Research Article (Open access)

Source of Water and Microbial Quality of Some Beverages Consumed on the Streets of Great Agglomerations of the Far-North Region of Cameroon

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Received: 04 Sept 2016/Revised: 28 Sept 2016/Accepted: 06 Oct 2016

ABSTRACT- To fight against thirst, peoples in sahelian regions have many choices: they can drink water or kinds of beverages like "kounou", lemon juice, tamarind juice baobab juice, tea or "folere" juice. These beverages have been prepared with wells water, drilling water or with the water of the national network distribution. The aim of this study was to evaluate the microbial quality of some non-alcoholic street waters and beverages sold in Maroua, Mora, Mokolo, Kaele, Kousseri and Yagoua, six major cities of the far north Region of Cameroun. Sampling was performed three times in three different points for the same product in each locality. Results obtained showed that water used in the production of different beverages sold in the towns of Maroua, Kousseri, Yagoua, Mora, Kaele and Mokolo is mostly provided by the national water distribution network with 51.24%; Drilling with 32.19%; wells with 6.34%. Among the beverages produced, "folere" juice was the most consumed (33%) while "kounou" was least consumed (9%). The products sold by mobile vendors have a higher microbial concentration than those of the fixed vendors. Although there was absence of *Escherichia coli* and *Clostridium botulinum* in our products; total coliforms were the pathogens most isolated in our beverages and among mobile street vendors.

Key-words- Microbial quality, Source of water, Beverages, Far-north Region, Cameroon

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INTRODUCTION

The far North is situated in sahelian zone of Cameroon and corresponds to the driest with a mean rainy season of four to five month per year. The hard climatic conditions (high temperature and dry air) compel people to consume refreshing beverages.

Access this article online	
Quick Response Code:	Website: www.ijlssr.com
	crossref DOI: 10.21276/ijlssr.2016.2.6.4

Consumers then have a wide range of products to quench their thirst. They have to choose between packaged and hygienically manufactured juices sold by great companies and those made by families in homes and vended in streets, schools, crossroads, markets and others public places [1]. These products have many advantages: they are available and less expensive than the other products of this category. Moreover, street foods particularly became a phenomenon of modern societies according to its nutritional and socioeconomic importance [2]. Generally the consumer can spend 100F CFA (0.152€) for 500mL for street-vended juices; on the other side, for hygienically manufactured juices, they can spend 500FCFA (0,763€) for the same 500mL.

When beverages and juices are produced by street vendors, water used can be of many origins: potable drinking water of the national distribution system; drilling and wells. The

different beverages produced in this region are: "kounou" (a traditional non alcoholic beverage), fruit juices (lemon, guava and mango), ginger juice, baobab juice, tamarind juice, "foléré" juice, tea and "bil-bil" (an alcoholic beverage made with maize). When preparing these products, a great quantity of water is used. Water could be one of the elements that vehicles many diseases like cholera, amoebic dysentery, typhoid and many other diseases. Furthermore some microorganisms might be accidentally present in the food, and may be at the origin of its alteration or diseases up to death in human [3]. The quality of beverage can also be affected by the manufacturer, which generally carries many germs and contaminate foodstuffs through his clothes, saliva; hair hand and others. The worker's hygiene is therefore a very important point [4]. Water born diseases are among the main causes of health problems among the poor's [5]. The objective of this study was thus to evaluate the quality of some non-alcoholic street waters and beverages sold in six major cities of the far north Region of Cameroon.

MATERIALS AND METHODS

Sampling and Study's Zone

The Far North represents the second most populated region of Cameroon with 3 480 414 inhabitants after the center Region [6]**.** In this region the street food sector is made up of small jobs developed around the processing and sale of the main agro-pastoral products of the region mainly cereals, fruits, milk, meat and vegetables. Production of street food has intensified with the galloping demography. The study was conducted during the months of August to October 2013 in six main towns of the Far North region of Cameroon: Maroua in the department of Diamare; Kousseri in Logone and Chari department; Yagoua in the department of Mayo-Danay; Mora in the department of Mayo-Sava; Kaele in the department of Mayo-Kani and Mokolo in the department of Mayo-tsanaga. Foods produced in this part of the country are numerous however, our study was carried on some non-alcoholic beverages produced and sold by street vendors of this region. Among these drinks and beverages there are: water in plastic bags, "Kounou", lemon, ginger, baobab, tamarind and "folere" juices. In general the production of such beverages depends on the raw material. Lemon juice is obtained by pressing lemons fruits, previously washed; to the concentrated juice obtained, sugar and water were added."Folere" juice is manufactured following the described techniques [7]. Tamarind and baobab juice are obtained by maceration of dried fruits in cold water for the first and in hot water for the second; to the filtered extract, water and sugar were added. All these products were conditioned in plastic containers from 250 to 1500 mL and refrigerated. Most of these drinks are prepared at homes and transported to sales places (market, streets, schools and other public places) in cool boxes carried on Wheelbarrow.

