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Authors: Keith Tomlins, Genevieve Fliedel, Danielle Rakoto, J.M. Kindossi, O.O.D. Akpo-Djenontin, V.B. Anihouvi1, N. Akissoé, Declemy, A-L, G. Vieira-Dalodé, D. Pallet, Mady CISSE Aurélie BECHOFF, Ndeye Mariama DIATTA, Cheikh TOURE, Ben Bennett & J.D. Hounhouigan

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Executive summary

The sensory profile and consumer acceptance of Lanhouin, a traditional salted fermented fish made from two types of fish (king fish and cassava fish) and three different fermentation processes (aerobic, semi aerobic and anaerobic condition) were explored. Traditional Lanhouin were sensorially different, with king fish Lanhouin having the highest smell (score of putrid odour) and cassava fish Lanhouin being the whitish. Three classes of consumers' behaviour essentially, those who like all the Lanhouin samples (Lanhouin likers; 35 % of consumers), those who does not prefer king fish Lanhouin from anaerobic fermentation (Lanhouin KFAN dislikers; 37 %) and those who does not like cassava fish Lanhouin from aerobic fermentation (Lanhouin CFA dislikers; 28 %) were identified. Consumers' acceptance was significantly associated with size of fish, whitish colour, dried fish odour and ammoniacal odour. Considering consumers' preference, Lanhouin from king fish with semi aerobic fermentation and Lanhouin from cassava fish (except for aerobic fermentation) were more accepted and could be interesting for reengineering. The similarity in tasting attributes for cassava fish and king fish when used for cooked rice will be helpful to design the form in which Lanhouin can be marketed for large acceptance

Considering Kong, no prior work has explored sensory tasting. Four samples were produced for the sensory test: Kong was smoked with wood only and or with wood/coconut. For the sensory evaluation, smoked kong only and smoked kong in sauce and were scored by a semi-trained sensory panel. Then, 109 consumers were interviewed. Acceptability was only evaluated on smoked kong. The results show that all four samples were quite distinctive from each other but not when in sauce. Most of the Kong products were on average acceptable but moist kong had a better acceptability than dried kong samples submitted to the same processes of smoking. Consumers were segmented into two three groups as: "indifferent likers" (27%), "dry kong dislikers" (15%), and "dry Kong less preferred" (59%). Clusters really differed in terms of professional activity in fish sector but did not significantly differ in the frequency of consumption. Therefore it appears that, smoked Kong is a main product of consumption in the Senegalese market. Since more than 50% of consumers consumed smoked Kong at least once a week, it appears that Kong is a main product of consumption with a strong potential for the Senegalese market but also for the international market.

Background

This deliverable report refers to the sensory and African consumer acceptance for Group 2. Group 2 products include the fermented salted fish and meat products, Lanhouin (Benin), Kitoza (Madagascar) and Kong (Senegal). The methodology is set out in D5.2.1. (Report on the methodology definition for the sensory testing and consumer acceptance studies).

Methodology

The detailed methodology for each product is given in annexes 1 to 3 for Lanhouin (Benin), Kitoza (Madagascar) and Kong (Senegal) respectively.

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

Ethical assessment and consent

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

Consumer testing

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

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

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

		Consumer type (and number)	
Country	**Product**	**African**	**Non-African**
Benin	Lanhouin (fish)	200	0
Madagascar	Kitoza (meat)	100	68
Senegal	Kong (fish)	109	0

Results

The summary and detailed reports are given in annexes 1 to 3 for Lanhouin (Benin), Kitoza (Madagascar) and Kong (Senegal) respectively.

Annex 1 – detailed report for Lanhouin

SENSORY EVALUATION AND CONSUMER ACCEPTABILITY OF LANHOUIN, A BENIN FERMENTED FISH

J.M. Kindossi*, O.O.D. Akpo-Djenontin*, V.B. Anihouvi[1]*, N. Akissoé*, Declemy, A-L***, G. Vieira-Dalodé*, K. Tomlins**, D. Pallet*** & J.D. Hounhouigan*

**Department of Nutrition and Food Science, Faculty of Agronomic Sciences, University of Abomey-Calavi, 01 BP 526, Cotonou, Benin*
***Natural Resources Institute, University of Greenwich at Medway, Central Avenue, Chatham Maritime, Kent ME4 4TB, UK*
**** International Agronomic Research Centre for Development (CIRAD), UMR Qualisud, 34398 Montpellier, Cedex5, France*
[1]Corresponding author: anihvic@yahoo.fr

Abstract
The sensory profile and consumer acceptance of Lanhouin, a traditional salted fermented fish made from two types of fish (king fish and cassava fish) through three different fermentation processes (aerobic, semi aerobic and anaerobic condition) were explored. While the sensory testing was performed by 17 semi-trained panellists, the acceptability of Lanhouin was tested by African ordinary consumers (n=200) in Cotonou and Abomey-Calavi municipalities. Traditional Lanhouin were sensorially different, with king fish Lanhouin having the highest smell (score of putrid odour) and cassava fish Lanhouin being the whitish. PCA revealed three classes of consumers' behaviour essentially, those who like all the Lanhouin samples (Lanhouin likers; 35 % of consumers), those who does not prefer king fish Lanhouin from anaerobic fermentation (Lanhouin KFAN dislikers; 37 %) and those who does not like cassava fish Lanhouin from aerobic fermentation (Lanhouin CFA dislikers; 28 %). Consumers' acceptance was significantly associated with size of fish, whitish colour, dried fish odour and ammoniacal odour. Considering consumers' preference, Lanhouin from king fish with semi aerobic fermentation and Lanhouin from cassava fish (except for aerobic fermentation) were more accepted and could be interesting for reengineering. The similarity in tasting attributes for cassava fish and king fish when used for cooked rice will be helpful to design the form in which Lanhouin can be marketed for large acceptance

Keywords: Lanhouin, fermented fish, sensory profile, consumer preference, acceptance

INTRODUCTION

Lanhouin is a salted and fermented fish product mainly produced in the coastal regions of West Africa.[1] It is produced by natural and largely uncontrolled fermentation. For traditional Lanhouin production, the fresh fish is scaled, gutted, washed, followed by a ripening period when biochemical and microbiological activities lead to partial deteriorated fish. The product obtained after ripening is treated with salt and allowed to ferment for 3 to 9 days [2,3] . Lanhouin is mostly used as taste enhancer and flavouring agent in many types of dishes in the West African countries. Previous works identified the different processing technologies of Lanhouin[2,3]. Thus, variations in sensory profile, essentially quality attributes such as flavour and texture are common, which may result in product rejection and then economic losses for the producer. Evaluation of sensory characteristics of Lanhouin is a challenge for reducing the gap in quality variation and developing relationships between consumer acceptance and the sensory characteristics. Indeed, product quality upgrading for African markets should be based on the assessment of consumer acceptance seen as an important step in marketing strategies. This study primarily explored the sensory profile and the consumer acceptance of Lanhouin. Secondary, it is important to establish the relationships between the sensory attributes, the consumer acceptance and their socioeconomic status in order to understand the factors that influenced acceptability of Lanhouin.

MATERIALS AND METHODS

Experimental samples

Two types of fish named cassava fish (*Pseudotolithus senegalensis*) and King fish/Spanish mackerel (*Scomberomorus tritor*) which are commonly used for Lanhouin production in Benin were bought at Agoué beach in Grand Popo municipality. The two types of fish were processed into Lanhouin by two well skilled processors using the three variants of

technologies of fermentation previously described.[2] When the Lanhouin samples are processed using the two first variants (fermentation in aerobic conditions and semi aerobic conditions), the fresh fish is scaled, gutted, arranged in a container, covered with cleaned clothes and left at ambient temperature for ripening for 11-16 h. The ripened fish is washed again and arranged in a basket to drain; dry salt is then rubbed into the gills, the belly cavity, on the surface, and then the ripened and salted fish is allowed to ferment in basket (aerobic conditions) or in basket with cement layer (semi-aerobic conditions) for 9 days before being sun dried for 1 day. For the third variant (fermentation in anaerobic conditions) the fresh fish was not ripened before being fermented for 9 days in a 2 meters depth hole. Three types of Lanhouin per type of fish were obtained based on the technology of fermentation described below:

- Fermentation in aerobic conditions in basket (FA)
- Fermentation in semi-aerobic conditions in basket with cement layer (FSA)
- Fermentation in anaerobic conditions by burying fish in the ground without ripening (salted fish buried in a 2 meters depth hole) (FAN)

Ethical assessment and consent

This study was based on writing panellists consent to participate. Beforehand, they were largely informed about the objectives and methodologies of the study and that their responses were anonymous and their participation was entirely voluntary, with the possibility to stop their participation at any point during the study.

Sensory evaluation

Samples were scored for descriptive terms by the sensory panel and for acceptability by ordinary consumers.

Lanhouin samples preparation for sensory evaluation

Two types of products were suggested to sensory testing: Lanhouin (raw) and cooked rice containing Lanhouin. Panellists evaluated whole Lanhouin samples because this is the form that Lanhouin is when consumers make a purchasing decision at the market. For consumption purpose, Lanhouin samples of king fish/Spanish mackerel (K) and cassava fish (C) obtained from tested processing technologies were integrated into rice which served as support according to local food practice: rice (400 g) was washed in tap water (400 mL) and drained of water for five minutes. Lanhouin sample (40 g) and rice were cooked together with 1000 mL tap water without salt on electric stove set at 250 °C for 30 min. Cooked rice containing Lanhouin was kept in a heated box (55 ± 2°C) for up to one hour until served.

