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Technological and socio-economic study of *akandji*, a neglected traditional foodstuff made from corn (*Zea mays* L.) in Benin

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ABSTRACT

Foodcrafts, active in Benin, offer a variety of products including *akandji*. It is a traditional bread made of corn consumed in South Benin. This work aimed to achieving a technological and socio-economic study related to *akandji* production and marketing activities in Benin. To do this, the methodology adopted was to conduct a pre-survey and a survey in the form of semi-structured interviews based on a questionnaire in the communes of Abomey, Bohicon and Ouidah (Pahou). After that, production monitoring was carried out with the three oldest *akandji* producers. The results showed that the production and sale of *akandji* were secular, exclusively female activities practised by women from *Fon* socio-cultural and sociolinguistic group. The profit per kg received by *akandji* producers in Abomey (266 XOF) was similar to that received by *akandji* producers in Pahou (256 XOF). The daily receipts for weekends and holidays were higher than those for working days in the survey localities. Furthermore, the results of the technological study showed that *akandji* manufacturing process in Abomey differs from that of Pahou. This process in Abomey involved the malting operation unlike that of Pahou. Fermentation times (12h), cooking times (1h) and production times (6 days) in Abomey exceeded fermentation times (1h30min), cooking times (45min) and production times (6h) in Pahou. In contrast, the fermentation (27 °C) and cooking (100 °C) temperatures of *akandji* at Abomey were lower than those of fermentation (31 °C) and cooking (178° C) in Pahou. The production of *akandji* is a profitable activity that strengthens the social status of the producer and ensures important socio-community functions by providing an appropriate local food for traditional rites and festivals and maintains sales markets firmly rooted in society.

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Keywords: *Akandji*, traditional food manufacturing process, socio-economic, Benin

INTRODUCTION

In Africa, and particularly in Benin, the agrifood industrial sector is poorly developed. Thus, a significant proportion of agricultural products is processed through food crafts (Dossou et al., 2015). Indigenous processing practices are transmitted and perpetuated over generations through family education and the traditional learning system (Tchekessi et al., 2014). With large sums of money involved, the food industry is undoubtedly one of the most important sectors of employment for a large proportion of the population, including entire families, especially women in developing countries (Aholou-Yéyi, 2007; FAO, 2009). In Benin, the trade in street food prepared within the food crafts generate daily income which amounted to between 1,500 and 15,000 XOF per saleswoman (FAO, 1996 cited by Tchekessi et al., 2014). Nago et al. (1990) have shown that this sector plays an important role in maintaining national food security through the processing of local products. The most widely used local products are cereals, of which maize is the most processed raw material in this sector. Ranked the second most cultivated cereal in the world after wheat, maize is the most energetic and most economical cereal in terms of production (Charcosset et al., 2009; Nuss et al., 2011). In addition, from this cereal, comes a wide range of very varied foods such as dishes, boiled, drinks, cakes, donuts, sauces, baked dishes etc. *Akandji*, cereal product, is a kind of traditional bread made from corn flour (Onzo et al., 2013). It is an endangered food commodity as demonstrated by Adjanohoun et al. (2015). Called *kandji* in *Yoruba* and *Goun*, or *bolou* in *Adja*, *akandji* is produced and marketed in South Benin mostly in the communes of Ouidah and Abomey in the streets and on the outskirts of the tracks. Like all street food, the production of *akandji* is subject to many constraints such as exposure to bad weather, external contamination and therefore poses a public health problem. Despite the importance of its production and marketing, no or very few studies have been devoted to this product. A

socio-economic and technological study related to *akandji* manufacturing process and marketing activities should therefore be carried out. The objective of this study is to evaluate the technology of *akandji* production in Benin. Specifically, the study aims to identify the different raw materials and technologies used in the production of *akandji*; to assess the state of hygiene during production and sale, as well as the economic profitability of the product.

MATERIALS AND METHODS

Study area

The geographical framework of this study is the South of Benin more precisely in the departments of Atlantic and Zou. The study was carried out in the municipalities of Abomey (Hounli), Bohicon (Bohicon) and Ouidah (Pahou) because they are considered to be Communes with high production, sales and consumption of *akandji* in Benin. The Municipality of Abomey is situated between 1° 50" and 2° 5' East longitude and 7° 0' and 7° 10" North latitude. Bohicon is at latitude 6°55 and 7°08 N, longitude 1°58 and 2°24 E, and Ouidah is at latitude 2°15 and 2°15 N and between latitude 6°15 and 6°30 E.

Survey material

Questionnaires incorporating socio-cultural, technological and economic questions were sent to *akandji* producers and sellers.

Plant material

The corn variety used is the white-coloured maize (*Zea mays* L.) locally referred to as *Adjakouin* or *Nikkikouin* (in the local language Fon) recognized and chosen for this purpose by *akandji* producers. A lot of maize was bought at the market of Pahou and Abomey. Banana (*Musa sapientum*), Greater Senegal Arum (*Lasiomorpha senegalensis*) and marante (*Thalia geniculata*) leaves, respectively called *kokoéman*, *toungoman* and *afléman* in *Fon* language were used for the packaging of *akandji*.

Other ingredients

Refined sugar, salt, instant yeast and water from the National Water Society of Benin (SONEB) were also used.

Field survey

The survey, divided into three phases, took the form of semi-structured interviews and the observation of the actors at work. These phases are the exploratory phase, the data collection phase, the data analysis phase.

Exploratory phase

This step identified the different areas of *akandji* production, marketing and consumption in Benin. The choice of survey communes is based on the information collected from the resource persons, but also with the literature search. The communes of Ouidah, Abomey, and Bohicon have targeted as the areas of high production, sales and consumption of *akandji* in Benin. This phase took place in focus group. Once the pre-investigation was completed, the cities of Pahou, Abomey and Bohicon were chosen as cities to be investigated.

Data collection phase

The second phase consisted in administering a questionnaire to the producers and sellers of *akandji* in Pahou, Abomey and Bohicon. The survey was carried out in the immediate vicinity of the production, sale and consumption places especially in houses, the markets of Pahou, Abomey; sites identified during the exploratory phase. The individual survey was carried out using the snowball method developed by Goodman in 1961 (Wilhelm, 2014) and involved 23 players in *akandji* production and marketing activity.

Survey on Akandji manufacturing process

This survey aimed to learning about the different stages of the *akandji* production process, the different varieties of raw materials used and to identify the risk practices associated with them. It took place in two stages. Initially, a questionnaire was administering to 23 *akandji* producers and sellers in Pahou (17), Abomey (06) and Bohicon (00). In a second stage, the three oldest *akandji* producers were selected and

followed during the manufacture of *akandji*. Informations related to socio-economic and cultural characteristics, unit production operations of *akandji* and the different raw materials used in its production were then collected.

