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Physico-Chemical Quality of Consumer Waters in N'djamena

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ABSTRACT

Water plays an essential role in the life of all living beings. In the Chadian capital, the population consumes tap water, drilling water, wells and mineral water. For human consumption, water must meet certain criteria or standards. And this is to ensure that we have carried out the physicochemical analyses of the network water, drilling and wells waters consumed by the inhabitants of the city of N'Djamena, the capital of Chad. Physical parameters such as pH, electrical conductivity, turbidity and concentrations of chlorides, phosphates, sulfates, nitrates, nitrites, bicarbonates, sodium, potassium, calcium, magnesium, iron, lead, manganese, nickel, copper, zinc were determined. The water analyzed concerns eleven (11) sites of the Chadian Water Network (STE), three wells in three boroughs, four boreholes in four boroughs and four mineral water production companies. The results show that all the physical parameters of the water are good for the STE network, wells, boreholes and mineral waters with the exception of the turbidity of certain wells (Walia, 100 NTU and Sabangali, 78 NTU). Superior concentrations of the following species were observed: Mg^{2+} = 138.8 ± 2.6mg/L and Fe^{3+} = 3.08 ± 0.06mg/L for the Walia well; Mg^{2+} = 76.5 ± 0.8 mg/L and Fe^{2+} = 0.50 ± 0.03mg/L for the Moursal well: Mg^{2+} = 70.9 ± 0.9 mg/L and Fe^{2+} = 2.89 ± 0 , 08) for the Sabangali well; Fe^{2+} = 1.84 ± 0.09mg/L for the drilling of Walia; Na^{+} = 75.0 ± 0.2mg/L and Na^{+} = 35.0 ± 0.2mg/L for mineral waters Zam Zam and Dala respectively; NO^{2-} = 4.00 ± 0.20 mg/L for mineral water Dala. Finally, abnormally high concentrations of lead were found in the STE network waters of some districts: FSEA (0.21 ± 0.02mg/L), Farcha district (0.15 ± 0.02 mg/L), School (0.10 ± 0.01mg/L), as well as in the drilling waters of the Ardepdjoumal district (1.42 ± 0.04mg/L) compared to the WHO international standard (0.05mg/L). This study shows that the population of the city of N'Djamena in its majority consumes water of rather poor quality, to say the least.

1. INTRODUCTION

The city of N'Djamena, capital of Chad, is an agglomeration often municipal districts with a population estimated at more than one million and located at the confluence of the Chari and Logone rivers. N'Djamena is located between $12^0$30 and 12°128 north latitude and between 14°50 and $15^0$100 east longitude. The climate is Sahelian and the average annual temperature is 28^0C. The average depth of the water table in N'Djamena is around 40m. However, the depth of the wells rarely exceeds 25 m.

The source of freshwater is limited but it is susceptible and vital resource for life, and development of the environment. According to the National Institute of Statistics and Development (NISEED), less than 50% of the Chadian population has access to drinking water. We take into account here the network water distributed by the Société Tchadienne des Eaux (STE), water from wells (with human power or with submerged pump) and wells developed.

The data collected on the quality of surface water of some rivers of Chad. These data include the work of Ngaram *et al*. (2011), Tchoroun *et al*. (2015), Hissein *et al*. (2015), Tchadanaye *et al*. (2016). Unfortunately, literature on water consumed by the population of N'Djamena is insufficient Mohagir *et al*. (2008). We know that the polluted water is cause of various diseases such as diarrhea, intestinal worms, typhoid fever, cholera etc. According to WHO (2011) the heavy metals (Pb, Hg, Cd) present in the water responsible for slowly killing. Water pollution also carried by various origins such as industrial, household, agricultural, slaughterhouse, etc., Scalon *et al*. (2005), El-Naqa *et al*. (2007), Eblin *et al*. (2014) or by infiltration. Given the state of their stock, the population of N'djamena consumes either mineral water, STE water, drilling water, or simply well water. The aim of this work is to determine the physicochemical quality of the water consumed by the inhabitants of the capital of Chad in order to ensure their quality. The analysis was carried out in 2007 -11.

2. EQUIPMENT AND METHODS

2.1 Study Environment

The city of N'Djamena (Fig. 1) comprises ten districts ranging from the first to tenth. The water network is distributed in the city by the Chadian Water Corporation (STE). It is important to note that only the old boroughs (from the 1^{st} to 7^{th}) have access to mains water. Specified irregularity of the water supply to the town by the STE, some inhabitants of

N'Djamena resort to drilling, underwater electric or human pumps. On the other hand, the less well dig well of the wells of which they reinforce the walls with iron casks. The districts of the boroughs which are the points of sampling of the water samples and which were the subject of our study are counted below:

1) Farcha and Faculty of Exact and Applied Sciences (FEAS) of the University of N'Djamena (1st arrondissement): network water.

2) Béguinage, (2nd arrondissement): network water.

3) Sabangali, Kabalaye and Ardepdjoumal (3rd Arrondissement): network water, drilling and wells waters

4) Center School, Main Market, Millet Market and Rest district (4th Arrondissement): network water

