SENSORY QUALITY OF *AGBELIMA* - A FERMENTED CASSAVA PRODUCT

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Summary

An investigation was carried out to identify the relevant sensory quality attributes consumers and producers associate with *'agbelima'*, the relative importance of these attributes in determining product acceptability, and the most adequate objective indicators of these attributes. A survey was conducted to identify the relevant attributes. Colour, smoothness, cohesiveness, aroma, sourness and degree of wetness, were identified as the most important attributes. Three of these attributes - colour, smoothness, sourness - were assessed by objective and subjective methods, using four different samples of *agbelima*. Instrumental methods (the Minolta Chroma Meter Model CR-200; and the Corning pH Meter Model 240) were used to objectively measure colour intensities and pH of the products. A chemical determination method was used to determine titratable acidity as a measure of sourness, whilst a physical separation method of classification was used to determine the particle size and uniformity index of the products, as indicators of smoothness. A ranking test employing a 36-member sensory panel was used to subjectively assess the three sensory attributes for differences in intensity characteristics and preference, simultaneously. Linear and multiple regression analysis of the data showed that colour was the most important attribute in determining product acceptability, with sourness being the least. The most adequate objective indicators of colour were found to be the 'b' parameter of the L*a*b* colour system, and the 'C' parameter of the L*C*H° colour system. For sourness, both pH and titratable acidity were excellent indicators, whilst smoothness was most adequately reflected by the average particle size rather than by the uniformity index.

Introduction

The fermentation of cassava for the production of a variety of products is an old tradition in Ghana and in most West African countries. The objectives for fermenting cassava are to detoxify the tuber - which contains significant amounts of cyanogenic glycosides (O'Brien *et al.*, 1994) - and to develop a characteristic taste and aroma in the final products of fermentation (El-Tiney *et al.*, 1984; Vasconcelos *et al.*, 1990).

Agbelima is one of the most important fermented cassava products in Ghana. It is a wet product, whose production process is similar to that of *gari* processing, from the peeling to the dewatering/fermentation stage (Al-Hassan, 1991). An inocullum - traditionally called *'kudeme'* is, however, added before the start of the fermentation. The *kudeme* is thought to be a product of microbial and/or biochemical disintegration of cassava tissue, possibly through the action of moulds (Sefa-Dedeh, 1989). Apart from hastening the fermentation process, the *kudeme* is believed to improve the sensory characteristics of the product (A-Hassan, 1991; Budu, 1990; Lartey, 1993). The production process has, however, not been standardised and the quality of the product is, therefore variable. Information on the sensory attributes that determine product quality is rather very scanty.

It is the objective of this investigation, therefore, to identify:

- the relevant sensory attributes consumers and producers associate with *agbelima*,
- the relative importance of these attributes in determining product acceptability,
- the most adequate objective indicators of the identified attributes.

The results are expected to form the basis for establishing quality specifications for the product and for standardising the production process in order to meet the established quality requirements.

Materials and Methods

Identification of Attributes

A survey was conducted using a classification of survey typology outlined by Casley and Lury (1981) as the basis for selecting the sample size. A questionnaire was prepared based on a preliminary semi-structured interview of 10 identifiable consumers of *agbelima*, leading to the preparation of a draft questionnaire, which was pre-tested on 20 randomly selected consumers. Adjustments were then made to obtain the final questionnaire used.

The questionnaire was administered to 107 consumers in the Accra Metropolitan area, twenty-one (21) of whom were producers. Respondents were required to indicate the sensory attributes they associate with good quality *agbelima*, and to rank these in decreasing order of importance on a scale of 1-7. Other attributes not included may be added and ranked accordingly. The first five ranked most important attributes were scored. A score of 5 was assigned the attribute ranked first, and a score of 1 to the attribute ranked fifth. The scores of the respondents were totaled and attributes with the highest scores were judged the most important, subject to confirmation by sensory evaluation.

Sample Selection for Analysis

Twenty (20) market samples, selected by a probability sampling procedure (Cochran, 1963; Gomez and Gomez, 1984), were screened for variations in colour, particle size and total titratable acid. Four of the samples - with values distributed as much as possible over the full range of values for the respective parameters - were selected for sensory and objective analysis.

Particle Size and Uniformity Index Determination

A modification of the method proposed by Henderson and Perry (1979) for the flours was used. The modification was made to suit the sample under investigation, which was a wet sample. 100g of *agbelima* was washed down a set of graded Tyler sieves with 10 litres of water. The aperture sizes of the sieves used were 1.00 mm, 0.5 mm, 0.25 mm and 0.125 mm. Fractions retained on each sieve were oven-dried at 120°C for two (2) hours, cooled and weighed. The dry matter content of the cassava dough was determined and used to estimate the amount of the sample that would, otherwise have collected in the pan. The results were used to calculate the fineness modulus from which the average particle size (D) in millimetres was calculated, according to the method of Henderson and Perry (1979). The uniformity index was calculated as the ratio of the weight of fractions retained above the 0.05 mm sieve, to the sum of weight fractions passing through it.

