

1 **Identification of the main dishes made from the**
2 **pulp of Tomi (*Tamarindus indica* L) consumed**
3 **in the savannah region of Côte d'Ivoire.**

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ABSTRACT

Tamarind (*Tamarindus indica* L) is a plant belonging to the Fabaceae family and the subfamily Caesalpinioideae 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 10 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.

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

1. INTRODUCTION

Tamarind (*Tamarindus indica* L) is a plant belonging to the family Fabaceae and subfamily Caesalpinioideae that is 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 cold drinks [5, 6] or enters 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 energy 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]. While more than 40% of the Ivorian population suffers from global acute malnutrition and more than 5% from severe acute malnutrition [10, 11, 12,

36 13, 14]. Given the nutritional richness of Tamarind pulp, the valorization of dishes
 37 incorporating this pulp in their production could have a beneficial effect on the health of
 38 consumers. Unfortunately, most of the available data on this wild fruit tree in Côte d'Ivoire
 39 only concern its ethnobotanical knowledge [1, 4, 5] and its nutritional value [1, 5]. Only a few
 40 recent studies [6, 9] have focused on juices or nectars from this wild fruit tree. To date, no
 41 study in Côte d'Ivoire has focused on cereal dishes incorporating tomi pulp in their
 42 preparation. In view of this situation, it is necessary to optimize the level of knowledge of
 43 these dishes derived from tomi. The objective is: to carry out a survey on the consumption of
 44 tomi fruits by households and to identify the derived dishes and their levels of consumption
 45 with a view to their valorization.

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47 **2. MATERIAL AND METHODS**

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49 **2.1 Materiel**

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

54 **2.2 Methods**

55 **2.2.1 Selection of the departments and villages**

56 According to Kouakou *and al.* [16] and Ambé [5], the wild fruit tree *Tamarindus indica* L. is
 57 widely distributed and consumed in the departments of Korhogo, Séguéla and Bouna. Thus,
 58 the consumption survey was carried out in 3 villages of each different department after a
 59 pre-survey based on the consumption of tomi pulp and the easy access. So, the villages of
 60 Nahouokaha, Lataha and Kotchiéri (Korhogo), Sifié, Sélakoro and Bobi (Séguéla), and
 61 Niandégué, Bouko and Panzarani (Bouna) were surveyed.

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63 **2.2.2 Sampling**

64 The size (n) of the households surveyed was calculated according to formula described by
 65 Dagnelie [17] for an independent non-exhaustive sample based on Côte d'Ivoire Population
 66 and Housing Census ((18).

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

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68 n = minimum sample size sought;

69 t = 95% confidence level (standard value of 1.96);

70 P = proportion of consumers in the study area;

71 p estimated at 50 % given the lack of knowledge of the number of households consuming wild fruit
 72 trees;

73 m = margin of error at 5%.

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

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78 **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

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2.2.3 Data treatment

82 Survey data were analyzed using SPHINX Plus² (V5) software. Recoding was performed on
83 the SPSS 20.0 software to establish the database and then transferred to the EXCEL 2016
84 spreadsheet. The data were grouped in tabular form and the percentages of the different
85 parameters were calculated. Descriptive statistics and statistical analyses were performed
86 using the XLSTAT version 7.5 statistical software and the EXCEL 2016 spreadsheet.
87 Descriptive statistics made to translate data into graphs, averages and standard deviations.
88 Excel software was used to graph periods, consumption frequencies and the level of
89 knowledge of food. Comparisons between dependent variables were determined by the Khi-
90 2 test and the Z test at the 5% threshold. Factor component analyses (CFAs) were
91 performed for comparisons of variables with more than three modalities.

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3. RESULTS AND DISCUSSION

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3.1 Results

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3.1.1 Socio-demographic characteristics of surveyed households

98 The socio-demographic characteristics of tomi processing and consuming households in
99 Korhogo, Séguéla and Bouna are presented in Table 2. The female/male sex ratio of the 405
100 respondents is 0.05, with the vast majority (78.51%) not attending school. The age of the
101 users varied from 16 to more than 50 years, with 8.39% aged 16 to 20 years and 31.11%
102 aged 21 to 35 years. People aged 36 to 50 years old constitute 32.34% of these wild fruit
103 users and those over 50 years old represent 28.18% of this population. 84.94% of the
104 respondents were Ivorians and 15.06% were non-Ivorians. They were 88.99% married,
105 10.12% single and 8.89% widowed.

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107 **Table 2. Socio-demographic characteristics of respondents**

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Features	Bouna	Korhogo	Séguéla	Total
Sex ratio (M/F)	4.65%	8%	1.50%	4.65%
Level of education (%)				
1 ^{er} cycle	5.93	5.18	8.89	6.67
2 nd 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

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110 **3.1.2 Consumption characteristics of Tomi**

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112 *3.1.2.1 Places and forms of tomi supply*

113 The locations where tomi is procured or collected in the different localities studied are
114 recorded in Table 3. The data reveal that the places of supply of tomi in the three localities
115 studied are the field and the market. However, tomi is more often collected in the field, with
116 proportions of 65.18% in Bouna, 68.94% in Séguéla and 71.64% in Korhogo, compared to
117 32.84% in Korhogo, 37.78% in Bouna and 41.67% in Séguéla. Consumers in Korhogo,
118 Séguéla and Bouna obtain tomi only in the form of pods and pulp (Table 4). The collection of
119 tomi in its pod form (65.93-73.13%) is about twice as important as in its pulp form (32.09-
120 41.67%) in all localities.

