Original Research Article

Typology of fermented porridges and socio-demographic characteristics of respondents in the northern part of Benin.

Abstract

Fermentation is an ancestral process and one of the most used economic methods in the preservation and transformation of cereal-based food raw materials. They are essentially rich in carbohydrates, but they can also be a source of micronutrients such as iron and are used in many traditional culinary preparations, in particular fermented porridges. The aim of this study is to identify the variability of fermented cereal-based porridges produced and consumed in northern Benin. Thus, 315 producers and consumers were randomly interviewed in nine localities of northern Benin. First, field surveys were carried out in the traditional areas of porridge production and consumption in the northern region of Benin in order to establish the consumption map of fermented porridges. Secondly, interviews and occasional conversations were used for sample collection as well as occasional interviews (individual survey). During our investigation, eight (*koko*, *bobossou*, *gbangba*, *apkan*, *sagagnega*, *akloui*, *bita* and *fourra*) porridge were reported. Corn, millet and sorghum are cereals that are used for proceeding those porridges. The interviewed people are predominantly (35.53%) between 18 and 25 years old of age followed by those aged between 25 and 31 years old (30.82%). Mostly (63.21%) women were interviewed with a sex ratio (M/F = 0.58) and involved in the production of traditional porridge. More than 36% of respondents had at least secondary education, 30.82% are uneducated, 22.64% have primary education and 10.06% had at least university level. A significant association was observed between the cereal used and the type of porridge ($p<0.001$). It can be seen that the marketing and consumption of different porridges is associated with different communes in northern Benin. The method of preserving these porridges and their processing differs from one producer to another or from one consumer to another. It also differs from one municipality to another.

Keywords: Cereals, Porridge, Endogenous Knowledge, Fermentation, Northern Benin.

Introduction

In sub-Saharan Africa, cereals are considered as one of the most important sources of nutrients, and cereal-based porridges are often given to young children under 5 (Year) as a complementary food to breastfeeding (Humblot et al., 2012). Thus, cereals used for the production of fermented products such as porridges through various traditional processes are frequently millet, sorghum,

Comment [h1]: Add

maize and rice (Koffi et al., 2017). These cereals, transformed to foods such as fermented porridge, occupy a prominent place (Tankoano et al.; 2017) and are considered to be one of the most important sources of nutrients (Humblot et al., 2012) and energy (Saubade et al., 2016).

In addition, studies have shown that fermented foods and probiotics are indigenous foods that have been shown to improve the nutritional value of food products such as corn and sorghum and thus confer nutritional and health benefits on young children. Indeed, fermented foods have been shown to reduce childhood illnesses such as diarrhea in hospitalized children, as they are effective in suppressing the growth of diarrheal viruses and bacteria (Guarino et al., 2015).

Nowadays, new technological tools are driving significant transformations in nutritional science and scientific approaches to new product design. As a result, fermentation is being challenged because it provides the fore as it provides a solid foundation for the development of safe food products with specific nutritional and functional attributes (Tsafrakidou et al., 2020). Thus, indigenous fermented foods are often used as part of the daily feeding program (Marsh et al., 2014). However, some authors reported a limited use of fermented foods because of its low availability, lack of its knowledge and vulgarization (Chilton et al., 2015).

Comment [h2]: Now-a-days

Despite their contribution to the fight against hunger and malnutrition (Chileshe et al., 2020), few studies in Benin have evaluated the processing of fermented foods at the household level as a means of adding value and improving nutrition, while triggering a process of transformation, two crucial dimensions on which food systems are built (Berkum et al., 2018). However, before any vulgarization, it important to better know the traditional production and uses of fermented cereal-based porridge. Thus, the aim of the present study was to evaluate endogenous knowledge of the production of fermented cereals-based porridges produced in northern Benin, west Africa.

Material and Methods

Study area

The study was conducted in 09 traditional areas (Kandi, Banikoara, Djougou, Copargo, Ouaké, N'Dali, Parakou, Cobly and Matéri) of production and consumption of fermented cereal-based porridges in northern Benin (Figure 1). In each target place, the survey was carried out in the neighboring town and village.

