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# Processing and Quality of "red kapsiki" an Opaque Beer from "Mandara" Mountain in Cameroon

**Bayoi James[1], Djoulde Darman Roger[2*], Aboubakar Dandjouma[3], Essia-Ngang Jean Justin[4] and François-Xavier Etoa[4]**

*[1]Department of Biological Sciences, Faculty of Science, University of Maroua, Cameroon.*
*[2]The Higher Institute of the Sahel, University of Maroua, Cameroon.*
*[3]Institute of Agricultural Research for Development, WAKWA, Ngaoundéré, Cameroon.*
*[4]Department of Microbiology, University of Yaoundé I, Cameroon.*

***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors BJ, DDR and FXE designed the study, managed the literature searches, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors AD and ENJJ managed the analyses of the study and read the draft. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** Mandara is a chain of Mountains located in northern Cameroun with the border of the republic of Nigeria. This area is populated by "kapsiki" an indigenous populations living. This non moslem population is brewing an opaque beer, which has both a symbolic and nutritional. This paper aims at investigating the physicochemical and microbial quality of this beer and highlights its processing.
**Study Design:** The study design used for describing processing method is cluster sampling of the cities surveyed, production sites and markets, and at the secondary level, individuals and groups of individual respondents.
**Place and Duration of Study:** In order to describe and follow the production process, a survey

**Corresponding author: Email: djoulde@gmail.com;*

was conducted in three kapsiki rural villages of Cameroon, namely Rhumsiki, Rhumzu and Mogodé. Later on, some samples from two urban town close to the area of Mokolo.
**Methodology:** To describe and follow the production process, a survey on the basis of a questionnaire was conducted. The sample pH, conductivity, density and brix, were recorded onsite using portables devices (conductimeter, densitometer and brixmeter).
Laboratory experiment: Following parameters: titrable acidity, polyphenols, ethanol, specific gravity,viscosity was determined according to accredited methods. Microbial analysis focused on total aerobic mesophilic bacteria, coliforms, *Escherichia coli*, *Staphylococcus aureus, Salmonella, Shigella,* yeasts, molds and sulphite-reducing clostridia were evaluated.
**Results:** The "red kapsiki" requires for its preparation following steps: malting with quenching, germination and "kilning", decoction, filtration, boiling and sterilizing, cooling, sowing and fermentation. The final beverage is opaque, soft and sparkling. The “red Kapsiki” presented an alcohol content of 3.85 to 4.28 (% v/v), a pH close to 2.40, soluble extract from 6.30 to7.29 °P, Brix from 7.0 to 7.46 °B, total sugar from 41.8 to 72.9 (g/l), conductivity from 1919 to 1990 (µS/cm), and Specific density (g/cm) à 15°C of 1.25. The color of the “red kapsiki” varies from a pinky brown to reddish according the variety of sorghum used. The microbial analyses indicate the presence of Coliforms including *Salmonella and Shigella*, yeasts and molds in the beverages which indicate the bad hygienic quality of “the red Kapsiki”.
**Conclusion:** Despite its poor hygienic quality, the “red kapsiki”, presented great potential source of income and nutrient for local beer producers.

