

Original Research Article

Local foods based on baobab pulp (*Adansonia digitata* L.) consumed in savannah areas of northern Côte d'Ivoire

ABSTRACT

The African baobab (*Adansonia digitata* L.) is an indigenous fruit tree in the dry savannah areas of sub-Saharan Africa. It is a species of great dietary and nutritional interest. The pulp of the fruit, in addition to being consumed raw or in cold drinks, is used for several others unknown foods in Côte d'Ivoire. Thus, a household survey was conducted in the localities of Korhogo, Séguéla and Bouna with 135 people per locality in order to identify these foods, and then to determine their modes, forms, frequency of consumption and their processes. The data revealed that consumers collect baobab in pods form (79.23-88.81%) in fields (76.15-86.57%) before using pulp in the preparation of 10 local foods with different technologies. Eight of these foods are meals and two are beverages (*Zoom-koom* and *Séladji*). Rural populations for its taste and health benefits consume the pulp of baobab fruit. The process of *Bacacrou* (*Sougé-baca*, *Badégé-baca*, *Manou-baca* and *Sougé ni manou-baca*) vary according to the practices of each locality. Among meals, *Kagbèlè* is a specific food of Korhogo while *Séla biscuit* is more specific to Séguéla, and *Tchobal*, *Zoom-koom* and *Bafouratou* are specific to Bouna. *Sougé-baca* and *Séladji* appears as the most known foods with a percentage of knowledge of 68.39 and 53.35 respectively, and the most consumed dishes precisely at breakfast and at the Muslim jêun break with 3 to 4 times per month as frequency of consumption. For a better promotion of these foods, it is essential to know their biochemical and nutritional composition.

Keywords: *baobab*, *pulp dishes*, *household survey*, *consumption practices*, *biochemical composition*, *Côte d'Ivoire*.

1. INTRODUCTION

The African baobab (*Adansonia digitata* L.) is the best known of the eight baobab species (genus *Adansonia*). It is most commonly found in the Sahelian, Sudano-Sahelian and Sudanian regions [1, 2, 3]. This plant is a natural resource belonging to the family of Bombacaceae, according to the classical classification, or Malvaceae, according to the phylogenetic classification. The fruit of this species is of great food interest in Africa [4, 5]. Baobab pulp is a good source of vitamins (A, B1, B2, B6 and C), minerals (Cu, Fe, Na, P, K, Mg and Ca) and phenolic compounds (catechins, tannins, polyphenols and flavonoids). It can therefore reduce the rate of dietary deficiencies due to its nutritional richness. Therefore, the exploitation of this product would contribute directly to the nutritional well-being of the population. Indeed, Côte d'Ivoire records food deficiencies of up to 40% for global acute malnutrition and more than 5% for severe acute malnutrition in some regions of the

country [6, 7, 8, 9]. However, foods based on baobab fruit of are unknown by the population. The pulp of this fruit is consumed raw or used in the preparation of cold drinks or in the composition of several other foods [10, 11, 12]. Only cold drinks (*Siradji*) derived from baobab pulp is widely consumed. Most of data available in Côte d'Ivoire on the pulp of this wild fruit tree concern its ethnobotanical knowledge and its nutritional value [10, 12, 13]. Only few studies [14, 15] have focused on the juices or nectars among the baobab-based dishes. No study in Côte d'Ivoire has yet looked at all dishes those incorporate baobab pulp in their preparation. With regard to this situation, the optimization of the level of knowledge of these dishes derived from baobab is necessary. Thus, the objective of this study is to identify the dishes derived from baobab pulp and their characteristics for a better valorization.

2. MATERIAL AND METHODS

2.1 Material

The biological material consisted of baobab pulp (*Adansonia digitata*. L) commonly consumed in the north of Côte d'Ivoire. A questionnaire containing consumption practices information (modes, forms and frequencies of consumption, supplemented by the production process) of baobab pulp-based dishes was also used.

2.2 Methods

2.2.1 Selection of the departments and villages

According to Ambé [12] [and Kouassi et al. [15], the wild fruit tree *Adansonia digitata* L. is widely distributed and consumed in the departments of Korhogo, Séguéla and Bouna. Thus, the consumption survey was carried out in 3 villages of each different department after a pre-survey based on the consumption of baobab pulp and the easy access. So, the villages of Nahouokaha, Lataha and Kotchiéri (Korhogo), Sifié, Sélakoro and Bobi (Séguéla), and Niandégué, Bouko and Panzarani (Bouna) were surveyed.

2.2.2 Sampling

The selection of households was made by the snowball technique. The size (n) of the households surveyed was calculated according to formula described by Dagnelie [16] for an independent non-exhaustive sample based on Côte d'Ivoire Population and Housing Census [17].

$$n = t^2 \cdot \frac{p \cdot (1 - p)}{m^2}$$

n = minimum sample size sought; t = 95% confidence level (standard value of 1.96); P = proportion of consumers in the study area; p estimated at 50 % given the lack of knowledge of the number of households consuming wild fruit trees; m = margin of error at 5%.

To compensate for probable errors of items incorrectly filled, 20 households were added in each department. Thus, 405 households were surveyed, i.e. 135 per department (Table 1).

Table 1. Households surveyed by department and village

| Departements | Village | Surveyed | Total |
|--------------|------------|------------|-------|
| Korhogo | Nahouokaha | 48 | 135 |
| | Lataha | 51 | |
| | Kohotiéri | 36 | |
| Séguéla | Sifié | 41 | 135 |
| | Sélakoro | 44 | |
| | Bobi | 50 | |
| Bouna | Niandégué | 18 | 135 |
| | Bouko | 62 | |
| | Panzarani | 55 | |
| Total | | 405 | |

2.2.3 Questionnaire survey

The survey was conducted to collect quantitative and qualitative on baobab pulp based dishes in rural zones of Korhogo, Séguéla and Bouna. A questionnaire was drawn up using SPHINX Plus² (V5) software (Version 4.5.0.19) in order to determine the modes, forms, frequency of consumption and process of these dishes. The questionnaire had three sections, including basic questions about the respondent (socio-demographic characteristics), consumption practices and processes.

