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Review Article

# Quality Evaluation of Some Processed Rice Brands Sold in Umuahia Metroplis Abia State Nigeria

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## Abstract

Quality parameters of 13 selected processed rice brands sold in Umuahia Metropolis were evaluated for their proximate, vitamin, mineral compositions and heavy metals (cadmium and lead) using standard methods. Nine brands of foreign rice (imported brands) and four locally processed brands were sampled. The samples were ground prior to analysis using a locally fabricated hammer mill. Result of proximate composition showed moisture content range of 7.40-12.65%, crude protein 2.32-7.42%, crude fibre 1.11-1.83%, ether extract 0.59-1.68%, ash 0.62-1.26% and carbohydrate 76.90-85.93%. Vitamin content showed thiamine (B1) range of 0.12-0.32mg/100g, riboflavin 0.08-0.27mg/100g and niacin 1.42-1.83mg/100g. Mineral content showed that calcium ranged from 0.16-0.23mg/100g, phosphorus 0.45-0.57mg/100g, potassium 0.16-0.27mg/100g, iron 0.55-98mg/100g, while sodium 0.11-016mg/100g. Cadmium and lead recorded low values of 0.001-8.00mg/100g and 0.004-0.022mg/100 respectively.

**Keywords:** Survey; Quality; Local Rice; Foreign Rice; Umuahia

## Introduction

Rice seed of the grass species *Oryza sativa* (Asian rice) or the *Oryza glaberrima* (African rice) is the staple food of over half of the world's population [1]. As a cereal grain, it is the most widely consumed staple food for a large part of the world's human population especially in Asia. Historically, rice was cultivated 1000 years ago in the river valleys of South and Southeast Asia and China since it serves as the most important food for people. According to data released by [2] it is the agricultural commodity with the third-highest worldwide population after sugarcane and maize. It is also the most important grain with regards to human nutrition and calorie intake providing more than one-fifth of the calories consumed worldwide by humans. On the average, milled rice grain sample will contain about 8% protein, 80% starch, 2% fat, 11% moisture, 0.2% fibre, 0.5% ash and 398 calories of food energy, and provides almost half of the caloric intake of about half the world's population [3]. Rice is healthful for what it does not contain; it has low fat, and no cholesterol, making it an excellent food to include in a balanced diet. Rice is also gluten free and hence non-allergic, thereby making it essential source for people with gluten free dietary requirements [4]. Rice is widely grown in over 100 countries in every continent (except Antarctica). In 2019/2020 cropping season, China ranked first as the major rice growing nation, followed by India, Indonesia, Bangladesh, Vietinam etc. [1].

Food processing is very important in many economies around the world. World trade in rice is enormous both in value and tonnage. Exporting rice provides foreign exchange eagerly sought for by developing and developed nations alike. At the same time, there are profitable opportunities for individuals trading in imported food in the country. Unfortunately, the interests of the final consumer (in the importing country) are not always the prime con-

sideration of those in the business [5]. Indeed, it is of concern that developing countries like Nigeria may be easy targets for marketing substandard food (rice) rejected elsewhere or that has not been subjected to appropriate control during manufacture and transport. Hence, the need for quality control since quality is important for food safety. Quality implies control to achieve goals whether these are consumer or business oriented. It therefore becomes the role of not only the Government but researchers and scientists alike in ensuring a safe and wholesome food supply [5]. Therefore, this work examined the nutritional qualities of some imported rice and locally processed packaged rice brands sold within Umuahia metropolis.

## Materials and Methods

### Sample procurement

1cup (180g) of thirteen different brands of processed local (4) and foreign (9) rice were sourced from three major markets in Umuahia North Local Government Areas Abia State. The markets visited included Ubani Main Market, Orie-ugba Market and Ndoro Market. Different brands were sourced from each location. The rice samples after collection were labeled accordingly following the brand name and the location from where they were procured and neatly packaged using white cellophane. Brands of rice used in this research include; Cap Rice, Indian Rice (La Queen), Peacock Rice, Abakaliki Rice, Ugwu-Awusa Rice, Mama Africa Rice, Tomato king Rice, Gold Chinkapa Rice, Vinkor Rice, Stone Free Mass, Milan Gold Rice, Turkey Thai-Parboiled rice and Ishiagu rice.

### Sample preparation

The rice samples after collection were sorted (basically for the local rice samples) to remove unwholesome grains, sands, stones and other impurities after which they were dry milled to powdered form (using a locally fabricated hammer mill), packaged and labeled for further analysis.

