African food tradition revisited by research

Project coordinator : Cirad
www.after-fp7.eu

African Food Tradition rEvisited by Research
FP7 n°245025

Start date of project: **01/09/2010**
Duration: **45 months**

Deliverable number: D 5.3.2.1

Title of deliverable: Initial report on sensory and African consumer acceptance for Group 1

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

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

Contractual date of delivery: September 2011 (month 12)

Actual date of delivery: July 2012 (month 22)

Work-package contributing to the deliverable: WP 5

Organisation name of lead contractor for this deliverable: **NRI / ESB**

Authors (in alphabetical order by family name): Laurent Adinsi, Zahra S. Ahmed, Noel Akissoe, Mary Amengor, Wisdom Amoa-Awua, Victor Anihouvi, Theophilus Annan, George Anyebuno, Aurelie Bechoff, Ben Bennett, Generose Dalode, Anne-Laure Declemy, Charles Diako, Matilda Dzomeku, Genevieve Fliedel, Habiba Hassan-Wassefa, Djidjoho Joseph Hounhouiagan, Mary Obodai, Charlotte Oduro-Yeboah, Hayford Ofori, Margaret Owusu, Dominique Pallet, Carole Sacca, Abdel Aati Shahat, Keith I. Tomlins and Charles Torto

This document has been send to :

The coordinator by WP Leader	Date: July 2012
To the Commission by the Coordinator	Date: July 2012

***** 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

The sensory profiles and acceptability of Akpan, Gowe, Akpan and Kishk Sa'eedi were tested using a focus group discussion, a quantitative descriptive panel and consumer panels comprising African and/or European consumers as indicated in the table below. It should be noted that consumer testing of Kishk Sa'eedi was delayed because of the current social unrest in Egypt. The number of consumers interviewed by product and country is summarised in the table below.

		Consumer Class (and number)	
Country	**Product**	**African**	**Non-African**
Benin	**Akpan**	103	74
Ghana	**Kenkey**	110	90
Benin	**Gowe**	141	-
Egypt	**Kishk Sa' eedi**	-	-

Sensory testing indicated that for each product, the sensory profiles widely differed. This was influenced by the raw material (Kenkey, Gowe, Akpan, KS), process (Kenkey, Akpan and KS) and addition of sugar/milk (Akpan and Gowe).

The products also differed according to acceptance.

Akpan - African and non-African consumers behaved differently with respect to acceptability. Europeans generally had a lower acceptability of Akpan products compared to Africans. This was probably due to the fact that most Europeans were not familiar with the product since when Europeans did report consuming Akpan, there were no differences in acceptability. Consumers' acceptance was significantly associated with fermented odour and milky taste. African consumers were more sensitive to the thick/concentrated texture and cereal taste whilst Europeans were more positively influenced by sweet taste but negatively by acidic taste.

Kenkey – African and non-African consumers differed in acceptance of Kenkey. Non-African consumers mostly preferred the white kenkey and to a lesser extent banku. Ghanaian consumers generally liked all of the samples or preferred banku. Sensory attributes important for the white likers were whitish colour, fruity odour, smooth and non-sticky texture, a less sour product without a pronounced fermented odour, and a bland taste. Salty taste correlated significantly with acceptance for the banku likers,

Gowe - The commonly consumed gowe were sensorially distinct products with differences between the sorghum and maize samples of gowe, but no significant difference was noted with sugar was added. Regarding consumer testing, three distinct patterns of consumer acceptability were observed, which were grouped as 'Sugary Gowe likers' or "Natural sorghum Gowe dislikers" (63.1%) followed by 'Sugary sorghum Gowe likers' (20.6%) and 'Indifferent Gowe likers' (16.3%). Saccharified malted and no-malted sorghum Gowe without sugar were the least preferred.

Kishk Sa'eedi (KS) has distinct sensory attributes and variation. Consumer acceptance has still to be completed.

The conclusions for reengineering are as follows:

Akpan – there are two options being products suited to a) Akpan from Maize Ogi containing Sugar and Milk (OMsm) or b) Akpan from Ogi Sorghum containing Sugar and Milk (OSsm). However, since they are representative of classes of akpan type, any of these two classes could be suited for the reengineering. That is the case of OMs or OSs membership of OMsm and OSsm respectively.

Kenkey - Two products should be considered, one adapted to both the European and the Ghanaian consumer 'white likers' and the second adapted to only the Ghanaian consumer 'all likers and 'banku likers'. Important sensory attributes which should guide re-engineering of the first product are whitish colour, fruity odour, smooth and non-sticky texture, a mildly sour product, and a bland taste. This may be achieved by a combination of processing factors including dehulling of maize kernels, use of mixed lactic acid bacteria/yeast starter culture containing high concentration of yeasts cells (for fruity odour), reduced fermentation period (to reduce sourness and fermented odour) and elimination of the aflata step (to reduce sticky texture). The second product should be a refinement of Ga/Fanti Kenkey and should also focus on improved packaging.

Gowe - Gowe made from saccharified malted sorghum with sugar (SSaSFs) was the most accepted and appears to be the most promising for reengineering.

KS – the consumer testing will take place later in 2012

These findings should be considered in combination with other AFTER deliverables relating to market and regulatory issues and technical feasibility.

Background

This deliverable report refers to the sensory and African consumer acceptance for Group 1. Group 1 products include the cereal based products; Akpan and Gowe (Benin), Kenkey (Ghana) and Kishk Sa'eedi (Egypt).

Methodology

The methodology is based on D5.2.1 but specific detailed methodology for each product is given in annexes 1 to 4 for Akpan (Benin), Kenkey (Ghana), Gowe (Benin) and Kishk Sa'eedi (Egypt) respectively.

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	Akpan	103	74
Ghana	Kenkey	110	90
Benin	Gowe	141	-
Egypt	Kishk Sa' eedi	-	-

Results

For each product, the summary and detailed reports are given in annexes for Akpan, Kenkey, Gowe and Kishk Sa'eedi respectively. The table and figure numbers refer to each annex respectively.

Annex 1 – detailed report for Akpan

Sensory profile and acceptability of Akpan

Noel Akissoe[a*].,Carole Sacca[a]., Anne-Laure Declemy[b]., Aurelie Bechoff[c]., Keith I. Tomlins[c]., Victor Anihouvi[a]., Generose Dalode[a]., Genevieve Fliedel[b], Dominique Pallet[b] and Djidjoho Joseph Hounhouiagan [a]

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

[b] CIRAD Montpellier, France TA B-95 / 16, 73 rue Jean-François Breton, 34398 Montpellier Cedex 5, France

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

*Corresponding author: E mail: noel.akis@yahoo.fr

ABSTRACT (max 300 words)
The sensory profile and acceptability of Akpan drinks were tested using a focus group discussion, a quantitative and descriptive panel and a consumer panel including African and/or European consumers. For this purpose, the sensory profile of Akpan was established with twelve Akpan types by 17 semi-trained panellists. Among tested Akpan, five different representative samples were evaluated by 177 consumers. PCA on sensory data revealed the effects of raw material, process and addition of sugar/milk. Furthermore, a cluster analysis indicated that African and European consumers behaved differently with respect to acceptability. Europeans generally had a lower acceptability of Akpan products compared to Africans. This was probably due to the fact that most Europeans were not Akpan consumers. For those Europeans who consume Akpan, there were no differences in the cluster dispersion and in acceptability. Consumers' acceptance were significantly associated with fermented odour (r=-0.94) and milky taste (r=0.92-0.97). Understanding acceptability of different types of consumers is important when doing a marketing study on a novel product for the European market such as Akpan. Africans were more sensitive to the thick/concentrated texture and cereal taste whilst Europeans were more positively influenced by sweet taste but negatively by acidic taste.

CONCLUSIONS RELATING TO REENGINEERING (MAX 200 WORDS)
With respect to acceptance the reengineering approach appears to have two options being products suited to a) Akpan from Maize Ogi containing Sugar and Milk (OMsm) or b) Akpan from Ogi Sorghum containing Sugar and Milk (OSsm). However, since they are representative of classes of akpan type, we can expect that anyone of each of the two classes could be suited for the reengineering. That is the case of OMs or OSs membership of OMsm and OSsm respectively.

Furthermore, for the reengineering purpose, new form of akpan such as akpan powder with instant use can be experienced.

Introduction

Street foods are part of catering business in developing countries, particularly in urban areas. Most of these products are ready-to-serve or ready-to-eat foods, sometimes under poor cooking and trading conditions which can lead to poor nutritive value and low hygienic quality. Among a variety of products collected as street foods (Nago et al., 1990), traditional beverages from cereal are of high importance in the diet of Beninese. The use of cereal grains as sources of fermented beverages for human consumption is well known in many African countries. As a matter of fact, besides the industrial process of drinks such as lager beer brewing, traditional long established processing technologies had developed endogenous drinks or beverages based on local cereal. They include alcoholic and non-alcoholic drinks or beverages such as Chakpalo, Tchoukoutou, Gowe and Akpan in Benin (Adandé, 1984; Nago, 1989; Hounhouigan, 1994), kunu in Nigeria (Gaffa, et al., 2002), muramba and bushera in Ugandan (Mukuru, 1992; Muyanja, et al., 2003). Akpan is a vegetal yogurt-like product traditionally prepared from ogi in Benin. As ogi beverage, Akpan has a widespread level of consumption, popularity and high demand. Ogi is a fermented cereal starch extracted from maize/sorghum/millet and used in a variety of ways to make porridge, beverage and a solid gruel (akassa).

Preliminary and recent survey revealed that different types of Akpan exist based on the raw materials and the processing technology which resulted from endogenous innovative actions of producers. The variability in the raw materials and processing methods used can lead to high inconsistency in the nutritional, microbiological and sensory qualities of Akpan. In traditional practice, Akpan is kept at ambient temperature (24-30 °C) for several days. It can be rolled up into balls and packed in leafy vegetables for selling. Generally, Akpan is a ready-to-serve product with a shelf-life of about 2 days. However, Akpan can be kept for up to 8 days at 4°C (Madodé, 2003). As a wet starchy product, fermentation continues during storage, and Akpan becomes too sour after one week and it is rejected by consumers.

Information on Akpan is limited to the description of the product (Adandé, 1984; Nago, 1989 and Hounhouigan, 1994) and a little attempt to upgrade its production process (Mestres, 2001; Madodé et al., 2003). Like many other indigenous fermented products of cereals grains, Akpan is valued for the sugary and light sour taste and aroma active components naturally produced or added during consumption. Up to now, there is no objective information on the sensory attributes of the types of Akpan, considering that the variance of Akpan types can result in the variability of sensory attributes poorly documented. Although previous works (Mestres, 2001; Madodé et al., 2003) indicated specific and qualitative sensory attributes of Akpan, the sensory profile of the types of Akpan needs to be set up in a view of handling the target criteria that match market demand.

Furthermore, consumers acceptability of Akpan should be subject of great concern, as the recent innovative practice in developing new forms of Akpan can represent a commercial fraud or fit consumers demand. Consequently, consumers' acceptability of

Akpan needs to be quantified together with factors that influence acceptance in a way of obtaining objective information for the reengineering of the process.
This work was undertaken to map Akpan samples in relation with the sensory attributes and to test consumers' acceptance.

Materials and Methods

Samples

White maize grains (*Zea maize*) and red sorghum grains (*Sorghum bicolor* (L.) Moench) were purchased from international market of Dantokpa (Benin). Traditional samples of Akpan were prepared by two skilled local processors using traditional methods described by Carole et al. (2012) but working under good conditions of hygiene/sanitation. In addition, one bottled commercial Akpan named *Cerealait* was purchased at local market. The list of Akpan types used for sensory testing was presented in Table 1.

Table 1 Samples of Akpan for sensory profile

Types of Akpan	Basic Processing technology	Existing Forms	**Initials**
maize	through ogi technology	Akpan from Maize Ogi containing Sugar	**OMs**
		Akpan from Maize Ogi containing Sugar and Milk	**OMsm**
sorghum	through ogi technology	Akpan Nature from Ogi Sorghum without any additive	**OSn**
		Akpan from Ogi Sorghum containing Sugar	**Oss**
		Akpan from Ogi Sorghum containing Sugar and Milk	**OSsm**
	kneaded fermented flour	Akpan Nature from Sorghum Flour without any additive	**FSn**
		Akpan from Sorghum Flour containing Sugar	**FSs**
		Akpan from Sorghum Flour containing Sugar and Milk	**FSsm**
mix cereals	kneaded fermented flour	Akpan Nature from mix of Sorghum+ maize Flour without any additive	**FXn**
		Akpan from Sorghum + maize Flour containing Sugar	**FXs**
		Akpan from Sorghum + maize Flour containing Sugar and Milk	**FXsm**
Commercial	Upgraded traditional technology	Cerealait	**Ism**

Where: initials 1st: process- O=ogi; F=fermented flour; 2nd: type-M=maize; S=sorghum; X=mixed; 3rd: additions; n=natural; s=sugar; m=milk

Ethical Assessment and Consent

This study has been assessed and approved by the University of Greenwich Research Ethics Committee and the University of Abomey-Calavi. Consent forms were signed by each sensory panellist and each consumer participating in this study. Participants were informed about the study and explained that their participation was entirely voluntary, that they could stop the interview at any point and that the information they provide and which is collected through written notes will be used solely for scientific purposes and

will be treated as strictly confidential. Anonymity was guaranteed and individuals will not be identified in any publication or dissemination of the study findings.

Sensory profile

The sensory profile of Akpan was established by 17 semi-trained panellists, using a simplified quantitative descriptive analysis (standards were not provided) (Meilgaard *et al.*, 2007; Tomlins *et al.* 2012). The panel was composed of university technicians and students screened for familiarity with the product. Sessions were conducted at the University of Abomey Calavi and the language used for the sensory testing was French. Panellists were first asked to generate objective vocabulary of sensory attributes (descriptors) during a preliminary focus group session using a variety of traditional Akpan (Table 1). Then, they were trained for the description of each attribute and the use of the score sheet. A list of 16 sensory attributes was then drawn up on score sheet. These were listed and clarified as follows:

- White colour – Colour characteristic of maize (white)
- Brown colour – Appearing brown in colour or colour of brown sorghum
- Concentrated aspect – Related to the ease of flow with a high proportion of solid matter
- Presence of bran- Related to particles in Akpan
- Cereal odour – Odour characteristic of cereal (related to maize or sorghum)
- Fermented odour - Aroma typical of fermented alcoholic products
- Vanilla aroma- Aroma characteristic of vanilla
- Citronella aroma - Aroma characteristic of citronella
- Grainy- Appearance of small particles
- Presence of lumps - Appearance of a mass of particles
- Taste sweet (sugary)- A taste sensation that is related to sugar
- Acidic taste – Taste characteristics of lemons
- Milky taste – Taste characteristics of milk
- Cooked taste - Taste sensation characteristic of cooked starch
- Aftertaste - Taste sensation that looks like abnormal
- Cereal taste – Taste characteristic of cereal (taste related to maize or sorghum)

Evaluations were then conducted on Akpan samples tested blind in triplicate and the order in which they were presented was randomized. At each session, four Akpan sample drinks (coded with 3-figure random numbers) were served in transparent plastic cups in random order to each panellist. Akpan was prepared before each morning and stored in the fridge until the sessions. The panellists scored the intensity of each attribute from 0 (lowest rating) to 100 mm (highest rating) by putting a mark on an unstructured line scale along the side of each attribute of the profile score sheet. Commercial bottled water was offered to rinse the mouth between samples tasting.

Consumer acceptance

Five Akpan forms were selected for consumer testing among the samples used for sensory testing:

- Akpan from Maize Ogi containing Sugar and Milk (OMsm)
- Akpan Nature from sorghum ogi without any additive (OSn)
- Akpan from Sorghum Ogi containing Sugar and Milk (OSsm)

- Akpan Nature from Sorghum Flour without any additive (FSsm)
- Akpan from Sorghum Flour containing Sugar and Milk (FSn)

Consumer acceptance was tested at different locations of Cotonou: University of Abomey Calavi, French Institute in Benin, Hotel du port, at the beach (Fidjorosse), in a restaurant in Calavi and in a bar in Godomey. 177 consumers (103 African and 74 European) were interviewed both from African and from European origins. 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). Akpan samples previously diluted with potable water were transported in cool boxes with ice. Each Akpan sample (50 mL) was presented in random order and coded with three figure random numbers. Besides acceptability data related to socioeconomic information were also collected as education, demographics, Akpan consumption and buying. Interviews were conducted in French or in the local language (Fon) if necessary. 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 were carried out using Statistica 7 (StatSoft, Tulsa, USA) or XLSTAT (V 5.2, Addinsoft). Multiple pair wise comparisons were undertaken using the Tukey test with a confidence interval of 95%.

Results

Sensory profile of Akpan

The relationships between the 12 Akpan samples and their descriptors were illustrated by Figure 1. The first two components explained 79.8% of the variability between samples. The PCA shows effects of process, raw material and addition of sugar or milk. Thus, a clear distinction between ogi and kneaded fermented flour processes is established. The cluster analysis revealed a difference between sorghum and maize samples of ogi. Ogi made with maize is whiter than ogi made with sorghum. For the fermented flour process, the addition of milk had more influence than the use of a mixed flour (sorghum/maize) since milk and sugar samples are part of the same cluster (FSsm and FXsm) whereas natural sorghum and mixed natural sorghum (FSn and FXn and FSs and FXs) are in the same cluster. However, the use of milk did not affect the characteristics of the Akpan made from ogi: the samples with sugar or milk and sugar are still in the same cluster.

In order to select the samples for consumer testing (5 samples), the cluster analysis shows five clusters with specific sensory quality (Table 2). The class of Akpan nature (without any additive) from kneaded fermented sorghum flour (FSn and FXn) is characterized by grainy mouthfeel, cereal taste, fermented odour and an aftertaste while Akpan nature from sorghum ogi is acidic. Akpan from ogi (maize or sorghum) had aroma of vanilla and/or aroma of citronella and then tasted milky. It can be observed that Ism (a newly developed akpan) was not different from traditional akpan of Ogi maize. However, the colour attributes seemed to be distinguishable for both Akpan types, with Akpan from maize ogi being essentially of white colour.

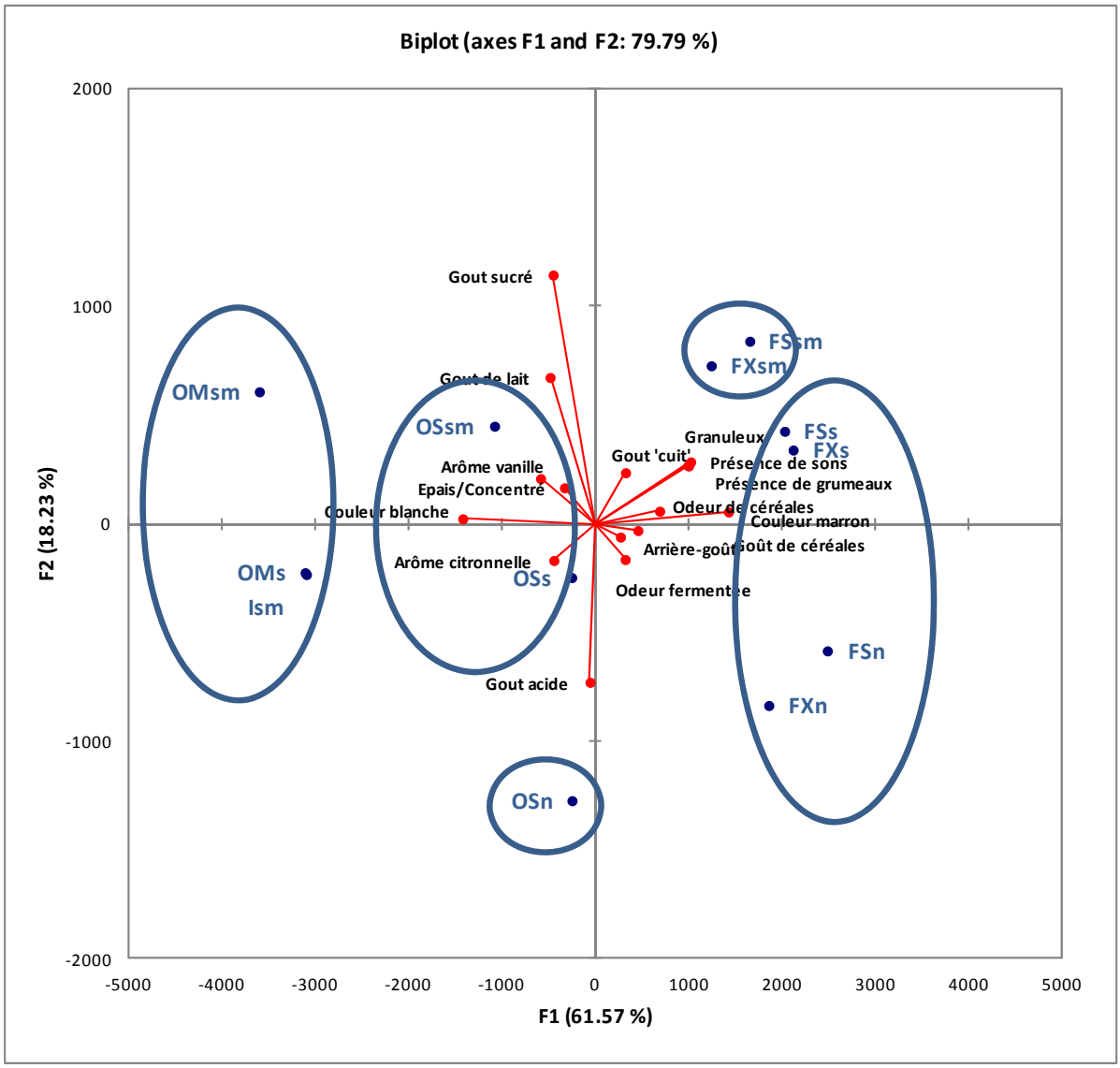


Figure 1: Principal Component Analysis (PCA) on the samples and relationship with sensory descriptors and clusters (determined by cluster analysis into 5 clusters)

Table 2. Classes of Akpan with specific quality

Class	1	2	3	4	5
	FSn	FSs	Ism	OSn	OSs
	FXn	FSsm	OMs		OSsm
		FXs	OMsm		
		FXsm			

The samples for the consumer testing are reasonably chosen among each of these 5 clusters (one sample per cluster).

The akpan types tested were significantly different (ANOVA; $P<0.05$) with respect to the sensory attributes (white colour, brown colour, citronella aroma, vanilla aroma, grainy, presence of bran, cooked taste, cereal taste and cereal odour ,sweet taste and

milky taste) (Table 3). The samples the most white were OMs and OMsm while the samples the most brown were FSs and FSn ($p<0.05$). Grainy was essential attribute which discriminated between akpan from ogi and akpan from flour dough, with akpan from ogi being lesser grainy.

