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Original Research Article

Traditional Processing and Characterization of "Kargasok" Drink, an Indigenous Tea from Far North Region, Cameroon

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Abstract: "Kargasok" is an artisanal drink with a tangy, slightly sparkling flavour obtained by fermenting sweet tea (green or black tea). This drink is highly prized for its therapeutic properties and a source of income to the producers but, its quality attributes are still unknown. The aim of this study was to highlight the manufacturing process and characterize the quality of "Kargasok" beverage. A survey was conducted in three divisions of the Far north region (Diamaré, Mayo dany and Mayo kani). Fifty-four (54) samples of "Kargasok" were randomly sampled and the sensory, physicochemical, phytochemical and microbiological properties were assessed according referenced techniques. The processing of "Kargasok" tea is rudimentary with two main steps, extraction either by decoction or infusion following with an "aerobic" fermentation. "Kargasok" drink had a mean pH of 3.41, total acidity between 5.76gL^{-1} and 6.11gL^{-1}, sugar content ranging from 2.82 gL^{-1} to 3.14 gL^{-1}, an average electrical conductivity of 669 µs/cm. The indigenous tea is rich in polyphenols (1717.54 mgGAEL^{-1}) with relevant antioxidant activities. Unfortunately, the microbial quality is unsatisfactory. However, the panellists judged "Kargasok" as orange-brown to brown in colour, sour and more fluid. The results suggest that "Kargasok" is a functional drink with huge potentials despite its production remains non-conventional.

Keyword: Kargasok, Processing, Physicochemical, Bioactive, Quality, Safety.

INTRODUCTION

In Cameroon and most especially in the northern regions, many local drinks are consumed depending on the circumstances and events. These drinks can be derived either from non-fermentative processes such as fruit juices (mango juice, foléré juice, baobab juice etc.) or from fermentative processes [1]. Nowadays, fermentation is the main biotechnological application in food processing in many developing countries due its low cost [2]. Within the category of beverages derived from fermentation, in the Far north region, there are alcoholic beverages such as "billi-billi" and non-alcoholic beverages such as "Kargasok" tea. Like many traditional beverages, "Kargasok" tea is traditionally produced by fermenting sweetened tea (green and/or black) and its consumption has tremendously expanded in the region. However, despite the importance of this beverage, little or no study has been done on the manufacturing process of "Kargasok tea". Moreover, the production processes are rather rudimentary and sometimes do not respect the rules of good practice and basic hygiene. These production processes differ from one locality to another likewise from one producer to another. These production conditions cannot guarantee consumers a healthy product of good nutritional and sensory qualities [3]. The non-respect of personal hygiene and environmental sanitary are also known to affect the qualities of food. Beverages obtained under these conditions are unstable and difficult to preserve [4]. "Kargasok" tea, like any other beverage intended for human consumption, requires the strict application of good hygienic practices throughout the process from production to consumption. The aim of this study is to describe the traditional production and to evaluate the quality of "Kargasok" tea produced and sold in the Far north region.

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MATERIAL AND METHODS

Description of the Study Sites

Three divisions Diamaré, Mayo Kani and Mayo-Danay were the study sites. In Diamaré, it was Maroua subdivision, Kaélé, Lara and Moutourwa in Mayo-Kani division, and Yagoua, Touloum and Datcheka in Mayo-Danay division. At the end of the survey, three (3) towns were chosen for sampling, namely Maroua (Diguirwo, Quartier toupouri and Dougoi), Kaélé (Carrefour Danay, Kaélé market and sector kani) and Yagoua (Sabongari, Fondation caudas Caritas of the Catholic Church and Sirataré quarter). The choice of sites was made on the basis of the frequency of production, consumption and marketing of the different types of "Kargasok tea". The GPS coordinates of the survey sites were taken using a hand-held GPS (GPS-test, NGA and U.S.) and were used to locate our survey sites in time and space (Figure 1).

