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Authors: Keith Tomlins, Mady CISSE, Aurélie BECHOFF, Nicolas AYEISSOU, Ndèye Adiara NDIAYE DIOP, Cheikh TOURE, Geneviève Fliedel, Anne-Laure Declémy, Noel Akissoe, Ben Bennett, Manuela Pintado and Dominique Pallet

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Executive summary

Sensory evaluation and consumer testing of Hibiscus, Baobab and Jaabi (Yaabande) was undertaken with African and EU consumers in Senegal and Cameroon.

The sensory profile and consumer acceptance of Bissap (*Hibiscus sabdariffa* L.) drink (commercial and traditional) made from infusions of red calices of either local or Sudanese origin, pure or mixed, and either as syrup or a juice (infusion) was explored. There were significant correlations between the sensory perceptions of the drink by panellists. The acceptability of the drink was tested by two consumer groups: Europeans (n=60) and Africans (n=100) in Dakar. Three classes of behaviour from the consumers were identified. There were a) those who preferred syrup (syrup likers; 43% of consumers) b) those who prefer juices (juice likers; 36% of consumers) and c) those who preferred all of the samples (indifferent likers; 21% of consumers). The liking by African and EU consumers was similar but European consumers were more likely to prefer syrup, consume bissap the least often and purchase bissap juice in bottles. African consumers were more likely to prefer juice, consume bissap more frequently and purchase it in sachets. Both groups preferred to purchase natural bissap drinks rather than ones with added flavour. The sensory characteristics important to each class of consumers differed. There were significant correlations between acceptability, bissap taste for the cluster of the group of the juice likers. There were significant correlations between acceptability, sweet taste, acidic taste for the syrup likers. The study shows that the distinctions between the acceptability groups are very clear from a sensory perspective. The market study should take these preference groups into account when launching Hibiscus drinks on a new market.

The sensory profile of seven samples of bouye (baobab) drinks (syrup and juice) was evaluated by 17 panellists. Consumer testing was investigated at four different locations in Dakar using the central location metho. These were the following: ESP high school (n=32); Grand Yoff (n=36), Guediawaye (n=12), and Gueule Tapée (n=26) areas. The acceptability of the drink was tested by African consumers (mainly Senegalese) (n=104) in Dakar who tested five different drinks from the seven first samples. A cluster analysis demonstrated that consumers behave differently with respect to acceptability. Three classes of behaviour from the consumers were identified. There were a) those who clearly preferred the juice from FWS (27% of consumers) b) those who preferred all of the samples (indifferent likers) (31% of consumers), c) those who liked the juices but not the syrups (juice likers) (42% of consumers). With respect to acceptance, the reengineering approach appears to have two options being products suited to a) milk taste or b) taste and odour characteristic of baobab with a good concentration for the two products. The reengineering approach should also explore ways to increase the shelf life with optimum quality regarding the sensory attributes and consumer acceptance. Optimizing scales for pasteurization shall be conducted in order to have a product without caramel smell.

Sensory profile and consumer acceptability was undertaken for *Jaabi*, a wild fruit commonly used in savannah region of Africa, and its processed product, a cake locally called: *Yaabande*. The study took in the northern part of Cameroon through collection of two varieties of *Jaabi* (*Dakamji* and *Lamouji*) from four origins (Garoua, Maroua, Mokolo, Mora), and processed *Yaabande* from these samples, using three baking techniques (Sun baking, vapour cooking, under earth stewing). Sensory and consumers tests indicated that the taste of the products constitutes the main criteria for consuming the products. The *Dakamji* variety of *Jaabi* appeared more homogenous whatever the origin than the *Lamouji* variety. Meanwhile, all samples were acceptable at comparable level corresponding to pleasant character. With respect to acceptance, the main option of reengineering approach is based on standardisation of process procedures in order to guarantee the taste of the products. Inclusion of therapeutic aspects of the products may be coupled to this option for market development.

Background

This deliverable report refers to the sensory and African consumer acceptance for Group 3. Group 3 products include the plant based extracts for functional foods Baobab (Senegal), Bissap or *Hibiscus* (Senegal) and Jaabi or *Ziziphus mauritiana*

(Cameroon). The methodology is set out in D5.2.1. (Report on the methodology definition for the sensory testing and consumer acceptance studies). [TO BE COMPLETED LATER]

Methodology

The detailed methodology for each product is given in annexes 1 to 3 for Baobab (Senegal), Bissap (Senegal) and Jaabi/Yaabande (Cameroon) respectively.

Common to all of the methodologies is the Ethical assessment and consent which is listed as follows:

Ethical assessment and consent

The studies have been assessed and approved by the University of Greenwich Research Ethics Committee and the Ethics Committee at CIRAD. Consent was sought from sensory panellists and from adult consumers participating in this study. Enumerators informed participants about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point and that the responses would be anonymous.

Consumer testing

While the methodology for consumer testing for each product was similar, the approach differed with respect to the exact number of consumers interviewed and whether non-African consumers were interviewed.

The number and types of consumers (African and non-African) interviewed for each products are shown in table 1.

Table 1. Number and types of consumer (African and non-African) interviewed

Country	Product	Consumer type (and number)	
		African	Non-African
Senegal	Hibiscus (Bissap)	100	60
Senegal	Baobab (Bouye)	106	0
Cameroon	Ziziphus (Jaabi)	100	0
	Processed Ziziphus (Yaabande)	164	0

Results

The summary and detailed reports are given in annexes 1 to 3 for Hibiscus (Bissap), Baobab and Ziziphus (Jaabi and Yaabande) respectively.

Annex 1 – detailed report for Hibiscus (Bissap)

Sensory profile and acceptability of hibiscus drinks in Senegal

Aurélie Bechoff ^a, Mady Cissé^b, Geneviève Fliedel^c, Anne-Laure Declémy^c, Nicolas Ayessou^b, Noel Akissoe^d, Cheikh Touré^e, Ben Bennett^a, Manuela Pintado^f, Dominique Pallet^c and Keith I. Tomlins^a

^a Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME7 3RU, United Kingdom

^b Cheikh Anta Diop Université deDakar, BP 5005, Dakar-Fann Sénégal

^c CIRAD Montpellier, France TA B-95 / 16, 73 rue Jean-François Breton, 34398 Montpellier Cedex 5, France

^d Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 01 BP 526 Cotonou, Bénin

^e Association Afrique Agro Export, Sot Sotrac Mermoz – BP 45.028 Dakar Fann, Sénégal

^f Escola Superior de Biotecnologia. Rua Dr. António Bernardino de Almeida, 4200-072 Porto, Portugal.

ABSTRACT (max 300 words)

The sensory profile and consumer acceptance of Bissap (*Hibiscus sabdariffa* L.) drink (commercial and traditional) made from infusions of red calices of either local or Sudanese origin, pure or mixed, and either as syrup or a juice (infusion) was explored. There were significant correlations between the sensory perceptions of the drink by panellists. The acceptability of the drink was tested by two consumer groups: Europeans (n=60) and Africans (n=100) in Dakar. Three classes of behaviour from the consumers were identified. There were a) those who preferred syrup (syrup likers; 43% of consumers) b) those who prefer juices (juice likers; 36% of consumers) and c) those who preferred all of the samples (indifferent likers; 21% of consumers). There were no differences in classes in terms of Europeans or Africans percentages. However European consumers were more likely to prefer syrup, consume bissap the least often and purchase bissap juice in bottles. African consumers were more likely to prefer juice, consume bissap more frequently and purchase it in sachets. Both groups preferred to purchase natural bissap drinks rather than ones with added flavour. The sensory characteristics important to each class of consumers differed. There were significant correlations between acceptability, bissap taste for the cluster of the group of the juice likers. There were significant correlations between acceptability, sweet taste, acidic taste for the syrup likers. The study shows that the distinctions between the acceptability groups are very clear from a sensory perspective. The market study should take these preference groups into account when launching Hibiscus drinks on a new market.

CONCLUSIONS RELATING TO REENGINEERING (MAX 200 WORDS)

With respect to acceptance, the reengineering approach appears to have two options being products suited to a) red in colour and acidity or b) sweeter in taste.

There were no differences in acceptance between African and non-African consumers the outlets for sale and packaging may differ according to place of purchase and willingness to pay.

Introduction

Hibiscus sabdariffa L. is an herbaceous plant that belongs to the family of Malvaceae (Cisse 2011). It is an annual herb cultivated for its leaves, stem, seed and calyces (Fasoyiro *et al.* 2005). *Hibiscus sabdariffa* mainly grows in tropical and subtropical areas (Fasoyiro *et al.* 2005). The crop is native to India but was introduced later to other parts of the world such as Central America, West Indies and Africa. It is known by different names such as Guinea sorrel or bissap in Senegal, karkadé in North Africa, roselle or sorrel in Asia and flora of Jamaica in Central America (Cisse 2011). *Hibiscus sabdariffa* has remarkable medical and therapeutic properties such as antioxidative, antitumor and anticarcinogenic activity (Gonzalez-Palomares *et al.* 2008). These physiological effects are related to the presence of anthocyanins with potent antioxidant activity (Sherif *et al.* 2011).

Calyx of *Hibiscus sabdariffa* is the plant part of greatest interest because it is used for making a variety of products including juices, infusions, food colorants and jam (Gonzalez-Palomares *et al.* 2008; Sherif *et al.* 2011). The consumption of the drink is widespread in Africa and Asia. In Senegal, in particular the drink is very popular (Cisse 2011). Most commonly consumed varieties of coloured bissap in Senegal are the local (also called Ordinary or Cor.) and one of Sudanese origin (also called Vimto). The drink is made from an extract obtained by aqueous extraction. The extraction is carried out between 25°C (ambient temperature) and 100°C (boiling temperature). After filtration, sugar and other ingredients, such as other flavourings (*eg.* banana, mint) may be added (Cisse *et al.* 2011). The process for syrup and for juice is quite similar; the differences being the amount of water and sugar added. Little data is available on export quantities of syrup, juice and calices from Senegal (Cisse 2011). There are reports of syrup being exported to Europe (*i.e.* France and Germany) (Gauthier, personal communication). Exports of calyx are mainly to the United States and Europe, including, notably France and Germany (Gueye, 2005), which represent 80% of the European market that is estimated at 3000 tons per year. The quantities currently exported are not sufficient to satisfy international demand, in particular in the European market (Gauthier, personal communication).

Consumer acceptance is important in marketing strategies for product development in the EU and Africa. Along with product development and economic viability, this will give food companies confidence to adopt these products in the EU and expand the adoption in Africa. A number of authors have published on the acceptability of *H. sabdariffa* juice (Bamishaie *et al.* 2011; Bolade *et al.* 2009; Fasoyiro *et al.* 2005; Foline *et al.* 2011; Mounigan *et al.* 2006; Mounigan *et al.* 2007; Nwafor and Ikenebomeh 2009; Suliman *et al.* 2011). Acceptance by African consumers was measured using a 9-point hedonic scale for appearance (*e.g.* colour); taste and overall acceptance. However these studies included a restricted number of people (between 10 and 20) that are not statistically valid (ISO 8587) (a minimum of 60 consumers is suggested). Acceptance was measured with 50 people (D'Heureux-Calix and Badrie 2004; Gonzalez-Palomares *et al.* 2009) but these studies were about hibiscus sauce and dried sprayed hibiscus. To our knowledge, there are few exhaustive studies on the acceptability of hibiscus drink. There is also a need for research that will include consumers from potential countries for *Hibiscus sabdariffa* exportation (*i.e.* Europe).

This study primarily explored the sensory profile of *Hibiscus sabdariffa* drinks and the acceptance. It was not known if the acceptance differed between African and European consumers. Relationships between the sensory attributes and physico-chemical compounds were related to consumer acceptance in order to understand the factors that influenced acceptability of the *Hibiscus sabdariffa* drinks.

Materials and Methods

Juice and syrup samples

Nine different Bissap samples (six juices and three syrups) were presented to the panellists. Juices were used as they were whilst syrups were diluted 1:4.

The bissap samples were from two different types: Sudanese or Vimto variety (originally imported from Sudan) and Ordinary or Cor variety (Senegalese variety). Selection of samples for sensory analysis was the following:

1. Commercial Sudanese juice (CSj)
2. Commercial Sudanese syrup (CSs)
3. Commercial Ordinary juice (COj)
4. Commercial Ordinary syrup (COs)
5. Commercial Mixed (Sudanese/Ordinary (50:50)) juice (CMj)
6. Commercial Mixed (Sudanese/Ordinary (50:50)) syrup (CMs)
7. Traditional boiled Ordinary juice (TBOj)
8. Traditional ambient temperature Ordinary juice (TAOj)
9. Traditional ambient temperature Sudanese juice (TASj)

Commercial samples were prepared by a local Senegalese fruit juice and syrup company that sells in supermarkets and restaurants in Senegal. Commercially made syrups and juices were processed from the same batch of calices. The process of preparation of commercial juices and syrups differed in terms of sugar addition. In both cases the first stage was an aqueous extraction at ambient temperature (typically 2h). Sugars (130 g/L) were added in the commercial juices, after filtration (to separate calyces from aqueous extract) and before pasteurization at 85 °C for 20 minutes. Sugars (1300 g/L) were added in the commercial syrups after filtration followed by pasteurisation up to a temperature of 105 °C. Traditional samples were prepared by a local processor using traditional practices but working under good safety conditions. Calices for the traditional juice were bought from the market. In the traditional preparation, calyces were either extracted at ambient temperature or boiled, sugar was added and the mixture filtrated. There was no pasteurisation stage in the traditional preparation.

Ethical assessment and consent

This study has been assessed and approved by the University of Greenwich Research Ethics Committee. Consent was sought from sensory panellists and from adult consumers participating in this study. Enumerators informed participants about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point and that the responses would be anonymous.

Sensory evaluation

Hibiscus juice and syrup samples were scored by a semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided (Meilgaard *et al.*, 2007; Tomlins *et al.* 2012). The panel was composed of university technicians, students or private company employees (17 people in total). Sessions were conducted at Cheikh Anta Diop University of Dakar (Senegal) in air conditioned room with controlled lighting and ambient temperature (22 to 25°C). The language used for the sensory testing was French. The panellists had been screened for familiarity with the product. Sensory attributes were generated during a preliminary focus group session guided by the panel leader. A total of 11 sensory attributes were developed for the hibiscus drink for which the group of panellists had a consensus. Sensory attributes generated were as follows (English translation):

Red colour – colour characteristic of red bissap

Clarity – drink you can see through

Concentration aspect – like a syrup that can be diluted or concentrated

Bissap odour – odour characteristic of bissap

Fermented odour – alcoholic odour indicating a fermentation and that the product quality is deteriorating

Acidic taste – taste characteristics of lemons

Sweet taste – tastes like sugar

Bissap taste – taste characteristics of bissap

Bitter taste – taste characteristic of coffee

Irritant – that has a foreign and piquant taste on the tongue

Fermented taste - alcoholic taste indicating a fermentation and that the product quality is deteriorating

After a period of training using these attributes, the nine bissap samples were tested blind in triplicate by the panel and the order in which they were presented was random. At each session, four bissap sample drinks (coded with 3-figure random numbers) were served in transparent plastic cups in random order to each panellist. Hibiscus drinks (50ml) were tested by the panellists. Juices were stored in the fridge overnight. The shelf life of a syrup and juice at 8°C (fridge temperature) is respectively of a year and of four months. Intensity for the sensory attributes was scored on a 100 mm unstructured scale, anchored with the terms ‘not very’ at the low end and ‘very’ at the high end.

Consumer acceptability

Consumers (160) were interviewed at five different locations in Dakar using the central location method (Meilgaard *et al.*, 2007). These were the following: Veterinary faculty (n=33); French cultural centre (n=72); Terou Bi (Beach) (n=36), Guediawaye (n=9), and Pikine (n=10) areas. Consumers were from African (mainly Senegalese) or from European origin. Because it is logistically difficult to transport the juice from Senegal to Europe, we used Europeans in Senegal as a proxy.

Four Bissap drinks were selected for consumer tasting among the samples used for sensory tasting as followed:

1. Commercial Sudanese syrup
2. Commercial Ordinary juice
3. Commercial Ordinary syrup
4. Commercial Mixed (Sudanese/Ordinary (50:50)) juice

During acceptability testing, each consumer was invited to taste each Bissap drink (50ml) (presented in random order and coded with three figure random numbers). Consumers were asked to score the acceptability with respect to appearance, taste and overall liking using a nine-point verbal hedonic box scale which varied from dislike extremely to like extremely (Meilgaard *et al.* 2007). Sample drinks were transported in cool boxes with ice. Syrup samples were diluted with potable water beforehand.

Along with obtaining information about the acceptability of the Bissap drinks, information was elicited from each consumer regarding demographics, education, bissap consumption and buying. All spoken interviews were conducted in French or in the local language (Wolof) and the score sheets and questionnaires were written in French. Trained enumerators assisted the consumers when required. The interview procedure (acceptability and the questionnaire) lasted no more than 30 min.

Statistical Analysis

Analysis of variance (mixed effect model), correlation analysis (Pearson), stepwise multiple linear regression, Chi-squared analysis and principal component analysis (correlation matrix) were carried

out using SPSS (V 18.0) or XLSTAT (V 5.2, Addinsoft). Multiple pairwise comparisons were undertaken using the Tukey test with a confidence interval of 95%.

