Assessment Of The Physicochemical And Bacteriological Quality Of Spring Water In The Wilaya Of Tiaret (Algeria)

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Abstract
The appreciation of the water quality of the surface is based on the measure of physicochemical parameters and the presence or the absence of organizations and watery, indicating micro-organisms of more or less a good quality of water. It is within this framework that this study was undertaken to carry out a diagnosis of the water quality of the sources in the wilaya of Tiaret, by the physicochemical and bacteriological analysis and their comparison for the Algerian lawful standards and those of WHO. Thus, the taking away of water was carried out on the level of 06 sources. This water can generate harmful effects in the natural environment and health hazards for the populations which are in permanent contact and consuming this water without preliminary treatment. Located, generally in agricultural zones where the position risk is high.
At the end of this study, it arises as the near total of the analyzed parameters conforms as well with the national regulation as regards potability of water as to that of WHO.
Indeed, the results obtained on the physical level showed that the pH of this water is correct and their temperature is good. On the chemical level, this water is also in the standards insofar as its hardness, the rate of dissolved salts as well as the contents of chloride are conformed to the national standards. We also note that the contents of the oxidable matter, phosphates, and nitrite are normal. The contents of calcium are normal except for the source of Tiaret (Gattara).
We realize that the contents of Nitrate largely exceed the standards of JORA (2014) in all the sources, except that of Dahmouni.
The microbiological analyzes carried out on the taking away revealed a complete absence of the pathogenic germs and germs of faecal contamination.
Following these results, we conclude that the source of Dahmouni is the only source where one can consume this water without danger and risk to human health.
To secure these risks, the spring waters must be supervised and controlled regularly and must respect the physicochemical and bacteriological limits of quality, fixed by the World Health Organization.

Keywords: Spring water, Physico-chemical Quality, bacteriological Quality, Tiaret.

Introduction

Freshwater constitutes an essential element for the life of men, animals and plants. Having water at disposal in quantity and sufficient quality contributes to the maintenance of health (WHO, 2003). The use of water at food ends or hygiene requires excellent physicochemical and microbiological quality. The drinking water in Algeria comes either from underground sources or from surface water.
Spring water is water with a natural taste that comes from the source. It can be generally drunk with the daily newspaper but is not inevitably free from pollution (Remini, 2010).
The consumption of drinking water is a determining factor in the prevention of diseases related to water. It must thus profit from special attention. Indeed, an intended water human consumption is drinkable when it is free from chemical and/or biological elements likely, in the more or less long run, to harm the health of the individuals (John and Donald, 2010).
Our study relates to the evaluation of the physicochemical and bacteriological quality of spring waters in the wilaya of Tiaret and their comparison for the Algerian lawful standards and those of WHO.
This water, which constitutes an important resource, however, generates harmful effects in the natural environment and health hazards for the populations which are in permanent contact with or consuming this water without preliminary treatment. Located, generally in agricultural zones where the position risk is high.

To secure these risks, the spring waters must be supervised and controlled regularly and must respect the physicochemical and bacteriological limits of quality, fixed by the World Health Organization.

1. Material and methods

1.1. Presentation of the zone of study

Located in the Western North of the country, the wilaya of Tiaret extends on a surface from 20.086,64 km ². It is characterized by a territory made up of mountainous areas in the North, high plains in the centre and steppe space in the South, which enables him to be a zone of contact between the North and the South (DPAT, 2013; DTP, 2013).

Delimited by the coordinates: Latitude: 35.35; Longitude: 1.43; it extends on part of the Tellian Atlas in the North and on the highlands in the centre and the South (DPAT, 2013; DTP, 2013).

According to DHWT (2017), the water tables recognized through the territory of Wilaya conceal important water resources of which 53% are used with the profit of the drinking water supply, irrigation and the food of the production facilities.

The area of Tiaret is rich in hydraulic cover, it is covered by two large basins slopes (fig. 01), namely: Cheliff and Oranian highlands (Mekkakia, 2001).

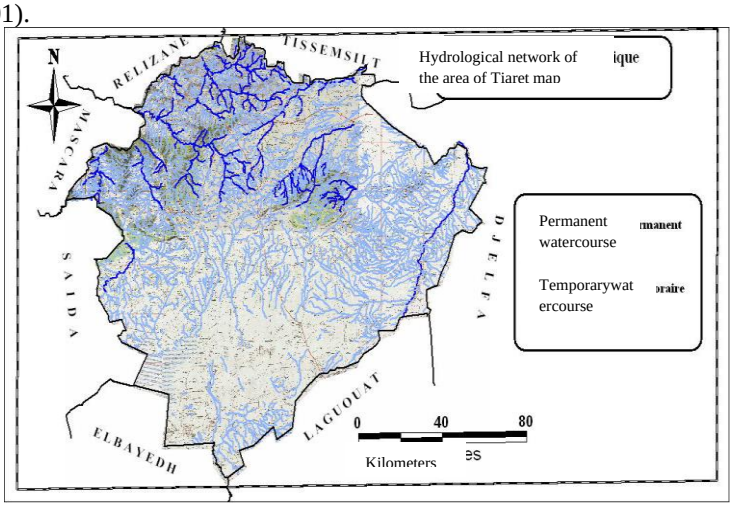

Figure N° 01: Hydrological network of the area of Tiaret (STEP, 2016)

1.2. Sampling and analyzes

After a preliminary investigation into the ground, the sites where take place the test sample selections of water are 06 [1 - Oulad Boughadou, 2 - Dahmouni, 3 - Sidi Hosni, 4 - Sebain, 5 - Mecharef "Melakou road", 6 - Tiaret (Gattara)]. These sources are attended by the inhabitants of the area.