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122 **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

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

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127 **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

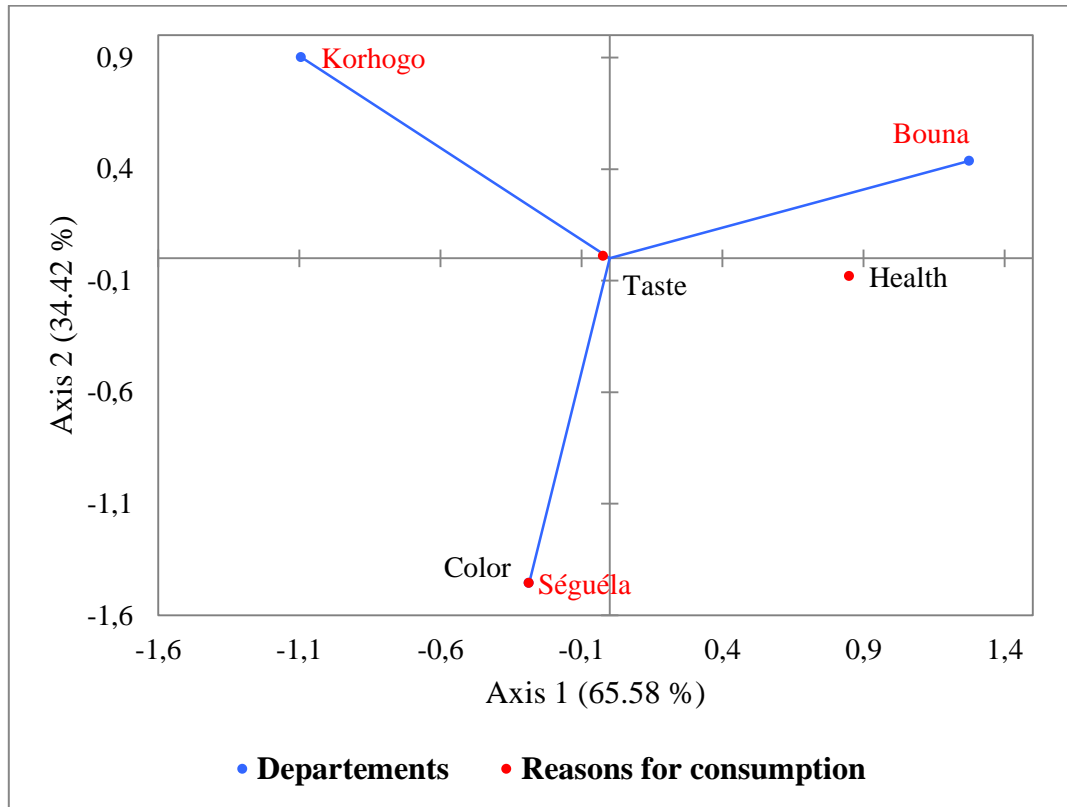
128 In the same column, data with the same alphabetical letters are not significantly different at the 5%
 129 threshold according to the z-test.

130 3.1.2.2 Reasons for tomi consumption

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

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

3.1.2.3 Identification and Classification of tomi-based dishes

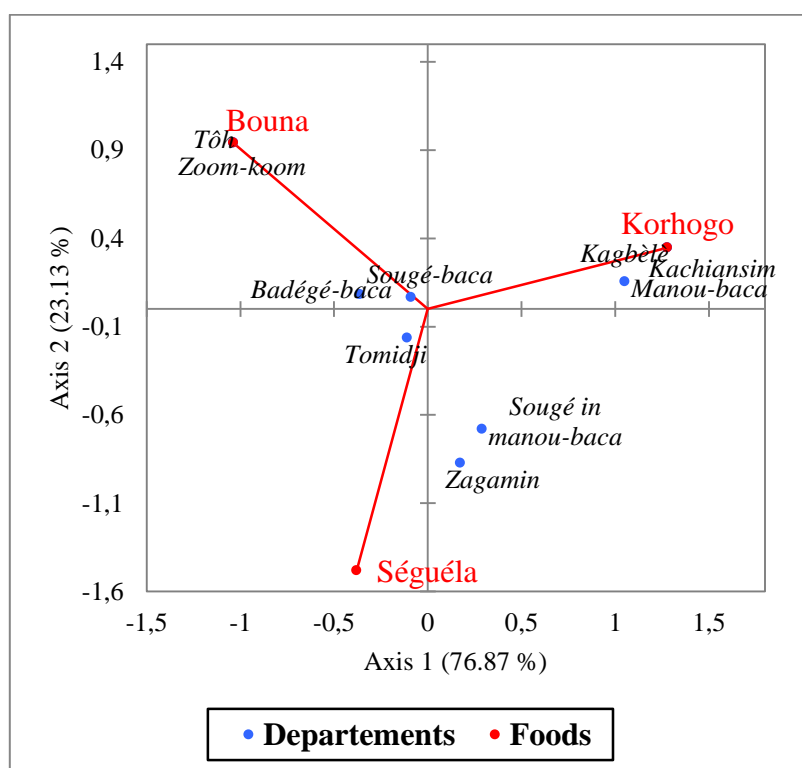
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The ten (10) tomi-based dishes identified in Korhogo, Séguéla and Bouna are recorded in Table 5. Factor analysis of these tomi-based foods made it possible to group the foods consumed by locality (Figure 2). Some foods are common to all three zones, while others are specific to them. For example, Sougé-baca, Badégé-baca, and Tomidji are consumed in Korhogo, Séguéla, and Bouna, while Sougé in manou-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.

