African Food Tradition rEvisited by Research
FP7 n°245025

Start date of project: **01/09/2010**
Duration: **51 months**

Deliverable number: D5.5.2

Title of deliverable: **Report on near-market consumer testing of new improved products and substitutes in Africa**

Deliverable type (Report, Prototype, Demonstration, Other): Report

Dissemination level (PU, PP, RE, CO)*: PU

Contractual date of delivery: October 2014

Actual date of delivery: January 2015

Work-package contributing to the deliverable: WP5

Organisation name of lead contractor for this deliverable: NRI

Authors
Benin: N. Akissoe, C. Sacca, G. Dalode, V. Anihouvi, J. Kindossi, J. Hounhouigan ; **Ghana**: W. Amoa, C. Oduro-Yeboah ; **Madagascar**: A. Ratsimba, I. Andrianarison, V. Ramaroson, Z. Andriantahiana, D. Rakoto ; **Senegal**: N. Ayessou, Mady Cisse, M. Boucher, J. Devilliers; **Portugal**: M.J. Monteiro, M. Pintado ; **Cameroon**: Robert Ndjouenkeu ; **Egypt**: Zahra S. Ahmed, S. Awad, M. Fathi, S. Abozed ; **France**: C. Mestres, G. Fliedel, D. Pallet ; **UK**: A. Bechoff, , K.I. Tomlins

This document has been sent to:

The coordinator by WP Leader	Date: January 2015
To the Commission by the Coordinator	Date: January 2015

* PU: Public; PP: Restricted to other programme participants (including the Commission Services); RE: Restricted to a group specified by the consortium (including the Commission Services); CO: Confidential, only for members of the consortium (including the Commission Services)

Table of Contents

Executive Summary

In this deliverable, the reengineered products relating to groups 1 to 3 are tested by consumers in Africa in order to test whether the acceptance meets consumer needs. The summaries are by group. These products were widely different and tested in differing cultures and situations. A common feature, however, is that all products are already commonly consumed by the communities and accepted, particularly with respect to the baseline products. Some products were found to be more acceptable (Gowe and Akpan in Benin, Kenkey in Ghana, Kong and Lanhouin in Senegal, Bissap and Baobab in Senegal), some of similar acceptance (Kitoza in Madagascar) and some were less acceptable (Kishk Sa'eedi in Egypt and Jaabi in Cameroon). Ways forward are discussed in all cases.

Group 1
The reengineered group 1 products had mixed acceptance to consumers. Ones that were highly accepted were the reengineered Akpan which was highly accepted regardless of age, gender, socio- professional category and possessions (goods) and the majority (84.9%) expressed an interest for purchasing the reengineered Akpan and the reengineered gowe (n=100 consumers) in Benin, which was strongly accepted and more so than the traditional gowe. However, the reengineered Kenkey in Ghana while being comparable acceptance to the traditional white kenkey this would only meet a niche market. However, for the reengineered Kishk Sa'eedi, it was less acceptable and the difference was due to sour taste and spicy flavour.

Group 2
The group 2 products had mixed acceptance among consumers. In the case of Kong in and Lanhouin in Senegal, the reengineered products had improved acceptance while for kitoza in Madagascar, there was no improvement in acceptance apart from those in terms of quality and safety. More specifically, Kong made using liquid smoke novel technique (RLK) had by far the highest acceptance and could easily be integrated as part of the Senegalese cuisine. This shows that there is a potential for RLK on the Senegalese market. Two types of reengineered Lanhouin types (Lanhouin dry powder, Lanhouin dry fillet) were greatly acceptable and the powdered form more than the fillet. In the case of Kitoza, consumer acceptance studies showed that there was no significant difference between all samples tested.

Group 3
Group 3 reengineered products had mixed acceptance among consumers. Re-engineered bissap (hibiscus drinks) in Senegal were positively appreciated by consumers in Senegal and better accepted than the traditional commercial infusion used as baseline comparison. However, the new drinks were not perceivably different from the baseline drink to consumers concerning both the traditional character and the nutritional and healthy attributes. The reengineered baobab drinks were positively appreciated by consumers in Senegal and significantly better appreciated than the traditional commercial ones earlier tested.

Jaabi (Ziziphus mauritiana). The result is the proposition of a reengineered Yaabande presenting fine texture well appreciated by consumers. However, particle size was critical and

this needed to be lower than 125µm. Due to this limit, processors have adopted the manual production of flour of particle size 250µm>Ø>125µm, which is less tiresome, though it appears in second rank in the preference of consumers.

The detailed methodology for each product is given for Groups I, II and III 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.

1 Reports for Group I

1.1 Detailed report for Akpan (Group I)

1.1.1 Akpan Summary

The reengineered "Akpan" packaged in plastic bottles of 33 cL was presented to 106 consumers to evaluate their acceptance, the acceptable (just right) price and the willingness to buy. Akpan was highly appreciated by all consumers, regardless of age, gender, socio-professional category and possessions (goods). The majority of consumers (84.9%) expressed an interest for purchasing the new Akpan, with the expected purchase price ranging between 200 and 300 FCFA.

1.1.2 Akpan Background

Akpan is a traditional ready-to-drink fermented yoghurt-like cereal beverage traditionally prepared from Ogi, fermented starchy flour made from maize, sorghum or millet grains. It is consumed in urban and rural areas in Benin (Nago et al.1998). A previous study on sensory evaluation and consumer acceptability showed that akpan from ogi maize was the best liked product with acceptability score of 7.2 over 9 (Akissoé et al., 2014). Akpan from ogi maize should be white, slightly acidic with fermented aroma, mid-cooked starch. This product was therefore selected for reengineering. Thus, the quality (sanitary, sensorial, and packaging) of Akpan from maize ogi was improved through several experiments. Essentially, steeping operation was revisited to improve the maize starch extraction; fermentation was performed using starter culture during which ogi maize was fermented with *Lb casei*, milk and sugar. In addition, cooking step was improved to avoid total gelatinization of starch maize. The resulted Akpan was bottled/packaged in plastic bottles of 33 cL to adapt it to new local and export markets. It was therefore necessary to evaluate the acceptability of the reengineered Akpan.

1.1.3 Akpan Methodology

Samples
White maize grains (*Zea maize*) was purchased from Dantokpa market. Reengineered Akpan (Figure 1.1.1) was produced under good conditions of hygiene/sanitation using method described in milestone M.2.2.1 . Akpan was bottled (30 cL) and stored at 4 °C.

Figure 1.1-1. Ready to drink Akpan

Consumer acceptance
Consumer acceptance was tested using Beninese people at different locations. Consumers were asked to score the acceptability with respect to appearance, taste and overall liking using a nine-point hedonic box scale, which varied from dislike extremely to like extremely (Meilgaard et al., 2007). A total of 106 respondents completed the questionnaire at Cotonou and Abomey-Calavi. Besides acceptability, the willing to purchase, the just-about-acceptable price and data related to socio-economic information were also collected.

Data analysis
Descriptive statistics were computed on consumer acceptability scores. Socioeconomic data was analysed using Chi-square tests, STATISTICA 7 software (StatSoft, Tulsa, USA).

1.1.4   Akpan results and discussion

Consumer socio-demographic characteristics
Consumers were in the range of 18 to 66 years old comprising essentially students (48%, n=106) and craftsmen (34%). The majority of the consumers were males (74%). Concerning the means of transport, among those who possess them (n= 50), 47.2% have a motorbike, 10.4% a car and 5.7% a bicycle. The majority of respondents were tenants (73.6%), and 66% had a television, 25.5% a refrigerator, and 11.3% a freezer.

Table 1.1-1 Socio-demographics characteristics of consumers

Demographics variables	Number (N=106)	Percentage (%)
Gender		
Male	75	70.8
Female	31	29.2
Age		
<25	54	50.9
[25-34]	35	33.0
[35-44]	13	12.3
>44	4	3.8
Occupation		
Student	51	48.1
Private	9	8.5
Public	8	7.5
Artisan	36	34
Housewives	2	1.9
Location		
Cotonou	27	25.5
Abomey-Calavi	79	74.5
Possession		
Bicycle	6	5.7
Motorbike	50	47.2
Car	11	10.4
TV	70	66.0
House	25	23.6
Tenant	78	73.6
Refrigerator	27	25.5
Freezer	12	11.3
Price of purchase (F CFA)		
200 (0.3 €))	48	45.3
300 (0.5 €)	54	50.9
400 (0.6 €))	4	3.8

Question	Probability (chi-square test p<0,05)
AGE	0.64362
Gender	0.48819
Occupation	0.74685
TV	0.96927
Motorbike	0.67659
Tenant	0.25817
House	0.13833
Voiture	ND
Freezer	0. 67440
Bicycle	0.79908
Refrigerator	0.28549
Appearance	0.94880
Taste	0.00348*
Odour	0.00702*
Texture	0.02111*
Acceptability	0.00000**
Intention Purchasing	0.00094**
Price of purchase	0.75168
Significance : * P<0.05 * *P<0.001	

Consumer preferences

The majority of consumers (97 %) scored above five (='neither like nor dislike') for the reengineered akpan. Only 3% of consumers were indifferent (='neither like nor dislike') suggesting that most consumers accepted the product. Consumer acceptability was not influenced (p>0.05) by socio-demographic characteristics of consumers (gender, age and possessions (goods)) (Table 1.1.1). Acceptability, socioeconomic characteristics and attitudes to buy Akpan are presented in Table 1.1.2. Considering each category of the hedonic scale, the new Akpan was "liked" by 51.9 % of respondents and very liked by 32.1%. These consumers were principally the young men (18-35 years old), who were owners or tenants, used motorcycle and worked as craftsmen or students. In addition, this group of consumers is ready-to-buy the reengineered akpan at 300 or 200F CFA.

Furthermore, about 14% of respondents, essentially men in the range of 18 and 44 years old having a motorbike or bicycle, or freezer, scored the new Akpan "like extremely" (7%) and "like moderately (7%)".

Sacca *et al*. (2012) showed that the traditional Akpan was highly appreciated by all consumers, regardless of age, gender, socio- professional category, and level education. However, students and craftsmen under 35 year of age should be the most targeted because they are the usual consumers of the traditional akpan product.

Table 1.1.2 : Consumers' acceptance in relation with socioeconomic characteristics (%)

		Neither like nor dislike	Like moderately	Like	Like very	Like extremely
% of consumers		2.8	6.6	51.9	32.1	6.6
Age	**<25**	1.9	3.8	28.3	13.2	3.8
	[25-34]	0.9	2.8	15.1	12.3	1.9
	[35-44]	0.0	0.0	6.6	4.7	0.9
	>44	0.0	0.0	1.9	1.9	0.0
Gender	**Female**	0.0	0.9	17.9	10.4	0.0
	Male	2.8	5.7	34.0	21.7	6.6
Occupation	**Student**	1.9	3.8	27.4	12.3	2.8
	Artisan	0.9	2.8	11.3	15.1	3.8
	Public	0.0	0.0	4.7	3.8	0.0
	Private	0.0	0.0	6.6	0.9	0.0
	Housewives	0.0	0.0	1.9	0.0	0.0
Possessions	**Bicycle**	0.0	0.9	4.7	0.0	0.0
	Motorbike	1.9	3.8	23.6	16.0	1.9
	Car	0.9	0.0	5.7	3.8	0.0
	Tenant	0.9	3.8	38.7	24.5	4.7
	House	1.9	2.8	11.3	6.6	0.9
	TV	1.9	4.7	32.1	22.6	4.7
	Freezer	0.9	0.9	5.7	3.8	0.0
	Refrigerator	0.9	0.0	13.2	11.3	0.0
Price of purchase	**200**	1.9	3.8	18.9	17.0	3.8
FCFA	**300**	0.9	2.8	30.2	14.2	2.8
	400	0.0	0.0	2.8	0.9	0.0

Willingness to buy and purchasing price
Figure 1.1.2 shows the variations in mean classes of consumer acceptability and purchasing intention with market price of akpan. The improved Akpan was positively appreciated by the majority of consumers who expressed an interest for purchasing the new Akpan. Indeed most consumers (84.9 %) rated their willingness to buy the product from 7 to 10 over 10.

According to consumers accustomed to products like yoghurt and dégué, the packaging of Akpan is a new form of presentation (akpan packaged in plastics bottle) which will favour its access to market.

The majority of consumers (50.9%) accepted to buy the "Akpan" packaged in 33 cL bottle for 300 FCFA. The lowest price (200 F CFA) was accepted by 45.3 % of respondents. Only 3.8 % of respondents accepted to buy Akpan at 400F CFA price (Table 1.1.1). Figure 1.1.4 shows the changes in the purchase price and the willingness to purchase based on the acceptability of the product.
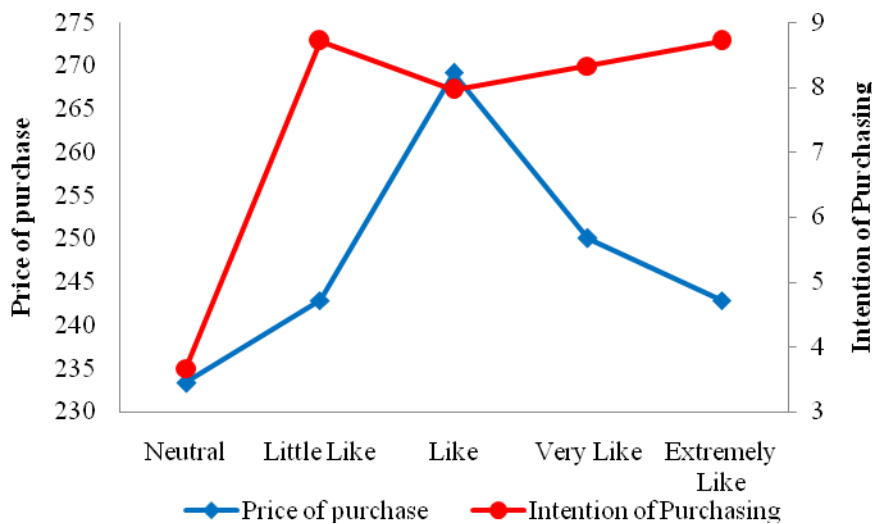
Figure 1.1-2 Relationships between acceptability, purchase intention and price

1.1.5   Akpan Conclusions

The reengineered Akpan was widely accepted by consumers, with an overall acceptability score of 7.3 similar to the value obtained for traditional Akpan (7.2), but with a more convenient packaging. Most of consumer was willing to buy the new product, preferentially with prices comprised between 200 and 300 F CFA.

1.1.6   Akpan References

Akissoe, H.N[a], C[a]. Sacca, A-l[b]. Declemy, A[c]. Bechoff, V[a]. Anihouvi, G[a]. Dalode, D[b]. Pallet, G[b]. Fliedel, C[b].Mestres, D.J[a]. Hounhouigan, K.I[c]. Tomlins. Cross-cultural acceptance of a traditional yoghurt-like product made from fermented cereal. Journal of Food Sciences and Agriculture. Accepted.

Hsu Y, Hsu L and Yeh C-W, A cross-cultural study on consumers' level of acceptance toward marketing innovativeness.Afr J Bus Manage, 4(6): pp. 1215-1228 (2010).

Nago M, Hounhouigan J, Akissoë N, Zanou E and Mestres C, Characterisation of the Beninese traditional ogi, a fermented maize slurry: physico-chemical and microbiological aspects. Int J Food SciTechnol, 33: pp. 307-315 (1998).

Sacca C, Adinsi L, Anihouvi V, Akissoé N, Dalodé-Vierra G, Mestres C, Jacobs A, Dlamini N, Pallet D and Hounhouigan DJ,Production, consumption and quality attributes of Akpan - a yoghurt-kike cereal product - from west africa.*Food chain,*2: pp. 207-220 (2012).

Schaafsma, G. (2008). Lactose and lactose derivatives as bioactive ingredients in human nutrition. International Dairy Journal 18(5): 458-465.

Takada H and Jain D, Cross-national analysis of diffusion of consumer durable goods in pacific rim countries. J Mark, 55(2): pp. 48-54 (1991).

1.2 Detailed report for Gowé (Group I)

1.2.1 Gowe Summary

The reengineered gowe was submitted to consumer testing (n=100 consumers) to assess the acceptance, market price and the willingness to buy.. The gowe beverage prepared from new gowe flour was well accepted with an overall acceptability score of 7.5 that was higher than the score obtained for traditional gowe (6.6). The market price (just-acceptable price to buy) of the packaged gowe flour (500g) ranged between 1500 FCFA (1.5 €) and 2000 FCFA (2.0 €).

1.2.2 Gowe Background

Gowe is a traditional Beninese food made from malted and non-malted sorghum or maize flours which are spontaneously fermented and then cooked into sweet dough (Adinsi *et al.,* 2014a). The latter is consumed after diluting in water, with the possible addition of sugar and milk. Sensory evaluation and consumer acceptability of traditional gowe were first carried out (Adinsi *et al.,* 2014b). The traditional sorghum gowe had sweet and sour taste, and fermented odour which are basic sensory attributes while it was scored 6.6 over 9 by 141 consumers (Adinsi *et al.,* 2014b). Furthermore, experiences were designed to produce gowe flour from malted, fermented and oven dried sorghum. The traditional processing of gowe was revisited in order to improve the reproducibility of the process, safety and long shelf-life of the product. The consumer acceptability of beverage produced from the reengineered gowe flour was tested in order to evaluate the market opportunities for the product. In addition, the market price (just acceptable purchasing price) of the packaged gowe flour was also evaluated.

1.2.3 Gowe Methodology

Sample preparation
Red sorghum grains (*Sorghum bicolor* (L.) Moench) were purchased from Dantokpan international market. Gowe flour was produced according to the new processing developed by the AFTER project D.2.4.2). This flour was cooked into a beverage which was left to cool down before adding sugar, and milk (Figure 1.2.1). The resulted product was used for consumer acceptability

Figure 1.2.1 Reengineered gowe flour packaged in cardboard (left) and Gowe beverage ready-to-drink (right)

Consumer evaluation methods

Consumers (n=100) were interviewed at two locations in Benin: Cotonou and Abomey-calavi. Acceptability for taste, appearance, aroma, and texture, overall liking of the new gowe beverage, and market price and purchasing behaviour for the reengineered gowe flour were tested as follows:

- Step 1: taste, appearance, aroma, texture and overall acceptability of gowe using a 9-point hedonic box scale (Meilgaard *et al*., 2007) from 'dislike extremely' to 'like extremely'.
- Step 2: 500g of gowe flour packaged in cardboard (Figure 1.2.1 left) was presented to consumers. The enumerator/interviewer explained to consumers that 3-4 litres of gowe beverage (Figure 1.2.1 right) can be obtained from this flour (500g). Three level of prices (1000 FCFA (1.5 €), 1500 FCFA (2.0 €) and 2500 FCFA (2.5 €) were proposed. Consumers scored first the purchasing behaviour for this gowe flour using a ten-point scale (from 0 to 10). Following this, consumers were asked to tick the just acceptable/right price (3 different choices) of gowe flour. Step 3: Consumers completed a questionnaire about socio-demographic information.

The interviews lasted about 15-20 min.

Data analysis

Descriptive statistics was carried out using Statistica 7 (StatSoft, Tulsa, USA).

1.2.4   Gowe Results and discussion

Consumer acceptance

In terms of global acceptance, the majority of consumers (93%, N=100) scored above five (='neither like nor dislike') for the reengineered gowe. Only 2% of consumers scored "neither like nor dislike" (Table 1.2.1). Overall acceptability score (7.5) of new gowe was higher than the score obtained for traditional gowe (6.6) (Adinsi et al. 2014b). In addition, the consumers scored around 7 for all separate hedonic attributes e.g. taste (7.5), aroma (7.2), appearance (7.3) and texture (7.1). Thus, the reengineered gowe was acceptable in terms of its main sensory attributes.

Table 1.2-1 Consumers' acceptance in relation with socioeconomic characteristics of gowe (%)

		Like extremely	Like very	Like	Like Moderately	Neither like nor unlike
% of consumers (n)						
		18	25	50	5	2
Age	<25	11	17	26	5	1
	25-34	6	3	14	0	1
	35-44	0	3	6	0	0
	45+	1	2	4	0	0
Gender	Male	15	19	33	3	1
	Female	3	6	17	2	1
Employment	Student	13	16	26	4	2
	Civil service	4	9	20	1	0
	Private service	1	0	4	0	0
Economic situation	Bicycle	1	1	3	0	0
	Motorbike	8	14	25	4	0
	Car	0	1	5	0	0
	TV	13	19	39	5	0
	House	2	3	10	0	0
	Frigo	3	2	8	0	0
	Freezer	1	0	2	0	0
Right price FCFA	1500 (1.5 €)	6	12	26	5	1
	2000 (2 €)	7	10	20	0	1
	2500 (2.5 €)	5	3	4	0	0

Socio economic profile and consumer attitudes to gowe
The demographic profiles are given in Table 1.2.1. Most consumers (84%) were less than 34 year-old (min.20; max.60). The consumers were predominantly students (61%) and males (71%).

The relationships between overall acceptability score and socio economic profile (Table 1.2-1) showed that gowe score such as "like", "like very" and "like extremely" were more associated to the males who had more than 35 years old, used car or motorbike and worked as student (55%) or in civil service (33%). These consumers are ready to buy gowe flour (500g) at a right price of 1500 FCFA (1.5 €) or 2000 FCFA (2.0 €). Consumers who gave "moderately like" possessed motorbike, television and worked as student and were ready to buy for 1500FCFA (1.5 €).

The relationships between market price, acceptability and purchasing behaviour are shown in Figure 1.2.2. A significant and positive correlation (r=0.99) was observed between market price and purchasing behaviour. Irrespectively of acceptability score, the purchasing behaviour varied between 6 and 8.5 over 10.
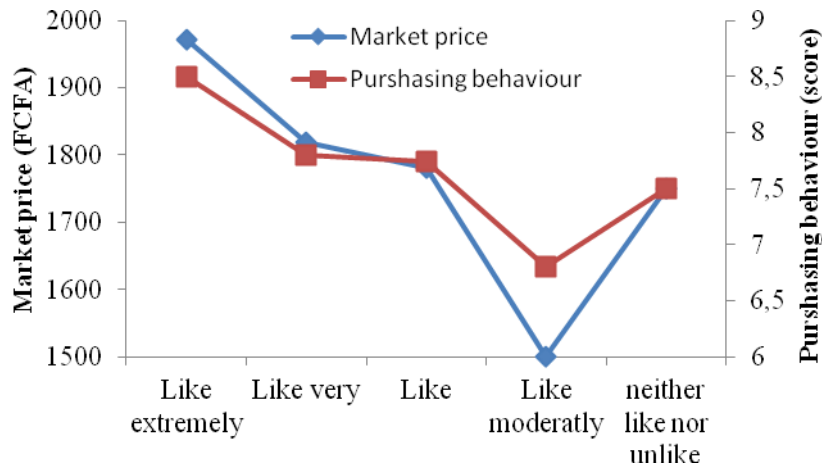
Figure 1.2-2 Variation in consumer acceptability and market price with purchasing behaviour of gowe

1.2.5   Gowe Conclusions

The reengineered gowe flour was very acceptable to consumers and had a similar hedonic attributes to traditional gowe. The suggested market price (right price) of gowe flour (500g) ranged between 1500 FCFA (1.5 €) and 2000 FCFA (2.0 €). Further information is neessary concerning the commercial viability of selling the gowe flour in the suggested price range.

1.2.6   Gowe References

Adinsi L, Vieira-Dalode G, Akissoé N, Anihouvi V, Mestres C, Jacobs A, Dlamini N, Pallet D, Hounhouigan J. 2014a. Processing and quality attributes of gowe-a malted and fermented cereal-based beverage from Benin. Food Chain 4: 171-183.

