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Research Article

Capitalization of Endogenous Technologies for Processing Cereals-Based Fermented Porridges in Northern Benin

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Abstract

Background and Objective: The manufacturing technology of porridges can be used to improve not only the organoleptic and nutritional qualities but also the shelf life of the finished products. The aim of this study was to establish the traditional manufacturing process of eight cereal-based fermented porridges consumed in the North of Benin, West-Africa. **Materials and Methods:** A survey was carried out among producers in the cereal-based fermented porridge consumption area in Northern Benin. A total of one hundred and eighty female producers were randomly interviewed in nine communes (Kandi, Banikoara, Djougou, Copargo, Ouaké, N'Dali, Parakou, Coby and Matéri) of Northern Benin at a rate of twenty per area. **Results:** The processing of fermented porridges in North Benin follows several optional and mandatory steps. However, washing the cereal can be considered the first step of the manufacturing of the cereal-based fermented porridge followed mostly by the first stage of fermentation putting the cereal in water (hot or not) for several hours which varies. After soaking, cereals milling is done using a local mill equipped with electric or diesel grinders and then mixed with water before filtration. The obtained mixture of water and starch is then left to stand for decantation during which the second lactic-type fermentation of the transformation takes place. Cooking is the final stage of processing. It allows you to obtain the porridge of the desired consistency. Thus, the technological diagrams were made according to the traditional methods of the populations. **Conclusion:** The common points for obtaining these porridges are among others: The cleaning of the cereal, the grinding and the sieving in one way or another.

Key words: Cereals, fermented porridge, traditional knowledge, production diagram, Northern Benin

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The State of Food Security and Nutrition in the World, reports an increase of more than 10 million undernourished between 2018 and 2019¹. This gap is widening due to the high costs and the lack of financial means for populations to access healthy or nutritious food. On the other hand, it is established that ensuring healthy food for the billions of people who cannot afford it could save billions of US dollars¹. In Africa in general and in Benin in particular, ways to combat food insecurity pass, among other things, through agricultural production, the reduction of post-harvest losses and the promotion of local products through the judicious use of technical knowledge².

In several African countries, cereals contribute significantly to the protein intake of populations and account for more than 77% of caloric intake. The processing of cereals such as corn, millet and sorghum, therefore, appears to be one of the economic solutions that women in the majority exercise in urban and rural areas³. They are used in the production of fermented porridge^{4,5}. Several million people depend, not only, on the technology of these porridges to improve, at a lower cost and sometimes in an artisanal way, the organoleptic and nutritional qualities but also the shelf life of the finished products⁶.

In Benin, a survey study carried out on the types of fermented cereal-based porridges consumed in the Northern part revealed the existence of eight porridges, namely: *Koko*, *bobossou*, *gbangba*, *apkan*, *sagagnèga*, *akloui*, *bita* and *fourra*⁵. The manufacturing technology of these porridges depends on several million people for the improvement at a lower cost and sometimes in an artisanal way, the organoleptic and nutritional qualities but also the shelf life of the finished products⁶. In the Northern part of Benin, little study has been done on the technology of fermented porridges made from cereals, which are a food widely consumed in this area. Thus, the objective of this study was to establish the manufacturing technology of the eight porridges listed in the North of Benin.

MATERIALS AND METHODS

Study area: The study was conducted in 09 traditional areas (Kandi, Banikoara, Djougou, Copargo, Ouaké, N'Dali, Parakou, Coby and Matéri) of production of at least four of the eight previously reported fermented cereal-based porridges in Northern Benin⁵. In each targeted place, the survey was carried out in the neighboring town and village.

Sampling: For the production of technical diagrams of the eight porridges in the North of Benin, surveys were carried out in the traditional production areas of these porridges. Only women were involved in the interview. In total, 180 female cereal-based fermented porridge producers (20 per sampling locality) were randomly interviewed.