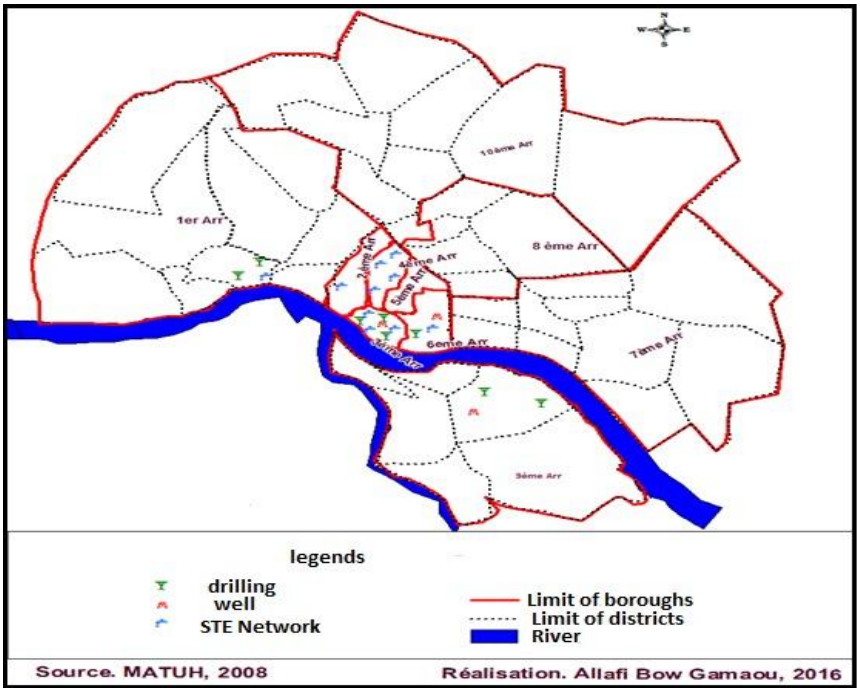

Figure 1: Sampling map in the city of Ndjamena

5) Moursal (6th Arrondissement): network, drilling and wells waters.

6) Walia (9th Arrondissement): drilling and well waters.

2.2 Sampling and Conservation

The water samples are taken from PVC bottles (polyvinyl chloride) previously washed with soap, rinsed with distilled water and dried at ambient temperature. The water from the wells is drawn from a bucket and placed in bottles. Each site was the subject of at least three catches. The date, time and place of sampling are recorded on each bottle. All samples are transported to the laboratory in coolers and stored at 4°C.

2.3 Physico-chemical analysis

The analysis was performed according to the techniques recommended in "Water Analysis" (Rodier 1996) and parameters such as temperature, pH, and conductivity was determined on site.

Sampling using the WTW 315i / SET conductivity meter, EUTECH Instruments p^H 510 and WTW pH / 330 / SET-1 p^H meter. The hardness and turbidity were determined, respectively, using a HACH digital titrimeter and a HACH 2100P turbidimeter. Measurements of the alkali and alkaline earth metals were carried out using the ELVI 655 and JENWAY flame photometers. Other parameters studied include anions, nitrates, nitrates, sulfates, phosphates, chlorides, fluorides, hydrogen carbonates and heavy metals: lead, manganese, nickel, chromium, zinc, copper and iron. These parameters were analyzed using a HACH DR / 2400 spectrophotometer, an atomic absorption spectrometer (AAS) and an ion chromatography.

3. RESULTS AND DISCUSSION

The results of the analysis of the network waters of the STE, the wells and drilling, as well as the mineral waters are presented in Tables 1, 2 and 3 respectively.

Table 1: STE Network Water

	Beguinage	Ardep	Kaba-laye	FSEA1	Marché (raw water)	Grand Marché	Centre (raw water)	Centre	Farcha	FSEA2	Moursal
Temp. (^0C)	29,8 ± 0,2	29,5 ±0,3	29,3 ± 0,3	31,3 ± 0 3	28,2 ± 0 ,1	25,3 ± 0 ,0	27,0 ± 0,2	26,0 ± 0,1	32,6 ± 0,2	23,0 ± 0,3	32,2 ± 0,2
pH	6,70 ±0,11	6,95 ±0,21	6,90 ±0,15	6,88 ±0,17	7,43 ±0,22	7,44 ±0,21	6,71 ±0,21	7,44 ±0,16	7,10 ±0,19	7,42 ±0,22	7,11 ±0 ?10
Conduc (µS)	58,0 ±0,1	69,6 ±0,3	88,5 ±0,4	58,5 ±0,4	90,0 ±0,5	89,5 ±0,7	49,1 ±0,3	49,5 ±0,4	61,1 ±0,4	46,1 ±0,2	109,4 ±0,5
Turbid. (NTU)	0	0	0	1	0	1	0	0	-	-	1
Ca (mg/L)	48,1 ±0,3	37,2 ±0,3	63,2 ±0,1	37,3 ±0,4	101,é ±0,7	76,1 ±0,5	62,3 ±0,5	47,2 ±0,3	23,6 ±0,1	22,0 ±0,2	24,0 ±0,0
Mg (mg/L)	30,4 ±0,3	14,3 ±0,1	9,1 ±0,2	25,3 ±0,1	11,3 ±0,1	25 ,5 ±0,6	3,2 ±0,1	12 7 0,5	3,6 0,3	3,6 ±0,4	6,0 ±0,2
NO_2^- (mg/L)	0,013± 0,002	0,017± 0,005	0,210± 0,008	0,240± 0,006	0,016± 0,004	0,008± 0,002	0,003± 0,001	0,022± 0,003	0,002± 0,001	0,002± 0,000	0,005± 0,001
NO_3^- (mg/L)	1,2±0,0	1,2±0,4	1,8±0,2	3,0±0,2	0,4±0,1	0,8±0 2	0,1±0,0	0,2±0,0	0,0±0 0	0,0±0,0	0,0±0,0
SO_4^{2-} (mg/L)	2,0±0,2	8,4±0,3	9,5±0,5	4,4±0,1	8,4±0,2	3,0±0,2	1,1±0,0	1,0±0,0	1,1±0,0	1,0±0,1	12,4±0 2
PO_4^{2-} (mg/L)	0,08 ±0,02	0,08 ±0 01	0,10 ±0,01	0,14 ±0,04	2,22 ±0,03	2,75 ±0,03	2,24 ±0,05	2,76 ±0 ,05	1,47 ±0,03	0,56 ±0,02	0,92 ±0,02
Fe (mg/L)	0,02 ±0,01	0,07 ±0,01	0,40 ±0,02	0,01 ±0,00	0,10 ±0,03	0,40 ±0,04	0,13 ±0,02	0,60 0,04	0,01 ±0,00	0,01 ±0,00	
Pb (mg/L)					0,01 ±0,00	0,08 ±,0,00	0,00	0,10 ±0,01	0,15 ±0,02	0,21 ±0,02	

