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Availability and Microbiological Quality of Drinking Water in the Kafubu Health Area in the City of Lubumbashi -DRC

Author:

Kalaka Mayur C[1], Mulungulungu N. HO Ali Déogracias[1, 2], M.J. Kahenga Mwana-Mwamba[1], Kaj-A-Musul C[1]., Alombong Kindinga M[3].

Address For correspondence:

[1]Food Research Center, CRAA, Lubumbashi, Democratic Republic of Congo
[2] Public Schools of Health, Lubumbashi University, Democratic Republic of Congo
[3]National Institution for the Study and Agronomic Research (INERA), Lubumbashi, Democratic Republic of Congo

Résume :

L'étude de la disponibilité et de la qualité des eaux de consommation dans la zone de santé de Kafubu a consisté en une enquête auprès de 422 ménages et des analyses microbiologiques de 20 échantillons d'eau au cours de deux saisons durant la période allant de Janvier à Avril 2018 pour la saison pluvieuse et de Juin à septembre 2018 pour la saison sèche. Il s'agit zone rurale avec une population estimée à 107.734 habitants en 2018 et consommant les types d'eau suivants : eau de forage, eau de puits, eau de source, eau de rivière. De l'étude descriptive transversale effectuée, l'eau de forage est la source principale d'eau (32,9%) pendant la saison de pluie et pendant la saison sèche la source principale est la rivière (30,8%). Pendant la saison de pluie 56,6% de ménages utilisent 20 à 30 litres par jour et par personne pour tous usage et 64,2% parcourent moins de 20 mètres pour arriver à la source d'approvisionnement en eau. Les analyses microbiologiques ont indiqué que 25% des échantillons étaient non potables pendant la saison pluvieuse contre 40% pendant la saison sèche.

Abstract:

The study of the availability and quality of drinking water in the Kafubu health zone consisted of a survey of 422 households and microbiological analyzes of 20 water samples over two seasons during the period from January to April 2018 for the rainy season and from June to September 2018 for the dry season. It is a rural area with a population estimated at 107,734 inhabitants in 2018 and consuming the following types of water: drilling water, well water, spring water, river water. From the cross-sectional descriptive study carried out, drilling water is the main source of water (32.9%) during the rainy season and during the dry season the main source is the river (30.8%).

During the rainy season 56.6% of households use 20 to 30 liters per day and per person for all uses and 64.2% travel less than 20 meters to reach the source of water supply. Microbiological analyzes indicated that 25% of the samples were not drinkable during the rainy season compared to 40% during the dry season.

Keywords: **Water, Availability, Quality, Health Zone, Kafubu.**

Accessibility is available in terms of resource availability, permanence, distance of less than 200 meters from the concession and cost. [1, 2, 3]

Today, more than 650 million of the poor live without access to an "improved" source of drinking water. However, access from improved points has improved globally, from 62% in 1990 to 84% in 2015, but significant disparities persist between urban and rural areas. Worldwide, 8 out of 10 people who do not have access to improved water sources live in rural areas. The lack of water in rural and agricultural areas causes populations to move. [2, 4, 5]

According to the United Nations Environment Program (UNEP, 2011) and the World Bank's 2011 report, only 26 percent of the Congolese population, or 17 million people out of a total of 67 million, have access to safe drinking water. . That is to say, almost 50 million people located mainly in suburban and rural areas do not have access to drinking water in the country, and only 10% have access to sanitation. [6, 7]

In 1990 access to water in the Democratic Republic of Congo was 70%. This rate dropped drastically to reach 26% in 2014, whereas the Millennium Development Goal of the DRC set the rate of access to drinking water at 71% in 2015. The African average is estimated at 60%. [8, 9]

Although the Democratic Republic of Congo (DRC) alone accounts for 40% of the 70% of freshwater in Africa; less than 50% of the Congolese population has access to drinking water. (6) During the dry season, the problem of water supply arises with great acuteness and the population is obliged at this moment to resort to sources of water. Dubious quality to get water

It can be seen that water problems are acute both quantitatively and qualitatively. According to UNDP and UNICEF in Lubumbashi, about 46.8% of the population consumes unsuitable water and 58.2% have access to a good quality water source, [10, 11]

If the quantitative aspect is essential, we must not neglect the qualitative aspect. The priority remains the biological risks. The consequences of certain contaminations, in particular bacteriological contaminations, are such that preventive measures and corrective treatments are of paramount importance and must not be compromised. Bacteriological contamination of distributed water may be related to such factors as the absence or failure of treatment systems prior to distribution, or the contamination of water in pipes or reservoirs [12, 13].