### Chemical analysis

### Proximate analysis

The moisture, crude protein (% N × 6.25), ash, fat, and crude fibre, Thiamine (vitamin $B_1$), Riboflavin (Vitamin $B_2$) and Niacin (Vitamin $B_3$) contents were determined according to the methods described by [6] while the carbohydrate content was determined by estimation using the arithmetic difference method.

### Mineral analysis

The mineral content of the rice samples were evaluated using the method described by [7]. One gram of the rice sample was digested with 2.5ml of 0.03N hydrochloric acid (HCL). The digest was then boiled for 5 minutes, and allowed to cool to room temperature after which it was then transferred to 50ml volumetric flask and made up to mark with diluted water. The resulting digest was then filtered using an ash-less Whiteman No. 1 filter paper. Filtrates from each sample was then analyzed for mineral (calcium, phosphorus, magnesium, Iron, sodium, potassium, lead and cadmium) content using an Atomic Absorption Spectrophotometer (Buck Scientific Atomic Absorption Emission Spectrophotometer Model 210 GVP) using standard wavelengths. The real values were extrapolated from the respective standard curves. Values obtained were adjusted for HCL extractability for the respective ions. All determines were performed in duplicates.

### Determination of anti-nutrients

The anti-nutritional properties of the samples have been published elsewhere by [1].

## Results and Discussions

### Proximate composition

The result of the proximate composition of the rice samples are shown in table 1.

The moisture content of the rice brands ranged from 7.40 to 12.65%. Turkey Thai Parboiled Rice had the lowest (best) moisture value (7.40%) and thus was significantly different ($p < 0.05$) from other rice brands, followed by Mama Africa Rice (8.50%) which was not significantly different ($p > 0.05$) from Indian Rice (La Queen) (8.60%). Milan Gold Rice was also significantly different ($p < 0.05$) from all other rice brands. Ugwuawusa Rice had the highest moisture value (12.65%) but was not significantly different ($p > 0.05$) from Ishiagu Rice (12.50%), while Peacock Rice (12.25%) was not significantly different ($p > 0.05$) from Mass Stone Free (12.25%) and Abakaliki Rice (12.20%) respectively. Again, it was observed that the local rice brands had the highest moisture values compared to the foreign rice brands and this could be attributed to their origin and processing techniques used; and infer longer shelf life during storage. The values recorded for moisture are within safe limit (15%) for rice intended for storage [8], however [3] and [9] reported lower value (11%) for some rice brands.

The crude protein content of the rice brands ranged between 2.31 to 7.42%. There was significant difference ($p < 0.05$) in protein content of the rice brands. Some of the locally processed rice recorded higher protein quantities such as Abakaliki rice (7.42%), Ugwuausa rice (7.28%), and Ishiagu rice brands (7.33%); and this could be attributed to the degree of milling which might have been effective in removing the aleurone layer and the embryo which are rich in protein substances and prolonged parboiling that lowers protein content of rice [10,11]. The lower protein values recorded for foreign imported rice brands may be attributed to the type of thermal processes which can affect protein and starch properties. [12] reported that Yellow rice from stack-burning of wet rough rice has lower lysine content than normal rice. Proteins are needed in the body to support the growth, repair and maintenance of body tissues as they are the major structural components of cells. It then implies that in terms of protein content, local rice are of better quality than foreign rice.

Crude fibre content of the rice brands varied from 1.11 to 1.83%. The values were quite high compared to the value (0.2%) reported by [3], but low to (9%) by [9] and that obtained by [13] for foreign (5.00%) and local (6.50%) respectively. The Gold Chinkapa Rice had the highest fibre value (1.83%) and thus was significantly different ($p < 0.05$) from other rice brands, followed by Tomato King Rice (1.72%). Vinkor Rice (1.44%) was not significantly different ($p > 0.05$) from Indian Rice (1.41%) and Stone Free Mass (1.42%) respectively. Peacock Rice had the least fibre value (1.11%) but was not significantly different ($p > 0.05$) from Ugwuawusa Rice (1.15%), followed by Ishiagu Rice (1.21%). Abakaliki Rice (1.52%), Cap Rice and Turkey Thai Parboiled Rice (1.28%) were significantly different ($p < 0.05$) from other rice brands. The low fibre contents of the individual rice brands implies low quality trait as rice is known for its good source of insoluble fibre which helps to reduce bowel disorder and fight against constipation [14] and could be attributed to milling effect which decreases the fibre content of rice. Dietary fibre is higher in the bran layer and the hull and lowest in milled rice.