Table 2: Well and Drilling Waters

	WELL WATER			DRILING WATER				
	Moursal	Walia	Sabangali	Atrone	Ardepdjoumal	Walia	Moursal	WHO Stand.
T⁰C	28,0±0,2	28±0,1	28,0±0,1	28,0±0,1	29,1±0,3	28,3±0,2	27,0±0,1	
pH	6,90±0,05	5,10±0,07	6,40±0,08	7,15	7,20	6,13	7,30	6,5-8,5
Cond. (µS)	29,6±0,3	11,3±0,5	43,5±0,8	69,6±0,4	51,5±0,9	28,0±1,2	27,2±0,9	400
Tur Turbidity NT NTU	1	100	78	1	1	9	2	5
Ca, mg/L	34,2±0,3	32,1±0,4	40,4±0,8	50,1±1,2	16,2±0,9	8,8±0,9	12,4±0,5	100
Mg,mg/L	76,5±0,8	138,8±2,6	70,9±0,9	20,7±0,6	30,5±0,9	22,3±1,0	18,9±0,9	5-50
NO_2^-, mg/L	0,260 ±0,01	0,086 ±0,009	0,022 ±0,010	0,014 ±0,009	0,054 ±0,011	0,015 ±0,008	0,057 ±0,010	0,1
NO_3^-, mg/L	7,20 ±0,09	0,13 ±0,05	9,30 ±0,09	1,40 ±0,05	0,22 ±0,09	0,00	0,70 ±0,07	10
SO_4^{2-}, mg/L	16,0±0,7	0,00	10,0±1,0	0,0	2,0±0,5	1,0±0,3	1,0±0,2	250
PO_4^{2-}, mg/L	2,80±0,12	2,31±0,09	4,21±0,15	0,84±0,08	1,30±0,09	0,9 5±0,05	1,22±0,08	5

Table 3: Mineral Waters

	Tangui		Zam-Zam		Cristal		Dala		WHO
	Experi-mental	label	Experi-mental	labe l	Experi-mental	label	Experi-mental	label	Stand
pH,	6,80±0,11		7,80±0,3		7,50±0,11		8,31±0,2		6,5-8,5
Cond. µS	69,4±0,2		53,1±0,3		37,0±0,2				400
Na, mg/L	5,0±0,2	1	75,0±0,2	14	15,0±0,1	12	35,0±0,2	34	30
K mg/L	2,5±0,1	10	1,5±0,2	8		4	1,0±0,1		12
T Ca mg/L	7,2±0,4	32	4,8±0,2	34		16	6,6±0,4	56	100

3.1 Physical Parameters

The mean values of the physical parameters are shown in Fig. 2, 3 and 4

Temperature

The temperature of the water plays an important role in the solubility of salts and gases, including oxygen. Moreover, the temperature increases the rates of chemical and biochemical reactions. According to the classification of drinking water in relation to temperature in the drinking water standards set by WHO (1994), all the water distributed by the STE network, the water from the wells and boreholes have temperatures above 25°C., taking account of the ambient temperature (Tables: 1,2). These values are of course superior to those of water consumed in the town of Annaba in Algeria reported by Kahoul *et al*. (2014).

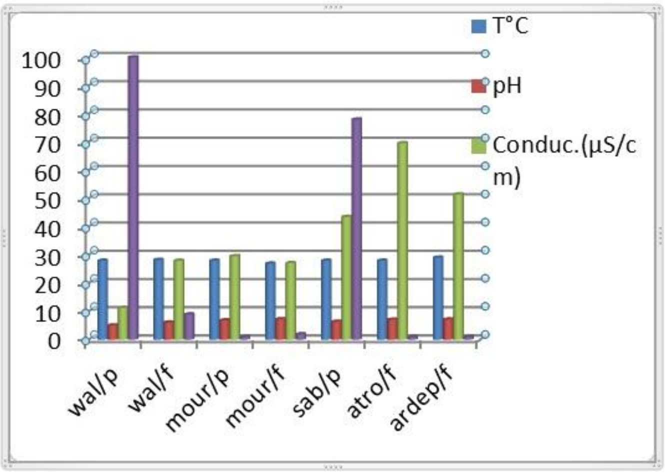

Figure 2: Physical Parameters of Well and Drilling waters

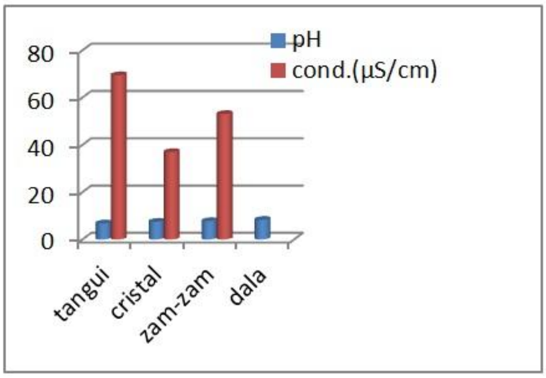

Figure 3: Physical Parameters of mineral

Hydrogen Potential

The acidity or basicity of the water generally poses no problem with respect to the health of the consumer provided that its p^H is between 6.5 and 8.5. Below (acid water) and beyond (basic water) of these values, the consumption of water in the long term can cause worries. Thus, the waters of Walia wells and boreholes are somewhat acidic (p^H: 5.10 ± 0.13 - 6.13 ± 0.12). The pH of the well and borehole waters of the Moursal neighborhood is neutral: 6.90 ± 0.12 - 7.30 ± 0.01 For STE water, the p^H is globally neutral, ranging from 6.70 ± 0, 11 (Beguinage) to 7.44 ± 0.15 (Center School, Grand Marché). As for mineral waters, their p^H is also generally neutral: 6,80 ± 0,11 (Tangui), 7,80 ± 0,30 (ZAM ZAM), 7,50 ± 0,11 (Crystal) and 8, 31 ± 0.20 (Dala). Referring to the Chadian regulations (Decree 2010) and the WHO standard (1994), we can say that the p^H of the water consumed in N'Djamena is globally acceptable.

