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QUALITY ASSESSMENT OF FERMENTED CASSAVA DOUGH (*AGBELIMA*) ON GHANAIAN MARKETS

N.T. Dziedzoave†, W.O. Ellis, I. Oduro. and J.H. Oldham,.
†Council for Scientific and Industrial Research, Food Research Institute, (CSIR-FRI),
P.O. Box M 20, Accra, Ghana
Department of Biochemistry, Kwame Nkrumah University of Science & Technology,
Kumasi, Ghana

ABSTRACT

In order to provide baseline data for developing standards for cassava fermented dough (*agbelima*) and standardizing the production process, an investigation was conducted to determine the extent of variation in certain quality indices of *agbelima* from various selected markets. Objective assessment of the chemical, textural and colour indices of twenty samples of *agbelima* purchased from five different markets were carried out. Significant differences in moisture content ($p < 0.01$), pH ($p < 0.01$), uniformity index ($p < 0.01$) and a* ($p < 0.05$) were observed between samples from different markets. No significant differences were observed with respect to total titratable acidity, starch content, fineness modulus, average particle size and the other colour parameters. Variations between samples from the same markets were very minimal except for the uniformity index which showed wide variations.

1. INTRODUCTION

The development and revision of quality standards for food products requires a thorough study of the food products, which could be in the form of a market assessment of the product's quality or an evaluation of product quality at the point of production or both [1]. Information obtained from such a study could form the basis for a preliminary draft of standards for discussion with stakeholders. Such information could also provide a useful fundamental knowledge for process improvement as shown in a market survey of cassava foods in Sierra Leone [2].

Agbelima is a traditional fermented cassava product produced in Ghana. The production involves the use of an inoculum traditionally called *kudeme*. In recent times the product has attracted significant research attention due to its increasing demand and export potential. Most of the studies have centered on the types and characteristics of the inoculum used during fermentation, the microorganisms involved in the fermentation and the dehydration of the product [3, 4, 5, 6, 7, 8]. These studies have established the existence of different types of inocula with varying characteristics and effects and the presence of some volatile compounds in both the fresh and the dehydrated product [8].

The production of *agbelima* may involve the use of a variety of cassava cultivars and different processing methods that differ in some of the finer details like fermentation time, mode of inoculum preparation, quantity of inoculum added and time of addition of the inoculum. These differences in processing methods are likely to result in variations in the quality of the product that is finally put on the market. An investigation of the extent of variation in the market quality of the product would provide baseline data for developing quality standards for *agbelima*.

Thus the objectives of this study are to determine whether significant differences exist in quality between *agbelima* samples from different markets in Ghana and to assess the extent of variation between samples from the same market.

2. MATERIALS AND METHODS

2.1. Determination of Sample size

The sample size used for the study was 20, and this was determined using the method [9, 10] based on a population mean of 0.923 and standard deviation of 0.199 obtained from a previous sample. A precision level of 10 % and a probability of 5 % were used in the estimation.

2.2. Sampling procedure

The Accra-Tema Metropolitan Area was used as the focal point for the study. Five markets were selected by means of a cluster sampling procedure. The metropolitan area was divided into 5 distinct zones; North, South, East, West and Central. One principal market in each zone was selected for product sampling. The markets selected were Ashiaman, Mallam-Atta, Mamprobi, Madina and Agbogbloshie. Four sellers were selected from each market by a systematic sampling procedure and the *agbelima* samples purchased from these sellers were used for the analyses.

2.3. Moisture content

A 2 g sample of *agbelima* from each of the sellers was transferred into a previously dried and weighed dish. It was then dried in a Genlab Mido/3/ SS/F oven at 105 °C for 18 h. Moisture content was determined by difference in weight using the conventional formula.

2.4. pH

A slurry of agbelima was made by mixing 5 g of sample with 50 ml of distilled water. The pH of the slurry was determined using a Corning pH meter (model 240).