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

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

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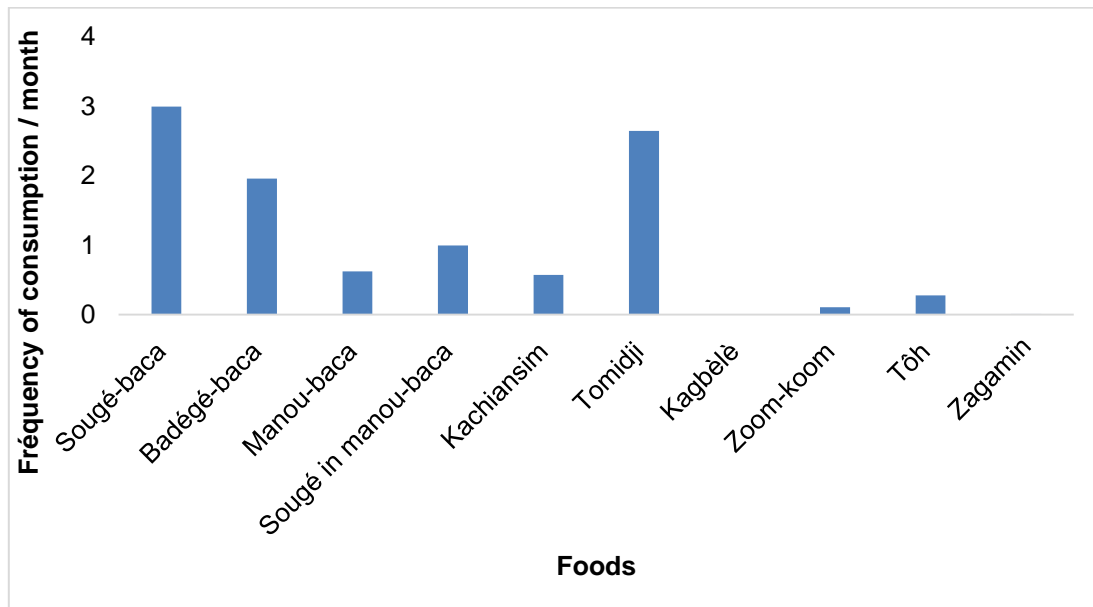
sougé-baca = millet granule porridge; *Badégé-baca* = maize granule porridge; *Manou-baca* = rice granule porridge; *Sougé in manou-baca* = ¾ millet and ¼ rice granule porridge; *Tomidji* = tomi juice; *Zoom-koom* = cereal juice; *Tôh* = cabato; *Kagbèlè* = fritter; *Zahamin* = fat rice.

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Fig. 2. Factor analysis of tomi-based dishes

158 *3.1.2.4 Frequency of consumption of tomi-based dishes*

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

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3.1.2.5 Consumption periods for tomi-based dishes

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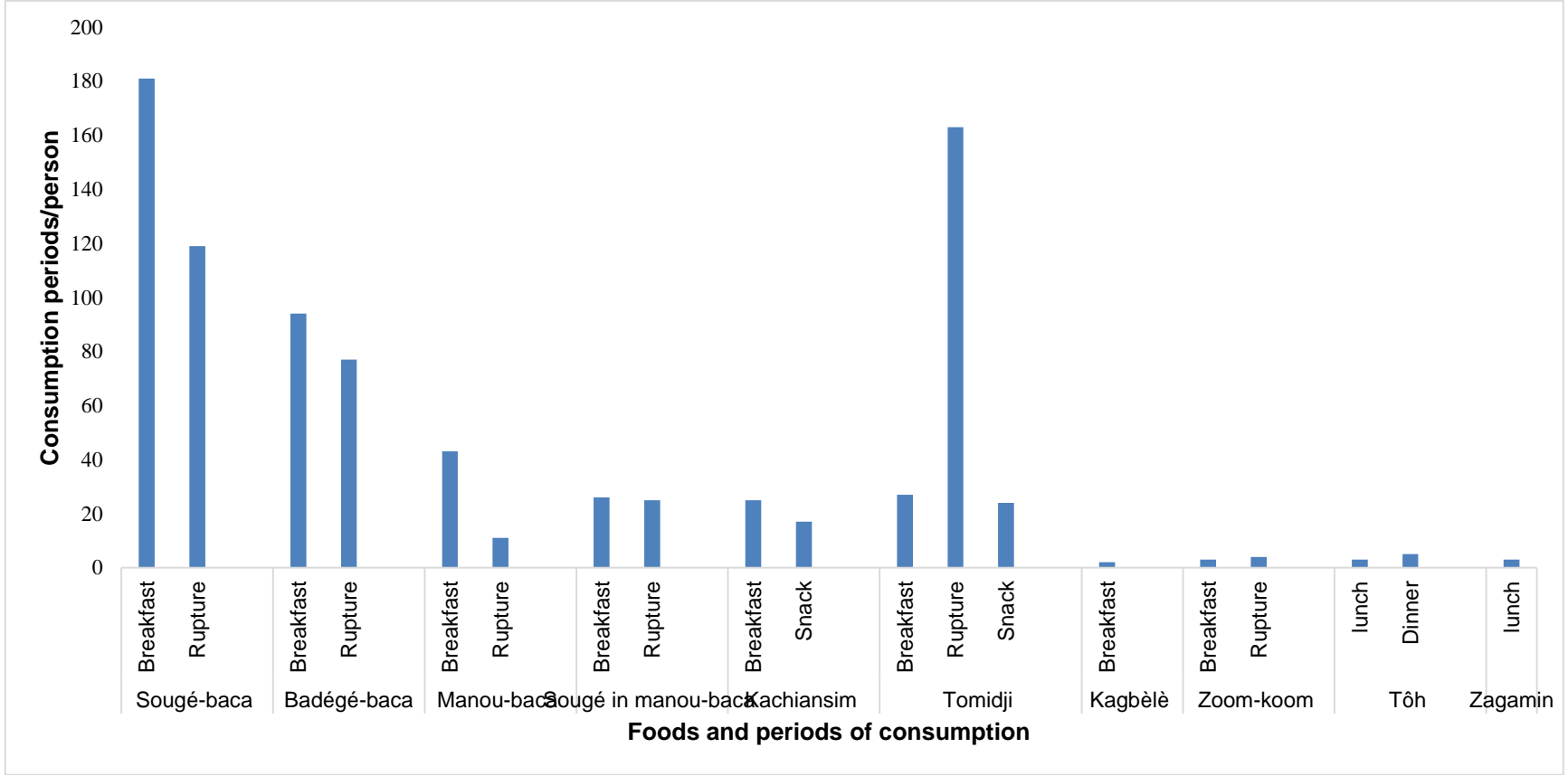