Processing of survey data

In Benin and more generally in Africa, local perceptions of phenomena and practices are strongly influenced by customs and practices, which themselves depend on socio-cultural groups (Gnanglè et al., 2011). As a result, the subjects surveyed were grouped under a single identified socio-cultural group, namely the *Fon*. In this group, subjects were grouped into three age categories (youth = 0 to 35 years; adult = 35 to 60 years; 60 years and older) and sex (Assogbadjo et al., 2008). Thus, in total, 03 socio-cultural types taking into account the combination of the main socio-cultural groups, age and sex were considered as presented in Table 1.

For each person surveyed, the perception index of each organoleptic characteristic as well as the perceptions of *akandji* and other processes were determined. For each category, an average perception index was calculated for each characteristic based on the average value of the perception indices for this characteristic by the individuals making up the group in question. A matrix of indices of perception for organoleptic characteristics was established. This matrix was subjected to a Primary Component Analysis (PCA) according to Bello et al. (2017) using MiniTab 2014 software, to describe the existing relationships between perceptions related to changes in the state of different organoleptic characteristics. The same analytical approach related to the establishment of socio-cultural groups was carried out for the assessment of organoleptic characteristics in relation to the socio-cultural group but also in relation to the origin locality of *akandji*. For each socio-cultural group and locality, the persons who opted for the different varieties were counted. The resulting contingency table was submitted at Simple Correspondence Factor Analysis (SFA) using Minitab 14 software (Bello et al., 2017). The

results of the various analyses were presented in tables and figures.

Statistical analysis

The data collected were compiled using the 2016 Excel spreadsheet and then coded and processed using the Statistical Package for Social Sciences (SPSS) version 20.0 (Norusis, 2002) for descriptive statistics determination in terms of percentage and average. The quantitative data were then subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) version 9.2 software according to Balogoun et al. (2014) and MiniTab 2014. Comparisons of multiple means were made with the Student Newman-Keuls test (Dagnelie, 1986). The level of significance was 5% ($p < 0.05$).

RESULTS

Socio-economic and demographic characteristics

Akandji, corn bread, is a food native to South Benin where the cultivation of corn is more widespread. It is found in Ouidah (Pahou), and on the Abomey-Bohicon axis. This corn bread was brought by the «Dada» that is to say ancestors according to the respondents. When their wives did not cook early, *akandji* allowed them to survive until the meal. *Akandji*, often accompanied by « ataclè (bean-based donut) », also served as provisions during the wars. This inspired a *Fon* adage that says « *nu e gbo ataclè de etchi bɔ e fuŋ hwa yeo ni egbo cleclɛ ɔ gbe djin e na yi* » which means « *akandji* does not get moldy quickly ». It did not only provide them with strength, but was also easily transportable and kept for a long time. In addition to the lucrative activity associated with *akandji*, the production and consumption of *akandji* occur on several occasions. It is served in Abomey during the «Adjagbé» (ritual of exit of the twins), the «Ninsounhwéhoun», funeral rites, and consultation of the oracle. It is given as food to vodoun (divinities) *Dan* and *Tohossou*.

Socio-cultural profile of respondents

Table 2 presents the results of the distribution of respondents by sex, age, ethnicity, nationality, social status and educational attainment. From it, it appears that the production and sale of *akandji* are exclusively female activities. The producers, all of Beninese nationality and *Fon* people were mostly young (56.50%), housewives (69.60%) and uneducated (56.50%). The variance analysis and the Student Newman Keuls test showed that the age of the actresses in the production and sale of *akandji* residing in Abomey is not significantly different ($p < 0.05$) from that of Pahou (Figure 1).

The Factorial Analysis of Correspondences (AFC) carried out on data related to the occupational category of the respondents revealed that the production of *akandji* is the prerogative of Adults and Old Women *Fon* both in Abomey and Pahou. Young Women *Fon* was only *akandji* resellers (Figure 2).

Source of *akandji* manufacturing process acquisition

It can be deduced that 17.4% of respondents had acquired this technology by inheritance compared to only 4.3% who had acquired it by apprenticeship. Figure 3 illustrates this distribution of respondents by source of technology acquisition.

Socio-economic characterization

Yield, Production cost and profit margin

Table 3 presents the results of Student Newman Keuls' tests on yield, unit price, revenues, cost of production and profit margin in the two *akandji* production municipalities. Analysis of this table shows that *akandji* production was less profitable in Pahou than in Abomey at the 5% threshold. On the other hand, the unit price, revenues and cost of production were higher in Pahou than in Abomey at the 5% threshold. But there is no significant difference between the profit margins of the two survey areas ($p < 0.05$).

Daily *akandji* receipts in both survey areas

Table 4 presents the results of the Student Newman Keuls test on daily receipts at the two *akandji* production locations. It reveals that the minimum revenues for weekends and holidays were higher in Abomey than in Ouidah. However, there was no significant difference between the minimum and maximum receipts for working days and the maximum receipts for weekends and holidays in the two regions surveyed.

Characterization of traditional *akandji* manufacturing technologies by producers

Corn variety

At the end of the survey, the targeted producers reveal that in 100% of the cases, that the variety of maize used for the production of *akandji* was the white variety used for the preparation of the white paste called Adjakouin or Nikkikouin (in Fon language).

Production equipment

The material involved in the production of *akandji* consisted of basins, cups, baskets, trays, sieves, strainers, clean cloths, plastic buckets, pots, a pallet, dishes, a mill, a fireplace and a traditional oven. The water used for the production was potable water.

Technical parameters of technologies

As a result of this survey, the technologies according to the producers showed the same cleaning temperature (28-30 °C) and washing temperature (28-30 °C). However, the number of people washing and cleaning could vary. They agreed that the cleaning and washing times depended on the purity of the corn, but also on the quantity of *akandji* to be produced. In addition to these similarities, there were some distinctive unit operations. Table 5 shows the similarities and dissimilarities of these two *akandji* production technologies. According to the data collected, each region corresponded to a specific technology. Our studies have shown that in Abomey, there is the malting operation, which was not the case in Pahou. To this end, we have tried to investigate the similarities and dissimilarities of technologies from one city to another presented in Table 5.

In addition, different parameters related to unit operations such as grind, fermentation and cooking found at the two technologies as well as *akandji* production time were subjected to the Student Newman Keuls test for analysis. The results of the test performed on these parameters are recorded in Table 6. From the latter, it appears that the grind cost and the fermentation temperature did not vary significantly at the 5% threshold from one region to another ($p > 0.05$). This same table shows that fermentation and production had a very high duration at Abomey than at Pahou ($p < 0.001$). As for cooking, it had a very high duration in Abomey than in Pahou ($p < 0.01$). In contrast, the cooking temperature of *akandji* in Pahou was very high compare to the cooking temperature of *akandji* in Abomey ($p < 0.001$).