Results and Discussion

Sensory profile of Hibiscus sabdariffa drinks

Principal component analysis (PCA) was used to summarize the relationships between the sensory attributes and the Bissap drinks (Fig. 1).

The PCA plot in Fig. 1, accounted for 91.43% of the total variation.

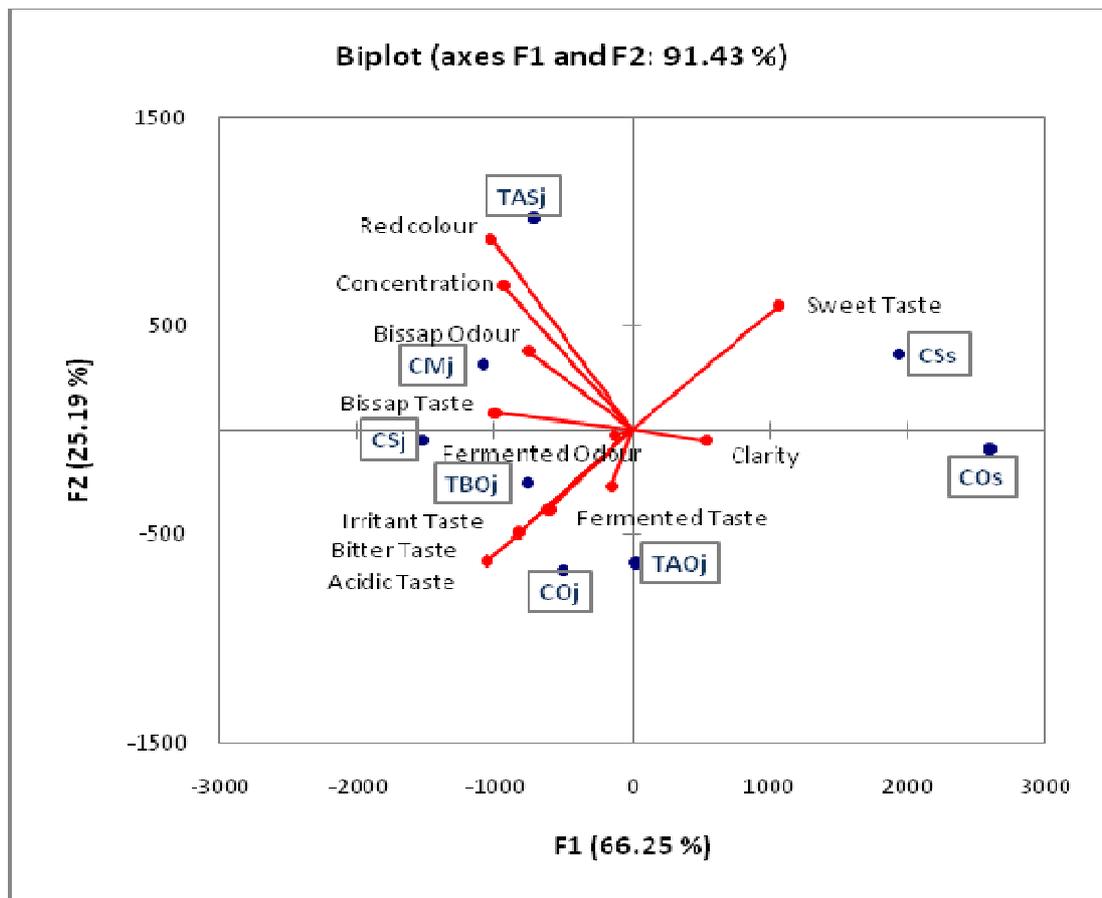


Fig. 1. Principal component plot illustrating the relationship between the sensory descriptors and the Bissap drinks tested (eight samples)

Where Commercial Sudanese juice (CSj); Commercial Sudanese syrup (CSs); Commercial Ordinary juice (COj); Commercial Ordinary syrup; (COs); Commercial Mixed (Sudanese/Ordinary (50:50)) juice (CMj); Traditional boiled Ordinary juice (TBOj); Traditional ambient temperature Ordinary juice (TAOj); Traditional ambient temperature Sudanese juice (TASj)

The commercial syrups (COs and CSs) were associated to the sweet taste whilst the juices (traditional and commercial) were associated with either an acidic taste or a Bissap taste. The commercial mixed syrup (CMs) (not represented on the Fig.1) was deselected because it was not fitting with the characteristics of a mixed syrup (mixture (50:50) of COs (ordinary syrup) and CSs (Sudanese syrup) as it was associated to fermented taste. It was revealed that there was a problem during processing (heating for too long). This shows that experimentally, it was critical that the production of the products for sensory testing is closely controlled.

It can be observed that traditional Bissap juices were not different from commercial ones. This was due to the wide diversity observed among traditional juices. Traditional juices with a different process: boiled (TBOj) or ambient (TAOj) ones were perceived different in their attributes. Besides, traditional juices with calices of different origin: ordinary (TAOj) or Sudanese (TASj) were also significantly different in terms of their sensory profile. This shows that both processing and calyx origin can have an important influence on the perception of Bissap drinks.

The sensory attributes of the eight Bissap drinks tested were strongly significantly different with respect to sample (linear mixed model; ANOVA; $P < 0.05$) for all the sensory attributes (red colour; clarity; concentration; bissap odour and taste; acidic, sweet, bitter, irritant and fermented taste) but for fermented odour (Table 2). Fermented odour was more difficult to differentiate among the panellists.

Table 2. Means and probabilities for sensory testing with respect to *Hibiscus sabdariffa* drink and sensory panellist

Descriptor/ Sample	Appearance			Odour		Taste					
	Red colour	Clarity	Concentration	Bissap	Fermented	Acidic	Sweet	Bissap	Bitter	Irritant	Fermented
CSj	61.2±17.0d	61.9±23.7cd	58.4±19.3d	51.5±18.3de	22.5±21.7ab	55.5±23.5cd	22.0±15.4a	65.9±16.5d	46.6±28.0b	37.4±27.1b	29.2±23.9cd
CSs	39.3±18.7b	68.8±22.6de	35.2±18.1b	27.9±19.9a	19.4±20.1ab	16.6±16.1a	69.5±17.1d	23.5±17.7a	16.0±17.4a	14.3±16.3a	27.3±27.0bcd
COj	35.6±15.8b	65.0±24.7cd	35.6±16.5b	45.1±18.5cd	19.4±17.8ab	58.6±23.6d	25.0±16.5ab	49.2±20.6bc	45.7±27.4b	39.8±25.3bc	28.6±25.5cd
COs	16.2±15.3a	78.7±17.8e	18.2±16.0a	24.5±19.6a	15.3±17.0a	12.8±13.1a	63.5±20.5cd	26.7±20.7a	13.7±14.0a	14.5±17.7a	15.2±18.2a
CMj	65.1±16.4d	64.1±22.5cd	60.4±19.9de	54.3±19.5de	20.1±19.5ab	45.7±23.9c	31.5±18.0ab	60.3±17.3cd	40.3±24.3b	28.8±21.3bc	24.9±20.4abc
TBOj	47.9±15.8c	37.4±29.4a	48.3±16.8c	40.1±22.1bc	21.2±19.1ab	52.0±30.9cd	31.7±29.7ab	46.3±25.1b	46.0±29.0b	39.1±29.2c	22.9±22.9abc
TAOj	33.8±16.3b	55.5±26.0ab	31.8±16.5b	30.9±19.5ab	25.6±21.3b	48.9±24.5cd	35.9±17.8b	46.3±20.9b	43.3±25.8b	38.2±28.4bc	36.7±25.7d
TASj	77.7±14.4e	49.2±26.8ab	67.1±22.2e	57.9±23.3e	21.9±23.2ab	30.8±24.1b	52.2±26.3c	55.8±23.3bcd	26.5±23.9a	27.7±23.6b	17.8±16.4ab
Sample	<0.001*	<0.001*	<0.001*	<0.001*	0.437	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Panellist	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.241	<0.001*	<0.001*	<0.001*
Sample x panellist	0.191	<0.001*	<0.001*	0.003	<0.001*	0.015	0.149	0.024	0.079	0.06	<0.001*

*Intensity of sensory attributes was scored a 100mm scale. Average (standard deviation).

Where Commercial Sudanese juice (CSj); Commercial Sudanese syrup (CSs); Commercial Ordinary juice (COj); Commercial Ordinary syrup; (COs); Commercial Mixed (Sudanese/Ordinary (50:50)) juice (CMj); Traditional boiled Ordinary juice (TBOj); Traditional ambient temperature Ordinary juice (TAOj); Traditional ambient temperature Sudanese juice (TASj). Differences between the samples (a, b, c, d or e in columns) were determined by the Tukey method

Sample panellist interactions for some of the attributes are probably because it was not possible to provide standards and because the panel was semi-trained and some attributes were more difficult to assess.

The sample the most red was the CMj that was not significantly different from CSj ($p < 0.05$). The ordinary juice (COj) and syrup (COs) were scored less in terms of colour and this was in accordance with local thinking. Senegalese people report that red Sudanese bissap has less flavour than the local one but is redder in colour. Wong *et al.* (2003) evaluated the sensory attributes of *H. sabdariffa* calixes submitted to different processes (cold or hot; with or without a press) to prepare the juice. The juice was evaluated by a sensory panel who scored colour (redness), odour (grassiness) and taste (grassiness, sourness, sharpness) using a scale of 100mm. The redness attribute varied according to the method of pressing (screw press) and extraction (hot water extraction). In this work, the redness of the bissap drink also varied according to the method of processing (juice or syrup) or extraction (cold or hot).

Syrups were significantly sweeter than juices ($p < 0.05$) and this is in accordance with the way these products are prepared. Syrups contain less water and more sugar.

In terms of bissap aroma (taste) the juices were scored significantly higher than the syrups. The Sudanese and Mixed juices (CSj and CMj) were scored having significantly greater bissap taste than the Ordinary one (COj) and this was contrary to local belief. The acidic tastes that were similar

for CSj and COj also contradicted the local thinking. According to the Senegalese customs, the ordinary Bissap is supposed to be more acidic and flavoured than the Sudanese one. It is a habit for some people to mix both types in order to obtain both aroma and redder colour.

Consumer testing

Consumer acceptance of Hibiscus Sabdariffa drinks

Overall, the acceptance of the Bissap drinks significantly differed between the four samples at $p < 0.01$ (One-way ANOVA) (Table 2).

Table 2. Mean overall acceptability scores for the four drinks tested

Hibiscus drink	Acceptability*
CMj	6.2 (0.1)b
CSs	5.9 (0.1)b
COs	5.6 (0.2)ab
COj	5.2 (0.2)a

*Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely. Average (error bars). Different letters are significantly different samples. Tukey test ($p < 0.01$).

Where Commercial Mixed (Sudanese/Ordinary (50:50)) juice (CMj); Commercial Ordinary juice (COj); Commercial Ordinary syrup; (COs); Commercial Sudanese syrup (CSs).

All of the drinks were on average acceptable since the mean scores were greater than a score of 5 (neither like nor dislike). The most liked was the Commercial Mixed Juice (CMj) followed by the Commercial Sudanese Syrup (CSs), the Commercial Ordinary Syrup (COs) and the Commercial Ordinary Juice (COj). The average liking was 5.7 over the four samples. As a comparison, Jaeger *et al.* (2009) reported that the acceptance of consumers for polyphenol-rich beverages made out of berries and chocolate (mixed or single varied between 2.3 and 5.1. Hence bissap juice as a polyphenol-rich beverage would be rated higher than these.

Segmentation of consumers into groups of similar acceptance patterns regarding the Hibiscus Sabdariffa drinks

Hierarchical cluster analysis (Wards method) was used to segment the European and African consumers interviewed at the different locations into three different groups.

Segmentation gives a more complex variation in acceptability among the consumers and is helpful to understand differences in consumer behaviour.

The mean liking for each of the four groups is illustrated in Fig. 2. We used a score of five ‘neither like nor dislike’ as an indicator of “neutral attitude”. The products rated below five were considered as “disliked” and above five as “liked”. For the purposes of cluster division, the groups were grouped as “syrup likers” (43%), “juice likers” (that could be alternatively called “syrup dislikers”) (36%) and “indifferent likers” (21%).

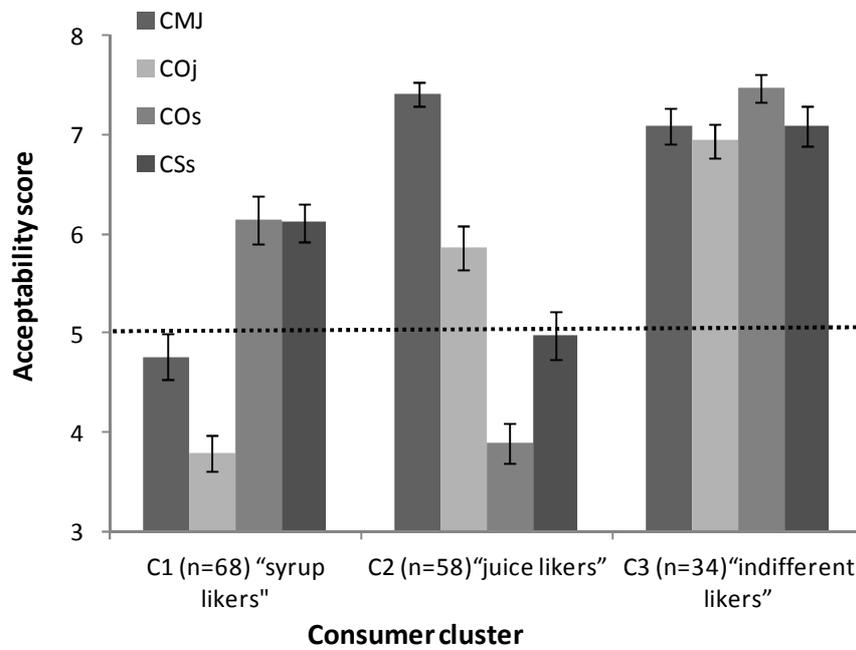


Fig 2. Mean consumer acceptance of bissap by cluster type (syrup likers, juice likers, indifferent likers). Where: error bars represent the standard error. Commercial Mixed (Sudanese/Ordinary (50:50)) juice (CMj); Traditional boiled Ordinary juice (TBOj); Commercial Ordinary juice (COj); Commercial Ordinary syrup; (COs); Commercial Sudanese syrup (CSs)

Demographic differences and consumer attitudes to Bissap with respect to cluster division are found in Table 3.

Table 3. Demographic differences and consumer attitudes to Bissap (buying and consumption) with respect to cluster division

Question		Cluster 1 “syrup likers”	Cluster 2 “juice likers”	Cluster 3 “indifferent likers”	Probability ^a One-way ANOVA (p<0.05) ^b Chi Square test (p<0.05)
Number of interviewees		65	56	39	
Age (years)		29	29	30	0.874 ^a
Male (%)		52%	53%	65%	0.429 ^b
Resident (%)		77%	78%	77%	0.987 ^b
African		56%	66%	71%	0.295 ^b
European		44%	34%	29%	
Education more than secondary school (%)		94%	91%	88%	0.362 ^b
Marital status (%)	Married	25%	28%	14%	0.627 ^b
	Single	72%	67%	79%	
	Other	3%	5%	6%	
No children		77%	74%	85%	0.449 ^b
Student		47%	53%	59%	0.604 ^b
Form in which consumers buy Bissap	Calices	41%	40%	32%	0.652 ^b
	Juice (sachet)	24%	32%	35%	
	Juice (bottle)	32%	21%	24%	
	Syrup	3%	5%	6%	
	Other	0%	2%	3%	
Frequency	Once a day ^a	9%	17%	12%	0.028* ^b
	Several times a week ^a	29%	45%	47%	
	Once a week ^a	24%	17%	21%	
	Once a month ^a	13%	2%	0%	
	Rarely	25%	17%	15%	
	Other	0%	2%	6%	
Consumed	Natural	68%	69%	54%	0.334 ^b
	With added flavours	32%	31%	46%	

*significant at p<0.05

The three clusters did not significantly differ in terms of sociological criteria such as age, sex, residency, education level, marital status etc.

There were no differences in the form the different clusters purchase Bissap: the most common form of buying was as calices followed by juice (in sachets), juice in recycled bottles, industrial juice and syrup.

In addition clusters did not significantly differ in the proportions of European or African consumers although there appears to be a tendency for European consumers to be ‘syrup likers’ (50% of Europeans versus 33% of Africans) and Africans consumers were more likely to be ‘juice-likers’ (33% of Europeans versus 38% of Africans) or ‘indifferent-likers’ (17% of Europeans versus 29%

of Africans). The lack of a significant difference in acceptance between European and African consumers would enable future consumer testing to be simplified. However, it is suggested that this study be repeated to determine if the trend is consistent.

Considering socio-economic differences between African and European consumers, they tended to be of similar age (27 against 32 respectively), single, with no children. A high proportion of the consumers were students (51% and 37% respectively). There was a higher proportion of males among the African consumers. Most of the African consumers were Senegalese (85%) and most of the European consumers were French (67%). Almost all the African consumers were resident of Senegal whereas the European residents represented 40%.