Sensory testing

Lanhouin samples and cooked rice containing Lanhouin were scored by a semi-trained sensory panel of 17 people, using a modified version of quantitative descriptive analysis (QDA) since standards were not provided.[4] Testing was carried out in air conditioned room and controlled lighting. The sensory testing was conducted at the Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin where individual panel booth area was arranged for each panellist to avoid interaction. The language used for sensory testing was French. The panellists had been screened for familiarity with product and ability to determine differences between Lanhouin samples, and then cooked rice containing Lanhouin samples. The panel generated 11 sensory attributes for all the Lanhouin samples and the cooked rice containing Lanhouin samples, during a preliminary focus group session guided by the investigator. Sensory attributes generated from group consensual discussion were as followed:

- Whitish colour (from ash to dirty whitish) – Lanhouin that had ash colour or dirty whitish colour
- Softness (from soft to hard texture) – facility to press the raw Lanhouin with one finger

- Dry (from moist to dry) – Lanhouin that had moist or dry feeling
- Size (from small to tall) – small or tall Lanhouin
- Dried fish odour (from weak to strong)- Lanhouin that is characterised by dried fish aroma
- Ammoniacal odour (from weak to strong) – Lanhouin that smelled ammoniac odour
- Salty taste (from less salty to very salty) – salt content in cooked rice containing Lanhouin
- Fish taste (from fresh to dried) – fish taste in cooked rice containing Lanhouin
- Smoked shrimp taste (from weak to strong) – smoked shrimp content in cooked rice containing Lanhouin.
- Shrimp odour (from fresh to smoked) - cooked rice containing Lanhouin that smelled fresh or smoked shrimp
- Fish odour (from fresh to dry) - cooked rice containing Lanhouin that smelled fresh or dried fish.

The sensory testing was conducted on the six Lanhouin samples and the six rice containing lanhouin samples using these sensory attributes. At each session, three Lanhouin samples (coded with three-figure random number) were first served on tray meal, and then cooked rice containing Lanhouin samples were served on whitish paper plate. The order in which they were presented was randomized for panellist. As far as cooked rice containing Lanhouin is concerned, panellists were offered mineral water to rinse their mouths between tasting. The intensity of each descriptor was scored on a 100 mm unstructured scale.

Consumer acceptability

Two hundred (200) consumers were interviewed at seven locations at Cotonou and Abomey Calavi, using the method of central location testing.[5] There were the following: Akassato (n= 55); University of Abomey-Calavi (n=43); Abomey-Calavi town (n= 12); Loading dock of

Abomey-Calavi (n= 44); Artisanal fishing port of Cotonou (n= 24) Agla Beach (n= 15); Placodji (n=7). All consumers were African. Consumers were presented with three whole Lanhouin (raw) samples in random order. They were asked to score the acceptability of Lanhouin samples on the basis of the colour and the odour using 9-point verbal hedonic box scale which varied from ‘dislike extremely’ to ‘like extremely [5,6]. After testing Lanhouin samples, consumers were interviewed to obtain demographic information regarding age, education, gender, occupation, type of fish of Lanhouin bought, form of Lanhouin bought, consumption of dishes containing Lanhouin, how often dishes containing Lanhouin were eaten, where dishes containing Lanhouin were eaten and preferred dishes containing Lanhouin. The interview took approximately 20 min.

Statistical analysis

The collected 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) and internal preference mapping were computed using XLSTAT (version 2011, Addinsoft, Paris, France) and STATISTICA (version 6, StatSoft France, 2004).

RESULTS AND DISCUSSION

Sensory profile of Lanhouin samples and cooked rice containing Lanhouin

Raw Lanhouin sample effect was significantly different ($P<0.05$) with respect to the sensory attributes of whitish colour, hard texture, dried aspect, size, dried fish odour, ammoniacal odour and salty taste (Table 1). This range of sensory attributes was higher than that reported by Anihouvi et al.[7] who pointed out that the acceptance of Lanhouin by consumers was determined by aroma and texture. No significant difference was evidenced for shrimp odour, fishy taste or smoked shrimp taste related to cooked rice containing Lanhouin. This indicated that the intensity of sensory attributes differs among Lanhouin samples but not for cooked rice containing Lanhouin. There were no significant differences among the panellists for whitish colour and size while significant difference ($p<0.05$) was observed among the panellists for all other sensory attributes (Table 1). In addition, significant interactions between Lanhouin type and panellists for attributes of whitish colour, dried aspect, dried fish odour and fishy taste were observed. These interactions for some of the attributes are probably due to the fact that it was not possible to provide standards and some attributes were more difficult to be evaluated. However, no significant interaction was observed between Lanhouin and panellists for hard texture, size, ammoniacal odour, shrimp odour, salty taste and smoked shrimp taste.

PCA of sensory attributes resulted in a two-factors solution accounting for 87.92 % of the total variation, of which 72.21 % was explained by the first principal component (PC) and

15.71 % by the second (Figure 1). The sensory attributes were largely separated in the direction of PC1, which spanned in whitish colour, hard texture, dried aspect, size, fishy odour, ammoniacal odour, shrimp odour and fishy taste. In the direction of PC2 the attributes spanned from salty taste to smoked shrimp taste.

The samples obtained with king fish/Spanish mackerel (*Scomberomorus tritor*) (KFA, KFSA, KFAN) were located in the left-hand quadrant and had the lowest score for the majority of sensory attributes apart from ammoniacal odour and size. In the right-hand quadrant, the samples obtained with cassava fish (*Pseudotolithus senegalensis*) (CFA, CFSA, CFAN) had lowest score of ammoniacal odour and size. Lanhouin samples of this type of fish were associated with high scores of dried fish odour, shrimp odour, fishy odour, whitish colour, texture, dried aspect, salty taste, fishy taste, and smoked shrimp taste as Lanhouin actors in previous work attributed a soft texture, firm and spongy and strong but not repugnant odour to a good Lanhouin.[2] It was revealed that cassava fish Lanhouin was better known than that of kingfish.

Cluster analysis (agglomerative hierarchical cluster analysis, wards method, Euclidean distance) of Lanhouin samples with respect to the technology indicated that Lanhouin samples were clustered into three different groups according to similarity of sensory attributes, as illustrated in the dendrogram (Figure 2.). Cluster 1 comprised king fish Lanhouin from anaerobic fermentation (KFAN, 16.7 %), and seemed different from other types of Lanhouin. Cluster 2 comprised two types of Lanhouin from semi aerobic fermentation and aerobic fermentation of king fish (KFSA+KFA, 33.3 %), which indicates that both fermentation technologies gave similar sensory properties for king fish Lanhouin. Cluster 3 comprised all Lanhouin samples from cassava fish whatever the technology used (CFAN+CFSA+CFA, 50.0

%). For consumer testing, one sample of each cluster was chosen as representative: KFAN for cluster1, KFSA for cluster 2 and CFA for cluster 3

Consumer acceptability of Lanhouin samples

The mean acceptability of Lanhouin samples differed significantly ($p<0.05$) with respect to technology; the anaerobic fermented kingfish Lanhouin giving the lowest acceptance value (Table 2). In general, consumers gave average acceptable score to all Lanhouin samples since the mean scores were above 5 which was the limit for acceptance

Segmentation of consumers into groups of similar acceptance patterns regarding Lanhouin samples

Hierarchical cluster analysis (Ward's method) indicated that consumers were clustered into three different segments as illustrated in the dendogram (Figure 3). Segmentation gives a more complex variation in acceptability among the consumers and is helpful to understand differences in consumer behaviour.

The three segments did not significantly differ ($p>0.05$) in terms of sociological criteria such as age, gender, marital status, education level, occupation (Table 3). There was no significant difference ($p>0.05$) in the form of Lanhouin, dishes containing Lanhouin more consumed and the frequency of eating dishes containing Lanhouin. In the opposite, the type of Lanhouin (cassava fish Lanhouin, king fish Lanhouin and lesser African threadfin Lanhouin) usually consumed differed significantly between cluster ($p<0.05$; Chi Square Test). This indicates that the consumers interviewed distinguish well the different types of Lanhouin fish.

The segments (clusters) of consumers differed significantly in acceptability ($p<0.05$; Turkey HSD test) for Lanhouin samples (Figure 4). The largest consumers cluster 2 comprised 37 % of consumers who like all type of Lanhouin, except Lanhouin KFAN (Lanhouin KFAN dislikers); this was followed by cluster 1 "Lanhouin likers" (35 %) who consume all kind of Lanhouin and cluster 3 comprised 28 % of consumers who also like all type of Lanhouin,

except Lanhouin CFA (Lanhouin CFA dislikers). Those in the cluster 1 gave high acceptability scores to all types of Lanhouin samples, with cassava fish Lanhouin made from aerobic fermentation (CFA: 7.5±0.1) followed by king fish Lanhouin made from anaerobic fermentation (KFAN: 7.0±0.1) and king fish made from semi aerobic fermentation (KFSA: 6.9±0.2). Consumers in cluster 2 gave the highest score for cassava fish Lanhouin made from aerobic fermentation (CFA: 7.0±0.1) and the lowest for kingfish Lanhouin made from semi aerobic fermentation (KFSA: 5.6±0.2). Consumers in the cluster 3 scored higher king fish Lanhouin made from semi aerobic fermentation (KFSA: 7.2±0.2) and lower the king fish Lanhouin made from anaerobic fermentation (KFAN: 6.2±0.2).

Correlations between sensory attributes and consumer acceptance

Regarding correlations between consumer acceptance and the sensory attributes, linear models relating consumer liking and sensory score were explored for Lanhouin samples as reported for parboiled rice in West Africa [6] (Figure 5). For the whole consumer group, no significant correlation between mean acceptance score and sensory attributes was observed. However, significant and positive correlations were observed between “Lanhouin CFA dislikers” acceptance and size, ammoniacal odour. These correlations showed that “Lanhouin CFA dislikers” are more discerning with these sensory attributes. Also significant and negative correlations were identified between “Lanhouin CFA dislikers” and whitish colour, dried fish odour. These correlations show that “Lanhouin CFA dislikers” distinguished well and knew that king fish Lanhouin cannot be of whitish colour but ashy colour and its odour is very different with that of dried fish whatever the technology used.

CONCLUSION

The study showed distinct descriptors profiles for all Lanhouin samples tested. The sensory descriptors for cassava fish Lanhouin from the three technologies are the same, while for king fish Lanhouin from aerobic and semi aerobic fermentation differed widely from king fish Lanhouin obtained by anaerobic fermentation. Consumers gave an acceptable score for different samples of Lanhouin presented. However, three clusters of consumers were distinguished: the largest consumer cluster 2 “Lanhouin KFAN dislikers” comprised 37 % of consumers followed by cluster 1 “Lanhouin likers” (35 %) and cluster 3 “Lanhouin CFA dislikers” (28 %). Consumer’s cluster “Lanhouin CFA dislikers” were positively correlated ($p<0.05$) with size and ammoniacal odour and negatively with whitish colour and dried fish odour. From cluster analysis it appeared that King fish Lanhouin from semi aerobic fermentation and cassava fish Lanhouin (except for aerobic fermentation) are more consumed because of their convenience. Consequently, these two types of Lanhouin may be paid more attention for reengineering perspective.

