



TECHNOLOGICAL DIVERSITY OF FERMENTED PORRIDGES PRODUCED IN OUAGADOUGOU AND ASSOCIATED HEALTH RISKS

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ABSTRACT

Background: The porridges are fermented foods, more or less fluid, obtained from cereals or tubers. **Objective:** The objective of this study was to evaluate the technological diversity of the porridges and the associated health risks during processing. **Methods:** A survey was conducted among 120 porridge producers. Collected information include socio-cultural characteristics of producers, types of cereals used, the production technology and good hygienic practices. **Results:** This study shows that the majority of women producers (53%) are between 20 and 40 years old and 81.66% of the respondents are illiterate. Many Muslim women (70%) were involved in the processing. The Mossi represents the majority (50.83%) out of a total of seven identified ethnic groups. Only 15% of producers showed signs of good hygienic practices. Four types of porridges production charts were identified based on the cereals used. *Benkida* is essentially the most produced porridge (43.33%). **Conclusion:** The study identified a variety of technological processes depending on the cereals used and the socio-cultural characteristics of the producers.

Keywords: cereal, technology, porridges, Ouagadougou

1. INTRODUCTION

In Burkina Faso, the locals usually consume cereal-based foods (millet, sorghum, maize and rice), which are processed into various food products. They contribute to the food and nutritional security of these populations [1,2,3]. These forms are couscous, *tô*, pancakes, locally fermented or non-fermented juices and drinks. Traditional fermented porridges are also found [4]. The processing of these cereals takes place at the family, artisanal, semi-industrial and sometimes industrial levels to obtain porridges before consumption [5].

These porridges have an important cultural role within certain populations, which attribute virtues to them based on empirical beliefs [6,7]. They are consumed by all age groups, particularly children, pregnant and breastfeeding women, patients and the elderly, simply or with added sugar, fresh milk or curd [8]. In Ouagadougou, as in other major urban centers of the country, *Benkida* or *Bensaalga*-type porridges, produced from pearl millet (*Pennisetum glaucum*) and rice porridge (*Oryza sativa*), are widely consumed by local populations. [1-9,10]. Data on the technological and nutritional aspects of these porridge, especially pearl millet, exist in Burkina Faso [11]. Other cereals such as sorghum (*Sorghum bicolor* and *Sorghum guinea*) and maize (*Zea mays*) are used in the production of porridge [12,13]. The latter are used alone or in combination, making it possible to obtain mixed porridges of *Benkida* or *Bensaalga*. The combination of cereals creates even more diversity in traditional technological processes not taken into account by previous studies. These cereals have important nutritional advantages for humans, such as the phenolic compounds found in sorghum as antioxidants and maize starch [14].

The involvement of these cereals in the preparation of porridge is sometimes done in a context of soaring millet prices. This allows a compensation and thus to ensure a continuous production of porridge, hence the sustainability of producers' income. Studies have shown that cereal-based porridges have low energy values, thus unable to meet the protein and micronutrient requirements of children at risk of malnutrition [13-15,16]. Approaches based on the gelatinization of starch by germination or malting of cereals, roasting or the combination with other ingredients are increasingly used [11-17,18] to improve the energy density and bioavailability of nutrients [16-19]. The objective of our work was to identify through a survey, the cereals used, the technological processes of production of porridges and the associated health risks.

2. MATERIALS AND METHODS

2.1 Study site: The survey was conducted in the city of Ouagadougou. A pre-survey was conducted in order to establish a definitive questionnaire in the twelve districts of Ouagadougou (Figure 1). The choice of Ouagadougou city is justified by its ethnic diversity, allowing for the identification of several types of technological processes used in porridge production.

