

Cross-cultural acceptance of a traditional yoghurt-like product made from fermented cereal

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Abstract

BACKGROUND: Akpan is a traditional ready-to-drink fermented yoghurt-like cereal beverage consumed in urban and rural areas in Benin. With the aim of adapting the product to new local and export markets, this work maps African and European consumer preferences for different types of Akpan.

RESULTS: A sensory profile of Akpan was created and consumer tests were conducted with 103 consumers of African origin and 74 consumers of European origin. Consumer acceptance was significantly correlated with fermented odour ($r = -0.94$) and milky taste ($r = 0.92-0.97$) attributes. Cluster analysis revealed different behaviour by African and European consumers with respect to acceptability of Akpan; European consumers did not like the sour taste and African consumers liked an intense sweet milky taste.

CONCLUSION: This study provides information on how Akpan, and other fermented yoghurt-type cereal products, could be adapted to African and European consumer preferences.

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Keywords: cereal; fermentation; Akpan; beverage; sensory profile; consumer acceptance

INTRODUCTION

Ready-to-eat or street foods are an integral part of catering in developing countries, particularly in urban areas. Among the range of products collectively referred to as street food,¹ traditional yoghurt-like beverages made from cereals play an important role in the diet of local populations. The use of cereal grains as a source of fermented beverages for human consumption is widespread in many African countries. For example, in addition to industrial products such as lager beer or soft drinks, endogenous beverages made from local cereals and processed using traditional long-established techniques account for a large share of the beverage market. These include alcoholic and non-alcoholic beverages such as Chakpalo, Tchoukoutou, Gowe and Akpan in Benin,²⁻⁴ Kunu in Nigeria⁵ and Muramba and Bushera in Uganda.^{6,7}

Akpan is a Beninese yogurt-like product traditionally prepared from Ogi, a fermented starchy flour made from maize, sorghum or millet grains.⁸ It is popular and widely consumed and the demand for the product on local markets is high. Like many other indigenous fermented cereal products, Akpan is appreciated for its sweet but slightly sour taste and the aroma of its active components, which develop naturally during processing or are added during consumption.⁹

Despite the high demand, the market for Akpan is limited, since it is only sold for immediate consumption. Those who produce Akpan could increase their income by expanding their

customer base with new storable forms of the product, including ready-to-drink bottled Akpan or ready-to-prepare flours. In addition, Akpan could progress from small-scale traditional processing units to medium- and large-scale traditional units or new semi-industrial units, and the product could be prepared for export to the EU and the USA where yogurts and legume- or cereal-based yogurt-like drinks already exist. However, for external markets, different types of Akpan are needed that are likely to sell on international markets because they take the preferences of the targeted consumers into account. As mentioned by many authors, designing a product that appeals to the consumers of a particular country requires knowledge of how the consumers' cultural backgrounds influence their preference for the products.^{10,11} Since different countries have different cultures and a wide range

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of food behaviours,^{10,11} it would be too expensive to test the products at the target sites. Thus foreign nationals who are residents in the country where the product developers work could be used as surrogates for consumer testing to avoid the time and cost of travelling to the target regions.¹¹ In some studies, consumers' cultural differences have been reported to affect their acceptance of new products,¹² while other authors have argued that the success of a product on a foreign market first requires understanding the target markets.¹³ Following this approach, we tested the acceptability of Akpan by different African and European consumers who live in Benin.

Recent surveys revealed the existence of different types of Akpan depending on the raw material and process used.⁹ The different raw materials and processes may lead to different perceptions of the sanitary and sensory properties of Akpan by consumers. In addition, producers store Akpan at ambient temperature (24–30 °C) for several days, but after 1 week it becomes too sour for sale owing to lactic-type fermentation. Not much information is available on Akpan beyond a basic description of the product,^{2–4} though qualitative sensory attributes of Akpan have been published.¹⁴ However, the sensory profiles of the different types of Akpan have not yet been determined, and since different processes are used in its preparation, variability in the sensory properties of the different types of Akpan is to be expected.

To further improve the product to suit new local markets as well as export markets, including the EU, acceptability by different cultural groups needs to be quantified and linked to sensory and physicochemical data with a view to obtaining objective information to upgrade processing. The aim of this work was thus to map consumer preferences for the different types of Akpan that are currently available and to characterize the sensory attributes and physical-chemical characteristics of Akpan. In addition, the relation between the culture and/or origin of the consumers and their preference was tested using African and European consumers who live in Benin. The results of this study provide useful background information for the creation of new types of Akpan for different markets and for the re-engineering of the Akpan process.