2.2.4 Data treatment

Survey data were analyzed using SPHINX Plus² (V5) software. Recoding was performed on the SPSS 20.0 software to establish the database and then transferred to the EXCEL 2016 spreadsheet. The data were grouped in tabular form and the percentages of the different parameters were calculated. Descriptive statistics and statistical analyses were performed using the XLSTAT version 7.5 statistical software and EXCEL 2016 spreadsheet. Descriptive statistics was made to translate data into graphs, averages and standard

deviations. Excel software was used to graph periods, consumption frequencies and the level of knowledge of food. Comparisons between dependent variables were determined by the Chi squared test and the Z test at the 5% threshold. Factor component analyses (CFAs) were performed for comparisons of variables with more than three modalities.

3. RESULTS

3.1 Socio-demographic characteristics of the households surveyed

The socio-demographic characteristics of baobab processing and consuming

households in Korhogo, Séguéla and Bouna are presented in Table 2. The female/male sex ratio of the 405 respondents is 0.05, with the vast majority (78.51%) not attending school. The age of the users varied from 16 to more than 50 years, with 8.39% aged 16 to 20 years and 31.11% aged 21 to 35 years. People aged 36 to 50 years old constitute 32.34% of these wild fruit users and those over 50 years old represent 28.18% of this population. 84.94% of the respondents were Ivorians and 15.06% were non-Ivorians. They were 88.99% married, 10.12% single and 8.89% widowed.

Table 2. Socio-demographic characteristics of consumers

| Characteristics | Bouna | Korhogo | Séguéla | Total |
|------------------------|-------|---------|---------|-------|
| Sex ratio (M/F) | 0.05 | 0.08 | 0.02 | 0.05 |
| Level of education (%) | | | | |
| Primary | 15.56 | 6.67 | 5.93 | 9.38 |
| Secondary | 8.89 | 8.89 | 11.11 | 9.63 |
| Upper | 1.48 | 5.18 | 0.74 | 2.47 |
| None | 74.07 | 79.26 | 82.22 | 78.51 |
| Origin (%) | | | | |

| | | | | |
|-----------------------|-------|-------|-------|-------|
| Ivorian | 65.93 | 100 | 88.89 | 84.94 |
| Non-Ivorian | 34.07 | 0 | 11.11 | 15.06 |
| Age group (Years) (%) | | | | |
| [16-35[| 48.15 | 26.67 | 43.70 | 39.51 |
| [36-50] | 31.11 | 37.04 | 28.89 | 32.34 |
| >50 years | 20.74 | 36.30 | 27.41 | 28.15 |
| Marital status | | | | |
| Married | 81.48 | 77.04 | 84.44 | 80.99 |
| Widowers | 8.15 | 12.59 | 5.93 | 8.89 |
| Single | 10.37 | 10.37 | 9.63 | 10.12 |

3.2 Consumption characteristics of baobab

3.2.1 Location and form of baobab acquisition

The forms of baobab procurement or collection vary according to department investigated (Table 3). The most collected form is in pods with a proportion of 79.23% (Bouna), 81.15% (Séguéla) and 88.81% (Korhogo). The second and third collected forms are powder (16.42-24.59%) and pulp (1.64-5.97%). For household use, the consumers collect baobab mainly from fields in Korhogo (86.57%), Séguéla (79.51%) and Bouna (76.15%) (Table 4).

Table 3: Forms of baobab collected

| | Bouna | Séguéla | Korhogo |
|------------|--------------------|--------------------|--------------------|
| Pulp (%) | 0.00 ^a | 1.64 ^a | 5.97 ^a |
| Powder (%) | 20.77 ^b | 24.60 ^b | 16.42 ^b |
| Pod (%) | 79.23 ^c | 81.15 ^c | 88.81 ^c |

| | | | |
|-----------|---------|---------|----------|
| χ^2 | 197.469 | 177.787 | 233.8184 |
| <i>dl</i> | 2 | 2 | 2 |
| <i>P</i> | < 0.001 | < 0.001 | < 0.001 |

The values, at the level of each column, bearing the same letters in superscript are not statistically different.

Table 4. Places of collected baobab

| | Bouna | Séguéla | Korhogo |
|------------|--------------------|--------------------|--------------------|
| Market (%) | 23.85 ^b | 27.87 ^b | 20.9 ^b |
| Field (%) | 76.15 ^a | 79.51 ^a | 86.57 ^a |
| <i>z</i> | -8.43 | -8.0884 | -10.781 |
| <i>P</i> | < 0.001 | < 0.001 | < 0.001 |

The values, at the level of each column, bearing the same letters in superscript are not statistically different.

3.2.2 Reasons for baobab consumption

The taste is mainly the first reason for baobab consumption in the three departments. Specifically, the baobab pulp is consumed in Korhogo for its health benefits, while in Séguéla it is consumed for its consistency and color (Figure 1).

3.2.3 Baobab dishes identification

Ten (10) baobab pulp based dishes were identified in the visited departments (Korhogo, Séguéla and Bouna). Traditional

dishes such as *Sougé-baca*, *Badégé-baca* and *Séladji* are common to the three localities but their names differ according to department. *Manou-baca*, *Sougé ni manou-baca* are consumed in Korhogo and Séguéla. *Kagbèlè* and *Zoom-koom* are specific to Korhogo. *Bafouratou* and *Tchobal* are consumed in Bouna. *Séla biscuit* is specific to Séguéla (Figure 2).

