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Environment and Forestry

Elixir Environment and Forestry 173 (2022) 56617- 56621

ISSN: 2229-712X

Physico-Chemical and Microbiological Analyzes of Water from Two Wells in the Town of Mangobo (Tshopo, Dr Congo)

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ARTICLE INFO

Article history:
Received: 22 October 2022;
Received in revised form:
16 December 2022;
Accepted: 26 December 2022;

Keywords
Analysis,
Physico-chemical,
Microbiological,
Well water,
Mangobo.

ABSTRACT

Water is a very essential product in life and has always been the subject of special attention because of its capital importance in the life of man, in terms of its use or consumption. Hence the need for more studies and research in this vital area. Thus, in the context of this study, we also wanted to pay particular attention to the waters of undeveloped wells which proliferate everywhere in the city of Kisangani and which are often used by the population in case of need during rupture. of drinking water supply by Regideso and especially those who do not yet benefit from this water service in their communities. This study concerns the bacteriological and physico-chemical analysis of the water of the wells of the commune of Mangobo and aims to determine the quality of the waters of these wells. The waters from these two wells (1 and 2) were analyzed in the field and in the laboratory. After analysis and processing of the data, the results proved that, compared to the physico-chemical parameters, these waters were out of standard for temperature (>29.1°C), pH (<6.01) and did not contain chlorine (0). These waters therefore do not undergo any treatment and are true culture media in relation to their temperature. From a microbiological point of view, the water from well 1 is of suspect quality (contains an average of 30,000 total germs per 100 ml and 1,300 total coliforms per 100 ml) and is not given for human consumption, while that from well 2 is of fairly good quality. The contamination of these waters is of strictly human origin, therefore coming from its users. This study underlines the importance of carrying out physico-chemical and microbiological analyzes of well water before any consumption by the population of Mangobo because drinking water must not contain pathogenic microorganisms or toxic substances.

Introduction

Water quality is an important parameter that affects all aspects of ecosystem and human well-being, such as the health of a community, the foodstuffs to be produced, economic activities, the health of ecosystems and biodiversity. As a result, water quality also influences the determination of human poverty, wealth and education levels. (Kazadi, 2012).

The poor supply of clean water leads to a high risk of waterborne infections such as cholera, typhoid fever, hepatitis A, amoebiasis and many other parasitic, bacterial and viral diseases. Every year, 4 billion cases of diarrhea cause 2.2 million deaths, most of them children under 5 [2]. This is equivalent to the death of a child every 15 seconds or the crash of 20 jumbo jets per day. These deaths represent approximately 15% of all deaths among children under 5 in developing countries.

However, the microbiological contamination of water is more serious, especially when it is linked to human excrement. Faecal contamination of drinking water is one of the main causes of diarrheal diseases. It is estimated that 2000 children under the age of 5 die from diarrheal disease worldwide every day. Nearly 90% of child deaths from diarrheal diseases are directly linked to contaminated water, lack of sanitation, or poor hygiene (UNICEF Canada, 2013).

In its report of June 26, 2008, the WHO estimates that dirty water is the cause of 9.1% of illnesses and 6% of deaths recorded each year in the world. Children are the first victims, since water is involved in 22% of illnesses among children under 14 years old. There is a strong inequality between rich and poor countries: water is the cause of less than 1% of

morbidity in developed countries, this proportion reaches 10% in developing countries. The number of deaths varies from 0.5% for developed countries to 8% for developing countries. Among children, dirty water is responsible for a quarter of deaths (Aubry and Gauzère, 2012).

Although the Democratic Republic of Congo is the African country with the most important hydrological resources, it must today face an acute crisis in the supply of drinking water. Indeed, only 26% of the Congolese population has access to safe drinking water, an estimate well below the average of 60% for all of sub-Saharan Africa.

In Kisangani, as in other cities of the Democratic Republic of Congo, drinking water supply is provided by Regideso, which offers drinking water connection services to the population. But, following the extension of the city and the galloping demography of the population, several of these regions still remain without a drinking water connection from Regideso. Hence the need to resort to wells and other local sources in order to meet this need for water as best they can.