In practice water is said to be drinkable when it does not contain fecal bacteria (coliforms, Escherichia coli and secondarily fecal streptococci and clostridia). [14,15].

In Lubumbashi, as elsewhere in developing countries, drinking water is used for the following domestic purposes: drinking and food, dishes, personal hygiene, linen, sanitary facilities. [12, 13]

From our observation, we noticed that in the rural areas in which our research will be conducted, the majority of inhabitants obtain water from rivers, undeveloped sources, open

wells, partially manual drilling. To alleviate this situation we have set the goal of preserving the health of the population.

2. Medium, method and material

2.1 Environment

The health zone of Kafubu was the place of our research. It is a rural health zone located in the province of Haut-Katanga, one of the 11 health zones of the city of Lubumbashi in the Democratic Republic of Congo (DRC).

It consists of 12 Health Areas namely: (Kikanda, Kafubu, Kalunda, Kinama, Kikuanda, Makulo, Sambwa, Kiwele, Adra 31, Adra 41, Shindaika and Mulwashi)

Figure 1 below shows the population divided by health area.

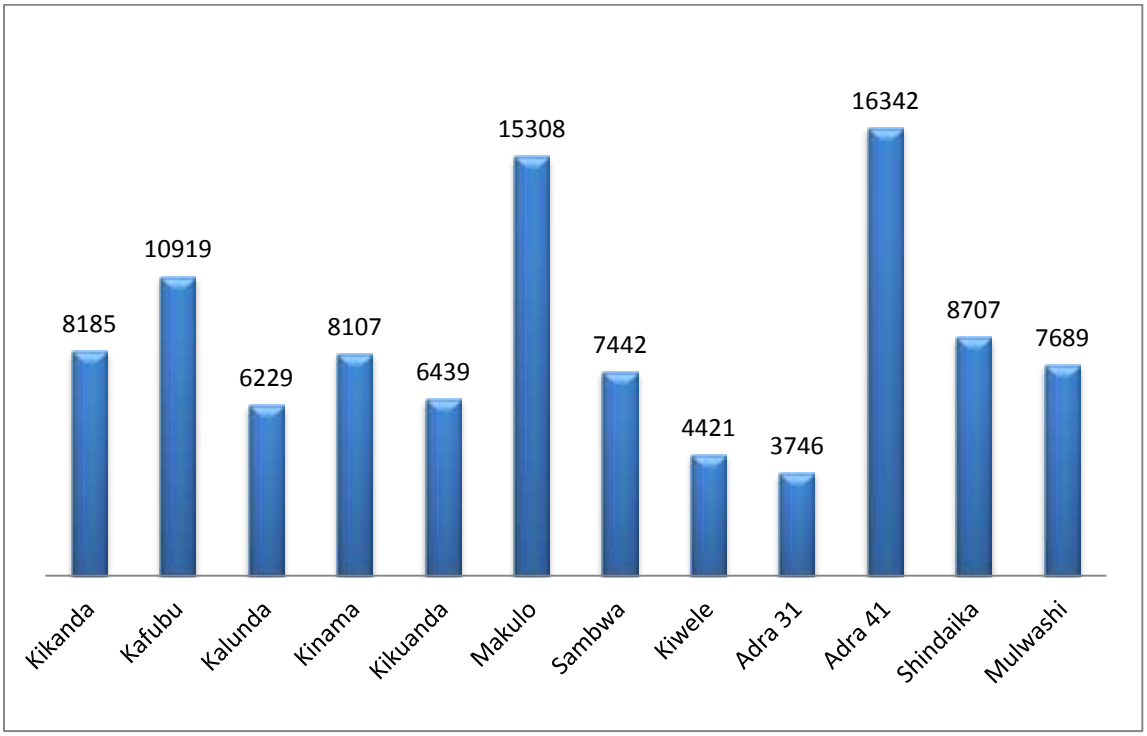

Fig 1: Population of the Kafubu Health Zone distributed by Health Area (Kafubu Health Zone Central Office)

