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Bacteriological Quality Of Water Consumed In Farming Environment In Rdc: Case Of The Province Of The Tshopo

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Abstract
The present work has for objective to make a survey compared of the bacteriological quality of the consumption waters between the certified villages and no certified of the zones of health of the Province of the Tshopo, in Democratic Republic of Congo. To the total 2.646 samples of these waters have been appropriated and have been submitted to the analyses. The bacteriological analyses of our samples were about the isolation, the numbering, identification and the sensitivity of the germs to the antibiotics. The sought-after germs were the coliformes (fecal and total), the Salmonellas, the fecal Streptococci and the E. coli. The isolation and numbering of the bacteria have been determined in situ thanks to the kit of Wagtech. The isolated stumps have been planted out thereafter in the soft gélose, then elated to the laboratory of microbiology of the biotechnical sciences to the Faculty of the Sciences and the one of the Center of Biodiversity Surveillance of the university of Kisangani, for identification. The bacteriological analysis of the samples of waters analyzed revealed that :

- ✓ *4,8% of the drinking water, that are in conformity with the norms of potabilité of the WHO and FEACHEM;*
- ✓ *Of all studied indicators (C. F; C. T; S. F; E.coli and Salmonella) from the waters of the points of provision in water and households, the classification of Feachem shows that 11,90±2,14% of the water samples are drinkable; 78,57±69,64% are acceptable; 16,66±32,50% are unfit and 2,38% of the samples are extremely unfit or contaminated;*
- ✓ *A strong concentration of the germs isolated in the waters of the households that those of the points of provision in water, except for the salmonellas, either 23,1107 UFC against 25,9762 UFC respectively;*
- ✓ *The test T-Student applied to this two samples matched (households and points of provision in water) didn't show a meaningful difference, for all isolated germs, between the level of water contamination consumed at home and the one of the points of provision in water. Therefore, the level of contamination of the consumption waters is in the same way to the level of the households that of the points of provision in water;*
- ✓ *The germs isolated in the analyzed waters are observed in all zones of health. The most elevated middle concentrations in total coliformes are observed in Basoko, Bafwasende and Lubunga, either 135,83 UFC; 130,99 UFC and 113,43 UFC respectively. The fecal Streptococci are observed more in Opala, Basoko, Bengamisa and Yakusu, either an average of 67,73 UFC; 65,83 UFC; 62,29 UFC and 52,06 UFC respectively. While the fecal coliformes is observed more in Opala and Bengamisa, either 49,40 UFC and 39,28 UFC respectively. Also, the salmonellas and E.coli are present in all zones of health;*
- ✓ *The application of ANOVA-test in the samples of analysis of water of the seven zones of health proves that the difference is very meaningful for all isolated germs, in said zones of health, with the exception of the salmonellas where the test proves a non meaningful difference of contamination of the consumption waters, either p=0,872, that is superior to the doorstep of probability of 0,05. Of where, generally, in farming environment in RDC, of which especially in Province of the Tshopo, the waters of consumption are not contaminated of the same way to the level of the health zones, because it is also bound to their ethnic groups or tribes, who defer themselves of a health zone to another;*
- ✓ *The river is contaminated more, in nearly all isolated germs, that the other types of the points of water analyzed. Globally, these are the total coliformes and the fecal Streptococci that are more numerous in the waters of the river analyzed. The fecal coliformes and the salmonellas evolve in the same sense for the samples of the aforesaid river, that means that the concentration in fecal coliformes nearly increases with the one of the*

salmonellas. While the Escherichia coli presents the same concentrations in nearly all types of the points of water analyzed;

✓ *The test of ANOVA applied to the samples of the different types of points of water analyzed (river, source, reserve water of the households and boring) specifies that there is not meaningful difference, as for their level of contamination, and this for all isolated germs, because the values of significance of the test are superior to the doorstep of probability 0,05. What comes back to say that the level of contamination of the types of the points of provision in water is the same in farming environment, in province of the Tshopo;*

✓ *The Interrelationship of Pearson applied to the samples of water analyzed (river, arranged sources and non arranged, reserve water of the households and boring) confirms that an interrelationship exists between the physico-chemical elements and the fecal bacteria, because the score shows that the r coefficient = 0,161; what comes back to say that $r \neq 0$;*

✓ *The CF/SF report of the points of provision in analyzed water is equal to 0,4; what confirms that the pollution of water is due to the house pets;*

✓ *Of the achieved antibiogramme, the Ciproxin has an efficient activity again on all identified stumps, either 51,70% of the cases; consistent of Negram and Amikacine, either 45,60% and 43,30% of the cases respectively. The other antibiotics only showed a weak action on the different identified stumps.*

Key words: Quality, Water of consumption, Bacteriological, farming Environment, DRC.

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I. I.Introduction

The drinking water is a water that the man can consume all along his/her/its life without danger or risk for health. This water, indeed, must be pleasant to drink, and must not contain in quantity, nor chemical substances, nor harmful germs for health (WHO, 2004).

Since the night of the times, paradoxically, water is at a time source of life and source of illness those that consume it. The access to the drinking water and to the adequate purification is vital for a meaningful reduction of the sanitary risks and the institution of a healthy environment. The knowledge of the situation and the evolution of provision in water and purification is of this indispensable fact. The objective of the follow-up is to inform the political decision-makers and the actors of the sector on the evolutions observed in view of an aware decision making. Provision in water results in the set of the operations as the catchment or the withdrawal, the treatment in order to make it healthy and edible, the transportation of this one toward points of consumptions in order to make it accessible to the users, the storage and the distribution (Thomas Kayobola, 2020).

Beyond the quantity, the quality of water is a determinant of human health particularly preoccupying in farming zone. In the world, 1,1 billion of people doesn't have a sufficient access to the drinking water. When she/it is accessible, water is often sujette to a chemical and/or bacteriological contamination. The fecal contamination of the consumption water is of human or animal, direct or indirect origin. The use of such a water as drink or in the preparation of food, can be at the origin of the new cases of infection. The pathogenic agents in reason are the bacteria, the viruses and the protozoa. They can provoke illnesses of variable gravity, of the benign gastroenteritis to the dysentery, to hepatitis or to the typhoid fever, or even to the stern and sometimes deadly diarrhea. The illnesses of water origin would entail each year 3,4 millions of death thus, of which 2,2 millions by illnesses diarrhéiques, notably the cholera (Ndiaye and al., 2010).

However, he/it imports to note that when the problem of the quantity of the waters necessary to the population and to his/her/its economic development offers to find some solutions (by the use of the surface waters), the problem of his/her/its quality, particularly microbiological, arises as well for the underground waters (all along the chain of water) that the waters of surface.

Indeed, a big part of the illnesses, in farming and out-of-town zone, is bound to a bad quality of water and the requirements of quality are more and more stern and coercive. Some parameters are generally followed to ascertain the "drinkable" quality of water proposed to the human consumption. The most frequent illnesses caused by the quality of the drink water and that put serious problems of health are bound to the content in matter fecal of water (Unicef, 2011).

In Democratic Republic of Congo, the data are in general rare, and representative studies that inform on the fecal contamination or the quality of water consumed to the level of the farming households don't exist practically. The practices and the uses that alter or keep the quality of this water are known little or listed insufficiently. The measures of accompaniment of the projects of investments in hydraulic infrastructures don't take sufficiently in account the obvious tie between the quality of water, hygiene and his/her/its importance for the health of the users (Unicef, 2011).

RDC counts around 80 to 85 millions (according to the evaluations) of inhabitants and spreads on 2.345.000 km2 of surface, of which 70% of his/her/its population live in farming environment. It is the second bigger African country by the surface, and the fourth country of Africa the more populated. In a general manner, this strong demographic explosion generates a demand exorbitant of basis services notably in the domains of water and purification. Water holds, indeed, a vital place with regard to the environment, the economy as well as the society in such a country the Democratic Republic of Congo (Kayobola, 2020).