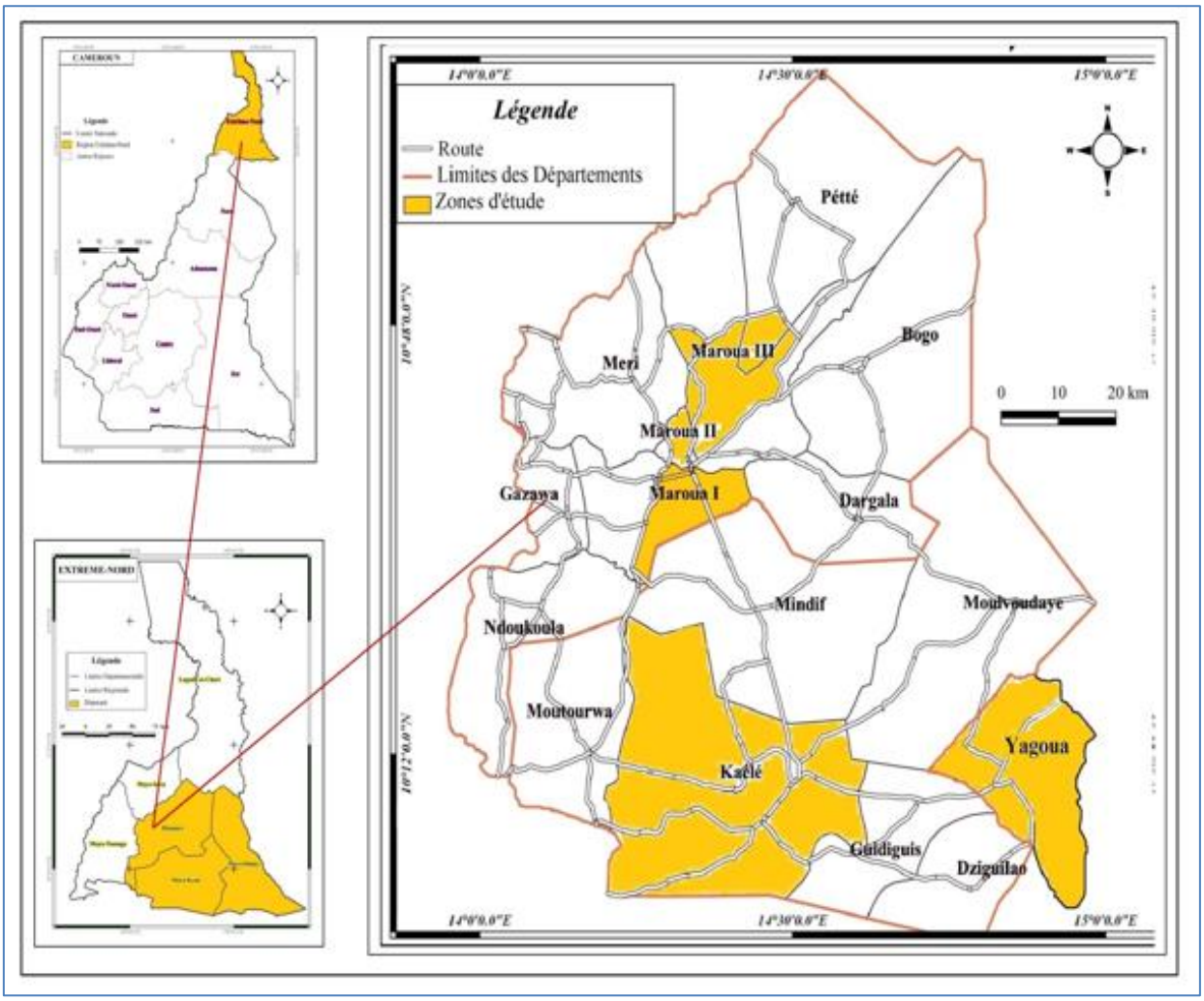

Figure 1: Map of study sites [39].

Data Collection on Manufacturing Process and Sampling of "Kargasok Tea"

To collect the information on the production of "Kargasok tea" production, field surveys made up of semi-structured questionnaires completed with interviews and observation [5] was carried out in urban and rural areas of the aforementioned divisions of the Far north region. The questionnaires were administered to both producers and consumers. The questionnaires focused on the socio-cultural status of the respondent (identity, gender, age, ethnicity, region of origin), the areas of activity, professional longevity, the raw materials and the factors determining their choice, type of tools, the production parameters and the volume of drink produced. A total of 33 producers and 21 vendors were interviewed during the process. Similarly, direct observations were made at selected sites to describe the natural environment and tools used in the production of the beverages with emphasis on the presence of stagnant water, the state of cleanliness of production tools, bottles and water used.

An oriented sampling approach was adopted. The samples of "Kargasok" tea were sampled from wholesalers and retailers in Maroua, Kaélé and Yagoua. The sampling was carried out between August and September 2021. The sampled beverages were introduced in sterile packages of 350 and 500 mL

according to the method described by [6], labelled and then transported aseptically in refrigerated coolers to the laboratory of Agro-food Science and Biology of IRAD-Maroua and to the laboratory of Microbiology (National Social Insurance Hospital of Maroua) for physicochemical, phytochemical, microbiological and sensory properties.

Physicochemical Analyses

The pH was determined directly according to the method described by [6], using of a portable ATC pH meter (Eco Testr, Singaore) after calibration with pH 4 and pH 6.8 buffers. The reading was taken when the equilibrium potential between the electrodes was reached. The titratable acidity (g/L) was determined by titrating the beverage sample with NaOH (0.1 N) in the presence of phenolphthalein until a persistent pink colouration appears [7]. The electrical conductivity (µS/cm) of the "Kargasok" tea samples was assessed directly using a portable multifunctional conductivity meter of the type "e-1 TDS&EC" by the method described by [8]. The approximate alcohol content was determined directly using a portable ATC refractometer (RHB 90, Shenzhen, China) calibrated at 20°C likewise the soluble solids. However, the value of the scale corresponding to the approximate alcohol content of the sample is located to the right of the observer and is expressed in alcoholic degree ($\%vv^{-1}$). The phenol-sulfuric acid method was used to determine the total sugar content (gL^{-1}) [9].