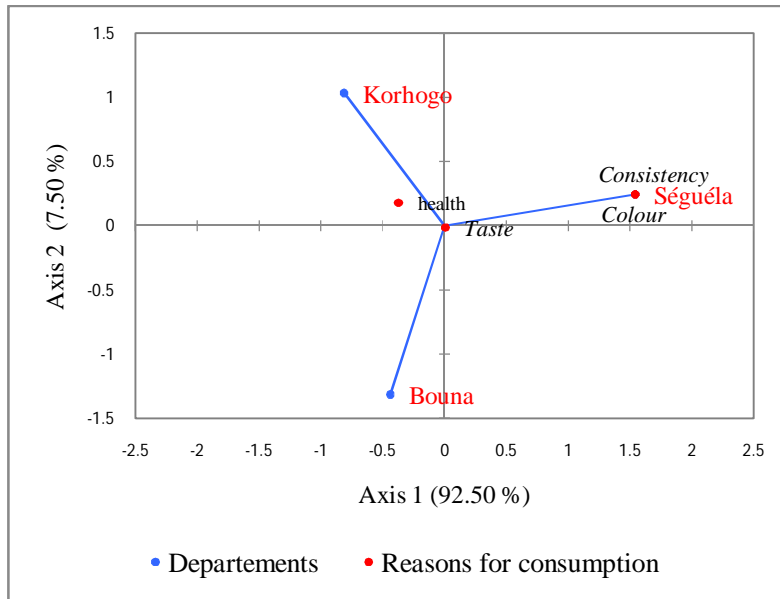
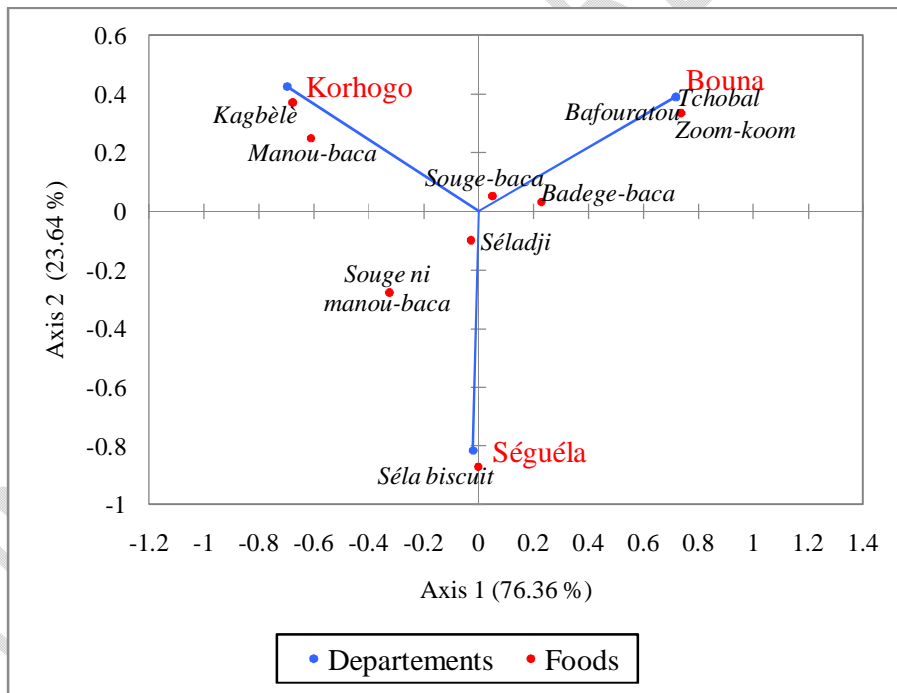


Figure 1. Reasons of baobab consumption by department in a factorial plan



Sougé-baca = millet granule porridge; *Badégé-baca* = corn granule porridge; *Manou-baca* = rice granule porridge; *Sougé ni manou-baca* = granular porridge of 3/4 millet and 1/4 rice; *Séladji* = baobab juice; *Zoom-koom* = cereal juice; *Tchobal* = bread; *Bafouratou* = donut; *Kagbèlè* = donut; *Séla biscuit*: baobab caramel.

Figure 2. Baobab dishes representation by department in a factorial plan

3.2.4 Baobab dishes knowledge level

Sougé-baca and *Séladji* are wellknown foods with a proportion of 68.39 % and 53.35 % respectively. With a proportion of

Table 5. Level of knowledge of baobab dishes

| | Korhogo | Séguéla | Bouna | Total | Proportion (%) | Level of knowledge |
|----------------------------|---------|---------|-------|-------|----------------|--------------------|
| <i>Sougé-baca</i> | 99 | 68 | 110 | 277 | 68.39 | Well-known |
| <i>Séladji</i> | 75 | 80 | 61 | 216 | 53.35 | |
| <i>Badégé-baca</i> | 34 | 39 | 78 | 151 | 37.29 | Moderately known |
| <i>Manou-baca</i> | 46 | 5 | 0 | 51 | 12.60 | Little known |
| <i>Sougé ni manou-baca</i> | 22 | 24 | 0 | 46 | 11.37 | |
| <i>Zoom-koom</i> | 0 | 0 | 3 | 3 | 0.74 | |
| <i>Kagbèlè</i> | 2 | 0 | 0 | 2 | 0.50 | |
| <i>Tchobal</i> | 0 | 0 | 2 | 2 | 0.49 | |
| <i>Bafouratou</i> | 0 | 0 | 2 | 2 | 0.49 | |
| <i>Séla biscuit</i> | 0 | 1 | 0 | 1 | 0.26 | |

37.29 %, *Badégé-baca* is moderately known where *Manou-baca* is one of the least known foods (12.60%) (Table 5).

