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CASE STUDY

SOME PHYSICOCHEMICAL CHARACTERISTICS OF SEVEN TYPES OF SPRING WATER AND WELL WATER OF THE AREA OF TIZI-OUZOU (NORTHERN ALGERIA)

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ABSTRACT

This paper presents, for the first time to our knowledge, some physicochemical characteristics (pH, soluble solids content (TDS, in mg/L), electrical conductivity (EC, in µS/cm), and turbidity (in NTU) of seven types of spring waters (AO, IK, TB, TNZ, TT, TZD and TZF) and well water (AZG) from the Tizi-Ouzou region. pH, TDS and EC were measured by direct reading using hand-held probes, while other characteristics, including turbidity, were determined at a certified quality control laboratory. The results show that pH, TDS and EC varied from 4.4 (case of AO) to 9.0 (case of IK), from 68 (case of TZD) to 656 mg/L (case of TT) and from 109 (case of TZD) to 1316 µS/cm (case of TT). Except for TZF, which has intolerable turbidity (> 5 NTU), the other samples analyzed show excellent transparency with zero turbidity except for TZD (turbidity =1.52 NTU). Knowing the practical and possible health implications of these parameters, further studies are needed.

Keywords: Electrical conductivity (EC), pH, physicochemical characteristic, total dissolved solids (TDS), turbidity, health, water quality.

INTRODUCTION

Human health is inseparable from the quality of drinking water. The latter is defined by a multitude of microbiological and organoleptic physico-chemical parameters.

pH, TDS, EC and turbidity are interrelated and easy to measure parameters. They are also sensitive to variations in the composition of the water and can therefore serve as indicators of possible contamination (Saalidong et al., 2022). Thus, the association between turbidity and microbiological contamination of water is well established (Wang et al., 2021), which implies a risk of toxicity for consumers. That said, the aesthetic character (color, taste and odor) of these parameters seems to preoccupy some organizations involved in drinking water management much more than the sanitary risk, an issue to which we will return at the end of this communication.

The generally recommended pH for drinking water is between 6.5 and 8.5. Acidic water with a pH below 6.5 is corrosive and capable of dissolving metal ions (iron, manganese, copper). Water with a pH above 8.0 can be difficult to disinfect by chlorination, for example. Health Canada recommends a pH of drinking water between 7.0 and 10.5 and that its fluctuation in the distribution system should not exceed 0.2 pH units (Health Canada, 2016).

According to the World Health Organization (WHO, 2011), the taste of water with a TDS of less than 600 mg/L is considered good, and it becomes unpleasant if the TDS exceeds 1000 mg/L with the added risk scaling of water pipes. However, the same organization does not mention any health effects.

This paper presents, for the first time to our knowledge, some physicochemical characteristics (pH, soluble solids content (TDS, in mg/L), electrical conductivity (EC, in µS/cm) and turbidity (in UTN)) of seven types of spring water (Assif Ousserdoune (AO), Ikoussa (IK), Thala Bouvridh (TB), Thala N'Zaouch (TNZ), Thala Toulmouts (TT), Tazerouts - Freshwater (TZD) and Tazerouts-Ferruginous Water (TZF)) and well water locally called Azaghar (AZG). All these water points are located in the Sebaou valley in the region of Tizi-Ouzou.

MATERIAL AND METHODS

Waters analyzed

The samples of the seven spring waters and the well water analyzed are designated by the name of the sampling location, which may be different from the location of the source:

- AO: tap drinking fountain, located near Assif Ousserdoune (the Serdoune wadi), located on the territory of the commune of Ifigha (district of Azazga), at ~ 400 m altitude;
- AZG: well water locally and improperly named Azaghar (AZG), which is at the same time the name of a wadi and a place called. In reality, the water catchment work is located in Boubhir (commune of Illoula Oumalou, district of Bouzeguène), which is the extension of Azaghar (wadi and place called);

- IK: tap drinking fountain, located in the village of Ikoussa (commune and district of Bouzeguène), at an altitude of ~800 m; the fountain is the final element of the small distribution network, also including a water tower and the spring that feeds it.
- TB: drinking fountain with continuously running water, called Thala Bouvridh and located in the village of Agni-Filkane (commune of Ait-Zikki, district of Bouzeguène), at ~ 1000 m altitude;
- TNZ: drinking fountain with continuously running water, located in the village of Thala N'Zaouch (commune and district of Mekla), at an altitude of ~200 m;
- TT: faucet fountain, located in the village of Thala-Toulmouts (commune and district of Tizi-Rached), at ~ 200 m altitude;
- TZD: freshwater mix from four sources taken near the collection points located ~ 3 km above the village Tazerouts (commune and district of Bouzeguène), at ~ 1000 m altitude;
- TZF: ferruginous water taken from a mini settling station located ~700 m from the point of emergence, not far from the point of emergence of the TZD fresh water.

pH, total dissolved solids (TDS), and electrical conductivity (EC)

The interest of these parameters lies in their sensitivities to the composition of the medium and their interdependencies. They were determined in July/August 2019 and June 2021 (case of TB water pH measurement) using a Pancellent brand portable pH meter and TDS-CE meter. The measurements were repeated six times.