Data collection: Individual interviews and occasional conversations were used for information collection. The individual interviews were used both to estimate knowledge and to solicit responses. The interviews were conducted mainly among the porridge manufacturers/sellers.

Data analyzes: Information collected during the survey and attending the different stages of the transformation of cereals into fermented porridges were used to make diagrams of each porridge manufacturing.

RESULTS

The processing of fermented porridges in North Benin follows several optional and mandatory steps. Washing the cereal before soaking is a step that is not common to each producer. After, soaking is the first stage of fermentation during the transformation of cereals into most of the consumed porridges since there are porridges such as *bita* that do not require this operation. It consists of putting the cereal in hot water or not for several hours which varies from one preparer to another.

Washing and draining after soaking consists of simply rinsing the cereal in clean water after discarding the soaking water. The soaked cereal is then drained in a basket or sieve. The addition of flavoring ingredients before grinding, in order to obtain the organoleptic properties sought by consumers, depends on the type of porridge one wishes to obtain. The milling is done in a local mill equipped with electric or diesel grinders. It is complete for most porridges, especially smooth ones (without lumps) and for others whose dumplings are shaped with the flour from the starch obtained. On the other hand, it is partial for porridges such as *bita* or by pounding to obtain lumps.

The filtration step consists of mixing the wet flour with water (mixing), then passing this mixture through the mesh of a muslin-type filter (fine mesh fabric: Approximately 0.25 mm) previously attached to a large container or kept by two people has ended. The spent grains, which mainly contain the pericarp of the grains, are retained by the filter and removed gradually during the operation. The mixture of water and

starch is then left to stand for decantation during which the second lactic-type fermentation of the transformation takes place. Decanting does not require any intervention from the preparer.

Cooking is the final stage of processing. It allows you to obtain the porridge of the desired consistency. The settling supernatant is first brought to a boil with the addition of water, then the fermented paste is added and diluted after removing the supernatant from the heat, then it is left to close for a few minutes. For lumpy porridges, the lumps are added to boiling water for 10 to 12 min before the diluted starch is added. The whole is left to cook for 10 to 15 min. In general, to obtain the usual consistency of the porridge, water is added at the end of the cooking of the mixture. The production diagram of each type of cereal-based porridge were presented in (Fig. 1-5).

Production of simple koko porridge: *Koko*, a smooth porridge without lumps commonly called *koko fofolou* in Atakora, *koko* in Donga, Alibori and Borgou. This porridge is made using cereals such as corn, millet and sorghum. It can be

made with a single cereal or a mixture of cereals. This mixture with sorghum gives the *koko* called "red porridge". The *koko* technology is practically the same undependably as the sampled area in Northern Benin. The cereal is washed, drained and then brought to the mill for grinding. After grinding, water is added for filtration through a cloth. Two phases were obtained: A pellet and a more liquid supernatant which are left to stand for 24 hrs to undergo spontaneous fermentation. The liquid phase of the pellet is then separated and then brought to a boil. The previously separated pellet is then added to the liquid phase with added water and the whole is mixed and cooked for 10 to 12 min (Fig. 1). In this study, a spicy *koko* was observed obtained from the processing of millet with the addition of spices. It is called *koko yasi* in the local language.

Production of bita porridge: Bita is a granulated porridge made from corn, millet, or sorghum. It is called *bita* in the Dendi language, *sorou mora* in the Bariba language and *bori* in the Fulani language. Corn-based *bita* can be obtained in white or brown with the addition of potash at the cooking stage (*kama bita*). After cleaning and washing the cereal, it is