3.2.5 Periods and frequencies of consumption of baobab dishes

Sougé-baca, *Badégé-baca*, *Manou-baca* and *Sougé ni manou-baca* are more consumed at breakfast where *Séladji* is more consumed during the breaking of the Muslim fast (Figure 3). *Sougé-baca* is the

most consumed baobab dish with 4 times per month as consumption frequency. *Sougé-baca* is followed by *Séladji* and *Badégé-baca* with consumption frequencies of 3 and 2 times per month respectively. *Kagbèlè* is far the least consumed food (Figure 4).

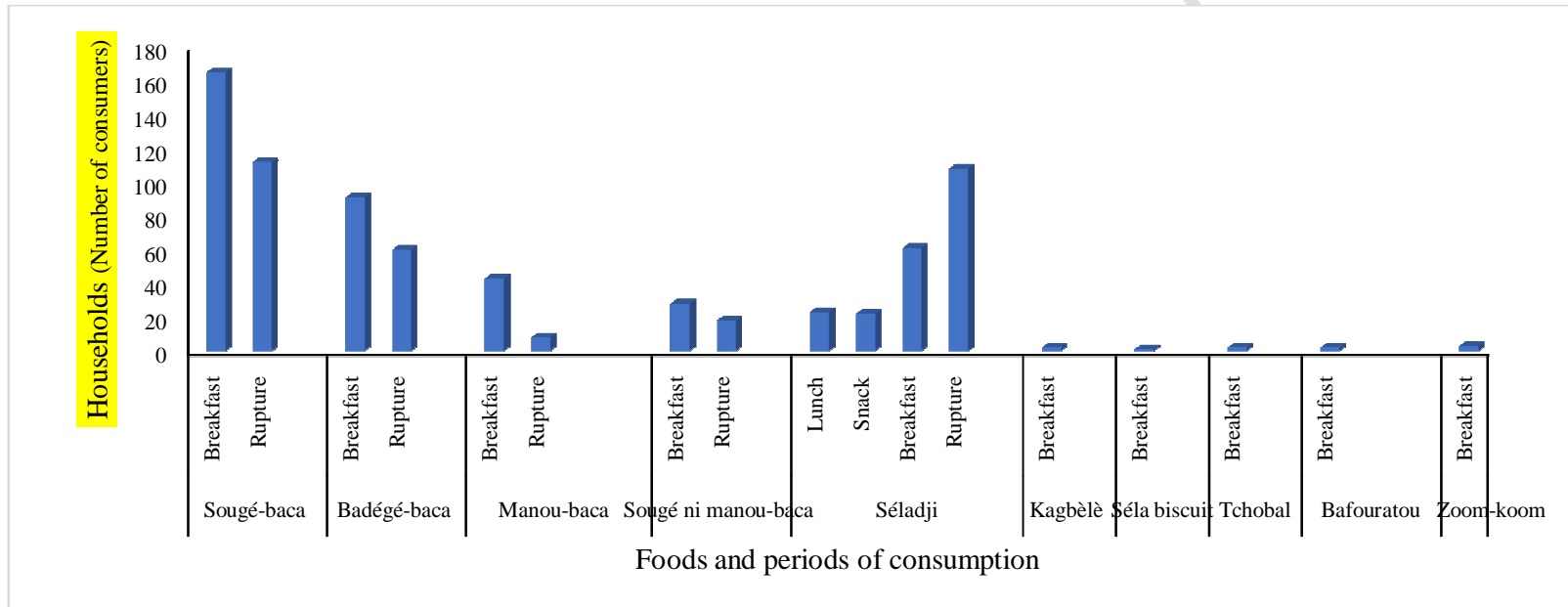


Figure 3. Period of consumption of baobab foods

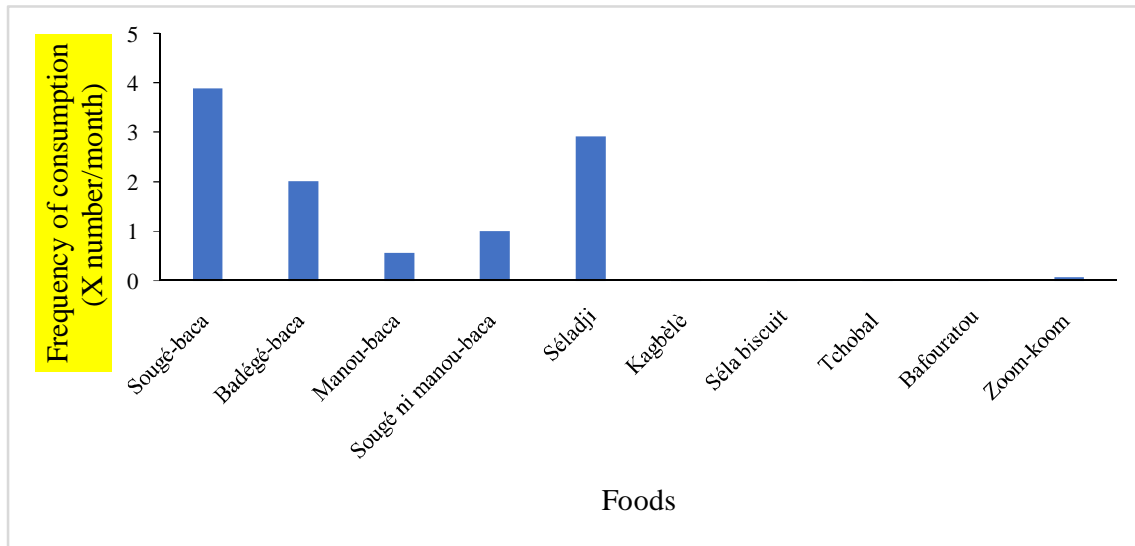


Figure 4. Consumption frequency diagram of baobab dishes

3.3 Production processes of baobab dishes

3.3.1 Production of Bacacrou

Four (4) types of *Bacacrou* exist (*Sougé-baca*, *Badégé-baca*, *Manou-baca* and *Sougé ni manou-baca*). The production process of *Bacacrou* varies slightly according to department (Figure 5). One (1) kg of cereal (millet or rice or corn or 3/4 millet + 1/4 rice) is soaked in 3 L of water for 120 min before removing and washing cereal in 3 L of water. After draining, cereal is ground with 100 g of

