

Article

# Brewing Technique of *Mbege*, a Banana Beer Produced in Northeastern Tanzania

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**Abstract:** *Mbege* is a beer made of banana (*Musa* spp.) and finger millet (*Eleusine coracana*). It is the most popular indigenous alcoholic beverage in northeastern Tanzania, and plays an important role in the economy of the region. In this study, we observed and recorded a detailed traditional technique for brewing *mbege*. We observed that *mbege* production was divided into three major steps: *nyalu* preparation, *mso* preparation, and mixing. Fermented porridge made of ripened banana, called *nyalu*, was used as a source of yeasts. As a source of fermentable sugars, a sweet porridge made of germinated finger millet called *mso* was used. In *mso* preparation, a brewing technique to enhance the effectiveness of saccharification was used. After the preparation, these two types of porridge were mixed. The ethanol concentration of the mixture increased when it was fermented for 6 h, and it then became *mbege*. It was supposed that yeasts in the *nyalu* converted fermentable sugars in the *mso* into ethanol. We found that the brewing technique used in the production of *mbege* in northeast Tanzania was similar to that used in southern Tanzania. We also demonstrated that the stem bark of *Rauwolfia caffra*, which was called *msesewe* and used as an additive in *mbege* production, accelerated the fermentation of *nyalu* and therefore increased the rate of ethanol production in the brewing of *mbege*. This result was consistent with the traditional knowledge in the field about the effect of *msesewe* on *mbege* production.

**Keywords:** Africa; alcoholic beverage; banana; brewing; food culture

## 1. Introduction

Indigenous alcoholic beverages are alcoholic beverages produced with locally available ingredients, instruments, and techniques. Although the production of indigenous alcoholic beverages has decreased globally in recent years due to the spread of mass-produced alcoholic beverages, indigenous alcoholic beverages are still popular in regions of Africa south of the Sahara desert. Statistically, about half of the total alcohol consumption in sub-Saharan Africa is in the form of indigenous alcoholic beverages [1]. In this region, these beverages take on socially, economically, and nutritionally important roles. They are served when people gather for social meetings in order to facilitate communication, and are also known to accompany religious and royal ceremonies [2–4]. In the case of cooperative work such as opening a field, weeding, and home building, it is served as an incentive and as a reward for work [2,3,5,6]. Producing indigenous alcoholic beverages is one of the precious few opportunities for women to earn a cash income [6,7]. They are also used as a source of nutrition and clean water [2,8]. Indigenous alcoholic beverages are necessary for people living in sub-Saharan Africa. Therefore, we must learn more about these beverages in order to further our understanding of the region.

Tanzania is one of the sub-Saharan African countries in which indigenous alcoholic beverages are most abundantly produced and consumed. According to a report by the WHO, 87% of the total alcohol consumption in Tanzania comes in the form of indigenous alcoholic beverages [1]. This proportion of total consumption is more than 1.5 times larger than the average percentage of alcohol consumption attributed to indigenous alcoholic beverages in all countries of sub-Saharan Africa. More than 20 varieties of indigenous alcoholic beverages are found in Tanzania [9]. Among them, *mbege*, a banana beer made of banana (*Musa* spp.) and finger millet (*Eleusine coracana*), is the most popular indigenous alcoholic beverage in northeastern Tanzania [10]. However, in spite of its popularity and importance in the region, detailed brewing techniques of *mbege* had not yet been investigated prior to this study. Therefore, we carried out this study in order to clarify and record the brewing techniques of *mbege*.

## 2. Materials and Methods

### 2.1. Field

Field research activities such as recording observations, conducting interviews, taking measurements and performing on-site trials were carried out at Kilema kaskazini ward (9669 inhabitants divided into 2166 households) located in northeastern Tanzania [11]. The field research was carried out in July and November of 2015 and in January of 2016.

### 2.2. Details of Mbege Production

The details of the brewing technique of *mbege* were clarified by observation and interview. During the heating process in *mbege* production, changes in the temperature of the samples were measured using a handy infrared thermometer (826-T3; Testo, Kanagawa, Japan).