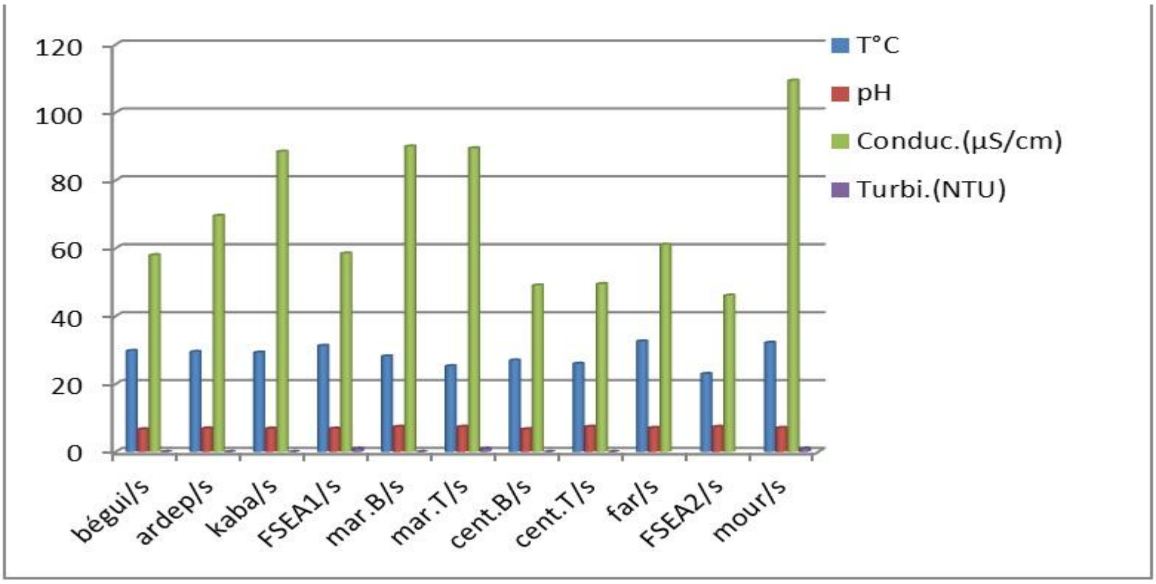

Figure 4: Physical parameters of STE water

Electrical Conductivity

Conductivity makes it possible to assess the degree of mineralization of water because most of the dissolved matter in water is in the form of electrically charged ions, Rodier (2009). This size generally indicates the total concentration of the ionic species present in the water. In well water, the electrical conductivity varies from 11.3 ± 0.5µS (Walia) to 43.5 ± 0.8µS (Sabangali); For drilling, it is between 27.2 ± 0.9µS (Moursal) and 69.6 ± 0.4µS (Atrone); And for mineral waters it varies from 37.0 ± 0.2 µS/cm (Crystal) to 69.4 ± 0.2 µS/cm (Tangui). The WHO standard being 400 µS, it appears clearly that all water consumed in the city of N'Djamena has very little mineralization. Higher values (300 µS/cm to 800 µS/cm) have been reported by Kahoul *et al*. (2014) for water consumed in the city of Annaba and (600 to 2000 µS/cm) for good water in the Berrahal region of Algeria. Finally, Lagnika et al. (2014) obtained the following values: 74-538 µS/cm for good water.

3.2 Alkaline Earth Metals and Iron

These parameters are related to the natural composition of the water and are, given their concentrations and, to varying degrees, responsible for its quality. Their mean concentrations are shown in Fig. 5, 6 and 7

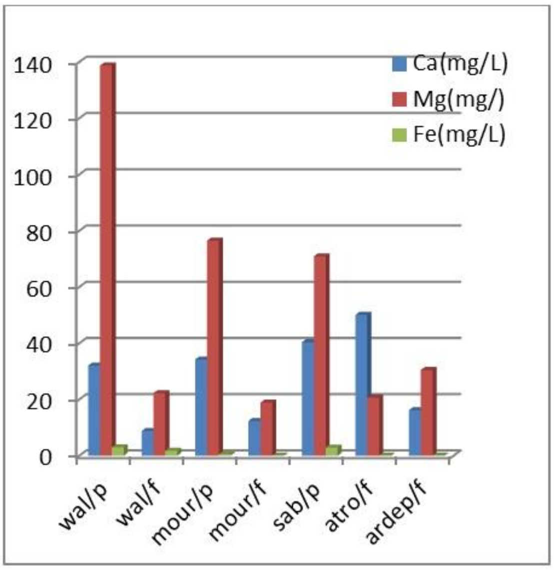

Figure 5: Metals in Wells and Drilling waters

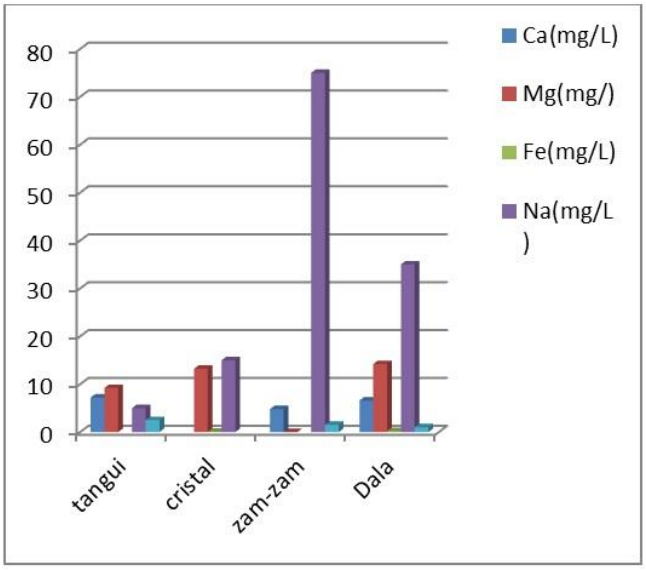

Figure 6: Metals in mineral waters

The Alkalines

We are particularly interested in sodium and potassium. All natural water contain these elements in the form of Na^+ and K^+ cations. These are minerals that ensure good blood osmosis. In very high amounts in the body, sodium causes hypertension. Conversely, a very low level of sodium can cause dehydration. A lack or excess of potassium can cause cardiac arrest.

