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Performance of a wooden box for production of Afitin, fermented food condiment from Benin

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Abstract

Afitin is a traditional condiment of African locust bean (*Parkia biglobosa*) largely consumed in Benin. It is produced with rudimentary equipment not always guaranteeing the optimal conditions for a successful fermentation. The investigations were focused on improving the Afitin production techniques by developing a wooden box. The study aims to evaluate the performance of a wooden box, the physicochemical characteristics and the sensory quality of the product. The box developed was successful for the fermentation of African locust bean with a very good appreciation of Afitin professional processors. The sensory quality of the Afitin from the box was similar to those of Afitin from the basket with jute bags/old cleaned clothes. The Afitin is rich in proteins (40.3% dry matter), lipids (38.0% dry matter), carbohydrates (11.3% dry matter) and fibers (4.2% dry matter). The wooden box developed looks more hygienic and offers better fermentation conditions than the basket with jute bags/old cleaned clothes used in the traditional process.

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Introduction

African locust beans (*Parkia biglobosa*) constitute a significant food resource for many populations in Africa (Isu and Ofuya, 2000; Chadare *et al.*, 2017). They were naturally fermented to produce food condiments named Afitin, Iru and Sonru at household level in Benin (Gutierrez *et al.*, 2000 ; Hongbété, 2001; Azokpota, 2007), Dawadawa in Nigeria (Iwuola and Eke, 1996 ; Dakwa *et al.*, 2005), Soumbala in Burkina Faso and Guinea, Nététu in Senegal and Mali (Diawara *et al.*, 1998).

These condiments are often used to season various dishes such as slimy vegetable sauces, leafy vegetable sauces, tomato sauce (Kindossi *et al.*, 2012). Also these condiments contribute significantly to the diet by supplementing the protein and micronutrient intake to population with low incomes (Achi, 2005). Several constraints related to the cooking, the husking and the fermentation of African locust beans were reported (Gutierrez *et al.*, 2000).

Some improvements were made for the fermentation processing of African locust beans to produce African flavouring condiment (Odunfa and Adewuyi, 1985; Diawara *et al.*, 1998; Oouba *et al.*, 2004; Azokpota *et al.*, 2010). Thus, to facilitate the dehulling, new equipments were introduced for the mechanization (Odunfa and Adewuyi, 1985) and to reduce the cooking time of African locust beans, cooking under pressure were proposed.

In addition, many works were reported on isolation of microorganisms involved in the naturally fermentation of African locust beans to Afitin and the development of starter cultures for controlling this fermentation (Odounfa and oyewole, 1986 ; Ouoba *et al.*, 2004; Azokpota *et al.,* 2007; Azokpota *et al.*, 2010).

In spite of these innovations, the various investigations did not tackle the question of the improvement of the fermentation equipment to produce Afitin. The African traditional flavouring condiments based African locust beans are continued to be produced with rudimentary equipments such as calabashes, baskets, jute bags, old cleaned clothes, etc (Gutierrez *et al.*, 2000; Hongbété 2001; Azokpota *et al.*, 2006). Such practices could be potential sources of contamination by pathogenic bacteria (Gutierrez *et al.*, 2000; Hongbété, 2001).

The product quality could vary from batch to batch (Hongbété, 2001; Motarjemi, 2002). Hygiene around the traditional equipment of fermentation is not always insured, and the optimal conditions for a successful fermentation are not guaranteed.

Regarding the significant role of fermentation equipment on the quality of the final product, its development is necessary to Afitin production. The purpose of the study was to improve the process of Afitin production by developing new fermentation equipment. Specifically, it was to evaluate the performance of the new equipment by local processors of Afitin, to determine the physicochemical and sensory characteristics of the final product.

Materials and methods

Description of the wooden box

The box tested for the fermentation of African locust beans was designed and manufactured with wood and cavity dimensions 80 (length) x 40 (width) x 30 (height) cm (Fig.1). It is provided with a wooden lid (Fig.1a). The box can contain approximately 6 kg of seed (Fig 1 b).

The box includes two compartments separated by a perforated plate. The compartment (height 30 cm) located above the perforated plate is used to contain the African locust beans for the fermentation and that under it (height 5 cm) is used to collect free water resulting from the African locust beans during the fermentation

Afitin process and sampling

Afitin was processed as outlined Figure 1 by two professional local processors. Dried African locust bean seeds bought from Dantokpa market (Cotonou, Benin) were boiled approximately for about 10 h to facilitate the dehulling and cooled for about 4 h.

