l	No guide value
Lead	Pb		0,01 mg/l
Manganese	Mn		0,4 mg/l
Mercury	Hg	< 0,5 µg/l	inorganic : 0,006 mg/l
Molybdenum	Mb	< 0,01 mg/l	0,07 mg/l
Nickel	Ni	< 0,02 mg/l	0,07 mg/l
Nitrate and nitrite	NO_3, NO_2		50 et 3 mg/l (short term exposure) 0.2 mg/l (long term exposure)
Turbidity			Not mentioned
pH			No guide value but an optimum between 6.5 and 9.5
Selenium	Se	< 0,01 mg/l	0,01 mg/l
silver	Ag	5 – 50 µg/l	No guide value
Sodium	Na	< 20 mg/l	No guide value
Sulfate	SO_4		500 mg/l
Inorganic tin	Sn		No guideline value: low toxicity
TDS			No guide value but optimum below 1000 mg/l
Uranium	U		0.015 mg/l

Zinc	Zn		3 mg/l

Before interpreting the results obtained, it should be said that in most cases, the so-called water hardness is not favorable for home use since it minimizes the action of soaps. However, water hardness in other sectors such as agriculture, forces the soil to maintain a suitable structure **(COUTURE, 2006)**. To do this, two samples were taken during the rainy season (February 2022), one sample for each water source, and the volume of each sample taken is approximately 5 liters. H_T is an index that allows us to calculate water hardness. It shows the overall water content in terms of lime salts (Ca^{2+}) and magnesia (Mg^{2+}) **(ANDRIAMANJATO NAJA, 2019)**. Further clarification is given in **Table 2**.

Table 2. Water classification concerning hardness **(Randriamitsiry, 2017)**

H_T (° f)	1-7	7-15	15-20	20-25	>25
Water	sweet, good	gently salty	Pretty salty	salinity limit	Tough

3.1 Determination of total hardness

The total hardness of the water is linked with the quantity of calcium and magnesium ions by these formulas **(RANDRIAMITSIRY, 2017)**:

$$H_T = H_{T_{Mg}} + H_{T_{Ca}} \tag{1}$$
$$1°fCa = 4 \, mg/l \tag{2}$$
$$1°fMg = 2.43 \, mg/l \tag{3}$$

The general formula can be translated by **(RANDRIAMITSIRY, 2017)**:

$$H_T = ([Ca^{2+}] + [Mg^{2+}]) \, 10^4 \tag{4}$$

At the equivalence point:

$$C_{EDTA} \, V_{eq} = C_s \, V_s \tag{5}$$

3.1.1 H_T of Ain Guilloume water

$$C_S = \frac{0.02 * 3.5}{105} = 0.0006 \, mol/l$$

$H_T = 0.0006 * 10^4 = 6.66 \, °f$ This implies that Ain Guilloume water is soft and good.

By exploiting equations (2) and (3):

$$[Ca^{2+}] = 6.66 * 4 = 26.64 \, mg/l$$
$$[Mg^{2+}] = 6.66 * 2.43 = 16.18 \, mg/l$$

3.1.2 H_T Of Ain Messai water

$$C_S = \frac{0.02 * 4.1}{105} = 0.0007 \ mol/l$$

$H_T = 0.0007 * 10^4 = 7 \ °f$ This implies that Ain Messai water is gently salted by limestone.

By exploiting equations (2) and (3), it was found:

$[Ca^{2+}] = 7 * 4 = 28 \ mg/l$
$[Mg^{2+}] = 7 * 2.43 = 17.01 \ mg/l$

This study aims to calculate the hardness of two samples of mineral water springs already used for the drinking water supply of residents from the Mechroha region to choose the best from them concerning quality and taste. To discuss the results obtained, the study carried out using comparison from the point of view of the hardness index (H_T) in other words, the results of the hydrotimetric titration tests and by evaluation with the reference values mentioned in **Table 1** it can be said that Ain Guiloume spring has soft water ($H_T = 6.66 \ °f$) compared to Ain Messai spring ($H_T = 7 \ °F$), which is above standard, and it is considered slightly salted by carbonates (Ca^{2+} and Mg^{2+}).

4. CONCLUSIONS

Given the purpose of this research project, we are focusing this study on the determination of the hardness from two water sources (Ain Guilloume and Ain Messai), both located in the municipality of Mechroha. The results harvested confirm that Ain Guilloume spring has a sweet taste and a pleasant quality compared with Ain Messai spring, which has a hardness close to the standard and can be acceptable as drinking water.

This paper illustrates the importance of hydrotimetric titration used as an effective analysis technique to characterize the nature of the waters studied and to distinguish between two qualities of potable waters, and it should be noted that excessive hardness reduces its ability to soap (formation of foam). In conclusion, the optimal hardness is less than 7 °F, and this is the case of Ain Guillome water.

5. NOMENCLATURE

H_T = hydrotimetric titration
°f = (French degree) that is equivalent to 10 mg/l $CaCO_3$
EDTA = ethylenediaminetetra-acetic acid
NET = eriochrome Black T
v_{eq} = equivalent volume
C_S = Solution concentration, mol/l
$[Ca^{2+}]$ = molar concentration of Ca, mol/l.
$[Mg^{2+}]$ = molar concentration of Mg, mol/l.
WHO = World Health Organization

6. ACKNOWLEDGMENT

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