Identification of the main dishes made from the pulp of Tomi (*Tamarindusindica* L) consumed in the savannah region of Côte d'Ivoire.

ABSTRACT

Tamarind (*Tamarindusindica* L) is a plant belonging to the Fabaceae family and the subfamily Caesalpinioidae that is often found in arid regions. The various parts of this tree are of great interest to rural African populations. The pulp of its fruit is used for the preparation of cold drinks or in the composition of several other foods. However, no study in Côte d'Ivoire has yet focused on these foods, only the juices or nectars of this wild fruit tree have been studied. Thus, a 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 of obtaining. The survey revealed that most of consumers are without level of education (78.51%), Ivorian (84.94%) and married (80.99%). The places of supply of tomi are often the field (65.18%-71.64%) than the market (32.84-41.67%) and in its pod form (65.93-73.13%). People use pods and pulp to make10 tomi-based foods with a meal/drink ratio of 7:3. This fruit is consumed by rural populations for health needs, for its taste and for the color it gives to dishes. The frequency of consumption varies from 0 to 3 and the Sougé-baca appears as the most known and consumed food with a percentage of knowledge of 74.07 and a frequency of consumption of 3 times per month.Sougé-bacais a meal more consumed at breakfast and at the Muslim jêun break. The production diagram of *Bacacrou*(Sougé-baca, Badégé-baca, Manou-baca and *Sougénimanou-baca*) vary according the practices of the three localities.

Keywords: Tomi, Pulp, Foods, Consumption practices, Food security, Côte d'Ivoire

1. INTRODUCTION

The Tamarind tree (*Tamarindusindica*L) is a plant belonging to the Fabaceae family and the Caesalpinioidae subfamily, often found in arid regions [1, 2, 3]. This tree is proving to be of great interest in the process of monitoring rural African populations [4]. The pulp of this fruit is used for the preparation of fresh drinks [5, 6] or is used in the composition of several other foods[7].However, it is mainly in the form of fresh drinks called *Tomidji*that the fruits of this tree are widely encountered and consumed in Côte d'Ivoire.

From a nutritional point of view, tomi pulp is of great importance due to its energetic content and its richness in vitamins (B1, B2, B3 and C), minerals (P, K, Na, Mg and Ca) [3, 8] and phenolic compounds (catechins, tannins, polyphenols and flavonoids) [6,9]. However, more than 40% of the Ivorian population suffers from global acute malnutrition and more than 5% from severe acute malnutrition [10, 11, 12, 13, 14]. Given the nutritional richness of Tamarind pulp, the valorization of dishes incorporating this pulp in their production could have a beneficial effect on the health of consumers.

Unfortunately, most of the available data on this wild fruit tree in Côte d'Ivoire only concern the ethnobotanical [1, 4, 5] and nutritional aspect[15]. Only a few recent studies [6, 9] have

focused on juices or nectars derivedfrom this wild fruit. To date, no study in Côte d'Ivoire has yet looked at thesecereal dishes thatincorporatetomi pulp in their preparation. With regard to this situation, the optimization of the level of knowledge of these dishes derived from Tomi is necessary. The objective is therefore to identify all the dishes derived from the incroporation of Tomi and their levels of consumption for its valorization.

2. MATERIAL AND METHODS

2.1 Material

The biological material consists of tomi pulp (*Tamarindusindica* L) commonly consumed in the north of Côte d'Ivoire. Then a questionnaire containing information such as consumption practices (modes, forms and frequencies of consumption, supplemented by the production process) of tomi pulp-based dishes.

2.2 Methods

2.2.1 Selection of the departments and villages

According to Kouakou*and al*. [16] and Ambé[5], the wild fruit *Tamarindusindica* L. is highly disseminated 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 tomi 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 size (n) of the households surveyed was calculated according to formula described by Dagnelie[17] for an independent non-exhaustive sample based on Côte d'Ivoire Population and Housing Census [18].

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

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, 20 households were added in each department. Thus, 405 households were surveyed, i.e. 135 per department (Table 1).

Table 1. Number of households surveyed by zone and by village

Departments	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 tomi 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 to determine their modes, forms, frequency of consumption and their processes of obtaining. This questionnaire had three sections, including basic questions about the respondent (socio-demographic characteristics), questions about the consumption and questions about process.

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 the EXCEL 2016 spreadsheet. Descriptive statistics 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 AND DISCUSSION

3.1 Results

3.1.1 Socio-demographic characteristics of surveyed households

The socio-demographic characteristics of tomi 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 respondents

Features	Bouna	Korhogo	Séguéla	Total
Sex ratio (M/F)	4.65%	8%	1.50%	4.65%
Level of education (%)				
1er cycle	5.93	5.18	8.89	6.67
2nd cycle	2.96	3.70	2.22	2.96
Primary	14.07	6.67	5.93	8.89
Superior	1.48	5.18	0.74	2.47
Koranic	1.48	0	0	0.49
No	74.07	79.26	82.22	78.51
Origin (%)				
Ivorian	65.93	100	88.89	84.94
No Ivorian	34.07	0	11.11	15.06
Age group (Years) (%)				
[16-20[	8.15	8.15	8.89	8.39
[21-35[	40	18.52	34.81	31.11
[36-50]	31.11	37.04	28.89	32.34
>50 years old	20.74	36.30	27.41	28.15
Marital status				
Married	81.48	77.04	84.44	80.99
Widows	8.15	12.59	5.93	8.89
Singles	10.37	10.37	9.63	10.12

3.1.2 Consumption characteristics of Tomi

3.1.2.1 Places and forms of tomi supply

The locations where tomi is procured or collected in the different localities studied are recorded in Table 3. The data reveal that the places of supply of tomi in the three localities studied are the field and the market. However, tomi is more often collected in the field, with proportions of 65.18% in Bouna, 68.94% in Séguéla and 71.64% in Korhogo, compared to 32.84% in Korhogo, 37.78% in Bouna and 41.67% in Séguéla. Consumers in Korhogo, Séguéla and Bouna obtain tomi only in the form of pods and pulp (Table 4). The collection of tomi in its pod form (65.93-73.13%) is about twice as important as in its pulp form (32.09-41.67%) in all localities.

