



Characterization of yam land races in Côte d'Ivoire with respect to food quality and end uses

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ABSTRACT

Objective: To characterize the nutritional value of local varieties of yam and to evaluate their traditional modes of transformation.

Methodology and results: Yam tubers were sampled from 210 producers in thirty-four villages in seven areas of Côte d'Ivoire. A total of 123 different local yam varieties were indexed in the seven areas of the project. The areas of Bondoukou-Tanda and Abengourou-Bongouanou have a rather high varietal diversity with 85 local varieties being listed in these areas against only 38 in the other localities (Gagnoa, Oumé, Daloa, Yamoussoukro, Toumodi, Me Bahiakro, Adzopé and Agboville). In general, the indigenous technology of yam transformation in the study areas is not very developed. Yam is mainly consumed in the forms of foutou (crushed form), akpessi or ngbô (boiled), stewed, mashed (fluid form) and roasted yam. Flour is produced and is used for the preparation of yam couscous in Bondoukou, through wetting and agitation of flour. Wassa wassa, a traditional food starting from yam peelings, is also produced in Bondoukou. In the visited localities, fougou (boiled yam, crushed and usually mixed with red palm oil, then shaped into a ball) is a speciality in the Bongouanou area. The technology for transforming yam into cossettes, which involves cutting yam into fragments followed by drying for better storage, is not known in the study areas. The physicochemical analyses carried out on 50 yam samples showed a soil effect on the chemical and nutritional composition of the tubers for each variety. For all the samples analyzed, dry matter content of the flour was higher than 90%. Concerning proteins, content below 10% was noted in general, except for the oulégni variety grown in Bondoukou which contains more than 16%, Kouassikro variety in Abengourou (10.36%) and Bete bete variety in Daloa (11.56%). Technological transformation and culinary preparations of these local varieties into more nourishing and better quality forms is important for acceptability of new products derived from yam. These results improve the available knowledge of the physicochemical characteristics of yam and the different modes of transformation.

Key words: Côte d'Ivoire, indigenous transformation, nutritional quality, yam



INTRODUCTION

Yam *Dioscorea spp.* is a tuber crop that is grown widely in many parts of the world. It is consumed as a staple diet in more than 30 countries in the world with more than 300 millions of inhabitants. In Côte d'Ivoire, yam is the main food crop with a production estimated at 3 million tons in 2002 (Faostat, 2003). In addition to its nutritional role and its wide climatic tolerance, the yam has a meaning in the cultural life of the people of Western Africa (Perrot, 1998; Tostain *et al.*, 2003; Baco *et al.*, 2003). It is the food of choice during several ceremonies and festivities and it is sometimes indispensable for dowry in some African societies (Hahn *et al.*, 1987). Unfortunately, in spite of its economic, food and cultural functions, the yam has for long not received adequate research support in western Africa. This situation has had adverse consequences on its production. The yam continues to be produced in a traditional way, without mechanization. The susceptibility to viruses, fungal and other diseases further reduces the realized returns (Odu *et al.*, 2006; Hiroshi *et al.*, 2009)

In Côte d'Ivoire, the local yam varieties are distributed within two large species that are *D. alata* and *D. cayenensis* - *D. rotundata*. The works of Hamon *et al.* (1992) and those of Kouakou *et al.* (2003) made it possible to separate varietal groups within these species. For example, *D. alata* group, representing 55 to 60% of the gross volume of yam produced in Côte d'Ivoire, has been subdivided into five varietal groups of which a substantial part of the accessions is of local origin (Kouakou *et al.*, 2003). The local yam varieties, except in some cases, have been classified in terms of agro morphological, enzymatic and molecular

MATERIALS AND METHODS

Inventory of the local yam varieties and the indigenous culinary preparations or transformation technologies was done in the following seven regions: Bondoukou-Tanda (Eastern district of the Abrons), Abengourou-Bongouanou (Eastern district of the Agnis), Oumé (West central district of the Gouros), Gagnoa-Bayota-Daloa (West central district of the Bétés), Yamoussoukro-Toumodi - M'Bahiakro (Central district

characteristics (Kassamada, 1992; Seniou, 1993; Hamon *et al.*, 1995; Goudou *et al.*, 1998; Tostain *et al.*, 1998; Hamon & Lebot, 1998; Lebot *et al.*, 2005). However, important work still remains to be done to characterize the yams based on food and nutritional quality.

Indeed, although many different local yam varieties are consumed in Côte d'Ivoire, only fewer than five main recipes are known according to the producing areas. Moreover, within the same region, food habits can vary. According to the regions, cultivars of *D. alata* and *D. cayenensis* - *D. rotundata* species are consumed as foutou (yam boiled in water and crushed), fofou (yam boiled in water and crushed in mixture with palm oil), yam mush (ngbô), roasted yam and yam stew (yam cooked in a sauce accompanied by vegetables) (Nindjin *et al.*, 2002). Regarding fried yam, they are especially consumed in urban areas. Nevertheless, research may identify other local processing methods in the producing regions.