2.2. Method:

2.2.1. Study of accessibility to water

a) Type of study

The study that we conducted is descriptive transversal analytical during the dry and rainy seasons respectively from February to April and from July to September 2017 proceeding by the technique of direct interview using a questionnaire.

b) Sampling

Our survey is based on a total of 844 households, or 422 households during the dry season and 422 households during the rainy season.

Our sample was drawn based on the following formula: $n = \mathrm{P\ x\ }(P-1)\ \mathrm{x}\frac{Z^2}{i^2}$ With: N: sample size; P: prevalence of previous years estimated at 50%; Z: parameter related to the risk of error which is equal to 1,962 I: degree of precision desired or error granted which is equal to 0, 05%.

Our sampling is of the stratified random proportional type, the strata being the health areas. Since the population is not uniform in the health areas, for the proportionality of the sampling, we divided the sample size by the total population and multiplied the result by 100. The proportion of the sample in the Health Zone is thus 422 x 100 /107734 which is equal to 0.391% taken into account for each health area.

Variables studied : the two seasons (dry and rainy), for which we compared the following parameters: the types of water consumed, the distance between the dwelling and the main point of water supply, the round-trip time set to draw water from the main source, the amount of water consumed per day and per person for all needs.

2.2.2. Microbiological analyzes

To assess the microbiological quality of the water, we performed non-probability sampling for convenience of 20 samples per season. For the representatives of the results, we have taken from the north, south, east, west and center of the health zone, researched and identified by culture on appropriate media germs indicating a contamination of fecal origin: salmonellae, group D streptococci, staphylococci, fecal coliforms, total coliforms [16]. It is important to note that the samples of the well water were the most numerous because of the propensity of the population to use them.

2.3. Material and sampling

2.3.1. Accessibility to water

The research was carried out with the population of the Z/S of Kafubu on the basis of a survey questionnaire entered by the Microsoft Word software 2010 edition and the results of the interview were analyzed with the software Epi info 7.1. 0.6.

2.3.2. Water quality

Portability of the water was evaluated on the basis of microbiological analyzes carried out at the provincial laboratory on Likasi Avenue in Lubumbashi and equipped with the following materials:

- A filtration apparatus consisting of: a cylindrical funnel receiving the liquid; a filter support on which the filter membrane is placed; a receiving vial connected to a vacuum apparatus; filter membranes made of cellulose ester with a porosity of 0.45µm.

- Sterilization and incubation equipment: autoclave, Pasteur oven, Bunsen burner, oven at 37 ° C and 44 ° C.

- Weighing equipment: balance with an accuracy of 0.01 gram.

- Glassware: petri dishes, 100 ml graduated test tube, test tubes.

- Miscellaneous equipment: pliers, scissors, pastoral pipettes, graduated pipettes, beaker.

- Culture media: four culture media were used: TTC, TSA, Slanetz and Bartley and BEA.