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Table 1. Probability values for effects of differences due to Lanhouin samples, panellists and their interaction to sensory attributes

Sensory attributes	Probability		
	Samples	Panellists	Interaction
Whitish colour	0.00*	**0.56**	0.00*
Hard texture	0.04*	0.00*	**0.10**
Dry	0.00*	0.00*	0.00*
Size	0.00*	**0.49**	**0.99**
Dried fish odour	0.00*	0.00*	0.00*
Ammoniacal odour	0.00*	0.00*	**0.62**
Shrimp odour	**0.75**	0.00*	**0.10**
Salty taste	0.00*	0.00*	**0.86**
Fishy taste	**0.14**	0.00*	0.00*
Smoked shrimp taste	**0.15**	0.00*	**0.85**

*Significantly different at $P < 0.05$

Table 2: Consumer acceptability of Lanhouin

Lanhouin samples	Mean ± standard error
KFSA	6.5±0.11b
KFAN	5.9±0.11a
CFA	6.2±0.14b

Letters a to b indicate significant differences ($p < 0.05$) between the samples (

CFA = Cassava fish Lanhouin from aerobic fermentation; KFSA= King fish Lanhouin from semi

aerobic fermentation; KFAN= King fish Lanhouin from anaerobic fermentation

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

Question	Cluster 1 "indifferent likers	Cluster 2 "CFA & KFSA likers"	Cluster 3 "KFSA &KFAN likers"	Probability Chi Square test (p<0.05)
Number of consumers	69	75	56	
Age (%)				
[18-35]	40	35	25	
[36-45]	27	40	33	0,32377
[46-55]	33	39	28	
[56-65]	33	67	0	
[66 +[	80	0	20	
Gender (%)				
Male	40	31	29	0,55868
Female	33	39	28	
Marital status (%)				
Single	38	40	23	
Maried	35	36	28	0,62172
other	9	45	45	
Education level (%)				
No formal education	33	43	24	
Primary school	32	32	37	0,84518
Secondary school	38	34	28	
University	36	38	26	
0ccupation (%)				
civil service	29	43	29	
Housewife	27	50	23	
Artisanship	32	32	36	
Unemployed	50	50	0	0,84488
Cooperated (Ambassador, advisor....)	0	50	50	
Student	38	40	23	
Trader	41	32	27	
Type of Lanhouin usually consumed (%)				
Lanhouin of Cassava fish	37	43	20	
Lanhouin of Kingfish	29	22	48	0,00356*
Lanhouin of Lesser African threadfin	50	50	0	
Form of Lanhouin (%)				
Whole Lanhouin	29	46	26	0,08812
Piece of Lanhouin	42	28	30	
Dishes containing Lanhouin more consumed				
Vegetable sauce (slimy, leaves)	32	39	29	
Cooked tomato sauce	20	20	60	
Uncooked tomato sauce	71	14	14	0,3746
Rice	50	25	25	
Groundnut sauce	60	20	20	

Question	Cluster 1 "indifferent likers	Cluster 2 "CFA & KFSA likers"	Cluster 3 "KFSA &KFAN likers"	Probability Chi Square test (p<0.05)
Palm nut sauce (decoussounou)	50	50	0	
Frequency of eating dishes containing Lanhouin (%)				
Everyday	64	9	27	
Several times in week	34	38	28	
Once a week	34	32	34	0,09251
Once a month	23	46	31	
Rarely	22	78	0	

*Significantly different at $P < 0.05$

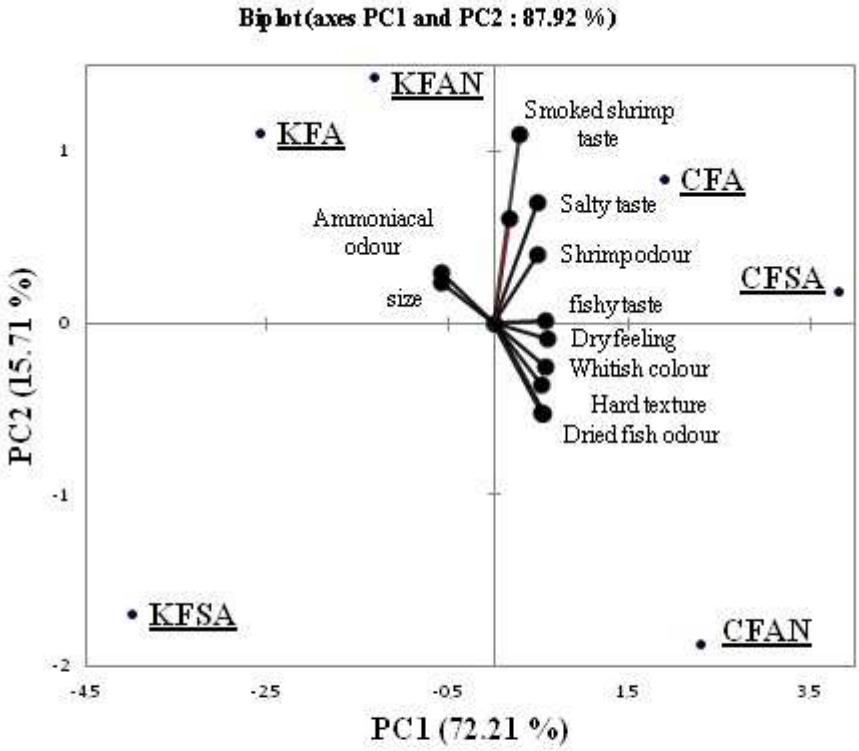

Figure 1: Principal components analysis (PCA) plot of sensory attributes of Lanhouin samples of different technologies. CFA = Lanhouin of Cassava fish from aerobic fermentation; CFSA= Lanhouin of Cassava fish from semi-anaerobic fermentation; CFAN = Lanhouin of Cassava fish from anaerobic fermentation; KFA = Lanhouin of Kingfish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation.

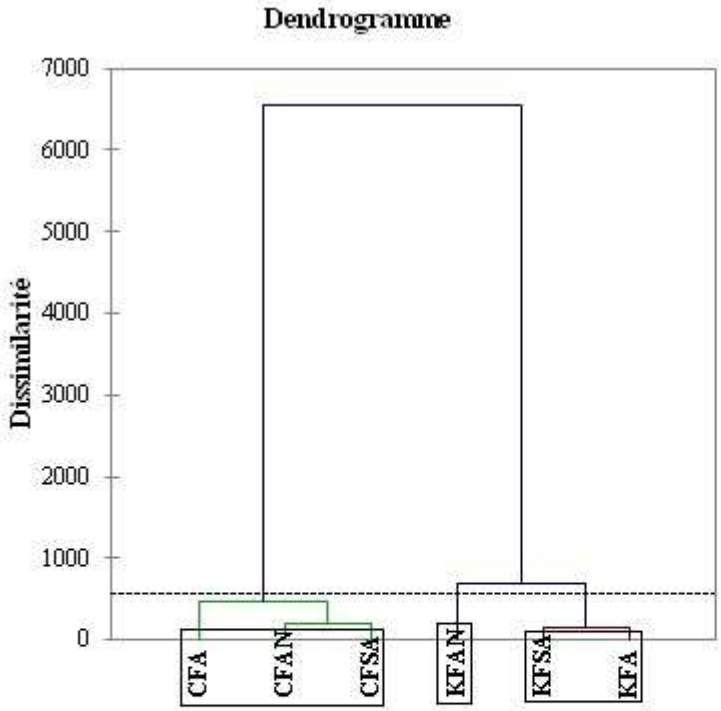

Figure 2. Agglomerative hierarchical cluster analysis dendrogram for clustering Lanhouin samples (n=6) into groups of similar perceptions assessed by panellists. Dashed line denotes level of dissimilarity along which the three clusters were selected. CFA = Lanhouin of Cassava fish from aerobic fermentation; CFSA= Lanhouin of Cassava fish from semi-anaerobic fermentation; CFAN = Lanhouin of Cassava fish from anaerobic fermentation; KFA = Lanhouin of Kingfish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation.

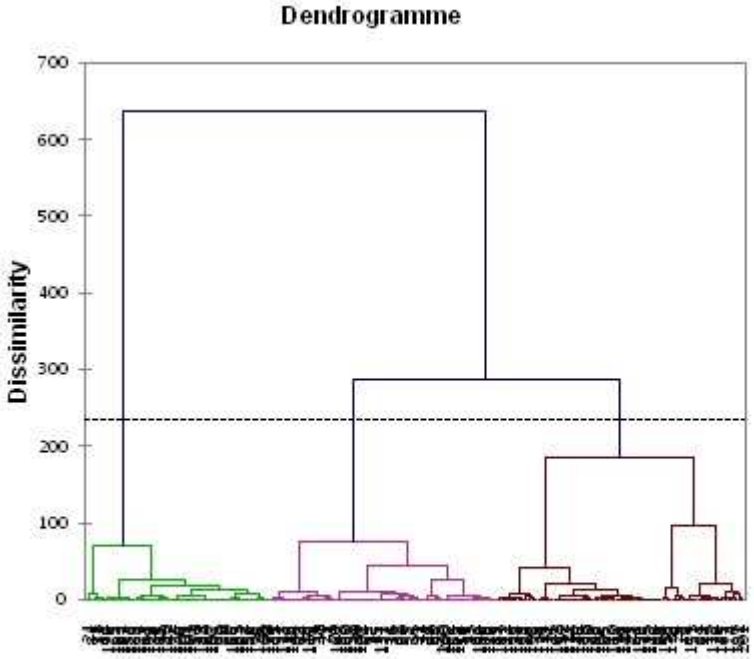

Figure 3: Hierarchical clusters analysis dendrogram for segmenting consumers into groups of similar perceptions of Lanhouin acceptability. Dashed line denotes level of dissimilarity along which the three segments were selected.

