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**Executive summary**

This deliverable concerns the sensory evaluation of the reengineered group 1 African products in the AFTER project. Specifically, it related to reengineered akpan and gowe from Benin, kenkey from Ghana and Kishk Sa'eedi in Egypt.

Concerning reengineered akpan from Benin, the sensory evaluation was undertaken in Montpellier, France. Re-engineering of akpan has focused primarily on improvement of sanitary properties of the product, which was a great achievement and will allow producing Akpan on a larger scale in SMEs in Africa. Sensory evaluation of the Akpan products was carried out using CATA and JAR techniques that have been developed for use with consumers instead of a trained panel. Three Akpan products were tested by 102 consumers: Akpan added with 10% sugar (AS10), Akpan added with 3% spray-dried milk and 8.7% sugar (AMS8.7) and Akpan added with 3% spray-dried milk and 15% sugar (AMS15). Independently of the Akpan tasted, Acidity or Sweetness attributes were scored "Just About Right, as I like" by 56 to 77% of consumers. Odour perception was perceived differently, depending on consumers. However, Texture was found "Too weak", too liquid by the majority of consumers (49 to 55%) and Taste "too strong" (46 to 54%). The most frequently CATA descriptors checked by consumers which better described Akpan products were: "Artificial", "Floral", "New/Different", "Strong in Taste", "Mealy", followed by "Liquid", "Drinking yoghurt", "Sweet", "Acidic", and "Rough". At the opposite, an ideal-yoghurt was described as Creamy, Natural, Good for health, Refreshing, Homogeneous, with a texture of a Bulgarian yoghurt-type, Thick, Sweet, Attractive, Nutritious and Milk taste. In terms of sensory evaluation, the three Akpan products did not significantly. If we remove the terms such as "artificial", "strong in taste", "floral" due to a manufacturing error (use of a few drops of citronella essential oil instead of citronella infusion as a traditional flavouring of Akpan in Benin), it remains the terms "mealy", "liquid" "drinking yoghurt" that better describe the product and were previously used for describing traditional Akpan product. This suggests that sensory properties of the reengineered Akpan may not be acceptable to French consumers who prefer a product with a creamy, homogeneous, Bulgarian yoghurt-type taste.

Gowe in Benin was not tested using sensory evaluation. Sensory testing of Gowe in Benin was not undertaken because this was planned to be undertaken in Europe. The reason is because the methodology used in sensory evaluation is independent of the location provided the samples are the same. However, the particular samples provided for French sensory testing contained a concentration of aflatoxin that was higher than the minimum EU allowable limit. It was not possible to repeat the sensory test in France because it would have taken too long to obtain a replacement supply from Benin and to repeat the processing (takes one week). In which case the samples would have been took different to enable a comparison.

The sensory evaluation of kenkey was carried at the Food Research Institute, Ghana. Current trends in urbanization, and the increasing popularity of *kenkey* among consumers, require larger scale production with consistent quality. Testing was conducted to determine the sensory profile of white reengineered *kenkey* made using the optimum pre-process conditions of steeping time (30 and 45h), steeping temperature (30°C and 35°C) and dough fermentation time of 12 hours. The qualitative descriptive analysis showed that the sensory profile of white kenkey was dependent on pre-processing variables. Thus merely optimizing the pre-processing variables with regards to acid production and other readily measurable constituents though could shorten the production process could not guarantee the best product sensory quality. The results show that all the descriptors generated were appropriate for differentiating sensory qualities among samples and could be used

for basic research and product development for white *kenkey*. Soft and sticky texture in white *kenkey* was highly appreciated.

Sensory evaluation of Kishk Sa'eedi (KS) was undertaken in Egypt. KS is an Egyptian indigenous wheat-based fermented food prepared traditionally according to the method applied by Upper Egyptians. This work is done to characterize sensory properties and sensory profile of the re-engineered KS. Quantitative descriptive analysis (QDA) coupled with principal component analysis (PCA) was used to study the interrelationship among and between sensory attributes. 14 terms regarding appearance, odour, flavour and texture of the samples, was selected and a glossary describing each descriptor was developed. Three *KS* samples were profiled by 11 assessors using the chosen 14 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. The re-engineered KS sample perceived as less sour and less salty compared with the traditional ones. With regard to texture quality, re-engineered sample was easy to fracture, and scored higher for grittiness. Meanwhile, the sample was rated lower than the traditional ones with regard to Kishk taste and fermented odour. Descriptive sensory evaluations between of the traditional and re-engineered KS samples showed that tastes i.e. sour, salty, and *KS* taste; fracutability and grittiness were discriminating attributes. Fermented odour, colour i.e. creamy and caramel; presence of fissure and presence of bran were least discriminating. Evaluation of the *KS* sensory characteristics provide in depth understanding of the sensory quality criteria as perceived by the sensory trained panel. The present study showed that substantial differences in sensory character were noted between the traditional and re-engineered *KS* in particular, differences in colour, fresh odour, *KS* taste, fracutability 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.

In conclusion the sensory evaluation showed clear sensory differences between the traditional and reengineered products relating to akpan from Benin, kenkey from Ghana and Kishk Sa'eedi from Egypt. Other deliverables will report on the acceptance by consumers.

## Detailed report for Akpan (Group 1)

## Akpan Summary

French sensory evaluation of re-engineered Akpan product was carried out in Montpellier, France. Sensory evaluation of the Akpan products was carried out using CATA and JAR techniques that can be applied with consumers. Three Akpan products were tested by 102 consumers: Akpan added with 10% sugar (AS10), Akpan added with 3% spray-dried milk and 8.7% sugar (AMS8.7) and Akpan added with 3% spray-dried milk and 15% sugar (AMS15). Independently of the Akpan tasted, Acidity or Sweetness attributes were scored "Just About Right, as I like" by 56 to 77% of consumers. Odour perception was perceived differently, depending on consumers. However, Texture was found "Too weak", too liquid by the majority of consumers (49 to 55%) and Taste "too strong" (46 to 54%). The most frequently CATA descriptors checked by consumers which better described Akpan products were: "Artificial", "Floral", "New/Different", "Strong in Taste", "Mealy", followed by "Liquid", "Drinking yoghurt", "Sweet", "Acidic", and "Rough". At the opposite end of the spectrum, an ideal-yoghurt was described as Creamy, Natural, Good for health, Refreshing, Homogeneous, with a texture of a Bulgarian yoghurt-type, Thick, Sweet, Attractive, Nutritious and Milk taste.

## Akpan Background

A first study on sensory evaluation of Akpan was carried out previously in France to collect French consumer views on that Beninese yoghurt-like product in view of re-engineering its process.
The main improvements concerned sanitary and sensory properties of the product in view of a broader production in Africa and to conquer European market for diaspora but also for Europeans. After re-engineering, French consumers were asked, in this current study, to give their impressions on that "new yoghurt-type product".