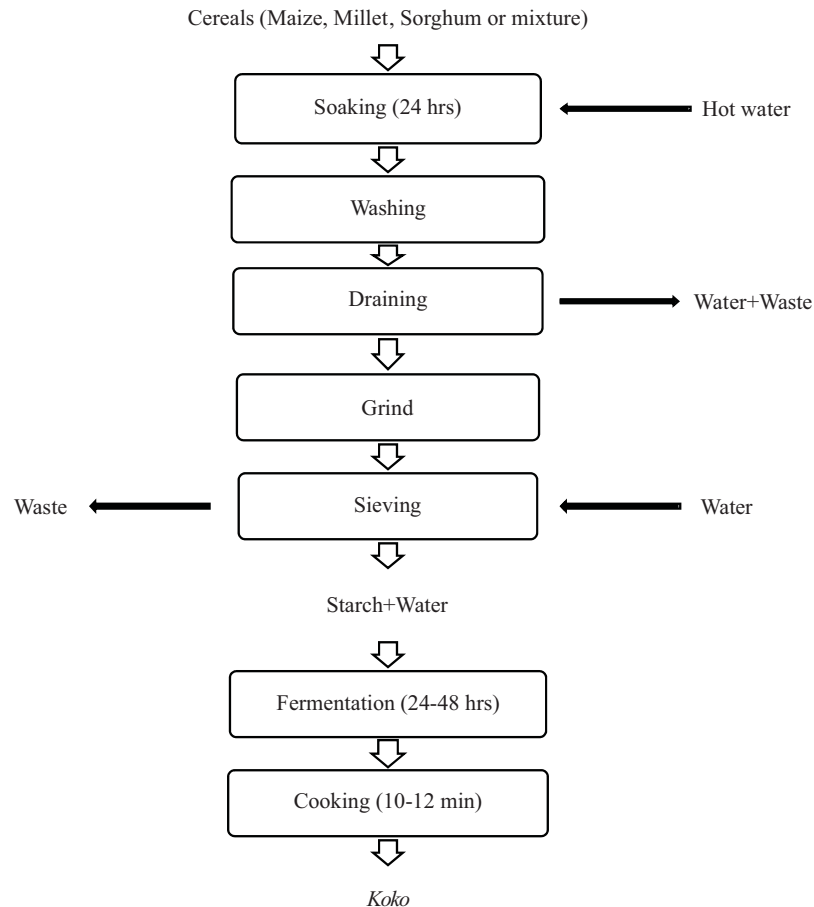


Fig. 1: *Koko* production diagram

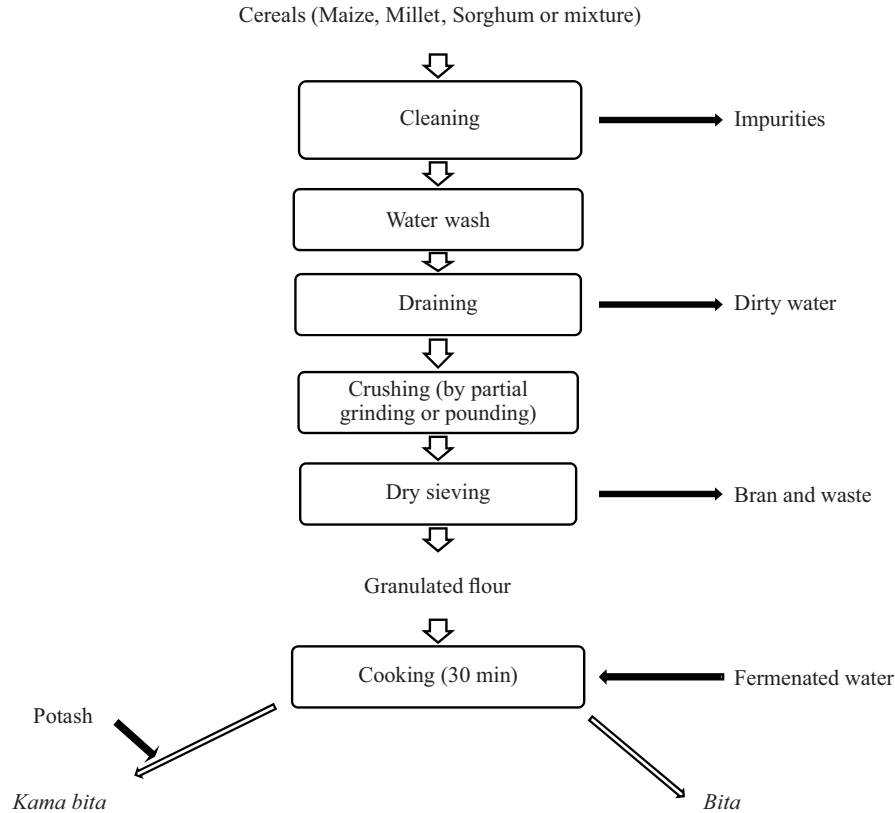


Fig. 2: *Bita* production diagram

crushed so as to obtain a granulated flour which will be sifted with a sieve which lets the granules and the flour pass and then the bran is removed from the cereal (Fig. 2). This flour will be diluted then pour into fermented boiling water and cook for 30 min, stirring.

Production of *akloui*, *bobossou* and *akpan* porridges:

Akloui and *bobossou* are corn-based porridges obtained following the chart in Fig. 3. Thus, after soaking, washing and grinding the corn, water is added to the flour to form a paste which will be left for 24 hrs for spontaneous fermentation. This paste will be delayed and poured into boiling water, flavored or not, then cook for 10 min to obtain the *bobossou* (Fig. 3).

As for *akloui*, after grinding the corn, the flour obtained is sieved with water to obtain starch and a supernatant of water which will be left to stand for 24 hrs. This starch is then put in a cloth and pressed to extract the water and then form pellets. These dumplings were presented in flavored boiling water for cooking for 12 to 15 min (Fig. 3).

For *akpan*, after fermentation of the starch obtained, the starch is delayed and then overturned in hot water for partial cooking for 3 min. *Akpan* is eaten with sugar, preferably milk and ice cubes.

Production of *fura*: *Fura* is a spicy millet-based porridge that is taken with fresh or curdled cow's milk or condensed or powdered milk and sugar. It was obtained as follows: After washing the millet, add condiments (ginger, pepper and chili) and then grind the whole to have flour that will be sieved (Fig. 4). A little hot water is then added to form a paste which will be left to rest for fermentation for 24 hrs. Then balls will be formed and put in boiling water for 20 min to obtain the *fura* balls. These balls are then diluted with milk and sugar.

Production of *Sagagnèga* and *gbangba*: The *sagagnèga* was a fermented porridge obtained after having mixed and fermented the dough of cereal-based flour. It is taken with sugar or simply by many farmers because according to them this porridge has the ability to fight against the fatigue of fieldwork and even malaria. It is therefore often diluted with enough water to be drunk throughout the day. *Sagagnèga* is therefore called miracle porridge by consumers. The *gbangba* was obtained after having diluted the flour with water and then left to ferment for 24 hrs. This fermented paste was boiled for at least 10 min (Fig. 5).