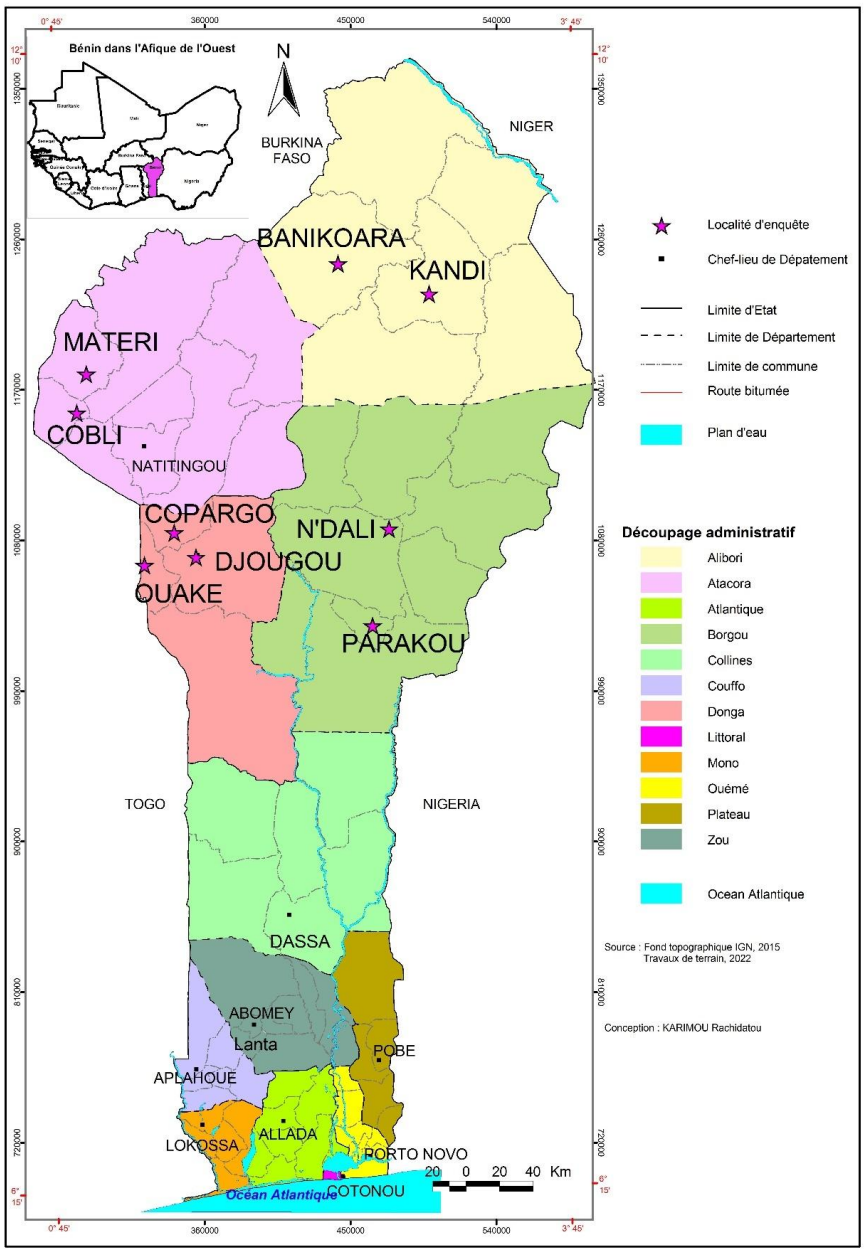

Figure 1. Map of the study area showing the surveyed area

Sampling

To establish the cereal porridge consumption map in northern Benin, field surveys were carried out in the above-mentioned traditional areas of production and consumption of porridge in Benin in the northern region of Benin. Men, women and children at least 10 years old were dismayed by the interview. In total, around 315 producers and consumers were randomly interviewed (35 respondents per municipality).

Data collection

Interviews and occasional conversations were used for information collection. Interviews based on a previously defined list of themes or questions were carried out in the selected areas. The individual interviews were used both to estimate knowledge and to solicit responses. The interviews were conducted first with the porridge sellers to find out the age, the type of porridge sold, the type of cereal used, the method used to obtain the porridge and the method of conservation. Secondly, with the buyers present who are consumers of this porridge. At their midpoint, information such as age, types of porridge he or she knows, method of consumption, preference and the reason for this preference were sought. Then in houses where production and consumption are domestic. Here, we also looked for the age of the respondent, the types of porridge, the preference and the well-made ones, the method of production, consumption and also conservation. The data collected relate to endogenous peasant knowledge, the history of consumption, the socio-economic and cultural value of the environment, the benefits of this porridge on the consumer's organism.

