

COOKING CHARACTERISTICS AND VARIATIONS IN NUTRIENT CONTENT OF SOME NEW SCENTED RICE VARIETIES IN GHANA

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Abstract

Commercially grown rice (*Oryza sativa*), though not an indigenous crop, has become an important staple in Ghana. But consumer preference is for imported rice. To promote the consumption of locally grown rice, consumers must know the desirable nutritional, cooking and eating quality characteristics of local rice. This study therefore evaluated the nutritional and cooking characteristics of some scented rice types in Ghana in order to provide data needed for quality improvement. Results show that the imported brands differed significantly ($p < 0.05$) from the local varieties by cooking faster (15.3-16.2 minutes) and having high lengthwise expansion (1.45-1.48). The local varieties had high water uptake ratios (1.91-2.08). Also, the local varieties generally had significantly higher mineral levels but Ex-Hohoe clustered separately from the other local varieties due to its high Mn and P content. The mean values (mg/kg) ranged as follows: Fe: 5.0-8.3, Zn: 18.2-20.8, K:1064-1171, Mg: 228-290, S:1005-1121, Mn: 8.4-11.5, P:1165-1374 and Ca: 110-111. Ranges for mean mineral content (mg/kg) for the imported brands were: Fe: 2.1-2.7, Zn: 16.4-16.7, K:753-827, Mg: 0.1-18, S:1052-1106, Mn: 8.6-8.7, P:657-688 and Ca: 108. Whilst the imported brands showed better cooking characteristics, the local varieties were nutritionally superior. The nutritional quality of the local scented rice varieties would be a useful index for promoting their use to address malnutrition.

Keywords: nutrient, composition, cooking, aromatic, indigenous, imported, rice

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1. INTRODUCTION

Rice (*Oryza sativa*) provides an inexpensive, non perishable and convenience food for urbanites and it is also grown and used by subsistence farmers in the rural areas (FAO, 2005; Tomlins, 2007). It is grown and consumed in more than 40 countries on the African continent. However, there is a high influx of imported rice onto the urban markets in sub-Saharan Africa (Nwanze et al., 2007). A survey on consumer perceptions, knowledge and preferences for rice types in Ghana revealed that most of the respondents are regular consumers of rice with about 95% of them being familiar with imported rice; leading to a corresponding high patronage (Diako et al., 2010). In Ghana, this consumer penchant for imported rice is reflected in a high demand deficit and heavy imports of rice (Ayithey and Banini, 2009). Over reliance on the importation of agricultural produce has a serious implication for incomes, food security and poverty reduction for developing countries like

Ghana. The Ghana Rice Inter-Professional Body (GRIB) has identified the potential of domestic aromatic rice varieties in the country. One of GRIB's current pursuits is the quality perfumed rice program which involves the development of markets for raw milled aromatic rice for big consumer centers. The intent of this venture is to select and promote the best domestic aromatic rice varieties to be grown by farmers to capture the huge market demand for aromatic rice in the country; and hence promote the patronage of local rice. Cooking and nutritional characteristics of rice are linked to consumer preferences for rice (Bhattacharjee et al., 2002; Isono et al., 1994; Song et al., 1991).

A study on urban rice demand analysis in Nigeria revealed that 85% of the respondents preferred imported rice because of the taste, neatness and quick cooking potential as compared to the local rice (Odusina, 2008). Therefore, to improve marketability of these new local scented rice types, their nutritional quality and cooking behaviour need to be

investigated and highlighted. This study evaluated the nutritional and cooking characteristics of some scented rice types in Ghana in order to provide data needed for quality improvement and enhanced market competitiveness.

2. MATERIALS AND METHODS

Samples

Four local varieties and two imported brands of scented rice were evaluated for their cooking and nutritional qualities. Three of the local varieties (*Marshall*, *Ex-Baika* and *Jasmine 85*) were grown under the same environmental and fertilizer regimes. The other local variety – *Ex-Hohoe* – was cultivated under rain-fed conditions. The two imported rice brands used as controls – *Sultana* and *Royal Feast* – were obtained from a retail outlet in Accra based on their high consumer patronage, as revealed by a preliminary consumer survey of local and imported aromatic rice varieties sold on the Ghanaian market (Diako et al., 2010).

Methods

Cooking Characteristics: The cooking characteristics evaluated were: minimum cooking time, water uptake ratio and elongation ratio (Singh et al., 2010) and amylose content (Blakeney et al., 1994.)