According to our analysis, the concentrations of alkali metals in mineral water are below the maximum allowed, 150mg/L for sodium and 12mg / L for potassium. These results are similar to those obtained by Bricha *et al*, (2007)

The Alkaline Earth Metal

These are mainly magnesium and calcium, all natural water contain calcium and magnesium. These elements contribute significantly to water hardness and have no impact on health (AWWA 2005, Rodier *et al*. 2009). But hard water is the source of some inconvenience for users: scaling of appliances in which water is heated, skin and hair dry, increased consumption of soap and detergents Kahoul and Touhami (2014). Calcium is generally the dominant element of drinking water and its content varies essentially according to the nature of the lands traversed (limestone or gypsum), Rodier *et al.* (2009). In the wells water, calcium concentrations ranged from 32.1 ± 0.4mg/L (Walia) to 40.4 ± 0.8mg/L (Sabangali); In boreholes, from 8.8 ± 0.9mg/L (Walia) to 50.1 ± 1.2mg/L (Atrone);

In the waters of the STE network, from 22.0 ± 0.2mg/L (FSEA2) to 101.2 ± 0.7mg/L (Grand Marché, raw water); In mineral waters they range from 3.3 ± 0.1mg/L (Crystal) to 7.2 ± 0.4mg/L (Tangui). These data are therefore well below the maximum set by the WHO (100mg/L), except raw (untreated) water from the STE (Grand Marché). Similar data have been published by Kahoul *et al*. (2014).

For magnesium, the content of this metal in well water varies from 70.9 ± 0.9mg/L (Sabangali) to 138.8 ± 2.6mg/L (Walia); it ranges from 18.9 ± 0.9mg/L (Moursal) to 30.5 ± 0.9mg/L (Ardep-djoumal) in boreholes water, and from 3.2 ± 0.1mg/L (Center School) to 25.3 ± 0.1 mg / L (FSEA1, Grand Market) for STE waters. We find that well water has very high concentrations of magnesium, which would probably be related to the nature of the land concerned. Lagnika, *et. al*. (2014) obtained lower values for Pobé wells in Benin (5.81 - 22.92 mg/L). Finally, for mineral water, the magnesium content is fairly low, ranging from 0.0mg/L (Zam-Zam) to 14.2 ± 0.9mg/L (Dala). All magnesium concentrations are below WHO standards (50mg/L), with the exception of those for wells (Tables 1, 2, 3).

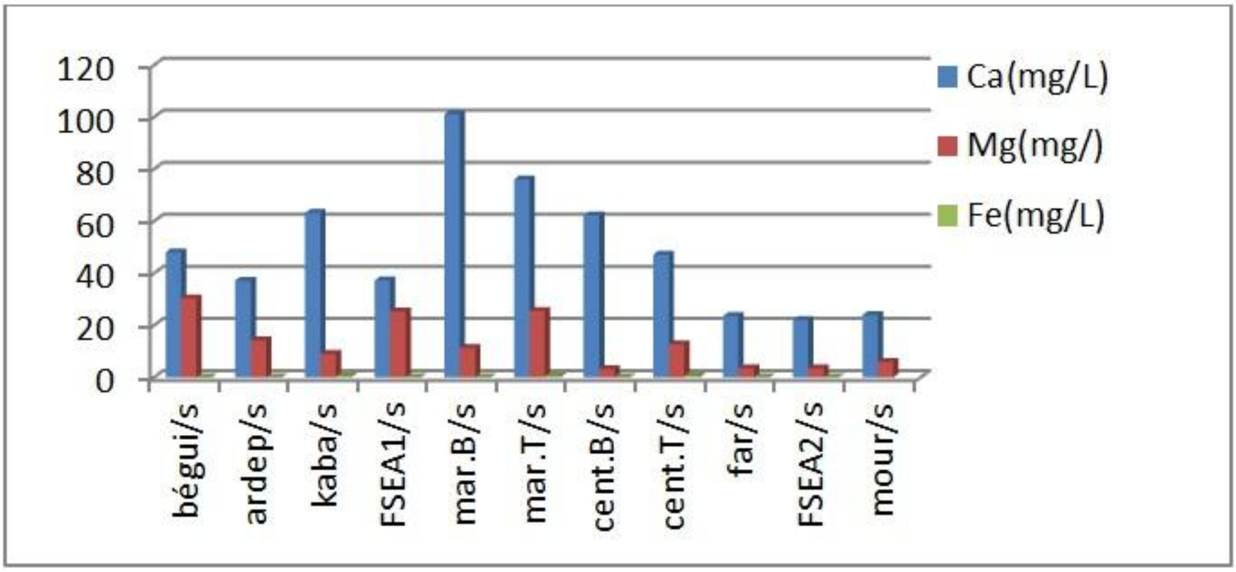

Figure 7: Metals in waters of the STE network

The Iron

Its presence in water is of natural origin. Iron is indispensable to the functioning of the human body (synthesis of blood hemoglobin). However, in water, this metal can promote the proliferation of certain strains of bacteria that precipitate iron or corrode the pipes. The presence of iron in water above 0.1 mg/liter is detrimental: metallic taste, putrid odors, stains on utensils, linen and food, stomach pain, presence of crystals in the urine.

Iron concentrations in wells water are well above Chadian and WHO standards (0.3 mg / L) with a minimum of 0.50 ± 0.03 mg / L (Moursal) and a maximum of 3.08 ± 0, 06 mg / L (Walia). In drilling water, there is a minimum of 0.06 ± 0.02 mg / L (Moursal) and a maximum of 1.84 ± 0.09 mg / L (Walia). For the STE network, the content varies from 0.01 ± 0.0 mg / L (Farcha, FSEA1) to 0.60 ± 0.04 mg / L (School Center). Iron content in mineral water ranges from 0.06 ± 0.01 mg / L (crystal) to 0.20 ± 0.04 mg / L (Dala). According to the results, well water, a few boreholes and the STE network water have high iron concentrations, thus exceeding drinking water standard. Explanations of this state of affairs should be sought in the use of drums for upholstering the walls of wells and the use till now in certain districts of old water pipes made of iron, asbestos and the like. However, mineral waters and a portion of drilling and STE water have acceptable iron contents, consistent with the results obtained by S. Yonkeu *et. al*. (2004).