Other physicochemical parameters

The other physicochemical parameters considered were analyzed in February 2021 at the Labo Dali quality control laboratory, located in Oued Amizour (120 km east of Algiers): dissolved iron (Fe, mg/L) and dissolved manganese (Mn, mg/L) using HACH brand LCK321 (for Fe) and LCW532 (for Mn) kits, hydrotimetric titer (TH, (°F) by DTA complexometry and turbidity (UTN) using a brand turbidimeter HANNA HI 93703. Each test was repeated at least twice.

It should be noted that in the case of the TZD sample, the Fe and Mn values are taken from an article under review at "Vertigo-Revue Electronique des Sciences de l'Environnement", while for the TZF sample, the value of Fe is that communicated by Benamara and Messaoui (2020).

RESULTS AND DISCUSSION

pH, total dissolved solids (TDS), and electrical conductivity (EC)

The obtained values of pH, TDS and EC are shown in Fig. 1 (a, b, and c). The results show that the pH varies within a wide range, from 4.4 (case of AO, which is therefore acidic) to 9.0 (case of IK, which is alkaline). Let us say that foods are either acidic (pH~2.5 for lemon juice) or low acid (pH~6 for fresh meat) on a pH scale that ranges from 7 to 14, knowing that a 1% aqueous baking soda solution has a pH of ~ 8.5. However, it is necessary to differentiate the acid character that we have just seen from the acidifying and alkalizing character, that is, the pH induced by the food at the end of the digestion and metabolization process. In the case of water and as has already been pointed out above, the values generally recommended are 6.5 to 8.5, but Health Canada (2016) recommends a pH between 7.0 and 10.5. In regard to health, opinions differ. Experiments in laboratory animals show that changes in the pH of drinking water affect both the composition of the gut microbiota and the metabolism of the host (Hansen et al., 2018). However, it is well established that pH influences the taste and effectiveness of chlorinating water for disinfection purposes. Indeed, disinfection by chlorination is optimal at a pH between 5.5 and 7.5. Based on data from the literature and in light of the results obtained, which remain to be confirmed, AO, TB and TZD seem too acidic.

TDS (Fig. 1b) and EC (Fig. 1c) vary from approximately 70 (TZD case) to 650 ppm (TT case) and from 1110 (TZD case) to 1300 µS/cm (TT case), respectively. Of the eight types of water analyzed, only TT has a TDS exceeding the recommendations of the World Health Organization (WHO, 2017a) (< 600 mg/L) and the US Environmental Protection Agency (EPA, 2018) (< 500 mg/L). On the other hand, according to the classification established by KENT RO Systems (2022), the taste of water is excellent for a TDS of between 50 and 150 mg/L (case of AO and TZD).

The results obtained for the EC (Fig. 1c) agree with those of the TDS since the TDS/EC ratio of the waters analyzed is between 0.5 and 0.7, which is consistent with the data in the literature concerning freshwater (Rusidy, 2018).