Different traditional *akandji* production technologies identified

Manufacturing process of Akandji in Pahou

Corn grains for *akandji* production are sorted, washed and drained. The drained corn grains are sent to the mill for crushing. The crushed corn is then sifted, resulting in flour, gritz and bran. The gritz and the corn flour are moistened with water and then sent back to the mill for a second milling. The resulting flour is left to cool. One third of it is washed in water and added to boiling water on the fire. This produces a slurry that is allowed to cool completely at room temperature. The rest of the flour, sugar (optional), salt and yeast to the dough on the floor are then incorporated. Some producers also add wheat flour. The whole is kneaded until the ingredients integrate well into the dough. The latter is covered it afterwards and rest for about 1h. After this time, the dough is packed in either banana, marante or large arum leaves from Senegal; it is baked for about 45 min in a preheated oven. The images on Figure 4 below illustrate the different stages of this production.

Production tracking and characterization of a traditional manufacturing process of *akandji* allowed us to obtain the diagram below (Figure 5).

Manufacturing process of Akandji in Abomey

The cleaned corn kernels undergo the malting process. The malted corn kernels are sent to the mill for milling. Water is added (moistened) to the malted corn kernels in the manner of making the *mawè* (fermented corn flour paste) (but with a greater quantity of water: it is said in *fon* « *ezin lifin* ». The whole is homogenized and left for a few hours in the sun. Let rest all night (10h - 12h). The next day, water is added to make the mixture a little more liquid. This dough is packed in banana leaves and steamed for 1 hour. The images below illustrate the different stages of this preparation (Figure 6).

Monitoring the *akandji* preparation process and characterization of traditional *akandji* production technologies allowed us to establish the production diagram below (Figure 7).

Organoleptic characteristics

According to the locality

Tables 7 and 8 respectively present the organoleptic characteristics of the two *akandji* varieties according to their origin of production and the eigen - Value of the first two components. The analysis in table 8 shows that the two axes have enabled to analyse 100% of the data.

The results of the Correspondence Factor Analysis (AFC) carried out on data related to the organoleptic characteristics of *akandji* showed that in Abomey, *akandji* was

white, compact, sweet acid, less hard and preserved for about 5 days according to the producers (Figure 8). On the other hand, *akandji* produced by women in Pahou was whitish, spongy, hard, salty sweet acid and kept for 2-5 days. However, *akandji* produced by women from the two survey localities had a smooth appearance.

Depending on the socio-cultural group

Figure 9 shows the distribution of respondents by age and sex. Figure 9 shows that the Abomey respondents were made up only of young and adult women in equal proportion. In contrast, in Pahou, the majority of respondents were young women (58,8%) followed by adults (35,3%) and old (5,9%) women.

Eigen value axis Proportion Cumulative proportion

The eigen values of the first three main components are shown in Table 9. Table 9 shows that 99% of the data collected were analysed in relation to the two axes.

The projection of the 3 socio-cultural groups (Figure 10) into the axis system defined by the organoleptic characteristics showed that the AFF produced whitish, smooth, spongy, hard, and salty sweet acid *akandji* that was preserved for five days. In contrast, JFF *akandji* kept for two to five days. VFF, on the other hand, produced *akandji* white, compact, less hard, sweet acid.

Table 1: Effectives associated with the 03 socio-cultural types studied (n = 23).

Socio-cultural types	Codes	Workforce
Adults Women Fon	AFF (AWF)	9
Young Women Fon	JFF (YWF)	13
Old Women Fon	VFF (OWF)	1
Total		23

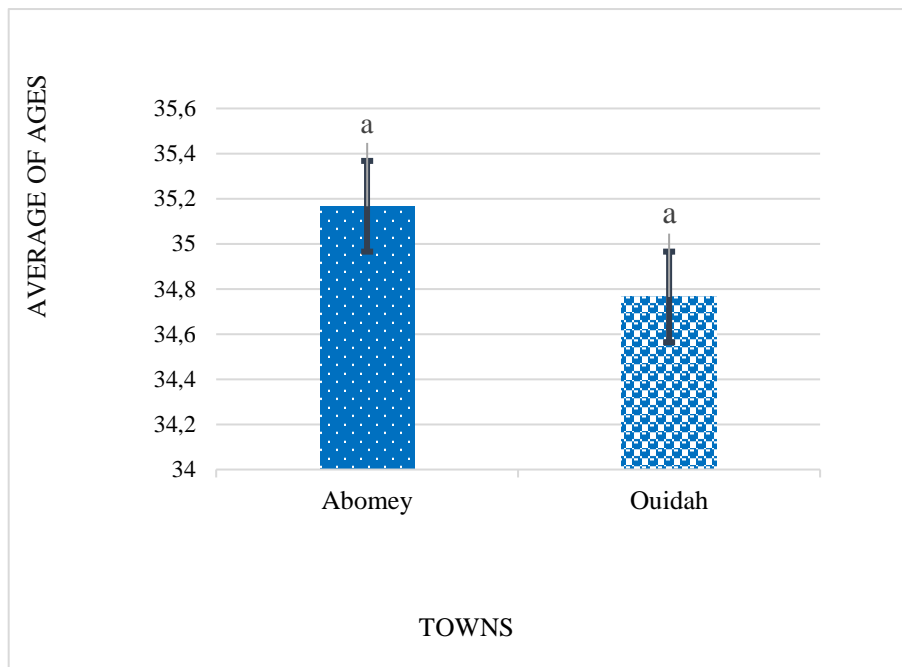


Figure 1: Ages of respondents.