Adinsi L, Akissoé N, Vieira-Dalode G, Anihouvi V, Genevieve F, Mestres C, Hounhouigan J. 2014b. Sensory evaluation and consumer acceptability of a beverage made from malted and fermented cereal: case of gowe from Benin. Food Science and Nutrition DOI : 10.1002/fsn3.166.
Meilgaard M, Civile GV, Carr BT. 2007. Sensory Evaluation Techniques 4th Edition, CRC Press, Florida, USA.

1.3 Detailed report for Kenkey (Group I)

1.3.1 Kenkey Introduction

Kenkey is the principal and most popular product prepared from fermented maize dough in Ghana. It is a stiff gruel or dumpling, usually packaged in maize husks, plantain leaves, or other broad leaves (depending on the type of *kenkey*). There are different types of *kenkey* based mainly on the procedure used in preparation and packaging. A third type of *kenkey* made using dehulled maize is white *kenkey* (*Akporhi* or *Nsiho)* produced mainly in the Central, Western and Eastern regions of Ghana.

Differences exist in the organoleptic properties for the different types of *kenkey* (Sefa-Dedeh, 1993; Amoa-Awua *et al*., 2007) due to the differences in processing procedures and packaging material. Some of the quality attributes of *kenkey* have directly been linked to processing parameters such as steeping of the maize grains and dough fermentation. Extended periods of maize dough fermentation have been associated with the development of undesirable flavours and high acidity (Halm *et al*., 2004). The study was conducted to determine the consumer acceptance of white reengineered *kenkey* made using the optimum pre-process conditions of steeping time (30 and 45h), steeping temperature (30$^\square$C and 35$^\square$C) and dough fermentation time of 12 hours and two traditional white *kenkey*.

1.3.2 Kenkey Materials and Methods

Traditional Anum white *kenkey* and traditional Atimpoku white *kenkey* samples for testing were obtained from a processor in each of the respective towns Anum and Atimpoku in the Eastern Region of Ghana. These were tested against two laboratory prepared samples of white *kenkey* developed based on optimization of pre-process variables for steeping and dough fermentation using the box Benkene design in the reengineering process. Other factors in the reengineering process included re-moulding the shape of *kenkey* to improve presentation, as well as vacuum packaging to extend the shelf life of *kenkey* from several days to three months under low temperature storage. In the consumer acceptance test only the sensory quality of kenkey was assessed. The two laboratory white kenkey samples were produced using dehulled maize dough which had been processed using the following optimized parameters: 30 h steeping time, 30 ℃ temperature and 12 h fermentation time (T3) and 45 h steeping time, 35 ℃ temperature and 12 h fermentation time (T4) (Table 1).

Table 1: Processing procedures used for dehulled dough preparation

Treatment	Steeping time (hours)	Steeping temperature (ºC)	Fermentation time (hours)
T1	25	40	12
T2	20	45	12
T3	30	30	12
T4	45	35	12

Treatments T1 and T2 were outside of the optimum pre-process region and T2 and T3 were within the optimum pre-process region of steeping time, steeping temperature and fermentation time.
Consumer acceptance test was carried out using 65 consumers recruited from CSIR-Food Research Institute and Food Science and Technology students from Kwame Nkrumah

University of Science and Technology. All selected participants regularly consumed *kenkey*, at least twice in a week. Each participant evaluated all 3 g slices of samples in a randomized order under red light at the Sensory Laboratory of the Food Research Institute. The samples were coded with 3-digit random numbers. A glass of water and cream crackers were provided to cleanse the palate between samples. Consumers were asked to provide their liking responses on a 9-point hedonic scale (1 = dislike extremely and 9 = like extremely) for taste, texture, odour and overall acceptability.

Analysis of variance (ANOVA, alpha=0.05) and Duncan Multiple range test were performed to determine significant differences between means of treatments for the consumer acceptance tests (Minitab 14, Minitab Inc., Brandon Court, United Kingdom).

1.3.3 Kenkey Results and discussion

Consumer scores for white *kenkey* obtained from the optimum region (T3 and T4) as well as traditionally processed white *kenkey* obtained from Anum and Atimpoku are shown in Table 2. The results show that all four samples, the two traditional and two laboratory developed samples were acceptable to consumers. Acceptability scores for all the samples ranged from 6.71 to 6.91 on the 9-point hedonic scale and were not significantly different (p<0.05) between any of the samples. Thus the reengineered and traditional white *kenkey* samples were all liked moderately by the consumers, therefore acceptable.

Aroma scores ranged from 6.61 for traditionally processed Atimpoku white *kenkey* to 7.14 for reengineered T3 white kenkey. The aroma score for T3 was significantly different from the other samples. Reengineered T3 white kenkey also recorded the highest score for taste, 6.55, though this was marginal and not significantly different from the others as seen from Table 2. With regards to texture, the traditional samples obtained higher scores, 6.64 and 6.69 compared to the reengineered samples whose texture were only liked slightly, 5.95 and 6.03. However the differences in texture were not significantly different.

Table 2: Mean sensory attributes scores for traditionally processed white *kenkey* (*nsiho*) and white *kenkey* produced from optimum region

Samples	Taste	Aroma	Texture	Acceptability
Traditional Anum *kenkey*	6.53 ± 1.79 [a]	6.76± 1.59 [a]	6.64 ± 1.72 [a]	6.91 ± 1.71 [a]
Traditional Atimpoku *kenkey*	6.26 ± 1.76 [a]	6.61± 1.48 [a]	6.79 ± 1.64 [a]	6.79 ± 1.29 [a]
T3	6.55 ± 1.64 [a]	7.14 ± 1.11 [b]	5.97 ± 1.80 [a]	6.86 ± 1.42 [a]
T4	6.12 ± 2.33 [a]	6.67 ± 2.02 [a]	6.03 ± 2.31 [a]	6.71 ± 2.18 [a]

Means with the same letters in a row are not significantly different (P < 0.05). T3 and T4 were within the optimum pre-process region of steeping time, steeping temperature and fermentation time

1.3.4 Kenkey Conclusion

The two reengineered white kenkey samples were acceptable to consumers based on sensory quality. They were liked moderately by the consumers just as the two traditional white kenkey

samples which were tested along. Based on the sensory quality alone there was not much difference between reengineered and traditional white kenkey. The preferred reengineered white kenkey was the sample prepared by steeping dehulled maize grains at 30 oC for 30 hours and subsequently fermenting the dough produced after milling at 30 oC for 12 hours. This sample was very comparable to the traditional white kenkey produced using the procedure used by traditional processors at Anum. However the additional factors of reengineered white kenkey over traditional white kenkey and the more common types of kenkey, Ga-kenkey and Fanti-Kenkey are the improved presentation and shelf life of reengineered white kenkey.

Pictures for consumer acceptance of reengineered white *kenkey*

Preparation of *kenkey* samples

Consumer assessing the reengineered and traditional white *kenkey* samples

1.3.5   Kenkey References

Amoa-Awua, W.K., Ngunjiri,P. Anlobe J. Kpodo, K. Halm M.Hayford, A.E., Jakobsen, M. (2007) .The effect of applying GMP and HACCP to traditional food processing at a semi-commercial *kenkey* production plant in Ghana. Food ControlVolume 18, Issue 11, Pages 1449–1457.

Halm, M., Amoa-Awua, W. K. A., and Jakobsen, M. (2004). *Kenkey*, an African fermented maize product. In Hui, Y. H., Toldra, F., Nip, W. K. and Meunier- Goddik L. (eds.), *Handbook on fermented foods and beverages science and technology*. Marcel Dekker, New York. pp. 799–816.

Sefa-Dedeh, S. (1993). Traditional food technology. In Macrae R., Robinson R. and Sadler M. (Eds.), *Encyclopedia of food science, food technology and nutrition* (pp. 4600–4606). New York: Academic Press.

1.4 Detailed report for KS (Group I)

1.4.1   Kishk Sa'eedi Summary

This deliverable report refers to the report on near-market consumer testing of new improved products and substitutes in Africa for group 1 products including the cereal based products Kishk Sa'eedi (Egypt). The acceptability of Kishk Sa'eedi was tested using consumer panels comprising 74 Egyptian consumers. Generally they liked all of the three KS samples i.e. traditional as well as re-engineered. No Significant differences in consumer acceptability were observed among the tested KS samples. The Egyptian consumers preferred KS with sour taste and spicy flavour. This explains why the consumer panel liked the most, the KS sample Mal-B-S35 over the re-engineered one. According to our previous consumer acceptability study of KS samples among Egyptian and non-Egyptian consumer, it was found that most non Egyptian consumers liked KS with mild sour taste, pleasant typical KS aroma and crunchy texture. It appears that "sour" taste and "crunchy" texture are the drivers of liking for KS, whereas strong sour and hard textures as well as the mouth feeling i.e. degree of adhesion seem to be the drivers of disliking for KS. These findings should be considered in combination with other AFTER deliverables relating to sensory evaluation study.

1.4.2   Kishk Sa'eedi background

Kishk Sa'eedi (KS) is an Egyptian indigenous wheat-based fermented food prepared traditionally according to the method applied by Upper Egyptians. The term Sa'eedi is the designation that is given to the people of the Sa'eed or the south of Egypt. Kishk Sa'eedi (KS) is typically prepared by mixing Laban Zeer (buttermilk separated from freshly drawn milk and left to sour in an unglazed earthenware container: the "zeer") with coarsely ground parboiled whole wheat. The Laban Zeer is mixed with the moistened coarsely ground parboiled wheat in a large earthenware magour, to produce a heavy paste called "hama". The milk cereal mixture is then allowed to ferment again and kneaded with the addition of more of the fermented salted milk diluted with water and spiced with cumin before cutting into unformed chunks (of about 3 cm in diameter) or shaped into small balls of about 2 cm in diameter. The shaped product is arranged on a reed mat to dry in the sun and stored in the form of the dried product.

1.4.3   Kishk Sa'eedi Materials and methods
Consumer testing was carried out on three different samples i.e. two traditional commercial samples and one re-engineered   sample Fig.1. The detailed method of preparation are previously described
(D5.5.1.1).
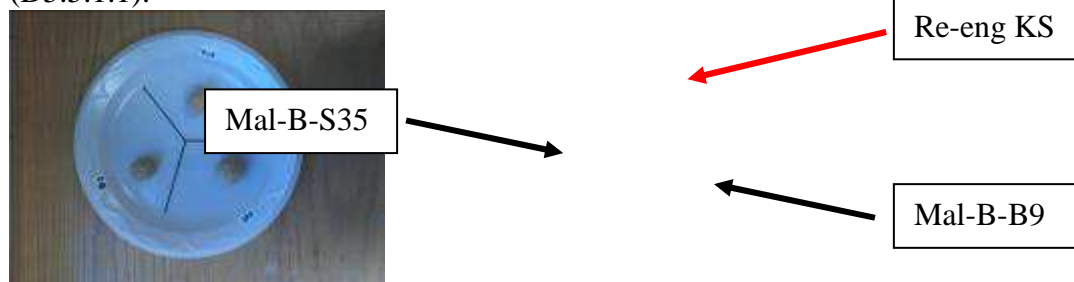
During acceptability testing, each consumer was invited to taste the samples presented in random order and coded with three digit random codes. Consumers were asked to score the

acceptability with respect to overall liking using a seven-point verbal hedonic box scale which varied from dislike extremely to like extremely (Meilgaard et al. 2007) Fig.2.

Along with obtaining information about the acceptability of the KS samples, information was elicited from each consumer regarding demographics, education, KS consumption and buying.   Trained enumerators assisted the consumers when required.   The interview procedure (acceptability and the questionnaire) lasted no more than 30 min.

Consumers (n=74, 65%F and 35%M) were interviewed at the campus of the National Research Centre. Consumers were randomly invited to participate in the tasting of the samples.

Fig. 2. The consumer panel at different location in the NRC campus

Statistical Analysis

   Analysis of variance, and correlation analysis were carried out using SPSS (V 18.0).

1.4.4   Kishk Sa'eedi Results and discussion

Overall, the acceptance of the KS did not significantly differed between the three samples at p<0.01 (One-way ANOVA) (Table 1). The re-engineered KS sample was as acceptable as the traditional ones. All of the samples were on average acceptable since the mean scores were greater than a score of 4 (neither like nor dislike). The score of four 'neither like nor dislike' was used as an indicator of "neutral attitude". The products rated below four were considered as "disliked" and above four as "liked".

Table 1. Mean overall acceptability scores for the three KS samples tested

KS samples	Acceptability*	N	Std
Re-eng	4.24[a]	74	1.686
Mal-B-B9	4.30[a]	74	1.718
Mal-B-S35	4.28[a]	74	1.676

*Acceptability was rated on a seven-point scale from 1 = dislike extremely, to 7 = like extremely. Different letters are significantly different samples where the re-engineered KS (Re-eng); Traditional KS (Mal-B-B9); and traditional commercial KS (mal-B-S35).

The consumers were asked to select the most liked as well as the least liked sample. Mal-B-S35 KS sample was the sample liked the most whereas, the re-engineered ones was the least liked sample figure (3). The Egyptian consumers preferred KS with sour taste and spicy flavour. This explains why the consumer panel liked the most, the KS sample Mal-B-S35 over the re-engineered one. According to our previous consumer acceptability study of KS samples among Egyptian and non-Egyptian consumer, it was found that most non Egyptian consumers liked KS with mild sour taste, pleasant typical KS aroma and crunchy texture. It appears that "sour" taste and "crunchy" texture are the drivers of liking for KS, whereas strong sour and hard textures as well as the mouth feeling i.e. degree of adhesion seem to be the drivers of disliking for KS.
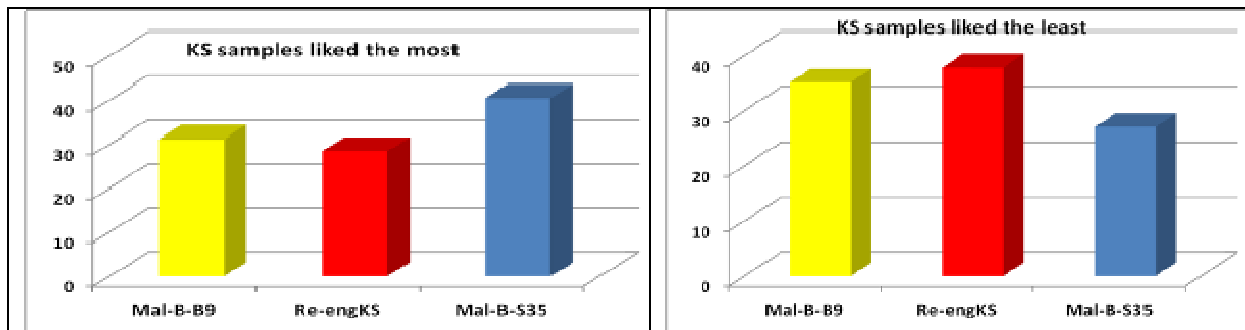

Fig. 3. The most and least liked KS samples

The age distribution of the consumer panel revealed that about half of the consumer are within the age category 18-35Y whereas 20% were among the age group 46-55Y Fig. 4.
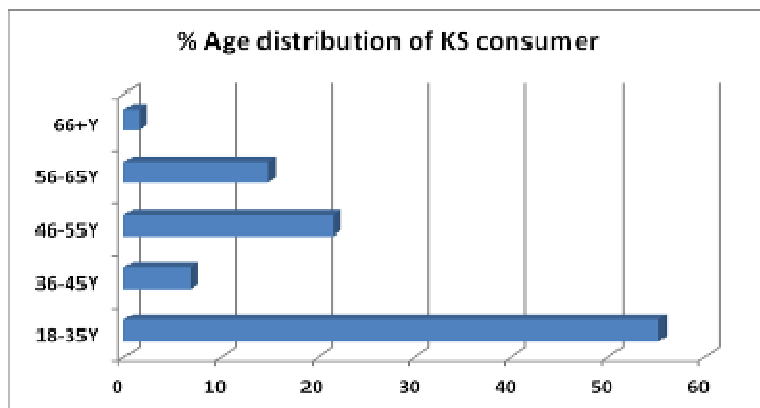

Fig. 4. Age distribution of the consumer panel.

1.4.5   Kishk Sa'eedi Conclusions

The sensory test and consumer acceptance help to provide a basis of understanding of the acceptability of re-engineered KS by African consumers. It gives us some information on how the product could be adapted to consumer taste and if it could have a potential success as a marketed product.

The authors would like to express her gratitude to the participants for spending their time participating in this project as a consumer.

1.4.6 Kishk Sa'eedi References

Ahmed, Z.S., Abozed, S.S., Awad, S., Ibrahim, A., mesters, C., Pallet, D. Novel snack inspired from the traditional Egyptian kishk Saeedi: Compositional, microbiological and microstructural qualities. AFTER Congress, Dakar, 2014.

Ahmed, Z.S., Abozed, S.S., AbdElaziz, S, Tomlins, K., Mesters, C., Awad, S., Hassan-Wassef, H.I., Pallet, D. The fermented wheat based endogenous kishk Sa'eedi: Proximate composition and sensory evaluation. EFOST, 2013.

Ahmed, Z.S., Hassan-Wassef, H.I. Pallet, D. Exploring the Egyptian traditional cereal-based Kishk Sa'eedi (KS) by survey. EFOST, 2012.

Hassan-Wassef, H.I., Ahmed, Z.S., Bennett, B., Pallet, D. Kish Sa'eedi of Egypt: The contribution of food value chain analysis methodology to the advancement of human development goals. EFOST, 2012.

Hesseltine, C. W. Some important fermented foods of Mid-Asia, the Middle East and Africa. Journal of American Oil Chemists Society, 1979, 56: 367–374.
Meilgaard, M., Civile, G. V., & Carr, B. T. (2007). Sensory Evaluation Techniques 4th Edition, CRC Press, Florida, USA.

Oyarekua, M. A. Sensory evaluation, nutritional quality and antinutritional factors of traditionally co-fermented cereals/cowpea mixtures as infant complementary food. Agric. Biol. J. N. Am., 2010, 1(5): 950-956

Powers, J.J. 1984. Using General Statistical Programs to Evaluate Sensory Data. Food Technology v38 (6):74-82, 84.

2 Reports for Group II

2.1 Detailed report for Kong (Group II)

2.1.1 Kong Summary

The appreciation of the new products obtained within the framework of the improvement of the smoking in Senegal was realized with the consumers. Four smoked fish products were tested. Results showed that Consumer acceptability of the Kong products was high (around 7 = moderately like). There were no difference in acceptance between the reengineered products prepared by soaking (RSK and RGK) and the traditional Kong product (TK). Kong made using liquid smoke novel technique (RLK) had by far the highest acceptance and could easily be integrated as part of the Senegalese cuisine. This shows that there is a potential for RLK on the Senegalese market.

2.1.2 Kong Introduction

Following the diagnosis of the stages of the smoking, a reorganization of the traditional diagram of production is proposed. It allowed improving on one hand the quality of the smoked fish for the local market and on the other hand for the new markets (with new products). These validated products were the object of deliverables D3.2.1.2 concerning the simplification of the diagram for an improvement of the traditional process; deliverables D3.2.2.4+D3.3.4 carried on new technological pathway for the factory of KONG. Demonstrations were organized for the benefit of some producers of Dakar to facilitate the transfer of the improvements. However the essential principle of the AFTER project is the improvement of the process and the quality in the respect of consumer's requirements. Smoked fish obtained through this improvement have been submitted to consumer analyses by comparison with traditional products. The aim of this report is to present the results of consumer acceptance between new products and traditional one.

2.1.3 Kong Materials and methods

Consumers
Hedonic test were led in the city of Dakar with a very heterogeneous population established) by 82 consumers. Consumers were interviewed using the central location method (Meilgaard *et al.*, 2007).

Samples
Four smoked Kong samples were tested including a traditional Kong product (TK) (baseline product) and three reengineered products being salted (RSK); garlic flavoured and salted (RGK) Kong; and Kong smoked with liquid smoke (RLK) (Table 1).

Table 1. Description of Kong products

Product	Process	Letter	Code
Traditionally smoked Kong (TK)	Bought on traditional site	A	106
Reengineered smoked and salted Kong (RSK)	Soaking 30 min. in salty bath (0.5kg salt/10L water)	B	654
Reengineered smoked, salted and garlic flavoured Kong (RGK)	Soaking 30 min. in salty bath with garlic (0.5kg salt/10L water)	C	972
Reengineered smoked Kong with liquid smoke (RLK)	Soaking 30 min. in 20% liquid smoke bath (2kg smoke/10L water)	D	380

Method
During acceptance testing, each consumer was invited to taste 20 g of each smoked kong presented in random order and coded with three figure random numbers. Consumers were asked to score the acceptance with respect to appearance, taste and overall liking using a nine-point hedonic scale which varied from "dislike extremely" to "like extremely" (Meilgaard *et al.*, 2007). Samples were transported in plastic airtight boxes. Along with information about the acceptance of smoked Kong, data regarding social level, education, Kong consumption and buying practice were elicited from each consumer. 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 (acceptance and the socioeconomic questionnaire) lasted no more than 30 min

Statistical analysis
Analysis of variance (mixed effect model), correlation analysis (Pearson), Chi-squared analysis and principal component analysis (correlation matrix) were carried out using SPSS (V 22.0) or XLSTAT (V 5.2, Addinsoft). Hierarchical cluster analysis (Wards method) was used to segment the 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. Multiple pairwise comparisons were undertaken using the Tukey test with a confidence interval of 95%.

Ethical assessment and consent
This study has been assessed and approved by Applied Biochemistry Department (Ecole Supérieure Polytechnique) of Dakar Chekh Ata Diop Universit. Consent was sought from 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 (see D 6.1.4 Report on tests results for Kong).

2.1.4 Kong Results and discussion

Overall acceptability

Table 2 presents the acceptability score for each of the four Kong products.

Table 2. Overall acceptability for Kong products

Product	TK	RSK	RGK	RLK
Acceptability*	6.7±1.5a	6.7±1.2a	6.7±1.4a	7.5±1.3b

*average±standard deviation on a 9-point hedonic scale. Different letters indicate that values are significantly different at p<0.05 (One way ANOVA; Tukey test)

With scores close to 7 (moderately like), all the samples were well accepted by the consumers in Dakar. Acceptability scores significantly differ between the four samples (p<0.05). There was a significant difference between TK, RSK, RGK and RLK. RLK was significantly more acceptable than the other samples (score of 7.5 (between moderately like or very much like)). The traditional and two samples prepared in salty bath did not differ (6.7). These results clearly show that the sample smoked using a more advanced technique (liquid smoke) was more acceptable than the traditional sample and the other reengineered samples.

Ranking: most liked and least liked Kong

Table 3. Count of most liked and least liked Kong products

	TK	RSK	RGK	RLK	none	blank
Least liked Kong	17	22	35	3	3	2
Most liked Kong	13	7	13	47	0	2

The most liked Kong product was RLK (47 people) and the least liked was RGK with 35 people. Results for the most liked Kong product (here RLK) were in agreement with the average score for this product (see Table 2).

The reasons for least liking Kong products are summarised in Table 4.

Table 4. Least liked Kong products and reasons

	TK (17 consumers)	RSK (22 consumers)	RGK (35 consumers)	RLK (3 consumers)
Appearance	Too cooked; too dark; too coloured; too smoked	Not enough cooked; Not coloured enough	Not enough cooked; Not coloured enough	Not attractive look
Smell	Too much smoke	Does not smell strong enough	Does not smell strong enough	Does not smell like the usual Kong
Texture	Too soft and should be drier	Too hard	Too dry	-
Taste	Tasteless and not enough salt	Tasteless	tasteless	Would need more salt. smoked taste is too much

TK was least liked for being overcooked and too soft whilst RSK and RGK were least liked for being undercooked and tasteless. A negative remark about RLK was that it had a different appearance and smell like to the usual Kong but that regarded only a minority of consumers (3). In fact, the following table (Table 5) shows that RLK that was considered the most similar to the Kong product people are accustomed to.