Table 3: Means and probabilities for sensory testing with respect to akpan sample and sensory panellist

	Appearance					Odour				Taste						
	White colour	Brown colour	Concentrated aspect	Presence of bran	Grainy	Cereal odour	Fermented odour	Vanilla aroma	Citronella aroma	Presence of lumps	Sweet taste	Acidic taste	Milky taste	Cooked taste	After-taste	Cereal taste
OMs	65.9 ± 15.8a	5.2 ± 9.9a	37.4 ± 22.3a	9.3 ± 13.3a	10.1 ± 10.5a	19.2 ± 23 .9a	19.7 ± 19.9ab	34.5 ± 22. 5a	24.5 ± 23.7a	9.2 ± 11.3a	43.9 ± 20.3a	38.9 ± 26.9b	24.1 ± 22.5c	31.3 ±19.8a	14.7 ± 17.5a	21.9 ± 24.2ab
OMsm	62.5 ± 16.6a	4.2 ± 5.1a	55.8 ± 22.1b	6.9 ± 9.5a	7.8 ± 10.2a	14.0 ± 20.6a	10.6 ± 12.0a	45.2 ± 25.0a	17.6 ± 18.7a	12.6 ± 19.0a	50.6 ± 23.2a	13.7 ± 18.1a	52.6 ± 19.8a	32.2 ± 19.7a	9.6 ± 10.6b	19.8 ± 23.1a
OSn	10.3 ± 14.1b	45.9 ± 21.9b	43.8 ± 21.4a	11.0 ± 17.2a	7.3 ± 9.6a	31.5 ± 29.2b	24.3 ± 22.3ab	12.5 ± 16.9b	25.4 ± 19.1a	6.5 ± 10. 1a	3.9 ± 6.8b	46.0 ± 26.3b	9.6 ± 14.3d	24.4 ± 18.1a	20.0 ± 22.7b	32.0 ± 27.9abc
OSs	7.9 ± 12.2b	55.7 ± 20.1bc	32.9 ± 19.7a	12.6 ± 20.0a	7.4 ± 10.9a	28.0 ± 27.2a	20.6 ±21.4ab	14.7 ± 19.7b	36.2 ± 23 .5b	12.9 ± 17.9a	44.9 ± 18.8a	27.9 ±24.6a	15.2 ± 16.4d	29.1 ± 17.2a	14.0 ± 14.5b	33.4 ± 26.7abc
OSsm	9.6 ± 12.1b	46.6 ± 22.6b	42.6 ± 20.9b	9.6 ± 16.1a	7.4 ± 11.7a	19.5 ± 26.4a	14.1 ± 18.5a	23.5 ± 21.7b	24.1 ± 18.1a	8.0 ± 12.5a	55.6 ±19.5a	13.5 ± 17.3a	40.4 ± 21.8b	33.4 ± 20.9ab	13.3 ±14.4b	26.1 ± 27.9abc
FSn	6.6 ± 10.1b	63.6 ± 19.7c	36.0 ± 22.8a	47.2 ±24.3b	44.6 ± 24.0b	37.1 ± 25.0b	26.4 ± 24.2b	9.9 ± 14.7b	13.6 ± 15.1a	53.7 ± 25.1b	4.4 ± 7.2b	35.0 ± 27.7b	6.6 ± 7.7d	39.2 ± 28.1b	20.3 ± 21.9b	35.7 ± 26.7abc
FSs	6.4 ± 10.4b	67.7 ± 22.2c	33.0 ± 19.8a	45.6 ± 22.2b	42.4 ± 22.6b	40.7 ± 24.4b	23.1 ± 21.1ab	13.0 ± 17.9b	17.4 ± 17.9a	46.3 ± 24.0b	50.9 ± 19 .6a	23.2 ± 22.3a	13.9 ± 14.8d	39.9 ± 27.4b	22.1 ± 21.1b	36.4 ± 26.9abc
FSsm	6.6 ± 10.6b	56.8 ± 25.3bc	46.4 ± 24. 1b	47.3 ± 23.0b	44.1 ± 25.5b	43.1 ± 27.6b	22.0 ± 21.5ab	14.7 ± 20.1b	15.7 ± 15.7a	47.7 ± 27.8b	54.4 ±16.6a	15.2 ± 17.2a	32.4 ± 23.4b	40.4 ± 27.4b	23.0 ± 23.9b	37.0 ± 26.9abc
FXn	7.5 ± 8.5b	49.5 ± 22.1b	33.4 ± 18.5a	38.7 ± 26.3b	40.3 ± 27.1b	42.0 ± 25.5b	36.4 ± 27.1b	9.9 ± 14.2b	15.0 ± 19.1a	37.6 ± 23.2	4.2 ± 8.5b	42.8 ± 24.9b	9.0 ± 11. 2d	38.0 ± 23.4b	30.1 ± 23.3c	42.5 ± 29 .8c
FXs	6.4 ± 9.5b	61.6 ± 20.9c	40.0 ± 23.1a	42.0 ± 26.9b	44.7 ± 28.6b	42.3 ± 26.3b	34.3 ± 29.8b	12.9 ± 18.2b	16.4 ± 15.8a	50.4 ± 32.0c	43.3 ± 22.2a	21.3 ± 22.4a	14.8 ± 17.0d	47.0 ± 27.6b	26.9 ± 26.6b	41.2 ± 27.7c
FXsm	4.9 ± 6.2b	52.1 ± 20.8b	47.3 ± 24.7b	45.0 ± 28.5b	38.1 ± 27.9b	46.1 ± 26.6b	27.5 ± 24.6b	13.7 ± 15.8b	17.8 ± 18.7a	30.3 ± 27.8c	51.7 ± 23.1a	14.9 ± 16.5a	37.7 ± 23.9b	43.3 ± 27.0b	24.1 ± 26.0b	38.5 ± 26.1bc
Ism	59.2 ± 19.1a	4.1 ± 7.5a	59.8 ± 24.2b	11.7 ± 20.7a	9.2 ± 16.4a	18.0 ± 27.7a	23.4 ± 24.9ab	20.9 ± 26.2b	55.7 ± 23.4c	13.8 ± 22.9a	49.4 ± 19.9a	39.1 ± 29.3b	22.1 ± 18.1c	25.8 ± 20.9a	21.9 ± 25.4b	24.6 ± 26.9abc
Panellist	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Sample	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Panellist X Sample	<0.001*	0.046	0.457	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.043	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.068	<0.001*

*Intensity of sensory attributes was scored on a 100mm scale. Average (standard deviation). Letters a to d indicate significant differences (P < 0.05) using the high significant difference (HSD) Tukey test.
Where Akpan from ogi maize with sugar (OMs);Akpan from ogi maize with sugar and milk (OMsm);Akpan from ogi sorghum nature (OSn); Akpan from ogi sorghum with sugar (OSs); Akpan from ogi sorghum with sugar and milk (Ossm); Akpan from Flour sorghum nature (FSn); Akpan from Flour sorghum with sugar(FSs); Akpan from Flour sorghum with sugar and milk (FSsm); Akpan from Flour mixture of "maize and sorghum" nature (FXn); Akpan from Flour mixture of "maize and sorghum" with sugar (FXs); Akpan from Flour mixture of "maize and sorghum" with sugar and milk (FXn).

Consumer acceptability

Table 4 shows the overall acceptability for each of the five Akpan products tested irrespective of the origin of consumer. Overall, the acceptance of the Akpan drinks significantly differed between the five samples at $p<0.01$ (One-way ANOVA) (Table 3).

Table 4. Mean overall acceptability scores for the five Akpan tested

Abbreviation	OSn	OMsm	OSsm	FSsm	FSn
Average	5.0b	7.2d	6.7d	5.7c	3.7a
SD	1.8	1.7	1.8	1.8	1.7

SD: Standard deviation
*Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely. Different letters are significantly different samples. Tukey test ($p<0.01$), where natural Akpan from Ogi sorghum (OSn); Akpan from Ogi Maize mixed with sugar and milk (OMsm); Akpan from Ogi Sorghum with sugar and milk (OSsm); Akpan from sorghum Flour type with sugar and milk (FSsm)); natural Akpan from sorghum Flour type natural (FSn)).

Most of the Akpan products were on average acceptable since the mean scores were equal or greater than a score of 5 (neither like nor dislike). Only the flour sorghum (FSn) had acceptability below 5 .The most liked were the Ogui Maize with added sugar and milk (OMsm) and the Ogui Sorghum with sugar and milk (OSsm) (CSs).

Segmentation of consumers into groups of similar acceptance patterns regarding the akpan drinks

Hierarchical cluster analysis (Wards method) was used to segment the consumers interviewed at the different locations into different groups. Four clusters were suggested which give more variation in acceptability among the consumers than the overall means previously indicated above (Table 4).

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

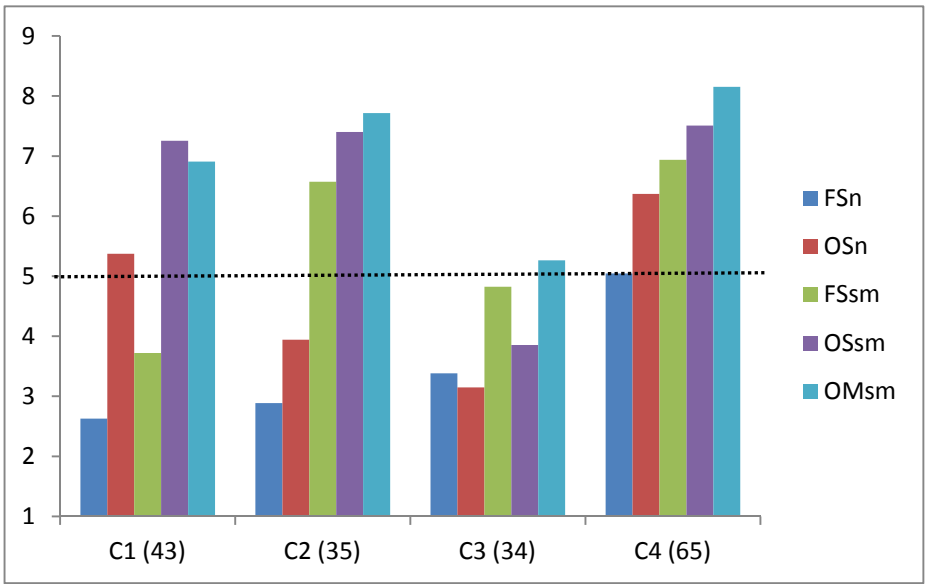


Figure 3. Mean consumer acceptance of Akpan by cluster type
Where: *Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely. Different letters are significantly different samples. Tukey test ($p<0.01$). Where natural Akpan from Ogi sorghum (OSn); Akpan from Ogi Maize mixed with sugar and milk (OMsm); Akpan from Ogi Sorghum with sugar and milk (OSsm); Akpan from sorghum Flour type with sugar and milk (FSsm)); natural Akpan from sorghum Flour type natural (FSn).

Referring to dominant characteristics of each cluster, the consumers were grouped as "Ogui Akpan likers" (24%), "sweet and milk Akpan" likers (20%), "Akpan dislikers" (19%), and "Akpan likers" (37%). However, this classification is indicative for each cluster and should not represent effective weights of consumers since the real Akpan likers are the sum of members of each cluster with acceptability score upper than 5.

Demographic differences and consumer attitudes to Akpan with respect to cluster division are presented in Tables 5 and 6.

Table 5.Demographic differences to Akpan with respect to cluster division

	Cluster 1 **"** Ogi Akpan likers "	**Cluster 2** " sweet and milk Akpan likers "	**Cluster 3** " Akpan dislikers "	**Cluster 4** **"**Akpan likers **"**
Number of interviewees	43	35	34	65
Male (%)	51.2	60.0	52.9	64.6
Resident (%)	81.4	88.6	73.5	89.2
African (%)	44.2	62.9	17.6	86.2
European (%)	55.8	37.1	82.4	13.8

Table 6. Demographic differences and consumer attitudes to Akpan (buying and consumption) with respect to cluster division

Question	**Probability** Chi Square test ($p<0.05$)	**Probability – Akpan consumers only** Chi Square test ($p<0.05$)
Gender	0.492	
Nationality	<0.001*	
Age	0.463	
European/African	<0.001*	0.659
Resident	0.179	
Marital status	0.194	
Education	0.196	
Occupation	0.253	
Bicycle	0.266	
Motorbike	<0.001*	
Car	0.135	
TV	0.156	
House	0.461	
Frigo	0.120	
[x]Frequency	-	0.046
[x]Consumption place	-	0.173
[x]Aromatic preference	-	0.640
[x]Purchase place	-	0.130
Type of Akpan (maize; sorghum or mixed; none)	<0.001*	
Form of Akpan (sugar; milk or both; natural; none)	<0.001*	

***significant at $p<0.05$;**
[x]Data do include only Akpan consumers

The four clusters did not significantly differ in terms of sociological criteria such as age, sex, residency, education level, marital status etc.
There were significant differences in the clusters in terms of European/African, type and form of Akpan and ownership of a motorbike. For those who consume Akpan, the four clusters did not differ in terms of frequency, consumption and purchase place, aromatic preference.

Clusters significantly differed in the proportions of European or African consumers (Figure 4). The difference in acceptance between European and African consumers is important and should be considered for further marketing studies. Interestingly when only the consumers who eat Akpan were considered there were no differences between Europeans and Africans (Figure 4). Figure 5 shows that most Europeans in the survey do not consume Akpan whilst most Africans do.

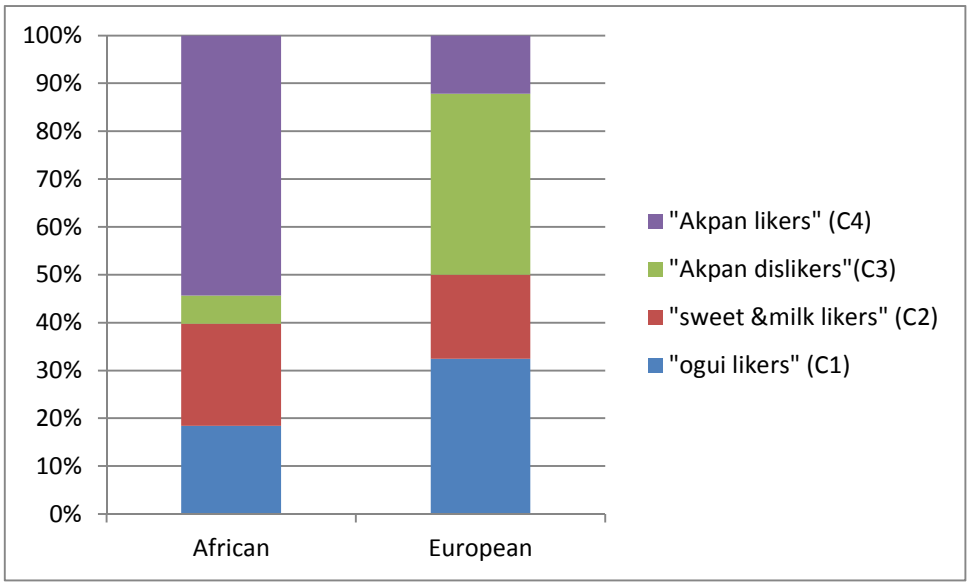


Figure 4. Consumers acceptance grouped within African or European origin

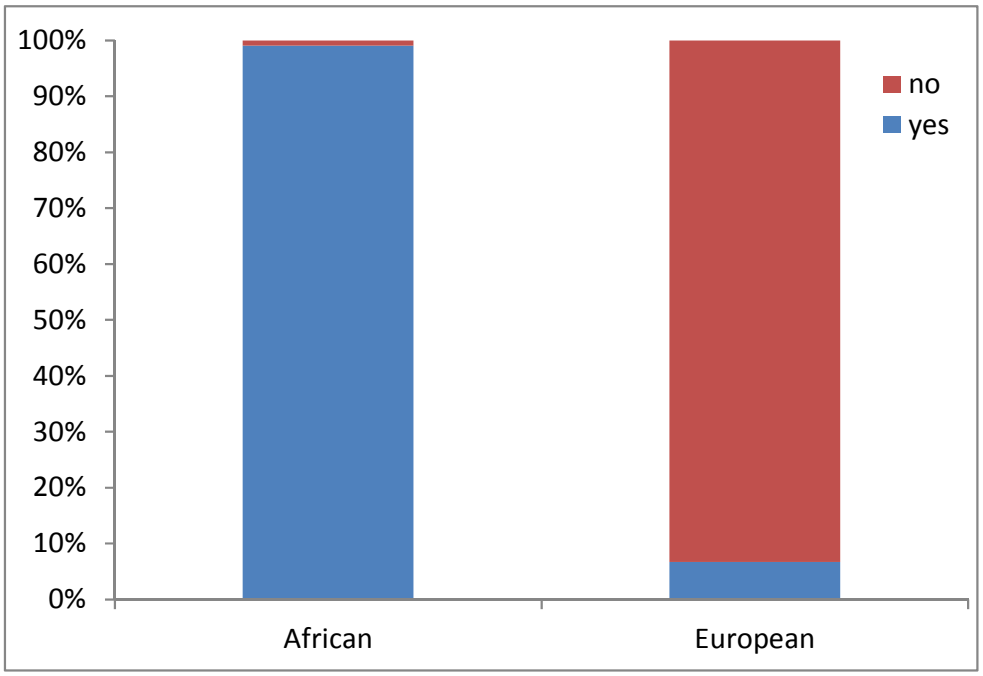


Figure 5. Consumption of Akpan by African or European origin in percentage

For those consumers who consume Akpan, there were differences in the form and type of Akpan (Figure 6 A&B).

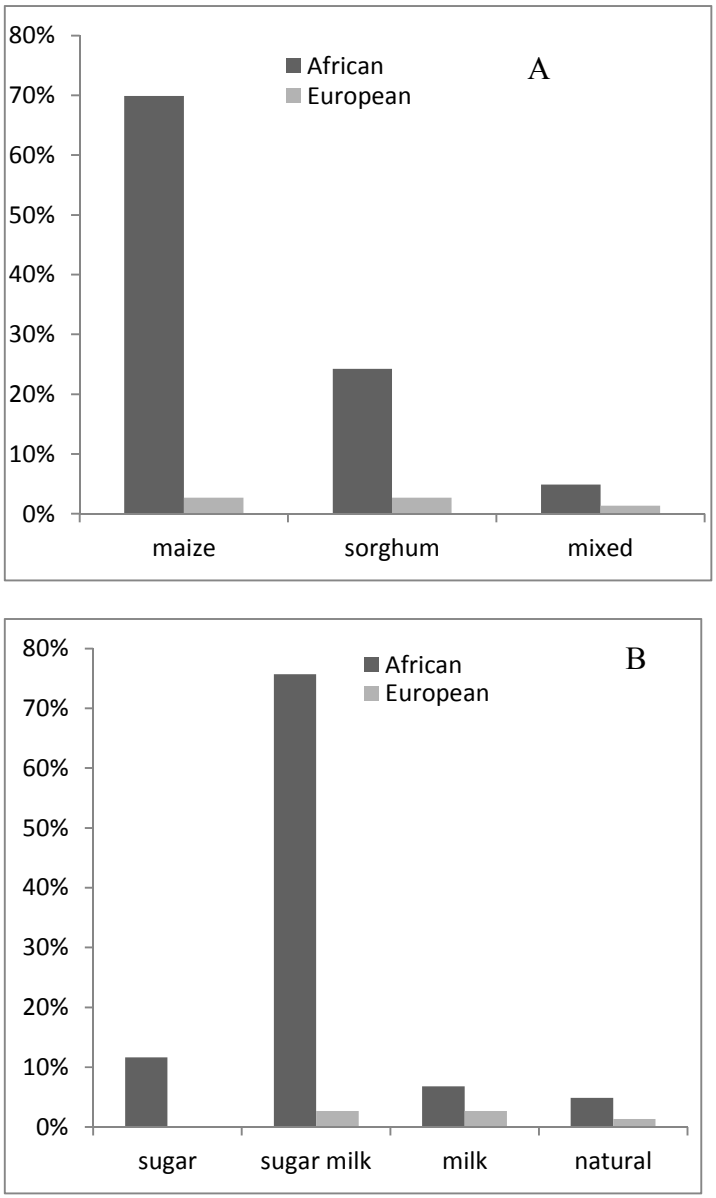


Figure 6. Type of Akpan consumed (A) and form of Akpan (B) by African or European origin in percentage

Most consumed type of Akpan was the maize type followed by the sorghum and mixed (maize/sorghum) types. Sugar and milk were the most common forms of addition and natural (without any addition) was the less common way of consuming Akpan.
There were no differences in the type of Akpan consumed by Europeans and Africans ($p = 0.219$; Chi Square Test) but there were differences in the form of Akpan consumed ($p =0.022$; Chi Square Test). However, because of the little number of Europeans who consume Akpan, it is difficult to determine whether Europeans and Africans have different ways of consumption.

The acceptability for the different Akpan products was compared for Europeans, Europeans consuming Akpan and Africans (Table 7).

Table 7. Acceptability of Africans, Europeans and Europeans consuming Akpan

Type of consumers	Number of consumers	OSn	OMsm	OSsm	FSsm	FSn
All Africans	103	5.9b	8.0b	7.3b	6.2b	4.2b
Only Africans consuming Akpan*	102	5.9b	8.0b	7.3b	6.2b	4.2b
All Europeans	74	3.9a	6.2a	5.9a	4.9a	3.1a
Only Europeans consuming Akpan**	5	5.2b	6.0a	7.8b	5.2ab	4.0ab

Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely. Different letters are significantly different samples. ANOVA. Tukey test ($p<0.01$).
Where natural Akpan from Ogi sorghum (OSn); Akpan from Ogi Maize mixed with sugar and milk (OMsm); Akpan from Ogi Sorghum with sugar and milk (OSsm); Akpan from sorghum Flour type with sugar and milk (FSsm)); natural Akpan from sorghum Flour type natural (FSn).
* One African consumer of Malian origin did not consume Akpan. ** Four French nationals and one Haitian national.

There were significant differences between Africans and Europeans in terms of acceptability ($p<0.001$). Europeans had lower acceptability of Akpan in general. However, the European consumers who consume Akpan had a similar acceptability to the African consumers, except for OMsm.

Correlations between sensory testing and consumer acceptability

Regarding correlations between consumer acceptance and the sensory attributes, a range of curves were explored for European and African consumers and the different clusters (Table 8).

Table 8.Correlations between sensory attributes and acceptability of Akpan

Variables	All	African	European	C1 (43) "Akpan ogui likers"	C2 (35) "Akpan sugar & milk likers"	C3 (34) "Akpan dislikers"	C4 (65) "Akpan likers"
white colour	0.643	0.667	0.595	0.534	0.528	0.687	0.660
brown colour	-0.762	-0.796	-0.696	-0.712	-0.614	-0.631	-0.779
presence of brans	-0.675	-0.725	-0.585	**-0.928****	-0.449	-0.049	-0.658
cereals odour	-0.748	-0.764	-0.711	**-0.893****	-0.583	-0.293	-0.702
fermented odour	**-0.951****	**-0.939****	**-0.952****	**-0.862***	**-0.897****	-0.672	**-0.922****
vanilla aroma	**0.838***	**0.843***	**0.814***	0.720	0.752	0.742	**0.833***
citronella aroma	0.334	0.384	0.250	0.673	0.154	-0.392	0.323
thick/concentrated	**0.813***	**0.839***	0.759	0.597	0.745	**0.827***	**0.863***
Grainy	-0.641	-0.693	-0.548	**-0.915****	-0.412	0.012	-0.625
Lumpy	-0.633	-0.687	-0.539	**-0.905****	-0.413	0.039	-0.623
sweet taste	**0.835***	0.784	**0.898****	0.524	**0.956****	0.791	**0.821***
acidic taste	-0.752	-0.688	**-0.838***	-0.422	**-0.894****	**-0.812***	-0.724
milk taste	**0.949****	**0.922****	**0.973****	0.712	**0.973****	**0.848***	**0.938****

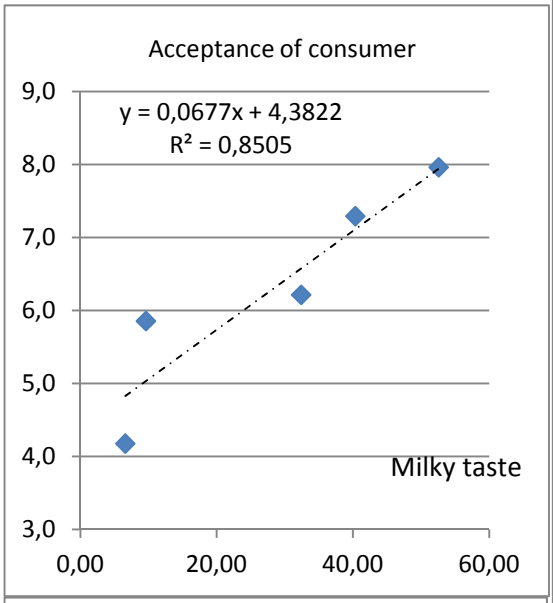
cooked taste	-0.207	-0.293	-0.072	-0.564	0.058	0.346	-0.229
back taste	-0.764	-0.767	-0.745	**-0.832***	-0.634	-0.422	-0.716
cereals taste	**-0.809***	**-0.827***	-0.768	**-0.876***	-0.656	-0.451	-0.780

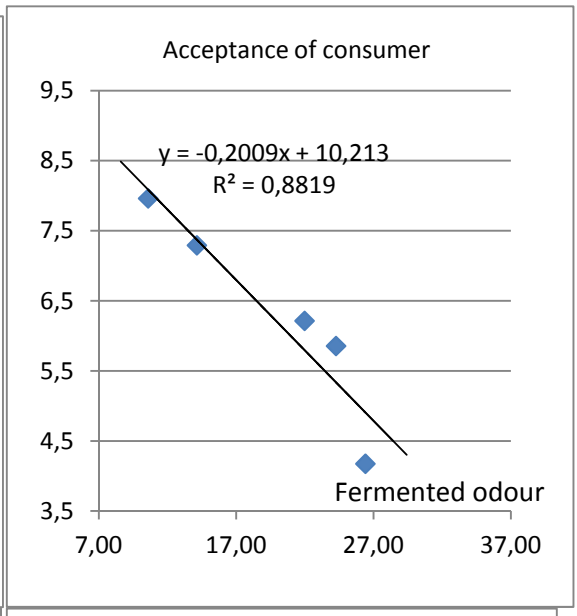
Values in bold are different from 0 with a significance level at <0.10; <0.05**.*

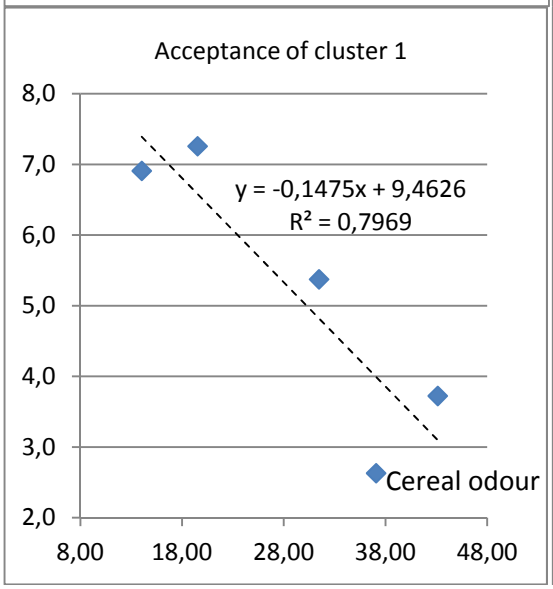
A Lot of attributes were associated with consumer acceptance. For the consumer group as a whole, their mean acceptance scores were correlated to fermented odour (negatively) and milk taste at $p<0.05$. Mean acceptance scores were correlated to vanilla aroma, thick/concentrated texture, sweet taste and cereal taste at $p<0.10$. Africans were more sensitive to the thick/concentrated texture and cereal taste whilst Europeans were more influenced by sweet taste and acidic taste.

