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Optimization of the Brewing of "Kablé-Missine", Togo Northern Local Sorghum Beer

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Abstract:
Kablé-missine is a traditional alcoholic beverage predominantly brewed in Northern region of Togo. Despite its widespread consumption and use in various festivities, its quality varies enormously depending on the individual brewing methods. This study aimed to optimize the brewing process of local sorghum beer, kablé-missine, with a particular focus on malting and mashing. Local sorghum grains were subjected to steeping, and key parameters including moisture content during malting, pH, and Brix of the wort were evaluated. The moisture content significantly increased during the steeping phase (39.77 ± 0.44%) and subsequently decreased during germination (37.93 ± 0.53%). The pH of the acidification process was adjusted to 3.11 ± 0.02, and the Brix level significantly increased with extended boiling time in both samples. Moreover, using a limited amount of water during mashing effectively reduced the boiling time.

Key words: kablé-missine, malting, mashing, Brix, pH.

1- Introduction

Cereals are a crucial source of nutritional elements and energy for the West African population. Sorghum is one of the primary cereals cultivated in African tropical countries due to its superior performance compared to other cereals under various environmental stresses, making its production less expensive [1]. More than 35% of sorghum grains are utilized specifically for human consumption due to their significant impact on human health [2]. The remainder of the sorghum is used in the production of local beer and various dishes such as porridge, pudding, bread dough, and semolina. Sorghum beer production involves traditional techniques and expertise which are specific to African cultures and according to geographical regions. In different regions, sorghum beer is known by various names: "kaffir" in South Africa [3], "pito" and "burukutu" in Nigeria and Ghana [4], "doro" and "chibuku" in Zimbabwe [5], "tchapalo" in Côte d'Ivoire [6], "dolo" in Mali and Burkina Faso [1], "bouza" in Ethiopia, "pombe" in parts of East Africa [7], "bili bili" in Chad [8], "tchoukoutou" in Benin and Togo [9], and "ikigage" in Rwanda [10]. These traditional opaque beverages serve as cultural markers for indigenous people across Africa. In Togo, the production process for "tchoukoutou" varies between ethnic groups, affecting the final product's characteristics. According to Reference [11], three main categories of "tchoukoutou" can be identified in Togo: "kablé-missine," produced by the Kabiyè; "losso-missine," produced by the Losso; and "tchakpa-missine" or "tchakpalo," produced by the Moba people. The Kabiyè and Losso are from the Kara region, while the Moba are from the Savane region, both in the northern of Togo. Although the processes for producing kablé-missine and losso-missine are similar, small differences exist and affect the final quality of the product. The physico-chemical properties of "tchoukoutou" can vary considerably from one production to another, even among the same producers [12]. These variations are attributed to the lack process standardization. In fact, the quantity of each ingredient involved into the production and the different decisions during the process depend only to the expertise of each producer. Therefore, the objective of this study was to optimize the brewing process, specifically malting and mashing, of "kablé-missine,", a local sorghum beer produced by the people of the Kara region in Togo.

2- Materials and methods

2.1- Materials

Preparation of kablé-missine

The red sorghum (*Sorghum vulgare* L.) was bought from local market of Tsevié (prefecture of Zio, Togo), was used to produce the malt. The production of Kablé-misisne was done using the diagram described by [13]: malting, mashing and fermentation. 9 kg of the sorghum grains were malted by steeping into water overnight (11h), then water was drained and the grains were held into a container at air-rest for 13h. Then water was added and grains were held for short time before draining. Drained grains were spread out in thin layer and covered for the germination at room temperature. After 72 h the germinated grains were turned and mixed to stop the germination and allow overnight drying in manner to obtain the green malt. For the mashing, the green sorghum malt was milled, cooled, mixed with water, decanted and divided into slurry and supernatant. The slurry is heated up to boiling, filtrated, cooled, mixed with supernatant, soured, boiled, cooled. In this study, one sample, the control (STD), was obtained using the traditional method in manner to identify the variable parameters. Then, two samples were produced with different level of added water to milled sorghum malt during mixing operation: low water (LW) and high-water, 4 and 5 liters of water per 1 kg of sorghum grains, respectively. For the optimization we used gas as fuel an energy source compare to firewood used by the women.