Table 5. The product that is considered similar to the consumer's usual Kong product

	TK	RSK	RGK	RLK	Not answered
Similar to usual	20	10	8	41	3

Interestingly the product that was considered the closest to the usual Kong product was RLK (by 41 consumers). RLK was made using a high tech processing that was not available in Dakar. In theory this product should have been considered very different from the product people were used to consume. The traditional product (TK) only came in second position with 20 consumers. The products considered most 'foreign' by the consumers were RSK and RGK.

The choice of RLK as a closest product to the one people are used to consumer might reflect the consumer liking of the product. This is good news for the market study because it shows that RLK could easily be adopted by the people of Dakar.

Segmentation of consumers into groups of similar acceptance
Out of 81 consumers interviewed, only 76 gave an acceptability score. Hierarchical cluster analysis (Ward Method) was applied on the results of the 76 consumers and indicated that there were three different groups of consumers with similar acceptance with respect to the four products of Kong (Figure 1).
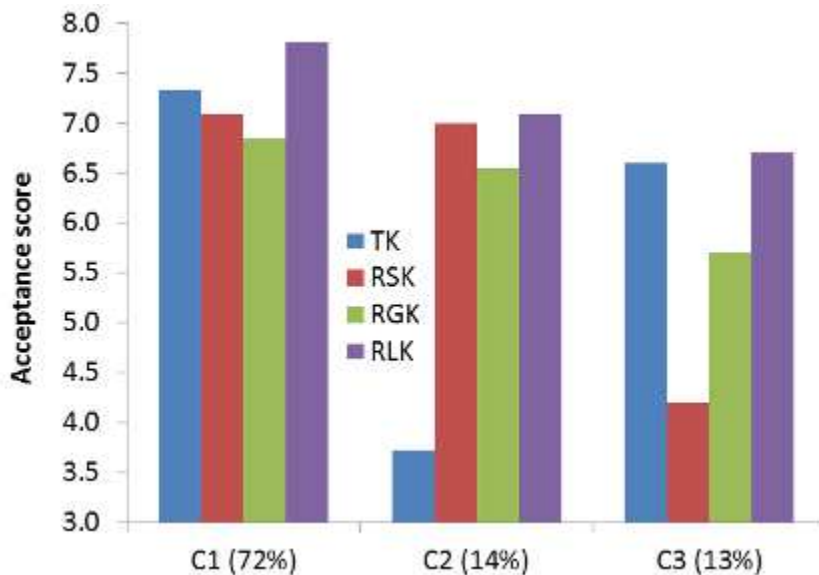

Figure 1. Mean consumer acceptance of Kong products per cluster type. C1: 'all likers'; C2: 'traditional Kong dislikers'; C3: 'salty Kong dislikers'. Where Traditionally smoked Kong (TK); Reengineered smoked and salted Kong (RSK); Reengineered smoked, salted and garlic flavoured Kong (RGK); Reengineered smoked Kong with liquid smoke (RLK)

The groups were divided into C1: 'all likers' (72%); C2: 'traditional Kong dislikers' (14%); C3: 'salted Kong dislikers' (13%).We used a score of five 'neither like nor dislike' as a neutral attitude.

- 'All likers' represented the majority of consumers and gave a high score (about 7 = like moderately) to all the products.
- 'Traditional Kong dislikers' rated the traditional Kong (TK) quite low (3.5 - between dislike moderately and slightly) and gave a high score for the reengineered Kong. This group shows that there is potential for the reengineered products.
- Finally the 'Salted Kong dislikers' disliked the Kong product soaked in salt only and liked all the other three products. Although the salted Kong with added garlic (RGK) was rated higher that the salted Kong (RSK) it was not rated as high as the traditional Kong and the Kong made by liquid smoke. Therefore it is likely that acceptance of C3 consumers was affected by the soaking process (i.e. salt content) of the reengineered Kong.

Relationship between socio-demographic factors with groups of similar acceptance
The influence of the socio-demographic status of the consumers on the cluster attribution is described in Table 6.

Table 6. Demographic differences and consumer attitudes to Kong with respect to cluster division

Question		C1'All likers'	C2 'Traditional Kong dislikers'	C3 'Salted Kong dislikers'	Probability [a]One-way ANOVA ($p<0.05$) [b]Chi Square test ($p<0.05$)
Number of interviewees		56	11	10	
Female		47.3%	36.4%	70%	0.282 [b]
Male		52.7%	63.6%	30%	
Age		24	29	31	0.168 [a]
Nationality	Senegalese	96.4%	81.8%	100.0%	0.104 [b]
Country of residence	Senegal	98.2%	100.0%	100.0%	0.824 [b]
Education	None	25.5%	18.2%	0.0%	
	Koranic school	7.3%	0.0%	0.0%	
	Primary school	23.6%	27.3%	10.0%	0.082 [b]
	Secondary school	7.3%	18.2%	10.0%	
	University	36.4%	27.3%	80.0%	
Consumption of Kong	Yes	100.0%	90.9%	100.0%	0.050 [b]
Frequency of consumption	Several times a week	18.2%	10.0%	0.0%	
	Once a week	23.6%	40.0%	20.0%	0.663 [b]
	Once a month	9.1%	10.0%	10.0%	
	Rarely	49.1%	40.0%	70.0%	
Willingness to buy	Likely	9.1%	9.1%	20.0%	0.578 [b]
	Very likely	90.9%	90.9%	80.0%	
Maximum price (cfa) people are willing to pay for their preferred Kong product.		2350	2494	2530	0.882 [a]

None of the factors (demographic: age; gender; nationality; education etc…and consumption or willingness to buy described in the table had an influence on the cluster type. Most people interviewed were of Senegalese origin and had a good level of education (university level). All consumers but one person had consumed Kong before. However their consumption was not frequent. Consumers were very willing to buy the Kong products that were presented and their maximum price was above the price of the market (1800 cfa).

Willingness to buy and maximum price
The average score for willingness to buy the products was 4.9 (very close to 5 the highest score on Likert scale=very willing to buy). The maximum price given for the products was 2467 cfa, which is above the referent price of the market (1800 cfa). Consumers were keen to find the products on the market (73.2% of consumers interviewed); in the supermarket (64.6%) and in shops (52.4%). Most consumers (59.8%) considered that the products did not need further improvement. However a minority of consumers expressed the opinion that they would like improvement on the products (32.9%). Overall the reaction of consumers to the product is very positive. The answers showed that there is a potential market for a reengineered Kong in Senegal.

2.1.5   Kong Conclusions

Consumer acceptability of the Kong products was high (around 7 = moderately like). There were no difference in acceptance between the reengineered products prepared by soaking (RSK and RGK) and the traditional Kong product (TK). Kong made using liquid smoke novel technique (RLK) had by far the highest acceptance compared to the other products. The results show that RLK could easily be integrated as part of the Senegalese cuisine since the product was not considered different from the known products on the market by most consumers. The willingness to buy was very high (very likely), which further shows that there is a potential for RLK on the Senegalese market.

2.1.6   Kong References

Meilgaard, M., Civile, G. V., & Carr, B. T. (2007). Sensory Evaluation Techniques 4th Edition, CRC Press, Florida, USA.

2.2 Detailed report for Lanhouin (Group II)

2.2.1 Lanhouin Summary

Two reengineered Lanhouin types (Lanhouin dry powder, Lanhouin dry fillet) were evaluated by 217 consumers for their acceptability, willingness to buy and the right price to which consumers are ready to buy. Both forms of Lanhouin were greatly acceptable and the powdered form more than the fillet. Four groups of consumer behaviour were observed; namely "Lanhouin likers" (32%), "Lanhouin powder likers" (46%), "Lanhouin fillet likers" (14%) and "Lanhouin dislikers" (7%). There was no difference between clusters in relation to the willingness to buy and the right price.

2.2.2 Lanhouin Background

Lanhouin is a traditional flavouring agent and taste enhancer (FATE). It is a dried salted fermented fish used as condiment largely consumed by African people. Surveys were undertaken to understand what type of reengineered Lanhouin should be produced for the international market.

The recent studies carried out on this product with an aim of improving its technology of production and of making the product more attractive (preserved in packaging polyester), led to the development of two products which are Lanhouin powder and Lanhouin fillet. Both products were evaluated by the consumers (users) of Lanhouin to collect their liking/preference and their willingness to buy.

2.2.3 Lanhouin Methodology

Experimental samples
Fresh cassava fish (*Pseudotolithus sp*.) was purchased from Cotonou seaport (Benin). The fish was transported and kept in an icebox with dry ice until experiment. This type of fish was chosen due to its general use to produce artisanal Lanhouin (Anihouvi et al., 2005; Kindossi et al., 2012).

Preparation of Lanhouin fillet
The fresh cassava fish (*Pseudotolithus* sp) was washed, scaled, eviscerated, beheaded and washed twice before filleting. The fresh fillets were then ripened in brine (4% salt/mass of fillet) during 4 hours. The ripened fillets were then salted (15% salted/mass of fillet), arranged in a perforated plastic bucket and allowed to ferment during 4 days at ambient temperature (30 ± 2°C). At the end of fermentation, fermented fish fillets were immersed for 5 min in mixed solution of lemon juice (8% of lemon juice) and garlic extract (8% of cloves of garlic) was prepared from equal quantities of lemon juice solution and garlic extract solution. All fermented fish fillet samples were spread in a type of shell of GERES/GRET drier and sun dried for 18 hours. All Lanhouin fillet samples were packaged in a plastic bag (Type Walovac 90 B), using a sealing apparatus.

Figure 2.2-1 Reengineered fillet Lanhouin

Preparation of Lanhouin powder

The fresh purchased cassava fish (*Pseudotolithus* sp) was washed, scaled, gutted, beheaded and washed before filleting. The fish flesh was separated from skin and bones and then marinated for 4 h in marinade solutions prepared from 1% of citric acid extrapure (AC07200500, Scharlau Chemie S.A., EC Label, Spain European Union), with 5% of Laboratory sodium chloride (NaCl) (GPR rectapur 11G130020 EC Label, European Union), 0.5% of spices (garlic, clove, black pepper grain) (purchased from local supermarkets) and distilled water. The marinated fish was ground using a vary mixer blender (type 1985/R20, Wodschow, Denmark). The marinated ground flesh fish was mixed with 5% of NaCl and 5% of sterilized cassava starch powder as fermentable carbohydrate source for *Staphylococcus xylosus* and *Lactobacillus plantarum*. The mixed flesh fish was inoculated with mixture of starter cultures of *L. Plantarum* (LP 652) (from laboratories of CIRAD-Montpellier) and *Staphylococcus xylosus* (SO3-188) (from INRA-Clermont-Ferrand Theix) and homogenized in aseptic conditions for fermentation. The end fermented products obtained were oven dried at 65°C during 12 hours, then presented in forms of powder and packaged in a plastic bag (Type Walovac 90B).

Figure 2.2-2 Lanhouin powder

Consumer acceptability

Two hundred seventeen consumers were interviewed randomly at six locations at Cotonou and Abomey Calavi, using the method of central location testing (Watts et al., 1989). There were the following: Fishing port of Cotonou (n= 41); Cotonou town (n= 67); University of Abomey Calavi (n= 28); Abomey-calavi town (n= 48); Godomey (n= 22); Calavi tokpa (n= 11). All consumers interviewed were African.

Consumers were presented with two samples named Lanhouin fillet and Lanhouin powder. They were asked to score the acceptability of Lanhouin samples using 9-point verbal hedonic box scale which varied from 'dislike extremely' to 'like extremely' (Watts et al., 1989; Tomlins et al., 2005) and then, to give their willingness to buy (on a scale from 1 to 10) and the price to which they are ready to buy.

Statistical analysis
Data were recorded using Sphinx survey plus2 (version 4.5) software. Analysis of variance (ANOVA) or kruskal-Wallis as appropriate, correlations, principal component analysis (PCA), cluster analysis (agglomerative hierarchical cluster; Ward's method) were computed using XLSTAT (version 2011, Addinsoft, Paris, France) and STATISTICA (version 6, StatSoft France, 2004).

2.2.4   Lanhouin results and discussion

Consumer acceptance of reengineered Lanhouin
All of Lanhouin samples were scored 6 ('like slightly' or more) with a mean score greater than 7 (like moderately) (
). No significant differences were found between Lanhouin fillet and Lanhouin powder ($p > 0.05$) with respect to acceptance. These acceptability scores of the reengineered Lanhouin were greater than that of traditional Lanhouin, which was 6.2 (Kindossi et al., 2013).

Table 2.2-1 Mean overall acceptability scores for two Lanhouin samples tested

Lanhouin samples	Acceptability*
Lanhouin fillet	7.16±0.96[§a]
Lanhouin powder	7.44 ±1.13[a]

*Acceptability was rated on a nine-point scale from 1= dislike extremely to 9= like extremely; [§]Mean ± Standard deviation

Segmentation of consumers into groups of similar acceptance patterns regarding reengineered Lanhouin samples
Hierarchical cluster analysis (Wards method) was used to segment African consumers interviewed in different locations into four different groups as illustrated in the dendogram (Figure 2.2.4). 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 Figure 2.2.5. We used a score of seven 'like moderately' as an indicator of "limit attitude for reengineered product". The products rated below seven were considered as "disliked" and above seven as "liked". For the purposes of cluster division, the consumers were grouped as "Lanhouin likers" (32%), "Lanhouin powder likers" (46%), "Lanhouin fillet likers" (14%) and "Lanhouin dislikers" (7%).
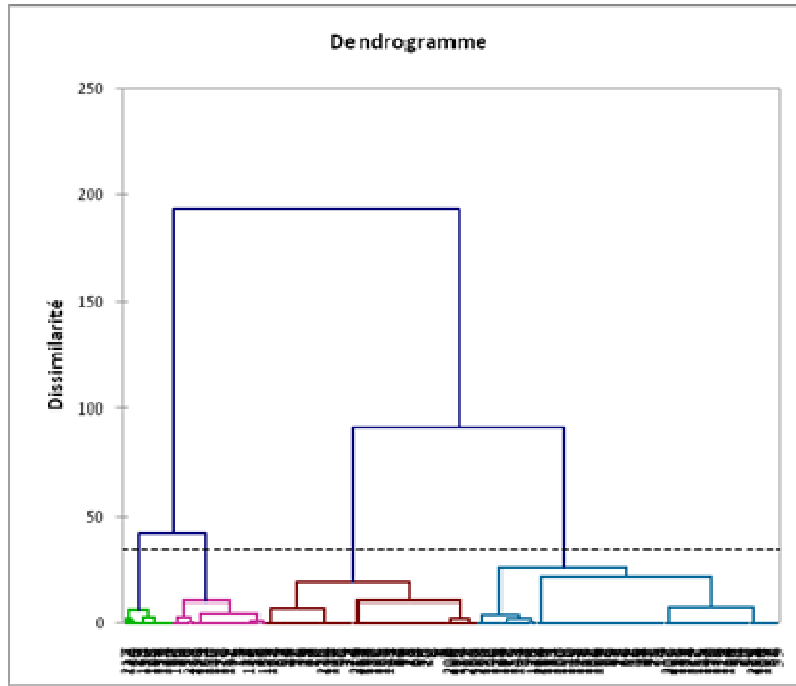
Figure 2.2-3 Hierarchical clusters analysis dendrogram for segmenting consumers into groups of similar perceptions of Lanhouin acceptability. Dashed line denotes level of dissimilarity along which the three segments were selected.
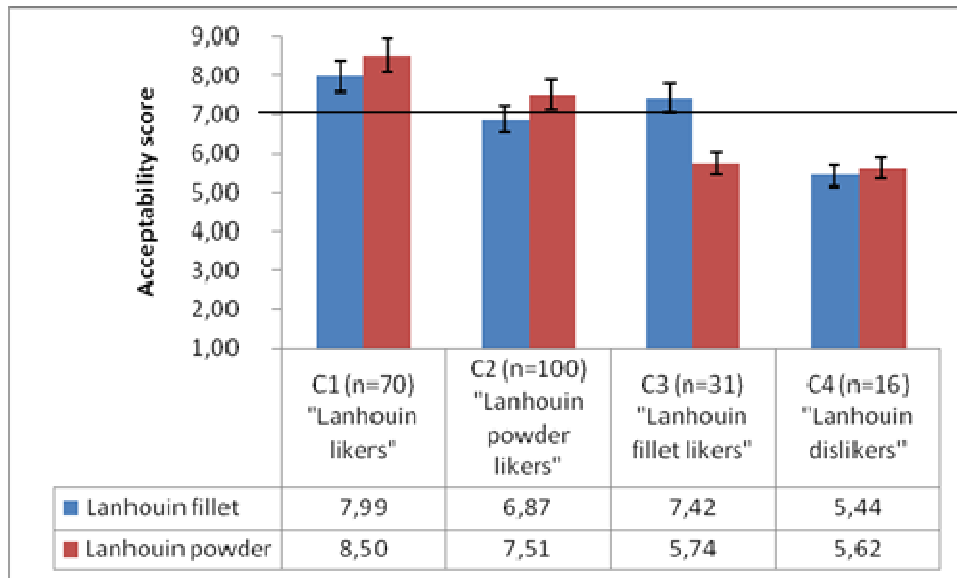

	C1 (n=70) "Lanhouin likers"	C2 (n=100) "Lanhouin powder likers"	C3 (n=31) "Lanhouin fillet likers"	C4 (n=16) "Lanhouin dislikers"
Lanhouin fillet	7,99	6,87	7,42	5,44
Lanhouin powder	8,50	7,51	5,74	5,62

Figure 2.2-4 Mean consumer acceptance of Lanhouin cluster type (Lanhouin likers, Lanhouin powder likers, Lanhouin fillet likers, Lanhouin dislikers).

The four clusters did not significantly differ ($p > 0.05$) in terms of sociological criteria such as age, gender, occupation.
There was no difference between clusters related to the preference, the willing to purchase and the right price to which consumers are ready to buy (
.2.2).

Table 2.2-2 Demographic differences and consumer attitudes to Lanhouin (buying and consumption) with respect to cluster division

Question	Cluster 1 "Lanhouin likers"	Cluster 2 "Lanhouin powder likers"	Cluster 3 "Lanhouin fillet likers"	Cluster 4 "Lanhouin dislikers"	Probability Chi Square test (p<0.05)
Number of consumers	70	100	31	16	
Age (%)					
[18-35]	60.0	44.0	51.6	50.0	0.21
[36-45]	30.0	34.0	29.0	18.8	
[46-55]	8.6	18.0	19.4	25.0	
[56-65]	1.4	3.0	0	0	0.24
[66 +[	0	1.0	0	6.3	
Gender (%)					
Female	94.3	88.0	90.3	93.8	0.21
Male	5.7	12.0	9.7	6.3	
Occupation (%)					
civil service	12.9	8.0	6.5	12.5	0.24
Artisanship	5.7	15.0	3.2	6.3	
Housewife	35.7	39.0	48.4	31.3	
Student	12.9	10.0	6.5	25.0	0.21
Trader	31.4	15.0	29.0	25.0	
Restaurant owner	1.4	13.0	6.5	0	
Preference for purchase (%)					
Fillet of Lanhouin	20.0	19.0	71.0	31.3	
Powder of Lanhouin	72.9	78.0	6.5	56.3	0.21
Indifferent	7.1	3.0	22.6	12.5	
Will to purchase (%)					
1	0	0	9.7	12.5	0.24
2	2.9	2.0	3.2	0	
3	8.6	4.0	16.1	12.5	0.21
4	2.9	3.0	6.5	6.3	0.24
5	8.6	14.0	6.5	25.0	
6	7.1	12.0	19.4	18.8	
7	12.9	20.0	9.7	12.5	0.21
8	31.4	30.0	16.1	12.5	
9	15.7	9.0	9.7	0	
10	10.0	6.0	3.2	0	
Price to which consumers are ready to buy 50 g (%)					

Question	Cluster 1 "Lanhouin likers"	Cluster 2 "Lanhouin powder likers"	Cluster 3 "Lanhouin fillet likers"	Cluster 4 "Lanhouin dislikers"	Probability Chi Square test (p<0.05)
[100-200]	15.7	26.0	45.2	56.3	
[300-400]	31.4	29.0	41.9	37.5	
[500-600]	27.1	31.0	6.5	0	0.21
[700-800]	14.3	7.0	3.2	0	
[900-1000]	10.0	5.0	3.2	0	
[1500-2000]	1.4	2.0	0	6.3	

Preference of reengineered products
Most consumers (72%, 78% and 56% respectively in the three clusters: C1"Lanhouin likers", C2"Lanhouin powder likers" and C4"Lanhouin dislikers" preferred Lanhouin powder while 71% of consumers in C3 "Lanhouin fillet likers" preferred Lanhouin fillet. According to consumers interviewed Lanhouin powder was preferable to Lanhouin fillet especially because it was easy to use: it could be sprinkled and well mixed with dishes .

Willingness to purchase
The majority of consumers (30.0% of total) in C2 "Lanhouin powder likers" and (31.4%) in C1 "Lanhouin likers" gave score of 8 over 10 for their willingness to buy. The willingness to buy would be also dependent on the packaging since accustomed consumers of Lanhouin argued that good packaging improves hygienic sanitary qualities of the product. Tomlins *et al.* (2007) reported that the willingness to buy is dependent on the consumer income and its perception of the quality, which is itself related to its food habits.

Price to which consumers are ready to buy (Just right price)
The majority of consumers (31.0% of the total) in C2 "Lanhouin powder likers" were ready to buy 50 g of Lanhouin powder for 500 and 600 FCFA while the majority of consumers (45.2%) in C3 "Lanhouin fillet likers" were ready to buy 50 g of Lanhouin fillet for 100 and 200 FCFA. The choice of the prices was done on the basis of total acceptability of the product, of its mode of presentation and the purchasing power of consumers.

2.2.5 Lanhouin Conclusions

This study sought to investigate consumer preference of reengineered Lanhouin and consumer acceptability of reengineered Lanhouin. Consumer acceptability varied between the products with Lanhouin powder being preferred to Lanhouin fillet. Acceptability scores of reengineered Lanhouin were greater than that of traditional Lanhouin, which were under 7. This acceptance study shows that reengineered Lanhouin is ready to be marketed. Individual consumer preference of reengineered Lanhouin varied and four clusters of consumers were identified; namely "Lanhouin likers" (32%), "Lanhouin powder likers" (46%), "Lanhouin fillet likers" (14%) and "Lanhouin dislikers" (7%). There was no difference between clusters with regards to the willingness to buy and the right price to which consumers are ready to buy

2.2.6 Lanhouin References

Anihouvi VB, Hounhouigan JD, Ayernor GS. 2005. La production et la commercialisation du lanhouin, un condiment à base de poisson fermenté du golf du Bénin. Cahier agric 14(3):323-30.

Kindossi JM, Akpo-Djenontin OOD, Anihouvi VB, Akissoé NH, Anne-Laure D, Vieira-Dalodé G,

Tomlins K, Pallet D, Hounhouigan JD. 2013. Sensory Evaluation and Consumer Acceptability of an African Fish Based Flavouring Agent and Taste Enhancer. Indian Journal of Applied Research 3 (8):317-21.

Kindossi JM, Anihouvi VB, Vieira-Dalodé G, Akissoé NH, Jacobs A, Dlamini N, Pallet D, Hounhouigan DJ. 2012. Production, consumption, and quality attributes of Lanhouin, a fish-based condiment from West Africa. Food Chain 2(1):117-30.