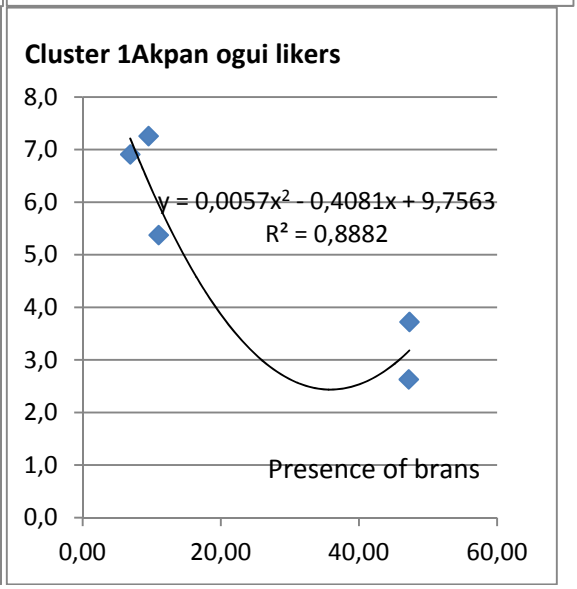
Correlations between attributes differed for the different clusters. Significant negative correlations were identified between the "ogi Akpan likers" and for presence of brans, cereal odour, grainy, lumpy, back taste and cereal taste. These correlations showed that "Ogui Akpan likers" are more discerning in terms of these attributes that are more associated to sorghum. A significant correlation with the sensory attributes for these clusters support the finding that the acceptance was related to sensory attributes and consumers had selective tastes according the products they like most.

Figure 7 shows some of associations between sensory attributes and consumers acceptance. Significant correlations were evidenced between consumers acceptance (African or European) and milky taste ($r=0.92$) and fermented odour ($r=-0.94$) as established above (Table 8). Thus consumers do not like fermented odour while milky taste is accepted (Figure 8). As far as cluster is concerned, the same trend was observed, except for cluster 3 "Akpan dislikers" who exhibit no significant correlation with any of sensory attributes. In addition, cluster 2 "Akpan sugar & milk likers" do not like acidic taste ($r=-0.89$) or fermented odour ($r=-0.90$) but their acceptance was associated with milky ($r=0.97$) and sugary ($r=0.96$) tastes. Cluster 1 "Ogi Akpan likers" disliked the presence of brans ($r=-0.89$), grainy and lumpy Akpan ($r=-0.91$).


Acceptance of consumer
y = 0,0677x + 4,3822
R² = 0,8505
Milky taste
9,0
8,0
7,0
6,0
5,0
4,0
3,0
0,00
20,00
40,00
60,00


Acceptance of consumer
y = -0,2009x + 10,213
R² = 0,8819
Fermented odour
9,5
8,5
7,5
6,5
5,5
4,5
3,5
7,00
17,00
27,00
37,00


Acceptance of cluster 1
y = -0,1475x + 9,4626
R² = 0,7969
Cereal odour
8,0
7,0
6,0
5,0
4,0
3,0
2,0
8,00
18,00
28,00
38,00
48,00


Cluster 1Akpan ogui likers
y = 0,0057x² - 0,4081x + 9,7563
R² = 0,8882
Presence of brans
8,0
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,0
0,00
20,00
40,00
60,00

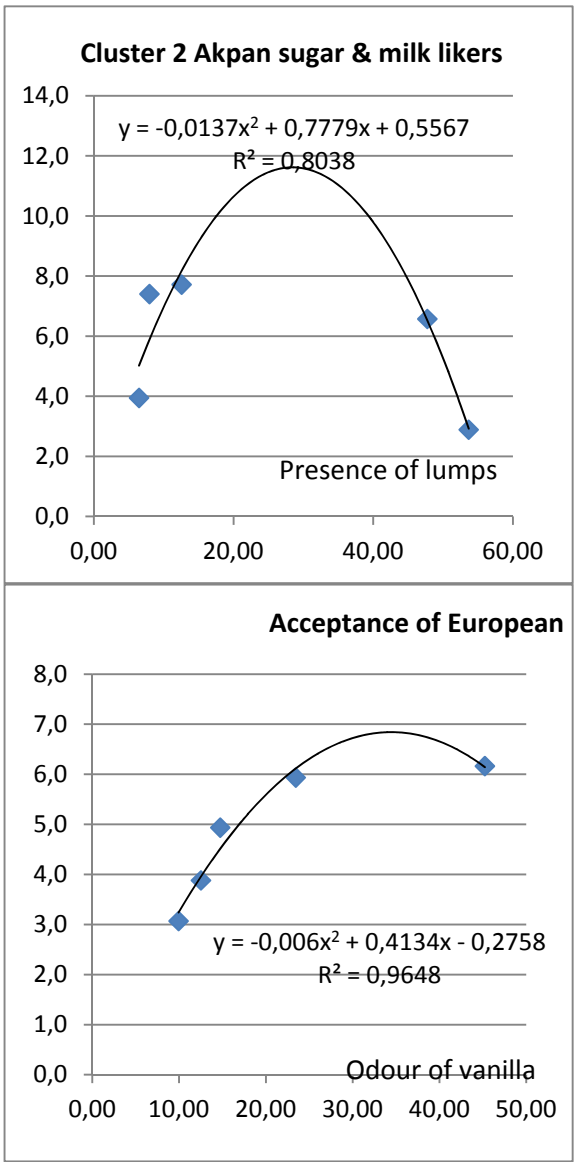


Figure 7. Relationships between sensory attributes and consumer acceptance

Conclusion

The sensory test and consumer acceptance help to provide a basis of understanding of the acceptability of *Akpan* both by African and European 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.

References

Adande, S. A. 1984. Le maïs et ses usages au Bénin méridional, Agence de coopération culturelle et technique, Les Nouvelles Editions Africaines, 100p.

Carole Sacca, Laurent Adinsi, Noel Akissoé, Générose Dalodé, Victor Anihouvi, Christian Mestres, Annali Jacobs, Nomusa Dlamini, Dominique Pallet and Djidjoho Joseph

Hounhouigan. 2012. Production, consumption and quality attributes of Akpan – a yoghurt-like cereal product - from West Africa, submitted for publication

Gaffa, I.A. and I. 2002. "Traditional production, consumption and storage of Kunu - a non-alcoholic cereal beverage." Plant Foods for Human Nutrition **57**: 73-81.

Hounhouigan (1994). Fermentation of maize (zea mays L.) meal for Mawe production in Bénin. .Physical, chemical and microbiological aspects. Wageningen**:** 99 p.

Madodé (2003). Valorisation des technologies de transformation de produits vivriers: Test de production et de marché pour le " Akpan " une boisson fermentée à base de maïs. Benin, Faculté des Sciences Agronomiques**:** 94p.

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

Mestres, Bada-Ogoun, Michodjehoun and Hounhouigan (2001). Valorisation des produits vivriers au Bénin. Benin, Faculté des Sciences Agronomiques**:** 27p.

Nago, C.M. 1989. Technologies traditionnelles et alimentation au Bénin : aspects économiques, biochimiques et nutritionnels. Identification et identification des principales filières et technologies traditionnelles de transformation de produits alimentaires. Rapport d'étude, Abomey-Calavi, Bénin, FSA/UNB 222p.

Nago, C.M., Devautour, H. and Muchnik, J. 1990. Technical resources of food processing micro-enterprises in Benin, Agritrop, 14, 3, 7-11
Tomlins, K.I., Owori, C., Bechoff, A., Menya, G. & Westby, A. (2012) Relationship among the carotenoid content, dry matter content and sensory attributes of sweet potato. *Food Chemistry, 131,* 14–21.

Annex 2 – detailed report for Kenkey

Sensory profile and acceptability of Kenkey and other fermented maize products in Ghana.

Wisdom Amoa-Awua[a], Margaret Owusu[a], Keith Tomlins[b], Mary Obodai[a], George Anyebuno[a], Hayford Ofori[a], Theophilus Annan[a], Charles Torto[a], Charlotte Oduro-Yeboah[a], Charles Diako[a], Matilda Dzomeku[a], Mary Amengor[a]

[a] CSIR-Food Research Institute, P.O. Box M.20, Accra, Ghana

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

ABSTRACT
The sensory profile and consumer acceptance of different types of Kenkey and other fermented maize products in Ghana were investigated. In the quantitative descriptive analysis, a PCA bi-plot grouped the products based on colour, odour, taste and texture into five classes; (i) Ga Kenkey, (ii) Fanti Kenkey, (iii) Normal Banku, FRI Banku, Neat Banku, (iv) Sweet Kenkey, White Kenkey–Atim, White Kenkey–Senchi, and (v) Kafa. The acceptability of the grouped products was tested by two consumer groups: 110 Ghanaians and 90 Caucasians in Accra and Tema. Sweet Kenkey and White Kenkey were the most preferred by the Caucasians, whilst Sweet Kenkey and Ga Kenkey were the most preferred by the Ghanaians. Socio-economic factors such as level of education, ethnicity, nationality, age, gender, occupation, residential status in Ghana and marital status of the consumers did not significantly influence ($p>0.05$) the acceptability of all samples tested. Three classes of behaviours of consumers were identified. Those who liked all the products 'all likers' (36%), those who preferred the white Kenkey 'white likers' (30%) and those who preferred Banku 'banku likers' (34%). 48% of the Caucasian consumers were white likers, 43% banku likers and 9% all likers, whilst 54% of the Ghanaians were all likers, 31% banku likers, and 15% white likers. Sensory attributes important for the white likers were whitish colour, fruity odour, smooth and non-sticky texture, a less sour product without a pronounced fermented odour, and a bland taste. All likers and banku likers were not very discerning consumers; whilst only salty taste correlated significantly with acceptance for the banku likers, none of the sensory attributes correlated with acceptance for the all likers. Based on these considerations two products will be re-engineered one targeting the white likers and another targeting the banku and the all likers.

CONCLUSIONS RELATING TO REENGINEERING
Two products should be considered, one adapted to both the European and the Ghanaian consumer 'white likers' and the second adapted to only the Ghanaian consumer 'all likers and 'banku likers'. Important sensory attributes which should guide re-engineering of the first product are whitish colour, fruity odour, smooth and non-sticky texture, a mildly sour product, and a bland taste. This may be achieved by a combination of processing factors including dehulling of maize kernels, use of mixed lactic acid bacteria/yeast starter culture containing high concentration of yeasts cells (for

fruity odour), reduced fermentation period (to reduce sourness and fermented odour) and elimination of the aflata step (to reduce sticky texture). The second product should be a refinement of Ga/Fanti Kenkey and should also focus on improved packaging.

Introduction

Kenkey is the principal and most popular product prepared from fermented maize dough in Ghana (Halm et al., 2004). Kenkey has been described as one of the best examples of traditional African foods that has played a significant role through history in food security as well as food safety (Halm et al., 2004; Amoa-Awua et al., 2007). Kenkey production serves as a form of income for the producers who are mainly women with little or no formal education (Halm et al., 2004). There are different types of Kenkey based mainly on the procedure used in preparation and the material used in packaging.

Other common fermented maize products are Banku and Kafa. Kenkey is a stiff gruel or dumpling made from fermented maize dough which is wrapped in maize husks and boiled. Processing of maize into Kenkey is an important activity in the food sector in Ghana. It is a traditionally produced ready–to–eat staple food in the southern coastal plains of Ghana particularly in urban areas. Two main types of Kenkey are produced, Ga Kenkey and Fanti Kenkey. They have a pH of about 3.7, moisture level of between 52-55% and usually eaten with sauce and fish (Allotey, 1996). During the production of Kenkey, the dough is divided into two parts: one part, the *aflata* is cooked into a thick porridge, while the other uncooked part is later mixed with the *aflata*. The resulting mixture is moulded into balls and wrapped in dried maize husks or plantain leaves, after which it is boiled.

Variations in the state of the maize i.e. whether used as whole or dehulled gives a third type of Kenkey known as dehulled Kenkey or white Kenkey (*Akporhi* or *Nsihu)* produced mainly in the Central, Western and Volta regions of Ghana. Differences exist in the organoleptic quality and the processing procedure for the types of Kenkey (Sefa-Dedeh, 1993; Amoa-Awua et al., 2007).

The process of Kenkey-making is lengthy and laborious; therefore it is more often purchased from a commercial Kenkey producer rather than cooked at home. Several studies have been carried out to upgrade and mechanize some of the unit operations involved in Kenkey production (Halm *et al*., 2004). It has been shown that some aspects of the Kenkey process can be upgraded by shortening the fermentation period using an accelerated fermentation process (Nche et al., 1994) or by reducing physical labour using pre-cooked dehydrated Kenkey mixes (Nche et al., 1996; Nout et al., 1996). It has also been concluded that the traditional 4-6 days Kenkey manufacturing procedure can be shortened to 24 hours by a combination of reducing soaking time of maize where pre-cracked maize kernels were used, using starter dough in a dough-*aflata* mixture, and by cooking in sausage casings. The cooking time and energy expenditure was reduced from 2 hours to 35 minutes by changing the dimension of the Kenkey balls from 10-15 cm diameter to 6 cm diameter cylinders. These resulted in considerable savings on cooking time and thermal energy (Nout *et al*., 1996). These are factors that have to be considered in re-engineering of the product.

Kenkey is consumed principally in the coastal areas of Ghana. It is consumed as a main meal served with fried or grilled fish and an accompanying sauce or soup. The sauce is

usually a blend of onions, tomatoes, pepper, and salt, which is freshly ground and the uncooked Kenkey forms an important article of diet in the food- eating habits of low income workers who may eat it as breakfast, lunch or dinner (Halm et al., 2004). Kenkey is a heavy meal because it is bulky, so when eaten as breakfast, it carries through to dinner thus making it economical (Halm et al. 2004). Consumption of Kenkey cuts across different ethnic groups and economic classes in Ghana.

Although Kenkey and other maize products have been popularized and enjoy a good patronage in Ghana, they are almost unknown outside the country. Kenkey in its present form enjoys little or no patronage among foreign consumers, especially Caucasians. This work is part of a project which aims at re-engineering Kenkey and repackaging it for the European market. The raw materials for the production of Kenkey and the other maize-based foods are of local origin and their supply is sustainable. The present study aims at determining the sensory characteristics of the major Kenkey varieties and other comparable maize products in Ghana. It is also to obtain information on the popularity of Kenkey among consumers and eventually to compare the overall acceptability of Kenkey among different consumers – Ghanaians and Caucasians. The study also sought to determine the sensory characteristics of Kenkey and other maize products that influenced consumer acceptability. Since it was not feasible to carry out the study in Europe, Europeans and other Caucasians living in Ghana at the time of the study were used as proxy.

Materials and Methods

Kenkey and other fermented maize samples

Nine different types of Kenkey/maize products namely:

- Fanti Kenkey
- Ga Kenkey
- White Kenkey (Anum)
- White Kenkey (Senchi)
- Sweet white Kenkey
- Normal banku (prepared from maize and cassava dough's)
- Kafa
- Food Research Institute (FRI) instant banku
- Neat banku.

Description of samples

FRI Banku is dehydrated flour prepared from a combination of fermented whole maize dough mixed with fermented cassava dough in the ratio 2:1. Slurry of the flour is cooked with the addition of salt. The paste obtained is moulded into oval shapes. It is eaten with hot sauces, stew or soups. The banku flour is produced by CSIR-Food Research Institute.

Neat Banku is dehydrated flour prepared from combination of fermented whole maize dough mixed with fermented cassava dough in the ratio 2:1. Slurry of the flour is cooked with the addition of salt. The paste obtained is moulded into oval shapes. It is eaten with either a hot sauce, stew or soup. This banku flour is produced by Neat Foods company limited.

Normal Banku is a paste prepared from cooked fermented whole maize dough mixed with fermented cassava dough in the ratio 2:1. The paste is moulded into oval shapes. It is eaten with hot sauces, stew or soups.

Kafa is produced from whole maize. Slurry of milled maize is sieved and fermented for 2 days. The sediment is poured into boiled water to pre-cook. The paste is moulded and packaged in green leaves. It has a moisture content of about 86%, pH 3.4, and shelf-life of about 2 to 3days.

Fanti Kenkey is non-salted cooked sour tasting stiff porridge with a pH of about 3.7, moisture level of between 52-55% and usually eaten with sauce and fish. During the production of the Kenkey, the dough is divided into two parts: one part, the *aflata* is cooked into a thick porridge, while the other uncooked part is later mixed with the *aflata*. The resulting mixture is moulded into balls and wrapped in plantain leaves, after which it is boiled for 6-7 hours. Fanti Kenkey has a shelf-life of about one week.

Ga Kenkey is a cooked sour-tasting stiff porridge with a pH of about 3.7, moisture level of between 52-55% and usually eaten with sauce and fish. During the production of the Kenkey, the dough is divided into two parts: one part, the *aflata* is cooked into a thick porridge, while the other uncooked part is later mixed with the *aflata*. The mixture is moulded into balls and wrapped in dried maize husk and boiled. Ga Kenkey has a shelf-life of about 3 to 4 days.

White Kenkey from Atimpoku (White Atim). White Kenkey or *nsiho* is produced from dehulled or polished maize. The slurry of milled maize is precooked with addition of salt and moulded into balls. The balls are packaged in maize husk and steam-cooked for 1 hour. It has a moisture content of about 62-68%, pH 4, and shelf-life of about 3 to 4 days with no refrigeration. The sample was obtained from a town called Atimpoku.

White Kenkey from South Senchi (White Senchi). This is the same as the white Kenkey described above but the sample was obtained from a town called South Senchi.

Sweet Kenkey is produced from dehulled or polished maize. The slurry of milled dehulled maize is precooked with addition of sugar and moulded into balls and packaged in *Ahahamua* leaf and steam-cooked for 45 min. It has a moisture content of about 77%, pH 4.3, and shelf-life of about 3 to 4 days with no refrigeration.

Sample preparation

Ga Kenkey, Fanti Kenkey, White Atim, White Senchi, sweet Kenkey and normal banku were obtained from commercial vendors whilst the two instant banku samples, FRI and Neat were prepared from dehydrated flours using the manufacturer's instructions on the package. The samples were cut into cubes and served to panellists/consumers in disposable plastic plates.

Methods

Panel Training

A semi-trained panel of 16 members was used to assess the samples. The panel was made up of students and staff from the Ghana Atomic Energy Commission and staff of the CSIR-Food Research Institute. Training involved a two-day focus group discussion to develop terms for the description of the appearance, texture, taste and aroma of the Kenkey and banku samples. The panel was also trained to quantify the intensity of observed sensory attributes using line scales. Table 1 shows the fourteen sensory attributes generated during the focus group discussions and their definitions.

The sensory descriptors for appearance, texture, taste and aroma agreed on during the focus group discussions were used to evaluate the Kenkey and banku samples.

Table 1. Sensory attributes generated for appearance, texture, taste, aroma and colour of Kenkey and other maize products

Sensory attribute	Definition
Brownish colour	colour of brown
Creamy colour	colour similar to cream
Whitish colour	colour that is similar to white
Maize odour	odour characteristic of maize kernel
Fruity odour	odour similar to that of ripe fruit
Burnt odour	odour of wood smoke
Fermented odour	odour characteristic of fermented maize dough
Hard texture	texture that is the opposite to soft
Sticky texture	texture that clings to the fingers and tongue
Rough texture	texture that is coarse and uneven
Sour taste	taste that is acidic and sharp
Sweet taste	tastes sweet as in sugar
Salty taste	tastes of table salt (sodium chloride)
Strong taste	opposite of bland taste or tasteless

Sensory evaluation

Each sample was coded with a three-digit random number and presented to panellists in a randomized order. Four samples were evaluated per panellist per session over four different sessions. Each judge was provided with a plastic plate containing four samples and a cup of water at room temperature for rinsing the mouth in-between sample tasting. Evaluations were done on a 100 mm line-marking scale anchored at the low end with 'not' and at the high end with 'very'. Panellists were instructed to evaluate the samples in the order indicated on the evaluation sheets provided.

Consumer Testing

Based on cluster analysis of the sensory data, six samples were chosen for the consumer testing. These included white (Atimpoku), sweet white, Ga and Fanti Kenkey, normal banku and kafa. Consumers were given information sheets on the objective of the work and also asked to sign consent forms.

Ghanaian and Caucasian consumers (n=209; namely Europeans, Americans, Canadians and Asians) participated in this study. Consumers were randomly selected from the Accra, Legon and Tema Areas of the Greater Accra Region of Ghana. The foreign

consumers were selected from Multinational organizations such as UNDP and Foreign students from the International Student Hostel at the University of Ghana, Legon. Criteria for recruitment included the following: (1) age of at least 18 years (2) having no aversion/allergy to maize products and (3) availability for the required 20 minutes to complete the survey. Consumers were presented with coded samples following the Randomized Block design. Consumers were served a 2 x 2 inch slice of each of the samples, which were coded.

Consumers rated the overall acceptability of the samples using a 7-point hedonic scale: 1. Dislike very much, 2. Dislike moderately, 3. Dislike slightly, 4. Neither like nor dislike, 5. Like slightly, 6. Like moderately and 7. Like very much. Demographic information of the consumers were collated as well as questions about the type of Kenkey they preferred, their preference for Kenkey or banku, the frequency and reason for eating Kenkey, and where they normally obtain the Kenkey they eat, were asked.

Statistical analysis

Data obtained from both the sensory evaluation and consumer testing was put into an Excel sheet. Analysis of variance was carried out with SPSS v. 16.0 whilst cluster analysis (Agglomeration method) and Principal Component Analysis were carried out using XLSTAT (V. 5.2, Addingsoft).

Results and discussions

Sensory profile of Kenkey and other maize products

The relationship between the samples of fermented maize dough products analysed and their sensory attributes is shown in figure 1. The mean scores for the attributes are presented in table 2. Two factors, F 1 and F 2 accounted for 91.7% of the total variations observed. Based on the principal component analyses the nine samples were grouped into five classes instead. All three Banku products, FRI Banku, Normal Banku and Neat Banku formed one group as the PCA did not show differences in their sensory characteristics. Their dominant sensory characteristics were creamy colour and sticky texture. Banku is usually prepared from a mixture of maize and cassava dough. Cassava dough has as a lighter colour and higher starch content which could account for the creamy colour and sticky texture of Banku in comparison to the whole maize products i.e. Ga and Fanti Kenkey.