The rivers, the lakes, the humid zones, and the aquiferous, all these ecosystems are extremely indispensable. These last procure the drinking water, of the water that serves habitats for the aquatic life, of the water essential to the cultures vivrières and to the industries of the country, and of water to master the periods of drought. Water constitutes therefore, in this sense, an important element to the lasting development, as well as au well-being of the humanity. Being on the horizon at the heart of the Lasting Development Program of 2030, the objective 6 of the Lasting Development aims to" to guarantee the access of all to water and to purification and to assure a lasting management of resources in water" (Ademe, 2007).

Although the Democratic Republic of Congo (RDC) either the propertied Africa country resources most important hydrologiques, she/it must face today a sharp crisis of provision in drinking water. Indeed, only 26% of the Congolese population have access to a healthful drinking water, an evaluation well below the average of the 60% for the whole sub-Saharan Africa (PNUE, 2011).

Because of the damaged infrastructures, weakened per years of under-investment and conflict and the fast growth of the population, the rate of provision cover in water declined until lately. The social and sanitary consequences of the rupture of the water services were considerable. The poorest slices of the society have been touched in a disproportionate way by the decline of the benefit of the services and the increase in prices of water. This situation has been observed in the farming zones, but also in an increasing way in the cities knowing a fast expansion (PNUE, 2011).

However, the population in reaction to the shortage of water had resort especially to wells to large diameter in the zones where water is easily accessible or to boring to reach water under ground beyond 30 meters. If these works have the advantage to solve the problem of the water availability, the quality of this commodity is not often guaranteed. In 2002 a survey revealed that the waters of well in the zone South Lagunaire of Lomé were contaminated by Coliformes thermotolérants and Escherichia coli (Sadaoc, 2002).

According to the World organization of Health, water destined to the consumption and the needs of the households must not contain any pathogenic microorganismes; no sample of 100 ml of a water destined to the consumption must contain germs anaerobic sulfito-reducing, of coliformes and streptococci (WHO, 2008).

Otherwise, Makoutode and al. (1999), esteem that all waters of consumption in farming environment are often victims of contamination by Entérocoqueses, of which most famous among them is the *E. coli*. Also, these bacteria witnesses of the contaminations of fecal origin of waters are recovered more in the waters of sources, wells, boring and rivers consumed in farming environment (Coulibaly, 2005).

According to Chippaux and al. (2002), the origin of the pollutions can be assigned to the shortcomings of purification and collection of the garbage, to the transfer of pollutants from the superficial layers of soil, to the conditions of drawing and to the structure of the works.

The hypothesis given out in this research is that waters consumed by the farming population of the province of the Tshopo, in Democratic Republic of Congo, don't answer the norms of potabilité(qualité), because they include harmful germs to health, with as consequences the intervening of the illnesses to water transmission.

The present survey has for objectives:

* To determine the bacteriological quality of waters consumed in farming environment of the Province of the Tshopo (points of provision and households), in accordance with the existing norms;
* To identify the most isolated indicatory bacteria of the pollution, according to instructions of the WHO.

II. Matériel And Methods

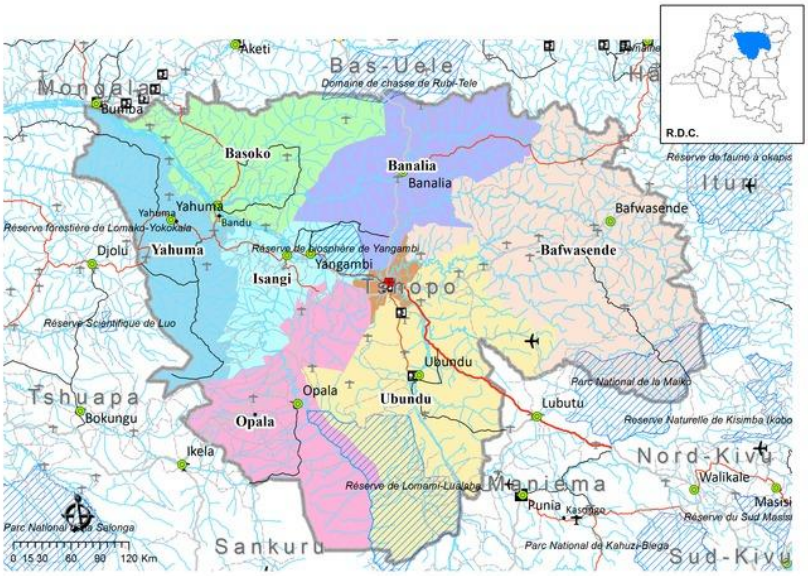
II.1. Middle of survey (Pronanut Tshopo, 2021).

Situated in the center of the Democratic Republic of Congo (RDC), the Province of the Tshopo spreads on a surface of 197 657 Km²s. She/it is therefore the vast province of the RDC.

Her population is estimated to 3.102.477 inhabitants, with a density of 15,6 hab. / Km². It is situated to 1°13'603 " of North latitude in relation to the equator and to 23°36'232 " of longitude is in relation to the meridian of Greenwich, with a middle altitude of 473 m above the sea level; but departure is also situated and of other of the Congo stream.

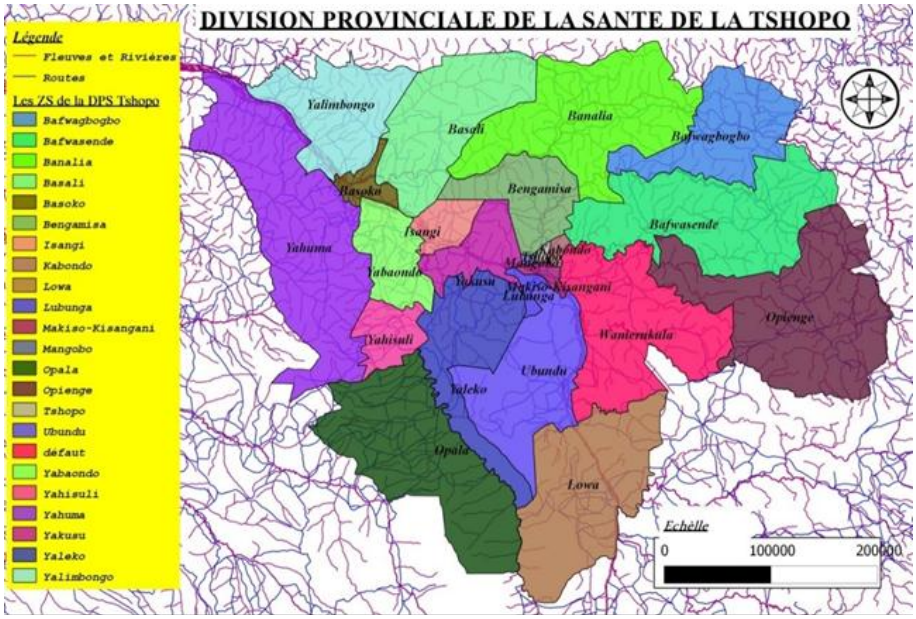
On the administrative plan, the province consists of 1 City of Kisangani, 6 townships (Makiso, Kisangani, Kabondo, Mangobo, Lubunga and Tshopo); 7 administrative territories (Basoko, Isangi, Yahuma, Banalia, Bafwasende, Ubundu and Opala) ;199 Sectors and Chefferieses; 23 zones of Health and 426 Aires of Health.

