

Process Development for Steamed Rice 'Aboloo'; a Traditional Sweetened Snack Food in West Africa

Mensah AA¹, Johnson PNT^{1, 2*}, Sakyi-Dawson E¹ and Saalia FK¹

¹Department of Nutrition and Food Science, University of Ghana, Legon, Accra, Ghana

²Department of Agro-processing Technology and Food Biosciences, CSIR- College of Science and Technology, Ghana

***Corresponding author:** PNT Johnson, Department of Agro-processing Technology and Food Biosciences, University of Ghana, Legon, Accra, Ghana, Tel: +233244601763; E-mail: paanii.johnson@gmail.com

Research Article

Volume 2 Issue 4

Received Date: September 02, 2017

Published Date: October 18, 2017

Abstract

This study aimed at developing a process for using local Ghanaian rice varieties to produce Aboloo; a traditional sweetened snack normally prepared from maize. Ten traditional producers of aboloo were interviewed to determine the critical unit operations and factors used in the preparation of aboloo to aid in process optimization. Consumer preference attributes for both baked and steamed aboloo were determined by interviewing 100 consumers using a semi-structured questionnaire. The magnitude of the preference for each attribute was determined using a 5 point scale (maximum = 5, minimum = 1). Critical unit operations identified that affect the quality included dehulling, soaking and fermentation. These unit operations were perceived by processors to affect the colour and texture of the final product. Four locally produced rice varieties, Beauty, Jasmine 85, Local Perfumed and Togo Marshall, were used for the process development of rice aboloo. For each rice variety, ten composite flour formulations involving rice, maize and wheat flour were made using the extreme vertices design. Sensory evaluation was carried by a trained panel to evaluate rice aboloo samples made from the four rice varieties. Rice aboloo made from Jasmine 85 with composite flour of 55% Jasmine85 rice: 40% maize: 5% wheat flour was found suitable for producing rice aboloo because the subsequent consumer acceptability test carried out on the developed steamed rice aboloo products was found to have the best desirable textural and sensory attributes.

Keywords: Rice varieties from Ghana; steamed rice; Aboloo; Sensory parameters of aboloo

Introduction

Rice is one of the most widely consumed and produced food crops in the world contributing to more than 60% of the world's food. It constitutes a major staple food for about some 4.5 million people in developing countries

namely in Asia, Africa, and Latin America [1]. In sub-Saharan Africa, the consumption of rice is higher than the local production making it necessary for large imports in order to bridge the gap in demand. This is even the case although there has been a tremendous increase in production over the past 50 years from about 3.14 million

metric tons to 14.60 million tonnes [2]. In Ghana, the production and consumption of rice has increased over the past few years. Rondon and Ashitey [3] reported an estimated increase in the production of rice from 295,000 metric tonnes in 2011/2012 to 310,000 metric tonnes in 2011/2012. This assertion was further strengthened by Bam et al. [4] who reported that the per capita consumption of rice is 45kg per year with this consumption rate increasing at a rate of 9% annually, and peaking at an expected rate of 64% in 2015.

In Ghana, as well as in most parts of the world, rice is usually eaten as milled or white rice which is obtained by the removal of the outer hull and bran layer of the rice paddy [5], Diako et al. [6] asserted that in Ghana rice is eaten in a number of forms namely as joll of rice (white rice cooked usually in tomato stew), rice balls (eaten with soup), rice porridge (partially broken or complete rice grains cooked in plenty of water), fried rice, and plain-cooked rice.

In spite of the increased production and consumption of rice in Ghana, patronage of locally produced rice is low. This has been attributed to the poor milling qualities, presence of stones, broken, discolored, and shriveled grains, poor nutritional quality, and the relative unavailability of the locally grown rice on the open market [6]. Poor packaging and the acquired taste for imported perfumed rice by most Ghanaians has added to the already low patronage of the local rice. This is affecting the returns of rice value chain actors. One method to solve the problem will be to utilize this broken rice in the commercial production of local convenient foods. One of such foods is “aboloo”. ‘Aboloo’ is a sweet steam-cooked or baked ‘bread’ (cereal product) which is mainly produced from dehulled maize of low moisture content, and free from adulteration. It is usually eaten with fried or dried anchovies by Ghanaian especially among communities along the Volta River, and also in some parts of the Central Region of Ghana where it is preferred baked instead. This study therefore aimed at developing an optimized processing method for aboloo made from local Ghanaian rice.