ginger and 20 g of cloves (Bouna practices) or with 10 to 20 g of chili pepper (Korhogo practices) to obtain a flour. The resulting flour is sifted and sprayed gradually with 100 to 200 mL water to obtain granules, which are dried in the sun or at room temperature for 4 to 5 h. Seven (7) to eight (8) L of water are boiled in a pot and granules are added and mixed to avoid clumping. An amount of 100 g of baobab pulp powder macerated in 0.5 L of water is added gently after 10 to 15 min of cooking and the resulting mixture is left cooking for

10 to 15 min. The sucrose (500 g) and 140 g of vanilla sugar (Bouna practices) or juice of 30 g of mint leaves (Séguéla practices) are added 2 min before the end of cooking.

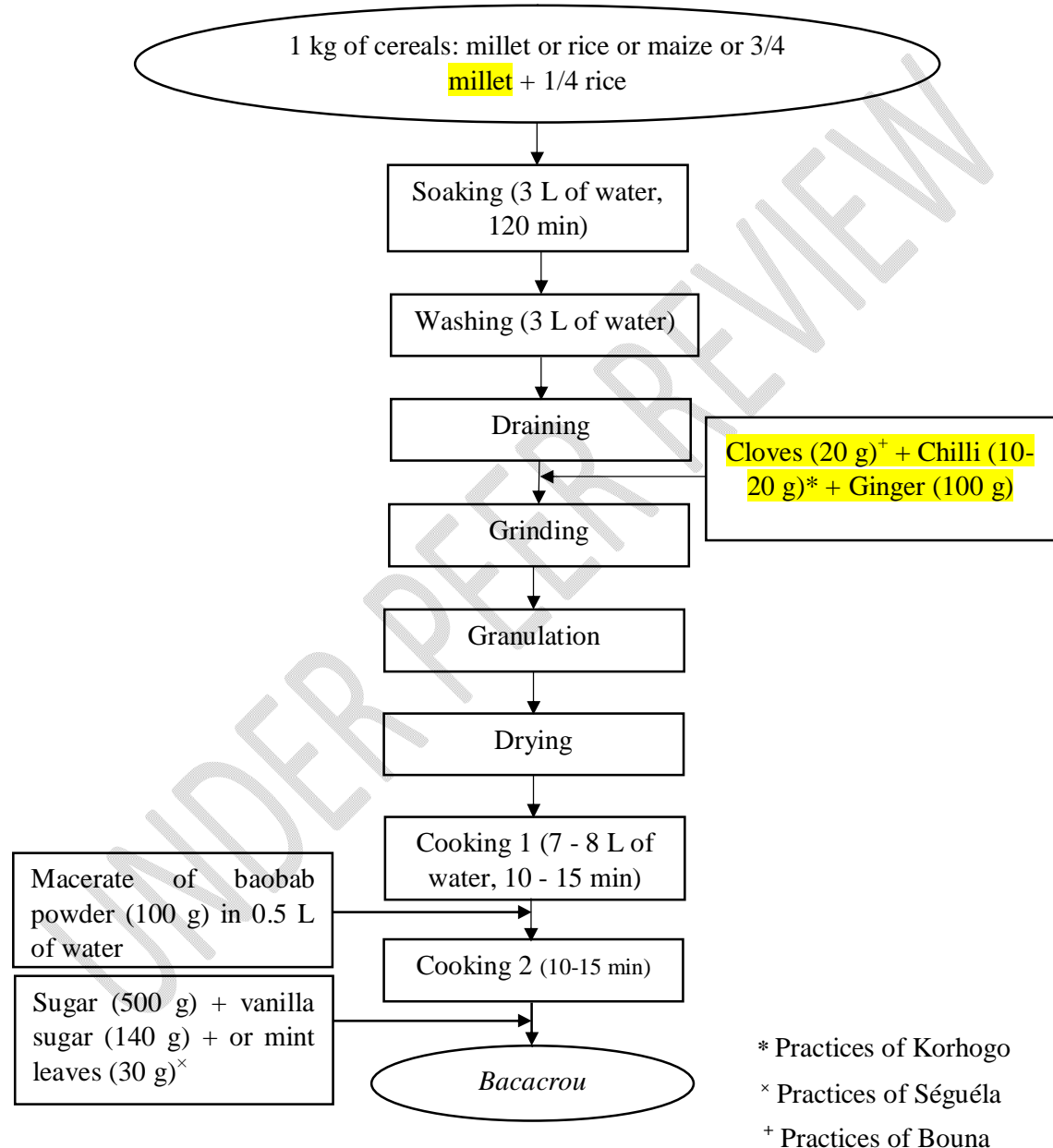


Figure 5. Production diagram of *Bacacrou*

3.3.2 Production of Kagbèlè

In 3 L of water, 1 kg of corn kernels are soaked for 120 min, then washed and removed (Figure 6). The grains obtained are drained and ground into flour with 100 g of chili pepper. An amount of 500 g of

baobab pulp powder macerated in 1.5 L of water and 30 g of salt are added in flour and the whole is kneaded for 10 to 15 min to obtain a consistent dough which is oil-fried into donuts as a cake (*Kagbèlè*).

