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Ethno-Food Knowledge of Baobab (*Adansonia digitata* L.) and Characterisation of Its Traditional Fermented Novel Foods from Benin

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Abstract

Adansonia digitata is a key economic tree used daily by local populations in Africa for food, medicines and cultural purposes. The aim of the study was to record the ethno-food knowledge on baobab processing and derived foods, and to further provide the properties of traditional fermented foods, for valorization purposes. Correspondence Analysis (CA) was used to link socio-cultural groups and food parameters. CA showed that the food uses of baobab parts vary from one ethnic group to another. The identified food categories were dough, gruel, drinks, sauces, snacks and flavouring agents. Some of the recorded products were fermented foods (spontaneous fermentation): *Dikouanyouri* (from seeds, pH=6.5), *Tayohounta* (from kernels, pH=7), and *Mutchayan* (from baobab pulp and sorghum, pH=4.2). The predominant microorganisms in *Dikouanyouri* and *Tayohounta* were *Bacillus* spp. (8.5 and 9.5 log cfu/g) and lactic acid bacteria (8.9 and 8.4 log cfu/g) respectively. In *Mutchayan*, the predominant microorganisms were lactic acid bacteria (8.1 log cfu/g) and yeasts (7.2 log cfu/g). From the outputs, strategies to improve processing techniques for production of more hygienic and safer baobab derived foods were proposed.

INTRODUCTION

Baobab (*Adansonia digitata* L.) is a widely distributed tree in many African countries and is used daily for food, as medicine and for other purposes (Wickens, 1982; Sidibe and Williams, 2002). Studies related to baobab species have provided data on the ecology, genetics, ethnobotanical aspects, and the chemical composition of its parts (Assogbadjo et al., 2006; Chadare et al., 2009; Diop et al., 2005). There is a recent awakening of interest and concern about the lack of documentation about traditional and indigenous food cultures which are important not only for their own sake, but for the legacy of food knowledge which they can confer on future generations, provided that they are not lost; hence, the value of special focus on African food cultures (Wahlqvist, 2007). However, the ethno-food knowledge of baobab is poorly documented and no study specifically addressed the characterization of traditional baobab foods. The present paper aimed at filling these gaps.

METHODOLOGY

Survey

First, a random check was performed on 198 users/processors offering their foods

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for sale on local markets to determine the proportion of users/processors of baobab food products. This proportion was used to compute the sample size N_i of baobab processors to be interviewed, using the following formula:

$$N_i = \frac{4p_i(1-p_i)}{d^2}, \text{ (Dagnelli, 1998)} \quad (1)$$

where N_i is the total number of users/processors to be surveyed for the study; p_i is the proportion of baobab users/processors among the 198 randomly checked persons; d is the expected error margin in the conclusion, which is fixed at 0.05 (Dagnelli, 1998). Multivariate analysis was used to link socio-cultural groups and baobab food uses.

Microbiological Analyses

Total aerobic mesophilic bacteria were enumerated on Nutrient Agar (Remel 454182, Bie and Berntsen, Rodovre, Denmark) (37°C, 48 h). Bacterial spores (mainly *Bacillus* spp.) were enumerated on Nutrient Agar (Remel 454182, Bie and Berntsen, Rodovre, Denmark) (37°C, 48 h), from a 10^{-1} dilution that had been heated for 10 min at 80°C to kill vegetative cells. Lactic acid bacteria were enumerated on de Man Rogosa and Sharpe Agar (MRSA, CM 361, Oxoid, Hampshire, England) containing 0.1% (w/v) natamycin (Delvocid, Gist-Brocades, Delft, The Netherlands) after incubation at 30°C for 3-4 days. Colonies were confirmed by oxidase and catalase tests (Nout, 1991). Yeasts were counted after incubation at 25°C for 3-5 days on a mixture -MYGP- of malt extract (3 g), yeast extract (3 g), glucose (10 g), peptone (5 g) and agar (20 g) supplemented with chloramphenicol and chlortetracycline (Jespersen et al., 1994).

Physico-Chemical Analyses

The pH and titratable acidity were measured immediately on the wet samples according to Nout et al. (1989). The dry matter, crude fat, and ash contents of the samples were determined, using AOAC methods 27.005, 27.006, and 27.009, respectively (AOAC, 1984). Protein contents were measured using the Dumas method (Jung, 2003). Free amino nitrogen was measured using formol titration (Han et al., 1999). Protein was converted and expressed as total nitrogen using the factor of 6.25.