Thus the water samples were removed aseptically using the sterile 100 ml vials with screw caps. Well water was collected using the usual well. The samples concerned the health areas at the following addresses:

- Sample 1: Kafubu drilling (manual drilling)

- Sample 2: Sambwa borehole (fountain with piping feeding several faucets in different places)

- Sample 3: Kitanda drilling (manual drilling cemented all around)

- Sample 4: Petro drilling (drilling feeding 3 taps on site)

- Sample 5: 41 FM 1 (unattended manual drilling all around)

- Sample 6: Shindaika drilling (unmanaged manual drilling all around)

- Sample 7: 41 Fountain

- Sample 8: Source Kitanda (swamp water)

- Sample 9: Sambwa source (source landscaping built around with a pipe planted in the basement)

- Sample 10: Kikanda source (source arranged with 3 pipes)

- Sample 11: Source kikuanda (swamp water)

- Sample 12: Kafubu River,

- Sample 13: 41 River,

- Sample 14: Luwowoshi River 1,

- Sample 15: Luwowoshi River 2

- Sample 16: Lwano shindaika River

- Sample 17: Makulo Ordinary well (wells unmanaged open cured two weeks before harvesting the dry season)

- Sample 18:41 PN (unfinished well without lid within 15m of the toilet),

- Sample 19: 31 PN (open wells whose contour is raised by soil)

- Sample 20: PA 2 (developed well located in front of the hospital)

3. Results and interpretation

3.1. Accessibility to drinking water

Figure 2 shows the most popular water source used by the Kafubu Health Zone population is drilling water during both seasons and dry season river water and well water during the rainy season and the sources are the least used during both seasons.

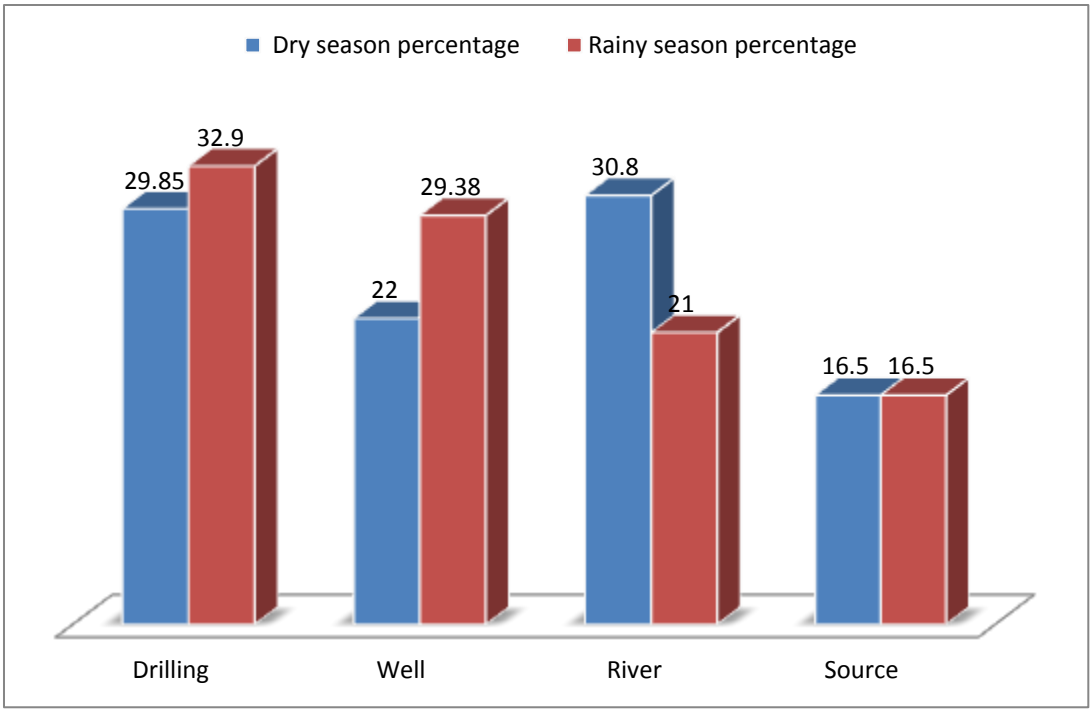

Fig. 2 Type of drinking water and availability for both seasons in the Kafubu Health Zone

Table I: Distance between dwelling and main point of water supply

Season	Dry	Rainy

Distance	Effective	Percentage	Effective	Percentage
Less than 20 meters	230	54,5	271	64,2
20 to 200 meters	152	36	128	30
201 to 500 meters	25	5,9	16	3,79
More than 500 meters	15	3,6	7	1,6
Total	**422**	**100**	**422**	**100**

This table shows that 64.2% of respondents traveled a distance of less than 20 meters to arrive at the place of supply of drinking water during the rainy season against 54.5% during the dry season.