Fig. 4. Consumption periods of Tomi-based dishes

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184 **3.1.3 Production process of tomi-based dishes**

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186 *3.1.3.1 Production of cereal porridges*

187 The production scheme for cereal porridges is shown in Figure 5. For the production of
188 Bacacrou, one (1) kg of cereal (millet or rice or maize or $\frac{3}{4}$ of millet + $\frac{1}{4}$ of rice) is soaked in
189 3 L of water for 120 min. The soaking water is then removed and the cereal is washed again
190 in 3 L of water. After draining, the cereal is ground with 100 g of ginger and/or 20 g of cloves
191 (Bouna) or 10 to 20 g of chili pepper (Korhogo) to obtain a flour. The flour obtained is sifted
192 and progressively sprinkled with 100 to 200 mL of water for the formulation of granules. The
193 granules thus obtained are dried in the sun or at room temperature for 4 to 5 hours. For
194 cooking, 7 to 8 L of water is put in a pot and brought to boil. The granules are added to the
195 pot and mixed as they come out to avoid their agglomeration. A macerate obtained from 250
196 g of tomi pulp in 0.5 L of water is added gently after 10 to 15 min of cooking. The mixture
197 obtained is left to cook for 10 to 15 minutes and then 500 g of sugar and/or 140 g of vanilla
198 sugar (Bouna) or the juice of 30 g of mint leaves (Séguéla) is added directly.

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200 *3.1.3.2 Kagbèlè production*

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

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208 *3.1.3.3 Production of Toh*

209 The production scheme for Toh is shown in Figure 7. The macerate of 250 g of tomi pulp in 2
210 L of water is filtered and heated. After boiling, 0.5 kg of millet flour is gradually added and the
211 mixture is homogenized by swirling until it becomes a slurry. After 5 to 10 minutes of cooking
212 the slurry, 1 kg of millet flour is gradually added. The mixture is regularly kneaded for 10 to
213 15 minutes before being served.

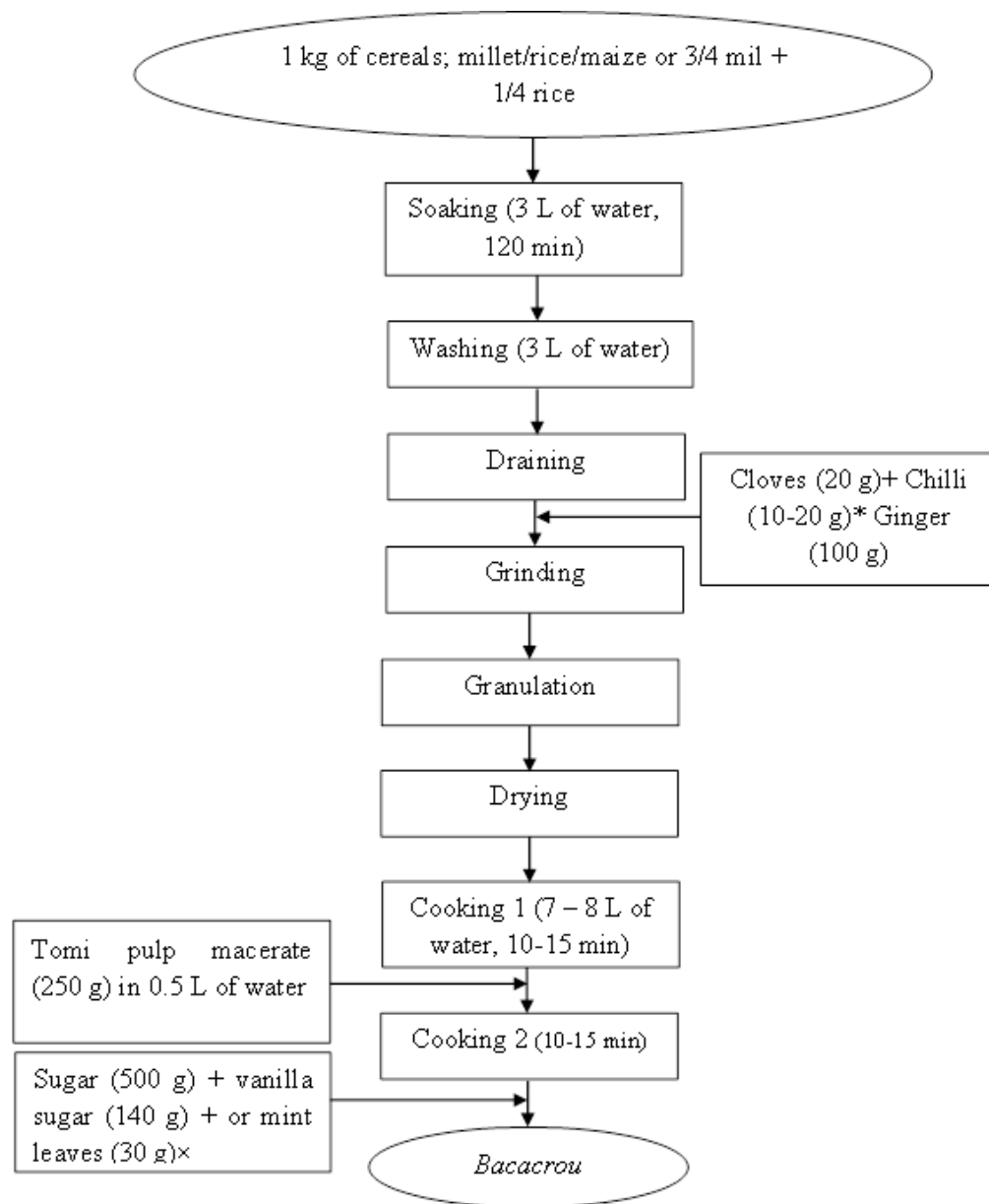
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215 *3.1.3.4 Production of Zoom-koom*

216 The description of the production of Zoom-koom is shown in Figure 8. One (1) kg of grain
217 (millet or rice) is soaked in 3 L of water for 120 min before being removed and washed in 3 L
218 of water. After draining, the cereals are ground with 200 g of ginger and 50 g of cloves. The
219 flour obtained is sifted and relayed in 10 to 15 L of water for 30 to 60 min. A macerate of 250
220 g tomi pulp in 250 mL water is added to the flour solution and the whole is homogenized,
221 filtered before adding 2 kg sugar and 280 g vanilla sugar.