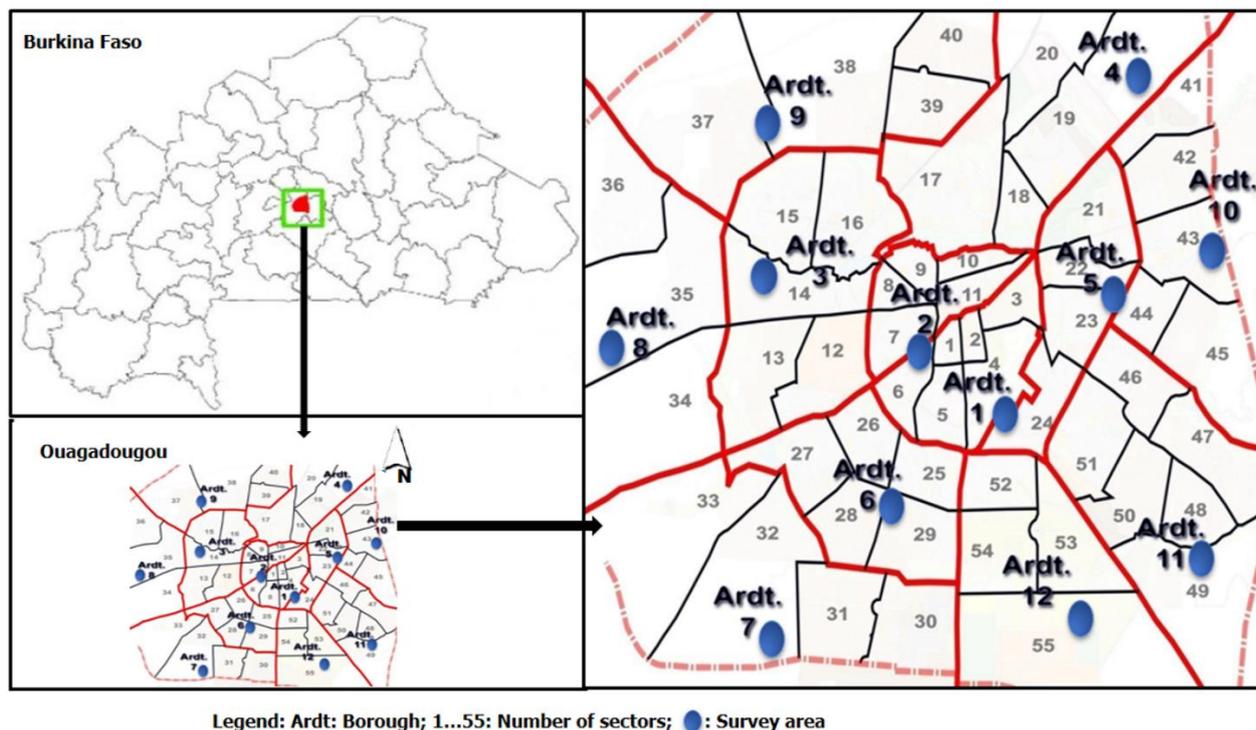


Figure 1: The figure presents the location of study sites.

2.2 Criteria for evaluating the hygienic characteristics of producers: The hygienic characteristics of the producers were evaluated on the basis of the places of production, sales, materials used, energy source, water source and the clothing [20]. Scores were assigned to each aspect, making it possible to first establish the hygienic performance of each producer. The second step is to assess the level of hygiene knowledge based on a participatory approach [21]. These characteristics were compared, allowing for ranking of the producers at three levels in hygiene according to the score obtained on 10: Bad (<5/10), Medium (5-7/10) and Good (>7/10 + presentation of certificate of recognition of public health services) (Table 1).

Table 1: The table presents the annotation scale on hygienic characteristics.

Variables		Score Out of 10
Place of production	Hygiene of utensils	1
	Course hygiene	1
Location and method of sale	Finished kiosk	1
	Fixed at home	1
	Street vending	0.50
Water source	Private faucet	1
	Public fountain	0.75
	Well	0.50
Energy source	Gas	1
	Coal	0.75
	Wood	0.50
Precautions taken during steps of processing	Sorting, washing	0.75
	Protection against flies	0.75
Hygienic characteristics of producers	Dress code	0.75
	Knowledge about hygiene	1.50
Certified producers	Certificate of recognition	2

Legend : 0 : Bad ; 0.5 : Unsatisfactory ; 0.75 : Satisfactory ; 1 : acceptable ; 1.5 : Very acceptable ; 2 : Excellent.

2.3 Data processing: The frequencies of the different variables evaluated during the survey were calculated using Microsoft Excel 2013 software. The paint.net v 4.0.6 software was used to resize the images.

3. RESULTS

3.1 Sociocultural characteristics of producers: Porridge production in Ouagadougou is mainly a female activity (100%) whose age is between 20 and 80 years and relatively experienced in this activity. It is an activity practiced mostly by women under 41 years old. The majority of producers (65%) have professional experience (PE) less than or equal to 20 years. 23.33% of the producers have work experience between 21 and 40 years old. The most experienced (EP between 41 and 60 years) represents only 14%.

The Muslim producers represent the majority with 53.33% against 26.66% and 15% Catholics and Protestants respectively. The survey revealed that the sector has several producers of various ethnicities. Thus the *Mossi* are the major ethnic group (50.83%), then followed by the *Bissa* (11.66%), *Samo* (11.66%), *Dioula* (10%), *Peulh* (06.66%), *Gourounsi* (05.83%) and *Sambla* (03.33%) (Table 2).

Table 2: The table presents the sociocultural characteristics of producers.

Variables		Producers	
		Numbers (N=120)	Frequencies (%)
Sex	Women	120	100
Ages (Years)	<20	-	-
	20-40	61	53.83
	41-60	39	23.50
	61-80	20	16.66
Professional experiences (Years)	≤20	78	65
	21-40	28	23.33
	41-60	14	11.66
Religions	Catholics	32	26.66
	Muslim	70	58.33
	Protestant	18	15
Level of education	Illeterate	98	81.66
	Primary	16	13.33
	Secondary	06	05
Ethnic group	<i>Bissa</i>	14	11.66
	<i>Dioula</i>	12	10
	<i>Gourounsi</i>	07	05.83
	<i>Mossi</i>	61	50.83
	<i>Peulh</i>	08	06.66
	<i>Sambla</i>	04	03.33
	<i>Samo</i>	14	11.66

3.2 Variables, methods of production, sale and consumption of porridges: Pearl millet is the most used cereal (60%) for the production of porridge, followed by rice (11.66%), sorghum (06.66%) and maize (05%). Some producers (16.66%) combine two or more grains. *Bensaalga* and *Benkida* represent 18.33% and 43.33% respectively of the porridges produced (Table 3) with 26.66% of producers processing both porridges. 11.66% of the respondents produce rice porridge, a porridge different from *Bensaalga* and *Benkida*.

Producers with low incomes (≤10000 Fcfa) after sales are the highest (63.33%). Those earning more than 10000 FCFA represent 36.66% (Table 3). A large proportion of producers use small quantities (≤6kg) of raw materials (55%). 28.33% of the producers use quantities of cereals comprised between 7 and 12 Kg, 10.83% use quantities between 13 and 18 Kg. Those which use quantities of raw materials relatively important are weakly represented with frequencies of 04.16% (19-24 Kg) and 01.66% (25-30 Kg).

Most sales are made in the evening (49.16% of respondents) than morning (33.33%). The saleswomen processing porridge all through the day are few (17.5%). Consumers are mostly children (53.33%), followed by adults (19.16%), breastfeeding women (11.66%) and pregnant women (09.16%), hospital patients (08.33) and the elderly (06.66%). The survey identified two types of traditional porridge sales pattern. The first form (70.83%) include selling the porridge at a fixed place (home or away from home). The second form (29.16%) vending porridge from one neighborhood to another in search of customers.