Table 3.Tomi collection locations

	Bouna	Séguéla	Korhogo
Market (%)	37.78	41.67	32.84
Field (%)	65.18	68.94	71.64
z	-4.558	-4.505	-6.3592
p	< 0.001	< 0.001	< 0.001

In the same column, data with the same alphabetical letters are not significantly different at the 5% threshold according to the z-test.

Table 4: Forms of Tomi collection

	Bouna	Séguéla	Korhogo
Pod (%)	65.93	68.18	73.13
Pulp (%)	37.78	41.67	32.09
z	4.697	4.363	7.247
p	< 0.0001	< 0.001	< 0.001

In the same column, data with the same alphabetical letters are not significantly different at the 5% threshold according to the z-test.

3.1.2.2 Reasons for tomi consumption

The reasons for tomi consumption are presented in Fig. 1. Discriminant factor analysis shows that tomi is consumed more in the three departments for its taste. In addition to taste, tomi is consumed in Bouna for health reasons, while in Séguéla it is consumed not only for health reasons but also for its color.

Fig. 1. Reasons for tomi consumption by place of residence

3.1.2.3 Identification and Classification of tomi-based dishes

The ten (10) tomi-based dishes identified in Korhogo, Séguéla and Bouna are recorded in Table 5. Factor analysis of these tomi-based foods made it possible to group the foods consumed by locality (Fig. 2). Some foods are common to all three zones, while others are specific to them. For example, Sougé-baca, Badégé-baca, and Tomidji are consumed in Korhogo, Séguéla, and Bouna, while Sougénimanou-baca and Zagamin au tomi are consumed only in Séguéla and Korhogo. Manou-baca, Kagbèlè and Kachiansim are specialties of Korhogo. Tôh and Zoom-koom are consumed only in Bouna.

147 **Table 5. Description and vernacular names of tomi-based dishes**

Foods	Localities	Consumers	vernacular names
Millet porridge	Bouna Korhogo Séguéla	Koulango Sénoufo Kôyaka	*Gôdi-baca* *Sougé-baca* *Gnon-monnie*
Corn porridge	Bouna Korhogo Séguéla	Koulango Sénoufo Kôyaka	*Brozougô-baca* *Badégé-baca* *Caba-monnie*
Rice porridge	Korhogo Séguéla	Sénoufo Kôyaka	*Manou-baca* *Malo-séri*
Millet porridge and rice	Korhogo Séguéla	Sénoufo Kôyaka	*Sougénimanou-baca* *Gnonmalo-monnie*
Corn cake	Korhogo	Sénoufo	*Kagbèlè*
Millet or rice drink	Bouna	Burkinabé	*Zoom-koom*
Tomi'sfermenteddrink	Korhogo	Sénoufo	*Kachiansim*
Tomi juice	Bouna Korhogo Séguéla	Koulango Sénoufo Kôyaka	*Illanoun-* *Kachian* *Tomidji*
Cabato of millet with tomi	Bouna	Lobi	*Djor*
Rice with tomi	Korhogo Séguéla	Sénoufo Kôyaka	*Manoukalo* *Zagamin*

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150 *sougé-baca*= millet granule porridge*; Badégé-baca* = maize granule porridge*; Manou-baca* = rice
151 granule porridge*; Sougénimanou-baca* = ¾ millet and ¼ rice granule porridge*; Tomidji* = tomi juice*;*
152 *Zoom-koom* = cereal juice*; Tôh*= cabato*; Kagbèlè* = fritter*; Zahamin* = fat rice*.*

153 **Fig. 2. Factor analysis of tomi-based dishes**

3.1.2.4 Frequency of consumption of tomi-based dishes

The frequencies of consumption of tomi dishes are presented in Fig. 3. Analysis of this figure shows that Tomidji and Sougé-baca are the most consumed foods, with average consumption frequencies of 3 times per month. Badege-baca comes in third place with an average consumption frequency of 2 times per month. Zagamin and Kagbèlè are the least consumed.

