FUNCTIONAL AND SENSORY PROPERTIES OF FIVE RICE VARIETIES PRODUCED IN OHAUKWU LOCAL GOVERNMENT AREA, EBONYI STATE.

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Abstract
Four local varieties of rice (IRR8Okwor, Faro 44 Okwor, Faro 15 Okwor, Faro 14 Okwor) grown and processed in Ohaukwu Ngbo and One foreign variety rice (caprice gold) were analyzed for their functional properties and sensory properties. The functional properties for all the varieties showed, water absorption capacity in the range of 0.1 to 0.2 mg/g, viscosity 2.88 to 9.80 RVA, swelling index 1.75 to 2.207, bulk density 0.625 to 0.769 g/cm³, and colour 20 to 69. Sensory evaluation of the five varieties indicates that caprice was generally preferred by the panelist in terms of colour, taste, aroma, texture and general acceptability. The results obtained from the four different local varietiesrice and foreign rice showed significant difference in their functional and sensory properties.

Keywords: caprice, functional properties, sensory properties, local varieties

INTRODUCTION
Rice (Oryza Sativa) is one of the most important cereal foods in the world. It is consumed mostly as intact grains with the exception of 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 brown on the endosperm (Lyon et al., 1999). The history and origin of rice cannot be fully stated though, it was discovered that, this cereal grain was first cultivated in China since ancient time and was introduced to India before the time of the Greeks. The geographical site of the origin of rice domestication occurred independently in China, India and Indonesia, thereby giving rice to three races of which are the Indonesia, India and China (also known as bulu in Indonesia). The common cereal cultivated in Nigeria includes, millet, maize sorghum, rice etc. (Okaka, 1997). Rice is a staple food for over half the world’s population. It is the predominant dietary energy for 17 countries in Asia and the pacific, 7 countries in North and South America and 8 countries in Africa. Rice provides 20 percent of the world’s dietary energy supply, while wheat supplies 19 percent and maize 5 percent (Food and Agricultural Organization of United Nations, 2005).

Rice is consumed and enjoyed by people when cooked soft. Texture and stickiness are the properties that determine the eating quality of cooked rice. There are other factors like colour of rice which differ much from variety to variety. Different people in different country have different liking for these qualities (Conway et al., 1992). These properties are related mainly to the nature of the starch in rice. Nearly 90% of the solid matters in milled rice are starch. Starch in nature is of two types’ amylose and amylopectin. Generally, amylose in rice starch ranges form 0-35%. It has been found that the more amylose the rice contains the more hard and sticky it become during cooking (Juliano and Pascal, 1980). The amylose content of rice is considered as the main parameter of cooking and eating quality (Juliano, 1972). On the other hand, the lower the amylose (that is more amylopectin) the sticky and more soft the rice become after cooking.

There are several varieties of rice and each variety varies in their functional and sensory characteristics. Sanniet 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 functional and sensory characteristics. Therefore, there is need to determine the functional and sensory 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 OkworNgbo rice mill in Ohaukwu LGA. The samples were collected consecutively for two days to get a representative samples. The varieties are (and foreign rice (Caprice gold) was bought from Abakaliki market.
The rice samples were analyzed for their functional and sensory properties.

**Sample Preparation**
The purchased rice samples were manually cleaned to remove crack kernels and foreign materials such as stones, dirt’s and immature grains.

**Methods**
The four locally processed rice sample (IRR8 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 and placed in thermostatically controlled heating mantle at 95°C. The cooked samples were then drained and stored for functional and sensory analysis.

**Functional Properties of Rice Sample**

**Bulk Density**
This method of Aluko and Yada (1995) was used. 2g of the cooked rice samples was measure into calibrated measuring cylinder. The bottom of the cylinder was tapped repeatedly on a pad placed on a laboratory bench. Tapping was done until there was no further reduction in the volume occupied by the sample. The bulk density was determined as the ratio of the weight of the sample to its volume calculated as

\[
\text{Bulk Density} = \frac{W}{V}
\]

Where

- \( W \) = Weight of sample in gram
- \( V \) = volume of sample in \( \text{Cm}^3 \)

**Swelling Index**
Swelling index was calculated using the method of (Akinyele et al., 1986). 1g of the processed sample was weighed and dispersed into a test tube, leveled and the height noted. Distilled water (10ml) was added and allowed to stand for 1h. The height was then recorded and the swelling index calculated as the ratio of the final height to the initial height.

\[
S = \frac{H_2}{H_1}
\]

Where

- \( S \) = swelling index
- \( H_1 \) = Initial height
- \( H_2 \) = Final height

**Viscosity**
The method of Onwuka (2005) was used. Viscosity was determined by suspending 10% flour of the samples in distilled water and stirred mechanically for 2 hours at room temperature. Using Oswald type of viscometer was used to measure the viscosity of the samples.