Three types of porridge production were identified. 63.33% of the surveyors whose home sales are made by producers, a family production (23.33%), part of which is reserved for family consumption and a semi-industrial production (11.66%) whose porridge is sold in kiosks.

Table 3: The table presents the variables, modalities of production, sale and consumption of porridges.

Variables	Producers		
	Numbers (N=120)	Frequencies (%)	
Cereals used	Maize	06	05
	Pearl millet	72	60
	Rice	14	11.66
	Sorghum	08	06.66
	Two cereals and more	20	16.66
Types of porridge	<i>Benkida</i>	52	43.66
	<i>Bensaalga</i>	22	18.33
	<i>Benkida and Bensaalga</i>	32	26.66
	Other	14	11.66
Quantity of raw material/ Production (Kg)	≤6	66	55
	7-12	34	28.33
	13-18	13	10.83
	19-24	05	04.16
	25-30	02	01.66
After-sale income (in F.cfa)	≤10000	76	63.33
	10001-20000	24	20
	20001-30000	12	10
	30001-40000	08	06.66
Type of production	Artisanal	76	63.63
	Domestic	30	25
	Semi-industrial	14	11.66
Headcount	1	36	30
	2-6	77	64.16
	7-10	07	05.83
Sales location	Fixed	85	70.83
	Mobil	35	29.16
Sales period	Morning	40	33.33
	Evening	59	49.16
	All day (Morning and evening)	21	17.50
Consumers	Children	60	50
	Adults	19	15.83
	Pregnant women	15	25.50
	Breastfeeding women	11	09.16
	Old persons	08	06.66
	Hospital patients	10	08.83

3.3 Supply, grain processing and porridge consumption circuit: The cereals supply chain as well as their processing into various products including porridge is provided in Figure 2. This includes producers, traders, processors and consumers. For example, cereals (pearl millet, sorghum, maize and rice) come from both local producers and imports. They are supplied to local markets in order to supply the producers. These ensure the processing into consumables such as *Dolo* (starch and fermented local drink), porridges and other local dishes (*Tô, zom-kom, Gappal, pancakes ...*).

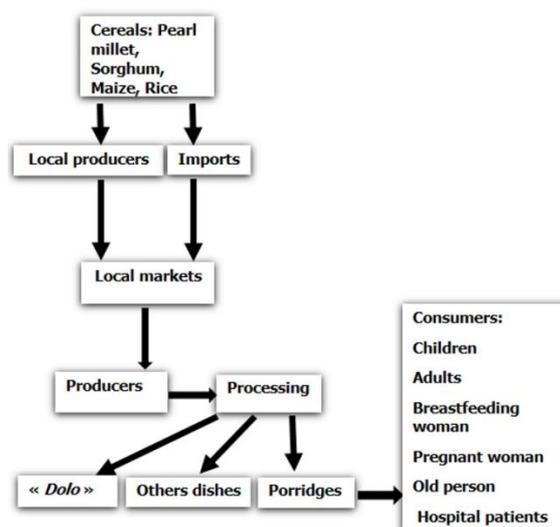


Figure 2: The figure presents the cereals Supply and Processing Circuit.

3.3 Processing chains for the types of porridges: Four (04) technological processing chains were identified based on the cereals used. The preparation of a porridge can be done with a single cereal or from the combination of several cereals.

Porridge made from a cereal: The steps in preparing the porridge from a single cereal are essentially soaking, milling, filtering, decanting and cooking (Figure 3). Other operations may be associated depending on the cereal used. Thus, *Benkida* or *Bensaalga* can be obtained from either pearl millet or red sorghum by an almost similar scheme. For the preparation of *Bensaalga*, grains of pearl millet or red sorghum are sorted, washed and soaked at times varying between 6 and 24 hours depending on the producer. This step makes it possible to observe a first fermentation. They are then ground with or without the ingredients (ginger, chilli pepper, mint, rice husk) and the flour is added with water. The wet flour obtained is filtered to remove the slugs and the filtrate is decanted for 6 to 10 hours. A second fermentation takes place at this stage. Part of the supernatant is diluted with water and boiled, and the pellet is added after stirring. The whole is cooked for 6 to 20 minutes.

The preparation of *Benkida* is similar to that of *Bensaalga*. The difference lies in the preparation of the granules. Part of the beans are dried, ground and sieved. The flour obtained is mixed with water, kneaded, sieved and stirred to obtain the granules. These granules are then added to the diluted supernatant and boiled until they rise to the surface. The pellet is homogenized and then added to the whole for cooking for at least 6 minutes.