After removing the testa by fulling, the cotyledons were sorted, washed and cooked for about 2 h. Two batches of cooked cotyledons were then spread on close containers (wooden box and basket with jute bags/old cleaned clothes) to produce Afitin in spontaneous fermentation conditions during 6, 12, 18 and 24 h. The first duplicate batch corresponded to modern production of Afitin in wooden box.

The second duplicate batch corresponded to traditional production of Afitin in basket with jute bags/old cleaned clothes for wrapping to provide good fermentation condition. After fermentation, the fermented cotyledons were taken for physicochemical and sensory analysis.

Physicochemical analysis

pH of the samples was measured with a pH meter (Hanna Instrument HI 9318) according to Nout *et al.* (1989). Dry matter contents were determined by oven drying at 105°C to constant weight according to AOAC methods 27.005, 27.007 (AOAC, 1984). Crude protein contents (N x 6.25) were determined by the method of Kjeldahl according to ISO standard 3188. Crude fat and ash contents were determined using AACC methods 30-25.01 and 08-01 respectively (AACC, 1984).

Total Basic Volatile Nitrogen (TBVN) content of the wet samples was determined as described by Pearson (1970). During the fermentation, the temperature of seed was measured using infrared thermometer (Brannan, High Temperature InfraRed Thermoter 50.0 to 550°C).

Sensory evaluation of afitin samples

The two types of Afitin (modern Afitin and traditional Afitin) obtained after 24 h of fermentation were presented to a panel of 18 trained judges to evaluate their preference for the products specific sensory attributes.

The multiple paired comparisons test was used to determine which of any two Afitin samples was preferred in terms of smooth texture, aroma, colour, taste and overall acceptability.

Performance evaluation of wooden box

The effectiveness, the production capacity, easy to use, the hygiene of the wooden box were evaluated by a panel of 15 professional local processors of Afitin using a 9-point hedonic box scale (Meilgaard *et al.*, 2007) from “dislike extremely” to “like extremely.”

Statistical analysis

Data were analysed using Statistica (version 6, StatSoft France, 2004) and significance was accepted at probability $p < 0.05$ with one-way analysis of variance (ANOVA) by using least significant difference (Student–Newman–Keuls test).

Results and discussion

Physicochemical changes during processing of African locust beans into Afitin

Table 1 presents changes in physicochemical characteristics during processing of African locust beans into Afitin according to two types of fermentation materials.

The results showed a significant increasing ($p < 0.05$) of the temperature during the fermentation. Temperatures recorded between 0 and 18 h of fermentation increased quickly for seeds within the basket with jute bags/old cleaned clothes (34.0 to 48.5°C) than that in the wooden box (34.0 to 47.0°C). This difference observed could be attributed to the effect of fermentation material.

An increase in dry matter of African locust beans was observed during the course of fermentation from 36.2 to 38.9%. This increase was significant difference ($p < 0.05$) and could be explained by loss of water by evaporation under high temperature recorded during fermentation and by the loss of water from the seeds by draining through the perforate plate of the wooden box or the basket during the fermentation. Similar increase in dry matter during fermentation of African locust bean, soybean, egusi or *Porpis africana* have been reported by Odunfa (1985), Obeta and Ugwuanyi (1998) and Azokpota *et al.* (2006).

Also a significant ($p < 0.05$) increase in pH and total basic volatile nitrogen (TBVN) was recorded during the processing of African locust beans to Afitin.

pH values increased from 5.8 to 7.3 for basket and 5.8 to 7.6 for wooden box. TBVN contents varied from 16.3 to 211.5 mg N/100g for basket and 16.3 to 231.9 mg N/100g for wooden box.

Table 1. Changes in physicochemical characteristics during processing of African locust beans into Afitin using two type fermentation materials at different fermentation times.