Table II: Round-trip time to draw water from the main source

Season	Dry		Rainy	
Durée	**Effective**	**Percentage**	**Effective**	**Percentage**
Less than 15 min	236	56	310	73,5
15 à 30 min	100	24	44	10,4
31 à 60 min	35	8	41	9,7
61 à 120	30	7	23	5,5
More than 120 min	21	5	4	0,9
Total	**422**	**100**	**422**	**100**

The result of this table is that 73.5% of the respondents spent less than 15 minutes in the rainy season compared to 56% in the dry season.

The figure below indicates that 12% of the respondents consumed 30 to 40 liters of water per household per day for all needs during the rainy season compared to 22.5% during the dry season.

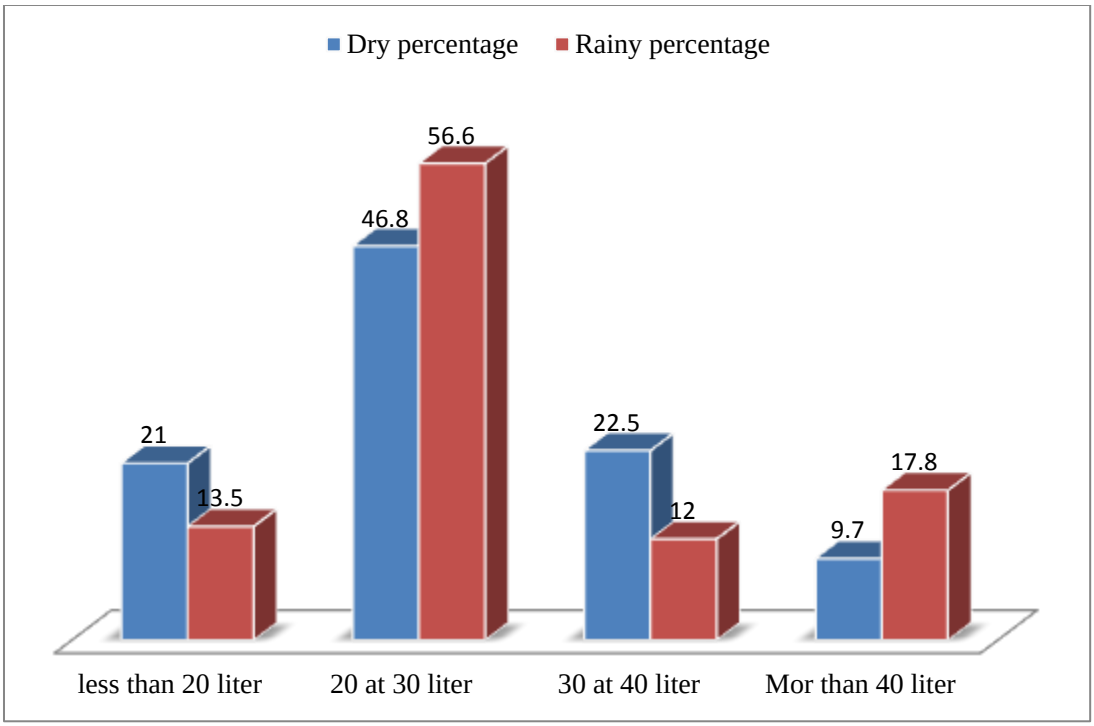

Fig 3: Quantity of water consumed per day and per household for all needs

3.2. Quality of drinking water in Kafubu Health Zone

The regulation requires the absence of thermotolerant coliforms and fecal streptococci in 100 ml of filtered water. [14]

Table III. Perception of drinking water quality by respondents

Season	**Dry**		**Rainy**	
quality of drinking water	**Effective**	**Percentage**	**Effective**	**Percentage**
Bad	43	10,19	83	19,67
Good	379	89,81	339	80,33
Total	**422**	**100**	**422**	**100**

This table shows that 89.81% of the respondents had a good appreciation of the quality of the water during the dry season while 80.33% had a good perception that they consume during the rainy season.

