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PHYSICOCHEMICAL AND BACTERIOLOGICAL QUALITY OF DRINKING WATER CONSUMED BY THE POPULATION OF ISIRO HEALTH ZONE

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ABSTRACT

The aim of this study is to determine the physicochemical and bacteriological qualities of drinking water consumed by the population of Isiro city. An analytical and observational study was conducted in the province of Haut-Uélé in the north-east of the Democratic Republic of Congo (DRC). Twenty-three water points and 115 households were selected for the collection of water samples. Physicochemical parameters: (temperature, pH, turbidity and electrical conductivity), nitrate, nitrite and ammonium were determined. The analyzes of bacteriological parameters: Fecal and total coliforms were determined by the membrane filtration method as described in Wagtech Kit. The study of the sensitivity of the antibiotic bacteria was made by the agar diffusion method. The data was analyzed using SPSS 20.0 and Stata 13 for a degree of meaning of 0.05. After the processing of all data, the following results were observed: the average water pH was 6.47 and 6.36 respectively at the level of supply points and households; The average water temperature was 28.10 ° C and 27.88 ° C respectively at the level of supply points and households; The average water turbidity at the level of supply points is 2.23 NTU. Only 8.7% of water points deliver drinking water according to WHO standards. 98.3% of the waters stored in households was very polluted and 51.7% strains of Escherichia coli were sensitive to ciprofloxacin.

KEYWORDS: Physicochemical, bacteriological quality, drinking water, ISIRO health zone

INTRODUCTION

Water quality is an important parameter that affects all aspects of ecosystem and man well-being such as the health of a community, economic activities, ecosystem health and biodiversity [1]. Peter Gleick [2] considered that, water withdrawals on the planet could increase by 17% only to ensure food production to the measurement of population growth, regardless of other uses of man.

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The problem of lack of drinking water is particularly overwhelmed in populations of third world cities. It has been found that two-thirds of people in developing countries, more than one billion men, do not have access to drinking water [3]

Beyond the quantity, the quality of water is a particularly worrying human health determinant in arid zone. In the world, 1.1 billion people do not have sufficient access to drinking water [4]. When accessible, water is often subject to chemical and / or bacteriological contamination. Fecal contamination of consumption water is of human or animal, direct or indirect origin. The use of such water as a drink or food preparation can be at the origin of new cases of infection. Thus, waterborne diseases would result in 3.4 million deaths each year, including 2.2 million in diarrheal diseases, including cholera [4].

In its report of June 26, 2008, WHO estimates that dirty water is at the origin of 9.1% of diseases and 6% of deaths registered each year in the world [5].

A UNDP study [6] shows that there is a real geographical disparity in the benefit of urban centers in terms of availability of drinking water. Of the 17.6 million people with access to drinking water, about 70% are urban residents against 30% living in rural and per- urban areas.

In the DRC, the studies that make it possible to check the quality of water at the level of households are rare in the context of the sixth objective of sustainable development, it is necessary to generate evidence on the quality of the water and collect and analyze the data from the villages of interventions of the various programs including the National School and Village Program on the sidelines of the MICS 2018 survey [7].

Like many cities of the DRC, Isiro keeps expanding. Its population is constantly increasing. The spontaneous implantation of neighborhoods not accompanied by urban planning or the establishment of drinking water infrastructures, streams, wells and traditional sources have become the current power mode in water. This is how in this study we wanted to determine the physicochemical and bacteriological qualities of the drinking water consumed by the population of Isiro city. Since the management of waterborne diseases poses problems following the bacterial resistance to antibiotics, the sensitivity test of the strains of fecal coliforms with antibiotics has been achieved.

MATERIAL AND METHODS

This study was carried out in Haut-Uélé province which has as a capital of the city of Isiro. It is located in the north-east of the DR Congo, specifically in the health zone of Isiro, Rungu Territory. The

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geographical location of the studied health areas is shown in Figure 1.