Data analyzes

Statistical analysis of recorded data was done using descriptive statistics and statistical tests. The relative frequencies were calculated for collected variables. These calculated frequencies were represented by means of histograms. In order to see if there are any association relationships between types of porridge and the cereals used, the ethnic group of the respondent, the sex of the respondent, the age of the respondent, the level of education of the respondent, the municipality of the respondent, chi-2 tests were carried out. Mosaic charts were used to represent these association relationships when significant. The significance threshold retained is 5% and the various tests were carried out in the R 4.1.2 software (R Core Team, 2021).

Results

Socio-demographic characteristics of the respondents

The people present and interviewed throughout our field survey are predominantly (35.53%) young (between 18 and 25 years) population followed by age group between 25 and 31 years old (30.82%). The population interviewed is mostly women 63.21% (sex ratio M/F = 0.58). About 36.48% of respondents had at least secondary education, 30.82% are uneducated, 22.64% have

primary education and 10.06% had at least university level. Interviewed people are mostly porridge vendors (32.70%), students (18.55%) and civil servants (0.94%). (Table 1).

Table 1: Frequency (%) of socio-demographic characteristics by parameter according to the municipality

()	TOWNS									Total proportion of the respondents (%)
	BANIKOARA	**COBLY**	**COPARGO**	**DJOUGOU**	**KANDI**	**MATERI**	**N'DALI**	**OUAKE**	**PARAKOU**	
Age class										
[12-18[	8.33	8.33	11.43	2.86	2.86	5.56	2.86	5.71	2.86	5.66
[18-25[	47.22	19.44	37.14	37.14	8.57	47.22	42.86	40.00	40.00	**35.53**
[25-31[	22.22	63.89	20.00	31.43	31.43	30.56	28.57	20.00	28.57	**30.82**
[31-38[	16.67	5.56	17.14	20.00	31.43	5.56	11.43	22.86	22.86	16.98
[38-42[	2.78		5.71	2.86	14.29	5.56	2.86	5.71	-	4.40
[42-48[	-	-	5.71	5.71	5.71	2.78	5.71	5.71	2.86	3.77
[48-54[	2.78	-	-	-	5.71	2.78	-	-	-	1.26
[54-60[	-	-	-	-	-	-	2.86	-	2.86	0.63
[60-66[	-	2.78	2.86	-	-	-	2.86	-	-	0.94
Gender										
Female	69.44	69.44	65.71	42.86	45.71	75.00	74.29	65.71	60.00	**63.21**
Male	30.56	30.56	34.29	57.14	54.29	25.00	25.71	34.29	40.00	36.79
Educational level										
None	11.11	11.11	48.57	28.57	48.57	22.22	42.86	40.00	25.71	**30.82**
Primary	36.11	44.44	8.57	11.43	37.14	27.78	5.71	22.86	8.57	22.64
Secondary	52.78	44.44	37.14	40.00	14.29	33.33	25.71	37.14	42.86	**36.48**
University	-	-	5.71	20.00	-	16.67	25.71	-	22.86	10.06
Respondent's occupation										
Farmer	-	13.89	11.43	8.57	25.71	13.89	-	17.14	2.86	10.38
Artisan	5.56	-	5.71	14.29	22.86	-	14.29	8.57	8.57	8.81
Driver	-	-	-	2.86	5.71	-	-	-	-	0.94
Trader	13.89	-	-	-	2.86	-	37.14	-	22.86	8.49
Pupil	33.33	11.11	22.86	22.86	-	27.78	-	25.71	22.86	**18.55**
Teacher	-	-	5.71	8.57	2.86	-	-	-	-	1.89
Student	11.11	8.33	2.86	8.57	-	16.67	2.86	5.71	25.71	9.12
Household	5.56	-	17.14	5.71	8.57	2.78	-	22.86	2.86	7.23
Health professional	2.78	2.78	-	-	-	-	-	-	2.86	0.94
Secretary	-	-	-	-	-	-	5.71	-	2.86	0.94
Saleswoman	27.78	63.89	34.29	28.57	31.43	38.89	40.00	20.00	8.57	**32.70**

Comment [h3]: Add age group

Comment [h4]: Close brackett

Comment [h5]: Close bracket

Typology of porridge marketed

The different porridges marketed in some municipalities of northern Benin are presented in Figure 2. Eight types of porridge (*akloui*, *apkan*, *bita*, *bobossou*, *fourra*, *gbangba*, *koko*, and *sagagnega*) were identified in the different municipalities investigated.