Generally, information on the processing methods or culinary preparations of local varieties is not available, and if it exists, it lacks data on transformation and processing ability and their physico-chemical and nutritional characteristics. The global objective of this survey was to characterize the local yam varieties in Côte d'Ivoire with respect to food quality and suitability for various end uses. The specific objectives were (1) to take stock of information concerning technologies of culinary preparations or transformation of local yam varieties; (2) determine food and nutritional quality of local varieties; (3) assess the acceptability of new products processed from the local yam varieties.

of the Baoulés), Adzopé (Southern district of the Attiés), and Agboville (Southern district of the Abeys). On the whole, 210 producers were visited, that is thirty producers per region. The data were obtained using a questionnaire presented to the farmers producing yam in 2006. The data included farmer name; and sex; zone of survey (village; area); samples (cultivated varieties) and the modes of transformation. To determine the

food and nutritional quality of the local varieties, flours of some varieties were produced according to the diagram below (Figure 1). On the flour samples, the following elements were analyzed: (1) proteins by the method of Kjeldahl, BIPEA (1976); (2) pH, titratable acidity, total sugars and dry matter by the AFNOR method (1991); (3) reducing sugars by the method of Bernfeld (1955); (4) ashes by the AOAC method (1985)

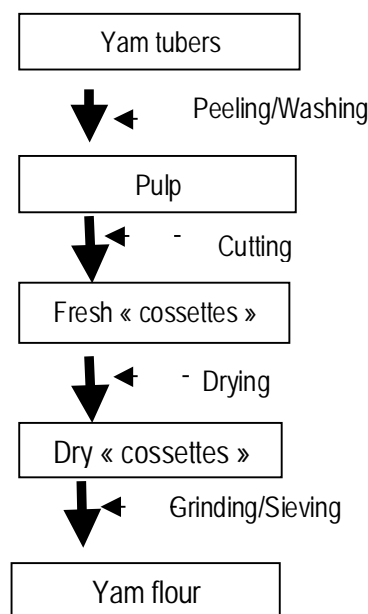


Figure 1: Flow chart of yam flour production process.

RESULTS

Inventory of local yam varieties: On the whole, 39 different local yam varieties were identified in the Bondoukou and Tanda regions, and 21 different varieties in Bondoukou sub-region. The most widely cultivated varieties are Kponan (26%), Florido (25%), Bètè bètè (9%), cocomisséné (8%) and Lokobèrè and Trela (7%). Other varieties such as ouologo (4%), kamgba (3%), amanikan (2%), djiolo, loko, loblè, vinvan, pagnité, krenglè, oulégni, krodja, namoussou, bêno, kroukroupa, kranifou are also grown in Bondoukou.

In Tanda area a total of 25 varieties were identified, with the most widely cultivated being Azaguié (14.65%), Cocomisséné (9.95%), Florido (9.4%), Bètè bètè (8.9%), Djirangbo (8.37%), Yayego (7.37% and Kponan (6.8%). The other varieties identified were sanpian (6.8%), lokobèrè (5.76%), bodo (3.66%), adjagnagni (3.14%), kamgba (3.14%), mampa (3.14%), TDR (2.61%), koffikan (1.57%), banakouassi (1.04%), akaba (1.04%), adokouma (1%), kassoum (1.04%), djé kouakou, siminidé, sronjdjé, trela, MAO 3, vipère. Seven varieties are common to the two sub-regions. They are florido, kponan, bètè bètè, cocomisséné, kamgba, lokobèrè and trela.

A total of 50 different local varieties were identified in Abengourou and Bongouanou region, with 23 varieties counted in Abengourou of which the 6 most

cultivated varieties are Nza (15.51%), Florido (14.36%), Bodo (12.64%), Eliopka (10.34%), Ebouassué klevoua (8.62%), Sopiè (8.04%) and Akassa (6.89%). Other varieties are zranzro, akako, ekra-ndoufou, essonnangloman, pèma, soglan, afou, bètè bètè, cocoassé, mihia, kounougbe, bona, yobouéassué, assobahèrè, kouassikro and sèprè. In the locality of Bongouanou, 36 varieties were identified, 9 of which are common in the two sub-regions. The six varieties most cultivated in this sub-region are Nza (12.44%), Eliopka (11.62%), Florido (11.62%), Bètè bètè (10.78%), Ndoufou (8.30%) and Assobahèrè (5.40%). The other 30 varieties listed are akapkri, gnan, kpkopkokpo, eliokoklo, doko, srin, gbodo, kounougbe, momihia, dahoumè, sopiè, adouassoa, kadjokomoufou, badiakouma, adobla(n)gassi, akatiako, elouoblié, nzoua, atonvlovonfou, missiablémi(n)zuo, bahèrè, mihia, tchritchripan, bondoukou, afiekoklo, komourouo, kamgba, soglan, dokonou, and akotrako. The nine varieties that are common to the two sub-regions are eliokpa, nza, bètè bètè, florido, kounougbe, sopiè, assohèrè, mihia and soglan.

Twenty eight different varieties of yam have been identified in the Yamoussoukro, Toumodi and M' Bahiakro sub-regions. Five main varieties are cultivated in the Yamoussoukro region and these are

(by order of importance): bètè bètè (32%), florido (28%), lokpa (20%), krenglè (18.6%) and nza (1.4%) varieties. It appears from the study that of the 18 varieties found in Toumodi, bètè bètè (26%) and lokpa (19%) are the most widely cultivated. Next are krenglè (11%), florido (10%), Sahué and Nza (7%). The other yam varieties identified are cocoassé and kondô kondô (3.5%), gnan and kamgba (2.6%), bolidiébou and brésil (1.7%), Akendewalokrou, blofouédouo, faitai, ndoufou, koto and djahou (0.87%).

