

Investigatory study on the qualities of locally grown Rice brands sold in main markets of Abeokuta, South-Western Nigeria

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Abstract

Qualities of some selected rice varieties sold in the main markets of Abeokuta, the capital of Ogun State where rice is mostly grown and consumed in the south-western part of Nigeria was investigated. Rice (Aroso, Mokwa, Royal niger, Orlam and Ofada rice) were evaluated for their physical, chemical properties and sensory qualities using established laboratory procedures. The average width of the rice ranged from “0.261 to 0.268 mm”, “0.260 to 0.265 mm”, “0.260 to 0.262 mm”, “0.269 to 0.270 mm”, and “0.271 to 0.275 mm” respectively. The rice average lengths ranged between “0.346 to 0.350 mm”, “0.365 to 0.368 mm”, “0.356 to 0.359 mm”, “0.357 to 0.357 mm” and “0.365 to 0.379 mm” respectively. The physical appearance of the rice investigated ranged from good to very good except for mokwa and orlam rice which shows fair colours. Chemical properties of the rice samples ranged from 10.21 to 11.97%, 0.83 to 2.62, 1.89 to 2.16%, 0.24 to 0.37%, 5.50 to 7.56%, 77.89 to 79.60%, 59.90 to 65.17%, 12.15 to 14.61% and 85.39 to 87.85% for moisture, total ash, fat, crude fibre, crude protein, carbohydrate, starch, amylose and amylopectin contents respectively. The cooking properties ranged from 2 to 7.5, 230 to 250% and 5.49 to 5.64 in length and 0.689 to 1.337mm for volume expansion ratio, water uptake and elongation ratio respectively. This study revealed that Aroso and Orlam rice were of excellent in physical, chemical, sensory qualities and are both recommended for consumption. This research finding serves as a basis of choice for consumers and it also reveals the areas for improvement in terms of qualities of the local rice investigated.

Keywords: Aroso; Ofada; Physical properties; Omida market; Sensory attributes

1. Introduction

Rice (*Oryza sativa*), according to Fukagawa and Ziska [1] is one of the cereal grains that play a very important dietary role in the nutrition of human beings. It was also reported that it ranks third after wheat and maize and constitutes the most important staple food of about half the world's population. Rice is a major staple crop cultivated in many countries including those of East Asia. Its cultivation has increased steadily and rice production has already reached up to 753 million tons in 2016, of which 686 million tons was harvested in Asian countries [2]. It is grown in all the ecological zones in Nigeria with different varieties possessing adaptation traits for each ecology [3]. According to Mohidem *et al.* [4], rice plays a very important role in the diets of many in developing countries where it provides 27% of the dietary energy supply and 20% of dietary protein intake. It is an excellent source of complex carbohydrates, protein, vitamins and minerals. In the recent times, there has been a structural increase in rice consumption in the country and this increase would likely continue in the near future. Consumer's demand for good high quality rice is very high due to their patronage for imported rice. However, Abdullahi [5] stated that lack of adequate technology in rice processing to meet International Standard led to imported rice dominating rice trade in Nigeria. Quality is one of the selection principles prioritized by farmers and consumers of rice [6] and physical quality has been described to have a great impact on commercial rice production as it greatly influences the final output as well as the consumer demand which greatly

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contribute to the economic profitability of farmers and millers. However, consumer preference is based on appearance (milling quality, grain length, and width) cooking and eating quality. *Oryza sativa* has a broad range of genetic diversity within specific quality characters like physicochemical, cooking, eating and aroma. Some of these individual qualities attributes got consumer's preference and became popular in different regions of the country [7]. Government of Nigeria has in recent times made a concerted effort to boost the production and distribution of locally grown rice in the country in a move to achieve self-sufficiency in rice production [3] and currently there is ban on the importation of foreign rice to the country so as to focus on rice produced in Nigeria. Due to this policy, there are lots of brands of rice in the Markets and the sources of some of these brands of rice are not known. Meanwhile, it has been previously reported that genetic and environmental factors are mainly responsible for variation in composition and cooking quality of rice [8]. Most Nigerians prefer to consume imported rice brands as compared to local rice varieties due to the fact that most Nigerian rice processors lack adequate technology of rice processing to meet international standard [9]. Obeta *et al* [3] also stated that; in Nigeria, local rice has a very low esteem with few research works and no industrial or technology processing yet developed. Sethy *et al* [10] stated that the quality of rice is an important necessity. Recently there has been a demand for healthy, high quality and low cost product. To protect consumers from substandard or rice with unknown qualities, it is necessary to determine the qualities of foods sold in the markets so as for them to make knowledgeable choice of their diet. There are some locally grown rice grains in Nigeria. Some of these rice grains for example 'ofada' are grown in Western part in which Ogun State is one of them. The rice grains are sold in Abeokuta open markets and also in some other parts of the Nigeria. Report exists on some locally grown rice in other countries but there is little or no adequate report on the qualities of local rice sold in Nigeria most especially in the main markets of Abeokuta which is the capital of Ogun State, Nigeria. The report from this research might serve as a basis of choice or improvement on the qualities of the local rice since there has been a ban on the importation of rice and the populace will henceforth be left to choose from the local rice for food. In view of these basic reports, this study is aimed at investigating the qualities of some selected locally grown rice brands sold in the main markets of Abeokuta the capital of Ogun State, Nigeria.

