British Journal of Applied Science & Technology
16(2): 1-9, 2016, Article no.BJAST.25875
ISSN: 2231-0843, NLM ID: 101664541

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Comparative Study of Nutrient Composition and Retention of Raw and Cooked Imported and Local Rice (*Oryza sativa*) Varieties

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Authors' contributions

This work was carried out in collaboration between all authors. Author AOT designed the study, supervised the technical section and carried out the writing of the second and final draft. Author AO carried out the technical aspect, statistical analysis and literature review. Author AK wrote the first draft of the manuscript and managed literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2016/25875
Editor(s):
(1) Ming-Chih Shih, Department of Health and Nutrition Science, Chinese Culture University, Taiwan.
Reviewers:
(1) Takeshi Nagai, Yamagata University, Japan.
(2) Anonymous, University of the Philippines Los Banos, Philippines.
(3) Anonymous, Acharya N G R A University, Hyderabad, India.
Complete Peer review History: http://sciencedomain.org/review-history/14673

Original Research Article

Received 24th March 2016
Accepted 22nd April 2016
Published 17th May 2016

ABSTRACT

Background: Cereals and grains constitute major sources of nutrients worldwide. Rice is a major staple in many household in Nigeria. However majority of people prefer imported rice to locally grown rice though it is costlier. Knowledge about nutrient composition of locally-grown rice can promote its acceptability and consumption among Nigerians. This study was carried out to determine the nutrient composition and nutrient retention of raw and cooked imported and local rice varieties.

Materials and Methods: Imported (*Aroso*) and local varieties (*Ofada* and *Abakaliki*) rice were purchased from Bodija market in Ibadan, Oyo state, Nigeria. The three samples were divided into two portions each. One portion each was used as raw samples while the second portion of each sample of rice was cooked for 40 minutes at 100℃. The co oked samples were then homogenised using the warring blender. The resultant six rice samples were analyzed using AOAC (2005) methods.

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Results and Discussion: An 100 g portion of raw rice samples contained between 10.97-11.36 g moisture, 6.98-8.28 g protein, 0.84-1.24 g crude fibre, 0.94-1.19 g ash, 77.51-79.46 g carbohydrates, 17.81-19.31 g amylose, 5.57-9.69 mg sodium, 113.07-118.75 mg potassium, 4.54-7.34 mg iron, 221.4-238.75 µg folate, and yielded 366.75 - 371.50 kcalories of energy. *Ofada* rice was highest in all the macro and micronutrients, followed by *Abakaliki* rice and imported rice, which was highest in gross energy. Cooking resulted in significant reduction in all the nutrients studied ($p<0.05$), but the reduction was less pronounced in the two local rice samples.

Conclusion and Recommendation: The local varieties of rice were nutritious and compared favourably well with the imported rice. Cooking caused significant reduction in the level of antinutrients in the samples. Consumption of local rice varieties is recommended as means of promoting dietary diversity.

Keywords: Local rice; nutrient composition; nutrient retention; antinutrients.

1. INTRODUCTION

Cereals are important in human nutrition and calorie intake, providing more than one fifth of the calories consumed worldwide by the human species, and are consumed in a variety of forms including pastes, noodles, cakes and breads, depending on the ethnic or religious affiliation [1]. Rice is the only cereal crop cooked and consumed mainly as whole grains, and quality considerations are much more important than for any other food crop [2].

Polished rice (or white rice), which primarily consists of starch, is produced through a series of mechanized processes including hulling and milling, and is the predominant type of rice consumed worldwide [3,4]. As of 2009 world food consumption of rice was 531,639 thousand metric tons of paddy equivalent (354,603 of milled equivalent), while the far largest consumers were China (156,312 thousand metric tons of paddy equivalent, 29.4% of the world consumption) and India (123,508 thousand metric tons of paddy equivalent, 23.3% of the world consumption) [5].