Sixteen varieties were identified in M'Bahiakro. The 5 varieties most cultivated are bètè bètè (20.36%), Nza (18.8%), florido (18%), lokpa (10.93%) and koffikan (7.86%). The 11 other varieties are: akakpli (6.25%), Bako (6.25%), krenglè (5.6%), assandrè (3.95%), kamgba (1.61%), kponan, lokopè, loko, shomla, siaka, wacrou (0.84%).

Five varieties are common in the three sub-regions, namely bètè bètè, florido, lokpa, krenglè and Nza.

Four main varieties are cultivated in the Oumé region, mostly by immigrants who come from the Center and East of the country. These varieties are bètè bètè (50%), cocoassé (30%), florido (10%) and

Inventory of indigenous transformation methods:

The different yam varieties grown in Bondoukou are consumed as foutou, mush (pieces cooked in water), stew, baca (yam crushed after cooking and moistened) and roasted. Flour is produced from varieties kponan, cocomisséné and amanikan for the preparation of yam couscous. The process of preparation of another traditional dish, the wassa wassa, from the peelings of the variety florido, is shown below (figure 2).

The preparation of wassa wassa adds value to yam peelings that are generally discarded. In Tanda area, the methods of transformation and consumption are not very different from those of Bondoukou. The different varieties are consumed as foutou, mush (pieces cooked in water), stewed, baca (yam crushed after cooking and moistened) and as roasted yam.

Suitability of the main yam varieties for end uses in Bondoukou and Tanda: Figure 3 shows the types of consumption that are mostly appreciated according to the varieties in Bondoukou and Tanda. Varieties Florido and kponan are especially used for the preparation of foutou and mush. With the kponan variety, it is possible to prepare the stew by addition of ingredients and meat to the boiled yam. Bètè bètè is appreciated in three forms: foutou, boiled and roasted yam. Djirangbo and yayego are respectively consumed in roasted form and

krenglè (10%). In Gagnoa and Daloa localities sixteen different varieties of yams were identified. In Gagnoa area the 12 most cultivated yam varieties are bètè bètè (25.45%), florido (20%), nza, cocoassé and lokpa (12.72%), krenglè and ko (3.64%), kponan, kankadiman, kouhoukou, tegni and seboigni (1.82%). In Daloa area ten main varieties were identified. These are bètè bètè (24.52%), nza (18.9%), krenglè (15.1%), florido (11.33%), cocoassé, lopka (9.44%), kamgba (5.66%), Kounougbe, djahou and bako (1.87%). Six varieties that are common in these two localities are bètè bètè, nza, krenglè, florido, cocoassé and lokpa.

In Adzopé region seven different varieties are produced. These are bètè bètè (27%), florido (27%), chiègbè (23%), cocoassé (7.69%), zapèche (7.69%) akomisso (3.84%) and ndage (3.84%). In Agboville region seventeen different varieties are produced. These are darié (22.22%), mbouté (14.81%), florido (11.11%), soglan (9.26%), cocoassé, bètè bètè (7.40%), aba, doré, topkafoué, blabla (3.7%), lokpa, krenglè, mboué, nkoukou, nziôsrô, sekprè and djehou (1.85%).

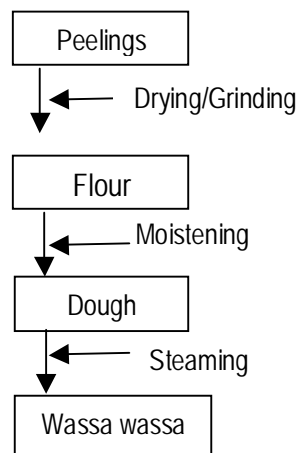


Figure 2: Traditional processing of wassa wassa.

as foutou while Florido and kponan are transformed into flours.

In Abengourou and Bonguanou the types of consumption mostly appreciated (Fig 4) are eliokpa, nza and ndoufou which are consumed as foutou. The roasted form and the foutou of eliokpa are preferred by the producers of these localities. None of these varieties are used to produce yam flour. In Toumodi area yam is consumed in the forms of foutou, boiled, roasted, stew and mashed. The lokpa variety is

consumed as foutou, next in importance are krenglè and bètè bètè. The bètè bètè variety is especially consumed as pieces of yam boiled (Ngbô), followed by lokpa and florido. The mash of yam is appreciated better when it is prepared with bètè bètè (figure 5).

In M'Bahiakro area the different varieties produced are consumed (by order of importance) in the forms of boiled, foutou, stew, roasted and mashed. The lokpa variety is more appreciated as foutou, followed by bètè bètè. The bètè bètè variety is especially consumed as pieces of yam boiled (Ngbô), followed by florido and lokpa. The stew and the mashed yam are better appreciated when they are prepared with bètè bètè (figure 6).

The types of consumption and the suitability of the varieties to the different forms of preparations in Oumé are similar to those of the region of Yamoussoukro, Toumodi and M'bahiakro because the producers of Oumé are from these areas. The varieties

are mainly consumed as foutou, roasted and boiled (Ngbô). The patterns of consumption and the suitability of the varieties to the different types of preparations in Gagnoa and Daloa are also similar to those of the region of Yamoussoukro-Toumodi-M'bahiakro. Indeed, the yam producers of Gagnoa - Daloa are from the zones of Toumodi, M'Bahiakro and even from Bondoukou. The autochthonous Bétés have rice as their staple food.