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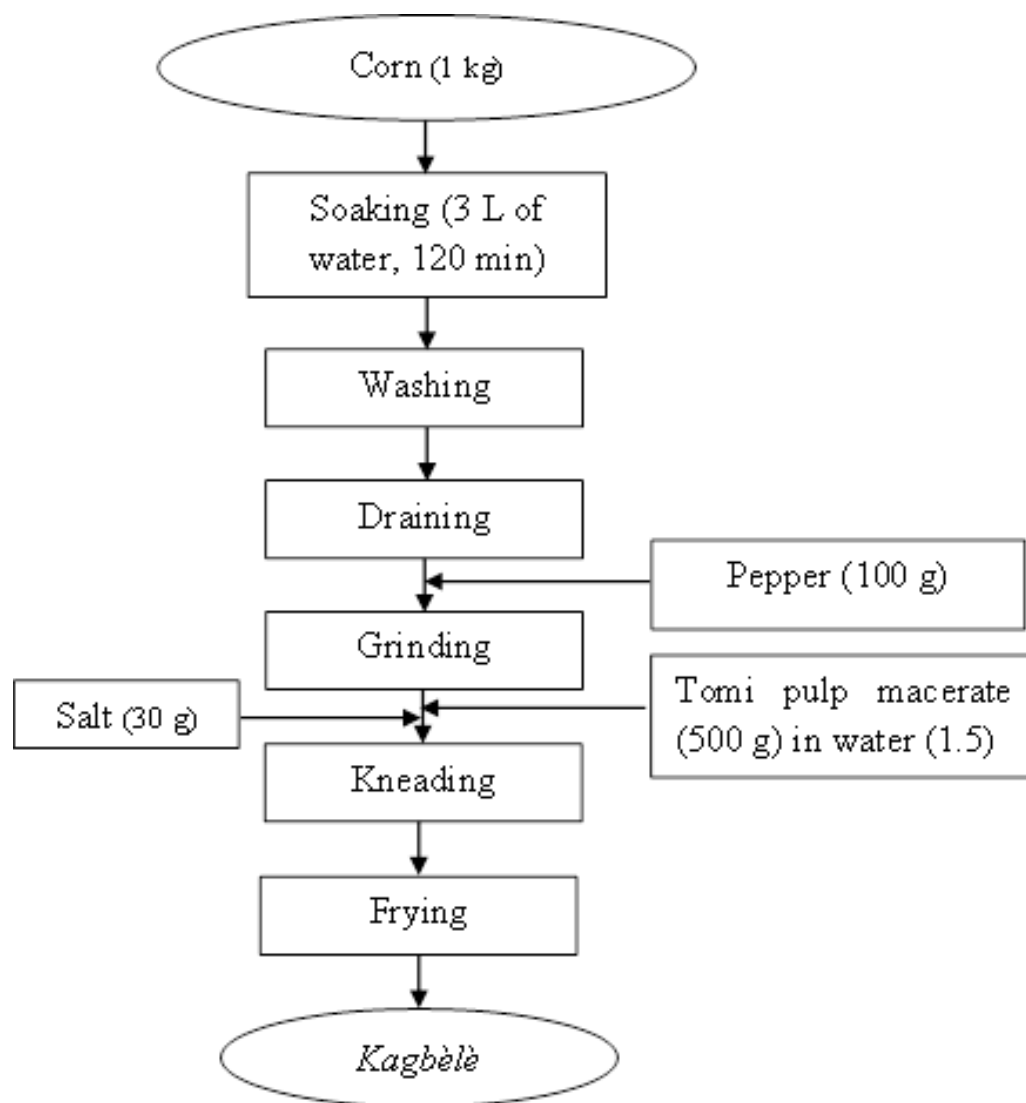
* Practices of Korhogo