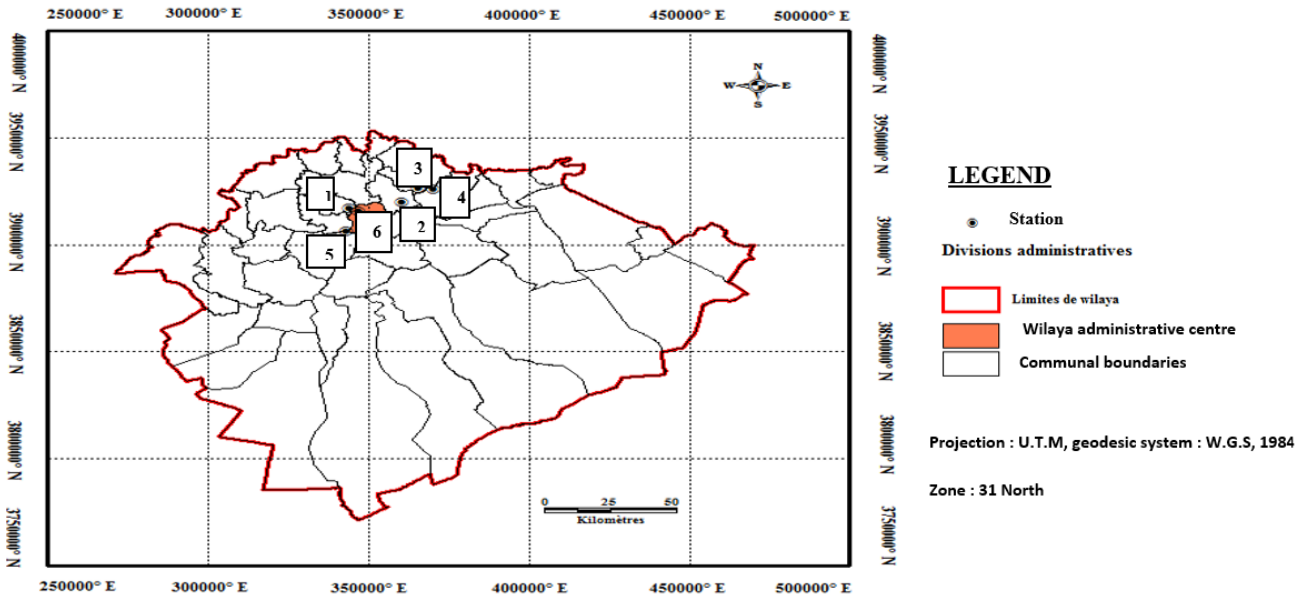

Figure N° 02: Location of different water sources

1- Oulad Boughadou, 2- Dahmouni, 3- Sidi Hosni, 4- Sebain, 5- Mecharef « Melakou road », 6- Tiaret (Gattara)

These sites were selected because of their strong frequency by the population; indeed, they are coveted by the local population with the daily newspaper. The water from these sources is consumed without preliminary treatment and for that, we aimed these sources. The taking away was made the 17/2/2019.

To carry out this sampling, we used disposable plastic bottles. The bottle is emerged at the time of the catch, once filled, it is stopped, labelled and preserved at 4°C. The analyzes of the taken water samples were carried out according to the methods described by Rodier et *al.*, (2009) and take place within 24 maximum hours. With each taking away, the temperature of the water, electric conductivity and pH were measured on the ground using the apparatus's multi-parameter, turbidity. The measurement of hardness (TH) was determined by the method of Mhor, nitrates, nitrites, chlorides and Calcium, magnesium, phosphate and sulphate by the method of spectrophotometry as well as the oxidable matters, nitrogenizes, sulfur and salinity

For the bacteriological analysis, the samples are taken in bottles out of glass, to detect the presence of possible bacteria, such as total coliforms; faecal coliforms and streptococcus faecal ones.

2. Results and discussion

2.1. Bacteriological results

The results of the bacteriological analyzes carried out during our study are represented in the following table.

Table N° 01: Bacteriological result of analysis

sources	Go back to taking away	Coliforms totals	Coliforms faecal	Streptococcus faecal
Oulad Boughadou	2/17/2019	20UFC/100 ml	0 UFC/100ml	0 UFC /100ml
Dahmouni	2/17/2019	0 UFC /100ml	0 UFC/100ml	0 UFC /100ml
Sidi Hosni	2/17/2019	25UFC/100 ml	0 UFC/100ml	0 UFC /100ml
Sebain	2/17/2019	0 UFC /100ml	0 UFC/100ml	0 UFC /100ml
Mecharef (Melakou road)	2/17/2019	10UFC/100ml	0 UFC/100ml	0 UFC /100ml
Tiaret (Gattara)	2/17/2019	0 UFC /100ml	0 UFC/100ml	0 UFC /100ml

We notice that the faecal coliforms are absent completely in all the taken samples. These values remain in conformity with the standards set by JORA (2014) which are < 0 UFC/100 ml. The absence of these bacteria informs the absence of faecal pollution.

According to WHO (2003), faecal coliforms are only in the digestive system of humans and animals. Their presence in natural water and the grounds indicates contamination by manure or faecal water coming from a neighbouring source such as a septic installation, sewages or a park of fattening.

We also note an absence of the total coliforms in the sources of Tiaret (Gattara), Dahmouni and Sebain. This shows that the water of the sampled sources conforms with the Algerian standards and is perhaps to consume without danger.

The total coliforms are bacteria present in the feces and the ground and the vegetation.

On the other hand, we observe the presence of the total coliforms in the sources of Sidi Hosni, Oulad Boughadou and Mecharef (Melakou road), with respectively of 25 UFC/ml, 15 UFC/ml, and 10 UFC/ml.

The total coliforms are not a sign of pollution, these values can be due to contamination of the bottle of taking away or can be with the passage of the animals right before the catch of the taking away. Of this fact, their presence does not indicate necessarily pollution or faecal contamination.

2.2. Physico-chemical results

2.2.1. Temperature

The results of the analysis of temperature, carried out on the water of the various sources, are illustrated in the figure below.