African and European consumers had a different buying pattern ($p < 0.01$; Chi Square Test) (Fig. 3). The most common form of Bissap bought were the calices for both Africans and Europeans. Europeans tended to buy less juice in sachets, more bottled juice (recycled or industrial) and more syrup compared to the African consumers.

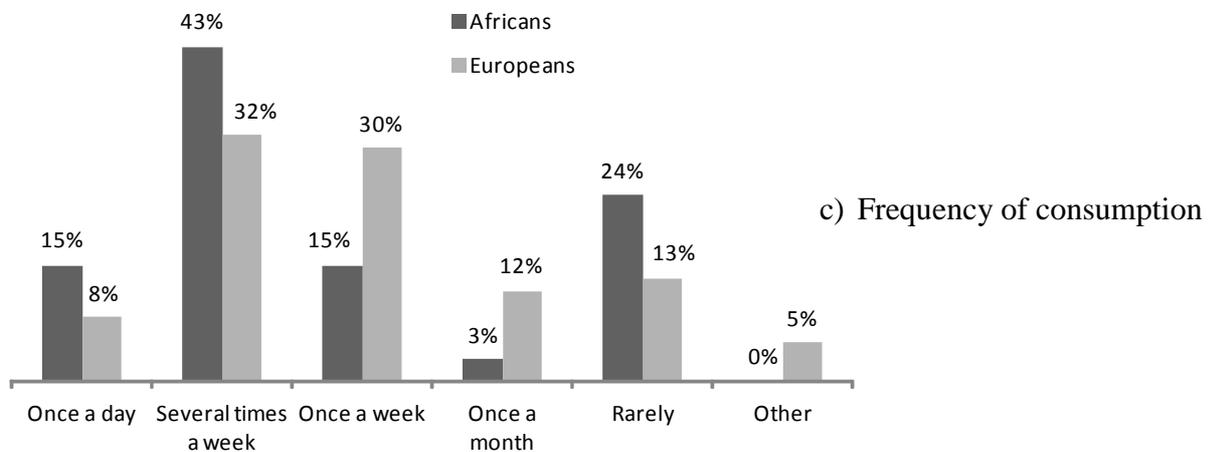
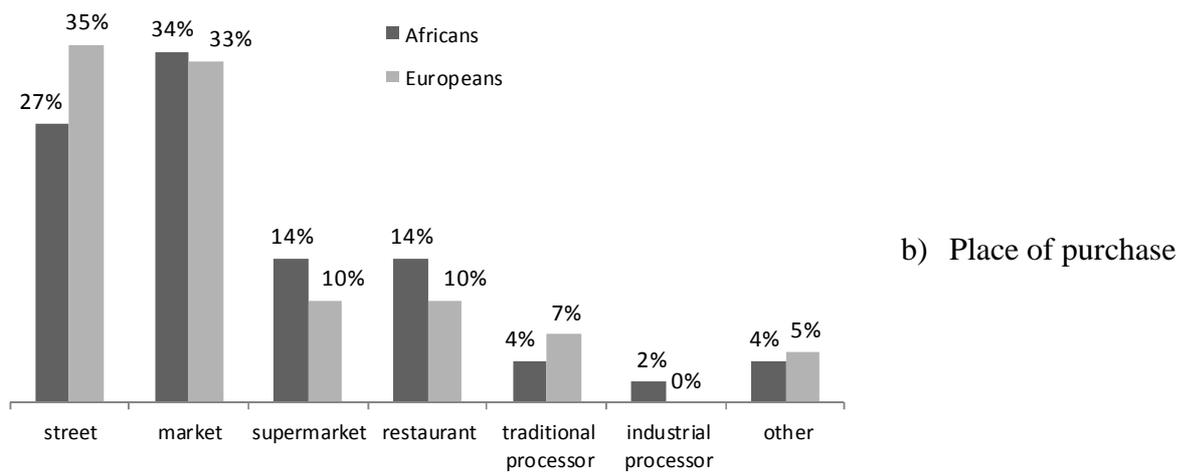
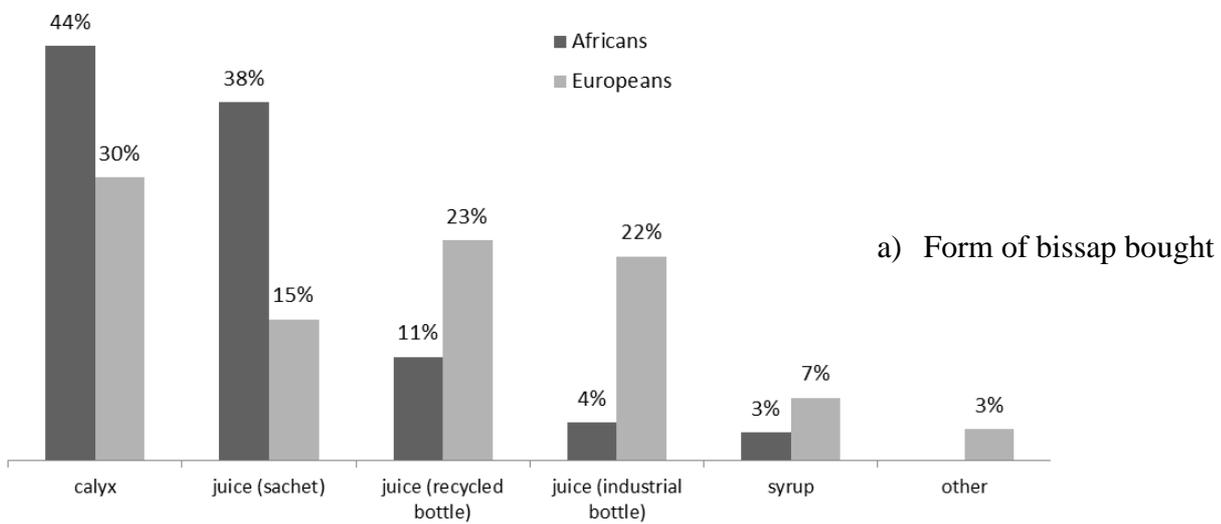


Fig 3. Most common forms of *H. sabdariffa* bought by the European (n=60) and African (n=100), place of purchase and frequency of consumption

In addition, the pattern of frequency of consumption was different between the Africans and Europeans (Fig. 3). However the frequency of consumption of Bissap drinks was high for both groups of consumers: 73% of Africans and 70% of Europeans consumed Bissap once a week or more. The frequency of consumption also differed within the three clusters: the “syrup likers” consumed Bissap significantly less frequently (62% of the consumers consumed Bissap more than once a week) compared to the “juice likers” and “indifferent likers” (77% and 82% respectively) (Table 5).

The answers given by the consumers on where they bought hibiscus are given in Fig. 3. Consumers either African or Europeans behaved the same way regarding on where they bought the product. Most consumers bought Bissap in the street or in the market. Fewer consumers bought it at an industrial processor. These data showed that *H. sabdariffa* is a popular product that is found in common places where most local consumers buy their food, the street and the market

In regard to the taste (natural (66%) or with added flavour (34%)) the responses given were also similar for African or European consumers. For the three clusters, percentage consumption of bissap natural or with added flavour was also the same (Table 5).

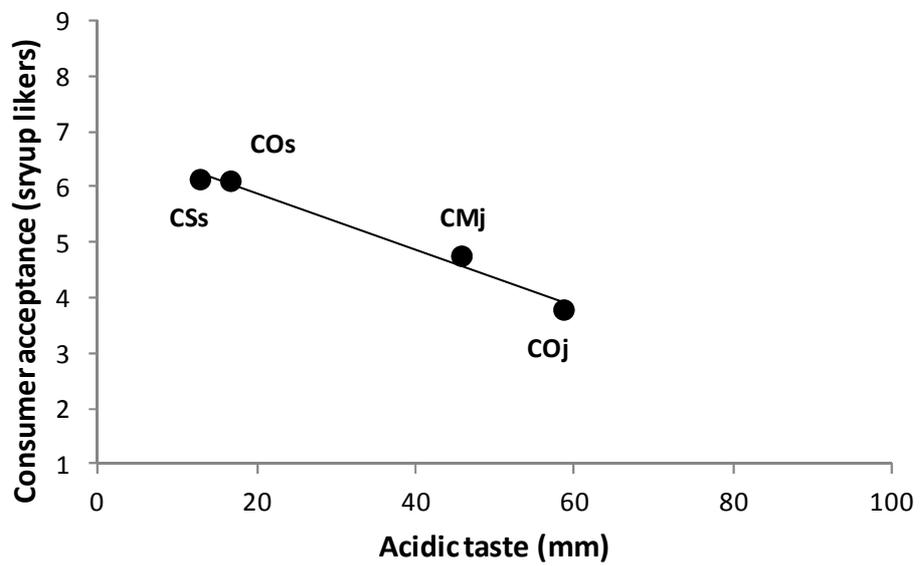
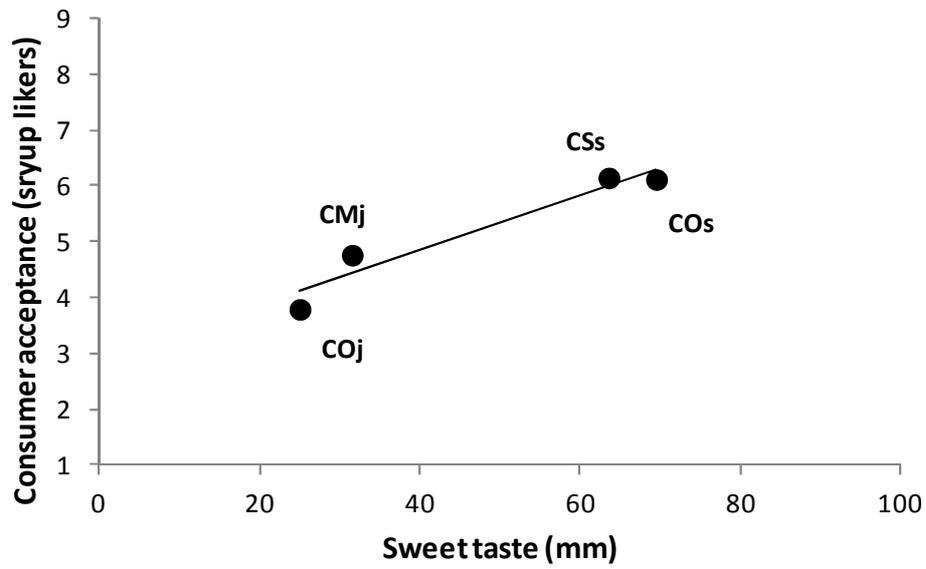
Although there were three clusters of consumers, most attributes of the consumers were similar in these clusters. Some few differences existed between African and Europeans in terms of the form of bissap most bought and the frequency of consumption. Little published literature has been found on the consumer acceptance related to the origin of the consumer and also on traditional food products. Kune *et al.* (2010) investigated how food innovation in the traditional food products in Europe would be perceived by the consumers. The study was undertaken in Belgium, Italy and Hungary and revealed that there were significant cluster differences (Cluster 1: Non-innovator chains; Cluster 2: Non-collaborating innovator chains; Cluster 3: High-collaborating innovator chains) with respect to country and this was different to the findings of our study. The lack of difference observed in this work on bissap between Europeans and Africans in terms of acceptability is good news because it means that there is the flexibility of using African consumers when doing the marketing study for European markets.

Correlations between sensory attributes and consumer acceptance

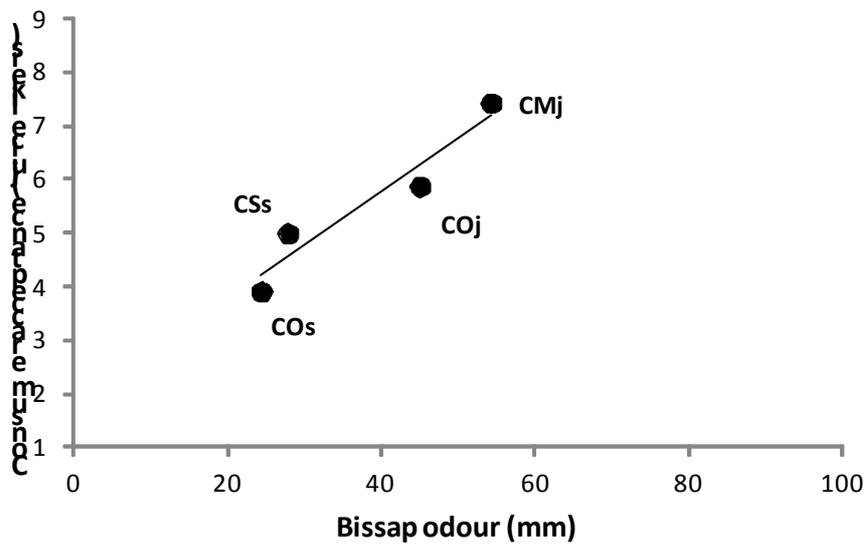
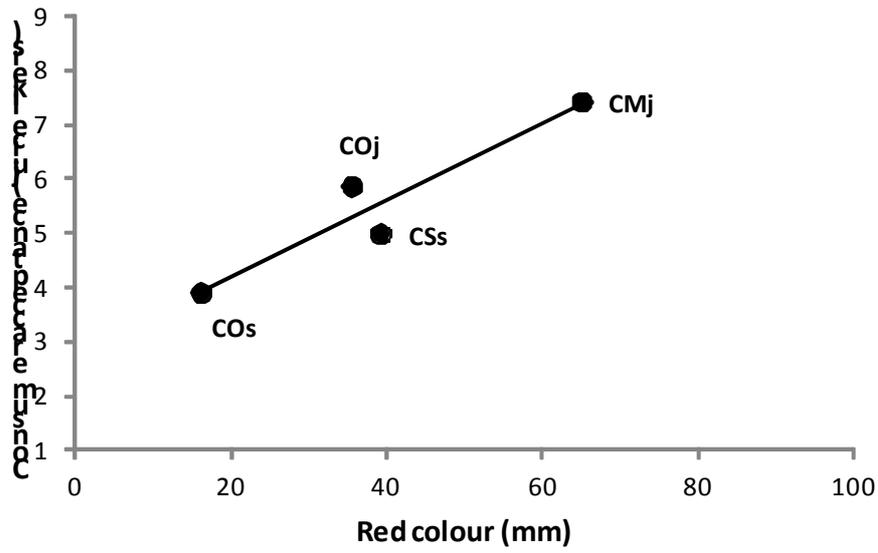
Regarding correlations between consumer acceptance and the sensory attributes, a range of curves were explored for each of the groups (Table 4 & Fig. 4).

