COOKING AND PHYSICOCHEMICAL PROPERTIES OF FIVE RICE VARIETIES PRODUCED IN OHAUKWU LOCAL GOVERNMENT AREA.

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ABSTRACT*: Four local rice varieties grown and processed in Ohaukwu and One foreign rice varieties (caprice gold) were analyzed for their cooking, chemical and physical properties. Cooking time differed with variety (p<0.05) and the ranged between 17-23 minutes. Volume expansion ratio varied from 1.67-3.67cm^3. Caprice, Faro44 and Faro 15 had higher volume expansion ratio than the other varieties (P<0.05). Gelatinization time varied with variety and the range between 4-11 minutes. Caprice took a longer time to gelatinize and Faro 14 and IRR8 the shortest time. The other varieties differ (p<0.05) in their gelatinization time. Grain elongation during cooking, amount of water evaporating during cooking and solid in cooking water ranged between 0.18-0.38m, 19-42%, 0.02-0.64(g). The values for the amylose ranged between 7.6-37.2% and amylopectin ranged between 69.8-79.8%. The range of physical properties from all the varieties were, length 0.595 to 0.753m, width 0.217 to 0.287m, length/ width ration 2.188 to 3.470mm.*

KEYWORDS: rice, cooking, varieties, gelatinization, time

INTRODUCTION

Rice *(Oryza Sativa)* is the most important cereal for human consumption. It is the staple food for over three billion people, constituting over half of the world's population (Cantral and Reeves, 2002). It is consumed mostly as intact grains except hulls, bran and germ. Although consumer's preferences vary from region to region, the majority of consumers prefer well milled or white rice that contain little or no bran on the endosperm, (Lyon *et al.*, 1999). Rice is grown in all the ecological and dietary zones of Nigeria, with different varieties processing adoption tracts for each ecology zone (Sanni *et al.*, 2005). The two commonly cultivated varieties of rice in Nigeria are *Oryza Sativa* and *Oryza glabbermia* (Abulude, 2004). Rice is an economic crop which is important in household food security, ceremonies, nutritional diversification, income and employment, hence it help in poverty alleviation. (Marshell and Wadsworth, 1993). It is utilized mostly at a household level where it is consumed as boiled or ground rice with stew or soup.

Rice is cooked by washing and boiling in water which leads to loss of some nutrients (Ihekoronye and Ngoddy 1985, Perez *et al.*, 1987). Unlike other cereals, rice is consumed largely as cooked whole kernel, which is produced after dehulling and milling processes. Cooking is the process of heating food to make it edible, suitable for consumption and a large portion of house hold energy attributed to cooking. Optimum cooking degree of rice is usually determined were rice reaches an end cooking point where it either absorbed a maximum amount of water while the core at the cooked rice kernels gelatinized (Kasai *et al*., 2005). Cooking time is important since it determines tenderness of cooked rice as well as stickiness to a great extends (Anonymous, 1997). Presoaking of Basmati rice before cooking in excess water reduced the time of cooking from 20 to 10 minutes and increased the dimensional change due to cooking (Hirannaiah et al., 2001). High volume expansion of cooking is still considered to be of good quality by the working class people who do not care whether the expansion is lengthwise or crosswise. Urban people, on the other hand, prefer the varieties that expand more in length than in breadth (Choudhury, 1979).

There are several varieties of rice and each variety varies in their cooking and sensory characteristics. Sanni *et al.* (2005) reported that rice grown in different ecology zones varies from their properties. Ohaukwu in Ebonyi State is known as rice producing area and produce several varieties of rice. Each variety is quite distinct in terms of their cooking and sensory characteristics. There is need to determine the cooking, physical and chemical attributes of different varieties of rice produced in Ohaukwu region. This will assist in enlightening the consumers of the quality of rice they consume.

MATERIALS AND METHOD

Source of Raw Materials

Four locally processed rice varieties were bought from Okwor Ngbo rice mill. The samples were collected consecutively for two days to get a representative samples. The varieties are IRR_8 Okwor, Faro 44 Okwor, Faro 15 Okwor, Faro 14 Okwor and foreign rice (Caprice gold) was bought from Abakaliki market.
The rice samples were analyzed for their cooking properties, chemical and physical properties.