Among the vendors some possess modern countertops and others possess fixed but traditional countertop made of straw. Another group is made of mobile street vendors which move from one corner to another to sell their products. The samples were collected randomly every two days at midday in different quarters of Maroua, Kaele, Mora, Yagoua, Kousseri and Mokolo. This sampling was done three times in three different places for the same product in each locality. The samples were collected aseptically from producers into 500 mL containers, put in an icebox containing 3 to 4 bottles of dry ice and transported under cold regime in the laboratory. The producers were also submitted to a questionnaire.

Microbial Analysis of Beverage Samples

The beverage samples were used directly and decimal dilutions were carried out by using a sterile physiological saline solution (0.85% w/v NaCl). 100µL of the serial dilution were plated (Ø=20cm) on to Plate Count Agar (PCA) for enumeration of total mesophilic flora; Eosin Methylene Blue agar (EMB) for *Escherichia coli*; ENDO agar medium for total coliforms. All the inoculated plates were incubated at 37°C for 24 to 48 hours for total flora and *E. coli*; 44° C for 24 to 48 hours for Total coliforms. For *Bacillus cereus*, each sample dilution was heated for 10min at 80° C, 100 µL were then spread on Mossel Agar, and the dishes were incubated at 37°C for 24 to 48h.TSN (tryptone sufite neomycin) agar was used to detect *Clostridium perfingens* in beverage sample by the technique used by Maïwore **[8]**, 1mL of the sample was warmed at 80°C for 10min and after cooling, 9mL of TSN was then added to the sample. Fungi (Moulds and yeasts) were isolated by inoculating Sabouraud plus chloramphenicol agar with 100 µL of sample. The Petri dishes were incubated at 25°C for 4 days. Colony forming unit (CFU) was counted with a Quebec Darkfield Colony counter (Leica, Inc, Buffalo, New York) equipped with a guide plate ruled in square centimeters. Plates containing 1 to 300 colonies chosen to calculate the microorganism population results, recorded as CFU per mL. Each count was the mean value of viable colony appearing in duplicate agar plates per individual sample.

STATISTICAL ANALYSIS

The results obtained in this study were expressed as mean ± standard deviation. Statistical analyzes were performed using ANOVA with one factor. The test of Duncan was done and thanks to statistical software Statgraphics Centurion software version 17.1.06 for windows.

RESULTS AND DISCUSSION

Water is a very important element used in the production of different beverages consumed in the far north region of Cameroon. Fig1 presents the source of water supply for the different beverages consumed in the streets of the far north Region of Cameroun. This figure shows that water used in the production of different beverages sold in the towns of Maroua, Kousseri, Yagoua, Mora, Kaele and Mokolo come mostly from the national water distribution network

(Camerounaise des eaux with 51.24%. Water Drilling also constitute an important source in drinking water with a frequency of 32.19%. This rate could be justified by the fact that a significant portion of the population lives in new areas not yet served by the national distribution network. The Far North region is characterized by a Sudano-Sahelian climate with a dry season that lasts seven months and a rainy season of five months. Although some families don't have access to running water of the national distribution network they are supplied by individuals selling water in polyethylene bottles of 20L sold for 25F CFA. This could justify the fact that although 13.8% of households have access to running water as demonstrated by MINSANTE Cameroun/SNV Cameroun in 2011, water of the national distribution network is used to prepare the most consumed beverages in the streets.