Colour

The colour was determined with the Minolta Chroma Meter (Model CR 200, Minolta Camera Co. Ltd.), using the L*(a*b*, and the L*C*H° colour systems. The chroma meter was calibrated with a white tile (L*=97.63, a*=0.48, b*=+2.12, C*=2.17, H°=1.27.

Total Titratable Acidity

Total titratable acidity was determined by means of the Ghana Standards Board method for *gari* and cassava chips (Ghana Standards Board). 18g of *agbelima* was made into a slurry in 200 ml of distilled water in a flask. The flask which was loosely stoppered was placed in a water bath at 40°C and shaken for 1 hr. The slurry was filtered through a dry filter (Whatman No.1). 100 ml of the filtrate was titrated with 0.2 MNaOH, using phenolphthalein as indicator. Total titratable acidity was calculated as percent lactic acid.

pH

A slurry of *agbelima* was made by mixing 5g of sample with 50 ml of distilled water in a beaker. The beaker was placed in a water bath at 40°C for 1 hr. with occasional shaking. The pH was then measured with the Corning pH meter (Model 240).

Sensory Evaluation

Samples of *agbelima* were prepared into a stiff dough by cooking 400g of sample in a total of 400 ml of water until well done. The samples were coded and presented to a 36-member laboratory panel to assess the intensity of the three attributes of colour, sourness, smoothness and overall preference by ranking on a 4-point

scale, ranging from least intense to most intense, based on the preliminary results from the study. Multiple correlation of the attributes with *the overall preference was carried out*. Linear correlation between the sensory scores of each attribute and the corresponding objective parameter was also done.

Results and Discussion

During the preliminary semi-structured interview, six attributes were listed namely - texture (smoothness, sourness (acidity), colour, aroma, starchiness (cohesiveness) and wetness). After the pre-testing of the questionnaire three additional attributes - swelling ability, fibrosity and absence of maggots - were identified. Fibrosity was thought to be directly related to texture and was, therefore, not included in the final questionnaire. Absence of maggots is not a sensory attribute and was also, consequently, excluded. At the end of the survey, three other attributes were revealed. These were freshness, cleanliness and palatability. Rank totals for all the attributes are shown in Table 1. The first six most important attributes identified were, smoothness, colour, starchiness (cohesiveness), degree of wetness, aroma and sourness (acidity) in descending order of importance.

Table 1
Rank Total for Quality Attributes Identified During Survey

Attribute	Rank Total	Relative Importance
Texture (Smoothness)	433	1
Colour	303	2
Starchiness (Cohesiveness)	294	3
Wetness	146	4
Aroma	119	5
Acidity (Sourness)	112	6
Swelling Ability	67	7
Fibrosity	17	8
Cleanliness	8	9
Freshness	5	10
Absence of Maggots	5	10
Palatability	1	11

The results of the sensory evaluation - as shown in Tables 4 and 6 - which compared three of the identified attributes - indicate the relative importance of the attributes as: colour, smoothness, and sourness in descending order. Whilst colour accounts for 45% of the preference of the product, sourness accounts for only 15%, with smoothness accounting for 40%. This compares favourably with the survey results, even though the relative importance of colour and smoothness are reversed. Considering that the ranking of attributes during the survey, apart from enabling identification of the important attributes, was intended to enable prediction of the behaviour of consumers during actual sensory evaluation, the results of the sensory evaluation with respect to the attributes of colour and smoothness may be taken as a better reflection of consumer perception. Hence, colour could be considered a more important attribute than smoothness. However, the closeness of the partial regression coefficients for colour and smoothness shows that it would be more appropriate to consider colour and smoothness as occupying comparable positions of importance in the determination of product acceptability.

The fact that colour and texture occupy the first two positions of importance confirms the relevance of the use of *kudeme* in the preparation of *agbelima* - the objective of which is to improve texture, colour and flavour (Budu, 1990; Lartey, 1993). It was expected that acidity, being the most often used indicator for the degree of fermentation, would have emerged as an important attribute, but this was not so. Thus, acid formation may be an unavoidable consequence in the attempt to improve texture and colour of *agbelima* by fermentation, rather than a desirable objective of fermentation. Also, the function of the *kudeme* in improving flavour may be more specific in terms of aroma improvement rather than imparting sourness (taste) to the product. The acids formed may, therefore, be more important in improving aroma than taste.

Table 2 shows the range of values for the objective analysis of the market samples from which four were selected for the sensory evaluation. The parameters which showed wide variations were particle size and uniformity index (CV = 0.752 and 1.098, respectively), whilst the L* and H° parameters of colour had the smallest

variations (CV = 0.008 and 0.019, respectively). Objective and subjective data for the selected samples are shown in Tables 3 and 4. Table 5 shows the correlation between the objective data and subjective data. The results showed an excellent correlation between total titratable acidity, pH, b* and C* (parameters of colour) and sensory attributes. In the correlation of objective and sensory data, a correlation coefficient of 0.90 and above is considered an excellent indicator of human evaluation, whilst a value of less than 0.80 is unsatisfactory (Krammer and Twigg, 1962).