* Practices of Séguéla

* Practices of Bouna

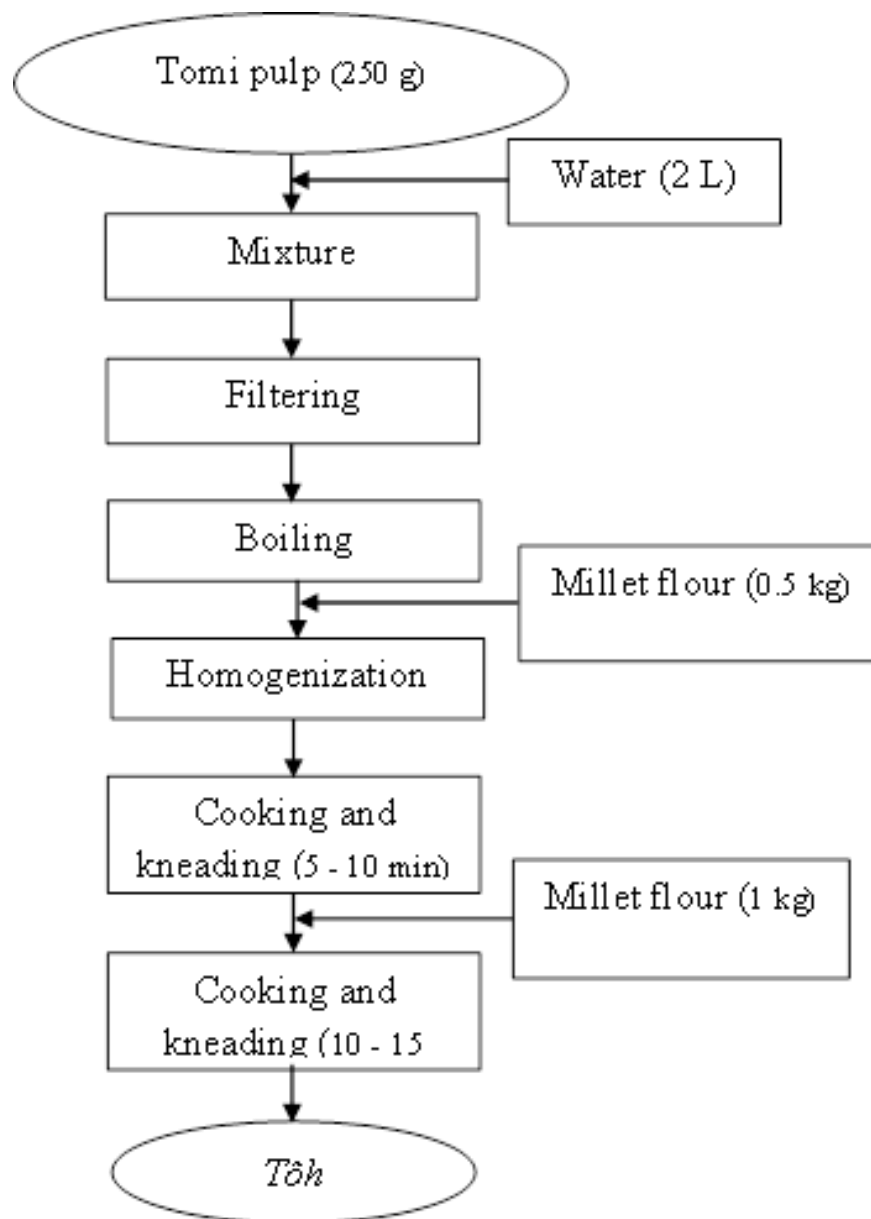
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Fig. 5. Production diagram of *Bacacrou*



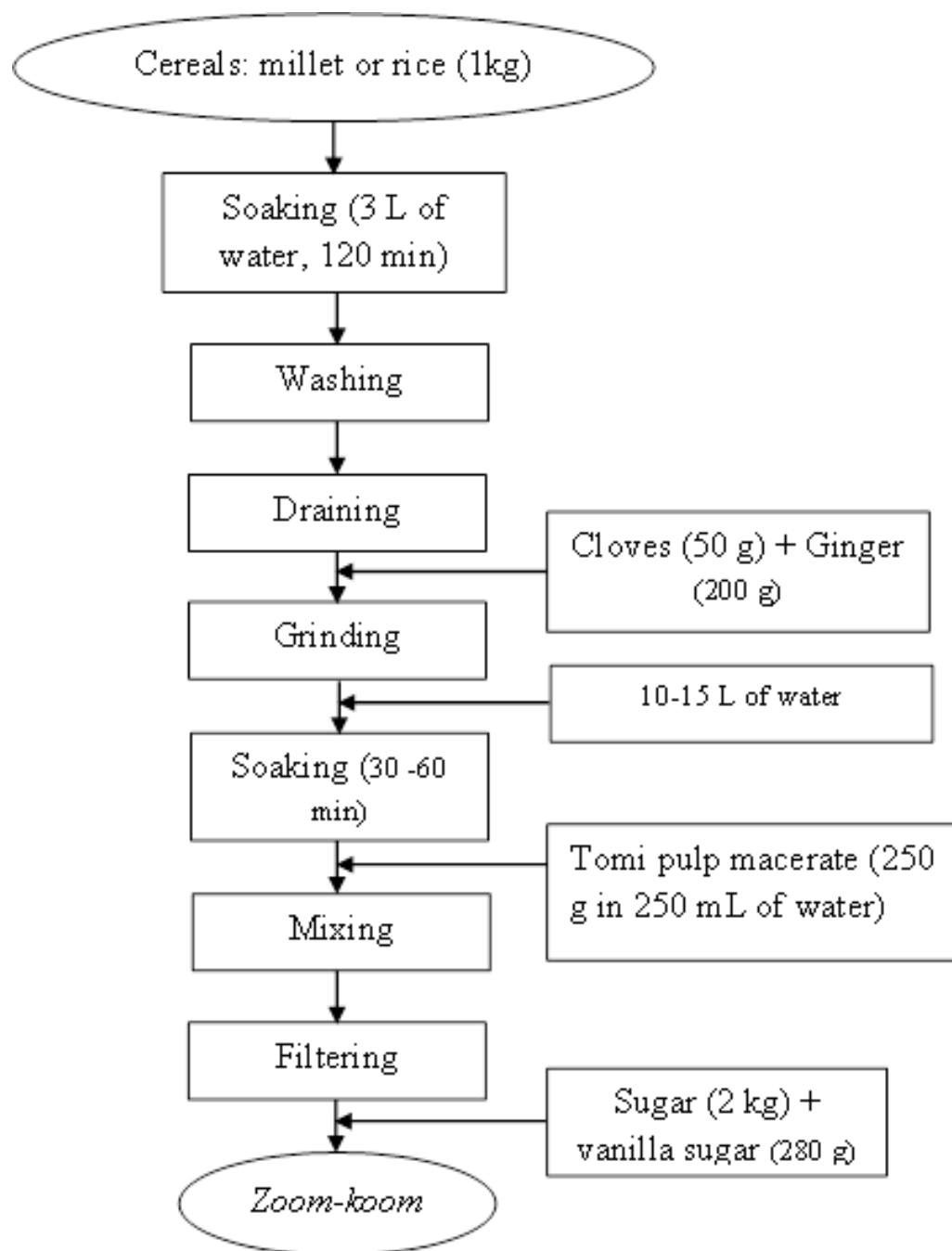
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Fig. 6. *Kagbèlè* production diagram