Figure 2. Picture of the eight identified porridge in the northern Benin

No association is observed between the type of porridge and the sex of the respondent (p-value = 0.606), the age of the respondent (p-value = 0.116), the level of education of the respondent (p-value = 0.064). (Figure 3).

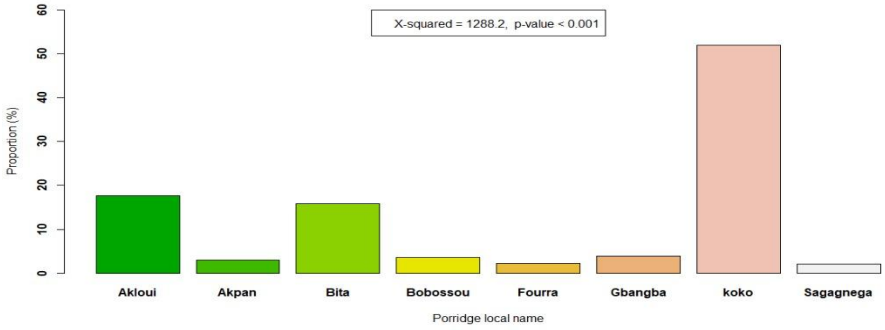

Figure 3. Proportion the types of porridge in northern Benin

These eight types of porridge listed in the nine municipalities of northern Benin can be classified as smooth (*koko*, *bobossou*, *gbangba*, *apkan*, and *sagagnega*) and lumpy (*akloui*, *bita* and *fourra*) porridges. The smooth porridges are porridges made up of all kinds of fermented porridges with a smooth appearance whereas the lumpy porridges are those containing lumps and whose appearance is not smooth. Those porridges can be eaten hot (*koko*, *bobossou*, *gbangba*, *akloui*, and *bita*) or cold (*apkan*, *sagagnega* and *fourra*).

There is an unequal distribution of these porridges in the communes. Thus, the figure 4 presents the different types of fermented porridge in the municipalities of northern Benin. Indeed, the municipality with the greatest diversity of porridges is that of Djougou (8 types of porridges). While the municipalities of Copargo, N'dali and Ouake have a diversity of seven types of porridge. The municipalities of Cobly and Materi are the least diversified with three types of porridge marketed. The associations tested show that there is a relationship of dependence between the type of porridge and the type of cereal used as well as the municipalities (Figure 4).

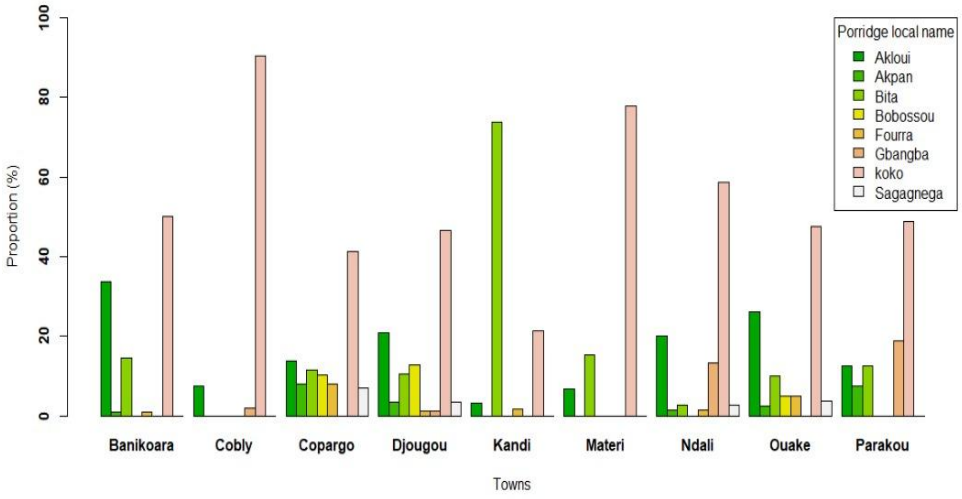

Figure 4: Distribution fermented porridges in the municipalities of northern Benin

Indeed, a significant association is observed between the cereal (Figure 5) used and the type of porridge (p-value < 0.001). This relationship is presented in Figure 3. This relationship shows that *akloui* are almost exclusively made from maize, even if an under-representation of production of this sorghum-based porridge is noted. The *bobossou* porridge is made exclusively

Comment [h6]: ?

from "maize" while that called *fourra* is made from millet. The *koko* and *sagagnega* porridges are made from all cereals or even a mixture of two cereals.