### 2.3. Measurement of the Changes of Ethanol Concentration, Brix Value and pH in Mbege Production

The changes in ethanol concentration, Brix value and pH during *mbege* production were measured as described below. Ethanol concentration was measured by using a kit for measuring ethanol concentration in saliva (Q.E,D<sup>®</sup> Saliva Alcohol Test; OraSure Technologies Inc., Bethlehem, PA, USA). We diluted samples with water as needed before taking the measurement. We determined the Brix value of samples by using an Abbe refractometer (FHR-1; TKG, Tokyo, Japan). The pH values were measured using a handy pH meter (B-212; Horiba Ltd., Kyoto, Japan). All treatments and experiments were carried out on location using instruments we brought with us.

### 2.4. On-Site Trial to Verify the Effect of Msesewe

In northeastern Tanzania, stem bark of *Rauvolfia caffra* is used as an additive in *mbege* [12]. It is called *msesewe* in the Chagga language and used for *mbege* production (Figure 1). *Msesewe* was dried and ground into powder before being used for *mbege* production. People working in this region believed that it accelerated fermentation and increased the final ethanol concentration of *mbege*. The effect of *msesewe* on *mbege* production had not been verified prior to our study. Therefore, we investigated its effect by conducting an on-site trial.

In the trial, we prepared two types of *mbege*, one with and one without *msesewe*, each according to the brewing techniques we learned previously during the observation and interview phases of this study. Ethanol concentration, Brix value and pH of samples, which were measured during the brewing process, were obtained using the methods described above. These measured parameters of *mbege* batches brewed with and without *msesewe* were compared to verify the effect of *msesewe* on *mbege* production.



**Figure 1.** *Msesewe*.

### 3. Results and Discussion

#### 3.1. Varieties of Bananas Cultivated in the Research Field

The banana is a fruit produced by several kinds of large herbaceous plants in the genus *Musa*. It is originally domesticated in southeastern Asia and brought into other parts of the world. In several parts of sub-Saharan Africa, it is eaten as a staple food. It is the most important crop as a staple food for the Chagga people in northeastern Tanzania. We found that there were 18 varieties of banana being cultivated within the research field (Table 1). Among them, *ndishi* was most frequently used for *mbege* production. According to the interview, the advantage of *ndishi* as an ingredient of *mbege* was that it was easily broken into small particles and became smooth when it was cooked. If banana was broken into small particles, the enzymes used for saccharification and the yeasts engaged in alcoholic fermentation could easily access the substrates of these reactions. Therefore, this characteristic of *ndishi* might contribute to increasing the productivity of ethanol. Although *ndishi* was suitable for *mbege* production, it was not used for cooking purposes because of its unpleasant taste. In addition to *ndishi*, other types such as *kimalindi*, *kipungara*, *kisukari*, *mchare*, *mrarao*, and *ndizi n'gombe* were also used for *mbege* production (Table 1). *Mchare*, which was the most popular variety for cooking purposes in the field, was not used for *mbege* production frequently. The reason was that *mchare* required a lot of time and energy to cook if it was used for brewing, because it was not easily broken into small particles. However, people believed that the quality of *mbege* could be enhanced if *mchare* were used for its production, because it contained a larger amount of sugar than *ndishi*.

**Table 1.** Names and usage of banana varieties found in the research field.

Local Name	Usage
Bokoboko	Cooking
Irongo	Cooking
Kimalindi	Fruit, cooking, brewing
Kinguruwe	Fruit, cooking, brewing
Kipungara	Brewing
Kisasa	Cooking
Kisukari	Fruit, brewing
Kitarasa	Cooking
Matoke ya Bukoba	Cooking
Matoke ya Mbeya	Cooking
Mchare	Cooking, brewing
Mkonosi	Cooking
Mnyenyele	Cooking
Mrarao	Fruit, brewing
Mzuzu	Cooking
Ndishi	Brewing
Ndizi n'gombe	Brewing
Ndizi Uganda	Cooking

### 3.2. Details of the Brewing Technique of Mbege

The scheme of *mbege* production is shown in Figure 2. The production of *mbege* involved three major steps: *nyalu* preparation, *mso* preparation, and mixing. Details of these three steps are as follows.