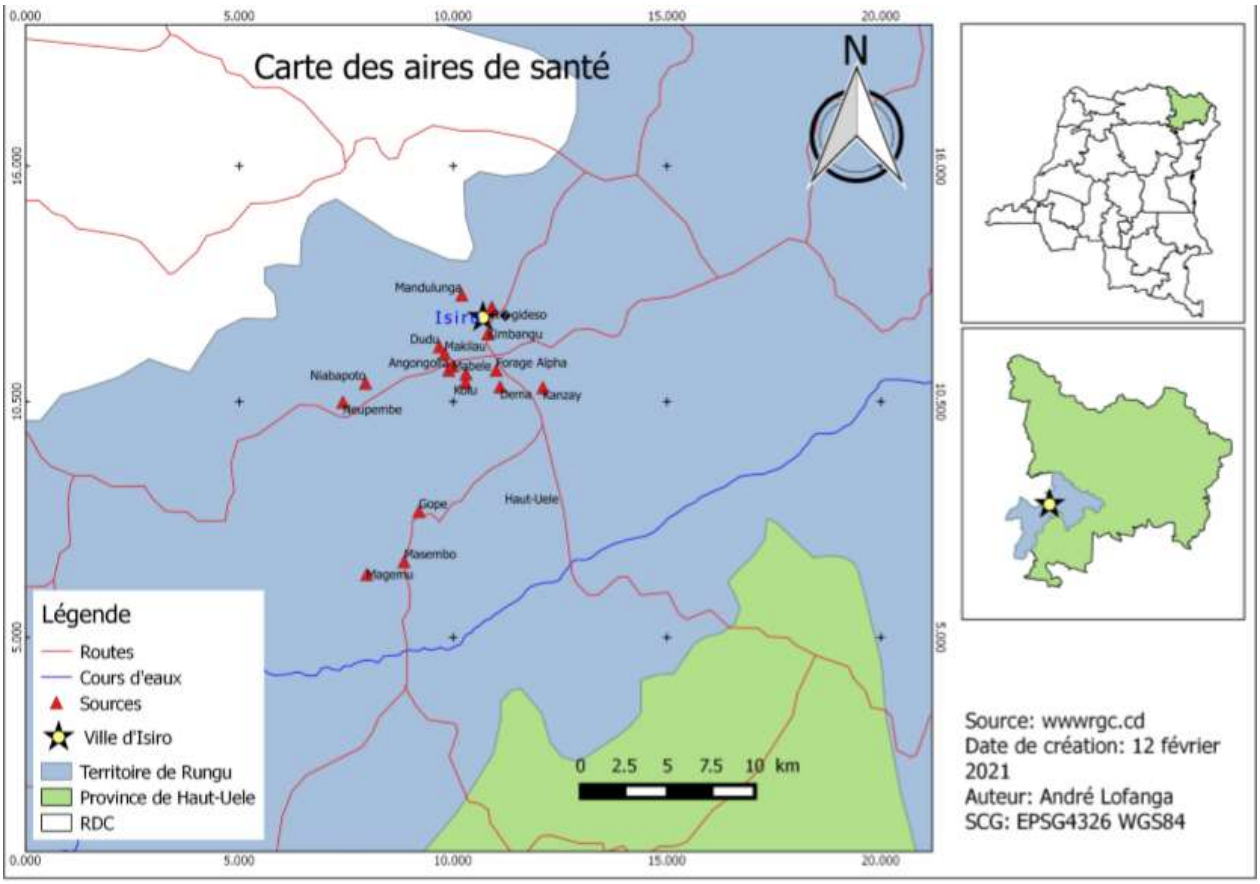

Figure 1. Location of the study area

The population targeted by this study is composed of sources of drinking water supply in the ISIRO health zone. This analytical study was carried out during the period from December 01, 2020 to May 31, 2021. The sampling sites were selected so as to allow fairly representative coverage following the frequency of the population at the level of the water supply point. On a total of 26 water points identified in the study environment, 23 most frequented waters were selected for levies including 17 waterpoints in the urban portion (10 improved sources, 3 standpipes and 4 Regideso taps) and 6 water points in the rural part (improved sources). These samples have made it possible to carry out physicochemical and bacteriological analyzes.

