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Farmers' perceptions on characteristics of cassava (*Manihot esculenta* Crantz) varieties used for chips production in rural areas in Benin, West Africa

Gbemenou J. Benoit GNONLONFIN [1,2,3*], Delphin O. KOUDANDE [1], Ambaliou SANNI [2] and Leon BRIMER [3]

[1] *National Institute of Agricultural Research of Benin, 01 P.O. Box 884, Cotonou, Benin.*
[2] *Biochemistry and Molecular Biology laboratory, Faculty of Sciences and Techniques, University of Abomey-Calavi, 04 P.O. Box 0320, Cotonou, Benin.*
[3] *Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen, Ridebanevej 9, DK-1870 Frederiksberg C, Denmark.*
[*] *Corresponding author, E-mail: bgnonlonfin@yahoo.fr ; bgjg@life.ku.dk ;Tel. +45 50336096 (Denmark); +229 97694562 (Benin)*

ABSTRACT

A survey aimed at collecting information about cassava varieties/cultivars and farmers' perceptions concerning cassava and chemical food safety was conducted in 10 villages located in two agroecological zones in Benin. A structured questionnaire to interview farmers was employed. Out of 100 farmers sampled, most of them relaying on chips as food and source of income were women. Overall, 40% of all farmers marketed chips locally. Tasting was the main technique use by farmers to discriminate cassava varieties including Kpaki Kpika, Kpaki Soan, Logo Guesse Kotorou and BEN 86052. The latter being introduced by research centres. Both bitter and sweet cassava were produced and the sweet varieties being used for chips production by farmers who do perceive bitter cassava as toxic crop. Our results call for more investigations in promoting gender oriented safety and hygiene/sanitation techniques.

Keywords: Survey, food safety, processors, chips.

INTRODUCTION

Cassava or manioc (*Manihot esculenta* Crantz, Euphorbiaceae) is widely grown as a staple food and animal feed in countries of tropical and sub-tropical Africa, Asia and Latin America between 30° N and 30° S with a total cultivated area over 13 million hectares, more than 70% of it being in Africa and Asia (FAO, 2000 ; Westby, 2002). In Benin, cassava ranks in the second place after maize followed by yam and sweet potato in the group of roots and tubers with a world production of 1,682,190 tonnes in 2007 (FAO, 2008). Cassava forms the most important part of many cropping systems and occurs in a wide array of marketing channels (Anonymous, 2006), thus constituting an important food security and income generating crop for several households. Both cassava leaves and roots are consumed (Aduni et al., 2005; Kehinde, 2006). Leaves provide an important protein intake (Khampa and Wanapat, 2006), thus cassava leaves have a value as a protein supplement (leaf crude protein content on dry basis ranges among cultivars from 21% to 39% (Ravindra, 1993) for man (Ndugi et al., 2003) and in animal nutrition either in feed formulations for monogastric animals or as a fresh forage to supplement low-quality roughages in ruminant feeds (Ravindra, 1993); whereas roots are a cheap source of carbohydrates (Nwokoro et al., 2005). However, one of the main constraints related to fresh roots of cassava is their poor shelf life. After harvesting, cassava roots cannot be stored longer than three or four days due to postharvest physiological deterioration (Buschmann et al., 2000). Another drawback associated with cassava is its potential toxicity: depending on cultivars, edible organs of cassava (leaves or roots) may contain large amounts of the cyanogenic glucoside linamarin, along with additional small quantities of a similar compound referred to as lotaustralin (Jørgensen et al., 2005). Both substances are highly toxic and negatively impact the health of animals and human upon consumption of cassava. In attempting to simultaneously increase shelf life of fresh roots and avoid dietary cyanide exposure due to the above-mentioned glucoside compounds, fresh roots are often processed into variable stable and durable products such as gari, lafun, flour, dried cassava chips and other dried products (Moorthy and Mathew, 1998; Zhou and Nzingamasobo, 2006; Gnonlonfin et al., 2008a). In this respect, cassava processing could be related to the necessity of having permanent food reserves and also to remove toxic cyanide glucoside contained in its edible organs before its consumption. Apart from overcoming the perishability and toxicity of the crop, transformation has also been shown to enhance the nutritional standard, along with adding substantial economic value to cassava (Laswai et al., 2006; Khampa and Wanapat, 2006).