**Water Absorption Capacity**
The method of Onwuka (2005) was used. 1g of sample was weighed and poured into a conical graduated centrifuge tube, then using a warning whirl mixer to mix thoroughly with 10ml of distilled water added for 30 seconds. The rice sample was allowed to stand for 30 mins at room temperature and then centrifuged at 500 g for 30 mins. The volume of free water was read directly from the graduated centrifuge tube and calculated with the formula below.

\[
\text{Water Absorption Capacity (WAC)} = \frac{\text{Final volume of water} - \text{initial Volume of water}}{\text{Cm}^3}
\]

**Colour**
Colour was determined by using photoelectric colorimeter.

**Statistical Analysis**
The results were made in triplicate and the mean score were subjected to analysis of 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 Functional Property of the Rice Samples**

<table>
<thead>
<tr>
<th>Samples</th>
<th>WAC (mg/g)</th>
<th>Viscosity (m²/s)</th>
<th>Swelling Index (g/g)</th>
<th>Bulky Density (g/cm)</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caprice</td>
<td>0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.795&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.769&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Faro 14</td>
<td>0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.88&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.754&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.714&lt;sup&gt;b&lt;/sup&gt;</td>
<td>31&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Faro 15</td>
<td>0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.34&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.207&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.667&lt;sup&gt;c&lt;/sup&gt;</td>
<td>28&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Faro 44</td>
<td>0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.088&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.714&lt;sup&gt;b&lt;/sup&gt;</td>
<td>27&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>IRR8</td>
<td>0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.88&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.833&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.625&lt;sup&gt;d&lt;/sup&gt;</td>
<td>20&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD</td>
<td>0.06</td>
<td>0.02</td>
<td>-</td>
<td>0.008</td>
<td>2.68</td>
</tr>
</tbody>
</table>

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

WAC= water absorption capacity/water uptake ratio

Table 1 shows the functional properties of the rice samples. From the Table, the water absorption capacity of the rice ranges from between 0.1 and 0.2%. Caprice and Faro 14 varieties had the highest values of 0.2 and 0.2% respectively, and the differed quiet significantly from others (P<0.05). The other varieties did not differ.
in their water absorption capacity (P>0.05), this highest value could be as a result of level of protein and starch which is responsible for the water absorption capacity (Tukeuchiet al., 1997). Amylose content might also be responsible for high water absorption capacity (Frei and Becker, 2003) as had 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 (Frei and Becker, 2005). It is worthy to note that high water absorption capacity affects the palatability of the cooked rice negatively. Many rice studies have concentrated on the soaking of rice grains at fixed temperature (Tukeuchiet al., 1997). Table 1 showed the functional properties of the rice samples. The viscosity of the rice samples ranges from 2.88 and 9.80m²/s with Caprice having the highest value of 9.80 and IRR8 has the least value of 2.88 respectively. Statistically, there is significant difference (P<0.05) between all the samples of the rice. The difference in viscosity is attributable to characteristics for varieties and in part to the difference in the environmental conditions in which the rice is grown, particularly temperature (Hettiarachchyet al., 1997).

The swelling index of the rice samples ranges from 1.754 to 2.207 with Faro 15 having the highest values of 2.207 while Faro 14 have the lowest value respectively, and they differed quite significantly from other samples (P<0.05). The other varieties did not differ in their swelling index (P>0.05). Swelling power indicates the ability of starch to hydrate under a specific cooking condition (92.5°C/30min) as reported by Sing et al. (2006). The swelling of the granules increases their size and directly changes the texture of the rice (Hupet et al., 2004). Previously Liict et al. (1995) explained that amylopectin and the crystal region of the starch granule are responsible for swelling and observed high swelling with low amylose in rice. The degree of swelling and level of solubilization also depends on the extent of chemical bonding within the granules, and also the degree of swelling and the amount of solubilization and on the chemical binding within the granules (Zholet et al., 2002). Sanjiva (1999) also opined that the extent of swelling of any variety of rice during cooking could be used as index of its quality.

The bulk density of the rice samples ranges between 0.625 and 0.769g/cm³ with Caprice having the highest value and IRR8 is having the lowest value. They differ significantly from each other statistically (p<0.05). Density is a determinant factor towards size and shape. Density is also an important factor to consumer preference. This is supported by the fact that round grains have the highest bulk density and slender grains the least. Bhattacharyya et al. (1999) reported a mean density of 1.452g/ml for different rice varieties. The more round the grain, the greater is the bulk density.

The colour of the rice samples ranged between 20 and 69 with Caprice having the highest value and IRR8 has the lowest value. The colour of the rice samples differs significantly from each other at p<0.05. Colour is used as one criteria of quality in all rice. The assessment however is performed on well milled whole grain rice (Grist, 1986). Colour of rice is often referred to as general appearance. Smut, which impacts a grey colour influences rice colour and gives milled rice a rosy colour, hence the result as obtained in this study (Grist, 1986).

