



RESEARCH PAPER

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Physicochemical and bacteriological characterization of an artisanal drink: the case of "Zoom-koom" sold in the streets of Port-Bouët, Abidjan, Côte d'Ivoire

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Abstract

Artisanal beverages sold in several areas of the district of Abidjan, particularly in Port Bouet, raise huge public health problems due to their unsatisfactory microbiological quality. The objective of this study was to assess the quality of an artisanal drink sold in the streets of the municipality of Port-Bouët in Côte d'Ivoire. Three sites in Port bouet such as Adjouffou, Jean-Folly and Derriere wharf were subject to the sampling of the artisanal drink called "Zoom-koom" at the rate of five sales women per site. The physico-chemical analyses carried out show that the Zoom-koom samples have a pH between 3.5 and 4.27 with a titratable acidity between 1.6 and 3.54 g/L. In addition, microbiological analyses showed that the Zoom koom from Derriere Warf is more contaminated by mesophilic aerobic germs and *E.coli* with loads of $7.34 \pm 5.84.10^7$ CFU/100 mL and $7.5 \pm 2.45.10^3$ CFU/100 mL respectively. While *Staphylococcus* contamination was more important in Adjouffou 2 and Jean-folly 2 with respective loads of $1.8 \pm 1.47.10^4$ CFU/100 mL and $1.35 \pm 1.25.10^4$ CFU/100 mL. These microorganisms' loads were higher than CODINORM (Côte d'Ivoire Normalisation) energy drink standard. With regard to the level of contamination of the « Zoom-koom » sold at Port-Bouët and according to the standard, this drink was unacceptable for consumption and represents a real risk for consumers.

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Introduction

Artisanal beverages are usually made by fermenting certain grains such as sorghum, maize and millet. These foods are often transformed into beverages whose manufacture includes an essential step of lactic and/or alcoholic fermentation. These foods play a sometime essential role in the cultures of the people (Songré-Ouattara *et al.*, 2009).

In West Africa, millet is often consumed in the form of cooked dough such as Tô in Burkina Faso, porridge such as ben-kida, bensalga and kirario (Konkobo *et al.*, 2002 ; Songré-Ouattara *et al.*, 2009), couscous or patties such as massa (Compaore/Sereme, 2016). It is also used in the production of alcoholic beverages such as millet beer or dolo in Burkina Faso (Sawadogo-Lingani *et al.*, 2008) or non-alcoholic beverages such as zoom-koom (Soma, 2014), koko sour water, obiolor, kunun-zaki (Achi, 1990 ; Blandino *et al.*, 2003 ; Agarry *et al.*, 2010) or used in the production of lumps and milk foods such as dèguè, tchobal and gappal (Hama *et al.*, 2009 ; Tchekessi *et al.*, 2014 ; Tankoano *et al.*, 2016). Zoom-koom is a non-alcoholic fermented sweet drink from Burkina Faso. This non-alcoholic, hot-tasting traditional drink is appreciated and abundantly well-known in others countries of the sub-region, such as Côte d'Ivoire (Nandkangre *et al.*, 2015; Mpondo *et al.*, 2017).

Zoom koom is made primarily from millet and/or rice, ginger, tamarind, mint and sugar (Soma, 2014). Like most fermented and sweetened artisanal beverages, it is sold either in large pans with ice, uncovered and served to customers in small bowls, or plastic cups (Soma, 2014). Most often, they use recycled plastic bottles and for packaging (Soma *et al.*, 2017). The processing, storage and marketing methods, of Zoom-koom can be a source of hazard for consumers and a potential risk to their health. In fact, the unhygienic conditions of preparation of these artisanal drinks sometimes lead to microbial contamination (Baba *et al.*, 2006). The preparation materials, the cleanliness of the site, individual hygiene and the healthiness of the home are all risk