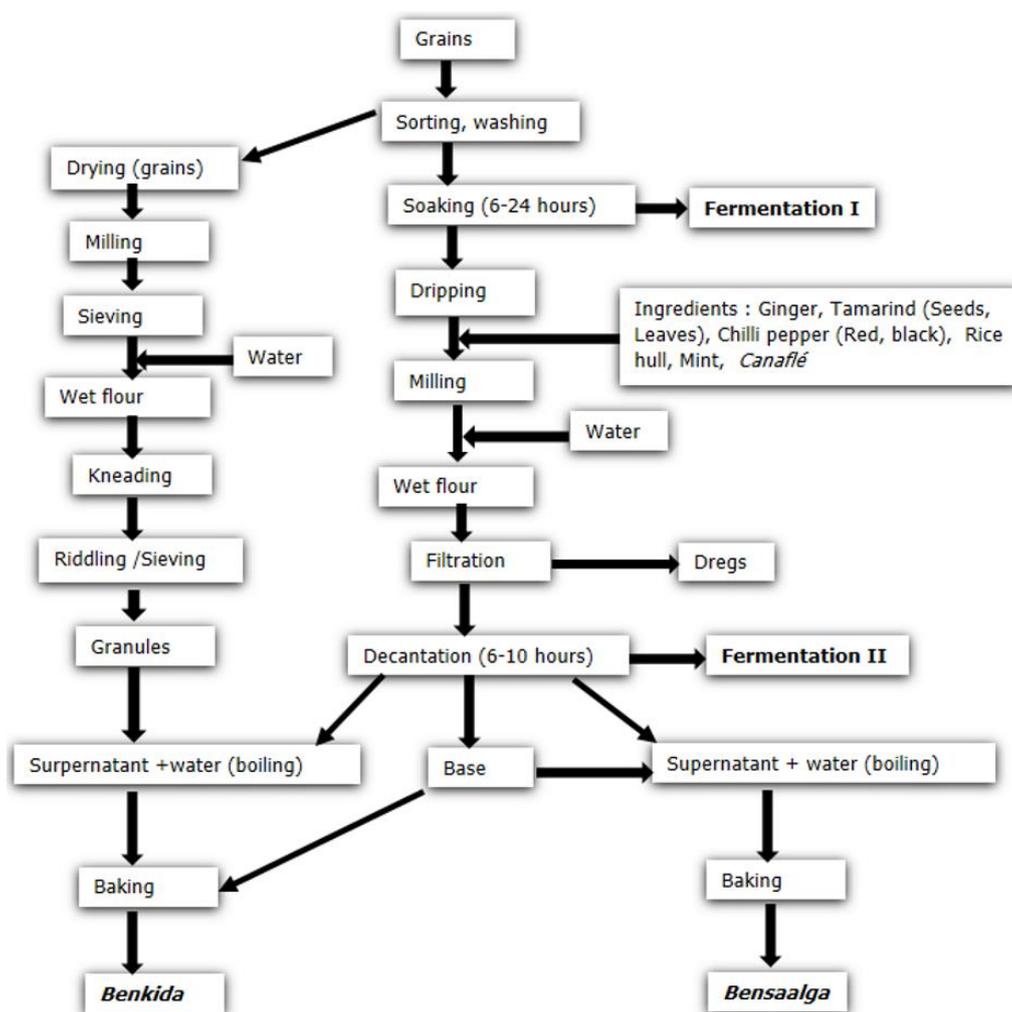


Figure 3: The figure presents the production diagram of *Benkida* and *Bensaalga* from pearl millet or red sorghum.

Benkida and *Bensaalga* can also be obtained from another processing line close to that of figure 3 using either white sorghum or maize with some differences in unit operations. In this case, the maize or white sorghum kernels undergo winnowing and dehulling operations. After a sorting operation, they are washed and then soaked. The soaking times are significant (24-72 hours) than those of pearl millet or sorghum. Decantation is also more important and can go up to 24 hours. Fermentations occur during soaking and decantation. The granules are produced in much the same way as pearl millet and red sorghum (Figure 4).