Materials and Methods

Materials

Four local rice cultivars: Jasmine 85, Togo Marshall, Local Perfumed and Beauty were obtained from the

Ghana Rice Inter-professional Body (GRIB). Of the four local varieties, three were aromatic types (that is, Jasmine 85, Togo Marshall, and Local Perfumed) whereas Beauty was a non – aromatic rice type. About 5kg of white dent maize (“Aburotia” or Tuxpeno P.B. C16) was also obtained from the producers of aboloo and used in the study. White maize is traditionally used in Ghana for the production of aboloo as it adds to the colour and appearance of the product.

Initial Consumer and Producer Surveys

A semi-structured questionnaire was used to interview a convenient sample of 100 willing respondents in communities where aboloo is widely consumed in the Accra Metropolis (Banana Inn and Madina) and Winneba Junction (in the Effutu Municipal District) in the Central Region of Ghana to determine the consumer preference for either steamed or baked aboloo. Their perceptions on the various attributes of what constituted good quality aboloo were determined and the magnitude of the preference for each attribute determined using a 5 point scale (maximum = 5, minimum = 1). Ten producers of aboloo (6 producers of steamed aboloo and 4 producers of baked aboloo) were then interviewed to determine the critical unit operations and factors in aboloo preparation to aid in process optimization.

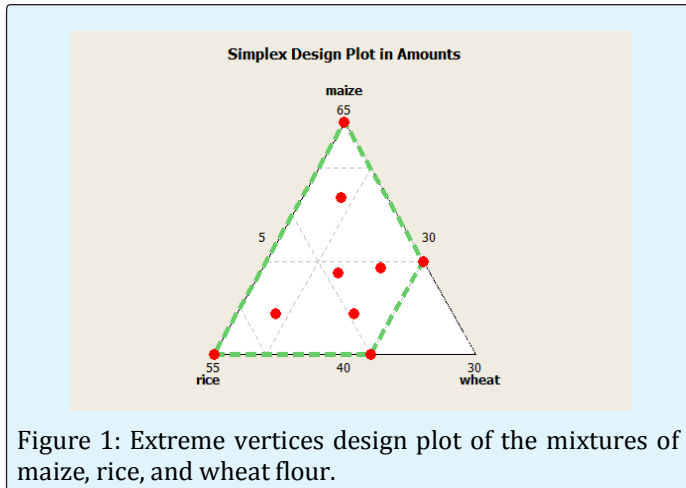
Steps Used in the Process Development of the Rice “Aboloo”

Use of Mixture Design to obtain Optimized Composite Flour from Rice for Aboloo Production

After the initial consumer and producers surveys, nine composite flour formulations used each of the four rice varieties were made with the help of mixture design (Minitab version 16). The ranges of maize, rice and wheat flour used in the mixture design are shown in (Table 1) and the extreme vertices design obtained in shown in (Figure 1)

Component	Lower Value (%)	Higher Value (%)
Maize	40	65
Rice	30	55
Wheat Flour	5	20

Table 1: Range of values for maize, rice, and wheat used for preparation of the mixture design.



Production of the Steamed Rice "Abollo"

(Figure 2) gives the processing steps used in the production of the rice abollo. From the survey of the processors, special attention was paid to the dehulling, soaking with (i.e. tempering) and the fermentation unit operations. These three units operations were identified as being very critical by the producers of abollo because they affected the colour and texture of the finished products. These factors were therefore experimentally varied using the mixtures design (Minitab version 16) to optimize the process.