## Akpan Methodology

### *Akpan samples*

Akpan was prepared in Cirad laboratory from white maize grains provided by UAC, Cotonou, Benin.

### *Process for making Akpan*

The traditional process for making Akpan from white maize grains was described previously by Fliedel et al. (2013). It involves several successive steps such as steeping maize grain, grinding, sieving to separate bran, fermenting and precooking.
In view of reducing the risk of contamination of the product, some of these steps were revisited (Adinsi et al., 2014).

- Soaking the grains was carried out at relatively high temperature (50°C, 15h) to inhibit undesirable microorganisms and prevent the cooking of the grains.
- A pasteurisation step (70°C, 15min) of the sieved material was introduced before fermentation to reduce the load of pathogenic microorganisms, and promote the efficiency of a starter culture (*lactobacillus casei*) during controlled fermentation (42°C, 15h).
- Milk and sugar were added into the sieved material before fermentation, to avoid risk of contamination after cooking.

- A part of Ogui (50%) was added to a boiled citronella infusion and cooked (90°C, 10min). The other part was pasteurized (70°C, 15min).
- After cooling to a temperature below than 70°C, precooked Akpan was mixed with pasteurized Ogui and the mixture was well homogenized to give Akpan ready to taste.

This improved process was applied in Benin to produce re-engineered Akpan products (Adinsi et al., 2014) that were used for sensory evaluation tests with Beninese consumers. The proportion of sugar was 15% and the product AMS15. In France, Akpan products were produced according to the same process but several proportions of sugar and milk were tested.

The following three Akpan products were prepared:

1. Akpan added with sugar (10%): AS10 (Benin reference)
2. Akpan added with spray-dried milk (3%) and sugar (8.7%): AMS8.7
3. Akpan added with spray-dried milk (3%) and sugar (15%): AMS15

***Sensory evaluation methods***

Sensory evaluation was conducted with consumers. This method has been validated by previous studies (Jaeger et al. 2013).

French sensory evaluation of Akpan was performed at Cirad Laboratory of Sensory Analysis in Montpellier with 102 consumers. No information about the product was provided to consumers beforehand. An announcement was sent some days before and on the morning to invite consumers to come and taste “a new type of yoghurt”. A beautiful reward was given to each participant to thank them for coming and for taking time during their working time.

The questionnaire was developed using on-line survey software Qualtrics. Ten computers were provided by our IT department. Each consumer follows instructions step by step by clicking with the mouse on the screen, and begins by answering a questionnaire (personal information, consumption habits) before tasting each Akpan product, one after the other, in a specific random order (30ml in a small clear plastic glass with a little spoon).

Consumers were asked to answer a Check-All-That-Apply (CATA) (Ares et al., 2010; Dooley et al., 2010) table including 20 sensory and 8 perceptions descriptors that have been mentioned in focus groups previously conducted in France and in Benin on traditional maize Akpan products (Fliedel et al., 2013 ; Akissoë et al., 2014). A Just-About-Right (JAR) test was also conducted. Just about right (JAR) scale was used to determine the optimum level of intensity for some sensory attributes of Akpan products. Such “attribute diagnostic” may help to understand why consumers like or dislike this product. Consumers were asked to precise how they perceived texture, taste, odour, sweetness & acidity of each Akpan product, by using a 3-point JAR scale (1 = “Too low than I like”, 2= “Just About Right, as I like” and 3 = “Too high than I like”). Consumers were invited to put a tick/mark in front of the descriptors appropriated to better describe each Akpan sample.

**Figure 1.** Sensory testing of Akpan with consumers in Cirad, Montpellier, France

***Statistical analysis***

For the CATA study, frequencies of citation for each descriptor were determined by counting the number of consumers that checked each descriptor for describing Akpan product. Cochran's Q test was carried out for each of the 28 descriptors to evaluate if the CATA method was able to detect differences in consumers' perception for the three Akpan products.
A Principal Component analysis (PCA) was performed on CATA responses for each category of descriptors in order to identify relationships between sensory descriptors & perceptions and Akpan products, and to get a sensory map of the products.
JAR counts were recorded.
All statistical analyses were performed using XLSTAT 2014 (Addinsoft).

**Akpan Results and discussion**

***Just About Right (JAR)***

Independently of the product tasted, consumers were satisfied with its acidity or sweetness. These two attributes were scored "Just About Right, as I like" by 56 to 77% of consumers. Odour was perceived differently, depending on the consumers. Some of them found Akpan odour "Too weak" (22 to 32% of answers) or "Just About Right, as I like" (33 to 40%), or "Too strong" for 34 to 38% of them. Texture was found "Too weak", too liquid by the majority of consumers (49 to 55%), mainly for Akpan added with sugar (53% and 55% for AMS8.7 and AMS15 respectively). It was considered "Just About Right" by 41 to 47% of consumers and only few persons (2 to 4%) checked it "too high", too compact. Taste of Akpan products was evaluated "too strong" by most of people (46 to 54%).


**Figure 2.** Intensity of some sensory descriptors perceived by French consumers for each Akpan product using a JAR Scale

Where JAR Scale : too weak (TW), JAR (Just About Right, as I like) and too strong (TS) and where Akpan added with 10% sugar (AS10), Akpan added with 3% spray-dried milk and 8.7% sugar (AMS8.7), Akpan added with 3% spray-dried milk and 15% sugar (AMS15).

***Check-All-That-Apply Question***

After scoring the acceptance and JAR intensity, consumers were invited to choose the most appropriate words among 20 sensory descriptors and eight perception descriptors to best describe each Akpan product. No significant difference (one-way ANOVA P>0,001) was observed in the frequency of citations used by consumers to describe each Akpan product, as shown in Table 3.

The most frequently selected descriptors were considered as the best for describing the products. They were the following : “Artificial”, “Floral”, “New/Different”, “Strong in Taste”, “Mealy” with a frequency of citation between 125 and 100, followed by “Liquid”, “Drinking yoghurt”, “Sweet”, “Acidic”, “Rough”, “Homogeneous”, “Refreshing” with a frequency of citation between 100 and 50. The least used term was “Attractive”, “Good for Health”, “Neutral/Nature”, “Thick”, “Lumps”, “Nutritious” and “Natural”.