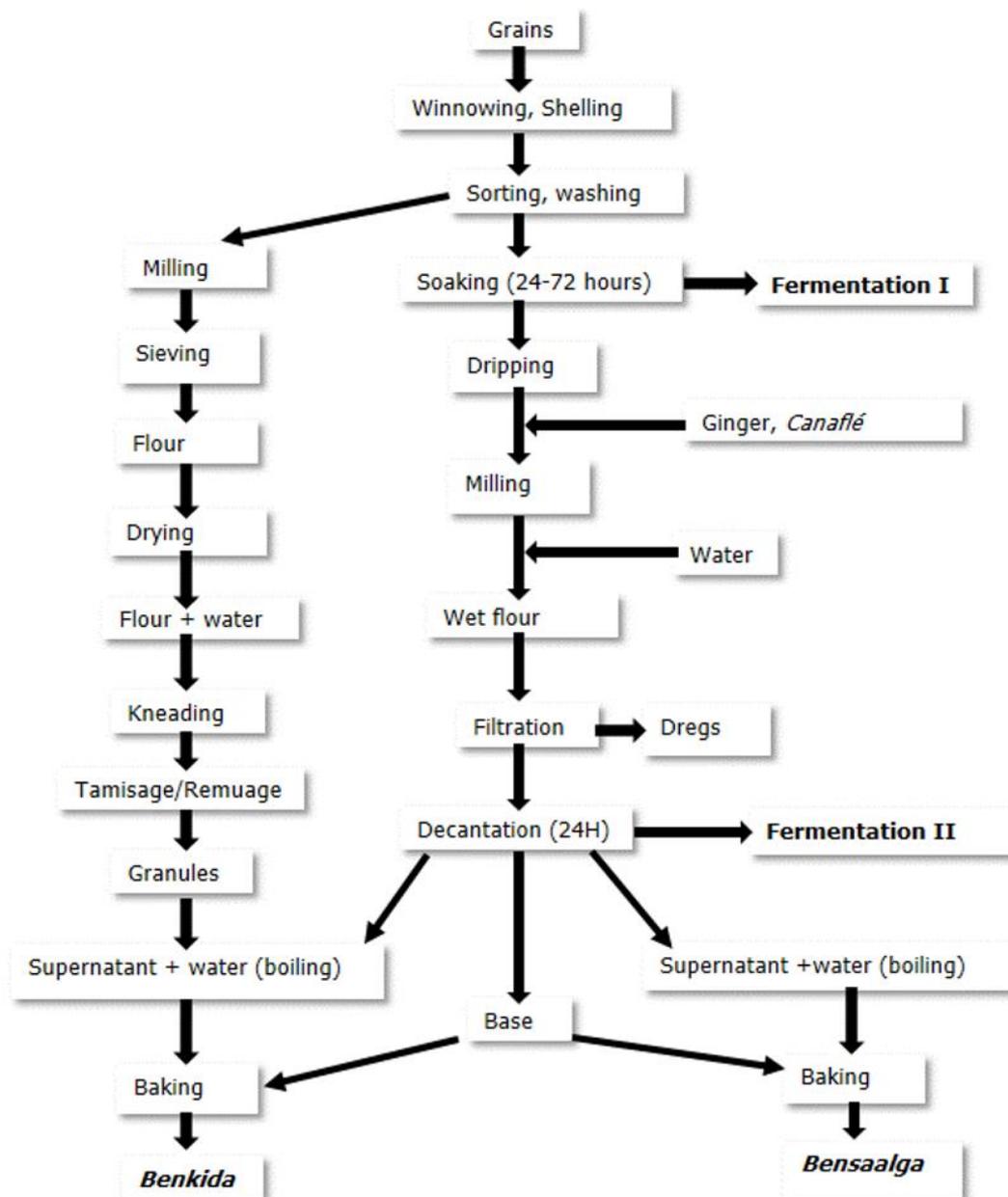


Figure 4: The figure presents the diagram of production of *Benkida* and *Bensaalga* from maize or white sorghum.

The nature of the porridge depends on the cereal and the associated ingredients used. Figure 5 shows some porridges at the base of different cereals. Thus, there is a variation of color and texture. Figure 5A shows *Bensaalga* pearl millet usually distinguished as a thin semi-liquid paste. Figure 5B also shows *Bensaalga* made with pearl millet associated with potash. This type of *bensaalga* takes the local name of *Benkoonré* which means boiled potash, with a slightly yellow color. Figure 5C corresponds to the *bensaalga* of red sorghum. Figure 5D, 5E, and 5F respectively correspond to *Benkida* made from corn, pearl millet and red sorghum. The granules are clearly distinguished in the case of pearl millet (Figure 5E) but also maize (Figure 5D) with pronounced white color relative to the fundamental dough. On the other hand, *Benkida* made from red sorghum does not clearly show the granules (Figure 5F).

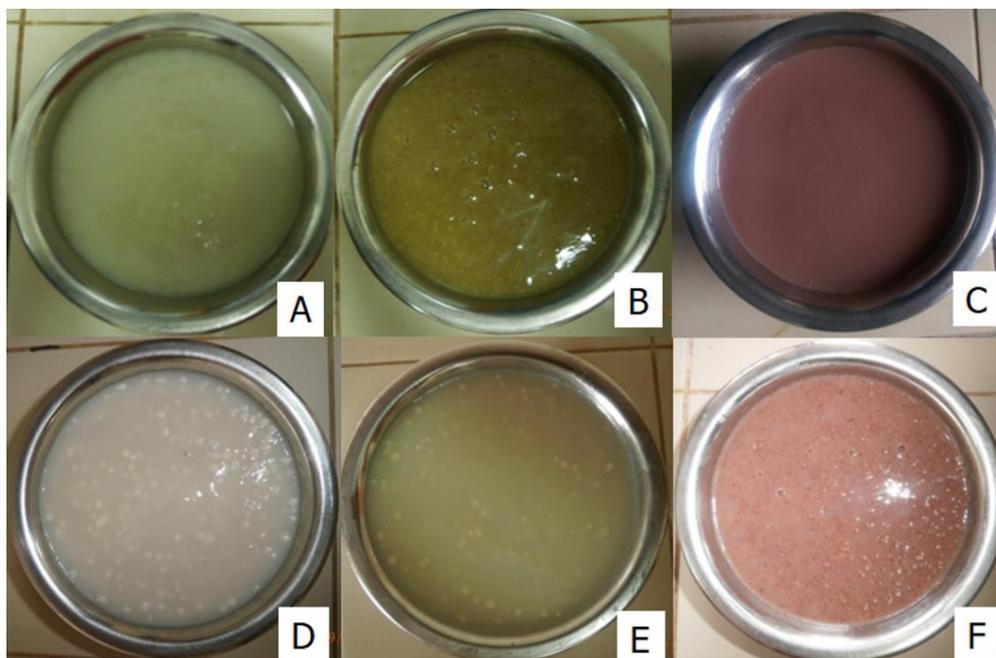


Figure 5: The figure presents the *Bensaalga* of pearl millet (A); *Benkoonré* of pearl millet (A); *Bensaalga* of red sorghum (C); *Benkida* of maize (D); *Benkida* of pearl millet (E); *Benkida* of red sorghum (F).

The porridge are also obtained from rice in three ways (Figure 6). The simplest method is to sort and wash the rice grains and cook them with water. The resulting porridge can be improved in two ways. The first is the addition of grated coconut followed by a second cooking, and an addition of butter. The second technical is to add oil to the porridge. After cooking, the whole is embellished with sugar or salt.