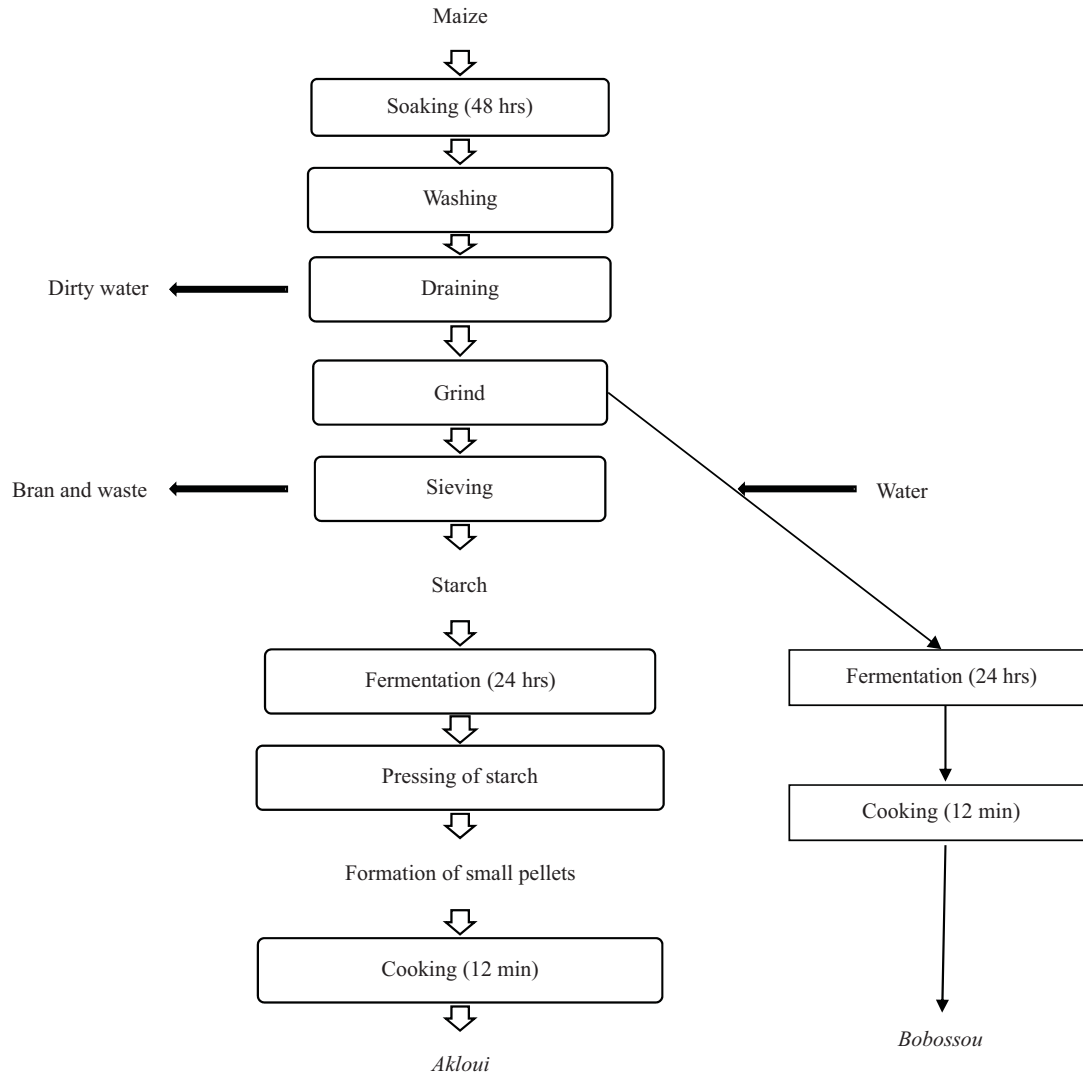


Fig. 3: Production diagram of *akloui* and *bobossou*

DISCUSSION

In this study, the processing technology of these porridges is practically the same in the communes of Northern Benin, as has small details for the same types of porridges, for example, the cleaning of the cereal before or after soaking, the leaf used for flavor porridge, porridge cooking time, etc. This difference can be explained by the preference and taste of each consumer or producer. *Koko* porridge, produced from cereals such as corn, millet and/or sorghum is a smooth lump-free porridge that is generally obtained after soaking corn or millet, sorghum, or a mixture of these three bowls of cereal for 24 hrs if it is in hot water or 48 hrs if it is lukewarm water, wash the cereal, drain it and then bring it to the mill for grinding. After grinding, water is added for filtration through a cloth. Two phases were obtained: A pellet and a more liquid

supernatant which were left to stand for 24 hrs to undergo spontaneous fermentation. The liquid phase of the pellet was then separated and then brought to a boil. We then add the previously separated pellet to boiling water, the whole is mixed and left to close for 10 to 12 min. It can be eaten with or without sugar, peanuts, donuts, or other appetizers. The same observations were made for obtaining *ben-saalga* with pearl millet grains⁷. The mixture of aromatics and spices such as ginger, pepper, mint, or groundnut with the millet before grinding makes it possible to obtain *Koko yasi*.

