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Traditional processing and quality attributes of Dambou, a steamed coarse semolina

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Dambou is a traditional cereal-based food consumed in northern Benin. The traditional production method, marketing and consumption of Dambou were evaluated through a field investigation. A semi-structured questionnaire composed of socio-cultural profile of the stakeholders, nature of raw materials and processing methods used in Dambou production, quality attributes and consumption forms of Dambou was administrated to stakeholders of Dambou value chain in the municipality of Parakou (Benin). The findings showed that Dambou is exclusively produced and marketed by women (100%). Two different Dambou production technologies were identified depending on the process and the raw material used. A significant difference ($p < 0.05$) was observed compared to the variety of cereal used for the production of Dambou. In addition, the study showed that Dambou is mostly consumed with mixture of *Moringa oleifera* leaves, spices and peanut powder. Dambou is appreciated by consumers for its quality attributes such as colour and soft texture.

Key words: Ethnic food, indigenous production, quality, rice, maize, Benin.

INTRODUCTION

In most African countries, including Benin, traditional food processing contributes to largely reduce post-harvest losses that varied from 10 to 30% of production (FAO, 1983; Hodges et al., 2011) and, thereby, to improve food security in developing countries.

Most traditional African foods are cereal-based products made from sorghum (Kayodé et al., 2012), maize (Amoa-awua and Oduro-yeboah, 2010; Hongbete et al., 2017a), rice (Houngbédji et al., 2018), pearl meal

(Garí, 2002), finger millet (Abulude et al., 2005; Amadou et al., 2013) and teff (Gebru et al., 2020; Homem et al., 2020). In North of Benin, Dambou, a cereal-steamed granulated dumpling usually made from rice and maize, is one of traditional food consumed by both rural and urban people. Dambou is ready-to-eat staple food often mixed with leaves of *Moringa oleifera* during consumption. The consumption of Dambou could be a potential way to prevent protein diseases due to the high

content of Moringa leaves in protein (Achigan-Dako et al., 2010; Coppin et al., 2015; Houndji et al., 2013; Sena et al., 1998; Shiriki et al., 2015; Weinberger and Msuya, 2004).

Despite the nutritional importance of Dambou, it is not well known by Beninese. To improve the quality of Dambou, information on traditional processing methods, problems associated with processing and quality criteria are needed. The main purpose of this study is to provide a better understanding on the traditional processing of Dambou and its quality as perceived by processors and consumers.

MATERIALS AND METHODS

Sampling of informants

The survey was conducted in the municipality of Parakou (latitude 9°21'North and longitude 2°36'East) located in the Department of Borgou, where Dambou is commonly consumed. A total of 52 processors (also sellers) and 166 consumers were randomly surveyed at different production sites of Dambou located in the municipality of Parakou.

Questionnaires design and field data collection

A semi-structured questionnaire was formulated to collect data on Dambou production during a face-to-face survey. The questionnaire was designed and divided into three parts. The first part dealt with demographic characteristics of Dambou processors (name, gender, age, education level, contact details). The second part was related to Dambou production (raw materials, ingredients used, processing steps, type of Dambou, etc.). The third part focused on the quality perception of Dambou processors. The questionnaire was administrated to Dambou processors and consumers as individual interviews in French and local languages (Dendi and Bariba).

Data analysis

The numerical version of the questionnaire was realised with the software Sphinx Survey Plus[2] (version 4.5) to record the collected data. The Microsoft Excel software (Microsoft office, version 2013) was used to calculate basic statistics (frequencies, percentages, means, etc.). Multiple comparisons of proportions of Dambou processors and consumers were realised based on 95% confidence interval (CI) using the following formula.

$$CI = 1.96 \times \sqrt{\frac{p(100-p)}{n}}$$

With p = proportion of Dambou processors or consumers and n = total number in sampled population.

RESULTS AND DISCUSSION

Socio-cultural profile of Dambou processors and consumers

The results of Socio-demographic characteristics of surveyed processors and consumers of Dambou are summarized in Table 1. All the interviewed processors (100%) were female. This result is in accordance with previous studies on traditional food processing and marketing which also reported similar results (Akpo-Djènontin et al., 2016; Hongbete et al., 2017b). However, both genders were represented among consumers with proportion of male consumers (61.4%) higher than female consumers (38.6%). This could be due to the fact that the majority (63.9%) of consumers especially men were unmarried having preference for street foods.