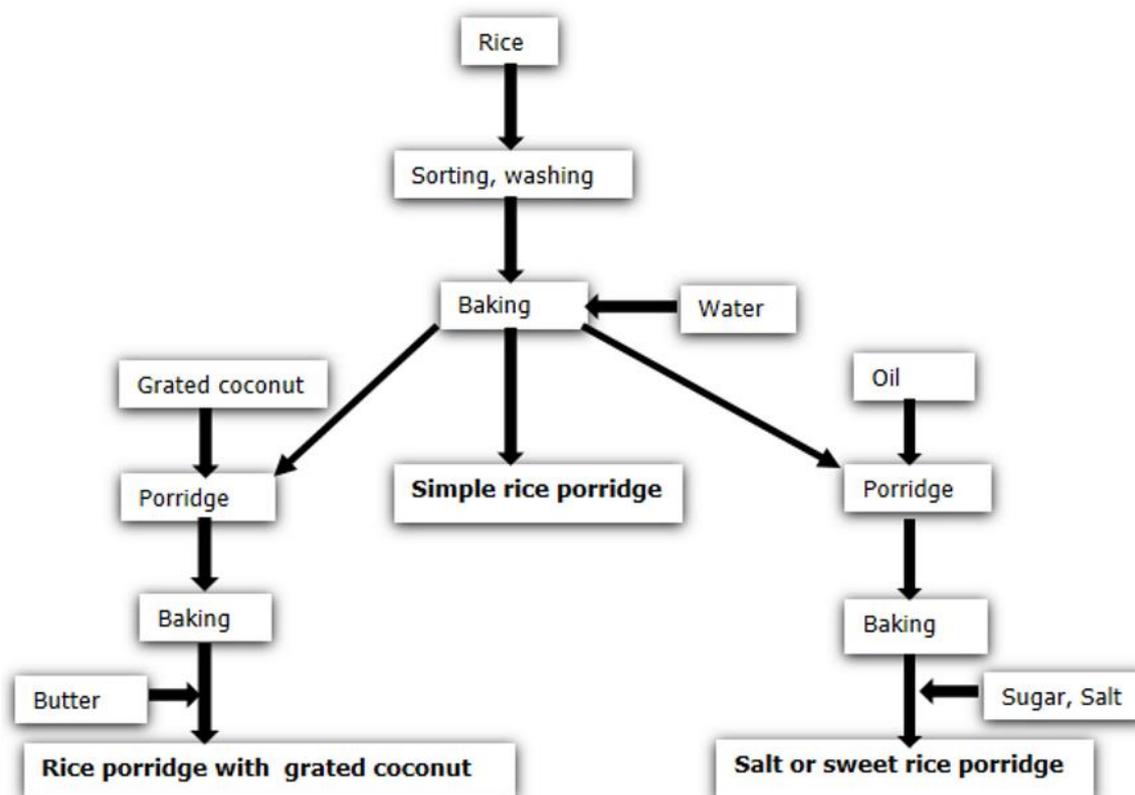


Figure 6: The figure presents the diagram of production of three rice-based porridges.

The simple rice porridge (Figure 7A) is distinguished from grated coconut porridge (Figure 7B) by the more pronounced white color of the latter. Figure 7C shows the rice porridge with grated coconut added milk that can be eaten with pancakes (*Gnomy* or *Maassa* in the local language).



Figure 7: The figure presents the single rice porridge (A); Rice porridge with grated coconut (B); Rice porridge with grated coconut added milk and pancakes (C).

Porridge made from a mixture of cereals: *Benkida* is obtained from a combination of cereals such as sorghum (red and white) and maize with pearl millet. The processes follow the same schemes as those described in Figure 3 and Figure 4. The three cereals namely: red sorghum, white sorghum and maize, follow the dehulling, soaking, milling, filtration and decantation stages and undergo the same fermentative processes described previously. Meanwhile, pearl millet is used for the production of granules that will be combined with the supernatant of each of the cereals to produce *Benkida* (Figure 8).