Fura is a porridge that is eaten with fresh or curdled cow's milk or condensed or powdered milk and sugar. It is obtained as follows: After washing the millet, spices and chilli are added. The whole is ground to have flour that will be sieved. A little hot water is added to form a paste which will be left to rest for instant fermentation for 24 hrs. Then balls will be formed and

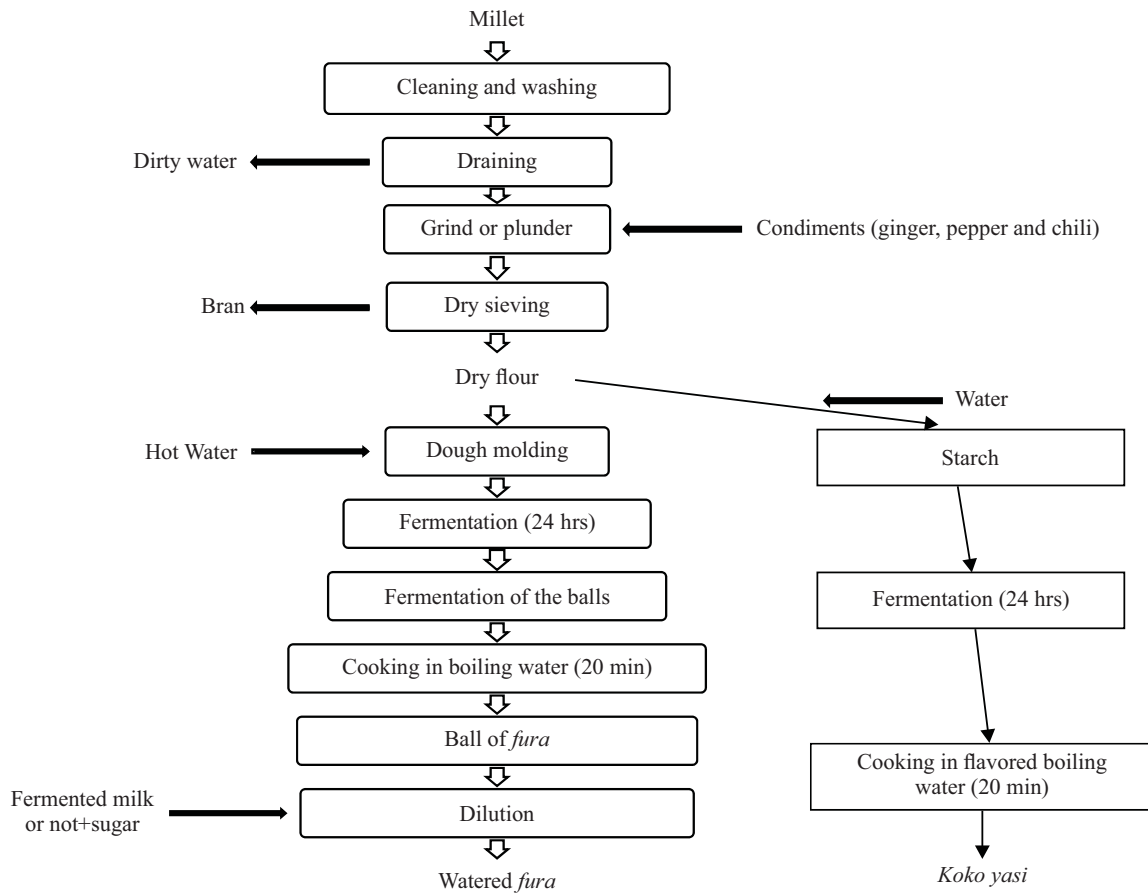


Fig. 4: Production diagram of *fura* and *koko yasi*

put in boiling water for 20 min to obtain the *fura* balls. These balls are then diluted with milk and sugar. The diagram in Fig. 4 showed that the different stages of this production. *Fura* is consumed in Northern Benin in combination with cow's milk or any milk and sugar. For Hama-Ba *et al.*⁸ *tchobal*, also called *fura*, is a foodstuff based on very consistent millet dough prepared from millet flour previously transformed into a dough and shaped into balls cooked in boiling water. *Tchobal* is consumed in most West African countries and particularly in Ghana, Nigeria and Burkina Faso^{9,10}. In Burkina Faso, the manufacturing process of the *tchobal* by Hama-Ba *et al.*⁸ differs at certain points from the manufacturing process in Northern Benin. This difference is observed at the level of husking, the winnowing of the millet before grinding by looting, or at the mill. The resulting flour is moistened with cold water before shaping. The balls obtained were once again crushed in a mortar to improve the texture and then shaped again into balls before marketing. In Ghana and Nigeria, a dough fermentation step takes place before baking^{9,11}.

Granulated porridges such as *bita*, *akloui* are obtained from corn, millet, or sorghum. Corn-based *akloui* porridge is the most produced and consumed in Northern Benin. This is explained by the fact that millet and sorghum are more expensive than maize and also the color that *akloui* presents with other cereals other than maize. *Akloui* has always been made with corn and has a white color. This porridge is obtained after washing the corn, grinding and shaping with a little water in the flour obtained to have granules which will be left to rest for a few hours before being boiled for 12 min. Another process consists in filtering the flour obtained with water to have starch and a supernatant. This starch will be pressed with a cloth before being shaped into lumps. The supernatant is used for cooking lumps to obtain *akloui* porridge. This production technology was similar to that described for the production of *Ben-kida* porridge which is a granulated fermented porridge produced in Ouagadougou from pearl millet¹². However, this process differs from that of *bita* porridge produced in Northern Benin. Indeed, for the *bita* porridge, after cleaning and washing the cereal, it is crushed