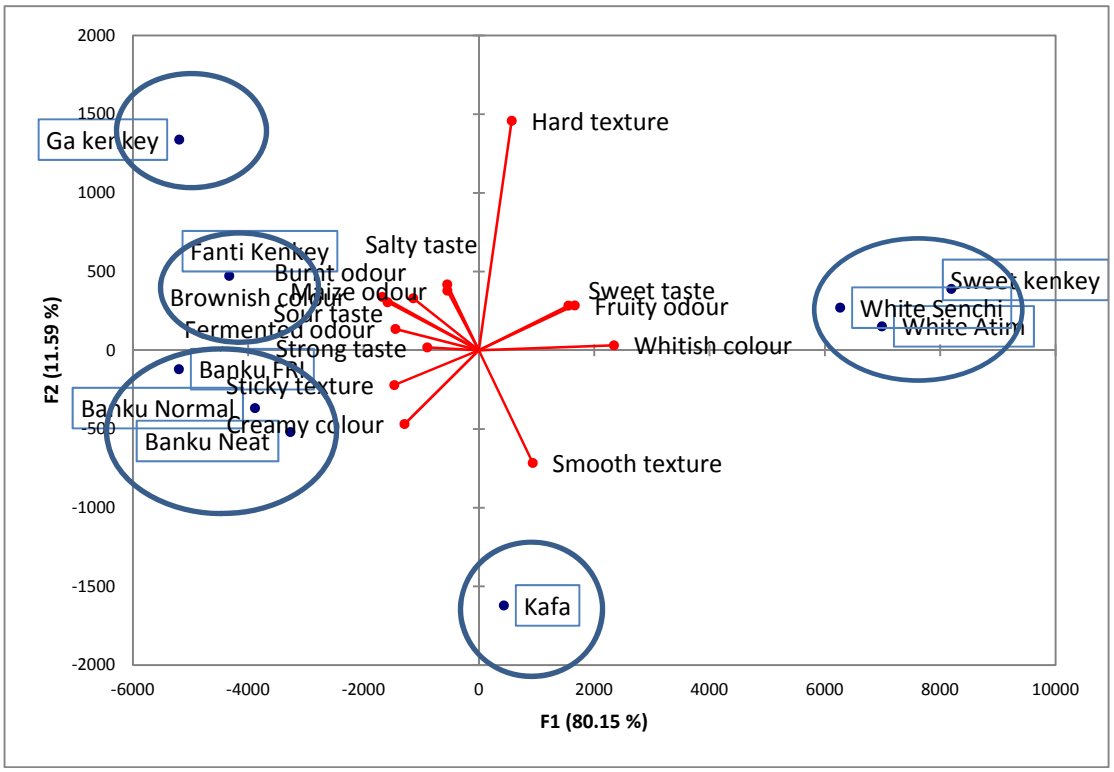


Figure.1. Principal Component Analysis (PCA) bi-plot showing the relationship between Kenkey and other traditional fermented maize products, and the sensory attributes used to describe their appearance, texture, taste and odour.

Fanti-Kenkey was classed separately, adjudged to be sensorially different from Ga-Kenkey also classed separately. The main difference between these two types of Kenkey is duration of fermentation, addition of salt, different aflata to uncooked dough ration, and type of leaves used for packaging. Fanti-Kenkey was described as being sour, having a salty and a burnt taste, a fermented and raw maize odour and brownish colour. The same sensory characteristics were attributed to Ga-Kenkey but the intensity of each attribute was significantly less. The more intense sensory character of Fanti-Kenkey could be due to a more pronounced fermentation and additional sensory notes from banana or plantain leaves rather than maize husks used to wrap the product before cooking. Fanti Kenkey was adjudged to have a saltier taste, which was unexpected, since Ga Kenkey is salted, whilst Fanti Kenkey is usually not. However some processors add salt to Fanti Kenkey.

All three products made from dehulled maize kernels formed the fourth group on the bi-plot. White Kenkey samples from Atimpoku and South Senchi occupied almost the same spot on the bi-plot and clustered with Sweet Kenkey. Sweet Kenkey is essentially White Kenkey to which sugar is added during processing. Sweet Kenkey has a markedly sweet taste and is easily distinguishable from White Kenkey based on sweetness. This group was described as having whitish colour, sweet taste, fruity odour, and slightly hard texture. These differences from the other groups could be attributed to the polishing of the maize resulting in the loss of the hulls and the yellowish endosperm. Fruity odour is often associated with yeasts and all the samples analysed had been fermented by lactic acid bacteria and yeasts (Halm et al. 1993;

Table 2. Means and standard deviation for sensory attributes used in evaluating Kenkey and other maize products by a semi-trained panel.

	Colour			Odour				Texture			Taste			
Attribute/ Sample	creamy	brownish	whitish	maize	fruity	burnt	fermented	hard	sticky	smooth	sour	sweet	salty	strong
Ga Kenkey	55,6± 36,8b	68,2± 36,6e	7,1± 7,3a	87,5±.3 3.2c	14,9± 17,4a	46,7± 31,6c	66,1±32,9c	78,5± 21,4e	58,1± 35,1c	29,8± 21,1a	71,2± 28,4e	16,6± 20,7a	54,0± 30,3d	56,8± 32,2c
Fanti Kenkey	54,6± 34,6b	69,3± 31,1e	15,6± 23,0ab	51,4± 33,2ab	21,5±2 9,7a	51,6± 37,5c	53,9±36,2c	54,4± 25,3c	61,1±2 6,1c	34,4± 26,8a	57,3± 25,7d	19,5± 22,7a	21,5± 21,0b	51,7± 29,2bc
White Atim	11,7± 14,4a	3,8± 4,6a	90,6± 25,4d	43,2± 29,6ab	68,3±3 2,4b	11,8± 20,2a	15,3±18,9a	55,1± 28,6c	19,7±2 0,9a	70,5± 24,5b	15,3± 21,0a	52,2± 31,5b	35,7± 29,6c	20,5± 23,9a
White Senchi	21,6± 22,2a	7,0± 6,3a	84,2± 20,2d	45,7± 28,8ab	67,6± 29,3b	9,1± 13,5a	18,9± 21,2a	62,0± 26,2cd	23,0± 21,4a	70,1± 22,8b	15,3± 15,6a	53,3± 31,1b	38,4± 33,0c	26,8± 23,7ab
Sweet Kenkey	11,6± 15,9a	5,4± 6,5a	89,0± 23,6d	39,3± 27,7ab	65,7± 34,5b	9,4± 27,4a	9,7± 13,5a	67,6± 25,3d	21,1± 23,0a	66,3± 30,3c	10,3± 15,7a	87,2± 25,2c	8,5± 16,2a	24,4± 24,6a
Normal banku	54,9± 32,3b	37,1± 27,6bc	32,5± 22,3c	54,7± 26,0ab	14,8± 16,9a	39,3± 27,4bc	59,4± 32,6c	21,7± 18,0b	75,2± 29,4d	42,4± 27,7a	67,0± 28,1de	18,0± 19,5a	48,7± 29,8cd	53,8± 32,9c
Neat banku	55,6± 35,7b	48,3± 34,0cd	19,1± 22,5b	55,5± 30,9ab	14,6± 21,7a	34,9± 27,8b	55,0± 34,5c	30,2± 21,8b	68,1± 22,4cd	60,9± 24,9a	44,5± 24,8c	21,8± 25,9a	37,1± 26,4c	41,8± 29,2abc
FRI banku	49,9± 32,4b	55,4± 31,9d	13,9± 14,2ab	61,8± 26,1b	13,4± 16,3a	50,0± 29,6c	57,7± 29,1c	22,6± 19,7b	74,9± 22,7d	40,1± 23,0a	63,9± 26,7de	16,5± 15,8a	52,4± 27,2d	45,7± 31,6abc
Kafa	60,9± 36,8b	33,1± 38,4b	38,7± 23,8c	32,5± 27,6a	24,8± 29,2a	15,0± 27,4a	32,6± 32,6b	9,2± 9,1a	41,1± 27,3b	77,7± 30,3b	28,0± 34,0b	47,9± 141,3b	11,6± 17,1ab	67,4± 141,1c
Sample	<0.001*	<0.001*	<0.001 *	<0.001 *	<0.001 *	<0.001 *	<0.001*	<0.001 *	<0.001 *	<0.001*	<0.001*	<0.001*	<0.001 *	<0.001*
Panellist	<0.001*	<0.001*	<0.001 *	<0.001 *	<0.001 *	<0.001 *	<0.001*	<0.001 *	<0.001 *	<0.001*	<0.001*	<0.001*	<0.001 *	<0.001*

Amoa-Awua et al., 1997; Hayford et al. 1999a, 199b). The fruity odour being absent in the Banku, Ga and Fanti Kenkey samples may be due to masking by other odour notes associated with the endosperm and hulls.

Kafa belonged to the last group and was described as having a much smoother texture than the rest. To produce Kafa, whole maize kernels are milled, made into slurry and sieved to remove the chaff and other particles before it is fermented. This would account for its smoother texture and also being closer in sensory characteristics to the dehulled maize products on the PA bi-plot.

Overall it can be seen from the mean sensory scores shown in table 2 that the dehulled maize dough samples had a less strong taste than the whole maize dough samples (Ga and Fanti-Kenkey, and the Banku samples). They also had a whiter colour but were not perceived to have a smoother texture despite the removal of the chaff and endosperm.

Although there were significant differences in judge-attribute interactions, judge-sample interactions were not significant across all attributes. This indicates that the latter was not a source of error and that judges agreed on the trend of intensities of the attributes in the different samples evaluated.

Consumer testing

To conduct the consumer test, Agglomerate Hierarchical Clustering (Ward's method), was also used to group the nine products. The Ward's method separated Sweet Kenkey from the White Kenkey samples, thus gave six groups instead as follows; (i) Ga-Kenkey, (ii) Fanti-Kenkey, (iii) White Kenkey (Atimpoku) and White Kenkey (Senchi), (iv) Normal Banku, FRI Banku and Neat Banku, (v) Sweet Kenkey, and (vi) Kafa. Based on this clustering, the six samples selected for consumer testing were Ga Kenkey, Fanti Kenkey, Normal banku, White Atim, Sweet Kenkey and Kafa. Acceptability of the six samples was evaluated over a seven-point Hedonic scale which made it easier to administer the questionnaire in the local dialects to those consumers who were barely literate.

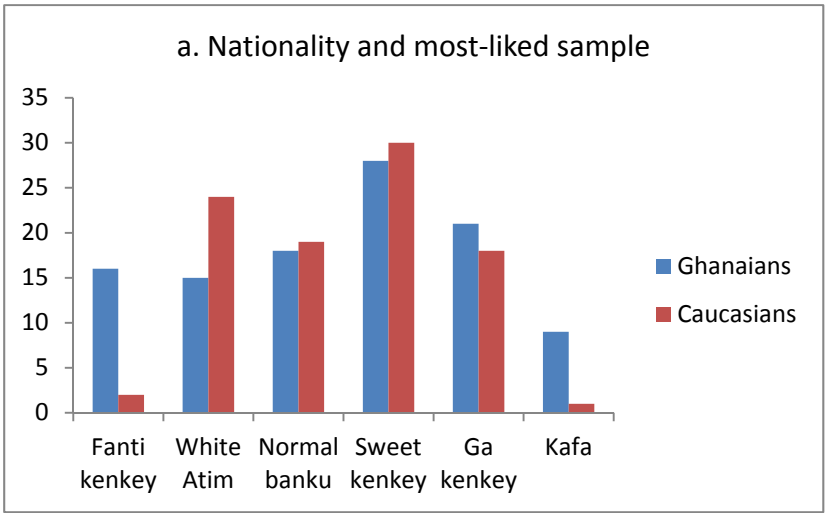
The mean scores for acceptability of the six products by the 110 Ghanaian and 90 Caucasian consumers are presented in table 3. None of the samples scored less than 4 (neither like nor dislike), therefore, all six products were acceptable to consumers. One way ANOVA showed no significant difference ($p>0.05$) between Kafa, Fanti Kenkey and Banku. These differed significantly from White Kenkey and from Sweet Kenkey. The least score was 4.2 for Kafa and highest 5.3 for Sweet Kenkey. The low score for Kafa can be understood from the Ghanaian perspective since Kafa is considered a convalescent food, hence associated with illness. Kafa, however, which is called Akasa in Benin, is very popular and eaten as a staple food in that West African country.

Figure 2a shows the choices of Ghanaian and Caucasian consumers when asked to select the most liked and the least liked products. Sweet Kenkey followed by Ga-Kenkey was the most liked by the Ghanaian consumers and White Kenkey followed by White Kenkey the most liked by the Caucasian consumers. The choice of Sweet Kenkey as the most liked product may have been influenced by the experimental design. It is the only product tested which is eaten

Table 3. Mean acceptability score for six Kenkey and other maize products tested

Sample	Acceptability
Kafa	4.2[a*]
Fanti Kenkey	4.3[a]
Normal banku	4.7[a]
Ga Kenkey	5.0[abc]
White Atim	5.2[bc]
Sweet Kenkey	5.3[c]

*Samples with the same letters are not significantly different at $p<0.05$. Overall acceptability was measured on a 7-point Hedonic scale.



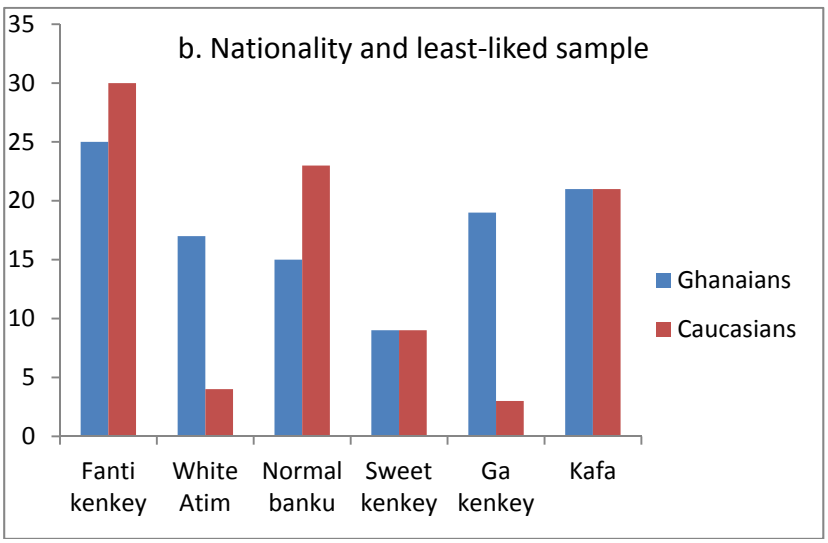


Figure. 2. Distribution of consumers according to the most-liked and least-liked product.

on its own as a snack due to its sweet taste. All the other products are eaten as a meal with a sauce, stew or soup. In presenting the samples to the consumers there were no accompanying sauces.

For the least liked product both Ghanaian and Caucasian consumers picked out Fanti-Kenkey followed by Kafa by the Ghanaian consumers and Banku by the Caucasian consumers (Fig 2b). It was surprising that Fanti-Kenkey was the least liked product even by the Ghanaian consumers since it is available throughout the country and eaten extensively. Fanti-Kenkey originated from the south-western parts of Ghana and in these parts would be preferred to Ga-Kenkey. Ga-Kenkey on the other hand is native to Accra where the consumer test was carried out, and is more popular here.

In addition to nationality, the results of the consumer test were also evaluated based on preference of consumers in order to identify potential markets to target for re-engineering Kenkey. Three categories or clusters of consumers emerged. The first cluster, 'all likers', liked all the products and made up 34% of the consumers interviewed (Fig 3a). The other clusters were 'banku likers, 36% and 'white likers' 30%. All products were acceptable to all likers, Banku, Ga-Kenkey, White Kenkey and Sweet Kenkey to banku likers, and White Kenkey, Sweet Kenkey and Ga-Kenkey to white likers. The highest proportion of male consumers were all likers, and female banku likers (3b). The highest proportion of Ghanaian consumers were all likers and Caucasians or non-Ghanaians white likers (Fig 3c). Thus the Caucasians liked Sweet Kenkey and White Kenkey best which represent the products made from dehulled or polished maize. This was followed by Banku.

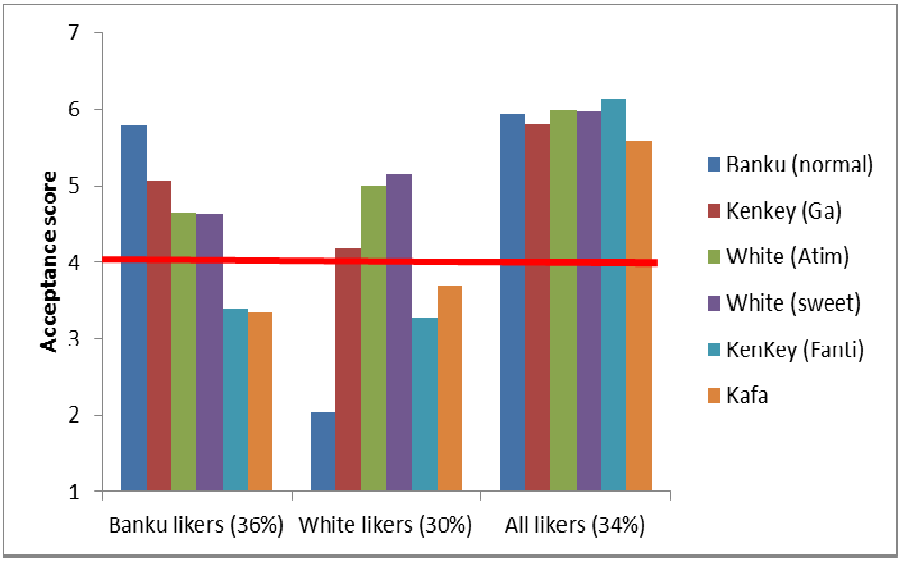


Figure 3a. Consumer cluster

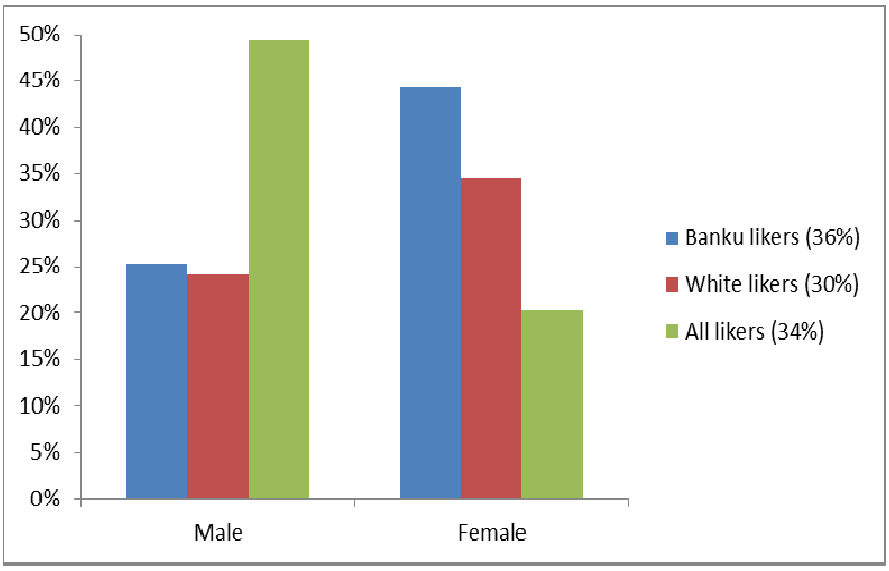


Figure 3b. Consumer perceptions by gender

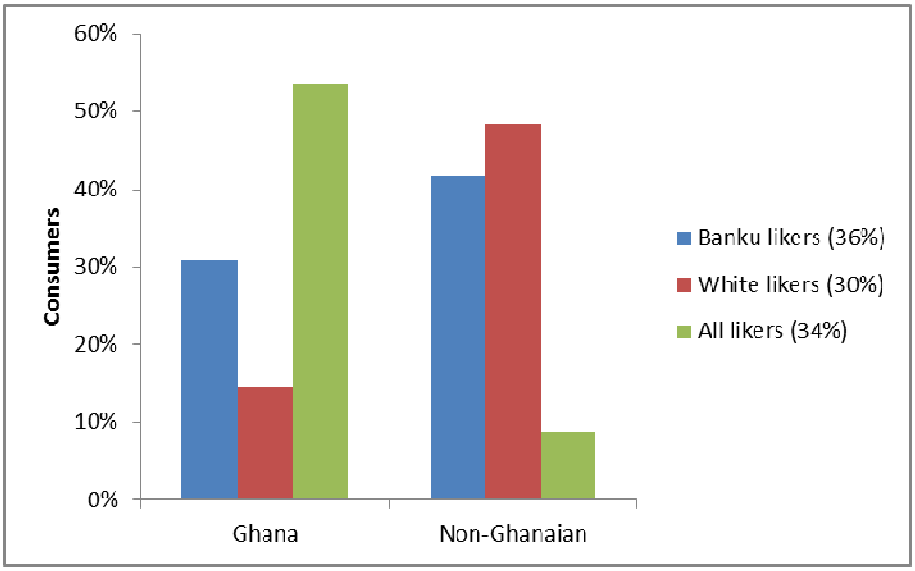


Figure 3c. Consumer perception by nationality

About 12% of the Ghanaian consumers eat Kenkey more than once a day, 16% once a day, and close to 40% a few times a week (Figure 4a). Only 5% of the Ghanaian consumers rarely eat Kenkey. Most of the Caucasians (about 40%) rarely eat Kenkey, 25%, about once a week whilst none eat Kenkey daily and about 5% had never eaten Kenkey. This must be understood from the point of view that nearly all the Caucasians tested were foreign students who had been in Ghana for less than 2 months.

Figure 4b shows that 60% of the all likers eat Kenkey more than once in a day, whilst most of the banku likers rarely eat Kenkey which is surprising since they are similar products in many reports.