2. Material and Methods

2.1. Source of material

25 kg of each of five 5 types of milled rice (Ofada, Aroso, Mokwa, Royal Niger and Orlam) Nigeria rice were purchased in duplicate from some main markets in Abeokuta. The markets were Osiele, Lafenwa, Kuto and Omida.

2.2. Methods

2.2.1. Collection of samples

Five milled rice varieties, Ofada, Aroso, Mokwa, Royal Niger and Orlam Nigeria rice were purchased in duplicate from some market area of Abeokuta main markets. The markets were Osiele, Lafenwa, Kuto and Omida. The rice grain samples were transported to the laboratory for analyses. Analyses were carried out on all the collected samples of rice

2.2.2. Analysis of samples

Physical analysis

Kernel width and length ratio were determined as described by [11]. Ten kernels of sample were arranged length wise and then width wise for cumulative measurement in centimeters with the aid of a venier caliper. Milled grain appearance was observed/rated by visual observation as very good, good and fair as described by [12]

2.3. Chemical Analysis

2.3.1. Determination of moisture content of rice

The moisture content of the rice varieties was determined using the method described by measuring five (5 g) of the each sample into a dried and pre-weighed moisture container. The container with its content was dried in an oven at a temperature of 105 °C for up to 3 hours until constant weight. Then, the moisture content was estimated as weight loss using the formula: Moisture content (%) = $\frac{(W_1 - W_2)}{W} \times 100$

where:

W_1 = weight of container + fresh sample

W_2 = weight of container + dried sample

W = weight of sample AOAC [13].

2.3.2. Determination of total ash content of rice

Total ash content was determined using a standard analytical method of AOAC [13]. Five (5) g of the rice grain sample was weighed into a dried and a previously weighed porcelain crucible. The sample was charred on a hot plate until water and other volatile constituents are eliminated in the form of black fumes. The sample was ashed by placing in a pre-heated muffle furnace that has been heated up to at 600 °C for 6 h until a resulting white colour indicating that the sample was properly ashed and was cooled in a desiccator. The cooled crucible containing the ash was weighed and the percentage total ash was calculated as follows: Total Ash content (%) = $\frac{(W_2 - W_1)}{W} \times 100$

where: W_2 = Weight of crucible + ash

W_1 = Weight of empty crucible

W = Weight of sample

2.3.3. Determination of crude protein content

This was determined using the analytical method of AOAC [13]. One (1) g of each samples was weighed into the digestion flask, Kjeldahl catalyst tablets was added, 20 ml of concentrated H_2SO_4 was added and the flask fixed into the digester at 410°C for 6 h until a clear solution was obtained. The cooled digest was transferred into 100 ml volumetric flask, and made up to mark with distilled water. The distillation apparatus was set up and rinsed for about 10 min after boiling. 20 ml of 4% boric acid was pipetted into a conical flask. After which five 5 drops of methyl red was added to the flask as an indicator. The sample was diluted with 75 ml of distilled water and 10 ml of the digested sample was pipetted into the Kjeldahl distillation flask. 20 ml of 40% NaOH was added through the glass funnel into the digested sample and it was distilled, the distillate was collected in the boric acid for 15 min until a pink color changes to green. The content of the flask was then titrated against 0.05 N HCl. Calculation:

$$\% \text{Nitrogen (W/W)} = \frac{14.01 \times (\text{Sample titre} - \text{blank titre}) \times \text{Normality of acid}}{10 \times \text{Weight of Sample}}$$

$$\% \text{Crude protein (W/W)} = \% \text{Nitrogen} \times 6.25$$

2.3.4. Determination of crude fat content

The crude fat of the rice was determined using the Soxhlet extraction method of [13]. After drying the extraction flask in the oven to a constant weight, four (4g) of each dried sample was weighed into fat free extraction thimble and plug lightly with cotton wool. The thimble was placed in the extractor, fitted up with reflux condenser and a 250 ml soxhlet flask which has been previously dried in the oven, cooled in the desiccator and weighed. The soxhlet flask is then filled to $\frac{3}{4}$ of its volume with petroleum ether (b.pt. 40° – 60 °C), and the soxhlet flask. Extractor plus condenser set was then placed on the heater. The heater was put on for six hours with constant running water from the tap for condensation of ether vapour. The set up was constantly watched for ether leaks and the heat source was adjusted appropriately for the ether to boil gently. The ether was left to reflux several times for at least 10 to 12 times until it was short of siphoning. The thimble containing sample was removed and dried on a clock glass on the bench top. The extractor, flask and condenser were replaced and the distillation continued until the flask was absolutely dry. The flask which now contains the fat was detached, its exterior cleaned and dried to a constant weight in the oven.

