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Physicochemical and bacteriological quality of drinking water from different regions of the wilaya of Skikda (Algeria)

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ABSTRACT The objective of this study is to evaluate the physicochemical and bacteriological quality of drinking water from different origins in the region of Skikda, Algeria (groundwater, dams and desalination). The study was carried out for a period of 3 months.

KEY WORDS Drinking waters; bacteriological pollution; physico-chemical parameters; Skikda.

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INTRODUCTION

Water is an important vital resource. Being an essential element in our life, both for human consumption and for industrial use, its quality is a constant concern of the authorities in order to protect the environment and the health of living beings.

Water intended for human consumption must have a certain number of organoleptic, physicochemical and microbiological characteristics. Sometimes it can become an important reservoir for the dissemination of microorganisms (bacteria, viruses, protozoa and parasites), making it unsuitable for consumption. In recent years, water quality control has become a major and mandatory operation. Other similar studies were conducted by our group (Ouamane et al., 2016).

In this study, we will try to determinate the physicochemical and bacteriological quality of drinking water from five sites in the region of Skikda (two underground springs, two dams and the water from the desalination plant) thus covering the different types of drinking water supplying the region.

MATERIAL AND METHODS

The wilaya of Skikda is located in the North-East of Algeria, it includes 38 municipalities, 14 of which are coastal, divided into 13 dairas. The wilaya is supplied by four dams: the Zerdezas dam (with a capacity of 20 million m^3), the Guenitra dam (with a capacity of 125 million million m^3), the Zit Emba dam (with a capacity of 120 million m^3) and finally the Beni Zid dam (with a capacity of 50 million m^3); it includes also 53 sources (ABH Constantine and ANRH Skikda, 2005).

Our study is based on the physico-chemical and bacteriological analysis of drinking water from different origins: groundwater from the western region of Skikda (2 underground sources located in the mountains of Collo (Ouled Atia), water from the dams of Béni Zid and Oum Etoub

and desalination water from the Skikda station (Fig. 1, Table 1).

The samples, transport and analysis of drinking water samples were conducted according to guidelines for the monitoring of the quality of swimming waters. This monitoring program was carried out for a period of three months (March 2019-April 2019). The collected data were measured in each water sample taken per month per site. The analysis focuses on the quantification of faecal indicator bacteria (total coliforms, thermotolerants, faecal streptococci and sulfo-reducing clostridiums) using the method of the enumeration in liquid medium by determining the most probable number (MPN) and incorporation into agar; as well as determining certain physicochemical parameters (electrical conductivity, pH, dissolved oxygen, ...) (Table 2).

Sample	Site	Type of water
S1	Béni Zid	Spring
S2	Ouled Atia	Spring
S3	Béni Zid	Dam
S4	Oum Etoub	Dam
S5	Station Skikda	desalination

Table 1. Identification of the different samples.

The health status of drinking water is assessed based on the results obtained and compared to thresholds, quality bacteriological and physico-chemical criteria present in the Executive Decree No. 11-125.

RESULTS AND DISCUSSION

As regards the average results recorded for the various physico-chemical parameters, we note that these are in line with the quality standards required for drinking water by the texts in force, for spring water (sites 1 and 2) and of poor quality for the other three sites (dam water and desalination) (Table 3).

Site 3 (water from Beni Zid Dam) has high average rates for turbidity and TDS parameters. Turbidity can be due to the poor quality of the source water, to improper treatment, etc. Regarding the level of total dissolved solids (TDS), this parameter is not a concern for the health of consumers, it only allow to judge only the flavour of the water, a level below about 600 mg/l generally corresponds to good water, drinking water becomes significantly and gradually undrinkable when TDS levels exceed about 1000 mg/l. High levels of TDS can lead to consumer complaints due to excessive crusting in pipes, radiators, boilers and domestic appliances (WHO, 2017).

Figure 1. Study area: location of sampling sites.

Site 4 (Oum Etoub dam) has a low rate of dissolved O2. The dissolved oxygen content of the water is influenced by the source, the temperature of the raw water, the treatment and the chemical and biological processes that occur in the distribution system. Dissolved oxygen depletion of water supplies can stimulate the microbial reduction of nitrates to nitrites and sulfates to sulfides. It can also cause an increase in the concentration of ferrous iron in solution, with a subsequent change in color at the tap when the water is aerated (WHO, 2017).

Sites 3, 4 and 5 have average nitrite levels higher than the current standards, and the presence of NO2 nitrites in the water is a sign of pollution.