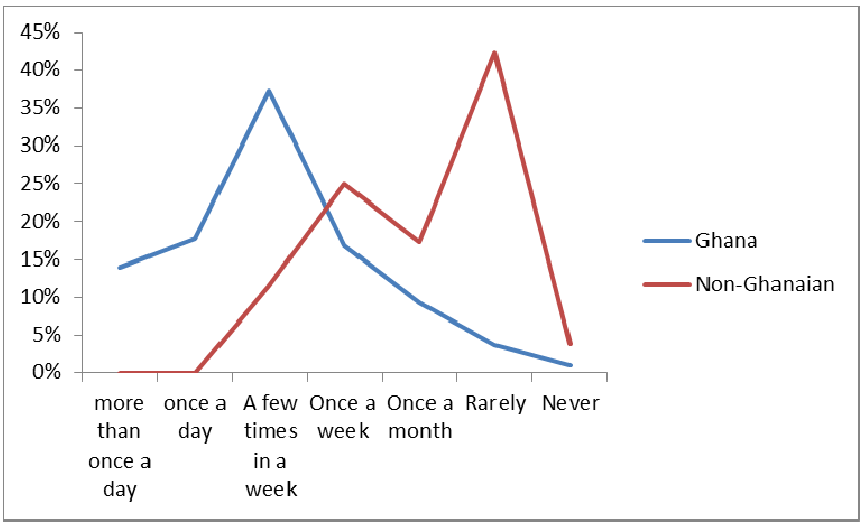


Figure 4a. Frequency of the consumption of Kenkey by nationality

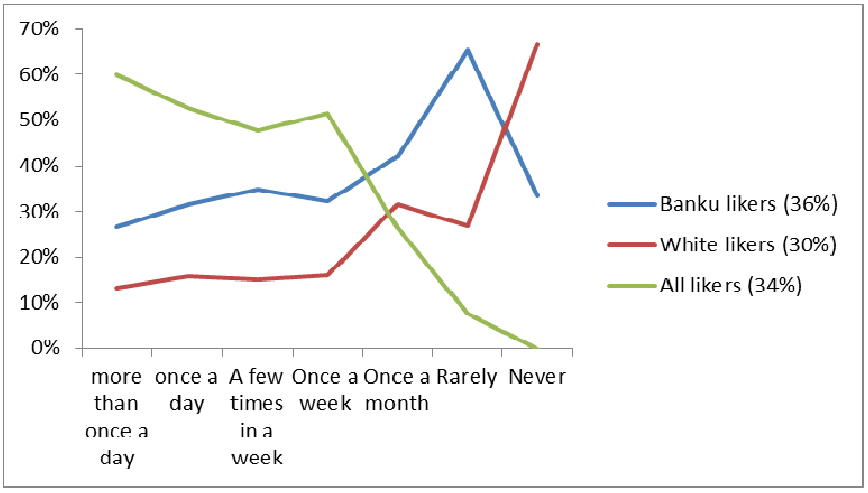


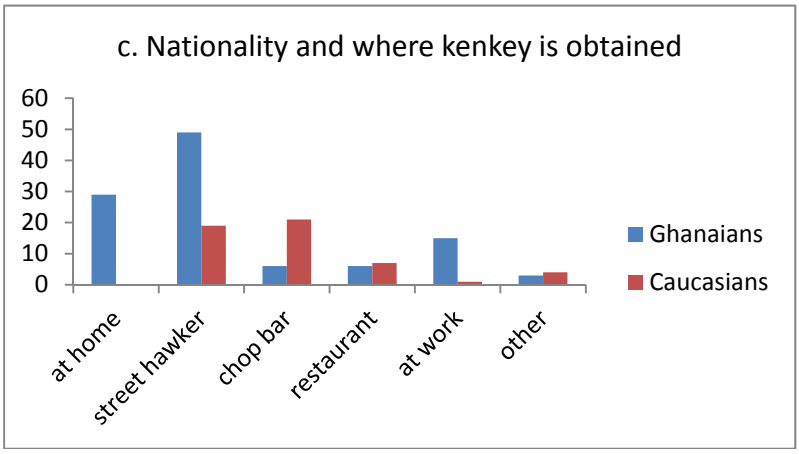
Figure 4b. Frequency of consumption of Kenkey by consumers who like all six fermented maize products

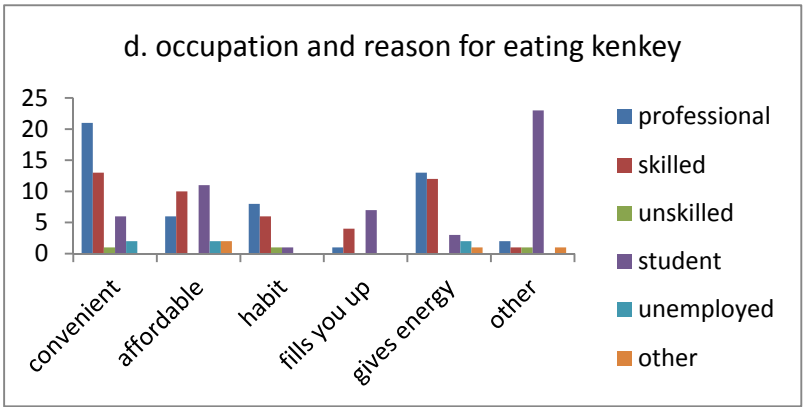
Effect of demographic characteristics of consumers on Kenkey consumption

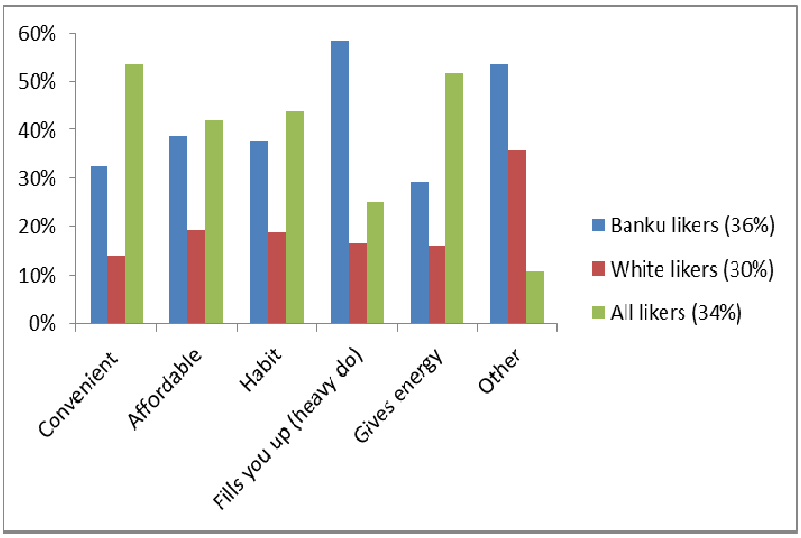
None of the socio-economic factors evaluated i.e. level of education, ethnicity, nationality, age, gender, occupation, residential status in Ghana and marital status of the consumers significantly influenced ($p>0.05$) the acceptability of any of the products (results not shown). There was no significant difference between Ghanaians and Caucasians with regards to the most liked and least liked products.

The main reasons given by Ghanaian consumers for eating Kenkey is its convenience (take away/ready to eat food) and also that it gives energy (Figure 5). The other reasons are its affordability and also out of habit. Though the consumers said that it gave energy they did not find it filling. The Caucasians eat Kenkey for reasons other than those mentioned in the questionnaire. The other reason given was its affordability by the Caucasian consumers who were mostly foreign students. Comparison of figures 5a and 5b show that occupation does not influence consumers' reason for eating Kenkey.

Most of the Ghanaians consumers obtain Kenkey from street hawkers or at home. The latter source is misleading since Kenkey is rarely prepared at home, the process being laborious and time consuming. Kenkey served at home is usually purchased from a vendor. The question may not have been properly understood by some consumers. Similarly Kenkey obtained at the workplace will come from a vendor, and in a restaurant from a supplier. However, Kenkey eaten in a chop bar would have been prepared in the chop bar.







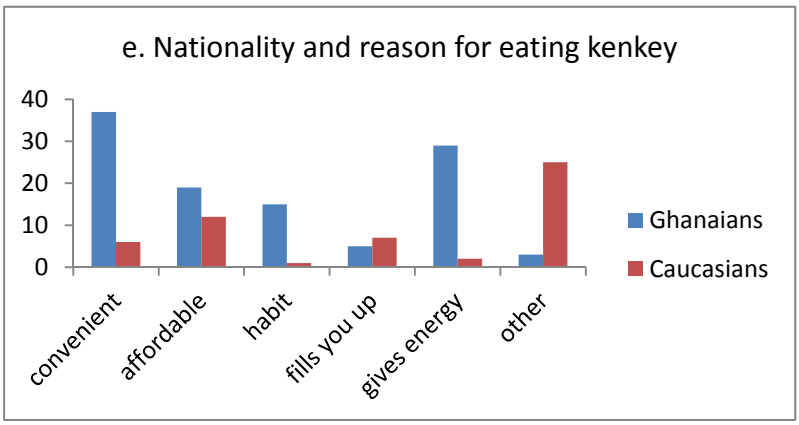


Figure. 5. Distribution of consumers according to reasons for eating Kenkey and where the product is obtained from.

Correlations between sensory attributes and consumer acceptance of Kenkey

There was positive correlations between whitish colour (due mainly to dehullng of the maize kernels) and fruity odour, smooth texture, and sweet taste (Table 3). Whitish colour, however, negatively correlated with burnt odour, sticky odour, sour and strong taste, and maize odour. This will be the result of the shorter cooking time of the dehulled maize products (for negative correlation with burnt odour), no aflata added mostly (for non-sticky texture), shorter fermentation period (for less sour taste and less fermented odour), and absence of endosperm (for the less maize odour). In the same manner, the brownish colour associated with the whole maize products was positively correlated with sour and strong taste, fermented and maize odour, and sticky texture. The brownish colour was negatively correlated with fruity odour,

Table 3. Correlation coefficients of sensory descriptors used to evaluate the colour, odour, texture and taste of Kenkey and other maize products

	Brownish colour	Creamy colour	Whitish colour	Maize odour	Fruity odour	Burnt odour	Fermented odour	Hard texture	Sticky texture	Smooth texture	Sour taste	Sweet taste	Salty taste	Strong taste
Brownish colour														
Creamy colour	0,83													
Whitish colour	-0,97	-0,93												
Maize odour	0,74	0,44	-0,70											
Fruity odour	-0,90	-0,96	0,98	-0,65										
Burnt odour	0,94	0,72	-0,90	0,86	-0,86									
Fermented Odour	0,92	0,86	-0,96	0,82	-0,96	0,93								
Hard texture	-0,12	-0,57	0,33	0,14	0,49	-0,12	-0,27							
Sticky texture	0,82	0,85	-0,90	0,72	-0,95	0,88	0,94	-0,52						
Smooth texture	-0,81	-0,47	0,71	-0,86	0,64	-0,92	-0,80	-0,22	-0,67					
Sour taste	0,89	0,79	-0,91	0,84	-0,91	0,95	0,98	-0,21	0,90	-0,88				
Sweet taste	-0,82	-0,90	0,89	-0,61	0,91	-0,79	-0,90	0,48	-0,86	0,58	-0,86			
Salty taste	0,34	0,22	-0,37	0,80	-0,38	0,50	0,57	0,06	0,48	-0,54	0,60	-0,52		
Strong taste	0,89	0,91	-0,92	0,62	-0,92	0,82	0,92	-0,27	0,82	-0,72	0,92	-0,83	0,35	

Acceptance of the products considering all consumers was in most cases linearly related to the sensory attributes (Figures 6a to 6g). Acceptance increased with the intensity of whitish colour, fruity odour and sweet taste, but decreased with brownish or creamy colour and fermented odour. A non-linear relationship was, however, observed between acceptance and sour taste (6g).

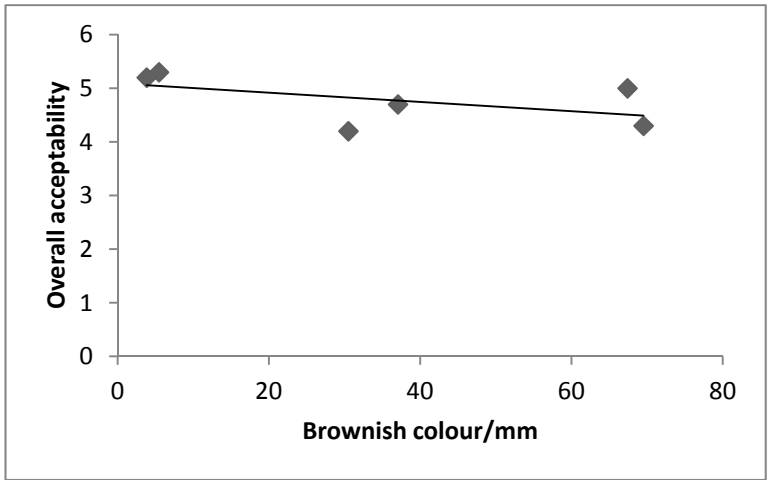


Figure 6a. Correlation between overall acceptance by all consumers and brownish colour

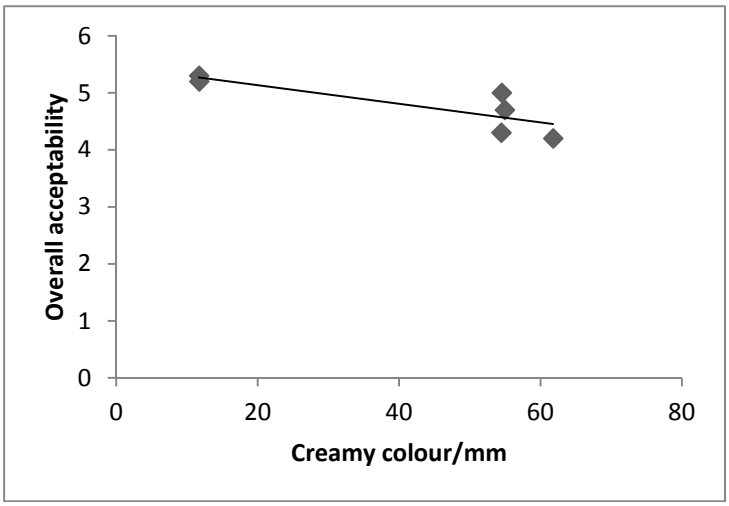


Figure 6b. Correlation between overall acceptance by all consumers and creamy colour

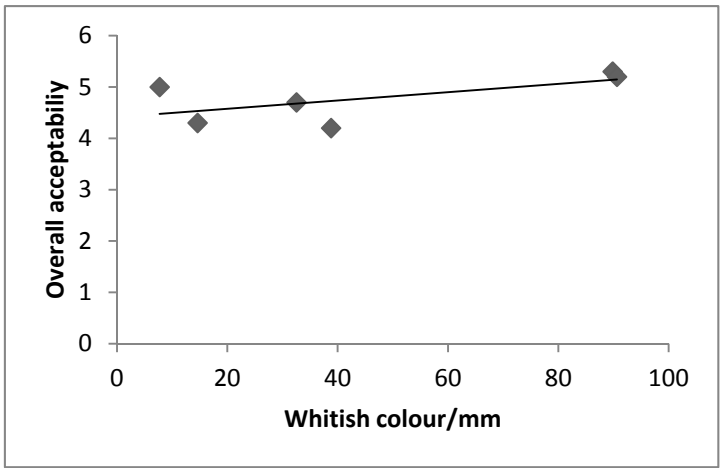


Figure 6c. Correlation between overall acceptance by all consumers and whitish colour

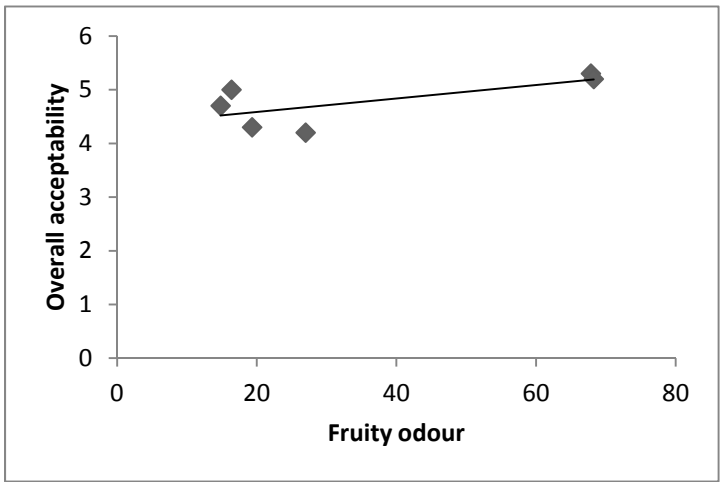


Figure 6d. Correlation between overall acceptance by all consumers and fruity odour

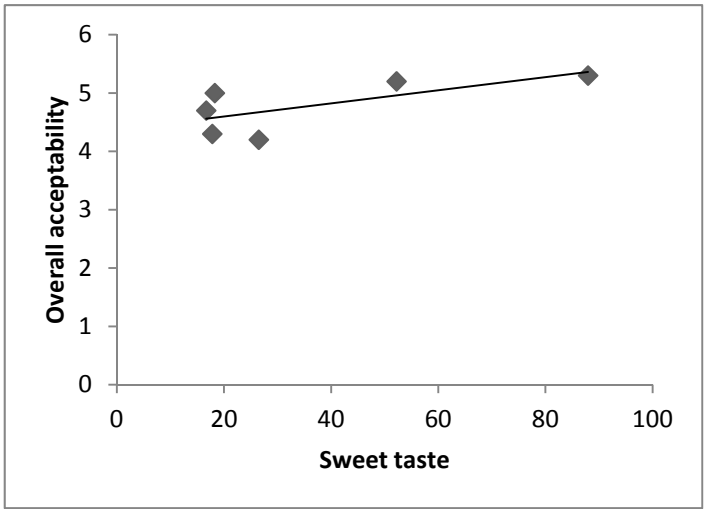


Figure 6e. Correlation between overall acceptance by all consumers and sweet taste

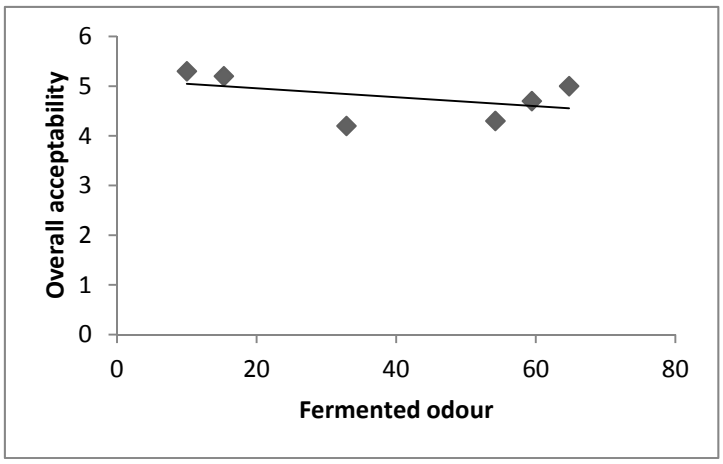


Figure 6f. Correlation between overall acceptance by all consumers and fermented odour

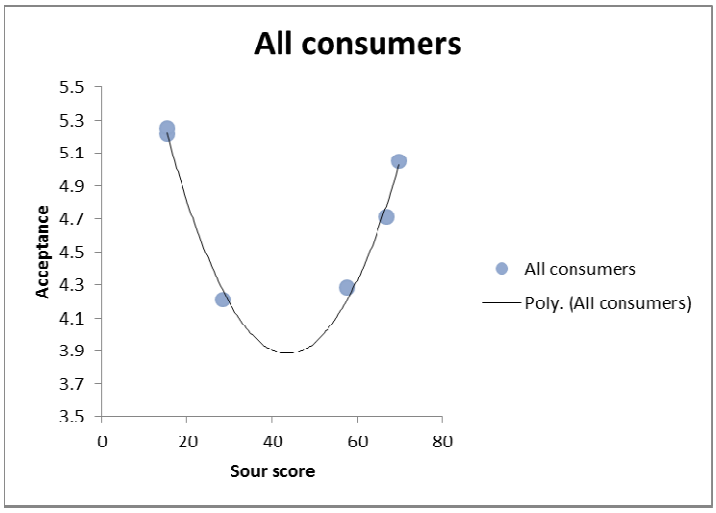


Figure 6g. Correlation between overall acceptance by all consumers and sour taste

Significant correlation between acceptance and sensory attributes by the three classes of behaviours of consumers showed only positive correlation with salty taste for banku likers without any negative correlations (Table 4). For white likers, acceptance was positively correlated with fruity odour and sweet taste, and negatively with creamy colour, fermented odour, sour and strong taste. There was no significant positive or negative correlation for any attribute by all likers. For all consumers there was a positive correlation with salty taste and negative correlation with creamy colour for acceptance.

Table 4. Consumer preference and sensory correlations

	Banku likers (36%)	White likers (30%)	All likers (34%)	All consumers
Brownish colour	-.150	-.516	.034	-.504
Creamy colour	-.201	-.750	-.438	-.785
Whitish colour	.095	.653	.176	.596
Maize odour	.562	-.275	.320	.255

Fruity odour	-.007	.817	.240	.652
Burnt odour	.106	-.627	.269	-.363
Fermented odour	.245	-.724	-.019	-.372
Hard texture	.198	.577	.465	.649
Sticky texture	.199	-.924	.013	-.552
Smooth texture	-.294	.489	-.417	.095
Sour taste	.318	-.731	.049	-.313
Sweet taste	.001	.825	.175	.655
Salty taste	.924	.018	.205	.737
Strong taste (bland)	.086	-.734	-.257	-.532

Correlation between acceptance and sour taste was further explored for the different classes of behaviour of consumers (Figure 7). There was a linear correlation between acceptance and sour taste by white and all likers; however, whilst acceptance decreased with increasing sourness for white likers, it increased slightly for all likers (Figures 7a and 7b). Correlation between banku likers and sourness was not linear (Figure 7c)

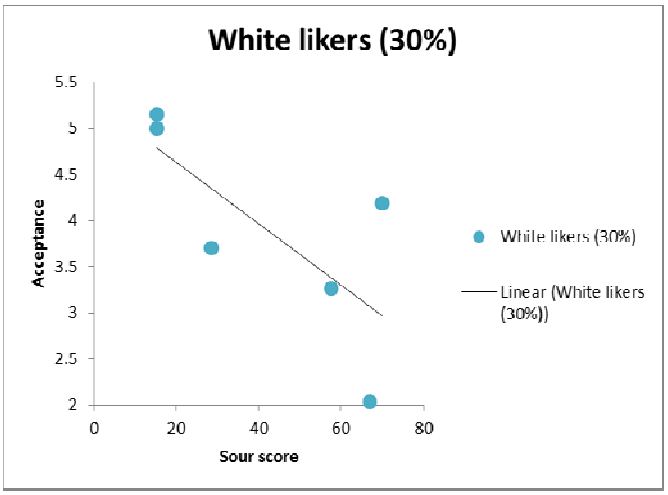


Figure 7a. Correlation between acceptance by white likers and sour taste

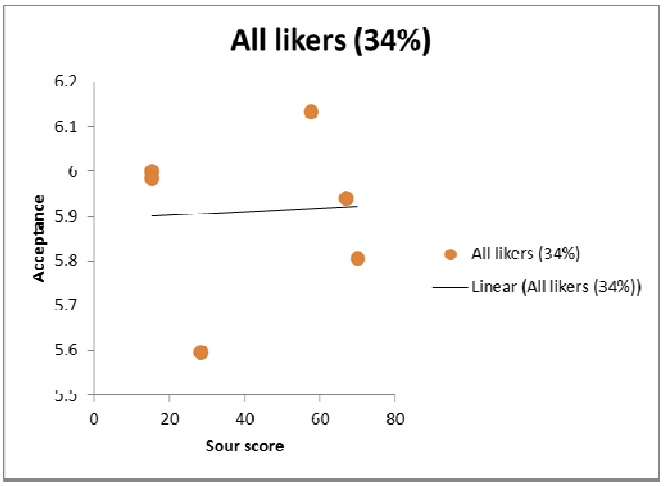


Figure 7b. Correlation between acceptance by all likers and sour taste

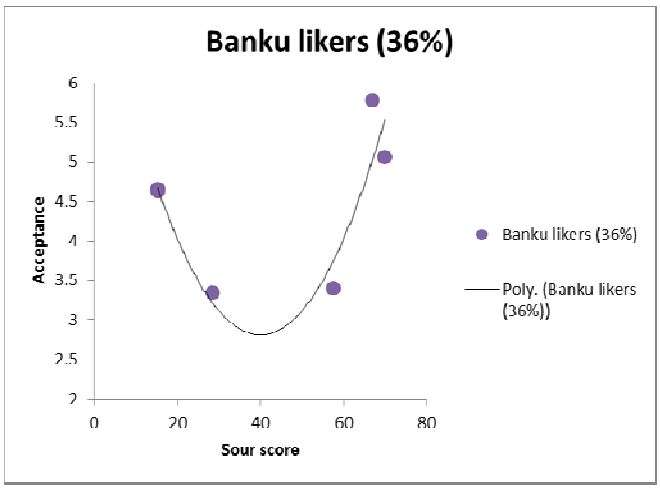


Figure 7c. Correlation between acceptance by banku likers and sour taste

Implication for developing Kenkey suited to European market and the local market in Ghana

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

Three groups of 'likers' or consumers emerged with different sensory characteristics. For the European market and also part of the Ghanaian market, considerations will be based on the preferences of the white likers group to which most of the Caucasians interviewed belonged. Sensory attributes which will be emphasized in re-engineering Kenkey for this market are whitish colour, fruity odour, smooth and non-sticky texture, a less sour product without a pronounced fermented odour, and bland taste. Important processing factors which will be explored to achieve these will include dehulling/polishing of maize kernels, use of mixed lactic acid bacteria/yeast starter culture containing high concentration of yeasts cells (for fruity odour), reduced fermentation period (to reduce sourness and fermented odour) and elimination of the aflata step (to reduce sticky texture).

For the Ghanaian market a second product will be developed to cater for the all likers and the banku likers, and will be an improved Ga/Fanti Kenkey. These two groups are not very discerning consumers; whilst only salty taste correlated significantly with acceptance for the banku group, none of the sensory attributes correlated with acceptance for the all likers.

Conclusions

This study has provided information on the sensory characteristics of the main types of Kenkey and other competing fermented maize products consumed in Ghana. The results help to provide a basis of understanding of the acceptability of these products by African and Caucasian consumers and indicate ways that the product could be adapted to consumer taste suited to the European and Ghanaian markets and can have a potential success as a marketed product.

References

Allotey, L.D. (1996). Trends and developments in *kenkey* production in Ghana. Technical Report, *Food Research Institute*, Accra, Ghana.

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 Control* 18: 1449–1457.

Amoa-Awua, W.K.A., Filtenborg, O., Sefa-Dedeh, S., Jakobsen, M. (1997). The contribution of moulds and yeasts to cassava dough 'agbelima' fermentation. *Journal of Applied Microbiology.* 83, 288-296.

Halm, M., Lillie, A., Sorensen, A.K. and Jakobsen, M (1993) Microbiological and aromatic characteristics of fermented maize doughs for kenkey production in Ghana. *International Journal of Microbiology*, 19, 135-143

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. 799–818.