In Nigeria, rice is cultivated by local farmers at subsistence levels, enough only to feed their families and a little left over for sale at local markets. Despite being West Africa's largest producer of rice, rice yield in Nigeria is low compared to other parts of the world, and this limited production is further reduced during post-harvest storage [6]. Despite different local varieties of rice cultivated in Nigeria, 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, imported into Nigeria and widely consumed is the polished rice named locally as '*Aroso*' rice.

Most Nigerians consume foreign rice brands rather than the local varieties such as '*Ofada'* and '*Abakaliki*' produced in the country. Low consumption of these local varieties are likely due to the lack of information regarding their nutritive values, the opinion that they usually contain stones and dirt (left over bran on the rice), presence of anti-nutrients among others, thereby causing their low production. Acceptance of *Aroso* (imported) rice might be due to its physical characteristics and cooking attributes such as shorter cooking time and swelling capacity. Dietary rice bran intake and rice bran components have demonstrated chronic disease fighting activity, particularly for protection against cardiovascular disease and certain cancers [7,8], and others have shown that rice varieties are not equal in content and composition of bioactive rice bran components [9]. Rice bran contains an array of micronutrients like oryzanols, tocopherols, tocotrienols, phytosterols, 20% oil and 15% protein, 50% carbohydrate (majorly starch) dietary fibres like beta-glucan, pectin, and gum [10].

Various large-scale studies have found an overall reduction in mortality with regular whole grain consumption. For instance, the Iowa Women's Health Study of 11,040 postmenopausal women found that those who regularly consumed whole grains had a 17% reduction in overall mortality compared to consumers of refined grains [11].

The chemical and physico-chemical properties of local rice have been investigated by various researchers [12-14], but there is dearth of information on their vitamin and anti-nutrient content, as well as their nutrient retention. This study was carried out to determine the nutrient composition, anti-nutrient content and nutrient retention of the polished and local rice varieties.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

Raw samples of imported '*Aroso*', and local '*Ofada*' and '*Abakaliki*' rice were randomly purchased from different sellers at Bodija market, Ibadan, Oyo state, Nigeria. Species identification was done at Institute of Agricultural Research and training (IAR&T), Moore Plantation, Ibadan, Oyo State, Nigeria.

The raw imported and local rice samples from different sellers were thoroughly mixed together separately to obtain their representative sample. Extraneous matter such as unhealthy or infected seeds, stones and chaff were handpicked from the samples. Each sample was divided into two portions, and one portion each was grinded into flour using the regular kitchen blender and labelled as raw samples. Each of the other portions was cooked for 30 minutes (imported rice) and 40 minutes (local varieties) at 100℃. The three cooked samples were mashed to homogenous paste before analyses. The six samples were analysed chemically according to the official methods of analysis described by the Association of Official Analytical Chemists (AOAC), 2005.

Plate 1A. Raw *Aroso* rice

Plate 1B. Cooked *Aroso* rice

Plate 2A. Raw *Ofada* rice

Plate 2B. Cooked *Ofada* rice

Plate 3A. Raw *Abakaliki* rice

Plate 3B. Cooked *Abakaliki* rice

2.2 Chemical Analysis of Samples

2.2.1 Proximate composition

Moisture content of the samples was determined by air oven at 105℃ (Plus 11 Sanyo Gallenkamp PLC UK) for 4 hours. The crude protein of the samples was determined using micro-Kjeldahl method (Method No 978.04) [AOAC, [15]], by digesting 5 g of the sample with conc. H_2SO_4 and Kjeldahl catalyst in Kjeldahl flask for 4 h. The digest was made up to 100 ml, and 5 ml of the resultant solution pipetted to Kjeldahl apparatus and 5 ml of 40% (w/v) NaOH added. The mixture was steam distilled, and the liberated ammonia collected in 10 ml of 2% boric acid, and titrated against 0.01 M HCl solution. The amount of crude protein was then calculated by multiplying percentage nitrogen in the digest by 6.25. Crude lipid was determined by weighing 5 g of dried sample into fat free extraction thimble and plugging lightly with cotton wool. The thimble was placed in the Soxhlet extractor (Method No 930.09) [15] fitted up with reflux condenser. The dried sample was then extracted with petroleum ether and the crude lipid estimated as g/100 g dry weight of sample, and then converted to g/100 g fresh sample weight. The ash content was determined by weighing 5 g of sample in duplicate and heated in a muffle furnace (Gallenkamp, size 3) (Method No 930.05) [15] at 550℃ for 4 h, cooled to about 100℃ in the furnace and then transferred into a dessicator to cool to room temperature; weighed, and ash calculated as g/100 g original sample. Crude fibre was determined using the method of Saura-Calixto et al. [16]. The carbohydrate content was obtained by difference. Gross energy of the samples was determined using ballistic bomb calorimeter (Manufacturer: Cal 2k – Eco, TUV Rheinland Quality Services (Pty) Ltd, South Africa).