She/it is limited naturally:
"To the East by the Avakubi river with the Province of the Ituri and North Kivu;
"To the west by the Itimbiri river with the province of the Mongala and Tshuapa;
"To the North by the river Television with the Province of Low-Uélé and High-Uélés;
"To the South by the Province of Maniema and Sankuru.
The Province of the Tshopo knows only one equatorial climate, according to the classification of Köppen-Geiger, characterized by a yearly middle temperature of 25°C, with a yearly thermal amplitude of 1,7°C. The minimal and maximal middle temperatures vary between 18°C and 30°C. The middle precipitations vary from 64,1 to 494,6 mm between the driest month and the most humid month. They are irregular in the time and in the space. The Province of the Tshopo knows four seasons économétriques:
- the big season of rains: spreads of the of August 15 to December 15;
- the small season of rains: go from March 15 to May 15;
- the big dry season: spreads du16 May to August 14;
- the small dry season: go from December 16 to March 14
The vegetation of the Province of the Tshopo is dominated by the dense forest, constituted of the trees and bushes of middle density. Besides, one finds the argilo-gritty soil, that makes there of shoed soil (yellow, red and ocher latasols), Ferri soil and areno - shoe-soil, and cover the whole province; and that the central pan constitutes the most dominant relief.
By his/her/its volume and his/her/its space, the Province of the Tshopo constitutes an important hydrographic artery of the RDC. She/it is flowed by one Stream, 9 rivers and several streams:
"Stream: Congo.
"Rivers: Aruwimi, Tshopo, Lindi, Lomami, Itimbiri, Maiko, Loleka, Lopori, Lowa,.
"Streams: Lokombe, Lonua, Loleka, Mokeke, Moliwa, Lobaie, Bunga, Lulu...
The Streams of the Province of the Tshopo constitute the potential seat of the peat-bogs for excellence of the aforesaid province.



Face 1: Administrative card of the Province of the Tshopo (Boss, 2022)

II.2. Setting of the survey
Our survey has been led in the 7 seven zones of health of the province of the Tshopo, to know: Bafwasende, Basoko, Bengamisa, Lubunga, Opala, Wani-rukula and Yakusu, precisely in 6(six) villages by Zone of health, because of 3(trois) villages certified by the organization Purified non governmental Village and 3(trois) non certified villages.
The 23(Vingt three) different zones of health of the Province of the Tshopo are represented below in the card:



Face 2: The different zones of the Province of the Tshopo (Pronanut Tshopo,2022).

II.3. Materials.

The materials that helped us to really lead our investigatings are: A complete Kit of Wagtech, one numeric camera, the small bottles in glass sterile Pyrex, the Erlen Meyerses, the Beak Busen or lamp to alcohol, they limp of Kneaded, the tubes to tests, the blades and gills, the shackle of turntable, the disks of antibiogramme, the microscope, the gnarl, the autoclave, incubator, plate burner, the distilled water, syringe, the sterile swabs, the surroundings of culture, Portoir for tubes, Tubes to sterile hemolysis and Pipette Pasteur.

Face 3: Kit of Wagtech

II.4. Methods

Our survey is transverse and bill on the physico-chemical and bacteriological quality, fashion of management of the consumption water and the sanitary risks bound to the consumption of water contaminated; but also purification in farming environment. She/it covers an active period of the month of January 2017 in the month of December 2020; either a period of 3 years of two main seasons of the year: dry and rainy. The Population of survey is constituted of 42 points of provision in water, of which 21 sources of water arranged, 17 sources of water non arranged, 2 Boring and 2 rivers, left in the 42 villages of the 7 zones of health, retained in relation to their company by the population of the survey middle. The samples of water analyzed were appropriated to the level of the sources of water arranged and non were arranged, of the boring; as well as au level of the rivers that some populations use regularly for their provision, but also to the level of the households.

In the setting of our survey, we did to the total 2.646 withdrawals, of which 126 in 42 points of water and 2.520 in 840 households; and that every point of water or household was the subject of 3 withdrawals for the analyses.

Indeed, we used the small bottles made of glass Pyrex, previously sterilized during one hour to 180°C in the Oven Pasteur. These withdrawals have also been done between 6 at 9 hours, in the aseptic conditions,

during the different seasons of the year; and that a part of the analyses has been achieved on land, while using the Kit of Wagtech.

Thereafter, the isolated stumps have been planted out in the soft gélose, then elated to the laboratory of microbiology of the biotechnical sciences, to the Faculty of the Sciences and the CSB of the university of Kisangani, for identification.

The bacteriological analyses of our samples were about the isolation, the numbering, identification and the sensitivity of the germs to the antibiotics. The sought-after germs were the coliformes (fecal and total), the Salmonellas, the fecal Streptococci and the *E. coli*.

The statistical treatment of the data has been achieved with the help of the software SPSS, version20, to draw the pictures and the diagrams, in relation with the different analyzed parameters. However, in this software, we used the T-Student tests for equality of the averages enters the points of provision in water and the waters of the households, between the certified villages and no certified and ANOVA for the analysis of variance, between the different zones of health, but also between the different types of the points of provision in water. The measured parameters have been valued according to the norms of the WHO (2011) for the quality of the consumption waters.

III. Résultats And Discussion

The results of the bacteriological analyses done are presented below in the faces or Pictures. The norms for the quality of the water of consumption of Feachem and the WHO acted as basis to the interpretation of our results.

III.1. Bacteriological quality of waters analyzed

a. Quality according to WHO and FEACHEM

Picture 1: *Bacteriological quality of water following the dawneds of provision in water (source, river and boring) and the classification of the WHO and Feachem.*