Maize	Millet	Sorghum

Figure 5. Pictures of the cereals used process porridge in northern Benin

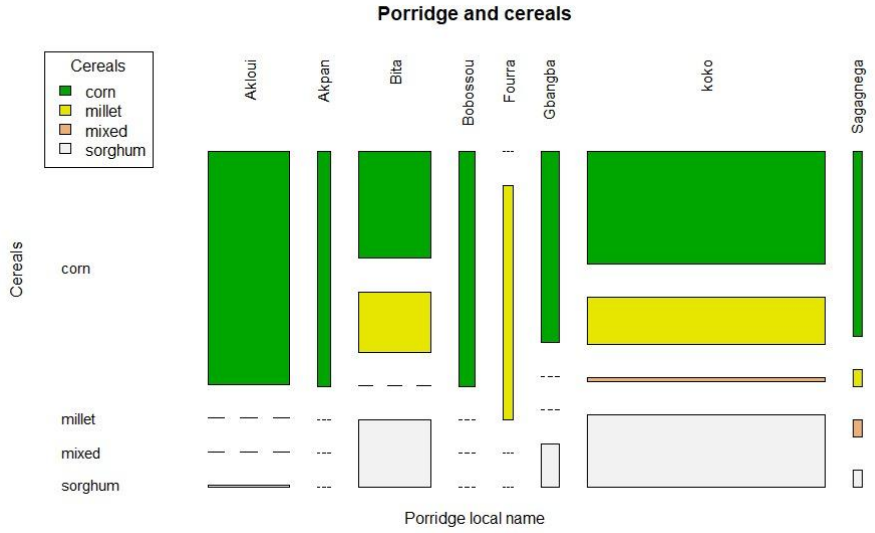

Figure 6: Association between the type of fermented porridge and the type of cereal

Figure 7 presents the associations between the type of fermented porridge and the commune. This figure shows that the marketing and consumption of *akloui* porridge is more associated with the municipalities of Banikoara and Ouake. The communes of Copargo and Parakou are those most associated with the *akpan* while the *bita* is more associated with the commune of Kandi.

Comment [h7]: Please check

Strong marketing of *fourra* and *sagagnega* is observed in the commune of Copargo. Concerning *gbangba*, it is associated with the municipalities of N'dali and Parakou. It is noted that *koko* is not associated with a particular municipality. It is marketed and consumed in all the towns covered.

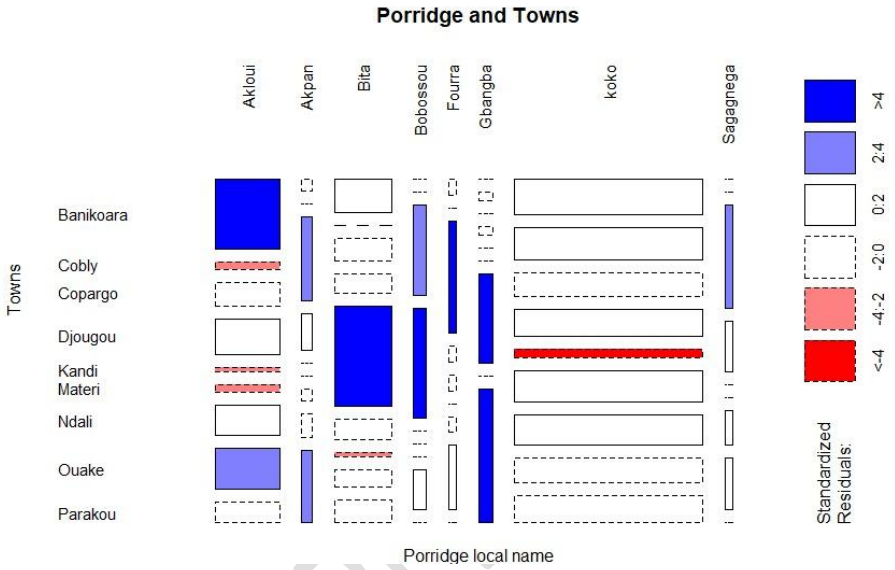

Figure 7: Association between type of fermented porridge and municipality

Method of porridge preserving

The method of preserving porridge differs from one producer to another or from one consumer to another. It also differs from one municipality to another. Table 2 summarizes the storage methods for fermented porridge by department and by municipality.