Table 4. Correlations between sensory attributes, chemical analyses and acceptability of Hibiscus drinks

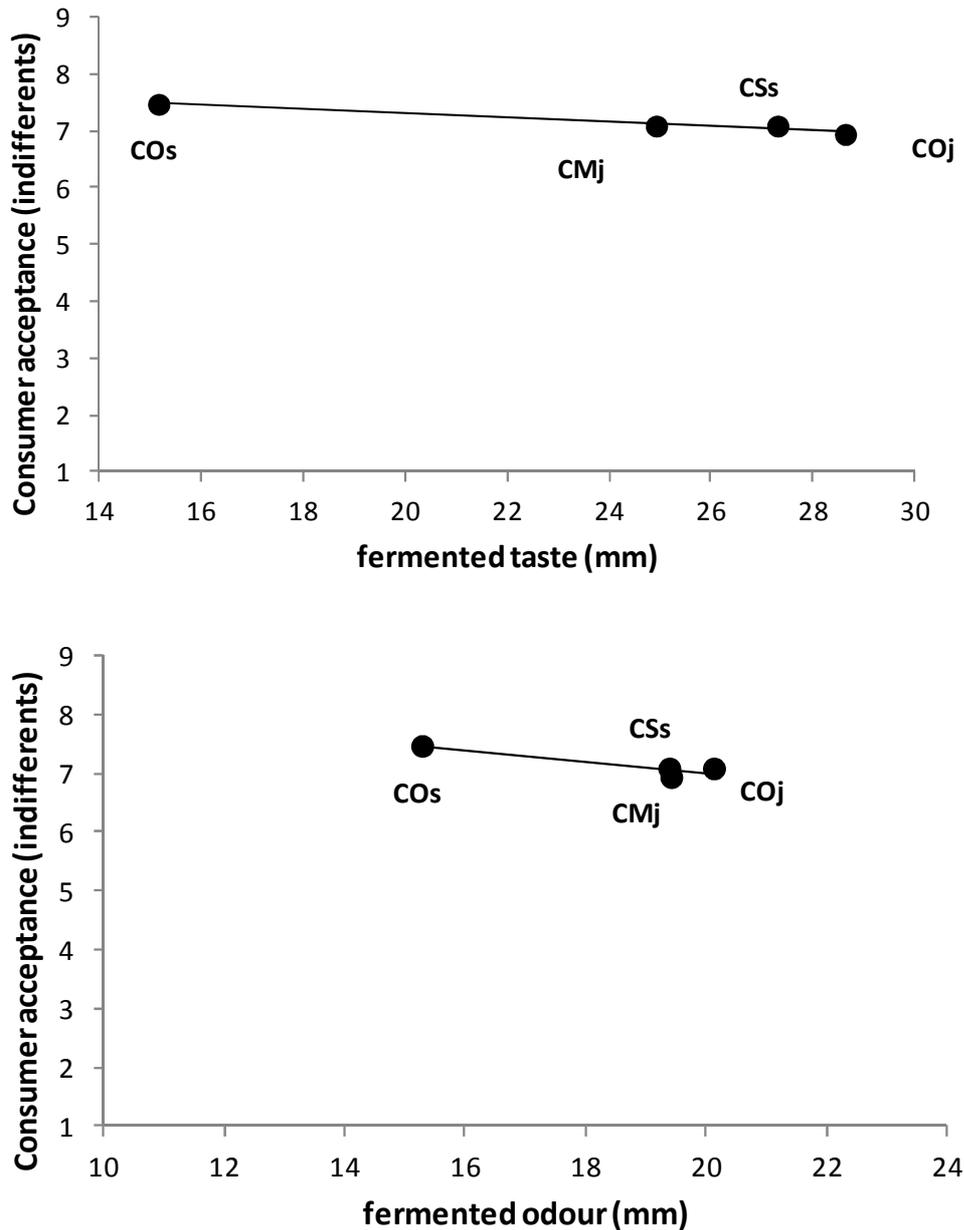
	Variables	All	C1 (n=68) "syrup likers"	C2 (n=58) "juice likers"	C3 (n=34) "indifferent likers"
Sensory attributes	Red colour	0.667	-0.405	0.949*	-0.601
	Clarity	-0.174	0.734	-0.883	0.938*
	Concentration	0.626	-0.466	0.972**	-0.599
	Bissap Odour	0.222	-0.808	0.962**	-0.644
	Fermented Odour	0.302	-0.560	0.827	-0.918*
	Acidic Taste	-0.266	-0.991**	0.748	-0.765
	Sweet Taste	0.207	0.966**	-0.760	0.623
	Bissap Taste	0.162	-0.815	0.910*	-0.532
	Bitter Taste	-0.173	-0.975**	0.805	-0.743
	Irritant Taste	-0.410	-1.000**	0.637	-0.720
	Fermented Taste	-0.039	-0.588	0.586	-0.981**



a) 'syrup likers' and sensory attributes



b) 'juice likers' and sensory attributes



c) 'indifferent likers' and sensory attributes

Fig 4. Correlations between sensory perception and consumer acceptance

Where Commercial Mixed (Sudanese/Ordinary (50:50)) juice (CMj); Traditional boiled Ordinary juice (TBOj); Commercial Ordinary juice (COj); Commercial Ordinary syrup; (COs); Commercial Sudanese syrup (CSs)

For the consumer group as a whole, their mean acceptance scores were not correlated to any of the sensory attributes. Significant positive correlations ($p < 0.10$) were identified between the “sryup likers” and sweet taste. Negative correlations were found between the “syrup likers” and acidic taste, bitter taste and irritant taste. Significant correlations ($p < 0.10$) were identified between the “juice likers” and for red colour, concentration, bissap odour and taste. Also there were significant correlations between the “indifferent likers” and clarity. “indifferent likers” were negatively correlated to fermented odour and taste. A significant correlation with the sensory attributes for these clusters support the finding that the acceptance was related to sensory attributes and consumers had selective tastes according the products they like most.

These correlations accord with the sensory perception of the samples and highlight that sweetness is an important criterion of acceptability for the “syrup likers” and bissap taste would be an important criterion of acceptability for the “juices likers”.

Implication for developing bissap juice and syrup products suited to European market and the local market in Senegal

Cluster analysis approach has been commonly used in consumer acceptance in order to determine which groups of people who would prefer which type of product. This approach is very useful in the marketing approach because it helps target specific consumers with the type of product they like. The liking can be depended upon many factors (socio-economic background; food customs) and knowing the consumers would help predict the product that they are more likely to adopt when launching a new product on the market for instance. In the case of this study involving *Hibiscus Sabdariffa* drinks, acceptability study will help re-engineering of the product that shall suit the consumer taste.

The sensory and chemical characteristics important to each group of consumers differed. For the indifferent likers, they were the least discerning consumers. However their acceptances correlated with clarity and were sensitive to fermented odour and taste. They shall be open to a wide variety of reengineered products in the measure that these are not perceived as fermented ones. The syrup likers are more discerning and prefer syrup that are sweet and without irritant, bitter or acidic taste (low titrable acidity). Red colour was not considered to be important. The most discerning consumers were the juice likers. They preferred bissap drinks that are red in colour, have the characteristic of a juice (concentration) and have the taste and odour characteristic of bissap.

H. sabdariffa juice is more popular than syrup in the Senegalese market. However syrup is easier to export than juice because it is less bulky. The findings that 50% of European consumers were syrup likers against 33% of Africans means that syrup has a good acceptance among European consumers and the exportation of syrups will not be a barrier to acceptance.

Conclusions

The results of this research help to provide a basis of understanding of the acceptability of *Hibiscus sabdariffa* drinks both by African and European consumers and indicate ways that the product could be adapted to consumer taste and can have a potential success as a marketed product.

Acknowledgement

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Annex 2 – detailed report for Baobab (Bouye)

Sensory and Consumer testing of drink from Baobab fruit (“Bouye”)

Mady CISSE ^a, Aurélie BECHOFF ^b, Nicolas AYEISSOU ^a, Ndèye Adiara NDIAYE DIOP ^a,
Cheikh TOURE ^c and Keith TOMLINS ^b

^a Laboratoire de Formation Continue en Industrie Agro-alimentaire, Cheikh Anta Diop Université de Dakar, BP 5005, Dakar-Fann Sénégal

^b Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME7 3RU, United Kingdom

^c Association Afrique Agro Export, Sot Sotrac Mermoz – BP 45.028 Dakar Fann, Sénégal

ABSTRACT (max 300 words)

The sensory profile of seven samples of bouye (baobab) drinks (syrup and juice) was evaluated by 17 panellists. Then consumer testing was investigated at four different locations in Dakar using the central location method (Meilgaard *et al.*, 2007). These were the following: ESP high school (n=32); Grand Yoff (n=36), Guediawaye (n=12), and Gueule Tapée (n=26) areas. The acceptability of the drink was tested by African consumers (mainly Senegalese) (n=104) in Dakar who tested five different drinks from the seven first samples. A cluster analysis demonstrated that consumers behave differently with respect to acceptability. Three classes of behaviour from the consumers were identified. There were a) those who clearly preferred the juice from FWS (27% of consumers) b) those who preferred all of the samples (indifferent likers) (31% of consumers), c) those who liked the juices but not the syrups (juice likers) (42% of consumers).

Syrups and juices had different characteristics. Juices were more associated with bouye attributes (taste and odour) than syrup. Juices were also associated with concentration and beige colour. The addition of milk had a significant influence on the characteristics of the product perceived but not the influence of guava flavouring. Traditional juice was not perceived significantly different from one the commercially juice. The commercial syrups were associated to the sweet taste and flavour. They are very close and are the least preferred products by consumers. The correlations highlight that concentration is an important criterion of acceptability for the consumer group as a whole and particularly for the “juice likers”.

CONCLUSIONS RELATING TO REENGINEERING (MAX 200 WORDS)

With respect to acceptance, the reengineering approach appears to have two options being products suited to a) milk taste or b) taste and odour characteristic of baobab with a good concentration for the two products. The reengineering approach must also be stressed on how to stabilize the products to increase their shelf life with optimum quality regarding the sensory attributes and consumer acceptance. Optimizing scales for pasteurization shall be conducted in order to have a product without caramel smell.

Introduction

The baobab (*Adansonia digitata L.*) is important to the livelihood and can be found in most of Sub-Saharan Africa’s semi-arid and sub-humid regions as well as in Western Madagascar providing food, medicine, etc. (Gebauer *et al.* 2002 ; Cisse *et al.* 2009, Caluwé *et al.*, 2010). Baobab fruit pulp is called "Bouy" or Monkey bread is widely used by Senegalese people and it is consumed in different forms (Cisse *et al.*, 2009).

Most of applications of the baobab pulp could include the preparation of refreshing drinks and caillement of milk (Diop et al. 2005), and in some cases it can be used for traditional therapy (D1.1.2.3). The pulp of baobab was approved by the European Commission as a convenient additive (Phytotrader Africa 2008). From Senegal also, the fruit is exported towards some European countries. In fact, the ingredients in powder form are well used in many circumstances for conservation advantages. Caluwé et al. (2010) has mentioned that when the pulp is soaked in water, it produces a milky solution which is then consumed as a milk substitute. This technique is used by urban area populations of Dakar and in many parts of countryside to produce ice creams (Diop et al. 2005, Cisse et al., 2009).

Baobab pulp is a semi processed food. During the preparation, the pulp is ground and sieved to produce a powder, and the powder is finally kept in convenient containers. Baobab fruit pulp is a natural dried fruit pulp. The pulp is used to develop other food products, such as ice cream, beverages, etc. In the market, the baobab pulp is sold into plastic sachets to avoid water rehydration. It begins to be sold by supermarkets using other specific packaging for many reasons added value. The baobab pulp is used specifically in some way by specific packaging material imposed by the Export market.

The baobab juice is made from baobab fruit or baobab pulp in some cases (in semi industrial level). The local market is well developed for baobab juice. In the cars' station, the streets, the supermarkets, the baobab juice is well commercialized. In the restaurants also, the baobab drink is mostly used as soft drinks for many tourists. The baobab syrup is more commercialized to the drinks in abroad because the shelf life is longer. According to the producers (D5.1.1.3), the market of syrup for exportation is developing. In the supermarkets, it is also sold in very nice plastic or glass bottles using sometimes coded design for labeling. The lack of the syrup in street market and market places is due to low demand for the specific related clients.

Consumer acceptance is important in marketing strategies for product development in Senegal where consumers are becoming more demanding on quality products. Along with product development and economic viability, this will give food companies confidence to expand the adoption in Africa and to adopt these products in the EU. To our knowledge, in the case of baobab products there are no studies on the acceptability of baobab drink like juice and syrup.

This study primarily explored the sensory profile of baobab drinks and the acceptance. Relationships between the sensory attributes and the characteristics of the products were related to consumer acceptance in order to understand the factors that influenced acceptability of the baobab drinks.

Materials and Methods

Juice and syrup samples

Seven different baobab samples (five juices and two syrups) were presented to the panellists. Juices were used as they were whilst syrups were diluted 1:4.

The baobab samples were made from *Adansonia digitata* fruit variety. Selection of samples for sensory and consumer analysis was in the following tables.

Table 1. Legend – samples for sensory tasting

Supplier	Product content	Type	Aroma or milk	Pasteurisation	Abbreviation
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Company A	Baobab + water + sugar	Juice	none	yes	Estev-J
Company A	Baobab + water + sugar	Syrup	none	yes	Estev-S
Company B	Baobab + water + sugar	Juice	none	No	FWS-J
Company B	Baobab + water + sugar	Juice	guava	No	FW-Guava-J
Company B	Baobab + water + sugar	Syrup	none	yes	FW-S
Traditional	Baobab + water + sugar	Juice	none	No	Tradi-J
Traditional	Baobab + water + sugar	Juice	milk	No	Tradi-milk-J

Table 2. Legend – samples for consumer tasting

Supplier	Product content	Type	Aroma or milk	Pasteurisation	Abbreviation
Company A	Baobab + water + sugar	Juice	none	yes	Estev-J
Company A	Baobab + water + sugar	Syrup	none	yes	Estev-S
Company B	Baobab + water + sugar	Juice	guava	No	FW-Guava-J
Company B	Baobab + water + sugar	Syrup	none	yes	FW-S
Traditional	Baobab + water + sugar	Juice	milk	No	Tradi-milk-J

Commercial samples were prepared by two local Senegalese fruit juice and syrup companies. The company A sells these products in supermarkets and restaurants in Senegal while the company B makes direct sales to consumers. Commercially made syrups and juices were processed from the same batch of baobab fruit for the two companies. For the traditional products, the same batch of baobab fruit was used. The process of preparation of commercial juices and syrups differed in terms of sugar addition. In both cases the first stage was an aqueous extraction at ambient temperature (typically 2h). Sugars (130 to 145 g/L) were added in the commercial juices, after filtration (to separate the seeds and the fibers from aqueous extract) and before pasteurization at 85 °C for 20 minutes only for the juice of company A. Sugars (1300 g/L) were added in the commercial syrups after filtration followed by pasteurisation up to a temperature of 105 °C. Traditional samples were prepared by a local processor using traditional practices but working under good safety conditions. In the traditional preparation, extractions were either extracted at ambient temperature. After sieve filtration and cotton wool filtration sugar and milk (for the case of Tradi-milk-J) were added. There was no pasteurisation stage in the traditional preparation.

Ethical assessment and consent

This study has been assessed and approved by the University of Greenwich Research Ethics Committee. The University of Dakar has also approved the study. Consent was sought from sensory panellists and from adult consumers participating in this study. Enumerators informed participants about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point. In fact we had two retirements during consumer testing. The responses would be anonymous.

Sensory evaluation

Baobab juice and syrup samples were scored by a semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided (Meilgaard *et al.*, 2007; Tomlins *et al.* 2012). The panel was composed of university technicians, students or private company employees (17 people in total). Sessions were conducted at Cheikh Anta Diop University of Dakar (Senegal) in air conditioned room with controlled lighting and ambient temperature (22 to 25°C). The language used for the sensory testing was French. The panellists had been screened for familiarity with the product. Sensory attributes were generated during a

preliminary focus group session guided by the panel leader. A total of 14 sensory attributes were developed for the baobab drink for which the group of panellists had a consensus. Sensory attributes generated were as follows (English translation):

- Beige colour
- Whitish colour
- Orange-yellow colour
- Baobab odour – odour characteristic of baobab
- Milk odour
- Fragrant odour
- Caramel odor
- Taste of baobab
- Sweetness
- Acidic taste
- Taste of milk
- Flavor
- Concentration aspect
- Cloudiness

After a period of training using these attributes, the seven baobab samples were tested blind in triplicate by the panel and the order in which they were presented was random. At each session, four baobab sample drinks (coded with 3-figure random numbers) were served in transparent plastic cups in random order to each panellist. Baobab drinks (50ml) were tested by the panellists. Juices were stored in the fridge overnight. The shelf life of a syrup and juice at 8°C (fridge temperature) is respectively of a year and of four months for the commercial products. For the traditional product, they were prepared the day before the test and the shelf-life is estimated to one week at fridge temperature. Intensity for the sensory attributes was scored on a 100 mm unstructured scale, anchored with the terms ‘not very or no’ at the low end and ‘very or much’ at the high end.

Consumer acceptability

Consumers (106) were interviewed at four different locations in Dakar using the central location method (Meilgaard *et al.*, 2007). These were the following: ESP high school (n=32); Grand Yoff (n=36), Guediawaye (n=12), and Gueule Tapée (n=26) areas. Consumers were from African (mainly Senegalese) origin. Five baobab drinks (Table 2) were selected for consumer tasting among the samples used for sensory tasting as followed:

1. Esteval commercial syrup
2. Esteval commercial juice
3. FWS commercial syrup
4. FWS commercial juice with guava aroma
5. Traditional juice with milk

During acceptability testing, each consumer was invited to taste each baobab drink (50ml) (presented in random order and coded with three figure random numbers). Consumers were asked to score the acceptability with respect to appearance, taste and overall liking using a nine-point verbal hedonic box scale which varied from dislike extremely to like extremely (Meilgaard *et al.* 2007). Sample drinks were transported in cool boxes with ice. Syrup samples were diluted with potable water beforehand.

Along with obtaining information about the acceptability of the baobab drinks, information was elicited from each consumer regarding demographics, education, baobab consumption and buying. All spoken interviews were conducted in French or in the local language (Wolof) and the score

sheets and questionnaires were written in French. Trained enumerators assisted the consumers when required. The interview procedure (acceptability and the questionnaire) lasted no more than 30 min.

Statistical Analysis

Analysis of variance (mixed effect model), correlation analysis (Pearson), stepwise multiple linear regression, Chi-squared analysis and principal component analysis (correlation matrix) were carried out using SPSS (V 18.0) or XLSTAT (V 5.2, Addinsoft). Multiple pairwise comparisons were undertaken using the Tukey test with a confidence interval of 95%.

Results

Sensory profile of baobab drinks

The following principal component analysis (PCA) shows the relationships between the 7 Bouye samples and their descriptors according to the sensory panel scoring (n=16 panellists). The PCA representation (Fig. 1) accounted for 79.60% of the total variation for the Bouye (n= 16 panellists).

Syrups and juices had different characteristics. Juices were more associated with bouye attributes (taste and odour) than syrups. Juices were also associated with concentration and beige colour. The commercial syrups (Estev-S and FWS-S) were associated to the sweet taste and flavour.

The addition of milk was perceived by the panellists as the juice with added milk was significantly different from the other juices. Traditional juice with milk was associated to the smell fragrant whitish color and cloudy.

The addition of guava flavouring did not influence on the perception of the product: guava added juice and non-added guava juices both traditional and commercial had similar characteristics.