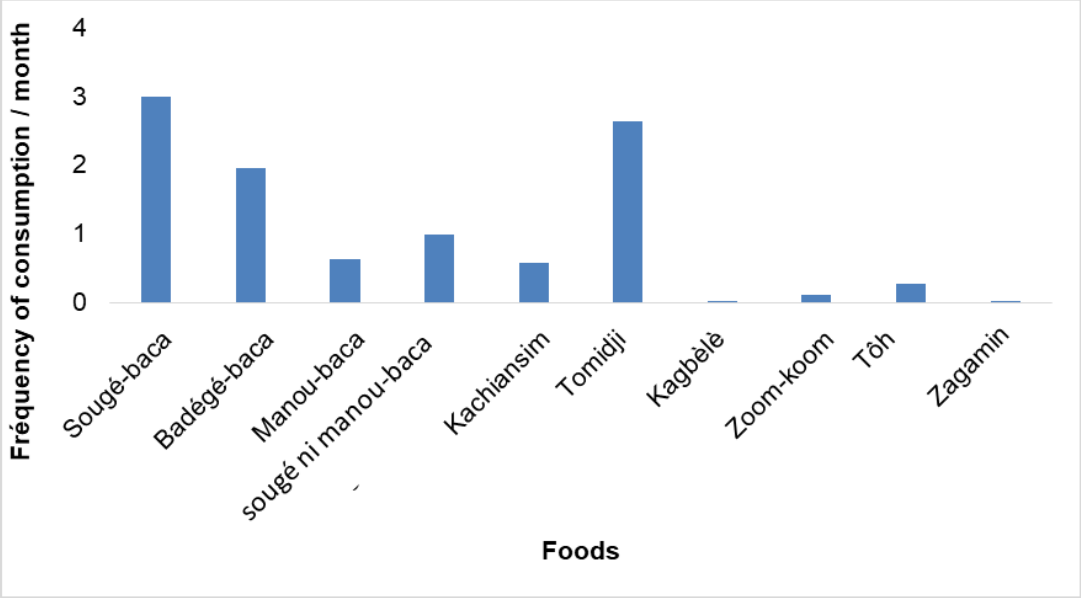


Fig. 3. Consumption frequencies of Tomi-based dishes

3.1.2.5 Consumption periods for tomi-based dishes

Fig. 4 illustrates the consumption periods of tomi-based dishes. It shows that with the exception of Zagamin, which is only eaten at noon, and Tôh, which is eaten at lunch and dinner, all other tomi-based foods are eaten at breakfast and during the Muslim jêun break. However, Sougé-baca and Badégé-baca, Manou-baca and Kachiansim are eaten more at breakfast, while Tomidji is eaten more at the Muslim jêun break.

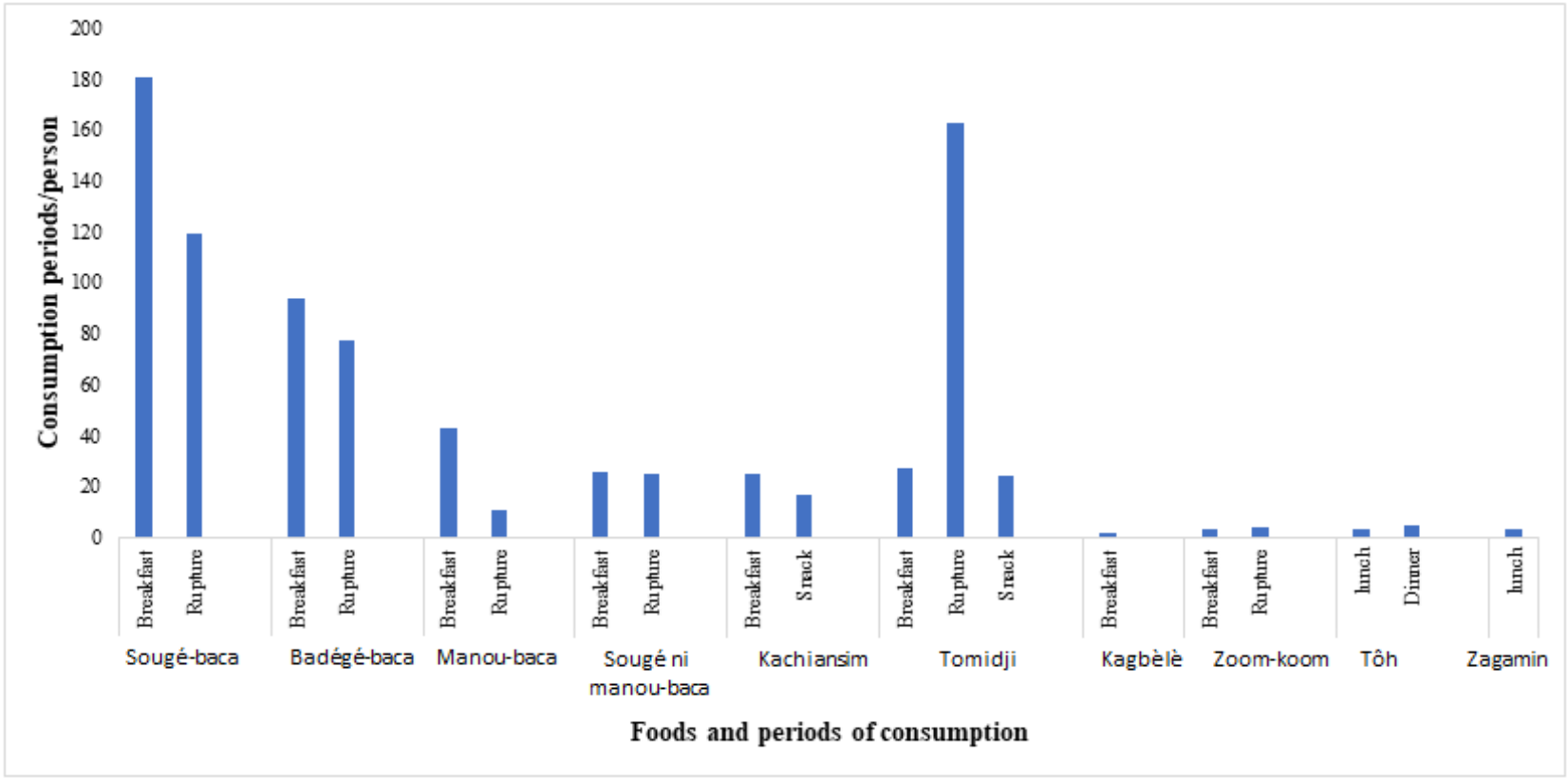


Fig. 4 Consumption periods of Tomi-based dishes

3.1.3 Production process of tomi-based dishes

3.1.3.1 Production of cereal porridges

The production scheme for cereal porridges is shown in Fig. 5. For the production of Bacacrou, one (1) kg of cereal millet (*Sougé-baca*) or rice (*Manou-baca*) or maize (*Badégé-baca*) or ¾ of millet + ¼ of rice (*Sougénimanou-baca*) is soaked in 3 L of water for 120 min. The soaking water is then removed and the cereal is washed again in 3 L of water. After draining, the cereal is ground with 100 g of ginger and/or 20 g of cloves (Bouna) or 10 to 20 g of chili pepper (Korhogo) to obtain a flour. The flour obtained is sifted and progressively sprinkled with 100 to 200 mL of water for the formulation of granules. The granules thus obtained are dried in the sun or at room temperature for 4 to 5 hours. For cooking, 7 to 8 L of water is put in a pot and brought to boil. The granules are added to the pot and mixed as they come out to avoid their agglomeration. A macerate obtained from 250 g of tomi pulp in 0.5 L of water is added gently after 10 to 15 min of cooking. The mixture obtained is left to cook for 10 to 15 minutes and then 500 g of sugar and/or 140 g of vanilla sugar (Bouna) or the juice of 30 g of mint leaves (Séguéla) is added directly.