In Adzopé yams are consumed as foutou, fougou, mush and as roasted yam. The mush of yam is better appreciated when it is prepared with the bètè bètè variety, followed by florido and cocoassé. The chiégbè variety is especially consumed as foutou and fougou (figure 7). In Agboville yams are consumed, by order of importance, in the forms of fougou, mush and foutou. Figure 8 shows that the darié and mbouté varieties are especially appreciated as fougou.

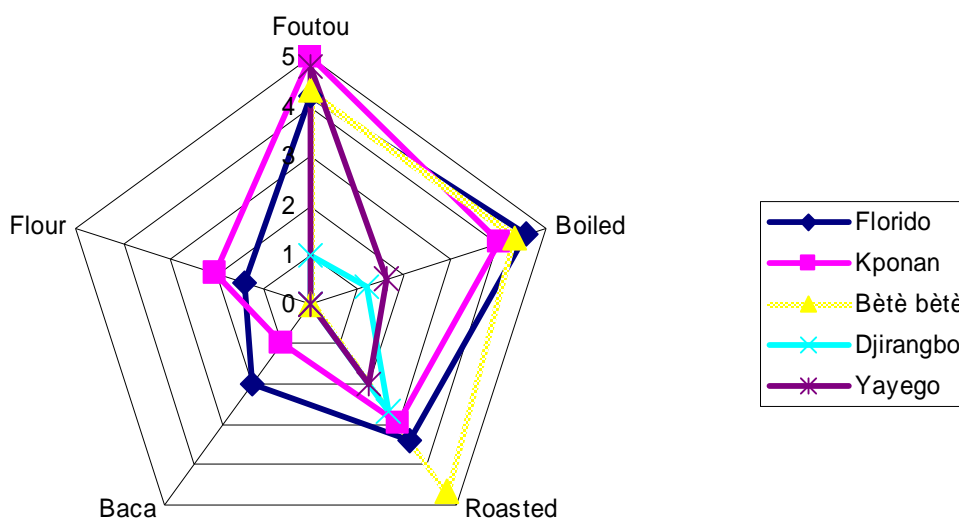


Figure 3: Types of consumption of yam in Bondoukou and Tanda.

Physico-chemical characterization of the yam varieties: Table 1 indicates the physico-chemical characteristics of some varieties of yams from Bondoukou and Tanda. The dry matter of these varieties is over 90% and variety sanpian of Tanda has the highest value. The oulégni variety in Bondoukou has the highest levels of ash (5.88%), free acidity (97.02 meq/100) and proteins (16.56%). The bètè bètè variety of Bondoukou is richer in reducing sugars than at Tanda. In Abengourou and Bongouanou (table 2), the varieties with high protein content include

kouassikro (10.36%), bètè bètè (10.91%) of Abengourou and Sopiè (10.52%) at Bongouanou.

The flour of variety lokpa grown at Yamoussoukro is richer in dry matter (96%) than that grown at M'Bahiakro (93.53%) and at Toumodi (92.2%) (table 3). Variety Krenglè grown at Toumodi has less ash (0.42%) than the one of Yamoussoukro (2.14%). The protein contents are in general lower than in Abengourou and Bongouanou except for variety florido (9.49%) and akakpli (8.96%) from M'Bahiakro.

At Gagnoa and Daloa variety nza is the richest in ash (4.13%), while the cocoassé variety has the most

elevated free acidity (51.81 meq/100) (table 4). The protein contents are in general low except the bête bête variety of Daloa that has a level of 11.56%.

In Agboville the florido variety has lower dry matter content (87.77%) than at Adzopé (93.2%). The

variety akomisso (Adzopé) and mbouté (at Agboville) have the highest protein content of 8.09 and 8.46%, respectively. The soglan variety (Agboville) has the highest level of reducing sugars.

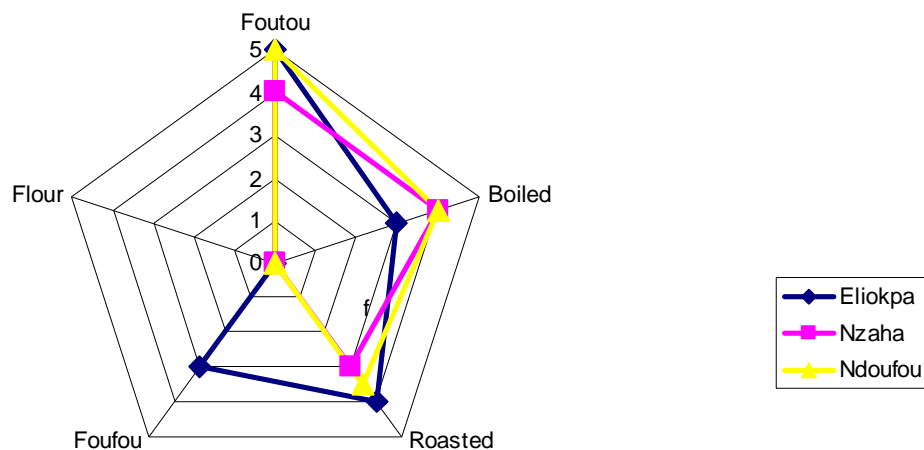


Figure 4: Types of consumption of yam in Abengourou and Bongouanou.

Table 1: physico-chemical characteristics of flour of some varieties from Bondoukou and Tanda.