MATERIALS AND METHODS

Samples

White maize grains (*Zea mays*) and red sorghum grains (*Sorghum bicolor* (L.) Moench) were purchased from the international market in Dantokpa. The grains were processed into Akpan by two skilled local processors using the traditional methods described by Sacca *et al.*,⁹ but under satisfactory hygiene/sanitary conditions. In addition, a bottle of commercial Akpan named Cerealait was purchased at the local market. The types of Akpan used for sensory testing are listed in Table 1. The basic formulation was drawn up for 1 kg of Akpan. For Akpan made with the Ogi technique,⁸ the ingredients were 600 g of plain Ogi, 100 g of sugar, 70 g of milk powder and 230 mL of ice water. For the kneaded fermented flour Akpan process, 530 g of plain Akpan, 88 g of sugar, 70 g of milk powder and 320 mL of ice water were mixed. Using these basic formulations, all other forms of Akpan tested were composed by omitting one or more components (Table 1).

Ethical assessment and consent

This study was 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 the study. Enumerators

informed participants about the study and explained that their participation was entirely voluntary, that they could stop the interview at any time and that the information they provided, collected through written notes, would be used solely for scientific purposes and treated as strictly confidential. Anonymity was guaranteed and individuals are not identified in any publication or dissemination of the study findings.

Sensory profile

The sensory profile of Akpan was established by 17 panellists using a simplified quantitative descriptive analysis (standards were not provided).^{15,16} The panel was composed of technicians and students from the University of Abomey-Calavi as well as people from surrounding areas. They were selected according to their familiarity with the product. Sessions were conducted at the University and the language used was French. Panellists were first asked to generate an objective vocabulary of sensory attributes (descriptors) during a preliminary group session using several traditional Akpan samples (Table 1). After group discussion and eliminating similar terms by consensus, a list of 16 sensory attributes was then drawn up (Table 2). Panellists were trained to use the score sheet and score scale by scoring four Akpan samples in nine sessions. The panellists scored the intensity of each attribute using a 100 mm unstructured line scale and put a mark on the line (lowest rating at the low end to highest rating at the high end).

Twelve Akpan samples were evaluated, each of which was tested in triplicate. At each session, four sample Akpan drinks (coded with three-digit random numbers) were served in transparent plastic cups in random order to each panellist. Akpan was prepared each morning and stored cold (4 °C) until the beginning of the session. Triplicate evaluations of the same Akpan paste were performed on three consecutive days. A commercial bottle of water was provided to each panellist so that he/she could rinse his/her mouth between samples.

Consumer acceptance

Consumer acceptance was tested on a subsample of five Akpan samples at different locations in Cotonou: University of Abomey-Calavi, the French Cultural Institute in Benin, Hotel du Port, at the beach (Fidjrosse), in a restaurant at Calavi and in a bar at Godomey. A total of 177 consumers (75 female and 102 male) of both African (103 consumers from Benin, Togo, Mali or Gabon) and European (74 consumers resident in Benin but coming from France, Italy, Belgium, Germany or Switzerland) origin were asked to score the acceptability of the Akpan samples with respect to appearance, taste and overall liking using a nine-point hedonic box scale, with 1 representing 'extremely dislike' and 9 representing 'extremely like'.¹⁵ Akpan drinks that had previously been diluted with potable water were transported in cool boxes with ice. Each Akpan sample (50 mL) was presented in random order and coded with a three-digit random number. Besides acceptability data, socio-economic information was collected, such as education, demographics, Akpan consumption and buying practices. Interviews were conducted in French or, if necessary, in the local language.¹⁷ The interview (acceptability and interviews based on a questionnaire) lasted less than 30 min.

Physical-chemical analysis

The dry matter (DM) of Akpan drinks was determined by AOAC methods 27.005 and 27.007.¹⁸ pH and titratable acidity (TA) were measured according to AACC method 02-31.01¹⁹ using an

Table 1. Types of Akpan for sensory profile

| Raw material | Process | Type of Akpan | Code ^a |
|---------------|--------------------------------|---|-------------------|
| Maize | Ogi | Akpan made from maize Ogi with added sugar | OMs |
| | | Akpan made from maize Ogi with added sugar and milk | OMsm |
| Sorghum | Ogi | Akpan made from sorghum Ogi with no ingredient added | OSn |
| | | Akpan made from sorghum Ogi with added sugar | OSs |
| | | Akpan made from sorghum Ogi with added sugar and milk | OSsm |
| | Kneaded fermented flour | Akpan made from sorghum kneaded fermented flour with no ingredient added | FSn |
| | | Akpan made from sorghum kneaded fermented flour with added sugar | FSs |
| | | Akpan made from sorghum kneaded fermented flour with added sugar and milk | FSsm |
| Mixed cereals | Kneaded fermented flour | Akpan made from a mixture of kneaded fermented flours (sorghum and maize) with no ingredient added | FXn |
| | | Akpan made from a mixture of kneaded fermented flours (sorghum and maize) with added sugar | FXs |
| | | Akpan made from a mixture of kneaded fermented flours (sorghum and maize) with added sugar and milk | FXsm |
| Maize | Industrial Akpan made with Ogi | Cerealait (with added sugar and milk) | lsm |

^a O, Ogi; F, kneaded fermented flour; M, maize; S, sorghum; X, mixture of flours; n, no ingredient added; s, sugar added; m, milk added.