$$\text{Percentage crude fat} = \frac{W_1 - W_0}{\text{Weight of sample}} \times 100$$

W_0 = initial weight of dry Soxhlet flask

W_1 = final weight of oven dried flask + fat

2.3.5. Determination of crude fibre content of rice

The analytical method of AOAC [13] was used in the determination. Three (3) g of the rice grain was weighed and extracted with petroleum ether. It was allowed to boil (under reflux condenser) for about 40 minutes. Filter paper was

placed in the funnel and the sample was drained by applying suction. The insoluble material was washed once with boiling water, 1% HCl, twice with alcohol and thrice with ether. The residue was dried in an electric oven at a temperature of 100°C to a constant weight, incinerated to ash, cooled and weighed. Therefore, the difference between the weight of the ash-less filter paper plus the insoluble material and that of the ash represents the fibre content. % crude fibre = $\frac{W_2 - W_3}{W_1} \times 100$

W1 = weight of sample used, W2 = weight of crucible plus sample, W3 = weight of sample crucible + ash.

2.3.6. Determination of the carbohydrate content of rice

The carbohydrate content was determined by difference according to the method described by Rampersad *et al.* (2003). The sum of percentages moisture, total ash, crude lipid, crude protein and crude fibre was subtracted from 100%

i.e. %Carbohydrate = 100 %- (% moisture + % ash + % protein + % fat + % fibre).

2.3.7. Determination of starch content of rice grain

The modified method described in AOAC [14] was used for the determination of the starch content of rice. Hot ethanol was used to extract starch from the rice flour samples. The extract (supernatant) and digest (from the residue) was quantified calorimetrically for starch, using phenol-sulphuric acid as the colour developing reagent; and absorbance read at 490 nm wave length. Twenty milligrams of the rice flour sample was weighed into a centrifuge tube and wetted with 1 ml of 95% ethanol. Two ml. of distilled water was added followed by ten ml of hot 95% ethanol. The content was vortexed and centrifuged in (GALLENKAMP Centrifuge Model 90 - 1, USA) at 2000 rpm for 10 min. The supernatant was decanted while the sediment was hydrolyzed with perchloric acid and used to estimate starch content.

The absorbance was read with a spectrophotometer (Milton Spectronic 601, USA) at 490 nm.

Therefore;

$$\% \text{Starch} = \frac{(\text{Absorbance} - 0.0044)4}{\text{sample wt} \times 0.55}$$

2.3.8. Determination of amylose and amylopectin content of rice

The amylose content of the rice grain was determined using the iodine colorimetric method described by [14]. About 0.1 g of the starch sample was solubilized with 1 ml of 95% ethanol and 9 ml of 1 N NaOH, and heated in a boiling water bath for 10 min; 1 ml of the extract was made up to 10 ml with distilled water. 0.1 ml 1 M acetic acid was added to 0.5 ml of the diluted extract and 0.2 ml iodine solution (0.2 g I₂+2.0 g KI in 100 ml of distilled water) to develop a dark blue colour. The coloured solution was made up to 10 ml with distilled water and allowed to stand for about 20 min for a complete colour development. The solution was vortexed and its absorbance was read on a spectrophotometer at 620 nm. Absorbance of standard corn amylose with known amylose concentration was used to estimate the amylose content.

$$\% \text{ Amylose} = \frac{\% \text{ amylose of standard} \times \text{Absorbance of sample}}{\text{Absorbance of standard}}$$

$$\% \text{Amylopectin} = 100 - \text{Amylose content}$$

2.4. Cooking characteristics

The cooking characteristics of the rice such as elongation ratio, volume expansion ratio and water uptake were determined using the method described by Tamu *et al* [16]. The elongation ration was determined by selecting ten whole milled rice grains randomly per variety. The length and width of each grain was measured using a vernier caliper, and the elongation ratio was estimated using the procedure by Sood *et al.* [17] as described by [16].

2.5. Volume expansion ratio

Five gram of milled rice grains of each variety was placed in a test tube containing 15ml of distilled water. The initial volumes of water measured, the grains were allowed to cook for 10 minutes and then placed in boiled water for 20 minutes at 80 °C. After which the rice samples were dipped into 50 ml water and the increase in final water volume for

each sample was measured using a calibrated measuring cylinder. The volume expansion ratio = $\frac{x-50}{y-15}$ Where Y = the initial volume of water, and X = final volume of water.