The traditional juice was not perceived significantly different from the commercial juices. It presents very similar characteristics than the Esteval juice. The acidic taste is much stronger for the juice Estev-J compared to other products (syrups and juices).

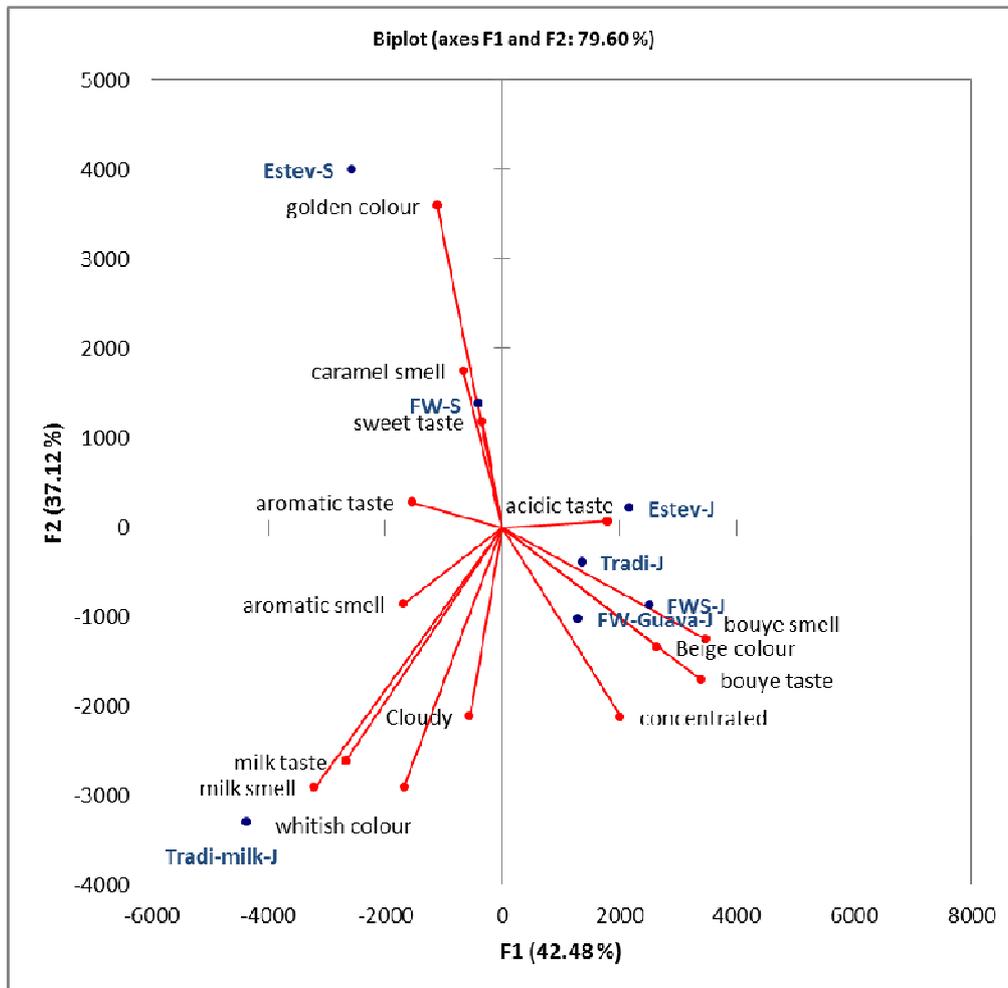


Figure 1. Principal component plot illustrating the relationship between the sensory descriptors and the Bissap drinks tested (seven samples) where Esteval commercial syrup (Estev-S); Esteval commercial juice (Estev-J) ; FWS commercial syrup (FWS-S); FWS commercial juice with guava aroma (FW-Guava-J); Traditional juice with milk (Tradi-milk-J); Traditional juice (Tradi-J); FWS commercial juice (FWS-J).

The seven different samples were divided into four and five clusters (Table 3) with statistical analysis (cluster analysis) in order to help determine the samples for consumer testing (=4 or 5 samples).

Table 3. Five sample– cluster division

Class	1	2	3	4	5
	Estev-J	Estev-S	FW-Guava-J	FW-S	Tradi-milk-J
	Tradi-J		FWS-J		

It is advised to go for a five cluster approach in the consumer work.

Consumer acceptability

Table 4 shows the overall acceptability for each of the five Baobab products tested independently of the type of consumer. Overall, the acceptance of the Bissap drinks significantly differed between the five samples at $p < 0.01$ (One-way ANOVA) (Table).

Table 4. Mean overall acceptability scores for the five baobab products tested

Name	Esteval juice	Esteval syrup	FWS guava juice	Tradi milk juice	FWS syrup
Average	5.9	4.9	7.9	6.7	4.8
Standard deviation	1.9	1.9	1.0	1.5	1.7
letter	b	a	d	c	a

*Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely. Different letters are significantly different samples. Tukey test ($p < 0.01$).

Most of the baobab products were on average acceptable since the mean scores were equal or greater than a score of 5 (neither like nor dislike). Only the Esteval syrup had acceptability below 5. The most liked was the FWS commercial juice with guava aroma (FW-Guava-J) followed by the traditional milk juice (Tradi-milk-J). The commercial syrup is very close and is the least preferred products.

Hierarchical cluster analysis (Wards method) was used to segment the consumers interviewed at the different locations into different groups. A division into three clusters was suggested by the program since a larger number of clusters would have produced clusters that contained too few consumers and additional smaller clusters were sub-sets of larger ones. Thus segmentation gives a more complex variation in acceptability among the consumers than the overall means previously indicated above (Table 3).

The mean liking for each of the four groups is illustrated in Figure 2. We used a score of five ‘neither like nor dislike’ as an indicator of “neutral attitude”. The products rated below five were considered as “disliked” and above five as “liked”.

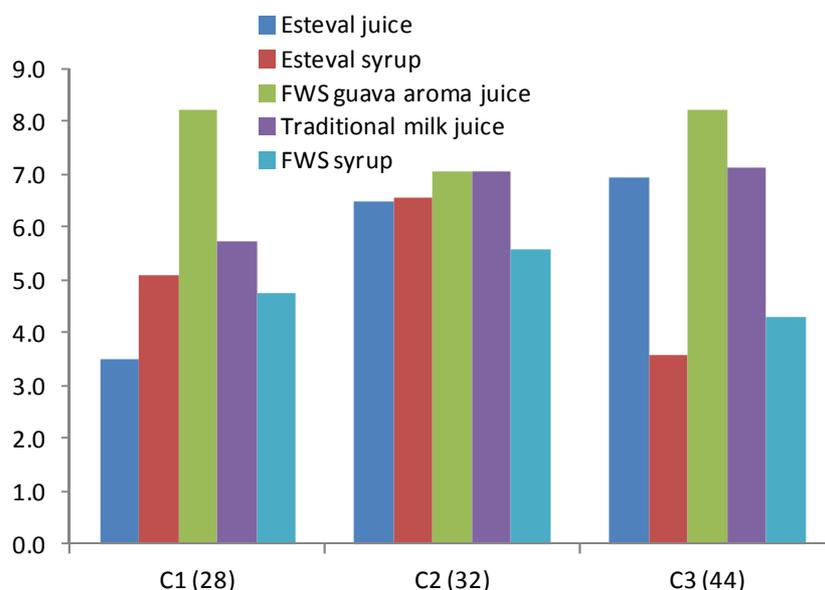


Figure 2. Mean consumer acceptance of Baobab by cluster type

For the purposes of cluster division, the groups were grouped as “FWS juice likers ”(27%), “Bouye indifferent likers” (31%), and “juice likers” (42%).

Demographic differences and consumer attitudes to Bouye with respect to cluster division are found in Table 5.

Table 5. Demographic differences and consumer attitudes to Bouye (buying and consumption) with respect to cluster division

Question	Probability Chi Square test (p<0.05)
Age	0.493
Gender	0.975
Resident	0.502
Marital status	0.239
Number of children	0.753
Education	0.295
Professional activity	0.335
Most consumed form of bouye	0.527
Which form of bouye is bought	0.161
Frequency	0.260
Place of purchase	0.051/0.049*
Place of consumption	0.051/0.029*
Added aroma preference	0.415

*significant at p<0.05; the ‘other’ category has been removed.

The three clusters did not significantly differ in terms of sociological criteria such as age, sex, residency, education level, marital status etc.

There were no differences in the form the different clusters purchase Bouye (Figure 3): the most common form of buying was as fruit pieces (42%) followed by bottled juice, powder, juice in sachets and as an entire fruit. None of the consumers interviewed bought Bouye as a syrup.

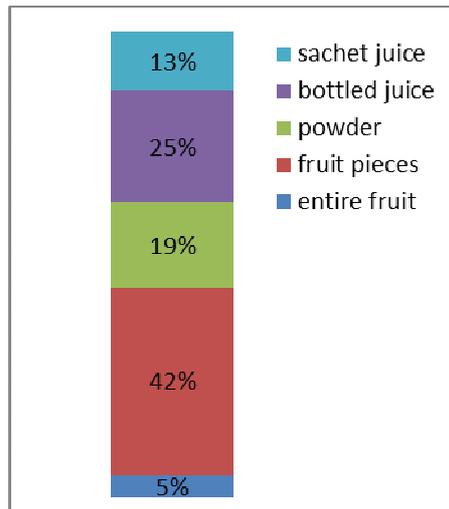


Figure 3. Form of consumption of Bouye

In addition clusters did not significantly differ in the frequency of consumption between the different clusters (Figure 4)

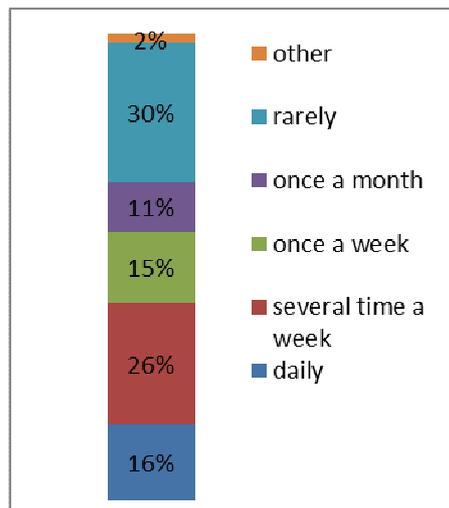


Figure 4 . Frequency of consumption of Bouye

More than half of the consumers interviewed (58%) consume Bouye at least once a week. This means that Bouye is an important drink for the Senegalese market.

Clusters significantly differed in the places of purchase and in the places of consumption. In general for the three clusters, consumers tended to buy Bouye from the market primarily. For the juice likers (C1 and C3), consumers then buy Bouye from the street (Figure 5). The indifferent likers (C2) would buy Bouye from various locations. These data showed that Bouye is a popular product that is found in common places where most local consumers buy their food, the street and the market

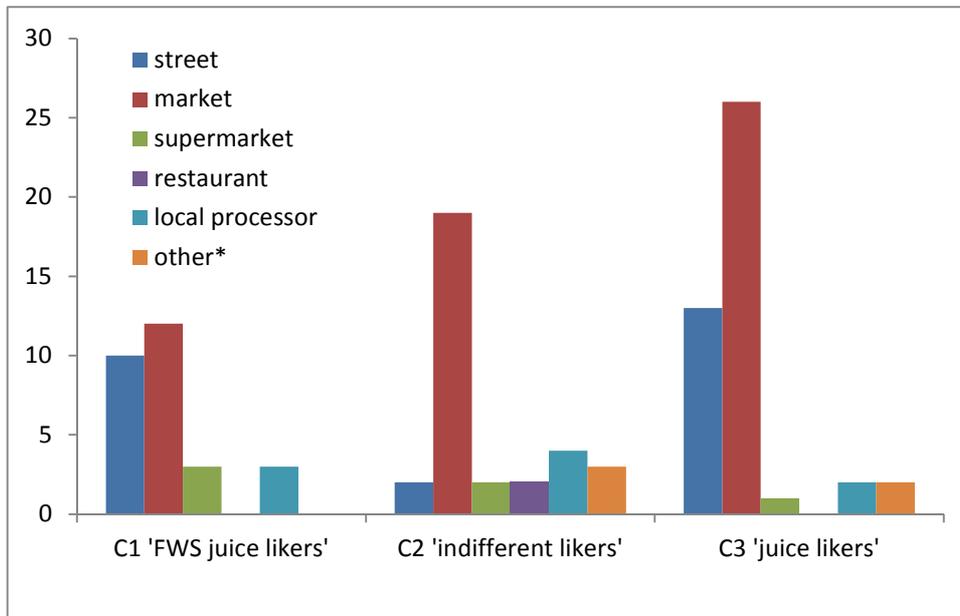


Figure 5. Most common places where consumers (n=104) purchase Bouye.

Regarding the place of consumption (Figure 6), the most common place is home for the three clusters. The second place of consumption is the street for juice likers (C1 and C3) whilst it is work for indifferent likers (C2).

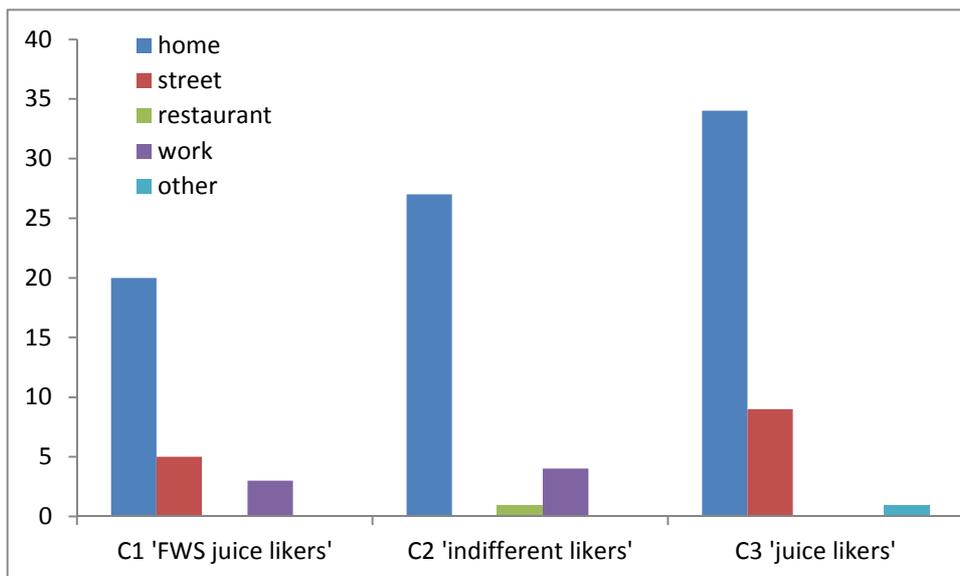


Figure 6 . Most common places where consumers (n=104) consume Bouye.

Correlations between physical and chemical analysis, sensory attributes and consumer acceptance

Table 6. Correlations between sensory attributes, chemical analyses and acceptability of baobab drinks

	Variables	C1 (28) FWS likers	C2 (32) indifferent	C3 (44) juice likers	All
	Beige colour	0.349	-0.075	0.615	0.518
	Whitish colour	0.330	0.540	0.508	0.531
	Golden colour	-0.396	-0.047	-0.613	-0.551
	Bouye smell	0.085	0.122	0.678	0.491
	Milk smell	0.168	0.519	0.369	0.378
	Aromatic smell	0.789	0.777	0.471	0.708
Sensory attributes	Caramel smell	-0.326	-0.284	-0.814*	-0.691
	Bouye taste	0.228	0.289	0.797	0.646
	Sweet taste	0.554	-0.238	-0.422	-0.109
	Acidic taste	-0.445	-0.004	0.306	0.037
	Milk taste	0.161	0.516	0.372	0.377
	Aromatic taste	0.590	0.471	-0.144	0.190
	Concentrated	0.379	0.646	0.949**	0.852*
	Cloudy	0.180	0.715	0.765	0.670

Values in bold are different from 0 with a significance level at <0.10*; <0.05**.