factors(.) for product contamination which can have a negative impact on the microbiological quality of beverages sold on the street. The consequence is frequent food poisoning, with effects that are sometimes difficult to manage (Tingbé *et al.*, 2018). The high bacterial contamination of artisanal beverages has been demonstrated by previous studies (Karamoko *et al.*, 2020; Traoré *et al.*, 2021). Thus, a study conducted by Kouassi *et al.* (2018) revealed the presence of *Escherichia coli* and pathogens such as *Staphylococcus aureus* and Salmonella in another refreshing artisanal drink "Gnamakoudji" sold in the city of Daloa (Côte d'Ivoire). Several outbreaks of disease have been attributed to beverages in various parts of the world and some infections have been reported in populations consuming these street foods (WHO, 2010; Mihajlovic *et al.*, 2013; Kouassi *et al.*, 2018). If the diet of this drink has proven positive aspects, the microbiological quality remains doubtful (Kouassi *et al.*, 2012; Bayoï *et al.*, 2014; Mbadu *et al.*, 2016).

The main objective of this study is therefore to assess the quality of the zoom-koom. More specifically, it was necessary to evaluate some physico-chemical (pH and titratable acidity) and microbiological (Mesophilic Aerobic Germs, *Escherichia coli* and *Staphylococcus*) parameters of Zoom koom sold in the streets of the municipality of Port-Bouët (Côte d'Ivoire).

Material and methods

Biological material

The biological material consisted of zoom-koom samples collected in three sites of the municipality of Port-Bouët (Adjouffou, Jean-folly, Derrière warf).

Technical equipment and cultural media

The technical equipment corresponded to that commonly used in all food microbiology laboratories. It was composed of sterilization and culture media preparation equipment such as an autoclave (SANoclav, Germany), the precision balance (RADWAG, Poland), glassware (test tubes, Erlenmeyer flasks, beakers, Petri dishes, pipettes,

flasks), ovens (STUART, United Kingdom), refrigerators and rotating hot plates (STUART, United Kingdom).

The sampling equipment consisted of bowls to collect the samples, and a cooler filled with deep-frozen dry

ice to transport the samples under cold conditions. The research equipment included Plate Count Agar (PCA), *E. coli*-coliform chromogenic (ECC) and BAIRD-PARKER media for the enumeration of mesophilic aerobic germs, *E. coli* and *Staphylococci* respectively.