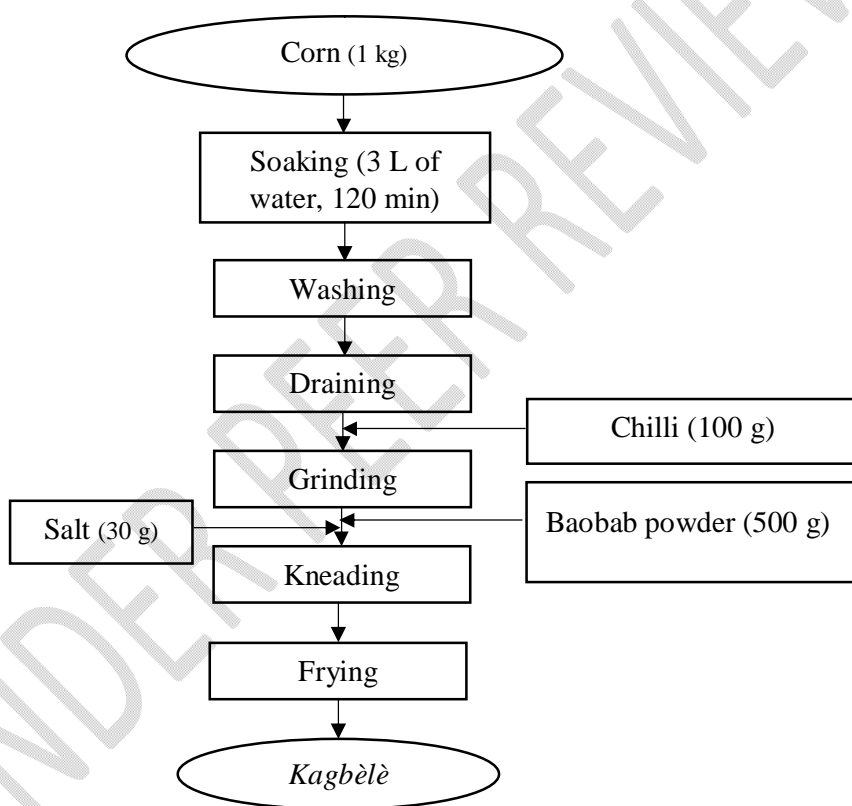


Figure 6. *Kagbèlè* production diagram

3.3.3 Production of Tchobal

Tchobal is a dish baked in an oven with baobab pulp powder and millet (Figure 7).

One (1) kg of millet flour is mixed with

500 g of baobab pulp powder and 0.5 g of baking powder to obtain homogeneous flour. Then, a volume of 0.5 L of water is

added and the whole is kneaded for 20 min until a baking dough is obtained. The dough is cut into slices of 25-30 g,

arranged for 10 to 15 min in bread molds before baking for 20 to 30 min.

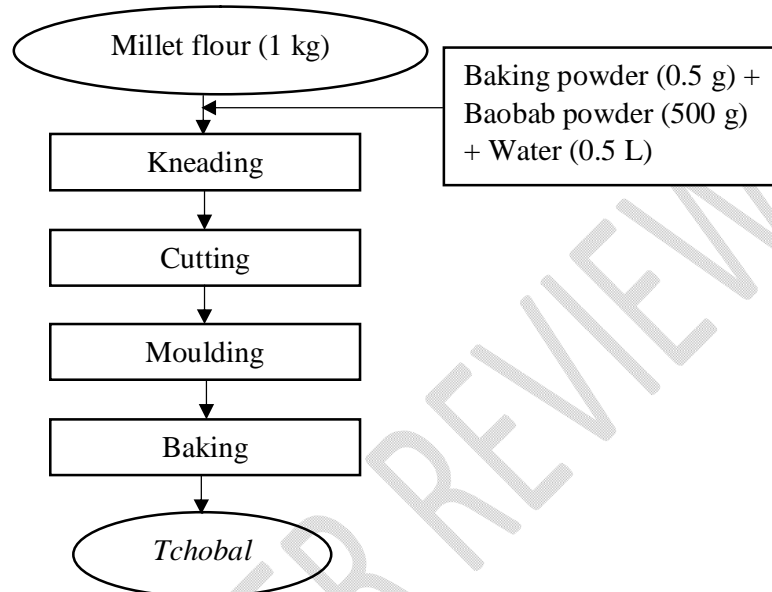


Figure 7. *Tchobal* production diagram

3.3.4 Production of Séla biscuit

To obtain *Séla biscuit* (Figure 8), a mass of 500 g of sucrose dissolved in 0.5 L of water is brought to heat. At boiling, an amount of 0.5 L of sterilized industrial liquid milk is gradually added and the

mixture is constantly stirred for 5 min.

Then, two (2) kg of baobab pulp powder are added and the mixture is homogenized for 5 min by rotational movements. The resulting dough is removed from heat to coolness and cut with a knife into shapes.