Considering the fact that the habits in the community are similar and in view of logistics constraints, five households have been selected by systematic sampling around each water point sampled for the sampling

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of water samples, then a total of 115 households were selected. These samples were divided into 8 health areas including 5 urban health areas and 3 rural health areas according to their respective demographic weights.

Samples for the physicochemical waters analyzes were taken from 500 ml polyethylene clean bottles previously rinsed three times with water to be analyzed.

Samples for bacteriological analyzes were taken in the morning in previously sterile jars and analyze on Kit Wagtech while coliform colonies were transported aseptically to the Faculty of Science of the University of Kisangani for the research of Escherichia Coli.

Regarding the analyzes of the physicochemical parameters, the water temperature was measured using a digital thermometer (multi thermometer ST-9269, Eurolab), the pH by a pH meter CE 370 (EU), The turbidity was measured by the Hi 93703 Microprocessor Turbidity Meter (Portugal) and the electrical conductivity was measured using a conductivity meter. While the dosage of nitrate, nitrite and ammonium were determined from built-in 7000 photometers using the Wagtech Kit. On the other hand, for bacteriological parameter analyzed, fecal and total coliforms have been enumerated in the field by the membrane filtration method described in Kit Wagtech. It consists of filtering 100 ml of water to analyze, through the Millipore filter. The filter is then placed in the petri dish containing a bottle on which the lauryl sulphate broth was previously soaked, and all placed in an incubator of the kit at 44 ° C (fecal coliforms) and 37 ° C (for the total coliforms) for 18 hours. The bacteria present form colonies identifiable with the naked eye and the counting results were expressed in number of colonial formed units (CFU) for 100 ml of filtered water [11, 12].

The classification of water according to the health of consumers was made on the basis of WHO standards formed colonies (C.F) per 100 ml. Thus, for the samples in which he had no colony formed (0 C.F/ 100ml), this water did not present any risk; from 1 to 10 C.F / 100ml the risk was low; from 10 to 100 C.F/ 100 ml, the risk was intermediate; from 100 to1000 C.F / 100 ml, was at high risk and greater than 1000 C.F / 100 ml the risk was very high.

The search for E-coli in drinking water was carried out in the medium of Luria Bertani agar, Lennox from the strains of fecal coliforms preserved on soft gels. As for the bacteriological quality of the waters, the classification was made according to WHO standards as well as the classification according to the order of Feachem. According to WHO standards (2004), the sample in which he had no indicator (0 coliform), this water was drinkable, the one whose one indicator had been found, the water was moderately drinking,

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the one with 2 indicators, the water was little polluted and the one in which he had 3 indicators or more, the water was very polluted.

The classification according to Feachem order was based on the concentration of CFU / 100ml indicators. Thus, was considered a drinkable, the water that was indicator free, less than 100 indicators, the water was acceptable; Less than 1000 indicator, the water was improper and greater than 1000, the water was extremely contaminated.

The study of the sensitivity of the antibiotic bacteria was made by the agar diffusion method. This method consists in depositing antibiotic disks on a seeded gel. The antibiotic will diffuse according to a concentration gradient and the bacteria will not develop for concentrations greater than or equal to the minimum inhibitory concentration. An area of inhibition is thus obtained around the disc, more or less large depending on the sensitivity of the strain and the power of diffusion of the antibiotic [13].

Seeding by the Kirby and Bauer method consisted of introducing a sterile swab in the suspension of the strain (the preculture of the strain). Then, the inoculum was spread on the Geller-Hinton agar by passing the swab two or three times over the entire surface of the medium, turning each time the box of 60 ° C so as to ensure a uniform seeding. Then we allowed the boxes 15 minutes to 37oC.

The antibiotic-soaked disks have been deposited aseptically on agar by means of a sterile forceps. Then, the boxes were allowed 15 minutes to the laboratory temperature to allow the antibiotics to diffuse and returned before being incubated at the oven, 24 hours at 37 ° C.

The effect of antibiotics on germs is highlighted by the appearance of inhibition areas. It is considered an inhibition zone, the clear halo around discs where there is total growth absence. Thus, the sensitivity of the antibiotic bacteria has been appreciated by measuring the zone diameter with a millimeter latte. The value obtained is compared to that of critical diameter of the antibiotic whose diameter of the inhibition zone lower than the critical diameter is suitable to conclude resistant, that of the inhibition zone greater than the critical diameter is appropriate to conclude sensitive (s) while intermediate responses are assimilated to resistance [14].