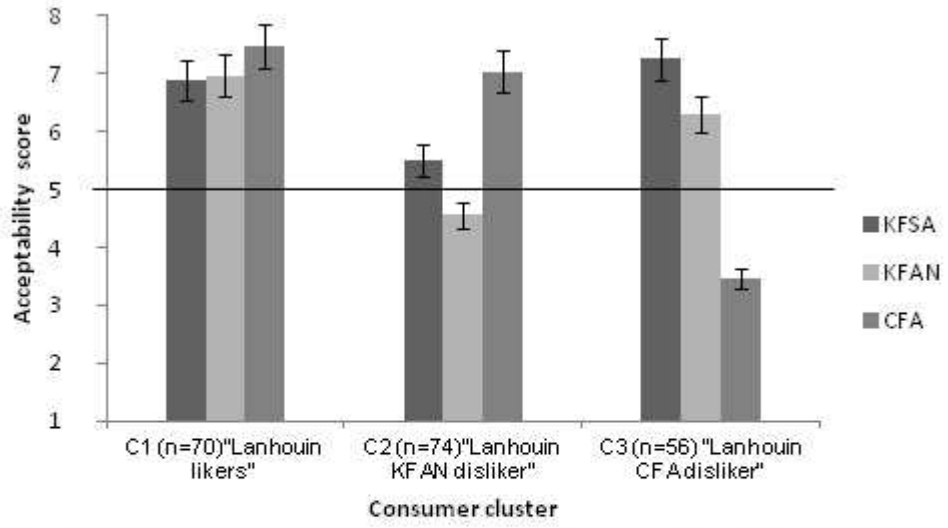

Figure 4. Mean consumer acceptance of Lanhouin cluster type (Lanhouin likers, Lanhouin KFAN dislikers, Lanhouin CFA dislikers). CFA = Lanhouin of Cassava fish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation.

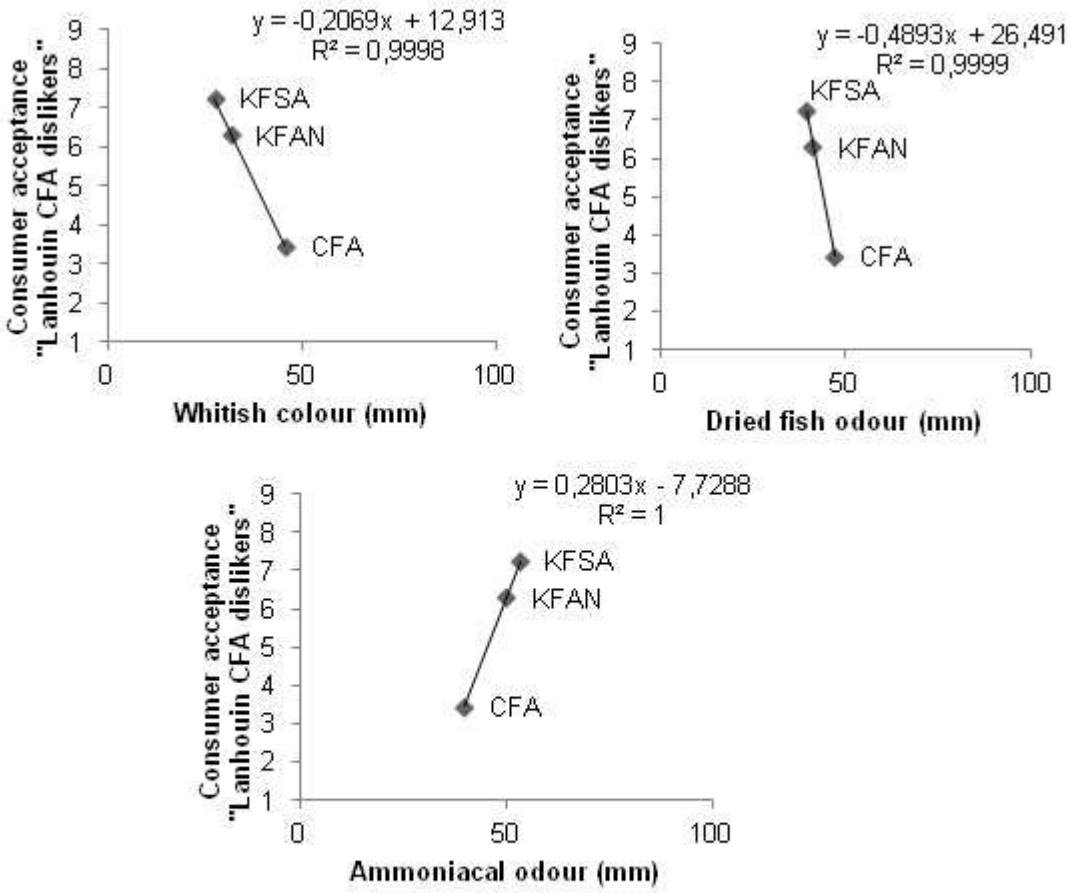

Figure 5. Correlations between sensory attributes and consumer acceptance of Lanhouin. CFA = Lanhouin of Cassava fish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation. Significantly different at $P < 0.05$.

Annex 2 – detailed report for Kitoza

Danielle Rakoto, Genevieve Flidel

Abstract

Introduction

In Madagascar, Kitoza is a traditional dish which is made from beef or pork meat. It consists of strips 20 to 50 cm long and 2 to 4 cm wide, salted and then dried and/or smoked. *Kitoza* has been eaten in Madagascar since its introduction long ago by the royal families, and the popularity of this tasty dish is still rising. Up to now, no literature data on quality of Kitoza are available.

Studies on Kitoza were undertaken through the international project funded by European Union and entitled: African Food Tradition Revisited by Research (AFTER). According to the results, the producers manufacture the beef and pork Kitoza only in the smoked form of which the maximum duration of preservation is one week. The producers or producers/retailers supply local markets, street eateries, shops and supermarkets. The product which is highly appreciated by all types of consumers, Malagasy people of different social classes and even foreigners, is principally eaten with rice soups at breakfast or dinner. This dish is known to be energising and is recommended for women in labour and nursing mothers.

During a value chain workshop, the beef and pork Kitoza key actors were identified. SWOT and GAP were analysed in order to reveal the possibility of enhancing smoked Kitoza production.

This report shows the sensory profile of 8 beef and pork smoked Kitoza from 5 different producers with varied processing, and results of acceptability tests undertaken on Malagasy and European consumers.

Materials and methods

Kitoza samples

Eight different Kitoza samples (four beef and four pork) were presented to the panellists. Selection of samples for sensory analysis is following:

1. Pork Kitoza, butcher's shop Andoharanofotsy (PMAndo)
2. Pork Kitoza, butcher's shop Ivandry (PZIvan)
3. Pork Kitoza vacuum Bongou (PSVBongou)
4. Pork Kitoza vacuum butcher's shop Mahamasina (PSVRMah)
5. Beef Kitoza, butcher's shop Ivandry (BZIvan)
6. Beef Kitoza, butcher's shop Behoririka (BEBeho)
7. Beef Kitoza vacuum Bongou (BSVBongou)
8. Beef Kitoza vacuum butcher's shop Mahamasina (BSVRMah)

General process for manufacturing Kitoza is given in annex. Kitoza were stored in a paper packing safe from air.

Table1: List of Kitoza samples with the ingredients and the process

	Ingredients	Marinade duration	Part of meat	Smoking duration	Wood	Smoking method
PMAndo	garlic, saltpetre, 4 spices, salt	2 jours	ham	1h30	eucalyptus	In oven & suspended
PZIvan	salt (10g/kg of meat)	No marinade	escalope	3h	eucalyptus	In oven & suspended
BZIvan	salt (10g/kg of meat)	No marinade	rib steak	3h	eucalyptus	In oven & suspended
BEBeho	salt, sugar, papaya juice, ail	3h	fine slice	1h20	eucalyptus	In oven & suspended
PSVRMah	garlic, salt	No information	escalope	no information	eucalyptus	In oven & suspended
BSVRMah	garlic, salt	No information	fine slice	no information	eucalyptus	In oven & suspended

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.

Sensory evaluation

Sessions were conducted at Sensory Laboratory of FOFIFA (National Research Centre Applied in Rural Development) with controlled condition: lighting and ambient temperature (22 to 25°C). The language used for the sensory testing was French. The panellists had been screened for familiarity with the product. Sensory attributes were generated during a preliminary focus group session guided by the panel leader. A total of fourteen (14) sensory attributes were developed for the Kitoza for which the group of panellists had a consensus. Sensory attributes generated were as follows (English translation):

Table 2: Lists of attributes with definitions

Sensory attributes	Definitions	Protocol of tasting
Smoked smell (weak in strong)	Smell of campfire, grill	Lift the plastic glass which covers the pieces of meat; get closer to feel the smell which gets free and to note the intensity of the smell which can be weak to strong.
Spicy smell (none in strong)	Smell of spices added as ingredients to the meat (garlic, pepper, ginger)	
Colour	The colour of the flesh of the meat can go of a clear colour (whitish, light pink) to a dark colour (dark brown, purple, and garnet).	Observe the pieces of meat and note if its colour is rather clear or darkened or presents an intermediate intensity.

Wet aspect (dry to adjutant)	Visually, the pieces of meat present on surface a wet, juicy or completely dry aspect.	Observe the pieces of meat and note if the flesh adorned you more or less juicy or rather dries.
Presence of fat (none in many)	The pieces of meat contain fat parts.	Observe the pieces of meat and note if the slice is completely thin or present fat parts
Fibrous aspect (smooth in fibrous)	Visually, the flesh of the pieces of meat presents on surface a smooth, homogeneous or in contrast fibrous or stringy aspect.	Observe the pieces of meat and note if the flesh present strands or on the contrary is rather uniform, smooth.
Grilled aspect (not in many)	Visually, the pieces of meat present a grilled outside or not.	Observe the pieces of meat and note if the "croute" is completely burned (blown) out or not.
Hardness in mouth (aim at hard)	In the chewing, the texture of the piece of meat seems soft, supple, soft or on the contrary hard, firm, or intermediate.	When you chew the piece of Kitoza, note the resistance of the product in the chewing or on the contrary the ease to chew it.
Elasticity in mouth (none in strong)	In the chewing, the texture of the piece of Kitoza seems more or less rubbery, elastic or not at all.	During the chewing, note the more or less elastic sensation of the product.
Fibrous texture in mouth (none in fort)	In the course of chewing, the product seems stringy in mouth or on the contrary very homogeneous, smooth.	Perceive in the course of chewing of the product the presence or not of strands of fibres in mouth before swallowing.
Spicy taste (none in fort)	During the chewing of the product, feel at least one some spices or ingredients added to the product (garlic, ginger, pepper, umami, …)	During the chewing feel the presence or not of spices in mouth. Rinse the mouth before estimating the next tasteful descriptor.
Salt taste (weak in fort)	The pieces of Kitoza present a more or less salty taste which can go from weak to fort.	During the chewing feel if the product is salty or not. Rinse the mouth before estimating the next tasteful descriptor.
Sweet taste (none in fort)	The pieces of Kitoza present or not a sugar taste which can be more or less pronounced.	During the chewing, feel if the product is sweetened or not. Rinse the mouth before estimating the next tasteful descriptor.
Smoked aroma (weak in fort)	The pieces of Kitoza present after gulp a more or less pronounced smoked aroma.	Having swallowed the product, note if you have felt or not a smoked aroma which goes back up towards the nose. Note the intensity which can go from weak (or none) to strong or intermediate.