Hayford, A,E., Jespersen, L. (1999) Characterization of *Saccharomyces cerevisiae* strains from spontaneously fermented maize dough by profiles of assimilation, chromosome polymorphism, PCR and *MAL* genotyping. *Journal of Applied Microbiology*, 86, 284-294.

Hayford, A,E., Jakobsen, M. (1999) Characterization of *Candida krusei* strains from spontaneously fermented maize dough by profiles of assimilation, chromosome profile, polymerase chain reaction and restriction endonuclease analysis. *Journal of Applied Bacteriology*, 87, 29-40.

Sefa-Dedeh, S. and Plange, H. (1989). Processing of Ga *Kenkey (komi*) in Greater Accra region. A techno-economic study. *Kellogg International Report* 03/1988 1–36.

Sefa-Dedeh, S. (1993). Traditional food technology. In Encyclopaedia of Foods, Food Technology and Nutrition, ed Macrae, R., Robinson , F. and Sadler, M. 4600-4606. New York : Academic Press.

Ackom-Quayson, G. (1992). Evaluation of *Komi* processing – process and product characteristics. M. Phil Thesis, Department of Nutrition and Food Science, University of Ghana, Legon.

Nche, P. F., Odamtten, G. T., Nout, M. J. R. and Rombouts, F.M. (1994). Dry milling and accelerated fermentation of maize for industrial production of *Kenkey*, a Ghanaian cereal food. *Journal of Cereal Science* 20: 291-298.

Nche, P. F., Odamtten, G. T., Nout, M. J. R. and Rombouts, F.M. (1996). Soaking determines the quality of *aflata* for *Kenkey* production. *Journal of Cereal Science* 24: 291-297.

Nout, M.J.R., Kok, B., Vela, E., Nche, P.F., and Rombouts, F.M. (1996). Acceleration of the fermentation of *Kenkey*, an indigenous fermented maize food of Ghana *Food Research International,* 28(6): 599-604.

Annex 3 – detailed report for Gowe

Sensory profile and acceptability of Gowe in Benin

Laurent Adinsi[a].; Noel Akissoe [a*]., Anne-Laure Declemy[b]., Aurelie Bechoff[c]., Keith I. Tomlins[c]., Victor Anihouvi[a]., Generose Dalode[a]., Genevieve Fliedel[b], Dominique Pallet[b]. and Djidjoho Joseph Hounhouiagan[a]

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

[b] CIRAD Montpellier, France TA B-95 / 16, 73 rue Jean-François Breton, 34398 Montpellier Cedex 5, France

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

*Corresponding author: E mail: noel.akis@yahoo.fr

ABSTRACT (max 300 words)
The purpose of this study was to describe the sensory characteristics of traditional Gowe and the consumer acceptability using focus group discussions, a descriptive panel and a consumer acceptability panel. The sensory profile was established with ten locally available Gowe samples (made from five different processes) which were tested by twenty two semi-trained panellists. For consumer acceptance, four samples were reasonably chosen from samples clusters and evaluated by 141 African ordinary consumers. The commonly consumed gowe were sensorially distinct products. The PCA plot on sensory data accounted for 78% of the variation of sensory attributes. The cluster analysis revealed a difference between sorghum and maize samples of gowe, but no significant difference was evidenced with respect to sugar addition", with the mixed Gowe (XFn and XFs) or the gowe from maize (MFn and MFs) being similar. In addition, integration of non-malted flour before or after saccharification is similar (SSaFn, SSaSFn). Regarding consumer testing, three distinct patterns of consumer acceptability were observed, which were grouped as 'Sugary Gowe likers' or "Nature sorghum Gowe dislikers" (63.1%) followed by 'Sugary sorghum Gowe likers' (20.6%) and 'Indifferent Gowe likers' (16.3%). However irrespective of the segmented consumers, saccharified malted and no-malted sorghum Gowe without sugar was the unique sample scored less than a neutral score of 5 (neither liked, no disliked).

CONCLUSIONS RELATING TO REENGINEERING (MAX 200 WORDS)
With respect to acceptance, the Gowe from saccharified malted sorghum with sugar (SSaSFs) was scored higher (upper than the neutral score of 5) irrespective of the consumers' clusters. So, the reengineering approach must focus on this gowe type (or one of its cluster).

Introduction

Gowé is one of the many popular traditional fermented products locally available and commonly consumed in Bénin. It is produced by small scale processors (Adinsi *et al.*, 2012) and consumed as a thirst quencher, social drink, energy drink. Originally, Gowe is mostly

popular in the centre of Benin (Michodjèhoun-Mestres *et al.*, 2005; Adinsi *et al.*, 2012), but its consumption is steadily spread to other regions of the country, essentially to the main cities. This expansion in Gowe consumption promotes the need for medium-or large-scale commercial production. This could, however, face serious problems, considering the current nature of production of Gowe. As a matter of fact, Gowe is spontaneously fermented and "chance saccharified" starchy product often resulting in inconsistencies in quality.

Recent survey reported different types of Gowe in Bénin based on the raw materials and the processing technology as a result of endogenous innovative actions of producers (Adinsi *et al*., 2012). While sorghum and maize were used singly or in combination, Gowe processing still relies on spontaneous malting and fermentation (Michodjèhoun-Mestres et *al.*, 2005; Vieira-dalodé *et al.,* 2007; Adinsi et *al.,* 2012). Consequently, the malting duration is variable and affects the functional properties of the malt. The fermentation is achieved by natural lactic acid bacteria and yeasts. Such fermentation with unpredictable microbial flora may result in delayed fermentations or even failure of fermentation (Sanni *et al*., 2002). The variability in the raw materials and processing methods used can lead to important variations in quality attributes such as taste, odour and texture, which may result in product rejection and thus economic losses for the producer. It is, therefore, imperative to standardize the processing technique referring to the consumer acceptance. Moreover, socioprofessional and demographic differences in the consumers might segment the attitudes and acceptability of Gowe. This study was set out to describe the sensory attributes of traditionally produced Gowe. Consumer acceptability and its relationship with the sensory attributes were also studied. The results of this work will form an important background for guiding the process of improving the production of Gowe.

Materials and methods

Gowe samples

White maize grains (*Zea maize*) and red sorghum grains (*Sorghum bicolor* (L.) Moench) were purchased from international market of Dantokpan. Five types Gowe were made using traditional processes under good hygienic conditions. Each type was consumed in two forms: nature form e.g. without any additive and the second form was diluted Gowe with water and sugar. The five types Gowe used in this study were as follows (Table 1):

SSaSF: Saccharified malted sorghum Gowe. The sorghum grains were cleaned and divided into two parts. One part (25%) was soaked, germinated and sun dried; the malted and no-malted sorghum grains (75%) were milled separately using a plat disc mill. The malted sorghum flour was kneaded with tap-water and left for a saccharification. Hot slurry of no-malted and no-malted sorghum flour were added to the dough previously obtained with water. The mixture was allowed to undergo a fermentation leading to Gowe which will be cooked.

SSaF: Saccharified malted and no-malted sorghum Gowe. The mixed flour of malted (25%) and no-malted (75%) sorghum flour was kneaded with tap-water and left for a saccharification. Hot slurry of malted and no-malted sorghum flour was added to the dough saccharified with water. The mixture was allowed to undergo a fermentation leading to Gowe which will be cooked.

SF: Sorghum Gowe. The flour of malted (25%) and no-malted (75%) sorghum flour was mixed with tap-water and hot slurry of malted and no-malted flour. The mixture was left for fermentation before cooking.

MF: Maize Gowe. It was produced as described for SF but the sorghum is replaced by maize.

XF: Mix cereal Gowe. The flour of malted sorghum (50%) and no-malted maize (50%) was mixed with tap-water and hot slurry of malted and no-malted flour. The mixture was left for fermentation before cooking.

Table 1 : Samples of Gowe for sensory profile

Types of Gowe	**Basic Processing technology**	**Existing Forms**	**Initials**
1 Gowe from sorghum	Malted sorghum (25%) + No-malted sorghum (75%) / Saccharification / Fermentation /Cooking	Nature Gowe sorghum	SSaFn
2 Gowe from sorghum	Malted sorghum (25%) + No-malted sorghum (75%) / Saccharification / Fermentation /Cooking	Sorghum Gowe with sugar	SSaFs
3 Gowe from sorghum	Malted sorghum (25%) + No-malted sorghum (75%) / Fermentation / Cooking	Nature Gowe sorghum	SFn
4 Gowe from sorghum	Malted sorghum (25%) + No-malted sorghum (75%) / Fermentation / Cooking	Sorghum Gowe with sugar	SFs
5 Gowe from sorghum	Malted sorghum (25%) / Saccharification / Adding of No-malted sorghum / Fermentation /Cooking	Nature Gowe sorghum	SSaSFn
6 Gowe from sorghum	Malted sorghum (25%) / Saccharification / Adding of No-malted sorghum / Fermentation /Cooking	Sorghum Gowe with sugar	SSaSFs
7 Gowe from maize	Malted maize (25%) + No-malted maize (75%) / Fermentation / Cooking	Nature Gowe maize	MFn
8 Gowe from maize	Malted maize (25%) + No-malted maize (75%) / Fermentation / Cooking	Maize Gowe with sugar	MFs
9 Gowe from mixed cereals	Malted sorghum + No-malted maize / Fermentation / Cooking	Nature Gowe mix cereals	XFn
10 Gowe from mixed cereals	Malted sorghum + No-malted maize / Fermentation / Cooking	Mix cereals Gowe with sugar	XFs

Ethical assessment and consent
Prior to being enrolled onto the consumer and descriptive panel, members were briefed about the study to enable them make an informed decision. Those that agreed to participate had to sign consent forms. Members were free to withdraw from any of the panels at any time.

Sensory evaluation
Ten Gowe samples were scored by a semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided (Meilgaard *et al.*, 2007; Tomlins *et al.* 2012). The panel was composed of university technicians, students or private company employees (22 panellists) and the sessions were conducted at the University of Abomey-Calavi, Benin under air conditioned and lighting. The panellists were spaced at least 2m in a booth area to avoid interaction. The panellists had been screened for perception of the basic tastes (sweet and sour) and familiarity with the product. Sensory attributes were generated during a preliminary focus group session guided by the panel leader. Thirteen descriptive terms were generated. They were listed as follows:

- Brown colour - Colour characteristic of sorghum
- White colour – Colour characteristic of maize
- Concentrated aspect – Related to the ease of flow with a high proportion of solid matter
- Presence of bran- Related to particles in Gowe
- Cereal odour – Odour characteristic of cereal (aroma related to maize or/and sorghum)
- Fermented odour - Aroma typical of fermented alcoholic products
- Burnt odour- A odour sensation that looks like abnormal
- Grainy- Appearance of small particles
- Presence of lumps - Appearance of a mass of particles
- Taste sweet (sugary)- A taste sensation that is related to sugar
- Acidic taste – taste characteristics of lemons
- Aftertaste - A taste sensation that looks like abnormal
- Cereal taste – taste characteristic of cereal (taste related to maize or sorghum)

After a period of training using these attributes, the ten Gowe samples were tested blind in triplicate by the panel and the order in which they were presented was random. At each session four Gowe samples (coded with four-figure random numbers) were served in random order to each panellist. The panellists rinsed mouth with mineral water before tasting each sample. Intensity for the sensory attributes was scored on a 100 mm unstructured scale anchored with the terms ‘not very’ at the low end and ‘very’ at the high end.

Consumer acceptance
Four Gowe forms were selected for consumer testing among the samples used for sensory testing. Consumers (141) were interviewed at two locations in Benin: Cotonou (76) and Abomey-calavi (64).

During testing, Gowe samples were freshly prepared every day and kept in a cooled box until serving. Consumers scored the acceptability of Gowe using a 9-point hedonic box scale (Meilgaard *et al*., 2007) from ‘dislike extremely’ to ‘like extremely’. The four cooked samples were coded with three-figure random numbers and presented simultaneously, but in random order to each consumer.

After testing the product, consumers were interviewed for collecting information on gender, age, occupation, marital status, number of children, education level, type of Gowe usually consumed, form of consumption, frequency of consumption, constraint limiting the consumption, place where Gowe has been eaten, period of consumption. The interviewed (acceptability and the questionnaire) took approximately 30 min.

Statistical Analysis

Data were subjected to Analysis of variance (AN0VA), Chi Square test ($p<0.05$), correlation analysis (Pearson), cluster analysis (Ward's method) and principal component analysis (PCA) using Statistica 7 (StatSoft, Tulsa, USA) or XLSTAT (V 5.2, Addinsoft).

Results

Sensory profile of Gowe

The Gowe samples differed with respect to sensory attributes of Gowe, except for Cereal odour and cereal taste which did not significantly differ ($p>0.05$) (Table 2). Regarding the sweet and sour tastes or fermented odour, saccharified Gowe samples nature (SSaFn, SSaSFn) were significantly scored weaker than the Gowe non saccharified Gowe samples nature (SFn and MFn). The low score of sweet taste is not expected for saccharified Gowe since the saccharification process might increase the sweet taste.

It seemed that "addition of sugar" affected the concentration of the product since Gowe with sugar were scored significantly lower than Gowe samples nature (without sugar) with respect to "Concentration feeling/aspect".

Concerning correlations between the sensory attributes, cereal taste was associated to white colour ($r=0.87$), brown colour ($r=-0.73$) and cereal odour ($r=0.84$). Sour taste was associated to fermented odour ($r=0.95$), presence of lumps ($r=0.90$), grainy ($r=0.74$) and aftertaste ($r=-0.66$).

Table 2: Means and probabilities for sensory testing with respect to Gowe and sensory panellist

Samples	Colour		Odour			Texture				Taste			
	White colour	Brown colour	Cerealodour	Fermented odour	Burnt odour	Concentrated aspect	Presence of bran	Grainy	Presence of lumps	Sweet taste	Sour taste	Aftertaste	Cereal taste
SSaFn	6.4±13.6a	72.9±15.1bd	41.9±22.8a	20.1±15.8a	29.8±18.8ab	82,5±19.7a	19.7±15.7a	19.1±14.7a	24.2±17.1a	5.3±6.2a	14.8±14.3a	41.5±22.5ab	38.5±19.6a
SSaFs	7.5±11.7a	60.8±16.4ab	39.1±24.1a	19.0±12.7a	28.7±17.1ab	44.3±12.1c	22.0±17.6ab	25.2±19.5a	47.5±19.6cd	38.8±16.6bc	15.0±9.3a	40.5±20.2ab	38.3±20.3a
SSaSFn	6.0±11.7a	77.0±13.2d	40.0±25.8a	15.8±11.6a	49.6±16.8d	78.8±20.1a	20.7±14.7a	22.0±14.9a	29.8±17.8ab	6.0±6.9a	21.5±17.4a	53.4±20.7b	37.6±21.9a
SSaSFs	7.9±12.0a	63.4±12.4ab	39.9±23.4a	19.1±13.3a	51.4±15.9d	35.0±13.8bc	26.8±16.8abc	33.5±22.3abc	55.6±18.0d	47.4±18.6cd	16.2±10.8a	52.9±20.2b	40.9±23.0a
SFn	6.3±9.1a	63.0±14.2ab	37.3±22.2a	41.1±21.2bc	30.5±11.5a	76.5±21.3a	38.0±19.5bc	31.1±18.2ab	32.2±15.5abc	29.0±13.6b	57.4±16.7b	40.5±14.4ab	39.9±22.6a
SFs	12.0±13.1a	50.8±16.0a	38.8±20.6a	31.3±18.5ab	30.0±13.2a	34.4±17.5bc	36.8±16.9abc	35.9±20.2abc	43.2±18.1bcd	60.7±21.1e	30.7±18.9a	45.5±17.0ab	37.0±19.9a
MFn	67.0±21.6b	3.1±5.0e	50.2±22.9a	41.3±25.2bc	14.0±15.0c	77.4±17.4a	42.0±21.5cd	33.4±14.4abc	27.3±17.6a	47.6±21.9cd	54.0±22.0b	31.5±23.5a	47.4±25.2a
MFs	49.5±18.9b	22.3±7.8c	47.3±22.2a	31.1±18.3ab	19.3±14.8abc	26.8±16.0b	33.3±14.6abc	28.0±14.4a	37.1±15.0abc	53.7±20.4de	25.8±17.0a	33.6±20.6a	46.3±21.8a
XFn	12.0±16.7a	35.6±18.4c	38.7±23.4a	55.3±21.7c	20.2±15.5abc	71.3±19.7a	56.4±20.4d	47.2±17.2bc	32.5±14.5abc	16.7±12.6a	62.9±17.8b	32.6±19.7a	36.1±24.2a
XFs	16.3±23.7a	29.3±16.7c	41.0±21.0a	51.3±21.3c	15.2±12.8bc	30.5±14.9bc	56.7±20.2d	49.1±19.6c	37.1±10.3ab	34.7±13.5b	55.8±19.7b	29.8±19.6a	37.0±23.2a
Samples	<0.001*	<0.001*	0.09	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.1
Panellists	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Sample	0.44	0.98	0.005	0.08	1.0	<0.001*	<0.001*	0.02	0.56	<0.001*	<0.001*	0.19	<0.001*

x panellists													

*Where: *Intensity of sensory attributes was scored a 100mm scale. Average (standard deviation).*
SSaSFs- saccharified malted sorghum Gowe with sugar; SSaSFn-saccharified malted and no-malted sorghum Gowe nature; SSaFs-saccharified malted sorghum with sugar; SSaFn-saccharified malted sorghum nature; MFs-maize Gowe with sugar; MFn-maize Gowenaure. SFs-sorghum Gowe with sugar; SFn-sorghum Gowe nature; XFs-mix cereal with sugar; XFn-mix cereal nature. Differences between the samples (a, b, c, d or e in columns) were determined by the Tukey method

The PCA plot of sensory attributes and Gowe (Fig.1) resulted in a two factor solution accounting for 78.01% of the total variation of which 50.18% was explained by the first principal component (PC) and 27.83% by the second. The sensory attributes were largely separated in the direction of PC1, which spanned from brown colour, white colour, fermented odour, presence of bran and sour taste. In the direction PC2 the attributes spanned from concentrated aspect, sweet taste, presence of lumps and sour taste.

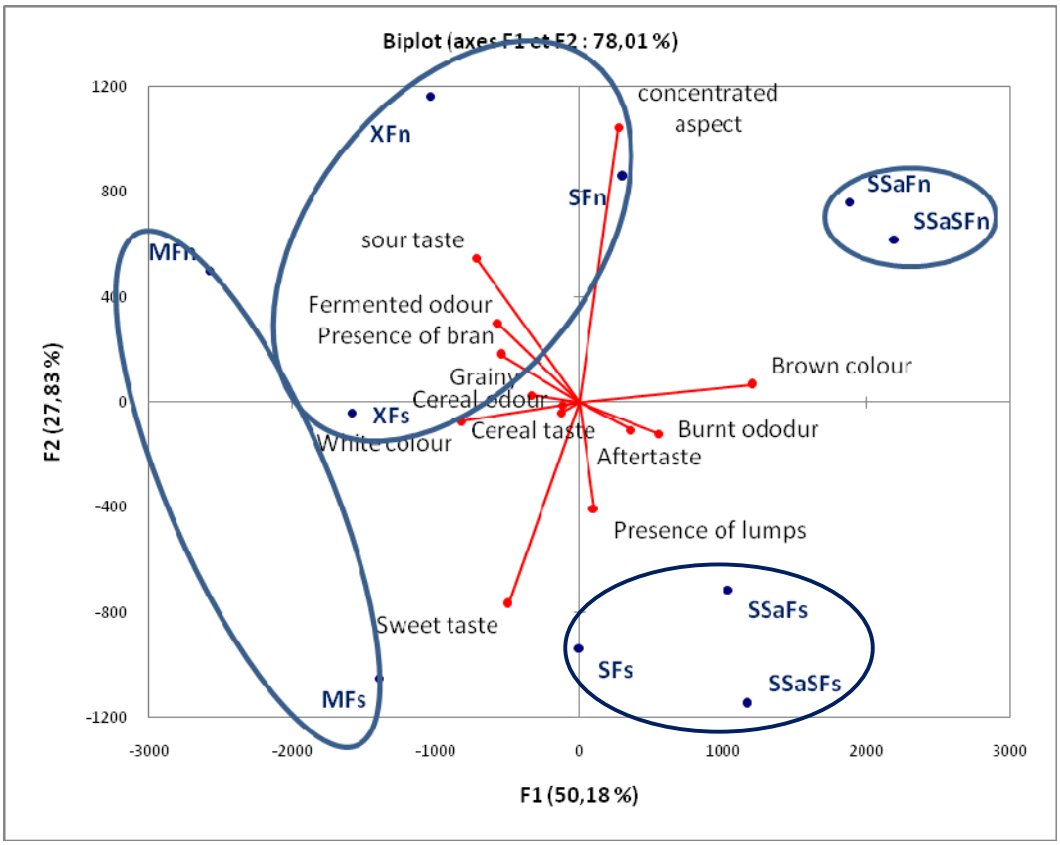


Figure 1: Principal Component Analysis (PCA) on Gowe and sensory descriptors

Where: SSaSFs-saccharified malted sorghum Gowe with sugar; SSaSFn-saccharified malted and no-malted sorghum Gowe nature; SSaFs-saccharified malted sorghum with sugar; SSaFn-saccharified malted sorghum nature; MFs-maize Gowe with sugar; MFn-maize Gowenaure. SFs-sorghum Gowe with sugar; SFn-sorghum Gowe nature; XFs-mix cereal with sugar; XFn-mix cereal nature.

Except for XFs, Gowe samples with sugar (MFs, SFs SSaSFs and SSaFs) were associated to the sweet taste. Saccharified Gowe samples from sorghum nature (SSaSFn, and SSaFn) were associated with concentrated aspect and brown colour. Sorghum Gowe nature (SFn), Mix cereal Gowe (XFn and XFs) and Maize Gowe nature (MFn) were associated to the sour taste, fermented odour, presence of brans, grainy and concentrated aspect. The cluster analysis shows four classes (Table 3) which revealed a difference between sorghum and maize samples of Gowe. Gowe from maize only is perceived different from the others while the mixed gowe (XFn and XFs) were similar to the sorghum gowe nature (SFn). In addition, for the mixed gowe,

addition of sugar did not affect gowé sensorially: the mixed Gowe (XFn and XFs) and the gowe from maize (MFn and MFs) were not perceived different.

The addition of non-malted flour before or after saccharification gave similar gowé (SSaFn, SSaSFn). In addition, Saccharified sorghum Gowe with sugar (SSaFs and SSaSFs) is not different from non saccharified malted sorghum Gowe with sugar (SFs).

The samples for the consumer testing are reasonably chosen among each of these four clusters (one sample per cluster).

Table 3: Cluster truncation of Gowe

Class	1	2	3	4
	MFs	SSaFs	SSaFn	XFn
	MFn	SSaSFs	SSaSFn	SFn
		SFs		XFs

Consumer testing

The mean acceptability of the Gowe samples differed significantly at $p<0.01$ (One-way ANOVA) (Table 4). All of the Gowe samples with sugar were on average acceptable since the mean scores were greater than a score of 5 (neither like nor dislike); only Gowe sample nature was scored less than a score of 5. The most liked was the Saccharified malted and no-malted sorghum Gowe with sugar followed by the mix cereal Gowe, and then the maize Gowe with sugar.