Table 2. Definition of sensory attributes

| Sensory attribute | Description |
|-------------------|--|
| White colour | Colour characteristic of white maize |
| Brown colour | Colour characteristic of brown sorghum |
| Presence of brans | Related to bran particles in Akpan |
| Cereal odour | Odour characteristic of cereal (aroma 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 |
| Concentrated look | Related to the difficulty to flow with a high proportion |
| Grainy | Appearance of small flour particles |
| Presence of lumps | Appearance of a mass of several agglomerated particles in the liquid |
| Sweet taste | A taste sensation that is related to sugar |
| Sour taste | Taste characteristic of lemon |
| Milky taste | Taste characteristic of milk |
| Cooked taste | Sensation in the mouth characteristic of cooked starch |
| Aftertaste | Sensation after swallowing that seems abnormal |
| Cereal taste | Characteristic taste of cereal (taste related to maize or sorghum) |

InoLab Series 730 pH meter (WTW, Weilheim, Germany). The instant apparent viscosity of the Akpan drinks was determined using a Rapid Visco Analyser (RVA, Newport Scientific, Narabeen, Australia); 28 g of homogenized sample was heated at 35 °C for 3 min with stirring at 160 rpm and the final apparent viscosity was recorded.

Statistical analysis

Analysis of variance (ANOVA, mixed effect model), correlation analysis (Pearson), stepwise multiple linear regression, chi-square

analysis and principal component analysis (PCA) were performed using Statistica 7 (StatSoft, Tulsa, USA) or XLSTAT 5.2 (Addinsoft). Agglomerative hierarchical clustering (AHC) analysis was performed on sensory data (clusters of Akpan types) and overall liking (clusters of consumers) using Ward's method, with clusters automatically truncated. Multiple pairwise comparisons were undertaken using Tukey's test with a confidence interval of 95%.

RESULTS

Sensory profile of Akpan drinks

Significant differences were revealed between panellists, indicating that they did not score in the same way. In most cases, their scores depended on the type of Akpan ($P < 0.05$; significant sensory attribute \times panellist interactions) (Table 3). Accordingly, these interactions should be expected, since the panel was trained without using standards.²⁰ The effect of the type of Akpan was highly significant ($P < 0.001$) for all sensory attributes. ANOVA showed that Akpan made from sorghum flours differed significantly from Akpan made from sorghum Ogi, the former having higher scores for presence of brans (46.7 vs 11.1), grainy texture (43.7 vs 7.4), presence of lumps (49.2 vs 9.2) and cooked taste (39.8 vs 29.0). Sorghum Akpan only differed significantly from maize Akpan on colour attributes (white and brown scores) and presented lower vanilla aroma (19.1 vs 39.9 for maize Akpan). It should also be noted that mixed Akpan was not scored significantly differently from pure sorghum Akpan. As expected, Akpan with added sugar was scored higher for sweetness, and Akpan with added milk was scored higher for milky taste, but the scores were less simple for sour taste; plain Akpan received the highest score for being the most sour (40.5), and Akpan with added sugar and milk was the least acidic (14.4). Akpan with added sugar had an intermediate position (acidity score of 25.6). Panellists were not able to clearly differentiate the pure sour sensation, since added sugar masked their perception of sourness.

The relationships between the different types of Akpan and their attributes were evaluated by PCA (Fig. 1). The first two components explained 79.8% of the variability between samples. The PCA

Table 3. P values of two-way ANOVA of sensory attribute scores

| Sensory attribute | Akpan | Panellist | Interaction |
|-------------------|--------|-----------|-------------|
| White colour | <0.001 | <0.001 | <0.001 |
| Brown colour | <0.001 | <0.001 | 0.068 |
| Presence of brans | <0.001 | <0.001 | 0.002 |
| Cereal odour | <0.001 | <0.001 | <0.001 |
| Fermented odour | <0.001 | <0.001 | <0.001 |
| Vanilla aroma | <0.001 | <0.001 | <0.001 |
| Citronella aroma | <0.001 | <0.001 | 0.216 |
| Concentrated look | <0.001 | <0.001 | 0.495 |
| Grainy | <0.001 | <0.001 | <0.001 |
| Presence of lumps | <0.001 | <0.001 | 0.960 |
| Sweet taste | <0.001 | <0.001 | <0.001 |
| Sour taste | <0.001 | <0.001 | <0.001 |
| Milky taste | <0.001 | <0.001 | <0.001 |
| Cooked taste | <0.001 | <0.001 | 0.026 |
| Aftertaste | <0.001 | <0.001 | 0.661 |
| Cereal taste | <0.001 | <0.001 | <0.001 |

showed the effect of the type of processing, of the nature of the raw material and of the addition of sugar or milk. This is consistent with a recent study reporting that the type of raw materials, utensils, processing methods and processor practices all influenced the quality of Obushera (fermented and non-fermented, alcoholic or non-alcoholic cereal beverages).²¹ The two types of process, using Ogi or kneaded fermented flour, were indeed clearly distinguished on the first axis, the former being on the left and the latter on the right. As evidenced by ANOVA, types of Akpan made from kneaded fermented flour were mainly characterized (variables on the right-hand part of the first axis) by brown colour, presence of brans, grainy texture and presence of lumps. The second axis was mainly correlated with three variables: sour taste (negatively, at the bottom) and sweet and milky taste (positively, at the top). Akpan samples appeared to be plotted from raw (no added ingredient) to

added sugar and added sugar and milk from the bottom to the top of the figure.