3.1.3.2 Kagbèlè production

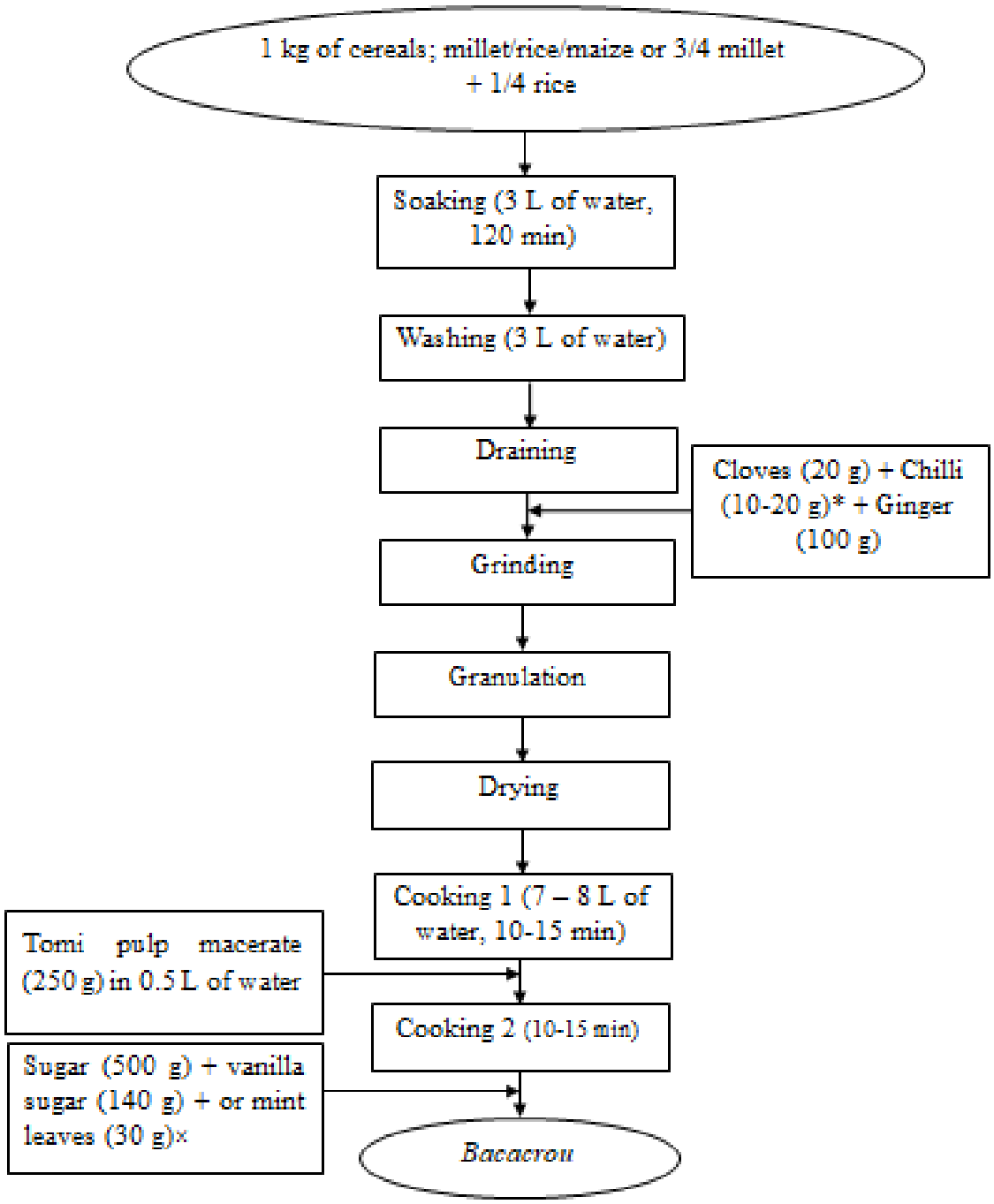
The Kagbèlè production process is shown in Fig. 6. In 3 L of water, 1 kg of maize kernels are soaked for 120 minutes, then removed and washed in 3 L of water. The grains obtained are drained and ground with 100 g of chili pepper to obtain a flour. To this flour, we add a macerate obtained with 500 g of tomi pulp in 1.5 L of water and 30 g of salt. The whole is kneaded by hand during 10 to 15 min and the consistent paste obtained is passed to the frying to obtain fritters in the shape of pancake (Kagbèlè).

3.1.3.3 Production of Toh

The production scheme for Toh is shown in Fig. 7. The macerate of 250 g of tomi pulp in 2 L of water is filtered and heated. After boiling, 0.5 kg of millet flour is gradually added and the mixture is homogenized by swirling until it becomes a slurry. After 5 to 10 minutes of cooking the slurry, 1 kg of millet flour is gradually added. The mixture is regularly kneaded for 10 to 15 minutes before being served.

3.1.3.4 Production of Zoom-koom

The description of the production of Zoom-koom is shown in Fig. 8. One (1) kg of grain (millet or rice) is soaked in 3 L of water for 120 min before being removed and washed in 3 L of water. After draining, the cereals are ground 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 30 to 60 min. A macerate of 250 g tomi pulp in 250 mL water is added to the flour solution and the whole is homogenized, filtered before adding 2 kg sugar and 280 g vanilla sugar.