The majority (90.4%) of processors surveyed were ≤ 45 years of age. Most of them had no formal education (illiterate and local language education) (46.2%), while 42.3 and 11.5% of them had primary and secondary education, respectively. The marital status of processors showed that 80.8% (p<0.001) of them were married. Also, the know-how acquisition of processors showed that 80.8% (p<0.001) of them received their knowledge from their mothers. Dambou processors and consumers belonged to various socio-cultural groups with the following composition: Haoussa (29.4%), Dendi (28.0%), Bariba (15.6%) and Zerman (12.8%), followed by minority group of Yoruba (9.2%) and Fulani (5.0%) (p<0.001). These socio-cultural groups were also found in Niger and Nigeria, countries with whom Benin shares land frontiers and traditional foods including Dambou (Luxereau, 2002).

Processing technique of Dambou

Required raw materials and ingredients

Table 2 presents the nature and quantity of raw materials used for Dambou processing and the frequency of production. The quantity of raw material used ranged from 10 to 140 kg per week and per processors depending on the type of Dambou. The ingredients added during consumption were pepper, cloves, ginger, onion, *M. oleifera* leaves, cowpea and groundnut powder.

In Benin, 42.3, 38.5 and 19.2% of processors claimed to use rice (*Oryza sativa* L.), maize (*Zea mays*) and mixture of rice and maize, respectively, as raw material to produce Dambou. These raw materials used were different from those used in Nigeria, which were millet and sorghum (Agu et al., 2015). Approximately 50% of Dambou processors used about 50-140 kg of rice or maize against 100% of them who use 10-20 kg of mixed rice/maize. For the three types of Dambou, most of processors produced Dambou four to five times per week.

According to the Dambou processors, in terms of quality perception, the colour of the cereal used as raw material to produce Dambou production is the main quality criteria. The majority of Dambou processors (100%) used rice and maize varieties for Dambou production. The grains should be well dried (50.1% of processors), free from weevils (83.4% of processors) and

Table 1. Socio-demographic characteristics of Dambou processors and consumers.

Variable	Processors		Consumers		Total	
	n = 52	Proportion (%±ci)	n = 166	Proportion (%±ci)	n = 218	Proportion (%±ci)
Gender						
Male	0	0[a]	102	61.4±13.2[a]	102	46.8±6.6[a]
Female	52	100.0±0.0[b]	64	38.6±13.2[a]	116	53.2±6.6[a]
Age						
18-25	13	25.0±11.8[ab]	9	5.4±6.2[a]	22	10.1±4.0[a]
26-35	21	40.4±13.3[a]	63	40.0±13.2[b]	84	38.5±6.5[b]
36-45	13	25.0±11.8[ab]	51	30.7±12.5[b]	64	29.4±6.0[bc]
46-55	5	9.6±8.0[b]	43	25.9±11.9[b]	48	22.0±5.5[c]
Education						
None (non-academic qualification)	24	46.2±13.5[a]	12	7.2±7.0[a]	36	16.5±4.9[a]
Primary school	22	42.3±13.4[a]	53	31.9±12.7[b]	75	34.4±6.3[b]
Secondary school	6	11.5±8.7[b]	55	33.1±12.8[b]	61	28.0±6.0[ab]
University			46	27.7±12.2[b]	46	21.1±5.4[a]
Socio-cultural groups						
Bariba	9	17.3±10.3[ab]	25	15.1±9.7[a]	34	15.6±4.8[a]
Dendi	12	23.1±11.5[ab]	49	29.5±12.4[a]	61	28.0±6.0[b]
Haoussa	21	40.4±13.3[a]	43	25.9±11.9[a]	64	29.4±6.0[b]
Zerman	8	15.4±9.8[b]	20	12.0±8.8[ab]	28	12.8±4.4[a]
Fulani	2	3.8±5.2[b]	9	5.4±6.2[b]	11	5.0±2.9[c]
Yoruba			20	12.0±8.8[ab]	20	9.2±3.8[ac]
Marital status						
Married	42	80.8±10.7[a]	50	30.1±7.0[a]	92	42.2±6.6[a]
Unmarried	10	19.2±10.7[b]	106	63.9±7.3[b]	116	53.2±6.6[b]
Divorcee			10	6.0±3.6[c]	10	4.6±2.8[c]
Know-how acquisition						
Mothers	42	80.8 ± 10.7[a]			42	19.3±5,2[a]
Mother-in-law	10	19.2 ± 10.7[b]			10	4.6±2.8[b]

CI: confidence interval at.95%; percentages of modalities of each variable with different letters (a, b and c) according to column of proportion are significantly different.

stones (87% of processors).