| Sample | Moisture content (%) | Crude protein (%) | Crude fiber (%) | Ether extract (%) | Ash (%) | CHO (%) |
|---|---|---|---|---|---|---|
| Abakaliki Rice* | $12.20^{b} \pm 0.14$ | $7.42^{a} \pm 0.02$ | $1.52^{d} \pm 0.01$ | $1.03^{c} \pm 0.01$ | $0.92^{f} \pm 0.02$ | $76.92^{g} \pm 0.17$ |
| Ugwuawusa Rice* | $12.65^{a} \pm 0.35$ | $7.28^{c} \pm 0.03$ | $1.15^{i} \pm 0.00$ | $0.76^{g} \pm 0.01$ | $0.62^{i} \pm 0.01$ | $77.54^{f} \pm 0.38$ |
| Stone Free Mass* | $12.25^{ab} \pm 0.07$ | $5.70^{f} \pm 0.01$ | $1.41^{ef} \pm 0.21$ | $0.59^{i} \pm 0.06$ | $0.82^{g} \pm 0.01$ | $79.23^{e} \pm 0.12$ |
| Ishiagu Rice* | $12.50^{ab} \pm 0.14$ | $7.33^{b} \pm 0.03$ | $1.21^{h} \pm 0.01$ | $1.08^{bc} \pm 0.03$ | $0.98^{e} \pm 0.01$ | $76.90^{g} \pm 0.14$ |
| Cap Rice | $10.75^{d} \pm 0.07$ | $7.15^{d} \pm 0.03$ | $1.38^{f} \pm 0.01$ | $0.95^{d} \pm 0.04$ | $0.77^{h} \pm 0.02$ | $79.03^{e} \pm 0.09$ |
| Mama Africa | $8.50^{f} \pm 0.28$ | $6.81^{e} \pm 0.01$ | $1.61^{c} \pm 0.01$ | $0.63^{i} \pm 0.04$ | $1.02^{de} \pm 0.02$ | $81.44^{d} \pm 0.21$ |
| Gold Chinkapa | $11.45^{c} \pm 0.07$ | $5.64^{g} \pm 0.01$ | $1.83^{g} \pm 0.02$ | $0.70^{h} \pm 0.01$ | $1.03^{d} \pm 0.03$ | $79.36^{e} \pm 0.07$ |
| Milan Gold | $9.40^{e} \pm 0.14$ | $3.95^{h} \pm 0.03$ | $1.65^{c} \pm 0.01$ | $0.87^{ef} \pm 0.01$ | $0.84^{g} \pm 0.01$ | $83.33^{b} \pm 0.11$ |
| Peacock Rice | $12.25^{ab} \pm 0.21$ | $2.82^{i} \pm 0.01$ | $1.11^{i} \pm 0.03$ | $0.84^{f} \pm 0.01$ | $0.76^{h} \pm 0.03$ | $82.22^{c} \pm 0.16$ |
| Vinkor Rice | $11.75^{c} \pm 0.07$ | $2.61^{j} \pm 0.01$ | $1.45^{e} \pm 0.06$ | $0.91^{de} \pm 0.01$ | $1.10^{c} \pm 0.03$ | $82.20^{c} \pm 0.01$ |
| India Rice | $8.60^{f} \pm 0.14$ | $2.39^{l} \pm 0.01$ | $1.44^{e} \pm 0.04$ | $0.72^{gh} \pm 0.14$ | $1.26^{a} \pm 0.01$ | $85.59^{a} \pm 0.11$ |
| Turkey Parboiled | $7.40^{g} \pm 0.28$ | $2.52^{k} \pm 0.03$ | $1.28^{g} \pm 0.01$ | $1.68^{a} \pm 0.01$ | $1.19^{b} \pm 0.01$ | $85.93^{a} \pm 0.03$ |
| Tomato King | $10.50^{d} \pm 1.74$ | $2.31^{m} \pm 0.17$ | $1.72^{b} \pm 0.03$ | $1.11^{b} \pm 0.01$ | $1.24^{a} \pm 0.01$ | $83.12^{b} \pm 0.16$ |

**Table 1:** Proximate Composition of Some Processed Rice Sold in Umuahia Metropolis Abia State.

Values are Mean + Standard deviations of two determinations. Mean values in the same column with different subscript are significantly different ($P < 0.05$)

KEY: * indicates local rice samples.