* Practices of Korhogo

˙ Practices of Séguéla

˚ Practices of Bouna

Fig. 5. Production diagram of *Bacacrou*

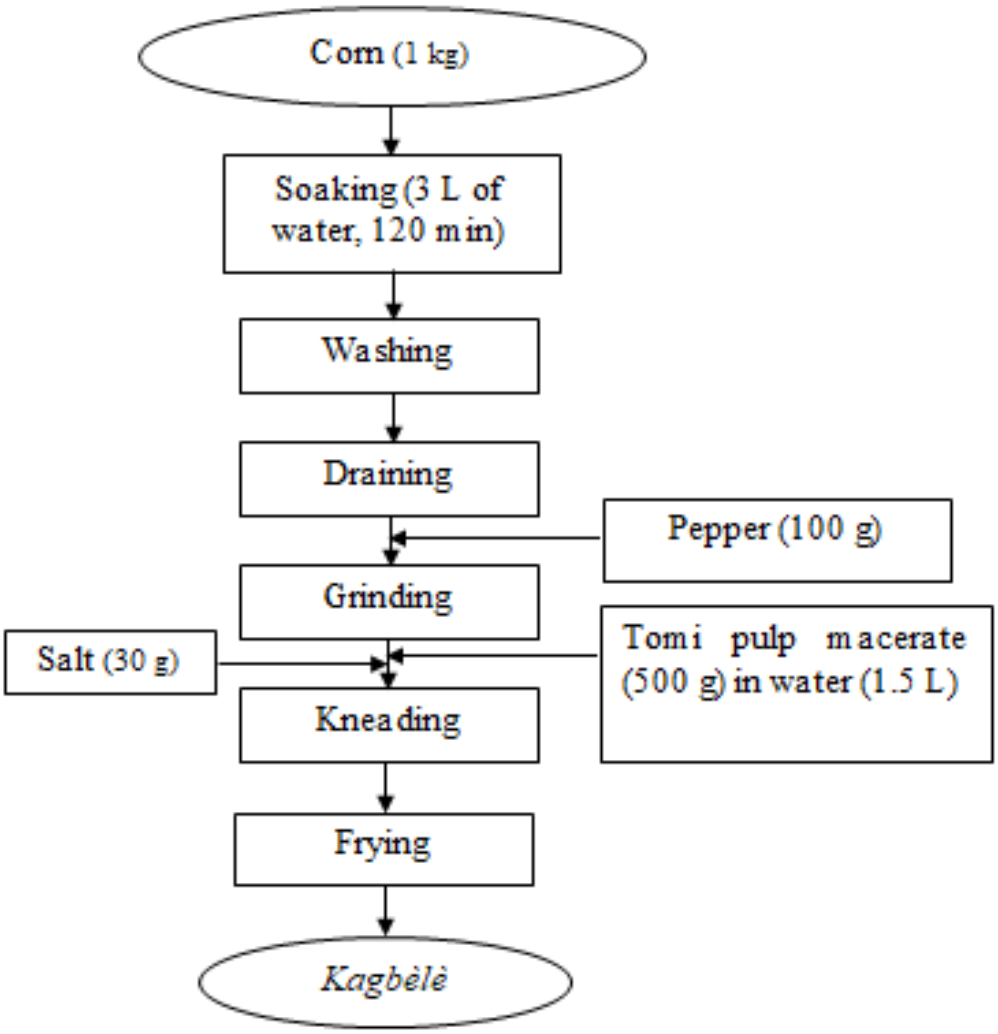


Fig. 6.*Kagbèlè* production diagram

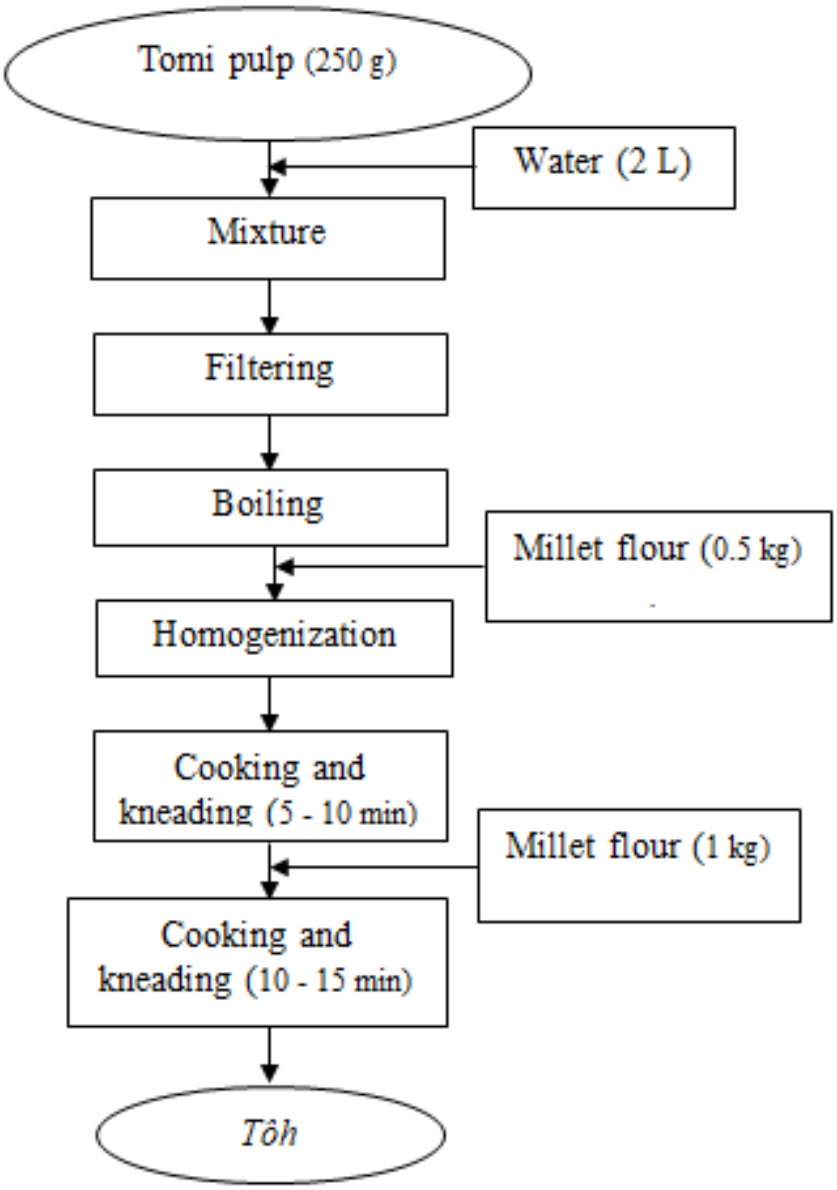


Fig. 7. *Tôh*production diagram

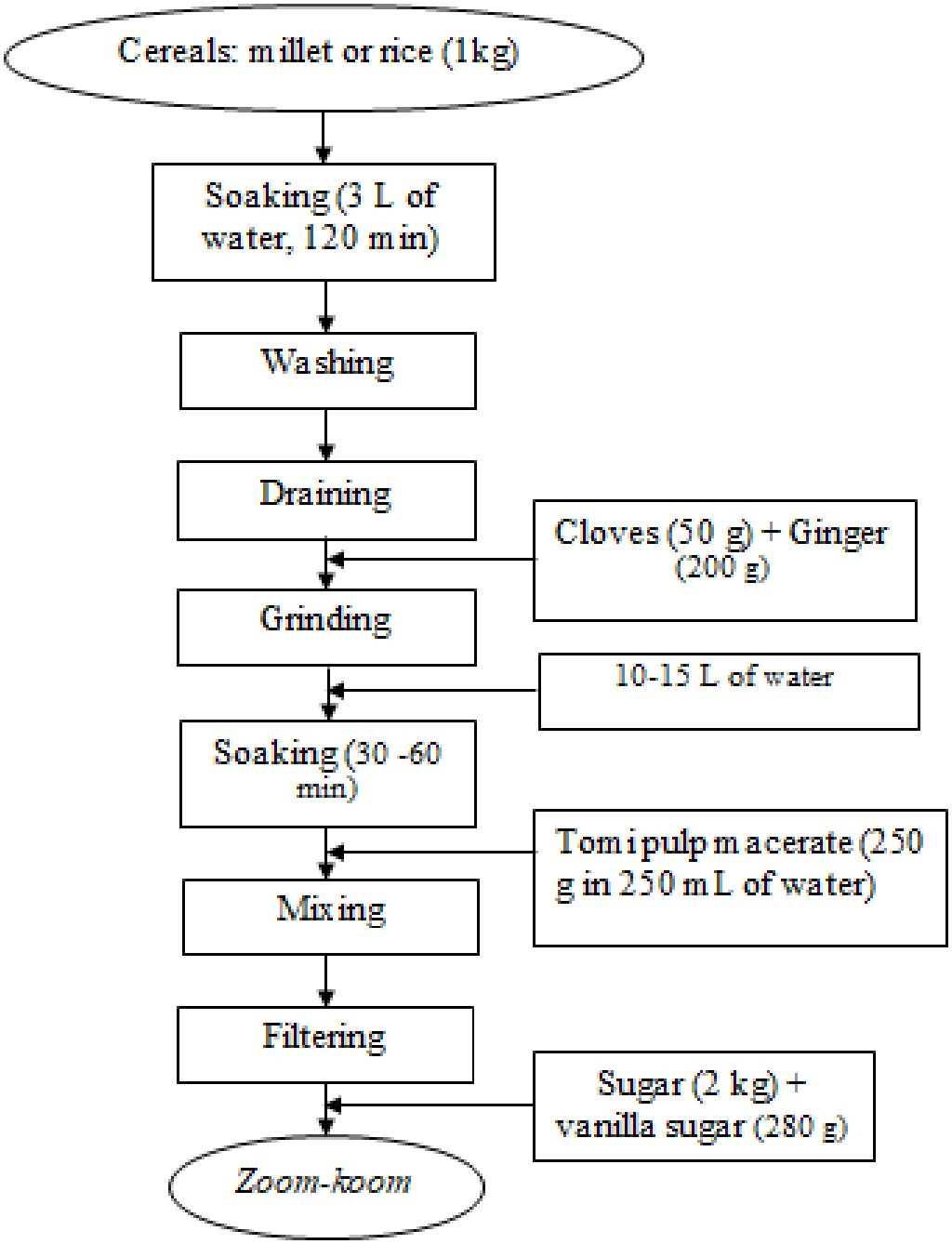


Fig. 8. *Zoom-koom* production diagram

3.1.3.5 Production of Kackiansim and Tomidji

The description of the production process of Kackiansim and Tomidji is detailed in Fig. 9. A 500 g portion of tomi pulp is boiled in 3 L of water for 2 to 3 minutes. The resulting solution is allowed to stand for 15-30 minutes to cool, then mixed and the juice is collected after filtering. A mass of 500 g of table sugar is directly added to the filtrate to obtain Tomidji. To obtain Kackiansim, the filtrate is left to ferment for 24 hours, then 500 g of table sugar and 200 g of chilli powder are added.

3.1.3.6 Production of Zagamin

The description of zagamin production is shown in Fig. 10. A 1-2 kg mass of meat or fish is fried in 0.25 L of vegetable oil for 5-10 minutes. To this mass 100 g of onion, 50 g of carrot, 100 g of cabbage and 40 g of salt are added before simmering for 5 minutes. Add 30 g of pepper and macerate of 250 g of tomi pulp in 1.5 L of water and leave the mixture on the fire until it boils. When it boils, one (1) kg portion of rice is put in the sauce solution for 15 to 20 minutes of cooking on low heat.