### Table 2 Sensory Evaluation of the Cooked Rice Sample

<table>
<thead>
<tr>
<th>Samples</th>
<th>Colour</th>
<th>Taste</th>
<th>Aroma</th>
<th>Texture</th>
<th>General Acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caprice</td>
<td>8.15a</td>
<td>8.10a</td>
<td>8.10a</td>
<td>8.00a</td>
<td>8.30a</td>
</tr>
<tr>
<td>Faro 14</td>
<td>6.30b</td>
<td>6.55b</td>
<td>6.75ab</td>
<td>6.70b</td>
<td>6.85b</td>
</tr>
<tr>
<td>Faro 15</td>
<td>6.15b</td>
<td>6.90ab</td>
<td>7.60a</td>
<td>7.05b</td>
<td>7.00b</td>
</tr>
<tr>
<td>Faro 44</td>
<td>7.8ab</td>
<td>7.25ab</td>
<td>7.10ab</td>
<td>7.40ab</td>
<td>7.65ab</td>
</tr>
<tr>
<td>IRR8</td>
<td>6.05b</td>
<td>6.45b</td>
<td>6.65ab</td>
<td>6.85b</td>
<td>6.50b</td>
</tr>
<tr>
<td>LSD</td>
<td>0.55</td>
<td>0.25</td>
<td>0.61</td>
<td>0.59</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Mean value in the same column with the same superscript are not significantly different (P<0.05) from each other.

The sensory evaluation which is the measure of the degree of likeness of the cooked rice samples are shown in Table 2. The cooked rice samples were analyzed for colour, taste, Aroma, texture and general acceptability for cooked rice.

The colour of the cooked local rice and foreign rice ranges from 6.05 to 8.15. Caprice has the highest appreciable colour while IRR8 and Faro 15 have the least appreciable colour. There was no significant different (p>0.05) on rice varieties (Faro 14, Faro 15, and IRR8) but significant different (p<0.05) exist with Caprice and Faro 44 rice. It is clearly indicated that consumers do not prefer dark cooked coloured rice like IRR8 and may have contributed to its low demand by consumers in the market. The result also indicated that the colour of Caprice was most preferred by consumers. From table 2 also, the taste of cooked local and foreign rice ranges from 6.45-8.10. Caprice has the highest appreciated taste while IRR8 has the least appreciated taste. The panelist expressed more satisfaction on the...
taste of caprice followed by Faro 44, which implies that caprice and faro 44 have the best taste while IRR8 rice are the least taste because it has the least appreciated taste of 6.45. It was observed that the colour of the IRR8 local rice has an effect on it taste and may be contributed to its low demand by consumer. Milling degree and protein levels in milled rice affects taste and flavour of rice (www. Seafood.com, 2005). In general, rice with high protein has a bland taste compared to rice with less protein (ww.seafood.com, 2005).

The aroma of cooked local rice and foreign rice varieties in Table 2 shows a range of 6.65-8.10. IRR8 has the least aroma as observed by panelist while caprice has the best aroma with the average range of 8.10. C. The panelist could not observed any significant different (p>0.05) in aroma of caprice, Faro 14, Faro 15, Faro 44 and IRR8 local rice varieties. The outer layers of the kernel contain the highest levels of oxidizable compounds that contribute to other aroma (Barber, 1972). This odour and aroma contributes to the consumer’s general acceptability and preference.

From table 2, the texture of cooked local and foreign rice ranges from 6.85-8.00. IRR8 has the highest appreciated texture while Caprice has the highest appreciated texture. The panelist expressed more satisfaction for the texture of Caprice followed by Faro 44 which implies that Caprice and Faro 44 rice have the best texture as preferred by panelist while IRR8 rice are the lesser value base on texture. Rice texture is affected by factors such as variety, amylose content, and gelatinization temperature, processing factors and cooking method.

From Table 2, the general acceptance of the local and foreign rice varieties ranges from 6.50-8.30. Caprice has the highest score of 8.30 while IRR8 has the least score of 6.50. Furthermore, Suwansri et al. (2001) reported that colour, aroma, flavour, and texture strongly impact consumers’ acceptance of cooked rice. Generally, caprice and faro44 are the most preferred in all the sensory attributes evaluated. This may be due to the fact that appearance and aroma were the most important factor determining Consumer’s acceptance of cooked non-aromatic and aromatic rice varieties (Meullenet et al., 2001).

CONCLUSION
The result of the analysis carried out on four different local rice varieties and foreign rice shows significant difference in functional and sensory properties of the rice samples. It can also be concluded from the responses of the sensory panelists that Faro 44 was highly rated in terms of sensory parameters (colour taste, aroma, texture and general acceptability); hence Faro 44 rice can be used as an alternative for foreign rice (Caprice gold). Results from this study can be used to promote a greater consumption of Faro 44 in spite of foreign rice.

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