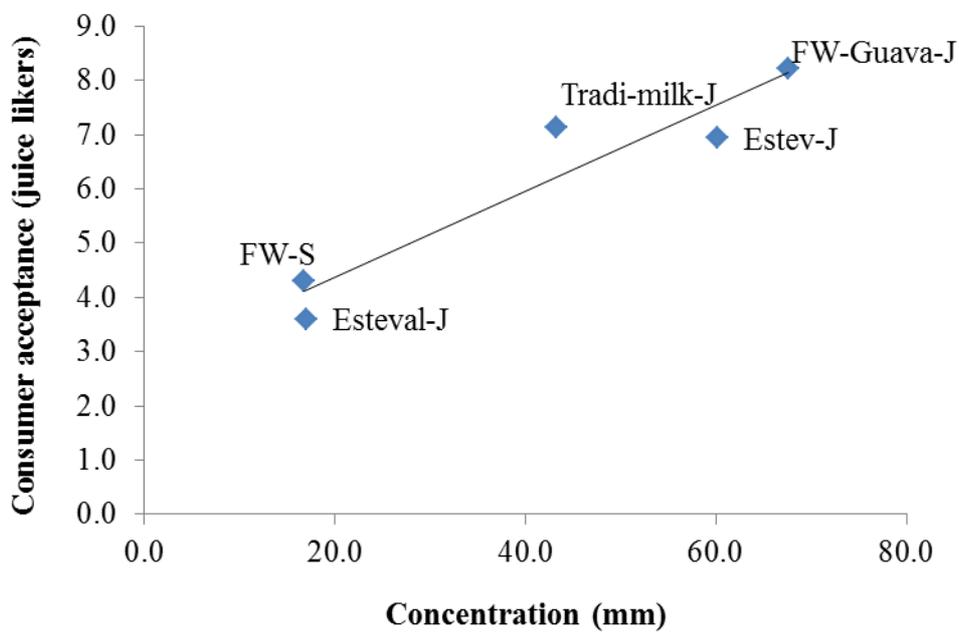
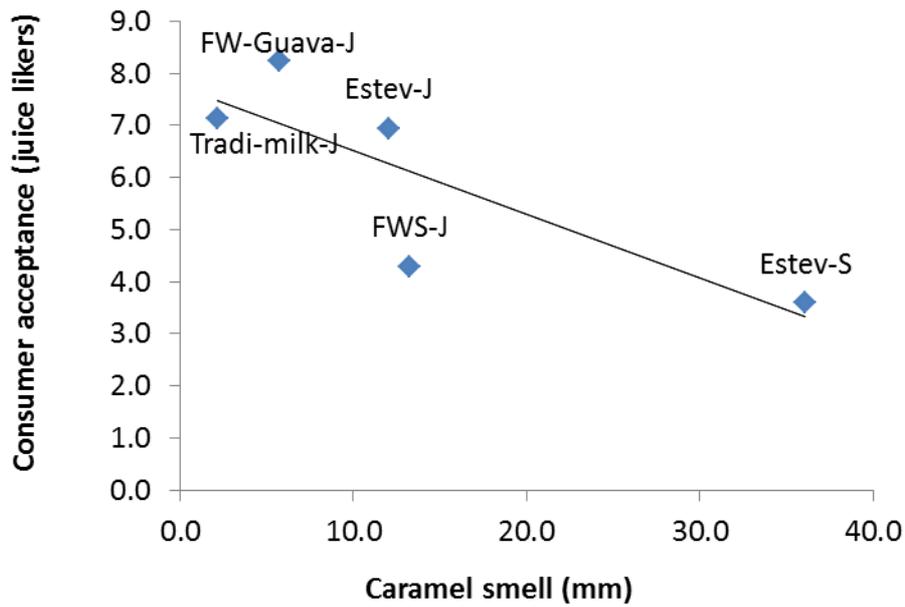


Figure 7. Correlations between sensory perception and consumer acceptance: juice likers and sensory attributes where Esteval commercial syrup (Estev-S); Esteval commercial juice (Estev-J); FWS commercial syrup (FWS-S); FWS commercial juice with guava aroma (FW-Guava-J); Traditional juice with milk (Tradi-milk-J); Traditional juice (Tradi-J); FWS commercial juice (FWS-J).

For the consumer group as a whole, the mean acceptance scores was correlated to the concentration of the product. Significant positive correlations ($p < 0.05$) were identified between the “juice likers” and concentration. Negative correlations ($p < 0.10$) were found between the “juice likers” and caramel smell. This probably contributes to consumer preferences for FWS juices which have not been pasteurized. Control of the pasteurization step is necessary for the product quality. A significant correlation with the sensory attributes for these clusters support the finding that the acceptance was related to sensory attributes and consumers had selective tastes according the products they like most.

These correlations accord with the sensory perception of the samples and highlight that concentration is an important criterion of acceptability for the consumer group as a whole and particularly for the “juice likers”.

Conclusions

The results of this research help to provide a basis of understanding of the acceptability of baobab drinks by Senegalese people and indicate ways that the product could be adapted to consumer taste and can have a potential success as a marketed product. Baobab juice is more popular than syrup in the Senegalese market. The most discerning consumers were the juice likers. They preferred baobab drinks that are beige in colour, have the characteristic of a juice (concentration) and have the taste and odour characteristic of baobab. However syrup is easier to export than juice because it is less bulky

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Annex 3 – detailed report for *Ziziphus* (Jaabi and Yaabande)

Sensory profile and acceptability of *jaabi* and *Yaabande* in Northern Cameroon

Abstract

Sensory profile and consumer acceptability of *Jaabi*, a wild fruit commonly used in savannah region of Africa, and its processed product, a cake locally called: *Yaabande*. The study took in the northern part of Cameroon through collection of two varieties of *Jaabi* (*Dakamji* and *Lamouji*) from four origins (Garoua, Maroua, Mokolo, Mora), and processed *Yaabande* from these samples, using three baking techniques (Sun baking, vapour cooking, under earth stewing). Sensory and consumers tests indicated that the taste of the products constitutes the main criteria for consuming the products. The *Dakamji* variety of *Jaabi* appeared more homogenous whatever the origin than the *Lamouji* variety. Meanwhile, all samples were acceptable at comparable level corresponding to pleasant character.

Conclusion related to reengineering:

With respect to acceptance, the main option of reengineering approach is based on standardisation of process procedures in order to guarantee the taste of the products. Inclusion of of therapeutic aspects of the products may be coupled to this option for market development.

Introduction

Jaabi is, in Cameroon, the local name of the fruit of jujube tree (*Ziziphus mauritiana*), a wild tree, largely spread in the savannah region of the country. The fruit is harvested dry and mainly consumed as side-dish. Its pulp is also pounded into flour which is then processed into a local cake called “*Yaabande*”. The processing of the fruit into *Yaabande* represents a form of conservation of the product which is consumed throughout the dry season, and even thereafter. In spite of the fact that *Jaabi* and *Yaabande* are currently sold on local market during the harvesting season, these products have not attracted significant scientific interest. *Jaabi* is then one of the underutilized plant species which has not received any benefit in terms of control of the cropping system or development for markets, contrary to the Asian practices where the jujube fruit is valorized into different foods and pharmaceutical products, with market, technology and quality development (Azam-Ali *et al*, 2006).

Out of information provided by Noyé (1989) on *Yaabande*, no scientific study exists on *Jaabi*. It is, in fact, evident that understanding the local production and processing systems of *jaabi*, in relation with its characteristics and quality, constitutes one of the main steps to fulfill, in order to set up technology and market development of the product.

In this respect, a survey of *Jaabi* production, processing, trading and consumption systems in Northern Cameroon (Ndjouenkeu & Biyanzi, 2011) has shown that *Jaabi* fruit is harvested from November to January by field collection of mature and dry grains fallen from jujube trees. Four varieties of fruits are recognized and locally called: *jaabi lammuji*, *jaabi dakamji*, *jaabi hadinga* and *Kurnadje*. Due to their sweet taste, *Jaabi lammuji* and *Jaabi dakamji* are the varieties used in *Yaabande* processing, while the two other varieties are less preferred and are consumed only during food scarcity period. The local processing practices of *Jaabi* into *Yaabande* involve four methods which differ mainly by the procedure used to pack end to cook the cake (Biyanzi, 2006; Ndjouenkeu & Biyanzi, 2011). In general the *Jaabi* flour is sprinkled with water, then either molded using small calabash of wrapped in vegetal leaves. The cooking is, either stewing under earth (only for sprinkled flour wrapped in vegetable leaves), sun drying or vapor cooking.

Diversity of processing practices and even diversity of *Jaabi* varieties results in diversity of appreciation and quality of the products on the market. Since consumer acceptance is important in marketing strategy and economic viability for product development, the present study explore the

sensory profile and acceptance of *Jaabi* and *Yaabande* sold on markets of the northern regions of Cameroon. The study assumes hypothetically that *Jaabi* variety and origin, and processing practices influence the acceptability of products.

Material and Methods

Sampling of *Jaabi* and *Yaabande*

Jaabi and *Yaabande* were collected in three villages of the Far north region (Mora, Maroua and Mokolo) and one village of the Northern region (Pitoea/Garoua) (Fig. 1) (cf. Deliverable D1.2.1.3: SOPs for sampling strategy group 3). For each sampling area, the two varieties of consumable *Jaabi* (*lamouji* and *dakamji*) were collected. In addition, *Yaabande* processed from each variety, according to the processing method available locally was also collected. A *Yaabande* sample of mixed *Jaabi* origins was also collected from a processor in Pitoea/Garoua. Both harvesters and processors in each sampling area were selected and sensitized in order to guarantee the original quality of collected products. A total of 19 samples were collected, made of 8 samples of *Jaabi* grains (2 varieties and 4 origins) and 11 samples of resulting *Yaabande* (Tab. 1)

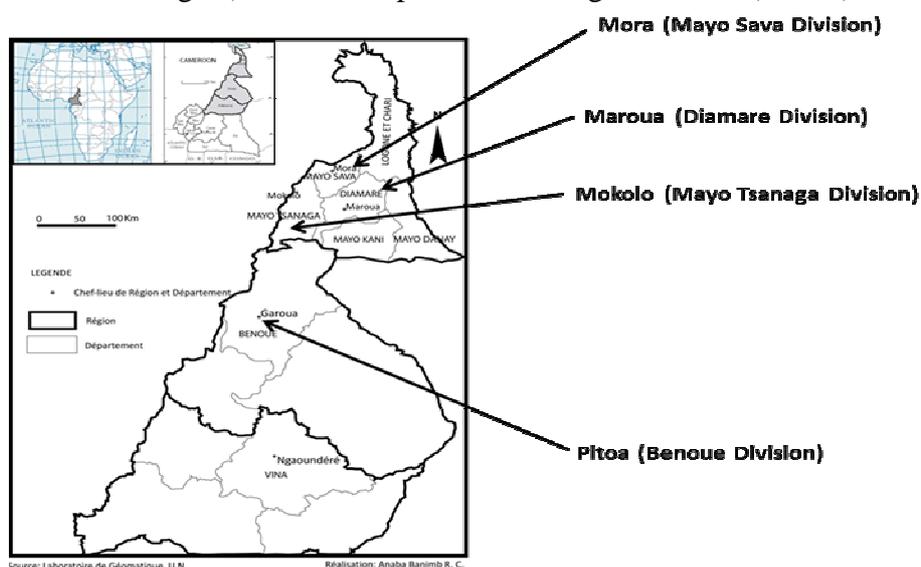


Figure 1 : Sampling areas of *Jaabi* and *Yaabande*

Table 1: Characteristics of collected samples of *Jaabi* and *Yaabande* according to variety, origin, and processing method

<i>Jaabi</i> Variety	Origin	<i>Yaabande</i>		
		Vapor cooking	Sun drying	Under earth stewing
<i>Lamouji</i>	Pitoea	X		
	Maroua	X		
	Mokolo	X		
	Mora	X	X	
<i>Dakamji</i>	Pitoea/Garoua	X		
	Maroua	X		X
	Mokolo	X		
	Mora		X	
Mixed	Pitoea	X		

Sensory evaluation

Jaabi and *Yaabande* samples were scored by a semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided (Meilgaard *et al.*,

2007; Tomlins *et al.* 2012). The panel was composed of university technicians and students (17 people in total for *Jaabi* tests and 19 for *Yaabande* tests). Sessions were conducted at ENSAI, University of Ngaoundéré (Cameroon) in room at ambient temperature (22 to 25°C). The language used for the sensory testing was French. The panellists were previously screened for familiarity with the product. Sensory attributes were generated during a preliminary focus group session guided by the panel leader. These sensory attributes are presented on tables 2 and 3.

Table 2: Sensory attributes of *Jaabi* and *Yaabande*

<i>Jaabi</i>	<i>Yaabande</i>
<p><u>Apparence</u></p> <ul style="list-style-type: none"> • Couleur • Aspect • Présence d'imperfections (tâches, trous, saleté...) 	<p><u>Apparence</u></p> <ul style="list-style-type: none"> • Couleur • Présence de tâches (intérieur et extérieur) • Aspect du produit • Granulométrie (à l'aspect)
<p><u>Odeur</u></p> <ul style="list-style-type: none"> • Odeur de fruit séché • Odeur de poussière (de terre) • Odeur de grillé (biscuit, gâteau, caramel) 	<p><u>Odeur</u></p> <ul style="list-style-type: none"> • Odeur de fruit • Odeur de grillé
<p><u>Texture</u></p> <ul style="list-style-type: none"> • Texture de la pellicule quand on croque le fruit • Texture globale du fruit quand on le croque • Epaisseur de la pulpe • Texture de la pulpe en début de mastication 	<p><u>Texture</u></p> <ul style="list-style-type: none"> • Texture du produit dès que je le croque • Texture à la mastication • Granulométrie (en bouche)
<p><u>Goût</u></p> <ul style="list-style-type: none"> • Gout sucré • Gout acide • Gout de fruit 	<p><u>Goût</u></p> <ul style="list-style-type: none"> • Goût sucré (fruit, bonbon...) • Goût acide • Goût de biscuit • Présence d'un arrière-goût (amertume, astringence, piquant...)

After a period of training using these attributes, the 8 *Jaabi* samples and 11 *Yaabande* samples were tested blind in triplicate by the panel and the order in which they were presented was random. At each session, four samples of *Jaabi* or *Yaabande*, coded with 3 figure random numbers, were served either on a white paper or in a white dish, in random order to each panelist, who had to score sensory attributes on a 100 mm unstructured scale, anchored with terms related to minimum intensity at the low end and maximum intensity at the high end.

Consumer acceptability

African consumers (116 for *Jaabi* and 164 for *Yaabande*) were interviewed in different locations of Garoua, Maroua and Ngaoundéré towns using the central location method (Meilgaard *et al.*, 2007). The locations were hotels, market places, coffee shops, Universities (Ngaoundéré and Maroua). Five *Jaabi* samples and four *Yaabande* samples were selected for consumer testing among the samples used for sensory testing (Table 3). During acceptability testing, each consumer was invited to taste each *Jaabi* or *Yaabande* (presented in random order and coded with three figure random numbers). Consumers were asked to score the acceptability with respect to appearance, taste and overall liking using a nine-point verbal hedonic box scale which varied from dislike extremely [1] to like extremely [9] (Meilgaard *et al.* 2007). Along with the testing, information was elicited from each consumer regarding demographics, education and products consumption and buying. All spoken interviews were conducted in French or in the local language (Ffulde) and the score sheets

and questionnaires were written in French. Trained enumerators assisted the consumers when required. The interview procedure (acceptability and the questionnaire) lasted no more than 30 min.

Table 3: Selected *Jaabi* and *Yaabande* samples for consumer test.

<i>Jaabi</i>			<i>Yaabande</i>			
Variety	Origin	Codes*	<i>Jaabi</i> Variety	Origin	Processing method	Code*
<i>Lamouji</i>	Pitoea	L-P	<i>Lamouji</i>	Mora	Sun drying	L-Mr-S
<i>Lamouji</i>	Mora	L-M _r	<i>Dakamji</i>	Pitoea (Garoua)	Vapour cooking	D-G-V
<i>Lamouji</i>	Maroua	L-M _a	<i>Dakamji</i>	Maroua	stewing	D-M _a -B
<i>Dakamji</i>	Maroua	D-M _a	<i>Dakamji</i>	Mokolo	Vapour cooking	D-M _k -V
<i>Dakamji</i>	Mokolo	D-M _k				

* In the codification of samples, the first letter indicates the *Jaabi* variety, the second letter the origin of the fruit, and the third letter the processing method for *Yaabande* production

Ethical assessment and consent

This study has been assessed and approved by the University of Ngaoundéré Research Ethics Committee. Consent was sought from sensory panellists and from adult consumers participating in this study. Enumerators informed participants about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point and that the responses would be anonymous.

Results and discussion

Sensory profile of *Jaabi*

The relationships between the sensory attributes of *Jaabi* grains are summarized using Principal Component Analysis (PCA). Up to 61.77% of these relationships can be represented by the first two main components (F1 and F2) as shown on Figure 2. Though the resolution is too low, the graph shows that *Jaabi* can be differentiated both by their variety and their origin.

Lamouji variety from Mora and from Mokolo was associated to smooth or rough aspect, while the same variety from Garoua (Pitoea) was mainly associated to pulp thickness and acidic taste. On the other hand, the *Lamouji* from Maroua presents common sensory attributes with the *Dakamji* variety from all regions. In this respect, the *Dakamji* variety from different origins seems more homogenous than the *Lamouji* variety. The fruity taste of *Jaabi* seems to be associated more to *Lamouji* variety than to *Dakamji* variety. The latter, whatever the origin, is mainly characterized by its dark color, its texture (pellicle, overall fruit and pulp) and its odor (dust or roasted). In general, *Dakamji* variety, whatever the origin, presents higher means for these attributes (Table 4). It should be noted from table 4 that sweet taste and fruity taste are almost common at relative equal value for the different samples, except for *Lamouji* Garoua in which the sweet taste is lowered by high acidity.

The dispersion of *Lamouji* variety with respect to origin may be explained by variability of harvesting conditions of the fruits in the different region. With regards to this hypothesis, all samples were not harvested at the same moment; thus the difference in the maturity of fruits may results in difference in their taste. In addition, fruits are not harvested from tree. They are harvested by field collection of mature and dry fruits fallen from jujube trees. This practice may justify both the dust odor of Fruits (particularly the *Dakamji* variety) and a modification of color and aspects attributes, depending on the time the fruit stay on the earth.