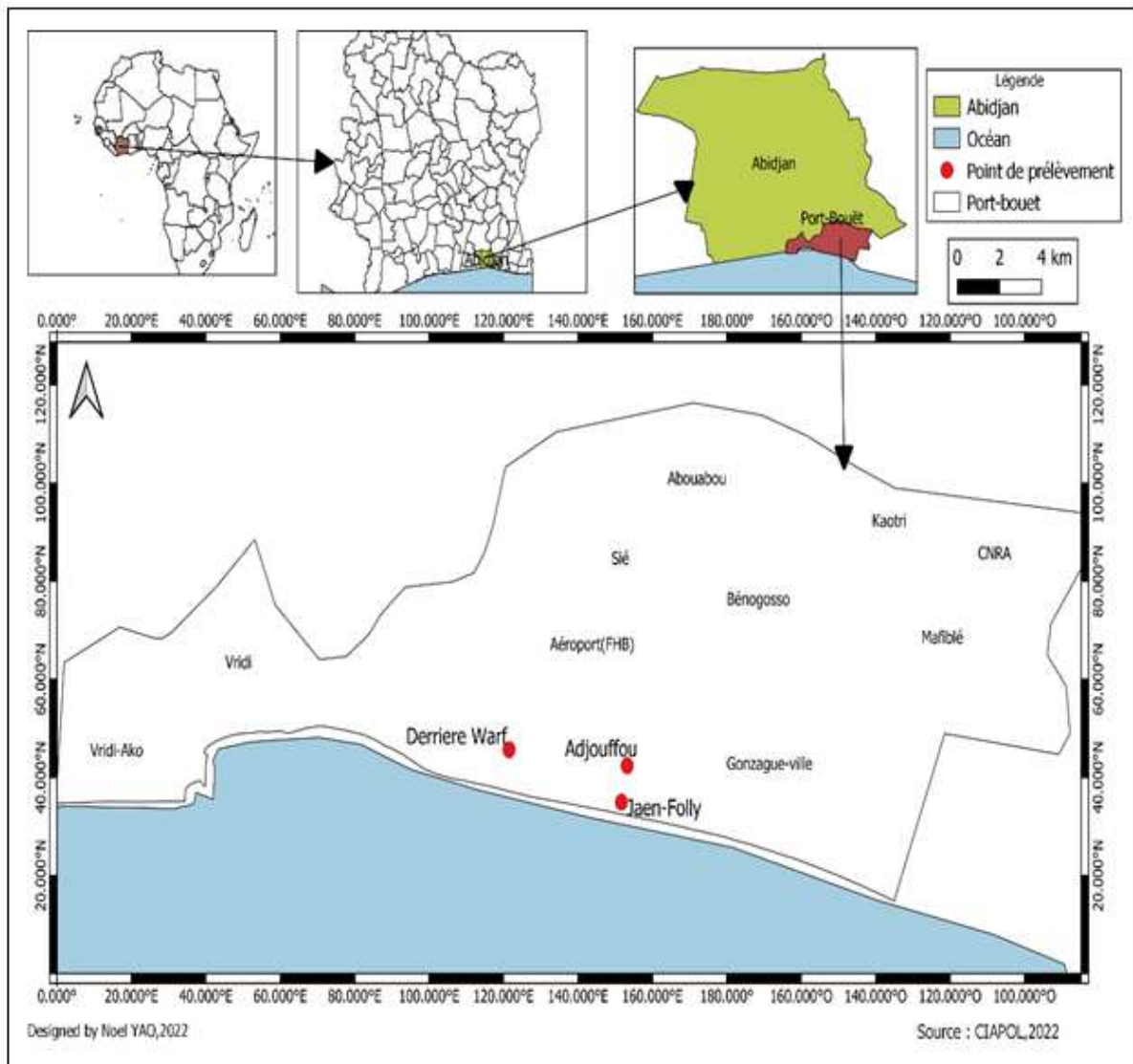


Fig. 1. Map of Port-Bouët municipality and the different sampling sites.

Study setting

The study was conducted in the commune of Port-Bouët, located in the southeast of the district of Abidjan. It is a peninsula located between the Atlantic Ocean and the Ebrié Lagoon and extends along the maritime coastline for nearly 30 km from east to west for an area of 111 km², representing approximately 12.3% of the Abidjan agglomeration (Coulibaly *et al.*, 2004) (Fig. 1).

Sampling

The study was carried out from July 2 to September 30, 2019. Ten samples of Zoom-koom were obtained from five (05) women processors located in the Adjouffou, Jean-folly and Derrière warf neighborhoods of the Port-bouët area. In total, fifty samples were taken in sterilized jars and transported to the Laboratory of Microbiology, Ecotoxicology and Radioecology of the Ivorian Anti-Pollution Center

(CIAPOL), in a cooler containing carbohydrate ice and then analyzed.

Physico-chemical analysis

Determination of pH and acidity

The pH of the samples was determined using a pH meter (RI microprocessor pH meter, HANNA INSTRUMENT), previously calibrated with two buffer solutions at pH 4 and 7. The measurement was made by dipping the electrode in 50 ml of samples and the pH value was read on the dial of the device. The tests were repeated three times.

The titratable acidity was obtained by the method described by Amoa-awua *et al.* (2007). The samples were titrated with a 0.1M sodium hydroxide (NaOH) solution after the prior addition of 3 drops of 1% phenolphthalein. The results obtained are the average of three (3) tests. The rate of acidity, expressed in g/L is given by the formula below:

$$A = C_A \cdot M_A$$

With :