Sample Preparation.

The purchased rice samples were manually cleaned to remove cracks kernels and foreign materials such as stones, dirt's and immature grain.

METHODS

The four locally processed rice sample (IRR_8 Okwor, Faro 44 Okwor, faro 14 Okwor, faro 15 Okwor) and a foreign rice (Caprice gold) was cooked by weighing 20g of the samples into a 250ml beaker, and 200ml of water was added to cover it and placed on thermostatically controlled heating mantle at 95^oC.

Determination of Cooking Properties

Cooking Time Determination

The cooking time of IRR_8, Faro 44, Faro 15, Faro 14 and foreign rice (caprice gold) was determined by the procedure described by Bhattacharya and Sowbhagya (1971). A rice sample of 10g was cooked in distilled water of 70ml at the temperature of 95^0C. After cooking for 10min, the samples were taken at every 2min intervals for testing until the end of the cooking cycle. Ten grains was randomly taken and pressed between two clean glass plates. Cooking time was recorded when at least 90% of the grains no longer had opaque core or uncooked centers. The rice was then allowed to simmer for about another 2min to ensure that the core of all grains has been gelatinized. Optimum cooking time included the additional 2 min of simmer.

Volume Expansion Ratio

The volume ratio of raw milled rice and cooked rice was determined by water displacement method using a measuring cylinder. The volume expansion was calculated with the method by Sidhu et al. (1975). A sample of 5g rice grains was poured into a beaker containing 15ml of water and the total volume was measured. Rice grain sample was cooked for 20min in a thermostatically controlled heating mantle at 90^oC then; the cooked rice was dipped into 50ml water. The volume of cooked rice after dipping was measured.

The volume expansion ratio was calculated by using equation (1).

Volume expansion ratio = (x-50)/(Y-15)

Where

(x – 50) is the volume of cooked rice (ml); and

(y-15) is the volume of raw rice (ml).

Grain Elongation during Cooking

This was determined by first measuring the initial grain length (Lo) before cooking and then final length (L_1) after cooking was measured. The grain elongation during cooking was calculated as

$L_1 - L_o$

Where

L_o = Initial grain length before cooking.

L_1 = Final length after cooking.

Solid in Cooking Water

The amount of total solid lost in cooking water was determined by cooking 2g milled rice in 20ml of water for 20 min. the solid was taken in a Petri dish and oven dried at 105^{0}C until its weight becomes constant. Total solid was calculated by taking the difference in the weights and reported on dry basis (Sidhu et al., 1975)

Water Absorption Capacity

The method of Onwuka (2005) was used. 1g of sample was weighed and poured into a conical graduated centrifuge tube using a warning whirl mixer to mix thoroughly with 10ml of distilled water for 30 seconds. The rice sample was allowed to stand for 30minutes at room temperature and then centrifuged at 5,00xg for 30minutes. The volume of free water was read directly from the graduated centrifuge tube and calculated with the formula below

Water Absorption capacity (WAC) = Final volume of water-initial

Volume of water expressed in (Cm^3)

Amount of Water Evaporated During Cooking

Five grammes (5g) sample of the rice samples was weighed using a top loading meter balance (model p1210). Five 100ml beakers was collected, washed and dried. 50ml of water was measured into various beakers using measuring cylinder, it was then put into thermostatically controlled heating mantle at 95°C, allow for 23 minutes. The cooked rice was removed from the thermostatically controlled heating mantle and allowed to cool, drained and weighed. Amount of water evaporated during cooking was calculated.

$$We = (R+W) - R_c$$

Where

We = water evaporated
R = Weight of raw rice
W = Weight of water added during cooking
R_c = Weight of cooked rice.

Gelatinization Time and Gelatinization Temperature at 90^{0}c

Two grammes (2g) of the different samples of rice was weighed and poured into 5 different test tubes, and 10mls of distilled water was added into each of the test tube containing the samples, and shaken vigorously to obtain uniform solution which was heated in a water bath placed on a hot plate at temperature of 90^{0}c and the components was continuously and gently stirred with the aid of glass rod stirrer until gelatinization was achieved.