2.6. Water uptake

Exactly two (2 g) of rice sample for each variety was placed in a 50 ml test tube containing 10ml of distilled water for about 30 minutes each. Each test tube was then placed in a boiled water bath for about 45 minutes at temperature 80 °C. At the same time, three test tubes without rice grains were each filled with 10 ml of water and placed in the water bath as controls. After cooling, the supernatant was transferred into a graduated measuring cylinder and the level of water was measured. Water uptake was then determined by the formula: water

$$\text{Uptake} = (100/2g) * \text{water absorbed [16].}$$

2.7. Sensory Evaluation

The sensory qualities of cooked samples of rice were evaluated by 50 panel of judges (because it is a staple food consume by all). The panelists were made up of both male and female individual within Moshood Abiola Polytechnic, Abeokuta. The panelist were instructed to indicate their preference for each sample on a Nine Point Hedonic scale, where 1 and 9 represent dislike extremely and like extremely [18]. The attributes evaluated were; Colour, aroma, taste, texture, appearance and overall acceptability

2.8. Statistical analysis

Data generated in this study were subjected to analysis of variance (ANOVA) using Statistical package for Social Sciences (SPSS) version 22.0 to determine the significant difference. The means were separated using Duncan Multiple Range Test (DMRTs) where applicable.

Note: After analysis of samples, the results generated for each variety of rice from the four different markets were subjected to statistical analysis. However, the highest score for each variety of rice were re-analysed statistically and presented in the results for clarity except in the case of the physical property.

3. Results and Discussion

3.1. Physical property of the 5 rice varieties

Grains size are among the major quality criteria that consumer consider in purchasing rice at the market. The values of width in this study revealed significant variability among the rice varieties studied. The width of the rice for different markets Ofada, Mokwa, Royal-niger, Aroso, Orlam ranged between 0.261 to 0.268 mm, 0.260 to 0.265 mm, 0.260 to 0.262 mm, 0.269 to 0.270 mm, and 0.271 to 0.275 mm (Table 1). The length property of the 5 varieties of rice is as presented in Table 2. The length for the different types of rice Ofada, Mokwa, Royal- niger, Aroso, Olam (from Osiele, Lafenwa, Kuto and Omida), ranged from 0.346 to 0.350 mm, 0.365 to 0.368 mm, 0.356 to 0.359 mm, 0.357 to 0.357, and 0.365 to 0.379 mm respectively. Orlam rice had the highest width, followed by Aroso while Ofada had the lowest width. Orlam rice had the highest length while ofada had the lowest. This difference in grain lengths might be due to the genetic make-up of the rice accessions. Grain size in breeding applications is usually assessed by the grain weight and it is positively correlated with several characters, including grain length, grain width and grain thickness ([19]). Grain shape or length/width (L/W) ratio is an important feature for grain quality assessment ([20]). The appearance is highly important for judging the quality of rice. Table 2 shows the appearance of the rice grains examined and it ranged from good to very good except for mokwa and orlam rice which shows fair. Two varieties of the rice samples tested translucent, one tested while both mokwa and orlam rice tested opaque. Kondo *et al.* (2023) stated that the greater the amount of chalkiness in grain, the more it is prone to grain breakage during milling, resulting in lower head rice yield

Table 1 Physical property (width in mm) of 5 rice varieties

Location/Sample	Ofada	Mokwa	Royal niger	Aroso	Orlam rice
Osiele	0.261±0.0048 ^a	0.263±0.0083 ^a	0.261±0.0068 ^a	0.270±0.0059 ^a	0.275±0.0078 ^a
Lafenwa	0.267±0.0070 ^b	0.262±0.0089 ^b	0.261±0.0085 ^a	0.270±0.0059 ^c	0.275±0.0077 ^a
Kuto	0.268±0.0053 ^b	0.265±0.0078 ^a	0.0265±0.0067 ^a	0.270±0.0059 ^a	0.275±0.0077 ^a
Omida	0.267±0.0070 ^b	0.260±0.0089 ^a	0.262±0.0067 ^a	0.269±0.0043 ^a	0.271±0.0057 ^a

Values are Means±Standard Deviation of triplicate determinations. Values in the same column with different letters differs significantly ($p < 0.05$).

Table 2 Physical property (length in mm) of 5 rice varieties

Location/Sample	Ofada	Mokwa	Royal niger	Aroso	Orlam rice
Osiele	0.345±0.135 ^a	0.368±0.010 ^a	0.359±0.0076 ^a	0.357±0.0083 ^a	0.366±0.0093 ^a
Lafenwa	0.348±0.133 ^a	0.365±0.010 ^a	0.360±0.0085 ^a	0.357±0.0083 ^c	0.379±0.0012 ^b
Kuto	0.348±0.0127 ^a	0.367±0.010 ^a	0.358±0.0085 ^a	0.358±0.0085 ^a	0.366±0.0093 ^a
Omida	0.350±0.128 ^a	0.367±0.011 ^a	0.365±0.0067 ^a	0.357±0.0083 ^a	0.365±0.0093 ^a

Values are Means±Standard Deviation of triplicate determinations. Values in the same column with different letters differs significantly ($p < 0.05$).