Tomlins K, Sanni L, Oyewole O, Dipeolu A, Ayinde I, Adebayo K, Westby A. 2007. Consumer acceptability and sensory evaluation of a fermented cassava product (Nigerian fufu). J Sci Food Agric 87:1949-56.

Tomlins KI, Manful JT, Larwer P, Hammond L. 2005. Urban consumer preferences and sensory evaluation of locally produced and imported rice in West Africa. Food Quality and Preference 16:79-89.

Watts BM, Ylimaki GL, Jeffery LE, Elias LG. 1989. Basic sensory methods for food evaluation. Centre IDR, editor. International Development Research Centre, IDRC-277è ed. Ottawa, Ont.160 pp.

2.3   Detailed report for Kitoza (Group II)

2.3.1   Kitoza Introduction

In view of the results of traditional process assessment, an improved method of preparation of smoked beef and pork Kitoza has been established.

Pork and beef Kitoza obtained by production trials have been submitted to sensory analyses by comparison with traditional products. Results showed that there was no significant difference between the traditional Kitoza tested and the improved ones, considering the sensory attributes which were used (see D5512).

The aim of this report is to present the results of consumer acceptance study on both pork and beef new Kitoza accompanied by one traditional product.

2.3.2   Kitoza Materials and methods

Consumers

Consumer tests were carried out with Malagasy consumers from different ethnical origins (number: 100). Consumers were interviewed at different locations in Antananarivo using the central location method (Meilgaard *et al.*, 2007). They were distributed as follows: Ankatso area (n=42), Tsaramasoandro Ambanidia (n=14), Société Artelia Ankadivato (n=7), Tsiadana (n=11), Soavimasoandro (n=26).

Samples

Among the samples used for sensory tests, three smoked Kitoza were selected for consumer tests, as follows:
111.   Beef Kitoza, butcher's shop Behoririka (BE Beho)
210.   Pork Kitoza locally reengineered (PR)
421.   Beef Kitoza locally reengineered (BR)

The process for manufacturing improved pork and beef Kitoza is shown below.

BE Beho Kitoza was chosen among 7 samples since according to sensory analyses it constituted a separated group (see D5512). Thus, each one of these Kitoza represents a distinct group.
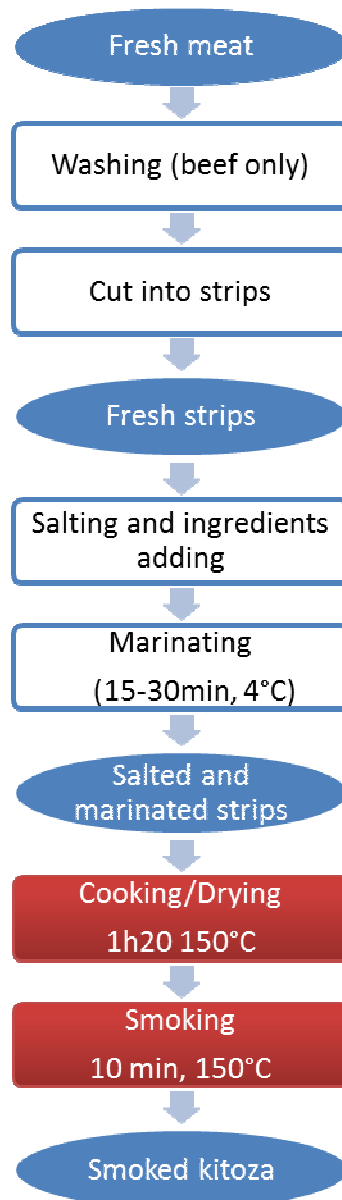
```
        Fresh meat
            │
            ▼
   Washing (beef only)
            │
            ▼
      Cut into strips
            │
            ▼
       Fresh strips
            │
            ▼
 Salting and ingredients
         adding
            │
            ▼
       Marinating
    (15-30min, 4°C)
            │
            ▼
      Salted and
    marinated strips
            │
            ▼
     Cooking/Drying
     1h20 150°C
            │
            ▼
        Smoking
     10 min, 150°C
            │
            ▼
     Smoked kitoza
```

Figure 1: Reengineered process of manufacturing beef and pork Kitoza

Method

During acceptance testing, each consumer was invited to taste 20 g of each Kitoza presented in random order and coded with three figure random numbers. Consumers were asked to score the acceptance with respect to appearance, taste and overall liking using a nine-point hedonic scale which varied from "dislike extremely" to "like extremely" (Meilgaard *et al.*, 2007). Kitoza samples were transported in plastic airtight boxes.

Along with information about the acceptance of smoked Kitoza, data regarding social level, education, Kitoza consumption and buying practises were elicited from each consumer. All spoken interviews were conducted in French or in the local language (Malagasy) and the score sheets and questionnaires were written in French. Trained enumerators assisted the consumers when required. The interview procedure (acceptance and the socioeconomic 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 XLSTAT (6.0). ANOVA was coupled to LSD (Least significant difference) test at a confidence interval of 95%.

Ethical assessment and consent

This study has been assessed and approved by the University of Antananarivo, Fundamental and Applied Biochemistry Department (Faculty of Sciences). 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.

2.3.3   Kitoza Results and discussion

Table 1 below shows the average overall acceptance of each studied Kitoza.

Table 1: Average overall acceptance of tested Kitoza

	Average acceptance
BEBeho (111)	6.48 a
PR (210)	6.58 a
BR (421)	6.81 a

Legend :
BE Beho (111): Beef Kitoza, butcher's shop Behoririka
PR (210): Pork Kitoza locally reengineered
BR (421): Beef Kitoza locally reengineered

Table 2 summarizes the LSD analyses contrasting the 3 products.

Table 2: Results of LSD analyses

Contrast	Difference	Standard difference	Critical value	Pr > Diff	Significant
421 vs 210	-0.333	-1.625	1.972	0.106	Not
421 vs 111	-0.101	-0.492	1.972	0.623	Not
111 vs 210	-0.232	-1.133	1.972	0.259	Not
LSD-value			0.405		

Legend :
111: Beef Kitoza, butcher's shop Behoririka (BE Beho)
210: Pork Kitoza locally reengineered (PR)
421: Beef Kitoza locally reengineered (BR)

According to statistical analyses (Table 1 and 2 above), the three samples, with a score equalling 6 to 7, were "moderately liked" by consumers. Moreover, they belonged to the same homogenous group "a". Consequently, cluster analysis was not needed for these results.
Thus, there was no significant difference between the 3 products from acceptance point of view.

2.3.4 Kitoza Conclusions

Applying the new improved process of manufacturing Kitoza allowed obtaining products similar to the traditional ones regarding sensory properties. Consumer acceptance studies showed that there was no significant difference between all samples tested. Therefore it is permitted to conclude that the new process had no impact on consumer appreciation. These sensory and consumer data have to be completed with physicochemical and microbiological characteristics of the reengineered Kitoza.

3 Reports for Group III

3.1 Detailed report for Bissap (Group III)

3.1.1 Bissap Summary

Senegalese consumers in Dakar evaluated three new Hibiscus (50% Kor and 50% Vinto) drinks – an infusion, a syrup and a vacuum-concentrate together with a traditional infusion (baseline).

Consumer profiling techniques based on hedonic acceptance, Just-About-Right intensity evaluation of specific descriptors (JAR) and Check-All-That-Apply questions with sensory and emotional descriptors (CATA) were used to establish sensory profiles and preference maps. Descriptors and other relevant evaluative information were obtained through two exploratory focus groups.

The results of this study showed that the Re-engineered hibiscus drinks were positively appreciated by consumers in Senegal and better accepted than the traditional commercial infusion used as baseline comparison. However, the new drinks were not perceivably different from the baseline drink to consumers concerning both the traditional character and the nutritional and healthy attributes.

With different sensory characteristics, the new drinks were differently appreciated by the identified consumers segments with similar overall liking patterns, mainly related with liking of sweetness, of acidity and intensity of bissap taste. The combined results of consumer acceptance evaluation and consumer profiling techniques employed showed significant drivers for two the three developed drinks, the Re-engineered Syrup (REs) and Re-engineered Infusion (REi). For the Re-engineered Syrup (REs), an increase in hibiscus concentration while maintaining the sweetness level could lead to an increase in consumer acceptance. For the Re-engineered infusion (REi) although positively evaluated by 75% of consumers, a decrease in bissap concentration with a perceptible increase in sweetness could lead to an increase in consumer acceptance.

The observed agreement between the results obtained in Overall liking evaluations, Intensity scoring of Specific attributes using JAR scales and product description using CATA was indicative of an adequate understanding and use of these methodologies by consumers in Senegal to evaluate the Hibiscus drinks.

3.1.2 Bissap Background

Bissap is a non-alcoholic drink commonly consumed in African countries, particularly in Senegal. It is made from Hibiscus sabdariffa L. - an herbaceous plant belonging to the Malvaceae, most often from its Ordinary/Kor (Senegal) and/or Vimto (Sudan) varieties. Past research has shown that Hibiscus drinks are generally rich in vitamins, minerals and bioactive compounds. These drinks are amongst the products investigated in this project aiming at the production of good quality (nutritional and sanitary) and extended shelf-life products of African tradition for local and European markets.

A previous AFTER study on the acceptability of four traditional Hibiscus drinks by a sample of Senegalese consumers uncovered significant effects of plant variety and processing method. This highlighted the importance of harmonizing the sensory profile of these drinks as part of the product re-engineering process, and re-assessing their acceptability amongst the Senegalese population. So, the new drinks tested resulted mainly from incremental changes in

the traditional manufacturing processes, with the aim of better extracting and preserving its nutritional value while increasing its eco-efficiency.

In view of this, three new Hibiscus (50% Kor and 50% Vinto) drinks – an infusion, a syrup and a vacuum-concentrate – were developed by AFTER researchers. The new drinks were developed at the Laboratoire de Formation Continue en Industrie Agroalimentaire of the Ecole Supérieure Polytechnique of Univeersité Cheikh Anta Diop (UCAD), in Dakar. Their manufacturing process was subsequently tested and scaled-up in the pilot plant of Centre Sectoriel de Formation Professionnelle aux Métiers des Industries Agroalimentaires (CSFP IAA), in Dakar.

Their sensory quality was evaluated, together with a traditional infusion (baseline), by Senegalese consumers in Dakar in October-November of 2013. Consumer profiling techniques based on hedonic acceptance, Just-About-Right intensity evaluation of specific descriptors (JAR) and Check-All-That-Apply questions with sensory and emotional descriptors (CATA) were used to establish sensory profiles and preference maps. Descriptors and other relevant evaluative information were obtained through two exploratory focus groups.

3.1.3   Bissap Methodology

Samples description and preparation

The four hibiscus drinks tested were produced from dried calyces of the local 'Koor' and the Sudanese 'Vimto' H. var. sabdariffa cultivars (50:50), purchased at Latmingue – Kaolack.

The traditional infusion (CTi) was manufactured by a local Senegalese company. To this end, the dried calyces were soaked in water – ratio of calyces/water 1/20 (w/v) - at ambient temperature for 2 hours. The resulting extract was filtered, sweetened with sucrose (130 gL-1, up to 14-16 °Bx) and subsequently pasteurised at 90-95 ºC, 20-25 minutes.

The three new hibiscus drinks were produced in the CSFIAA pilot plant. The improved infusion (REi) was obtained from a ratio of ground calyces/water 1/40 (w/v) and sweetened with sucrose (150 gL-1, up to 16-18 ºBx). The Re-Engineered syrup (REs) was obtained employing an eco-efficient process. A ratio of 1/10 dried Hibiscus calices/water and 30 min extraction time at ambient temperature was used. The resulting infusion was filtered at 0.45 µm and pasteurized at 75ºC during 30 minutes. An addition of sucrose of 1.2 kg/L (until approximately 65-70°Brix) was used as in the traditional process. Syrup was cooled down immediately after pasteurization and was bottled as the product reached a temperature of 70°C. Syrup was stored at room temperature.

Lastly, the under-vacuum concentrate (UVc) was obtained using a ratio of ground calyces/water 1/5 (w/v) and 30 minutes extraction time at ambient temperature. The resulting infusion was filtered at 0.45 µm and pasteurized at 75ºC during 30 minutes. The extract was subsequently evaporated under-vacuum at 75 °C and remained unsweetened. Upon cooling to ambient temperature, the concentrate was stored at 4 to 8 °C.

The REs sample was diluted 4 times with potable water prior to tasting. The UVc concentrate was diluted 40 times with potable water and sweetened with sucrose (130 gL-1). CTi and REi required no preparation.

Figure 1- *Hibiscus drinks*

Focus groups

Two focus groups were conducted with ten persons (five men and five women in each) of varying ages. They were invited to taste the four Hibiscus drinks, and to give their overall impression about them, their motivation to buy, to consume and, the circumstances and location for consumption. The objective of this group interview was to get first impressions, reactions and views about Hibiscus by Senegalese consumers with a view of establishing a more comprehensive questionnaire for subsequent larger consumer testing.

Figure 2: Focus group on the evaluation of four Hibiscus drinks

Consumer testing

Participants

Consumers of hibiscus drinks were non-probabilistically recruited at four different locations in Dakar – UCAD (near the city centre; n=37), *Centre Culturel Français* (city centre; n=29), Point E (residential area; n=42) and *Association Culturelle d'Aide a la Promotion Educative et Social* (*Parcelles Assainies*, suburbs; n=44) – in the fall of 2013, according to their willingness and their availability to participate in the study. Their ages ranged between 18 and 73 years old (average 33.8, standard deviation 17.2); 61% were male, 88% were Senegalese or long-term Senegal residents and 81% consumed hibiscus drinks at least several times per month.

Tasting sessions
Tasting sessions took place at each of the four aforementioned recruiting sites and included a written questionnaire in French about other consumption, socio-demographic and attitudinal variables.

All the drinks were transported in cool boxes with ice. Thirty millilitre samples of each of the four hibiscus drinks tested were served in clear plastic glasses and presented to participants in a sequential monadic mode, following a complete balanced experimental plan. Each sample was identified by a random code with 3 digits. Water was supplied to clean the palate between tastings. Trained enumerators assisted participants in French or in the local *Wolof* language when required. No information about the samples was provided to participants except for safety and hygiene considerations related to their preparation.

Figure 3- Tasting session. Trained enumerator assisting participant in *Wolof language* .

Figure 4 – Tasting session.

Consumer acceptance measures
Consumer acceptance was measured by overall liking ratings, provided on a 9-point hedonic scale (Jones, Peryam, & Thurstone, 1955; Peryam & Girardot, 1952; Peryam & Pilgrim, 1957). The intensity of five sensory attributes – *colour*, *bissap odour*, *sweet taste*, *bissap taste*, *acid taste* -, relatively to participants' ideal level, was measured by ratings provided on a 3-point, just-about-right scale [*too weak* (TW), *just-about-right* (JAR), *too strong* (TS)] (Moskowitz, 1972).

Consumer sensory profiling
Sensory profiles were obtained for each sample by employing check-all-that-apply (CATA) questions (Adams, Williams, Lancaster, & Foley, 2007; Ares, Barreiro, Deliza, Giménez, & Gámbaro, 2010). These entailed 24 sensory or hedonic-oriented descriptors – *light red*, *dark red*, *clear*, *sharp odour*, *odourless*, *tasteless*, *acid*, *bitter*, *sweet*, *astringent*, *syrup taste*, *light in bissap*, *strong in bissap*, *diluted*, *balanced taste*, *good taste*, *stimulating/energizing*, *natural, appealing*, *refreshing*, *artificial*, *good for health*, *nutritional* and *traditional* -, drawn from two previous focus groups (n=20, 55% men, 18-70 years old) with Senegalese hibiscus drinkers. The order of presentation of descriptors was randomized across subjects.

Statistical Analysis

XLSTAT software (Addinsoft SARL, France) and IBM SPPS Statistics, Version 22.0 (IBM Corp., USA). were used to carry out all statistical analyses. The significance of statistical tests was evaluated at $p<0.05$, unless otherwise mentioned.

Preliminary data analysis
One participant gave the same overall liking and attribute ratings to all samples and attributes evaluated, whereas another provided an atypical overall liking rating for the UVc sample (z-score >4). The responses of two participants were hence excluded from further analysis (n=150).
The significance of associations between participants' gender and age, and overall liking ratings were investigated using Student's t-tests and pairwise Pearson correlations, respectively.

It became noticeable while debriefing participants after the tasting sessions that three CATA sensory descriptors – clear, odourless and tasteless -, had not been correctly understood by a great number of participants. These descriptors were excluded therefore from further analysis.

Consumer acceptance measures
Analysis of Variance (ANOVA) was performed on overall liking ratings for the four samples, considering participants and samples as sources of variation. Mean sample ratings were calculated and significant differences between them tested post-hoc using Tukey's HSD (Honest Significant Difference) tests. Pairwise Pearson correlations between samples' overall liking ratings were then computed to assess their degree of association.
Hierarchical cluster analysis (Euclidean distances and Ward's agglomeration method) was subsequently performed to identify groups of participants with dissimilar patterns of sample liking. Analysis of Variance (ANOVA) was performed on within-clusters' overall liking ratings for the four samples, considering participants and samples as sources of variation. Within-cluster mean sample ratings were calculated and significant differences between them tested post-hoc using Tukey's HSD tests. When cluster size was smaller than 30, non-parametric Kruskal-Wallis H tests and Dwass-Steel-Critchlow-Fligner multiple comparison analyses were employed instead.
The existence of significant differences between clusters' mean ages was assessed using Student's t-tests, except when cluster size was smaller than 30, in which case a non-parametric Mann-Whitney U-test was employed. Finally, the existence of significant differences between clusters' gender proportions was evaluated by Pearson's chi-square tests with Monte Carlo simulations.
The frequency of intensity ratings (TW, JAR, TS) for each of the five sensory attributes evaluated by participants was determined for each sample, and the corresponding proportions calculated. A Correspondence Analysis (CA) was then performed on the contingency table of proportions for all samples and attributes (Popper, 2014). The frequency of intensity ratings for each sample and attribute was finally tallied for each cluster of participants based on overall liking ratings.
A penalty analysis (Popper, 2014) was employed to relate attribute intensity ratings to overall liking ratings for each participant and sample. To this end, participants were grouped according to their intensity ratings for each sample and attribute, and mean overall liking ratings for each group were computed. The overall liking mean drops, or penalties, obtained when comparing the TW and the TS group with JAR participants were then calculated.

Weighted penalties (Popper, 2014) were equally computed by taking both the mean drops and the proportion of participants in each group.

Consumer Sensory profiling
The frequency with each of the 24 sensory and hedonic-oriented descriptors was checked by participants for each sample was tallied, and the corresponding proportions calculated. To investigate which descriptors were most frequently co-elicited across samples, a Multidimensional Scaling (MDS) procedure was applied to the chi-square distances' matrix of descriptors (Meyners & Castura, 2014). A Cochran's Q test was performed for each descriptor, followed by the computation of multiple pair-wise comparisons with the Marascuilo procedure, to assess the extent to which it discriminated between samples (Meyners & Castura, 2014; Meyners, Castura, & Carr, 2013). Only descriptors discriminating significantly ($p<0.05$) between samples were considered for further analysis. To obtain a bi-dimensional representation of CATA results a CA was performed (Meyners & Castura, 2014). A penalty-lift analysis (Williams, 2011) was employed to relate participants' choices of descriptors for each sample to the corresponding overall liking ratings. To this end, sample overall liking ratings were averaged across all participants for which the descriptor under consideration was elicited and for which it was not. A positive penalty-lift was obtained when the former was higher than the later and negative penalty-lift when the reversed occurred.

Relating consumer acceptance measures and sensory profiling results
A multiple factor analysis (MFA) was performed (Ares, Varela, Rado, & Giménez, 2011), considering overall liking ratings, the frequency of intensity ratings of the sensory attributes evaluated and the frequency of choice of discriminating CATA descriptors, across all samples and participants, as active variables.

3.1.4 Bissap Results and discussion

Consumer acceptance measures

Overall liking
Table 1 depicts the mean overall liking ratings of the four hibiscus drinks tested (n=150). These were higher than 5.50 out of 9 points for all samples, which indicates that participants, on average, positively appreciated them. Highly significant associations between overall liking ratings and participants' gender and age were observed only for REi, with women appreciating this sample less than men (5.54 and 6.60, respectively; $t=3.78$, $p<0.001$) and overall liking increasing with age ($r=0.219$, $p<0.01$).

Table 1 – Overall liking ratings of hibiscus drinks (n=150).

Sample	Overall liking ratings
UVc	$7.07^a \pm 0.93$
REs	$6.65^b \pm 1.12$
REi	$6.19^c \pm 1.74$
CTi	$5.65^d \pm 1.59$

Mean ± standard deviation. Different superscripts indicate significant differences according to Tukey's HSD ($p<0.05$). UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

Mean rating differences were found to be highly significant (F=34.1; p<0.0001). UVc was the preferred drink; all new drinks were liked slightly to moderately and were better appreciated than the CTi (p≤0.01). Overall liking ratings of CTi were highly significantly correlated (p<0.01) with those of UVc (Pearson's r=0.239) and REi (Pearson's r=0.213).

Additionally, mean acceptability of re-engineered drinks were compared with the mean acceptability of traditional Hibiscus drinks previously reported by Bechoff et al. (2014), using Student's t-test. This study was held in in Dakar in July 2012, including 160 consumers and four traditional hibiscus drinks: a Commercial Sudanese syrup (CSs), a Commercial Ordinary syrup (COs), a Commercial Ordinary infusion (COi) and a Commercial Mixed (Sudanese/Ordinary 50:50) infusion (CMi). The results are shown in table 2. A significantly higher acceptability mean was obtained for the Re-Engineered syrup when compared with the traditional ones. Concerning the Re-Engineered infusion (REi), a significantly higher acceptability mean was obtained when compared with the traditional Commercial Ordinary infusion (COi) but for the comparison with the traditional Commercial Mixed infusion (CMi) no significant differences were found.

Table 2 – Overall liking scores of the hibiscus drinks.