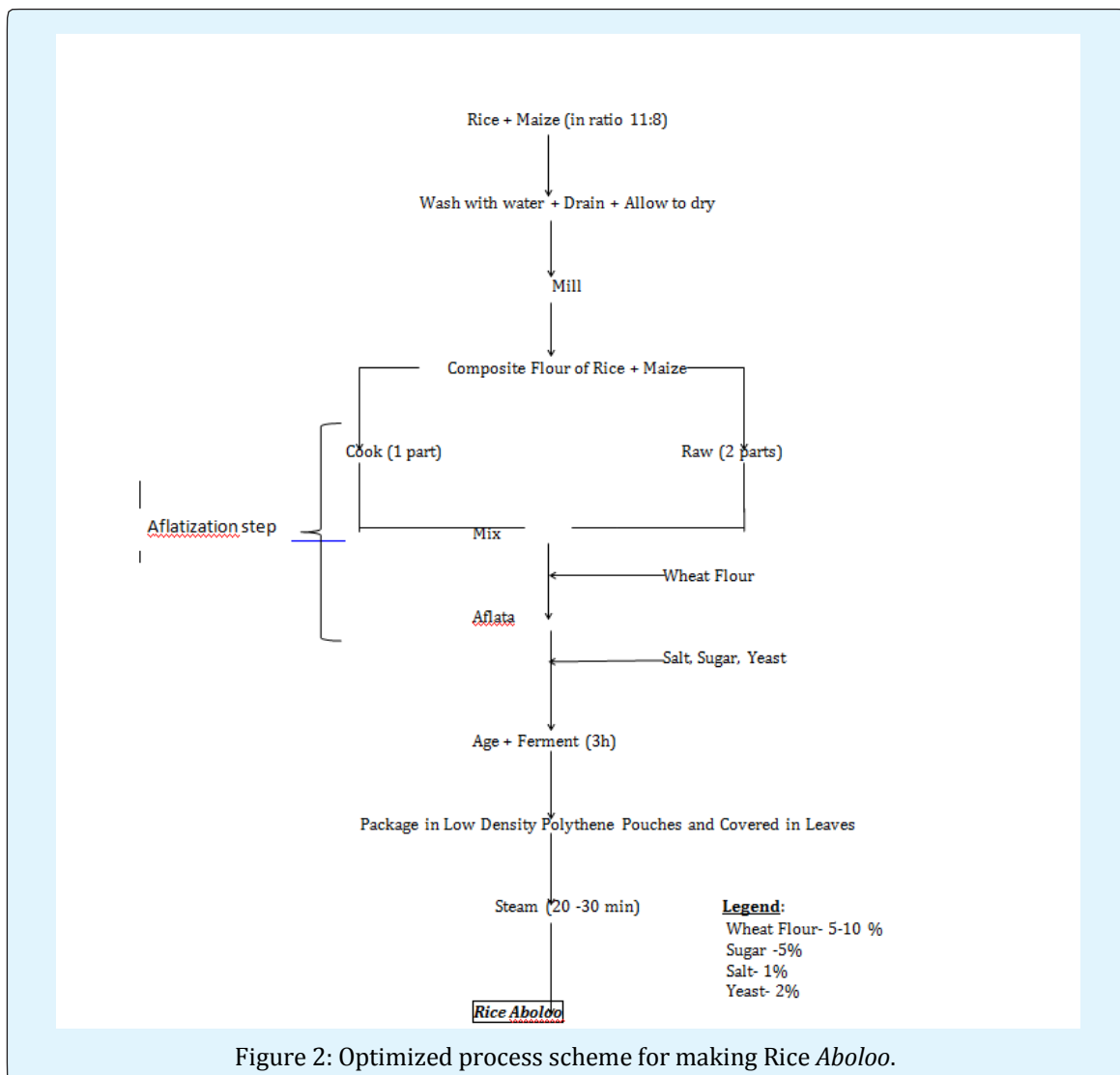




Figure 3: Picture of Rice Abollo.