Among the derived cassava products identified in Sub-Saharan Africa, cassava chips have been the most commonly encountered (Anonymous, 1992). Also, recent research reports suggest that cassava chips form the bulk of cassava based-foods in several cassava consuming populations (Zhou and Nzigamasobo, 2006). These are the derived products of fresh roots of cassava, obtained after cutting and sun light drying, and usually followed by their subsequent storage (Hahn, 1993; Gnonlonfin et al., 2008b). In many cassava growing communities, chips are used as foods, feeds, and may serve as raw material to manufacture starch, and alcoholic drinks (Kehinde, 2006; Gnonlonfin et al., 2008a,b). Cassava chips' production is therefore likely to be of growing importance to farmers in several communities where the crop forms the staple. In Benin, research results showed that drying conditions are very poor and favor pests and fungi attacks during storage (Gnonlonfin et al., 2008b). Furthermore, there is no fermentation step during chips' production. Cassava variety with high cyanide glucoside content normally requires fermentation prior to drying (to facilitate cyanogenic glucoside removal). In Benin, farmers do not include such a step in chips production. Therefore they use only low cyanogenic cassava for chip production. This indicates that producers and processors have some indigenous methods to discriminate cassava varieties. There is still limited knowledge about cassava varieties used by farmers and processors and how do they recognize the safety of the root. Such an understanding is important for stimulating appropriate collaboration between farmers and scientists helpful to further provide the necessary assistance to farmers, for the production of safe cassava based-products for local and international markets. The present study was conducted to obtain an overview of farmers and processors general knowledge of the cultivated varieties/cultivars, including their taste classification of cassava. Furthermore, we investigated whether the activity was profitable for them.

MATERIALS AND METHODS

Study areas

The study was carried out in Benin in the two agroecological zones [Northern Guinea Savannah (NGS) and Sudan Savannah (SS)] where cassava chips are being produced as described by Gnonlonfin et al. (2008a). Ten villages (Figure 1) with 5 villages per agroecological zone were studied with 10 farmers randomly chosen in each village. A total of 90 women and 10 men were interviewed.

Field methods and tools

From May to June 2010, surveys were undertaken across the 10 villages throughout the two agroecological zones of the benchmark at the household level. Participatory rapid rural approaches (Pretty et al., 1995) were used for investigation. The tools included focus group discussions with information on questionnaire. Ten focus group sessions were held with 15 farmers in each village. The findings from the focus groups were used to design the questions used in the questionnaire. Then individual interviews (approximately 15 min.) on cassava production and processing into chips, number of varieties/cultivars in use, origin of these cultivars, main activities of the respondent, test for roots toxicity and the end use of chips (family consumption, marketing and other use). The survey was conducted with the help of interpreters where needed. Two types of questions were included in the questionnaire. Fixed choice questions were those where the respondents had to choose one item among several alternatives or questions for which the expected response was «yes» or «no».

