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Full Length Research Paper

Effect of cooking and soaking on physical characteristics, nutrient composition and sensory evaluation of indigenous and foreign rice varieties in Nigeria

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The objective of this study is to ascertain the effect of cooking and soaking on the physical characteristics, nutrient composition and sensory evaluation of indigenous 'ofada' rice and foreign 'aroso' rice varieties in Nigeria. The two rice varieties were freshly purchased in the raw state, soaked in water and cooked. The physical characteristics, such as, length, width, weight, colour, purity, breakage, cooking time, dispersability and swelling capacity of the raw rice varieties were determined. The raw, soaked and cooked rice varieties were oven dried as 60°C for 4 h and milled to attain uniform surface area. The proximate composition and some minerals of the raw, soaked and cooked rice varieties and the sensory evaluation of the cooked rice were determined. Ofada and aroso rice varieties were brown and creamy in colour, respectively. There were significant ($p<0.01$) differences in the purity, breakage, cooking time, swelling capacity and weight of the whole grain, but with no difference in the length and width. The raw, cooked and soaked ofada rice contain more protein, fat, and fibre than in aroso rice, but with no change in carbohydrate content .There were no significant ($p>0.01$) differences in the levels of minerals; Ca, Fe, Mg and P, in raw, cooked and soaked ofada and aroso rice. Sensory evaluation showed that cooked aroso rice was generally preferred, in terms of colour, aroma, taste, texture and overall acceptability.

Key words: Rice varieties, 'Ofada', 'Aroso', nutrients, sensory properties, Nigeria.

INTRODUCTION

Rice is the most important cereal for human consumption. It is the staple food for over 3 billion people, constituting over half of the world's population (Cantral and Reeves, 2002; Davidson et al., 1979). Golden rice was genetically engineered to contain beta-carotene, not present in standard rice, to combat the widespread vitamin A deficiency and eradicating blindness in children of the developing world (Beyer et al., 2002; Central and Reeves, 2002). Beri-beri, as a disease from the consumption of white rice is now rare if the rice is parboiled or enriched (Davidson et al., 1979; Juliano and Perez, 1986).

Rice is grown in all the ecological and dietary zones of Nigeria, with different varieties processing adaptation traits for each ecology (Sanni et al., 2005). The two commonly cultivated varieties of rice in Nigeria are *Oryza sativa* and *Oryza glabberima* (Adeyemi et al., 1986; Abulude, 2004). Rice is an economic crop, which is important in household food security, ceremonies, nutritional diversification, income generation and employment (Perez et al., 1987). It is utilized mostly at the household level, where it is consumed as boiled or fried or ground rice with stew or soup. Rice is cooked by washing and boiling in water which leads to loss of some nutrients (Ihekeronye and Ngoddy, 1985; Perez et al., 1987). The proximate composition of rice has been previously reported (Oyenuga, 1968; Temple and Bassa, 1991; Adeyeye and

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Ajewole, 1992; Bishnoi and Khotarpaul, 1993; Adeyemi et al., 1986; Abulude, 2004).

Despite the fact that different varieties of rice are widely cultivated in Nigeria, for example, 'Ofada' and 'Abakaliki' rice, there is an upsurge in the influx of foreign or imported rice varieties into the country. A popular foreign and parboiled rice variety produced in Thailand, widely consumed and imported into Nigeria, is 'Aroso' rice. Majority of Nigerians prefer to consume foreign rice brands as compared to any of the local rice varieties produced in the country. It is therefore imperative to ascertain why this preference exists and to determine whether there are significant differences in the nutritive composition of these rice varieties. In addition, the effect of processing methods, such as cooking and soaking of the rice varieties on its physical characteristics, nutrient composition and sensory attributes can be investigated. Therefore, the objective of the present study is to investigate the effect of processing methods, specifically cooking and soaking on the physical characteristics, nutrient composition and sensory qualities of indigenous ofada and foreign aroso rice varieties in Nigeria.