CA : mass concentration calculated by the following formula

MA: molar mass of lactic acid

Microbiological analysis

The quantification of mesophilic aerobic germs was performed on Plate Count Agar (PCA) (Oxoid LTD, Basingstore, Hampshire, England) and the plating technique used was surface spreading. For this purpose, several successive dilutions were made, and 0.1 mL of each dilution was taken and spread on different Petri dishes according to the dilutions. The incubation of the seeded Petri dishes was done at 30°C and the reading was done every 24 hours. Colony counting is done by counting all colonies present in Petri dishes containing between 30 and 300 colonies according to the international standard ISO 4833 (2003). *E. coli* -chromogenic coliforms (ECC) medium is the medium used for the enumeration of *E. coli* and the technique used for plating is surface spreading. Petri dishes were incubated in an oven at 37°C. The characteristic

colonies were blue for *E. coli*. The medium used for staphylococci research is BAIRD-PARKER medium and also the plating technique is surface spreading. The plates were incubated at 37°C for 24 hours. The characteristic colonies are shiny black with a clear halo.

Expression of results

The calculation of the number N of microorganisms is done using the boxes of two successive dilutions using the formula

below:

$$N = \log \frac{\sum C}{(n_1 + 0.1n_2) \cdot V} \times 100$$

N: Number of bacteria per 100 ml of product, expressed in log CFU

$\sum C$: Sum of colonies counted

V : volume of the sample plate

d : first dilution retained

n1 : number of plates retained at the first dilution

n2 : number of plates retained at the second dilution.

Statistical analysis

Physicochemical (pH and titratable acidity) and microbiological (mesophilic aerobic germs, *E. coli* and Staphylococci) results were expressed as mean values and their standard deviation. One-way analysis of variance (ANOVA) was performed with graph pad prism version 8.0 software for comparison of values at 5% risk and the tukey test was used. Calculations and figures were performed using EXCEL 2016 software.

Results

pH and titratable acidity of Zoom-koom

Table 1 shows that the pH values in Zoom-koom ranged from 3.5 to 4.27 and the titratable acidity ranged between 1.6 and 3.54 g/L.

Mesophil aerobic germs in drink

Zoom koom from Derrrière Warf was significantly ($p < 0.05$) more contaminated with mesophilic aerobic germs with an average load of $7.34 \pm 5.84 \cdot 10^7$ CFU/100 ml, while the lowest load ($1.8 \pm 1.02 \cdot 10^5$ CFU/100 ml) is obtained at Adjouffou 1 (Fig. 2).

Table 1. pH and titratable acidity of Zoom-koom according to the site of sampling.

Sites	Titratable acidity (g/L Lactic acid)	pH
Adjouffou 1	1,17± 0,4 ^c	4,4± 0,2 ^a
Adjouffou 2	2,97± 0,2 ^b	3,9± 0,12 ^a
Jean-Folly 1	3,33± 0,3 ^a	3,6±0,5 ^a
Jean-Folly 2	3,63±0,24 ^a	3,5±0,7 ^a
Derriere Warf	2,82 ±0,16 ^b	3,5 ±0,09 ^a

The means of a column followed by the same letter do not show any significant difference ($P > 0.05$).

Load of *Escherichia coli* in drink

Escherichia coli loads were almost low in most of the « Zoom koom » samples analyzed. However, we noted that the « zoom koom » from Derrière wharf contain significantly ($p < 0.05$) high loads of *Escherichia coli* with a value of $7.5 \pm 2.45.10^3$ CFU/100 ml (Fig. 3).

Load of *Staphylococci* in the drink

Staphylococci were found in the « Zoom koom » at Adjouffou 2 and Jean Folly 2 with the higher load of $1.8 \pm 1.47.10^4$ CFU/100 ml and $1.35 \pm 1.25.10^4$ CFU/100 mL (Fig. 4).

Discussion

The pH and the titratable acidity of the « Zoom koom » ranged from 3.5 to 4.5 and between 1.2 and

3.7g/l respectively. This could be due to several factors such as the fermentation time, the amount of microorganisms degrading the organoleptic quality of the « Zoom koom » and the initial amount of lactic acid in this drink.