Cluster analysis revealed five groups of Akpan drinks with specific sensory properties (Table 4). The first two clusters grouped all types of Akpan made from kneaded fermented flour and presented higher significant scores for presence of lumps, presence of brans, grainy texture, cereal odour and cooked taste. The first cluster, with no added ingredient (FSn and FXn), differed from the second one only by a less sugary taste. The third cluster grouped Akpan drinks made from maize Ogi and the industrial one; it was scored with high white colour (63 vs 6–10 for the other clusters; and, conversely, low brown colour), higher vanilla aroma (33 vs 10–19) but lower cereal taste (22 vs 30–40). Clusters 4 and 5 only gathered Akpan drinks made from sorghum Ogi; they presented opposite scores to maize Ogi Akpan on colour, vanilla aroma and cereal taste. Cluster 4 (OSn) only differed from cluster 5 by sugary taste.

Consumer acceptability

Five samples, one sample per cluster, were chosen for consumer testing, as highlighted in Table 4. On average, four Akpan drinks were acceptable to the whole set of consumers, since their mean scores were equal to or greater than 5 (neither like nor dislike); only the Akpan made from kneaded fermented sorghum flour with no added ingredient (FSn) had an acceptability score below 5. The most liked Akpan drinks were those made from Ogi with added sugar and milk or from maize or sorghum (OMsm and OSsm).

AHC analysis (Ward’s method) was used to segment the consumers interviewed at the different locations into different groups. Four clusters, presenting different preferences, were defined. The mean liking for each of them is illustrated in Fig. 2. A score of 5 (neither like nor dislike) was used as an indicator of ‘neutral attitude’. The products rated below 5 were considered as ‘disliked’ and those above 5 as ‘liked’. The consumer clusters were named based on the dominant characteristics of each cluster. The first cluster, ‘Ogi Akpan likers’, accounted for 24% of the consumers, the second,

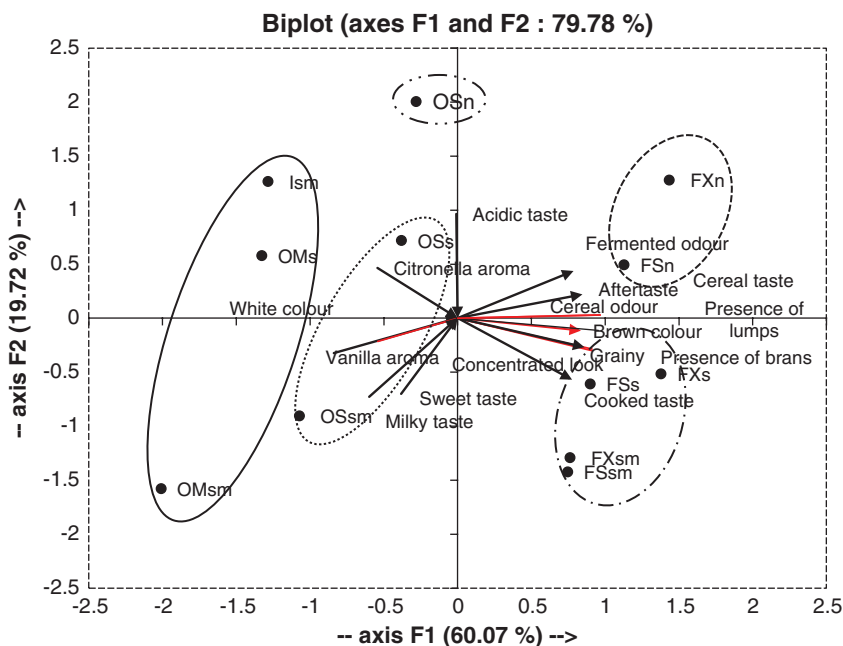


Figure 1. PCA of relationships between sensory attributes (described in Table 2) and different types of Akpan (described in Table 1).

Table 4. Cluster analysis, sensory and acceptability scores of different types of Akpan

| Cluster | 1 | 2 | 3 | 4 | 5 |
|--|-------------------|-----------------------------------|---------------------------|------------|--------------------|
| | FSn FXn | FSs FSsm FXs FXsm | ISM OMs OMsm | OSn | OSs OSsm |
| <i>Selected sensory attributes</i> | | | | | |
| White colour | 7b | 6b | 63a | 10b | 9b |
| Presence of brans | 43a | 45a | 9b | 11b | 11b |
| Cereal odour | 40a | 43a | 17c | 31b | 24bc |
| Vanilla aroma | 10b | 14ab | 34a | 13ab | 19ab |
| Sweet taste | 4b | 50a | 48a | 4b | 50a |
| <i>Mean overall acceptability scores</i> | | | | | |
| Average | 3.7d | 5.7b | 7.2a | 5.0c | 6.7a |
| Standard deviation | 1.7 | 1.8 | 1.7 | 1.8 | 1.8 |

Values with different letters in the same row are significantly different according to Tukey's test ($P < 0.01$).