2.2- Methods

2.2.1- Amount of water used during malting and mashing

The quantity of water was measured using the precision balance, (HLT-610, Zhejiang, China), **scale** 600 ± 0.10 kg. The amount of water used for the steeping and mixing operations was weighted on the balance before using, in manner to have an idea concerning the amount of the water. Five productions were done from different women.

2.2.2- Moisture content

Moisture content (MC, % g water / 100 g product) of sorghum grains was determined by weight loss by drying in a forced-air oven (OSI Thermosi SR 1000, Califormia, USA) at 105°C up to constant weight and the loss in mass was determined. At least 3 replications were done for each production.

2.2.3- pH measurement

The pH of all “tchoukoutou” products was measured at 25°C (HANNA HI98128, Woonsocket, Rhode Island, USA). pH meter was calibrated with two buffer solutions (pH 7 and pH 4). At least five measurements were effectuated.

2.2.4- Degree Brix

The total soluble solids content, expressed as °Brix, of “tchoukoutou” samples was measured by the AOAC methods [14] with an optical hand-held refractometer. Some drops of the sample were placed on the prism of the refractometer using a pipette. On closing the folding lid, the sample is evenly distributed between lid and prism. The value was read off between the light / dark boundaries. AT least three measures were obtained by production.

2.2.5 Statistical analysis

Significant differences ($p \leq 0.05$) among different samples were assessed by one-way-analysis of variance (ANOVA) with a Tukey and LSD post-hoc test. A SPSS software statistical analysis was (Version 29.0.1.0, IBM SPSS Statistics, Armonk, New York, USA) was used for all analyses.

3- Results and Discussions

Malting:

The malting process of local sorghum beer was done according to the traditional steps followed by the women. Malting, generally, start with preliminary operations, as sorting and washing, which were done to eliminate waste as stones, crumb of sorghum plants, weed seeds, dust, and reduce the microorganism [15]. Then the steeping which is, generally, consisted to soak sorghum grains into a large quantity of water for a long time allowing it to absorb sufficient water for germination. The measurement of the quantity of water allowed us to observed that more than 2.70 ± 0.27 L / Kg of sorghum grains were used for steeping (Table 1).

Table 1: Different parameter of traditional brewing of Kablè-missine

	Soaking water (L / Kg)	Mashing water (L / Kg)	°Brix	pH
STD	**2.70 ± 0.27**	**6.40 ± 0.55**	**17.88 ± 1.24**	**3.11 ± 0.02**

This result was less than the quantity used by [16] who reported that 3 liters of water are used for 1 kg of sorghum. At the first draining, the moisture content after 11 h of steeping was significantly increased. In fact, the initial moisture content of sorghum grain was 10.37 ± 0.04 % (g of water / 100 g of product) but it became 35.80 ± 0.31 % (g of water / 100 g of product) (Figure 1).