Dakar 2013 (n=150)	Dakar 2012 (n=160)	
Sample Mean ± stdev	Sample Mean ± stdev	
REs 6.65 [A] ±1.12	COs 5.61[B] ±2.11	CSs 5.91[B] ±1.76
REi 6.19 [A] ±1.74	COi 5.21[B] ±1.10	CMi 6.22[A] ±1.88

Different superscripts within a line indicate significant differences according to Student t (p ≤ 0.05)

Hierarchical clustering yielded three clusters of participants with distinct overall liking patterns of hibiscus drinks, as depicted in Figure 5. Mean sample likings for each of the three clusters identified - *Traditional infusion dislikers* (C1;18.7%), *Improved infusion dislikers* (C2;25.3%), *Overall likers* (C3;56.0%) are shown in Figure 6.
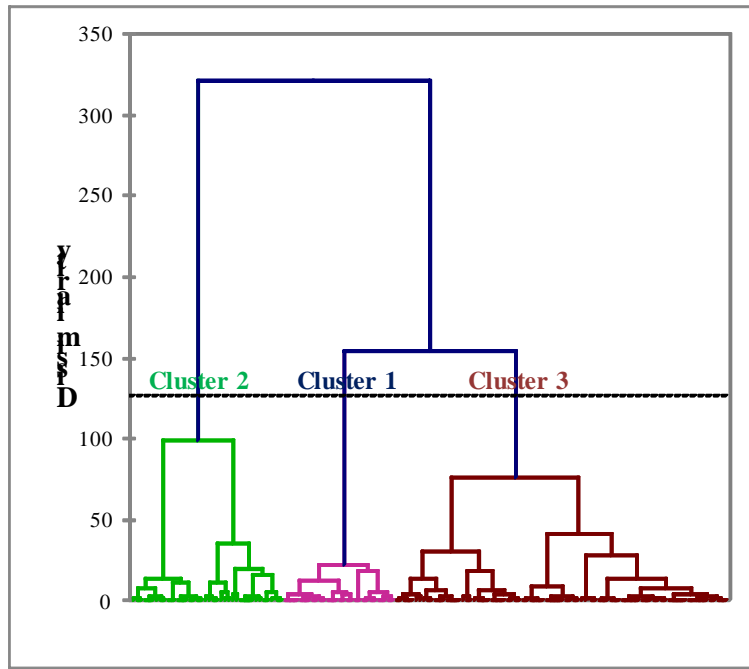
Figure 5 – Hierarchical clustering dendogram segmenting participants according to their overall liking patterns of hibiscus drinks (n=150).
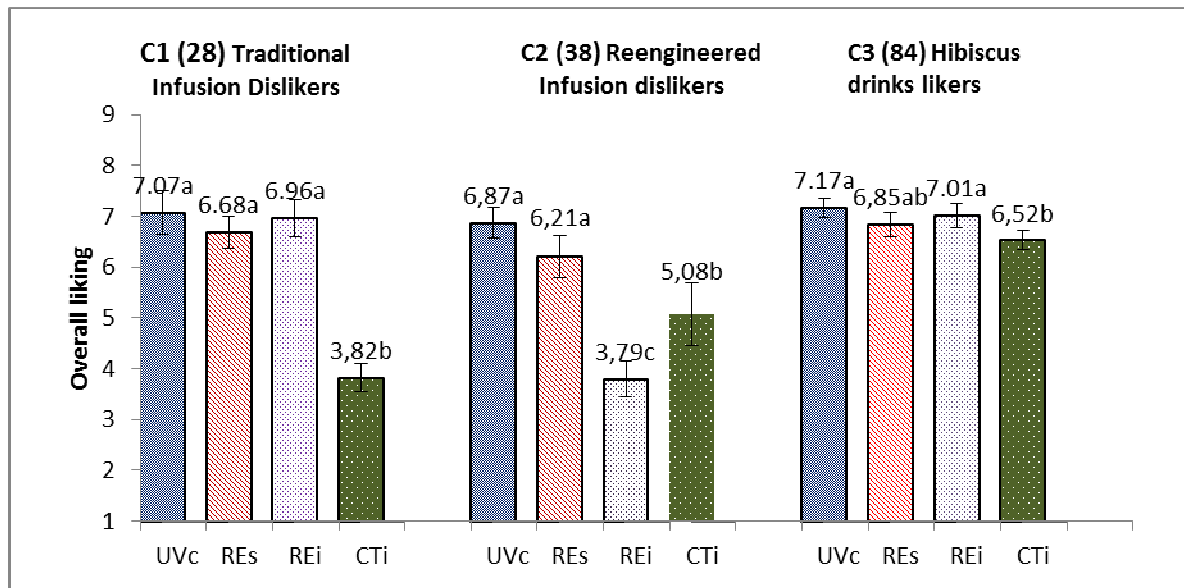
Figure 6 - Means of the overall liking ratings of hibiscus drinks per cluster. Error bars represent confidence intervals of means (p=0.95). Different superscripts within a cluster indicate significant differences according Tukey's HSD and Dwass-Steel-Critchlow-Fligner Multiple Comparisons (p<0.05). UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

Mean overall liking ratings for UVc and REs were similar across clusters, indicating that participants in general liked these drinks slightly to moderately. On average, participants in C1 liked REi moderately, but disliked CTi slightly. Participants in C2, on the other hand, disliked REi slightly and were neutral regarding CTi. Finally, participants in C3 liked all samples moderately.

Cluster did not differ significantly in participants' education level and mean ages (C1=34.6; C2=32.4; C3=34.4). There was however a significantly higher proportion of women in C2

(60.5%) than in C1 (32.1%; Pearson's chi-square=5.20, p<0.05) and C3 (32.1%; Pearson's chi-square=8.72, p<0.001). No differences between clusters were found concerning frequency of consumption of Hibiscus drinks, form of consumption and the reasons beneath that form of consumption. For all clusters, hibiscus drinks prepared at home using dried hibiscus calyces were the main form of consumption (p<0.01) followed by hibiscus drinks bought in sachets or bottles. The most frequent reasons pointed out by the consumers regarding their choice of the form of consumption was hygiene and good taste, and less frequent price and practicability. For the three clusters, hibiscus drinks prepared from syrups were the least frequently consumed.

The larger dimension of cluster C3 can be explained by the popularity and diversity of Hibiscus drinks consumed in Senegal (Cisse et al., 2009b) and an effective improvement of the re-engineered drinks. In fact in the results earlier reported by Bechoff and colleagues (2014) only 21% of consumers had liked all tested drinks. No demographic differences between clusters were reported by (Bechoff et al., 2014).

Evaluation of Intensity of sensory attributes relatively to participants' ideal level, using JAR scales

Figure 7 shows the frequencies of intensity ratings, measured on a 3-point JAR scale, for each hibiscus drink and sensory attribute evaluated, whereas Figure 8 depicts the first two dimensions of the correspondence analysis performed on these ratings.
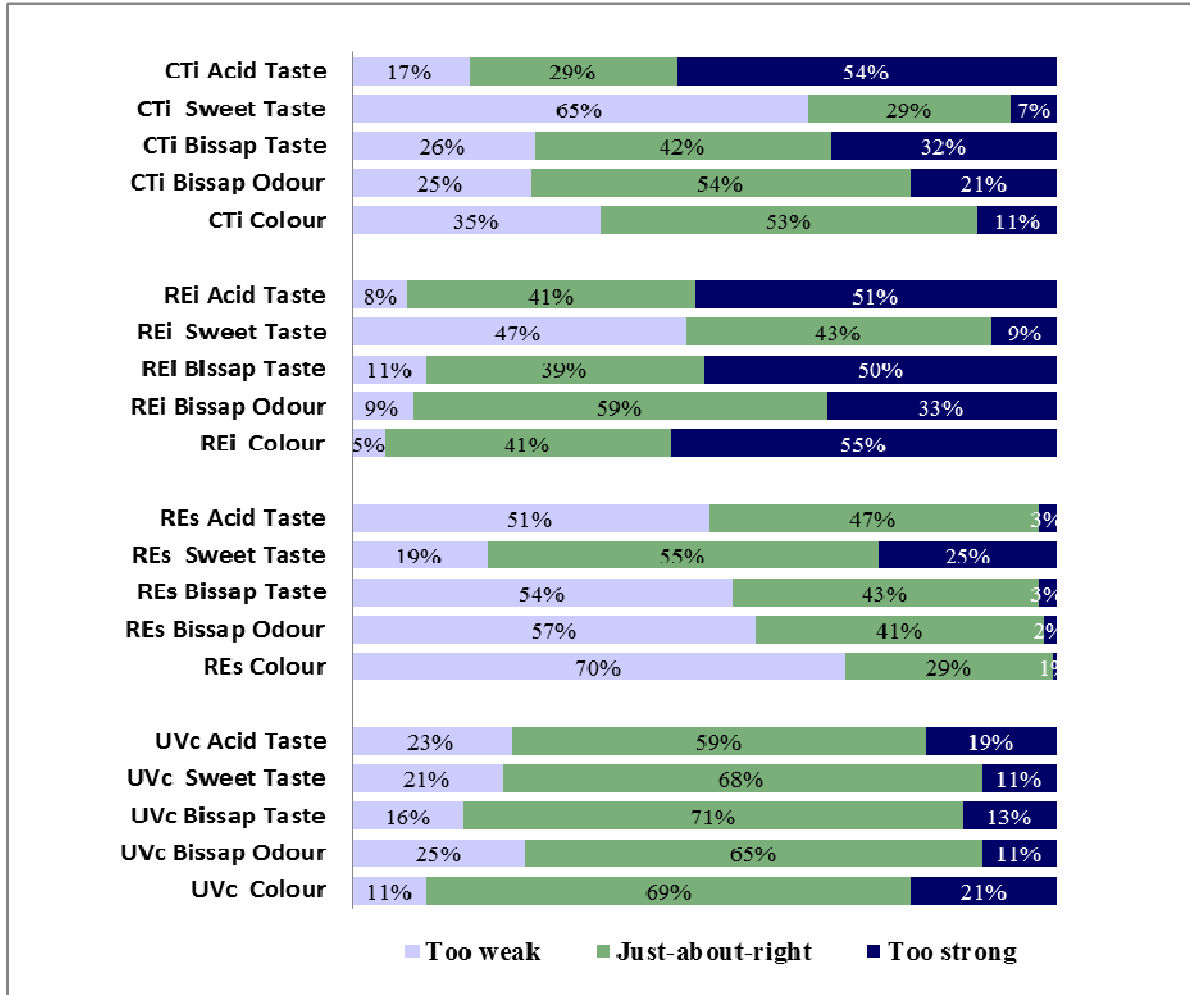
Figure 7 -Frequencies of intensity ratings, measured on a 3-point just-about-right scale, for each sample and sensory attribute evaluated. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.
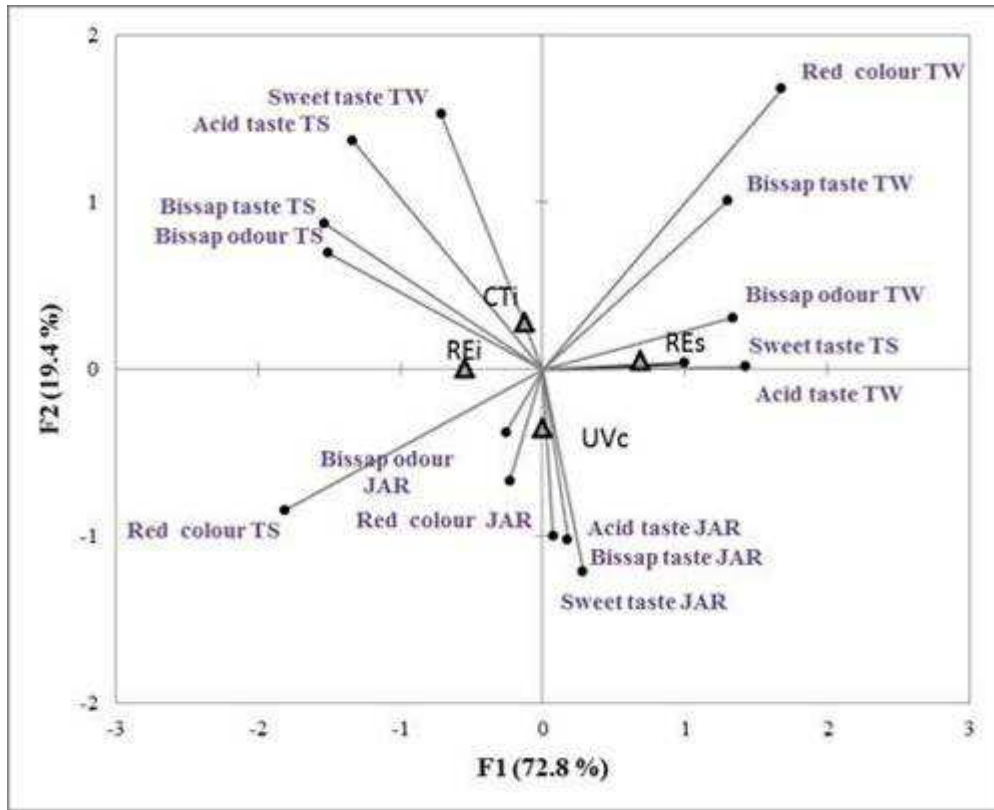
Figure 8 - Representation of the hibiscus drinks and sensory attributes evaluated in the first two dimensions of a correspondence analysis, performed on attribute intensity ratings measured on a 3-point just-about-right scale [too weak (TW), just-about-right (JAR), too strong (TS)]. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

A preponderance of JAR ratings was observed for UVc for the five attributes evaluated, with their frequencies ranging from 59 to 71%. This is well in line with overall liking results, which showed that UVc was the preferred drink. For REs, TW ratings dominated all attributes' intensity evaluation, with the exception of sweet taste, nevertheless, this was still the second most preferred drink by participants, which might be associated with a preference for beverages with high perceivable sweetness. For REi, opposed evaluations were obtained, with TS ratings being preponderant for most attributes except for sweet taste. For the traditional drink CTi, high frequencies of TW ratings were observed for sweet taste while for acid taste TS ratings were preponderant.

With the purpose of identifying attributes which appear to have a strong impact on overall liking, weighted penalties were calculated for all samples and attributes. The weighted penalties are represented in figure 9. Mean drops of 1.0 for nine-point overall liking scale and 20% respondents, are often considered the cut-off for a meaningful decline in acceptance related to a particular attribute, for this reason weighted penalties below 20 are usually considered negligible. This was the case for UVc drink for all attributes evaluated. For REs a significant impact of the weak hibiscus concentration was observed, reflected of the weak bissap taste and odour, colour and acidity. Within the new drinks, the stronger weighted penalties were observed for REi, due to the strong hibiscus content and low sweetness. The evaluation of the traditional infusion by the consumers was the least consensual of all drinks.

A significant weighted penalty was observed due to participants considering the drink too strong in hibiscus flavour and odour and due to participants considering the drink too weak.
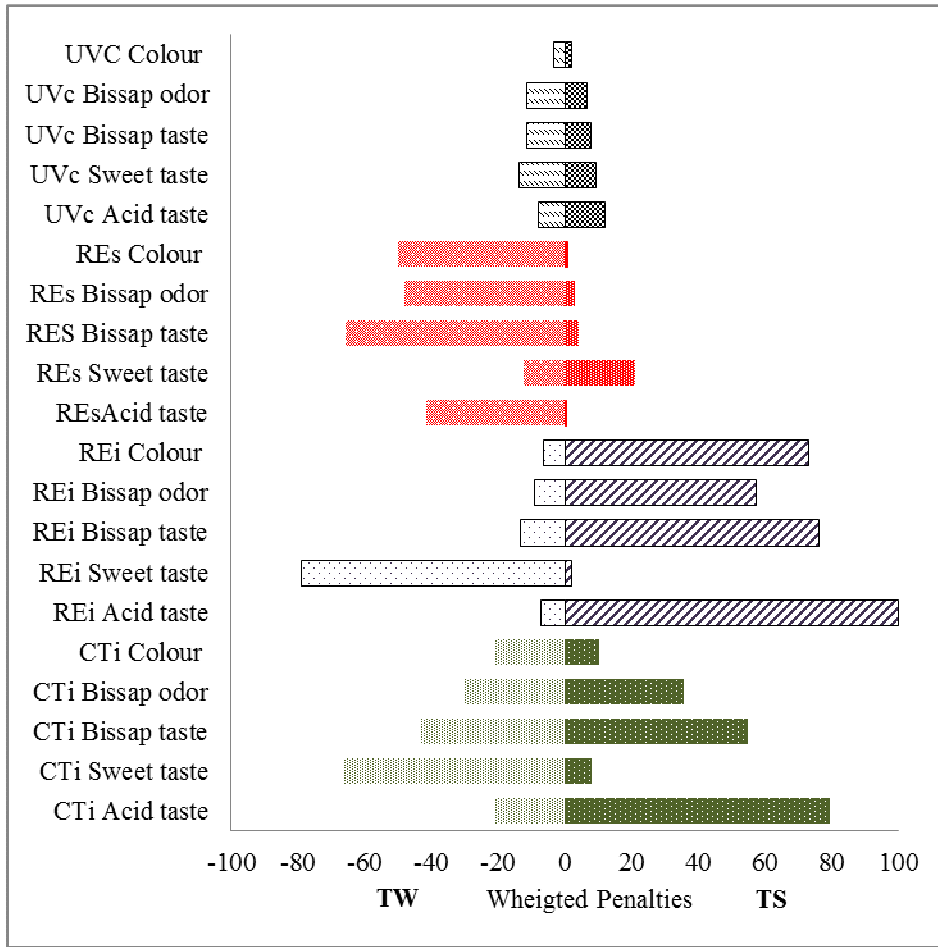

Figure 9 - Representation of the weighted penalty values relating overall liking ratings drops for each sample and attribute in relation with JAR attribute intensity ratings. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

Since the results of univariate analysis revealed significant gender and age effects on overall liking of the new infusion drink (REi), the corresponding JAR data was also analysed to uncover, which evaluative sensory dimensions might explain these effects. Concerning gender, differences were found for REi for sweet and acid taste ($p < 0.05$) and for bissap taste ($p=0.07$). Women preferred higher sweetness and lower acidity and weaker bissap taste than man. Concerning age, significant differences were found for REi for sweet taste ($p \leq 0.01$) and acid taste ($p \leq 0.05$), younger consumers would prefer higher sweetness and lower acidity than older consumers. These findings are in accordance with the social demographic differences found in cluster C2 (Reengineered infusion dislikers), which as a higher proportion of women and younger participants than clusters C1 and C3.

CATA profiling

The CATA terms used were: *acid, bitter, astringent, good taste, diluted, balanced taste, light in bissap, strong in bissap, syrup taste, sharp odour, light red, dark red, sweet, artificial, clear, appealing, good for health, natural, nutritional, refreshing, stimulating/energizing, traditional, odourless* and *tasteless.* The descriptors odourless and tasteless were not considered in the analysis of results since they were misinterpreted by some native consumers as without *spoilage odour* and *spoilage taste*. The descriptor clear was also not taken into account in the analysis of results since

during the interviews it was noticed that the meaning wasn't correctly understood for many consumers.

Consumers used between 1 and 14 terms to describe each drink, with an average of six terms per drink. Table 3 shows the number of consumers who used each term of the CATA ballot. The most frequently selected term was natural and the less frequently selected sharp odour. Significant differences among samples in the frequency of citation were found for 17 out of the 21 descriptors (p<0.05).

No significant difference was detected related to the descriptor traditional although three of the products were new drinks resulting of the re-engineering process undertaken within the scope of After project. All products were equally perceived as being good for health and nutritional.

Table 3 – Frequency of selection for each descriptor by consumers (Check-All-That-Apply method).

CATA descriptors	UVc	REs	CTi	REi
Light Red*	20[a]	101[c]	62[b]	11[a]
Dark Red*	62[b]	4[a]	20[a]	104[c]
Sharp Odour*	4[a]	2[a]	16[b]	19[b]
Acid*	27[b]	3[a]	70[c]	73[c]
Bitter*	10[a]	3[a]	42[b]	36[b]
Sweet*	62[b]	68[b]	22[a]	39[a]
Astringent*	7[a]	4[a]	14[a,b]	18[b]
Syrup Taste*	17[a,b]	27[b]	12[a]	21a[a,b]
Light Bissap*	18[a,b]	68[c]	35[b]	8[a]
Strong Bissap*	39[b]	8[a]	50[b]	89[c]
Diluted*	8[a b]	54[c]	22[b]	3[a]
Balanced Taste*	64[c]	44[b]	18[a]	27[a,b]
Good Taste*	75[c]	64[b,c]	39[a]	49[a,b]
Stimulating / Energizing*	33[a,b]	15[a]	23[a b]	36[b]
Natural*	83[b]	72[a,b]	56[a]	69[a,b]
Appealing*	55[b]	36[a]	33[a]	39[a,b]
Refreshing*	68[c]	65[b,c]	43[a]	49[a,b]
Artificial	10[a]	21[a]	16[a]	9[a]
Good for Health	58[a]	53[a]	49[a]	55[a]
Nutritional	40[a]	26[a]	25[a]	26[a]
Traditional	55[a]	48[a]	41[a]	48[a]

Different superscripts within a line indicate significant differences according to Cochran Q test with Marascuilo pairwise comparisons ($p < 0.05$). * Identifies discriminant descriptor ($p < 0.05$).

A Correspondence Analysis (CA) was performed on discriminating terms to identify relationships between descriptors and drinks. The first two CA dimensions explained 96.7% of the variability, figure 10, and allowed a good differentiation among hibiscus drinks.
The most liked drink, Under-Vacuum concentrate (UVc), was located opposite to the least liked Commercial Traditional infusion (CTi) on the first axis. Re-Engineered infusion (REi) and syrup (REs), were also oppositely located on the second axis. The Under-Vacuum concentrate (UVc) was related with the descriptors: balanced taste, good taste, sweet, dark red, appealing, natural, refreshing and stimulating/energizing, whereas the Commercial Traditional infusion (CTi) was related with the descriptors: bitter, sharp odour and acid. Re-engineered syrup (REs) in the CA plot was related to descriptors: light bissap, diluted, syrup taste, sweet, light red and refreshing. Oppositely located Re-engineered infusion (REi) was described by terms such as strong in bissap, dark red, astringent, acid and stimulating/energizing.
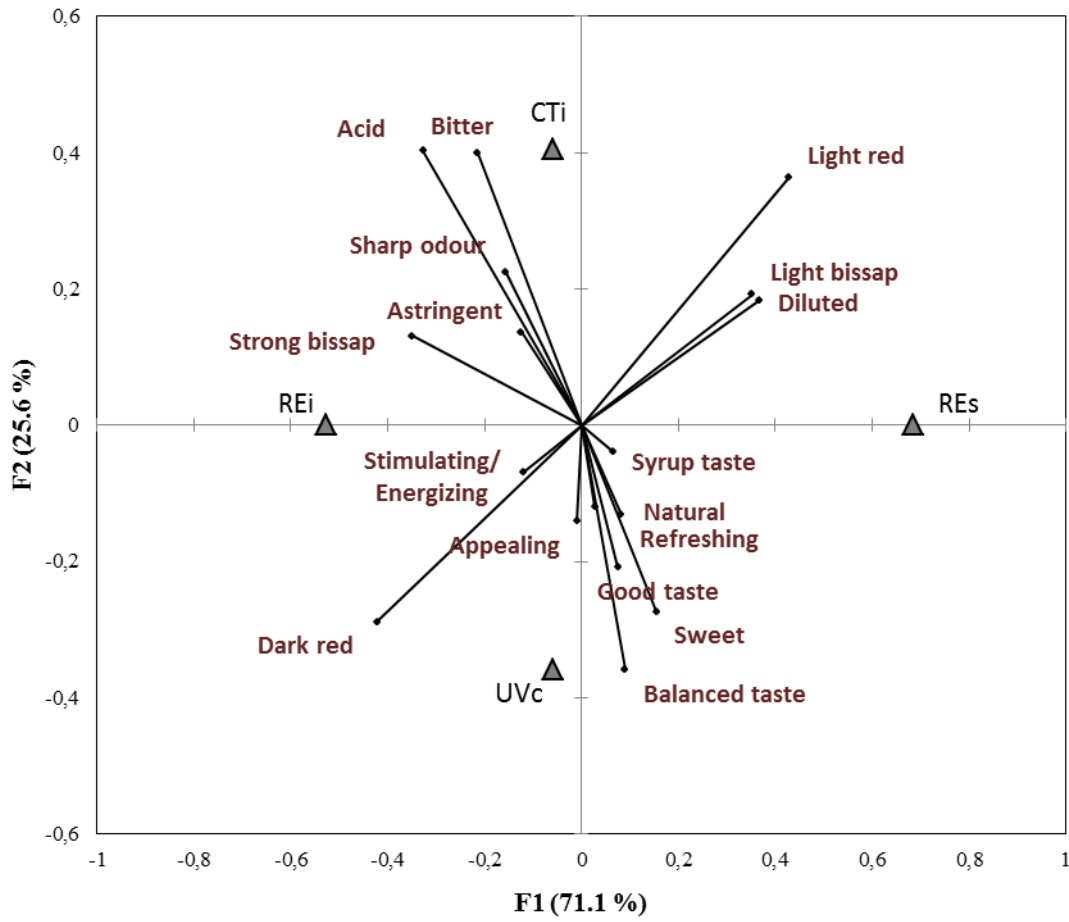
Figure 10 - Representation of the hibiscus drinks and CATA descriptors in the first two dimensions of a correspondence analysis. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