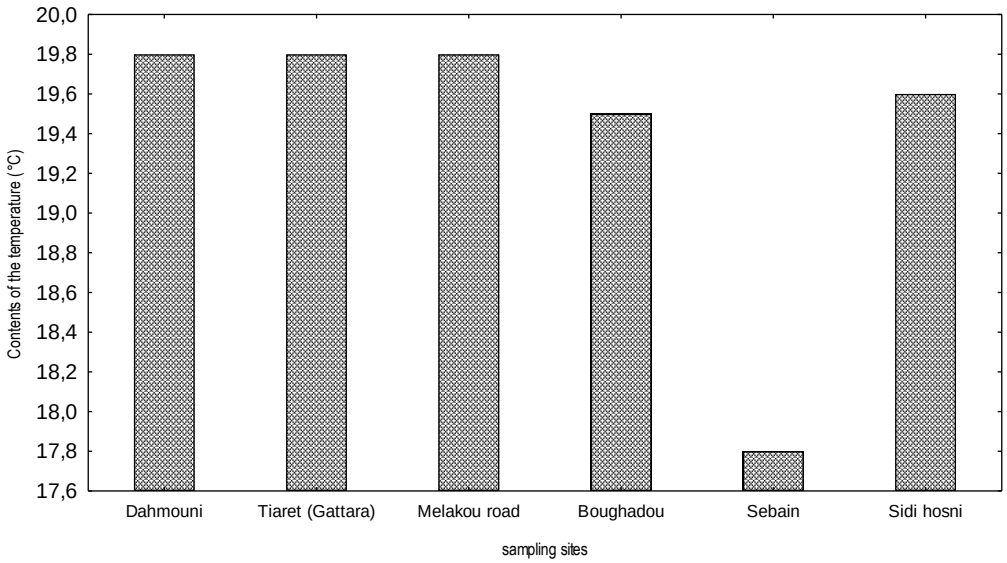

Figure N° 03: Contents of the temperature (°C) in the various studied sources of water

In the studied samples, this parameter presents values ranging between 17,9 °C for the source of sidi Hosni and 17,8 °C For the source of water of Sebain.
According to JORA (2014), the temperature of the water so that it is drinkable does not owe not exceeded 25°C.
Indeed, Chapman (1996) *in* Ghazali and Zaid (2013) announces that the temperature of the water is a big factor in the watery environment because it governs almost the totality of the physical, chemical and biological reactions.
According to Rodier et *al.* (2009), the values of temperature are influenced by the environmental conditions related to the geographical location of the locality, the geology of the crossed grounds, the hydrology of the ecosystem and especially the reigning climate.

2.2.2. Electric conductivity

The results of the electric analysis of conductivity, carried out on the water of the various sources, are illustrated in the figure below.

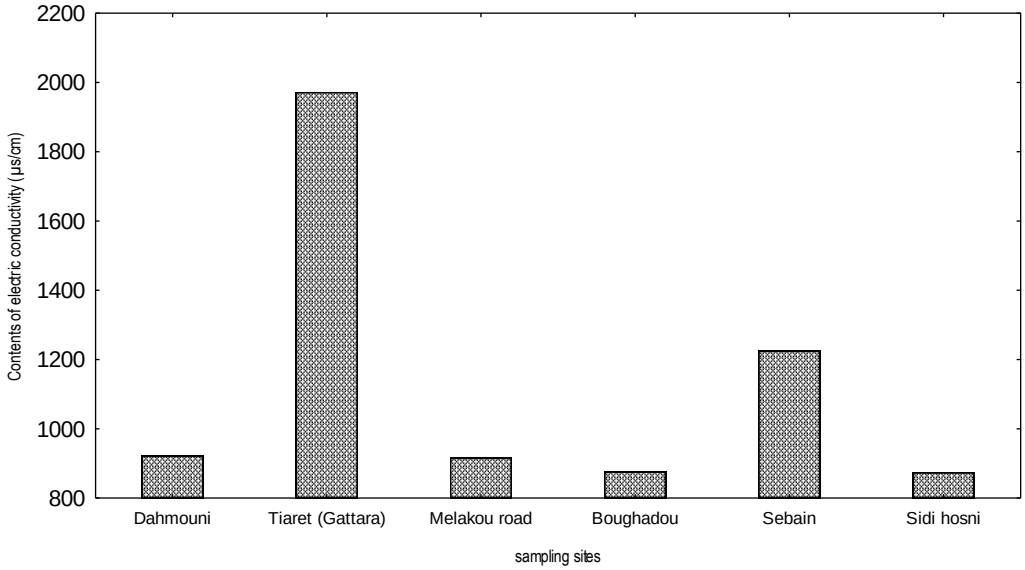

Figure N° 04: Contents of electric conductivity (µs/cm) in the various studied sources of water

Concerning electric conductivity, these contents vary between a minimum value of 874 µs/cm and a maximum value of 1972 µs/cm respectively for the source Sidi Hosni and Tiaret (Gattara).
These values remain always in conformity with the standard of JORA (2014) which of 2800 µs/cm.
According to Rodier et *al.* (2009), conductivity makes it possible to appreciate the degree of mineralization of water insofar as the majority of the dissolved matter in water is in the form of electrically charged ions.

2.2.3. pH

The results of the analysis of the pH, carried out on the water of the various sources, are illustrated in the figure below.