2.2.2 Mineral analysis

Potassium and sodium were determined by digesting the ash of the samples with perchloric acid and nitric acid, and then taking the readings on Jenway digital flame photometer/spectronic20 [17]. Phosphorus was determined by Vanado-molybdate colorimetric method [18]. Calcium, magnesium, iron zinc, manganese, copper and selenium were determined spectrophotometrically by using Buck 200 atomic absorption spectrophotometer (Buck Scientific, Norwalk) [19], and compared with absorption of standards of these minerals. Determinations were carried out in duplicate and the error reported as standard deviations from the mean.

2.2.3 Vitamin analysis

2.2.3.1 Thiamine (vitamin B_1) determination

Thiamine content of the sample was determined by weighing 1 g of it into 100 ml volumetric flask and adding 50 ml of 0.1 M H_2SO_4 and boiled in a boiling water bath with frequent shaking for 30 minutes. 5 ml of 2.5 M sodium acetate solution was added and flask set in cold water to cool contents below 50℃. The flask was stoppered and kept at 45-50℃ for 2 hours and thereafter made up to 100ml mark. The mixture was filtered through a No. 42 Whatman filter paper, discarding the first 10 ml. 10 ml was pipetted from remaining filterate into a 50 ml volumetric flask and 5 ml of acid potassium chloride solution was added with thorough shaking. Standard thiamine solutions were prepared and treated same way. The absorbance of the sample as well as that of the standards was read on a fluorescent UV Spectrophotometer (Cecil A20 Model) at a wavelength of 285 nm.

2.2.3.2 Riboflavin (vitamin B_2) determination

1 g of each sample was weighed into a 250 ml volumetric flask, 5 ml of 1 M HCl was added, followed by the addition of 5ml of dichloroethene. The mixture was shaken and 90 ml of de-ionized water was added. The whole mixture was thoroughly shaken and was heated on a steam bath for 30 minutes to extract all the riboflavin. The mixture was then cooled and made up to volume with de-ionized water. It was then filtered, discarding the first 20 ml of the aliquot. 2 ml of the filterate obtained was pipetted into another 250 ml volumetric flask and made up to mark with de-ionized water. Sample was read on the fluorescent spectrophotometer at a wavelength of 460 nm. Standard solutions of riboflavin were prepared and readings taken at 460 nm, and the sample riboflavin obtained through calculation.

2.2.3.3 Niacin (vitamin B_3) determination

5 g of sample was extracted with 100 ml of distilled water and 5 ml of this solution was drawn into 100 ml volumetric flask and make up to mark with distilled water. Standard solutions of niacin were prepared and absorbance of sample and standard solutions were measured at a wavelength of 385 nm on a spectrophotometer and niacin concentration of the sample estimated.

2.2.4 Selected antinutrient analysis

2.2.4.1 Saponins analysis

Saponin was determined by comparing the absorbance of the sample extracts with saponin standard solution at 380 nm [20].