Table 4: Mean overall acceptability scores for the four Gowe tested

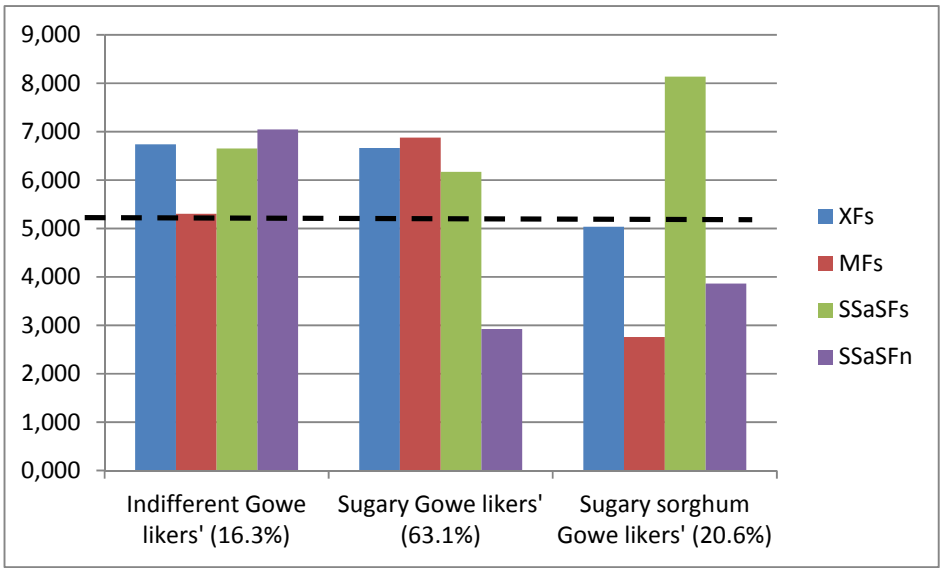
Gowe samples	Mean*	Standard deviation
XFs	6.3ab	1.64
MFs	5.8a	2.07
SSaSFs	6.6b	1.65
SSaSFn	3.8c	2.04

*Where: *Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely.. Different letters indicated significantly different samples. Tukey test ($p<0.01$). Where SSaSFs- saccharified malted sorghum Gowe with sugar; SSaSFn: saccharified malted and no-malted sorghum Gowe nature; MFs: maize Gowe with sugar; XFs: mix cereal with sugar;*
Except for saccharified malted and no-malted sorghum Gowe nature (SSaSFn), all gowe sample were on average acceptable since the mean scores were greater than a score of 5 (neither like nor dislike). The saccharified malted sorghum Gowe with sugar (SSaSFs) seemed to be the most accepted followed by the mix of cereal with sugar (XFs).

Segmentation of consumers into groups of similar acceptance patterns regarding the Gowe

Agglomerative hierarchical cluster analysis (Ward's method) indicated that consumers were clustered into three groups as illustrated in the Figure 2. The consumers were grouped as 'Sugary Gowe likers' or "Nature sorghum Gowe dislikers" (63.1%) followed by 'Sugary sorghum Gowe likers' (20.6%) and 'Indifferent Gowe likers' (16.3%). The 'indifferent Gowe likers' generally

gave high acceptability scores to sorghum Gowe samples but the lowest score to the maize Gowe. Consumers clustered as 'Sugary Gowe likers' scored the Gowe samples with sugar higher than Gowe nature sample. The group of 'Sugary sorghum (only) Gowe likers' gave the highest score only for Gowe from sorghum with sugar. In addition, irrespective of clusters, this Gowe sample (from sorghum with sugar) was scored more than a score of 5. Consequently, it can be interested for the reengineering purpose.



*Where: *Acceptability was rated on a nine-point scale from 1 = dislike extremely, to 9 = like extremely.. Different letters indicated significantly different samples. Tukey test (p<0.01). Where SSaSFs-saccharified malted sorghum Gowe with sugar; SSaSFn: saccharified malted and no-malted sorghum Gowe nature; MFs: maize Gowe with sugar; XFs: mix cereal with sugar;*
Figure 2: Mean consumer acceptability of Gowe by consumer segment.

Regarding demographic differences between consumers of each segment, the Chi Square test indicated no significant difference for. age, gender, marital status, education level, occupation (Table 5).

Concerning consumers' attitudes to buy Gowe, the Chi Square test indicated that the consumers behaved the same way even if the tendency is to the sorghum Gowe. Regarding the types of Gowe consumed, the clusters were similar, with the sorghum Gowe type being the most consumed followed by the maize and mixed (maize/sorghum) types. Concerning the consumption form, there was no difference between the clusters, however, the most common form was Gowe with water and sugar. For the three clusters, Gowe is consumed at home (87.0 to 93.1%) mainly during the hot period (50.0 to 61.5%). Although there were three clusters of consumers, no-difference was evidenced between consumers in term of frequency of consumption.

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

		'Indifferent Gowe likers' (16.3%)	'Sugary Gowe likers' (63.1%)	'Sugary sorghum Gowe likers' (20.6%)	Chi Square test (p<0.05)
Age (years)		30	32	34	0.37
Gender (%)	Male	69.6	67.4	51.7	0.26
Marital status (%)	Married	47.8	52.8	75.0	
	Unmarrried	52.2	43.8	25.0	0.11
Education (%)	Education more than primary school	95.7	79.3	72.4	0.1
Occupation (%)	Civil service	34.8	22.0	39.3	
	Housewife	0.0	2.4	0.0	
	Artisanship	0.0	20.7	21.4	0.21
	Traders	8.7	14.6	10.7	
	Student	43.5	24.4	10.7	
	Private company employee	13.0	15.9	17.9	
Economic situation (%)	Bicycle	8.7	2.4	0.0	0.33
	Motorbike	69.6	55.0	65.5	0.34
	Car	21.7	25.8	17.2	0.62
	TV	91.3	79.8	82.8	0.43
	House	43.5	30.3	37.9	0.51
	Frigo	39.1	29.2	3.4	0.62
Type of Gowe purchased (%)	Gowe from sorghum	82.6	75.3	96.6	0.14
	Gowe from maize	13.0	15.7	0.0	
Form in which Gowe is consumed (%)	Gowe with water and sugar	77.3	53.9	69.0	0.34
	Gowe with water, sugar and milk	18.2	38.2	17.2	
Frequency of consumption (%)	Consume more than once by month	39.1	52.3	61.7	0.34
	Rarely	60.9	47.7	48.3	
Problems with Gowe following consumption (%)	Don't find the good quality in Cotonou	39.1	41.5	27.6	0.56
	Availability (Place of sale)	65.2	58.5	75.9	0.33
Consumption place (%)	At home	87.0	92.3	93.1	0.78
Consumption period (%)	Hot period	54.5	61.5	50.0	
	All period	45.5	38.5	50.0	0.77

Correlations between sensory attributes and consumer acceptance

Table 6 shows the correlation between consumer acceptance and the sensory attributes. Few of these attributes were correlated with consumer acceptance. Significant negative correlations

(p<0.10) were established between the "indifferent Gowe likers" and white colour (r=-0.98) and cereal odour (r=-0.98). Positive and significant correlations were found between the "Sugary Gowe likers" and sweet taste and cereal taste. In addition 'Sugary sorghum Gowe likers' was not correlated to any of the sensory attributes.

Significant correlations were evidenced between consumers' acceptance and concentrated aspect (r=-0.94) and sweet taste (r=0.90) (Fig. 3). Thus, Consumers do not like concentrated aspect while sweet taste is accepted.

Table 6: Correlations between sensory attributes and consumers acceptability of Gowe

Descriptors	All	'Indifferent likers' (16.3%)	'Gowe with sugar likers' (63.1%)	'Sorghum or maize Gowe with sugar likers' (17.0%)
White colour	0,21	**-0,98**	0,57	-0,63
Brown colour	-0,55	0,73	-0,83	0,39
Cereal odour	0,14	**-0,98**	0,50	-0,65
Fermented odour	0,49	-0,12	0,62	-0,16
Burnt odour	-0,37	0,54	-0,66	0,51
concentrated aspect	**-0,92**	0,61	**-1,00**	-0,19
Presence of bran	0,55	-0,07	0,63	-0,05
Grainy	0,71	0,11	0,65	0,30
Presence of lumps	0,61	-0,10	0,37	0,79
Sweet taste	**0,90**	-0,73	**0,92**	0,21
sour taste	0,28	0,09	0,38	-0,20
Aftertaste	-0,42	0,51	-0,69	0,45
Cereal taste	0,67	-0,84	**0,92**	-0,24

Values in bold are different from 0 with a significance level at <0.10

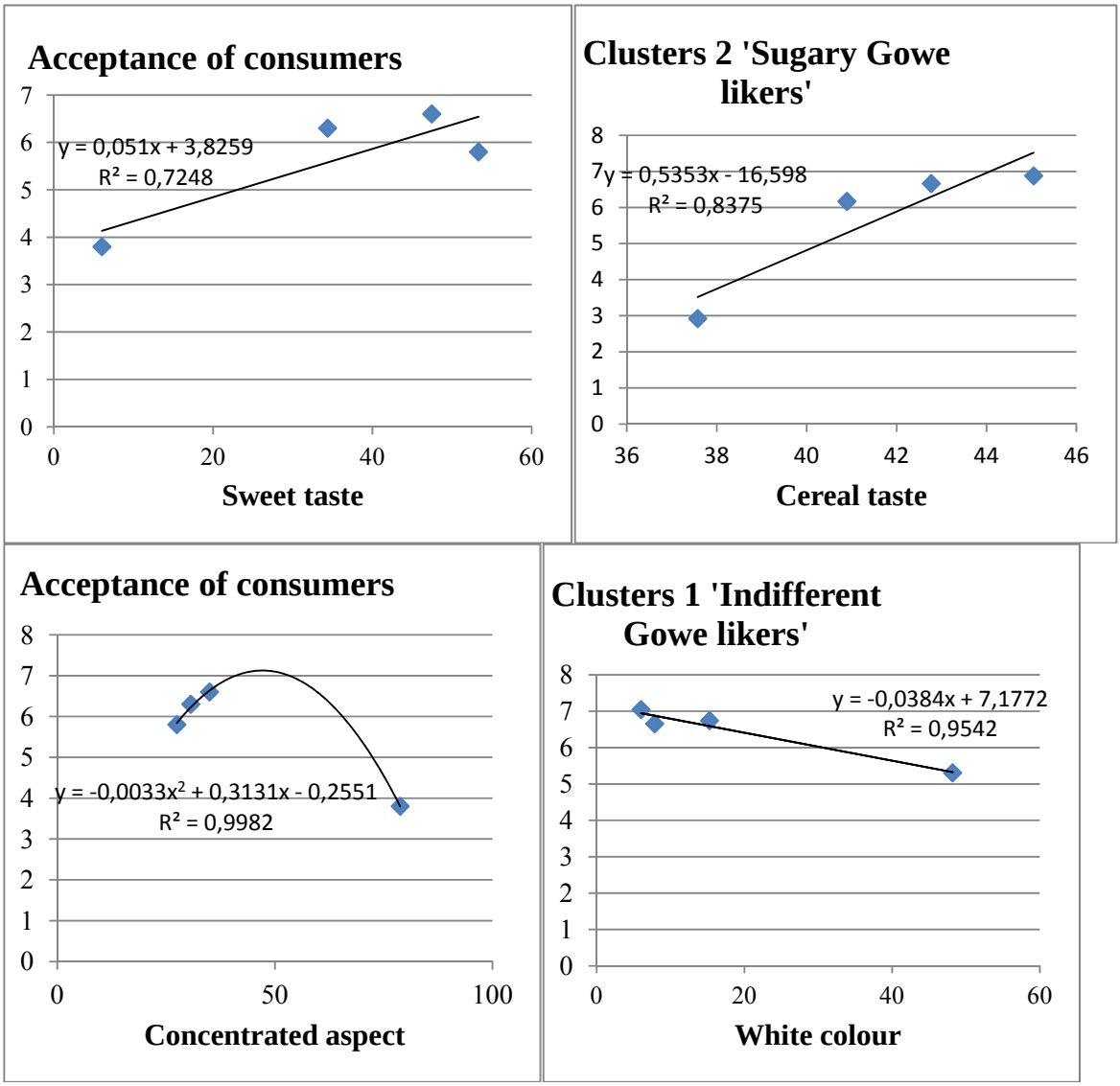


Figure 3. Relationships between sensory attributes and consumer acceptance

Implication for developing Gowe for African

For the 'Indifferent Gowe likers', any Gowé type can be developed but the consumers were demanding for sorghum since their acceptance were negatively associated to white colour. Accordingly, they shall be opened to a wide variety of reengineered products including the sorghum singly or combined with a low proportion of maize.

The 'Sugary Gowe likers' preferred Gowe diluted in water (fluid, non-concentrated) and with sugar. For this group, the colour of Gowe was not considered to be important.

Regarding the third cluster 'Sugary sorghum gowe likers', the acceptance is associated with the raw material, essentially the sorghum singly appears to be important for this group.

It was observed that Gowe from saccharified malted sorghum with sugar (SSaSFs) or gowe type in the same cluster (SSaFs or SFs) is accepted by the three cluster with high acceptance score. Consequently, any barrier to acceptance does not exist for their commercialization for African consumers. Accordingly, Gowe from sorghum is more popular in market than the other types of Gowe, and 80.9% of the consumers interviewed commonly consumed this type of Gowe.

Conclusions

Sensory evaluation showed distinct profiles for the Gowe samples tested. Segmentation of consumer acceptability suggested the way for Gowe reengineering with emphasis on Gowe from saccharified malted sorghum with sugar (SSaSFs) or on this gowe type (or one of its cluster, e.g. SSaFs or SFs). In addition, acceptance appears to be not associated to demographic, socioeconomic situation and buying attitude of consumers for each segment.

References

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

Michodjèhoun-Mestres, L., Hounhouigan, D.J., Dossou, J., Mestres, C. (2005). Physical, chemical and microbiological changes during natural fermentation of *Gowe*, a sprouted or non-sprouted sorghum beverage from West-Africa. *African Journal of Biotechnology* **4 (6)** : 487-496.
Oyewole, O.B., 1997. Lactic fermented foods in Africa and their benefits. *Food Control* 8, 289–297.

Sanni, A.I., Onilude, A., Fadahunsi, I., Ogunbanwo, S. and Afolabi, R. 2002. Selection of starter cultures for the production of *ugba*, a fermented soup condiment. *Eur. Food Res. Technol. 215*, 176– 180.

Tomlins, K.I., Owori, C., Bechoff, A., Menya, G. & Westby, A. (2012) Relationship among the carotenoid content, dry matter content and sensory attributes
of sweet potato. *Food Chemistry, 131,* 14–21.

Vieira-Dalodé, G., Jespersen, L., Hounhouigan, J., Moller, P. L., Nago, C.M. &Jakobsen, M. (2007). Lactic acid bacteria and yeasts associated with gowé production from sorghum in Benin. *Journal of Applied Microbiology* **103 :** 342-349.

Annex 4 – detailed report for Kishk Sa'eedi

Sensory profile of Kiskh Sa'eedi in Egypt

Zahra S. Ahmed*[a], Abdel Aati Shahat[a], Aurélie Bechoff [b] ,Keith I. Tomlins[b], Dominique Pallet[c] and Habiba Hassan-Wassef[a]

[a] The National Research Center (NRC) Tahrir St, Dakki, Cairo, Egypt PO 17311

[b] Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME7 3RU, United Kingdom
[c]CIRAD Montpellier, France TA B-95 / 16, 73 rue Jean-François Breton, 34398 Montpellier Cedex 5, France

*Corresponding author. Email: zahra3010@hotmail.com. Tel: (202) 33371211 – Fax (+202) 33370931

ABSTRACT (max 300 words)
Kishk Sa'eedi (KS) is a homemade fermented wheat-based stable food that has been produced and eaten in Upper Egypt since the time of the ancient Egyptians. Despite *KS* is part of the rich food heritage of Egypt, it received limited attention by researchers. The composition and sensory properties of *KS* has never investigated. This work present the first piece of evidence pertaining to sensory evaluation results in the main production zones and in the trade centres of the *KS*.

Quantitative descriptive analysis (QDA) coupled with principal component analysis (PCA) was used to study the interrelationship among and between sensory attributes. 17 terms regarding appearance, odour, flavour and texture of the samples, was selected and a glossary describing each descriptor was developed. *KS* samples (7) were profiled by 19 assessors on about 10-cm unstructured scale using the chosen 17 sensory descriptors. Mean intensity ratings of the descriptive attributes showed that there were significant differences ($p<0.05$) within *KS* samples for all the 14 attributes tested. In general, high ratings for creamy colour, fresh odour, *KS* taste and fracturability are considered as positive effects that would be favoured by panellists while increase in caramel colour, sour taste, denseness and mouth coating are regarded as undesirable.

Descriptive Sensory evaluations between of the *KS* eating panellists and non-*KS* eating panellists revealed that assessors perceive the sensory descriptors differently. The *KS* samples were acceptable to the non-*KS* eating panellists, but the typical *KS* aroma was not popular to them. *KS* non-eaters scored tastes attributes i.e. sour, salty, spicy, and *KS* taste lower than *KS* eaters whereas, creamy colour, denseness and grittiness were scored higher by *KS* non-eaters. Tastes i.e. sour, salty, spicy and *KS* taste; denseness, and grittiness were discriminating attributes. Fermented odour, colour i.e. creamy and caramel; presence of fissure and presence of bran were least discriminating.

Introduction

According to FAO Food and Agriculture Organization, traditional foods are those foods which have specific feature or features which distinguish it clearly from other similar products of the same category in terms of the use of traditional ingredients (materials of primary products) or traditional composition or traditional type of product or processing method. Such foods has been transmitted from generation to generation through oral tradition or other means and its processing methods has remained in line with methods used originally, thereby maintaining the intrinsic (physical, chemical, microbiological and organoleptic) features of such foods.

Kishk Sa'eedi (KS) is a traditional wheat-based fermented product that has been produced and eaten in homes of Upper Egyptians since the time of the ancient Egyptians. The term *Sa'eedi* is the designation that is given to the people of the *Sa'eed* or the South of Egypt. *KS* is the undisputed national food of Upper Egyptians where it shares the importance of bread as a basic component of the diet.

The know-how for preparation of *KS* is handed down from mother to daughter across generations. The production of *KS* is commonly home based and 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 wheat. The milk is fermented alone, then mixed and fermented again with the coarsely ground mature whole wheat that had been previously parboiled and sun dried.

This technology is indigenous and is a product of the traditional culinary culture of the people**.**
Traditional production of *KS* is characterised by the following: a) commonly produced on a small scale in homes and in villages; b) consists of two main ingredients namely: local grown parboiled dried and coarsely crushed wheat and unpasteurized fermented buttermilk *(Laban Zeer);*and c) two stages fermentation process.

KS production is essentially a home-based process and at present, there is no large-scale factory production. The methods employed for the manufacture of KS may differ from one region to another because these processes are based on traditional systems. However, it is traditionally made of home grown parboiled wheat dried and coarsely crushed mixed with fermented buttermilk *(laban Zeer);* shaped into nuggets or small balls; and sun dried. The product is stored in the form of the dried product. The *KS* is well adapted to hot weather and enjoys a long shelf life. *KS* can be stored without depreciation or spoilage up to the coming *KS* making season, that is, a shelf life of one year.

KS is mainly produced in Upper Egypt but is widely anchored in the consumption pattern of millions of Egyptian from all social strata. For consumption, though it can be munched in the dry state, it is often reconstituted in a little water to be consumed as a drink in the morning, or cooked in a variety of recipes. Prepared in a number of different ways, it can be served at any of the three main meals.

Despite *KS* is part of the rich food heritage of Egypt, it received limited attention by researchers. Published literature on *KS* is scanty, and the locally produced grey literature that dates back to

the 1950's was limited by the state of the art of the technical plateau of that period. From the organoleptic point of view, except for the pleasant acidic and sour taste of *KS*, little is known of the sensory quality of the product. No KS sensory evaluation research has been done to understand consumer perception and acceptability. Therefore, this paper responds to the need to narrow the knowledge gape. The main objective of this work is to understand the sensorial quality characteristics of *KS* and provide the first piece of evidence needed to explore the sensory quality criteria as perceived by the traditional processors and consumers.

Materials and Methods

Sensory evaluation

Panel selection and training
11 panellists (4 males, 7 females, age 22-43 yr), identified as familiar and consumers of *KS* and who had completed a graduate course in sensory analysis, participated in the study. Panellists were recruited from National Research Centre (NRC) and Faculty of Agriculture. Panellists were then attended several training sessions consisted of:

- Initial orientation session where panellists received detailed explanation about the descriptive sensory methodology and the purpose of the study.
- Focus group discussion where panellists used group discussions to establish descriptive terms characterising the appearance, odour, taste, and texture, which required seven 1-hour sessions. They were seated in a conference-type table to facilitate communication. In these sessions, the assessors served 11 different samples i.e. 5 balls and 6 nuggets that represent the wide spectrum of *KS* quality attributes. They tested the samples and discussed the most suitable sensory descriptors. Panellists were trained who to develop the descriptors with a common language which comprehensively and accurately describes the product attributes.
    - A list, composed of 27 descriptors was developed and redundant or poorly understood terms were deleted. The assessors discussed the individual results obtained and reached consensus descriptors for sensory evaluation. Finally 17 terms regarding appearance, odour, flavour and texture of the samples, was selected.
- Individual training on the developed lexicon, which required five 30-minutes sessions. Panellists attained individual training on the different intensities of the developed lexicon using a 10-cm line scale. They were told about the main objective of the test and also a brief explanation of how to answer the *KS* sensory and questionnaires (see annex 8.1).
    - Seven commercial samples of *kS* (four nuggets and three balls) were used in three successive sensory profiling sessions. The panellists *KS*-eaters (7males and 12 females, age 21-37) and panellists *KS* non-eaters (12 males and 9 females, age 27-47y) evaluated *KS* using the developed lexicon, which included three appearances, two odour, four taste, and four texture attributes (Table1).

Product Evaluation
The *KS* samples were subjected to evaluation through two stages namely: Sensory evaluation by *KS* eaters where the assessors are familiar with *KS* and regular consumers as well. The second

stage was dedicated for sensory evaluation by *KS* non-eaters assessors who are not familiar with the product and not consuming it. Samples were placed in plastic plates and the panellists evaluated four then three samples once during a 60-minutes session and the evaluation was repeated two more times. The three evaluation sessions were separated by at least one hour to eliminate flavour carryover and fatigue effects.

All samples were coded with random three-digit numbers and served to the panellists in a randomized complete block design. Assessors were asked to evaluate samples in the same order given to them and answer questionnaires when evaluating each sample. Subjects recorded the intensities of the attributes on about 10-cm scale, where zero indicates the absence of intensity, and ten corresponds to an extreme intensity. They worked in partitioned booths, free from distracting noises and odours. They were provided with room-temperature drinking water, and disposable cup to cleanse their palate.

Ethical assessment and consent

This study has been assessed and approved by the National Research Centre Ethics Committee. Consent was sought from sensory panellists participating in this study. Panel leader 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 annex 8.2)

Statistical analysis

Comparison results between samples among triplicates readings of experimental were treated using the ANOVA test (analysis of variance) with a probability level of ($p>0.05$) using computer program (SPSS, V 18.0) Oyarekua, M. A 2010. Principal component analysis (correlation matrix) was carried out using XLSTAT (V 5.2, Addinsoft).

Results and Discussion

Sensory evaluation

Analysis of variance (ANOVA)

The Focus Group discussion (FGD) technique generated 27 attributes e.g. descriptors amongst the 11 panellists. The attribute of appearance including the visual characteristic colour included 7 descriptors. Other descriptors included *KS* aroma were detected by the panel members and named to describe the distinguish *KS* aroma. For the attribute texture, 7 descriptors were used. The attribute of taste contributed 5 descriptors, while the attribute texture had the most descriptors, 8 in total, including the first bite, Chew, and residual sensation. After comprehensive discussion the redundant or poorly understood terms were deleted. The assessors discussed the individual results obtained and reached consensus descriptors for sensory evaluation. Finally 17 terms regarding appearance, odour, flavour and texture of the samples, was selected and a glossary describing each descriptor was developed table (4).