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Fig. 7. Tòh production diagram



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Fig. 8. Zoom-koom production diagram

243 3.1.3.5 *Production of Kackiansim and Tomidji*

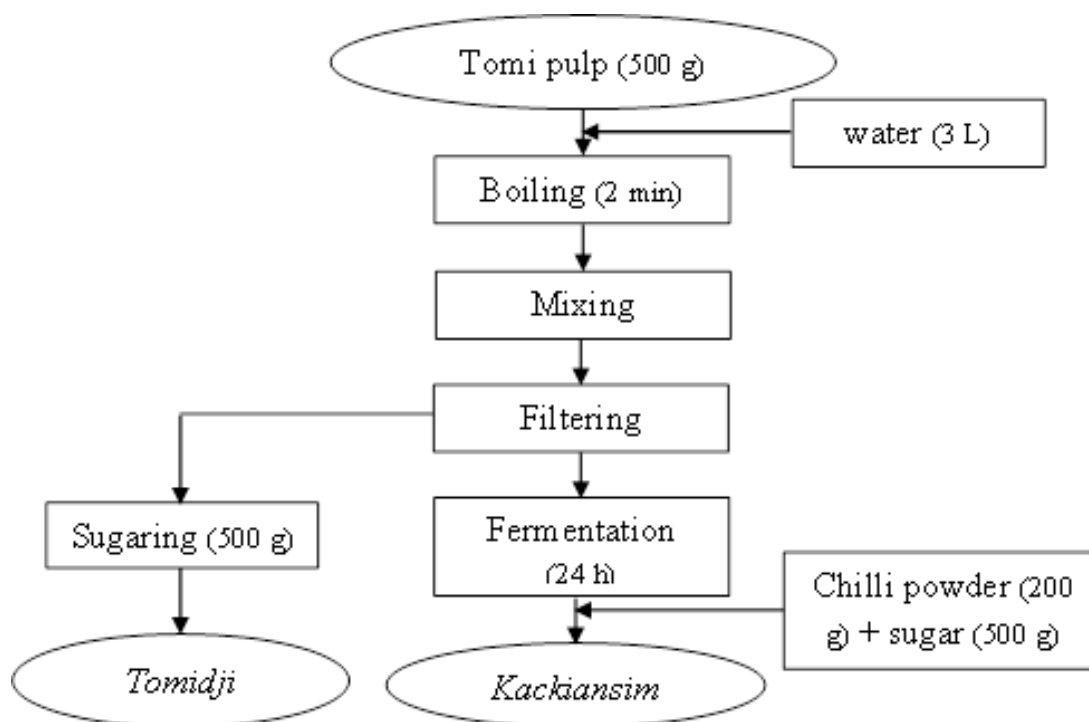
244 The description of the production process of Kackiansim and Tomidji is detailed in Figure 9.
 245 A 500 g portion of tomi pulp is boiled in 3 L of water for 2 to 3 minutes. The resulting solution
 246 is allowed to stand for 15-30 minutes to cool, then mixed and the juice is collected after
 247 filtering. A mass of 500 g of table sugar is directly added to the filtrate to obtain Tomidji. To
 248 obtain Kackiansim, the filtrate is left to ferment for 24 hours, then 500 g of table sugar and
 249 200 g of chilli powder are added.

250

251 3.1.3.6 *Production of Zagamin*

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

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

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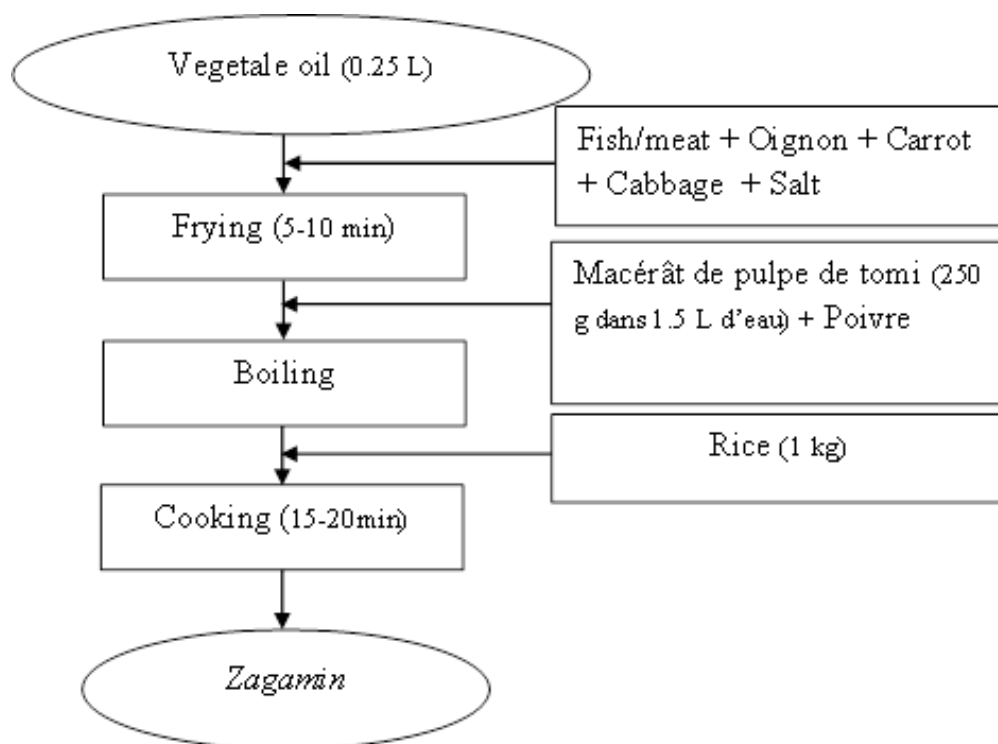
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Fig. 10. Zagamin production diagram