The Multidimensional scaling (MDS) representation determined on chi-square distances between these CATA descriptors is shown in figure 11. It shows that attributes light red, light in bissap and diluted were frequently coelicited, as were good taste, appealing, natural and refreshing. Acid and bitter taste, astringent and sharp odour attributes were also shown to be frequent coelicited, although in a smaller degree.
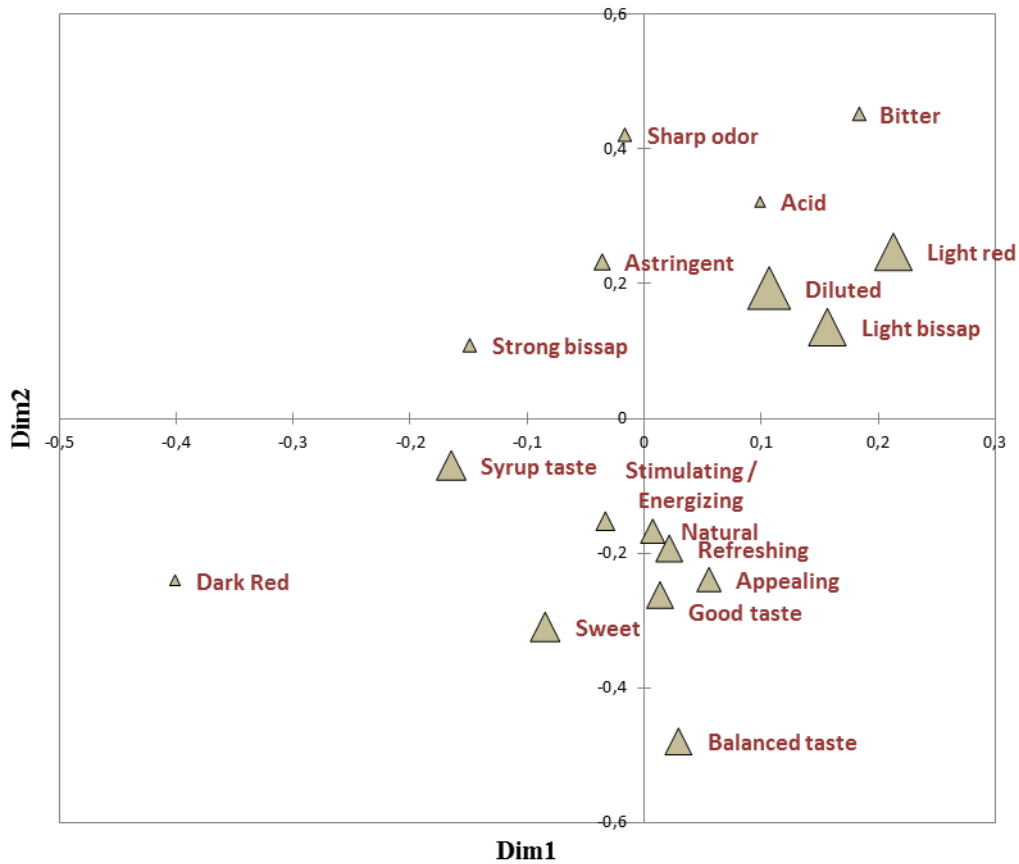
Figure 11 – Tridimensional representation of the multidimensional scaling of CATA descriptors based on chi-square distances. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

A penalty-lift analysis was used to relate overall liking with CATA attribute's elicitation Williams at al. Positive values represent an increase in liking observed when the attribute is elicited, while negative penalty-lift values are related to a decrease in liking.

This analysis showed, as expected, an increase in liking related with the elicitation of the positive descriptors: balanced taste, good taste, stimulating/energizing, natural, appealing and refreshing, for all hibiscus drinks. These results are in accordance with the descriptors associated with the Under-Vacuum concentrate (UVc), the preferred drink. The results for the remaining CATA descriptors are represented in Figure 12. For the descriptors bitter, astringent and light in bissap, a negative penalty-lift was observed for all drinks, showing these descriptors to be negative liking drivers. The higher absolute values for bitter and astringent were obtained for the least appreciated re-engineered drink: the re-engineered infusion. Small penalty-lift values were observed for light red, dark red and strong in bissap for all drinks indicating weak liking drivers. For the descriptors sharp odour, acid, sweet, syrup taste and diluted, the relation between elicitation and average liking depended on particular drink. This can be related with the absolute attribute intensity and by interdependence of sensory attributes in the product.
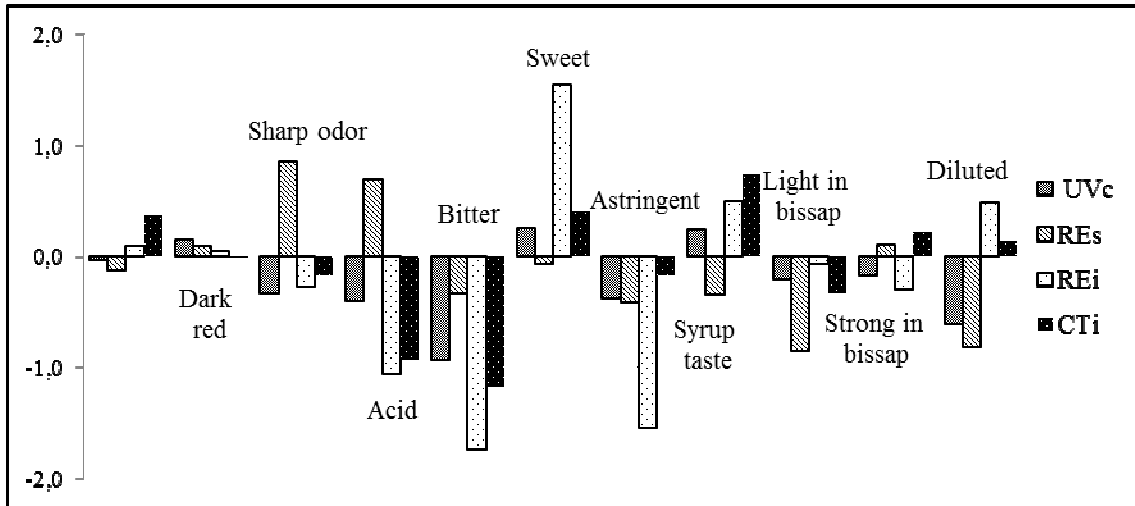
Figure 12 - Penalty-lift analysis of CATA descriptors. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

Relationship between CATA, JAR and Hedonic Overall appreciation

A Multiple Factor Analysis (MFA) was used to relate consumers' overall liking scores, JAR scores and CATA terms, for all samples. The partial representation of the samples and centroids in the first two dimensions of MFA plot in Figure 13, corresponding to 92.6% of the explained variability, shows a good differentiation among drinks and good agreement between appropriateness evaluations using JAR scales and CATA evaluations for all hibiscus drinks.
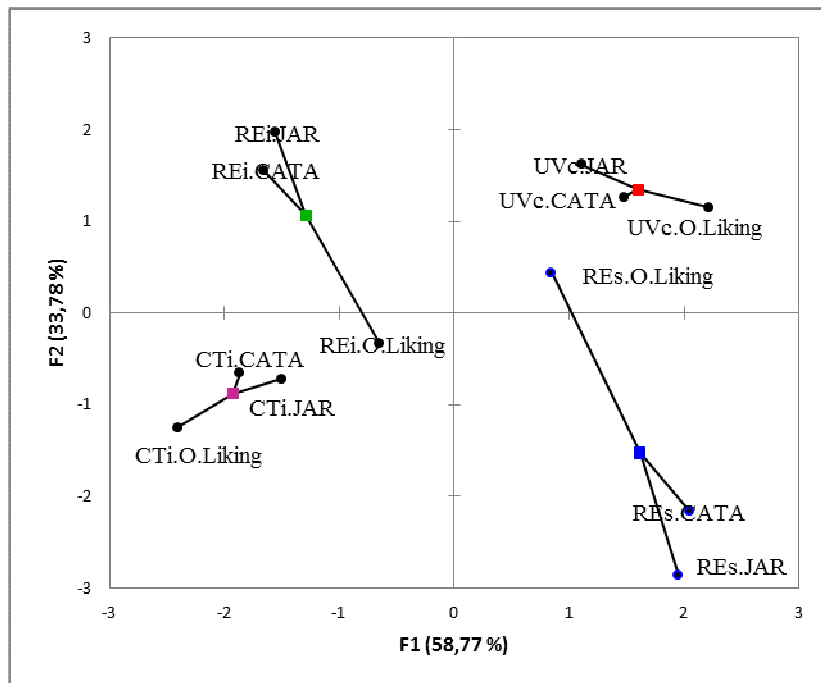
Figure 13 –Partial representation of the samples and centroids in the first two dimensions of MFA plot of CATA, JAR and overall liking ratings. UVc=under-vacuum concentrate; RES=improved syrup; REi=improved infusion; CTi=traditional infusion.

3.1.5 Bissap Conclusion

The results of this research study showed that the Re-engineered hibiscus drinks developed by AFTER were positively appreciated by consumers in Senegal and better accepted than the traditional commercial infusion used as baseline comparison. Additionally, the comparison with the results obtained for the traditional syrups previously reported by Bechoff et al. (2014), showed also that the Re-engineered syrup evaluated was better accepted.

Despite being the result of a re-engineering process the new drinks were not perceivably different from the baseline drink to consumers concerning both the traditional character and the nutritional and healthy attributes.

With different sensory characteristics, the new drinks were differently appreciated by the identified consumers segments with similar overall liking patterns. These liking patterns were mainly related with liking of sweetness, of acidity and intensity of bissap taste. The combined results of consumer acceptance evaluation and consumer profiling techniques employed show significant drivers for further development for two the three developed drinks, the Re-engineered Syrup (REs) and Re-engineered Infusion (REi). For the Re-engineered Syrup (REs), described as light bissap and diluted, with a too weak red colour, acid and bissap taste and bissap odour, an increase in hibiscus concentration while maintaining the sweetness level could lead to an increase in consumer acceptance. For the Re-engineered infusion (REi) although positively evaluated by 75% of consumers, was described as not sweet enough with a very strong in bissap, astringent and acid. For this drink a decrease in bissap concentration with a perceptible increase in sweetness could lead to an increase in consumer acceptance.

The observed agreement between the results obtained in Overall liking evaluations, Intensity scoring of Specific attributes using JAR scales and product description using CATA was indicative of an adequate understanding and use of these methodologies by consumers in Senegal to evaluate the Hibiscus drinks.

3.1.6 Bissap References

Adams, J., Williams, A., Lancaster, B., & Foley, M. (2007). Advantages and uses of check-all-that-apply response compared to traditional scaling of attributes for salty snacks. Paper presented at the 7th Rose-Marie Pangborn Sensory Science symposium, Minneapolis, MN, USA.

Ares, G., Barreiro, C., Deliza, R., Giménez, A. N. A., & Gámbaro, A. (2010). Application of a check-all-that-apply question to the development of chocolate milk desserts. Journal of Sensory Studies, 25(Ss1), 67-86. doi: 10.1111/j.1745-459X.2010.00290.

Ares, G., Varela, P., Rado, G., & Giménez, A. (2011). Are consumer profiling techniques equivalent for some product categories? The case of orange-flavoured powdered drinks. International Journal of Food Science & Technology, 46(8), 1600-1608. doi: 10.1111/j.1365-2621.2011.02657.

Bechoff, A., Cissé, M., Fliedel, G., Declemy, A.-L., Ayessou, N., Akissoe, N., . . . Tomlins, K. I. (2014). Relationships between anthocyanins and other compounds and sensory acceptability of Hibiscus drinks. Food Chemistry, 148, 112-119. doi: http://dx.doi.org/10.1016/j.foodchem.2013.09.132

Cisse, M., Dornier, M., Sakho, M., Ndiaye, A., Reynes, M., & Sock, O. (2009b). Le bissap (Hibiscus sabdariffa L.) : composition et principales utilisations. Fruits, 64(3), 179-193. doi: 10.1051/fruits/2009013

Jones, L. V., Peryam, D. R., & Thurstone, L. L. (1955). Development of a scale for measuring soldiers' food preferences. Journal of Food Science, 20(5), 512-520. doi: 10.1111/j.1365-2621.1955.tb16862.

Meyners, M., & Castura, J. C. (2014). Check-All-That-Apply questions. In P. Varela & G. Ares (Eds.), Novel Techniques in Sensory Characterization and Consumer Profiling (pp. 271-305). Boca Raton: CRC Press

Meyners, M., Castura, J. C., & Carr, B. T. (2013). Existing and new approaches for the analysis of CATA data. Food Quality and Preference, 30(2), 309-319. doi: 10.1016/j.foodqual.2013.06.010

Moskowitz, H. R. (1972). Subjective ideals and sensory optimization in evaluating perceptual dimensions in food. Journal of Applied Psychology, 56(1), 60-66. doi: 10.1037/h0032140

Peryam, D. R., & Girardot, N. F. (1952). Advanced taste-test method. Food Engineering, 24(7), 58-61.

Peryam, D. R., & Pilgrim, F. J. (1957). Hedonic scale method of measuring food preferences. Food Technology, 11(Suppl.), 9-14.
Popper, R. (2014). Use of Just-About-Right scales in consumer research. In P. Varela & G. Ares (Eds.), Novel Techniques in Sensory Characterization and Consumer Profiling (pp. 137-155). Boca Raton: CRC Press

Williams, A., Carr, B.T., & Popper, R. (2011). Exploring analysis options for check-all-that-apply (CATA) questions. Paper presented at the 9th Rose-Marie Sensory Science symposium, Toronto, Canada.

3.2 Detailed report for Buy (Group III)

3.2.1 Buy Summary

Senegalese consumers in Dakar evaluated four new baobab drinks developed under After project scope: two baobab juices and two syrups. Consumer's acceptance was evaluated using a nine point hedonic scale and intensity of specific descriptors evaluated using Just-About-Right intensity scales (JAR) The results of this study showed that the new baobab drinks were positively appreciated by consumers in Senegal and significantly better appreciated than the traditional commercial ones previously evaluated under After project scope (Dakar 2012).

With different sensory characteristics, the new juices were preferred to the syrups. The drinks were, nevertheless, differently appreciated by the identified consumers segments with similar overall liking patterns, which can be related to the intensity of sweetness, acidity, fruit flavour and colour.

Excellent results were observed concerning the willingness to buy the consumer´s preferred drink, with 95% of consumers stating they were likely/very likely to buy their preferred evaluated drink if it was available in the market.

3.2.2 Buy Background

The baobab (*Adansonia digitata L.*) is important to the livelihood and can be found in most of Sub-Sahara 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 (Diop et al. 2005; Cisse et al., 2009). The pulp of baobab was approved by the European Commission as a convenient additive (Phytotrade Africa 2008). From Senegal also, the fruit is exported towards some European countries

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 by 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 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 labelling. 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.

A previous AFTER study primarily explored the sensory profile and the acceptance of seven different baobab samples (five juices and two syrups) by African consumers (mainly Senegalese). 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.

The results of this work shown 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 liked 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 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".

This study suggests a reengineering approach to stabilize the products in order 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.

In view of this, four news Baobab products (BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval) were developed by AFTER researchers using optimized process. The new products were developed at the Laboratoire de Formation Continue en Industries Agroalimentaires of the Ecole Supérieure Polytechnique of Université Cheikh Anta Diop (UCAD), in Dakar. Their manufacturing process was subsequently tested and scaled-up in the pilot plant of Centre Sectoriel de Formation Professionnelle aux Métiers des Industries Agroalimentaires (CSFP IAA), in Dakar and in the ESTEVAL Company.

The sensory quality of the new drinks was evaluated, by Senegalese consumers in Dakar in October of 2014. Consumer's acceptance was evaluated using a nine point hedonic scale and intensity of specific descriptors evaluated, Just-About-Right intensity scales (JAR)

3.2.3 Baobab Methodology

Samples description and preparation
The Baobab drink (BBE) and Syrup baobab Esteval (SBE) were made from fruit of baobab in the ESTEVAL Company. The company has put HACCP in place and all their products are pasteurized. Those products were stored at T° < 4°C until consumption. Baobab drink from powder (BBP), SBC= Syrup baobab cold were processed in the pilot plant of Centre Sectoriel de Formation Professionnelle aux Métiers des Industries Agroalimentaires (CSFP IAA) with applying the good manufacturing practices and good practices hygienic. The processes used are presented in annexe 1. Baobab powder is from Baobab des Saveurs Company (Annexe 2). Table 1 shows the main characteristics of samples.

Table 1 – Main characteristics of samples

Sample	Raw Material	Ratio /time	Baobab/water	Pasteurisation
BBE	Baobab fruits	1/6 ; 2 h		85 °C / 30 min
BBP	Powder	1/15 ; 15 min		85 °C / 30 min
SBC	Powder	1/6 ; 15 min		85 °C/15 min
SBE	Baobab fruits	½ ; 2 h		105 °C / 15 min

The syrups samples were diluted 4 to 5 times with potable water prior to tasting to have the same total soluble solids that the baobab drinks (130-145 $g.L^{-1}$).

Figure 1- *Baobab drinks*

Consumer testing

Participants and consumers sessions
Consumers of Baobab products were non-probabilistically recruited (100). Tasting sessions took place at Ecole Supérieure Polytechnique of Université Cheikh Anta Diop (UCAD), in

Dakar and included a written questionnaire in French about other consumption, socio-demographic and attitudinal variables.

All the drinks were transported in cool boxes with ice. Thirty millilitre samples of each of the four baobab drinks tested were served in clear plastic glasses and presented to participants in a sequential monadic mode, following a complete balanced experimental plan. Each sample was identified by a random code with 3 digits. Water was supplied to clean the palate between tastings. Trained enumerators assisted participants in French or in the local *Wolof* language when required. No information about the samples was provided to participants except for safety and hygiene considerations related to their preparation.

Consumer acceptance measures

Consumer acceptance was measured by overall liking ratings, provided on a 9-point hedonic scale (Jones, Peryam, & Thurstone, 1955; Peryam & Girardot, 1952; Peryam & Pilgrim, 1957. The intensity of five sensory attributes – *colour*, *sweet taste*, *fruit taste*, *acid taste* -, relatively to participants' ideal level, was measured by ratings provided on a 3-point, just-about-right scale [*too weak* (TW), *just-about-right* (JAR), *too strong* (TS)] (Moskowitz, 1972).

Other consumer measures

Consumers were asked to state their most liked and least liked drink as well as the drink most similar to the usually consumed. Willingness to buy the preferred evaluated baobab drink was measured using a 5-point scale. Finally consumers were asked to choose the preferred packaging.

Statistical Analysis

XLSTAT software (Addinsoft SARL, France) and IBM SPPS Statistics, Version 22.0 (IBM Corp., USA). were used to carry out all statistical analyses. The significance of statistical tests was evaluated at $p < 0.05$, unless otherwise mentioned.

Preliminary data analysis

One participant was excluded due to atypical age (z-score >4). One participant provided an atypical overall liking rating for the BBP sample (z-score >4), and two participants provided atypical overall likings for SBE (z-score >3) The responses of these four participants were hence excluded from further analysis, remaining ninety six participants.

Consumer acceptance measures

Analysis of Variance (ANOVA) was performed on overall liking ratings for the four samples, considering participants and samples as sources of variation. Mean sample ratings were calculated and significant differences between them tested post-hoc using Fisher LSD (Least Significant Difference) tests. Pairwise Pearson correlations between samples' overall liking ratings were then computed to assess their degree of association.

Hierarchical cluster analysis (Euclidean distances and Ward's agglomeration method) was subsequently performed to identify groups of participants with dissimilar patterns of sample liking. Analysis of Variance (ANOVA) was performed on within-clusters' overall liking ratings for the four samples, considering participants and samples as sources of variation.

Within-cluster mean sample ratings were calculated and significant differences between them tested post-hoc using Fisher LSD tests. When cluster size was smaller than 30, non-parametric Kruskal-Wallis H tests and Dwass-Steel-Critchlow-Fligner multiple comparison analyses were employed instead.

The existence of significant differences between clusters' mean ages was assessed using Student's t-tests, except when cluster size was smaller than 30, in which case a non-parametric Mann-Whitney U-test was employed. Finally, the existence of significant differences between clusters' gender proportions was evaluated by Pearson's chi-square tests with Monte Carlo simulations.

The frequency of intensity ratings (TW, JAR, TS) for each of the five sensory attributes evaluated by participants was determined for each sample, and the corresponding proportions calculated. A Correspondence Analysis (CA) was then performed on the contingency table of proportions for all samples and attributes (Popper, 2014). The frequency of intensity ratings for each sample and attribute was finally tallied for each cluster of participants based on overall liking ratings.

A penalty analysis (Popper, 2014) was employed to relate attribute intensity ratings to overall liking ratings for each participant and sample. To this end, participants were grouped according to their intensity ratings for each sample and attribute, and mean overall liking ratings for each group were computed. The overall liking mean drops, or penalties, obtained when comparing the TW and the TS group with JAR participants were then calculated. Weighted penalties (Popper, 2014) were equally computed by taking both the mean drops and the proportion of participants in each group.

Other consumer measures

The frequencies for each measures were tallied, and the corresponding proportions calculated. For the most liked and least liked drink as well as the drink most similar to the usually consumed significant differences evaluated using chi-square method with pairwise comparisons using Marascuile procedure.

3.2.4 Buy Results and discussion

Consumer acceptance measures

Overall liking

Table 2 depicts the mean overall liking ratings of the four baobab drinks tested (n=96). These were higher than 5.50 out of 9 points for all samples, which indicates that participants, on average, positively appreciated them. No significant associations between overall liking ratings and participants' gender were observed. Significant associations between overall liking ratings and age were only observed for with overall liking increasing with age (r=0.251, p=0.014).

Table 2 – Overall liking ratings of Baobab drinks (n=96).

Sample	Overall liking ratings
BBE	$7.35^a \pm 0.86$
BBP	$6.82^b \pm 1.02$
SBC	$6.32^c \pm 1.10$
SBE	$5.59^d \pm 1.24$

Mean ± standard deviation. Different superscripts indicate significant differences according to Fisher LSD (p<0.05). BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

Mean rating differences were found to be highly significant (F=3.86; p<0.0001). BBE was the preferred drink; all drinks were liked slightly to moderately. Overall liking ratings of BBE and BBE were highly significantly correlated (p<0.05) with those of SBC and SBE (p<0.05).

Additionally, the mean acceptability of new Baobab products drinks was compared with the mean acceptability of traditional Baobab drinks previously reported by Cisse et al. (2012. This earlier study was held in Dakar in June 2012, included 106 consumers and five traditional Baobab drinks prepared by two local companies. Three of these drinks are comparable with the new products tested: two syrups [Esteval commercial syrup (Estev-S) and FWS commercial syrup (FWS-S)] and one juice [Esteval commercial juice (Estev- J)].

The results of the comparison are shown in table 3. A significantly higher acceptability mean was obtained for all the new products when compared with the traditional ones in the same category.

Table 3 – Overall liking scores of the Baobab .