Site 4 (Oum Etoub dam water) has an average sulphate concentration above regulatory values, which is not dangerous but carries a risk of diarrheal disorders, especially in children. The presence of sulphates is linked to the nature of the land crossed. It may also be evidence of industrial releases (Rodier et al., 2009).

For the average results of the bacteriological parameters, we note that the majority of the water is of good quality except for site 1 (Béni Zid spring water) which records high levels of total and thermotolerant coliforms synonyms of recent faecal contamination (Table 4). This can be explained by climatic conditions during the study season and by runoff.

CONCLUSIONS

The major problem with water intended for human consumption is above all a sanitary one. This problem arises from the presence of microorganisms (bacteria, viruses, protozoa, parasites) which transmit many dangerous infections for humans.

The aim of the study carried out during this work was to assess the physico-chemical and bacteriological quality of water intended for human consumption from different regions of the wilaya of Skikda.

The results of the physicochemical analyses showed that:

- Source water from the Ouled Atia (S2) site is of good quality according to national and international standards.

Parameters	Methods
Physical PH Dissolved oxygen Temperature Conductivity TDS Turbidity	electrochemical
Chemical Total hardness Calcium hardness Chloride Nitrite COD	Volumetric
Nitrate Phosphate Iron Sulfate Ammonium Alkalinity TA and TAC Heavy metals	Spectrophotometric
Quantified germs	**Methods used**
total Coliforms	determination of the most probable number (MPN)
thermotolerant Coliforms	
Escherichia coli	
faecal streptococci	
sulfo-reducing clostridiums	incorporation into agar

Table 2. Physicochemical and bacteriological parameters measured.

- Beni Zid spring (S1), Oum Etoub dam (S4), and desalination water (S5) are of acceptable quality.

- Béni Zid dam (S3) is of poor quality, which may be justified by the siltation state of the dam.

During our study, we noticed that the water analysed water don't contain heavy metals, which

Site	pH (6.5-9)	Temperature (C°) (25)	Electrical conductivity (µS/cm) (2800)	Dissolved oxygen (mg/l) (5-8)	Turbidity (NTU) (5)	TDS (mg/l) (<600)	TA et TAC (mg/l) (0.3)	THMg (mg/l) (150)	THCa (mg/l) (200)	TH_T (mg /l) (200)	Chlorures (mg/l) (500)
S1	0.7	19.3	198.8	5.08	1.12	97	7.70	7.30	4.80	21.60	31.16
S2	6.37	20.5	197.6	5.48	0.38	97	3.30	12	8	20	21.81
S3	6.72	22.1	1839	7.67	6.51	901	7.15	9.60	4	13.60	37.39
S4	7.57	19.1	567	2.5	4.06	278	13.97	16.40	24.80	41.20	60.76
S5	7.87	20.0	567	6.28	0.21	278	18.70	6.40	1.60	8	155.80

Nitrate (mg/l) (50)	Nitrite (mg/l) (0.1)	Phosphate (mg/l) (5)	Iron (mg/l) (0.3)	Sulphate (mg/l) (400)	Ammonium (mg/l) (0.5)	COD (mg/l)	Cooper (mg/l) (2)	Nickel (µg /l) (70)	Lead (µg /l) (10)	Manganese (µg /l) (50)	Zinc (mg /l) (5)	Cadmium (µg /l) (0.01)
0.004	0.10	0.51	0	107.28	0	0	0	0	0	0	0.08	0.024
5.75	0.03	0.70	0	217.60	0	0	0	0	0	0	0.15	0.0028
0	0.18	1.09	0	8.28	0	0	0	0	0	0	0.06	0.0028
21.62	0.22	0	0	1293.48	0	0	0	0	0	0	0.13	0.0021
0	0.13	0	0.007	2.32	0.09	0	0	0	0	0	0.05	0.0021

Table 3. Average results of the physico-chemical parameters measured.

	Total coliforms (/100ml) (0)	Thermotolerants Coliforms (/100ml) (0)	E. Coli (/100ml) (0)	Faecal Streptococci (/100ml) (0)	Clostridia sulfito-reducers (/100ml) (0)
S1	23	23	0	0	none
S2	0	0	0	0	none
S3	0	0	0	0	none
S4	0	0	0	0	none
S5	0	0	0	0	none

Table 4. Average results of the bacteriological parameters measured.

allows us to conclude that these waters are of good potability.

From a bacteriological point of view the results obtained showed that:

- source Ouled Atia (S2), dams Béni Zid and Oum Etoub (S3 and S4), and desalination water (S5) are of good bacteriological quality.

- the Beni Zid (S1) source is of poor quality.

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