**Table 1.** Frequency of descriptor citations for each Akpan product (Check-All-That-Apply method)

| | | AS10 | AMS 8.7 | AMS15 | Ideal Yoghurt | Frequency | Frequency/category | Average Frequency/ category |
|---|---|---|---|---|---|---|---|---|
| **Sensory descriptors** | Liquid | 18 | **32** | **37** | 3 | 87 | 981 | 16.35 |
| | Bulgarian yoghurt | 11 | 7 | 9 | **36** | 27 | | |
| | Lumps | 3 | 4 | 6 | 0 | 13 | | |
| | Neutral | 6 | 3 | 2 | 22 | 11 | | |
| | Soya | 8 | 6 | 9 | 6 | 23 | | |
| | Sweet | 22 | 19 | **43** | 29 | 84 | | |
| | Cereals | 16 | 7 | 10 | 11 | 33 | | |
| | Floral | **38** | **30** | **36** | 15 | 104 | | |
| | Acidic | 10 | **32** | 15 | 11 | 57 | | |
| | Fermented | 3 | 13 | 8 | 10 | 24 | | |
| | Sour | 8 | 17 | 7 | 2 | 32 | | |
| | Milk Taste | 2 | 11 | 4 | 26 | 17 | | |
| | Tasteless | 16 | 8 | 3 | 1 | 27 | | |
| | Strong in Taste | **30** | **33** | **38** | 11 | 101 | | |
| | Mealy | **33** | **32** | **35** | 1 | 100 | | |
| | Watery | **23** | 6 | 10 | 1 | 39 | | |
| | Thick | 7 | 2 | 4 | 30 | 13 | | |
| | Creamy | 17 | 12 | 17 | **70** | 46 | | |
| | Homogeneous | 16 | 18 | 22 | **42** | 56 | | |
| | Drinking yoghurt | 22 | **33** | **32** | 10 | 87 | | |
| Perceptions | New/Different | **35** | **35** | **34** | 16 | 104 | 384 | 16.00 |
| | Refreshing | 21 | 11 | 23 | **48** | 55 | | |
| | Natural | 4 | 4 | 7 | **51** | 15 | | |
| | Artificial | **42** | **38** | **43** | 1 | 123 | | |
| | Rough | 17 | 25 | 15 | 0 | 57 | | |
| | Nutritious | 5 | 5 | 5 | 25 | 15 | | |
| | Good for Health | 3 | 2 | 3 | **50** | 8 | | |
| | Attractive | 3 | 1 | 3 | 27 | 7 | | |
| Overall Appreciation | | 5 | 5 | 5 | | | | |
| | Frequency/sample | 439 | 446 | 480 | 555 | | | |
| | Average Frequency/sample | 15.68 | 15.93 | 17.14 | 19.82 | | | |

The frequent citation of the terms “Artificial”, “Floral”, “New/Different”, “Strong in Taste”, for each Akpan product, may find an explanation: essential oil drops of citronella were used in place of citronella infusion during pre-cooking of Akpan. They have taken over the real taste of Akpan, masking probably specific sensory characteristics and limiting a better acceptance of the product. A majority of people found citronella taste and odour too strong. However, the terms that followed well characterized the product and were certainly more easily checked by consumers who are used to consume other “plant” milk.

AS10, Akpan added with 10% sugar, was described as artificial (42 citations), floral (38), new/different (35), mealy (33), with a strong taste (30), watery (23), with a texture of a drinking yoghurt (22), sweet and refreshing (22 and 21 citations respectively).
Consumers used the same descriptors to describe AMS8.7, Akpan added with 3% spray-dried milk and 8.7% sugar, with almost the same frequencies of citation. AMS8.7 was not perceived refreshing (11 citations only) but it was qualified liquid (32 citations), acidic (32) and rough (25).
AMS15, Akpan added with 3% spray-dried milk and 15% sugar, the sweeter Akpan, was also considered as artificial by consumers (43 citations), sweeter (43 citations), strong in taste (38),

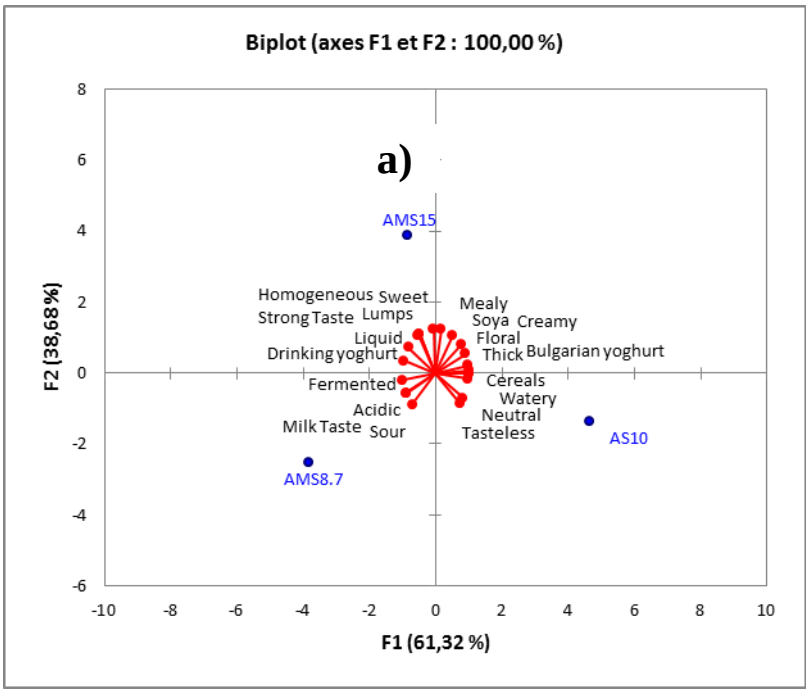
liquid (37), floral (36), mealy (35), new/different (34), with a consistency of a drinking yoghurt (32), and refreshing and homogeneous (23 and 22 citations respectively).

At the end of the questionnaire, consumers were asked to kindly describe an ideal yoghurt on their point of view using the same CATA descriptors than already used for describing the three Akpan products. No significant difference (one-way ANOVA P>0,001) was observed in the number of citations used by consumers to describe an ideal yoghurt and each Akpan product, as shown in Table 3. However, if the frequency of citations is almost the same, the descriptors chosen were completely different for a "perfect" yoghurt compared to those chosen for Akpan products.
The "ideal" yoghurt was described as creamy (70 citations), natural (51 citations), good for health (50), refreshing (48), homogeneous (42), with a texture of a Bulgarian yoghurt-type (36), thick (30), sweet (29), attractive (27), with a milk taste and nutritious (26 and 25 citations respectively). None of these descriptors was used to describe Akpan products unless refreshing, homogeneous and sweet with a lower frequency of citation.

Principal component analysis (PCA) was used to summarize the relationships between sensory characteristics of CATA task and Akpan samples. The PCA plot in Figure 4, explained 100% of the variance, the first and second axes accounting for 61.32% and 38.68% respectively. Regarding perception descriptors of CATA task, the two first axes of PCA explained 100% of the variance, the first and second axes accounting for 83.69% and 16.31% respectively. Most of the variance was explained by the first axis.

The loading of sensory descriptors on PCA plan (Figure 4a) shows that axis 1 was mainly explained by the terms such as Cereals, Watery, Bulgarian yoghurt, Thick, Floral, Neutral, and Tasteless, related to AS10 Akpan (with no milk and 10% sugar) and negatively by the terms such as Fermented, Drinking yoghurt, Acidic, Milk Taste, Liquid and Sour, related to AMS 8.7 Akpan (added with milk and 8.7% sugar). Axis 2 was mainly explained by the terms such as Strong in Taste, Soya, Homogeneous, Creamy, Lumps, Mealy, and Sweet, related to AMS 15 Akpan (added with milk and 15% sugar).