2.2.4.2 Amylase Inhibitor Activity (AIA)

Sample (0.5 g) was weighed into a screw cap tube and shaken with 10 ml phosphate buffer for 2 hours on a tube rotator. The mixture was centrifuged at 3000 rpm for 15 minutes. The supernatant obtained was incubated at 70℃ for 10 min and filtered. The filterate was used as the inhibitor extract which was incubated at 30℃ for 30 mins. One millilitre starch solution was added after 3 minutes of incubation, followed by addition of 2 ml of 3, 5-dinitrosalycylic acid placed in boiling water bath for 5 min and cooled, with 10 ml water added. The absorbance was read at 550 nm. Enzyme inhibitor blank solution was treated as above after which 3, 5-dinitrosalycylic acid reagent was added. Different concentrations of maltose standard were prepared from 0-5 ppm and 2 ml of 3, 5-dinitrosalycylic acid added. The tubes were placed in boiling water for 5 mins, cooled and absorbance read at 550 nm. Average gradient was calculated from the absorbance of different concentration of standard maltose solutions.

2.3 Nutrient Retention

The percent apparent retention (% AR) of nutrients was calculated by the formula of Murphy et al. [21] as:

> % AR = (Nutrient content per g of cooked food on dry basis/Nutrient content per g of raw food on dry basis) x 100

2.4 Statistical Analysis

The data were analyzed using SPSS version 15.0. Descriptive statistics (mean±SD), analysis of variance (ANOVA) and Duncan multiple range test were used to interprete the data obtained at $p<0.05$.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of raw and cooked imported (Samples 1 and 2) and local rice varieties (Sample 3 – 6) are as shown in Table 1. For the raw samples, the moisture content of the three rice varieties was very low and closely related with no significant difference ($p>0.05$). *Ofada* rice had the lowest moisture content while *Abakaliki* had the highest. The result of the proximate composition of the three raw rice samples showed that they were very low in moisture content, *Abakaliki* rice being highest in value, followed by imported rice (*Aroso*), *Ofada* being lowest in value. The low level of moisture content of the rice samples accounted for their keeping quality for a long period of time without undergoing any spoilage. Cooking significantly increased the moisture content of the boiled rice samples, the imported rice having slightly higher moisture content. This is indicative of good swelling property of the rice compared to the local samples, and might probably be responsible for its being more preferred by consumers.

There were significant differences ($p<0.05$) in their crude protein content, *Ofada* variety having the highest value and *Aroso* the least. The values obtained for the crude protein of the rice samples were in close agreement with the ones reported in the literature [13]. The raw rice samples were low in crude protein. Cooking of raw rice samples resulted in significant reduction in value of crude protein. This was in line with the findings of Ebuehi and Oyewole [13]. *Ofada* variety had the highest value for crude lipid, ash and amylose content ($p<0.05$), while *Aroso* was highest in total carbohydrates and gross energy with no significant difference ($p>0.05$). There was slight reduction in amylose content of cooked *Ofada* rice while there was slight increase in the amylose content of *Aroso* and *Abakaliki* samples.

The value of crude lipid obtained in this study is lower than 1.8-2.6% reported by Ebuehi and Oyewole [13]. This difference may be attributed to the degree of milling, as milling of rice removes the outer layer of the grain where most of the fats are concentrated [22]. The fat contents of both raw and cooked varieties were very low for all the three rice samples, hence, rice is not a good source of fat. The amylose content of Ofada rice obtained in this study is within the values stated in the literature [12,23]. The high amylose content of the rice samples is an added advantage as high amylose rice cook into dry flaky form while those low in amylose content cook into pasty form [24]. The values obtained for ash content of the raw rice samples was a bit lower than the one reported by Edeogu et al.

[25], but higher than that of Ebuehi and Oyewole [13]. There was reduction in ash content in the cooked samples, which might be due to the leaching out of both macro and micro elements into cooking water [25].