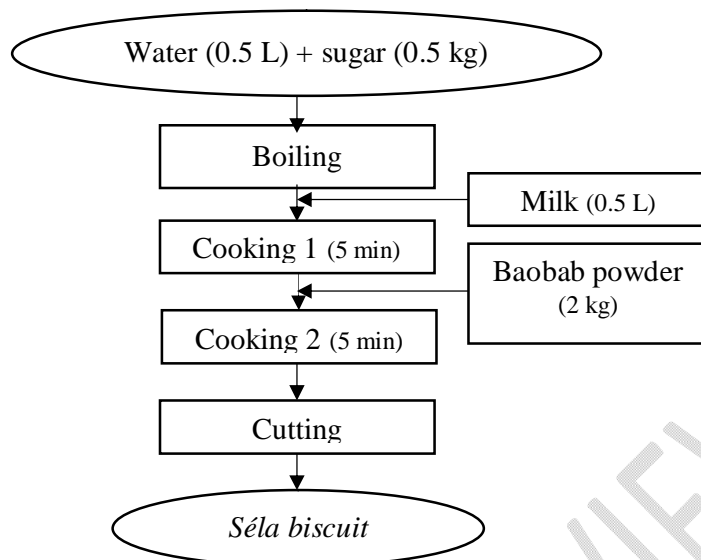


Figure 8. Production diagram of *Séla biscuit*

3.3.5 Production of Bafouratou

A mass of one (1) kg of *néré* (*Parkia biglobosa* L.) pulp powder is mixed with 1 kg of baobab pulp powder and 1 kg of millet flour to obtain a homogeneous flour.

A volume of 1.5 L of water is added to the resulting flour and the whole is kneaded by hands for 10 to 15 min to have dough which is oil-fried to obtain donuts as cakes (Figure 9).

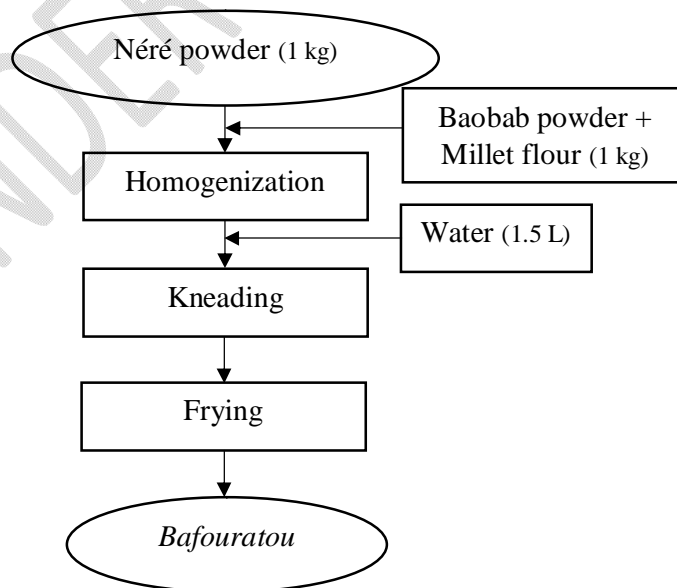


Figure 9. *Bafouratou* production diagram

3.3.6 Production of Séladji

A mass of 1 kg of baobab pulp powder is relayed in 7 L of water. The obtained

solution is filtered, and 1 kg of sucrose and 140 g of vanilla sugar are added for another filtration (Figure 10).

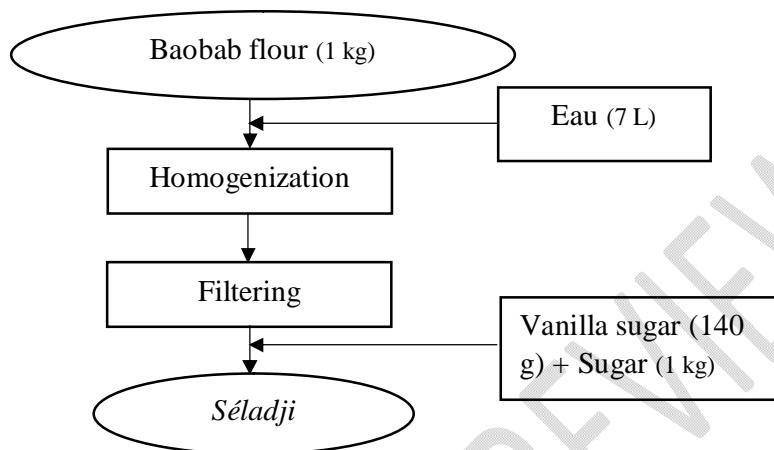


Figure 10. *Séladji* production diagram

3.3.7 Production of Zoom-koom

Zoom-koom is produced from millet flour powder or rice to which baobab pulp is added (Figure 11). One (1) kg of cereal (millet or rice) is soaked in 3 L of water for 120 min before removing and washing in 3 L of water. After draining, the cereals are ground into flour with 200 g of ginger and

50 g of cloves. The flour obtained is sifted and relayed in 10 to 15 L of water for 1 h. Then 100 g of baobab pulp powder are added in 500 of water and the floury solution is homogenized, filtered before adding 2 kg of sucrose and 280 g of vanilla sugar.