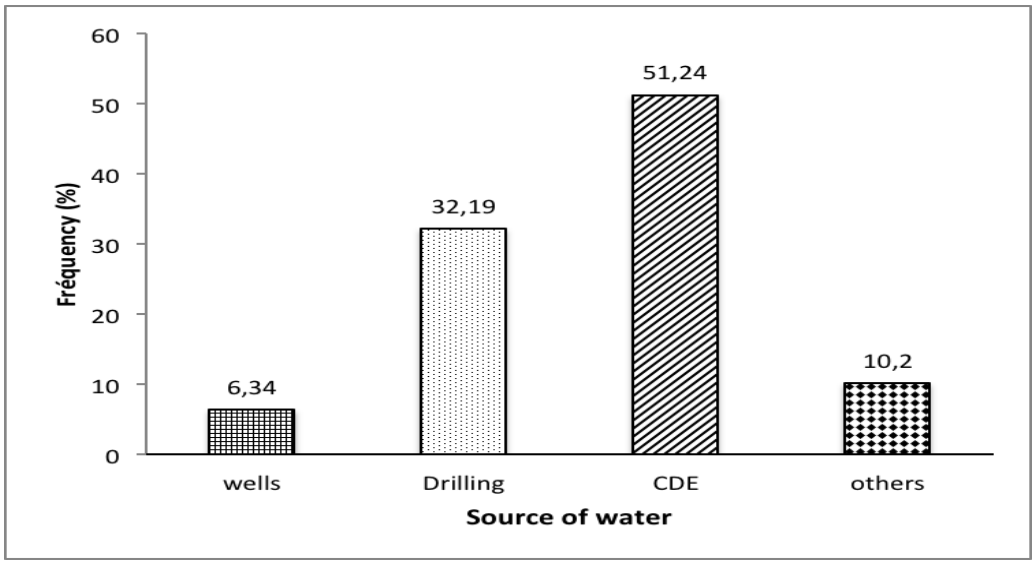

Fig. 1: Source of water supply consumed on streets
(CDE: Camerounaise des Eaux)

With 6.34% well water represents a proportion that, although small, could also be a source of contamination of beverages. When waters from drilling and wells are not treated, it is possible that they contain large amount of total coliforms, fecal coliforms, *Streptococcus sp, Salmonella sp* and *Proteus sp.* [9-11]. Person's who consume these kinds of water and beverages produced with these waters are exposed to many health risks such as typhoid dysentery and gastroenteritis [12].

In the Far north Region, water from wells, drillings and water of the national water distribution network is used either to produce beverages or to be packaged in plastic in order to quench the consumer's thirst. Fig 2 presents the different street beverages consumed in the far north Region. This figure shows that "folere" juice is the most consumed with 33% while the least consumed drink is "Kounou". This result is justified by the fact that "folere" juice, lemon juice, and packaged water are most often sold by street vendors and they are found in every neighborhood of the towns. It is the same for tea that although found in many places is rather sold by street vendors who possess a device composed by a barbecue containing ambers on which is put down an aluminum kettle. "Kounou" is sold about in some periodicals markets. It is so much consumed on baptism and traditional wedding ceremonies by those who don't consume alcoholic beverages. That could justify the relatively low consumption rate of "kounou" compared to other products.