Phytochemical Analyses

The spectrophotometric Folin Ciocalteu, $AlCl_3$ and vanillin acid methods were used to assay the total polyphenol, flavonoid and tannin contents respectively [11] [12]. The results were as mg of gallic acid equivalent per litre ($mgGAEL^{-1}$) for total polyphenol content, mg of quercetin equivalent per litre ($mgQEL^{-1}$) for total flavonoid content and mg of catechin equivalent per litre ($mgCEL^{-1}$) for total tannin content. In addition, the DPPH free radical scavenging and ferric reducing antioxidant power were equally assessed [13] 14]. The results were expressed as mg of trolox equivalent per litre ($mgTroEL^{-1}$).

MICROBIOLOGICAL ANALYSES

Preparation of Dilutions

The "Kargasok tea" was serially 10-fold diluted in sterile peptone water (9 mL). 1 mL of the stock solution was added into 9 mL of peptone water and the mixture was vortexed. This operation was repeated in a series of test tubes until the desired dilution was obtained.

Hygienic and Sanitary Profile of "Kargasok Tea"

One millilitre (1 mL) of the inoculum was deeply plated in Plate Count Agar (PCA) for the enumeration of total aerobic count. The plates were incubated in an oven at 30°C for 24h and the colonies obtained were counted [15]. Similarly, 1 mL of the sample was plated in MacConkey Agar and incubated at 37°C/24h and 44 °C/24h for the search of total coliforms and fecal coliforms respectively. The presence of coliforms after incubation was seen as purple-red colonies, 0.5mm in diameter with a precipitation zone were counted [16] Salmonella and Shigella were identified [16]. This method consists of pre-enrichment in buffered peptone water for at least 16 hours and at most 24 hours at 37°C, followed by selective enrichment on Mueller Kauffman Tetrathionate for 24 hours at 37°C and finally inoculation in Salmonella/Shigella (SS) agar medium at 37°C for 24h after which the colonies were enumerated. On the other hand, 0.1 mL of the inoculum was surface plated in Sabouraud agar supplemented with Chloramphenicol at 25°C for 3 days to search fungi [17].

Sensory Analysis

The samples of Kargasok teas were presented to a panel of twelve (12) mixed gender made up of student (7) and consumers (5) aged between 22 and 41 years. The panellists were from three sites (Maroua, Kaélé and Yagoua), but also from Ngong (north region) belonging to different ethnic groups (Moundang, Toupouri, Massa, kotoko, Arabe choua and Fulani). The test was conducted in the morning in a clean room. Each taster received 30 mL of each sample in a disposable glass with the sample code and water next to it to rinse the mouth after each tasting. The panellists were given evaluation form with a hedonic scale rated from 1 (dislike extremely) to 9 (like extremely) which they used to grade the tea. The sensory attributes evaluated were the colour, acidity, texture, flavour/smell, taste and overall acceptability [18].

Statistical Analysis

The results were organised using Microsoft Office/Excel 2013 workbook and processed with STATGRAPHICS Centurion 16.1 software. Comparison of means was performed by ANOVA and then Tukey's honest significant difference (HSD) multiple comparison test was used to discriminate between pairs of significantly different means. Mean values were considered statistically different at $p \leq 0.05$. At the end of the analyses, the results obtained were presented in a table in the form of Mean ± standard deviation.

RESULTS

Traditional Manufacturing of "Kargasok" Tea

Figure 2 below shows the traditional production flow chart for "Kargasok" tea. This production involves two main operating units; decoction or infusion depending on the type of Kargasok desired and fermentation. The decoction consists of either introducing into a container containing a previously measured quantity of water (2 L) of tea plus additives. The mixture is then boiled at 100°C for 30 to 45 minutes to permit maximum

extraction of chemical constituents. The mixture can be boiled with or without sugar (140 to 160 g). In case, it was not boiled with sugar, after filtration (using a sieve or mesh), the sugar (140 to 160 g) is added into the filtrate and brought back to ebullition to completely dissolve the sugar. The resulting mixture is allowed to cool at room temperature. With infusion, of the 2 L, only 1 L is been boiled. 140 to 160 g of sugar is dissolved in boiled water before introducing the tea to be infused (green or black) and the content is allowed to stand for10-15 minutes before filtration. The filtrate is then diluted with the remaining 1 L (not boiled). Of these two methods, decoction is the most used by women producers (76%). This "matrix broth" must be brought to room temperature. In both cases, after cooling, the next common step is to introduce the starter which is suspension from the previous preparation stored in water or refrigerated. However, if it is taken out of the refrigerator, it must be allowed to warm up to room temperature, as any thermal shock is highly detrimental to the starter, and therefore the quality of the "Kargasok" tea itself. Finally, we should cover the container with a thin cotton cloth or canvas and tie it with rubber so that air can circulate between the surface of the liquid and the outside, which is essential for the success of the operation. The container thus covered is placed in a well-monitored place at room temperature away from light, dust and smoke for fermentation between 8 and 14 days.