The total carbohydrate content of raw rice samples in this study were higher than the range (75.37-76.37%), [26], but within the range 76.92 - 86.03%, [27] reported in the literature. *Aroso* rice was highest in carbohydrate content, followed by *Abakaliki* rice. The high carbohydrate content of the rice samples explain why rice is consumed as a staple source of energy. There was a highly significant reduction in the carbohydrate content of cooked rice sample compared with the raw one. The significant reduction is believed to be as a result of increase in moisture content of cooked samples. *Ofada* rice had highest value of all the macro nutrients in the cooked form. The three raw rice samples were high in gross energy content. This confirms the fact that rice is an energy-giving food. These gross energy content of the rice samples were higher than the values in the literature [13,14]. *Ofada* rice had the least gross energy content after cooking, followed by *Abakaliki* rice and then imported sample.

3.2 Mineral and Selected Vitamin Composition

Table 2 shows the mineral and selected vitamin composition of the raw and cooked imported and local rice varieties. The three varieties were low in sodium, calcium, and magnesium content, moderate in potassium, phosphorus and iron. *Ofada* rice was significantly higher in all the minerals studied ($p<0.05$). *Abakaliki* and *Aroso* rice had closely related values for all the minerals, with *Abakaliki* variety being insignificantly higher in value compared with *Aroso* variety. The observed difference in mineral values could be due to varietal variation, difference in soil conditions as well as the extent of polishing of the rice [28]. The very low sodium and moderate level of potassium content of rice makes it suitable for consumption by all. However, its low calcium content implies that consumption of rice should be accompanied by calcium rich source, such as vegetables and fruits.

There was a significant reduction ($p<0.05$) in all the mineral content of the cooked samples compare with their raw form. This is believed to be due to increasing level of moisture content. Cooking generally leads to reduction in mineral content of food samples due to leaching of the minerals into the cooking water [29]. *Ofada* variety retained more of its minerals in the cooked form than other two varieties, and had the highest value for all the minerals in the cooked samples.

The three varieties of rice contain appreciable amount of thiamine (0.46 - 0.64 mg/100 g), riboflavin (0.07 - 0.16 mg/100 g), and niacin (3.94 - 4.83 mg/100 g). The presence of these vitamins confirms the fact that cereals are good source of B-vitamins, and can contribute significantly to meeting their recommended dietary allowance (RDAs) [30,31]. B-vitamins are important in carbohydrate, protein and fat metabolism, and they serve as co-enzymes; hence their presence in rice is beneficial to digestion and utilisation of rice and other foods. The local rice varieties with some bran had higher values of vitamins than the imported rice which has undergone more polishing, the *Ofada* variety being the highest in vitamin content. Generally, cooking significantly reduced the vitamin content of all the samples ($p<0.05$). The *Ofada* variety was significantly higher ($p<0.05$) in all vitamins both in the raw and cooked forms, followed by *Abakaliki* rice, while *Aroso* rice had the least vitamin content.

Table 1. Proximate composition of raw and cooked rice varieties (g/100 g)

Parameter	*Aroso*		*Ofada*		*Abakaliki*	
	Raw	**Cooked**	**Raw**	**Cooked**	**Raw**	**Cooked**
Moisture	11.12 ± 1.15^{a}	70.59 ± 0.09^{b}	10.97 ± 1.50^{a}	69.73 ± 1.43^{c}	11.36 ± 1.19^{d}	70.20 ± 1.86^{e}
Crude protein	6.98 ± 0.28^{a}	2.42 ± 0.04^{b}	8.28 ± 0.25^{c}	2.71 ± 0.13^{d}	7.19 ± 0.01^{e}	2.53 ± 0.14^{f}
Crude lipid	0.67 ± 0.00^{a}	0.18 ± 0.01^{b}	0.82 ± 0.03^{c}	0.32 ± 0.01^{d}	0.62 ± 0.02^{e}	0.24 ± 0.02^{f}
Ash	0.94 ± 0.00^{a}	0.30 ± 0.00^{b}	1.19 ± 0.04^{c}	0.42 ± 0.01^{d}	1.13 ± 0.01^{e}	0.37 ± 0.01^{f}
*TC	80.30 ± 1.27^{a}	26.53 ± 0.04^{b}	78.75 ± 1.14^{c}	26.83 ± 1.27^{b}	79.72 ± 1.17^{d}	26.66 ± 1.16^{b}
Amylose	17.96^{a}	18.14^{b}	19.31^{c}	19.24^{d}	17.81^{a}	17.88^{e}
G. E (kcal/)	371.50 ± 0.41^{a}	369.65 ± 0.21^{b}	366.75 ± 0.21^{c}	364.40 ± 0.28^{d}	370.40 ± 0.28^{a}	368.75 ± 0.21^{b}