The general objective of this study is to assess the quality of water from the wells of the Mangobo commune. The general objective of this study will make it possible to verify the hypotheses according to which: the waters of the wells used by the population of the commune of Mangobo are not of good quality and that the contamination of these waters is of human origin.

Place, Materials and Methods

Physical framework

The water samples were taken in the city of Kisangani in the Democratic Republic of Congo, precisely in the commune of Mangobo. The city of Kisangani (Figure 1) is located near the equator between 0.30° North latitude and 25.16° East longitude. Its altitude is between 376 and 425m.

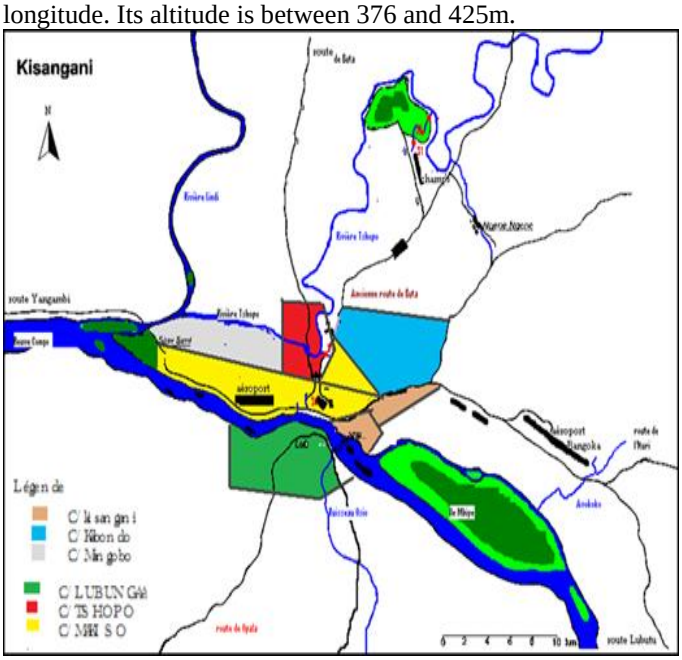

Figure 1. Map of the city of Kisangani

The commune of Mangobo is one of 6 communes of the city of Kisangani, capital of the province of Tshopo. It is subdivided into 10 districts which are:

Aruwimi district
- Elima district
- Rwenzori district
- Itimbiri district
- Okapi district
- Minzoto district
- Imbolo district
- Limanga district
- Lindi district
- Segama district

The water was taken from two wells in the Mangobo commune, one of which is located in the Rwenzori district, Block Bahema II at number 224 (Well 1) and the other is located in the Lindi district, Avenue Kimbi at number 36 (Well 2).

Method

Sampling and Sampling

Two wells (wells 1 and 2) were selected for this study because they are used by the surrounding population to meet their drinking water needs in the absence of drinking water supply from Regideso.

To carry out the bacteriological analyses, we took 2 samples from each well with an interval of one week between each sample. The samples were always taken in the morning (between 7 a.m. and 9 a.m.) in previously sterile jars and transported in a portable cooler to the microbiology and phytopathology laboratory of the Faculty of Sciences of the University of Kisangani for analysis.

Physico-chemical analyzes of water

Determination of residual chlorine

Rinse the chambers of the comparator three times with the water to be tested then fill the three chambers with the sample. Place a fast-dissolving DPD1 reagent tablet in the right comparator (C12), and a phenol red tablet in the left comparator (pH). Replace the comparator lid, securing it firmly, and invert the assembly several times until the two reagent tablets are completely dissolved. Immediately read the free residual chlorine concentrations and the pH in natural light, and compare the colour obtained with those of the comparator scale (Oxfam-Delagua, 2000).

Determination of pH and temperature

The pH and temperature were determined in the lab using a pH meter with built-in thermometer. This method consists of immersing the two electrodes of the device in the water sample.

Bacteriological analyses of water

Total germ count

The count of total germs was carried out by the method of successive dilutions described by Diouf (1992). It consists of having 5 test tubes each containing 9 ml of sterile peptone water and representing the five dilutions to be made. Take 1 ml of the water sample and put it in the first test tube containing 9 ml of peptone water to make the 10-1 dilution. 1ml of the 10-1 dilution was taken and put in a second tube to make the 10-2 dilution and so on until the 10-5 dilution was made.