The ether extract content of the rice brands varied from 0.59 to 1.68%. The Turkey Thai Parboiled Rice had the highest ether extract value (1.68) and was significantly different ($p < 0.05$) from other rice brands, followed by the Tomato King Rice (1.11) which was not significantly different ($p > 0.05$) from Ishiagu Rice (1.08%). Vinkor Rice (0.91) was not significantly different ($p > 0.05$) from Milan Gold Rice (0.87%) while Stone Free Mass had the least ether extract value (0.59%) but was not significantly different ($p > 0.05$) from Mama Africa Rice (0.63%). These values are low compared to the value (2%) reported by [3] and [9], but high compared to that obtained by [13] for local (1.00%) and foreign (0.04%) rice respectively. This low fat content of the rice brands is normal and is considered a good quality trait because excess consumption of saturated fat increases cholesterol level as well as causes obesity which is a factor in the causation of diseases [15]. The low ether extract of the rice brands could be attributed to the degree of milling and polishing. Polishing removes the aleurone layer of the rice grain which is rich with health supportive essential fats.

The ash value of the various rice brands varied from 0.62 to 1.26%. There was significant difference ($p < 0.05$) in ash content of the brands. The values for ash reported by [13] for local (1.50%) and imported (1.00%) rice brands were in agreement with this report. This high ash content may be attributed to the effect of poor drying during heating which also affects mineral availability. The minerals (ash) are concentrated in the outer layer of the brown rice that is the bran fraction.

The carbohydrate value of the different rice brands ranged between 76.90 to 85.93%. The values were quite higher than (65.00%) reported by [9] for typical percentage composition of rice grain and also higher than the values (75.75%) obtain by [13] for imported rice but lower for local rice (78.05%). Rice starch as seen in most other cereals is a mixture of amylase and amylopectin which are higher in milled rice than in brown rice and the portion of the two starches have much to do with cooking and eating quality of rice. The higher the proportion of amylase, the drier the rice and the more separated the grains will be after cooking [3]. The low carbohydrate content of the local brands (Table 1) could be attributed to their high protein value which is the second most abundant constituents in rice [16].

## Vitamin composition of some processed rice sold in Umuahia metropolis

The result of the thiamine ($B_1$), riboflavin ($B_2$) and niacin ($B_3$) composition of the rice samples are shown in table 2.

Thiamine ($B_1$) content of the rice brands ranged from 0.12 and 0.32 mg/100g. There were significant differences in Vitamin content of the samples. [17] reported value (0.32 mg/100g) for the local rice brands. They are also low compared to the stipulated federal standard for enrichment (2.00-4.0 mg/100g) [9] and that obtained by [18] (2.4-1.6 mg/100g) for brown and milled rice respectively. The low thiamine content of the rice brands could be attributed to the effect of milling which remove the outer layer where most vitamins are concentrated. [3] reported that rice does contain small amount of the B vitamins, thiamine, riboflavin and niacin which are majorly highly concentrated in the bran layer of the brown rice but are usually lost since the bran and germ are removed during milling. It could also have been lost through leaching since thiamine is water soluble vitamin. Although the local rice brands had higher thiamine value than the foreign rice brands, generally, the thiamine contents of all the rice brands were low and could be regarded as low quality trait. Thiamine is needed in the body for a healthy heart

| Sample | Thiamine(mg/100g) | Riboflavin(mg/100g) | Niacin(mg/100g) |
|---|---|---|---|
| Cap Rice | $0.26^{b} \pm 0.01$ | $0.07^{de} \pm 0.01$ | $1.78^{c} \pm 0.01$ |
| Mama Africa | $0.27^{b} \pm 0.00$ | $0.08^{cde} \pm 0.01$ | $1.75^{cd} \pm 0.01$ |
| Gold Chinkapa | $0.24^{b} \pm 0.01$ | $0.08^{cde} \pm 0.01$ | $1.72^{d} \pm 0.01$ |
| Milan Gold | $0.16^{cd} \pm 0.01$ | $0.05^{e} \pm 0.01$ | $1.50^{h} \pm 0.01$ |
| Peacock Rice | $0.14^{de} \pm 0.01$ | $0.08^{cde} \pm 0.01$ | $1.54^{fg} \pm 0.01$ |
| Vinkor Rice | $0.12^{e} \pm 0.02$ | $0.07^{de} \pm 0.01$ | $1.57^{ef} \pm 0.03$ |
| Indian Rice | $0.15^{de} \pm 0.02$ | $0.09^{cd} \pm 0.01$ | $1.51^{gh} \pm 0.01$ |
| Turkey Parboiled | $0.14^{de} \pm 0.01$ | $0.11^{c} \pm 0.01$ | $1.42^{i} \pm 0.03$ |
| Tomato King | $0.18^{c} \pm 0.01$ | $0.07^{de} \pm 0.01$ | $1.59^{e} \pm 0.01$ |
| Abakaliki Rice* | $0.32^{a} \pm 0.01$ | $0.27^{a} \pm 0.01$ | $1.83^{b} \pm 0.01$ |
| Ugwuawusa Rice* | $0.31^{a} \pm 0.01$ | $0.26^{a} \pm 0.01$ | $1.86^{b} \pm 0.01$ |
| Stone Free Mass* | $0.32^{a} \pm 0.01$ | $0.21^{b} \pm 0.01$ | $1.92^{a} \pm 0.01$ |
| Ishiagu Rice* | $0.25^{b} \pm 0.01$ | $0.25^{a} \pm 0.01$ | $1.77^{c} \pm 0.04$ |