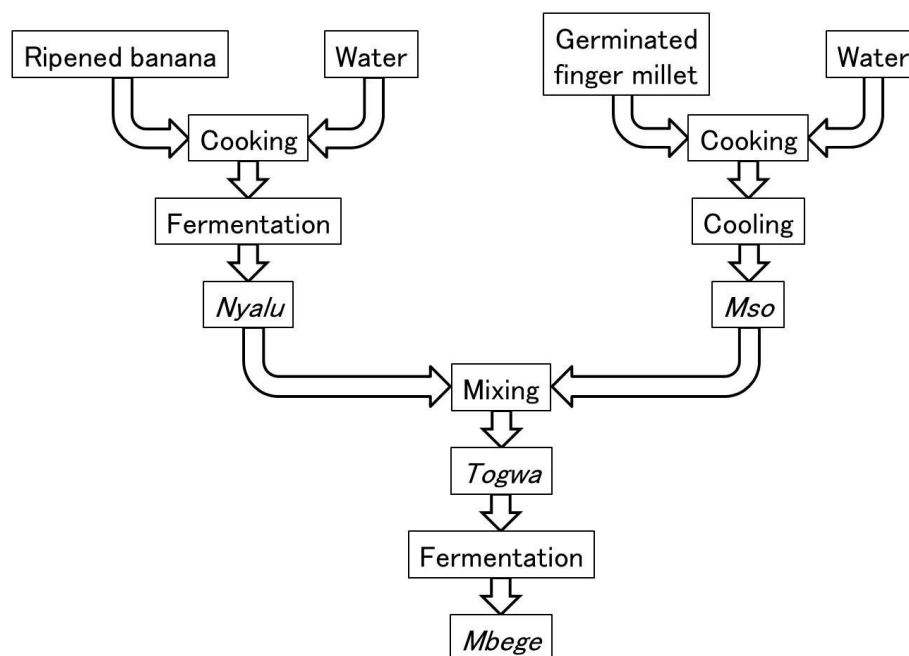


Figure 2. Scheme of *mbege* production.

*Mbege* production began with the preparation of *nyalu*. *Nyalu* was fermented porridge prepared with ripened banana. It was prepared as follows. First, 36 L of ripened banana was mixed with the same volume of water in an oil drum. The mixture was cooked over a high flame until its color became red and all the lumps were thoroughly broken down (Figure 3). After cooking, the mixture was transferred from the oil drum to a wooden barrel (Figure 4). It was then left to stand for 12 days at ambient temperature without covering. According to the brewer, the length of time required to ferment the cooked banana mixture varies with the season. Generally, the mixture is left to stand for nine to 10 days in the hot season and 12 to 13 days in the cold season. If the brewer uses *msesewe* for *mbege* production, a handful of it is added into the mixture after cooking. In this case, the mixture with *msesewe* will be ready after five days of fermentation. After a sufficient period of spontaneous fermentation, the mixture was filtered using a nylon bag (Figure 5). The mass leftover after the filtration step was called *makati*, and was utilized as feed for pigs. The obtained filtrate was the *nyalu* (Figure 6), a red porridge that had a slightly sour odor. According to our analysis, the ethanol concentration, Brix value and pH of *nyalu* were 1.2%, 5.6 and 4.5, respectively. The presence of ethanol in *nyaly* indicated that yeasts were present in the mixture and spontaneous alcoholic fermentation had occurred. We observed bubbling at the surface of the cooked banana mixture during the fermentation stage. Its pH value suggested that *nyalu* could provide suitable conditions for yeasts to proliferate. By taking these facts into account, it was supposed that *nyalu* was the medium for yeast cultivation in *mbege* production.



**Figure 3.** The mixture of ripened banana cooked on a high flame.



**Figure 4.** The wooden barrel to keep the cooked mixture.



**Figure 5.** Filtering the fermented mixture using a nylon bag to obtain *nyalu*.



Figure 6. *Nyalu*.