Table 3 Physical properties of 5 rice varieties

Sample	Chalkiness	Appearance
Aroso	Transparent	Very Good
Royal Niger	Translucent	Good
Orlam	Opaque	Fair
Mokwa	Opaque	Fair
Ofada	Translucent	Good

3.2. Chemical composition of 5 rice varieties

Table 4 shows the chemical composition of the 5 rice varieties. The rice samples varied significantly ($P < 0.05$) in their chemical compositions. Moisture content has been reported to have a marked influence on all aspects of paddy and rice quality. It plays a significant role in determining the shelf life. Moisture content was highest (11.97%) in Aroso rice variety and lowest (9.89%) in Royal niger. The study conducted by Thomas *et al* [21], moisture ranged from 10.04 to 12.88% among rice varieties examined. This variation in the moisture content may be attributed to environmental conditions during filling and maturation, such as high day time temperatures, low humidity and dry winds. Tegegne *et al.* [22] stated that the ash content present in a food sample usually plays an important role while determining the levels of essential minerals. In this study, ash content was higher (2.62%) in Royal niger rice and lower (0.83%) in Aroso rice. The results are consistent with literature data on proximate composition cited by [23]. Ofada rice had the highest fat content (2.16%) while Aroso had the lowest (1.89%). Yadav *et al* [24] reported the fat content of different rice cultivars usually ranged from 0.43 to 0.80%. Fibre has been reported to play a vital role in the prevention of several diseases such as diabetes, irritable color cancer and some other diseases [25]. Fibre has also been reported to help in aiding digestion and lower plasma cholesterol level [26, 27]. The crude fibre was high (0.37%) in Royal niger and low in Mokwa variety compare to others. It also contributes to the health of gastro-intestinal system and metabolic system in man. Proteins are vital to the living process and carry out a wide range of functions essential for life sustainability. The highest (7.56%) protein content was recorded for Mokwa rice variety while Royal niger variety had the lowest (5.60%) protein content. Varietal difference in protein may be attributed to several factors including environmental stresses such as salinity,

alkalinity, temperatures, diseases, total nitrogen in the soil and other minerals such as molybdenum and total chlorine which tend to increase the grain protein content [28]. Carbohydrate content of the rice ranges from 77.89 to 79.8%. These values are within the range reported by [30] and a bit lower than the values reported by Oko *et al.* [31] who analysed the chemical nutrient composition of selected local and newly introduced rice varieties grown in Ebonyi State of Nigeria. The carbohydrate content of the rice sample were of no significant difference and this high percentage show that rice is a good source of energy. The total starch content ranges from 59.90 to 65.17%. Royal niger was higher in terms of total starch (65.17%) while aroso had 59.90. The differences between the total starch content in the rice varieties could be affected by extraction process. Previously, the purity of rice starch reflected by the higher content of total starch content, low protein and low lipid content [31]. Amylose Content (AC) is the most important character for predicting rice cooking and processing behaviour [24]. Has revealed by researchers, rice can be grouped based on their amylose content into waxy (0-2%) very low (3-9%), intermediate (20-25%) and high above 25% amylose content amylose containing cultivars [32]. The results from this study indicated that all the rice samples had very low amylose content with highest (13.57%) in mokwa rice and lowest (12.15%) in Aroso rice variety. The variation in amylose content may be due to variation in the temperature during grain ripening stage, whereby the amylose content generally decreases as the mean temperature increases [28]. Furthermore, the amylose content is also influenced by nitrogen fertilization, whereby the value decreases slightly with nitrogen fertilization but is not affected by the stage at which nitrogen is applied [28]. The amylopectin values of rice (table IV) ranges from 85.39 to 87.85%, where aroso has the highest percentage of amylopectin and Royal niger had the lowest. Statistically, there is significant difference ($p \leq 0.05$) among the rice samples in terms of amylopectin content. Amylopectin is composed of glucose molecules with branch links and is less resistant to digestion. This means that rice varieties with a greater proportion of starch in the form of amylopectin tend to have a higher glycemic index (GI). These varieties absorb less water upon cooking and have a sticky texture [33]. Foods with higher GI are, in principle, more quickly digested than those with lower GI value. Therefore, Royal niger and Ofada rice may be suitable than other varieties in this regard, as it has the highest percentage of amylose which indicates relatively lower glycemic index and could be recommended as appropriate diet for diabetic patients.

3.3. Cooking characteristics of 5 rice varieties

The cooking quality of the rice varieties differ from one another significantly indicating considerable variability among the rice in volume expansion ratio, grain length after cooking. The cooking quality of rice is influenced by the gelatinization and retrogradation characteristics of its starch [34]. From table V, the volume expansion ratio ranges from 2.5 to 3 with aroso rice having the highest, mokwa together with royal niger having the least values. The high value of aroso rice could be as a result of swelling of starch granules that might be due to high temperature [35]. There were significant ($P < 0.05$) different among all the samples of rice evaluated. The elongation ranges from 5.499 to 5.625 in length and 0.348 to 1.161mm in width as shown in (table 5). The values for the water uptake ratio show that Ofada rice had the highest. Amylose content might be responsible for high water uptake ratio it has been reported that rice with high amylose content tends to absorb more water upon cooking. This might also be as a result of high moisture content of the rice varieties which is worthy to note for high water-uptake.