RESULTS

Relationship between Final Food Uses and Socio-Cultural Groups

Among the 15 ethnic groups investigated, some have similar uses of parts of the baobab tree, while others differ. The result of the correspondence analysis (CA) (Fig. 1a and b) performed on the final food uses and socio-cultural groups showed that the first three axes explained 55.2% of the observed variation. Partial correlations and contribution of each of the considered modalities allow identification of the socio-cultural groups and the end uses that are the best represented on each axis. The projection of the different modalities in the axes system shows that the food uses of baobab parts are specific for the ethnic groups. Considering axis 1 (Fig. 1a), Berba, Wama, and Yom ethnic groups use baobab pulp to make *Yewowi* (P36 = product no.36), *Tcho* (P35) and *Nanganfirou* (P10) beverages. These ethnic groups, especially the women, process leaves into dry leaf (P5), dry leaf sauce (P22), and *Touwoundou* sauce (P28). Kernels are mainly used for *Sarai* sauce (P27). By contrast, Otamari and Tchocossi ethnic groups, especially adult and elderly people, use baobab pulp for making sour dough (P12), pulp drink (P3) and baobab syrup (P30). In these ethnic groups, seeds are used for making *Matofaman* (P17), *Batokoue* sauce (P19), and *Dikouanyouri* (P20) especially from the seeds that cannot be decorticated. Specifically, the Otamari people use baobab kernels mixed with locust beans for making *Tayohounta* type 2 (P34) and *Mougoun-Mougoun* (P7). With respect to axis 2 (Fig. 1a), the following ethnic groups: Datcha, Mahi (locality of Dassa), Otamari,

Tchocossi, Comcombè, Dendi, and Lokpa have quite similar uses of some baobab parts; they use baobab fruits for making potash (P13). Apart from Datcha and Mahi, who use the whole fruit to make potash, all other ethnic groups use the empty fruit shell as raw material to make potash. In addition, the other ethnic groups (except Datcha and Mahi) produce baobab pulp (P16) from the fruits; they use pulp for making iced pulp beverage (P32) and they use leaves to produce and prepare dry leaf powder (P14), fresh leaves sauce (P21), and dry leaf powder sauce (P26). Specifically, Bariba use the pulp for *Solani* (P31) production; young people from the Dendi ethnic group produce *Moukou-Moukou* (P9) from pulp; the Dendi from Karimama locality produce *Mougoundoro* (P8) from whole seeds; Otamari, Tchocossi and Comcombè ethnic groups use seeds for making kernels (P1), kernels for making *Tayohounta* type 1 (P33) and roasted kernels (P2), and leaves to make *Yatirankounti* sauce (P29). Regarding axis 3 (Fig. 1b), it can be observed that the Gourmantche ethnic group produces roasted seed powder (P15); and the Nateri use leaves for *Kouimkoundi* sauce (P23); the Wama ethnic group uses pulp to make *Norendoorou* beverage (P11). Most ethnic groups (Berba, Brouba, Gourmantche, Dendi, Peulh, Otamari and Wama), produce seeds (P6) from the fruits, *Moutopkei* sauce (P24) from the seeds, gruel from the pulp and, with the exception of the Dendi, produce kernel sauce (P18) from the kernels.

Figure 2 shows the flow diagram for the processing of *Dikouanyouri*, *Mutchayan* and *Tayohounta*.

Microbiological Characteristics of *Mutchayan*, *Dikouanyouri* and *Tayohounta*

Table 1 shows that *Dikouanyouri* and *Tayohounta* contain very high levels of mesophilic aerobic bacteria (9.5 log cfu/g). Sporeformers (8.5 and 9.1 log cfu/g respectively) and lactic acid bacteria (8.9 and 8.4 log cfu/g respectively) were detected in large numbers. Especially for the sporeformers, this indicates that also high levels of vegetative cells of *Bacillus* spp. may be expected (i.e., the difference between the total count and the sporeformers and lactic acid bacteria). Possibly, other microorganisms will be present in these products; this will require further investigation. *Mutchayan* contained mainly lactic acid bacteria (7.6 log cfu/g) with a substantial amount of yeasts (7.2 log cfu/g) (Table 1). Counts in unfermented products were below the minimum level to be considered of relevance.

Physico-Chemical Characteristics of *Mutchayan*, *Dikouanyouri* and *Tayohounta*: Impact of Fermentation

Table 2 shows the characteristics of the 3 fermented products before and after fermentation. Important changes were noticed in *Dikouanyouri* and *Tayohounta*. For example, as a result of protein degradation, the ratio amino nitrogen/total nitrogen (i.e., an arbitrary index of protein cleavage) rose from 2.3% in the non-fermented product to 13.7% in the fermented *Dikouanyouri* and from 2.3% in the non fermented to 21.3% in the fermented *Tayohounta*.

DISCUSSION

Ethno-Food Knowledge of Baobab Food Products

The end uses of baobab parts are quite specific for the ethnic groups interviewed and differences were observed in the processing techniques for similar products among these ethnic groups. Over time, socio-cultural groups have accumulated a rich knowledge on the use of baobab but mostly with reference to their locality of origin. Moreover, ethnic groups are located in specific localities; the combination of an ethnic group and its locality may be a determinant for their food uses since food practices are usually cultural. According to Wahlqvist (2007), food culture is influenced most by the locality of its origin, which will have been one of food acquisition and processing by various means. Rivera et al. (2007), using hierarchical cluster analysis on gathered food plants in the mountains of Castilla-La Mancha in Spain, found that clusters of food plant species form

culture-specific logical entities, which allow people to structure and manage their environment. Local populations have an outstanding knowledge of food uses of baobab.