After a period of training using these attributes, the eight samples were tested blind in triplicate by the panel and the order in which they were presented was random. At each session, four Kitoza sample (coded with 3-figure random numbers) were served in white plate in random order to each panellist. 20g of each Kitoza sample were tested by the panellists. The software Fizz ® v.2.46I (Biosystems, Couternon, France) was used for scoring, and data were automatically collected by this software. Intensity for the sensory attributes was scored on a linear scale, anchored with the terms "not very"' at the low end and "very" at the high end.

Consumer acceptability

Consumer test was divided in two parts: the first one with Malagasy consumers from different ethnical origins (number: 100) and the second one with European consumers (number: 68). Consumers were interviewed at different locations in Antananarivo and in Tamatave using the central location method (Meilgaard et al., 2007). For Malagasy consumers, these were the following: Ankatso area (n=19), Tsiadana (n=20), Ambatobe (n=11), AUF Ankatso (n=17), Glacier restaurant (n=1), Antanimena area (n=20), Le Louvre hotel : 9, Le B Restaurant : 4 ; and for European consumers, sensory test were doing at Glacier restaurant (n=7), Louvre hotel (n=9), Le B Restaurant (n=29), LAS Ambatobe (n=7), Parc Andasibe (n=2), La terrasse Restaurant Tamatave (n=10), Le Bateau ivre Restaurant Tamatave (n= 4).

Because it is logistically difficult to transport the product from Madagascar to Europe, we used Europeans in Madagascar as a proxy.

Four smoked Kitoza were selected for consumer tasting among the samples used for sensory tasting as followed:

1. Pork Kitoza, butcher's shop Andoharanofotsy (PM Ando)
2. Pork Kitoza, butcher's shop Ivandry (PZ Ivan)
3. Beef Kitoza, butcher's shop Ivandry (BZ Ivan)
4. Beef Kitoza, butcher's shop Behoririka (BE Beho)

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

Along with obtaining information about the acceptability of the smoked Kitoza, information was elicited from each consumer regarding demographics, education, Kitoza consumption and buying. 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 (acceptability and the questionnaire) lasted no more than 30 min.

Statistical analysis

Analysis of variance (mixed effect model), correlation analysis (Pearson), stepwise multiple linear regression, Chi-squared analysis and principal component analysis (correlation matrix) were carried out using Fizz (R) or XLSTAT (6.0). Multiple pairwise comparisons were undertaken using the Tukey test with a confidence interval of 95%.

Results and discussion

Sensory profile of Kitoza

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

The PCA plot in Fig. 1, accounted for 83.97 % of the total variation

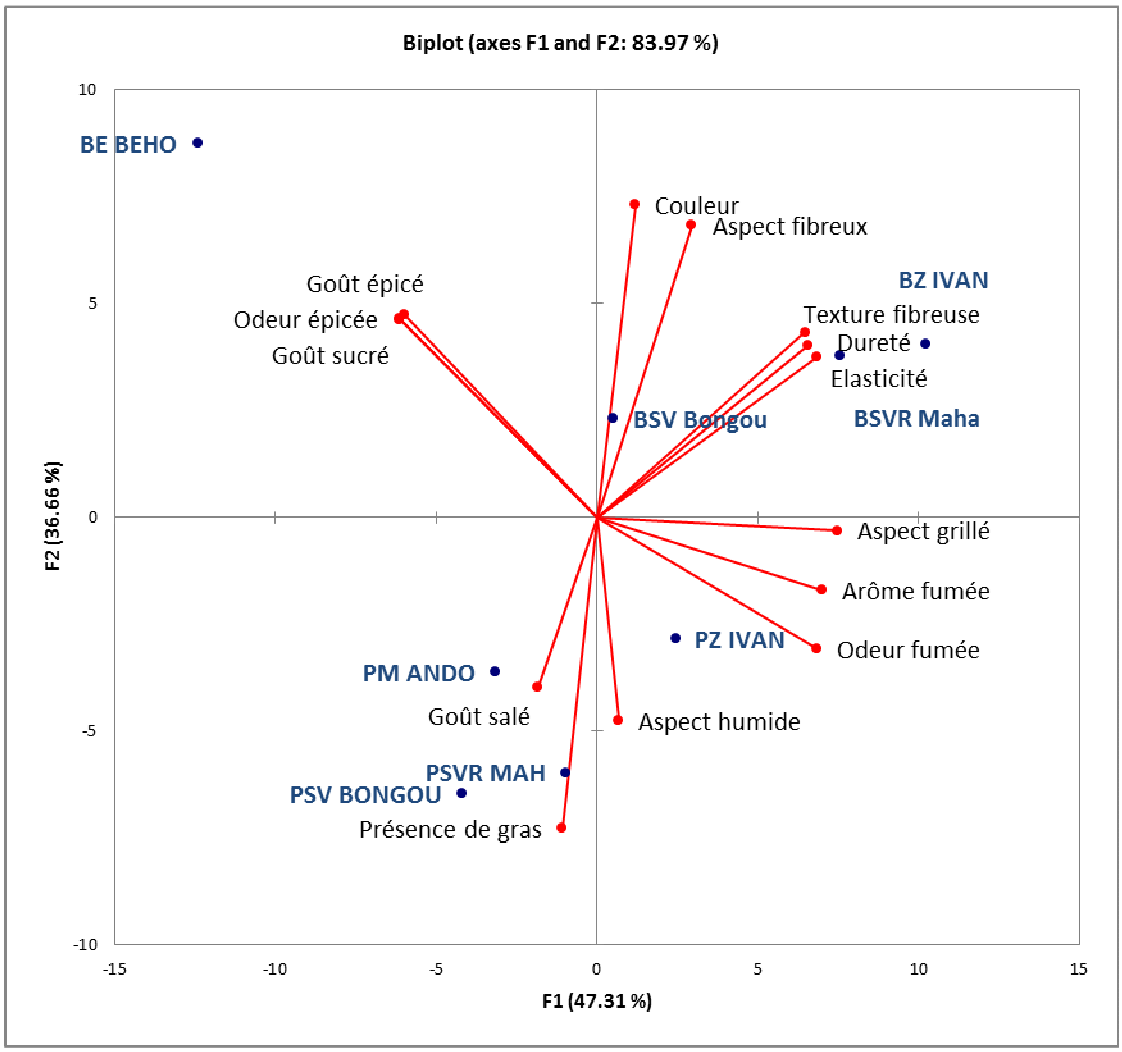

Figure 1: Principal component plot illustrating the relationship between the sensory descriptors and the Kitoza tested (eight samples)

Legend:

Odeur fumée: Smoked smell
Odeur épicée: Spicy smell
Couleur: Colour
Aspect humide: Wet aspect
Présence de gras: Presence of fat
Aspect fibreux: fibrous aspect
Aspect grille: grilled aspect
Dureté en bouche : Hardness in mouth
Elasticité en bouche: Elasticity in mouth
Texture fibreuse: Fibrous texture in mouth
Gout épicé: Spicy taste
Gout salé: Salty taste
Gout sucré: Sweet taste
Arôme fumé: Smoked aroma

One the one hand, the samples PSVRMaha, PMAndo and PSVBongou were associated to fat aspect and salted taste contrary to fibrous aspect and colour. On the other hand, BSVRMah and BZIvan were associated in elasticity and hardness and fibrous aspect. BEBeho and

PZIvan were singles: BEBeho is in spicy smell, spicy and sweet tastes in opposite to PZIvan which is in smoked and aroma smells. BSVBongou was deselected.

Sensory profile of smoked Kitoza is not susceptible to be influenced by packaging if vacuum packed or traditional. Observations of the PCA representation showed that there was a clear difference between pork and beef samples. Pork samples were more associated to fatty and salty sensations while beef samples differed in their sensory perception.