3. The Anions

Some anions such as chlorides and sulfates are linked to the natural structure of water, others are undesirable or even harmful: nitrates, nitrites, fluorides, sulfurs, cyanides etc. We have analyzed only a few of them. The variations of the average concentrations of the anions studied are shown in Fig. 8, 9 and 10.

Chlorides

Chlorides are very common in nature and related to the structure of water. Their content in the water varies considerably, mainly in view of the nature of the lands traversed. According to the drinking water standards, chlorides must have a content of less than 250mg / L. The concentrations of chlorides in the mineral waters studied ranged from 37.0 ± 1.6 mg / L (Crystal) to 73.0 ± 1.8 mg / L (Dala), which was well below standards.

Nitrates and Nitrites

These are natural substances which derive from the oxidation of nitrogen. Nitrates are more stable and are generally used as fertilizers and by reduction, they turn into nitrites. Excessive concentrations of nitrates in water can cause serious or even fatal diseases such as methemoglobinaemia in infants, L'Hirondel (2009). As for nitrites, they have carcinogenicity. Overall, all the specified concentrations of nitrates and nitrites are below (National, European, and WHO) standards for nitrates at 10 mg / L and for nitrites at 0.1 mg / L, in contrast to those reported by Lagnika *et al*. Nevertheless, similar results have been obtained by Kahoul *et. al*. (2014) for the city of Annaba. On the contrary, Bricha *et. al*. (2007) reported results with higher concentrations of nitrates.

Sulfates

Sulfates are widely distributed in nature and may be present in natural waters, with concentrations varying from a few milligrams to several thousand milligrams per liter. On the sanitary level, sodium and magnesium sulfates have a cathartic power. For the waters studied, sulfate ions concentrations in mineral, wells, boreholes and STE do not exceed 4 mg / L and is lower than the Chadian and WHO standards (250mg / L). These results are similar to those of Bricha and Lagnika.

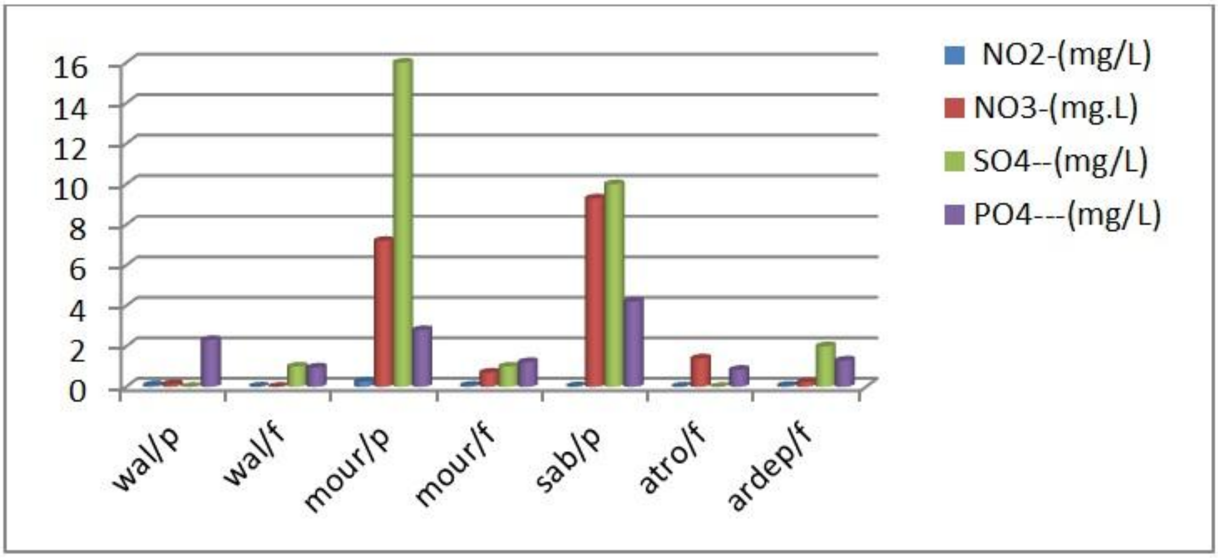

Figure 8: Anions in Well and Drilling Waters

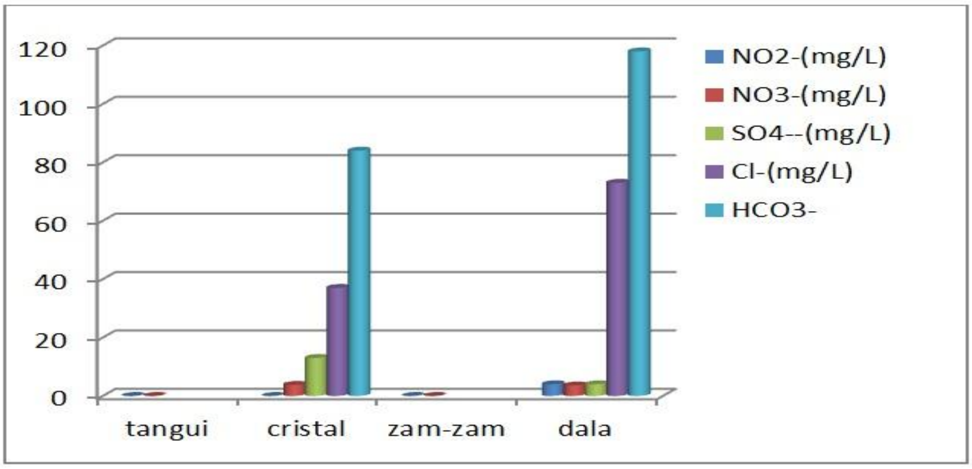

Figure 9: Anions in mineral waters

Phosphates

These are compounds that contain phosphorus, essential for life. Phosphates are necessary for plants and animals. Their excessive presence in the waters causes aquatic plant growth and oxygen depletion in deep waters. This phenomenon is called eutrophication. Phosphorus poisoning causes behavior disorder. Concentrations of phosphate ions are all below the Chadian and WHO standards (5 mg / L):