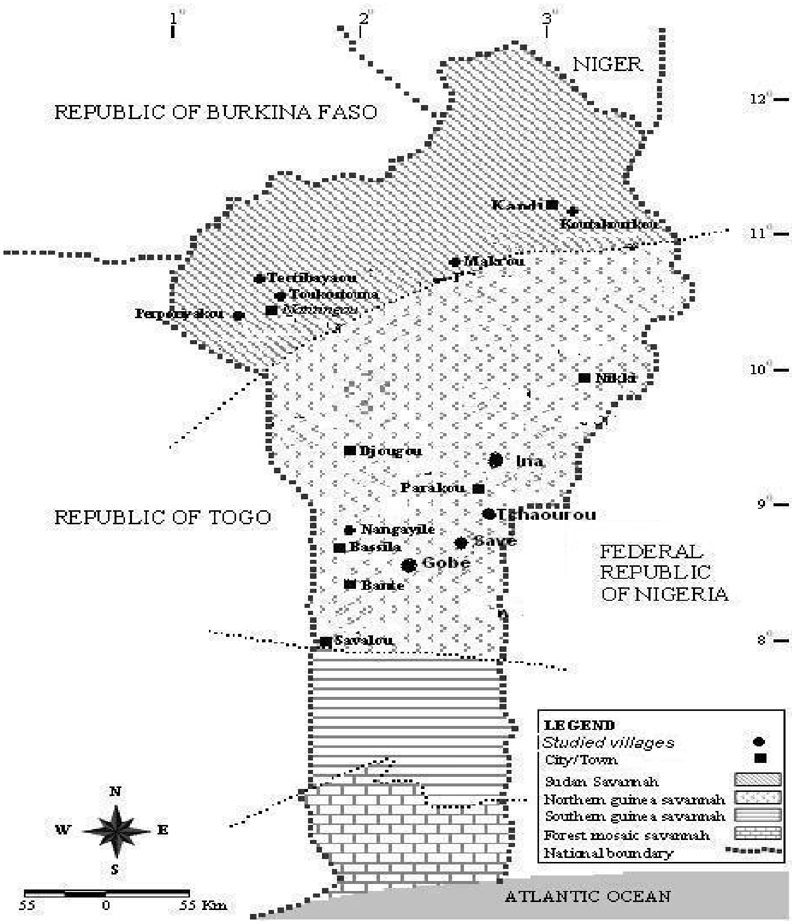

Figure 1: Map of the Republic of Benin with the diffrent villages and agroecological zones.

Examples: Do you produce cassava to feed your family only? What is your principal activity? Open-ended questions were those which allowed the informants to express their opinion. Examples: How many cultivars do you have? And their origin? How do you test for the roots toxicity?

Data analysis

Answers were coded numerically. For fixed questions, positive and negative answers were coded «1» and «0», respectively. For open-ended questions, the various responses were recorded, checked, and grouped into similar categories. After that, they were given additional code numbers. Codified data were processed using SPSS for windows version 12.0 (SPSS Inc., Chicago, IL). Results were expressed as percentages of responses obtained from farmers.

RESULTS

Personal characteristics of farmers and rational for cassava chips production

The farmers interviewed are grouped into various age groups with 85% of the respondents having an age between 30-50; processing experience and education levels (Table 1). An important observation associated with the present results is connected to the fact that 85% of the respondents were not educated. Cassava chips production was carried out surely by female (100%) while the fresh roots production was done mainly by male (93%) (Table 2). For casssava chips production more than based on households own growing, women bought fresh roots from men who are owners of the farm. In all the locations investigated, cassava chips were produced mainly for home consumption and/or commercial purposes (Table 2). The use of cassava chips for feeding animals was not reported. Furthermore, no industrial uses of the chips such as gums or starch manufacturing was mentioned by any of the target groups.

Cultivated varieties/cultivars in the two specified zones of Benin

Based on the information gathered during the interviews, it appeared that the cassava consuming communities depended mostly on their own locale varieties or cultivars; very few improved varieties released by a research centre were cultivated. Farmers described yield in terms of high or low based on the number of roots produced per plant or the size of the roots rather than in tonnes/ha. Reasons for preferring a certain variety were supported by the yield, the degree of susceptibility to post harvest deterioration and the toxicity (Table 3). In both agroecological zones sweet as well as bitter varieties previously were grown the latter for *gari* production. However, at the time of interview only sweet varieties processed into chips were found. Apart from BEN 86052 which was released by a research centre (Southern Agricultural Research Centre which belong to the National Agricultural Research in Benin, Ministry of Agriculture, Livestock and Fichery) and at the time of the survey was still in use by very few farmers, all other varieties were given by friends or relatives with the two bitter varieties Olouchoute and Esse ewele being not in current use (Table 4).

Farmers' perceptions of the potential toxicity of raw products

Raw cassava and its derived products were not considered to be a problem. Farmers were confident that the different methods they use for discriminating varieties as bitter or sweet were very good. Cassava taste (100% of respondent) was determined by cutting a piece before tasting it. Women were the primary tasters as they were, again, the primary harvesters (bought the land ready to harvest fresh cassava and do the harvesting themselves with the help of children where needed) and processors of cassava intented for human consumption. No farmer said consumption of cassava root can cause vomiting, while seven farmers said it can cause stomach upset (Table 5).

Table 1: Characteristics of interviewed farmers (90 women and 10 men).