Table 2. Methods of preserving fermented porridge by department and by municipality

Mode de conservation	Proportion (%) by municipality								
	Parakou	**N'Dali**	**Kandi**	**Banikoara**	**Djougou**	**Copargo**	**Ouaké**	**Matéri**	**Cobly**
Thermos	10.04	19.18	1.96		2.94		1.32	18.64	
Aluminum container immersed in water	26.20	10.96							2
Container in the open air in a clean place	4.57	1.37	13.72	1.59		9.09	3.95		42
Cooler	15.60	60.27	1.96		33.82	50.65	46.06	66.1	52
Reheating	33.33	5.48	3.92		23.53	16.88	22.37		
Hermetically sealed plastic container	2.56	1.37	49.02	50.78	16.18	16.88	17.11	13.56	4
Lemon in the dough for the fermentation of the *sagagnega*, and its conservation							1.32		
Refrigeration	7.69		1.96		7.35	6.49	2.63		
Partially closed plastic container			9.80	9.52	10.29		5.26	1.69	
Balls in a basket and cover with a loincloth		1.37		1.59					
Balls in the open air			1.96		1.47				
Without conservation			15.69		2.94				
Plastic in a bag of rice or sugar				36.52	1.47				

Discussion

Today, many efforts to eradicate hunger include increasing agricultural production, processing raw materials, and supplementing and fortifying foods. Locally produced foods are an important part of food systems because they help fight hunger and malnutrition. To effectively contribute to this mission, we evaluated the endogenous knowledge of the production of fermented porridges produced in northern Benin from cereals.

This study revealed that the population surveyed in North Benin is a young population (18 and 25 years) at 35.53% and then group aged between 25 and 31 years (30.82%). This can be explained by the fact that the porridges listed are not specifically infant porridges. Meanwhile, our results are lower than those obtained in Ouagadougou (Djossou, 2001). by more than 40% of surveyed households and especially by nearly 3/4 of the children under 2 years of these households Thus, in their study, the author has shown that the fermented millet porridges, called in Moré *Binkida* and *Binsaalga*, marketed are widely consumed. In our study, women are predominant with a percentage of 63.21% against 36.79% for men. This could be explained by the fact that household chores are performed by women. In addition, this may be due to the fact that most men are only porridge consumers. Only women are producers and also consumers so they had more information to provide as part of our survey.

In our study, there is a diversity of fermented porridges. Eight types of fermented porridge were identified in the nine investigated municipalities in northern Benin. These eight porridges are unevenly distributed in the communes of northern Benin. We obtain all eight porridges in the commune of Djougou followed by the commune of Copargo, N'dali and Ouaké which have seven types of fermented porridge. The municipalities of Cobly and Matéri are the least diversified with three types of fermented porridge. This diversity lies at the level of the raw material used, the social, cultural, religious aspect and the technological transformation processes used (Mouquet-Rivier et al., 2008).

However, a dependency relationship exists between the type of porridge and the type of cereal used as well as the communes. Also, there is a significant association between the cereal used and the type of porridge (p-value < 0.001). Indeed, the type of *akloui* porridge is mainly associated with the type of corn cereal. An under-representation of production of this sorghum-based porridge was noted. The bobossou is made exclusively from corn, the *fourra* is made from millet, while the *koko* and the *sagagnega* are produced from all kinds of cereals. A mix of cereals is also possible at this level. *Akloui* porridge is consumed more in the communes of Banikoara and Ouake. The communes of Copargo and Parakou are those most associated with *akpan* porridge while *bita* porridge is more associated with the commune of Kandi. A strong commercialization of *fourra* and *sagagnega* porridges is observed in the commune of Copargo. The *gbangba* is associated with the communes of N'Dali and Parakou. It is noted that the *koko* is not associated with a particular municipality. It is marketed and consumed in all the towns covered. No association is observed between the type of porridge and the sex of the respondent