Table 2

Market Sample Analysis - Range of Values for Specified Parameters

Parameter		Range of Values		Mean	CV**
		Min.	Min.		
Colour:	L*	87.66	91.03	90.07 (0.721)	0.008
	a*	-0.16	-1.74	-1.11 (0.458)	0.414
	b*	+11.42	+17.09	+13.69 (1.489)	0.109
	H*	90.76	96.95	94.36 (1.820)	0.019
	C*	11.46	17.16	13.73 (1.508)	0.110
Acidity:	TTA[1](%)	0.685	1.390	1.139 (0.185)	0.162
	pH	3.79	4.26	3.99 (0.108)	0.027
Texture:	Particle Size	0.127	0.184	0.153 (0.115)	0.752
	Uniformity Index	0.051	0.800	0.143 (0.157)	1.098

Table 3

Objective Measurements for Colour, Acidity and Texture of Selected Samples

Sample	Colour					Texture		Acidity	
	L*	a*	b*	H°	C*	PS	UI	TTA(%)	pH
A	90.65	-1.51	+13.77	96.26	13.85	0.153	0.125	0.685	4.26
B	90.15	-0.54	+11.45	92.70	11.46	0.148	0.088	1.350	3.89
C	89.26	-0.43	+12.82	91.92	12.83	0.154	0.093	0.980	4.06
D	90.87	-1.25	+14.46	94.94	14.51	0.156	0.097	1.190	3.89

PS = Average Particle Size UI = Uniform Index

Table 4

Sensory Evaluation of Selected Samples - Rank Totals for Individuals Attributes and Overall Preference

Samples	Attribute Scores			Preference Scores
	Colour	Smoothness	Sourness	
A	64	109	53	95
B	137	113	111	105
C	86	73	88	86
D	73	65	106	74

Table 5

Correlation between Subjective and Objective Measurements

Subjective Parameter	Objective Parameter	Correlation	
		r	r^2
Colour	L*	0.30	0.09
	a*	0.71	0.51
	b*	0.92	0.84
	C*	0.92	0.84
	H°	0.65	0.42
Smoothness	Particle Size	0.82	0.68
	Uniformity Index	0.32	0.10
Sourness	Total Titratable Acidity	0.98	0.96
	pH	0.99	0.98

Table 6

Partial Regression Coefficients from Multiple Analysis of Preference Scores with Attribute Scores

Attributes	Correlation With Overall Preference	
	Partial Regression Coefficients	% (Rounded)
Sourness	0.580	15
Smoothness	1.558	40
Colour	1.754	45

The perfect correlation between total titratable acidity and pH with sourness is not surprising, since the taste modality of sourness is elicited by acid conditions or H+ions (Guyton, 1991; Jenkins, 1978). The +b parameter of the Hunter L*a*b* colour system is an indicator of the degree of yellowness (Penfield and Campbell, 1990) in the product. Its perfect correlation with human evaluation of colour shows that the colour of the product is judged principally by the degree of yellowness rather than by whiteness (L*) or the degree of greenness (-a*). The C* parameter of the L*C*H° colour system, which indicates psychometric chroma (McLaren, 1980), represents the intensity of the colour hue resulting from the combined effect of the two colour shades of yellow (+b*) and green (-a*) in the product. Its perfect correlation with sensory scores reflects the predominance of the yellow shade over the green in influencing human evaluation. It is possible, however, that because of the small variations in the L* and H° values for the screened samples, the selected samples did not reflect enough differences to enable effective ranking of the products during sensory evaluation, and hence, the lack of correlation. This explanation would, however, not be valid for the a* parameter, since it showed a wider variation than even the b* and C* parameters, which correlated perfectly.

The correlation between particle size and human evaluation of smoothness, though not excellent, is satisfactory. This buttresses the fact that particle size is an adequate measure of kinaesthetic property (Stewart and Amerine, 1982); and could, therefore, be conveniently applied in the assessment of *agbelima* texture.

Conclusion

It is clear from the results, that the six most important sensory attributes of *agbelima*, from the viewpoint of both consumers and producers, are: colour, smoothness, starchiness (cohesiveness), sourness, aroma and degree of wetness. Of the three attributes investigated, the most important in determining product acceptability was colour, followed by smoothness, then sourness. The most adequate objective indicators for colour were the b* and C* parameters. Smoothness was most satisfactorily measured by the average particle size. With respect to sourness, both total titratable acidity and pH were excellent indicators. Investigations are continuing to

establish the importance of the other attributes relative to these three; and to identify adequate objective indicators for these as well. The optimum levels of all attributes for acceptability is also under investigation.

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