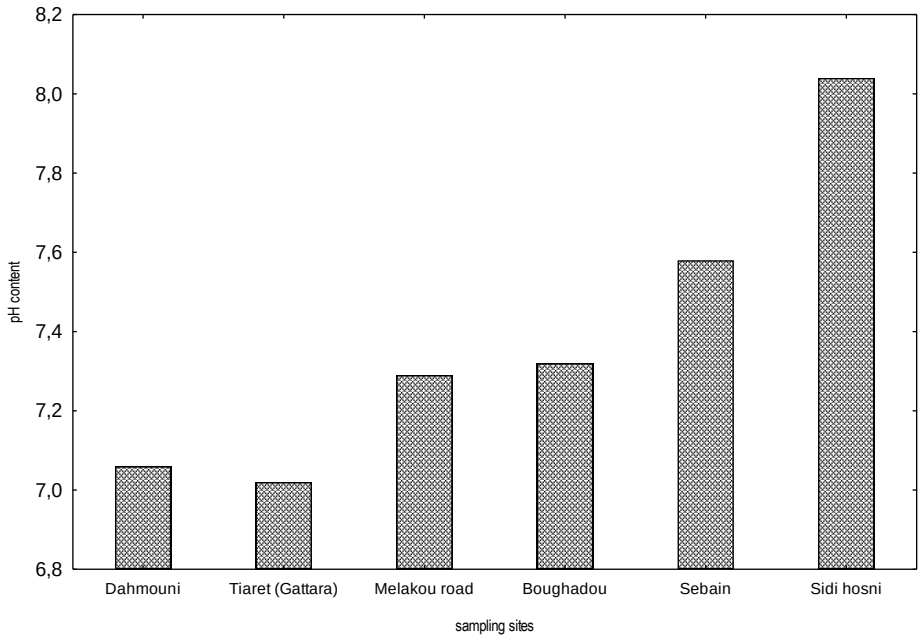

Figure N° 05: Contents of the pH in the various studied sources of water

By examining figure N° 05, we note that the pH of the sources of Sid Hosni, Oulad Boughadou, Mecharef (Melakou road) and Sebain is basic whereas that of the sources of Tiaret (Gattara) and Dahmouni is neutral.
By comparing the results obtained with the Algerian standards, it arises that their pH is normal since it lies between 7,02 and 8,04 whereas that of JORA (2014) is between 6,5 and 9.
In the same way, WHO (2006) declares that there are no value guides but an optimum recorded between 6,5 and 9,5.
The pH is a measurement of the acidity of water, i.e., concentration in hydrogen ions (H^+). The pH of natural water can vary from 4 to 10 according to the acid or basic nature of the crossed grounds. PH weak (acid water) increases in particular the risk of the presence of metals in a more toxic ionic form. PH high increases the ammonia concentrations, which poison the fish (De Villers et *al.*, 2005).
This parameterized is of great importance in biological activity. An acid or basic pH is a direct sign of pollution (Rodier et *al.*, 1984).

2.2.4. Turbidity

The results of the analysis of turbidity, carried out on the water of the various sources, are illustrated in the figure below.

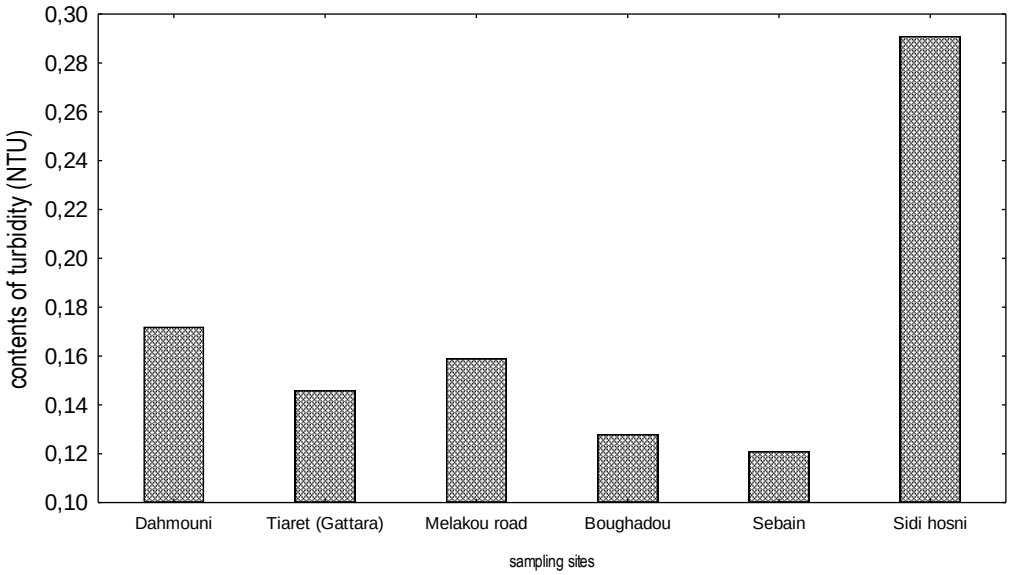

Figure N° 06: contents of turbidity (NTU) in the various studied sources of water

The analysis of figure N° 06 lets appear that the spring water of Sidi Hosni to a value raised in turbidity compared to the other sources, indeed this source records 0,291 NTU whereas the other sources have values oscillating between 0,172 and 0,121 NTU.
Nevertheless, these values remain largely lower than the standards set by JORA (2014) which is of 5 NTU.

2.2.5. Nitrate
The results of the analysis of nitrates, carried out on the water of the various sources, are represented in figure N° 07.