Varieties	Dry matter (%)	Ash (%)	Free acidity meq /100g	Proteins(%)	Reducing sugars(%)	Total glucides (%)	pH
Bondoukou							
Oulegni	94,0±0,40	5,88±0,02	97,02±0,81	16,56±0,70	5,41±0,16	56,58±0,07	4,74±0,02
Bete Bete	93,24±0,8	2,24±0,02	23,60±0,32	6,00±0,0	5,40±0,28	70,23±0,08	4,68±0,02
Name	<i>Dioscorea alata</i>						
Kponan	92,1±0,08	2,53±0,01	31,05±0,12	5,13±0,02	2,38±0,24	73,20±0,08	4,43±0,04
Name	<i>Dioscorea cayenensis rotundata</i>						
Tanda							
Bete Bete	94,11±0,03	2,40±0,02	28,90±0,40	5,95±0,70	3,18±0,10	67,89±0,20	5,31±0,02
Sanpian	94,28±0,08	2,47±0,01	53,71±0,16	8,25±0,22	4,21±0,20	65,38±0,20	4,76±0,02
Name	<i>Dioscorea alata</i>						

Values are average of three analyses.

DISCUSSION

A total of 123 different local yam varieties were identified in the seven regions of this study. The regions of Bondoukou-Tanda and Abengourou-Bongouanou presented the highest diversity with a total of 85 local varieties against only 38 in the other localities (Gagnoa, Oumé, Daloa, Yamoussoukro, Toumodi, M'Bahiakro, Adzopé and Agboville). Nearly all the yams grown in the study regions are consumed fresh. Traditionally, yam product transformation occurs mostly in the zones

where it is grown, and is generally a means to use the tubers which cannot be stored.

In this study the only yam product produced through traditional transformation in the villages is flour. Thus, the suitability of the different varieties to the final use depends on the region. Generally, the local technology of transformation of yam in the studied villages is not well developed. Yam is consumed mainly as yam foutou (pounded yam), akpessi or ngbô (boiled

yam), yam stew, mashed and roasted. These results are in agreement with those of Nindjin *et al.* (2002) on

yam consumption in Côte d'Ivoire.

Table 2: Flour physico-chemical characteristics of some varieties of Abengourou and Bongouanou (Average of three analyses).

Varieties	Dry matter (%)	Ash (%)	Free acidity (meq /100g) (db)	Proteins (%) (db)	Reducing sugars (%) (db)	Total glucides (%) (db)	pH
Abengourou							
Akako	94,41±0,16	2,19±0,02	30,93±0,08	8,34±0,27	4,00±0,16	51,39±0,07	5,08±0,02
Lopka	94,62±0,16	1,62±0,02	26,00±0,08	4,99±0,07	2,68±0,16	41,85±0,041	4,65±0,02
Name	<i>Dioscorea</i>	<i>cayensis</i>	<i>rotundata</i>				
Bodo	92,27±0,16	2,38±0,02	33,83±0,08	8,25±0,36	3,45±0,16	89,46±0,05	5,33±0,17
Nza	93,31±0,16	4,62±0,02	43,51±0,16	9,37±0,24	2,61±0,16	78,07±0,06	5,03±0,03
Bète Bète	90,1±0,08	3,02±0,01	38,80±0,32	10,99±0,08	2,98±0,24	54,53±0,02	5,31±0,02
Sopié	92,2±0,32	2,97±0,01	33,83±0,16	7,40±0,32	2,68±0,08	77,78±0,06	4,77±0,01
Name	<i>Dioscorea</i>	<i>alata</i>					
Bongouanou							
Florido	94,12±0,09	3,5±0,02	36,36±0,16	9,7±0,16	4,07±0,14	67,57±0,04	5,18±0,06
Sopiè	91,41±0,98	2,98±0,01	35,66±0,16	10,52±0,040	4,14±0,08	71,20±0,08	4,91±0,06
Name	<i>Dioscorea</i>	<i>alata</i>					

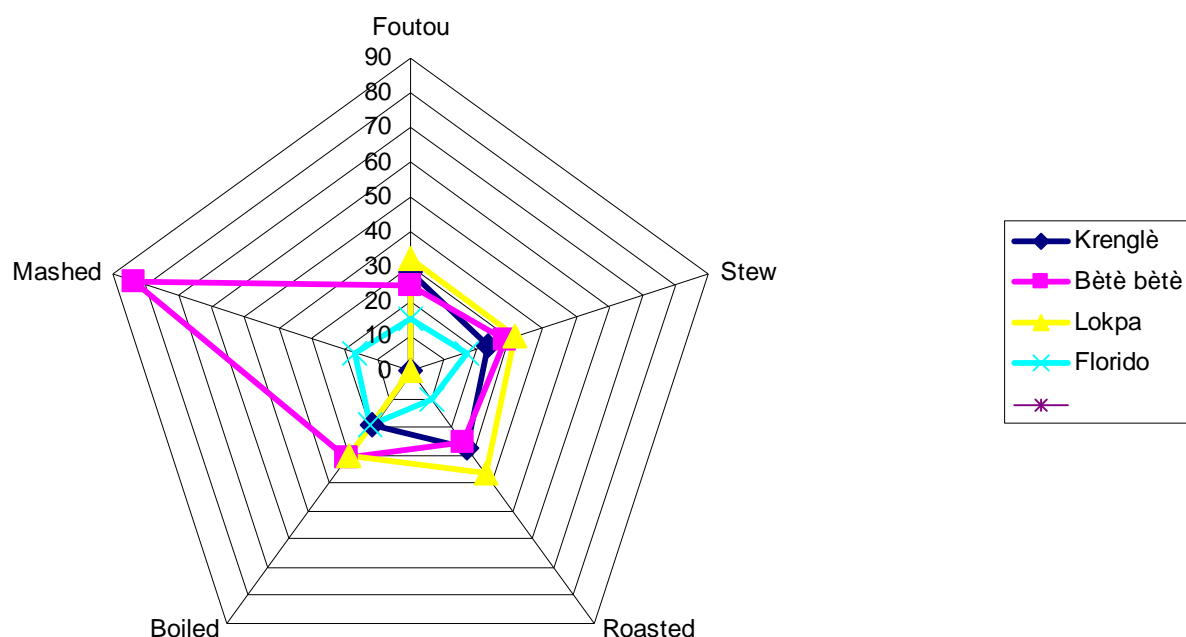


Figure 5 : Types of consumption of yam in Toumodi.