The beginning of the acidic smell (usually from the 8th day) is the initial sign of beverage's maturity. The beverage is known to be matured when the ferment floats the surface and hence should be thick enough to be grasped between the fingers as thin ferment indicates that the beverage is immature. In the interval between the tenth and fourteenth day, the taste should be acidic and less sweet than on the eighth day of fermentation. The resulting liquid may be slightly fizzy. The tea is then filtered through a sieve to separate the various debris of the ferment that may have formed at the bottom of the container. The filtrate obtained is a clear, translucent, slightly orange-brown liquid. The tea obtained in this way can be consumed for two weeks at room temperature, depending on the season and the level of maturity of the fermented tea. If it is refrigerated, it can be kept for up to 45 days. However, the ferment should be carefully seized and stored either in water (the water should be changed every two days), or refrigerated for future preparations.

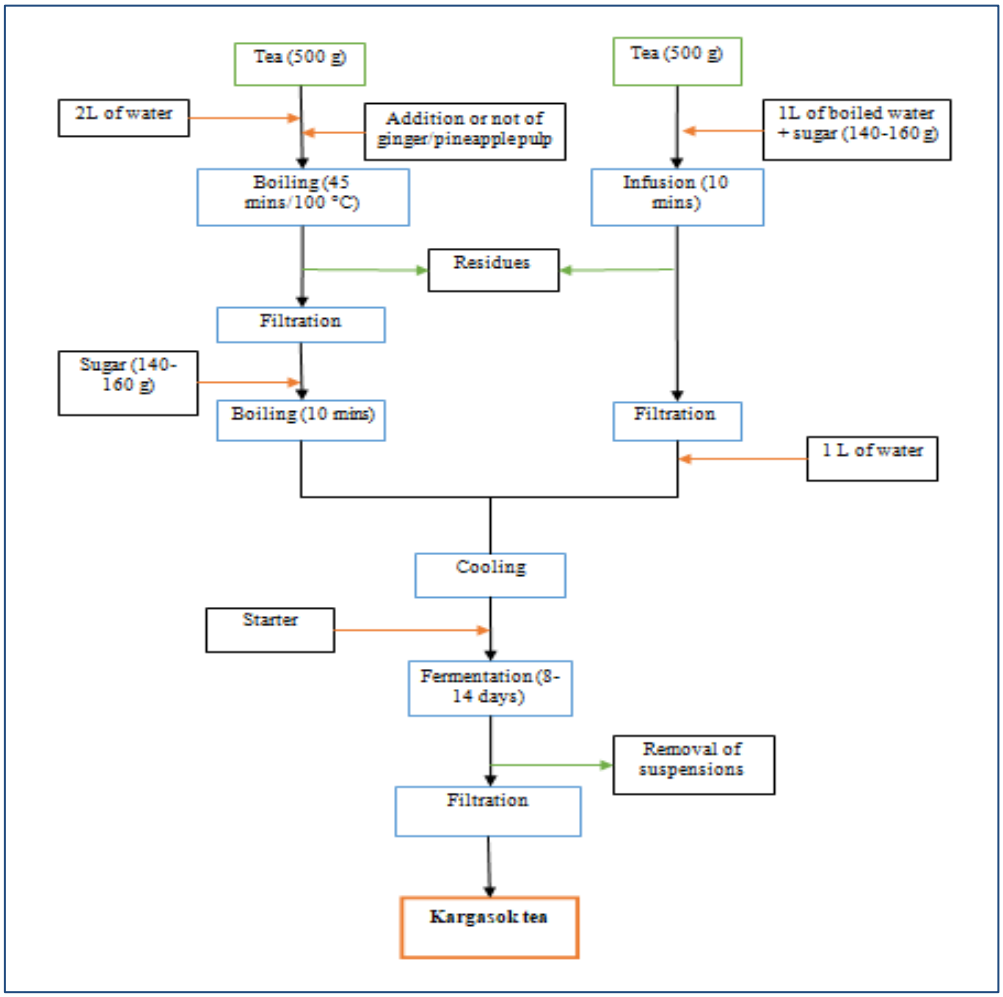

Figure 2: Traditional flowchart of "Kargasok" tea

Physicochemical quality of "Kargasok" tea

The physicochemical profile of "Kargasok" tea is presented in Table 1. The results revealed no significant differences ($p \geq 0.05$) between pH, total sugar and alcohol content for "Kargasok" tea sampled from different sites. The pH varies between 3.29±0.04 and 3.47±0.33 from one site to another. This result shows that "Kargasok" tea is acidic in nature with an average pH of 3.41±0.22. The total sugar content varies between 2824.32±449.294 mg/L and 3141.36±633.182 mg/L meanwhile the alcohol content has an average value of 4.22±0.64 $\%vv^{-1}$. The Maroua sample contains less sugar than those from Yagoua and Kaélé.