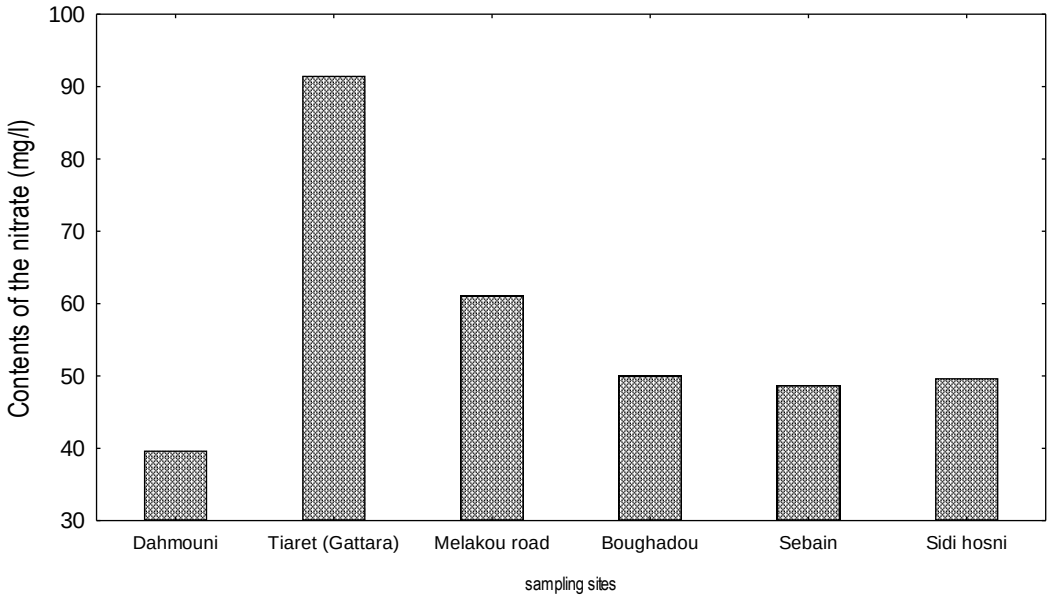

Figure N° 07: Contents of the nitrate (mg/l) in the various studied sources of water

The examination of figure N° 07 makes it possible to note that the water of our sources has a nitrate value that varies between 39,7mg/l and 91, 5 mg/l respectively for the Dahmouni sources and Tiaret (Gattara).
We observe, that the contents of the source of Tiaret (Gettara) and Mecharef (Melakou road) largely exceed the acceptable value by JORA (2014) and the WHO (2006) which is 50 mg/l the recorded contents are 91,5 mg/l and 61,1 mg/l.
The contents of nitrate in the sources of Oulad Boughadou, Sebain and Sidi Hosni are raised and close to the limit fixed by the regulation, indeed, these values are 49,7 mg/l - 48,7 mg/l -50,02 mg/l. of this made these sources must make the object of monitoring strict and prohibit the consumption of this water.
From the results obtained, the studied water is prone to position risk by nitrates except for the source of Dahmouni.
The high contents of nitrate of the source of Tiaret (Gattara) are probably due to the bad condition of the network of cleansing of the cartier where this source is, indeed, the network of cleansing of this last dates from the colonial period, badly maintained causing the contamination of the source as well as the contamination several then in this cartier.
Whereas the sources of Mecharef (Melakou road), Boughadou and Sidi Hosni are localized in agricultural zones or the farmers use nitrate fertilizers.
The nitrates are present in water by scrubbing of the products nitrogenized in the ground, by decomposition of the organic matters or manures of synthesis or natural (Belghiti et *al.*, 2013).

2.2.6. Nitrite
The results of the analysis of nitrites, carried out on the water of the various sources, are represented in the following table.

Table N° 03: Contents of the nitrite (mg/l) in the various studied sources

Sources	**Contents of nitrite**
Dahmouni	< 0,02 mg/l
Tiaret (Gattara)	< 0,02 mg/l
Mecharef (Melakou road)	< 0,02 mg/l
Oulad Boughadou	< 0,02 mg/l
Sebain	< 0,02 mg/l
Sidi Hosni	< 0,02 mg/l

The examination of table N° 03, indicates that the concentration of nitrite is almost null (< 0,02 mg/l) in all the analyzed samples. This shows that our sources are far from all nitrite contributions and do not exceed the standards of JORA (2014) and the WHO (2006) which is fixed at 0,2 mg/l.
The nitrites come either from incomplete oxidation from ammonia and nitrification not being led to its term or from a reduction of nitrates under the influence of an action denitrifying (Rodier et *al.*, 2009).

2.2.7. Phosphates

The results of the analysis of phosphate are illustrated in the N°04 table.

Table N° 04: Contents of the phosphate (mg/l) within the various sources

Sources	Contents of phosphate
Dahmouni	< 0,02 mg/l
Tiaret (Gattara)	< 0,02 mg/l
Mecharef (Melakou road)	< 0,02 mg/l
Oulad Boughadou	< 0,02 mg/l
Sebain	< 0,02 mg/l
Sidi Hosni	< 0,02 mg/l

In all our samples the concentration of phosphate is almost null (< 0,02 Mg /l). These values remain lower than the standard set by the JORA (2014) and the WHO (2006) which respectively 400 mg/l and 500 mg/l.

The grounds where our sources are grounds rich person phosphates that of it explains the weak content of phosphate in water. Indeed, the phosphates belong to the anions easily fixed by the ground; their natural presence in water is related to the characteristics of the crossed grounds and the decomposition of organic matter (Rodier et *al.*, 2009).

According to Rodier et *al.* (2009), contents higher than 0,5 Mg /l constitute an index of pollution, therefore our water is not prone to pollution by phosphates.

2.2.8. Calcium

The results of the analysis of calcium, carried out on the water of the sources, are illustrated in the figure below.