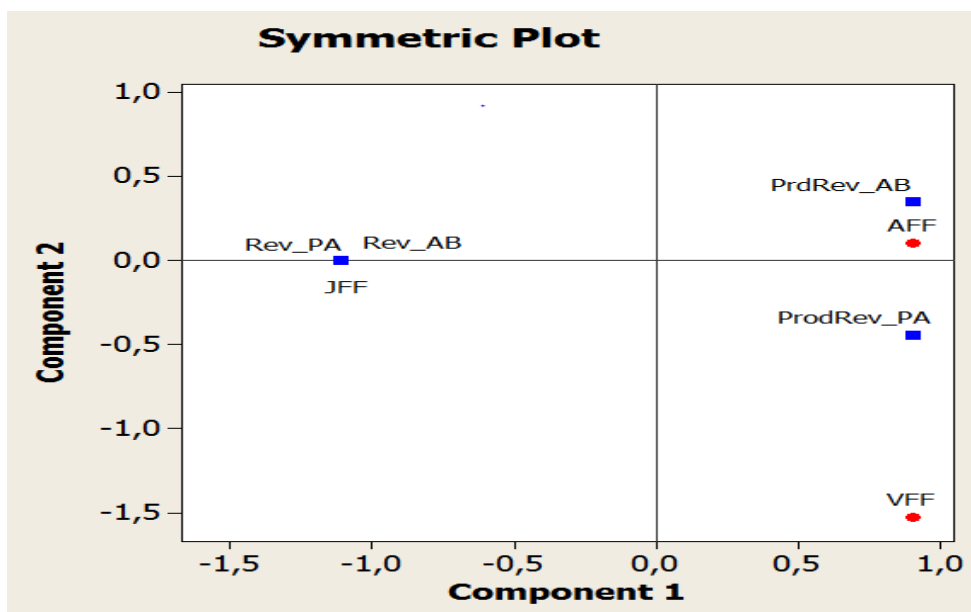


Figure 2: Category of respondents: projection of socio-cultural groups in the factor axis system following a correspondence factor analysis (AFC).

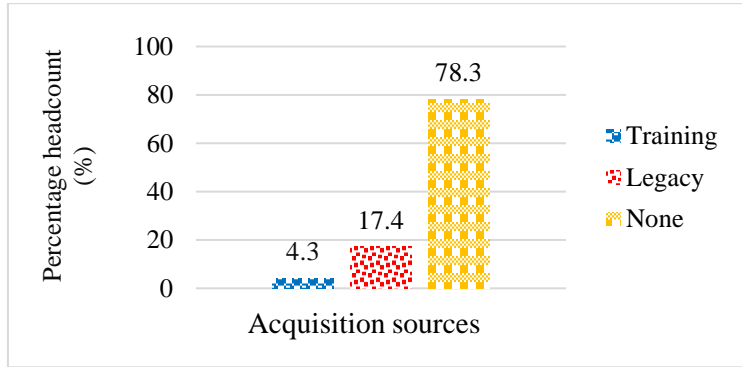


Figure 3: Distribution of respondents by acquisition source.



Figure 4: Production stages of *akandji* in Pahou.

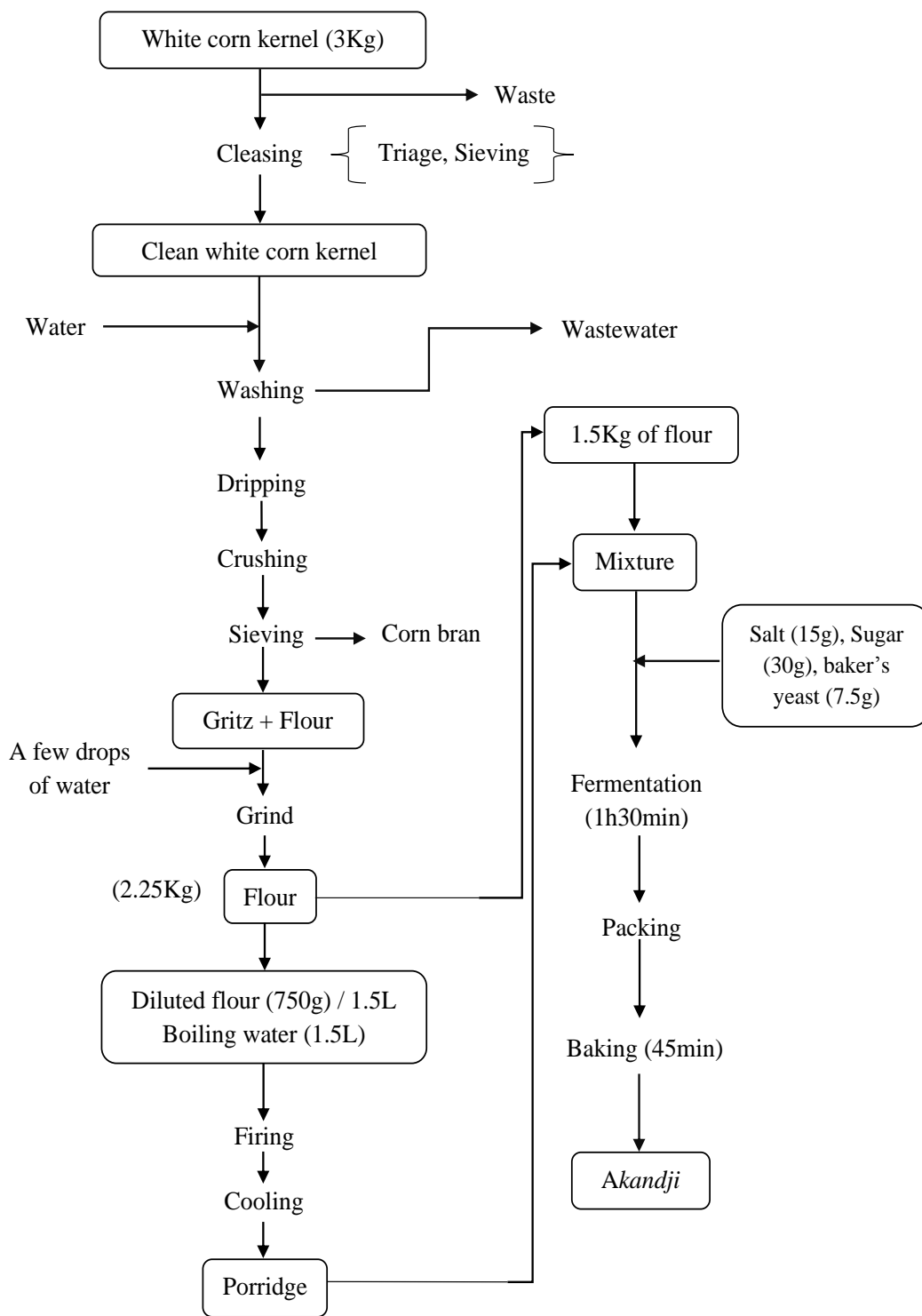


Figure 5: Traditional akandji production technology diagram at Pahou.