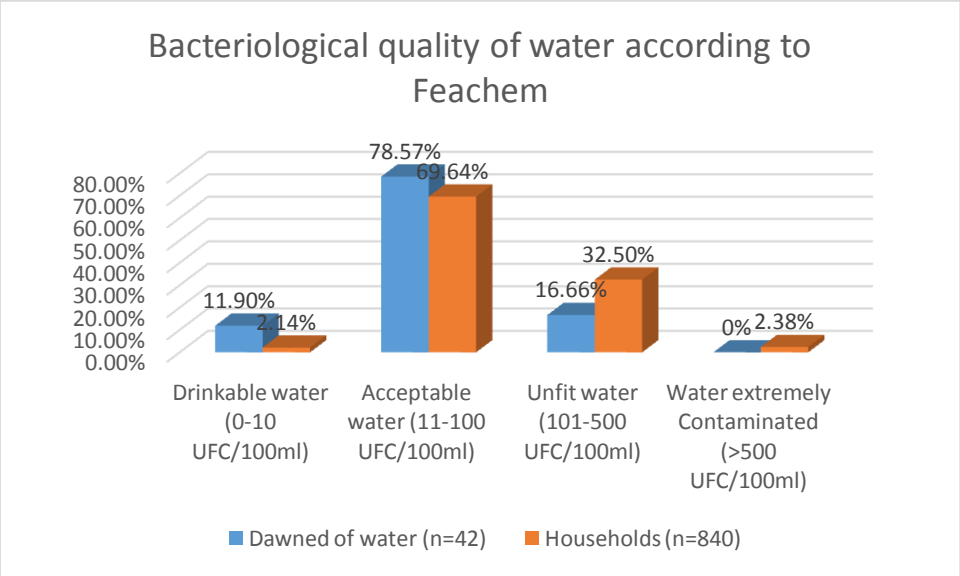
Dawned of water	Bacteriological parameters					Quality of water according to the WHO	Quality of water according to the Feachem
	C.F	C.T	S.F	E.coli	Salmonella		
Source Akolikotcha	34	62	56	A	44	No drinkable	Acceptable
Source Bokululu	8	58	66	P	2	No drinkable	Acceptable
Boring Yandafe	0	4	21	A	12	No drinkable	Acceptable
Source Bakonga	16	16	26	A	0	No drinkable	Acceptable
Source Musenge	0	6	46	A	0	No drinkable	Acceptable
Source Adjigidjigi	23	88	76	A	15	No drinkable	Acceptable
Source Angombe	30	57	86	A	21	No drinkable	Acceptable
Source Tsalama	0	0	21	A	0	No drinkable	Acceptable
Source Nyangedebia	88	62	91	A	32	No drinkable	Acceptable
Source Adobo	88	10	31	A	13	No drinkable	Acceptable
Source Badjoge	21	32	56	A	5	No drinkable	Acceptable
Source Ngande	20	84	65	A	11	No drinkable	Acceptable
Source Chololo	0	32	9	A	0	No drinkable	Acceptable
Source Botokona	2	62	19	A	8	No drinkable	Acceptable
Source Masumbuko	0	0	0	A	0	No drinkable	Acceptable
Source Sinailanga	9	13	8	A	19	No drinkable	Acceptable
Source PK76	10	33	10	P	6	No drinkable	Acceptable
Source Amakulu	0	21	0	A	0	No drinkable	Acceptable
Boring Bafwadodi	0	53	0	A	0	No drinkable	Acceptable
Boring Bafwamondulu	0	53	0	A	0	No drinkable	Acceptable
Source Kimbangu	14	129	13	A	20	No drinkable	Unfit
Source Balambi	0	453	12	A	0	No drinkable	Unfit
Source Caritas	0	37	0	A	0	No drinkable	Acceptable
Source Bafwa	0	123	0	A	0	No drinkable	Unfit
Source Betombe	9	4	7	P	15	No drinkable	Unfit
Source Ngenengene	0	0	0	A	0	Drinkable	Drinkable
Source Busandja	0	0	0	A	0	Drinkable	Drinkable
Source Bale	0	365	16	P	0	No drinkable	Impropre
Source Kirundu	36	76	28	P	23	No drinkable	Acceptable
Source Lobonga	12	65	18	A	16	No drinkable	Acceptable
Source Isoloiyongo	28	32	57	A	4	No drinkable	Acceptable
Source Isoloisimo	8	28	21	A	9	No drinkable	Acceptable
Source Isoloofala	16	128	39	A	3	No drinkable	Acceptable
Source Miakamiaka	80	357	500	P	32	No drinkable	Acceptable
Source Yuho	38	20	65	A	25	No drinkable	Acceptable
Source Letuteme	29	66	106	P	42	No drinkable	Unfit
River Aruwimi	35	158	66	P	43	No drinkable	Unfit
Source Gbundu	14	82	46	A	8	No drinkable	Acceptable

Boring Makele	2	54	22	A	22	No drinkable	Acceptable
Boring Bombanzoto	0	6	86	A	0	No drinkable	Acceptable
River Lulu	44	88	126	P	51	No drinkable	Unfit
Source Plaine	22	84	126	P	12	No drinkable	Unfit
TOTAL	**736**	**3101**	**2041**	-	**513**	-	-

Legend: C.F= Fecal Coliformes ; C.T = Total Coliformes ; SF= fecal Streptococci ; E.coli= *Escherichia coli*
The results of the picture 1 watch that, on 42 dawned of provision in analyzed water, there are only two points that are in conformity with the norms of potability of the WHO and FEACHEM, either 4,8% of the cases.
These results confirm the literature according to which the farming water or perished urban, in tropical or sub-tropical zones, rarely answers instructions of potabilité of the World organization of Health (WHO, 2007).
In the same way, according to the WHO (2019), 2 billions of people in the world use points of water contaminated by fecal matters.

As for what concerns us, these results prove that the climatic change, the increasing shortage of water, the growth and the evolution demographic as well as the urbanization already poses some problems for the systems of food in water. Of 2025, the half of the world population will live in subject regions to the water stress. The retraining of the worn-out waters, to recover the nutriments or the energy, becomes an important strategy (WHO, 2019).

b. Bacteriological quality of water according to FEACHEM



Face 4: Bacteriological quality of water following his origin and the classification of Feachem (all indicators: C.F; C.T; S.F; E. coli and Salmonella).

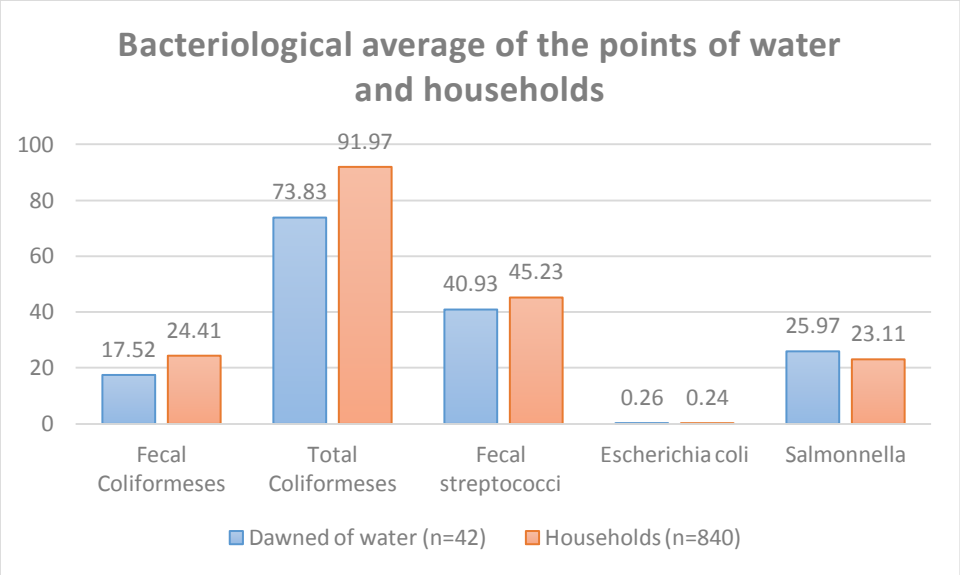
Concerning all studied indicators (C. F; C. T; S. F; *E.coli* and Salmonella) from the waters of the points of provision and households, as consigned in the face 4, the classification of Feachem shows that 11,90±2,14% of the water samples are drinkable; 78,57±69,64% are acceptable; 16,66±32,50% are unfit and 2,38% of the samples are extremely unfit or contaminated.

Thus, we think like Makoutoude and al. (1999), that estimate that the pollution of water so much during the storage that to the practices exercised at the time of the chain of water are bound of the withdrawal.

Also, a survey led by Mirindi and al. (2005) in the zone of health of Katana in Bukavu, to the south-kivu, reveal that the pollution of water to the level of the households is enormous, and pass the norms of water potabilité. This survey proved that the averages of the total coliformes and *E.coli* in the reserve water of the households went against by the arranged sources were respectively of 1903,5UFC and 40,7 UFC.

However, our results prove the potability of water is bound to the bad reserved manipulation practices to the water of consumption by the farming population at the time of the chain of water, but also to their behavior, because these last often use some containers without lid to draw or to stock the water of consumption.

III.2. Comparison of the samples of the points of water to those of the households (T-Student).
a. Bacteriological average of the points of water and households (T-Student).



Face 5: Comparison of the bacteriological averages of the samples of the points of water to those of the households.

The analysis of the face 5 shows that there is a strong concentration of the germs isolated in the waters of the households that those of the points of provision in water, except for the salmonellas, either 23,1107 UFC against 25,9762 UFC respectively.

Our results corroborate those of Mirindi and al. (2005) in Bukavu, to the south-kivu, where they found the averages of 1903,5UFC and 40,7 UFC respectively for the total coliformes and the *E.coli* in the reserve water of the households went against by the arranged sources; and that we found 91,97% of the total coliformes in the waters of consumption stocked in the households of the farming population of the Province of the Tshopo.