One millilitre of each dilution was inoculated into the Petri dishes due to two dishes per dilution. Then, 15 ml of supercooled nutrient agar were poured into the various Petri dishes. The dishes were incubated in an oven at 37°C for 24 hours.

To determine the number of germs per ml of sample, we only retained the dilution having at least one interpretable box (containing 30 to 300 colonies). Thereby:
- For a retained dilution, we multiplied the sum of colonies of the interpretable dishes by the factor of the retained dilution
- If no dilution is retained, we calculated the arithmetic mean of the colonies of dishes corresponding to the lowest dilution, which we multiplied by the factor of this dilution.

Enumeration of Faecal Coliforms

The enumeration of faecal coliforms was carried out in the lactose broth according to the technique of fermentation in multiple tubes which consists in placing 3 series of three

test tubes each containing 10 milliliters of sterile medium with Durhans tubes reversed. In the tubes of the first series in which the concentration of the medium is doubled, 10 milliliters of water to be analysed are inoculated into each tube. In those of the second and third series where the concentration is simple, we inoculate respectively 1 milliliter and 0.1 milliliter of the sample and stopper with cotton wool.

After 24 to 48 hours of incubation in an oven at 44°C, the tubes in which there is production of acid and gas were considered positive. The most probable number (MPN) of presumed coliforms present in 100 ml of water is obtained by referring to Mac Graddy's table (Rodier, 1978; Lambert, 1989).

Enumeration of total coliforms

Total coliforms were counted in the lactose broth following the same procedure for counting faecal coliforms. Here, the incubation was carried out at 37° C for 24 hours. The tubes in which there is acid and gas production were considered positive. The most probable number (MPN) of presumed total coliforms present in 100 ml of water was obtained by referring to Mac Graddy's table (Rodier, 1978; Lambert, 1989).

Enumeration of faecal streptococci

Faecal streptococci were counted in Sherman's milk using the multiple-tube fermentation technique: 3 sets of three test tubes each containing 10 milliliters of Sherman's milk whose enzymes are already heat-activated were placed in a rack. In the tubes of the first series whose concentration is doubled, 10 ml of water to be analysed are inoculated. In those of the second and third series having a simple concentration, one inoculates respectively 1 ml and 0,1 ml of the sample and one plugs with wadding.

After 24 hours of incubation at 37°C, the tubes in which there is discoloration and coagulation of the milk were considered positive. The most probable number of presumed streptococci present in 100 ml of water analysed is obtained by referring to the Mac Graddy table (Rodier, 1978).

Determination of the level of health risk

The classification of the health risk according to the concentration of faecal coliforms and streptococci was made according to the standards of the World Health Organization (WHO, 1997) found in Table 1 of this work.

Determination of the origin of faecal contamination of water

The origin of the faecal contamination of the waters of these two Wells was determined according to these criteria defined by Borrego and Romero (1982):

The contamination is of animal origin if the ratio (R) faecal coliforms (CF)/faecal streptococci (SF) is less than 0.7, and of human origin if this ratio is greater than 4. The origin of the contamination is mixed, predominantly animal if R is between 0.7 and 1; this origin is uncertain if R is between 1 and 2. The origin of the contamination is mixed, predominantly human, if R is between 2 and 4.

Table 1. Origin of faecal contamination of water (Borrego and Romero, 1982)

C. F/ S.F (R)	Origin of water contamination
< 0,7	animal
> 4	human
0,7 < R < 1	Mixed with animal predominance
1 < R < 2	Uncertain origin
2 < R < 4	Mixed predominantly human

Results and Discussions

Physico-Chemical analyzes of water

Table 2. Results of physico-chemical water analyses

Well	Well Parameter (unit)	Standards	Value found	Observation
P1	Température (°C)	< 25	29,1	Extraordinary
	pH	6,5 à 8,5	6,01	Extraordinary
	Chlore (mg/l)	> 0,2	0	Extraordinary
P2	Température (°C)	< 25	27	Extraordinary
	pH	6,5 à 8,5	5,75	Extraordinary
	Chlore (mg/l)	> 0,2	0	Extraordinary

It appears from the above table that the average water temperature of Well 1 is 29.1°C while the average water temperature of Well 2 is 27°C. Thus, for the temperature, the waters of both Wells were out of the ordinary because they had a temperature above 25°C.