The statistical processing of the data was carried out using the SPSS software 20.0 and STATA 13. The Student Test (T. Test) seemed useful to seek the possible significant difference between the level of contamination of the home water and water points by a degree of significant of 0.05. Nevertheless, since the Student Test concerns quantitative data, it has allowed us to make average comparisons of two paired samples.

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RESULTS AND DISCUSSION

Physicochemical parameters of water

The figure 2 present the average value observed for physicochemical parameters of water assessed.

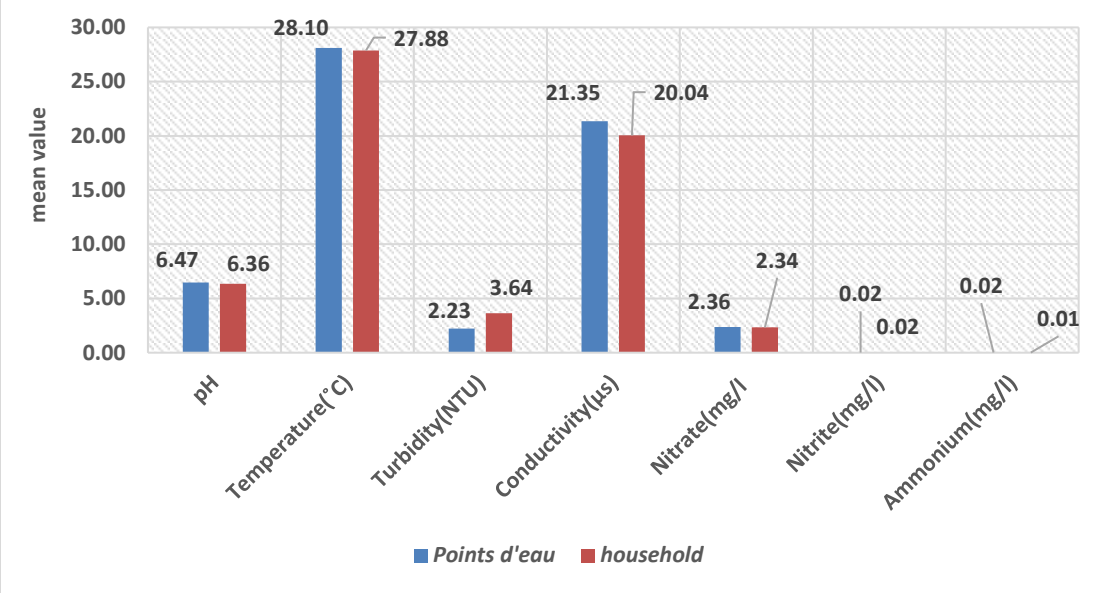

Figure 2. The physicochemical parameters of water analyzed

It can be seen from the figure above that the average pH of water at the point of supply is 6.47 while that of household water is 6.36. There is no significant difference between the pH of water at supply points and that of water stored in households (t = -0.55 and p = 0.5882). It is generally recommended to maintain a pH between 6.5 and 8.5 (Rossiter et al., 2010). Indeed, for pH values below 6, the water risks becoming too corrosive, which could lead to the deterioration of infrastructure.

The average water temperature at supply points is 28.10 ° C while that of household water is 27.88 ° C. There is no significant difference between the temperature of the water at the point of supply and that of the water stored in households (t = -0.17 and p = 0.8701). In general, cold water is considered to be more suitable for consumption. The temperature of the samples taken, generally above 30 ° C, appears to be very conducive to microbiological development.

The average turbidity of water at the point of supply is 2.23 NTU while that of household water is 3.64 NTU. There is no significant difference between the turbidity of water at supply points and that of water

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stored in households (t = -0.94 and p = 0.3559). Water turbidity characterizes the mass of suspended matter per unit volume of water. Turbidity can be an indicator of pollution. Indeed, the presence of suspended matter can be of animal or mineral origin, living or detrital. No source exceeds the standard and this parameter therefore poses no problem in terms of potability.