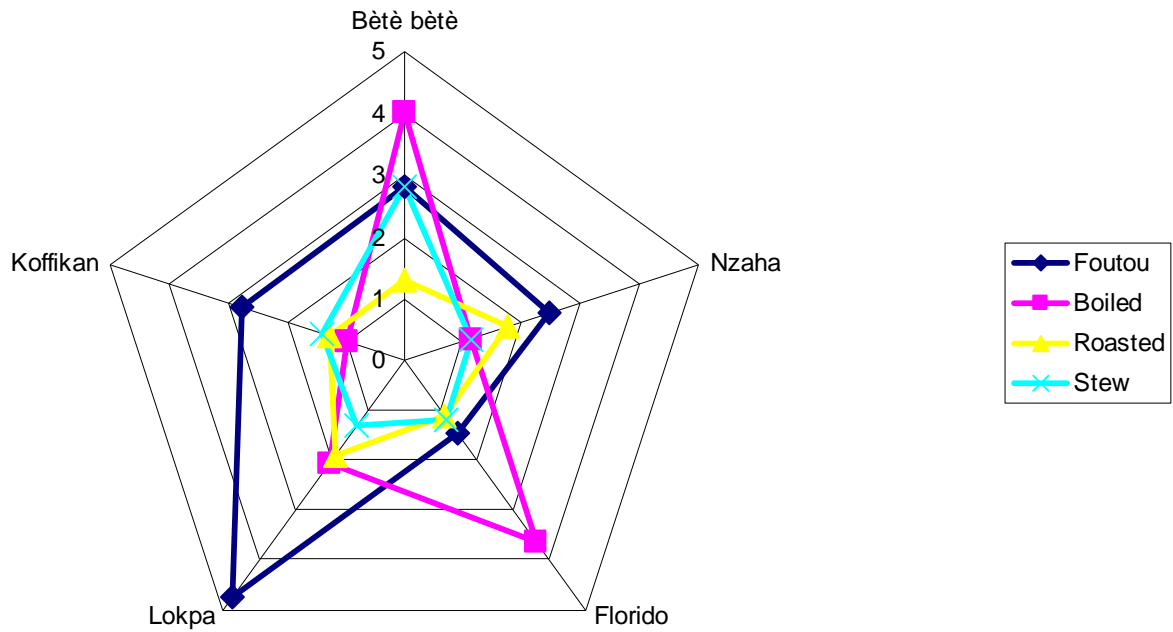


Figure 6 : Types of consumption of yam in M'bahiakro.

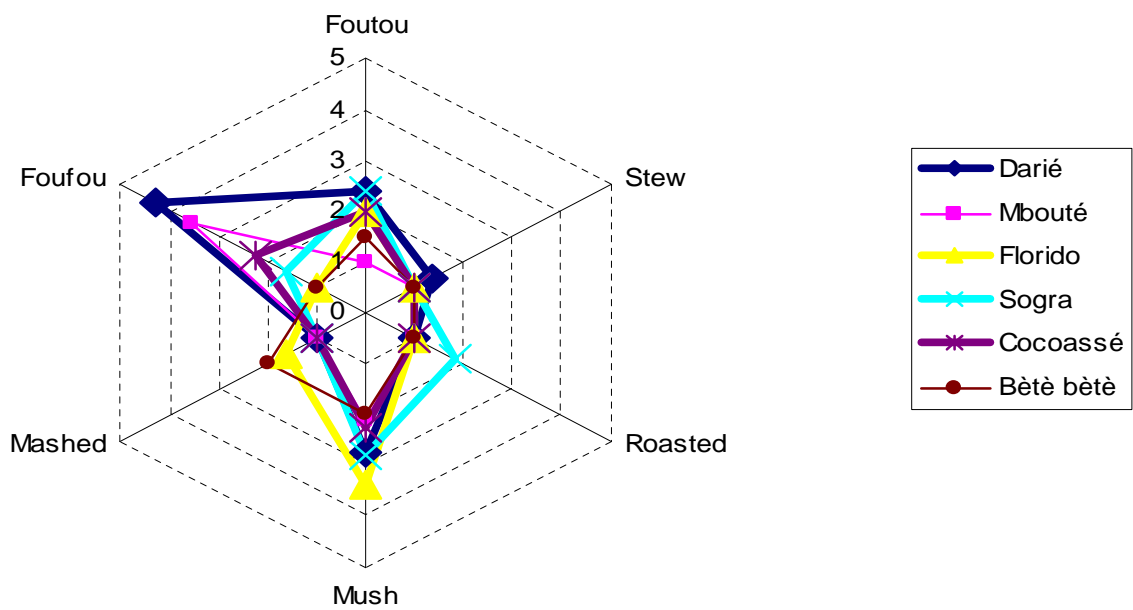


Figure 7: Types of consumption of yams in Agboville.