*Keywords: Beer; Cameroon; kapsiki; microbial; quality.*

## 1. INTRODUCTION

The artisanal fermentation of cereals into beers and wine like alcoholic drinks is not recent in Africa. The traces of the first artisanal fermentation were found by archaeologists in the Blue Nile region of Sudan [1,2]. In mountainous area of central African savannah, cereals, mainly millet and sorghum are the most important crops use for fermented beverage [3]. One of this drink is an opaque alcoholic beer like beverage made from fermented sorghum gritz and malted maize, mainly use for rituals and for festivities [4]. Two types of this beverage are produce in « Kapsiki land ». They are: “tè and mpedli”. The first, “tè”, is the ritual beer. “Mpedli”, is the 'white' beer, which is mainly brewed by women for commercial purpose and has no ritual significance. « Mpedli » is made by a quick process for immediate consumption [5,6]. The red “tè” beer, in which we focus our study is traditionally a man's brew. It’s processing follow a strict procedure, with numerous prohibitions, and red “tè” was for long time mainly used for ritual purposes than festivities. Symbolism was more focused on this beer rather than commercial and technical [6]. However « red tè » has increasingly become a sales commodity for women both at the village markets and in the cities as it’s generally preferred by the men over « mpedli » [7,8]. The “red kapsiki” beer locally called “tè” often has a high symbolic content "the message of beer" is by no means uniform. Though most of the symbolism around beer is a male dominated discourse which concentrates on bonding and power, the symbolism is less straight forward and more hidden [6]. Despite of the importance of the “red kapsiki” amongst this tribe, the beer itself remain unknown in scientific community and little is known on it processing and quality. This paper thus aims at valorizing this opaque beer by describing its processing technique and provides some data in regard with its quality.

## 2. MATERIALS AND METHODS

### 2.1 Field Work and Sampling

In order to describe and follow the production process, a survey was conducted in three «kapsiki” rural villages of Cameroon, namely Rhumsiki, Rhumzu and Mogodé. Later on, some samples from two urban towns close to the area of Mokolo, were also collected for comparison purpose. The choice of thisurban area is justified by the fact that Mokolo is the immediate administrative area populated in majority by “kapsiki” populations. The sampling method used for processing method study was cluster sampling [9] with two degrees of units, with at the primary level, the cities surveyed, production sites and markets. At the secondary level individuals and groups of individual respondents storeyed. Two layers were formed: rural area and urban area. As urban area, Mokolo were chosen

because of the possibility of finding markets as well as production sites. In mountainous Kapsiki land, three cities were selected: Rhumsiki, Rhumzu and Mogodé. As for the surveyed markets, we conducted a random choice in Mokolo; in Rhumsiki, Rhumzu and Mogodé, all markets were taken into account because of the very limited number of markets and their periodical characters. Producers and women retailers were also randomly chosen in the areas and markets selected for the survey. A total of 15 production sites and 7 markets were visited, 50 producers and 23 women retailers were interviewed. The interviews were conducted on the basis of a questionnaire and collected data were processed using the software Winstat through a counting sheet constructed from the questionnaire.

## 2.2 On Site Experiment

For characterization, 40 samples of the "red kapsiki" were collected from 10 sites of production and sales. The sample pH was measured directly onsite using a portable pH meter. The conductivity, density and brix were also recorded on site using portables devices (conductimeter, densitometer and brix meter). Around 10 ml of each sample were introduced into test tubes and gently shaken. The probe of designated apparatus (pH meter, conductimeter and densimeter) was then submerged into the test tube and the values read directly in the screen of the device. The experiment was repeated four times for each sample. The mean of each read result were considered. For Total Soluble Solids (% Brix), the refractometric method was used to determine the soluble solids in beers samples [10]. The portable refractometer was first calibrated at 20°C using water bath, and regularly calibrated with cooled distilled water until the screen of the device show 20°C. Soluble solids were then obtained from read refractive index on device screen, by reference to a standard table.

## 2.3 Laboratory Experiment

### 2.3.1 Physicochemical analysis

*2.3.1.1 Titrable acidity*

Titrable acidity (as percentage (w/w) tartaric acid) was determined according to the Association of Analytical Chemists method [11]. Acidity was determined by titration with 0.1 N NaOH, solution and expressed as percentage tartaric acid; bromothymol blue was used as an indicator.

*2.3.1.2 Total polyphenols*

Total polyphenols were assayed by calorimeter using the Folin-Dennis Ciocalteau reagent as described by Mangas et al. [12] and the results were expressed as mg/l of gallic acid.

*2.3.1.3 Total ethanol*

Total ethanol content was determined by a spectrophotometric micro-method after distillation of wine that was made alkaline by a suspension of calcium hydroxide [13].