After the *nyalu* was prepared, *mso* preparation began. *Mso* was porridge made of germinated finger millet. *Mso* was prepared according to the following process. First, 35 L of water was poured into a metal barrel, and then 5 L of germinated finger millet flour was added into the water. The barrel and its contents were heated over a fire for a few minutes, and once the temperature of the water had increased, 15 L of the warm, thin mixture was removed and put aside. This warm, thin mixture was used later to adjust the thickness of the main mixture. According to the brewer, the warm, thin mixture was used to thin out the main mixture instead of cold water so as to prevent a drop in temperature throughout the course of cooking. After removing the thin mixture, an additional 15 L of germinated finger millet flour was added into the main mixture cooking over the fire. The mixture was then stirred vigorously using a wooden rod with the occasional addition of the thin mixture (Figure 7). The mixture was cooked for 25 min with intermittent stirring after the incorporation of the second addition of germinated finger millet flour. The temperature of the mixture was checked carefully throughout the process, and was adjusted by adding or removing firewood. The brewer said that *mso* preparation could not be successful if the mixture was cooked at too-high temperatures. The change in the mixing temperature during cooking is shown in Figure 8. The result shows that the temperature was kept around 50–70 °C. The amylase activity of finger millet is maximized at 50–60 °C, but it is denatured beyond 70 °C [13]. Therefore, in *mso* preparation, the effectiveness of saccharification was maximized by keeping the temperature of the mixture in the range of 50–70 °C. The same brewing technique was also observed in southern Tanzania [14]. Finally, the cooked mixture was transferred into several containers to let it cool. The obtained mixture was *mso*. *Mso* was a thick brown porridge with a sweet taste (Figure 9). The ethanol concentration, Brix value and pH of *mso* were 0%, 25.0% and 5.4%, respectively. It did not contain ethanol. However, it showed a high Brix value. This meant that the *mso* was rich in fermentable sugars, which were generated by the action of amylase during cooking. The high amylase activity of germinated finger millet compared to other cereals cultivated in Tanzania might contribute to the high Brix value of *mso* [15]. It was suggested that *mso* was a source of fermentable sugars.



Figure 7. Stirring the mixture of germinated finger millet flour using a wooden rod.

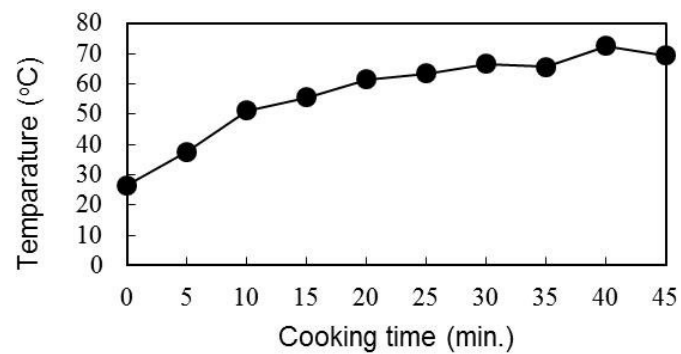


Figure 8. Change in the temperature of the germinated finger millet mixture during cooking.



Figure 9. *Mso*.

Finally, the freshly prepared *nyalu* and *mso* were mixed together in a wooden barrel. As shown in Table 2, the mixture contained only a small amount of ethanol (1.0%) right after the mixing process. The mixture was called *togwa* in this state. *Togwa* is the name of a saccharified beverage that is widely consumed in Tanzania [16]. It was a sweet and slightly sour beverage. After 6 h of

fermentation, the ethanol concentration of the mixture increased to 2.7%, and its Brix value decreased (Table 2). This was mainly the result of spontaneous alcoholic fermentation by yeasts in the *nyalu* using fermentable sugars from the *mso*. A yeast (*Saccharomyces cerevisiae*) and lactic acid bacterium (*Lactobacillus plantarum*) are the main microorganisms engaged in *mbege* production [10]. Therefore, lactic acid bacteria might also be engaged in the spontaneous fermentation in addition to yeasts, and might cause the decrease of the pH of the mixture. The mixture was called *mbege* in this state. *Mbege* was a red-colored alcoholic beverage with a slightly sour taste. A gourd cup was used to drink it (Figure 10). It was consumed within one or two days. The changes of the ethanol concentration, Brix value, and pH of the *mbege* over the course of 48 h of spontaneous fermentation after mixing are shown in Table 2. After 48 h of the fermentation, its ethanol concentration reached 4.0%, and its Brix value dropped to 6.0. A similar brewing technique involving a mixture of two different types of porridge was also reported in southern Tanzania [14]. In that region, germinated finger millet is also used as an amylase source, and the brewing technique to control the temperature of the mixture during saccharification exists [14]. The results of this study showed that there were many brewing techniques shared between northeastern and southern Tanzania.

**Table 2.** Ethanol concentration, Brix value, and pH of *togwa* and *mbege*.

	Ethanol Concentration (%)	Brix	pH
<i>Togwa</i> (0 h) *	1.0	9.0	4.6
<i>Mbege</i> (6 h)	2.7	8.0	4.4
<i>Mbege</i> (9 h)	3.0	8.5	4.4
<i>Mbege</i> (12 h)	3.2	7.5	4.2
<i>Mbege</i> (24 h)	3.0	6.5	4.2
<i>Mbege</i> (48 h)	4.0	6.0	4.2

\* Length of time (hours) after mixing *nyalu* and *mso*.