Item	NGS		SS		Total	
	# 50	%	# 50	%	# 100	%
Age (years)						
<30	3	6	1	2	4	4
30-50	40	80	45	90	85	85
>50	7	14	4	8	11	11
Education						
Not edu.	45	90	40	80	85	85
<6 yrs 1ary edu.	4	8	8	18	12	12
6 yrs 1 ary edu.	1	2	2	2	3	3
Experience (years)						
1-5	2	4	3	6	5	5
6-10	3	6	3	6	6	6
11-20	15	30	12	24	27	27
>20	30	60	32	64	62	62
Main occupation						
Agriculture	100	100	100	100	100	100
Non agriculture	0	0	0	0	0	0

=Number of farmers ; % = Percentage of farmers ; Yrs = Years ; 1 ary= primary ; not edu.= do not attend school ; NGS = Northern Guinea Savannah ; SS = Sudan Savannah.

Table 2: Gender roles within the household as disclose from interviews and household rational for chips production.

Item	NGS		SS		Total	
	# 50	%	# 50	%	# 100	%
Gender						
(Fresh roots production)						
Male	45	90	48	96	93	93
Female	5	10	2	4	7	7
Gender (Chips processing)						
Male	0	0	0	0	0	0
Female	50	100	50	100	100	100
Rationale for cassava chips production						
Food	25	50	35	70	60	60
Feed	0	0	0	0	0	0
Food and locale sale/cities	25	50	15	30	40	40

=Number of farmers; % = Percentage of farmers; NGS = Northern Guinea Savannah; SS = Sudan Savannah.

Table 3: Varieties/cultivars grown: characteristics and use in Benin.

Variety/cultivar (local names)	Characteristics and use
Kpaki kpika	Leaf cool and tasty good once cooked; high yielding 5-8 roots per plant; roots spread/easy to harvest; mature at 5-6 months; palatable roots ; immerses completely when soaked; not fibrous; sweet/cool ; used for chips production and gari. Identification: white petioles, green leaves; whitish roots and stem; susceptible to mosaic virus (brown streak inside).
Kpaki soan	Similar characteristics to kpaki kpika but leaf bitter (not eatable); yielding up to 10-12 roots per plant; used for chips production. Identification: red petioles and stem; green leaves.
Logo guesse kotorou	Low yield; long and big roots; eaten roasted or boiled. It is sweet and highly desired by people; used for chips production. Identification: leaves and petioles yelowish and stem; susceptible to mosaic virus.
BEN 86052	Breeding variety; similar characteristics to kpaki soan but more susceptible to post harvest deterioration; not many farmer used it because of its highly perishability; leaf eatable; use for chips production. Identification: red petioles and stem, green leaves; resistant to mosaic virus.
Olebekpe	Sweet; low yield, difficult to harvest; very susceptible to mosaic virus; used by very few farmers in NGS.
Olouchoute	Bitter; low yield, easy to harvest; not in current use.
Esse ewele	Bitter, high yield, animal died when eaten the leaves; easy to harvest, not in current use.

Table 4: Percentage of usage and origin of cassava varieties/cultivars.

Variety/cultivar (local names)	Origin	NGS %	SS %	Total %
Kpaki kpika	Given by friends	100 (50)	100 (50)	100 (100)
Kpaki soan	Given by friends	100 (50)	100 (50)	100 (100)
Logo guesse kotorou	Given by friends	100 (50)	100 (50)	100 (100)
BEN 86052	Research centre	6 (3)	0 (0)	6 (3)
Olebekpe	Given by friends from Togo	4 (2)	0 (0)	4 (2)
Olouchoute	Given by friends	0 (0)	0 (0)	0 (0)
Esse ewele	Given by friends	0 (0)	0 (0)	0 (0)

( ) = number of farmers ; NGS = Northern Guinea Savannah ; SS = Sudan Savannah

Table 5: Farmers' perception/test of potential toxicity of cassava.

Factor	NGS %	SS %	Total %
Tasting	100 (50)	100 (50)	100 (100)
Leaf shape/colour	60 (30)	40 (20)	100 (50)
Other*	10 (5)	4 (2)	14 (7)

( ) = number of farmers; * = beef dies after eating the leaves or stomach aches after eating boiled roots; NGS = Northern Guinea Savannah; SS = Sudan Savannah

DISCUSSION

Results of this survey show that the production of cassava chips is widespread and mainly carried out by women in the study areas (Table 2). This finding is in line with previous works done in Cameroon (Essono et al., 2008) Tanzania and Nigeria (Oluwole et al., 2007). Within the group of women included in our study most of them (85%) were not formally educated (Table 1). This observation raises the question of education which can be a factor for food safety.