(p-value = 0.606), the age of the respondent (p-value = 0.116), the level of education of the respondent (p-value = 0.064). These results could be explained by the fact that traditional fermented foods are processed at the household level for home consumption using locally available raw materials (Materia et al., 2021). Surplus products are sold in local markets by some processors (Materia et al., 2021). Traditional fermentation helps prevent food loss and extend the shelf life of raw materials, which can increase seasonal food availability and the range of food options available to individuals (Keding et al., 2013) also during difficult, high-risk climate and conflict zones (Marshall and Mejia, 2011). Therefore, fermented foods provide benefits to both sellers and consumers by improving diets and health, thereby contributing to food security and local livelihoods (Marshall and Mejia, 2011). But the technological diversity can have an impact on the quality of the mixtures in general. In our 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, the taste of each consumer or producer. Koko porridge, produced from cereals such as corn, millet and/or sorghum is a smooth lump-free porridge which is generally obtained after soaking corn or millet or sorghum or a mixture of these three cereals for 24 hours if it is in hot water or 48 hours 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 are obtained: a pellet and a more liquid supernatant which are left to stand for 24 hours to undergo spontaneous fermentation. The liquid phase of the pellet is then separated and then brought to the boil. We then add the previously separated pellet in boiling water, the whole is mixed and left to close for 10 to 12 minutes. It can be eaten with or without sugar, peanuts, donuts or other appetizers. The same observations were made by Greffeuille et al. (2010) for obtaining Ben-Saalga with pearl millet grains. 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.

Fourra 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 a 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 hours. Then balls will be formed and put in boiling water for 20 minutes to obtain the *fourra* balls. These balls are then diluted with milk and sugar. The diagram in Figure 8 shows the different stages of this production. *Fourra* is consumed in northern Benin in combination with cow's milk or any milk and sugar. For Icard-Vernière et al (2010), 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 the boiling water. Chobal is consumed in most West African countries and particularly in Ghana, Nigeria and Burkina Faso (Owusu-Kwarteng et al., 2012). In Burkina Faso, the manufacturing process of the tchobal by Icard-Vernière et al (2010) 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

Comment [h8]: Where is this figure

moistened with cold water before shaping. The balls obtained are 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 (Owusu-Kwarteng et al., 2012).

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, 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 minutes. 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 is similar to that described by Djossou et al. (1999) for the production of *Ben-kida* porridge which is a granulated fermented porridge produced in Ouagadougou from pearl millet. 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 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 is 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 minutes, 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 works organized in the villages by the population in other 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 (2017) confirm 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 carried out in the North of Benin, made it possible to develop the typology of marketed porridges and their technological diagrams. Among the eight porridges (*akloui*, *apkan*, *bita*, *bobossou*, *fourra*, *gbangba*, *koko* and *sagagnega*), some are smooth, those lumpy. Porridges can be are eaten cold or hot depending to the kind. Only women produce porridge in northern Benin. The fermentation processes of the eight listed porridge are spontaneous and traditional. Traditional fermented porridges in northern Benin are culturally embedded in society and are generally well accepted by consumers. This offers potential for local processor entrepreneurship, value chains to be built and food security to be promoted locally. This should be taken into account when developing policies and research programs aimed at promoting food and nutrition security based on the development of livelihoods for smallholder farmers, processors and local consumers, both in urban and rural areas.

References

Berkum SV, Dengerink J, Ruben R. (2018). The food systems approach: Sustainable solutions for a sufficient supply of healthy food. The Hague: Wageningen Economic Research.

Chileshe J, Talsma EF, Schoustra SE, Borgonjen-Van den Berg KJ, Handema R, Zwaan BJ, Brouwer ID. (2020). Potential contribution of cereal and milk based fermented foods to dietary nutrient intake of 1-5 years old children in central province in Zambia. PLoS One, 15, e0232824.

Chilton SN, Burton JP, Reid G. (2015). Inclusion of fermented foods in food guides around the world. Nutrients, *7*(1), 390-404.

Djossou VA, Mouquet C, Trèche S. (1999). Les bouillies de petit mil fermenté à Ouagadougou : modes de production, de commercialisation et de consommation. Poster présenter à l'atelier international : Les petites industries agroalimentaires pour une nutrition saine en Afrique de l'Ouest''. Ouagadougou, Burkina Faso, 3-9.