Products	Fermentation times (h)	Temperature (°C)	pH	TBVN (mg N/100 g)	Dry matter (%, wb[1])	Crude proteins (%, dwb[2])	Crude fats (%, dwb)	Ash (%, dwb)
Traditional Afitin (Basket with jute bags/old cleaned clothes)	0	34.0±0.5a	5.8±0.2a	16.3±4.8a	36.2±0.2a	42.5±0.2a	34.2±0.1a	5.2±0.4a
	6	38.5±0.3b	6.1±0.1a	85.6±28.1b	36.5±0.1a	41.8±0.1b	34.9±0.6a	5.3±0.1a
	12	44.5±0.1c	6.5±0.1b	167.6±30.1c	37.1±0.3b	41.3±0.5b	37.6±0.2b	5.7±0.1a
	18	48.5±0.1d	7.3±0.1c	205.8±27.5c	37.5±0.2b	40.4±0.2c	38.3±0.5bc	5.9±0.1a
	24	32.5±0.3f	7.3 ±0.1c	211.5 ±32.4c	38.4±0.3c	40.6 ±0.1c	37.6 ±0.1b	6.1 ±0.1a
Modern Afitin (Wooden box)	0	34.5 ±0.4a	5.7±0.3a	16.3±4.8a	36.3±0.1a	42.3±0.1a	33.9±0.2a	5.3±0.3a
	6	37.5 ±0.5b	6.2±0.2a	93.2±16.0b	36.8±0.2a	41.6±0.1b	35.3±1.1a	5.5±0.2a
	12	43.5 ±0.8c	6.7±0.1b	180.4±25.2c	37.5±0.1b	40.8±0.3b	38.5±0.1c	6.0±0.1a
	18	47.0±1.0e	7.6±0.1d	221.7±30.4c	38.6±0.1c	40.1±0.3c	38.7±0.4c	6.3±0.3a
	24	32.5 ±0.5f	7.6±0.1d	231.9±45.1c	38.9±0.1d	40.3±0.2c	38.0±0.6c	6.4±0.2a

Values are means ± S.D. of two independent determinations.
Values in the same column related to the same product and having the same letter are not significantly different (P<0.05).
TBVN: Total basic volatile nitrogen
[1]wb: weight basis.
[2]Dwb: dry weight basis.

The increase of pH could be attributed to significant ammonia production which characterized the fermentation of protein-rich products (Omafuvbe *et al.*, 2000; Azokpota *et al.*, 2006).

The increase in TBVN resulted from the production of nitrogenous basic compounds, as ammonia due to proteins degradation through microbial and enzymatic activities (Ndir *et al.*, 1997; Beaumont, 2002, Azokpota *et al*, 2006).

As observed from Table 1, crude fat and ash contents were recorded to increase at variable extent in basket and wooden box but crude protein contents were observed to decrease from 42.5 to 40.3% during the fermentation time whatever the fermentation material.

The decrease of proteins could be due to microbial and enzymatic activities and drain with water from the cotyledons during the fermentation.

Table 2. Proximate composition of *Afitin* from two type fermentation materials.

Parameters	Dry matter (%, wb[1])	TBVN (mg N/100 g)	Crude proteins (%, dwb[2])	Crude fats (%, dwb)	Ash (%, dwb)
Traditional *Afitin* from basket with jute bags/old cleaned clothes	38.4 ±0.3a	211.5 ±32.4a	40.6 ±0.1a	37.6 ±0.1a	6.1 ±0.1a
Modern *Afitin* from wooden box	38.9±0.5a	231.9±45.1a	40.3±0.2a	38.0±0.1b	6.4±0.2a

Values are means ± S.D. of two independent determinations.
Values in the same column with the same letter are not significantly different (P<0.05).
[1]wb: weight basis.
[2]Dwb: dry weight basis.

Proximate composition of afitin

The proximate compositions of final product (Afitin) from two fermentation materials after 24 h of fermentation are presented in Table 2. There was no significant difference (p> 0.05) in the means of proximate compositions of two types of Afitin obtained whatever the fermentation materials. These results indicated that the wooden box can be used for Afitin production.

Table 3. Sensory quality attributes of Afitin from wooden box and basket after 24 h of fermentation.

Parameters	Colour/ appearance	Soft texture	Aroma	Overall acceptability
Traditional *Afitin* from basket, jute bags and old clean clothes	7.0 ±0.5a	8.6 ±0.7a	7.1 ±0.0a	7.2±0.1a
Modern *Afitin* from wooden box	8.0 ±0.1b	7.0±0.9a	7.5 ±0.2b	8.2±0.3b

Values are means ± S.D. of two independent determinations.

Values in the same column with the same letter are not significantly different (P<0.05).

The proximate compositions of Afitin were dry matter (38.4 – 38.9 % wb), TBVN (211.5 - 231.9 mg N/100g), crude proteins (40.3 - 40.6% dwb), crude fats (37.6 - 38.0 % dwb) and ash (6.1 – 6.4 % dwb). TBVN values of Afitin were significantly lower compared to TBVN values of fermented product rich in protein like meat and fish (457.9 mgN/100g for Lanhouin, Benin fermented fish) (Kindossi *et al.*, 2016).