3.4. Sensory characteristics of 5 rice varieties

Sensory property of the cooked rice is shown in Table 6. The rice samples were significantly difference ($p > 0.05$) in colour. It has been reported that colour is an important sensory attribute of any food because of its influence on its acceptability. The old adage that says 'the eye accepts the food before the mouth' is very true. The colour score of between 6.45 and 7.50 on the 9 point hedonic scale indicated that the cooked rice were at least liked slightly and agrees with the observation of [36]. Taste is also an important sensory attribute of any food because of its influence on acceptability of the food. The taste of the cooked rice samples ranged between 6.65 and 7.90. Aroma is another attribute that influence the acceptance of rice even before they are tasted. It ranged between 6.10 and 7.45 with no significance difference between aroso and orlam niger rice and both being the most appealing in terms of aroma. Texture is the sensory manifestation of the structure of food and the manner in which the structure reacts to the applied force (Jemziya and Mahendran [37] and is one of the most important parameters connected to product quality. Texture analysis involves measuring the properties related to how a food feels in the mouth (initial bite or chew). The rice samples differs significantly ($p > 0.05$). The overall acceptability of the rice shows that aroso rice had the highest value of 7.65 while least value 6.35 was recorded for ofada rice maybe due to its colour and aroma.

Table 4 Chemical composition of the 5 rice varieties

Sample	Moisture Content (%)	Total Ash (%)	Fat (%)	Crude fibre (%)	Crude protein (%)	Carbohydrate (%)	Starch (%)	Amylose (%)	Amylopectin (%)
Aroso	11.97±0.35 ^e	0.83±0.007 ^a	1.89±0.007 ^a	20.24±0.021 ^a	5.50±0.007 ^a	79.60±0.063 ^a	59.90±0.007 ^a	12.15±0.014 ^a	1 87.85±0.014 ^e
Royal Niger	9.89±0.007 ^a	2.62±0.021 ^d	2.00±0.007 ^c	20.37±0.007 ^e	5.60±0.007 ^e	79.52±0.007 ^b	65.17±0.035 ^d	14.61±0.021 ^e	1 85.39±0.021 ^c
Ofada	10.21±0.007 ^b	1.56±0.007 ^c	2.16±0.007 ^e	20.34±0.014 ^c	6.83±0.00 ^{bc}	78.91±0.028 ^c	62.25±0.078 ^c	13.57±0.028 ^d	1 86.43±0.028 ^b
Mokwa	11.11±0.028 ^c	0.88±0.007 ^b	1.95±0.014 ^b	20.28±0.007 ^b	7.56±0.007 ^e	78.21±0.034 ^b	60.84±0.057 ^b	12.89±0.007 ^c	1 87.11±0.007 ^c
Olam	11.45±0.014 ^d	0.88±0.007 ^b	2.06±0.007 ^d	20.27±0.007 ^{ab}	7.50±0.014 ^d	77.89±0.007 ^a	59.97±0.028 ^a	20.47±0.014 ^b	87.53±0.014 ^d

Values are Means ± Standard .Deviation of triplicate determinations. Values in the same column with different letters were significantly (p<0.05) different

Table 5 The Cooking characteristics of 5 rice varieties

Sample	Volume Expansion	Water uptake (%)	Elongation Ratio(mm)	Width	Length
Aroso	3	230	1.033 ^c	5.499 ^a	
Royal Niger	2	240	0.689 ^b	5.518 ^a	
Orlam	2.5	250	1.161 ^d	5.625 ^a	
Mokwa	2	235	1.337 ^{cd}	5.621 ^a	
Ofada	2.75	245	0.348 ^a	5.508 ^a	

Table 6 Sensory properties of 5 cooked rice varieties

Sample	Colour	Taste	Aroma	Texture	Appearance	Overall acceptability
Aroso	7.65±1.565 ^b	7.00±2.248 ^{ab}	7.45±1.817 ^b	6.80±1.881 ^{ab}	7.00±2.017 ^b	7.10±1.774 ^{ab}
Royal Niger	7.50±1.701 ^b	7.20±1.965 ^{ab}	7.30±1.559 ^b	7.00±1.919 ^{ab}	6.85±1.785 ^b	7.33±1.814 ^{ab}
Orlam	7.40±1.465 ^b	7.90±1.119 ^b	7.45±1.468 ^b	7.75±1.333 ^b	7.85±1.387 ^b	7.65±1.187 ^b
Mokwa	6.95±1.395 ^b	6.85±1.565 ^a	7.10±1.410 ^b	7.05±1.538 ^b	6.75±1.713 ^b	7.15±1.631 ^{ab}
Ofada	6.45±1.605 ^a	6.65±2.059 ^a	6.10±1.0971 ^a	6.35±2.231 ^a	4.40±1.847 ^a	6.35±2.007 ^a