Nutritional Analysis: Nutritional analysis evaluated were proximate composition (AOAC, 2000) and mineral analysis - iron, zinc, potassium, magnesium, phosphorous, sulfur, manganese and calcium contents using X-ray fluorescence spectroscopy using the following procedure: Rice grains (7 g) were ground by adding tungsten balls in a paint shaker (Fast and Fluid Management SO 400 Service; The Netherlands) for 1 hour at speeds of up to 720 rpm. The fine ground rice flour (5 g) was pelleted in a stainless steel mould at a pressure of 10 t. The pellet was then placed in a Panalytical MiniPal 4 X-Ray Fluorescence and run for 30 minutes. Measurement was based on a standard calibration curve of the National Institute for Standards and Technology, USA,

using rice flours of known micronutrient concentrations.

Statistical Analysis: Minitab (version 14) was used for statistical analysis and graphical presentation of the data. ANOVA was used to test for significant differences between means. A multiple range test (Tukeys Honestly Significant Differences) was conducted at a level of significance of $p < 0.05$. Cluster analysis (cluster observations) was carried out to determine rice varieties with similar characteristics. Principal Component Analysis (PCA) was used to determine any patterns and to explore the relationships between the various parameters and the rice samples.

3. RESULTS AND DISCUSSION

Cooking Characteristics

Statistically significant differences ($p < 0.05$) were observed for the rice cooking quality indicators (Table 1). The local rice varieties had higher minimum cooking times, higher water uptake ratios and higher amylose contents than the imported brands. Cooking times ranged from 15.31 minutes for *Sultana* to 23.27 minutes for *Jasmine 85*. Grains of smaller thickness and higher degree of milling have lower cooking times than those with larger thickness and coarser surfaces (Mohapatra, D. and Bal, S. 2006). The results of this study agree with this finding.

The imported brands, being better polished and having smaller sizes than the local varieties, cooked faster. Grain elongation on cooking is dependent on genetic factors as well as the degree of milling. Highly polished rice tends to have higher elongation ratio due to less restriction by streaks of bran on the expansion of starch granules (D. Mohapatra and S. Bal 2006).

The differences in the degree of milling could have contributed to their higher elongation ratios. Rice that expands lengthwise gives finer appearance while that which expands girthwise gives a coarser appearance on cooking (S. S. Dipti et al., 2004).

Table 1. Cooking characteristics of some scented rice varieties in Ghana

Sample	Minimum Cooking Time /min	Water Uptake Ratio	Elongation Ratio	Amylose (%)
<i>Local varieties</i>				
Ex-Baika	20.13±0.03 ^b	1.91±0.01 ^{a,b}	1.41±0.01 ^{b,c}	17.5±0.91 ^b
Ex-Hohoe	22.57±0.47 ^c	2.05±0.01 ^b	1.34±0.08 ^a	22.7±0.06 ^d
Jasmine 85	23.27±0.23 ^c	2.08±0.02 ^b	1.43±0.08 ^{b,c}	20.2±0.02 ^c
Marshall	21.07±0.03 ^b	2.01±0.06 ^b	1.41±0.08 ^{b,c}	19.3±0.01 ^c
<i>Imported brands</i>				
Royal Feast	16.16±0.04 ^a	1.72±0.06 ^a	1.45±0.06 ^{b,c}	16.0±0.43 ^{a,b}
Sultana	15.31±0.01 ^a	1.76±0.05 ^a	1.48±0.06 ^c	15.9±0.10 ^a

^{a,b,c} Samples with the same superscript in a column are not significantly different at p<0.05

An elongation ratio less than 1.3 is not desirable (Dipti et al., 2004). These varieties, therefore, have desirable elongation ratios. Because of their high elongation ratios (1.45 and 1.48), the imported brands had a finer appearance on cooking while the local varieties had a relatively coarser appearance due to their lower elongation but higher water uptake ratios. The amylose contents ranged from 15.9 to 22.7% with the imported brands having lower amylose contents than the local varieties. The varieties were, thus, classified into low to intermediate amylose content rices (Juliano, 1981). Jasmine 85 and Ex-Hohoe are intermediate amylose varieties (20 – 25%) while the rest are low amylose rice types (10 – 20%). The amylose content determines the stickiness and hardness of cooked rice. Unlike

high amylose rice which cooks dry and less tender, becoming hard on standing; these low to intermediate amylose rice varieties will produce a soft, relatively sticky rice on cooking.