Properties of Baobab Fermented Foods

The dominant microflora in *Tayohounta* and *Dikouanyouri* are bacteria, especially sporeforming bacilli (*Bacillus* spp.) and lactic acid bacteria. The predominance of *Bacillus* spp. was to be expected as it the case for most fermented seed products. In such seed products the fermentation is proteolytic; the bacilli are strong producers of proteolytic enzymes. Proteolysis leads to an increase of free amino acids such as lysine (Odunfa, 1985). Their predominance in these fermentations may be due to their ability to survive cooking and to initiate fermentation of both nitrogenous and carbohydrate products (Omafuvbe et al., 1999). This proteolysis is also expressed through protein degradation during the fermentation process. Though *Mutchayan* is primarily made from cereals, it is the only fermented cereal food enriched with baobab pulp juice. This addition increases the ascorbic acid content, which may play an important role as enhancer of mineral uptake (Hemalatha et al., 2005). The microflora of *Mutchayan* was dominated by lactic acid bacteria but the product contained also substantial amount of yeasts. This was to be expected in such a product due to its acidic pH of 4.2, which is favourable for the development of such microorganisms. More detailed studies leading to development of starter cultures are necessary for production of safer products for a larger public.

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Tables

Table 1. Microorganisms (log cfu/g) in “Mutchayan”, “Dikouanyouri” and “Tayohounta”.

Microorganisms group	Mutchayan	Dikouanyouri	Tayohounta
Total mesophilic aerobic bacteria (TMC)	7.5±0.8 b	9.5±0.6 a	9.5±0.6 a
Total sporeformers (TS)	ND	8.5±1.0 a	9.1±1.1 a
Lactic acid bacteria (LAB)	7.6±0.4 c	8.9±0.4 a	8.4±0.8 b
Yeasts (Y)	7.2±0.6 a	5.5±0.5 b	5.3±1.3 b

Values represent the mean scores (n=6 samples and 2 replications of each ± standard deviation).

ND: not detected.

For each parameter (each row), means with the same letter are not significantly different (p<0.05).

Table 2. Effect of fermentation on the physico-chemical characteristics of “Mutchayan”, “Dikouanyouri” and “Tayohounta”.

Parameters	Dikouanyouri		Tayohounta		Mutchayan	
	Unfermented	Fermented	Unfermented	Fermented	Unfermented	Fermented
Dry matter (g/100 g)	36.6±0.2c	37.5±0.1c	49.7±0.5a	46.1±1.9b	22.2±0.3d	22.5±1.5d
Crude lipids (g/100 g dm)	13.0±0.5d	17.2±1.06c	36.9±0.9a	42.5±0.6b	0.7±0.06e	1.6±0.4e
Ash (g/100 g dm)	4.7±0.2b	10.9±3.2a	8.6±0.2a	9.6±0.4a	2.2±0.0b	2.2±0.4b
pH	6.7±0.0a	6.5±0.7a	6.4±0.0a	7.0±0.5a	4.2±0.0b	4.2±0.3b
Titrateable acidity (mmol NaOH/100 g dm)	6.9±0.2d	14.3±1.7b	11.6±01.7c	17.5±2.8b	23.2±0.4a	17.5±3.7b
Total nitrogen (mmol N/100 g dm)	342.5±17.2b	290.5±42.4c	476.9±11.6a	496.5±16.6a	106.6±1.1d	120.2±6.9d
Free amino nitrogen (mmol AN/100 g dm)	7.9±0.5c	39.7±5.0b	11.0±0.3c	105.7±10.8a	0.0±0.0d	0.00±0.0d
Index of protein cleavage = free amino nitrogen/total nitrogen (%)	2.3	13.7	2.3	21.3	0	0

Values represent the mean scores (n=6 samples and 2 replications of each ± standard deviation). For each parameter (each row), means with the same letter are not significantly different (p<0.05).

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Fig. 1. a. Correspondence analysis to reveal linkages between baobab uses and socio-cultural groups on axes 1 and 2; b. correspondence analysis to reveal linkages between baobab uses and socio-cultural groups on axis 3. Legend: P = Product; P1=Kernels; P2 = roasted kernels; P3 = pulp drink; P4 = Gruel; P5 = dry leaf; P6 = seeds; P7 = Mougou-Mougou; P8 = Mougoundoro; P9 = Moukou-Moukou; P10 = Nanganfirou; P11 = Norendoorou; P12 = sour dough; P13 = potash; P14 = dry leaf powder; P15 = powder from roasted seeds; P16 = pulp; P17 = Matofaman sauce; P18 = kernels sauce; P19 = Batokoue sauce; P20 = Dikouanyouri sauce; P21 = fresh leaves sauce; P22 = dry leaf sauce; P23 = Kouimkoundi sauce; P24 = Moutokpei sauce; P26 = leaf powder sauce; P27 = Sarai sauce; P28 = Touwoundou sauce; P29 = Yatirankounti sauce; P30 = baobab syrup; P31 = Solani; P32 = iced pulp beverage; P33 = Tayohounta type 1; P34 = Tayohounta type 2; P35 = Tcho; P36 =Yewowi.

Fig. 2. Flow diagram for the processing of “Dikouanyouri”, “Mutchayan” and “Tayohounta”.