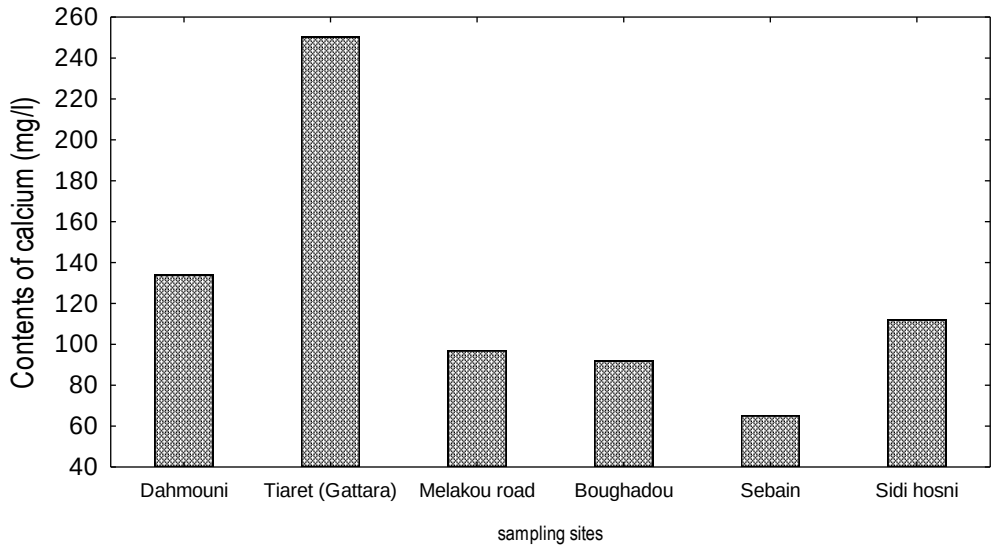

Figure N° 08: Contents of calcium (mg/l) in the various studied sources of water

The analysis of figure N° 08, makes it possible to notice that the calcium contents oscillate between a minimal value of 65,2 mg/l recorded in the Sebain source and a maximum value 250,4 mg/l recorded in the Tiaret (Gattara) source.

We note, that the contents of calcium in all the sources are lower than the standard set by JORA (2014) which is 200 mg/l; except for the source of Tiaret (Gattara) which has contents exceeding this standard, indeed these contents are 250,4 mg/l.

Calcium is an earthy alkaline metal extremely answered in nature and in particular in the rocks limestones in the form of carbonates. It is a component major of water hardness (Rodier et *al.*, 2009).

According to Lechaari (1990), the existence of this element in water originates in the dissolution of the carbonated and gypseous formations.

2.2.9. Magnesium

The results of the Magnesium analysis, are illustrated in figure N° 09.

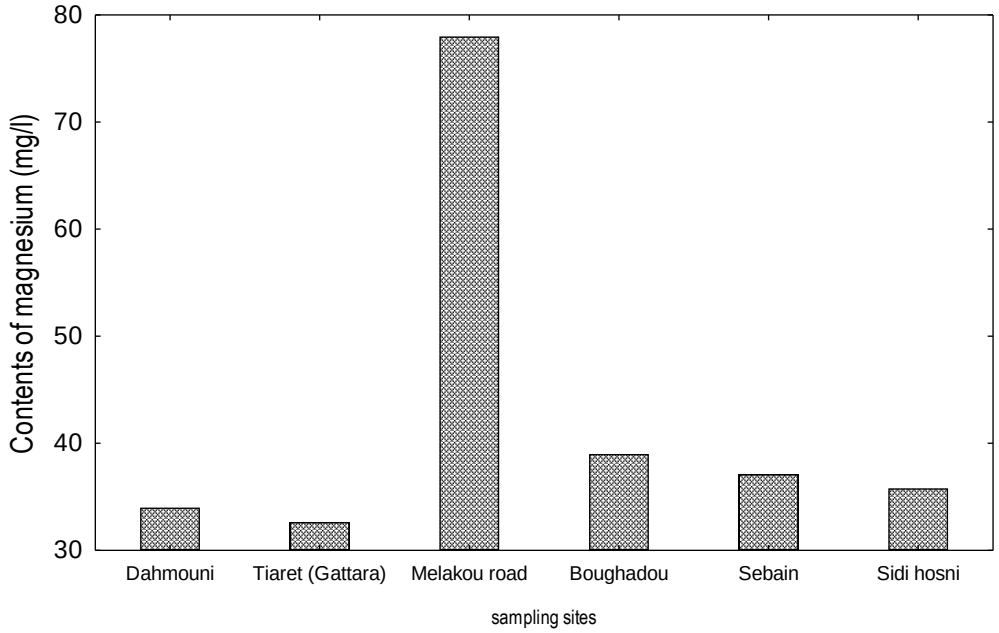

Figure N° 09: Contents of magnesium (mg/l) in the various studied sources of water

Figure N° 09 indicates that the whole of our sources has contents of magnesium ions which vary between 32,64 mg/l Tiaret (Gattara) and 78 mg/l (Mecharef « Melakou road»).
We notice that all the sources conform with the Algerian standard (2014) which is 50 mg/l, except the source of Mecharef (Melakou road) which has contents that exceed the Algerian standard of 78 mg/l.
Magnesium is one of the most widespread elements in nature; it constitutes approximately 2,1% Earth's crust whose majority of its salts are very water-soluble. Its content depends of the composition of the sedimentary rocks met (Rodier et *al.*, 2009).
According to Dib (2009), the variation of magnesium in water is due to the dissolution of the formations carbonated such as limestones of a part and the formations sulphuretted of another part like clays and the navy which is rich in Mg^{+2}.

2.2.10. Chloride

The results of the analysis of Chloride, are illustrated in the figure below.