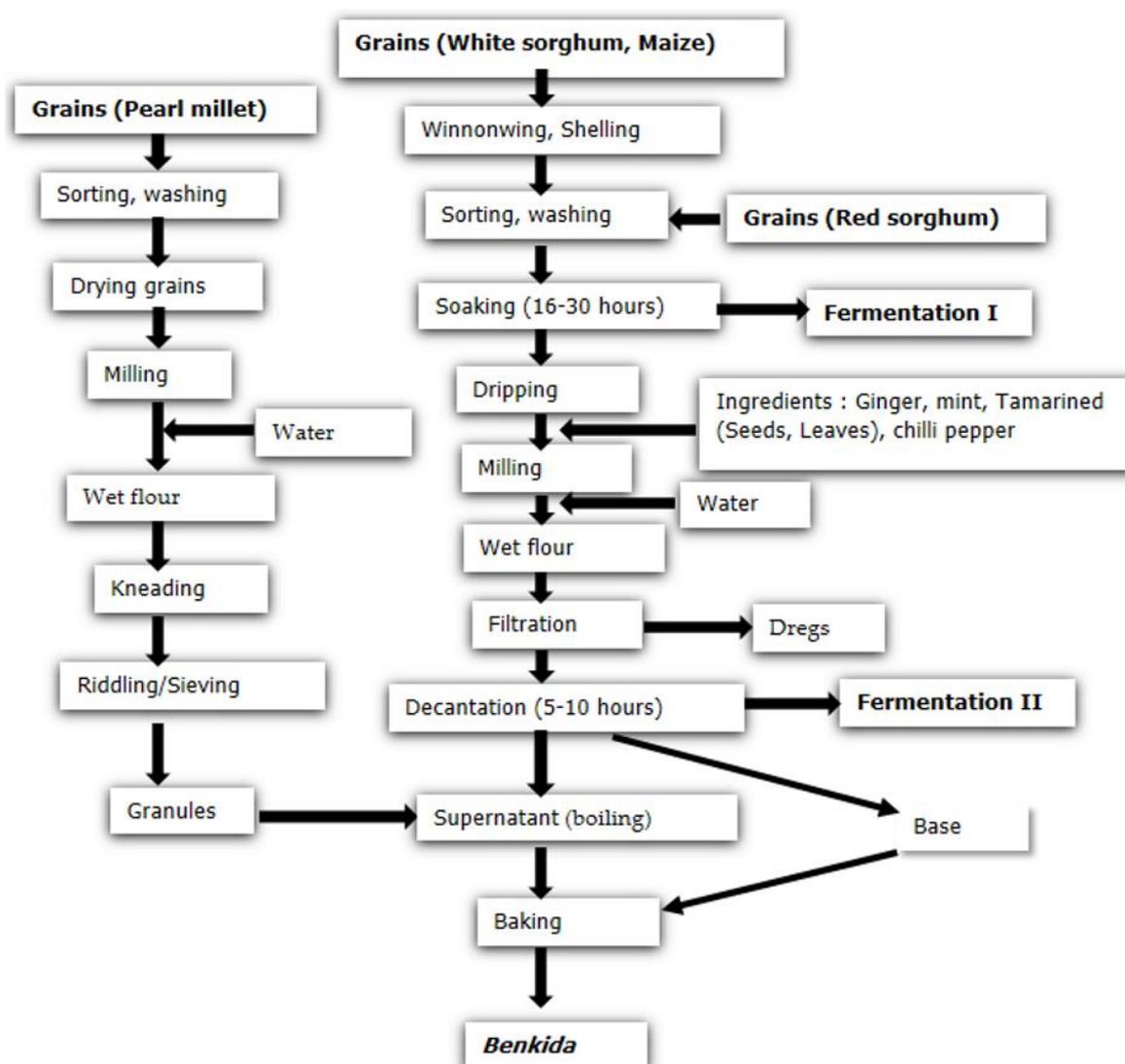


Figure 8: The figure presents the production diagram of *Benkida* made from a mixture of cereals.

The most common mixtures are those using red sorghum as the basic material (fine paste) with granules composed of pearl millet, maize or white sorghum (Figure 9). Figure 9A shows *Benkida* made from red sorghum and pearl millet. Thus pearl millet granules are distinguished in the fine red sorghum paste. Figure 9B, 9C also show *benkida* made from red sorghum with granules of maize and white sorghum, respectively. All these images given in Figure 9 show porridges having almost the same characteristics.

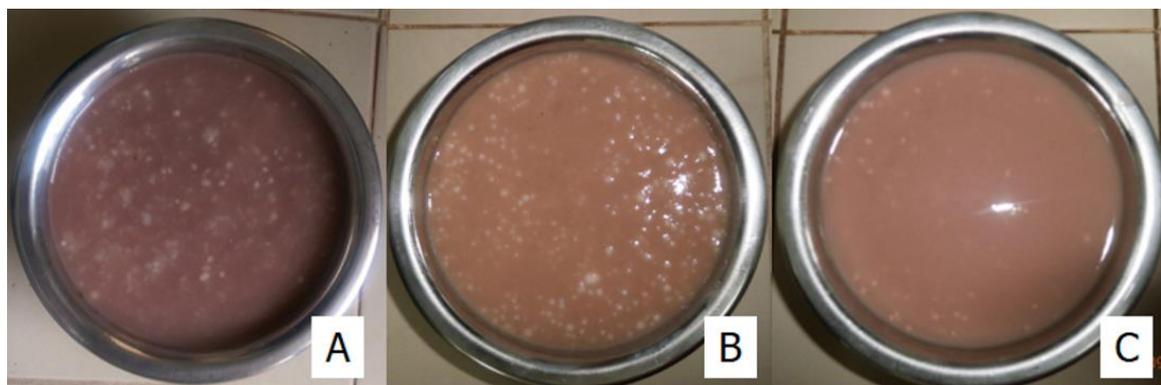


Figure 9: The figure presents the *Benkida* (red sorghum + pearl millet) (A); *Benkida* (Red sorghum + maize) (B); *Benkida* (red sorghum + white sorghum) (C).

3.4 Production, sales and associated health risks: A majority (70.83%) of these producers received an average grade on hygienic quality rules. Producers who received the "Good scores" represent 12.5% of respondents. Some quality deficiencies made it possible to identify a third category of producers with the word "Bad". These represent 16.66% (Figure 10).

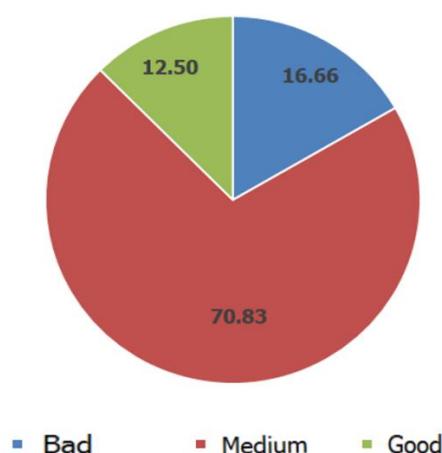


Figure 10: The figure presents the hygienic characteristics of the producers.

Figure 11 shows some pictures showing good and bad hygienic practices in the sale of porridge. Figure 11A shows a sales room where good practices are observed. This room represents a well-appointed fixed place, an acceptable cleanliness and accessories to disinfect the hands before and after consumption. Figure 11B shows a different sanitary situation, because there is a water of questionable appearance used for rinsing the bowls used by several consumers. Figure 11C shows a porridge vended on the streets. The vendor does not observe the good hygienic practices as the porridge is exposed to risks of contamination.



Figure 1: The figure presents the good hygiene (A); (rinsing water) (B); Bad practice (unshelled porridge) (C).