^{a-e}values with different letters in the same column are significantly (P<0.05) different

4. Conclusion

In conclusion, the rice varieties investigated were different in physical properties, chemical composition and sensory qualities. Local rice in terms of physical and chemical are of good quality among the studied varieties, Aroso and Orlam Nigerian rice varieties showed the excellent chemical composition, physical, cooking and sensory characteristics compared to other varieties. This report will serve as a guide for the choice of rice most especially when purchasing it in the market. This information suggests to us that local rice could compete with foreign rice in terms of the considered qualities.

However, further studies on other types of rice consume in these areas or other areas of Ogun State could be investigated. Also, other properties of the rice could be carried out for adequate documentation on the locally grown rice varieties.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

- [1] Fukagawa, N. K., Ziska, L. H. Rice: Importance for Global Nutrition. *Journal of Nutrition Science Vitaminol (Tokyo)* 2019;; 65(Supplement):S2-S3.
- [2] Sultana, S., Faruque, M., Islam, M. F. Rice grain quality parameters and determination tools: a review on the current developments and future prospects. *International Journal of Food Properties* 2018; 25(1):1063-1078.
- [3] Obeta, N. A., Ukom, A. N., Ossai, O. I. Production and quality evaluation of instant rice from three local rice varieties in Ebonyi state. *Asian Journal of Applied Science* 2019; 12: 52-60.
- [4] Mohidem, N. A., Hashim, N., Shamsudin, R., Che-Man, H. Rice for Food Security: Revisiting Its Production, Diversity, Rice Milling Process and Nutrient Content. *Agriculture* 2022; 12:741.
- [5] Abdullahi, A. Comparative Economic Analysis of Rice Production by Adopters and Non-Adopters of Improved Varieties among Farmer in Paikoro Local Government Area of Niger State. *Nigerian Journal of Basic and Applied Science* 2012; 20(2): 146-151.
- [6] Abukari I., Donkoh S.A., Ehiakpor, D.S. Perceived quality characteristics influencing households' preference for local and imported rice and their effect on price in the northern region, Ghana. *Ghana J. Dev Stud.* 2019; 16(1):135–154.
- [7] Kaur S., Panesar P. S. and Bera, M. B. Studies on evaluation of grain quality attributes of some basmati and non-basmati rice cultivars. *Journal of Food Quality* 2011.34(6):435–441.
- [8] Hemalatha, K. Ramana, A. V. Sharma N.and Sunil Kumar. Correlation and Regression Analysis of Semidry Rice-Weed Ecosystem. *Environment & Ecology* 2016.35 (3A): 1814—1817.
- [9] Usanga, U. J., Effiong, E. O., Akpan, O. D., Okon, N. I. Promoting Home-grown Rice for Wealth Creation and Sustainable Development. International Conference on Rice Food, Market and Development. Raw Materials Research and Development Council, Abuja 2021.
- [10] Sethy, P. K., Behera S. K., Dash S., Pattnaik A. Rice Quality Evaluation Based on Image Processing: A Survey. *Journal of Information Technology & Electrical Engineering* 2019; 8 (4) pp. 26-34.
- [11] Adeyemi, I.A. Some Quality Factors of Raw and Processed rice. Paper presented at the NIFSTS Workshop on Rice Processing, Packaging and Marketing, Women Development Centre, Abakaliki, July 2006; Pp 12-13.
- [12] Dipti, S.S., Bari, M.N., Kabir, K.A. Grain Quality Characteristics of some Beruin Rice Varieties of Bangladesh. *Pakistan Journal of Nutrition* 2003; 2(4) Pp 242-245.
- [13] AOAC. Official Methods of Analysis International 18th Edition. Association of Official Analytical Chemists, USA 2005.
- [14] AOAC. Official Methods of Analysis. 18th Edition, Association of Official Analytical Chemists, Gaithersburgs, MD 2006.
- [15] Addy R. N., Wireko-Manu F. D., Oduro I. Physicochemical and Pasting Properties of Starch Extracted from Four Yam Varieties. *Journal of Food and Nutrition Sciences* 2004; Vol. 2, No. 6., pp. 262-269.