'sweet milky Akpan likers', for 20%, the third, 'Akpan dislikers', for 19% and the fourth, 'Akpan likers', for 37%.

The demographic characteristics and consumer attitudes to Akpan of each consumer cluster are listed in Tables 5 and 6. The four clusters did not differ significantly in terms of socio-demographic variables such as age, sex, residency, education level, marital status, etc. They only differed in terms of the ratio of Europeans to Africans. Cluster 3 (Akpan dislikers) indeed comprised more Europeans (Fig. 3), whereas cluster 4 (Akpan likers) mainly comprised Africans. The mean acceptability scores of Akpan by Europeans were lower by 1–2 points than those by Africans. This may be due to Europeans being less familiar with the product. Interestingly, when only consumers who regularly consume Akpan were considered, there was no difference between Europeans and Africans (Table 5). Differences between African and European acceptance may also be due to a bias in the use of scales; it has been reported that consumers of Chinese origin rated products that were new to their culture significantly higher than consumers of European origin.²² It should also be noted that Europeans clearly preferred Akpan made from Ogi (mainly Europeans in cluster 1), with a mean acceptability score close to or above 6 for OMsm and OSsm. This difference in acceptability between European and African consumers is important and should be taken into consideration in further marketing studies.

Table 5. 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 | |
| Motobike | <0.001*** | |
| Car | 0.135 | |
| TV | 0.156 | |
| House | 0.461 | |
| Refrigerator | 0.120 | |
| Frequency ^a | – | 0.046* |
| Consumption place ^a | – | 0.173 |
| Aromatic preference ^a | – | 0.640 |
| Purchase place ^a | – | 0.130 |
| Type of Akpan (maize; sorghum or mixed; none) | – | <0.001*** |
| Ingredients (sugar; milk; milk and sugar; no ingredient) | – | <0.001*** |

Significance:
* $P < 0.05$
*** $P < 0.001$.
^a Data only include Akpan consumers.

For those who already consume Akpan, there were no differences between the four clusters in terms of frequency, consumption, purchase place and aromatic preference, but differences between clusters appeared concerning the type of Akpan and the added ingredients (Table 5). The most consumed Akpan was that made from maize. Nevertheless, it should be noted that acceptability of Akpan prepared from sorghum Ogi was similar to acceptability of Akpan prepared from maize Ogi (Table 4). Sugar and milk were both most commonly added to prepare Akpan drinks, whereas plain Akpan (with no ingredient added) was the

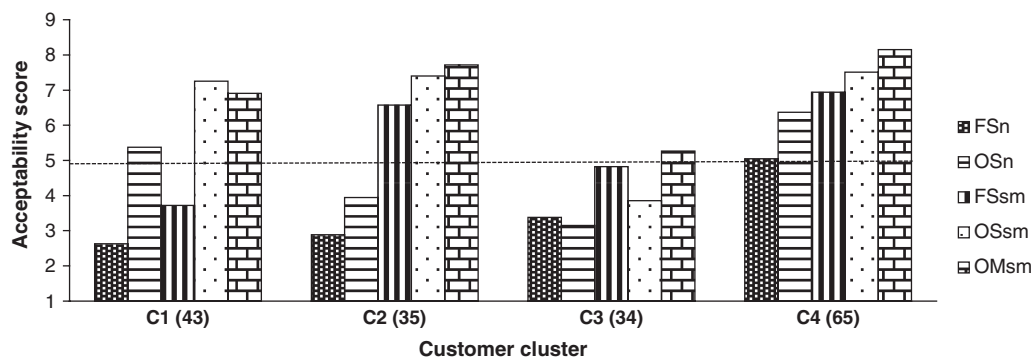
**Figure 2.** Mean consumer acceptance of different types of Akpan (described in Table 1) by cluster type: C1, 'Ogi Akpan likers'; C2, 'sweet milky Akpan likers'; C3, 'Akpan dislikers'; C4, 'Akpan likers'. Acceptability was rated on a nine-point scale from 1 = dislike extremely to 9 = like extremely.