From the results of this study the importance of cassava chips production in the diet and income generation of farmers in the household sampled is demonstrated (Table 2). This result corroborates with Nweke (1998) and Essono et al. (2008) when they conducted a research on cassava food systems in several sub-Sahara African countries and farmers' perceptions of practices and constraints in cassava chips production in rural Cameroon, respectively.

Cassava varieties are often grouped into bitter or sweet and/or high or low (toxic/non toxic) cyanogenic varieties. Although such dual grouping of cassava is common in many african farming communities as shown in Malawi (Chiwona-Karltum et al., 2004) and Zambia (Nyirenda et al., 2011), bitter or sweet is not used consistently by farmers in all african countries/regions. Therefore, it cannot just be assumed that farmers will differentiate cassava varieties on the basis of bitter or sweet.

In the present study farmers mostly used attributes of taste to characterize the potential toxicity of cassava (Table 5). The practice of tasting the tuberous roots to evaluate the need for processing (degree of bitterness as associated with toxicity) was carried out by women and men, but in varying degrees. Women in general assess these qualities in the field while harvesting, as opposed to men who taste at the homestead before requesting their wives to cook the harvested cassava in a desired way. Both Chiwona-Karltum et al. (2004) and Nyirenda et al. (2011) have demonstrated that farmers also use taste to describe cassava varieties. Thus our observation is in line with the work done by Nyirenda et al. (2011) when conducting a study in Malawi and Zambia. These results calls for laboratory based testing to check whether the cassava roots are low or high content in cyanide glucosides.

From our results it appears that certain morphological characteristics including leaf shape or colour (Table 5) can also be used to group cassava varieties in terms of potential toxicity as reported by early works (Chiwona-Karltum, 2001 ; Mkumbira et al., 2003). In contrast, it has been stated that these morphological characteristics are not used by farmers in Nigeria and Tanzania for this purpose (Oluwole et al., 2007).

Different scientific systems of classifying cassava varieties into «toxic» and «non toxic» exists. The Indonesian Ministry of Industry and Trade sets the food safety level for cyanide content at 40 mg CN/kg fresh weight (Hidayat et al., 2000). While the internationally agreed trade rules states that sweet varieties of cassava are those that contain less than 50 mg/kg hydrogen cyanide fresh weight basis (CAC, 2003). Sweet cassava varieties are described to predominate in farming systems in Africa (Oluwole et al., 2007). More recent study has shown, however, that in Malawi and Zambia cassava classified by farmers as being sweet predominate only in regions where cassava plays a secondary role as staple food (Nyirenda et al., 2011). This could probably be at least partly explained by the fact that bitter varieties that need processing give the female farmers control over the crop (Chiwona-Karltun et al., 1998).

The differences in tasting as used locally and interpretations concerning toxicity to determine whether cassava tuberous roots products are safe when comparing our results to previous reports (Oluwole et al., 2007; Nyirenda et al., 2011) do suggest that there is an urgent need for training, information and sensitization at both national, regional and international levels.

Cassava varieties are not always distinct genetic entities because local naming of cassava are generally not based on systematic taxonomy (Nye, 1991). Different cassava plants with distinct names were identified in this study (Tables 3 and 4). Apart from the cassava variety BEN 86052 that was introduced by a research centre (Table 4), cassava names in this study either symbolize social importance of cassava varieties in the community like early maturation or high yield, place of origin of the varieties, or names of persons that introduced the varieties in the community or based on certain morphological characteristics. These observations are consistent with reports from Malawi (Chiwona-Karltum, 2001 ; Mkumbira et al., 2003).

Conclusion

The fact that women are identified as the custodians of processing calls for target information on processing techniques, directed towards being gender oriented. When processing techniques are simplified enough and made affordable for women, then women can contribute significantly to food hygiene/sanitation and safety as well as take more advantages of the surge in cassava chips commercialisation at national, regional and international levels. Our results reveal the necessity of extended research in order to empower the dissemination of safe techniques and processing. Other cassava by-products such as gari, lafun, flour are being made in Benin, which could be viewed as an important feature in cassava processing, there is still the need for industrialization of this food crop and its derived products.

In all respect, however, the most important observation that can be drawn from the present study is related to farmers' statement about potential toxicity and use of cassava varieties that calls for more investigations in cassava producing areas.

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