*2.3.1.4 Specific Gravity at 20°C*

Specific Gravity at 20°C and Viscosity (poise) at 25°C: These two parameters were evaluated as describe by Nanda et al. [14]. The specific gravity determination were done as follows, 20 ml of sample was poured into the specific gravity test tube to overflow, then the stopper was inserted, then incubated in water-bath at 20°C for 30 minutes. The test tube was removed from the water-bath wiped and weighed. Thereafter sample was boiled. Cool water was similarly treated the same way as that of sample then the specific gravity was calculated as the ratio of weight of ash over the weight of fresh sample 100.

*2.3.1.5 Volatile acidity*

The volatile acidity (g/l): This was determined using Mathieu method by titration of the volatile acids separated from wine by steam distillation and titration of the distillate [15].

### 2.3.2 Microbial analysis

10 milliliter of "tè" samples from each location was mixed with 90 ml sterile peptone physiological saline solution (1 g Peptone, 8.5 g NaCl and 1000 ml distilled water). Decimal dilutions were prepared up to $10^6$ from initial sample as describe by Loyer, & Hamilton [16].

*2.3.2.1 Total aerobic mesophilic bacteria*

Total aerobic mesophilic bacteria was enumerated on Plate Count Agar (PCA-OXOID) supplemented with cycloheximide 0.5% [17]. The plates were incubated at 28°C for 48 to 72 h.

*2.3.2.2 Total coliforms and Escherichia coli*

Total coliforms and Escherichia coli were accessed on Bubble Lactose Bile with Brilliant green (BLBVB- DIFCO). The tubes containing the Durham bells were incubated at 30°C for 24 to 48 h. The positive tubes were used to inoculate another test tube containing water peptone without indol and were incubated at 44°C for 24 h for *E. coli* determination. *E. coli* was revealed using Kovac's reagent [18]. Total coliforms and *E. coli* were evaluated by the method of the most probable number.

*2.3.2.3 Staphylococcus aureus*

*Staphylococcus aureus* was enumerated on Manitol Salt Agar (MSA - Sigma) and revealed by the coagulation test with rabbit's plasma. The plates were incubated at 37°C for 48 h. *Faecal* Streptococcus was enumerated on Slanet Agar (SL-Merck) supplemented with Cycloheximide at 0.5% after 48 h of incubation at 37°C [19].

*2.3.2.4 Salmonella and Shigella; sulphite-reducing bacteria, Yeasts and molds*

Salmonella and Shigella were analysed as describe by Ribot et al. [20]. Yeasts and moulds were enumerated on YPD-Chloramphenicol (200 g yeast extract, 10 g peptone, 20 g glucose, 20 g agar, 0.5 g chloramphenicol and 1000 ml distilled water) after 48 to 72 h of incubation at 30°C [18]. Enumeration of sulphite-reducing clostridia were done according to Mossel [21] method in anaerobic jar. All enumeration in solid media was carried out in triplicate and the plates containing between 33 and 333 colonies were considered. The enumeration in liquid media was evaluated according to the most probable number.

## 3. RESULTS AND DISCUSSION

### 3.1 Production Method of "the red kapsiki"

Sorghum beer is generally made from grain and water; sometimes with a gelatinous or mucilaginous agent [22]. In Cameroon, most of non-Islamized ethnic groups process it even if in different forms. The obtained beer is named according to ethic groups and countries. We can highlight Tchoukoutou in Togo and Benin, Pito in Ghana and Nigeria, Tchpalo in Ivory Coast, Bili-Bili in Cameroon. The artisanal techniques commonly used include:

#### 3.1.1 Malting

In the case of "red kapsiki" also locally named "té", as most of beers, the process production starts by the selection of grains. The "red kapsiki" being a noble beer, only good quality grains are considered. Mostly the sorghum variety "mouskwari" is selected for the "red kapsiki" production. However in raining season, "Djigari" variety can also be selected.

*3.1.1.1 Quenching*

After being washed, the grains are immersed in water for 12 hours to 24 hours, so as to obtain a moisture content of 35% to 40% for germination. The temperature of water is very important: At high temperature the quenching is rapid. The immersion temperature is close to that of room temperature (around 40°C to 45°C in the region). The grains are then drained on tissue, and then placed in double layer on cotton cloth bags or on woven mats.