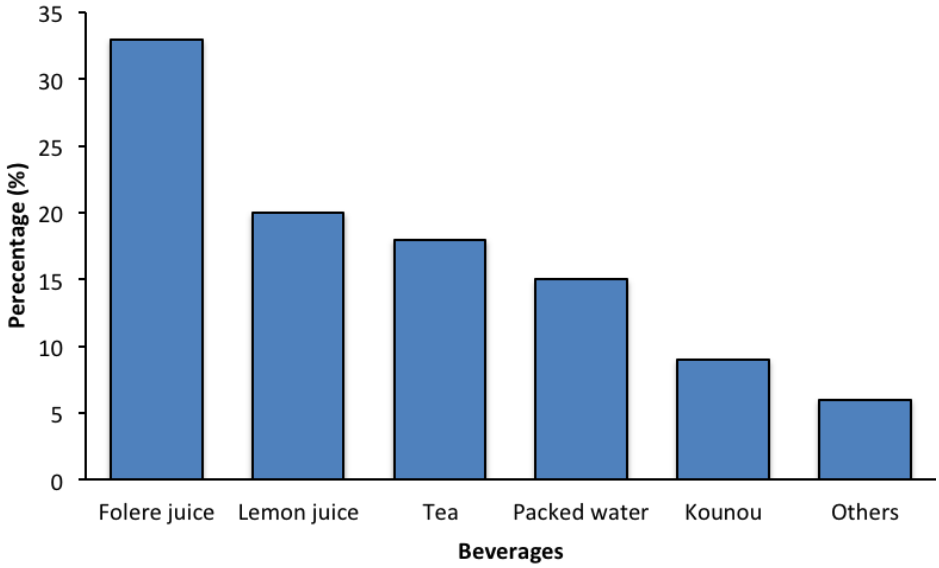

Fig 2: Typology of street beverages consumed in the far North Region

Microbiological analysis was carried out to appreciate the sanitary quality of these products. Table 1 shows that the concentration of total flora was between (0.5±0,0) $x10^3$ to (5±0.3) $x10^3$ for fixed modern vendors; (0.9±0.0)$x10^3$ to (8±0.5) $x10^3$ for fixed traditional vendors; (1.8±0.1) $x10^3$ to (13±0.9) $x10^3$ for mobile vendors. The difference between the total floras of different products was statistically significant only for fixed vendors. The fungi flora's concentration was between 0 to (0.6±0.0)$x10^3$ for fixed modern vendors; 0 to (2.8±0.7) $x10^3$ for fixed traditional vendors and 0 to (6.9 ±0.3)$x10^3$ for mobile vendors. The difference between these values was statistically significant. Globally the different analysis done show that the products sold by mobile vendors have a higher microbial concentration than those of the fixed vendors. That could be justified by the fact that, when they are sold, these beverages can be contaminated by atmosphere, wind and insects [13-14]. In addition the ambient temperature in this part of the country is usually from 38 to 42°C, the products contained in iceboxes therefore tend to warm. This increase in temperature can thus induce microbial growth in the various products. Whatever type of vendor the total flora and fungal flora are more important in the "Kounou" than other products. This abundance can be justified by the fact that "Kounou" is a starchy and slightly fermented beverage prepared with many ingredients like maize or millet flour, groundnuts paste, sugar, malted millet or rice and a large quantity of water. During the production of "kounou", flour and groundnuts paste are mixed with water and cooked to obtain a thick porridge. After cooling at room temperature, the thick porridge is hydrolyzed by adding millet malt, rice malt or pieces of dried potato. The mixture was maintained à room temperature for at least 12 hours. After this the hydrolyzed mixture was filtered and water added. The microbial flora in the "Kounou" could have as origin the raw material, which can be charged with microorganisms [2, 15-16]. Microorganisms can be added in the product through millet malt, rice malt, pieces of dried potato, when the mixture is filtered or when water is added. Water added during the preparation of this beverage can also have many origins: drilling, wells and running potable water. It is well known like shown by Moussa [17] that well water is quite often contaminated by many pathogenic germs.

Table 1: Presence of total and fungi flora in beverages in function of the type of vendors

	Fixed and Modern		**Fixed and Traditionnal**		**Mobile**	
Samples	Total flora	Yeast and fungi	Total flora	Yeast and fungi	Total flora	Yeast and fungi
Kounou	(5±0.3)$x10^3$	-	(8 ±0.5) $x10^3$	(2.8±0.7) $x10^3$	(13±0.9) $x10^3$	(6.9 ±0.3) $x10^3$
"Folere" juice	(1±0.3) $x10^3$	(0.6±0.0) $x10^3$	(2.6 ±0.2) $x10^3$	(0.7±0.0) $x10^3$	(6±1) $x10^3$	(1.3 ±0.0) $x10^3$
tea	(0.5±0.0) $x10^3$	-	(1±0.0) $x10^3$	-	(2.2±0.8) $x10^3$	(0.1 ±0.0) $x10^3$
Fruit juices	(0.7±0.0) $x10^3$	(0.1±0.0) $x10^3$	(5.7 ±0.8) $x10^3$	(0.9±0.0) $x10^3$	(7.6±0.9) $x10^3$	(4.5±0.4) $x10^3$
water	(0.8±0.1) $x10^3$	-	(0.9±0.0) $x10^3$	(0.1±0.0) $x10^3$	(4.3±0.5) $x10^3$	(0.3±0.0) $x10^3$
Water in plastic bag	(0.8±0.0) $x10^3$	-	(1±0.2) $x10^3$	-	(1.8±0.1) $x10^3$	-

- =Absence

Among all the analyzed beverages, the least contaminated were waters in plastic packaging and tea. Their low concentration in microorganisms could be justified by the fact that there are quite not exchanges between the sellers and the ambient atmosphere in the case of water, in the other side; tea is served hot (average temperature 80°C), for this reason many microorganisms cannot grow.