3.2 Discussion

278 This study consisted in identifying and collecting information on dishes integrating tomi
279 (*Tamarindus indica* L.) pulp in their formulations in Côte d'Ivoire. The results obtained show
280 the importance of the valorization of local dishes for food security. From a sociodemographic
281 point of view, the sex ratio of respondents is in favor of women with a proportion of 95.95%.
282 This high proportion of women could be justified by the fact that they are generally the ones
283 who do the cooking in rural households and are therefore more competent in the preparation
284 and knowledge of the dishes consumed. This result is consistent with Adepoju *and al.* [19]
285 that identifies women as the main pillars of food security in rural households. The
286 identification of tomi (*Tamarindus indica* L.) fruit-based foods in the departments of Korhogo,
287 Séguéla, and Bouna revealed 10 tomi-based foods. This diversity of foods produced from
288 this wild fruit could further contribute to the food security of rural and urban populations. This
289 idea is supported by the studies of Lockett and Grivetti [20], who state that wild edible plants
290 can be incorporated into foods to enhance or diversify them. These authors also state that
291 the wild edible plant diet has been a mainstay of the Fulani diet since ancient times.
292 Therefore, the popularization of these foods could help reduce food insecurity in developing
293 countries, particularly in Côte d'Ivoire. According to studies by Sackou *and al.* [21] on food
294 insecurity in the city of Abidjan, only 3.8% of households were food secure. From a culinary
295 point of view, this wild fruit can be transformed into several forms of food. Thus, foods made
296 from tomi pulp are generally consumed in the form of meals and drinks with a meal/drink
297 ratio of 7:3. The high use of these wild fruits in the diet as meals would reflect their
298 importance in the dietary habits of local populations. These different forms of use in the form
299 of drinks or meals are consistent with those described by several authors [22, 23]. Indeed,
300 these authors indicate that tamarind pulp is consumed in non-alcoholic sweetened drinks or
301 mixed with ginger, for the preparation of ice creams. It can also be used in weaning foods.
302 Three (3) of the 10 prepared foods (Sougé-baca, Badégé-baca and Tomidji) are consumed

303 in all localities with some small differences related to the production process. The similarity
304 of the foods consumed in the different study areas could be explained by the interaction
305 between the peoples. Van der stege *and al.* [4] corroborate this hypothesis, suggesting that
306 the similarities and differences in the use of tamarind foods are related to shared knowledge
307 and general interactions between ethnic groups living in close proximity to each other.
308 Kruger and Gericke [24] and Thurber *and al.* [25] continue in this same vision stating that it is
309 evident that there is a divergence in the foods consumed, with culture being one of the
310 important factors that influence the attitude of consumers of a given food. For the
311 preparation of all these dishes, tomi is generally collected in the field in a proportion of
312 65.18% to 71.64% depending on the locality. This result could be explained mainly by the
313 fact that the surveys were conducted in rural areas and secondarily by its strong presence in
314 these three different areas of northern Côte d'Ivoire. This is corroborated by the studies of
315 Kouakou *and al.* [16] and Andon *and al.* [26] who reported the abundance of this wild fruit
316 tree in these areas. The results of the study show that the reasons for the uses of tomi in
317 food making vary by locality ranging from health needs, to taste and color of dishes. These
318 reasons are confirmed by [22, 27, 28, 29] who argue that tomi is added to meals for
319 digestion, to improve taste or to protect food from bacteria. In fact, despite its acidifying
320 nature, tomi is described as the most acidic and sweetest fruit. It is one of the few fruits that
321 retains the estimated 98% tartaric acid content of its pulp during ripening, while the amount
322 of reducing sugars increases to give it a sweeter taste [8]. Tartaric acid is an antimicrobial
323 agent that inhibits the growth of food spoilage microorganisms by lowering cellular pH [30,
324 31] and the production of malic acid, which is a key intermediate in the production of glucose
325 in the process of gluconeogenesis, the main fuel of cells [30]. The study data reveal that the
326 foods produced by these populations are predominantly consumed at breakfast and during
327 the Muslim fasting break period especially porridges and drinks. These results confirm those
328 of Sadiq *and al.* [7] and N'Guessan *and al.* [32] who stipulates that porridges are consumed
329 at breakfast, snack time and are highly valued during Ramadan. Indeed, the results show
330 that Sougé-baca porridge is more known and consumed. This preference for millet porridge
331 could be explained by its good acceptability but also by the availability of millet in the study
332 areas. This hypothesis is confirmed by Tou *and al.* [33] who report the good organoleptic
333 quality of millet porridge compared to maize porridge. This result could also be due to the
334 fact that according to [32], millet porridge is the main form of millet processing. Regarding
335 the availability of millet, Koffi *and al.* [34] reported that millet and sorghum are traditionally
336 grown in the northern region of Côte d'Ivoire. Parry [35], confirms this report by adding that
337 the northern zone of Côte d'Ivoire is the most suitable for growing millet. However, the use of
338 tomi in several foods by rural populations clearly indicates that beyond ignorance of the
339 benefits of these fruits, they are nevertheless exploited by these populations. But the level of
340 knowledge and information about these foods limits their use.

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343 4. CONCLUSION

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345 The objective of this study was to identify foods made from tomi fruits (*Tamarindus indica* L.)
346 in Côte d'Ivoire. At the end of this study, ten (10) tomi-based foods were identified. The
347 production processes and consumption patterns of these foods vary according to the
348 localities studied, with a meal/drink ratio of 7:3. This fruit is consumed by rural populations
349 for health reasons, for its taste and for the color it gives to dishes. Millet porridge (Sougé-
350 baca) is the most known and consumed food with a percentage of knowledge of 74.07 and a
351 frequency of consumption of 3 per month. However, a better knowledge of the impact of
352 these different foods on the well-being of these consumers is necessary given the nutritional
353 importance of this fruit. It would be interesting to determine the biochemical composition of
354 these foods for a better popularization.

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