Djossou VA (2001). Etude de la production, de la consommation et de la commercialisation des bouillies de petit mil fermenté (Binkida et Binsaalga) à Ouagadougou (Burkina Faso). Mémoire de DESS, Université de Ouagadougou, p. 58.

Greffeuille V, Mouquet Rivier C, Icard-Vernière C, Ouattara L, Avallone S, Hounhouigan J, Kayodé P, Amoussa W, Ba HF (2010). Traditional recipes of millet, sorghum, and maize-based dishes and related sauces frequently consumed by young children in Burkina Faso and Benin= Recettes locales des plats à base de mil, sorgho ou maïs et leurs sauces fréquemment consommés par les jeunes enfants au Burkina Faso et au Bénin, 120p.

Guarino A, Guandalini S, Vecchio AL. (2015). Probiotics for prevention and treatment of diarrhea. Journal of Clinical Gastroenterology, *49*, S37-S45.

Humblot C, Perez-Pulido R, Akaki D, Loiseau G, Guyot J-P. (2012). Prevalence and Fate of Bacillus cereus in African Traditional Cereal-Based Foods Used as Infant Foods. Journal of Food Protection, 75(9): 1642–1645. doi: 10.4315/0362-028X.JFP-11-450.

Icard-Vernière C, Ouattara L, Avallone S, Hounhouigan J, Kayodé P, Amoussa W, Ba HF. (2010). Recettes locales des plats à base de mil, sorgho ou maïs et de leurs sauces fréquemment consommées par les jeunes enfants au Burkina Faso et au Bénin." 129.

Keding GB, Schneider K, Jordan I. (2013). Production and processing of foods as core aspects of nutrition-sensitive agriculture and sustainable diets. Food Security, *5*: 825–846.

Koffi EK, Yao SDM, Diarrassouba N, Siene LAC (2017). Etat des lieux et gestion des semences des principales céréales cultivées au Nord de la Côte d'Ivoire. European Scientific Journal, 13 (3): 112-125.

Marsh AJ, Hill C, Ross RP, Cotter PD. (2014). Fermented beverages with health-promoting potential: Past and future perspectives. Trends in Food Science & Technology, *38*(2): 113-124.

Marshall E, Mejia D. (2011). *Traditional fermented food and beverages for improved livelihoods* Rome: FAO diversification booklet. FAO. p. 86.

Materia VC, Linnemann AR, Smid EJ, Schoustra SE. (2021). Contribution of traditional fermented foods to food systems transformation: value addition and inclusive entrepreneurship. Food Security, 13(5) : 1163-1177

Mouquet-Rivier C, Icard-Vernière C, Guyot JP, Hassane Tou E, Rochette I, Trêche S. (2008) Modèle de consommation, composition biochimique et valeur nutritive des bouillies de mil perlé au Burkina Faso. Journal International des Sciences de l'alimentation et de la Nutrition, 59 (7-8) : 716-729.

Owusu-Kwarteng J, Akabanda F, Nielsen DS, Tano-Debrah K., Glover RL, Jespersen L. (2012). Identification of lactic acid bacteria isolated during traditional fura processing in Ghana. Food Microbiology 32(1): 72-78.

R core Team (2021). R: A language and environment for statistical computing. R Fondation for Statistical Computing, Vienna, Austria. URL https:// www.R-prject.org/.

Saubade F. (2016). Potentiel nutritionnel du microbiote d'aliments fermentés à base de céréales : le cas des folâtes. Thèse de doctorat en Agroressources, Procédés, Aliments, Bioproduits. Université de Montpellier, France. 274p.

Tankoano A, Diop MB, Sawadogo-Lingani H, Kaoré D, Savadogo A. (2017) Les aspects technologiques, microbiologiques et nutritionnels des aliments fermentés à base de lait de mil en Afrique de l'ouest. International Journal of Advanced Research, 5 (8), 1509-1526.

Tsafrakidou P, Michaelidou AM, G Biliaderis C. (2020) Fermented Cereal-based Products: Nutritional Aspects, Possible Impact on Gut Microbiota and Health Implications. Foods. 9(6) :734. doi : 10.3390/foods9060734.