Table IV: Results of bacteriological analyzes of samples of drilling water

Location Drilling Levy	**Dry Season**					**Rainy Seanson**				
bacteria	Salmonella CFU/ml	Staphylo-cocci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptococci of the group D CFU/ml	Salmonella CFU/ml	Staphylococci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptococci of the group D CFU/ml
Kafubu Drilling	0	0	0	0	0	0	0	0	0	0
Sambwa Drilling	0	0	0	0	0	0	8000	0	0	0
Kitanda Drilling	0	0	0	0	0	0	2000	0	0	0
Petro Drilling	0	20000	0	0	0	0	15000	0	0	0
41 FM 1	0	15000	25000	5000	2000	0	15000	0	0	0
Drilling shindaika	0	2000	0	0	0	0	0	0	0	0
41 Fontaine	0	0	0	0	0	0	0	0	0	0

Table IV shows that only water from Kafubu Drilling and 41 Fountain are potable. This potability is 20%.

Table V: bacteriological analysis of samples of water sources

Source levy	Dry **Season**					**Rainy Season**				
Bacteria	Salmonella CFU/ml	Staphylococci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptococci of the group D CFU/ml	Salmonella CFU/ml	Staphyloco-cci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptoco-cci of group D UFC/ml
Kitanda source (swamp water)	0	0	0	0	0	0	0	0	0	0
Sambwa source	0	15000	25000	5000	2000	0	0	0	0	0
Kikanda source	0	5000	0	0	0	0	0	0	0	0
kikuanda Source (swamp water)	0	0	0	0	0	0	0	0	0	0

Analysis in source waters indicated that Sambwa source and Kikuanda source samples are contaminated.

Table VI: bacteriological analysis of samples of river water

River levy	**Dry Season**					**Rainy Season**				
Bacteria	Salmonella CFU/ml	Staphylo-cocci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptococci of the group D CFU/ml	Salmonel-la CFU/ml	Staphylococci CFU/ml	thermo-tolérants Coliform-s CFU/ml	E. Coli CFU/ml	Streptococci of the group D CFU/ml
Kafubu rivière	0	28000	45000	15000	0	0	0	5000	12000	0
River41	0	17000	0	0	0	0	15000	75000	15000	20000
River1 Luwowoshi	0	0	95000	12000	0	0	0	75000	5000	0
River2 Luwowoshi	0	30000	105000	3000	0	0	0	102000	8000	10000
River Lwano shindaika	0	36000	78000	25000	0	0	12000	0	0	0

Next the samples to the river water during the two seasons, Table VI reveal that the river water is unsafe to drink.

Table VII: bacteriological analysis of samples of well water

Well levy	**Dry season**					**Rainy season**				
	Salmonel-la CFU/ml	Staphylo-cocci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptoco-cci of the group D CFU/ml	Salmonella CFU/ml	Staphyloco-cci CFU/ml	thermo-tolérants Coliforms CFU/ml	E. Coli CFU/ml	Streptococci of the group D UFC/ml
well ardinaire Makulo	0	17000	0	0	0	0	15000	75000	15000	20000
41 PN	0	28000	0	0	0	0	0	5000	12000	0
31 PN	0	0	0	0	0	0	2000	0	0	0
PA 2	0	0	0	0	0	0	3000	45000	5000	0
PN 1	0	8000	0	0	0	0	0	0	0	0

Regarding Table VI, we noted the following during the two seasons, three samples taken in the wells during the dry season were contaminated and during the rainy season only one sample (PN1) was not contaminated.

4. Discussion

4.1. Diponibility to wate

Figure two shows that the most popular water source used by the Kafubu Health Zone population is Drilling Water during the rainy season (32,9%) and River water during the dry season (30,8%) comes after drilling water during the dry season (29,85%) in fourth position comes water well (29,38%) during the rainy season is the least used source in the two seasons is spring water (16,5% and 16,5%) respectively in the rainy season and in the dry season.