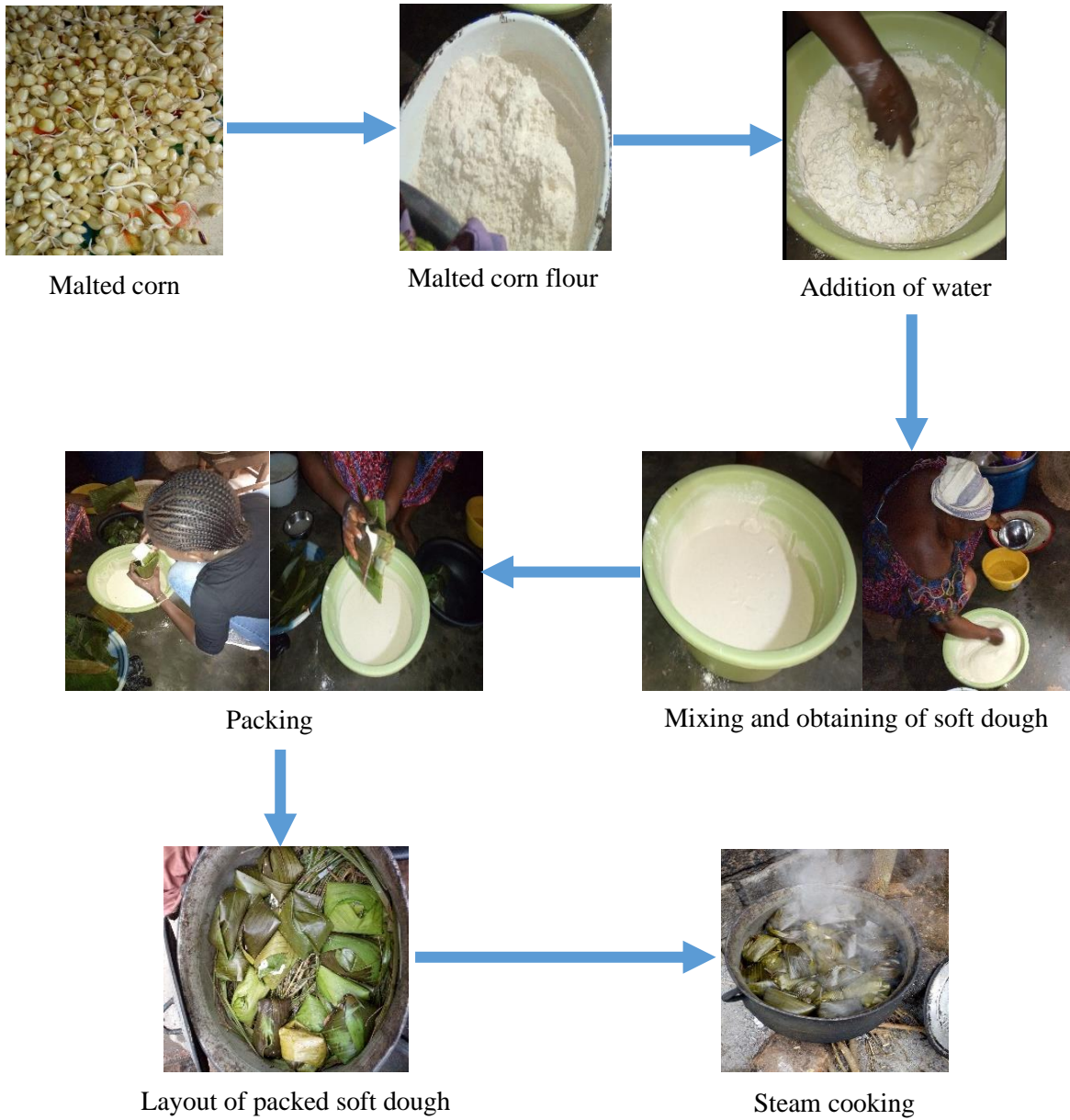


Figure 6: Stages of *akandji* production in Abomey.

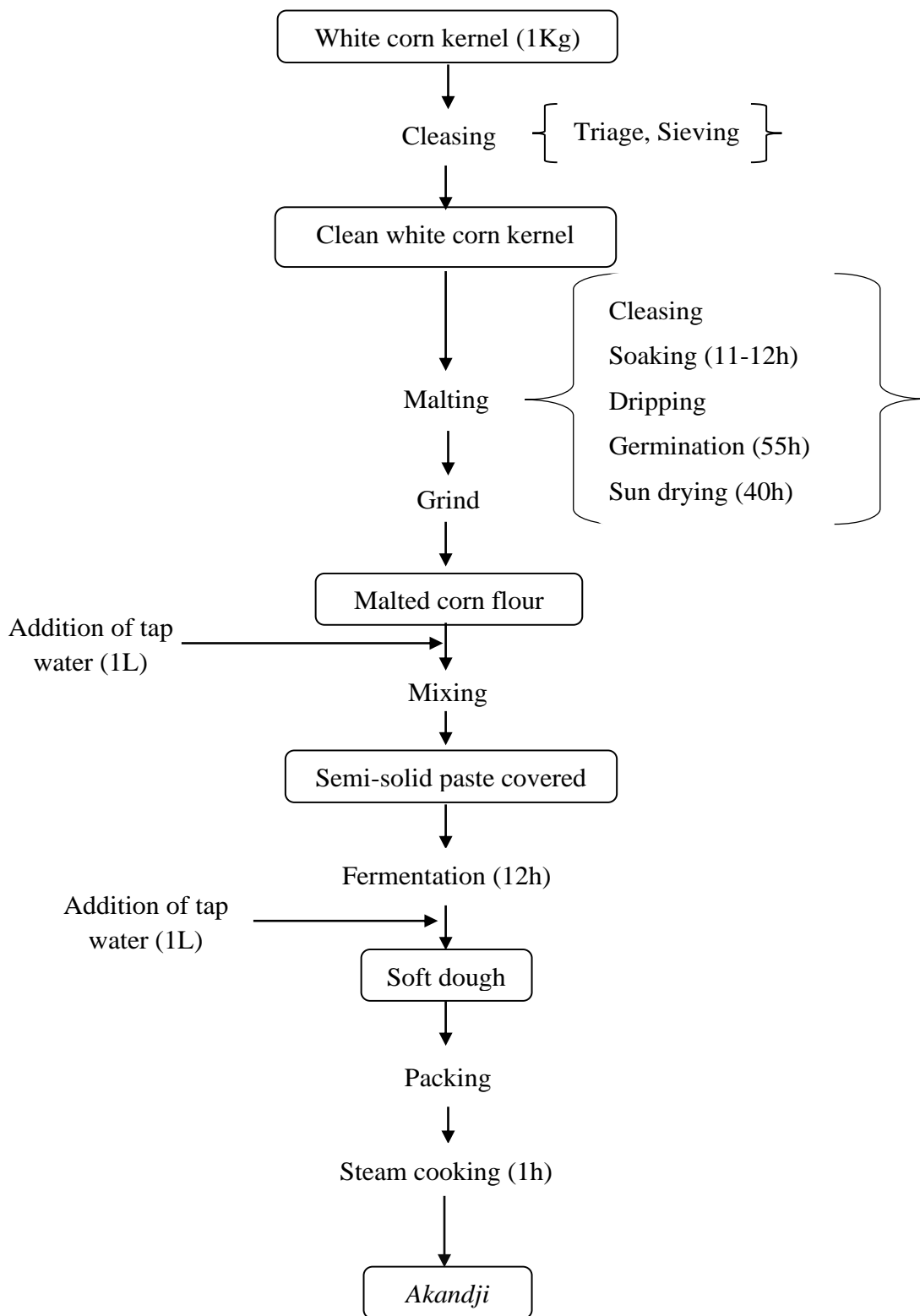
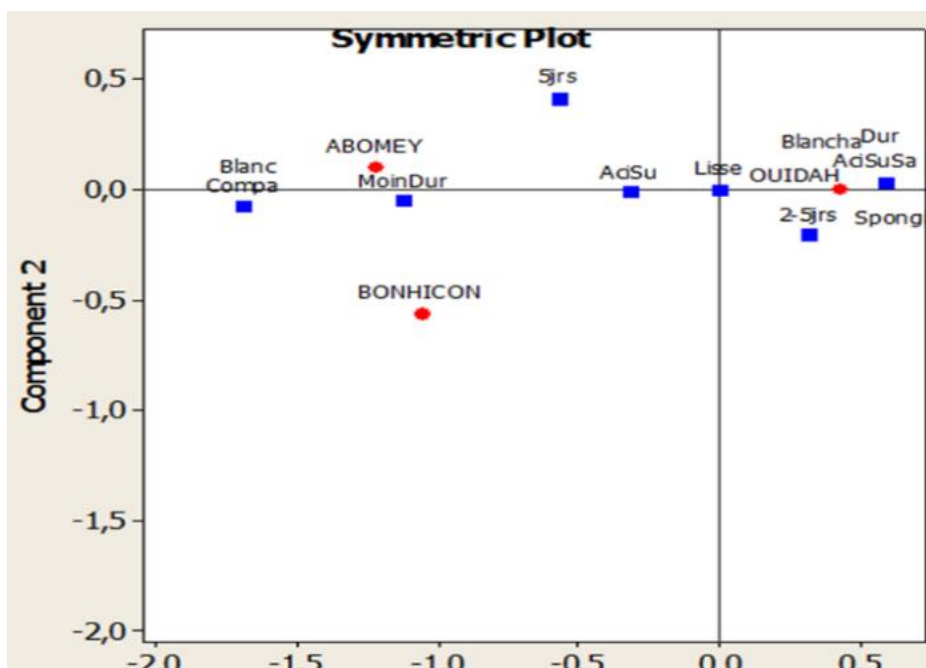