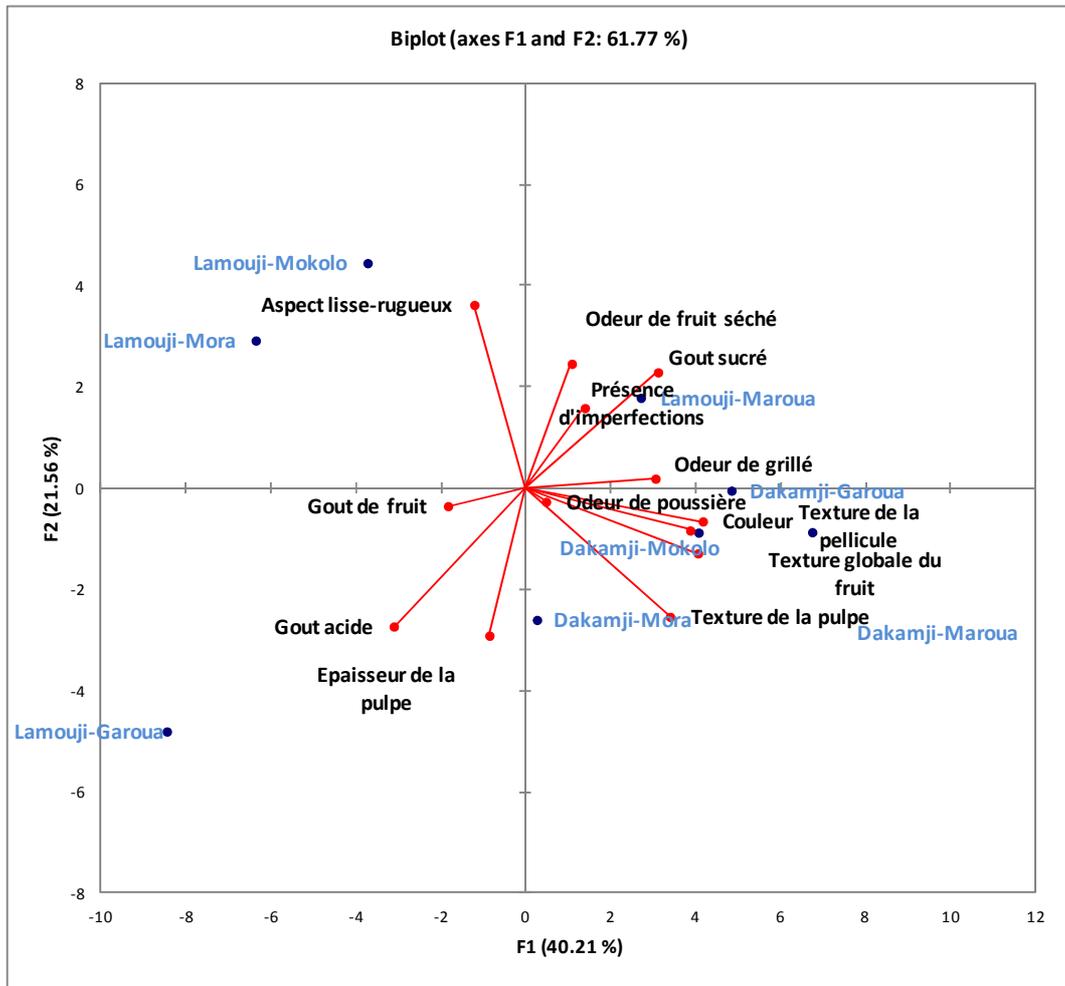


Figure 2: Principal Component Analysis (PCA) on *Jaabi* samples and relationship with sensory descriptors (Analysis performed by Aurelie Bechoff)

From the observations above, *Jaabi* samples can be divided into 3 different clusters (Fig. 3): C1 (4 *Dakamji* samples + *Lamouji-Maroua*), C2 (*Lamouji-Garoua*) and C3 (*Lamouji-Mokolo* and *Lamouji-Mora*). It was advised to choose samples from each cluster for the consumer study. In this respect the samples chosen were: *Lamouji-Garoua* (Pitoa), *Lamouji-Mora*, *Lamouji-Maroua*, *Dakamji-Maroua* and *Dakamji-Mokolo*

Table 4: Means, standard deviation and coefficients of variation of *Jaabi* sensory testing (analysis performed by Aurelie Bechoff)

Descriptors Samples	Couleur	Aspect lisse- rugueux	Présence d'imperfections	Odeur de fruit séché	Odeur de poussière	Odeur de grillé	Texture de la pellicule	Texture globale du fruit	Epaisseur de la pulpe	Texture de la pulpe	Gout sucré	Gout acide	Gout de fruit
Means													
Dakamji-Garoua	77.7	35.7	35.6	54.1	36.2	48.9	60.1	61.5	56.0	66.0	64.3	20.3	63.7
Dakamji-Maroua	79.1	30.9	27.5	53.5	43.0	48.2	64.2	67.1	57.2	65.2	61.9	12.9	55.9
Dakamji-Mokolo	60.4	39.7	63.8	41.7	40.5	34.6	71.4	64.8	56.1	61.5	59.2	20.1	53.2
Dakamji-Mora	57.4	37.1	24.5	45.9	34.9	37.3	57.4	56.2	66.3	63.7	63.6	23.5	63.2
Lamouji-Garoua	19.6	25.5	14.7	45.2	42.2	36.0	41.9	44.5	60.4	53.4	35.0	63.6	63.1
Lamouji-Maroua	50.8	46.8	22.4	54.2	45.6	46.5	53.2	59.4	53.2	59.2	62.6	13.7	58.0
Lamouji-Mokolo	31.8	50.5	51.4	52.1	37.6	37.4	46.6	40.3	51.2	40.5	61.6	17.7	63.7
Lamouji-Mora	20.5	63.9	25.1	50.9	38.8	33.9	42.6	42.6	59.3	39.7	55.5	26.0	57.9
stdev													
Dakamji-Garoua	15.0	16.7	20.4	23.7	24.8	29.7	24.5	21.8	21.1	21.5	19.4	20.6	20.3
Dakamji-Maroua	11.5	18.5	20.8	22.1	25.4	29.6	24.3	21.5	22.9	21.3	19.5	14.2	20.0
Dakamji-Mokolo	20.0	22.0	19.1	22.2	24.2	25.8	19.3	22.8	23.5	23.5	19.2	20.8	17.6
Dakamji-Mora	22.8	21.4	16.3	24.2	20.2	26.6	24.8	27.0	19.2	25.0	22.9	24.1	21.5
Lamouji-Garoua	12.5	19.1	12.8	23.7	24.0	26.4	27.7	25.2	24.6	23.1	22.2	26.1	19.7
Lamouji-Maroua	22.9	23.5	15.3	22.5	21.7	28.9	26.1	24.7	24.5	25.9	20.1	16.9	20.1
Lamouji-Mokolo	17.5	19.2	24.8	24.8	23.5	25.8	24.1	22.3	23.2	27.1	20.9	15.7	17.7
Lamouji-Mora	14.5	21.6	19.0	21.8	23.6	26.2	27.3	25.8	22.5	24.5	20.9	21.8	18.5

CV(%)													
Dakamji-Garoua	19.3%	46.8%	57.2%	43.8%	68.4%	60.7%	40.8%	35.5%	37.7%	32.6%	30.1%	101.5%	31.9%
Dakamji-Maroua	14.5%	59.9%	75.9%	41.3%	59.0%	61.4%	37.9%	32.1%	40.0%	32.7%	31.6%	110.4%	35.8%
Dakamji-Mokolo	33.0%	55.4%	29.9%	53.3%	59.9%	74.7%	27.0%	35.2%	41.8%	38.1%	32.5%	103.7%	33.1%
Dakamji-Mora	39.7%	57.6%	66.6%	52.8%	58.0%	71.5%	43.2%	48.1%	28.9%	39.2%	35.9%	102.4%	34.0%
Lamouji-Garoua	63.9%	74.7%	87.2%	52.5%	56.8%	73.3%	66.2%	56.6%	40.7%	43.3%	63.5%	41.0%	31.3%
Lamouji-Maroua	45.1%	50.3%	68.4%	41.5%	47.6%	62.0%	49.0%	41.5%	46.1%	43.7%	32.1%	123.5%	34.6%
Lamouji-Mokolo	54.9%	38.0%	48.1%	47.5%	62.7%	68.9%	51.7%	55.2%	45.3%	66.8%	33.9%	88.2%	27.8%
Lamouji-Mora	70.8%	33.8%	75.8%	42.8%	60.8%	77.3%	64.1%	60.4%	37.9%	61.7%	37.6%	83.9%	32.0%

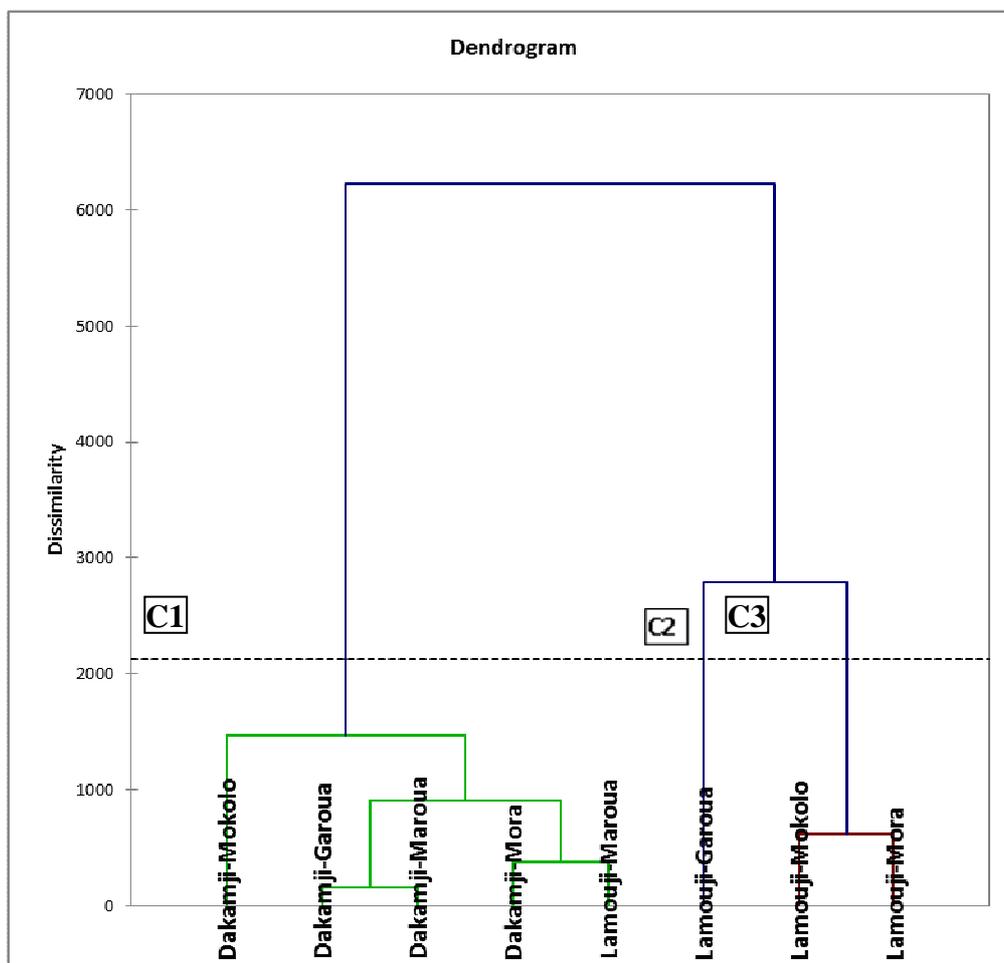


Figure 3: Cluster analysis on *Jaabi* samples (Analysis performed by Aurelie Bechoff)

Sensory profile of *Yaabande*

The PCA on figure 4 shows the relationships between the 11 *Yaabande* samples and their descriptors according to the sensory panel scoring (n=18 panellists). Abbreviations were given in order to have clearer graphic view.

Observations of the PCA representation showed that there were a clear difference between samples processed in the sun and samples processed otherwise (stewed or steamed). *Yaabande* prepared by sun-baking was more granular both by tasting and by visual observation. In addition there was a clear difference between samples from Mora region and the other regions. L-Mora vapor (L-Mr v) was significantly more coloured and less granular than most samples. Considering the effect of variety, *Yaabande* made with L or D variety using the same process do not significantly differ in terms of sensory profile in most cases. There is however a difference in L-Mk v and D-Mk v.

Four clusters were defined, from which samples for consumer testing should be chosen (Tab. 5).

However, from verification in processor workshop, it was discover that the *Yaabande* made from *Lamouji* variety in Mora (L-Mr-v) was not processed according to local conventional practice, since the processor molded the *Jaabi* flour with excess water which resulted in a highly brown color. For this reason, considered as an error of the local usual practice, this sample was discarded.

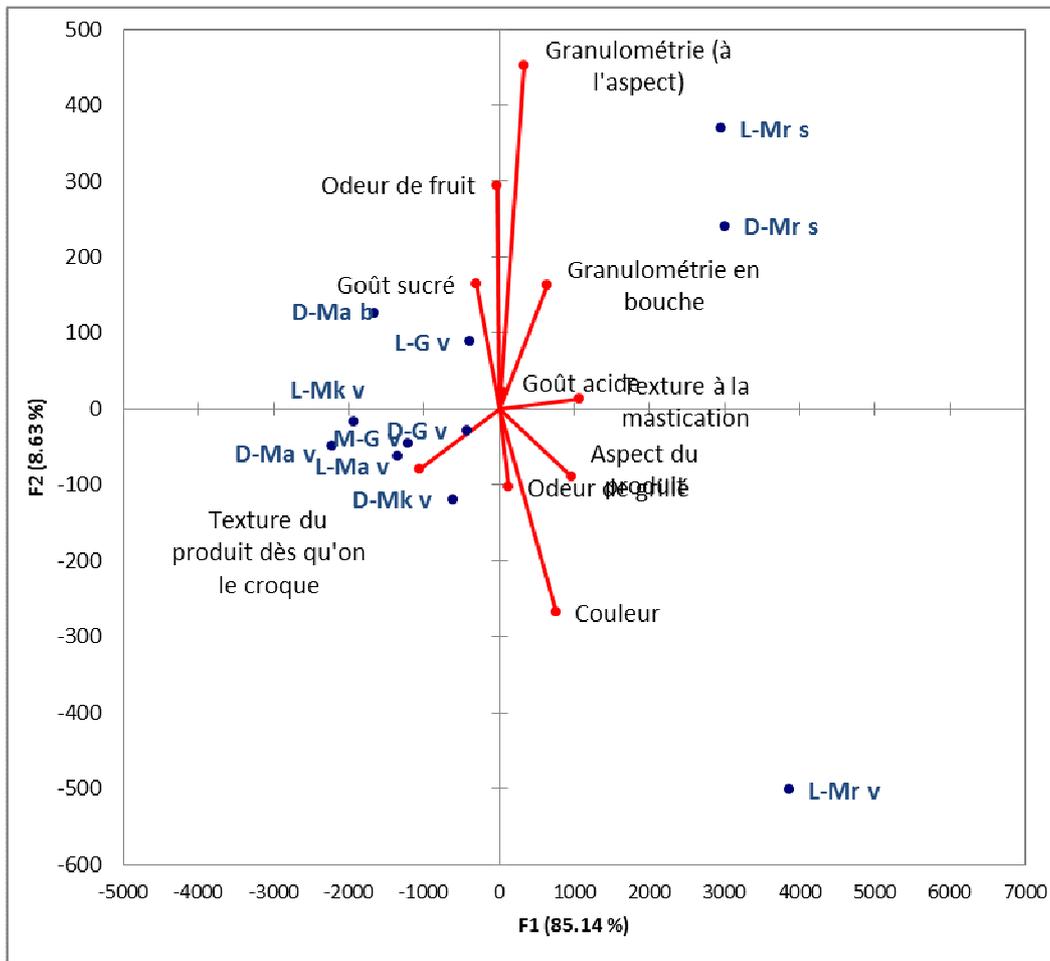


Figure 4: Principal Component Analysis (PCA) on the Yaabande samples and relationship with sensory descriptors (Analysis performed by Aurelie Bechoff and Keith Tomlins). With: D-G v (Dakamji-Garoua-vapot cooking); D-Ma b (Dakamji-Maroua-earth stewing); D-Ma v (Dakamji-Maroua-vapor cooking); D-Mk v (Dakamji-Mokolo-vapor cooking); D-Mr s (Dakamji-Mora-sun drying); L-G v (Lamouji-Garoua-vapor cooking); L-Ma v (Lamouji-Maroua-vapor cooking); L-Mk v (Lamouji-Mokolo-vapor cooking); L-Mr s (Lamouji-Mora-sun drying); L-Mr v (Lamouji-Mora-vapor cooking); M-G v (Mixed sample-Garoua-vapor cooking)

Table 5: Main classes of Yaabande cake based on sensory attributes (Analysis performed by Aurelie Bechoff)

Class	1	2	3	4	5
			D-Mk		
	D-G v	D-Ma b	v	D-Mr s	L-Mr v
	L-G v	D-Ma v	L-Ma v	L-Mr s	
		L-Mk v	M-G v		

Samples selected for consumer testing are highlighted in green

Consumer testing

Consumer acceptance of Jaabi

Table 6 shows overall appreciation of Jaabi sample regarding appearance, taste and acceptability. It is noted that all samples are globally acceptable since the mean scores of acceptability and taste are greater than a score of 6 (slightly pleasant). In addition, samples are not significantly different from taste and acceptability point of views, while they are significantly different according to appearance

Table 6 : Mean overall scores of Jaabi

Sample	Appearance	Taste	Acceptability
D-Maroua	5,7 ± 1,8	6,2 ± 2,0	6,3 ± 1,9
D-Mokolo	5,7 ± 1,6	6,3 ± 1,7	6,2 ± 1,6
L-Garoua	7,8 ± 1,3	6,2 ± 1,9	6,5 ± 1,7

L-Maroua	5,8 ± 1,5	6,4 ± 1,7	6,3 ± 1,6
L-Mora	6,2 ± 1,7	6,5 ± 1,6	6,4 ± 1,5

The relationship between the three variables (appearance, taste and acceptability) through PCA is shown on figure 5. It is noted that 93,25% of these relations are represented by the two first components (F1 & F2) and that the acceptability of *Jaabi* is mainly associated to its taste (Fig. 5).