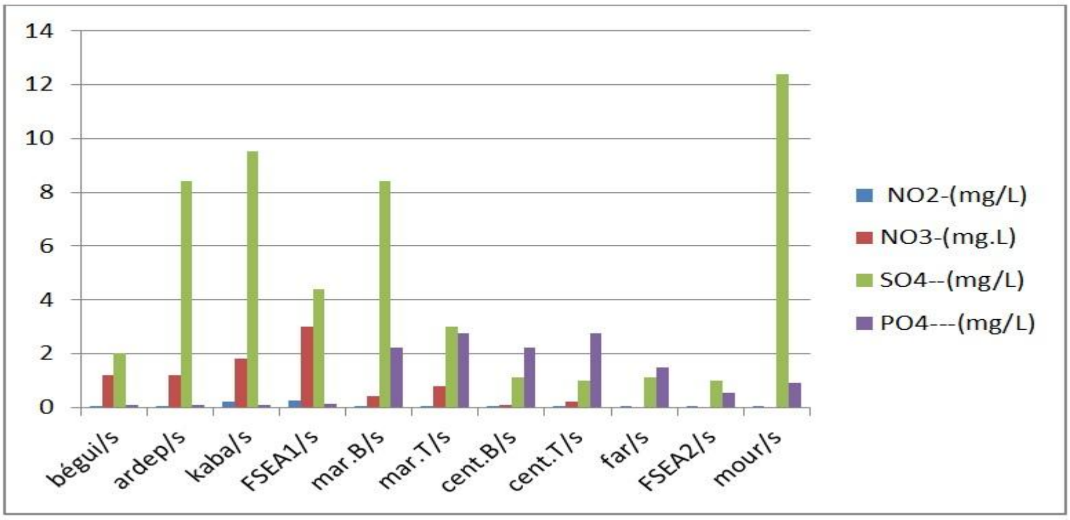

Figure 10: Anions in the STE water network

3.4 Heavy metals

Water is universal solvent, which is likely to contain dissolved species which are iron, nitrates, nitrites, phosphates, sodium, potassium, sulfates ... which we have already done. Other specific indicators are manganese, chromium, zinc, copper, lead, and cadmium ..., which are necessary, harmful or downright toxic to humans (AWWA, Rodier). We analyzed some of them (see Tables 1, 2 and 3).

Manganese

Like iron, it is essential to the functioning of the human body (growth, metabolism of carbohydrates and lipids). Beyond 0.15mg / L in water, it causes the same inconveniences as iron. At high exposure conditions, it accumulates in the brain, causing "manganism", a debilitating disease. According to our data, manganese levels were higher than 0.05 mg / L in the following mineral waters: Dala (0.20 ± 0.04 mg / L), and Cristal (0.30 ± 0.01 mg / L, probably related to the nature of the soil or water treatment prior to bottling.

Nickel, Copper, Zinc and Chrome

These metals are substances that, at high concentrations, can be harmful or even toxic to humans. And it is for these reasons that we analyzed them. Fortunately, as shown in Tables 1, 2 and 3, their mean concentrations are below standards.

The Lead

With cadmium and mercury, lead is an essentially toxic element. In river water, its concentration is 0.003 mg/liter and in groundwater, it does not reach 0.1 mg/liter. In the water of distribution, its presence may originate from the dissolution of the lead that enters the composition of the pipes. Lead is toxic by ingestion and poison by accumulation. Fish are major concentrators of this element. Man, by consuming them, literally poisons himself in the long run.

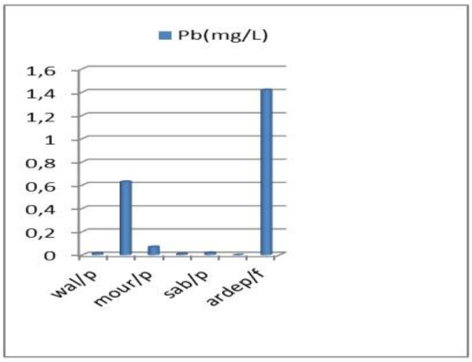

Figure 11: Lead in Well and Drilling Waters

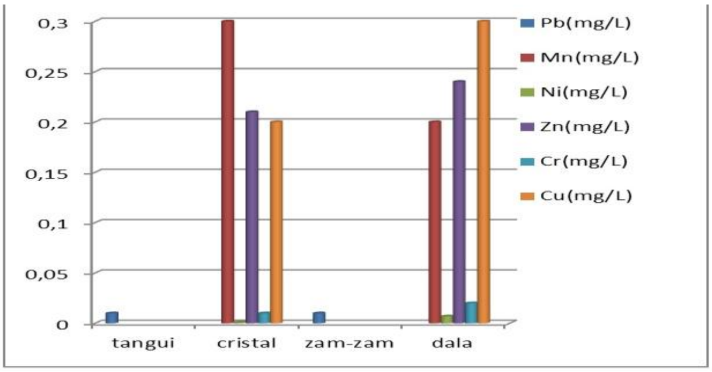

Figure 12: Undesirable and toxic metals in mineral

The reasons mentioned above are sufficient for us to be interested in the concentrations of lead in the waters consumed in N'Djamena (Figures 11, 12 and 13).