Table 2: Means and probabilities for sensory testing with respect to smoked Kitoza and sensory panellists

	Smell			colour		aspect					
Descriptor/ Sample	Smoked smell	Spicy Smell				Hudid aspect	Fat aspect	Fibrous aspect	Grilled aspect	hardness	elasticity
BZ IVAN	5±2.15 b	1,44± 1.54c		6,14± 1.57a		5,03±2 .33b	0,67±1 .09d	6,44± 2.27a	6,32± 1.77a	7,03±1 .45a	6,86± 1.81a
PSVR MAH	5.07±2 .31b	1.54± 2.03c		2.48± 1.21c		4.2±1. 85c	2.92±2 .52a	3.36± 1.93d	4.63± 1.75b	2.44±1 .47de	2.22± 1.97d
BE BEH O	1.39±1 .8e	6.89± 1.82a		6.54± 1.86a		3.08±1 .75d	0.47±1 .22d	5.65± 1.89b	2.43± 1.98d	2.37±1 .61de	2.68± 2.01d
PM AND O	3.86±2 .02d	2.36± 2.4b		1.47± 0.99d		5.82±1 .94a	1.43±1 .84c	3.91± 2.3cd	3.93± 1.62c	2.51±1 .54d	2.29± 1.78d
PZ IVAN	4.59±2 .18bc	1.32± 1.94c		2.55± 1.63c		4.98±2 .07b	2.32±2 .05b	3.97± 2.04c	4.67± 1.74b	4.41±2 .27c	4.13± 2.63c
PSV BON GOU	4.07±2 .21cd	2.53± 2.4b		1.78± 0.94d		4.74±2 .05bc	2.74±2 .08ab	1.91± 1.32e	4.79± 1.69b	1.89±1 .34e	2.14± 1.9d
BSVR MAH	6.04±2 .03a	2.28± 2.26b		5.69± 1.66b		2.77±1 .89d	0.32±0 .79d	5.63± 1.71b	6.51± 1.51a	5.84±2 .12b	5.31± 2.61b
BSV BON GOU	4.18 ±2.05c d	2.34± 2.21b		6.48± 1.58a		3.26±1 .72d	0.49±0 .83d	4.16± 1.78c	4.99± 1.66b	4.36±2 c	4.46± 2.62c
Sample	<0.000 1 ***	<0.00 01 ***		<0.00 01 ***		<0.000 1 ***	<0.000 1 ***	<0.00 01 ***	<0.00 01 ***	<0.000 1 ***	<0.00 01 ***
Panellist	<0.000 1 ***	<0.00 01 ***		<0.00 01 ***		<0.000 1 ***	<0.000 1 ***	<0.00 01 ***	<0.00 01 ***	<0.000 1 ***	<0.00 01 ***
Sample x panellist	<0.000 1 ***	<0.00 01 ***		<0.00 01 ***		<0.000 1 ***	0.0071 **	<0.00 01 ***	<0.00 01 ***	<0.000 1 ***	0.009 9**

.	texture		taste		Flavour (aroma)	

Descriptor/ Sample	Fibrous texture		spicy	salted	sweet		smoked	
BZ IVAN	6.34±2.08a		2.04±1.91c	3.69±1.58d	0.18±0.39b		5.57±2.55a	
PSVR MAH	2.87±2.06de		1.84±1.94c	5.53±1.51a	0.29±0.74b		4.84±2.39b	
BE BEHO	3.3±2.27d		6.36±1.87a	4.09±1.39cd	2.01±1.83a		1.16±1.65e	
PM ANDO	2.86±2.07de		2.29±2.35c	3.96±1.62cd	0.3±0.59b		3.02±2.41d	
PZ IVAN	4.4±2.55c		1.22±1.72d	3.77±1.45d	0.19±0.36b		3.71±2.32c	
PSV BONGOU	2.3±2.09e		2.91±2.36b	5.31±1.35ab	0.41±0.8b		3.86±2.57c	
BSVR MAH	5.48±2.46b		2.17±2.07c	4.29±1.8c	0.2±0.36b		5.22±2.37ab	
BSV BONGOU	4.29±2.49c		3.17±2.46b	5±1.36b	0.39±0.69b		3.42±2.45cd	
Sample	<0.0001***		<0.0001***	<0.0001***	<0.0001***		<0.0001***	
Panellist	<0.0001***		<0.0001***	<0.0001***	<0.0001***		<0.0001***	
Sample x panellist	<0.0001***		<0.0001***	0.0003***	0.0013**		<0.0001***	

*Intensity of sensory attributes was scored a 100mm scale. Average (standard deviation).
Differences between the samples (a, b, c, d or e in columns) were determined by the LSD method.
Sample × panellist interactions for some of the attributes are probably because it was not possible to provide standards and because the panel was semi-trained and some attributes were more difficult to assess.

The Kitoza was evaluated by a sensory panel who scored colour, smell, aspect, taste, texture, taste and aroma using the scale in the software Fizz.

First, the sample with the most smoked smell was the BSVRMaha and the less smoked was the BEBeho. This last had the most spice smell. The less spicy smell was the BZIvan that was not significantly different from PSVRMaha and PZIvan ($p<0.0001$). PMAndo and PSVBongou were scored less in terms of colour, contrary to the BZIvan, BEBeho, BSVBongou whom were the most cultured and that were in accordance with the type of meat (beef is a red meat and pork a white meat).

Next, concerning the Kitoza aspect, first, PMAndo was the most humid and BEBeho, BSVRMaha and BSVBongou were the driest. PSVRMaha was the sample which presented the fattiest contrary to BEBeho, BSVRMaha and BSVBongou. Thereafter, BZIvan was the most fibrous contrary to PSVBongou. In addition, BZIvan was the most grilled and that was not significantly different from BSVRMaha ($p<0.0001$), the BEBeho was the less grilled. The sample the most dough was the BZIvan and the less was PSVBongou and it was in relation with the type of meat. PSVRMaha was the less elastic and that was not significantly different from BEBeho, PMAndo, PSVBongou ($p<0.0001$), and the most elastic was the BZIvan.

Besides, in terms of texture in mouth, the sample the most fibrous was the BZIvan and the less were the PSVRMaha, PMAndo, PSVBongou.

Finally concerning the taste, BEBeho was the spiciest and PZIvan was the less spicy. PSVRMaha is the most salted and BZIvan with PZIvan were the less. Besides, BZIvan was the sample the less sweetly and BEBeho is the most sweet and this result was in accordance with the Kitoza ingredients.

The sample which had the most smoked aroma was the BZIvan and the less smoked was BEBeho and that was in accordance with the smoked duration.

Annex 3 – detailed report for Kong

Sensory and Consumer testing of smoked fish *Arius heudelotti*

Nicolas AYESSOU [a], Mady CISSE [a], Aurélie BECHOFF [b], Ndeye Mariama DIATTA [a], Cheikh TOURE [c] and Keith TOMLINS [b]

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

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

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

ABSTRACT (max 300 words)
Kong smoked fish is a popular food product in Senegal. Previous surveys and studies have accurately described the value chain, microbiological, chemical quality and process. However, no prior work has explored sensory tasting of smoked Kong. This deliverable makes investigations on consumers' sensory perception and likings of smoked Kong. Four samples were produced for the sensory test: Kong was smoked with wood only and or with wood/coconut. For the sensory evaluation, smoked kong only and smoked kong in sauce and were scored by a semi-trained sensory panel. Then, 109 consumers were interviewed. Acceptability was only evaluated on smoked kong. The results show that all four samples were quite distinctive from each other but not when in sauce. Most of the Kong products were on average acceptable but moist kong had a better acceptability than dried kong samples submitted to the same processes of smoking. Consumers were segmented into two three groups as: "indifferent likers" (27%), "dry kong dislikers" (15%), and "dry Kong less preferred" (59%). Clusters really differed in terms of professional activity in fish sector but did not significantly differ in the frequency of consumption. Therefore it appears that, smoked Kong is a main product of consumption in the Senegalese market. Since more than 50% of consumers consumed smoked Kong at least once a week, it appears that Kong is a main product of consumption with a strong potential for the Senegalese market but also for the international market.

Introduction

The fish *A. heudelotti* called "Kong" belongs to a Family of fish (Ariidae) whose representatives are often subject to hot smoking in the tropics (Knockaert, 1999; Goueu, 2006, Da Silva et al., 2008; Salaaudeen et al., 2010). Smoking techniques used are still traditional and the conditions of handling and storage expose consumers to high health risks. Thus, in some African countries these smoked fish have been evaluated through microbiological quality (Bukola, et al., 2008; Salaudeen et al., 2010) and chemical (Jonsyn and Lahai, 1992; Goulas and Kontominas, 2005). D.1.2.5.2 deliverables that address the microbiological quality of A. heudelotti sold in some important markets of Senegal brings to the conclusion showed that 40% of samples have satisfactory quality. However, no prior work has not yet integrated sensory tasting of smoked Kong. However, outside beyond the preservation objectives, smoking is important because it gives the finished product specific organoleptic

characteristics desired by consumers in Africa. This deliverable makes investigations on consumer's sensory preferences and quality attributes of smoked Kong.

Materials and Methods

Previous surveys during the evaluation of value chain described two processes (wet and dry) and two methods used for smoking (wood and wood plus coconut) *A. heudelotti* in Senegal in order to get two types of end-products. Based on this, four samples were produced for the sensory test (table I).

Table 1. Nomenclature of samples used during sensory test

Sample type and conditions of production	wood and coconut-smoked humid kong	wood-smoked dry kong	wood-smoked humid kong	wood and coconut-smoked dry kong
Abbreviation*	Kong H-T	Kong S-B	Kong H-B	Kong S-T

*From the French; H stands for 'humide'= humid; S stands for 'sec'= dry; T 'tout' = total = different types of combustibles; B = 'bois' = wood

Both dry and wet smoked Kong were produced with two combustibles: wood only and wood /coconut. During a focus group organized a sauce recipe has been discussed and proposed for inclusion in the sensory testing approach. The sauce was prepared with very little seasoning to minimize its influence on the assessment of smoked fish. A total of 20 litres of sauce was prepared and divided into four different samples to receive appropriate smoked fish. After adding the smoked fish, these sauces have were left to simmer for 15 minutes.

Consent was sought from sensory panellists and from adult consumers participating. Enumerators informed participants about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point and that the responses would be anonymous.

Sensory evaluation

Smoked kong only and smoked kong in sauce were scored by a semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided (Meilgaard *et al.*, 2007; Tomlins *et al.* 2012). The panel was composed of university technicians, students or private company employees (19 people in total). Sessions were conducted at Cheikh Anta Diop University of Dakar (Senegal) in air conditioned room with controlled lighting and ambient temperature (22 to 25^{o}C). The language used for the sensory tasting was French. The panellists had been screened for familiarity with the product. Sensory attributes were generated during a preliminary focus group session guided by the panel leader. A total of 13 sensory attributes were generated and are as follows (English translation):

- Yellow-gold
- Brown
- Clean appearance
- Fleshy
- Odour of wood
- Odour of smoke
- Smell pungent
- Firm texture
- crusty
- Dry and harsh
- Taste of smoked flavour
- Salty test

- Bitter taste

After a period of training using these attributes, all four samples (smoked kong only and then in sauce) were tested blind in triplicate by the panel and the order in which they were presented was random. At each session, samples (coded with 3-figure random numbers) were served in transparent plastic plates in random order to each panellist. Intensity for the sensory attributes generated was scored on a 100 mm unstructured scale, anchored with the terms 'not very' at the low end and 'very' at the high end.