The majority (62.8%) of respondents indicated that whitish rice was the major raw material for Dambou production, whitish maize can also be used alone (26.2% of processors) or in combination with rice (11.0% of processors). Other criteria recorded were the fleshly harvested maize (64.3% of processors) was not accepted for Dambou production due to the fact that the fleshly harvested maize could not take enough water.

Dambou processing

Three processing techniques were identified according to

the raw material used: Dambou made from maize, Dambou from rice and Dambou from mixed maize/rice in a ratio 2:1 (w/w) (47.3% of processors), in a ratio 1:1 (w/w) (28.1% of processors) and ratio (3/1) (w/w) (24.6% of processors), respectively. The maize and rice are processed into Dambou using the diagram showed in Figure 1.

The cereal grains were crushed and winnowed to perform a separation of the bran and germ of the maize. After the separation of the pericarp (bran), the rest of the grain was washed and sun dried (Figure 1A). The coarse, dried maize grain was crushed again followed by sieving (step 6) to produce coarse sieved maize semolina (step 7).

Table 2. Nature and quantity of raw materials used for Dambou production and production frequency.

Variable	Dambou from rice n=22	Dambou from maize n=20	Dambou from rice and maize n=10
Quantity of raw material (kg/week, n=52)			
[10-20]	7 (31.8%)	6 (30%)	10 (100%)
[20-50]	3 (13.6%)	4 (20%)	-
[50-140]	12 (54.5%)	10 (50%)	-
Frequency of production (times per week)			
Two to three	5 (22.7%)	3 (13.6%)	-
Four to five	14 (63.6%)	10 (45.5%)	10 (100%)
Six to seven	3 (13.6%)	7 (31.8%)	-

Value in brackets is percentage of respondents within each type of Dambou (n = respondents of the kinds of Dambou).
-: not mentioned.

Blended coarse, sieved maize semolina and coarse rice flour were also used to produce Dambou (Figure 1B). The rice was crushed to produce coarse rice flour (Figure 1C). The coarse cereal semolina was humidified manually by hand (step 8). The humidification step is very delicate, which required a homogeneous wetting of the semolina by confirming the volume of the additional water. High amounts of water lead to formation of dough during the steaming step (step 9). The steaming step is done two and three times for rice and maize, respectively. The objective of steaming is to make the coarse semolina soft. After each steaming, the steamed coarse cereal grits was cooled in water, which is in direct contact with the product (step 10) and broken up into granular lumps for 30 to 40 min for end product (step 13). This traditional cooling step is associated with many problems, such as poor quality of water, equipment used, and possible contamination by processor.

Frequency of Dambou production

The frequency of production varied depending on type of Dambou. Dambou from rice is the most frequently produced with 42.3% of processors who made it more than four to five times per week (63.6% of processors) (Table 2); Dambou from maize was made by 38.5% of processors producing it more than four to five times per week (45.5% of processors); Dambou from the mixed rice and maize was produced with 19.2% of processors who made it four to five times per week (100% of processors).

Preference of consumption

The majority of consumers (70.5%) preferred Dambou made from rice, followed by Dambou based maize (21.1%) and Dambou from a mixture of both cereals (8.5%). Before consumption, the main ingredients used

were *M. oleifera* leaves, pepper, ginger, onion, cowpea, groundnut powder and cloves. The majority (65.7%) (p<0.001) of consumers reported that Dambou is consumed with *M. oleifera* leaves, pepper, ginger, onion, cowpea and groundnut powder (p<0.001). According to processor's perception *M. oleifera* is believed to have special nutritional qualities. So, *M. oleifera* leaves contribute to both household nutrition and health (Dansi et al., 2008; Shiriki et al., 2015). Also, groundnuts contain high amounts of vegetable protein and fat, mostly unsaturated fatty acids. Groundnuts are clearly nutrient dense foods (Shibli et al., 2019; Timbadiya et al., 2017).

Frequency of Dambou consumption

Regarding the frequency, higher levels of Dambou consumption were reported. About 95.7 and 100% of interviewed Dambou consumers who made the Dambou from rice and maize, respectively, ate Dambou at least once per week. All the consumers (100%) of Dambou made from mixed rice/maize claimed to consume Dambou two to three times per week (Table 3).