*3.1.1.2 Germination*

The soft grains are covered and placed in dark area for two to three days for germination. Water is sprayed on the mixture, when the ambient air is dry or when the temperature is hot. Alternatively the grains are left on the ground and sprayed until the germination process starts and rootlets appear. The high temperature facilitates the beginning of germination. In this case the germination time can lasts four days. It should be noted that the same technique is used at the household level to improve the energy density of slurries [23]. During germination, amylolytic enzymes are produced and protein digestibility of sorghum, which is generally low is improved [24]. It was also demonstrated that after three days of malting, there was production of amylolytic enzymes including α-amylase, β-amylase and dextrinase, which are all essential for good quality of malt [25].

*3.1.1.3 Drying*

This corresponds to the "Kilning" and brings moisture of the malt to 15-20% without moldy. The malt is dried in sun for one or more days, sometimes less if the processor goes straight to brewing stage. In case of the production of special "red kapsiki" it was noticed that after malting, grains are roasted in firewood and ground coarsely. The obtained powder is kept in dark for two days before brewing.

### 3.1.2 Brewing

*3.1.2.1 Milling*

The previously obtained malt is crushed in a mortar or wen in urban area, the malt is brought to a motorized milling machine set to crushing mode, to obtain a coarse flour.

*3.1.2.2 Pasting*

The grind is mixed with water and a gelatinous or mucilaginous agent (okra or sap of various trees that improve flocculation and filtration of insoluble in suspension). After an hour of storage at temperature 25° to 35°C, the mixture separates into two phases the upper liquid phase, which is collected and the bottom pasty part, which is use as animal feeds. The upper liquid phase already contains a soluble portion of malt sugar.

*3.1.2.3 The decoction*

The lower phase containing malt flour is cooked slowly to boiling, so as to obtain a starch paste (slurry consistency). The upper liquid base is then mixed with water to be more easily saccharified than if it was not being cooked, the diastatic actions being more effective on cooked starch than on raw starch. Alternatively, like for other sorghum beer processing, where the raw grain is added [26,27,28] in the case of the "red kapsiki" production may continue with malted sorghum powder. In fact, ground malted sorghum is dissolved in water at the ratio of 1/9 (w/v). After one to three hours of soaking, supernatant is removed and keep for a later use. The remaining mealy material at the bottom of the soaking container is then removed and cooked for three to five hours. It must be noted that some enzymes produced during the malting stage seem inactive. This may be due to the soaking temperature, which is not optimal for enzymes. The mealy deposit is constituted by 80% raw starch. This starch is cooked and lightly cooled before the previously removed soaking water probably containing starch digesting enzymes, is added. The mixture is then kept warm for one to five hours or let stand overnight at room temperature.

*3.1.2.4 Filtration*

After the decoction phase the paste like mixture previously removed become liquid and is filtered. The dry mater is discarded while the sour mash obtained is kept for the next step of the process. The filtration is mostly done through polypropylene bags, the slurry obtained after decoction is passed through this polypropylene bag. The filtrate now called “liquid sour must” is kept for further processing where the drench is use as animal feed.

### 3.1.3 Cooking

The liquid must is concentrated and clarified by skimming. This operation is stopped by several criteria: clarity, color of the must, cold consistency (syrupy appearance)and also the flavor of the must. In fact this operation consists of producing a sweetish liquid must which is called “tè kwarhèni” [4] in Kapsiki dialect.

### 3.1.4 Fermentation

The sweet must is cooled either spontaneously or by successive decanting and then starter culture is added. Fermentation lasts 12 to 24 hours at room temperature.