We think that it is due to the bad manipulation of the water chain. The analysis of the face 5 shows that there is a strong concentration of the germs isolated in the waters of the households that those of the points of provision in water, except for the salmonellas, either 23,1107 UFC against 25,9762 UFC respectively.

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b. Application of the T-Student test on the found bacteriological averages

Picture 2: Research of the possible meaningful difference between the level of contamination of the water of consumption of the points of water and households.

Test of independent samples.

Test / **Parameters**	**Test t-Student for equality of the averages**		
	t	ddl	Significance (bilateral)
Fecal Coliformeses	0,955	880	0,340
Total Coliformeses	1,058	880	0,290
Fecal streptococci	0,612	880	0,540
Escherichia Coli	-0,308	880	0,758
Salmonella	-0,878	880	0,380

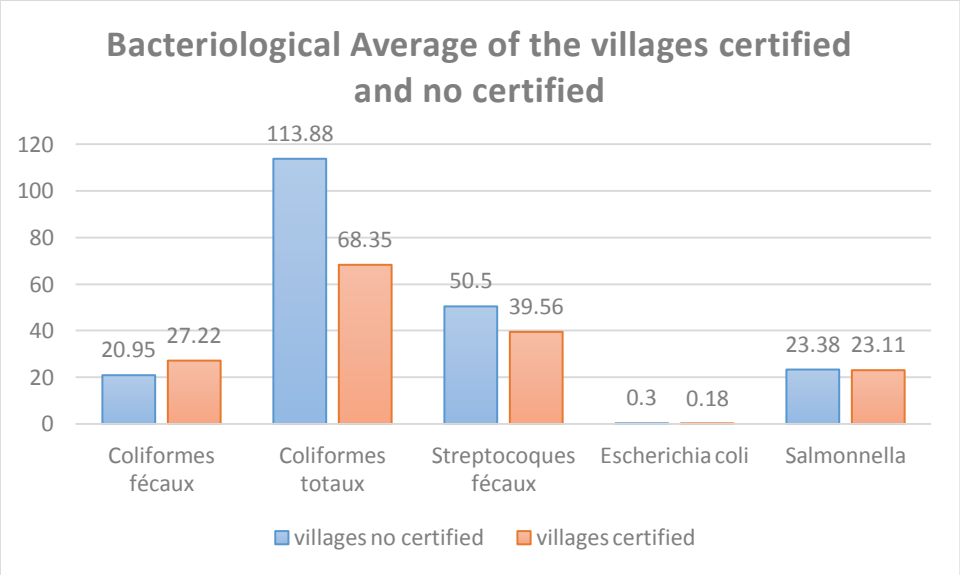
The test T-Student applied to this two samples matched of the picture 2 shows that, the differences are not meaningful, for all isolated germs, between the level of contamination of the consumption water at home and the one of the points of provision in water. Therefore, the level of contamination of the consumption waters is in the same way to the level of the households that of the points of provision in water.

We think that this situation is due to the environment unsanitary of the points of water, the doubtful hygiene of the utensils of drawings, transportation and storage, non access to the drinking water, but also to the use more of the children to ends of consumption water; what is at the origin of the deterioration of the water quality by contamination manu or airborne.

According to the WHO, more of one billion of people don't have access to a system of provision in water improved capable to provide at least 20 liters of per person healthful water and per day. Some authors proposed to analyze the access to water in terms of available quantities then, of distance to the point of water and cost bound to the purchase of water. These annoyances are especially felt in the households to weak incomes or those that live in periphery of the city (Sackou and al., 2010).

III.3. Comparaison of the samples of the villages certified to those of the no certified (T-Student).

a. Bacteriological Average of the villages certified and no certified



Face 6: Comparison of the bacteriological averages of the samples of water of the villages certified to those of the non certified.

He/it clears himself/itself of the face 6 that, the contamination of the consumption water by the bacteria of fecal origin is raised very for the total coliformes and fecal streptococci. The waters of the villages no certified are contaminated more that those of the villages certified, except for the cases of the fecal coliformes and salmonella where the bacteriological averages observed in the certified villages and no certified are respectively of 27,22±20,95 UFC and 23,11± 23,38 UFC. The presence of *E.coli* is raised more in the waters of the villages non certified (0,3 UFC) that those of the villages certified (0,18 UFC); while the one of the fecal coliformes is raised more in the waters of the villages certified (27,22 UFC) against 20,95 UFC of the non certified.

We dare to believe that the contamination of the consumption water in farming environment of the Province of the Tshopo (certified villages like no certified) is musted to the passage of the travelers, of which in individuals the Mbororos, that defecate with their beasts along the points of provision in water on the one hand, on the other hand by the raising of the small bétails in said villages, that are in free raving next to the population until the points of provision in water; but also to the behavior of the villagers facing the water of consumption.

b. Application of the T-Student test on the found bacteriological averages

Picture 3: Research of the possible meaningful difference between the level of contamination of the consumption water between the certified villages and no certified.

Test of independent samples.

Test / **parameters**	**Test t-Student for equality of the averages**		
	t	ddl	Significance (bilateral)
Fecal Coliformeses	-2,045	880	0,041
Total Coliformeses	6,369	880	0,000
Fecal streptococci	3,682	880	0,000
Escherichia Coli	4,086	880	0,000
Salmonella	0,196	880	0,845

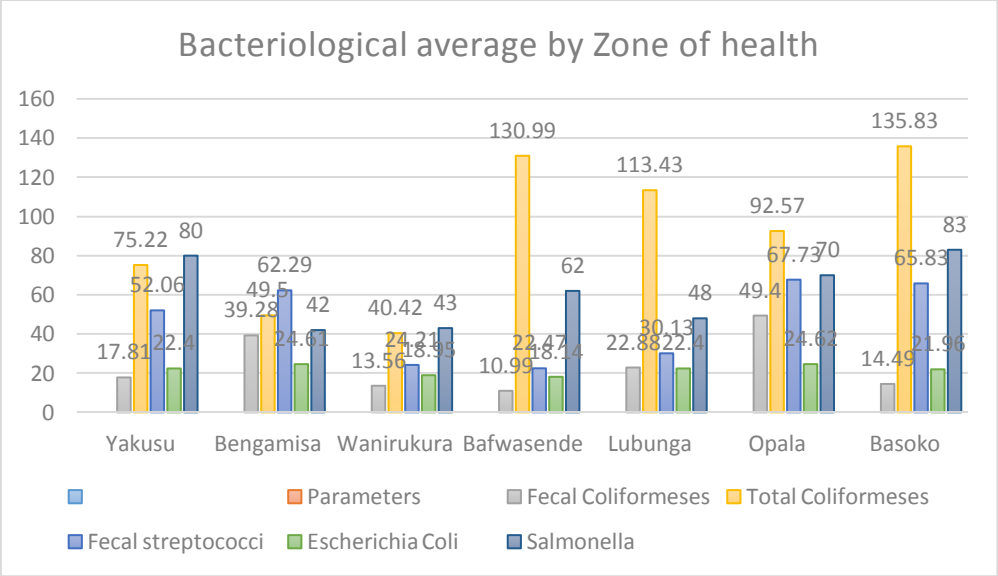
Considering the relative result to the level of contamination of the water of the villages certified in relation to the non certified, the test T-Student applied to this two samples matched of the picture 3 shows that, the difference is very meaningful for all isolated germs, between the level of contamination of these two types of villages, except for the salmonellas where the difference of contamination is not meaningful, either p=0,845, that is superior to the doorstep of probability of 0,05. Therefore, generally, in farming environment in DRC, of which especially in Province of the Tshopo, the waters of consumption are not contaminated of the same way to the level of the villages.