Consumer acceptability

Consumers (109) were interviewed at three different areas in Dakar using the central location method (Meilgaard *et al.*, 2007). These were the following: University of Dakar (42) a site processing of fishery products located in a fishing district, Yoff Tonghor (50) and Soumbedioun (17). All Consumers were from African (mainly Senegalese).

During acceptability testing, each consumer was invited to taste smoked kong presented in random order and coded with three figure random numbers. Consumers were asked to score the acceptability with respect to appearance, taste and overall liking using a nine-point verbal hedonic box scale which varied from dislike extremely to like extremely (Meilgaard *et al.* 2007). Smoked kong in sauce is not tested for consumers acceptability.

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

Statistical Analysis

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

Results and Discussion

Sensory tasting

The PCA representation accounted for 99.59% of the total variation for the Kong fish only (figure 1) and for 99.62% of the total variation for the Kong fish in the sauce (figure 2), which was excellent. The F1 axis accounted for 97.49% and 96.81 respectively whilst the F2 axis only accounted for 2.10% and 2.82% respectively. Therefore the horizontal axis F1 accounted for most of the variations in the samples of Kong fish only and Kong fish in the sauce (Figures 1, 2).

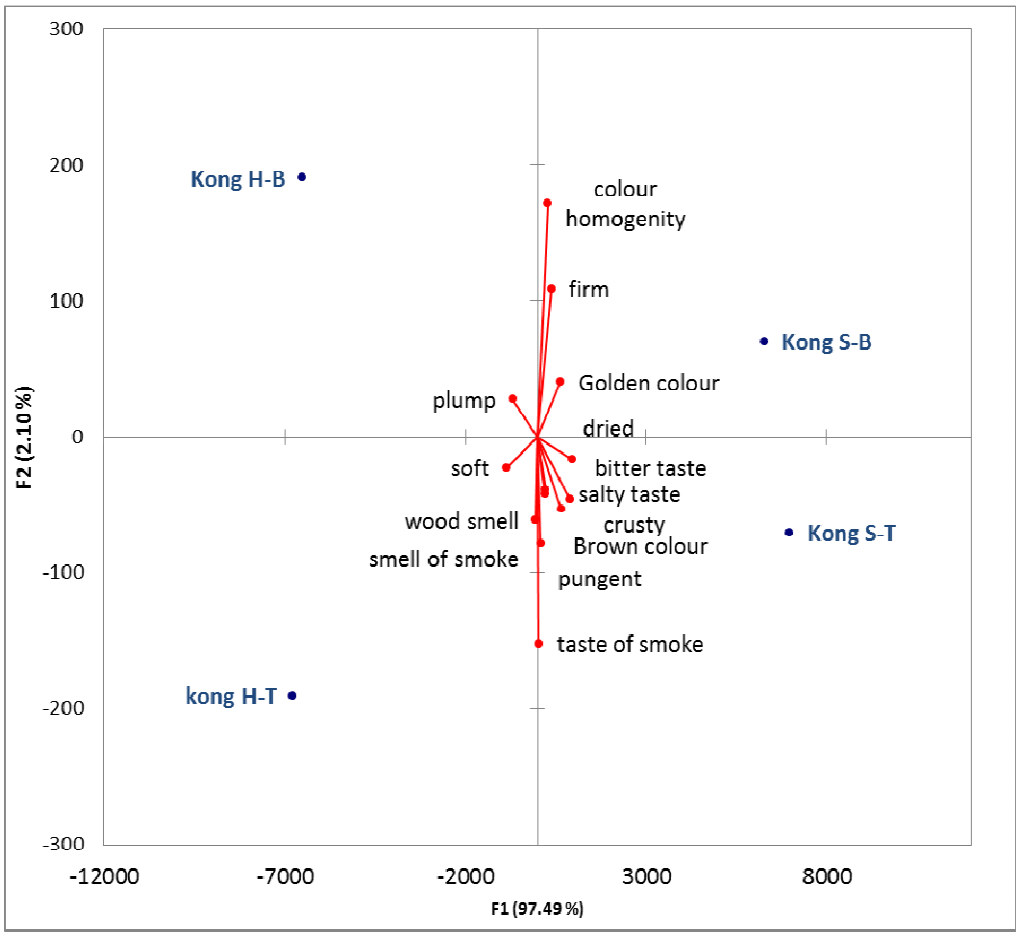

Figure 1. Sensory scoring of the clusters on the descriptors for the Main test - Kong only (99.59% of total variation)

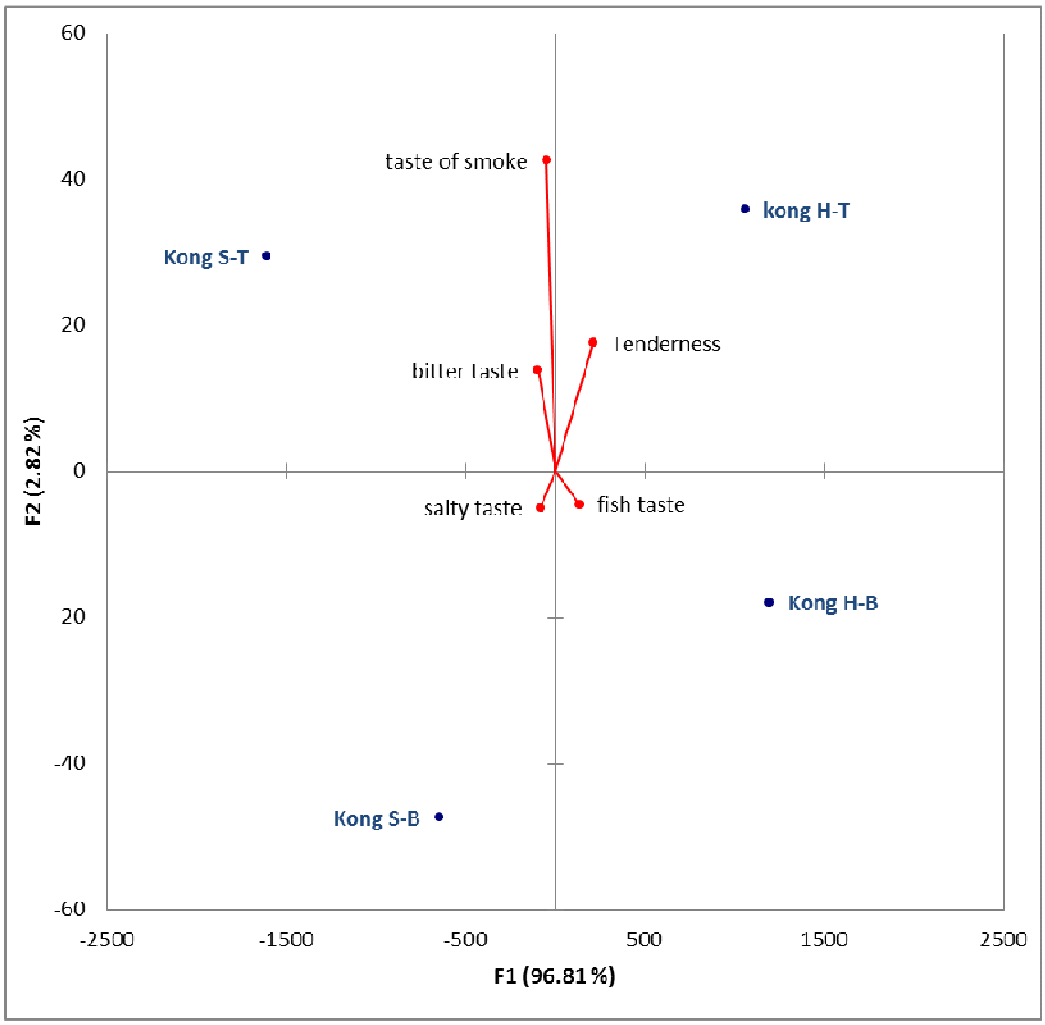

Figure 2. Sensory scoring of the clusters on the descriptors for the Main test -Kong in the sauce (99.62% of total variation)

In both cases all four samples were quite distinctive from each other. These results advised to work with each of these samples for consumer testing. But the length of the attributes' lines was short for the Kong in the sauce, which means that there were few variations in the samples, meaning panellists were not able to make very clear judgements about the samples in the sauce. For the consumer testing it was advised to work with the four samples of Kong fish only.

Consumer acceptability

Table 2 shows the overall acceptability for each of the four Kong samples products tested independently of the type of consumer. Overall, the acceptance of the Kong samples significantly differed between the five samples at $p<0.01$ (One-way ANOVA).

Table 2. Mean overall acceptability scores for the four Kong samples tested

Abbreviation	Kong H-T	Kong S-B	Kong H-B	Kong S-T
Sample name	wood and coconut-smoked humid kong	wood-smoked wood dry kong	wood-smoked humid kong	wood and coconut-smoked dry kong
Average	7.8	5.7	7.4	5.5
Standard deviation	0.9	1.8	1.3	1.8
letter	b	a	b	a

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

Most of the Kong products were on average acceptable since the mean scores were equal or greater than a score of 5 (neither like nor dislike). But there was a clear distinction in terms of acceptance between the dried kong and humid kong. Humid kong samples (wood and coconut smoked and wood smoked) overall had a better acceptability than dried kong samples submitted to the same processes of smoking.

Hierarchical cluster analysis (Wards method) was used to segment the consumers interviewed at the different locations into different groups. A division into three clusters was suggested by the program since a larger number of clusters would have produced clusters that contained too few consumers and additional smaller clusters were sub-sets of larger ones. Thus segmentation gives a more complex variation in acceptability among the consumers than the overall means previously indicated above (in Table 2).

The mean liking for each of the four groups is illustrated in Figure 3. We used a score of five 'neither like nor dislike' as an indicator of "neutral attitude". Products rated below five were considered as "disliked" and above five as "liked".