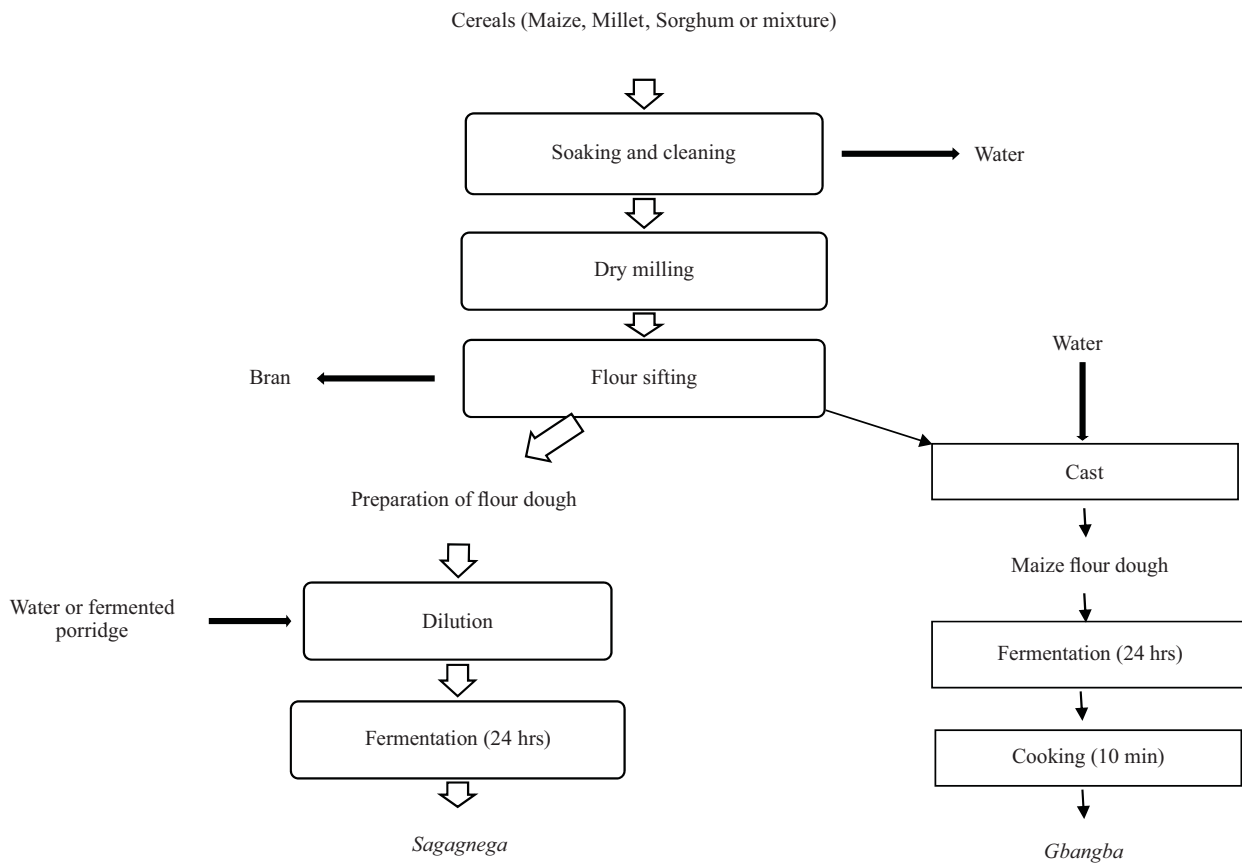


Fig. 5: Production diagram of *sagagnega* and *gbangba*

in a mill or pounded in a mortar so as to obtain a granulated flour which will be sieved with a sieve which lets the granules and the flour pass and then removed the sound of the cereal. This flour was diluted and then poured into fermented boiling water or the flour obtained is left to rest with a little water for a few hours before being cooked for 30 min, stirring it regularly. This fermented porridge is called *bita* in the Dendi language, *sorou mora* in the Bariba language and *bori* in the Fulani language. The addition of potash at the cooking stage in the bita gives the *Kama bita*. In Northern Benin, *bita* is used much more for the rise of milk in breastfeeding women. It is an ancestral dish highly appreciated, because of its availability and nutrients contained in the cereals used, it also provides enough energy to breastfeeding women.

Sagagnega is a fermented porridge made from fermented cooked cereal dough. It was used by our grandparents during the collective work organized in the villages by the population in order to hydrate themselves. It is also eaten as porridge after work. This porridge not only helps to hydrate but also to gain strength and fight against malaria

according to consumers. This statement can be explained by the fact that the spontaneous fermentation that the dough undergoes improves the taste of *sagagnega* and provides the nutritional elements necessary for the body. Tankoano *et al.*¹³ confirmed this statement by the fact that the complexity of the microbiota during natural fermentation leads to great variability in the nutritional, health and sensory quality of traditional fermented foods. Today, this porridge can be eaten by adding sugar, milk, peanuts, or even donuts. But this porridge is on the way to extinction for lack of recovery.

CONCLUSION

This study elucidated the traditional processing of cereal-based fermented porridge produced and consumed in Northern Benin. This knowledge can be used to carry out further technological studies to upgrade empirical stages of the processing and microbial analysis to achieve a large view of the hygienic and sanitary qualities of this cereal-based fermented porridge.

SIGNIFICANCE STATEMENT

This study elucidated the traditional processing of the height cereal-based fermented porridges commonly consumed in Northern Benin. This study will help producers to improve the processing of those porridges. In addition, the researchers can use these findings to uncover the critical areas of data processing including indigenous processing of local raw materials and the cooking process.

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