**Figure 10.** *Mbege*.

### 3.3. The Effect of *Msesewe* on *Mbege* Production

Under the direction of the local brewer, we prepared *mbege* with and without *mesesewe*, according to the brewing method shown in Figure 1. The ethanol concentration, Brix value and pH of the *nyalu* and *mbege* after 12 h of spontaneous fermentation were measured in each batch. The parameters of the samples are shown in Table 3. Our results showed that the ethanol concentration of the *nyalu* with *mesesewe* was higher than that without *mesesewe*. In contrast, the Brix value of the *nyalu* with *mesesewe* was lower than that without *mesesewe*. We also observed bubbling in the *nyalu* with *mesesewe*



after five days of spontaneous fermentation, although it was not observed in that without *msesewe*. These facts suggested that the alcoholic fermentation had taken place much more actively in the *nyalu* with *msesewe* than in that without *msesewe*. It was reported that the stem bark of mangroves can suppress the growth of all microorganisms in palm wine except for yeasts [17]. This suppressive effect is due to the tannins in the bark. As *msesewe* also contains tannins, it was supposed that *msesewe* helped yeasts to become the dominant microorganism in *nyalu* [12]. Yeasts might be able to proliferate rapidly once they dominate the population of microorganisms in *nyalu*. Our observations were consistent with the traditional understanding that *msesewe* accelerated the fermentation process.

**Table 3.** Ethanol concentration, Brix value, and pH of *nyalu* and *mbege* with *msesewe* (A) and that without *msesewe* (B).

	Ethanol Concentration (%)	Brix	pH
A. <i>Mbege</i> with <i>msesewe</i>			
<i>Nyalu</i>	0.7	10.0	4.7
<i>Mbege</i> (12 h) *	4.2	9.0	4.7
B. <i>Mbege</i> without <i>msesewe</i>			
<i>Nyalu</i>	0.2	15.0	4.6
<i>Mbege</i> (12 h) *	1.8	11.0	4.6

\* Length of time (hours) after mixing *nyalu* and *mso*.

Similarly to the case of *nyalu*, the ethanol concentration of *mbege* with *msesewe* after 12 h of spontaneous fermentation was higher than that without *msesewe*, and their Brix values showed the opposite relationship (Table 3). This result was also consistent with the traditional knowledge of brewers in this region, which stated that *msesewe* increased the ethanol concentration of *mbege*. It was supposed that the ethanol concentration of *mbege* with *msesewe* became higher than that without *msesewe*, because *nyalu* with *msesewe* contained a much larger population of yeasts capable of spontaneous alcoholic fermentation. In this on-site trial, we demonstrated the validity of the traditional understanding of the effect of *msesewe* on *mbege* production. However, an excess amount of *msesewe* may cause inefficient alcoholic fermentation and an unpalatable taste of *mbege* because of the effect of tannins [18]. Therefore, we must determine the adequate range of the quantity of *msesewe* to add for improving the quality of *mbege* in a future study.

#### 4. Conclusions

This study observed and recorded a detailed traditional brewing technique of *mbege*. *Mbege* was produced by mixing two different porridges, *nyalu* and *mso*. The *nyalu* was a fermented porridge made of ripened banana. It was the source of yeasts in *mbege* production. The other ingredient, *mso*, was a sweet porridge made of germinated finger millet. Its role was as a source of fermentable sugars. In the preparation of *mso*, we observed the technique to maintain the temperature of the mixture within a specific range for optimized saccharification. We found that the brewing techniques of *mbege* in northeastern Tanzania had similarities with the techniques of southern Tanzania.

We also verified the effect of *msesewe* on *mbege* production. The on-site trial found that *msesewe* accelerated the fermentation of *nyalu* and increased the final ethanol concentration of *mbege*. These effects of *msesewe* were consistent with the traditional knowledge of this region. Therefore, we demonstrated the validity of this traditional knowledge in regards to the effect of *msesewe* through the on-site trial.

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**Author Contributions:** In this study, Ryosuke Kubo conceived and designed the field research and experiments; Ryosuke Kubo and Method Kilasara conducted the field research together; Ryosuke Kubo performed the experiments in the field; Ryosuke Kubo wrote the paper under the supervision of Method Kilasara.

**Conflicts of Interest:** The authors declare no conflict of interest.

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