In addition, interviewed consumers claimed that ingredients added to Dambou (Table 3) included the following: pepper/ ginger/onion/*M. oleifera*/groundnut powder (70.1-100% of interviewed consumers), cloves/ ginger/onion/ *M. oleifera*/groundnut powder (8.5% of interviewed consumers) or cloves/ ginger/onion/ *M. oleifera*/groundnut powder/ cowpea (21.4% of interviewed consumers). The majority of interviewed consumers (91.5, 74.3 and 93.3%, respectively) ate Dambou of rice, maize and mixed rice/maize, respectively, during lunch time.

Quality perception of Dambou

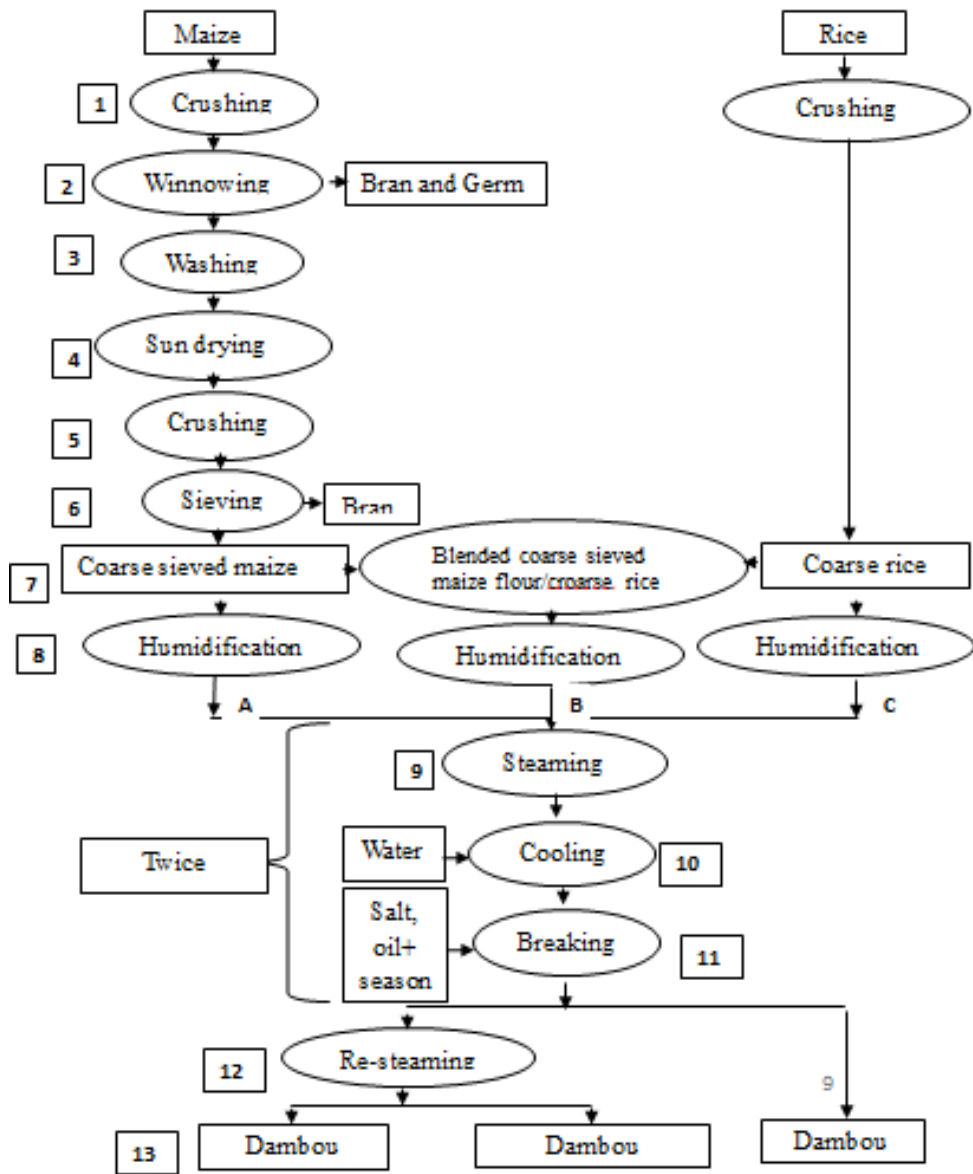According to the processors or consumers interviewed

Figure 1. Flow chart of Dambou processing. These pictures represent products of some steps: 6) Sieving semolina; 7) coarse semolina; 8) Humidification of the coarse semolina; 9) Cooking (Steaming); 10) Cooling process by humidification; 13) Dambou.