**Table 2:** Vitamin Composition of Some Processed Rice Sold within Umuahia Metropolis.

Values are Mean + Standard deviations of two determinations. Mean values in the same column with different subscript are significantly different ($P < 0.05$).

KEY: * indicates local rice samples.

and nervous system, optimizes metabolism and brain function and most especially, it helps in the fight against beriberi which is a disease which occurs as a result of the deficiency of thiamine.

The riboflavin content of the rice brands varied between 0.05 and 0.27 mg/100g. Ishiagu Rice had the highest riboflavin value (0.27 mg/100g) but was not significantly different ($p > 0.05$) from Abakaliki Rice (0.26 mg/100g) and Stone Free Mass (0.25 mg/100g) Rice. UgwuAwusa Rice (0.21 mg/100g) was significantly different ($p < 0.05$) from other rice brands. Milan Gold Rice had the least riboflavin value (0.05 mg/100g) but was not significantly different ($p > 0.05$) from Cap Rice (0.07 mg/100g), Vinkor Rice (0.07 mg/100g), Tomato King (0.07 mg/100g), Mama Africa (0.08 mg/100g), Gold Chinkapa Rice (0.08 mg/100g) and Peacock Rice (0.08 mg/100g) respectively. The values agree with 0.05 mg/100g reported by [17], and [18] (0.5-0.3 mg/100g) for some rice brands. The values were also low compared to the Federal standard for rice enrichment (1.2-2.4 mg/100g) [9]. The low riboflavin content of the rice brands could be attributed to the fact that rice naturally contains low amount of this vitamin which during milling are readily removed together with the layer containing them. The brands with the higher riboflavin content were majorly the local rice brands which most times do not undergo high degree of processing hence their ability to retain this vitamin. Riboflavin in the body helps in the formation of antibodies and red blood cells and facilitates carbohydrate, fat and protein metabolism.

The niacin ($B_3$) content of the rice brands varied between 1.42 and 1.92 mg/100g. Ugwuawusa Rice had the highest niacin value (1.92 mg/100g) and was significantly different ($p < 0.05$) from other rice brands. Abakaliki Rice (1.86 mg/100g) was not significantly different ($p > 0.05$) from Ishiagu Rice (1.83 mg/100g). Turkey Thai-Prboiled Rice had the least niacin value (1.42 mg/100g) and was significantly different from other rice brands. Niacin is beneficial for healthy nervous and digestive system and aids in blood circulation. The local rice brands again recorded the highest niacin content than the foreign rice brands. The values were very much low compared to that (4.60 mg/100g) reported by [17] and that (29.0 and 6.0 mg/100g) obtained by [18] for brown and milled rice respectively. They are also low compared to the Federal standard for rice enrichment (16-32 mg/100g) as reported by [9] especially for the foreign rice brands and implies low quality trait for the rice samples. Niacin is a water soluble vitamin which can easily be leached out in water during soaking or parboiling. The low niacin content can therefore be attributed to the milling effect which resulted in the loss of the bran layers where the vitamins are located.

## Lead and cadmium profile of some processed rice sold in Umuahia metropolis

Table 3 shows the result for the Lead and Cadmium content of the rice samples.