The loading of perception descriptors on the PCA plan (Figure 4b) shows that axis 1 was mainly explained positively by the term such as Refreshing, Artificial, Good for Health and Attractive related to AMS 15 Akpan (added with milk and 15% sugar) and negatively by the terms Rough related to AMS 8.7 Akpan (added with milk and 8.7% sugar). Axis 2 was mainly explained positively by the term New/Different related to AS10 Akpan (with no milk and 10% sugar) and negatively by the term Natural.



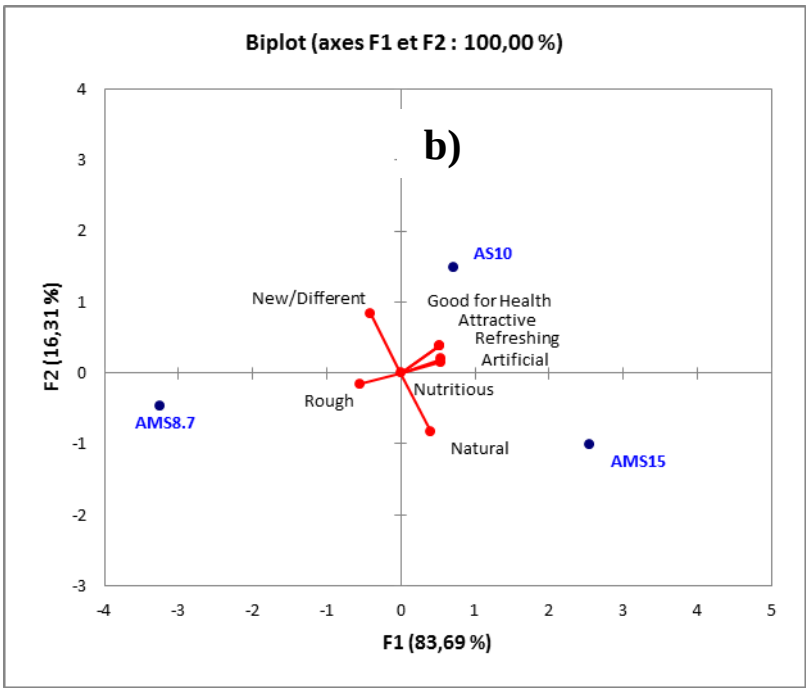




**Figure 3.** PCA on CATA descriptors: Projection of sensory descriptors a) and projection of perception descriptors b) with Akpan products.
Where Akpan added with 10% sugar (AS10), Akpan added with 3% spray-dried milk and 8.7% sugar (AMS8.7), Akpan added with 3% spray-dried milk and 15% sugar (AMS15).

## Akpan Conclusions

In terms of sensory evaluation, the three Akpan products did not significantly. If we remove the terms such as “artificial”, “strong in taste”, “floral” due to a manufacturing error (use of a few drops of citronella essential oil instead of citronella infusion as a traditional flavouring of Akpan in Benin), it remains the terms “mealy”, “liquid” “drinking yoghurt” that better describe the product and were previously used for describing traditional Akpan product. This means that sensory properties of traditional Akpan were not totally improved during re-engineering to meet French consumer taste.

Re-engineering has focused primarily on improvement of sanitary properties of the product, which was a great achievement and will allow producing Akpan on a larger scale in SMEs in Africa. However, to meet expectations of French consumers who would like a creamy, homogeneous, Bulgarian yoghurt-type product, Akpan texture needs to be improved. It must be less liquid, creamier and not mealy. The proportion of uncooked Ogui added to cooked Ogui (to avoid a too thick consistency after starch gelatinization) must be modified, or another alternative must be proposed to reduce consistency of whole cooked Ogui and supressing mealy sensation, while maintaining its creaminess.

## Acknowledgements

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## Detailed report for Gowé (Group 1)

Sensory testing of Gowe in Benin was not undertaken because this was planned to be undertaken in France. The reason is because the methodology used in sensory evaluation is independent of the location provided the samples are the same. However, the particular samples provided for French sensory testing had a concentration of aflatoxin that was higher than the minimum EU allowable limit. It was not possible to repeat the sensory test in France because it would have taken too long to obtain a replacement supply from Benin and to repeat the processing which takes one week. In which case the samples would have been too different to enable a comparison.

## Detailed report for Kenkey (Group 1)

### Kenkey Summary

Two types of white *kenkey* are commonly recognized in Ghana, and they are the non-sweetened (Anum and Atimpoku) and sweetened (Osino) types. The basic raw material for white *kenkey* (sweetened or non-sweetened) is maize dough obtained after milling of steeped dehulled maize. The process of white *kenkey* may or may not include a further fermentation step. They are the partially fermented (Atimpoku) type in which steeping is the only step of fermentation and the fermented (Anum) type, in which the dough is fermented after obtaining meal from steeped dehulled grains. Among the *kenkey* types, the non-sweetened white *kenkey* is far more patronized than sweetened white *kenkey*.

Differences exist in the organoleptic properties for the different types of *kenkey* (Sefa-Dedeh, 1993; Amoa-Awua *et al*., 2007) due to the differences in processing procedures and packaging material. Some of the quality attributes of *kenkey* have been linked to processing parameters such as steeping of the maize grains and dough fermentation.

Unlike Ga- and Fante- *kenkey*, the enterprise of white *kenkey* (*nsiho*) processing has remained at the level of "ethnic food", restricted to very few socio-cultural communities (Atimpoku and Anum). Current trends in urbanization, and the increasing popularity of *kenkey* among consumers, require larger scale production with consistent quality. Upgrading production from the artisanal to industrial level will require consumer input on critical quality attributes that influence product acceptability.

The work was conducted to determine the sensory profile of white *kenkey* made using the optimum pre-process conditions of steeping time (30 and 45h), steeping temperature (30°C and 35°C) and dough fermentation time of 12 hours.

## Kenkey Methodology

*Preparation of samples*
White *kenkey* samples were prepared based on four pre-determined outside and within the optimum pre-process parameters for processing white *kenkey* as shown in table 1. Traditionally processed white *kenkey* obtained from Anum was used as a control in the QDA.

**Table 1:** Processing procedures used for dehulled dough preparation

| Treatment | Steeping time (h) | Steeping temperature (h) | Fermentation time (h) |
|---|---|---|---|
| T1 | 25 | 40 | 12 |
| T2 | 20 | 45 | 12 |
| T3 | 30 | 30 | 12 |
| T4 | 45 | 35 | 12 |

Treatments T1 and T2 were outside of the optimum pre-process region and T2 and T3 were within the optimum pre-process region of steeping time, steeping temperature and fermentation time.