MATERIALS AND METHODS

Materials

Two major and popular rice (*O. sativa*) varieties, ofada, a local and indigenous rice cultivated in the south west of Nigeria , and aroso, a foreign and imported rice produced in Thailand, were used for this study.

Physical characteristics determination

Raw dehusked grains of the two freshly produced rice varieties were pooled stored in a cool and dry container at room temperature, 27°C. The length and width of the rice grains were measured using a micrometer screw gauge, weighed, colour was reported using a colour chart and while purity and breakage were determined by weighing and simple calculations. The swelling capacity, cooking time and dispersability were determined according to the method of Bishnoi and Khotarpaul (1993).

Nutrients determination

Five hundred gram of the raw rice varieties was cooked in 2 litres of water in a serile steel pot for 45 min. The cooked rice varieties were oven-dried (Gallenkamp, model 420) at 60°C, before being ground to pass through in a 45 mm mesh serve and used for further analysis. 500 g of raw grains were washed with 4 litres of distilled water to remove impurities and later soaked in 2 litres of water at room temperature for 6 h.The soaked rice was drained, oven-dried and ground as previously described. The proximate moisture, ash, crude protein (N x 5.70), fat,crude fibre and carbohydrate of the raw, cooked and soaked rice varieties were determined according to the method of AOAC (2000). The levels of iron, calcium, magnesium and phosphorus ions in the raw, cooked and soaked rice varieties were analyzed using atomic absorption spectrophotometer (AAS Model 305 B). The base line of the instrument was set to zero with the standards and the Boerhinger commercial control samples as per manufacturer's instruction. The caloric values of whole grain and, of protein, fat and carbohydrate in the grain were computed (Davidson et al., 1979).

Sensory evaluation

Sensory evaluation of the cooked rice varieties was carried out by 20 untrained taste panelists in a special room prepared for the purpose (Ebuehi et al., 2004). They were instructed to taste the rice samples and to rinse their mouth after each sample taste. They were requested to express their feelings about the samples by scoring the following attributes: appearance, texture, taste, aroma and overall acceptability. Sensory scores were based on a nine point hedonic scale, where 1 is dislike extremely and 9 is like extremely (Watts et al., 1989).

Statistical analysis

Differences between means were assessed by Student's t-test, while the levels of significance of the data were calculated by analysis of variance according to Snedecor and Cochran (1969).

RESULTS AND DISCUSSION

The physical characteristics of raw ofada and aroso rice varieties are presented in Table 1. The ofada and aroso rice varieties were brown and creamy in colour, respectively, while the dispersability of both varieties in hot and cold water were good. The aroso rice was smoother and purer than ofada rice, which often contains more dirt, small stones and with rough surfaces. The aroso rice was slightly longer and thinner than the ofada rice while the ofada rice was heavier than the aroso. The aroso rice gets cooked much faster than the ofada rice. There were no significant ($p>0.01$) differences in the length and width of whole grain, but there were significant differences in the purity, breakage, cooking time, swelling capacity and weight of whole grain (Table 1).

The nutrient composition of raw, cooked and soaked ofada and aroso rice varieties are shown in Table 2. The raw, cooked and soaked ofada rice were significantly ($p<0.01$) higher in protein, fat, ash and fibre contents than in aroso rice, but with no significant change in carbohydrate content. The moisture contents of raw, cooked and soaked ofada rice were significantly lower than in aroso rice (Table 2).The iron and calcium ions levels in the raw, cooked and soaked ofada and aroso rice were not significantly ($p>0.01$) different. The magnesium ions levels were not significantly different in both cooked and soaked ofada and aroso, but higher in the raw aroso than in raw ofada. The phosphorus levels of the raw, cooked and soaked ofada rice were significantly higher as compared to aroso rice. The total energy in the raw, cooked and soaked ofada and aroso rice varieties do not significantly vary. The individual energy from carbohydrate, protein and fat were not significantly altered in all the raw, cooked and soaked rice varieties.

The mean sensory scores of the cooked ofada and aro-

Table 1. Physical characteristics of raw ofada and aroso rice varieties*.