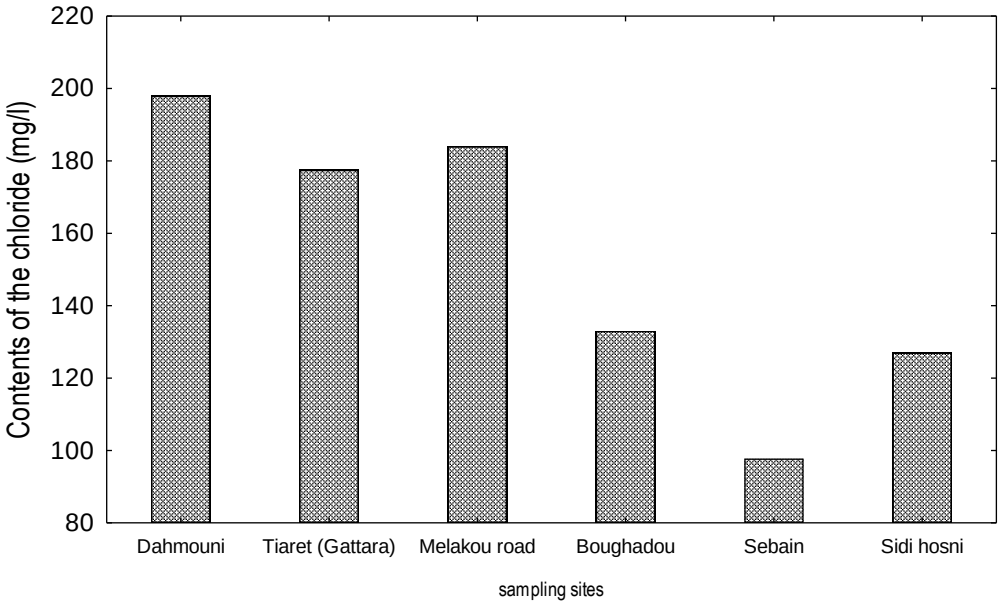

Figure N° 10: Contents of the chloride (mg/l) in the various studied sources of water

The examination of figure N° 10, watch that the contents of chloride oscillate between 97,8 mg/l (Sebain) and 198 mg/l (Dahmouni).
These contents, in the whole of the sources, are lower than the limits fixed by JORA (2014) which are 500 mg/l.
The chloride gives a bad taste to water. Indeed WHO (2006), indicates that there is no limiting value but one can note a taste starting from 250 mg/l.

2.2.11. Oxydable matters

The results obtained from the analysis of the oxidable matter are represented in the following figure.

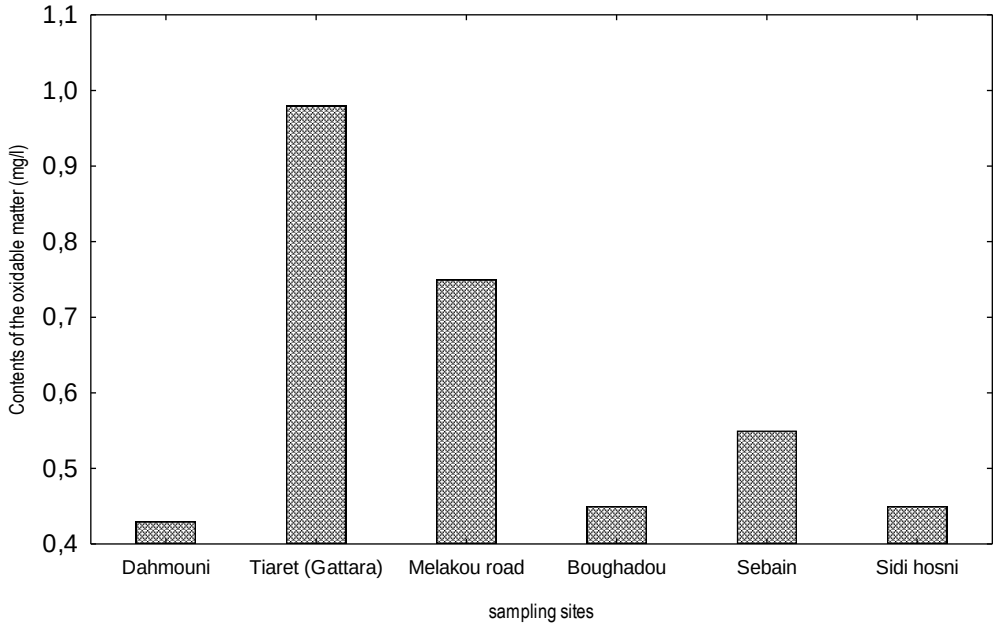

Figure N° 11: Contents of the oxidable matter (mg/l) in the various sources of water

We observe, in the figure above, that the oxidable matter rate varies between 0,43 mg/l (Dahmouni) and 0,98 mg/l (Tiaret (Gattara).

Our results corroborate with those fixed by the Algerian legislation (JORA, 2014) which is limited to 5 mg/l.

2.2.12. Sulphate

The results obtained from the analysis of sulphate are represented in the following figure.

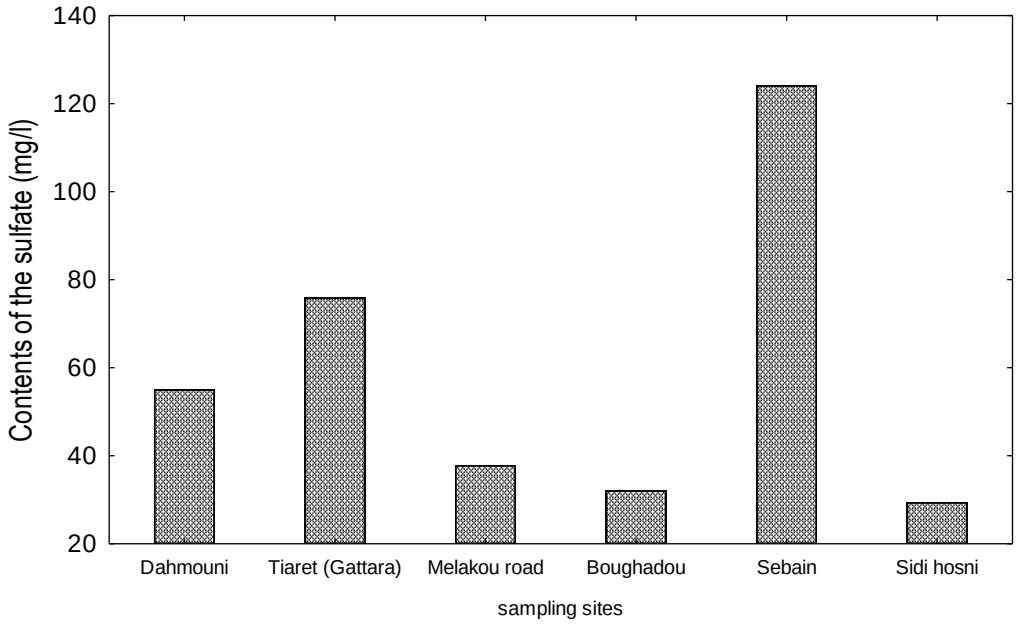

Figure N° 12: Contents of the sulphate (mg/l) in the various studied sources of water

From the analysis of figure N° 12, let's appear that the highest content of sulphate of 124,1 mg/l is recorded in the source of Sebain whereas the lowest content recorded in the source of Sidi Hosni is 29,4 mg/l.