	Dakar 2014 (n=96) Sample Mean ± stdev	Dakar 2012 (n=106) Sample Mean ± stdev
Juices	BBE 7.4 ^{A} ±0.9; BBP 6.8 ^{B} ±1.0	Estev-J 5.9^C ±1.9
Syrups	SBC 6.3 ^{A} ± 1.1; SBE 5.6^B ± 1.2	Estev-S 4.9^C ±1.9, FWS-S 4. 8^C ±1.9

Different superscripts within a line indicate significant differences according to Student t (p ≤ 0.05)

Hierarchical clustering of the new drinks hedonic ratings yielded two clusters of participants with distinct overall liking patterns of baobab drinks, as depicted in Figure 2. Mean sample likings for all participants and for the cluster identified are shown in Figure 3.
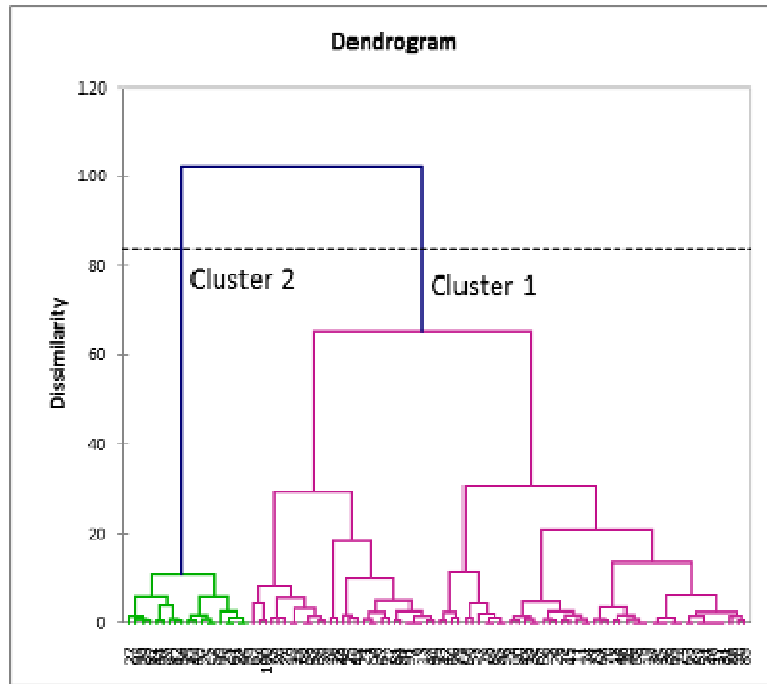
Figure 2 – Hierarchical clustering dendogram segmenting participants according to their overall liking patterns of baobab drinks (n=96).
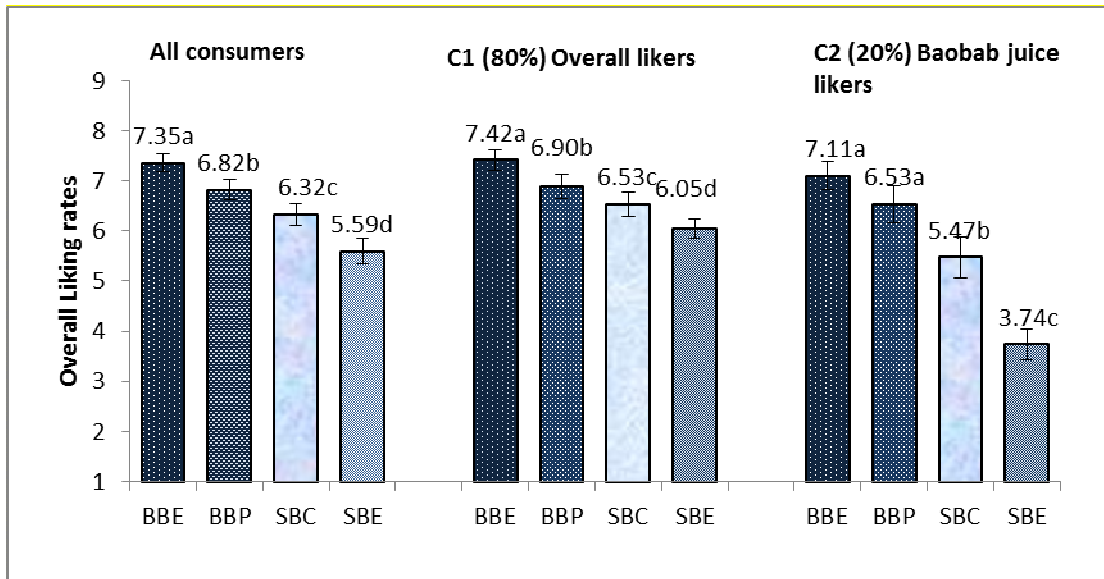
Figure 3 - Means of the overall liking ratings of hibiscus drinks per cluster. Error bars represent confidence intervals of means (p=0.95). Different superscripts within a cluster indicate significant differences according Fisher LSD or Dwass-Steel-Critchlow-Fligner Multiple Comparisons (p<0.05).). BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

Mean overall liking ratings for BBE and BBP were similar across clusters, indicating that participants in general liked these drinks. On the other hand participants no cluster 2 liked the Baobab juices were neutral regarding SBC and disliked SBE. Cluster did not differ significantly in participants' age and gender.

Evaluation of Intensity of sensory attributes relatively to participants' ideal level, using JAR scales

Figure 4 shows the frequencies of intensity ratings, measured on a 3-point JAR scale, for each baobab drink and sensory attribute evaluated, whereas Figure 5 depicts the first two dimensions of the correspondence analysis performed on these ratings.
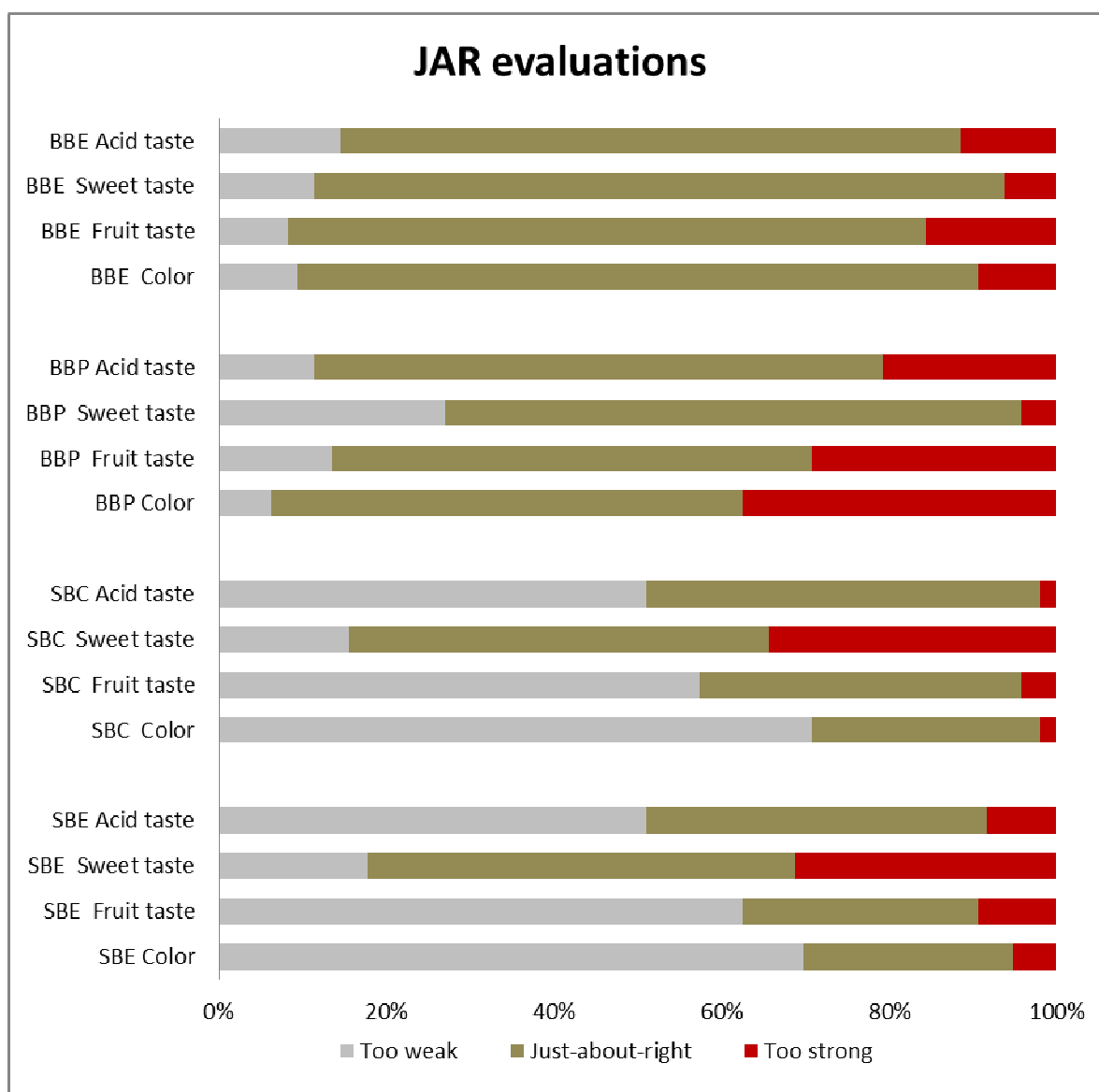
Figure 4 -Frequencies of intensity ratings, measured on a 3-point just-about-right scale, for each sample and sensory attribute evaluated. BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval
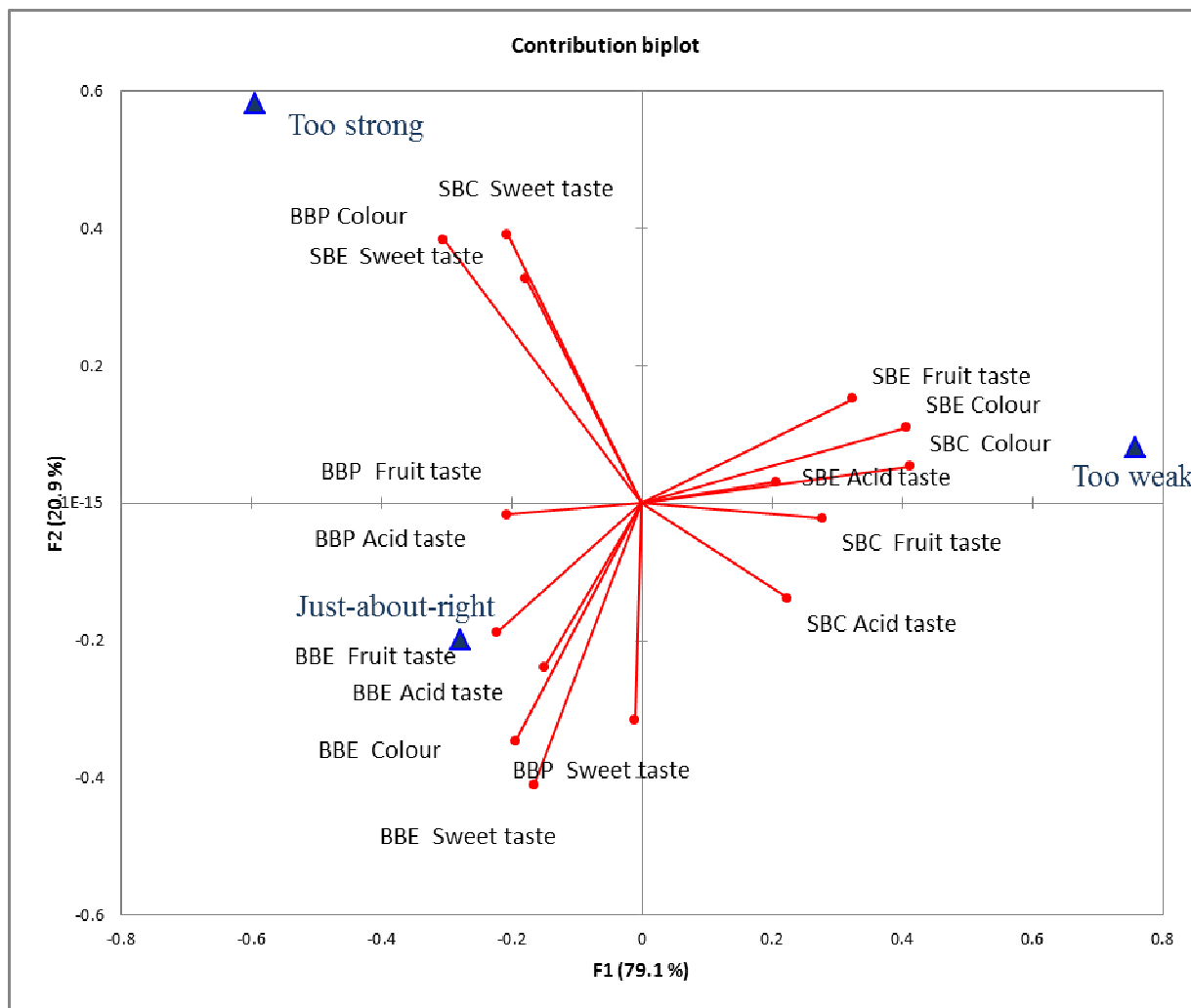
Figure 5 - Representation of the baobab drinks and sensory attributes evaluated in the first two dimensions of a correspondence analysis, performed on attribute intensity ratings measured on a 3-point just-about-right scale (too weak , just-about-right , too strong). BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

A preponderance of JAR ratings was observed for BBE for the four attributes evaluated, with their frequencies ranging from 74 to 82%. This is well in line with overall liking results, which showed that BBE was the preferred drink. For SBE and SBC, TW ratings dominated all attributes' intensity evaluation, with the exception of sweet taste (Figure 6).
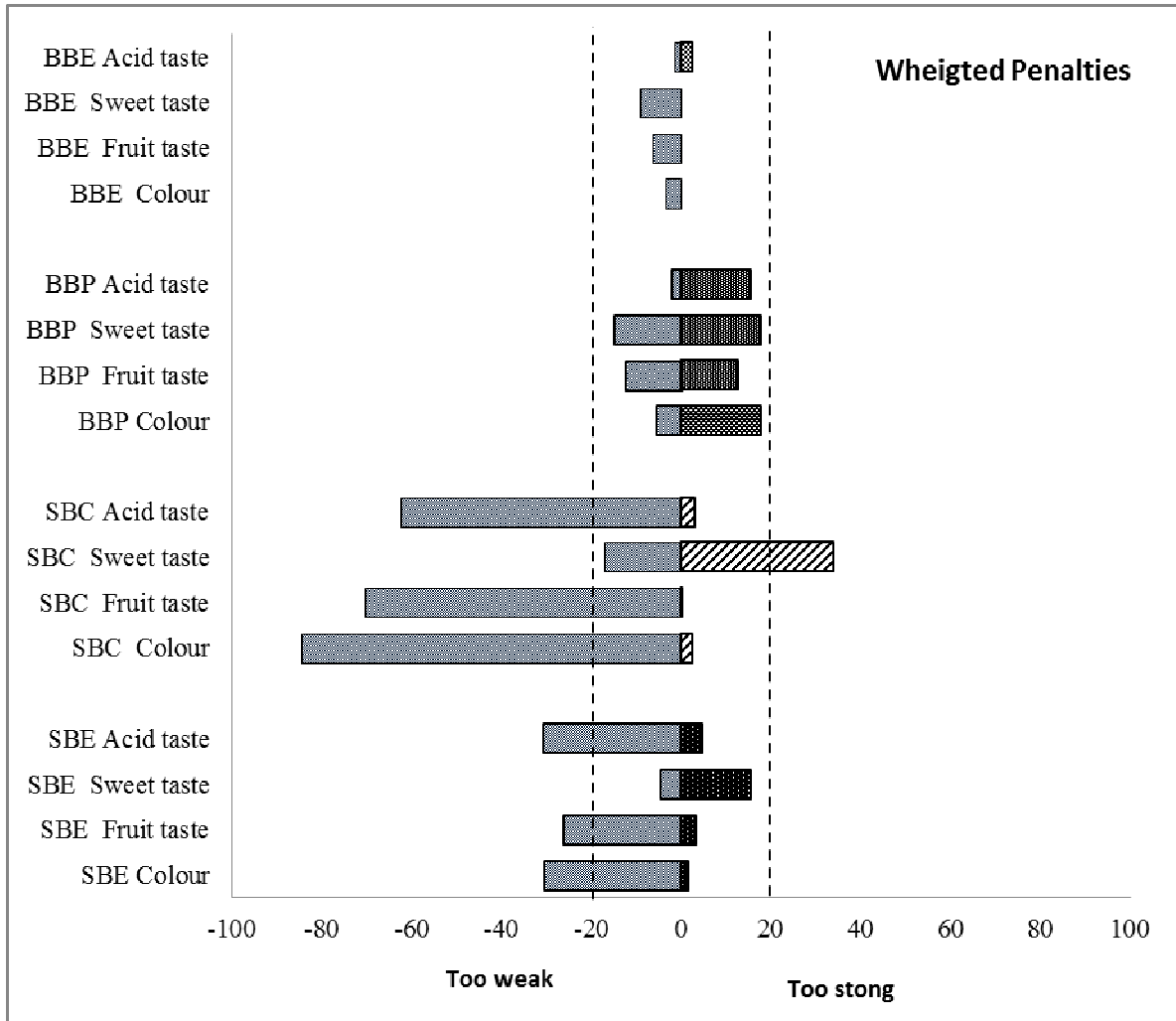
Figure 6 - Representation of the weighted penalty values relating overall liking ratings drops for each sample and attribute in relation with JAR attribute intensity ratings. BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

With the purpose of identifying attributes which appear to have a strong impact on overall liking, weighted penalties were calculated for all samples and attributes. The weighted penalties are represented in figure 9. Mean drops of 1.0 for nine-point overall liking scale and 20% respondents, are often considered the cut-off for a meaningful decline in acceptance related to a particular attribute, for this reason weighted penalties below 20 are usually considered negligible. This was the case for BBE and BBP drinks for all attributes evaluated. For SBC a significant impact of the weak fruit and taste and colour were observed, reflected of the weak bissap taste and odour, colour and acidity, similar but less strong penalties were observed for SBE.

Other consumer measures

Figure 7 shows the frequency of selection of each drink in relation to the most similar to usual, the most and least liked. These results are well in line with the ones observed for overall liking ratings, with the favourite drink being chosen more frequently as the most liked. BBE and BBP were chosen as the drinks more similar to the usually consumed.
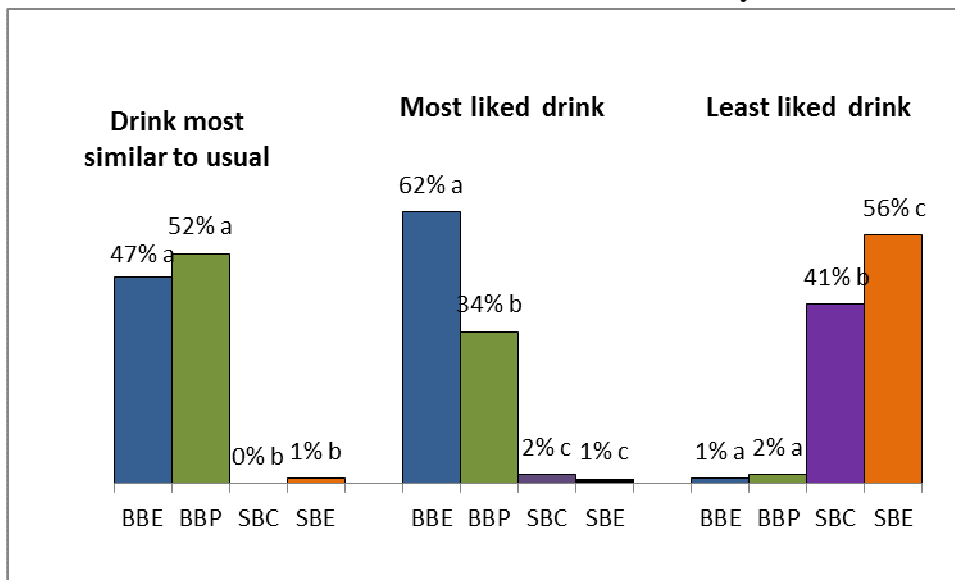
Figure 7 – Representation of frequencies of drinks chosen as most similar to usual, most liked and least liked. Different letters within the same question indicates significant difference according to chi-square method with pairwise comparisons using Marascuile procedure. BBE= Baobab drink from fruit, BBP= Baobab drink from powder, SBC= Syrup baobab cold, SBE= Syrup baobab Esteval

The stated willingness to buy the most liked evaluated drink using a five point scale in represented in figure 8. The obtained results can be considered very good since 95% of consumers stated they were likely/very likely to buy their preferred evaluated drink if it was available in the market.
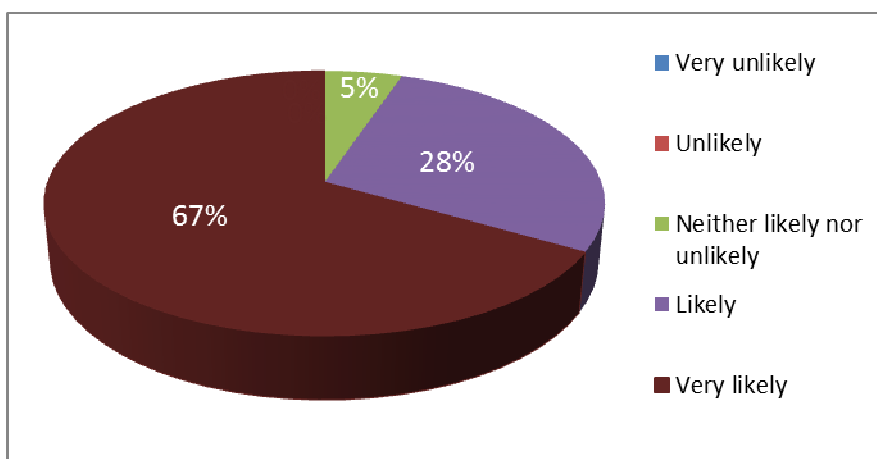
Figure 8 – Willingness to buy the favourite drink evaluated using a five-points categorical scale.

The consumers' opinion about the most suitable package for the baobab drinks is represented in figure 9, showing no clear tendency regarding neither of the proposed packages: tin can, bottle and pouch.
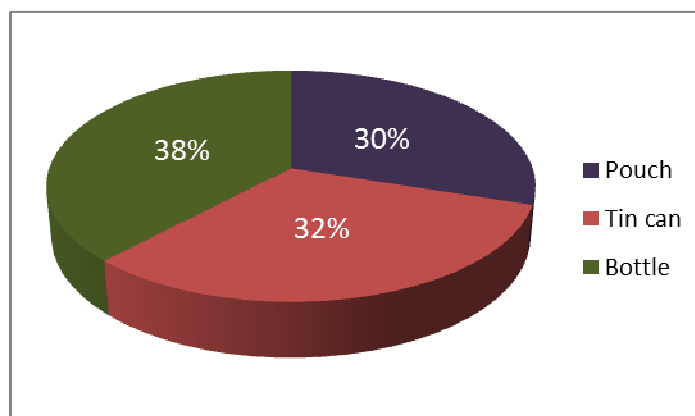
Figure 9 – Preferred package

3.2.5   Buy Conclusion

The results of this research study showed that the new baobab products developed by AFTER were positively appreciated by consumers in Senegal. Additionally, the comparison with the results obtained for the traditional baobab syrups and juices, previously reported by Cisse et al. (D5.3.2.3), showed also that the all new products evaluated were better accepted than the traditional commercial ones.