**TC = Total Carbohydrate obtained by difference.*
G. E = Gross Energy
Values with different superscripts on the same row are significantly different (p<0.05)

Table 2. Mineral and selected vitamin composition of raw and cooked rice varieties (mg/100 g)

Parameter	*Aroso*		*Ofada*		*Abakaliki*	
	Raw	**Cooked**	**Raw**	**Cooked**	**Raw**	**Cooked**
Sodium	5.57±0.11^{a}	2.06±0.06^{b}	9.69±0.30^{c}	3.13±0.17^{d}	5.93±0.06^{e}	2.07±0.08^{b}
Potassium	113.07±1.45^{a}	37.73±0.22^{b}	118.75±1.86^{c}	40.61±2.26^{d}	114.25±1.71^{e}	37.10±2.29^{f}
Calcium	27.96±0.69^{a}	9.15±0.08^{b}	31.31±0.74^{c}	10.76±0.46^{d}	28.60±0.03^{e}	9.37±0.56^{f}
Magnesium	24.36±0.56^{a}	8.28±0.10^{b}	29.81±0.85^{c}	9.71±0.41^{d}	25.49±0.08^{e}	8.36±0.48^{f}
Phosphorus	113.91±2.23^{a}	37.47±0.08^{b}	121.34±2.31^{c}	41.56±1.81^{d}	114.54±1.51^{e}	36.80±2.35^{f}
Iron	4.54±0.22^{a}	1.72±0.08^{b}	7.34±0.33^{c}	2.38±0.06^{d}	4.94±0.31^{e}	1.72±0.07^{b}
Zinc	1.43±0.23^{a}	0.54±0.07^{b}	2.75±0.25^{c}	1.00±0.02^{d}	1.78±0.11^{e}	0.64±0.01^{f}
Manganese	1.18±0.16^{a}	0.33±0.05^{b}	2.00±0.31^{c}	0.76±0.04^{d}	1.38±0.12^{e}	0.51±0.01^{f}
Copper	0.19±0.03^{a}	0.08±0.01^{b}	0.32±0.14^{c}	0.10±0.01^{d}	0.14±0.14^{e}	0.07±0.01^{f}
Thiamine	0.46±0.01^{a}	0.40±0.01^{b}	0.64±0.01^{c}	0.60±0.01^{d}	0.50±0.02^{e}	0.48±0.01^{f}
Riboflavin	0.07±0.01^{a}	0.04±0.02^{b}	0.16±0.01^{c}	0.12±0.01^{d}	0.10±0.01^{e}	0.08±0.01^{f}
Niacin	3.94±0.03^{a}	3.88±0.02^{b}	4.83±0.01^{c}	4.77±0.03^{d}	4.14±0.02^{e}	4.10±0.01^{f}

Values with different superscripts on the same row are significantly different (p<0.05)

3.3 Antinutritional Factors

Selected anti-nutrient composition of the raw and cooked imported and local rice varieties is as shown in Table 3. The level of anti-nutrients in the raw and cooked samples was very low, the three rice varieties containing negligibly small amount of saponin. The local varieties had higher value of antinutrient compared with imported rice. However, cooking generally reduced the level of the antinutrients significantly (p<0.05). *Aroso* and *Abakaliki* samples contained no saponins. Saponins are characterised by a bitter taste and foaming properties [32].

3.4 Nutrient Retention Capacity

The nutrient retention capacity of the three rice varieties is as shown in Table 4 (a) and (b)). The local rice retained more nutrients compared with the imported rice (*Aroso*), *Ofada* variety being the best in nutrient retention.