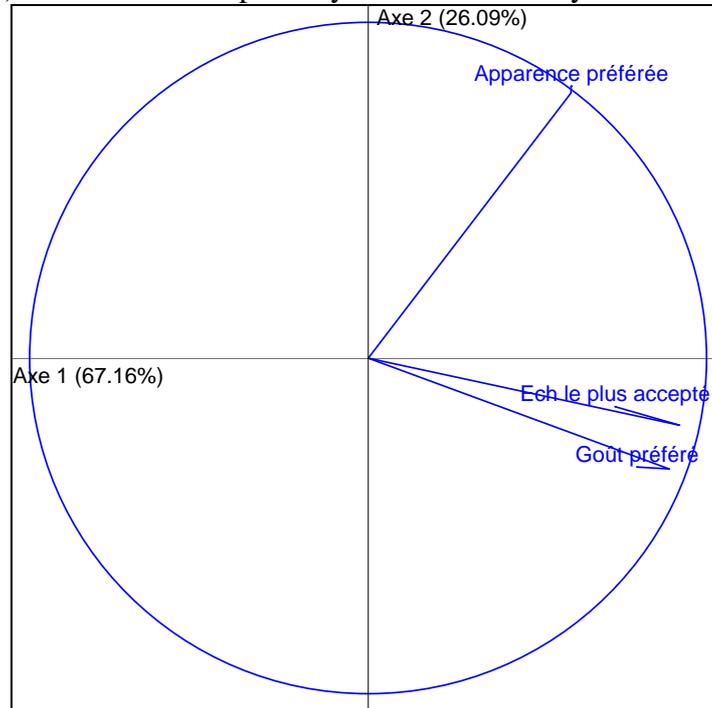


Figure 5: PCA on sensory attributes of *Jaabi*

Considering the frequency at which each product is cited as appearance, taste and acceptability are concerned, it appears that the acceptability of L-Garoua seems to be due to its taste (Fig. 6). This is confirmed by the fact that the taste of the fruit is the main criteria by which *Jaabi* consumers choose their product (Fig. 7). This is normal since, when buying the fruit, consumer use to taste it. In the same way, when consumers are asked why they consume *Jaabi*, the taste of the product is cited as the main reason (Fig. 8). This taste has preferably to be sweet. In fact, up to 80% of consumers prefer sweet *Jaabi* as shown on figure 9. The same figure indicates that appearance of the fruit is characterized by its color which should be either red or Yellow, while on eating, the pulp should preferably be floury.

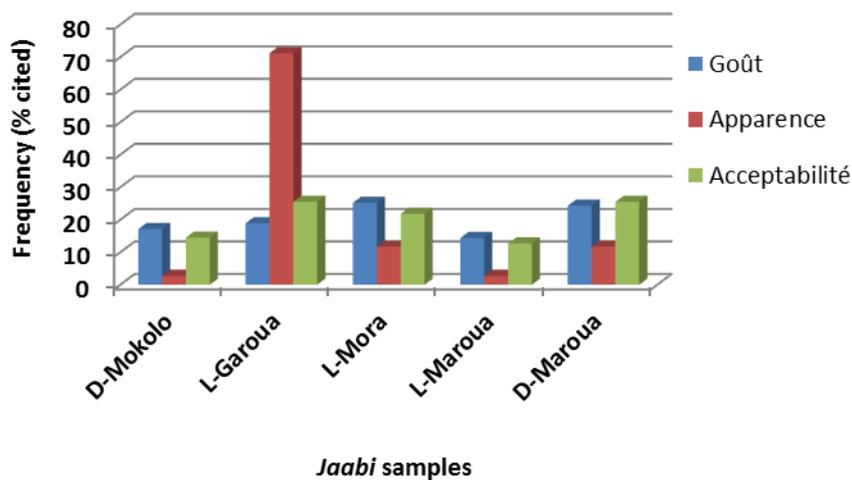


Figure 6: Overall appreciation of *Jaabi* according to appearance, taste and acceptability

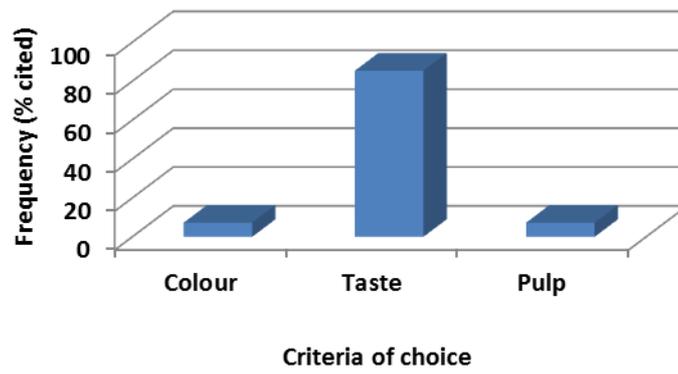


Figure 7: Criteria of choice by *Jaabi* consumer

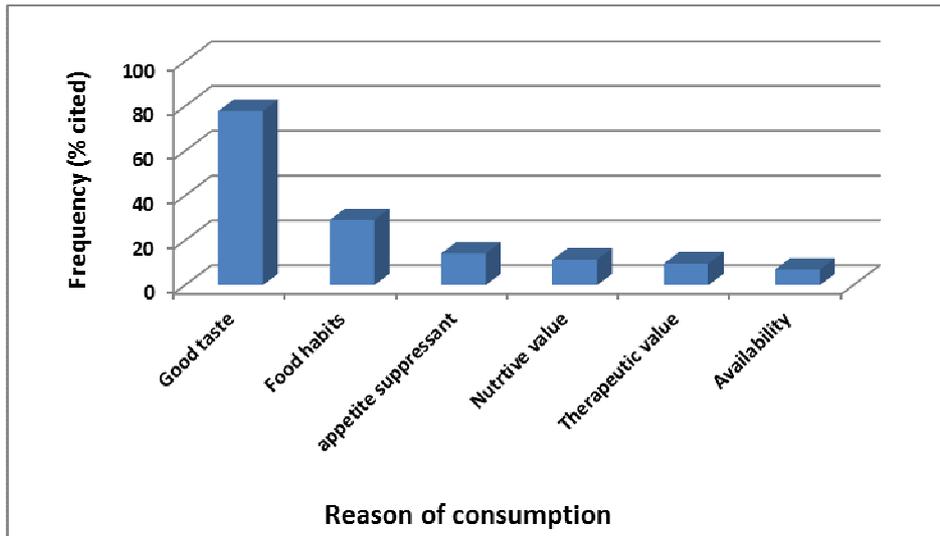


Figure 8: Main reasons explaining why *Jaabi* is consumed

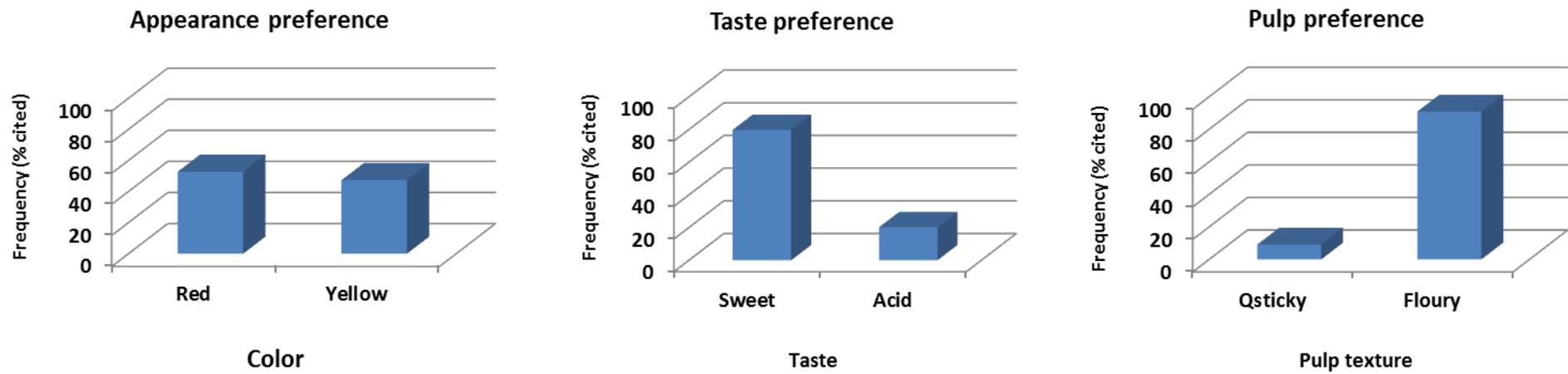


Figure 9: Sensory attributes of *Jaabi* related to appearance, taste and pulp of the fruit

Consumer acceptance of Yaabande

Globally, all *Yaabande* samples are acceptable and considered as pleasant, since scores are close to 7 (pleasant) (Tab. 7). Meanwhile, *Yaabande* made with *Jaabi Dakamji* from Maroua, using under earth stewing method (D-Ma-B) and *Yaabande* made with *Jaabi Dakamji* from Mokolo, using vapor cooking (D-Mk-V) are scored higher for all sensory attributes.

Table 7 : Mean overall scores of *Yaabande*

Samples	Appearance	Taste	Acceptability
D-G-V	6,0 ± 1,5	6,2 ± 1,7	6,4 ± 1,5
D-Ma-B	7,1 ± 1,7	7,2 ± 1,5	7,2 ± 1,5
D-Mk-V	6,8 ± 1,5	6,9 ± 1,3	6,9 ± 1,2
L-Mr-S	6,2 ± 1,4	6,0 ± 1,8	6,0 ± 1,7

As previously observed for *Jaabi*, the acceptability of *Yaabande* is linked mainly to the taste of the cake (Fig. 10, 11 & 12). In fact, as observed with *Jaabi*, the taste of the product and food habits are the main reasons justifying consumption of *Yaabande*. The cake should preferably be yellowish, friable in mouth and floury (Fig 13).

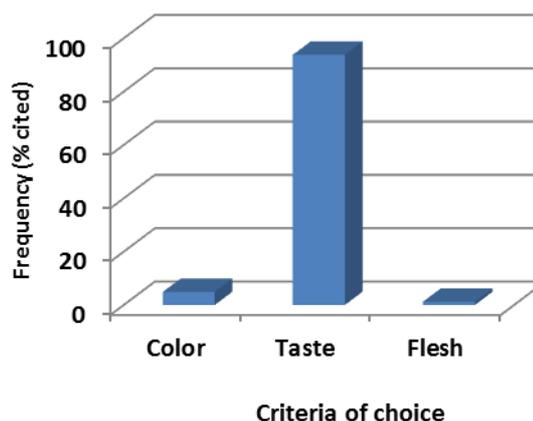
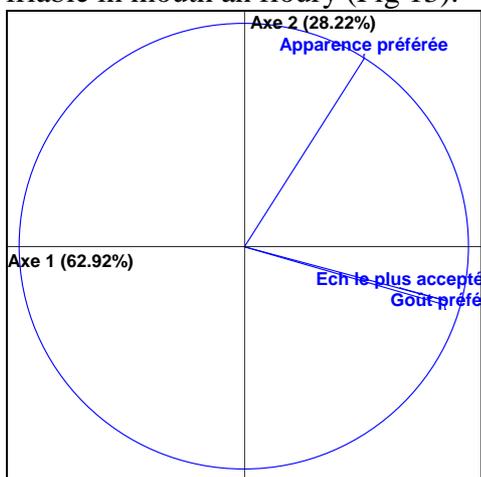


Figure 10: PCA on sensory attributes of *Yaabande*
Criteria of choice by *Yaabande* consumers

Figure 11:

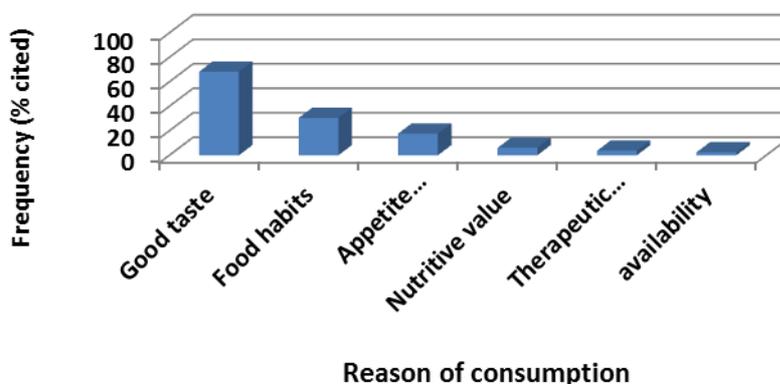
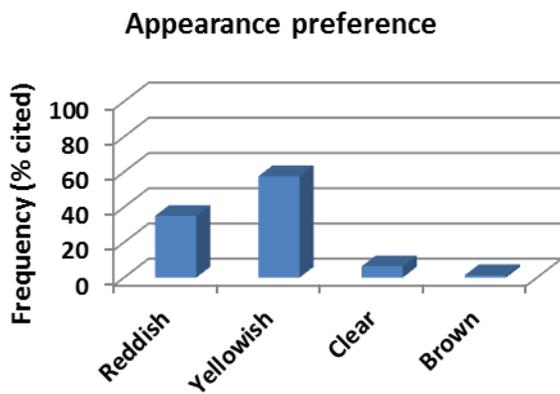
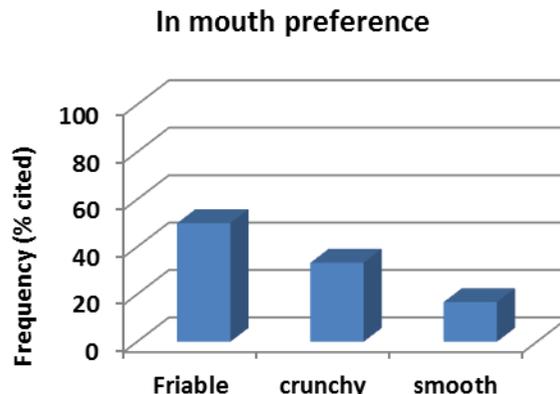


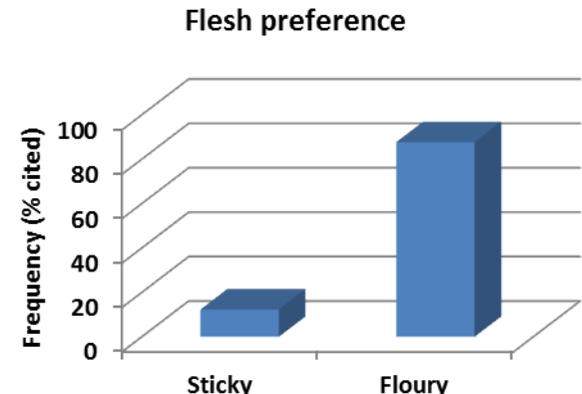
Figure 12: Main reasons explaining why **Figure 8:** Main reasons explaining why *Yaabande* is consumed



Color



Texture



Texture

Figure 9: Sensory attributes of *Yaabande* related to appearance, in mouth texture and flesh characteristics

Conclusion

This study shows that the taste of *Jaabi* and *Yaabande* is the main sensory attribute governing the consumption of these products. All *Jaabi* and *Yaabande* samples are globally acceptable by African consumers, whatever the origin and the variety. Meanwhile, it should be noted that throughout the study, no reference was made by consumers to the aroma complex and therapeutic properties of the products.

Thus, the market development of *Jaabi* and resulted products is just based on proposing a product presenting original taste of the product. In this respect, standardizing the process procedures appears as an option for the market development. Associated to this option, it should be interesting to determine physico-chemical compounds which build up the taste of the products. Additionally, taking into account the therapeutic properties of the fruits may constitute a parameter to be considered during this standardization.

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