Determination of Physical Properties

Length, Width and Length/Width (L/W) Ratio

Adeyemi (2006) method was used. 20 whole grain samples was collected at random from each variety and dimension was measured using a venial caliper calibrated in millimeters (mm) to obtained the average length and width ratio.

$$L/W = \frac{\text{Average length of rice (mm)}}{\text{Average width of rice (mm)}}$$

Determination of Chemical properties

Amylose and Amylopectin Content Determination

The method of Juliano (1971) was used. 0.1g of starch was weighed into a test tube, 1ml of 95% ethanol and 9ml 1N NaOH was added. The mouth of the tube covered with paraffin to mix content very well. 0.5ml of aliquot was used in the analysis. 0.1m of acetic acid solution and 0.2ml of standard solution was added to make up 10ml of solution of distilled water and allowed for 20minutes for colour development and the % amylose was calculated as follows.

$$\%\ \text{amylose} = \frac{\%\ \text{amylose of standard x absorbance of sample}}{\text{Absorbance of standard.}}$$

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

Statistical Analysis

The results were made in triplicate and the mean score were subjected to analysis variance (ANOVA) method at 5% level of significance as described by Obi (2002) to ascertain if there is significant different among the different parameters between the rice samples.

RESULTS AND DISCUSSION

Table 1

SAMPLES	COOKING TIME (mins)	VOLUME EXPANTION RATIO (cm^3)	GELATINIZATION TIME AT 90^OC (mins)	GRAIN ELONGATION AFTER COKKING(m)	AMOUT OF WATER EVAPORATED DURING COOKIN G%	SOLID IN COOKING WATER(g)
Caprice	17^b	3.67^a	11^a	0.38^a	26^a	0.059^a
Faro 14	19^b	2.25^{ab}	4^c	0.28^b	28^c	0.02^a
Faro 15	23^a	3.25^a	8^b	0.22^c	42^d	0.15^a
Faro 44	21^{ab}	3.67^a	5^c	0.18^d	33^b	0.64^a
IRR8	22^a	1.67^c	4^c	0.28^b	19^e	0.13^a
LSD	2.66	0.05	2.40	0.03	1.68	-

Cooking Properties Of The Rice Samples

Results are average score of triplicate samples. Values with same alphabet in a column are not significant at ($P>0.05$).

The cooking properties of the rice samples are shown in Table 1. The cooking time of the rice samples ranged between 17 to 23 minutes with Faro 15 having the highest value and Caprice having the lowest value. The statistical analysis in Table 2 shows that they differ quite significantly ($P<0.05$). Faro 15, Faro44 and IRR8 cooked for a longer time than the other varieties, but among all the rice samples Faro 15 variety had the longest cooking time. The variation in the cooking time could be traced to its gelatinization temperature since gelatinization temperature positively determines the cooking time of rice. It has been asserted that the higher the value of gelatinization temperature, the longer time it takes to cook rice (Frei and Becker, 2003) and cooking time was observed to be dependent on gelatinization temperature. This was in agreement with what Dipti et al. (2003) reported. The higher the gelatinization time of the grain will determine the cooking time of that grain. According to (Bhatlacharga and Snowbhagya, 1971), cooking time is primarily related to the surface area of the milled rice and unrelated to other grain properties. And also, the difference in cooking time may be due to varietal difference and it has been reported that rice with high protein content or a high gelatinization temperature requires more water and longer cooking time to reach the same degree of doneness as rice with lower values for these properties (Juliano, 1971).

From the Table 1 above, the volume expansion ratio of the rice samples ranges from 1.67 – 3.67 with caprice and IRR8 having the highest and the least values respectively. The statistical analysis in Table 1 shows that IRR_8 rice has a significant difference with other rice varieties analyzed statistically. The Faro varieties were observed not to differ quite significantly ($P>0.05$) with the foreign processed rice. The higher value of Faro 44 and Caprice could be could be as a result of swelling of starch granules due to high temperature (Ihekoronye and Ngoddy, 1985). Length wise expansion without a corresponding increase in girth is considered a highly desirable rice grain quality trait (Sood and Sadiq, 1979). Urban people on the other hand, prefer the varieties that expand more in length than in breath (Choudhury, 1979).