4. DISCUSSION

Producers all belong to the female gender, which means that this activity is exclusively carried /out by female, thus justifying the fact that in our countries there are certain occupation/work reserved for women [8-22]. The majority of

them are Muslim women aged between 20 and 40 years. Their involvement in this activity can be explained by the fact that at the beginning, they produced porridge just for breakfast [1] or for breaking the fast in the month of Ramadan (fasting). Subsequently, some have made it a professional activity as it is seen as a source of income, just as in the case of other street foods [23]. Family education means that this local "know-how" is transmitted and perpetuated [24]. This Muslim majority is also explained by the fact that in this religion encourages women to be involved in domestic activities that will not take them away (for a long time) from their families such as the production of porridge [25]. The frequency of producers with work experience is decreasing in the older age groups and this indicates a shift from the profession as age increases. The weakness of after-sales revenue can also explain the abandonment of this activity by producers, especially when taking into account the difficulties required by unit operations [22]. The *Mossi* occupy the first place in this activity; this had been confirmed by the work of Guyot et al., (2004) who previously estimated the frequency of producers at 75%. This is due to the fact that in the central plateau and in particular Ouagadougou, the *Mossi* are the most numerous compared to other ethnic groups [26].

The use of pearl millet compared to other cereals has evolved as Songré-Ouattara et al., (2016) evaluated this frequency at 75% [11] against 60%, given by the results of our surveys. This means that producers are increasingly inclined to use other cereals in production operations other than pearl millet, despite its importance for food [27]. Authors have highlighted the economic assets (simpler to produce, harvest and store) that maize could bring in the various processing intended for human consumption. This explains its increasing use by producers [14, 28]. In this study, some producers mentioned the lack of financial means to acquire large quantities of cereals. Others also mentioned the fact that porridge is first made for home consumption and the rest is for sale. This has an impact on after-sales earnings and justifies variability in the quantities used. Customers buy porridge sold in the evening for breakfast the next day, which justifies their choice of sale at this time. Two types of porridge and sometimes other types are recorded mainly from local knowledge. *Benkida* is the most produced porridge because it is consumed by all social classes compared to *Bensaalga* which is much more recommended for young children and sick people [29]. The largest consumers of traditional fermented porridges remain children; this is explained by their accessibility to a good part of the less well-off population as a supplementary food [30]. Bichard et al., (2004) reported that in Limpopo (South Africa) children's consumption of porridge was related to cultural reasons. For example, children eat sorghum in the form of porridge because their parents consider it good for their health. On the other hand, we should also note the rejection of sorghum by adolescents and young adults simply linked to its color [6]. The low production of the other porridges is explained by the lack of enthusiasm for the latter by the populations, which is justified by the lack of valorization through the improvement of the organoleptic characteristics in order to make them more competitive [31].

As traditional porridge is considered a staple food from the point of sale, the issue of consumer health is becoming a concern [32]. A large majority of these producers scored average in terms of good hygienic practices. This may be related to the fact that most of them have a low level of education, not allowing access to training on quality standards [33]. Low after-sales income for the majority of women producers may be a constraint on the acquisition of adequate equipment such as utensils and access to drinking water that are potential sources of microbiological contamination [15-34, 35]. Work has established links between the street market, sales outlets, manipulations of banknotes, coins and street food contamination [20]. However, our survey showed that some of the producers are involved in street sale, which is a major risk for food contamination. The less experienced in the profession are the most numerous, indicating a marked interest of more and more young producers. However, the traditional processing of cereals requires stages that are long and tedious that only those who have the control and patience can support [25]. Failure to control these processes may constitute a major risk that may affect the nutritional, microbiological and organoleptic qualities of the porridges.

The diversity of the technological processes is explained initially by the mode of use of the different cereals. For some cereals, such as maize and white sorghum, dehulling, for example, remains paramount in unit operations [1]. On the other hand, other cereals such as pearl millet and some species of red sorghum are not very suitable for dehulling, but have the advantage of giving finer flours [5]. The use of husked maize in production has advantages for consumers because of its high starch, protein, lipid and mineral content [28-36]. Missihoun et al., (2012) emphasized the importance of white sorghum, which has the advantage of presenting white flour, used in the preparation of baby food and for breastfeeding women in Benin [37]. There could also be a transfer of technology from Benin to Burkina Faso.

Also, the rice already husked does not require such complex operations in the preparation of traditional porridges, but its mode of use can lead to the existence of several processes depending on the specificities of the producers. Producers do not use the rice steeping step, which is considered by some authors as crucial for obtaining rapidly digestible starch [38]. Recommendations could be made at this level for obtaining porridges with gelled starch. Thus, the use of butter, oil and sugar does not significantly modify the viscosity of the porridges but increases the energy density [29]. The diversity of cereals makes it possible to obtain porridges in several ways. Added to this is the mixture of cereals that sometimes modifies unit operations and broadens the list of technological diagrams used by traditional producers of porridges. The difference in cereals plays on the durations of unit operations, especially those of soaking, settling and cooking. These minor variations, they, can create modifications on the nutritive values of the porridges [39].

5. CONCLUSION

The traditional porridge production sector is an area reserved for low-income women for the most part and remains poorly regulated. The investigation identified the stages and conditions under which these porridges are produced. Thus, production is generally done on an artisanal level with a majority of women who have not received training on quality standards posing risk to consumers' health. It is therefore necessary to increase sensitization and training for actresses, which will ensure a healthy production from a nutritional and microbiological point of view. Also, a variety of processes has been identified in those producers who use one cereal or combine several at a time. These different forms of association between cereals in obtaining porridge deserve in-depth studies to identify the nutritional and health risks that it represents for consumers. Finally, the improvement of these processes will lead to the production of quality porridge conforming to the standards recommended as complementary food for infants, but also with added value for improving the living conditions of producers.

Acknowledgment

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