Sensory Analysis

Fifteen trained panelists were used to evaluate the sensory attributes colour, appearance, aroma, taste, hardness, mouth feel, and overall acceptability prepared steamed rice abollo samples using a 9-point hedonic scale (1= dislike extremely and 9 = like extremely). A balanced incomplete block design ($t = 10$, $b = 15$, $r = 6$, $N = 60$, $k = 4$, $\lambda = 2$) described by Cochran and Cox (1957) was used to determine these sensory attributes of the rice-maize abollo mix since it would be difficult for an individual consumer to evaluate 10 different samples ($t = 10$) at a time. Each of the fifteen panelists were presented with four coded samples ($k = 4$) each time to assess.

Consumer Acceptability Liking Test

The sensory evaluation established the rice abollo made from Jasmine rice variety was most likeable product. A final consumer acceptability liking test, involving 50 people, was therefore carried out on this production the communities where the initial consumer surveys were done.

Results and Discussion

Patronage of Abollo

The results of the consumer survey as indicated in (Table 2) shows that more than half of the respondents (about 85 %) were regular consumers of abollo. Although similar numbers of respondents were interviewed in each locality where steamed abollo was popularly consumed (Banana Inn $n = 51$) and where baked abollo too was

widely consumed (Winneba Junction $n = 49$), 74% of the respondents preferred steamed abollo to baked abollo. Migration, employment, schooling and cultural diversification affect the choice of foods of a greater number of the population. This suggests that majority of the respondents were familiar with steamed abollo as compared with baked abollo due to the reasons given earlier. This observation is in agreement with observations made by Popkin et al. [7] and Shepherd [8]. They argue that the choice of foods by consumers was affected by economic and social factors, food prices, the physical environment, cultural diversification, and education. It comes as no surprises then that most of the responses given for the respondents' preference for either steamed or baked abollo were their availability/popularity of the traditional sweetened bread in their locality.

Variable	Number (%)
<i>Frequency of consumption</i>	
Sometimes	35 (35)
Frequently	50 (50)
Once a month	6 (6)
More than once a month	4 (4)
Seldom	5 (5)
Total	100 (100)
<i>Which of the two kinds of abollo do you prefer?</i>	
Steamed Abollo	74 (74)
Baked Abollo	26 (26)
Total	100 (100)
<i>Reasons for Preference</i>	
Better Texture/ Softer	25 (25)
Popular/ Availability	48 (48)
Nice and Tasty	23 (23)
Dry and Hot	3 (3)
Traditional	1 (1)
Total	100 (100)

Table 2: Abollo patronage patterns in some selected localities in Ghana ($n = 100$).

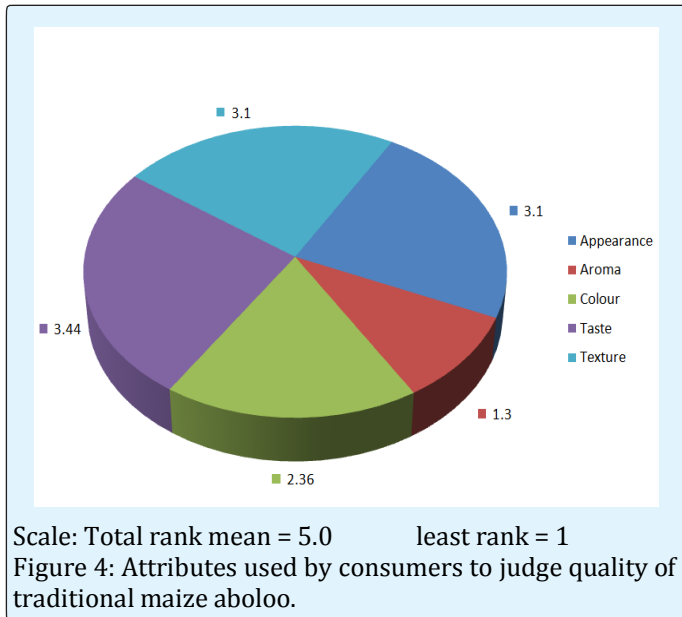


Figure 4: Attributes used by consumers to judge quality of traditional maize abollo.