According to Karamoko *et al.* (2020), the acidophilic microorganisms involved in the fermentation of such beverages are yeasts, molds, lactobacilli and streptococci of the lactic group. This variability could also be attributed to the nature and quantity of the ingredients used in the manufacture of « Zoom-koom ». According to Karamoko *et al.* (2020), the producers of this drink use pineapple, lemon, mint and baobab powder. All of these ingredients would contribute to the acidification of the « Zoom-koom » produced.

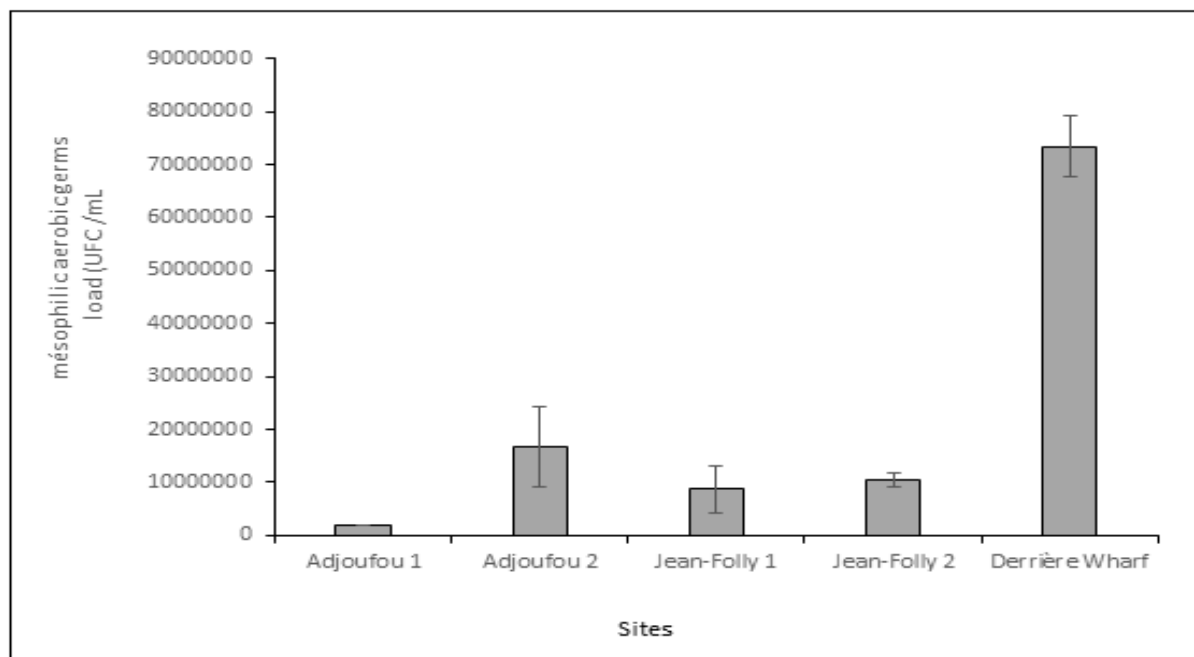


Fig. 2. Average aerophilic mesophilic germ load (CFU/100mL) in Zoom-koom sold in the five sites of Port Bouet district (Adjouffou, Jean-folly and Derrière warf).

This observation was made by Aka *et al.* (2008) who worked on the variability of the physico-chemical properties of Tchapalo, another artisanal drink. Concerning the pH, these results obtained, are relatively lower compared to those of Soma *et al.* (2019) (pH between 5.02 and 5.13) and higher with regard to titratable acidity (1.21 and 1.89 g of lactic acid/100 g of product). This difference in results can be explained by a variation in the manufacturing process; « Zoom-koom » is produced in an artisanal way. Concerning the microbiological quality of the drink, the « Zoom-koom » produced at Derrière Wharf showed the highest average loads of mesophilic aerobic bacteria and *Escherichia coli*

whereas *Staphylococcus* was found in Adjouffou 2 with the highest load. As « Zoom-koom » is an artisanal drink, there are no specific standards for this local drink. However, according to Codinorm's ISO 4833-1 (2021) standards for energy drinks, it is generally considered a health risk to the consumer if the limit of 100 CFU/ml for aerobic mesophilic bacteria is reached. Furthermore, according to ISO 7251 and 6888-1 standards, the absence of *E. coli* and *Staphylococcus aureus* in 10 mL of ready-to-drink energy drinks is required. According to these different standards, the « Zoom koom » samples from the Port-Bouet commune are of poor quality and therefore at risk for human consumption.