Nutrient Variations

Samples showed significant differences (p<0.05) in their mineral and proximate compositions (Tables 2 and 3). The moisture levels were within the acceptable limit (12%) for long term storage of rice (C. R. Adair, 1973). Protein content recorded for the varieties in this study were generally lower (5.3 – 5.9%) than what has been previously observed for common rice varieties, including scented ones, which ranged from 7.1 to 8.9% (Bhattacharjee, 2002).

Table 2. Mineral composition of some scented rice varieties in Ghana

Sample	Mineral (mg/kg)							
	Fe	Zn	K	Mg	P	S	Mn	Ca
<i>Local varieties</i>								
Ex-Baika	5.3 ^b	19.4 ^c	1065 ^c	229 ^c	1184 ^c	1093 ^d	8.7 ^{a,b}	111 ^b
Ex-Hohoe	6.1 ^c	20.8 ^d	1147 ^d	288 ^f	1374 ^e	1005 ^a	11.5 ^c	108 ^a
Jasmine 85	5.0 ^b	18.2 ^b	1170 ^e	261 ^e	1244 ^d	1067 ^c	8.4 ^a	110 ^{a,b}
Marshall	8.0 ^d	18.0 ^b	1152 ^d	243 ^d	1167 ^b	1121 ^f	8.9 ^b	110 ^{a,b}
<i>Imported brands</i>								
Royal Feast	2.1 ^a	16.6 ^a	755 ^a	0.1 ^a	658 ^a	1052 ^b	8.6 ^{a,b}	108 ^a
Sultana	2.7 ^a	16.4 ^a	827 ^b	18 ^b	686 ^a	1106 ^e	8.7 ^{a,b}	108 ^a

^{a,b,c,d,e} Samples with the same superscript in a column are not significantly different at p<0.05

Table 3. Proximate composition of some scented rice varieties in Ghana

Sample	Proximate Composition (%)				
	Moisture	Protein	Fat	Ash	Crude fibre
<i>Local varieties</i>					
Ex-Baika	11.8±0.05 ^a	5.8±0.16 ^b	0.7±0.06 ^c	0.5±0.03 ^{a,b}	0.05±0.02 ^{a,b}
Ex-Hohoe	11.6±0.04 ^a	5.6±0.14 ^{a,b}	0.7±0.07 ^c	0.7±0.13 ^b	0.22±0.01 ^d
Jasmine 85	11.6±0.04 ^a	5.8±0.10 ^b	0.5±0.03 ^b	0.6±0.01 ^{a,b}	0.11±0.01 ^{b,c}
Marshall	12.2±0.04 ^b	5.9±0.01 ^b	0.7±0.07 ^c	0.6±0.02 ^{a,b}	0.02±0.01 ^a
<i>Imported brands</i>					
Royal Feast	11.7±0.04 ^a	5.3±0.15 ^a	0.1±0.01 ^a	0.4±0.16 ^{a,b}	0.13±0.02 ^c
Sultana	11.2±0.15 ^c	5.6±0.14 ^{a,b}	0.1±0.03 ^a	0.3±0.02 ^a	0.04±0.01 ^{a,b}

^{a,b,c}Samples with the same superscript in a column are not significantly different at $p < 0.05$

Earlier research in Ghana also found generally high levels of protein in local and some breeding lines, with protein ranging from 5.95 – 10.50% (Adu-Kwarteng, 2003).

However, similar low protein contents (5.1 – 5.3%) have been observed in a different study (Champagne et al., 2005).

The results, therefore, agree with available literature. Ash content of the varieties agrees with findings of previous study (Adu-Kwarteng, 2003, Bhattacharjee, 2002). The imported brands had significantly lower ash levels than the local varieties. Fat content also similarly varied among samples. Studies on the composition of rice milling fractions have revealed significantly higher levels of nutrients in brown rice than milled rice (Juliano, 1985; Singh, 1998). The observed variations can therefore be attributed to differences milling. Crude fibre content of the rice varieties were below 1.0% and differed significantly among samples ($p < 0.05$). Ex-Hohoe registered the highest level of crude fibre (0.22%) and differed significantly from the others. The local rice varieties were rich in iron, zinc, potassium, magnesium and phosphorous. High levels of potassium, calcium and phosphorous in rice bran in Ghana has also been found (Amissah, 2003). Since most of the minerals of rice are situated in the outer layers of the rice grains, milling has an effect on the micronutrient composition of rice. Although milled, the local

varieties retained most of their mineral content than the imported brands.

Similarities and differences between rice samples

There were three clusters (Figure 1) for the rice varieties and these were divided along local and imported lines.