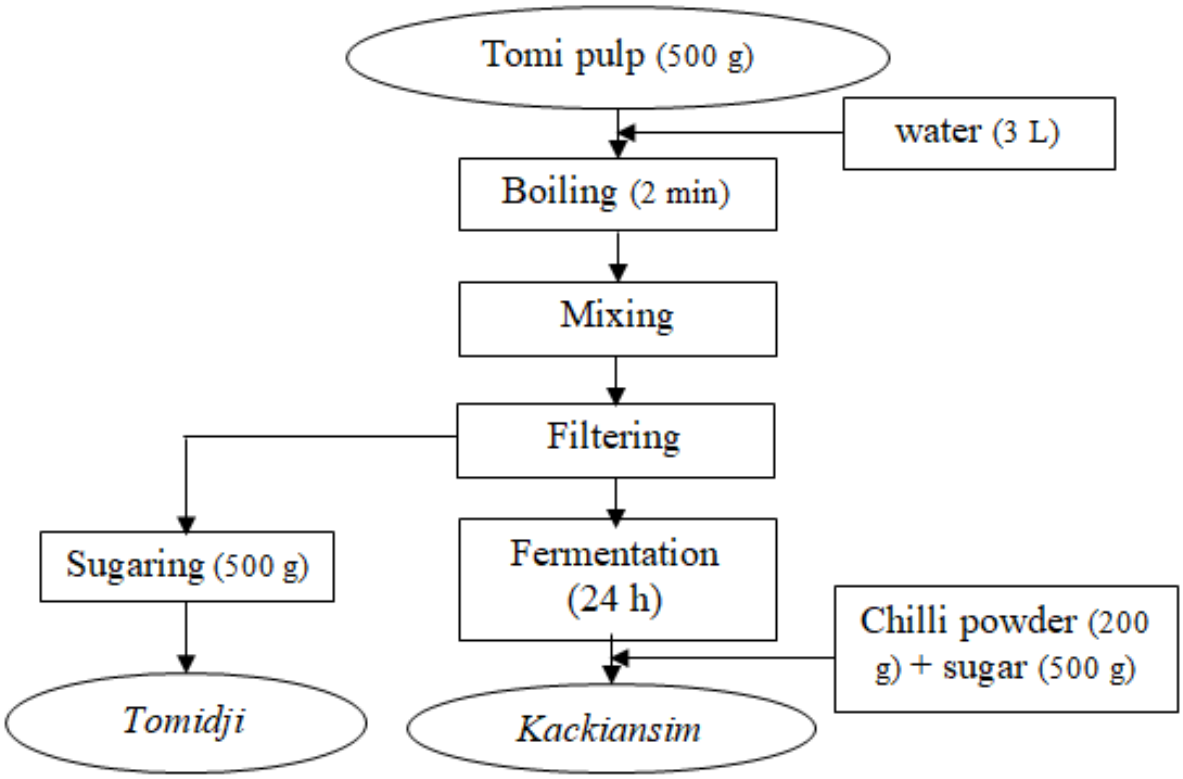


Fig. 9. *Kackiansim*and*Tomidji* production Diagram

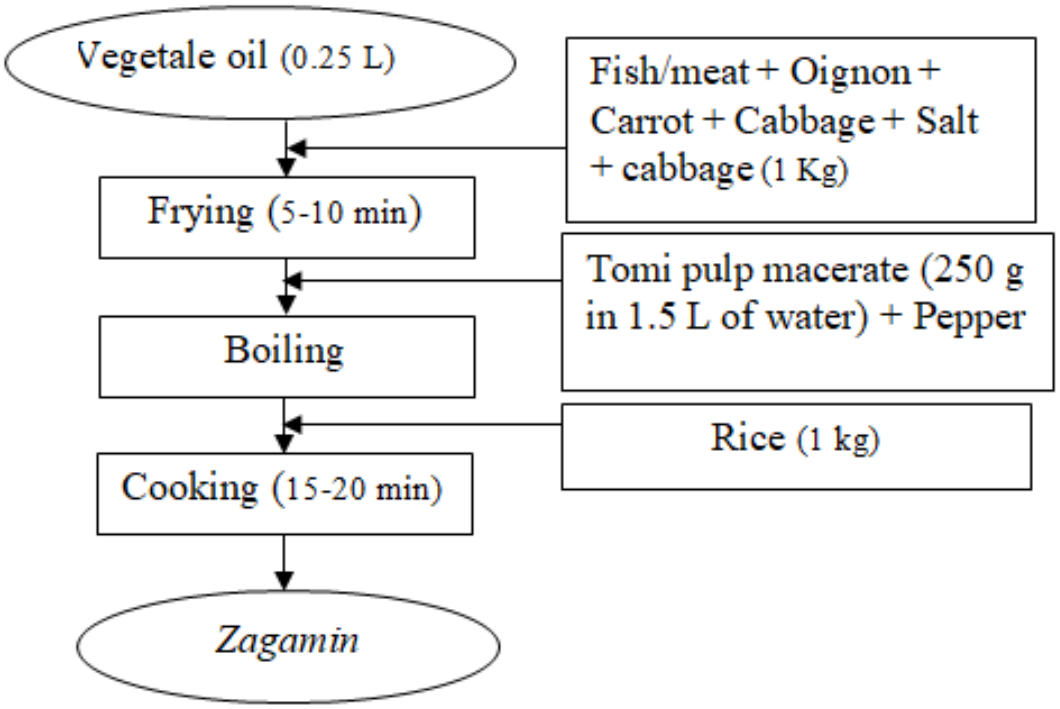


Fig. 10. *Zagamin* production diagram

3.2 Discussion

This study consisted in identifying and collecting information on thedishes integrating the pulp of Tomi (*Tamarindusindica* L.) in their formulations in Côte d'Ivoire. The results obtained show the importance of the valorization of local dishes for food security.