Rice Variety	Colour	Dispersability		Purity %	Breakage %	Swelling capacity	Cooking time (min)	Mean/S.D length of whole grain (mm)	Mean/S.D width of whole grain (mm)	Mean/S.D weight of whole grain (g)	
		hot water	cold water								
ofada	brown	good	good	87.8±2.53	43.8±1.56	0.024± 0.002	40±2.50	6.95±0.07	2.04±0.05	2.41±0.12	2nd
aroso	cream	good	good	99±1.64	13.46±1.07	0.031± 0.004	30±1.32	7.27±0.07	1.88±0.04	1.63±0.19	1st

*Values are expressed as mean ± S.D of three determinations.

Table 2. Nutrient composition of raw , cooked and soaked ofada and aroso rice varieties*.

Nutrient composition	Raw		Cooked		Soaked	
	ofada	aroso	ofada	aroso	ofada	aroso
Moisture (%)	7.5 ± 0.08	8.0 ± 0.02	9.1 ± 0.04	11.2 ± 0.31	8.1 ± 0.06	10.1 ± 0.42
Ash (%)	0.80 ± 0.02	0.53 ± 0.06	0.70 ± 0.02	0.42 ± 0.03	0.74 ± 0.03	0.47 ± 0.02
Protein (%)	7.30 ± 0.14	6.95 ± 0.07	4.19 ± 0.06	3.50 ± 0.04	6.08 ± 0.12	5.74 ± 0.08
Fat (%)	2.6 ± 0.07	1.9 ± 0.02	2.3 ± 0.05	1.8 ± 0.02	2.2 ± 0.01	1.6 ± 0.04
Crude fibre (%)	3.5 ± 0.04	1.5 ± 0.02	2.5 ± 0.03	1.0 ± 0.03	1.8 ± 0.03	1.2 ± 0.03
Carbohydrate (%)	78.3 ± 1.64	81.1 ± 1.24	81.2 ± 2.11	82.1 ± 2.04	81.1 ± 2.47	80.9 ± 2.15
Fe (mg/100 g)	46.3 ± 2.11	42.9 ± 2.15	41.6 ± 3.42	38.6 ± 4.45	42.8 ± 5.26	40.9 ± 5.08
Ca (mg/100 g)	80.0 ± 4.87	80.0 ± 2.43	72.2 ± 4.98	70.0 ± 6.17	74.3 ± 6.42	64.0 ± 7.13
Mg (mg/100 g)	67.0 ± 7.12	82.0 ± 5.46	55.8 ± 6.12	54.9 ± 3.86	45.0 ± 3.56	38.8 ± 1.54
P (mg/100 g)	73.0 ± 8.04	94.0 ± 7.24	72.1 ± 4.67	24.0 ± 2.90	57.4 ± 7.79	37.1 ± 2.56
E^o (Kcal/100 g) of Carbohydrate	312.2 ± 10.74	324.4 ± 15.30	324.8 ± 17.68	328.4 ± 10.65	324.4 ± 25.74	323.6 ± 14.35
E^o (Kcal/100 g) of Protein	29.2 ± 1.78	27.8 ± 1.45	16.8 ± 1.35	14.0 ± 1.64	24.3 ± 3.26	23.0 ± 1.86
E^o (Kcal/100 g) of Fat	10.4 ± 1.16	7.6 ± 0.87	9.2 ± 0.94	7.2 ± 0.64	8.8 ± 0.75	6.4 ± 0.36
Total E^o (Kcal) in Rice	351.8 ± 12.59	359.8 ± 16.52	350.8 ± 21.06	349.6 ± 24.42	355.5 ± 19.58	353.0 ± 24.46

*Values are expressed as mean ± S.D of three determinations.

Table 3. Mean sensory scores of cooked ofada and aroso rice varieties*.