Dehulled fermented maize dough (800g) obtained using one of the four treatment conditions outlined in Table 1 was mixed with 400 ml of water to obtain a slurry and 6g of table salt was added. Half a litre of water was brought to boil and the slurry poured into it whilst stirring continuously for 5 mins to form a thick paste. The paste was mixed thoroughly with 400 g of uncooked dehulled maize dough. Three hundred and fifty (350) grams of the mixture was moulded into a ball, wrapped with washed dried maize husk and steamed for 45minutes to produce white *kenkey*. The white *kenkey* was cut into 3 g slices and used for the sensory analysis.

*Sensory panel*
Eighteen (18) panellists from the Food Research Institute, CSIR, who had previous experience in descriptive sensory analysis of *kenkey,* were selected for the study. Further training and group discussions were conducted for two (2) days for 6 hours each to generate descriptors for white *kenkey*. The panel was also trained to quantify the intensity of sensory attributes using line scales. All panellists were over 18 years old, were regular consumers of *kenkey*, had no known food allergy and had expressed the willingness to participate in the study. The training was carried out at the sensory laboratory of the Food Research Institute. The descriptors agreed on by the panel and their definitions are shown in Table 2.

**Table 2:** Generated descriptors and their definitions

| Descriptors | Definition |
|---|---|
| **Aroma** | |
| Boiled fresh maize | aroma characteristic of boiled fresh maize |
| Fermented maize dough | aroma characteristic of fermented maize dough |
| Smoky | aroma of wood smoke |
| Sweet | aroma that gives an impression of a sweet taste |
| Boiled dry maize | aroma characteristic of boiled dry maize as in cooked 'maize grits' |
| Cooked rice | aroma characteristic of cooked non-aromatic rice |
| Maize porridge | aroma characteristic of cooked maize slurry |
| **Texture** | |
| Sticky | texture that clings to the fingers and tongue |
| Soft | Texture that is opposite to hard |
| Crumbly | Texture that easily breaks apart |
| Smooth | texture that is not coarse but even |
| **Taste** | |
| Sweet | tastes sweet as in sugar |
| Salty | tastes of table salt (sodium chloride) |
| Sour | taste that is like vinegar (acetic acid)/ fermented taste |
| Milky | taste of milk or cream |
| Cooked rice | taste associated with cooked non-aromatic rice |
| Astringent | Dry mouth-feel (experience one has after eating unripe bananas) |
| **Colour** | |
| Whitish colour | Colour that is similar to white |

*Test Protocol*

Sensory analysis of the five white *kenkey* samples (i.e. the four treatments in Table 1 and a control sample obtained from traditional *kenkey* processors) was carried out by the panellists in purposed booths at the sensory laboratory of the Food Research Institute under controlled lighting at ambient temperature. Each panellist was served with a 3g sample of each of the five white *kenkey* samples. The samples were coded with 3 digit random numbers and served randomly to panellists on white paper plates. There were a total of five samples and each panellist evaluated five samples per session over three different sessions. Each panellist was provided with biscuit and a cup of water at room temperature for rinsing the mouth in-between sample tasting. Each session lasted about 20 mins. The samples were scored using a modified version of quantitative descriptive analysis (QDA) since standards were not provided (Meilgaard *et al*., 1988) (Tomlins *et al*., 2005).

Intensity ratings were scored on a 10 mm unstructured scale, anchored with the terms 'not very' at the low end and 'very' at the high end. Panel sessions were repeated until all samples were scored in triplicate. Cooked samples were prepared using the same method as for Quantitative Descriptive sensory analysis training session.

## Kenkey Results and Discussion

*Quantitative Descriptive Analysis (QDA) of optimized and traditional white kenkey*

The sensory scores for the various descriptors of the products made from outside and within the optimum region of pre-processing variables and traditionally processed white *kenkey* are shown in table 3. There were significant differences ($p<0.05$) in the sensory attributes among the product types. The descriptor that was very intense in all the five samples was whitish colour. All the samples scored between 7.5 and 8.5 for whitish colour on the scale of 0-10 cm. Thus all the

samples had intense white colour, and there was not much difference in the intensity of whitish colour between the five samples. The whitish colour of the samples is due to the removal of the germ and the yellowish hull during decortication and degerming of the maize grains.

There was not much variation in the intensity of four other descriptors among the five different samples including the control. The descriptors had low scores and they included boiled fresh maize aroma (3.3-4.5), sweet aroma (2.8-4.0), maize porridge aroma (3.0-4.2), cooked rice taste (2.8-3.5) and astringent mouthfeel (2.2-2.8) (Table 3).

| **Descriptors** | **T1** | **T2** | **T3** | **T4** | **Control** |
|---|---|---|---|---|---|
| Boiled fresh maize aroma | 3.74±0.87$^{a}$ | 4.51±0.02$^{b}$ | 3.55±0.07$^{c}$ | 3.61±1.46$^{d}$ | 3.33±0.91$^{c}$ |
| Fermented maize dough aroma | 6.69±0.27$^{a}$ | 4.54±0.38$^{b}$ | 6.27±2.17$^{c}$ | 6.66±0.72$^{a}$ | 3.88±0.68$^{d}$ |
| Smoky aroma | 1.24±0.50$^{a}$ | 1.73±0.51$^{b}$ | 1.59±0.25$^{c}$ | 1.27±0.55$^{c}$ | 3.07±0.39$^{d}$ |
| Sweet Aroma | 2.82±0.62$^{a}$ | 3.88±0.77$^{b}$ | 3.96±0.07$^{c}$ | 2.82±1.21$^{c}$ | 4.80±0.98$^{d}$ |
| Boiled dry maize aroma | 3.11±0.48$^{a}$ | 3.43±0.56$^{b}$ | 3.92±0.80$^{c}$ | 2.93±0.09$^{d}$ | 3.18±0.18$^{e}$ |
| Cooked rice aroma | 1.37±0.33$^{a}$ | 2.95±0.43$^{b}$ | 2.73±0.65$^{c}$ | 1.75±0.17$^{d}$ | 2.73±0.22$^{e}$ |
| Maize porridge aroma | 3.33±1.56$^{a}$ | 4.17±0.87$^{b}$ | 3.98±0.55$^{c}$ | 4.33±0.72$^{d}$ | 3.18±0.46$^{e}$ |
| Sticky texture | 4.45±0.39$^{a}$ | 6.52±1.19$^{b}$ | 4.53±0.66$^{c}$ | 5.14±1.40$^{d}$ | 3.88±1.47$^{e}$ |
| Soft texture | 3.83±0.92$^{a}$ | 6.20±2.13$^{b}$ | 3.31±0.32$^{c}$ | 7.23±0.66$^{d}$ | 5.42±1.84$^{e}$ |
| Crumbly texture | 4.91±0.44$^{a}$ | 3.41±0.29$^{b}$ | 5.13±0.44$^{c}$ | 3.23±0.85$^{d}$ | 4.64±1.36$^{c}$ |
| Smooth texture | 3.60±0.41$^{a}$ | 3.90±1.09$^{b}$ | 2.25±0.35$^{c}$ | 6.03±0.53$^{c}$ | 6.29±1.83$^{d}$ |
| Sweet texture | 4.40±0.93$^{a}$ | 2.61±1.02$^{b}$ | 3.58±0.70$^{c}$ | 4.08±0.35$^{d}$ | 4.71±0.54$^{e}$ |
| Milky texture | 4.12±0.54$^{a}$ | 3.23±0.51$^{b}$ | 2.26±0.29$^{c}$ | 2.71±0.02$^{d}$ | 3.26±0.58$^{e}$ |
| Sour taste | 4.98±0.76$^{a}$ | 3.06±0.56$^{b}$ | 3.21±0.32$^{c}$ | 3.00±0.17$^{d}$ | 3.56±0.20$^{e}$ |
| Salty taste | 3.98±0.23$^{a}$ | 3.29±0.25$^{b}$ | 2.67±0.39$^{c}$ | 2.58±0.53$^{d}$ | 5.72±0.60$^{e}$ |
| Cooked rice taste | 2.85±0.22$^{a}$ | 3.50±0.36$^{b}$ | 2.74±0.15$^{c}$ | 2.83±0.27$^{a}$ | 3.40±0.70$^{d}$ |
| Astringent mouthfeel | 2.47±1.54$^{a}$ | 2.12±1.20$^{b}$ | 2.78±0.30$^{c}$ | 2.51±0.98$^{d}$ | 2.21±0.33$^{e}$ |
| Whitish colour | 7.45±0.48$^{a}$ | 8.09±0.50$^{a}$ | 7.89±0.43$^{a}$ | 8.52±0.13$^{b}$ | 8.16±0.09$^{a}$ |