The isolation of pathogenic flora in the different beverages revealed a total absence of *Escherichia coli* and *Clostridium botulinum*. Table 2 revealed that, total coliform was comprised between 0 to (0.6±0.0) $x10^3$ for fixed modern vendors; 0 to (4±0.2) $x10^3$ for fixed traditional vendors and 0 to (7±1) $x10^3$ for mobiles vendors. The *Bacillus cereus* concentration was comprised between 0 to (6.8±1) $x10^3$ for fixed modern vendors ; 0 to (8±0.9) $x10^3$ for fixed traditional vendors and 0 to (0.9±0.0) $x10^3$ for mobiles vendors. The difference between these values was statistically significant. Moreover no pathogenic microorganism was found in tea.

Table 2: Presence of Total coliforms, *Escherichia coli, Clostridium botulinum* and *Bacillus cereus* in beverages in function of the type of vendors

	Fixed and Modern				Fixed and Traditional				Mobile			
Samples	**EC**	**TC**	**BC**	**CB**	**EC**	**TC**	**BC**	**CB**	**EC**	**TC**	**BC**	**CB**
Kounou	-	-	(6.8±1)x 10^3	-	-	(4±0.2) x 10^3	(8±0.9) $x10^3$	-	-	(7±1) $x10^3$	(0.9±0.0)$x10^3$	-
"Fole-rejuice"		-	-	-	-	-	-	-	-	(0.003±0) $x10^3$	-	-
Tea	-	-	-	-	-	-	-	-	-	-	-	-
Fruit juice	-	-	-	-	-	-	-	-	-	(1.4±0.0) x 10^3	-	-
Water	-	-	-	-	-	(0.1±0.0) $x10^3$	-	-	-	(0.1±0) $x10^3$	-	-
Water in plastic bag	-	(0.6±0.0) $x10^3$	-	-	-	(3.8±0.1) $x10^3$	-	-	-	(5.5±0.1)x 10^3	-	-

- =Absence*; EC : Escherichia Coli ;* TC: Total Coliform ; BC: *Bacillus Cereus ;* CB: *Clostridium Botulinum*

The presence of microorganisms in fruit juices and in other non-alcoholic beverages is more often related to the quality of raw material.

The microbial flora in the freshly squeezed fruit juice is very high and depends on the state of the fruit cleanliness and maturity. On these fruits it is easy to find yeasts, molds and bacteria [4,18-19]. Globally our analysis show that total coliforms are the pathogens most isolated in our beverages and among mobile street vendors. Once more, among all the analyzed beverages" Kounou" is the most contaminated product. Fecal coliforms are classic indicators of fecal origin. They are: *Escherichia coli, Citrobacter sp., Enterobacter sp, Serratia sp*. Some microorganisms of fecal origin correspond to total coliforms, they are present in soil, faeces and unpolluted waters [20-22]. In the beverages, the presence of coliforms could be due to: either an insufficient treatment applied to the beverage or a contamination post-treatment, principally lack of hygiene.

Bacillus cereus was isolated only in "Kounou". This could be due to the presence of spores in the raw material (millet, maize, groundnuts, rice or millet malt). These heat-resistant spores are able to survive to cooking while the vegetative form was destroyed [23]. The presence of *Bacillus cereus* is related to the poor hygiene of raw materials or during the preparation of product. This bacterium can cause food borne diseases.

CONCLUSIONS

It emerges from this study that nearby the national distribution network running water, well waters and drilling waters, although less consumed, represent a non-negligible part of consumed water in the far north region of Cameroun. Many Juices and beverages prepared with these waters have a deplorable hygienic quality since they contain coliforms, which are fecal contamination indicators. In these beverages, in addition to the presence of *Bacillus cereus* in some samples, the total flora is well above the standard. The production of theses beverages in good hygiene conditions and the utilization of water of good quality will surly permit to have products of better quality.

ACKNOWLEDGEMENT

We are so grateful to all the personnel of the laboratory of Microbiology of ENSAI (National Advanced School of Agro-industrial Sciences) of Ngaoundere for their help in the realization of this study.

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How to cite this article:
Maïworé J, Bouba AA, Ngoune LT, Mbofung CM: Source of Water and Microbial Quality of Some Beverages Consumed on the Streets of Great Agglomerations of the Far-North Region of Cameroon. Int. J. Life Sci. Scienti. Res., 2016; 2(6): 665-670. DOI:10.21276/ijlssr.2016.2.6.4
Source of Financial Support: Nil**. Conflict of interest:** Nil