Figure 7: Traditional technology diagram of *akandji* production in Abomey and Bohicon.



Legend: Compa=Compact ; MoinDur = less Hard) ; Acisu = Sweet Acid) ; Blancha = (Whistish) ; AcisuSa = Sweet Salt Acid ; Spong=Spongy

Figure 8: Organoleptic characteristics of *akandji* ; projection of localities in the factorial axis system following correspondence factor analysis (AFC).

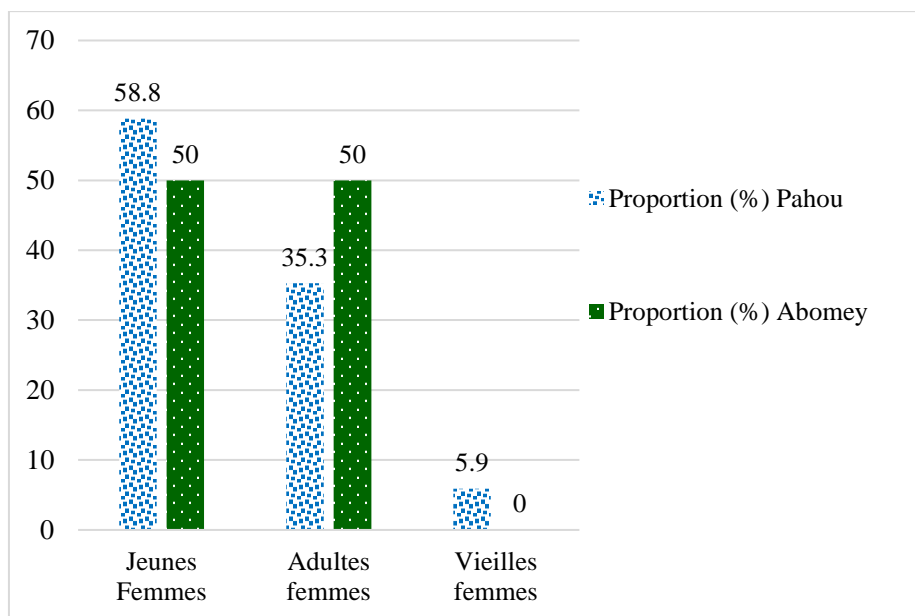
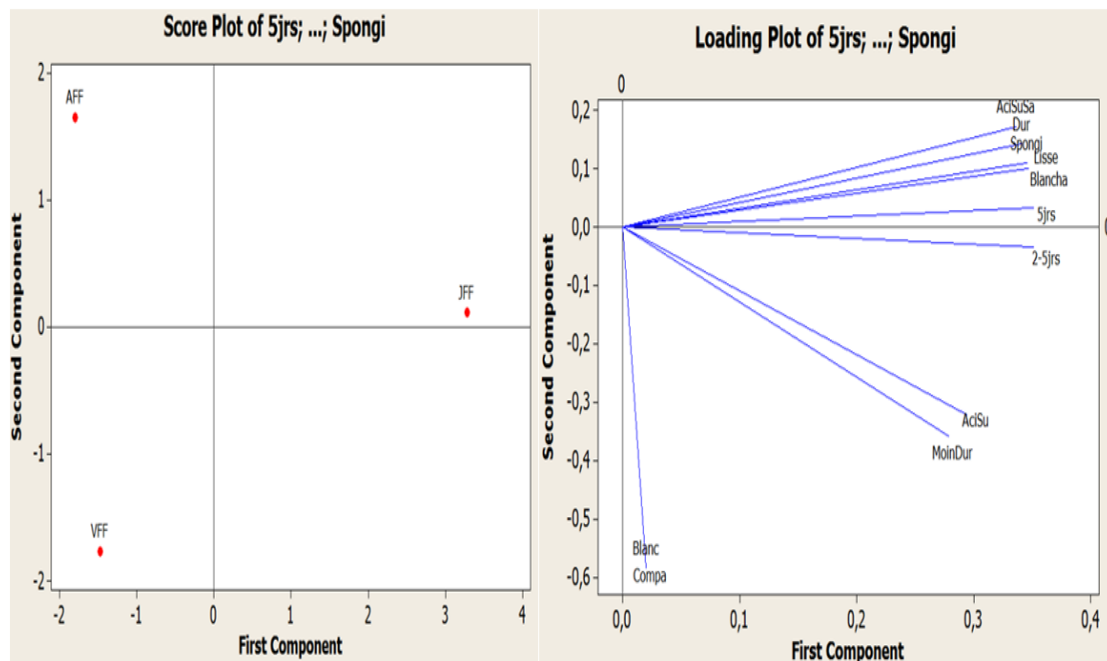


Figure 9: Distribution of female producers and female resellers by age.