These contents remain largely lower than the Algerian standards (2014) which are 400 mg/l and 500 mg/l for WHO (2006). According to Rodier et *al.* (2009), the presence of sulphate gives a bad taste to water.

2.2.13. Ammonium

The results of ammonium analysis carried out on the samples are illustrated in the table below.

Table N° 05: Contents (mg/l) of ammonium within the various sources

Sources	Ammonium contents
Dahmouni	< 0,02 mg/l
Tiaret (Gattara)	< 0,02 mg/l
Melakou road (Mecharef)	< 0,02 mg/l
Oulad Boughadou	< 0,02 mg/l
Sebain	< 0,02 mg/l
Sidi Hosni	< 0,02 mg/l

In all our samples the ammonium concentration is almost null (< 0,02 Mg /l). These values remain lower than the standard set by the JORA (2014) which of 0,5 mg/l (Table N° 05).
Generally, its presence represents an incomplete degradation of the organic matter (Danel, 2017).
According to Rodier et *al.* (2009), contents higher than 0,5 Mg /l constitute an index of pollution, of this fact our water is not contaminated by ammonium pollution.

2.2.14. Total hardness
The results obtained from the analysis of total hardness are represented in the following figure.

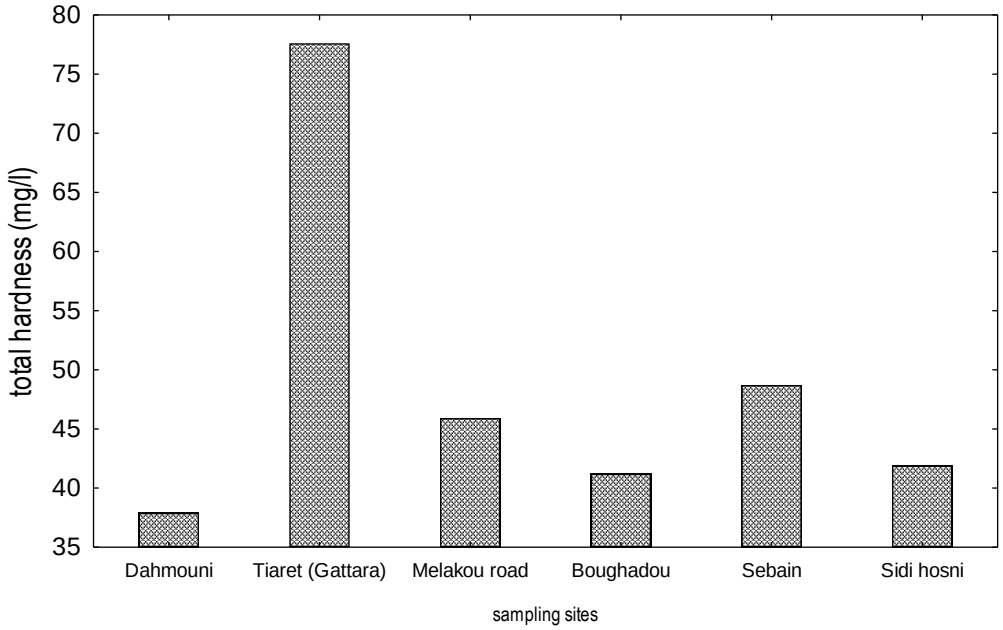

Figure N° 13: Contents of total hardness (mg/l) in the various sources of water

We note, from the N°13 figure, that the rate of total hardness varies between 37,9 mg/l (Dahmouni) and 77,6 mg/l (Tiaret « Gattara »).
Our results of the analysis carried out are all lower than the standard set by the Algerian legislation (JORA, 2014), which is limited to 500 mg/l and that of the WHO (2006) which fixed at 200 mg/l.

Conclusion
At the end of this study which related to a diagnosis of the water quality of sources of the area of Tiaret, it arises as the near total of the analyzed parameters conforms as well with the national regulation as regards the potability of water that of WHO.
Indeed, the results obtained on the physical level showed that the pH of this water is correct, its degree of mineralization is average and its temperature is good.
On the chemical level, this water is also in the standards insofar as its hardness is relatively high but without risk to the health of the consumer, the rate of dissolved salts as well as the contents of chloride are conformed to the national standards.
We also note that the contents of the oxidable matter, phosphates and nitrite are normal. The contents of calcium are normal except for the source of Tiaret (Gattara).
We realize that the contents of Nitrate largely exceed the standards of JORA (2014) in all the sources, except that of Dahmouni, the nitrate is known for its harmful effect on health.
The microbiological analyzes carried out on the taking away revealed a complete absence of the pathogenic germs and germs of faecal contamination.
The various analyzes (physicochemical and bacteriological) carried out during this work on various spring water of the area of Tiaret (Dahmouni, Tiaret (Gattara), Mecharef (Melakou road), Oulad Boughadou, Sebain and Sidi Hosni) show

that the source of Dahmouni is the only source where one can consume this water without danger and risk for the human health.

It would be desirable to carry out this type of study regularly founded on the physicochemical evaluation but while consolidating with bacteriological analyzes.

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