## 3.2 Some Physico Chemical Profile of the “red kapsiki”

Compared to other African beer as describe by Lyumugabe et al. [18], the “red kapsiki” present a greater alcohol content (3.85-4.28% v/v), a pH between 2.40±0.19 and 3.26±0.03. Soluble extract varies from 6.30 to7.29 °P, Brix from 7.0 to 7.46 °B, total sugar from 41.8 to 72.9 (g/l) a conductivity from 1919 to 1990 (µS/cm), and Specific density (g/cm) at 15°C of about 1.25 (Table 1). The color of the “red kapsiki” varies from a pinky brown to reddish according the variety of sorghum used. As most of African sorghum beers, the “red kapsiki” present a touch of fruitiness added to their fermentation odor. This beer is mainly consumed in an actively fermenting state leading to a short shelf life as mentioned for other African beer in literature [28,29,30,31].

As presented in Table 2, the “red kapsiki” contains a quite good amount of polyphenols. The recorded amount varies from 843±27 mg/l in Mogode samples to 1150±27 in Rhumzu sample. It must be noted that some of these polyphenols are rare or absent in other “industrial” beer. As indicated by Bröhan et al. [32] when barley malt is used for mashing, around 30% of total beer polyphenols are containing from hop, although added in 100 times lesser quantity than malt. In the case of the “red Kapsiki”, the sorghum contribution to beer polyphenols could be much

higher. In fact sorghum phenolic acids include hydroxybenzoic (mainly protocatechuic and p-hydroxybenzoic acid) and hydroxycinnamic acids (mainly ferulic and p-coumaric acid) [33,34] both free and bound as esters. Most of them are found in usual lager beers brewed either from barley malt or from hop [35]. Sorghum anthocyanins are unique, as they lack the hydroxyl group at the 3-position of the C ring.