The average conductivity of water at supply points is 21.35 µs / cm and that of household water is 20.04 µs / cm. There is no significant difference between the conductivity of water at supply points and that of water stored in households (t = 1.11 and p = 0.2783). Conductimetry consists of evaluating the ionic content of water, that is to say its conductive capacity called conductivity. Measuring the conductivity of water therefore provides a first approach to its composition and its chemical properties. Although there are exceptions, in most cases it is possible to relate two water samples with the same conductivity to the same source. So, if two sources from the same village have different conductivities, this means that the boreholes do not pump in the same groundwater. For all sources, conductivity is normal for groundwater and acceptable for consumption.

The average concentration of nitrate in water at the point of supply is 2.36 mg / l while that of household water is 2.34 mg / l. The average nitrite concentration in the water at the supply points is equal to that of the water stored in households, either 0.02 mg / l. There is no significant difference between the concentrations of nitrate and nitrite in water at supply points and those in water stored in households (t and p> 0.05 with CI = 95%).

Finally, the average concentration of ammonium is 0.02 mg / l in spring water and 0.01 mg / l in household water. There is no significant difference between the concentration of ammonium in water at supply points and that of water stored in households (t = -1.10 and p = 0.2850).

Bacteriological quality of water

In the figure 3, are presented, the bacteriological quality of water supply sources according to the number of indicators found.

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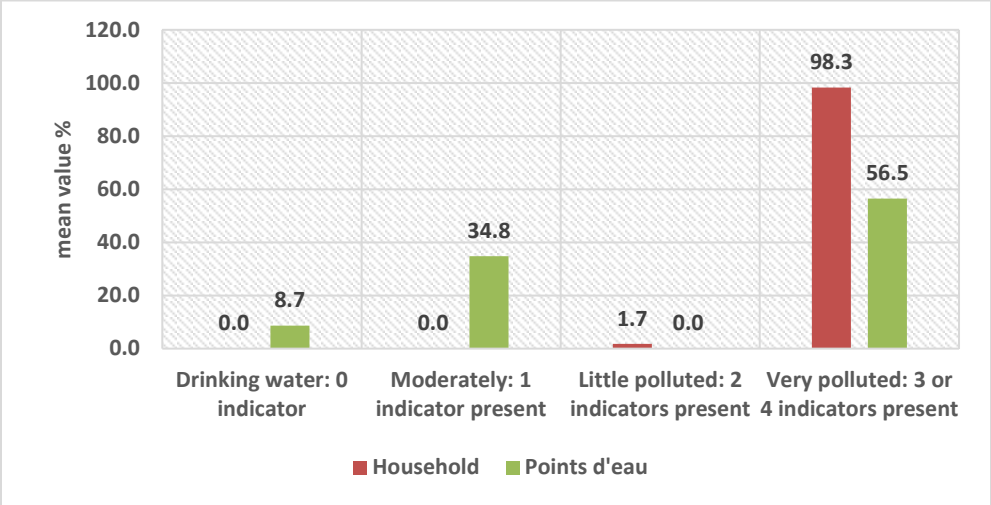

Figure 3: Water quality for households and supply points.

At the water supply point level, out of a total of 23 water points, only 2 water points or 8.7% deliver drinking water according to WHO standards [15] because they are exempt from any water indicator fecal contamination while 13 water points or 56.52% deliver highly polluted water because it contains 3 or 4 indicators of fecal contamination. After bacteriological analyzes of the water stored in the households, our results revealed that no drinking water was found while the water stored in 113 households (out of a total of 115 households), either 98.3%, is highly polluted with 3 or 4 indicators of fecal contamination.

A study carried out in 1985 revealed that 100% of the draw-off vessels and 62% of the storage vessels had a fecal coliform pollution rate of more than 206 units per 100 milliliters, despite a supply of potable water [16]. We think like OUEDRAOGO [17] and Kazadi [1] that it is the man who by his ignorance and / or by the lack of hygiene directly and indirectly ensures the pollution or the contamination of water.