Table 3: Physico-chemical characteristics of some yam varieties from Yamoussoukro, Toumodi and M'Bahiakro regions of Cote'd Ivoire. (Values are means of three analyses).

Varieties	Dry matter (%)	Ash (%)	Free acidity (meq /100g) (db)	Proteins (%) (db)	Reducing sugars (%) (db)	Total Glucides (%) (db)	pH
M'Bahiakro							
Lopka	93,53±0,82	2,14±0,01	26,95±0,08	3,38±0,24	16,89±0,16	40,32±0,08	3,77±0,06
Kamgba	95,13±0,09	2,10±0,01	37,85±0,16	6,25±0,20	12,16±0,11	57,09±0,07	4,07±0,03
Name	<i>Dioscorea cayenensis rotundata</i>						
Bètè bètè	92,13±0,09	2,17±0,01	24,53±0,16	4,27±0,18	13,06±0,05	47,66±0,04	3,95±0,17
Florido	94,4±0,28	3,60±0,01	48,72±0,24	9,49±0,28	10,72±0,24	41,41±0,01	4,66±0,01
Akapkli	92,73±0,09	4,52±0,01	54,58±0,14	8,96±0,09	11,44±0,16	63,17±0,05	4,38±0,05
Nza	93,66±0,09	3,20±0,02	38,46±0,16	5,60±0,42	12,76±0,24	46,48±0,06	4,62±0,04
Name	<i>Dioscorea alata</i>						
Yamoussoukro							
Lopka	96±0,0	1,87±0,01	30,41±0,16	5,28±0,16	6,75±0,08	78,18±0,08	4,01±0,06
Krenglè	93,26±0,09	2,14±0,01	32,18±0,08	5,26±0,16	8,86±0,16	48,81±0,16	5,10±0,22
Name	<i>Dioscorea cayenensis rotundata</i>						
Bètè bètè	95,46±0,09	3,14±0,01	44,02±0,01	5,34±0,24	18,61±0,32	89,72±0,02	4,52±0,01
Florido	91,46±0,09	4,37±0,01	29,10±0,04	4,78±0,24	11,79±0,24	50,60±0,08	4,86±0,02
Cocoassié	93,8±0,01	2,98±0,01	51,81±0,16	3,64±0,32	7,10±0,08	34,17±0,08	3,86±0,19
Name	<i>Dioscorea alata</i>						
Toumodi							
Lopka	92,2±0,16	1,29±0,01	31,01±0,01	4,75±0,16	6,96±0,08	26,68±0,06	4,97±0,20
Krenglè	93,6±1,02	0,42±0,01	14,52±0,16	3,73±0,24	3,23±0,14	54,04±0,04	5,30±0,13
Gondo gondo	94,4±0,16	2,33±0,01	22,45±0,12	5,74±0,24	15,76±0,24	41,41±0,07	4,59±0,10
Gnan	93,46±0,09	2,13±0,02	27,83±0,16	6,36±0,24	6,08±0,06	22,48±0,02	4,22±0,37
Name	<i>Dioscorea cayenensis rotundata</i>						
Blofoué douo	92,5±1,22	3,78±0,01	49,72±0,24	3,78±0,16	6,49±0,24	23,35±0,04	4,02±0,06
Name	<i>Dioscorea esculenta</i>						
Brésil	93,8±0,01	3,41±0,01	38,37±0,16	4,41±0,28	10,89±0,16	41,15±0,08	4,37±0,30
Nza	95,46±0,09	4,19±0,02	31,44±0,02	5,77±0,24	21,38±0,16	54,79±0,01	3,87±0,07
Bolidiè boui	92,8±0,02	3,01±0,01	17,88±0,16	2,64±0,29	13,34±0,08	55,49±0,01	4,62±0,04
Nom latin	<i>Dioscorea alata</i>						

In the region of Bondoukou, flour is produced for the preparation of a type of yam couscous. The wassa wassa, a traditional dish (couscous) from the dried peelings of yam, is also produced in Bondoukou. Cossettes can keep (preserve) for more than a year. Through transformation, post-harvest losses are thus reduced and the availability of yam products is more regular (Hounhouigan *et al.*, 1997; Attaie *et al.*, 1998; Bulletin TPA n°18, 2000). In the visited localities, the fofou (yam mush, crushed and if possible mixed with red palm oil then shaped in ball) is a specialty of Bongouanou.

The content of the biochemical components varies according to the varieties and the production regions. The dry matter content of yam flour varies within the different varieties, and was observed to be high (more than 90% in general) in most of the varieties. The dry matter is an important criterion of appreciation of the firmness of the fofou. In fact, the higher the dry matter content of the flour of yam, the stiffer will be the fofou and its boiled form will be floury.

Table 4: Physico-chemical characteristics of some yam varieties of Gagnoa and Daloa (values are means of three analyses).