Optimizing the unit operations for producing rice abollo

One of key intermediate product during the production of abollo is the aflata as described by Fadahunsi et al. [9] and Annan et al [10]. The aflata of the abollo is made using 5% yeast previously fermented dough, initially fermented with yeast as done by the traditional maize abollo. It was found that when fermented for 6 h, as done for the maize abollo, the resulting rice abollo became rather wet and soggy product with slight alcohol aroma. This was an indication of over-fermentation. Further laboratory trials helped to establish that fermentation of the aflata, using 2 % yeast and for 4 h gave the best aflata used subsequently for the final production of the rice abollo.

Sensory evaluation of Abollo made using the different rice varieties

(Figure 5) shows a summary of the sensory evaluation. As indicated, the Rice Abollo made from Jasmine 85 scored the best attributes in terms of all the key parameters. Even though Abollo from Togo Marshall Rice variety had the highest acceptability and mouth feel, it had a relatively low rating for colour. In relation to abollo, appearance refers to uniformity in pore sizes and pore homogeneity of the crumb. In terms of colour Jasmine85 had the highest consumer rating. The colour of milled rice is affected by the storage conditions and the degree of milling [11], [12]. This presupposes that Jasmine85 may have undergone better milling conditions than the other local rice cultivars, hence its enhanced

colour or whiteness. A criterion used for eliminating samples from a lot during sensory analysis is the 'overall acceptability'. Phang and Chan [13] used the 'overall acceptability' to distinguish between the consumer preference for kaya ("a popular local spread with jam-like consistency, is prepared by processing egg, sugar and coconut milk and may contain edible starch") and kaya partially substituted with insulin. The overall acceptability of abollo from the local rice cultivars was highest for Jasmine 85 with a value of 6.58; Togo Marshall was next with value of 6.1. Abollo from Beauty rice type was least liked overall. Based on this assertion Jasmine 85 was used for preparing abollo.

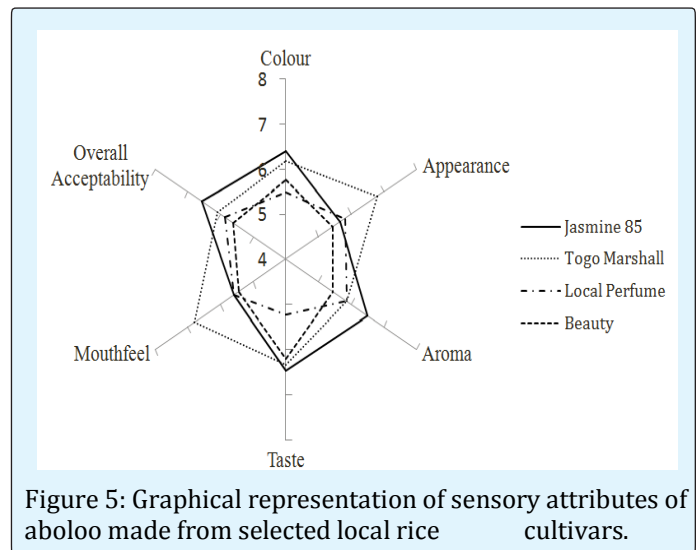


Figure 5: Graphical representation of sensory attributes of abollo made from selected local rice cultivars.

Consumer acceptability for abollo made from mixtures of maize, rice, and wheat flour

A consumer acceptability test of the abollo made from mixtures of maize, rice, and wheat flour was done to determine which mixture was most preferred in terms of its sensory attributes. Abollo from mixture 1 (40% maize, 55% rice, and 5% wheat flour) had the highest ratings for all the sensory attributes. At a p-value of < 0.05, the colour, hardness, and overall acceptability were significantly different among the various mixtures. Carreresetal [14] asserted that the texture of a food material together with its appearance affects the overall consumer acceptability of the food material. This was observed in the consumer acceptability ratings of the sensory analysis in this research as the colour (appearance), hardness (in this case softness) and the overall acceptability were significantly different at $p < 0.05$ (Table 3).