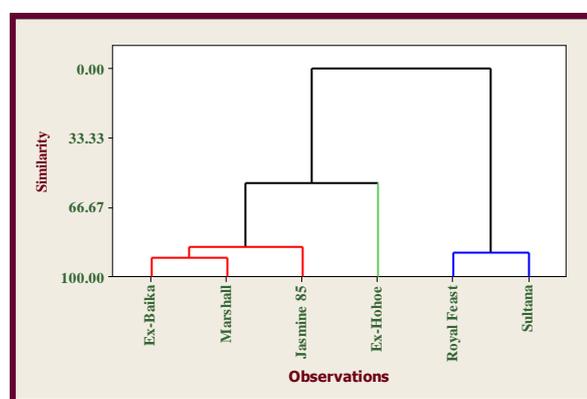


Figure 1. Dendrogram for cooking and nutritional characteristics of some scented rice varieties in Ghana

Three local varieties (Ex-Baika, Marshall and Jasmine 85) formed the first cluster. Ex-Hohoe alone was in the second cluster while the imported brands (Sultana and Royal Feast) constitute the third cluster.

Principal component analysis applied to the cooking and nutritional characteristics of the rice varieties shows that two components explained a total of 88.2% of the total

variability in the data. While PC1 accounted for 64.1% of the total variation in the cooking and nutritional characteristics, PC2 explained 24.1%.

Most of the minerals and ash loaded on the right side of PC1 (Figure 2) which corresponded to the loadings of the local varieties on the sample scores plot (Figure 3).

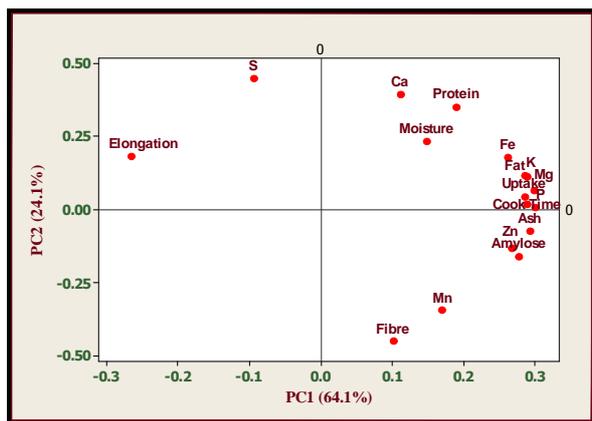


Figure 2. Variable weights plot for the PCA of cooking and nutritional characteristics of some scented rice varieties in Ghana

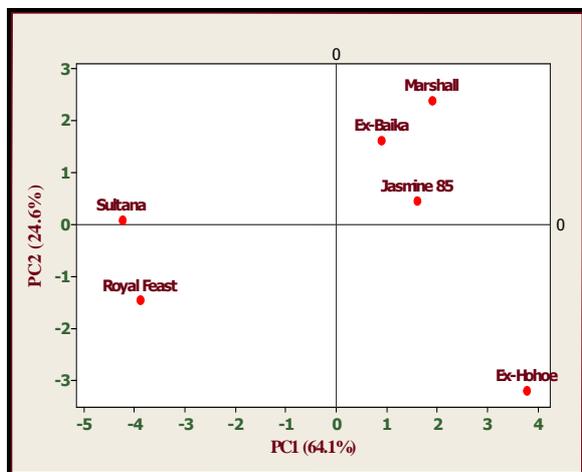


Figure 3. Sample scores plot for cooking and nutritional characteristics of some scented rice varieties in Ghana

This confirms that the local varieties are related on the nutritional level predominantly in terms of their mineral content. Due to the much higher levels of Zn, Mn, Mg and P in Ex-Hohoe, it clustered separately but on the same side of PC1 as the other local varieties (Table 2 and Figure 3). The clustering of the imported brands (Figure 2 and 3) was based on their

better cooking quality – much more as a result of their higher elongation ratios.

4. CONCLUSION

The local varieties were significantly different from the imported brands on the nutritional level. Among the local varieties, Ex-Hohoe was found to be different from the rest. The local ones were found to be associated with higher levels of ash and mineral content than the imported brands. The fact that Ex-Hohoe was different from all other local varieties has to do with its comparatively higher level of ash content which reflected correspondingly on higher levels of six of the eight minerals investigated. Whilst the local scented rice varieties were superior in their mineral composition, the imported ones had better cooking characteristics.

5. ACKNOWLEDGMENTS

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