Table 4. Performance evaluation of wooden box and basket by local processors

Fermentation material	Effectiveness	Hygiene	Easy to use	Production capacity
Basket, jute bags and old clean clothes	7.5 ±0.1a	6.1 ±0.2a	5.3±0.2a	6.5 ±0.3a
Wooden box	8.5 ±0.2b	8.6 ±0.5b	8.5 ±0.4b	4.1±0.6b

Values are means ± S.D. of two independent determinations.

Values in the same column with the same letter are not significantly different (P<0.05).

Sensory characteristics of afitin samples

The results of sensory quality attributes of Afitin samples from the two types of fermentation materials evaluated by the panel for preference for colour, texture, aroma, taste and overall acceptability were shown in Table 3. The colour and appearance of Afitin to great extent depends on the level of hygiene exhibited by processor and also on fermentation material used (Hongbété, 2001).

The sensory scores for colour of Afitin samples varied between 7.0 and 8.0 with Afitin (traditional) from basket with jute bags/old cleaned clothes recording the lowest mean (7.0) and the Afitin (modern) from wooden box recording the highest score (8.0). The sample from wooden box recorded significantly ($p < 0.05$) higher score when compared with that obtained from basket with jute bags/old cleaned clothes.

Soft texture is one of important quality attributes of Afitin that influence its acceptability by consumers (Gutierrez *et al.*, 2000; Agbobatinkpo *et al.*, 2012). The score for the texture of Afitin samples ranged from 7.0 to 8.6. The samples of Afitin obtained from basket with jute bags/old cleaned clothes recorded significantly higher score for soft texture than the samples of Afitin obtained from wooden box.

This difference was due to jute bags/old cleaned clothes used to cover the cotyledons which have created high temperature during the processing. Also a positive correlation ($r = 0.82$) was observed between the temperature and the smooth texture of the seeds. These results indicated that more the temperature generated during the fermentation increased, more the fermented cotyledons were softened.

Fig. 1. Wooden box, (a) box with cover, (b) box with fermented African locust bean.

The softening of seeds is characteristic of a successful fermentation. But the unhygienic nature of rudimentary materials such as baskets, jute bags and old cleaned clothes used for processing African locust beans to Afitin were potential sources of contamination and responsible of variable quality of the final product from batch to batch (Iwuoha and Eke, 1996; Gutierrez *et al*., 2000 ; Motarjemi, 2002). Afitin is most preferred when its aroma is strong ammoniacal, meaning that it must have undergone alkaline fermentation. Afitin obtained from wooden box had the highest score (7.5) on aroma while the Afitin obtained from basket with jute bags/old cleaned clothes recorded lowest score (7.1). For the aroma, samples of Afitin obtained from wooden box recorded significantly higher ($p < 0.05$) score when compared with samples of Afitin obtained from basket with jute bags/old cleaned clothes. Flavouring condiments as Afitin and Lanhouin (Kindossi *et al*., 2013) have strong characteristic flavour and aroma. These flavour and aroma resulted from the degradation of protein with the formation of nitrogenous basic compounds during alkaline fermentation (Beaumont, 2002 ; Azokpota *et al*., 2006).

Overall acceptability is the reflection of the total scores for all sensory quality attributes. It ranged from 7.2 to 8.2. Both of samples were accepted by the panel but the acceptability score of samples of Afitin obtained from wooden box was the significant ($p < 0.05$) highest score (8.2) when compared with that of samples of Afitin obtained from basket with jute bags/old cleaned clothes (7.2). This implies that Afitin obtained from wooden box is more acceptable to the consumer than that obtained from traditional material.

Performance evaluation of the fermentation material

The scores of performance evaluation of fermentation material with regard to the Afitin sensory quality attributes are shown in the Table 4. The local processors found that the score for effectiveness of the fermentation material ranged from 7.5 to 8.5. The wooden box recorded significantly ($p < 0.05$) higher score for effectiveness than the traditional fermentation material (basket with jute bags/old cleaned clothes).

Hygiene is essential to improve the quality of product. The Wooden box recorded significantly higher ($p < 0.05$) score (8.6) than the traditional fermentation material (6.1). Also the wooden box recorded significantly ($p < 0.05$) higher score (8.5) for easy to use compared with traditional material which score was lower 5.3. This indicated that the local processors found the wooden box easy to be cleaned and offers high quality for the final product.