The presence of thermo-tolerant coliforms or E-coli which testify to recent fecal contamination. Contaminated water supply points are therefore probably located either close to latrines with a leaky seal, or close to a stream that can allow the infiltration of bacteria because it contains animal feces; or the presence of animals near the borehole leads to the infiltration of microorganisms from their feces into the water and the presence of fecal streptococci which testify to long-standing fecal contamination.
All samples from households (transport and storage) using polluted sources are also contaminated. This figure is explained by the low use of home water treatment techniques and the use of non-disinfectant techniques.

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After the phase of transport and storage, this increase is even more noticeable since the majority of samples have a bacterial load greater than that of the source. This is explained by the fact that the transport time (of the order of one hour) is much less than the storage time (24 hours). The increase in bacterial loads after transport therefore probably comes from the enrichment of the water by the deposition of the walls of the cans, whereas after storage the increase would come from the same phenomenon and from a proliferation of bacteria (medium humid and a temperature above 30 ° C favorable to bacterial development).

Figure 4 shows the water quality according to the Feachem classification [18] for rural areas because the WHO standards are too strict.

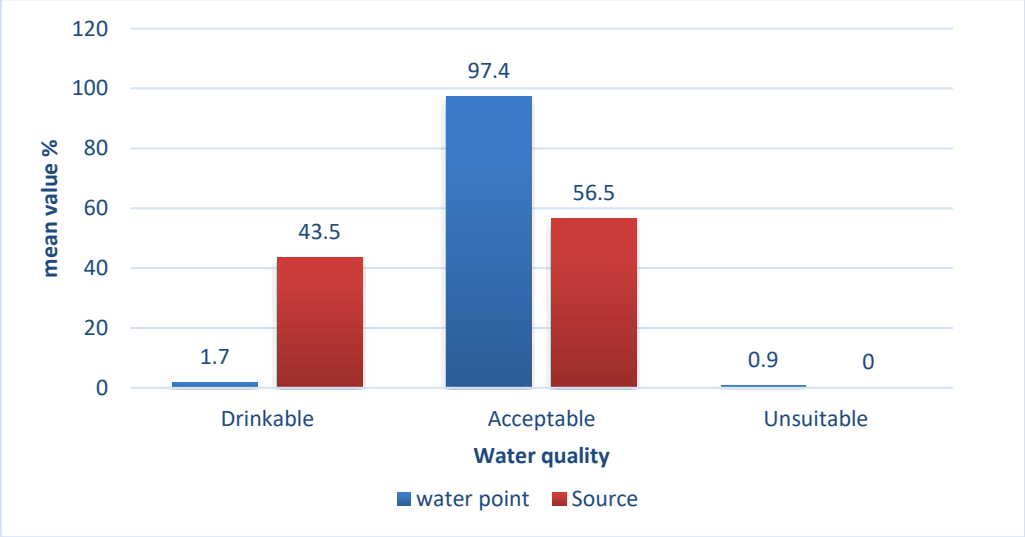

Figure 4: Classification of samples according to the order of Feachem

By this classification we see that 43.5% of supply points deliver drinking water and 56.5% of water points deliver acceptable water. This shows that the water supplied is acceptable in a large majority. On the other hand, it is observed that 97.4% of water afterwards stored in households has an acceptable quality and 0.9% is unfit for consumption.

Storing drinking water is an important step in preserving or degrading water quality. According to MONJOUR [19], if the water is drinkable when collected from drinking water points (0 C.F / 100 ml), it becomes a veritable microbial culture broth in the storage jars (30,000 CF / 100 ml). A study carried out by REQUILLART [16] in West Africa revealed that 100% of drawing vessels and 62% of storage vessels

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had a fecal coliform pollution rate of more than 206 units per 100 milliliters, despite a supply in drinking water. Human ignorance and lack of hygiene directly and indirectly cause pollution or contamination of water [17]. The use of certain containers as basins, cans without cover used to supply and store drinking water, constitutes a risk of water pollution since, not being covered, these containers are exposed to dust and flies. Usually without handles, they are hoisted on the head so that fingers can spoil the water. This practice exposing the water to fecal pollution and can constitute a risk of water-borne diseases.