Our results are contrary to those found by the Unicef (2018), where he/it found that there is not a meaningful difference between the waters of consumption of the villages certified (25%) and non certified (30,8%). We think that this noted difference is due to the size of the sample.

As for our set, the meaningful difference is bound to the behavior of the villagers and the customary habits.

III.4. Comparaison of the water samples analyzed between the zones of health (ANOVA).

a. Bacteriological average by Zone of health



Face 7: Comparison of the bacteriological averages of the samples of water of the different zones of health.

It is evident from the face 7 that, the germs isolated in the analyzed waters are observed in all zones of health. The most elevated middle concentrations in total coliformeses are observed in Basoko, Bafwasende and Lubunga, either 135,83 UFC; 130,99 UFC and 113,43 UFC respectively. The fecal Streptococci are observed more in Opala, Basoko, Bengamisa and Yakusu, either an average of 67,73 UFC; 65,83 UFC; 62,29 UFC and 52,06 UFC respectively. While the fecal coliformes is observed more in Opala and Bengamisa, either 49,40 UFC and 39,28 UFC respectively. Also, the salmonellas and *E.coli* are present in all zones of health.

Our results corroborate those of Compaoré (2013), to the Burkina-Faso, where he/it notes the presence of all pollution indicators in his/her/its analyses on the quality of the drink waters in regions of Burkina-Faso, of which Tama, Vipalogo, Biron Marka and Bondigui; and the rate raised in fecal Streptococci testifies an old contamination of water.

We think that our results justify themselves by the fact that the regions dedicated to our investigatings are constituted more of the breeders of the small bétail in raving, and that share the same points of provision in water with the men, source of fecal contamination of this last on the one hand, but also, by the fact that the majority of these health zones is dominated by the fishers, agriculturists and hunters, that, often defecate around the points of provision in water of consumption at the time of the exercise of their professions.

b. Application of the ANOVA test on the found bacteriological averages

Picture 4: Research of the possible meaningful difference between the level of contamination of the water of consumption of the different zones of health.

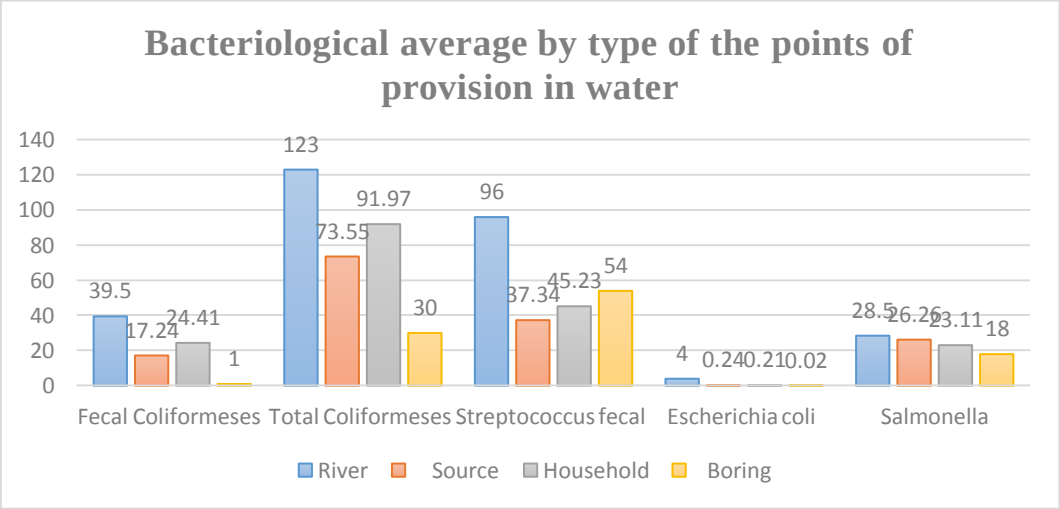
ANOVA to 1 factor

Parameters	Sum of the squares	ddl	Average of the squares	F	Significance
Fecal Coliformeses	162364,388	6	27060,731	14,151	0,000
Total Coliformeses	1090629,494	6	181771,582	17,157	0,000
Fecal streptococci	368184,310	6	61364,052	39,124	0,000
Escherichia coli	8,597	6	1,433	8,184	0,000
Salmonella	1053,490	6	175,582	0,411	0,872

The application of ANOVA-test in the samples of analysis of water of the seven zones of health consigned in the picture 4 proves that, the difference is very meaningful for all isolated germs, in said zones of health, with the exception of the salmonellas where the test proves a no meaningful difference of contamination of the consumption waters, either p=0,872, that is superior to the doorstep of probability of 0,05. Of where, generally, in farming environment in RDC, of which especially in Province of the Tshopo, the waters of consumption are not contaminated of the same way to the level of the health zones, because it is also bound to their ethnic groups or tribes, who defer themselves of a health zone to another.
We think that the test of ANOVA confirms the results of bacteriological average as justified in the face 7

III.5. Comparison of the water samples according to the types of the points of provision in water (ANOVA).

a. Bacteriological average by type of the points of provision in water (ANOVA).



Face 8 : Comparison of the bacteriological averages of the samples of water of the different types of the points of provision in water.

The observation of the face 8 show that the river is contaminated more in nearly all isolated germs that the other types of the points of water analyzed. Globally, these are the total coliformes and the fecal Streptococci that are the most numerous in the waters of the river analyzed. The fecal coliformeses and the salmonellas evolve in the same sense for the samples of the aforesaid river, that means that the concentration in fecal coliformes nearly increases with the one of the salmonellas. While the Escherichia coli presents the same concentrations in nearly all types of the points of water analyzed.

Our results agree with those of Orelien (2017), to Belgium, that found at the time of his studies on the quality of water destined to the human consumption in the under-basin pouring of Gullys Devil (Shackle-To-Veal), that the samples of spring water, river and the Berné cistern analyzed presented a concentration raised for all sought-after germs (C.F, C.T, S.T, *E.coli* and pathogenic germs), and that these waters were not in conformity with the norms of international potability of water admitted.

Although a relative difference in density of the measured germs has been noted as the shows the face 8 for the sources and the river, we think that the origin of this contamination is the same. It is probably about the fashion of management of excreted them human and of the stools of animals.

Indeed, more of the half of the population of the riparian regions don't have access to a latrine, and defecate to the free air (on the floor, or even on the very river). Wind and the waters of ruissellement act as agent of transportation of this excreted the receiving environment until the sources and to the river. Otherwise, in the immediate perimeter of these points of provision in water as well as in their distant perimeter, we observed the presence of a lot of animals of raising (caprin, bovine, pork, etc.) that are driven on all sides

(upstream, downstream, laterally) of these points of water, and that their excrements, sources of pollution, often taken away by wind and rain, provoke the contamination of these last.

b. Application of the ANOVA test on the found bacteriological averages

Picture 5: Research of the possible meaningful difference between the level of contamination of the water of consumption of the different types of the points of provision in water.

ANOVA to 1 factor

Parameters	Sum of the squares	ddl	Average of the squares	F	Significance
Fecal Coliformeses	3413,598	3	1137,866	0,545	0,651
Total Coliformeses	21838,331	3	7279,444	0,618	0,603
Fecal streptococci	7637,882	3	2545,961	1,290	0,277
Escherichia coli	1,268	3	0,423	2,312	0,075
Salmonella	471,546	3	157,182	0,368	0,776

The ANOVA-test applied to the samples of the different types of points of water analyzed (river, source, reserve water of the households and boring) some picture 5 shows that, the difference is not meaningful, as for their level of contamination, and this for all isolated germs, because the values of significance of the test are superior to the doorstep of probability 0,05. Therefore, the level of contamination of the types of the points of provision in water is the same in farming environment, in province of the Tshopo.

In short, the test confirms the analyses and justifying of the face 5.