2.5. Total Titratable Acidity

A quantity of 18 g of *agbelima* was made into a slurry in 200 ml of distilled water (CO_2-free) in a flask, which was loosely stoppered, placed in a water bath at 40 °C and shaken for 1 h. The slurry was filtered through dry filter paper (Whatman No. 1). A 100 ml volume of the filtrate was titrated with 0.2 M NaOH using phenolphthalein as indicator. Total titratable acidity was calculated as percent lactic acid.

2.6. Colour

Based on the CIELAB color system, the colour of the samples was determined using the Minolta Chromameter CR 200; which was calibrated with a standard white tile code of L* = 97.63 (White), a* = -0.48 (Green tint), b* = +2.17 (Yellow).

2.7. Starch content

The starch content of the samples was determined by the Anthrone colorimetric method [11].

2.8. Sieve Analysis (Average particle size)

Hendersen and Perry method of sieve analysis for dry flours [12] was modified to suit the wet *agbelima* samples being investigated. A 100 g of the sample was washed down a set of graded Tyler sieves with 10 l of distilled 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 2h; cooled and weighed. The dry matter content of the cassava dough was determined and used to estimate the amount of sample that would otherwise have collected in the pan. The results were used to calculate the fineness modulus from which the average particle size (mm) was calculated according to the method of Henderson and Perry [12]. The uniformity index was calculated as the ratio of the weight fractions retained above the 0.5 mm sieve to the sum of weight fractions passing through it.

2.9. Statistical Analysis

Analysis of variance (ANOVA) was made on the data obtained using the Microsoft Excel software. All analyses were carried out in triplicate.

3. RESULTS AND DISCUSSIONS

The results showed a highly significant difference ($p < 0.01$) in moisture content between *agbelima* samples from Mamprobi market and the other markets. The extent of variation between samples from the same market was very low (c.v. = 0.03 - 0.04) as shown in Table 1, implying a high degree of uniformity between samples from the same market.

There were no significant differences in the total titratable acidity of *agbelima* samples from the different markets. However, the extent of variation between samples from the same market were slightly higher for total acidity (c.v. = 0.05-0.19) relative to the moisture content. The largest variations were observed for samples from Mamprobi market and the lowest for samples from Ashiaman market. The overall average total titratable acidity expressed as lactic acid was 1.14 %. Unlike total titratable acidity, pH values for samples from Mamprobi market were significantly different ($p<0.05$) from those of the other markets, but variations between samples from each of the individual markets were very low (c.v. = 0.01 - 0.03).

The starch content of samples from the various markets were not significantly different. The extent of variation in starch content of samples (c.v. = 0.02 - 0.08) was low compared to that of the total titratable acidity. The average starch content was 57.80 %.

The apparent uniqueness of samples from Mamprobi market with respect to moisture content and pH may be attributed to the fact that traders in this market possibly obtained the supplies from a source different from the other markets. The differences in the source of supply brought about differences in the variety of cassava used for production since cassava varieties cultivated differ from area to area. Studies have shown that varietal differences have a significant effect on the quality attributes of various cassava based products. The swelling capacity, garification rate and other quality attributes of gari vary depending on the variety of cassava used for processing [13]. It has also been reported that the texture of pounded cassava fufu is very much affected by differences in cassava variety [14]. Ellis et.al. [7] have reported that the interaction between varietal differences and processing method significantly affected the performance of *kudeme* in *agbelima* production.

With the exception of uniformity index which showed highly significant differences ($p < 0.01$), the textural characteristics of the samples from the different markets (Table 2) showed no difference with respect to both fineness modulus and average particle size. Variations between samples from the same market were relatively low (c.v. = 0.03 - 0.27). The uniformity index, which describes the ratio of medium size particles to small particles differed for all market samples with Mallam-Atta market having the lowest value (0.07) and Ashiaman market the highest (0.25). Samples from Agbogbloshie market were much more similar (c.v. = 0.10) than those from the other markets (c.v. = 0.30 - 1.50) in uniformity index. The extremely high variation in the uniformity index of samples from Ashiaman market may be attributed to the mode of processing. *Agbelima* is produced by different processors using different cassava varieties and different processing methods, which differ in fermentation time, mode of inoculum preparation and quantity of inoculum added [15, 4, 16]. The differences in processing techniques together with variations in aperture sizes of graters are likely to result in variations in the texture characteristics of the final product.