According to WHO standards, for water to be safe for consumption, it must not contain any indicator of contamination in a 100 ml sample [14]. Although these recommendations are based on a question of health risk, they are too strict when access to quality water is difficult. Indeed, in the context of our study, the villagers have access to water for which no disinfection phase is implemented before consumption and the level of sanitation recommended by the WHO cannot be reached without an appropriate water treatment.

Level of risk to consumer health

Table 1. Classification of health risk according to the concentration of fecal coliforms [14]

Risk level	Source		Ménage	
	Effective	%	Effective	%
No risk	10	43,5	2	1,7
Low	8	34,8	39	33,9
Intermediate	5	21,7	73	63,5
High	0	0,0	1	0,9
Very high	0	0,0	0	0
TOTAL	23	100	115	100

This table shows that 10 of the 23 samples taken from supply points, either 43.5%, do not present a risk to the health of consumers while 34.8% present a low risk to health. At the household level, only 2 samples out of 115, either 1.7%, present no risk, while 73 samples, either 63.5% present an intermediate risk.

Number of colonies formed per unit

The general average of the coliform concentration in the water at the supply points is 3.8 CFU per 100 ml of water while that of the water stored in households is 18.2 CFU per 100 ml of water. water analyzed (figure 4). There is a significant difference between the concentration at water points and at household level ($t = 3.73$ and p-value = 0.0012). Thus, water stored at household level contains more fecal coliforms

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than water at supply points and this water goes from low risk at supply points to intermediate risk at household level.

Figure 5. Number of colonies formed per unit

The figure 6 shows the sensitivity of fecal coliform strains to antibiotics

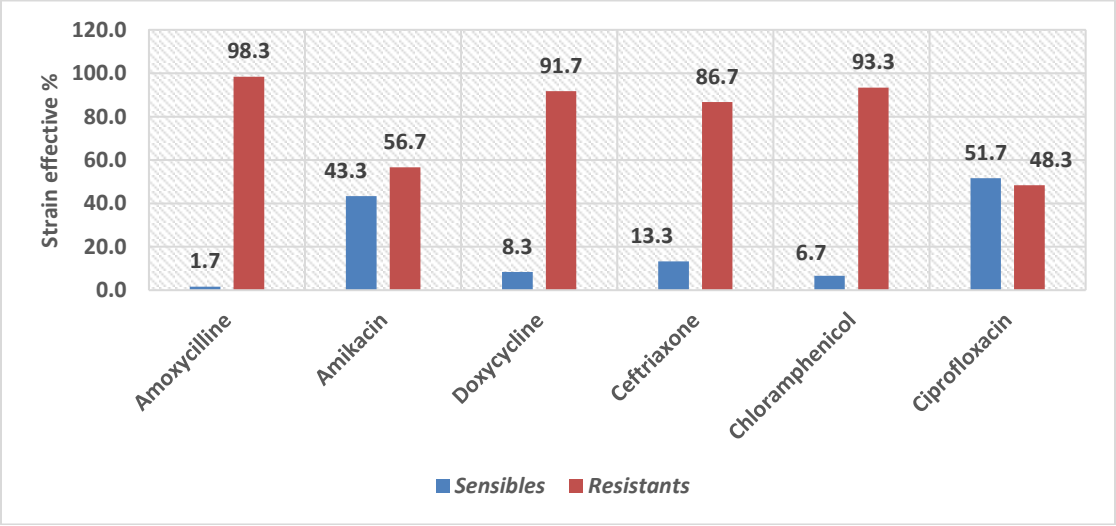

Figure 6: Sensitivity of Escherichia coli Strains to Antibiotics

It emerges from the above figure that 51.7% (N = 60) of Eschericia coli strains were sensitive to Ciprofloxacin, 43.3% of strains are sensitive to Amikacin, 13.3% of strains are sensitive to Ceftriaxone. Our results are in part similar to those of Abisa [20] who, out of 20 strains tested, found that half were

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sensitive to Ciprofloxacin. The difference with the result we found is that for Abisa it was the Salmonella strains.