Gelatinization time of the rice samples ranges from between 4-11 minutes with caprice having the highest value of 11 minutes, and Faro 14 and IRR8 having the least value of 4 minutes and it varies with varieties and is independent of cooking time, and gelatinization temperature. The gelatinization time of the rice varieties Faro 14, Faro 44 and IRR8 do not differ significant by (P>0.05) statistically but caprice and Faro 15 Significantly difference at (P<0.05). Faro 14 and IRR8 had the least value in grain gelatinization time. This may be influenced by the nature and type of starch the grains are made up of, in the gelatinization time for both samples could be as a result of high heat treatment which may reduce its gel temperature (Juliano and Perez, 1986) reported that higher cooking time both have a high gel temperature values.

From Table 1 above, Grain elongation during cooking ranges from 0.18-0.38 with Caprice having the highest value of 0.38 min followed by Faro 14 and IRR8 has 0.28 min and 0.28 min respectively. The grain elongation during cooking of the rice samples Faro 14 and IRR8 do not differ significantly by (P>0.05) statistically but caprice, Faro 15 and faro 44 significantly by (P<0.05).

Grain elongation of rice is one of the major characteristic of good rice (Sood and Sadiq, 1979). It was reported that higher elongation ratio of the cooked rice is preferred by the consumer than that with lower elongation ratio (Shalidulla et al., 2009) some varieties expand more in size than others upon cooking length-wise expansion without a corresponding increase in girth is considered a highly desirable rice grain quality trait (Sood and Sadiq, 1999). Grain elongation during cooking is affected by over cooking as this may lead to disintegration and curling of the cooked rice grain (Juliano et al., 1982)

The result of amount of water evaporated from the table 2 show significantly difference (P<0.05). Faro 15 and IRR_8 has the highest and the least value of 42 and 19 respectively. The solid in cooking water of the rice samples ranges from 30.2 and 97.15 with Faro 15 having the highest values of 97.15 and Faro 14 has the least value of 30.2 respectively (Table 1). The solid in cooking water of the rice varieties caprice and Faro 14 do not differ significantly by (P>0.05) statistically but Faro 15, Faro 44 and IRR8 differ significantly from each other, statistically at P<0.05). The variation in values may be as a result of the grains during and after cooking, as they are of different varieties (Borasio, 1985). Caprice, Faro 15, Faro 44 and IRR8 variety lost a very high amount of solid in the cooking water. Solid in cooking water (loss in solids), affect the stability of the cooked rice (Juliano *et al.*, 1982b). Webb (1985) proposed that cooking of rice grain reduces the rate of disintegration during cooking than the corresponding raw rice.

Table 2

SAMPLES	AMYLOSE (%)	AMYLOPECTIN (%)
Caprice	37.2^{a}	62.8^{c}
Faro 14	30.2^{b}	69.8^{d}
Faro 15	7.6^{e}	72.4^{a}
Faro 44	21.7^{c}	78.3^{c}
IRR8	20.2^{d}	79.8^{b}
LSD	0.26	0.26

Chemical Properties Of The Rice Samples

Results are average value of triplicate samples value with same alphabet in a column are not significant at (P>0.05).

Table 2 shows the chemical properties of the rice samples. The amylose content of the rice samples ranges from 7.6-37.2% with Caprice having the highest percentage of amylose of 37.2% followed by Faro 14 having 30.2%. The amylose content of rice samples varies significantly at (P<0.05). Differences in amylose content are attributed to characteristics of the varieties and in part to the differences in the environmental conditions in which the crop is grown, particularly temperature (Hettiarachchy *et al*., 1997). Rice varieties with a greater proportion of starch in the form of amylose tend to have a lower glycemic index.