Table 1: Physicochemical properties of "Kargasok" tea

Parameters	Sampling sites			
	Maroua	**Kaélé**	**Yagoua**	**Mean**
pH	3.47±0.33[a]	3.46±0.11[a]	3.29±0.04 [a]	3.41±0.22
Total acidity (gL^{-1})	5.76±1.03[a]	5.88±1.05[a]	6.11±1.04[b]	5.92±1.10
Soluble solids (°Brix)	8.46±1.31[b]	8.45±0.82[b]	6.76±0.08[a]	7.89±1.21
Total sugar (gL^{-1})	2.82±0.45[b]	3.1±0.27[b]	3.14±0.64[b]	2.98±0.41
Conductivity (μScm^{-1})	669.5±97.3[a]	626.33±13.67[b]	699.66±36.7[a]	669.95±68.8
Alcohol content ($\%VV^{-1}$)	4.58±0.29 [a]	4.02±0.18[a]	4.08±0.32[a]	4.22±0.64

Mean ± standard deviation not followed by the same letter (a, b, c) on the same line are significantly different ($p<0.05$)

On the other hand, the total acidity, soluble solids and conductivity vary significantly ($p<0.05$) from one site to another (Table 1). The total acidity of the tea collected from the Yagoua site is higher (6.11±1.04 gL^{-1}) compared to those of Maroua and Kaélé samples which are in the order of (5.76±1.03 gL^{-1}) and (5.88±1.05 gL^{-1}) respectively. These values confirm the pH comparison result presented in the same table since pH and acidity are closely correlated. The comparative study of "Kargasok" tea samples shows that the soluble solids content of the samples from Yagoua is low (6.76±0.08°Brix) compared to those from Maroua and Kaélé sites which 8.46±1.31°Brix and 8.45±0.82°Brix respectively. Similarly, an average conductivity of 669.96±68.88μScm^{-1} was registered for the tea samples.

Phytochemical and Antioxidant Activity of "Kargasok" Tea

Table 2 summarises the level of bioactive components and antioxidant property of "Kargasok" tea. The beverage has varying levels of polyphenols, flavonoids and tannins. The total polyphenol content between 1649.29±132.2 $mgGAEL^{-1}$ and 1799.29±240.30 $mgGAEL^{-1}$. The level of polyphenol was significant between the samples from Maroua and those from Yagoua and Kaélé but the samples from Yagoua recorded the highest content (1799.29±240.30 $mgGAEL^{-1}$). As for the flavonoid content, it varies from 54.39 ±14.02 $mgQEL^{-1}$ to 295.78±41.61 $mgQEL^{-1}$. We noted a significant difference ($p<0.05$) between the samples from Kaélé and those from Maroua and Yagoua. The samples from Kaélé had a relatively low flavonoid content (54.3966 ±14.0202 $mgQEL^{-1}$) compared to the samples from Maroua (295.78±41.61 $mgQEL^{-1}$) and Yagoua (293.33±79.64 $mgQEL^{-1}$). Furthermore, the tea samples from Yagoua contain more tannins (345.78±115.2 $mgCEL^{-1}$) than the samples from Maroua (301.75±58.25 $mgCEL^{-1}$) and Kaélé (329.67±89.57 $mgCEL^{-1}$).

Table 2: Bioactive and antioxidant properties of "Kargasok" tea

Parameters	Sampling sites			
	Maroua	Kaélé	Yagoua	Mean
TPC ($mgGAEL^{-1}$)	1649.29±132.2[b]	1731.43±232.34[a]	1799.29±240.30[a]	1717.54±180.62
TTC ($mgCEL^{-1}$)	301.75 ±58.24[b]	329.667±89.56[a]	345.778±115.19[a]	322.49±30.32
TFC (mg QEL^{-1})	295.776±41.609[a]	54.39 ±14.022[b]	293.33 ±79.633[a]	214.492 ±79.636
FRAP($mgTroEL^{-1}$)	2500.0±346.777[a]	2406.25±265.165[c]	2161.11±48.1125[b]	2366.2 ±266.247
TAC ($mgTroEL^{-1}$)	266.023±87.1648[a]	98.42±17.19[c]	230.606±82.8949[b]	198.606±32.8949

TPC: total polyphenol content, TTC: total tannin content, TFC: total flavonoid content, TAC: total antioxidant capacity
Mean ± standard deviation not followed by the same letter (a, b, c) on the same line are significantly different ($p<0.05$)