III.6. Interrelationship between the physico-chemical and bacteriological parameters

Picture 6: Research of the possible Interrelationship between the physico-chemical and bacteriological parameters of waters analyzed.

Interrelationship of Pearson

		Physyco-chemical Score	Bacteriological score
Physyco-chemical Score	Interrelationship of Pearson	1	0,161**
	Sig. (bilateral)		0,000
	N	882	882
Bacteriological score	Interrelationship of Pearson	0,161**	1
	Sig. (bilateral)	0,000	
	N	882	882

* *The interrelationship is meaningful to the level 0.01 (bilateral).

The Interrelationship of Pearson applied to the samples of water analyzed (river, arranged sources and non arranged, reserve water of the households and boring) consigned in the picture 6 shows that, the interrelationship is very meaningful between the physico-chemical and bacteriological parameters, because the value of significance is equal to 0,000 <p <0,01. It proves that an interrelationship exists between the physico-chemical elements and the fecal bacteria in the waters of consumption analyzed, because the score shows that the coefficient r = 0,161; what comes back to say that r≠ 0.

Josse and al. (2016), in their analysis on the Interrelationship between the physico-chemical and microbiological results of the lixiviats of the sanitary burying place (Them) of Ouèssè/Ouidah and those of the underground and superficial waters of the middle, proved that the analysis in main component of the physico-chemical and microbiological parameters of the first two axes of the interrelationship explains to 68,19% the variability of the level of the physico-chemical parameters and to 75,88% the one bound to the concentration in microorganismes in the waters of all points sampled around the lixiviats.

As for our set, we think that, the level of water contamination by the physico-chemical elements is in relation with the bacteriological elements in farming environment of the province of the Tshopo.

III.7. Origin of the pollution of waters analyzed

The results of our investigatings in relation with the origin of the pollution show that the CF/SF report of the waters of the points of provision analyzed is equal to 0,4(cfr the picture 1). These results are in conformity with the theory of Geldreich (1976), that estimates that, when the CF/SF report is located between 0,1 to 0,76, either 0,1 <CF/SF <0,6, the pollution of water is musted to the house pets.

According to the office French of Biodiversity, the consequences of the pollution of the aquatic surroundings are multiple. They drive to massive mortalities of species, but they also have less visible effects: an eutrophisation of the surroundings, of the toxic effects to more or less long term, of the illnesses or the endocrine disruptions (OFB, 2019).

As for the earths, water meets contaminated by the chemicals and the excrements of the animals. This water infiltrates under ground and joins the underground tablecloths of water, what contaminates big quantities of drinking water. (OFB, 2019).

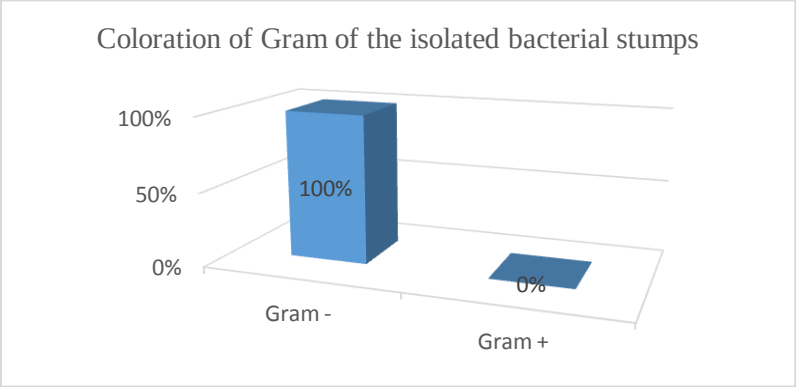
In the same way, he/it has been noted that, the chemical pollutions of water and their major reason are to look for next to the big cultures and animal evacuations of raisings: manure (nitrates, phosphates, cadmium), pesticides, herbicides, veterinary medicines and food complements distributed in raisings (copper, zinc), nitrogen ammoniacal and phosphor...

In 2006, the organization of the Nations United for the food and agriculture (FAO) described raising as" one of the most important contributors to most serious present environmental problems" (ONE, 2006).

Also, raising is part of the most destructive sectors of the planet, accentuating the rarefaction of resources notably in water and contributory, among other things, to the contamination of water with animal garbage, of the antibiotics and hormones, of the chemicals coming the tanneries, manures and the chemical pesticides pulverized in the cultures vivrières (FAO, 2012).

As for our investigatings, the pollution of the consumption water in farming environment of the Province of the Tshopo by the house pets justifies itself by the fact that raising constitutes one of the socioeconomic activities of the province, that makes itself in free raving where the animals circulate in the immediate perimeter of the points of provision in water as well as in their distant perimeter, of which their excrements, sources of pollution, often taken away by wind and rain, provoke the contamination of these last.

III.8. Coloration of Gram



Face 9: Distribution of the stumps isolated according to the Gram

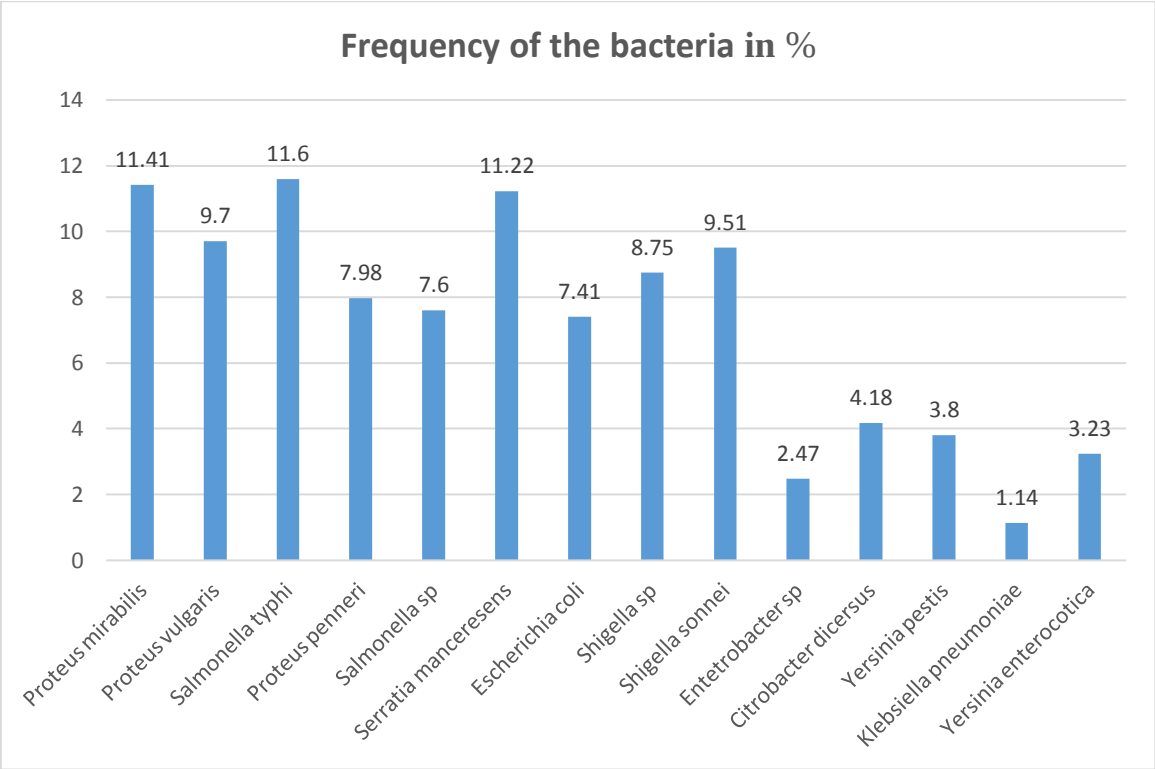
As one can note it in the picture 9, the bacilli in negative Gram present the maximum rate of 100% in the samples of the consumption water analyzed.