Our results are similar to those of Aissi (1992) in Cotonou, who found spring water temperatures varying between 27 and 30°C.

We think that the high degrees of water temperature of the Wells concerned would be justified by the shallow depth of the groundwater table. It should also be noted that water at a temperature of more than 25°C constitutes a good culture medium for micro-organisms in the environment, i.e. creates favourable conditions for water pollution in the environment. tropical (WHO, 1998).

The pH of the waters of Wells 1 and 2 are respectively 6.01 and 5.75. Thus, the pH of the water in Well 1 is slightly lower than the minimum pH required by the WHO, while that of the water in Well 2 is lower than the standards. Indeed, for pH values below 6, the water risks becoming too corrosive, which could lead to the deterioration of infrastructure or living tissue.

The acidity of the waters of Well 2 is explained by the fact that its users often do the dishes, laundry all around this Well and these waste waters infiltrate and thus cause the said acidity.

It also follows from our results that no trace of chlorine was found in the waters of these two wells. Nyamaifofe (2016) also found the same result for three sources in the peri-urban area of Kisangani. Indeed, the absence of chlorine in these waters testifies that they do not undergo any chemical treatment.

Bacteriological analyses

Enumeration of total germs and total coliforms

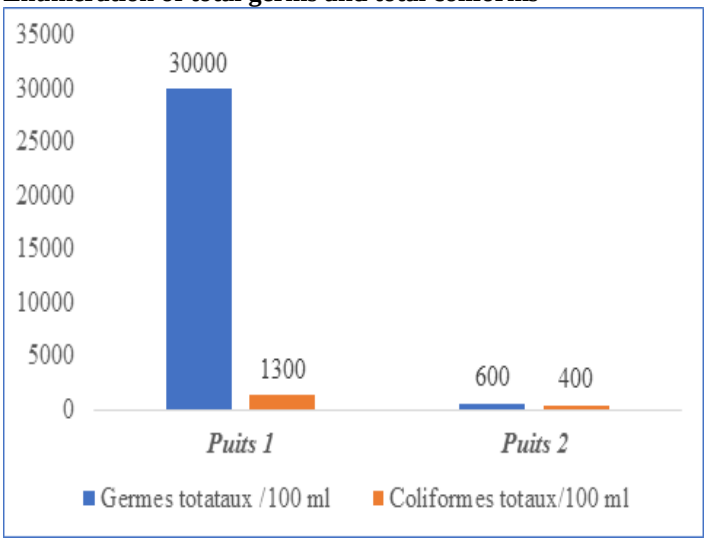

Figure 2. Average concentration of total germs and total coliforms in water

The water from Well 1 contains on average 30,000 total germs per 100 ml and 1,300 total coliforms per 100 ml while the water from Well 2 contains 600 total germs per 100 ml and 400 total coliforms per 100 ml. According to the WHO, water intended for consumption must contain less than 10 total germs and total coliforms in 100 ml.

Indeed, the count of total coliforms as well as total germs does not make it possible to judge the quality of these waters. Their presence in the water does not indicate faecal contamination or a health risk, but rather a deterioration in the bacterial quality of the water. This degradation can be attributed, among other things, to surface water infiltration into the well.

The count of total germs in water is an orientation test, used as an indicator of pollution either in natural environments or in networks, also used as an indicator of treatment efficiency. Thus, the high concentration of total germs and coliforms in the water of these two wells testifies to the lack of treatment and the infiltration of surface wastewater in these wells.