With different sensory characteristics, the new drinks were differently appreciated by the two identified consumers segments with similar overall liking patterns: Overall likers (80%), consumers that positively appreciated all evaluated drinks, and Baobab juice likers (20%) consumers who positively appreciated the baobab juices, were neutral regarding Baobab syrup cold and disliked the Baobab Syrup Esteval. These liking patterns can be explained in part by the intensity of the specific descriptors evaluated, since for the least liked drinks, the syrups, the insufficient fruit flavour, colour and acidity significantly penalized the drinks acceptance.

Excellent results were observed concerning the willingness to buy the consumer´s preferred drink, with 95% of consumers stating they were likely/very likely to buy their preferred evaluated drink if it was available in the market.

3.2.6   Buy References

Caluwé, E. D., Halamová, K., & Damme, P. V. (2010). *Adansonia digitata* L. – A review of traditional uses, phytochemistry and pharmacology. afrika focus 23(1), 11-51.

Cisse M., Bechoff A, Toure C. , Ayessou N., Tomlins K. Sensory and Consumer testing of drink from Baobab fruit ("Bouye"). Initial report on sensory and African consumer acceptance/preference for group 3. AFTER Project.

Cissé, M.; Sakho, M.; Dornier, M.; Diop, C. M.; Reynes, M.; Sock, O (2009)., Caractérisation du fruit du baobab et étude de sa transformation en nectar. *Fruits*, 64, 19-34.

Gebauer, J., El-Siddig, K., & Ebert, G. 2002. Baobab (*Adansonia digitata* L.): a Review on a Multipurpose Tree with Promising Future in the Sudan. Gartenbauwissenschaft 67(4), 155-160

Phytotrade Africa. (2008). Registered in South Africa (registration number -2006/001433/08). The registered name is SANPROTA (Association Incorporate under section 21) trading as PhytoTrade Africa.

Diop, A. G., Sakho, M., Dornier, M., Cissé, M., & Reynes, M. 2005. Le baobab africain (*Adansonia digitata* L.) : principales caractéristiques et utilisations. *Fruits* 61, 55-69.

Jones, L. V., Peryam, D. R., & Thurstone, L. L. (1955). Development of a scale for measuring soldiers' food preferences. Journal of Food Science, 20(5), 512-520. doi: 10.1111/j.1365-2621.1955.tb16862.

Moskowitz, H. R. (1972). Subjective ideals and sensory optimization in evaluating perceptual dimensions in food. Journal of Applied Psychology, 56(1), 60-66. doi: 10.1037/h0032140

Peryam, D. R., & Girardot, N. F. (1952). Advanced taste-test method. Food Engineering, 24(7), 58-61.

Peryam, D. R., & Pilgrim, F. J. (1957). Hedonic scale method of measuring food preferences. Food Technology, 11(Suppl.), 9-14.

Popper, R. (2014). Use of Just-About-Right scales in consumer research. In P. Varela & G. Ares (Eds.), Novel Techniques in Sensory Characterization and Consumer Profiling (pp. 137-155). Boca Raton: CRC Press

Williams, A., Carr, B.T., & Popper, R. (2011). Exploring analysis options for check-all-that-apply (CATA) questions. Paper presented at the 9th Rose-Marie Sensory Science symposium, Toronto, Canada.

3.3 Detailed report for Jaabi (Group III)

3.3.1 Jaabi Summary

Jaabi (*Ziziphus mauritiana*) is traditionally processed into flour by pounding and baking into small round cakes locally called *Yaabande*. Previous consumer test has shown that the texture of the product is among the main quality attributes considered by consumers. From observation of constraints faced by processors during the processing of *Jaabi* into *Yaabande*, and considering the quality demand of consumers, the present work has developed, with local processors, an improvement of the processing practice, based on the use of flour of fine particle size by introducing a milling and sieving steps in the *Jaabi* flour production process. The result is the proposition of a reengineered *Yaabande* presenting fine texture well appreciated by consumers. Flour of particle size lower than 125µm gives the best *Yaabande* cake in terms of firmness, texture and taste. Meanwhile, the production of fine flour (Ø<125µm) through hand sieving constitutes the main limit of the innovation. Due to this limit, processors have adopted the manual production of flour of particle size 250µm>Ø>125µm, which is less tiresome, though it appears in second rank in the preference of consumers.

3.3.2 Jaabi Background

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*". A survey of *Jaabi* production, processing, trading and consumption systems in Northern Cameroon (Ndjouenkeu & Biyanzi, 2011) identified 3 varieties of *Ziziphus*, endemic in the savannah region of Cameroon, among which *Z. mauriatiana* is used for human consumption, with two main ecotypes (*Jaabi lammuji* and *Jaabi dakamji*). The survey also evidenced different processing practices depending on tribes and locality.

Diversity of *Yaabande* processing practices and even diversity of *Jaabi* varieties results in diversity of appreciation and quality of the products on the market. With respect to this observation, assessment of traditional production, processing and quality attributes (Dairou *et al.*, 2014) showed that processing of *Jaabi* grains into *Yaabande* goes through pounding of grains to obtain flour, which is moulded and baked using steam cooking, solar drying or stifle cooking; with the steam cooking being the more popular technique. The main limits of the traditional processing practices rely heavily on the low yield of flour production and the unstandardized cooking time. The main consequence on the quality of the end product is the weak and heterogeneous texture of the cake, due to the coarse particle size distribution of the *Jaabi* flour. A reengineered *Yaabande* has been proposed through introduction of flour milling and sieving (Ndjouenkeu & Cisse, 2012, Ndjouenkeu, 2013).

Since consumer acceptance is important in marketing strategy and economic viability for product development, the present study explore the consumer acceptance of the reengineered *Yaabande* cake, in comparison with the traditional one.

3.3.3 Jaabi Materials and methods

Area of study and process reengineering

A processor in Pitoa town, situated at 15 km from Garoua (Fig. 1) was used for the production of *Yaabande*. The choice of the town was based on the high activity of *Jaabi* processing into *Yaabande* in the area. The reengineered protocol is presented on Figure 2. It consisted mainly in the introduction of a milling and a sieving steps to obtain fine flour, and an overall baking time of 10-12 minutes. Flours of different particle sizes (Ø>500µm [traditional], 250µm<Ø<500µm, 125µm<Ø<250µm and Ø<125µm) were used for the *Yaabande* production
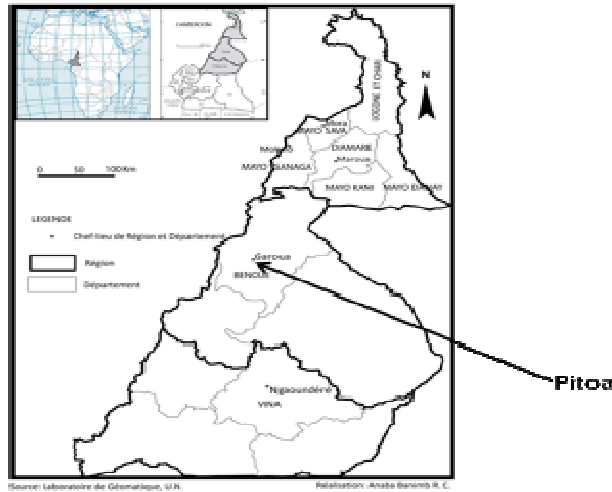
Figure 5: Area of study for processing and consumer testing
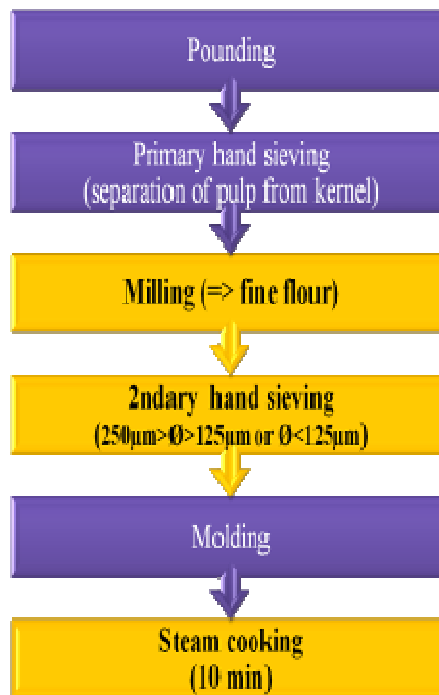
Figure 2: Reengineered protocol of traditional *Yabaande* production
(*Innovations proposed are indicated in yellow boxes*)

Consumer testing

150 consumers (110 men and 40 women) were interviewed in different locations of Garoua (hotels, market places, coffee shops), using the central location method (Meilgaard et al.,

2007). The four *Yaabande* samples, coded with three figure random numbers, were presented in random order to the consumer who was invited 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]. Along with the testing, information was elicited from each consumer regarding demographics, education and product consumption and buying. All spoken interviews were conducted in French or in the local language (Fufulde) 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.

Physical analyses of products
Particle size and fractionation of the Jaabi flour was measured using vibrating siever (Endecotts Minor -1332-06).
The texture of the Yaabande cake was measured using LFRA Texture Analyzer (Brookfield) which measures the force needed by a needle to penetrate the cake (Blumenkrantz & Asboe-Hansen. 1973). Colour parameters of cakes were analysed using Lovibond RT100 Colour Measurement Kit 172 V 2, 28 on the basis of L*, a* and b* values (Nisha et al., 2006).

3.3.4 Jaabi Results and discussion

Physical characteristics of Yaabande cake as influenced by the flour particle size

Table 1 shows the Yaabande cakes produced with their physical characteristics. The cake appears as firmer and as lighter (as represented by increased value of L*) as the flour particle size is small. The fineness of the flour appears as the main innovation to introduce in the Yaabande processing system.

Table 1: Physical characteristics of *Yaabande* from *Jaabi* flour of different particle size

Characteristics	Particle size (µm)			
	Raw flour	**250µm<Ø<500µm**	**125µm<Ø<250µm**	**Ø<125µm**
Texture (N)	153,94 ± 3,54	197,97 ± 5,80	228,55 ± 6,62	282,00 ± 1,69
Colour parameters				
L*	55,74 ± 0,01	60,14 ± 0,14	63,49 ± 0,76	65,50 ± 0,26
a*	10,28 ± 0,05	9,30 ± 0,32	8,85 ± 0,08	8,65 ± 0,20
b*	23,06 ± 0,03	24,46 ± 0,04	26,24 ± 0,26	26,44 ± 0,14

Consumer's appreciation
The consumer appreciation of the cakes is presented on figures 3. The cake is appraised as positively as the *Jaabi* flour used for its baking is fine. In this respect, consumers rank cake of fine particle size from pleasant to extremely pleasant, while traditional *Yaabande* is mostly ranked from slightly pleasant to unpleasant. Based on this logic, cake made with flour of very fine particle size (Ø<125µm) was preferred both for its appearance and its taste and was then more acceptable for the consumers (Fig. 4). This sample was followed by *Yabaande* made with flour of particle size between 250µm and 125µm.
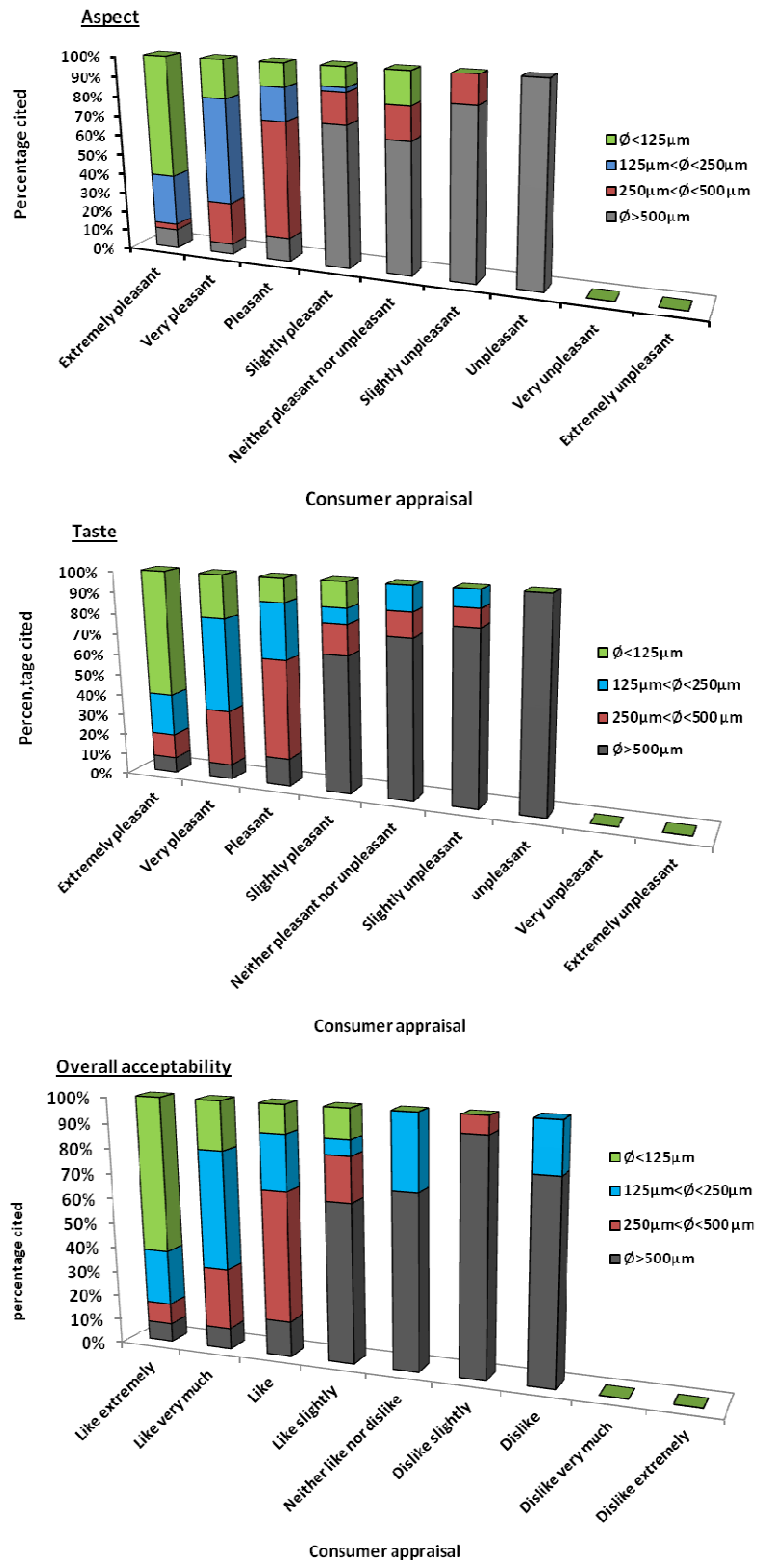
Figure 3: Consumer appraisal of *Yaabande* aspect, taste and overall acceptability as influenced by flour particle size
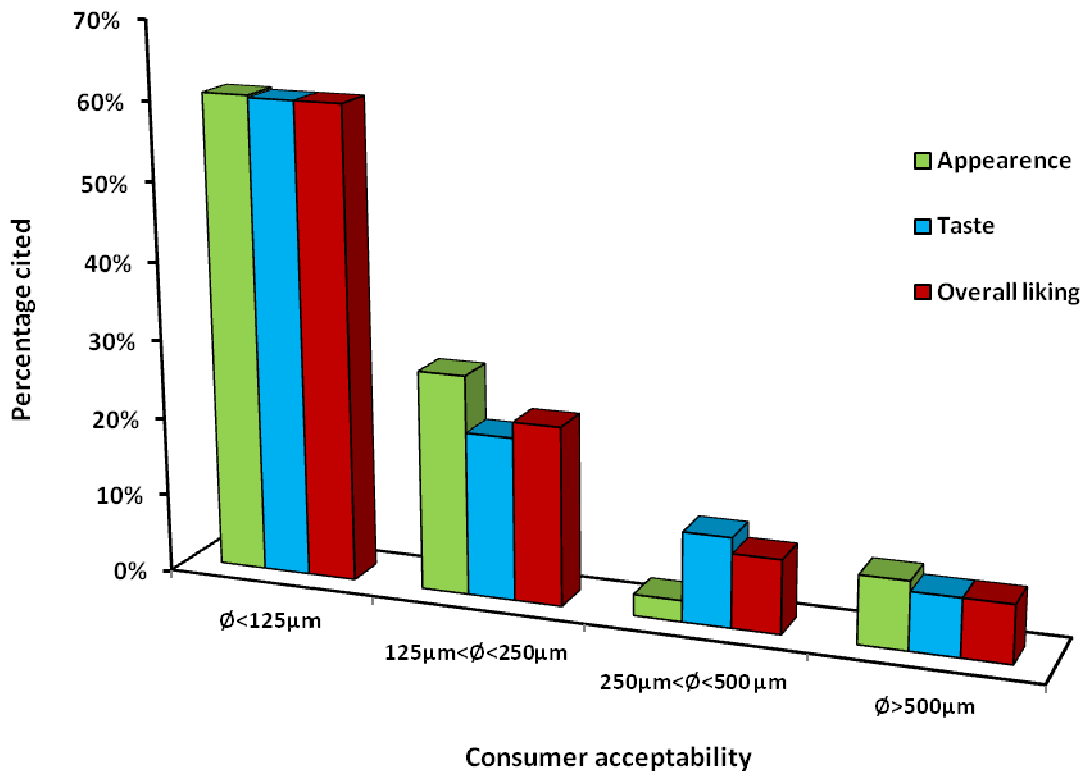
Figure 4: Consumer preference of *Yaabande* as a function of flour particle size

Considering the reason of consumer preference, the aspect of the reengineered *Yaabande* is preferred for the fineness of its texture and its nice colour, while the sweet taste appears as the main attribute of the taste (Fig. 5). These observations are in conformity with the consumer demand previously found in the study of consumer acceptability of traditional *Yaabande* (Touwang *et al*, 2015). In final, the overall acceptability of reengineered *Yaabande* is determined mainly by the sweet taste, followed by the smoothness of the aspect; colour, melting in mouth and biscuit aspect comes in third position (Fig. 6).
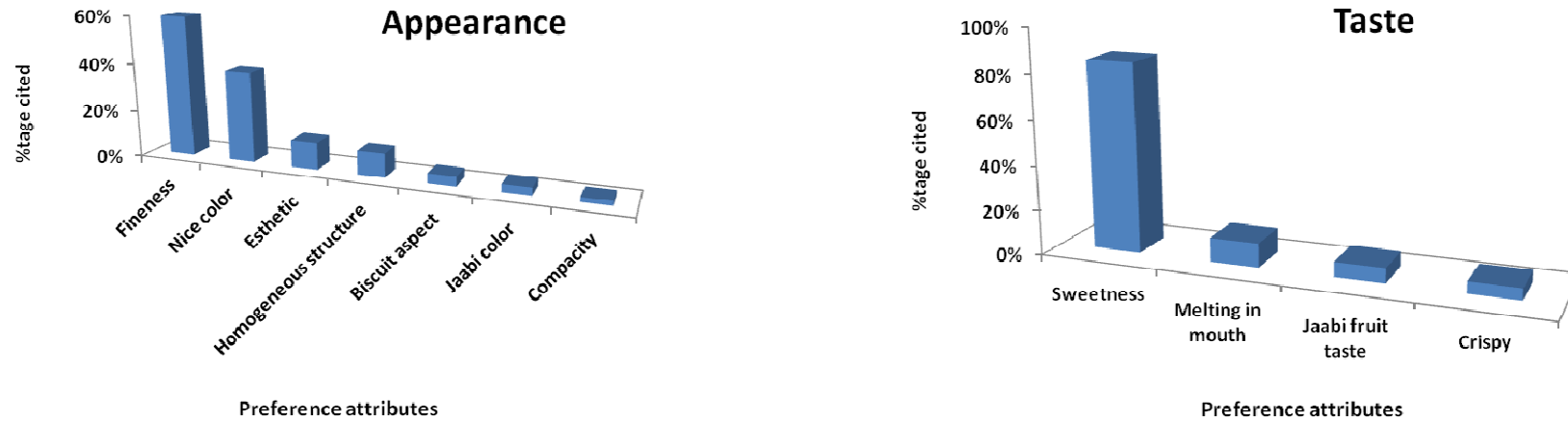
Figure 5: Consumer preference of reengineered *Yaabande* related to appearance, taste and overall acceptability
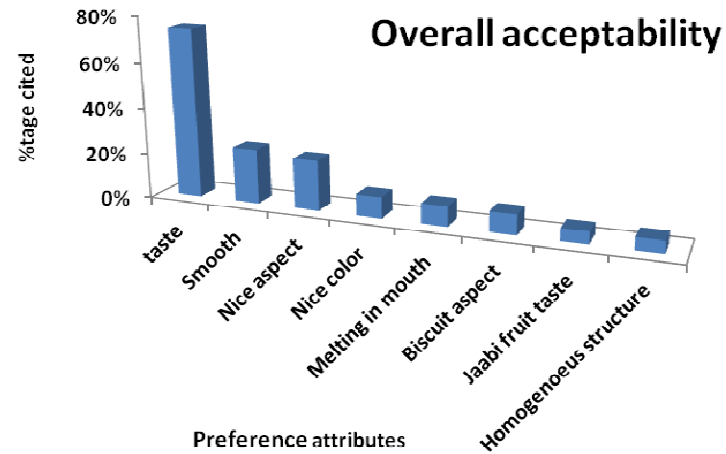

Figure 6: Hierarchy of quality attributes justifying consumer's preference of improved Yaabande

3.3.5   Jaabi Conclusions

In conclusion, the fineness of *Jaabi* flour improves both the physical and organoleptic characteristics of *Yaabande*, and thus its acceptability. In this respect, *Yaabande* made with flour of particle size lower than 125µm is the most accepted sample by consumers. Meanwhile the production of this sample presents a principal limit due to the fact that, since the flour production goes through milling and sieving, convenient sieves of 125µm mesh are not easily available on local market. In addition, hand sieving at this particle size is time consuming. On the contrary, the availability of sieves of 250µm mesh on local market has made processors to adopt flour of particle size 250µm for the production of new *Yaabande*. This choice is also supported by the fact that the use of sieve of 250µm mesh is less tiresome than the 125µm one.

3.3.6   Jaabi References

Blumenkrantz, N. and G. Asboe-Hansen. 1973. New method for quantitative determination of uronic acids. *Anal. Biochem.* 54: 484 - 489.

Dairou S, Biyanzi P, Pallet D, Ndjouenkeu R. (2014). Traditional production, processing and quality attributes of Ziziphus mauritiana in Savannah Region of Cameroon. *Journal of Scientific Research & Reports*. 3(5):686-699.

Meilgaard M, Civile GV, Carr BT. (2007). Sensory Evaluation Techniques 4th Edition, CRC Press, Florida, USA.

Ndjouenkeu R. Biyanzi P. 2011. *Jaabi* production, processing, trading and consumption systems in Cameroon. AFTER, Deliverable 1.1.2.1-3

Ndjouenkeu R., Cisse M. (2012). Prototypes of new functional products obtained with *Ziziphus mauritiana*. AFTER, Deliverable D4.3.2.4

Ndjouenkeu R. (2013). List of new processing protocols for improvement of the quality of Cameroon products and guidelines. AFTER, Deliverable D4.3.1.2

Nisha P, Singhal Rekha S, Pandit Aniruddha B. Kinetic modelling of texture development in potato cubes (*Solanum tuberosum* L.), green gram whole (*Vigna radiate* L.) and red gram splits (*Cajanus cajan* L.). *Journal of Food Engineering* 2006;76:524–530

Touwang C., Biyanzi P., Ndjouenkeu R., Fliedel G., Bechoff A., Tomlins K. I. and Pallet D. (2015). Sensory Profile and Consumer Acceptability of *Ziziphus mauritiana* and Processing Product in Savannah Region of Cameroon. Journal of Scientific Research and Report. 4(7): 635-651