Legend: AFF = Adult Women Fon ; JFF = Young Women Fon ; VFF = Old Women Fon ; AcisuSa = Sweet Acid Salty ; Spongi = Spongy ; Blancha = Whitish ; jrs = days ; Acisu = Sweet Acid, MoinDur = Less hard, Compa = Compact

Figure 10: Organoleptic characteristics studied from a Principal Component Analysis (PCA): projection of socio-cultural groups and organoleptic characteristics in the factor axis system.

DISCUSSION

The various surveys conducted show that *akandji* production and marketing activities were exclusively female (Table 2), as were those of *gowé* (Tchekessi, 2012), *foura* (Moussé, 2018), *Ablo* (Banon, 2012) and *gnomy* (traditional fermented millet donut) in Côte d'Ivoire (N'goran-Aw et al., 2017). It is a food typically native to the Fon ethnic group of South Benin as shown in Table 2. More than half of female producers were not enrolled in school (56.50%), housewives (69.60%) and young women (56.50%). The succession to the parents, the profitability of the activity or the provision of financial assistance in the home are all reasons that pushed the producers and sellers of *akandji* to choose this sector of activity. These same reasons were cited by Tchekessi et al. (2013) for the choice of the sector of activity by the *gowé* producers and by Moussé (2018) for the choice of the sector of activity by the *foura* producers. Whether in Abomey or Pahou, *akandji* production activity

was carried out only by Adults and Old Women Fon (Figure 2). This is due to the fact that Adults and Old Women had a better grasp of technology than young people. This mastery of *akandji* production is the result of many years of experience (at least 15 years of service) and skill acquired. In fact, most of them came by inheritance through the transmission of knowledge from their mother, mother-in-law or grandmother (Figure 3), as was the case for *ablo* and *gowé* producers. Apart from these study areas, namely Abomey, Bohicon and Pahou, *akandji* is marketed in Adjra-Dovié, Godomey and even in Cotonou within the Dantokpa market thanks to mobile sales. These mobile resellers originate from the aforementioned production areas (Abomey, Bohicon and Pahou).

From an economic point of view, there was no fluctuation between the profits earned by women in the two localities (Table 3). These average profits in both localities ranged from 256 XOF to 266 XOF. These results are similar

to those of Bokossa et al. (2013a) which showed that the average profit received by gowé producers is 240 XOF. They are also close to that of Banon (2012), which showed that the average profit received by ablo producers varied between 220 XOF and 266 XOF. However, yields, unit price, cost of production and revenues varied. The higher yield in Abomey than in Pahou is explained by the differences observed between the unit operations that make up each technology. In fact, in Pahou, part of the flour from the grinding of the gritz was used for the production of porridge which was mixed with the rest of the flour. This was not the case in Abomey where all the flour from the malt milling was used for mixing. The *akandji* unit was sold cheaper in Abomey (25 XOF) than in Pahou (50 XOF) (Table 3). This is due to the addition of other ingredients (sourdough, sugar and salt) other than maize in the manufacture of *akandji* in Pahou, unlike Abomey where it was produced solely from maize. This justifies this fluctuation and by the same token, the high cost of production that was noticed in Pahou compared to that of Abomey (Table 3). The higher revenues in Pahou than in Abomey are due to the location of the sales activities. The sale at Pahou takes place on the Cotonou-Lomé interstate route. On the other hand, the sale in Abomey takes place in the local market which was animated every five days and occasionally for the ceremonies, in the houses (Table 3). Daily receipts do not vary significantly except for the minimum receipts for weekends and holidays which were higher in Abomey than in Pahou (Table 4). Indeed, in Pahou, the saleswomen could stay a whole day without selling all or part of their goods. On the other hand, in Abomey, they did not stay a day without making a recipe even if it is weak. However, revenues for weekends and holidays were higher than for business days. This increase is due to the travel of a large number of Beninese consumers and the organization of most ceremonies during the weekends as highlighted by Bokossa et al. (2013b).

Based on this study, it was found that all of the *akandji* producers surveyed used the

white corn variety called Adjakouin as in the gowé production reported by Bokossa et al. (2013a). These surveys also allowed to identify two production technologies according to the localities. Abomey's production technology differs from that of Pahou on several points. At Abomey, the producers were malting the maize grains, adopting spontaneous fermentation and steaming. On the other hand, in Pahou, there was no malting, the fermentation was caused by the introduction of instant yeasts and the baking of the loaves was done in the oven (Table 6). This difference in production technology according to localities is due to the lack of optimization of parameters and the modeling of *akandji* production technologies.

In Abomey as in Pahou, the cost of crushing was the same. The temperature of fermentation did not change from one locality to another. Fermentation, however, took eight times longer in Abomey than in Pahou (1h30min in Pahou and 12h in Abomey). The duration of fermentation during the production of *akandji* in Abomey is close to that of ablo (Bokossa et al., 2013b) during its production in the localities of Abomey, Bohicon and Covè. Baking *akandji* justified the high temperature of this operation at Pahou (178°C / 43 min) as opposed to Abomey where it was done at 100°C / 60 min steam (Table 8). The production time was higher in Abomey (6 days) than in Pahou (about 5h – 6h) because of the grain malting operation during *akandji* production in Abomey. The long production time of *akandji* in both localities highlights the tedious nature of this production activity, as well as traditional cereal processing activities, as demonstrated by N'goran-Aw et al. (2017) as for the production of gnomy in Côte d'Ivoire. It must be recognized that, regardless of the region, producers packed the fermented dough before baking. Kokoéman banana leaves were used in Abomey while in Pahou, producers used the leaves of the great arum of Senegal «tougoman». This study has shown us that this traditional corn bread is a royal and historic food. Indeed, originally, *akandji* was prepared especially for the royal family during the demonstrations, but also for the warriors not