There exist the significant difference ($p<0.05$) in the total antioxidant capacity content of the tea samples. The DPPH free radical activity varies from 98.42±17.19 $mgTroEL^{-1}$ to 266.02±87.17 $mgTroEL^{-1}$. Tea samples from Kaélé had the lowest antioxidant capacity content (98.42±17.19mg $TroEL^{-1}$) followed by those from Yagoua (230.61±82.9 $mgTroEL^{-1}$) and lastly Maroua (266.023±87.17 $mgTroEL^{-1}$). Similarly, the reducing power (FRAP) varies significantly ($p<0.05$) between 2161.11±48.11 $mgTroEL^{-1}$ and 2500.0±346.78 $mgTroEL^{-1}$ from one site to another. The highest reducing power was recorded with tea samples from Maroua (2500.0±346.78 $mgTroEL^{-1}$) and the least were those from Kaélé (2161.11±48.11 $mgTroEL^{-1}$).

Hygienic Quality of "Kargasok" Tea

The results of the microbiological analyses of "Kargasok" tea samples are presented in Table 3 below. From the analysis, the total aerobic plate count, total coliforms and total fungi vary significantly ($p<0.05$). The total aerobic plate count varies from 3.84 $x10^4$ $CFUmL^{-1}$ to 3.6 $x10^6$ $CFUmL^{-1}$. The highest plate count was registered with the tea samples from Yagoua (3.6 $x10^6$ CFU/mL) which slightly exceeded that set by AFNOR. In the same train, the total coliform load varies from 1.7±0.03 $x10^2$ $CFUmL^{-1}$ to 4.6±0.26 $x10^4$ $CFUmL^{-1}$. Contrary to the plate count, tea samples from Kaélé recorded the highest level of total coliforms (4.6±0.26 $x10^4$ $CFUmL^{-1}$) which surpasses the fixed level according to AFNOR. Similarly, the total fungi varied from 3.12±0.22 $x10^3$ $CFUmL^{-1}$ to 6.4±0.76 $x10^4$ $CFUmL^{-1}$. These values were far below the limit set by French agency of normalization (AFNOR). On the other hand, the fecal coliforms were only revealed in tea samples from Kaélé (2.1±0.13 $x10^2$ $CFUmL^{-1}$) likewise, all the indigenous tea samples were free of salmonella.

Table 3: Microbiological profile of fermented "Kargasok" tea

Sampling sites				
Microbial flora (cfu/mL)	Maroua	Kaélé	Yagoua	References
Total plate count	$(1.25\pm0.06)10^{5b}$	$(3.84\pm0.21)10^{4c}$	$(3.6\pm0.14)10^{6a}$	$<10^6$
Total coliforms	$(1.96\pm0.02)10^{3b}$	$(4.6\pm0.26)10^{4a}$	$(1.7\pm0.03)10^{2c}$	$<10^3$
Fecal coliforms	ND	$(2.1\pm0.13)10^{2a}$	ND	$<10^2$
Total fungi	$(6.4\pm0.76)10^{4a}$	$(2.08\pm0.16)10^{4b}$	$(3.12\pm0.22)10^{3c}$	$<10^5$
Salmonella/Shigella	ND	ND	ND	Absence/25mL

Mean ± standard deviation not followed by the same letter (a, b, c) on the same line are significantly different ($p<0.05$)

Sensory Analysis

Table 4 below summarises the sensory profile of "Kargasok" tea. The result revealed that the tea samples were accepted irrespective of the site. The overall acceptability was insignificant but the tea samples from Yagoua (7.2±1.55) were preferentially accepted over those from Maroua (6.08±0.98) and Kaélé (5.54±1.89). The preferential acceptance of Yagoua tea could be due to its texture (7.02±1.00), acidity (6.78±1.40), flavour/odour (7.4±1.28) and aroma (7.14±1.72) which were highly scored over those from Maroua and Kaélé. However, in terms of colour (6.92±1.74) and taste (6.94±1.64) tea samples from Kaélé were best rated even though it was the least appreciated.

Table 4: Sensory profile of "Kargasok" tea

Sampling sites				
Attributes	Maroua	Kaélé	Yagoua	Means
Colour	5.29 ± 0.71^{ab}	6.92 ± 1.74^{b}	4.13 ± 0.82^{a}	5.45±0.98
Texture	6.11 ± 1.08^{a}	6.58 ± 1.12^{a}	7.02 ± 1.00^{b}	6.57±1,21
Flavour/Odour	5.56 ± 1.53^{a}	5.72 ± 1.76^{a}	7.4 ± 1.28^{b}	6.22±1,88
Acidity	6.04 ± 1.86^{a}	5.14 ± 1.52^{a}	6.78 ± 1.40^{b}	5.98±1,94
Taste	5.41 ± 1.34^{a}	6.94 ± 1.64^{a}	5.64 ± 1.82^{a}	6.00±1.46
Aroma	4.18 ± 1.02^{a}	4.32 ± 1.22^{a}	7.14 ± 1.72^{b}	5.21±1.48
Overall acceptability	6.08 ± 0.98^{a}	5.54 ± 1.89^{a}	7.2 ± 1.55^{a}	6.27±1.24