Table 1: Definitions of the indicated descriptors used for ksihk Sa'eedi

Descriptor	Definition

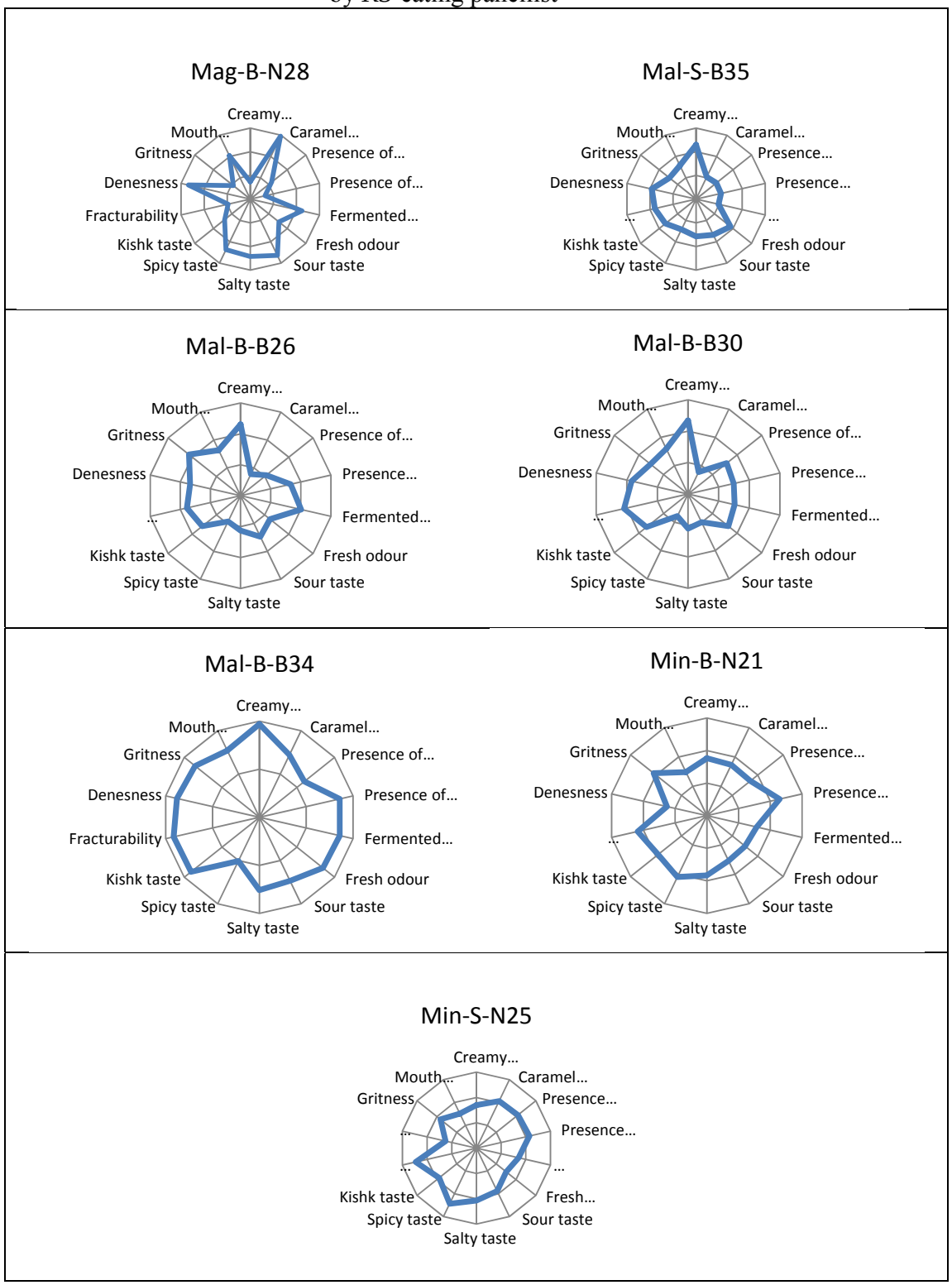
Appearance	
Creamy colour	colour similar to cream
Light yellow /caramel colour	colour similar to caramel
Presence of bran particles	degree of containing bran particle
Presence of fissures on the surface	Presence of cracks on the surface of the sample
Odour	
Fermented odour	odour characteristic of fermented wheat dough
Fresh odour	the opposite of aged odour (rancid, musty, stale)
Taste	
Sour taste	taste that is acidic and sharp
Salty taste	tastes of table salt (sodium chloride)
Spicy taste	taste that is describe the cumin and hot pepper taste
kishk taste	taste that is characteristics to kishk Sa'eedi
Texture	
Fracturability	the ability of the sample to crack or crumble, opposite of cohesiveness
Denseness	Compactness the sample after biting completely through with the molars
Grittiness	presence of small, hard particles.
Mouth coating	referred to how the sample adheres to the inside of the mouth surfaces during chewing

Seven different *KS* samples were tasted at room temperature in a random 3-digit number coded plastic plate in individual sensory booths. An unstructured line scale, with appropriate anchors, ranging from zero (0) denoting not (e.g. not salty) to ten (10) denoting extreme (e.g. extremely salty) was constructed and used to evaluate the different samples Questionnaire annexed. (See annex 8.2).

In order to ensure that panellists were not influenced in any way, no information with regard to the nature of the samples was provided. Panellists were once again informed not to use cosmetics (like lipstick) and to avoid exposure to foods and fragrances at least one hour before the evaluation sessions.. Three evaluation sessions were scheduled with a 20 minute rest period between each session, amounting to a total of three evaluation sessions per product. During one session four samples were evaluated in triplicate. Three replications were considered the absolute minimum to ensure reliability and validity of results.

Mean intensity ratings of descriptive attributes are tabulated in table (2, 3) and profiled in Figure 1. Results showed that there were significant differences ($p<0.05$) within *KS* samples for all the 14 attributes tested. In general, high ratings for creamy colour, fresh odour, kishk taste and fracturability are considered as positive effects that would be favoured by panellists while increased in caramel colour, sour taste, denseness and mouth coating are regarded as undesirable.

Figure 1. Spider diagram of the mean intensity ratings for the sensory attributes of the *KS* samples by *KS*-eating panellist



The mean QDA parameters are listed in Table in the Supporting Information.
** Each spoke of the diagram represents an individual KS sample. The intensity scales each go from lower values at the centre point to higher values at the outer end of the spoke. The intensity of an attribute in a specific product is represented by the point on the spoke at which the connecting line for that product crosses*

Table 2: Mean intensity ratings for the sensory attributes of the *KS* samples by *KS*-eating panellists

Attribute	Mag-B-N28	Mal-B-B26	Mal-B-B30	Mal-B-B34	Mal-S-B35	Min-B-N21	Min-S-N25
Creamy colour	21.9	68.9	70.2	58.2	68.9	52.9	52.05
Caramel colour	88.5	23.3	23.2	43.2	31.1	52.0	55.27
Presence of bran	34.7	31.9	47.2	35.9	32.9	51.3	66.52
Presence of fissures	19.2	49.7	44.8	51.5	32.5	68.8	68.72
Fermented odour	67.3	61.0	45.6	51.5	29.3	47.2	46.15
Fresh odour	46.4	36.7	49.3	50.7	56.0	45.1	51.68
Sour taste	79.2	43.8	29.9	44.1	50.3	46.1	43.87
Salty taste	72.7	33.0	33.1	45.5	47.3	55.1	55.90
Spicy taste	71.1	26.7	23.4	30.3	42.7	62.7	53.74
Kishk taste	41.6	46.6	50.8	54.7	49.7	57.4	46.98
Fracurability	28.9	52.7	62.7	55.0	55.0	55.0	72.34
Denseness	80.5	50.8	55.2	52.8	57.7	37.8	38.57
Grittiness	27.3	63.9	45.8	51.4	43.2	62.8	58.25
Mouth coating	61.1	49.1	47.9	46.2	47.3	44.6	40.56

⋆ Values represent means ± standard deviation; n =57
Ratings are based on a 100 mm line scale with anchors. 19 eaters trained descriptive panellists rated each attribute for each sample for a total of
3 times in 3 different days

Table 3: Mean intensity ratings for the sensory attributes of the *KS* samples by *KS* non-eating panellists

Attribute	Mag-B-N28	Mal-B-B26	Mal-B-B30	Mal-B-B34	Mal-S-B35	Min-B-N21	Min-S-N25
Creamy colour	17.39	74.89	81.14	66.47	71.59	53.33	52.05
Caramel colour	91.22	19.62	17.63	29.90	26.56	54.22	55.27
Presence of bran	43.37	38.42	42.82	32.99	38.09	42.67	66.52
Presence of fissures	21.47	52.63	43.40	43.40	48.75	37.49	70.84
Fermented odour	52.10	69.21	49.37	50.21	33.02	47.83	46.15
Fresh odour	35.73	34.69	47.13	44.52	52.69	44.76	51.68
Sour taste	52.87	47.39	35.64	36.16	42.01	39.37	43.87

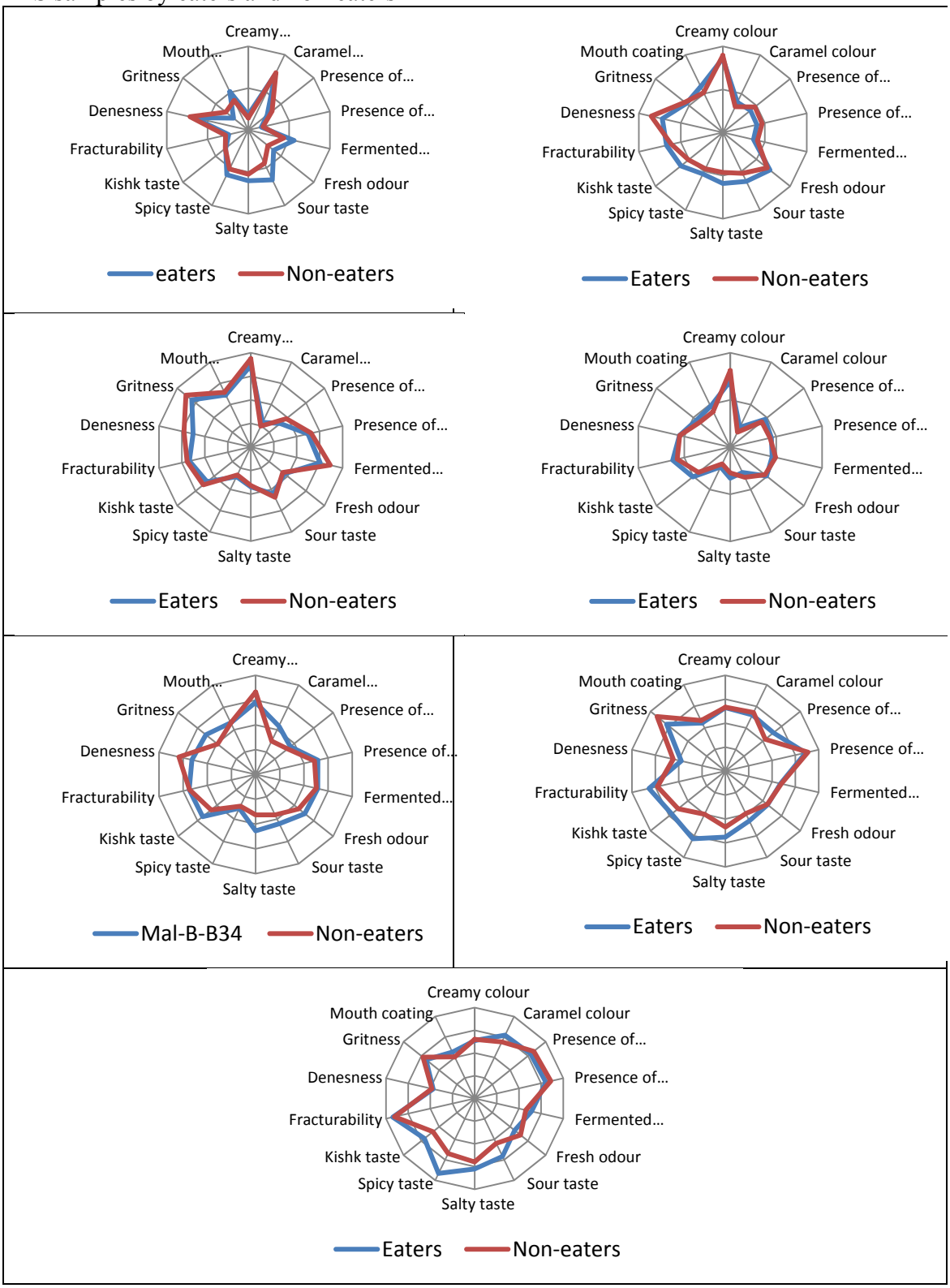
Salty taste	63.28	32.68	27.40	32.60	37.08	46.78	55.90
Spicy taste	62.05	26.33	19.89	28.43	37.35	40.01	53.74
Kishk taste	42.35	51.55	43.14	45.94	40.69	50.45	46.98
Fracturability	33.55	55.52	57.64	54.75	48.98	58.14	72.34
Denseness	85.90	58.18	55.06	63.54	68.11	44.76	38.57
Grittiness	41.31	70.45	41.77	39.23	45.10	72.97	58.25
Mouth coating	46.94	51.56	41.80	46.16	41.07	46.93	40.56

* Values represent means ± standard deviation; n =63
Ratings are based on a 100 mm line scale with anchors. 21 non-eaters trained descriptive panellists rated each attribute for each sample for a total of 3 times in 3 different days

KS eating panellists VS non-KS eating panellists

Descriptive Sensory evaluations between of the *KS* eating panellists non-KS eating panellists revealed that assessors perceive the sensory descriptors differently figure (2).The *KS* samples were acceptable to the non-*KS* eating panellists, but the typical *KS* aroma was not popular to them. Tastes i.e. sour, salty, spicy and *KS* taste; denseness, and grittiness were discriminating attributes. Fermented odour, colour i.e. creamy and caramel; presence of fissure and presence of bran were least discriminating. *KS* non-eaters scored tastes attributes i.e. sour, salty, spicy, and *KS* taste lower than *KS* eaters whereas, creamy colour, denseness and grittiness were scored higher by *KS* non-eaters.

Figure 2. Spider diagram of the mean intensity ratings for the sensory attributes of the KS samples by eaters and non-eaters



** Each spoke of the diagram represents an individual KS sample. The intensity scales each go from lower values at the centre point to higher values at the outer end of the spoke. The intensity of an attribute in a specific product is represented by the point on the spoke at which the connecting line for that product crosses*

Cluster analysis (CA)

Cluster analysis CA is a technique that involves the use of mathematical and graphical tools to situate and define grouping of data (Muñoz, 1997). It is a procedure that groups variables or cases according to some measure of similarity (Resurreccion, 1988). Variables within a cluster (group) are highly associated with each other, while those in diverse clusters are relatively different from each other (Hair, 1998). CA can be used for determining agreement between trained panellists (Powers, 1984; Yeh and others, 2002; Richardson-Harman, and others, 2000), and to differentiate products (McNeil and others, 2002; Noronha and others, 1995).

To group products sharing similar sensory features, HCA was performed on QDA means. The resulting dendrogram is shown in Figure 3. Four main groups were identified, consisting of products Mag-B-N28 (C1); products Min-B-N21 and Min-S-N25 (C2); products Mal-S-B35 and Mal-B-B30 (C3) and products Mal-B-B30 and Mal-B-B34 (C4)

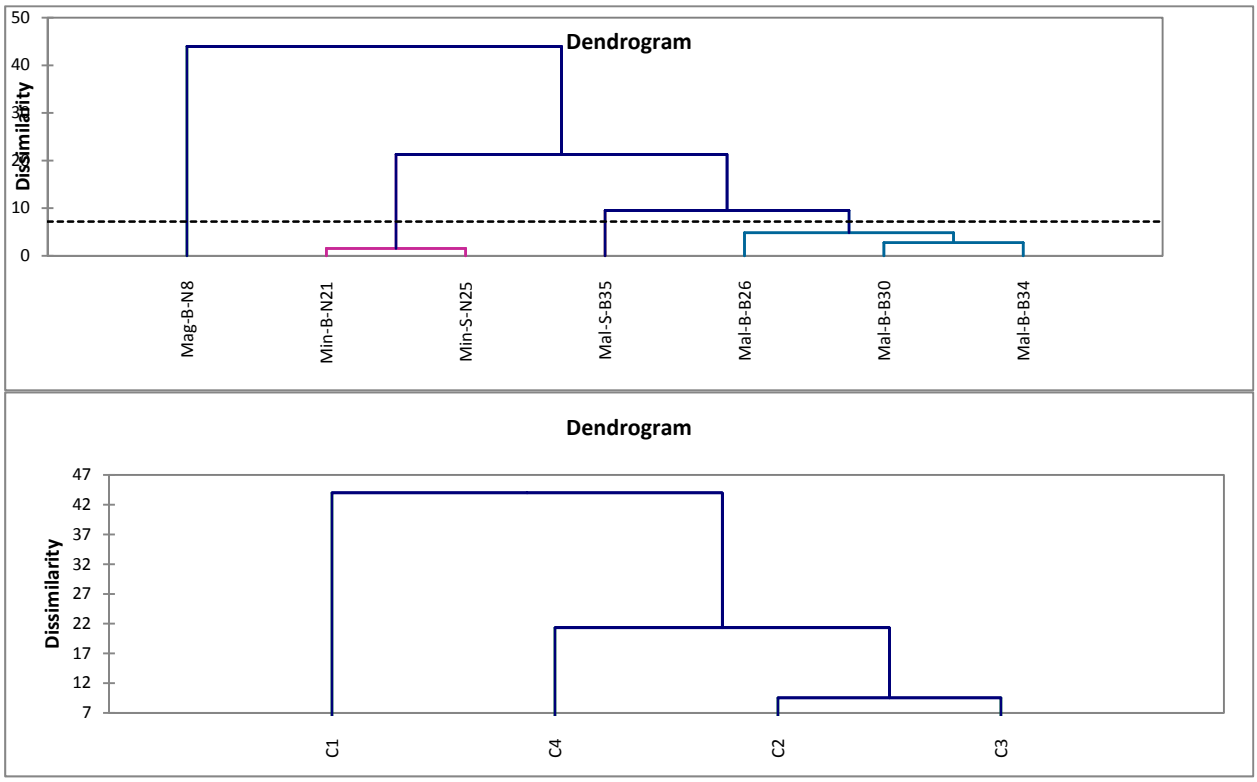


Figure 3. Dendrograms showing the similarities between KS samples based on QDA.

Class	Colour		Presence of		Odour		Taste				Fracturability	Denseness	Grittiness	Mouth coating
	Creamy	Caramel	bran	fissures	Fermented	Fresh	Sour	Salty	Spicy	Kishk				
1	21.93	88.49	34.68	19.24	67.31	46.38	79.24	72.70	71.12	41.62	28.94	80.48	27.33	61.14
2	69.20	23.18	31.93	49.90	60.36	36.56	44.24	33.90	27.92	47.55	53.51	50.29	64.10	49.05
3	65.92	32.48	38.60	43.25	42.36	52.26	41.35	41.82	32.06	51.56	57.14	55.34	46.71	47.05
4	51.93	56.92	57.17	66.60	49.25	45.09	51.36	58.58	67.98	57.00	69.64	37.63	58.70	44.92

Principal Component Analysis (PCA)
Principal Component Analysis (PCA) was used to study attribute-sample relationships. With PCA, a sensory space was created where samples were positioned in the attribute-sample space according to their characteristic sensory attributes. The distance between a sample and an attribute indicated the extent to which the attribute can be used to describe such sample.

Individual observations for product attributes were used to perform PCA. If two variables had high loadings along the same PC, it meant that the two variables were highly correlated. If both loadings had the same sign, the correlation was positive (when one variable increased, so did the other). Otherwise, it was negative (when one variable increased, the other decreased).

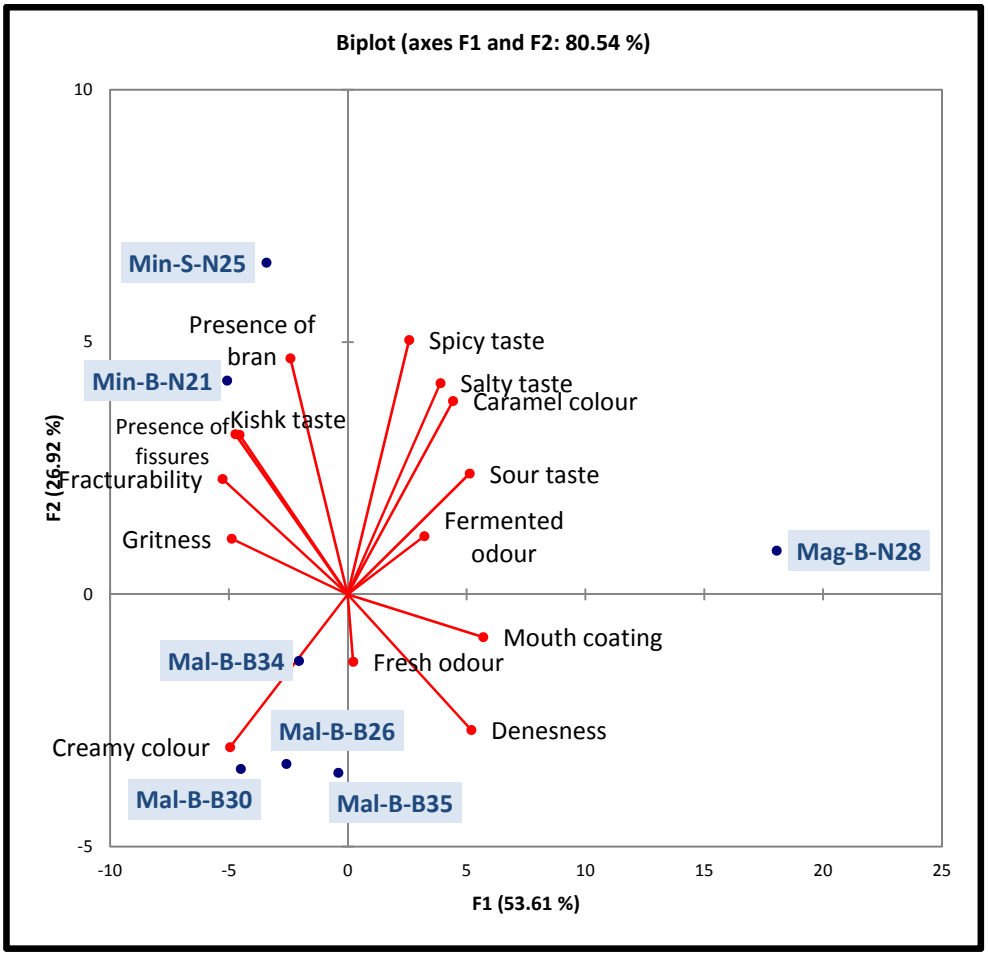


Figure 4: PCA Bi-plot of descriptive sensory attributes of the *KS* (Descriptive sensory attributes are plotted in red colour, products in blue colour)

Results indicated that large and significant variations in quality characteristics of *KS* were observed among the tested samples ($p \leq 0.05$). The PCA bi-plot (Fig. 4) shows that the data of KS was located on the left side of PC1 (explaining 70% of the variance).

Conclusion
Evaluation of the *KS* sensory characteristics provide in depth understanding of the sensory quality criteria as perceived by the traditional processors and consumers. The present study showed that traditional *KS* has good organoleptic properties and also good

sources of the minerals studied. Substantial differences in sensory character were noted between the *KS* in particular, differences in colour, fresh odour, *KS* taste and mouth coating. This work showed that the application of QFD and PCA techniques could provide the useful information to *KS* and helped to identify the importance of product attributes.

Acknowledgement
The author would like to express her gratitude to the panellists for spending so many hours participating in this project as trained panellists.

References

Amadi1 B.A , Onyeike E .N. and Ayalogu E.O. 2012. Archives of Applied Science Research 4 (1):330-335.

FAO, Food and Agricultural Organization at the 26th FAO regional Conference for Europe, 26th-27th June, **2008**, Innsbruck, Austria.

Hair, J.F., Anderson, R.E., Tatham, R. L., and Black, W.C. 1998. Multivariate Data Analysis. 5th Edition. Prentice Hall, Inc. Upper Saddle River. New Jersey. 730 pp.

Hesseltine, C. W. (1979). Some important fermented foods of Mid-Asia, the Middle East and Africa. Journal of American Oil Chemists_ Society, 56, 367–374.

Lasztity, R., & Lasztity, L. (1990). Phytic acid in cereal technology. In Y. Pomeranz (Ed.), Advances in cereal science and technology. St. Paul: AACC.

McNeil, K., Sanders,T.H., and Civille,G.V. 2002. Descriptive Analysis of Commercially Available Creamy Style Peanut Butter. Journal of Sensory Studies v17 (5):391-414.

Muñoz, A.M. 1997. Relating Consumer, Descriptive, and Laboratory Data. American Society for Testing and Materials, West Conshohocken, PA. 103pp.

Noronha, R.L., Damasio, M.H., Pivatto, M.M, and Negrillo, B.G. 1995. Development of the Attributes and Panel Screening for Texture Descriptive Analysis of Milk Gels Aided by Multivariate Statistical Procedures. Food Quality and Preference v6:49-54.

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.
Resurreccion, V.A. 1988. Applications of Multivariate Methods in Food Quality Evaluation. Food Technology. v42 (11):128,130,131-134.

Richardson-Harman N. J., Stevens R. F., Walker S., Gamble J., Miller M., Wong M., and McPherson, A. 2000. Mapping Consumer Perceptions of Creaminess and Liking for Liquid Dairy Products. Food Quality and Preference v11 (3):239-246.

Yeh, J.V., Resurreccion, A.V., Phillips, R.D., and Hung, Y.C. 2002. Overall Acceptability and Sensory Profiles of Peanut Spreads Fortified with Protein, Vitamins, and Minerals. Journal of Food Science. v67 (5):1979-1985.