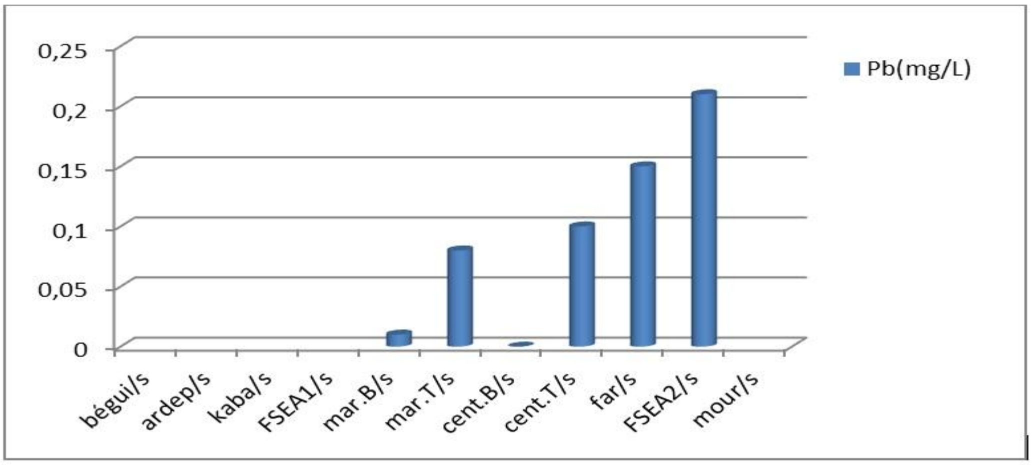

Figure 13: Lead in STE water

Thus, if our results give the lead content lower than the international standard (0.05 mg / L) in most cases: 0.015 ± 0.01 mg / L for the Walia well, 0.00 mg / L for the Drilling of Atrone, that of the STE network in some arrondissements is significantly high of which FSEA2. 0.21 ± 0.02 mg / L. Its presence in mains water is due to the dissolution of the lead used in piping. Indeed, the raw water from the STE collected in the center district contains only 0.01 mg / L of lead. The very high concentration, 1.420 ± 0.04 mg / L of lead in the drilling waters of the Ardepdjoumal district is probably due to the nature of the terrain, human activities, or accidental pollution.

CONCLUSION

Within the limits of the physicochemical analysis carried out, the following conclusions can be drawn:

- Mineral waters are of acceptable quality, except for Dala, which has already been removed from the commercial circuit

- STE network waters have high lead levels in places and are due to dilapidated piping. Their replacement is a solution, at least salutary for the populations concerned.

- If the water quality of certain boreholes meets somewhat the standards of potability, others deviate from it, and sometimes significantly.

- Consumption of good water should be avoided as much as possible, as the deviation from norms is often very important.

REFERENCES

1. AWWA, Standard Methods, 2OO5, 21th edition
2. Bricha S., Ounine K, S, Oulkheir S, EL Haloui. N. et Attarassi B., 2007 : Etude de la qualité physicochimique et bactériologique de la nappe phréatique M'nasra (Maroc). Afrique Science 2007 03(3) pp391-404
3. Décret N 615/PR/PM/ME/MSP/2010. Définition nationale de l'eau potable au Tchad.
4. Eblin S.G,, Sombo A.P,, Soro G,, Aka N., Kambiré O,, Soro N, 2014 Hydrochimie des eaux de surface de la region d'Adiaké, J. Appl. Biosc. 75, 6259-6271
5. El-Naqa A., Al- Momani M.,, Kilani S., Hamouri N., 2007. Groundwater deterioration of shallow groundwater aquifers due to overexploitation in northeast Jordan, Clean Soil, Air, Water 35? 156-166.
6. Hissein A.A.T,, Kamga R. Tchadanaye .N.M., Physico-chemical Analysis of Logone River at Moundou City in Southern Chad, Int. J.Bio. Chem.Sci. 2015 9(3) p 1654-1664
7. Scalon B.R., Ready R.C., Stonestron D.A., Prudic D.D.D.E., Daneby K.F., 2005. Impact of land use and land cover change on groundwater recharge and quality in the southwestern US. Global Biol.11, 1577-1593
8. IGBE : Données de l''L'eau à Bruxelles'', 2005. Qualité physico-chimique et chimique des eaux de surface : Cadre général. Institut Bruxellois pour la Gestion de l'Environnement/ Observatoire des données de l'environnement.

9. Kahoul M., Touhami M., 2014 : Evaluation de la qualité physico-chimique des eaux de consommation de la ville d'Annaba (Algérie). Larhyss Journal, 2014, n°19, pp.129-138.
10. Kahoul M., Derbal N., Alioua A., Ayad W., 2014 : Evaluation de la qualité physico chimique des eaux des puits dans la région de Berrahal (Algérie). Larhyss Journal 2014, n°18, pp.169-178.
11. Lagnika M,, Ibikounle M, Montcho J.P.C., Wotto V. D., Sakiti N.G., Caractéristiques physico-chimiques de l'eau des puits dans la commune de Pobè (Bénin, Afrique de l'Ouest) J. of Appli. Biosciences. 2014 pp 6887-6897.
12. L'HIRONDEL J.(1993). Les méthémoglobinémies du nourrisson, Données nouvelles, Cah. Nutri-Diet., 28,341-9.
13. Mohagir A.M., Bouba A.I, Tchadanaye N.M., Nanadoum M., Kayem J., Capseu C.,. Kamga R., Tchiegang C. Bup .N.D. Using of Ozone and UV in Treatment of N'Djamena's Municipal Underground Water, 2008 AL-NAWAH, Volume 7, number 11 p. 36-44
14. Ngaram N., Tchadanaye N.M., Merle A., Lanteri P., Caractérisation physicochimique des eaux du fleuve Chari au niveau de N'Djamena, Annales de l'Université de N'Djamena, 2011, Série C N° 05 p. 93-120
15. Normes Européennes (1998). Directives du conseil 98/83/EC sur la qualité de l'eau OMS (1994). Directives de qualité pour l'eau de boisson, 1,9-187.
16. OMS 2011. Directives de qualité pour l'eau de boisson. Quatrième édition. Organisation Mondiale de la Santé, Genève, Suisse 307-447
17. Principes de Rio / Dublin 1992
18. Rodier J.. L'analyse de l'eau. 2009 Dunod, 9eme édition, 1526p.
19. Tchoroun M., Noumi G.B.. Tchadanaye N.M. International Journal of Environmental Monitoring and Analysis 2015, Vol.3, No 5 p. 275-281
20. Tchoroun M., Noumi G.B.. Tchadanaye N.M. International Journal of Environmental Monitoring and Analysis 2015, Vol.3, No 5 p. 275-281
21. Yonkeu S., Denyigba K., Wethe J.. Maïga A.H, Djotsa A., Roche M., 2004 : Qualité des eaux de consommation dans le bassin versant du barrage de Yittinga.