- [16] Tamu A., Asante M. D., Akromah R., Soe I. Evaluation of physicochemical characteristics of rice (*Oryza sativa* .L.) Varieties in Ghana. International Journal of Agricultural Sciences 2017; (8):1342-1349.
- [17] Sood B.C, Siddiq E.A, Zaman F.U. Genetic analysis of kernel elongation in rice. Ind. J. Gen. 1983; 43: 40-43.
- [18] Ihekonroye, A.I., Ngoddy, P.O. Integrated Food Science and Technology for Tropics 135 London: Macmillian Publisher 1985
- [19] Gasparis, S., Miłoszewski, M. M. Genetic Basis of Grain Size and Weight in Rice, Wheat, and Barley. International Journal of Molecular Science 2023; 29;24 (23):16921.
- [20] Kondo M., Bulonza J. C., Zihahirwa E., Godefroid, M., Mamadou F. Rice grain quality: a comparison of some local varieties with improved varieties in Eastern DR Congo. Journal of Research in Agriculture and Animal Science.2023; Volume 10 ~ Issue 12 pp: 12-17.
- [21] Thomas, R., Wan-Nadiah, W. A., Bhat, R. Physicochemical properties, proximate composition and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia International Food Research Journal 2013;. 20(3): 1345-1351.
- [22] Tegegne, B., Belay, A., Gashaw, T. Nutritional potential and mineral profiling of selected rice variety available in Ethiopia. Chemistry International 2020; 6(1):21-29.
- [23] Devi, L. M., Badwaik, L. S. Variety difference in physico-chemical, cooking, textural, pasting and phytochemical properties of pigmented rice. Food Chemistry Advances 2022;.1:100059.
- [24] Yadav, R. B., Malik, S., Yadav, B. S. Physicochemical, pasting, cooking and textural quality characteristics of some basmati and non-basmati rice varieties grown in India. Journal of Agricultural Technology 2016; 12(4):675-692.
- [25] Compaore-Sereme, D., Tapsoba, F. W., Zoénabo, D., Compaoré, C. S., Dicko, M. H., Sawadogo-Lingan, H. A review on dietary fiber: definitions, classification, importance and advantages for human diet and guidelines to promote consumption International Journal of Biological & Chemical Science 2022; 16(6): 2916-2929.
- [26] Ioniță-Mîndrican, C. B., Ziani, K., Mititelu, M., Oprea, E., Neacșu, S. M., Moroșan, E., Dumitrescu, D. E., Roșca, A. C., Drăgănescu, D., Negrei, C. Therapeutic Benefits and Dietary Restrictions of Fiber Intake: A State of the Art Review. Nutrients 2022; 26; 14(13):2641.
- [27] Khalid, W., Arshad, M. S., Jabeen, A., Muhammad, A. F., Qaisrani, T. B., Suleria, H. A. R. Fiber-enriched botanicals: A therapeutic tool against certain metabolic ailments. Food Science & Nutrition 2022; 10(10):3203-3218.
- [28] Salim, R., Nazir, F., Yousf, N., Amin, F. Chemical composition of different rice cultivars grown in North India. International Journal of Chemical Studies 2017; 5(6): 1929-1930.
- [29] Oko, A. O., Ugwu, S. I. The proximate and mineral compositions of five major rice varieties in Abakaliki South-Western Nigeria International Journal of Plant Physiology & Biochemistry 2011; 3(2): 25-27.
- [30] Oko, A. O., Ubi, B. E., Efişue, A. A., Dambaba, N. Comparative Analysis of the chemical Nutrient composition of selected local and newly introduced Rice varieties Grown in Ebonyi state of Nigeria. International Journal of Agriculture and Forestry 2012; 2(2): 16-23.
- [31] Anugrahati, N. A., Pranoto, Y., Marsono, Y., Marseno, D. W. Physicochemical properties of rice (*Oryza sativa* L.) flour and starch of two Indonesian rice varieties differing in amylose content. International Food Research Journal 2017; 24(1): 108-113.
- [32] Sultana, S., Faruque, M., Islam, M. F. Rice grain quality parameters and determination tools: a review on the current developments and future prospects. International Journal of Food Properties 2022; 25(1):1063-1078.
- [33] Adewusi K.M., Sowemimo F.A., Nassir A.I., Oguntade O.A. Evaluation of M6 Ofada rice mutant selection and parent for grin for physicochemical and nutritional characters. Nigeria Agricultural Journal 2022; Vol. 53 No 2
- [34] Jui-cheng, R., Chen, H., Lu, S., Chiang, W. Effects of cooking, retrogradation and drying on starch digestibility in instant rice making. Journal of Cereal Science 2015;65.
- [35] Bhat, F. M., Riar, C. S. Physicochemical, cooking, and textural characteristics of grains of different rice (*Oryza sativa* L.) cultivars of temperate region of India and their interrelationships. *Journal of Texture Studies* 2017; 48(2):160–170.
- [36] Wichchukit, S., O'Mahony, M. The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. Journal of Science, Food & Agriculture (wileyonlinelibrary.com) 2014. DOI 10.1002/jsfa.6993
- [37] Jemziya, M. B. F. Mahendran, T. Quality characteristics and sensory evaluation of cookies produced from composite blends of sweet potato (*Ipomoea batatas* L.) and wheat (*Triticum aestivum* L.) flour. Sri Lanka Journal of Food and Agriculture 2015;.1(2): 23-30.