**Table 3:** Means intensity rating for attributes used for describing white *kenkey* (*nsiho*) by trained panel ($n$ = 18).

Treatments T1 and T2 were outside of the optimum pre-process region and T2 and T3 were within the optimum pre-process region of steeping time, steeping temperature and fermentation time. Same letters in a row are not significantly different at $p \leq 0.05$.

The intensity scores for the descriptors were used to generate spider webs (figures 1 and 2) in order to compare the different products from within and outside the optimum region of the pre-process variables as well as the control. The scores for *kenkey* obtained from the optimum regions for pre-processing variables showed difference ($p<0.05$) in intensity scores for fermented maize dough aroma, maize porridge aroma, boiled fresh maize aroma, cooked rice aroma, sour taste and salty taste. The intensity scores for fermented maize dough aroma (6-6.5), maize porridge aroma (3-4), boiled maize aroma (4), cooked rice aroma (3) were generally high for *kenkey* obtained from optimum region compared to those of the control sample. However, the scores for salty taste (4.5), sour taste (2.5) and cooked rice taste (3.5) were higher for the control sample than for *kenkey* obtained from the optimum region of the pre-process variables (figure 1).

The intensities of salty taste, sweet taste, smooth texture, sweet aroma and smoky aroma were minimal in some cases. With regard to salty taste, the reduced intensity in the optimized products could be attributed to using less salt than the traditional processors add to precooked dough (*aflata)*. It was difficult to quantify the levels used by the traditional processors because the level of salt appeared to be added arbitrarily from processor to processor. The optimal level of salt was not determined through a sensory panel but a lower level was desired. With smoky aroma, this was detected in the traditional product because the traditional processors use firewood both for

cooking *aflata* and also steaming the product. The within and outside the optimum region samples were however cooked on an electric stove during *aflata* preparation whilst a steaming equipment operated by electricity was used for steaming. That was why those products attained low scores for smoky aroma. The scores for smoky attributes could probably be attributed to burning of the dough during *aflata* preparation.

Apart from the variations observed in the descriptors associated with texture (figure 2), the sample obtained from the optimum region (T3 steeped for 30 h at 30 ºC and T4 for steeped for 45 h at 35 ºC) did not vary much in their scores for the other descriptors. The variations in the texture for the two products were unexpected. Even though the texture of the two products from the optimum region were assessed to be different, T4 compared very closely with the texture of the control suggesting that the optimum region is valid. T4 was softer then the control. Also the crumbliness of T3 compared with the control (figure 2).

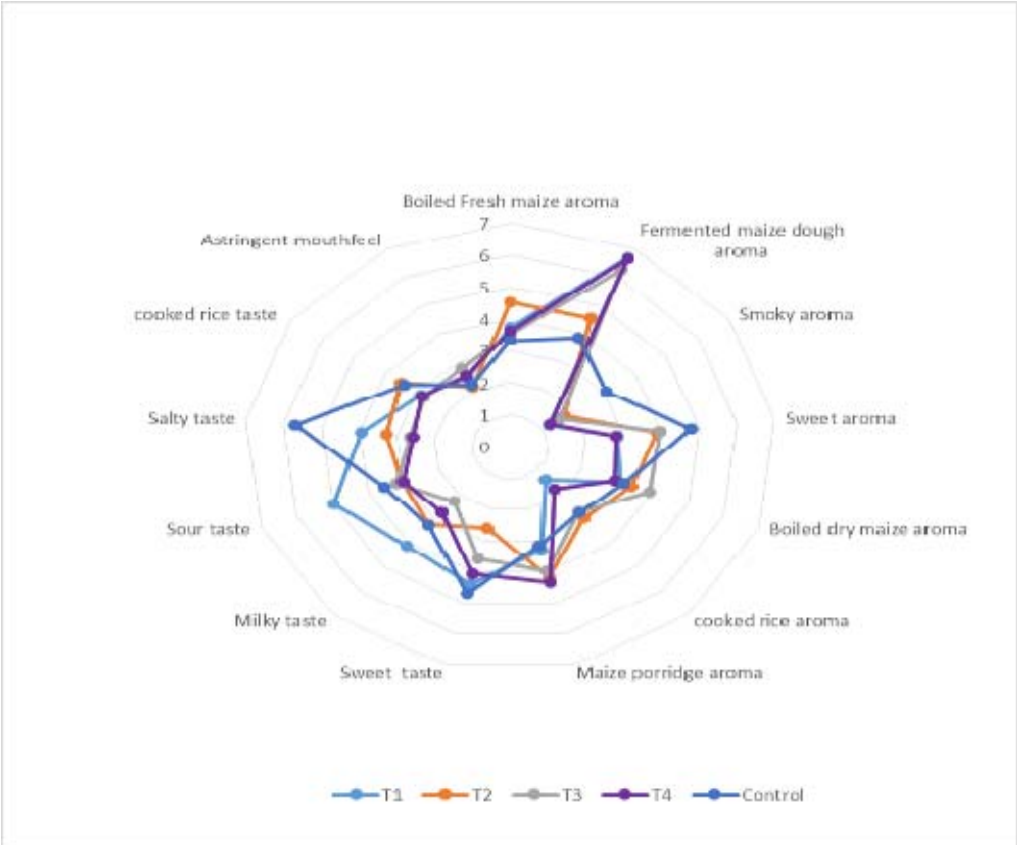


**Figure 1:** Spider web plot showing the mean scores for aroma and taste intensity for white *kenkey* (*nsiho*).

Treatments T1 and T2 were outside of the optimum pre-process region and T2 and T3 were within the optimum pre-process region of steeping time, steeping temperature and fermentation time.