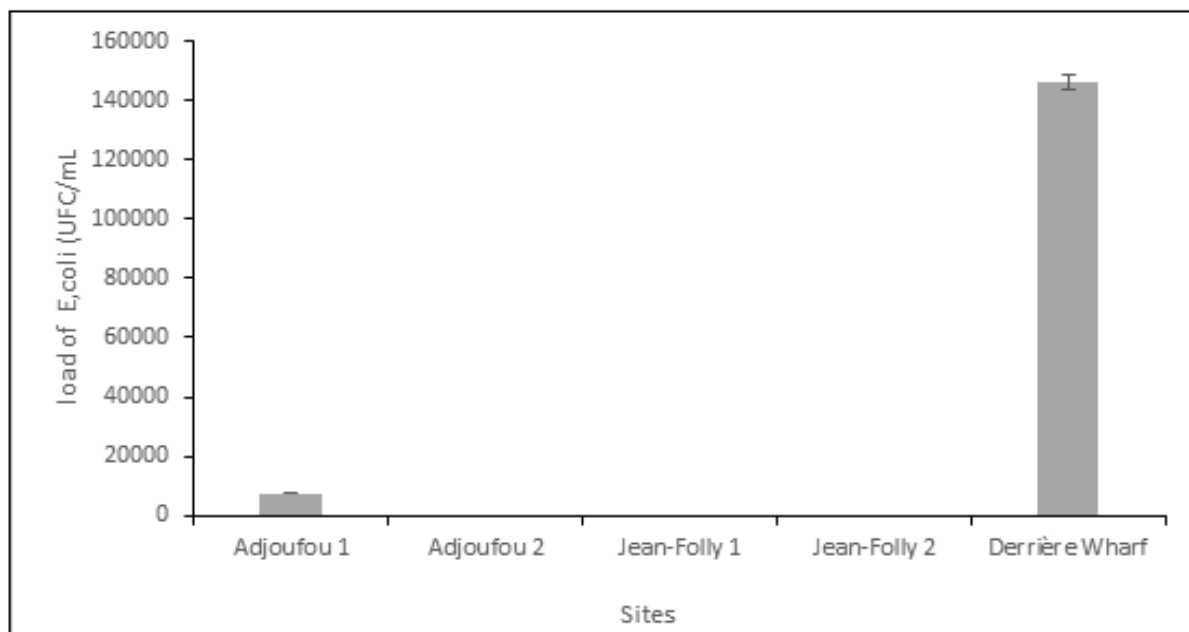


Fig. 3. Average load (CFU/100mL) of *Escherichia coli* in Zoom-koom from the five sites of Port Bouet (Adjouffou 1 and 2, Jean Folly 1 and 2 and Derrière Warf).

The strong presence of these germs could be explained by the fact that the production of « Zoom-koom » needs several steps. Indeed, the production of this drink involves the mixing of several ingredients. These different ingredients could influence the microbial load of « Zoom-koom ». The microorganisms present in the drink could come from the different parts of the machines used to grind the ingredients. Some of them would be brought by the producers during the addition of water. This was observed by Soma (2014) who worked on the use of *Lactobacillus fermentum* cultures in the « Zoom-

koom » technology. According to this author, the very high load of mesophilic aerobic bacteria in zoom-koom samples would be due to the lack of knowledge and application of good hygiene and processing practices by the producers of this drink. The presence of *Escherichia coli* in « Zoom-koom » indicates recent fecal pollution. Undeniably, the presence of these bacteria is due to a lack of hygiene in the production, sale and packaging of this drink. Similarly, the presence of staphylococci in « Zoom-Koom » is due to the soiling of the hands of the sellers and the containers that come into contact with the drink.