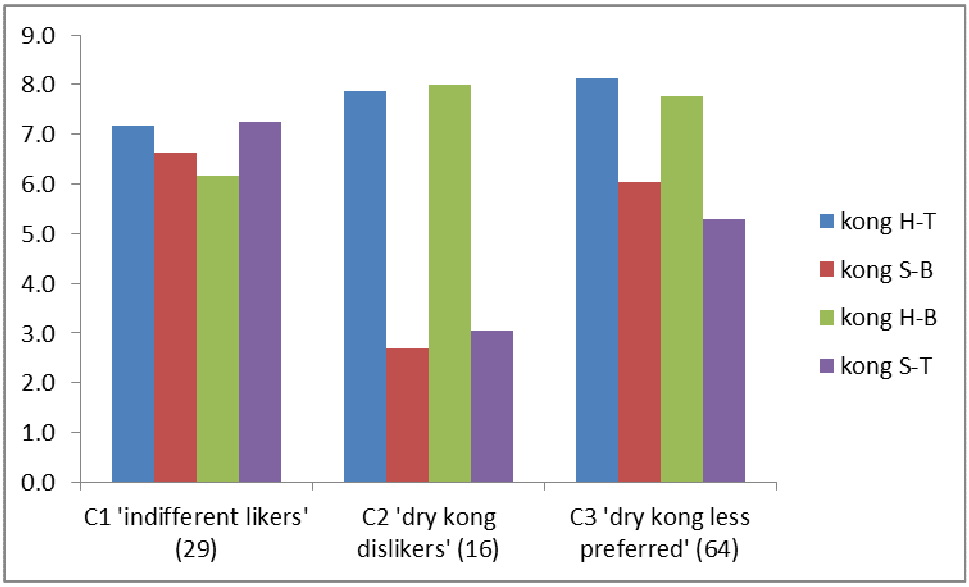

Figure 3. Mean consumer acceptance of Kong fish by cluster type (Number of consumers =109)

For the purposes of cluster division, the groups were grouped as “indifferent likers” (27%), “dry kong dislikers” (15%), and “dry Kong less preferred” (59%).

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

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

Question	**Probability** Chi Square test ($p<0.05$)
Age	0.493
Gender	0.219
Marital status	0.660
Number of consumers per household	0.542
Education	0.337
Professional activity	0.072
Professional activity in fish sector	0.030*
Most consumed form of kong	0.072
Form of Kong that is bought (dry or humid)	0.124
Frequency	0.663
Place of purchase	0.039*
Place of consumption	0.563
Form of kong that is mostly liked (dry or humid)	0.006*

***significant at $p<0.05$;**

The three clusters did not significantly differ in terms of sociological criteria such as age, sex, residency, education level, marital status. However clusters differed in terms of professional activity in fish sector. Those consumers who were working in the fish sector liked all types of smoked kong and hence were mostly in clusters 1 and 3. Only 5% of those consumers were in cluster 2 (Figure 4).

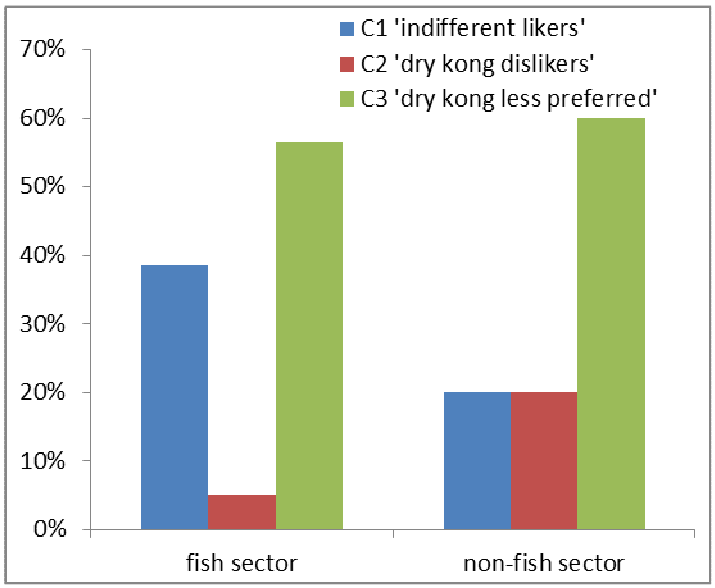

Figure 4: distribution of cluster within professional activity

Clusters also differed in the place of purchase (figure 5). Consumers from cluster 3, (all kong likers but distinguished between the types of kong (=‘expert consumers) tended to buy more from the market. ‘Dry kong dislikers’ (cluster 2) did not buy from the traditional/local processor.

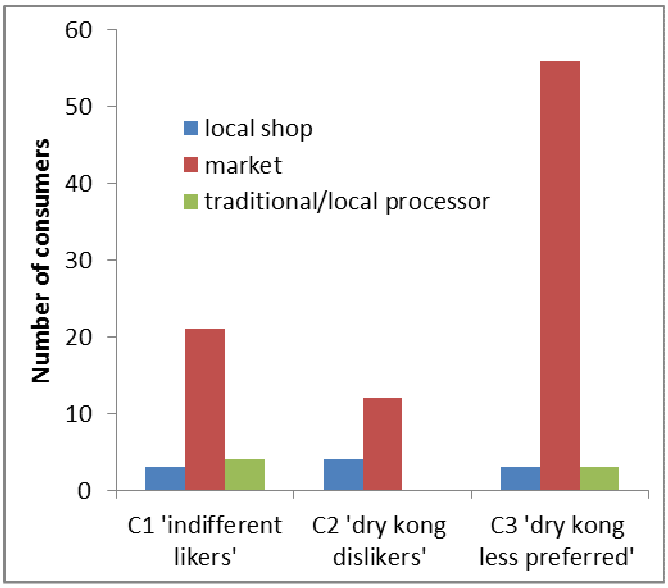

Figure 5: Clusters’ place of purchase preference

Indifferent likers indicated that they liked dry kong most whereas ‘dry kong dislikers’ obviously reported that they liked wet kong most. The “expert” consumers (cluster 3) indicated they liked both types but with a preference for the wet kong form. This shows that the consumers ‘acceptance is in agreement with what they actually reported.

Considering the importance of smoked kong in culinary habits of Senegalese, the data's analysis proves that clusters did not significantly differ in the frequency of consumption. Over fifty percent of consumers consumed Kong fish at least once a week (figure 6). Therefore it appears that, smoked kong is a main product of consumption in the Senegalese market.

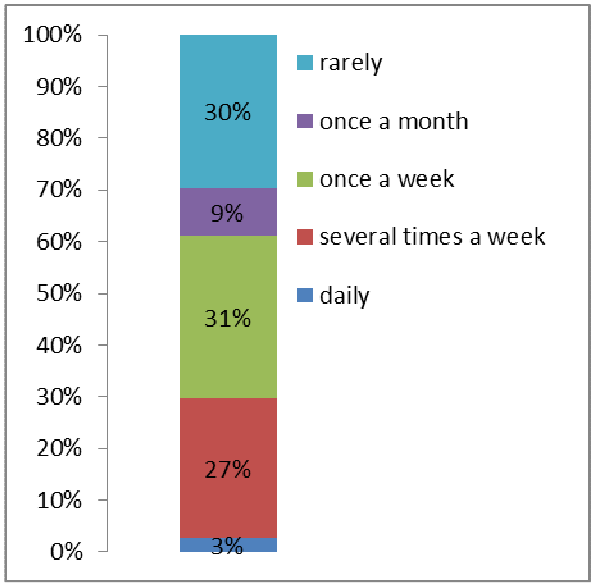

Figure 6. Frequency of consumption of Kong

Relationships between sensory attributes and consumer acceptance

Sensory attributes were related to consumer's acceptance to reveal any correlation. In fact, appreciation of any food lays is linked before on to its biochemical composition that ensues from the raw material and the processing applied. Pearson test was used to reveal any relationships between all parameters (table 7). allowed some important conclusions.

The study of relationships between chemical parameters allowed concluding that humid kong samples had a better acceptability than dried kong samples. The acceptability of 'Indifferent likers' (C1) did not correlate with most of the sensory attributes (only taste of smoke…). 'Dry kong dislikers' (C2) had a stronger negative response than 'dry Kong less preferred' consumers (C3) on brown colour, golden colour, salty taste, crusty, dried, firm. 'Dry kong dislikers' and (C2) had a more positive response than 'dry Kong less preferred' consumers (C3) on plum, soft characteristics of the product.

Table 7. Relationships between clusters and sensorial and physical parameters

	Variables	Global sensory acceptability	C1 "indifferent likers"	C2 "dry kong" strong dislikers	C3 "dry kong" less preferred consumers
Sensory attributes	Brown colour	**-0.973**	0.374	**-0.994**	**-0.967**
	Golden colour	**-0.998**	0.257	**-0.984**	**-0.990**
	colour homogeneity	-0.913	-0.209	-0.842	-0.863
	plump	**0.984**	-0.344	**0.993**	**0.978**
	taste of smoke	-0.068	**0.968**	-0.195	-0.157
	salty taste	-0.935	0.465	**-0.980**	-0.933
	bitter taster	-0.948	0.489	-0.933	**-0.982**
	smell of smoke	0.689	0.562	0.632	0.585
	pungent	-0.631	0.792	-0.602	-0.742
	wood smell	0.523	0.667	0.504	0.390
	crusty	**-0.982**	0.353	**-0.993**	**-0.977**
	dried	**-0.983**	0.314	**-0.998**	**-0.969**
	firm	**-0.989**	0.053	**-0.950**	**-0.960**
	soft	**0.987**	-0.271	**0.999**	**0.967**
	Kong+sauce taste of smoke	-0.540	0.874	-0.534	-0.657
	Kong+sauce salty taste	**-0.970**	0.348	-0.925	**-0.996**
	Kong+sauce bitter taste	-0.907	0.514	-0.866	**-0.962**
	Kong+sauce fish taste	0.945	-0.506	0.937	**0.977**
	Kong+sauce Tenderness	**0.977**	-0.406	**0.966**	**0.993**

Values in bold are different from 0 with a significance level alpha=0.05

Conclusion

Smoked Kong is a very popular food in Senegal. The consumer acceptability demonstrated that smoked kong samples were all very appreciated by Senegalese consumers interviewed (all clusters). In fact, the different clusters of consumers: 'indifferent likers' (27%), 'dry Kong dislikers' (15%), and 'dry kong less preferred 'group (59%) did not significantly differ in the frequency of consumption. While submitted to the same processes of smoking, dried and humid smoked Kong were quite distinctive from each other but not when in sauce. For a future re-engineering stage it seems clear that either humid or dried Kong options must be more explored. Therefore in addition, the re-engineering stage would have to take shelf-life into consideration appears to be the bottleneck especially in particular for when promoting humid smoked Kong.

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