Amylose content of milled rice has been found to be positively correlated with hardness values of cooked rice and negatively with stickiness value (Perez et al., 1987). Cooking quality of rice mainly depends on amylose content and gelatinization temperature. Amylose contents determine the texture of cooked rice and rice varieties the texture of cooked rice and rice varieties with amylose content of more than 25% absorb more water and have a fluffy texture after cooking (Frei and Becker, 2003). Since Caprice and Faro 14 had the highest percentage of amylose, this means that Caprice and Faro 14 will be ideal for the use of diabetic patients. Since starchy foods with high amylose level are associated with lower blood glucose level and slower emptying of the human gastrointestinal tract compared to those with low levels of this macromolecule (Frei and Becker, 2003). Feeding with cooked rice high in amylose instead of cooked rice low in amylose may be effective to control serum blood glucose and lipid (Magdy *et al.*, 2010). Moreso, Cristiane et al. (2007) reported that serum triglyceride and cholesterol levels significantly decreased after consumption of a diet rich in amylose compared to a diet rich in amylopectin (Low amylose). Rice varieties high in amylose would invariably be low in amylopectin content.

The amylopectin values of rice from Table 2 ranges from 62.8 and 79.8 respectively, where IRR8 has the highest percentage of amylopectin and Caprice has the lowest percentage of amylopectin, statistically, there is significant difference (P<0.05) among the rice samples in terms of amylopectin content. Amylopectin is composed of glucose molecules with branched 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). The starch of waxy rice varieties consists of amylopectin only. These varieties absorb less water upon cooking and have a sticky texture (Frei and Becker, 2003). Foods with a higher GI are, in principle, more quickly digested than those with a lower GI value. Therefore, Caprice and Faro 14 with the least percentage of amylopectin may be better suited 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.

Table 3

SAMPLE	LENGTH (m)	WIDTH (m)	LENGTH/WIDTH RATION (MM)
Caprice	0.753^{a}	0.217^{d}	3.470^{a}
Faro 14	0.661^{b}	0257^{c}	2.572^{b}
Faro 15	0.642^{c}	0.285^{a}	2.522^{c}
Faro 44	0.595^{d}	0.267^{b}	2.228^{d}
IRR8	0.628^{e}	0.287^{a}	2.188^{d}
LSD	0.0037	0.0045	-

Physical Properties Of The Rice Samples

Result are average score of triplicate samples values with same alphabet in a column are not significant at (P>0.05).

The physical properties of the rice samples are shown in Table 3. The length of the rice samples ranged between 0.595 and 0.753m with caprice having the highest value and Faro 44 having the lowest value. The values of the raw samples are classified as medium and long grain (Codex Standard, 1995). Statistically they differed quite significantly from each other at (P<0.05).From the Table 3, the width of the samples ranges between 0.217 and 0.287m with IRR8 and caprice has the highest and lowest value respectively. Statistically, the values of raw rice samples differ significantly from each other at (P<0.05)

The length/width ratio (shapes) of the rice varied from 2.188 to 3.470mm. The ratio of 3.470 for caprice was the highest and it differed quite significantly with others (P<0.05). The other varieties were observed not to differ in their shape (P<0.05). Wasserman and calderwood (1972) reported that rice samples whose ratio was greater than 3.0 are classified as slender, ratios between 2-3 are bold grains while ratios < 2 are round. All the tested varieties fall within the bold shape except caprice which falls within the slender shape. The shape of the grain influences its volume and weight. In slender varieties of rice occupy more volume than round varieties. Therefore, one tonne of a slender variety of rice will need more storage space than the same weight of a round variety of rice. If rice is traded in volume rather than in weight, the buyer will gain if it is a round variety while the seller will gain if it is a slender variety. Size and shape of rice affect many other properties like sieving, dehusking, polishing, storage as well as cooking. Consumer preference for grain size and shape vary from one group to another. Anonymous (1997), reported that in Bangladesh, high income people prefer long slender grains whereas the low income group prefer the short bold grains because of its high volume expansion. The grain size and shape of most modern rice varieties is short to medium bold with translucent appearance (Biswas et al., 1992).

CONCLUSION

The result of the analysis carried out on four different local rice varieties and foreign rice shows that cooking time varied with variety and depended very much on gelatinization temperature. Volume expansion during cooking was observed to differ with variety. Gelatinization time was not dependent on cooking time or gelatinization temperature. Solid loss during cooking was observed to be less in Faro 44 than the other varieties and there is significant difference in their physical, amylose and amylopectin content of the rice samples.

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