Sensory attribute	ofada	aroso
Appearance	6.1±0.02[a]	8.0±0.01 [b]
Texture	5.5±0.04[a]	7.8±0.04 [b]
Tastes	5.3±0.06[a]	8.2±0.02 [b]
Aroma	5.4±0.03[a]	7.8±0.03 [b]
Overall acceptability	5.6±0.02[a]	8.1±0.02[b]

*Values are expressed as mean ± S.D of three determinations.

so rice varieties are presented in Table 3. The mean scores of the appearance, texture, taste, aroma and overall acceptability of the indigenous ofada rice were between 5.3 and 6.1, while those of the foreign aroso rice were between 7.8 and 8.2. There were significant ($p<0.01$) differences in the appearance, texture, taste, aroma and overall acceptability in the ofada rice as compared to aroso rice.

The two rice varieties, ofada and aroso, contain high carbohydrate contents, whether raw, cooked or soaked in water. The carbohydrate contents in these rice varieties were not affected by cooking or when soaked in water. Rice is a good source of energy since it is rich in carbohydrate. The complex carbohydrate in rice digests slowly allowing the body to utilize the energy released over a long period which is nutritionally efficient. The protein contents of ofada and aroso rice varieties were affected by cooking and soaking in water. Cooking of rice denatures the protein, which resulted in its reduction. There was a slight reduction in the protein level of both varieties when soaked in water due to solubility of some proteins.

The ofada rice variety contains higher protein at raw, cooked and soaked state, as compared to aroso rice. The variation may be due to processing, storage and transportation methods employed during and after harvesting of the rice varieties. The fat contents of both rice varieties were low and not affected by cooking and soaking in water. However the ofada rice contained more fibre than aroso rice. The differences in the fibre content may be attributed post-harvest processing techniques. Dietary fibre results in reduction of the risk of bowel disorders and fights constipation (Champe and Harvey, 1994). The aroso rice contains more water than the ofada rice at raw, cooked and soaked states. The aroso rice requires less time to cook and hence consumes lesser electricity units and energy. This finding is in agreement with Abulude (2004) and Sanni et al. (2005). It also follows that the ofada rice variety may have a longer shelf life compared to the aroso rice due to the lower moisture content.

Data of the present study show that cooking and soaking in water do not significantly affect the mineral contents of both ofada and aroso rice varieties. Both rice varieties contain useful quantities of iron, calcium, magnesium and phosphorus. These observations support previous reports (TFCT, 1999). Both rice varieties are good sources of minerals which will contribute to the recommended dietary allowance (Heinemann et al., 2005). Minerals are constituents of the bone, teeth, soft, tissue, muscle, blood and nerve cells. They are vital for overall mental and physical well-being. Minerals act as co-factors for many biological reactions within the body, including muscle contraction, neuro-transmission, production of hormones, digestion and utilization of nutrients (Champe and Harvey, 1994).

Data of the study indicate that the foreign aroso rice was preferred to the indigenous ofada rice. It is suggested that the preferred acceptance of aroso rice could be due to its physical characteristics and superior cooking attributes, in terms of cooking time and swelling capacity. Although the sum of the micro nutrients, specially vitamins were not investigated in the present study, it may be opined that enrichment with vitamins in the parboiled aroso rice may be responsible for its preference, since the local ofada rice is not fortified with any micronutrients after production.

Cooking and soaking of these rice varieties significantly resulted in nutrients depletion, especially in protein, phosphorus and magnesium. These losses in nutrients may be due to protein denaturation, anti-nutritive factors, extraction and leaching effects of water (Perez et al., 1987; Bhattacharya and Ali, 1986; Adeyemi et al., 1986; Adeyeye and Ajewole, 1992). However, differences in soil chemistry, environmental factors, storage, transportation and processing methods may contribute to variations in the physical characteristics, nutrients composition and sensory attributes of the indigenous and foreign rice varieties.

Conclusion

Nutrient depletion occurs in both indigenous and foreign rice varieties during cooking and soaking. There are significant differences in the physical characteristics, nutritive composition and sensory attributes of the local and foreign rice varieties in Nigeria, and are affected by processing methods.

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