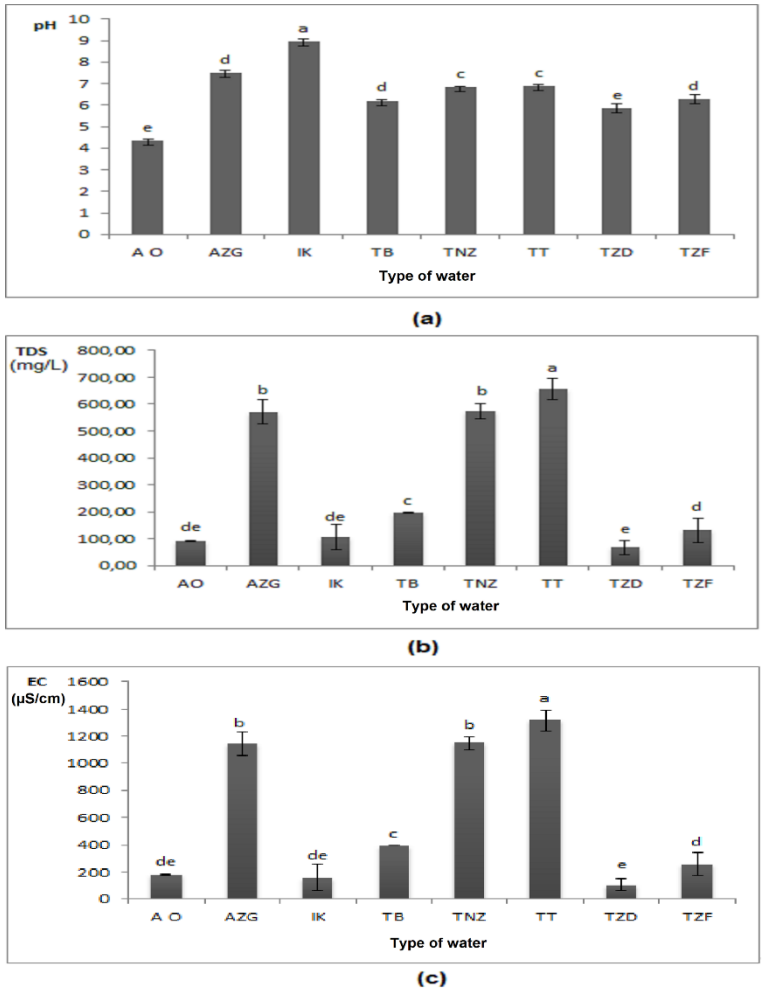

Figure 1: **pH (a), total dissolved solids (TDS, mg/L) (b), and electrical conductivity (EC, µS/cm) according to the type of water.**

AO = Assif Ousserdoune, AZG = Azaghar, IK = Ikoussa, TB = Thala Bouvridh, TNZ = Thala-N'zawèche, TT= Thala-Toulmouts, TZD = Tazerouts (fresh water), and TZF = Tazerouts (ferruginous water). The same lowercase letters on the columns indicate the absence of a significant difference between the corresponding values (p > 0.05).

Other characteristic physicochemical parameters

The other physicochemical parameters analyzed are given in Table 1.

Table 1: Other physicochemical parameters of the analyzed water

Water	Fe (mg/L)	Mn (mg/L	TH (°F)	Turbidity (NTU)
AO	0.095	0.141	2.84	0.00
AZG	0.099	0.012	28.73	0.00
IK	0.124	0.051	1.53	0.00
TB	0.108	0.033	11.30	0.00
TNZ	0.132	0.023	34.72	0.00
TT	0.097	0.016	33.95	0.00
TZD	0.154	0.019	12.42	1.52
TZF	4.00	0.234	5.04	0.00
Standards	0.3[a]	0.05[a]	8-10[b]	< 1[c]
RDA[d]	11	3.0	-	-

a Official Journal of the Algerian Republic (JORA, 2011); b Values ensuring an acceptable balance between corrosion and scaling (Health Canada, 2009); c World Health Organization (WHO, 2017b); dRecommended dietary allowances (mg/day) according to the European Food Safety Agency (EFSA, 2015)

According to these results, only the TZF sample, which is ferruginous water, presents an excess of iron with a content exceeding 10 times the generally recommended threshold value. Concerning Mn, we again find TZF as well as IK but to a lesser extent, with contents exceeding the threshold value. The result related to TZF is in agreement with the data in the literature, which indicates that the Fe and Mn contents in Algerian waters sometimes exceed the required standards (Achour et al., 2017).

Based on the TH value, AO, IK and TZF waters are very soft ($0 \leq TH < 7$), TB and TZD are soft ($7 \leq TH < 15$), AZG is rather hard ($15 \leq TH < 30$) and TNZ and TT are hard ($30 \leq TH \leq 40$).

Except for TZF, which has an intolerable turbidity (> 5 NTU), the other samples analyzed show excellent transparency with zero turbidity except for TZD (turbidity = 1.52 NTU).

It is true, as has already been emphasized above, that accredited bodies and other standards generally attribute to the parameters studied here an impact solely of an aesthetic nature, while sometimes recalling the indirect effects on health. However, researchers point to serious risks of infection in this regard. Based on a clinical study, Bellizzi et al. (1999) suggested favoring the consumption of fresh water in the preventive approach to calcium nephrolithiasis. However, opinions differ on this issue since a high content of magnesium and bicarbonate in the water is, for example, recommended for patients suffering from kidney stones (Sulaiman et al., 2020). De Roos et al. (2017) found positive associations between drinking water turbidity and the incidence of gastrointestinal infections. For their part, Richer et al. (2017) highlighted various physicochemical parameters of water (pH, TH, Fe, Mn…) as probable risk factors in

neurodegenerative diseases. Finally, numerical solutions show that with the optimal control of calcium and magnesium hardness of water, the proportion of individuals suffering from kidney diseases can be minimized (Ndii et al., 2020).

CONCLUSION

The results obtained show that the different parameters studied vary considerably from one type of water to another. Given the divergent opinions concerning the impact of the physicochemical factors of water on health, it seems to us more judicious for consumers to diversify and adapt, according to their needs, the sources of supply of this resource while respecting zero tolerance for microbiological quality.

In addition to an in-depth physicochemical and microbiological study, epidemiological investigations are desirable in the concerned region to look for possible relationships between the physicochemical quality of water and the frequency of certain pathologies.

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