From a sociodemographic point of view, the sex ratio of respondents is in favor of women, with a proportion of 95.95%. This high proportion of women could be justified by the fact that they are the ones who generally do the cooking in rural households and are therefore more skilled in the preparation and knowledge of the dishes consumed. This result is in agreement withAdepoju*and al*. [19]who identify women as the main pillars of food security in rural households.

The identification of tomi-based foods in the departments of Korhogo, Séguéla, and Bouna revealed 10 tomi-based foods. This diversity of foods produced from this wild fruit could contribute moreto the food security of rural and urban populations. This thought is corroboratedby the studies of Lockett and Grivetti [20], according to which they stipulate that wild edible plants are incorporated into foods to improve or diversify them. These authors also arguethat the wild edible plant foods have been a mainstay and supplement to the Fulani diet since ancient times. Therefore, the popularization of these foods could help reduce thefood insecurity that affects developing countries, particularly in Côte d'Ivoire. According to studies by Sackou*and al*. [21] on food insecurity in the city of Abidjan, only 3.8% of households were food secure.

From a culinary point of view, this wild fruittree can be transformed into several food forms. Thus, foods made from tomi pulp are generally consumed in the form of meals and drinks with a meal/drink ratio of 7:3. The high use of these wild fruits in the diet as meals would reflect their importance in the dietary habits of local populations. These different forms of fooduse asdrinks or meals are consistent with those described by several authors [22, 23]. Indeed, these authors indicate that tamarind pulp is consumed in non-alcoholic sweetened beverages or mixed with ginger, for the preparation of ice creams. It can also be used in weaning foods. Three (3) of the 10 prepared foods (Sougé-baca, Badégé-baca and Tomidji) are consumed in all localities with some small differences related to production process.

The similarity of the foods consumed in the different study areas could be explained by the interaction between the peoples. Van der stege*and al.*[4] corroborate this hypothesis, suggesting that the similarities and differences in tamarind food use are related to knowledge sharingand general interactions between ethnic groups living in close proximity to each other. Kruger and Gericke[24] and Thurber *and al.*[25] continue this view by stating that it is evident that there is divergence in the foods consumed, as culture is one of the important factors that influence consumer attitudes toward a given food.

For the preparation of all these dishes, tomi is generally collected in the field to the extent of 65.18% to 71.64% depending on the locality. This result could be explained mainly by the fact that the surveys were conducted in rural areas and secondarily by its strong presence in these three different areas of northern Côte d'Ivoire. This is corroborated by the studies of Kouakou*and al.*[16] and Andon *and al*. [26] who reported the abundance of this wild fruit tree in these areas.

The results of the study show that the reasons for the uses of tomi in food making vary by locality ranging from health needs, taste and color of dishes. These reasons are confirmed by [22, 27, 28, 29] who argue that tomi is added to meals for digestion, to enhance taste or to protect food from bacteria. In fact, despite its acidic nature, tomi is described as the most acidic and sweetest fruitat the same time. It is one of the few fruits that retainits tartaric acid content estimated at98% of the organic acids contained in its pulp during ripening, while the amount of reducing sugars increases to give it a sweeter taste [8]. Tartaric acid is an antimicrobial agent that inhibits the growth of food spoilage microorganisms by lowering the pH of the cell[30, 31] and the production of malic acid, which is a key intermediate in the production of glucose in the process of gluconeogenesis, the main fuel of cells [30].

Study data reveal that all foods made by these populations are mostly consumed at breakfast and during the Muslim lent especially porridges and drinks. These results confirm those of Sadiq*and al.*[7] and N'Guessan*and al.*[32] who stipulates that porridges is consumed at breakfast, snack time and is highly valued during Ramadan. Indeed, the results show that Sougé-baca porridge is more known and consumed. This preference for millet porridge could be explained by its good acceptability but also by the availability of millet in the study areas. This hypothesis is confirmed by Tou*and al.*[33] who report the good organoleptic quality of millet porridge compared to maize porridge. This result could also be due to the fact that according to N'guessan*and al*. [32], millet porridge is the main form of millet processing. Regarding the availability of millet, Koffi*and al*. [34] reported that millet and sorghum are traditionally grown in the northern region of Côte d'Ivoire. Parry [35], confirms this report by adding that the northern area of Côte d'Ivoire is the most suitable for growing millet. However, the use of tomi in several foods by rural populations clearly indicates that beyond theignorance of the benefits of these fruits, they are all the same exploited by these populations. But the level of knowledge and information about these foods limits their use.

4. CONCLUSION

The objective of this study was to identify foods made from tomi fruits (*Tamarindusindica* L.) in Côte d'Ivoire. At the end of this study, ten (10) tomi-based foods were identified. The

production processes and consumption patterns of these foods vary according to the localities studied, with a meal/drink ratio of 7:3. This fruit is consumed by rural populations for health reasons, for its taste and for the color it gives to dishes. Millet porridge (Sougé-baca) is the most known and consumed food with a percentage of knowledge of 74.07 and a frequency of consumption of 3 per month. However, a better knowledge of the impact of these different foods on the well-being of these consumers is necessary given the nutritional importance of this fruit. It would be interesting to determine the biochemical composition of these foods for a better popularization.This was made in rural areas. So, we needs to extend the survey to urban areas for a broader mapping of tomi-based dishes consumed.

AUTHORS' CONTRIBUTIONS

KONAN Gbe Aya Jacqueline, KOUASSI Kouakou Nestor, N'DRI Yao Denis and AMANI N'Guessan Georges designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript.
KONAN Gbe Aya Jacqueline, KOUASSI Kouakou Nestor and NIMAGA Daoudamanaged the analyses of the study.
KONAN Gbe Aya Jacqueline and KOUASSI Kouakou Nestor managed the literature searches
All authors read and approved the final manuscript.

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