Table 6. Correlations between sensory attributes and acceptability of Akpan

| Attribute | All | African | European | Cluster 1 (43) 'Ogi Akpan likers' | Cluster 2 (35) 'Sweet milky Akpan likers' | Cluster 3 (34) 'Akpan dislikers' | Cluster 4 (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 |
| Cereal 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 |
| Concentrated look | 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 |
| Presence of lumps | -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* |
| Sour taste | -0.752 | -0.688 | -0.838* | -0.422 | -0.894** | -0.812* | -0.724 |
| Milky 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 |
| Aftertaste | -0.764 | -0.767 | -0.745 | -0.832* | -0.634 | -0.422 | -0.716 |
| Cereal taste | -0.809* | -0.827* | -0.768 | -0.876* | -0.656 | -0.451 | -0.780 |

Values in bold are different from zero at a significance level of

* $P < 0.10$ or

** $P < 0.05$.

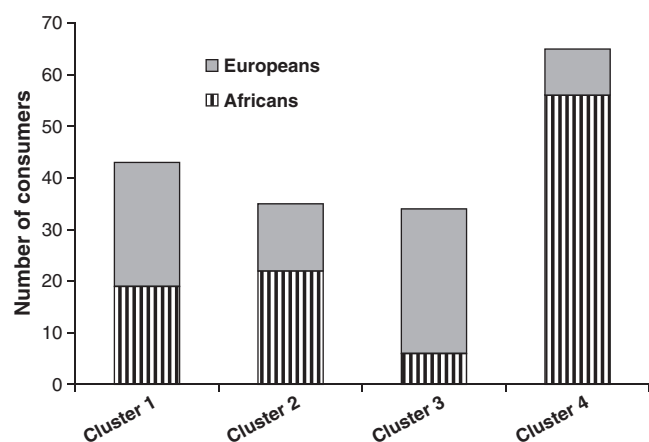


Figure 3. Number of consumers per group type (cluster) by African or European origin: cluster 1, 'Ogi Akpan likers'; cluster 2, 'sweet milky Akpan likers'; cluster 3, 'Akpan dislikers'; cluster 4, 'Akpan likers'.

least common way of consuming Akpan. There was no difference in the type of Akpan consumed by Europeans and Africans ($P = 0.219$; chi-square test), but there were differences in the type of ingredient added ($P = 0.022$; chi-square test). However, because of the small number of Europeans (five) use to consuming Akpan, it was not possible to determine whether Europeans and Africans actually have different ways of consuming Akpan.

Correlations between sensory attributes, physical-chemical characteristics and consumer acceptance

The pH of Akpan drinks ranged from 3.60 to 4.63 and the TA from 0.17 to 0.32% (wet basis (wb), lactic acid equivalent) (Table 7), which appeared to be quite low. Apparent viscosity ranged from 309 to 597 cP (Table 7) and appeared to be significantly correlated with DM content (Fig. 4). Surprisingly, the apparent viscosity of plain Akpan was similar to that of Akpan with added sugar or

with added sugar and milk, whereas the DM of plain Akpan was half that of the other two. With the exception of DM content, there was no significant difference between the physical-chemical characteristics of the different types of Akpan.

The measured physical-chemical characteristics of Akpan samples were not clearly correlated with their sensory attributes. However, some relations appeared with each type of Akpan (Fig. 4). pH and TA were not significantly correlated with the acidity score, which was more linked to the addition of sugar and of milk, i.e. to each type of Akpan (Fig. 4). In addition, there was little evidence of a significant relationship between the apparent viscosity of Akpan and its texture sensory scores. The concentrated appearance increased with apparent viscosity for Akpan with added sugar and milk but decreased for plain Akpan. Neither did the grainy and 'presence of lumps' scores appear to be directly related to apparent viscosity; for example, grainy scores ranged from 35 to 50 for Akpan prepared from flours as compared with 5–10 for Akpan prepared from Ogi, which presented very similar apparent viscosity.