The lead content of the brands ranged between 0.001 and 0.022 mg/100g. The values were lower than FAO/WHO value (0.026 mg/100g) for normal provisional tolerance weekly intake (PTWI) limit and the value (0.314 and 0.126 mg/100g) obtained by [13] for local and imported rice samples. The quality of rice greatly affects human health, as consuming rice contaminated by cadmium (Cd), lead (Pb) and other metals can seriously deplete body stores of iron (Fe), vitamin C and other essential nutrients, leading to decreased immunological defenses, impaired psycho-social faculties and disabilities associated with malnutrition [19]. Hence, this low lead content (Le) of the rice brands implies low toxicity for consumers of such rice products. Ugwuawusa Rice had the highest lead content (0.022 mg/100g) and was significantly different ($p < 0.05$) from other rice brands. This could be attributed to the rate of fertilizer application and native paddy field. The repeated applications of agrochemicals potentially contributed to the accumulation of heavy metals in agricultural soils as some of these fertilizers and pesticides contain heavy metals such as Cd, Pb, Zn [20]. Indian Rice (0.008 mg/100g) was not significantly different ($p > 0.05$) from Milan Gold and Peacock Rice (0.008 mg/100g). Turkey Thai-Parboiled Rice had the least lead content (0.001 mg/100g) and was also significantly different ($p < 0.05$) from other rice brands and could thus be considered the best among the evaluated rice brands for consumption. Lead has been widely recognized as the single most significant environmental health issues to children. Lead exposures has been a significant health issue for decades and is associated with neurological impairment such as learning disabilities and lower IQ even when ingested at low levels [21].

The cadmium content of the rice brands ranged between 0.001 to 8.000 mg/100g. The values when compared to the provisional tolerance weekly intake (PTWI) for cadmium (7µg/kg) by FAO/WHO [18] were quite lower to a reasonable extent. Cap Rice, Ugwuawusa Rice, Abakaliki Rice and Ishiagu Rice had the highest and same mean value (8.000 mg/100g), while Peacock Rice had

the least cadmium value (0.001 mg/100g) but was not significantly different ($p > 0.05$) from Milan Gold (0.001 mg/100g), Indian (0.001 mg/100g), Turkey Thai Parboiled (0.001 mg/100g), Vinkor (0.001 mg/100g), Stone Free Mass (0.002 mg/100g), Gold Chinkapa (0.002 mg/100g) and Tomato King (0.010 mg/100g) Rice respectively. Environmental exposure to cadmium may act on blood pressure through mechanisms related to oxidative stress [22], increased vasoconstriction and activation of the sympathetic nervous system [23]. The main route of human lead and cadmium exposure occurs through ingestion of food as well as through contaminated water and soil (Agency for Toxic substances and disease registry) [24] Chronic exposure to cadmium can cause kidney, liver, and bone damage in human, children being the most susceptible to the effects of exposure to low doses of cadmium over time.

| Sample | Lead (mg/100g) | Cadmium (mg/100g) |
|---|---|---|
| Cap Rice | $0.014^{d} \pm 0.003$ | $8.000^{a} \pm 0.000$ |
| Mama Africa | $0.009^{e} \pm 0.001$ | $4.000^{b} \pm 0.000$ |
| Gold Chinkapa | $0.009^{e} \pm 0.000$ | $0.002^{c} \pm 0.000$ |
| Milan Gold | $0.008^{f} \pm 0.000$ | $0.001^{c}$+0.000 |
| Peacock Rice | $0.008^{f} \pm 0.000$ | $0.001^{c} \pm 0.000$ |
| Vinkor Rice | $0.005^{h} \pm 0.000$ | $0.002^{c} \pm 0.000$ |
| Indian Rice | $0.008^{f} \pm 0.000$ | $0.001^{c} \pm 0.000$ |
| Turkey Parboiled | $0.004^{i} \pm 0.000$ | $0.001^{c} \pm 0.000$ |
| Tomato King | $0.007^{g} \pm 0.000$ | $0.010^{c} \pm 0.000$ |
| Abakaliki Rice* | $0.021^{b} \pm 0.00$ | $8.000^{a} \pm 0.00$ |
| Ugwuawusa Rice* | $0.015^{c} \pm 0.00$ | $8.000^{a} \pm 0.00$ |
| Stone Free Mass* | $0.022^{a} \pm 0.00$ | $8.000^{a} \pm 0.00$ |
| Ishiagu Rice* | $0.009^{e} \pm 0.00$ | $0.002^{c} \pm 0.00$ |

**Table 3:** Lead and Cadmium Profile of Some Processed Rice Sold within Umuahia Metroplis.

Values are Mean + Standard deviations of two determinations.

Mean values in the same column with different subscript are significantly different ($P < 0.05$).

KEY: * indicates local rice samples.

## Mineral composition of some processed rice sold within Umuahia metropolis

The result of the mineral composition of different rice brands is shown in table 4.