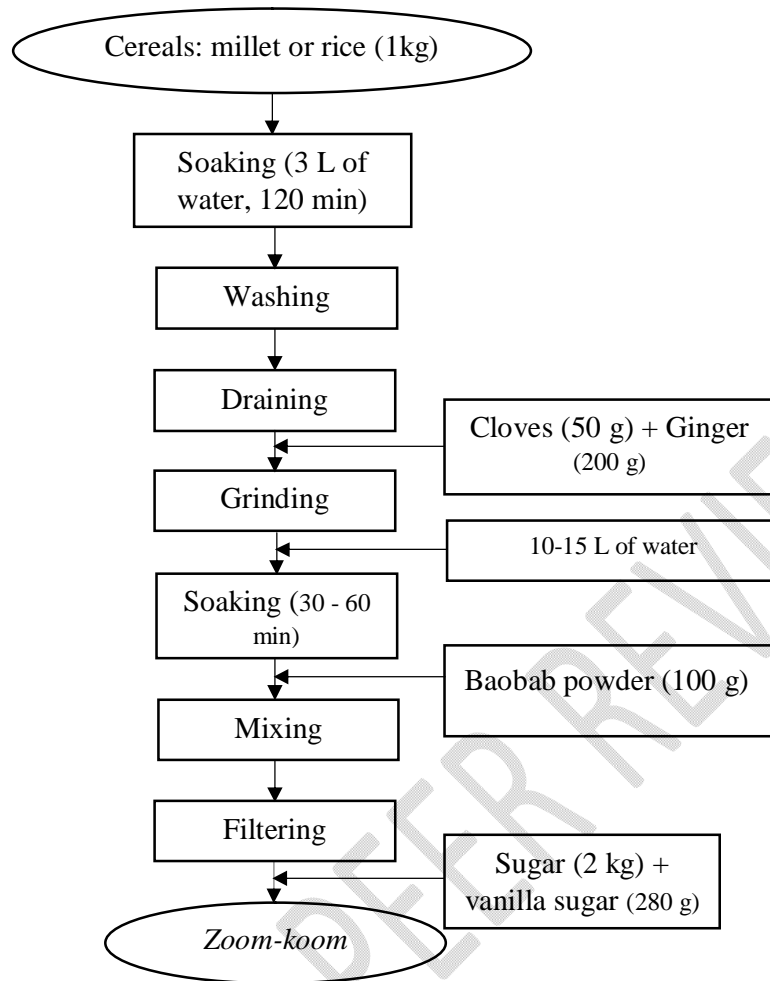


Figure 11. *Zoom-koom* production diagram

4. DISCUSSION

The present study focused on foods made from the pulp of the fruit of the African baobab (*Adansonia digitata* L) consumed in the savannah areas of northern Côte d'Ivoire. Data showed that consumers were mainly women (95%). The high proportion of women could be justified by the rural

character of the survey and by the culture of women to cook. Monyn et al. [18] and Kouakou et al. [19] confirm this hypothesis by reporting that in Côte d'Ivoire, as in all African societies, women perform household tasks and spend more time. Beagan et al. [20] have shown that women's involvement in food tasks is due

to the fact that women themselves have chosen food work because it is easier or prefer to cook for reasons of quality, cleanliness and family health.

Ten (10) dishes based on baobab pulp (*Adansonia digitata* L) were identified in the departments of Korhogo, Séguéla and Bouna. This diversity of foods justifies the importance of wild fruit such as baobab in food security of rural populations. Thus, the popularization of these foods could contribute to the reduction of food insecurity in developing countries, particularly in the rural and urban populations of Côte d'Ivoire. According to Sackou et al. [21], 3.8% of households were food insecure in Abidjan. Several authors have shown the importance of wild fruits in the human diet. Indeed, Douma et al. [22] identified 37 woody species providing food during the lean season to local populations with a rate of fruit use varying from 25.5% to 28.8% depending on the locality. Okori et al. [23] confirm

the use of wild edible fruits as coping strategies to deal with food insecurity.

The processing of baobab pulp provides 8 meals and 2 drinks. Kouyaté et al. [24], Krishnamurthy and Sarala [25] confirm these results, stating that wild fruits are generally used as a complement to cereal and starch-based diets, due to their richness in minerals and vitamins. These different forms of food (beverages or meals) are consistent with those described by many researchers. Andon et al. [26], Amani and Kieba [27] reported that the floury pulp of the baobab fruit can be diluted with liquid to make a sweet and refreshing drink. In addition, the floury pulp can be consumed as porridge [28].

Three (3) dishes (*Sougé-baca*, *Badégé-baca* and *Séladji*) are consumed in all the departments surveyed with some differences related to the production process. The consumption of the same dishes could be due to the interaction between the peoples. Atakpama et al. [29] corroborate this hypothesis by linking the

similarity of knowledge and eating habits between neighbouring ethnic groups to interethnic exchanges through marriages and interethnic friendships. However, some specificities in food consumption exist depending on the locality. These practices could be related to culture and food habits. According to Al-Fatimi et al. [30] there is a strong relationship between local people and their environment, so traditional knowledge is passed on from generation to generation.

The study showed that baobab pulp is used to cook many foods that are better known and consumed in Korhogo than the others localities. This observation could be due to baobab availability and the reasons of its use in human diet. In our study, health benefits appears the most important reason in baobab pulp consumption. Our findings corroborate those of Ouattara et al. [31] in which the habits, knowledge and uses of plants that differ from one region to another and from one people to another are linked to the ethno-floristic space. For

Soma-massieke et al. [32], the lack of knowledge on the benefits of fruits can influence their dietary uses.

Among dishes, *Bacacrou* notably *Sougé-baca* is the most consumed at breakfast and during Muslim jêun break. These results confirm those of N'Guessan et al. [33] who showed that porridges are consumed at breakfast, as a snack and are highly appreciated during Ramadan. This preference for millet porridge (*Sougé-baca*) could be explained by the good acceptability and availability of millet in northern Côte d'Ivoire. This hypothesis is supported by Koffi et al. [34] who reported that millet and sorghum are traditionally grown in the northern region of Côte d'Ivoire. For Tou et al. [35] millet porridges have a good organoleptic quality compared to maize porridges.

5. CONCLUSION

At the end of this study, ten (10) dishes based on baobab were identified. There are important in the reduction of food insecurity. The taste and health benefit of

baobab justify its use in numerous traditional foods processes. The production processes and consumption patterns of dishes are largely cultural, with a strong preference (68.39 %) for millet porridge (*Sougé-baca*). However, the contribution of baobab pulp based-foods in food security requires the perception of consumers through scientific knowledge on their nutritional and functional properties.

CONFLICT OF INTEREST

The authors declare no conflicts of interest. Potential funders had no role in the design of the study, in the collection, analysis, or interpretation of the data, in the writing of the manuscript, or in the decision to publish the results.

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