Enumeration of Faecal Coliforms and Faecal Streptococci

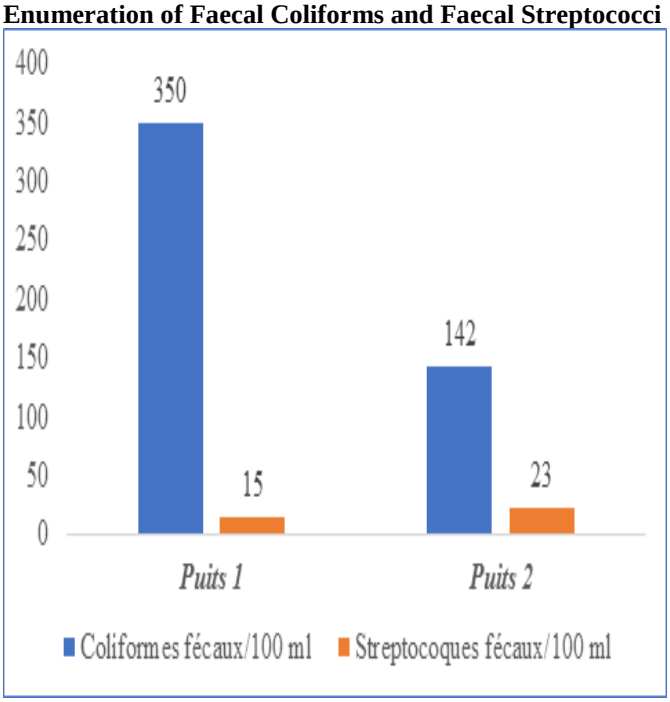

Figure 3. Average concentration of C.F and S.F in water

This figure shows that 100 ml of water from well 1 contains on average 350 total coliforms and 15 faecal streptococci while 100 ml of water from well 2 contains on average 142 faecal coliforms and 23 total coliforms. By comparing these results with the potability standards of spring and well water according to the African reality proposed by Duchemin and described by Bemmo et al. (1998), the water from Well 1 is of suspect quality while the water from Well 2 is of fairly good quality.

Our results are different from those of Nyamaifofe (2016) who found that the water from all springs in the peri-urban area of the city of Kisangani was of poor quality. The presence of faecal coliforms and faecal streptococci in the waters of these two wells indicates faecal contamination of these waters. This contamination would result from the infiltration of wastewater and other surface water into these wells, poor practice in water collection (dirty collection container, dirty hands of users,) or bringing these wells closer to latrines.

Determination of the level of health risk

Table 3. Classification of well water according to health risk

Puits	C.F/100 ml	S.F /100 ml	C.F/S.F	Origin of pollution
P1	350	15	23	human
P2	142	23	6	human

We observe in the table above that faecal contamination of the waters of wells 1 and 2 is entirely of human origin. Indeed, human activities around these wells may explain these results. These results are different from those found by Koffi-Nevry R. et al (2012) in Abidjan. They found that in 50% of irrigation water production sites, the contamination was strictly of human origin.

Conclusions and recommendations

This study on the bacteriological and physico-chemical analysis of the water of the wells of the commune of Mangobo aimed to determine the quality of the waters of these wells. The waters from these two wells (1 and 2) were analyzed in the field and in the laboratory. After analysis and processing of the data, our results proved that, compared to the physico-chemical parameters, these waters were out of standard for temperature, pH and did not contain chlorine. These waters therefore do not undergo any treatment and are real culture media in relation to their temperature. From a microbiological point of view, the water from well 1 is of suspect quality and is not suitable for human consumption, while that from well 2 is of fairly good quality. The contamination of these waters is of strictly human origin, therefore coming from its users.

Given these results, we make the following recommendations:

To the Provincial Ministry of Public Health of Tshopo:

- To carry out a systematic bacteriological and physico-chemical control of the wells used by the Boyoma population to prevent the risks of waterborne diseases
- To distribute to users of wells who do not have access to drinking water from Regideso, products for simple treatment of drinking water

To the population of Mangobo, consumer of well water:

- Properly manage and channel domestic wastewater
- Not to build latrines near water wells
- Wash hands after defecation before drawing water from wells
- To have a cover for the wells
- Boil the water before using it or treat the container with chlorine.

To future researchers who will address the same theme:

- To address the aspects that we have not identified, in particular the search for Escherichia coli, the addition of other physico-chemical parameters and increasing the number of wells.
- To determine the level of risk to consumer health based on the concentration of faecal coliforms in water.

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