Results from (Figure 3) on the initial consumer survey interviews suggested that the taste was considered more

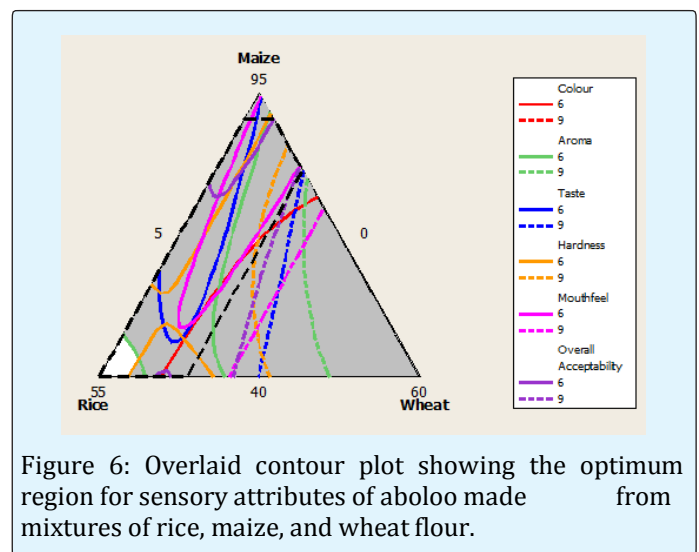
important than the aroma than for preference of abollo. However in the consumer acceptability tests of the abollo made from mixtures of maize, rice and wheat flour no significant differences were observed between the taste and the aroma of the different abollo samples. Spence [15] asserted that many sensory panelists experienced ambiguity and sometimes difficulty in distinguishing between taste and aroma, especially when the food product is made from similar products. The different types of abollo made from the different mixtures of rice, maize, and wheat although having different compositions

may give the same aromatic notes when smelled by panelists but with different intensities of perception. A similar study by Champagne et al [16] on the sensory properties of rice showed no significant difference ($P < 0.1$) in the flavour (aromatics, taste, mouth feel) of cooked premium and second best rice varieties from Japan, India, and Brazil. This may support also the observation of no significance ($P < 0.05$) between the taste and aroma of the different abollo made from the mixtures of rice, maize and wheat from (Table 3).

Sample	Rank Sum					
	Colour	Aroma	Taste	Hardness	Mouth feel	Overall Acceptability
Mixture 1	47	42	47	43	48	49
Mixture 2	33	36	38	33	41	39
Mixture 3	40	28	34	31	42	39
Mixture 4	31	36	38	41	40	42
Mixture 5	35	36	33	28	39	33
Mixture 6	40	34	40	39	41	44
Mixture 7	35	33	36	36	35	35
Mixture 8	45	35	37	42	39	42
Mixture 9	39	33	38	38	34	39
Mixture 10	39	38	40	39	32	36
p-value	0.015	0.797	0.429	0.04	0.125	0.037

Table 3: Mean scores for consumer acceptability of sensory attributes of abollo from mixtures of rice, maize, and wheat flour.

Using the responses from the scores of the consumer acceptability test an overlaid contour plot was drawn to determine the optimum regions for the mixtures of maize, rice, and wheat flour that would be best for preparing abollo with desirable sensory qualities. Using a scale of 6 (like slightly) on the hedonic scale as the lower limit and 9 (like extremely) an overlaid plot in (Figure 6) was obtained from the sensory attributes colour, aroma, taste, hardness, mouth feel and overall acceptability. The scores for liking were superimposed to obtain the contour plot in (Figure 6). It can be noticed that an optimum region (white area) close to 55% rice was obtained.



Conclusion

Regular consumers of abollo preferred steamed abollo to baked abollo due to its availability, and softer texture. Results from the sensory analyses conducted on both the abollo made from only rice and wheat flour, and abollo made from a composite mixture of rice, maize and wheat flour show that the use of locally produced Ghanaian rice can be diversified when it is incorporated in the abollo making process. Steamed abollo from Jasmine85 rice cultivar yielded the most favorable results among the selected local rice varieties. A mixture of 55% rice, 40% maize and 5% wheat flour is the optimum mix for making steamed rice abollo.

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