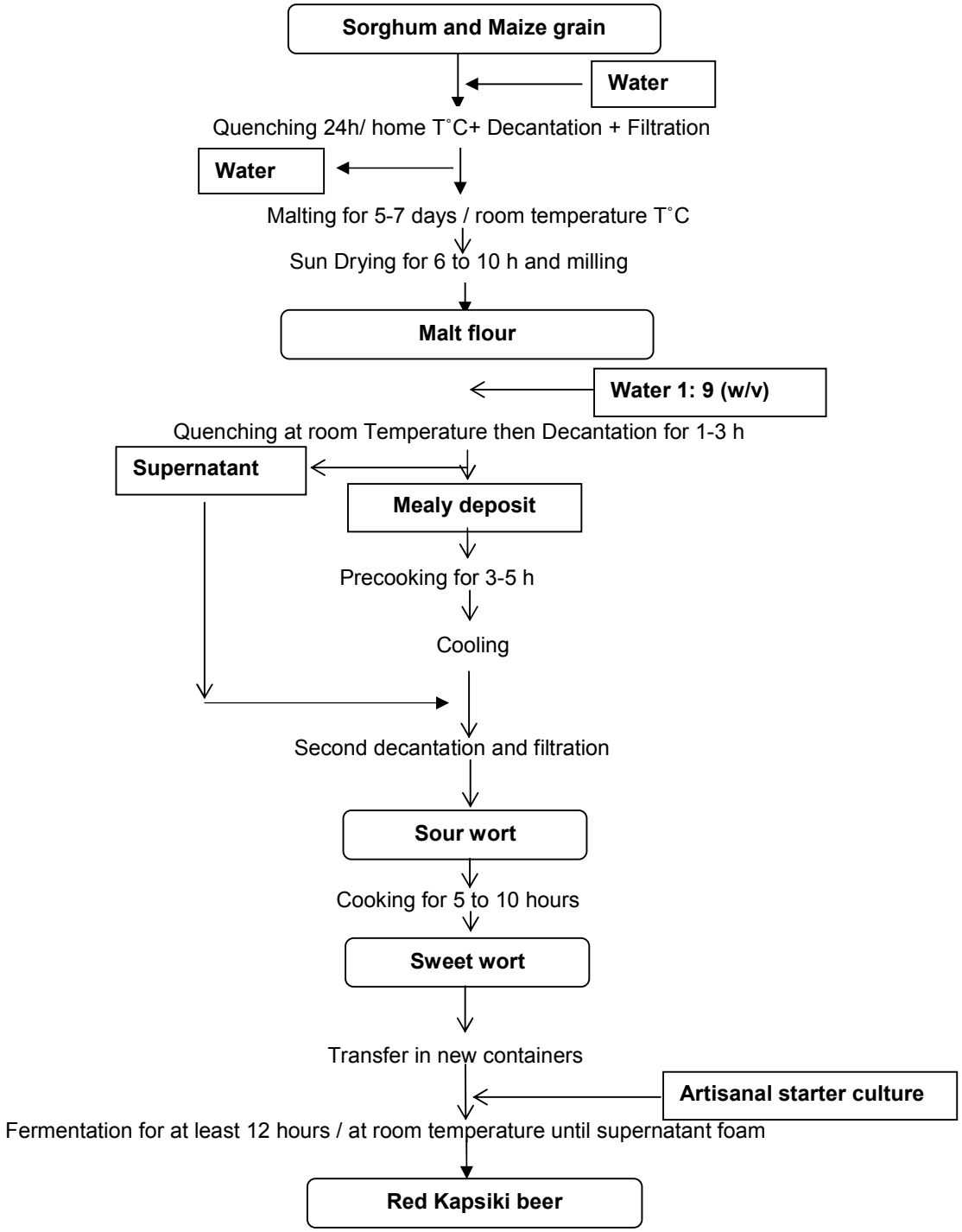


**Fig. 1. Technological diagram of homemade "red Kapsiki" beer**

These 3-deoxyanthocyanins such as luteolinidin and apigeninidin are used as natural food colourings, because they are more stable than anthocyanidins in both organic solvents and acidic solutions. The amount of 1500 mg/l of flavonol were recorded in « red Kapsiki ». Bröhan et al. [22] indicate that Flavanols such as apiforol (leucoapigeninidin) and luteoforol (leucoluteolinidin) are sorghum polyphenols, as precursors of sorghum 3-deoxyanthocyanins. Never reported in beer, they have been found at concentrations up to 4200 mg/kg in sorghum [36]. Other sorghum flavonoids include the flavones apigenin and luteolin [37] the flavanones naringenin and eriodictyol [38], the flavonol kaempferol, the dihydroflavonol taxifolin, and the flavan-3-ols (þ)-catechin and epicatechin. Hops brings similar flavonols and flavan-3-ols to wort, in industrial brewing.

### 3.3 Microbial Profile of the "red kapsiki"

The results of the microbiological analysis of beers obtained are shown in Table 3. Analysis of these results shows that the parameters sought in the produced beers are not in accordance with international microbiological criteria [39]. The presence of microorganisms and pathogens as coliforms, *Salmonella* and *Shigella* and Yeasts and molds in this beverages indicate that the "red kapsiki", is of bad hygienic quality. In fact it's said that one of the main factor limiting the use of the "red kapsiki" like most of African opaque beers, is that they spoil rapidly due to extra bacterial. Despite its low acidity and pH, the load of microorganisms is significantly high (Table 3). Total aerobic microflora is up to 6.2 $10^7$ ufc/ml. This may be explained by the fact that "the red kapsiki" is still actively fermenting when sold and consumed. Meaning the process is not optimal yet when the beverage is consume. The total coliform load is higher in Mogodé (2.4±0.7) $10^5$ sample than in other samples. The presence of coliforms and fecal *Streptococcus* genera is obvious as the "red kapsiki" present a low acidity level and presence of alcohol even in insufficient amount. It was expected to have a synergetic effect of acid and alcohol against microorganisms.

Indeed, studies on traditional sorghum beer in West Africa show that these drinks are a complex biotope composed of several genera and species of microorganisms dominated by yeast [28,40,41]. Their prevalence is probably because they are added by inoculation of the traditional starter in the sweet wort to ensure alcoholic fermentation [42,43]. During fermentation, yeasts initially increase in number. Then in the later stage of logarithmic growth the production of ethanol starts and proceeds during the stationary phase. It has been observed that during this time, very little or no increase in the number of contaminating organisms seems to occur [18]. The isolated pathogenic bacteria can originate from the environment including humans, the equipment used and raw material. Among the pathogenic microorganisms could be isolated in craft beers, we can mention Escherichia coli and Bacillus species. Their presence and persistence in these beverages would not only be linked to a simple contamination but more to their adaptation ability. Indeed, several studies have shown that some environmental parameters such as low temperatures and pH had the capacity to induce the resistance of these microorganisms to high temperatures [44,45] and strongly acidic pH [46,47,48]. Leyer et al. [47] showed that the persistence of *E. coli* O157: H7 cells to acidic conditions (pH 5) promoted their survival in highly acidic foods such as apple juice. In addition, the surveys of Cheng et al. [49] have shown that this adaptation also involved the induction of highly heat resistance.