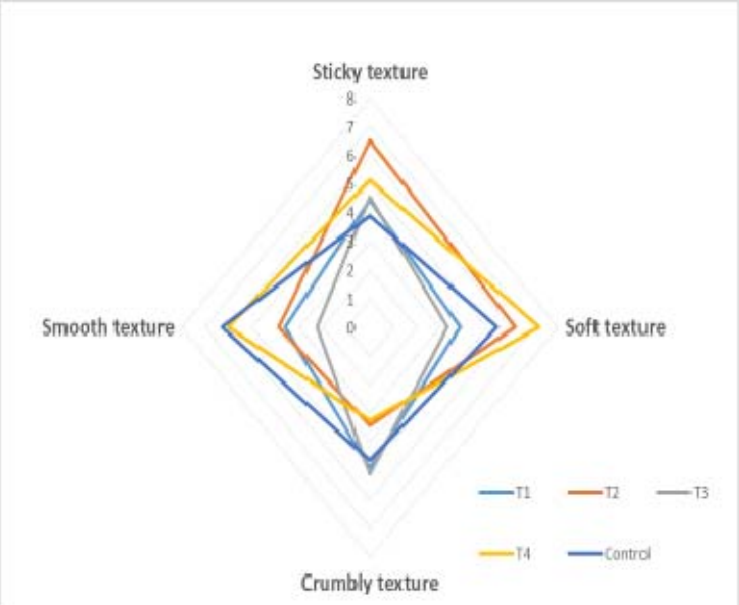


**Figure 2:** Spider web plot showing the mean scores for texture of white *kenkey* (*nsiho*)

Treatments T1 and T2 were outside of the optimum pre-process region and T2 and T3 were within the optimum pre-process region of steeping time, steeping temperature and fermentation time.

## Kenkey Conclusions

The qualitative descriptive analysis showed that the sensory profile of white kenkey was dependent on pre-processing variables. Thus merely optimizing the pre-processing variables with regards to acid production and other readily measurable constituents though could shorten the production process could not guarantee the best product sensory quality. The results show that all the descriptors generated were appropriate for differentiating sensory qualities among samples and could be used for basic research and product development for white *kenkey*. Soft and sticky texture in white *kenkey* was highly appreciated.

Pictures for Qualitative Descriptive Analysis

Panel members brainstorming and generating descriptors to describe white *kenkey* samples.


Descriptors generated for attributes

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## Detailed report for Kishk Sa'eedi (Group 1)

### Kishk Sa'eedi Summary

Kishk Sa'eedi (KS) is an Egyptian indigenous wheat-based fermented food prepared traditionally according to the method applied by Upper Egyptians. The term Sa'eedi is the designation that is given to the people of the Sa'eed or the south of Egypt. Kishk Sa'eedi (KS) is typically prepared by mixing Laban Zeer (buttermilk separated from freshly drawn milk and left to sour in an unglazed earthenware container: the "zeer") with coarsely ground parboiled whole wheat. The Laban Zeer is mixed with the moistened coarsely ground parboiled wheat in a large earthenware magour, to produce a heavy paste called "hama". The milk cereal mixture is then allowed to ferment again and kneaded with the addition of more of the fermented salted milk diluted with water and spiced with cumin before cutting into unformed chunks (of about 3 cm in diameter) or shaped into small balls of about 2 cm in diameter. The shaped product is arranged on a reed mat to dry in the sun and stored in the form of the dried product. This technology is indigenous and is a product of the traditional culinary culture of the people. For consumption, though it can be munched in the dry state, it is often reconstituted in a little water to be consumed as a breakfast meal 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. The sensory properties of the traditional Kishk Sa'eedi (*KS)* were previously investigated. This work is done to characterize sensory properties and sensory profile of the re-engineered KS.

Quantitative descriptive analysis (QDA) coupled with principal component analysis (PCA) was used to study the interrelationship among and between sensory attributes. 14 terms regarding appearance, odour, flavour and texture of the samples, was selected and a glossary describing each descriptor was developed. Three *KS* samples were profiled by 11 assessors on about 10-cm unstructured scale using the chosen 14 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.

The re-engineered KS sample perceived as less sour and less salty compared with the traditional ones. With regard to texture quality, re-engineered sample was easy to fracture, and scored higher for grittiness. Meanwhile, the sample was rated lower than the traditional ones with regard to Kishk taste and fermented odour.

Descriptive sensory evaluations between of the traditional and re-engineered KS samples showed that tastes i.e. sour, salty, and *KS* taste; fracutability and grittiness were discriminating attributes. Fermented odour, colour i.e. creamy and caramel; presence of fissure and presence of bran were least discriminating.

### Kishk Sa'eedi Background

This document contributes to deliverable 5.5.1.1 "**Final** report on sensory and African consumer acceptance for Group 1. This deliverable aims to determine the sensory properties and consumer

acceptance of the re-engineered Kishk Sa'eedi (*KS*) in an African market namely Egypt. The expected outcome is to furnish knowledge of a product's sensory properties from a scientific as well as technical viewpoint and a broader understanding of the consumer acceptance in the main production zones and in the trade centres of the *KS*.

**Kishk Sa'eedi Materials and methods**

The traditional KS was re-engineered and the detailed methodology for re-engineering are explained below (Figure 1).

**Figure 1.** Picture of reengineered kishk Sa'eedi

**Method of preparing the re-engineered kishk Sa'eedi samples**
**Butter milk fermentation**
Three hundreds and eleven isolated strains (isolated from good quality traditional Laban Zeer) have been examined for flavour acceptability in reconstituted skim milk powder to select only strains that produce accepted flavour. The strains that produce acceptable flavour have been screened for proteolytic and esterase activities. The selected strains were then screened according to antagonistic system and antibiotic sensitive. At the end of experimental, 15 strains have been selected and used in fermentations butter milk to produce Laban Zeer. Skimmed milk, full cream milk, butter milk, mixture of Skimmed milk and butter milk, mixture of full cream milk and butter milk, mixture of Skimmed milk and full cream milk have been used in different ratios to produce Laban Zeer like. The best accepted flavour was in full cream milk and butter milk (1:2).

**Inoculation Culture concentration**
The concentration of inoculated culture was studied with 2, 3, 4 and 5% of culture. The 2% is selected to be used in fermentation the final product. The fermented product is cooled overnight and then concentrated by filtration though thick cheese cloth. The filtration time was studied to reach the 22-25% of dry matter in Laban Zeer. The filtration time is set to be 6 h.