This result is similar to those of Dongue (1999) and of Abdoulaye (2002) in Ouagadougou, where it was notify a predominance of the germs of the intestinal flora to bacilli negative Gram in the polluted waters.

On the other hand our results are distant of those achieved to Madagascar indicating a rate equally in bacilli in negative Gram of 65.14% as persons responsible of the illnesses to water transmission (Andrianarivelo and al., 2010).

As for what concerns us, this result explains itself by the use of the specific culture surroundings for the isolation of the Ç. FS, C. TS, S. FS, *E.coli* and the Salmonellas, belonging to the class of the entérobactéries, that is bacteria to negative gram.

III.9. Frequency of the bacteria identified



Face 10: Frequencies of the bacteria identified in the waters of consumption analyzed.

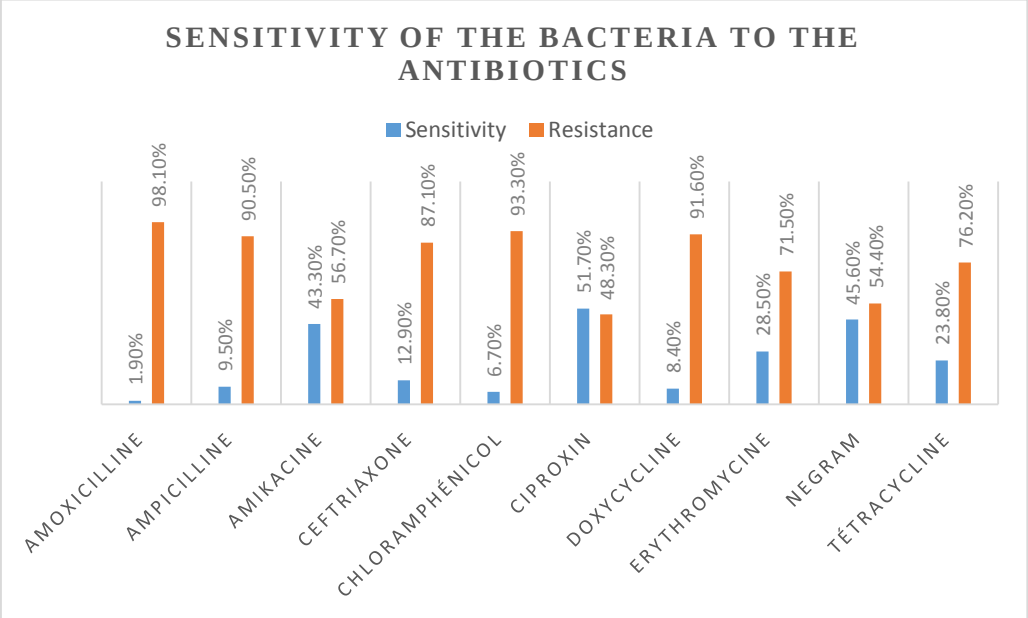
The biochemical characterization aims to identify the species of the generally present bacterial population in the water of consumption, of which most are not pathogenic. However, some species can be pathogenic opportunists and can cause some infections at the people whose immune system is weakened. Indeed, the strong concentration in total germs generates problems of water order organoleptique (Dahel Zanat, 2009).

The results carried on the face 9 show that the species *Salmonella typhi*, *Proteus mirabilis* and *Serratia manceresens* are the most abundant in all samples of water analyzed, either 11,60%; 11,41% and 11,22% of the cases respectively; consistent of the *Proteuses vulgaris*; *Shigella sonnei* and *Shigella sp*, with 9,70%; 9,51% and 8,75% of the cases respectively. The Enterobacter and *Klebsiella pneumoniae* are the less observed, either 2,47% and 1,14% respectively.

Our results agree with those of Yassimina (2016), in his/her/its studies on the microbiological analysis of water distributed in the city of Tébessa, where he/it identified the Salmonella and the Shigellas as the only pathogenic bacteria frequently sought-after in water, outside of case of epidemics, and play the role of alarm signal. It is only these last years that a certain importance has been assigned to the Yersinia, Campylobacter, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Legionella pneumophila*, *Aeromonas hydrophila* and *Vibrio cholerae*.

Within sight of these results, we understand that the water of consumption requires a particular attention, because it constitutes a problem of public health, following the illnesses to water transmission that it is responsible.

III.10. Sensitivity of the bacteria to the antibiotics



Face 11: Profile of sensitivity and resistance of the bacteria isolated to the antibiotics

The achieved antibiogramme allowed us to determine the sensitivity and the resistance of theisolated stumps and identified previously in the samples of the consumption water to the 10antibiotics chosen according to their action on the entérobactéries, consigned in the face 11.

He/it clears himself/itself of the observation of this face that the Ciproxin has an efficient activity again on all identified stumps, either 51,70% of the cases; consistent of Negram and Amikacine, either 45,60% and 43,30% of the cases respectively. The other antibiotics only showed a weak action on the different identified stumps.

These results measure us in the same lengths of waves that Kunde (2010), in his/her/its microbiological survey and antibiogramme to the mali, where he/it found that the Ciprofloxacine and the Ceftriaxone remain the most active antibiotics on the entérobactéries in Africa.

As Filgona (2009), in his/her/its survey on the Transfer of genes of the resistance of the gentamicine among the entérobactéries isolated of the out-patients external with urinary infections of the extent, note a profile of resistance of 36,4% to the ciprofloxacine (CIP).

Within sight of our results, we think that the idleness of the antibiotic majority on the stumps of the isolated entérobactéries and identified results the counterfeiting and/or the acquirement of the resistance on the one hand; of others leaves us adds the opinion of the authors that estimates that the main mechanism of resistance to the quinolones and fluoroquinolones implies an accumulation of mutations within the genes coding for the enzymes DNA gyrase and IV topoisomérase, the main targets of these antibiotics (Muylaert and Mainil, 2012).

IV. Conclusion And Perspectives

The bacteriological quality of water, exit of sources supposed to be drinkable, to the consumption to the level of the majority of the households let to want. This quality is function of several determinants of which some are situated to the level of the access points in the sources, to the means used for the transportation and the storage and others are relative to the beliefs, uses and convenient to the level of the households them even. However the results of the tests of the microbiological quality of water to all levels of the water chain, of the observation of the countenance tools used for the transportation and the storage of the consumption water show that the improvement of the water quality necessarily consumed in the households pass by the definition and the setting in work of a strategy of conservation and treatment of water to the level of the household.

In particular, the survey revealed than only 11,90% and 2,14% respectively of the points of provision in water and households that have the drinking water in farming environment of the Province of the Tshopo.

This survey puts in relief the weak interest granted by the population about treatment of water destined to the consumption to the level of the households and the necessity to consider the option of water treatment as strategic option to eliminate the microbes in the water of consumption, in order to improve their health.

Besides, these results push us to estimate that the majority of the farming population of the province of the Tshopo doesn't have access to water.

The observations not very objective, the numbering and the identification of the bacteria to the laboratory being complex enough, the statistical tests specified to every level the bacteriological contamination of the consumption water analyzed in farming environment of the province of the Tshopo.

For intervention in these zones, it would be more discriminating to observe, the practices and the traditions, in order to be able to propose the help that would be adopted indeed by these populations, for a long time. The bad behavior of the farming populations at the time of the chain of water is the biggest brake to.

The adoption of the good practices of hygiene facing the blue gold. Once there is adoption of the responsible behavior facing this however blue of the planet, the DRC, of which particularly the Province of the Tshopo would know a big development on all plans, with the reduction of the illnesses to water transmission, but also of the access to a healthy environment etc.

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