Table 3. Selected anti-nutrient composition of raw and cooked rice varieties

Parameter	*Aroso*		*Ofada*		*Abakaliki*	
	Raw	**Cooked**	**Raw**	**Cooked**	**Raw**	**Cooked**
Amylase Inhibitor	1.95±0.21^{a}	1.45±0.21^{b}	5.20±0.14^{c}	4.55±0.21^{d}	1.70±0.14^{e}	1.40±0.14^{f}
Saponin (g/100 g)	0.00±0.00^{a}	0.00±0.00^{a}	0.01±0.00^{a}	0.01±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}

Values with different superscripts on the same row are significantly different (p<0.05)

Table 4a. Macronutrient retention of rice varieties (%)

Parameter	*Aroso*	*Ofada*	*Abakaliki*
Crude protein	104.89±0.81^{a}	96.03±1.31^{b}	103.51±0.53^{c}
Crude fat	78.73±4.76^{a}	114.02±0.62^{b}	119.36±0.44^{c}
Crude fibre	94.15±3.23^{a}	108.84±0.15^{b}	107.19±0.83^{c}
Ash	96.85±0.05^{a}	104.19±0.08^{b}	102.65±0.05^{c}
Carbohydrate	99.75±0.07^{a}	99.85±0.16^{a}	99.30±0.05^{a}

Values with different superscripts on the same row are significantly different (p<0.05)

Table 4b. Micronutrient retention of rice varieties (%)

Parameter	*Aroso*	*Ofada*	*Abakaliki*
Sodium	111.63±6.69^{a}	94.87±2.84^{b}	108.34±0.19^{c}
Potassium	100.75±0.43^{a}	100.78±0.79^{a}	100.70±0.20^{a}
Calcium	98.77±0.24^{a}	100.80±0.23^{b}	101.56±0.75^{c}
Magnesium	102.63±0.27^{a}	95.49±0.66^{b}	101.75±0.85^{c}
Phosphorus	99.31±0.37^{a}	99.69±0.91^{b}	99.61±0.18^{b}
Copper	127.17±11.48^{a}	87.69±9.81^{b}	151.80±35.53^{c}
Iron	115.14±0.35^{a}	95.25±0.82^{b}	108.10±3.29^{c}
Zinc	113.94±2.04^{a}	107.30±0.56^{b}	111.15±0.87^{c}
Manganese	83.22±1.90^{a}	112.88±5.36^{b}	114.36±1.45^{c}
Thiamine	83.41±5.40^{a}	93.75±0.14^{b}	109.31±2.48^{c}
Riboflavin	163.34±4.72^{a}	134.96±27.70^{b}	125.40±4.50^{c}
Niacin	98.35±0.17^{a}	98.76±0.03^{b}	101.10±0.18^{c}

Values with different superscripts on the same row are significantly different (p<0.05)

4. CONCLUSION AND RECOMMENDATION

The three rice varieties were low in protein, fat, fibre, sodium, calcium and magnesium, moderate in amylose, zinc, B-vitamins, and high in gross energy, potassium, phosphorus and iron content. Local rice varieties were higher in most macro and micronutrients than the imported rice variety. The three rice varieties were very low in saponins and low in amylose inhibitors, hence there is no fear of poor digestibility and malabsorption of nutrients in the rice varieties. The local rice varieties compared favourably well nutritionally with the imported rice, being higher in nutrients in many cases, hence their consumption should be encouraged and popularized among the general populace to improve their dietary diversity, thereby reducing national level of malnutrition and reduce importation of rice and foreign exchange expended on rice importation.

DECLARATION

Some part of this manuscript was previously presented and published in the following conference.

Conference name: 3^RD^ Federation of Africa Nutrition Societies Conference, Tanzania, May, 2015.

Dates: 25 – 29 May, 2015.

Location: Arusha, Tanzania.

Web Link of the proceeding:
www.ennonline.net/newsroom/3rdfanusconferencetanzania2015 or
http://www.fanusonline.org/callforabstract

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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