The calcium content of the rice brands ranged between 0.12 to 0.23 mg/100g. The decrease in calcium content for the rice brands could be attributed to the milling effect which results in the loss of the bran layer where most minerals are concentrated. The Turkey Thai-Parboiled Rice had the highest calcium content (0.23 mg/100g) which may be attributed to the effect of enrichment but was not significantly different ($p > 0.05$) from Stone Free Mass (0.21 mg/100g) and Ishiagu Rice (0.21 mg/100g). Mama Africa Rice (0.19 mg/100g) was not significantly different ($P > 0.05$) from Milan Gold and Turkey Thai-Parboiled Rice (0.18 mg/100g). Abakaliki Rice had the least calcium value (0.12 mg/100g) and was significantly different ($p < 0.05$) from other rice brands. [18] reported lower of 0.1mg/100g for both brown and milled rice, but less than (12.00mg/100g) reported by [17] and (16.0 mg/100g) for Federal standard for rice enrichment [9].

The phosphorus content of the rice brands ranged from 0.45 to 0.57 mg/100g. The values were less than (2.90 mg/100g) obtained by [17] for mineral status of rice grain and that (3.2 and 1.5 mg/100g) obtained by [18] for both brown and milled rice and this again could be attributed to the effect of milling resulting in the loss of the bran layer containing the minerals. The Stone Free Mass had the highest phosphorus content (0.57 mg/100g) and could be attributed to the fact that it is not as highly processed as the foreign rice brands, but was not significantly different ($p > 0.05$) from Tomato King Rice (0.55 mg/100g), Abakaliki Rice (0.55 mg/100g) and Ishiagu Rice (0.55 mg/100g). Peacock Rice had the least phosphorus value (0.45 mg/100g) but was not significantly different ($p < 0.05$) from Cap Rice (0.47 mg/100g) and Indian Rice (0.47 mg/100g) and could be attributed to the effect of milling on the rice grain.

The potassium content of the rice brands ranged between 0.16 to 0.23 mg/100g. The values agree with those (0.23-0.15 mg/100g) obtained by [25]. These values are appreciably high and thus considered a good quality trait for the rice brands. The high phosphorus content of the rice brands could be attributed to the chemical make-up of the individual rice grain and the composition of the soil in which they were cultivated. Stone Free Mass had the highest potassium value (0.23 mg/100g) but was not significantly different ($p > 0.05$) from Abakaliki Rice (0.22 mg/100g) and Ishiagu Rice (0.21 mg/100g). Turkey Thai-Parboiled Rice was not significantly differ-

| Sample | Calcium (mg/100g) | Phosphorus (mg/100g) | Potassium (mg/100g) | Iron (mg/100g) | Sodium (mg/100g) |
|---|---|---|---|---|---|
| Cap Rice | $0.17^{cd} \pm 0.01$ | $0.47^{ef} \pm 0.01$ | $0.16^{e} \pm 0.01$ | $4.92^{d} \pm 0.00$ | $0.15^{ab} \pm 0.01$ |
| Mama Africa | $0.19b^{cd} \pm 0.00$ | $0.54^{abc} \pm 0.01$ | $0.17^{de} \pm 0.01$ | $4.65^{f} \pm 0.01$ | $0.13^{abc} \pm 0.01$ |
| Gold Chinkapa | $0.17^{cd} \pm 0.01$ | $0.49^{de} \pm 0.01$ | $0.18^{cde} \pm 0.01$ | $4.30^{h} \pm 0.01$ | $0.12^{bc} \pm 0.01$ |
| Milan Gold | $0.18^{bcd} \pm 0.01$ | $0.49^{de} \pm 0.01$ | $0.20^{abcd} \pm 0.01$ | $4.81^{e} \pm 0.01$ | $0.16^{a} \pm 0.01$ |
| Peacock Rice | $0.16^{d} \pm 0.01$ | $0.45^{f} \pm 0.02$ | $0.18^{cde} \pm 0.01$ | $2.91^{k} \pm 0.00$ | $0.11^{c} \pm 0.01$ |
| Vinkor Rice | $0.19^{bcd} \pm 0.01$ | $0.51^{cd} \pm 0.01$ | $0.19^{bcde} \pm 0.01$ | $2.12^{l} \pm 0.03$ | $0.11^{c} \pm 0.01$ |
| Indian Rice | $0.20^{abc} \pm 0.01$ | $0.47^{ef} \pm 0.01$ | $0.17^{de} \pm 0.01$ | $3.58^{i} \pm 0.02$ | $0.16^{a} \pm 0.01$ |
| Turkey Parboiled | $0.23^{a} \pm 0.01$ | $0.51^{cd} \pm 0.01$ | $0.20^{abcd} \pm 0.01$ | $3.44^{j} \pm 0.01$ | $0.11^{c} \pm 0.01$ |
| Tomato King | $0.18^{bcd} \pm 0.01$ | $0.55^{ab} \pm 0.01$ | $0.19^{bcde} \pm 0.01$ | $0.55^{m} \pm 0.01$ | $0.14^{abc} \pm 0.01$ |
| Abakaliki Rice* | $0.21^{ab} \pm 0.01$ | $0.55^{ab} \pm 0.01$ | $0.21^{abc} \pm 0.01$ | $6.177^{a} \pm 0.01$ | $0.15^{ab} \pm 0.02$ |
| Ugwuawusa Rice* | $0.12^{e} \pm 0.01$ | $0.55^{ab} \pm 0.01$ | $0.22^{ab} \pm 0.01$ | $5.983^{b} \pm 0.00$ | $0.15^{ab} \pm 0.00$ |
| Stone Free Mass* | $0.20^{abc} \pm 0.01$ | $0.52^{bcd} \pm 0.01$ | $0.19^{bcde} \pm 0.01$ | $4.60^{g} \pm 0.00$ | $0.14^{abc} \pm 0.01$ |
| Ishiagu Rice* | $0.21^{ab} \pm 0.01$ | $0.57^{a} \pm 0.01$ | $0.23^{a} \pm 0.01$ | $5.67^{c} \pm 0.00$ | $0.14^{abc} \pm 0.01$ |