Mean ± standard deviation not followed by the same letter (a, b, c) on the same line are significantly different ($p<0.05$)

DISCUSSION

Generally speaking, the traditional production of "Kargasok" tea includes two main classical stages: decoction or infusion and fermentation which remains empirical and rudimentary. This production completely differs from the production of most indigenous drinks like kounou, foléré among others [19] [20]. These beverages are either prepared by decoction or infusion with milder fermentation periods. Even though most people consider "Kargasok" tea as a refreshingly acidic drink drunk to quench taste, the appreciation goes beyond just refreshing. Like with foléré, téa lémi, kounou [20], [7], [19], it is considered as a functional drink consumed in most cases to prevent, strengthen or treat one's body against possible illnesses. Fermentation remains the key biotechnological process in most food industries and the production of "Kargasok" tea does not make an exception. The fermentation period of "Kasgasok" tea varies between 8 and 14 days. This time is far above that registered during the production of kounou but far less than that recorded with tea lémi [21] and [7]. However, this fermentation is aerobic contrary to the anaerobic fermentation observed during the production of tea lémi [7]. Hence, "Kargasok" tea is a non-alcoholic fermented beverage because the ethanol produced is transformed either by oxidation with oxygen in the air or by the action of bacteria into acetic acids.

The pH values of Kargasok" tea from different sites were no significant ($p>0.05$). This indifference could testify the homogeneity and the mastering of the

production. "Kargasok" tea has a pH of about 3.41 which is slightly more acidic than "zoom-koom" (pH 3.63) [22], but less acidic than foléré (pH 1.57) [23] and this pH was closer to a cereal based drink, "kounou" (pH 3.51) [21]. A drink with a pH below 4.5 is of satisfactory quality [24]. Titratable acidity indicates the level of organic acids present in the sample. Organic acids are often intermediate metabolites which can affect the growth of microorganisms and also enhances the organoleptic properties. The total acidity which varied between 5.76g/L and 6.11g/L is much higher than those of "foléré" [23], "kounou" [19] and higher than that of gowé, a traditional non-alcoholic fermented drink produced from millet in Benin [25]. This variation could due the nature of raw materials and processing techniques. The average soluble solids of "Kargasok" tea was 7.89 °Brix which is slightly closer to that obtained in fermented Tiger Nut milk (8.2°Brix) [26] but lower than that obtained with "kounou" [21]. Soluble solids represent all solids dissolved in water, including sugars, salts, proteins and carboxylic acids [27]. The relative loss soluble solids of "Kargasok" tea mostly related to the raw material than the production process. Tea plant is known to be rich in bioactive components than macromolecules. The conductivity value of "Kargasok" tea which varies significantly ($p<0.05$) between 626.33±13.67µScm^{-1} and 699.66±36.71µScm^{-1} makes us to believe that this drink could be rich in electrolytes hence mineral salts. Indeed, the raw materials and production ingredients would probably be the source of these minerals. However, this conductivity is lower than those found on manufactured tea liquors prepared from synthetic water [24]. The processing of "Kargasok" highly accounts for this difference. "Kargasok" tea is rich in sugar than most indigenous beverages made from the same regions. The total sugar content was insignificant ($p\geq0.05$) and varies from 2824.32±449.294 mg/L and 3141.36±633.182 mgL^{-1}. This result is higher than those obtained with "Zoom koom" (177.3 mgL^{-1}) [4] and ginger drink (1789 mgL^{-1}) but less than that of foléré (159-160gL^{-1}) [23]. These differences could be traced from the production and the nature of the raw materials. Most traditional beverages are a means of subsistence to the brewers and as such they are highly diluted accounting for the low sugar observed with "Zoom koom" and ginger drink likewise much sugar is used to blend the sour taste of foléré.

The functional property of the tea is based on the presence of plant secondary metabolites such as alkaloids, phenolic compounds, essential oils, tannins to a certain dietary fibre. The polyphenols content of "Kargasok" varies significantly ($p<0.05$) from 1649.29±132.2 mgGAEL^{-1} and 1799.29±240.30 mgGAEL^{-1} between the sites. This value is closed to the decoction obtained from *Camelia sinensis* plant extract (1.87 gL^{-1}) [28] but lower than that found in unfermented sweet tea (2.14 gL^{-1} to 3.12 gL^{-1}) [29]. Similarly, an average flavonoid content of 214.49 ±79.64 mgQEL^{-1} was recorded for "Kargasok" tea. This data corroborates with those found in *F. capensis* plant extracts [30]. These differences in the phytochemical contents could be due the nature of raw materials and processing procedures. Antioxidant activity greatly depends on the phytochemical contents. The total antioxidant capacity varies from 98.42±17.19 mgTroEL^{-1} to 266.02±87.17 mgTroEL^{-1} meanwhile the reducing varies between 2161.11±48.11 mgTroEL^{-1} and 2500.0±346.78 mgTroEL^{-1} from one site to another. Polyphenols and flavonoids are known to exert antioxidant activities [31]. The tea collected from Maroua and Yagoua had high flavonoid content. This flavonoid content greatly accounts for its highest antioxidant capacity and reducing power compared to that from Kaélé. Geographical area, climatic and genetic factors can also influence the content of phenolic compounds [32]. The antioxidant capacity of the beverages was therefore relatively dependent on total polyphenol and flavonoid contents.