only because of its ease of transport and its storability but also because of its energy input. It was also revealed to us by the producers of the two localities that in reality the *akandji* name given to this bread produced in Pahou is by abuse of language. Its real name is “ablo kpo me ton” which means in English “baked ablo”. The identification of organoleptic characteristics according to localities shows that *akandji* produced at Pahou is whitish, hard, spongy, salty sweet acid (Figure 8). This spongy character is due to the action of yeast (instant yeasts) added for fermentation. The salty acid taste is justified by the acidic pH induced by fermentation and the addition of salt and sugar during the production of *akandji*. *Akandji* of Abomey was white, compact, less hard, acidic and sweet. The sweet taste

observed at Abomey (while there is no addition of sugar in the process) is due to the hydrolysis of starch into soluble sugars during germination. Although *akandji* from the two technologies were smooth, it remained more in Abomey than in Pahou (Figure 8). Depending on the socio-cultural group, it is noted that *akandji* adult women lasted longer than Young Women Fon during conservation. This is due to the mastery and skill acquired during the many years of practice of Adult Women Fon who were generally producers and Young Women Fon who were resellers (Figure 10). The introduction of sugar and leaven into *akandji* at Pahou is also a favorable factor for the alteration of the product thus reducing its shelf life.

Table 2 : Socio-cultural profile of respondents.

Percentage (%)		
Variables	Modalities	Total (n=23) ¹
Categories	Producer	0.0
	Producer - Reseller	21.7
	Reseller	78.3
Age	Youth (0 to 35 years)	56.5
	Adults (35 to 60 years)	39.2
	Older (> 60 years)	4.3
Sex	Female	100.0
Social status	Merchant	4.3
	Student	26.1
	Housewife	69.6
Ethnicity	Fon	100.0
Nationality	Beninese	100.0
Educational level	None	56.5
	Primary	13.1
	Secondary	30.4

Legend: n = workforce

Table 3: Production yield, unit price, revenue, cost and profit per kilogram of *akandji*.

Parameters	Origin		F – Value	P
	Abomey	Pahou		
Yield (Loaves/Kg)	30.00 ± 0.00 ^a	21.52 ± 0.41 ^b	38.63	< 0.0001
Unit price (XOF)	25.00 ± 0.00 ^b	50.00 ± 0.00 ^a	Infin	< 0.0001
Revenues (XOF)	750.00 ± 0.00 ^b	1075.76 ± 20.31 ^a	22.78	< 0.0001

Production cost (XOF)	483.33 ± 33.33 ^b	819.70 ± 9.96 ^a	94.99	< 0.0001
Profit margin (XOF)	266.67 ± 33.33 ^a	256.06 ± 11.46 ^a	0.07	0.79

The affected values of the same letter on the same line are not significantly different at the 5% threshold (p < 0.05) ; NB : -
 Abomey : loaves weight = 614 g
 - Pahou : loaves weight = 593 g

Table 4: Variation in daily receipts by locality.

Revenues (FCFA)	Abomey	Pahou	F - Value	P
RWDMin	583.33 ± 190.47 ^a	605.88 ± 173.09 ^a	0.01	0.94
RWDMax	2583.33 ± 153.66 ^a	3447.06 ± 283.25 ^a	3.08	0.09
RWHMin	4000.00 ± 408.25 ^a	3111.76 ± 112.09 ^b	8.73	0.01
RWHMax	8083.33 ± 746.29 ^a	8647.06 ± 434.63 ^a	0.43	0.52

Legend: RWDMin: Recipes Working Days Minimum; RWDMax : Recipes Working Days Maximum RWHMin : Recipes Weekend Holidays Minimum ; RWHMax : Recipes Weekend Holidays Maximum.
 The values carrying of the same letter on the same line are not significantly different at the 5% threshold.

Tableau 5 : Comparison of *akandji* production technologies.

	Pahou	Abomey
Ressemblances	Cleaning, washing, dripping, grinding, packing, firing	
Dissemblances	Crushing, sieving, preparation of corn porridge, non spontaneous fermentation, baking	Malting, soaking, germination, sun drying, spontaneous fermentation, steam cooking

Table 6: Comparison of technological parameters.

Distinctive parameters	Origins		F-value	p
	Abomey	Pahou		
Grind cost / Kg (FCFA)	50.00 ± 0.00 ^a	58.33 ± 8.33 ^a	0.60	0.49
Fermentation temperature (°C)	27.50 ± 2.50 ^a	31.33 ± 0.88 ^a	3.08	0.18
Fermentation time (h)	11.50 ± 0.50 ^a	1.67 ± 0.17 ^b	522.15	0.0002
Firing temperature (°C)	100.00 ± 0.00 ^b	178.33 ± 4.41 ^a	189.34	0.0008
Firing time (min)	60.00 ± 0.00 ^a	43.33 ± 1.67 ^b	60.00	0.0045
Production time (days)	6.00 ± 0.00 ^a	0.23 ± 0.02 ^b	71829.60	< 0.0001

The values carrying of the same letter on the same line are not significantly different at the 5% threshold.

Table 7: Organoleptic characteristics of *akandji*.

Pourcentage (%)			
Variables	Modalities	Atlantique (n=17) ¹	Zou (n=6) ¹
Hardness	Hard	88.2	00.0
	Less hard	11.8	100.0
Couleur	White	00.0	100.0
	Whitish	100.0	00.0
Flavour	Sweet acid	52.9	100.0
	Sweet Salty Acid	47.1	00.0
Aspect	Smooth	100.0	100.0
	Rough	00.0	00.0
Texture	Compact	00.0	100.0
	Spongy	100.0	00.0

Legend: n = workforce

Table 8: Eigen values of the first two main components.

Axe de PC	Eigen value	Proportion	Proportion cumulée
PC1	0.50	0.97	0.97
PC2	0.10	0.03	1.00*

Table 9: Eigen value of the first three main components.

Axe de PC	Eigen value	Proportion	Proportion cumulée
PC1	0.351	0.73	0.73
PC2	0.351	0.26	0.99*
PC3	0.279	0.01	1.00

Conclusion

This study shows *akandji* production is an exclusively female activity and economically profitable. It generates income and enables producers to meet their daily needs. The production technologies encountered in the field are dependent on empirical knowledge and constitute a heritage for producers. Two types of *akandji* have been identified in the field, one in Abomey and another in Pahou. These two varieties differ from the point of view of fermentation, but also from the point of view of cooking.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Authors TCKC and CIO designed the study, wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Authors dMR, GGJ, SSAP, BSJ and DA, managed the analyses of the study and performed the statistical analysis. Authors ATK, BTMR and BYPI managed the literature searches. All authors read and approved the final manuscript.

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