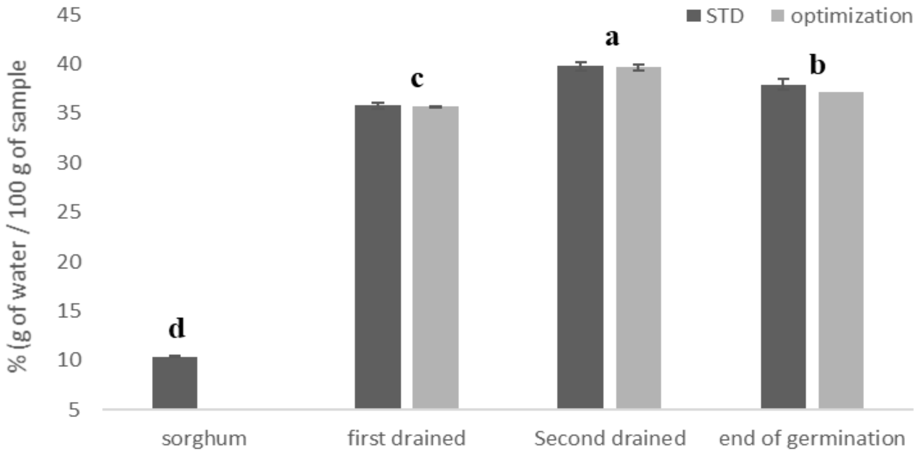

Figure 1: Moisture content during the malting process. Different letters indicate significant difference among samples ($p \leq 0.05$), where the "a" letter was assigned to the highest value.

It was significantly increased (39.77 ± 0.44 %) again after the second draining (13 hours after the first draining) and significantly decreased at the end of the germination (37,93 ± 0.53 %). To optimize the quantity of water implicated in the steeping we used 1.67 L of water per 1 Kg of sorghum grains. In fact, 9 Kg of sorghum grains were soaked into 15 L of water, which resulted to be enough because all sorghum grains were completely immerged. The results of the moisture content are showed in Figure 1. Similar trend of water absorption was observed in this case but there was no significant effect observed in the optimization experiment. In fact, the moisture content was 35.65 ± 0.26 %, 39.63 ± 0.09 % and 37.17 ± 0.31 % for first draining, second draining and after germination, respectively. Despite the reduction of the amount of steeping water, the similar moisture content might suggest that there is a waste of water during the traditional brewing method. Therefore, the reduction of water amount is important if the production will be at industrial scale because water waste might affect the benefit of the industry. The results showed an important absorption of water during the first step and this rapidly increase in moisture content was related to the high driving force for water transfer during that step of hydration. The limited absorption of water during the second step might be explained by the fact that the grain was going slowly to the equilibrium [17], [18], [19]. The steeping process allows the grain to absorb sufficient water which is necessary for the germination. In fact, the moisture content reached in our study was similar to those reported by [20] who reported that the optimum moisture content for sorghum seeds germination (35 and 40%). According to these results we might hypothesize that the first part of steeping operation is crucial to start observing the presence of sprouts. In fact, according to the traditional brewing process, the presence of sprouts is a signal for them to do the second part of steeping-draining. If the sorghum did not sufficiently soak into the water, the starting initial sprouts won't be able. However, if the grains were soaked for long time into the water, it would absorb more water, that the putrefaction could be observed during germination [21]. The optimal moisture content is important for having a good result during malting process. Concerning the germination, the decrease in moisture content might be associated to the evaporation during the germination process. However, during our study, we did not need to spray the grains and this might be associated to an efficacy steeping process. The evaporation of water might be related to the increase of temperature due to the respiration mechanism during germination. That situation might be avoided spraying water during germination as suggested by some authors [22].

Mashing

The traditional brewing method was used to produce the control (STD). The mashing started by milling the green malt, then it was mixed with the water. Generally, the quantity of water used is not measured and this affects the final quality of the product. The measured water during the production of the STD resulted to be 6.40 ± 0.55 L / Kg of sorghum grain. That means for 9 kg of sorghum grains we used 57.6 liters of water. Another critical step is the acidification because it determines the beginning of the second boiling. In fact, to start the second boiling operation, the women used to taste and smell the mash before deciding if the second boiling can be done. This operation is crucial because if the appreciation is not well defined, the quality of "tchoukoutou" is hardly affected. Measuring the pH after women decision we observed that the pH of the mash before the second boiling was 3.11 ± 0.02 and was strongly affected by environment temperature. It was very difficult to define the duration of the acidification operation due to the environment conditions [22]. The second parameter which is crucial during mashing is the Brix of the wort, because the women did not used a fixed quantity of water and the boiling time is not also specified. The boiling time was reported to be 6-9 hours of boiling [13]. The traditional brewing of the STD showed that the Brix of the sorghum wort before fermentation was different from one production to another, and variating from 16.0 to 19.4 with an average of 17.88 ± 1.24, after 5-6 h of boiling using the firewood. This boiling time might be associated to an inconstant heat transfer due to the fact that women used to combine the brewing with other household activities. Therefore, to optimize the mashing process two levels of water were fixed and the standardized pH was used. The results obtained for the production of the experimental samples are shown in fig. 2.