However the local processors attributed low score to wooden box (4.1) for production capacity and gave higher score (6.5) to the traditional fermentation material which volume capacity is above 15 kg of African locust beans.

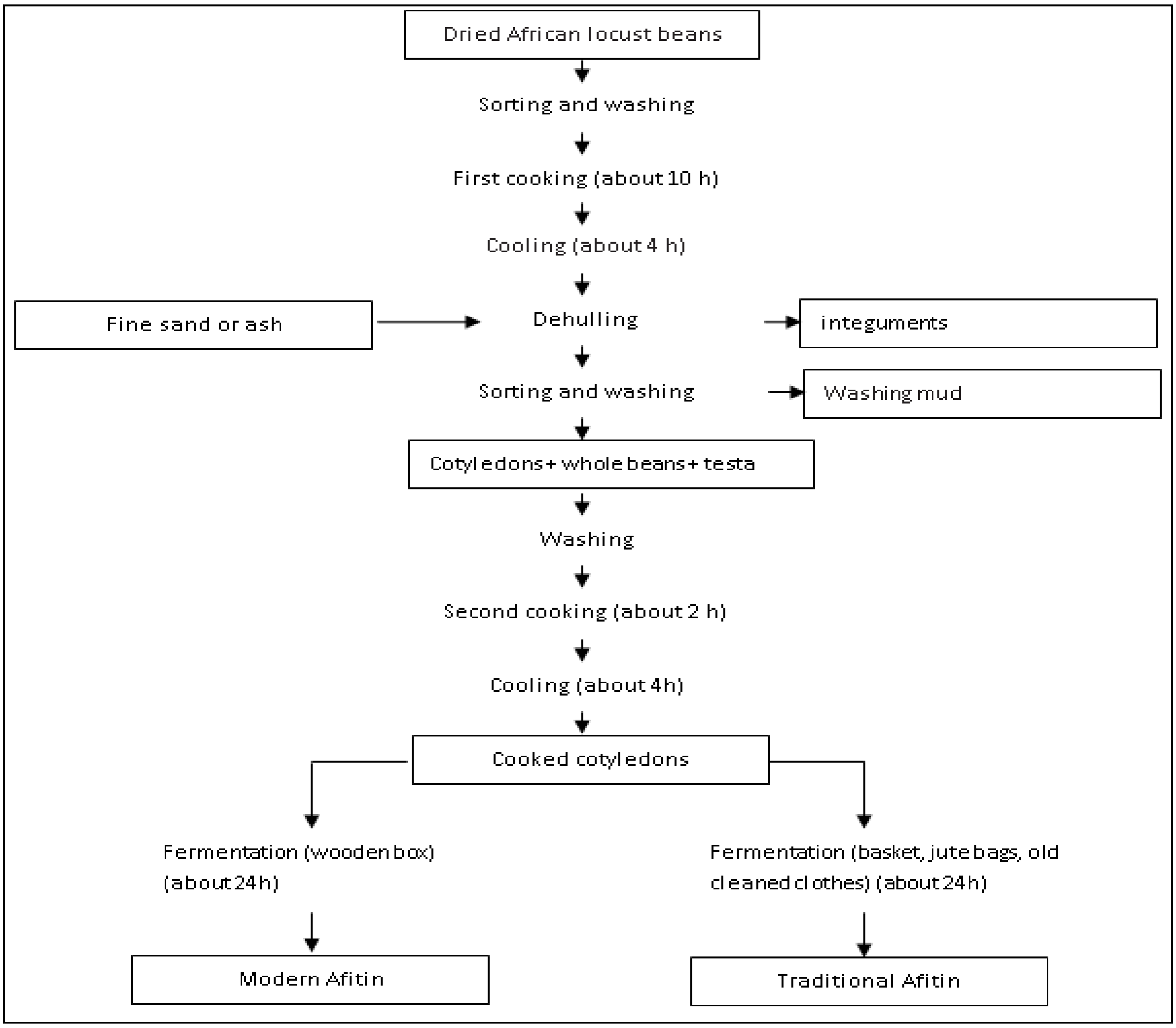

Fig. 2. Flow sheet of Afitin production.

Conclusion

The study showed a better adaptation of wooden box to be used for Afitin production technology. It revealed a great similarity between the traditional Afitin from basket with jute bags/old cleaned clothes and the modern Afitin obtained from wooden box. The modern Afitin from wooden box recorded higher physicochemical and sensory characteristics than those of the traditional Afitin. An adaptation of wooden box dimensions for production capacity is necessary to its adoption by local processors.

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