Table 3. Consumption frequency of Dambou and ingredient for accompanying.

Variable	Dambou from rice	Dambou from maize	Dambou from rice and maize
	n=117	n=35	n=15
Frequency of consumption (times per week)			
Once	13 (11.1)	8 (22.8)	-
Two to three	29 (24.8)	10 (28.6)	15 (100)
Four to five	70 (59.8)	17 (48.6)	-
Six to seven	5 (4.3)	-	-
Accompanying dish			
Peper/ginger/Onion/Moringa/Groundnut powder	82 (70.1)	35 (100)	15 (100)
Cloves/ginger/Onion/moringa/groundnut powder	10 (8.5)	-	-
Cloves/ginger/Onion/moringa/groundnut powder/cowpea	25 (21.4)	-	-
Moment of consumption			
Lunch	107 (91.5)	26 (74.3)	14 (93.3)
Dinner	10 (8.5)	6 (17.1)	-

Value in brackets is percentage of respondents within each type of Dambou (n: respondents of the kinds of Dambou).
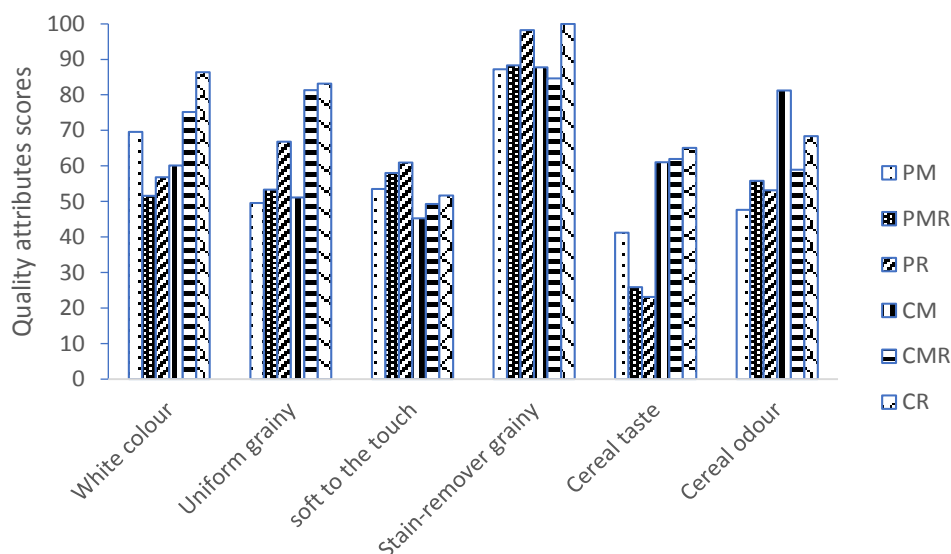-: not mentioned.

Figure 2. Quality attributes of Dambou from different cereal grains according to processors/consumers. PM: Processor of Dambou from maize; PMR: Processor of Dambou from mixture of maize and rice; PR: Processor of Dambou from rice; CM: consumer of Dambou from maize; CMR: consumer of Dambou from mixture maize and rice; CR: consumer of Dambou from rice.

(Figure 2); whatever the raw material (rice or maize) used, Dambou should have a white colour (51.6-69.6% of processors and 60.1-86.4% of consumers), a uniform grainy (49.6-66.8% of processors and 51.1-83.2% of consumers), firm texture (53.6-60.9% of processors and 45.2-51.7% of consumers), stain-removed and grainy (87.2-98.2% of processors and 84.6-100% of consumers),

cereal taste (23.1-41.2% of processors and 61.0-65.1% of consumers) and cereal odour (47.6-55.8% of processors and 58.9-81.2% of consumers). Among the processors interviewed, 71.2% claimed that the yellow cultivar of maize or rice should not be used for Dambou production due to the fact that the yellowish colour is too repulsive.

Conclusion

This study revealed that Dambou is a ready to eat staple food based cereal very appreciated by consumers. Regarding to the raw material used (rice, maize and mix of rice and maize), Dambou is obtained via three processing methods, leading to intermediate product as coarse cereal flour. Moreover, the results showed that rice is the cereal mostly used for Dambou production. For most of consumers, Dambou of good quality should be soft to the touch, uniform and stain-removed with grainy consistency.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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