The users trust the Drilling Water because it considers them potable because it is treated water and therefore drinkable. In the rainy season, the drilling water is partially replaced by rainwater.

Spring, well and river water is also used for various purposes as considered relatively drinkable. Nevertheless, they are less in the rainy season because households collect, effortlessly, use and store rainy water.

The use of river water, well water and spring water is not generalized due to their dubious quality, message relayed by the media. Those who use them would do it for want of anything better. (17) It is important to note that only one household can use more than one source of water. This water problem is due to the lack of distribution networks of REGIDESO in this corner of the city of Lubumbashi (Kafubu Health Zone).

Table I indicates that 64, 2% of the respondents in the rainy season and 54, 5% in the dry season travel less than 20 minute to reach the main water point. This would indicate that the majority of the surveyed their homes are not far from water supply point. Indeed, a large part of the population of Kafubu health zone is located in the rural part of the city of Lubumbashi.

The distance traveled to obtain water supplies increases during the dry season due to the lowering of groundwater and aquifers. Thus 3, 6% of respondents travel distances exceeding 500 meters to fetch water while the water availability is considered good when the water source is located within 200 meters of the house. [18]

This interpretation is supported by the results in Table II, which indicates that 73, 5% of respondents spend less than 15 minutes acquiring water during the season, compared to 56% during the dry season when water is less available and the population is obliged to go fetch her further. Tom Burgess et al report 50 liters of water per day per person as the recommended "intermediate" amount required to meet health, hygiene and household needs. [19] [20]. The figure of 20 liters per person per day is often cited as the minimum quantity if hygiene needs are added.[18, 21]

The results in Figure 3 indicate that the majority of respondents (56.6% in rainy season and 46.8% in dry season) consume daily and per person between 20 and 30 liters of water for all domestic purposes. In the rainy season, water being more available and accessible, the respondents consuming less than 20 liters are less numerous (13.5% compared to 21% in the dry season) and those consuming more than 40 liters are less numerous (17.8% against 9.7% in the dry season). These quantities, however, are lower than the urban averages of 50 liters mentioned by the CNRS [20] as a result of the low average annual income of the population.

4.2. Water quality

Respondents' perception of water quality is reported in Table III. It is considered good during the dry season at 89.81% against 80.33% during the rainy season. The difference in results could be explained by the fact that this assessment is organoleptic. In rainy weather, rainwater carries various materials and substances that can influence the organoleptic characteristics of water including color and smell as well as taste. This statement is also valid for Drilling Water which does not undergo filtration, settling or deodorizing treatment. The results of the microbiological analyzes are shown in the tables below. The WHO recommends the absence of thermos-tolerant coliforms in 100ml of filtered water.

These are germs excreted in the faces of humans and infected animals in which they are normal and habitual hosts of the digestive tract. This character earns them their universally recognized choice as reliable indicators of fecal contamination.

Tables IV, V, VI and VII of the results of the microbiological control during the rainy season and during the dry season from different sources indicate respectively a potability of 40% during the dry season against 25% during the dry season. The presence of thermo-tolerant coliforms in drinking water suggests that there is insufficient treatment, post-treatment contamination or excessive nutrient concentration. [22]

Allusion to the non-drinkability of drinking water, we can evoke the negative pressures in case of lack of water. In fact, during sampling, we found leaks upstream of the sampling sites. Well, river and spring water are contaminated during the rainy season as a result of runoff and dry season pickets.

Conclusion

The study of the accessibility and the potability of drinking water in the Kafubu health area that a significant proportion of the population travels 200m or more and lose at least 30 minutes in search of water. This situation is more pronounced in the dry season. In addition, a large part of the population consumes 20 to 30 liters of water for all needs, which is less than the minimum required for a predominantly rural population. The results concerning the population's perception of the water quality of this health zone are good, but microbiological analyzes reveal that much of the water consumed in this health zone is of poor quality.

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