**Table 4:** Mineral Composition of Some Processed Foreign Rice Sold within Umuahia Metropolis.
Values are Mean + Standard deviations of two determinations. Mean values in the same column with different subscript are significant ($P < 0.05$)
KEY: * indicates local rice samples.

ent ($p > 0.05$) from Milan gold (0.20 mg/100g), same with Tomato king rice and Ugwuawusa Rice (0.19 mg/100g). Cap rice had the least potassium value (0.16 mg/100g).

The iron content of the rice brands varied between 0.55 to 6.18 mg/100g. These values when compared to (2.0 mg/100g) reviewed by [17] were higher for most rice brands evaluated except for tomato king rice which had a considerably low Iron content (0.55 mg/100g). The values were also observed to be less than the Federal standard for rice enrichment (16.0 mg/100g) [9]. It was also observed that each rice brand varied significantly ($p < 0.05$) from each other. Ishiagu Rice had the highest iron content (6.18 mg/100g) followed by Abakaliki Rice (5.98 mg/100g), Stone Free Rice (5.67 mg/100g), Cap Rice (4.92 mg/100g), Milan Gold Rice (4.81 mg/100g), Mama Africa (4.65 mg/100g) and Ugwuawusa rice (4.67 mg/100g). The low iron content (0.55 mg/100g) 0f Tomato King Rice could be attributed to the effect of milling which resulted in the loss of brown layer and the embryo containing those minerals. This also affected the protein content as observed in table 1. The brands with low iron content were mostly the foreign rice brands and therefore call for effective enrichment of these brands with iron.

The sodium content of the rice brands varied between 0.11 to 0.16 mg/100g. The values were appreciably high and agree with values (0.10 t0 0.16 mg/100g) obtained by [25]. Indian rice had the highest sodium value (0.16 mg/100g) but was not significantly different ($p > 0.05$) from Milan Gold rice (0.16 mg/100g). Abakaliki Rice, Ishiagu Rice and Cap Rice had the same mean value (0.15 mg/100g) and thus, were not significantly different ($p > 0.05$). Ugwuawusa rice, Stone Free Mass and Tomato King Rice also had the same mean value (0.14 mg/100g) and were not significantly different from each other ($p > 0.05$). The brands with the least sodium value were Peacock Rice, Vinkor Rice and Turkey Thai Parboil Rice which again were mostly the foreign rice brands. It then implies that in terms of mineral composition, local rice brands tend to have higher mineral composition than the foreign rice brands.

## Conclusion

From this study, it is very much evident that great variation exist in nutrient composition between different brands of rice, both imported and locally processed rice products and this to a greater extent is influence by whichever method of processing employed in the processing of such rice products, causing substantial nutrient

losses and subsequent variations in nutrient composition. The results obtained from this study shows that whenever a rice product is subjected to any form of processing, say milling operation, losses abound which significantly might be minimal depending on brand. The study also reveals that heavy metals are present in rice products at varying degrees and levels depending basically on the type of soil in which the rice paddy is grown and the type of manure administered, and that locally processed rice were much better in nutrient retention especially vitamins, minerals, protein and fat. There is therefore need for proper check and regulation on both rice imported and those processed within the country by the regulatory bodies in order to ensure that rice they adhere to standard in terms of nutrient composition and general safety and quality attributes to ensure uniformity.

## Conflict of Interest

This work is for research and academic purposes only and not to promote any rice brand over the other.

The authors declare no conflict of interest.

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