**Table 1. Physico-chemical profile of the "red kapsiki"**

| | Mogodé | Mokolo | Rhumsiki | Rhumzu |
|---|---|---|---|---|
| pH | 2.46±0.08$^a$ | 2.42±0.12$^a$ | 2.40±0.19$^a$ | 3.26±0.03$^a$ |
| Soluble extract (°P) | 7.28±1.29$^a$ | 7.29±0.26$^a$ | 7.29±0.26$^a$ | 6.30±1.09$^a$ |
| Brix (°B) | 7.0±1.06$^b$ | 7.46±0.83$^b$ | 7.42±0.84$^b$ | 7.0±0.16$^b$ |
| alcohol (% vol) | 3.85±0.58$^a$ | 4.10±0.46$^a$ | 4.08±0.46$^a$ | 4.28±0.78$^a$ |
| Total sugars (g.l$^{-1}$) | 72.8±1.29$^a$ | 72,9±0,30$^a$ | 72,9±0,40$^a$ | 41.8±0.39$^a$ |
| Conductivity (µS/cm) | 1919.23±8.12$^a$ | 1990.0±4.08$^b$ | 1990.0±3.53$^b$ | 1929.00±4.02$^a$ |
| Specific density (g/cm) à 15°C | 1.03±0.00$^a$ | 1.33±0.00$^a$ | 1.00±0.00$^a$ | 1.62±0.00$^a$ |

*Mean values preceded by at least one common letter in the same row are not significantly different (p <0.05) according to the ANOVA and DUNCAN comparison test*

**Table 2. Some essential compound of the "red Kapsiki"**

| Sample | Total titrable acidity (mg/l) | Volatile acidity (g/l) | Total polyphenols (mg/l) | Flavanol (mg/l) |
|---|---|---|---|---|
| Rhumzu | 7.2±0.6$^{ac}$ | 0.3±0.00$^{d}$ | 1150±27$^{a}$ | 1300±27$^{a}$ |
| Rhumsiki | 7.7±0.1$^{bc}$ | 0.2±0.00$^{e}$ | 911±22$^{b}$ | 1000±32$^{c}$ |
| Mogodé | 6.7±0.4$^{a}$ | 0.1±0.00$^{f}$ | 843±27$^{ba}$ | 834±16$^{ad}$ |
| Mokolo | 8.1±0.5$^{b}$ | 0.2±0.00$^{e}$ | 1111±32$^{ca}$ | 750±23$^{ea}$ |

*Mean values preceded by at least one common letter in the same column are not significantly different (p <0.05) according to the ANOVA and DUNCAN comparison test.*