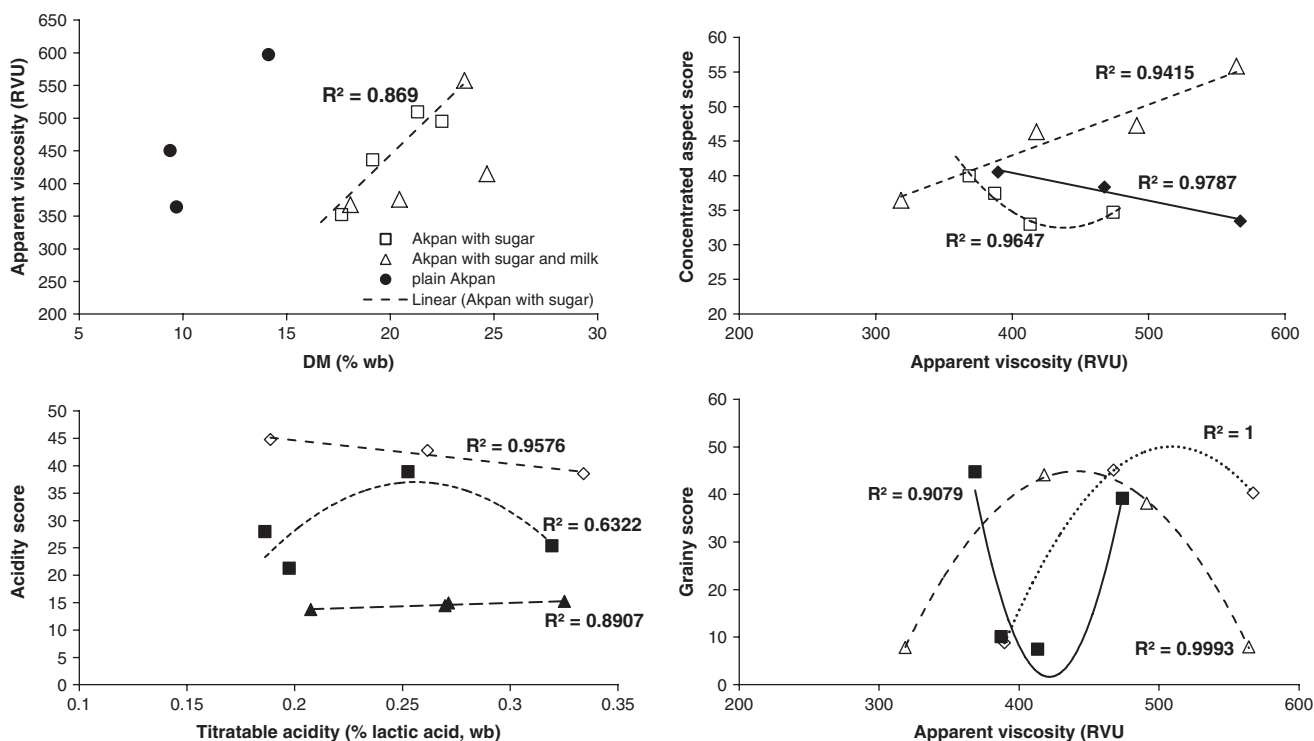
Regarding correlations between consumer acceptance and sensory attributes, a range of curves was explored for European and African consumers and for the different clusters (Table 6). Many attributes were associated with consumer acceptance. For the consumer group as a whole, the most significant correlations were between mean acceptance scores and fermented odour ($r = -0.94$, $P < 0.05$) and milky taste ($r = 0.92$, $P < 0.05$). Consumers in general consequently look for an Akpan with a milky taste and a limited fermented odour (Fig. 5). Measured acidity was quite low for all samples and did not vary significantly with the raw material and the process. We thus recommend using a short fermentation period in order to reduce the fermentation odour of the product.

Correlations between attributes and mean acceptance scores of consumers differed in the different clusters (Table 6). Acceptance by 'Ogi Akpan likers' was negatively correlated with the attributes linked to the use of kneaded fermented flours (as evidenced by the PCA, Fig. 1): presence of brans (Fig. 5), grainy and presence of lumps. 'Akpan likers' (mainly Africans) particularly look for an

Table 7. Selected physical-chemical characteristics of Akpan drinks

| Type of Akpan | pH | TA (% lactic acid, wb) | DM (% wb) | Viscosity (RVU) |
|---------------|------|------------------------|-----------|-----------------|
| FSn | 4.03 | 0.32 | 9.7 | 364 |
| FSs | 4.63 | 0.31 | 17.7 | 352 |
| FSsm | 4.20 | 0.27 | 20.4 | 376 |
| FXn | 4.00 | 0.20 | 9.4 | 450 |
| FXs | 3.73 | 0.17 | 19.1 | 436 |
| FXsm | 3.80 | 0.23 | 18.1 | 367 |
| lsm | 4.10 | 0.30 | 24.1 | 309 |
| OMs | 3.63 | 0.26 | 21.3 | 510 |
| OMsm | 3.83 | 0.23 | 23.6 | 558 |
| OSn | 3.90 | 0.25 | 14.1 | 597 |
| OSs | 3.60 | 0.23 | 22.5 | 495 |
| OSsm | 3.83 | 0.21 | 24.7 | 415 |
| Mean | 3.94 | 0.25 | 18.5 | 436 |
| Minimum | 3.60 | 0.17 | 9.4 | 309 |
| Maximum | 4.63 | 0.32 | 24.7 | 597 |
| SD | 0.28 | 0.05 | 5.3 | 89 |

TA, titratable acidity; DM, dry matter; SD, standard deviation.

**Figure 4.** Relationships between physicochemical characteristics and sensory attributes of Akpan.

aromatic Akpan with high milky taste (Fig. 5) and vanilla aroma. 'Sweet milky Akpan likers' look for an Akpan with high milky ($r = 0.97$) and sweet ($r = 0.96$) tastes. These results show that, for the African market, Akpan made from either maize or sorghum Ogi and with high milk and sugar contents could satisfy most consumers. 'Akpan dislikers' particularly disliked the sour taste (Fig. 5). This cluster was mainly composed of Europeans, and correlations with European consumers alone confirmed that Akpan with very short fermentation (little sour taste, little fermented odour) and moderate addition of milk and sugar should be suited to the European market.