CONCLUSION

The supply of drinking water remains a major public health problem in the Democratic Republic of Congo in general and in the Haut-Uele province in particular. The drinking water consumed by this population has identified a greater risk to consumers in terms of its quality, bacteriological compared to WHO standards. This situation would partly justify the water-borne diseases encountered in this environment. It therefore appears important to set up a program including sanitation, management of water sources and education practices to sensitize mothers / caregivers to diarrheal diseases in order to reduce this prevalence. As it can be shown in the figure 7 below how people use to pass each time in the water point and the storage tool.

Figure 7. Different water points

REFERENCES

1. Kazadi, M.Z.A. *Contribution à l'étude de la qualité et de la gestion de l'eau de boisson dans la région de Kisangani.* Thèse de doctorat. Faculté des Sciences. Université de Kisangani. Dep. Sciences Biotechnologiques. Kisangani. 145 p. 2012.
2. GLEICK P. H., Basic Water Requirements for Human Activities: Meeting Basic Needs, Water International, 21(2), pp 83-92. 1996
3. Gentilini ; : Médecine Tropicale, éd. Flammarion. Médecine-sciences, 520p. 1993
4. N'DIAYE, A., Etude bactériologique des eaux de boisson vendues en Sachet dans quelques Communes d'Abidjan, Thèse Inédit, Fac.de médecine, pharmacie et d'odonto-stomatologie, Université de Bamako, 136p 2008

ISSN: 2582-6271

Vol.2 No.4; July-Aug 2021

5. AUBRY, P. et GAUZERE, B.A., Les maladies liées à l'eau : actualité 2011, Médecine Tropicale, 7p 2012
6. PNUE *Problématique de l'Eau en République Démocratique du Congo: Défis et Opportunités.* Rapport Technique. p. 57-61. Nairobi, Kenya. 94 p. 2011.
7. BASANDJA L. et al., Gestion des risqués de contamination de l'eau des sources aménagées et dans les ménages des villages certifiés de la Province de Tshopo en RDC, Projet « UNIKIS-SP/ VA-UNICEF ».23p 2018.
8. OMS: Directives de qualité pour l'eau de boisson, deuxième édition, Volume 2, critères d'hygiène et documentation à l'appui, Genève, 1050 p. 2000
9. MISC: Enquête nationale sur la situation des enfants et femmes, (Enquête par grappe à indicateurs multiples), 43p. 2001
10. ATLAS: Accès à l'eau potable, à l'hygiène et l'assainissement pour les communautés rurales et périurbaines de la République Démocratique du Congo. Programme National Ecole et Village Assainis 127p 2018
11. CUQ J-L., Microbiologie alimentaire ; contrôle microbiologique des aliments, UM 2, Montpellier, 119P. 2010
12. Lambert R., Microbiologie des aliments; Université Catholique de Louvain-la Neuve 123p. 1989
13. Biomerieux,. Bactériologie, Biomerieux, Bruxelles, 83p 1989
14. INSTITUT PASTEUR, Antibiogramme Pasteur: détermination de la sensibilité aux antibactériens, Abaques de lecture, 16p 1983
15. OMS, 2004: Directives de qualité pour l'eau de boisson. Recommandations. Troisième Edition. Volume 1. Genève, Suisse. 110 p
16. REQUILLART J.C., Projet eau potable, Rapport final, 54 p. 1985
17. OUEDRAOGO; L'eau et les problèmes sanitaires à Kamboinsé. Mémoire de maîtrise de géographie, Institut National des sciences Humaines et sociales, Université de Ouagadougou, 119p. 1993
18. FEACHEM R. G., Bacterial Standards for Drinking Water Quality in Developing 1980
19. MONJOUR L, Désinfection et chloration de l'eau dans les pays du tiers monde. 2006 http ://www.oieau.fr/ciedd/contributions/at1/contribution/monjour.htm.
20. ABISA, G.Y, Dénombrement, caractérisation et sensibilité des Staphylocoques et Entérobactéries isolés à partir du Boudin vendu au marché central de Kisangani, Mémoire inédit, Fac.des Sciences, UNIKIS, 26p 2004.