**Wheat preparation**
Whole wheat grains were manually cleaned and boiled in excess of water till soften. At the end of boiling and after drying the wheat gelatinize to 43.5 (Laboratory measured after boiling, drying, and grinding). Then oven dried and coarsely grinded (PSI 89% measured by sieve analysis technique).

**Dough preparation**
The ration of dry coarse flour to Laban zeer to was studied at ration of 1:2, 1:3 and 1:4. The ratio of 1:2 is selected as received the highest score for flavour, texture and overall acceptability.

**Spicing**
Some trials were made with adding cumin and some other trials were made without adding spices. The product made using cumin received high score of acceptability.

**Shaping and drying**
The KS is manually shaped into small balls or other shapes (see picture). The flat shapes kishk is dried faster at 40 C. The costumers accepted both shapes.

**Storage**
When Kishk Sa'eedi packed in glass jar, the product become soft and wet, but the product have a good shelf life when t packed in paper bags or cotton bags and kept in dry area.

**Sensory evaluation methods**
Quantitative descriptive analysis (QDA) coupled with principal component analysis (PCA) was used to evaluate the KS samples from sensorial point of view as follows.

**Panel selection and training**
11 panellists (3 males, 8 females, age 22-37 Y), identified as familiar and consumers of KS, who had completed a graduate course in sensory analysis, and were previously participated in the traditional KS sensory evaluation study. Panellists were recruited from National Research Centre (NRC) and Faculty of Agriculture. Panellists were then attended previously several training sessions. Initial orientation session where panellists received detailed explanation about the descriptive sensory methodology and the purpose of the study was conducted.
They were involved in the focus group discussion and established descriptive terms characterising the appearance, odour, taste, and texture. A list, composed of 14 descriptors regarding appearance, odour, flavour and texture of the samples, was developed.

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. Three KS samples (one re-engineered and two traditional) were used in three successive sensory profiling sessions. The panellists evaluated KS by the developed lexicon (Table1), using a 10-cm line scale.

**Table 1:** Definitions of the indicated descriptors used for kishk Sa'eedi.

| Descriptor | Definition |
|---|---|
| | *Appearance* |
| Creamy colour | colour similar to cream |
| 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 |

**Product Evaluation**

The KS samples were placed in plastic plates and the panellists evaluated the 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.

**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). Principal component analysis (correlation matrix) was carried out using XLSTAT (V 5.2, Addinsoft).

**Kishk Sa'eedi Results and discussion**

Three 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.
Mean intensity ratings of descriptive attributes are tabulated in table (2). 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.

The re-engineered KS sample perceived as less sour and salty compared with the traditional ones, which is considered as desirable sensory traits. With regard to texture quality, re-engineered sample was easy to fracture, and scored higher for grittiness. Meanwhile, the sample was rated lower than the traditional ones with regard to Kishk taste and fermented odour.

**Table 2:** Mean intensity ratings for the sensory attributes of the traditional and re-engineered *KS* samples

| Attribute | Re-eng KS | Mal-B-B9 | Mal-B-S35 |
|---|---|---|---|
| Creamy colour | 61.8 | 68.7 | 59.5 |
| Caramel colour | 68.7 | 41.1 | 83.1 |
| Presence of bran | 59.5 | 46.7 | 56.9 |
| Presence of fissures | 64.9 | 63.3 | 68.7 |
| Fermented odour | 41.8 | 57.9 | 82.5 |
| Fresh odour | 61.8 | 72.8 | 53.8 |
| Sour taste | 47.3 | 54.9 | 83.0 |
| Salty taste | 46.0 | 56.2 | 65.9 |
| Spicy taste | 53.2 | 44.3 | 67.3 |
| Kishk taste | 57.2 | 75.2 | 74.5 |
| Fracutrability | 76.0 | 67.9 | 48.5 |
| Denseness | 68.6 | 56.1 | 68.5 |
| Grittiness | 72.9 | 61.2 | 63.1 |
| Mouth coating | 54.3 | 60.0 | 64.1 |

* Values represent means ± standard deviation
Ratings are based on a 100 mm line scale with anchors. 11 trained descriptive panellists rated each attribute for each sample for a total of
3 times in 3 different sessions.

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.

Results indicated that large and significant variations in quality characteristics of re-engineered *KS* were observed compared with traditional samples ($p \leq 0.05$). The PCA bi-plot (Fig. 2) shows that the data of re-engineered KS was located on the upper left side of PC1 (explaining 70% of the variance).

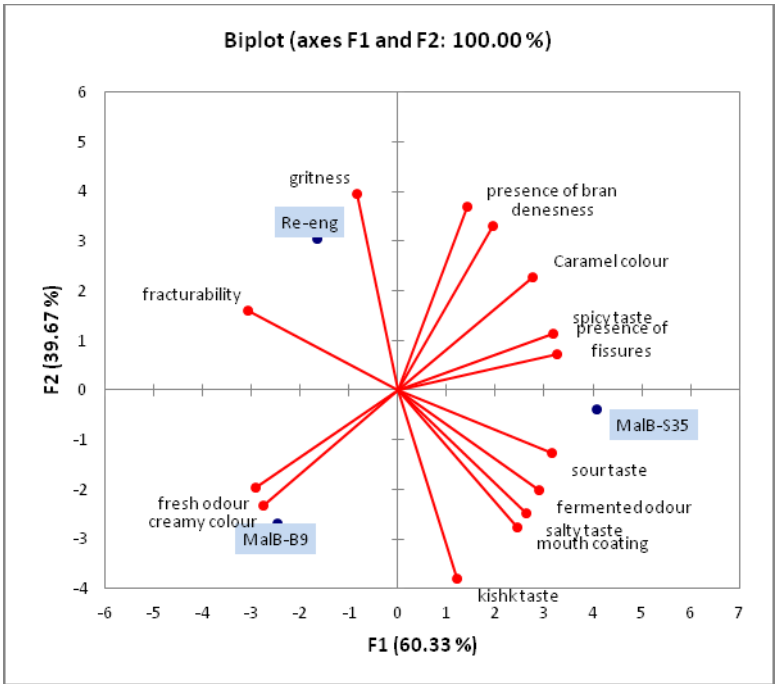


**Figure 2:** PCA Bi-plot of descriptive sensory attributes of the *KS*[a]
[a]Descriptive sensory attributes are plotted in red colour, products in blue colour

## Kishk Sa'eedi Conclusions

Evaluation of the *KS* sensory characteristics provide in depth understanding of the sensory quality criteria as perceived by the sensory trained panel. The present study showed that substantial differences in sensory character were noted between the traditional and re-engineered *KS* in particular, differences in colour, fresh odour, *KS* taste, fracutability 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.

## Acknowledgements

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

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