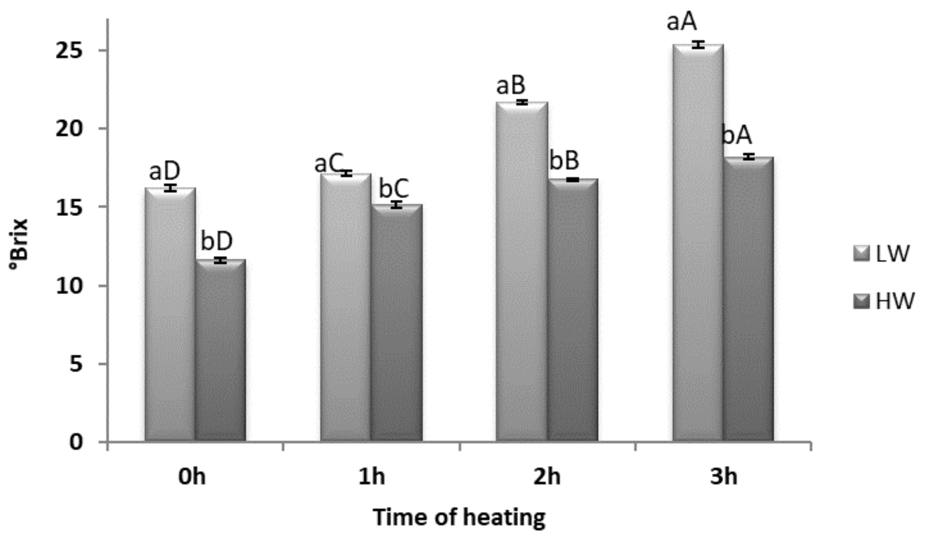

Figure 2: Brix value at different boiling time. Different letters indicate significant difference among samples ($p \leq 0.05$), where the small letter referred the difference due to the amount of the water and the big one to the heating time. The "a" and "A" letters were assigned to the highest value.

We observed that the Brix of the acidified wort was significantly high for low water (LW) than those for high water (HW) at the beginning of the second boiling operation. The Brix degree significantly increased as augmenting the boiling time in both samples [23]. Comparing our results with the STD, we observed that the samples with high water amount showed not significance difference in Brix value like STD, and the sample with low water amount was significantly higher than the STD. However, the HW showed similar Brix value as STD, that result is very interesting due to the fact that we significantly reduced the boiling time, 3 hours compared to 5-6 hours. It is important to specify that the source of energy was not the same because we used gas compare to the devoted women who use firewood. However, the using of gas might reduce the exposition of the devoted women to the firewood pollution which affects their health and impacts negatively the environment [24], [25], [26], [27]. However, it must be important to evaluate the both cooking methods for highlighting the benefice that the devoted women can obtain, in manner to encourage that women for using the gas as energy source.

4- Conclusion

The optimization of the process of "kablé-missine", a local beer around Togo regions, is an important action for manufacturing a good quality product. During the brewing the sorghum beer, malting and mashing are an important step and might be controlled. The acidification of the wort is crucial for the quality of the final product and might be controlled by measuring the pH. The Brix degree is another parameter which might be controlled and fixed. This will allow to have the same quality of kablé-missine. It might be necessary to evaluate the benefit using the gas as energy source in manner to encourage the

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