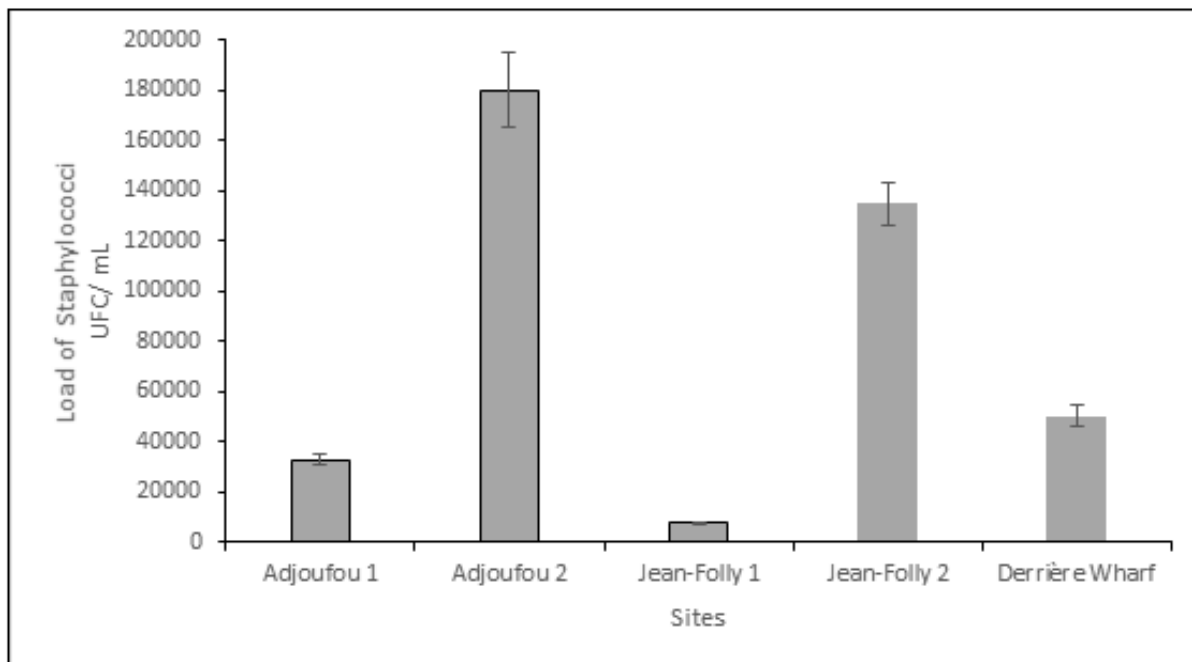


Fig. 4. Average Staphylococcus load (CFU/100mL) in the Zoom-Koom from the five sites districts of Port Bouet (Adjoufou, Jean Folly and Derrière Warf).

The results of this study are similar to those of Karamoko *et al.* (2020), who found in their work on the physicochemical and microbiological characterization of Zoom-koom sold in the city of Korhogo that this drink was highly contaminated by aerobic mesophilic bacteria, *Escherichia coli* and lactic bacteria. Soma *et al.* (2019) also found high loads of aerobic mesophilic germs, total coliforms and thermotolerant coliforms in their study of Zoom-koom in Burkina Faso. In view of these results, the consumption of a drink produced under these conditions could be harmful to the health of consumers.

Conclusion

The study showed that the quality of « Zoom-koom » sold in Port Bouet was unacceptable for consumption regarding the level of contamination by aerobic mesophilic germs, *Staphylococci* and *Escherichia coli*. The presence of these fecal contamination germs indicates a lack of hygiene in the production and conservation practices of this beverage sold in the Port-Bouët commune. It is therefore important to indicate a potential risk of intoxication or food poisoning for the population consuming these drinks. Preventive measures must be taken by the authorities

of this commune to raise awareness of the hygiene rules among producers.

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