**Table 3. Microbial profile of the "red kapsiki"**

| | Mogodé | Mokolo | Rhumsiki | Rhumzu |
|---|---|---|---|---|
| Total count (cuf/ml) | (6.1±0.2) $10^{5\,b}$ | (6.2±0.5) $10^{7\,a}$ | (5.1±0.3) $10^{5\,b}$ | (7.4±0.1) $10^{4\,b}$ |
| Total coliform (cfu/ml) | (7.2±0.5) $10^{4\,b}$ | (2.4±0.7) $10^{5\,a}$ | (4.2±0.4) $10^{3\,b}$ | (1.4±0.3) $10^{4\,b}$ |
| Total thermo tolerant coliforms (cfu/ml) | (9.2±0.4) $10^{1\,a}$ | (3.1±0.4) $10^{3\,b}$ | (5.2±0.7) $10^{1\,a}$ | (3.1±0.5) $10^{2\,ac}$ |
| *Staphylococcus aureus* | (1.1±0.3) $10^{1\,b}$ | (2.5±0.1) $10^{2\,a}$ | (8.1±0.3) $10^{3\,b}$ | (4.1±0.3) $10^{2\,c}$ |
| *Faecal Streptococcus (cfu/ml)* | (2.2±0.2) $10^{2\,c}$ | (3.7±0.4) $10^{4\,a}$ | (3.2±0.3) $10^{3\,c}$ | (2.2±0.2) $10^{4\,b}$ |
| *Salmonella and Shigella* (cfu/20g) | (8.1±0.7) $10^{1\,b}$ | (4.5±0.2) $10^{3\,a}$ | (9.2±0.7) $10^{2\,b}$ | (7.2±0.5) $10^{3\,c}$ |
| sulphite reducing *Clostridia* (cfu/ml) | (5.0±0.4) $10^{1\,b}$ | (7.7±0.3) $10^{3\,a}$ | (7.2±0.9) $10^{1\,b}$ | (2.5±0.6) $10^{2\,b}$ |
| Total fungi (cfu/ml) | (3.5±0.8) $10^{3\,b}$ | (3.2±0.7) $10^{5\,a}$ | (4.5±0.4) $10^{4\,b}$ | (6.1±0.2) $10^{4\,b}$ |

*Mean values preceded by at least one common letter in the same row are not significantly different (p <0.05) according to the ANOVA and DUNCAN comparison test*

These observations could probably explain partially the persistence of this pathogen and other similar in our beer samples. As for Bacillus, the persistence can be explained by their ability to spore-forming but also the capacity of their endospores to induce some of their extraordinary resistances such as heat and acid resistance [44,46,50].

The hygienic quality of beer produced depends solely on the conditions of fermentation of the must. Indeed, the levels of total sugar and vitamin C are relatively high in beers obtained from the fermented mash. The recorded values for "the red kapsiki" are higher than those in the "Tchapalo" [27,43] where the fermentation is carried out at room temperature with a starter culture based on previous productions. It must also be note to explain the prevalence of pathogens, that after few days of fermentation, the amount of yeasts decreases because of autolysis. With little or no competition from yeasts for the readily available nutrients, contaminating microorganisms increase rapidly in number and their metabolites may change and spoil the beer. Because of the relatively high temperature of the "red kapsiki" fermentation, these sequential events occur within a short time period. This period does not usually exceed more than 3 days in summer or 5 days in winter before this spoilage occurs. The metabolic activities of mesophilic bacteria may primarily responsible for the spoilage [50]. These bacteria, along with other undesirable bacteria may produce acetic acid, volatile off-flavors, fruity odors, and pellicles which render the taste, odor and texture of the beer unacceptable to consumers.

## 4. CONCLUSION

The "red kapsiki" as discussed above present a symbolic value for local mandara population. The "red kapsiki" requires for its preparation following steps: malting with quenching, germination and "kilning", decoction, filtration, boiling and sterilizing, cooling, sowing and fermentation. The "red kapsiki" present an alcohol content of 3.85 to 4.28 (% v/v), a pH between close to 2.40, soluble extract from 6.30 to 7.29 °P, Brix from 7.0 to 7.46 °B, total sugar from 41.8 to 72.9 (g/l), conductivity from 1919 to 1990 (µS/cm), and Specific density (g/cm) à 15°C of a 1.33. The color of the "red kapsiki" varies from a pinky brown to reddish according the variety of sorghum used. The microbial analyses indicate the presence of microorganisms including

pathogens. The contaminating microorganisms include coliforms, *Salmonella* and *Shigella* and Yeasts and molds in the beverages which indicate the bad hygienic quality of "the red kapsiki". Despite its importance and interesting physicochemical profile, this alcoholic beverage has a high degree of microbial contamination for consumption. The potential of the beverage for sales and income stream illustrates the need for the improvement of its processing and hygienic quality.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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