CONCLUSION

This study highlighted the sensory attributes and consumer acceptance of Akpan, a yoghurt-like cereal product from West Africa. The information collected regarding the cross-cultural acceptance of Akpan will help reformulate existing products and/or develop new forms of the product that fulfil consumers' sensory expectations. The results advance the understanding of the acceptability of Akpan by both African and European consumers. Irrespective of the type of cereal used, Akpan drinks made using the Ogi process and with added sugar and/or milk (OMsm, Oms, OSsm and OSs) were the most preferred and should be re-engineered for local and

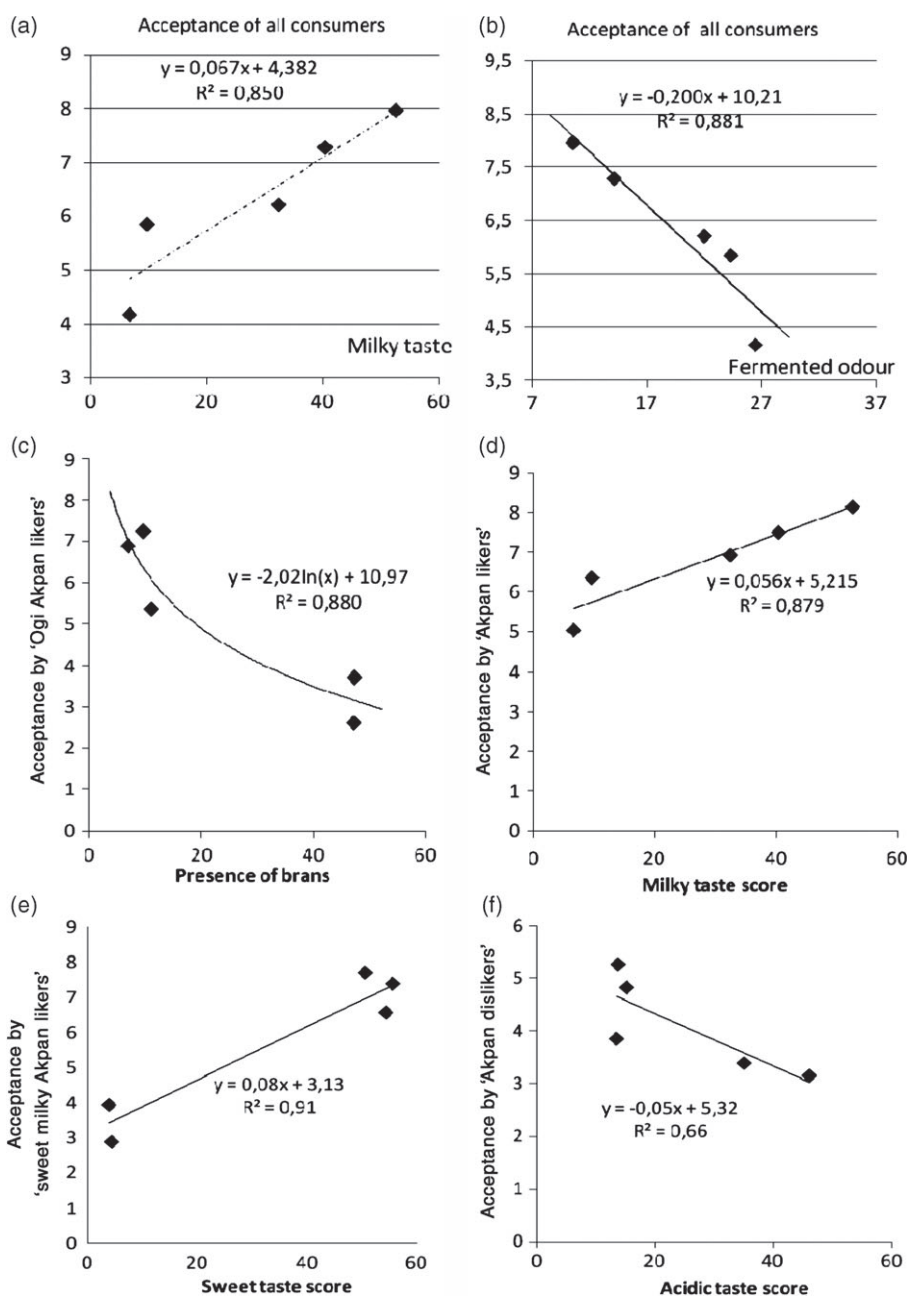


Figure 5. Relationships between sensory attributes (a, milky taste; b, fermented odour; c, presence of brans; d, milky taste; e, sweet taste; f, acidic taste) and consumer acceptance.

European markets. This investigation provides useful information on how Akpan, and other fermented cereal yoghurt-type products, could be adapted to African and European consumer preferences.

ACKNOWLEDGEMENT

This publication is an output from a research project funded by the European Union (FP7 245 – 025) called African Food Revisited by Research (AFTER – <http://www.after-fp7.eu/>). The views expressed are not necessarily those of the European Union.

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