Table 3 shows the colour characteristics of the *agbelima* samples from the five different markets. The results show that colour of a sample is basically a blend of white (L*) and yellow (+b*) with a slight tint of green (-a*). The purity of the green tint is low whilst that of the yellow is relatively high. All the colour parameters with the ex-

Table 1. Chemical characteristics of *agbelima* from different market surveys

Market	Moisture (%)**		Total Titratable Acidity (%) ns		pH*		Starch (%) ns	
	Mean ± σ	C.V.	Mean ± σ	C.V.	Mean ± σ	C.V.	Mean ± σ	C.V.
Mamprobi Market	45.56± 1.60	0.03	0.89 ± 0.17	0.19	4.11 ± 0.11	0.03	47.84 ± 3.96	0.08
Agbogbloshie Market	51.67± 1.32	0.03	1.19 ± 0.16	0.13	3.93 ± 0.09	0.02	51.72 ± 3.14	0.06
Mallam Atta Market	51.01± 1.45	0.03	1.18 ± 0.09	0.08	3.96 ± 0.10	0.03	57.98 ± 1.01	0.02
Madina Market	51.17± 1.91	0.04	1.33 ± 0.17	0.13	3.91 ± 0.09	0.02	55.04 ± 2.03	0.04
Ashiaman Market	50.30± 1.85	0.04	1.10 ± 0.05	0.05	4.04 ± 0.06	0.01	56.40 ± 1.10	0.02
Overall	**49.94± 2.71**	**0.05**	**1.14 ± 0.19**	**0.16**	**3.99 ± 0.11**	**0.03**	**57.80 ± 4.34**	**0.08**

Legend: ns (not significant), * Significant ($p<0.05$), ** High significant ($p<0.01$), σ (Standard deviation)

Table 2. Textural characteristics of *agbelima* from different markets

Market	Fineness Modulus (ns)		Average Particle Size (mm) (ns)		Uniformity Index**	
	Mean ± σ	C.V.	Mean ± σ	C.V.	Mean ± σ	C.V.
Mamprobi Market	0.617 ± 0.09	0.144	0.160 ± 0.01	0.056	0.161 ± 0.05	0.304
Agbogbloshie Market	0.566 ± 0.05	0.081	0.155 ± 0.01	0.032	0.098 ± 0.01	0.102
Mallam Atta Market	0.517 ± 0.05	0.103	0.150 ± 0.01	0.033	0.073 ± 0.04	0.607
Madina Market	0.618 ± 0.14	0.227	0.161 ± 0.02	0.099	0.116 ± 0.05	0.474
Ashiaman Market	0.421 ± 0.11	0.273	0.140 ± 0.01	0.071	0.246 ± 0.37	1.504
Overall	**0.549 ± 0.11**	**0.205**	**0.153 ± 0.11**	**0.752**	**0.143 ± 0.16**	**1.098**

Legend: ns (not significant), * Significant ($p<0.05$), ** High significant ($p<0.01$), σ (Standard deviation)