The microbiological analyses are an important indicator of the hygienic and sanitary quality of a product. A highly appreciated and cherished product can be rejected due to the presences of certain microbes. The total aerobic count, total coliforms and faecal coliforms of "Kargasok" tea vary significantly ($p<0.05$) from one site to another. The total aerobic count varies between 3.84 x10^4 CFUmL^{-1} and 3.6 x10^6 CFmL^{-1} but this value was greater that than 2.8±0.7-8±0.5 x10^3 CFUmL^{-1} found in "kounou" [33] and was lower than that recorded with tiger nut milk (average load 2.8±0.4x10^7 CFUmL^{-1}) [26]. Despite this variation, the total aerobic plate count remains within the limit set by ANFOR but does not confine a satisfactory hygienic perception of the tea. Similarly, the total coliforms went from 1.7±0.03 x10^2 CFUmL^{-1} to 4.6±0.26 x10^4 CFUmL^{-1}, the total faecal coliforms registered was 2.9±1.8 x10^5 CFUmL^{-1} and the total fungi recorded range from 12±0.22 x10^3 CFUmL^{-1} to 6.4±0.76 x10^4 CFUmL^{-1}. The high level of coliforms does not guarantee the health of consumers. Indeed, the quality of the water used in the production of artisanal drinks is always a limiting factor. This water is used not only for household activities but also for the consumption of livestock and humans in rural areas. Boreholes, springs, well water, and unhygienic working environments are tools that vehicle the spread of these organisms. Research studies have shown the presence of coliforms including salmonella, vibrio in most water sources of the northern regions [34]. Fortunately, faecal coliforms were only detected for tea samples from Kaélé and no Salmonella/Shigella was no detected. However, the non-detection of these organisms do not mean they are completely absent. The study on traditional drinks produced in Congo also showed that the acidic environment may not be favourable for the growth of certain microorganisms [35]. It is possible that these germs have become resistant to these conditions. However, fungal flora, especially moulds, unlike other

microorganisms, are extremely tolerant to different pH levels as they are able to grow in a pH range of 2 to 9, with an optimum of 4 to 6.5, and can even withstand very strict anaerobic environment [36]. At room temperature, "Kargasok" has a maximum duration of 10-15 days depending on the initial degree of fermentation and the time of year. The absence of salmonella in fermented tea could be related to the acidic pH of this beverage which only favours the proliferation of certain acidophilic microorganisms.

All the samples of indigenous "Kargasok" tea were palatable with different degree of appreciation. The appreciation of food is based on several attributes; colour, texture, taste, aroma, viscosity, flavour/odour just to cite a few. Except for the taste, the colour, acidity, the texture, aroma and flavour were significant ($p<0.05$) between the different tea samples. With all these attributes, the tea samples from Yagoua registered the highest scores except for colour and taste which were highly scored for tea samples from Kaélé. The differences in these attributes could be due to the nature of raw materials used. Indeed, the black colour of the tea samples from Kaélé is more appreciated than the orange-brown colour of those from Maroua and Yagoua. Black tea is the most used tea in the production of "Kargasok" in Kaélé compared to the green tea used in Maroua and Yagoua. Also, the use of pineapple pulp and ginger in Kaélé to fortified the tea must have raised the taste making it to be preferentially accepted over those from Maroua and Yagoua. However, the overall acceptability shows that consumers appreciated "Kargasok" according to its appearance, colour, odour/flavour and acidity. Despite the no significant difference ($p>0.05$) observed with the overall acceptability, the tea sample from Yagoua was the most accepted and graded (7.2±1.55) followed by those from Maroua (6.08±0.98) and lastly Maroua tea samples (5.54±1.89). This heterogeneity is quite normal since the production, of artisanal type is made without precision measuring apparatus. This result is similar to those obtained with "kounou" [21] and "téa lémi" [7] respectively.

CONCLUSION

The present study was conducted to highlight the traditional production and assessment of the quality of "Kargasok" an indigenous tea made in the northern region of Cameroon. The production of "Kargasok" tea remains empirical and rudimentary with two key steps decoction or infusion and fermentation. The fermentation is said to be aerobic which runs from 8-14 days. The tea is rich in sugar with outstanding high level of bioactive components. However, "Kargasok" registered an acid pH hence cannot be consumed with an empty belly. The tea is highly appreciated but the hygienic quality is not satisfactory which vary from one site to another. The beverage is loved because its colour, acidic taste and texture.

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