Varieties	Dry matter (%)	Ash (%)	Free acidity (meq /100g) (db)	Proteins (%) (db)	Reducing sugars (%) (db)	Total Glucides (%) (db)	pH
Gagnoa							
Kponan	93,53±0,24	1,49±0,02	25,66±0,05	6,39±0,24	12,52±0,24	85,34±0,03	4,41±0,40
Kangadiman	93,66±0,09	3,41±0,01	20,51±0,01	4,57±0,02	9,33±0,15	48,35±0,04	4,65±0,02
Krengle	86,9±0,08	2,76±0,02	28,99±0,08	6,14±0,02	5,86±0,16	59,26±0,04	4,24±0,14
Cocoassié	93,8±0,02	2,98±0,01	51,81±0,07	7,64±0,32	9,38±0,16	41,04±0,03	3,86±0,19
Name	<i>Dioscorea cayenensis rotundata</i>						
Nza	91,93±0,09	4,13±0,01	32,64±0,16	6,18±0,08	8,25±0,08	47,81±0,15	4,44±0,05
Florido	95,53±0,09	2,51±0,02	28,48±0,16	7,0±0,02	21,78±0,24	43,03±0,02	4,75±0,17
Name	<i>Dioscorea alata</i>						
Daloa							
Krengle	95,4±0,02	1,68±0,02	30,60±0,05	5,89±0,10	6,17±0,10	81,44±0,02	4,64±0,01
Lopka	94,66±0,09	1,69±0,02	38,68±0,08	6,70±0,24	7,33±0,16	77,58±0,06	4,30±0,01
Name	<i>Dioscorea cayenensis rotundata</i>						
Bete bete	93,8±0,16	2,77±0,01	36,88±0,09	11,56±0,40	11,34±0,16	43,81±0,01	4,79±0,67
Name	<i>Dioscorea alata</i>						

Table 5: Physico-chemical characteristic of some yam varieties of Adzopé and Agboville (means of three analyses).

Varieties	Dry matter (%)	Ash (%)	Free acidity (meq /100g) (db)	Proteins (%) (db)	Reducing sugars (%) (db)	Total Glucides (%) (db)	pH
Adzopé							
Florido	93,2±0,01	3,00±0,20	28,54±0,03	6,30±0,08	19,33±0,13	60,51±0,014	5,31±0,05
Bètè bètè	93,6±0,02	2,13±0,0	25,64±0,08	6,02±0,02	20,02±0,21	47,35±0,04	4,81±0,10
Akomisso	95,13±0,09	2,94±0,01	36,38±0,02	8,09±0,07	03,56±0,16	38,48±0,024	4,54±0,04
Name	<i>Dioscorea alata</i>						
Agboville							
Soglan	92,53±0,09	2,81±0,01	29,40±0,08	6,84±0,16	22,12±0,09	76,86±0,03	5,57±0,4
Darié	94,86±0,09	2,95±0,02	34,38±0,08	3,87±0,16	3,41±0,16	52,02±0,02	4,18±0,08
Florido	87,77±0,09	2,96±0,01	18,24±0,04	6,8±0,16	16,41±0,08	42,98±0,02	3,88±0,09
Mbouté	95,13±0,09	3,99±0,01	40,58±0,02	8,46±0,14	10,18±0,08	42,40±0,08	4,56±0,03
Name	<i>Dioscorea alata</i>						

The protein content of yam varies as shown by Trèche and Guion (1979) and Kouassi (1985). Some varieties studied contain more than 10% protein, e.g. oulégni (16.56 % at Bondoukou), sopié (10.52% at Bongouanou), and kouassikro (10.36% at Abengourou). These results are in agreement with those of Degras (1986) or Akinmutimi and Onen (2008). The protein content of plants roots is influenced by the variety, the cultural practices, the climate, the period of growth and the production area (Woolfe, 1987). However, the protein content is lower than 10% in the

majority of cases. This variability has also been noted by Martin and Thompson (1971) with observation of substantial variation of 7.11 to 9.98% within some cultivars belonging to clones of *D. alata*. Generally, the protein content in yam varies between 1.7 and 10.9 % of dry weight according to variety. A food based on yam could thus contribute mostly to cover protein requirements. The yam is rich enough in leucine, phenylalanine and thréonine but deficient in lysine and tryptophan (Splittstesser, 1976). The protein content is a criterion of appreciation of the sensory characteristics

of the foutou. It favours the extensibility or the springiness of the dough and so would contribute to make more malleable or tenderer the dough of foutou (Ashay *et al.*, 2001; Babalola *et al.*, 2007).

The content of ashes in the different tubers varies from 0.42 to 4.68% in relation to the dry matter. Nevertheless one notes a raised rate of 5.88% for variety oulegni. These results agree with those of Bouret (1973) and of Trèche & Guion (1979) that found a variation of 2.4 to 3.7% of ash content in yam tubers. According to Treche & Agbor (1986), yams can cover 28% of the daily needs in calcium and 37% in phosphorous for 500 g of edible part. Le Berre *et al.* (1969) assert that yams appear as relatively rich in calcium (130 mg / 100 g of dry weight) and phosphorous (160 mg / 100 g of dry weight).

The determined total glucosides vary from a cultivar to another. The highest values were observed

with variety bété Bète (89.72% at Daloa), bodo (89.46% at Abengourou) and krengle (81.44% at Daloa). Concerning the reducing sugars, the range of the values spreads from 3 to 21%. The highest values were observed with variety soglan (22.12%) and nza (21.36%) in contrast to a weak rate for krengle (3.23%).

The investigations carried out in 34 villages among 210 producers in the seven regions of the project allowed us to identify 123 different local yam varieties and to determine the different transformation methods of yams and their biochemical characteristics. The production of cossettes is not well understood in Ivory Coast. The determination of the extent of technological transformation and the culinary preparations of 30 local varieties with high and better nutritional quality is important for the acceptability of the new products derived from the transformation of the identified yam varieties.

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