Table 3. Colour characteristics of agbelima from different markets

Market	L		a*		b^{ns}	
	Mean ± σ	C.V.	Mean ± σ	C.V.	Mean ± σ	C.V.
Mamprobi Market	90.40 ± 0.36	0.00	-1.38 ± 0.01	0.16	+13.31 ± 1.46	0.11
Agbogbloshie Market	90.17 ± 0.68	0.01	-0.81 ± 0.39	0.48	+13.18 ± 1.35	0.10
Mallam Atta Market	90.14 ± 0.53	0.01	-0.76 ± 0.26	0.34	+13.39 ± 1.43	0.11
Madina Market	90.02 ± 0.33	0.00	-1.54 ± 0.16	0.00	+15.19 ± 1.90	0.13
Ashiaman Market	89.62 ± 1.42	0.02	-1.04 ± 0.68	0.65	+13.39 ± 1.19	1.09
Overall	**90.07 ± 0.72**	**0.01**	**-1.11 ± 0.46**	**0.41**	**+13.69 ± 1.49**	**0.11**

Table 4. Market quality ranges for specified parameters

Quality Attribute	Measured parameter	Range of Values		Mean ± σ	c.v.**
		Min	Max		
Texture	F.M.‡	0.28	0.72	0.55 ± 0.11	0.20
	Av. Particle Size	0.13	0.18	0.15 ± 0.11	0.75
	Uniformity Index	0.05	0.80	0.14 ± 0.16	1.10
Acidity	TTA#	0.68	1.39	1.14 ± 0.18	0.16
	pH	3.79	4.26	3.99 ± 0.11	0.03
Colour	L*	87.66	91.08	90.07 ± 0.72	0.01
	a*	-0.16	-1.74	-1.11 ± 0.46	0.41
	b*	+11.42	+17.09	+13.69 ± 1.49	0.11
	c*	11.46	17.16	13.73 ± 1.51	0.11
	H°	90.76	96.95	94.36 ± 1.82	0.02
Starchiness	Starch Content(%)	42.15	58.80	57.80 ± 4.34	0.08
Wetness	Moisture Content (%)	44.06	52.63	49.94 ± 2.71	0.05

*Legend: ‡ (Fineness Modulus); # (Total titratable acid); ** (Coefficient of variation)*

ception of the a* parameter, showed no significant difference ($p < 0.05$) between samples from the different markets. However, the value of a* parameter for *agbelima* samples from the Agbogbloshie and Mallam-Atta markets were not very different.

Variations between samples from the same market was also high for a* relative to the other colour parameters. The largest variation was observed for samples from Ashiaman market and the least for samples from Madina market. Previous investigations have shown that the preferred colour for *agbelima* was white or cream [15]. Thus, the fact that the colour of the market samples did not vary with respect to the preferred colours but rather with the green colour (Table 3) suggests that the green colour is what is easily influenced. This effect is observed during production, storage and marketing and its effect on the preferred colours reduces the brightness of these colours. This results in the variations observed in the overall colour of the *agbelima* samples.

The maximum and minimum ranges of each of the monitored parameters and the extent of variation is presented in Table 4.

The data showed that parameters with extensive variations were the uniform index (c.v. = 1.10), average particle size (c.v. = 0.75) and the a* parameter (c.v. = 0.41) respectively. All the other parameters showed minimum variations.

4. CONCLUSIONS

The results of this study has revealed that significant differences in quality as measured by moisture content ($p < 0.01$), pH ($p < 0.05$), uniformity index ($p < 0.01$) and degree of greenness (-a*) ($p < 0.05$) existed between samples from the different markets. However, there were no differences with respect to total titratable acidity, starch content, fineness modulus, average particle size and the L* and b* colour parameters. There were relatively very little variation between samples from the same market except for the uniformity index which showed wide variations. The highest overall variation between samples was observed for the uniformity index (c.v. = 1.10) and average particle size (c.v. = 0.75); whilst the lowest, was observed for the L* colour parameter

(c.v. = 0.01). On the whole, the differences observed did not seem to be very pronounced. However, an investigation of the relative importance of the various quality indices in determining product acceptability would help establish whether the differences observed in moisture, pH, uniformity index and a* are important or not. Also the evaluation of a wide range of cassava varieties for processing into *agbelima* and the different processing conditions applied, would help to establish the sources of the observed differences in quality.

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