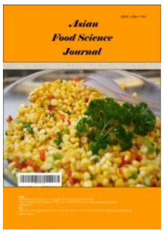

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Nutrient and Anti-Nutrient Composition of Four Rice Varieties in Port Harcourt Metropolis

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Authors' contributions:

This work was carried out in collaboration among all authors. Author GOW designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author ACO and Author MAHC managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

This study evaluated the nutrient and anti-nutrient content of four rice varieties in Port Harcourt metropolis. Four rice varieties (Tomato gold TG, Mama's pride MP, Ultimate gold UG and daily choice DC) were used in this study. The rice varieties were purchased, milled into fine flour and evaluated for proximate, mineral and anti-nutrient analysis using standard methods. Proximate composition of the rice varieties revealed that moisture content ranged from 11.51-12.80%, ash (0.45-0.60%), fat (0.39-1.39%), crude protein (5.73-6.07%), crude fibre (0.90-6.85%) and carbohydrate (73.67-80.09%). Mama's pride rice variety contained higher ash and fat contents while Tomatoes gold had significantly higher crude fibre. On the other hand, ultimate gold rice variety contained higher protein and carbohydrate; however, ash, protein and moisture contents did not vary significantly ($p>0.05$) between the rice varieties. Mineral composition of the rice varieties also showed that magnesium content ranged from 6.28-9.63 mg/100 g, calcium (3.74-

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8.23mg/100g) and iron (1.50-5.48mg/100g). The concentration of these mineral elements was found to be superior in ultimate gold rice variety. Phenol content of the rice varieties ranged from 9.92-14.58mg/100g, phytate (1.22-1.53g/kg), saponin (5.86-6.37%), tannin (47.03-66.89 mg/100 g) and flavonoid (2.29-2.80%). Ultimate gold rice variety also contained higher concentrations of phenol and tannins while saponin content was higher in daily choice rice variety. Phytate content on the other hand did not vary significantly ($p>0.05$) between the rice varieties. The result therefore revealed that ultimate gold rice variety contained a considerable amount of nutrients and should be highly recommended to consumers for derivation of the above-mentioned nutrients.

Keywords: Rice; varieties; proximate; minerals; anti-nutrient.

1. INTRODUCTION

Rice is a cereal crop which comprises of two species of food crop (*Oryza sativa* and *Oryza glaberrima*) in the family Poaceae [1]. It ranks second after maize in terms of production and constitutes the most important staple food of about half of the world's population. The rice plant is a monocarpic annual plant which grows in tropical areas and temperate zones. It grows up to 1-1.8m tall depending on the variety of the crop and soil fertility [2]. The plant has long, slender leaves which are about 50-100 cm (20-39 inch) long and 2-2.5 cm (0.79-0.98 inch) broad [3]. The rice grain consists of the endosperm, embryo and several thin layers which include the pericarp, seed coat and nucleolus.

Rice is a staple food in many parts of the world and in many African countries. According to FAO [4], rice provides 20% of the world's dietary energy supply, while wheat supplies 19% and maize 50%. It also provides 45% of calories and 40% of the total protein requirement of humans in developing countries [5]. Oko *et al*. [6] reported the grain to contain 75-80% starch, 12% water and only 7% protein with a full complement of amino acids. The authors also reported the grain to contain thiamine, riboflavin and niacin. Rice has been used commercially and industrially for the production of rice flour, starch, rice flakes, rice cakes, rice milk and other extended uses such as rice husk, rice bran for animal feed and broken rice used for the preparation of snacks and beverage [7]. Rice starch is used in making ice cream, custard powder, puddings, gel, distillation of potable alcohol, etc while Rice flour is used in confectionery products like bread, snacks, cookies and biscuits [8].

Rice is grown in all the ecological and dietary zones of Nigeria with different varieties possessing adaptational traits. The major rice varieties grown in Nigeria are the local rice namely Gboko, Abakaliki, Mokwa and Ofada; while improved domestic varieties are Faro series, Nerica 8 and ITA series. In Nigeria and other developed countries, rice is usually consumed in polished form (white rice) due to the low demand for brown rice resulting from lack of awareness of its high nutritional value and health-related beneficial effects [9]. Various varieties of polished rice are sold in the Nigerian markets. Some of these polished rice varieties are produced in the country while some are imported. Despite the strict regulations and enforcement by relevant regulatory agencies of the sale of standard commodities to consumers, at times manufacturers and importers do not comply with standards. In addition, a wide range of rice varieties are reported and their nutritional compositions vary from one another depending on variety, climate, irrigation and fertilizer application [10]. Since each variety has different nutritional composition, there is a need to compare the nutritional values of the rice varieties in order to ascertain if there is any nutritional advantage between these varieties. Knowledge of the differences in nutrient composition of the rice varieties will help in selecting the best variety for human consumption. This study therefore evaluated nutrient and anti-nutrient composition of four varieties of rice in Port Harcourt metropolis, Rivers State.

2. MATERIALS AND METHODS

2.1 Materials

A total of four polished rice varieties (Tomato gold, Mama's pride, Ultimate gold and daily choice) were purchased from Mile three market in Diobu, Port Harcourt. Rivers State, Nigeria. Chemicals used in this study (such as Kjedahl catalyst, Sulphuric acid (H_2SO_4), hydrochloric acid) were of analytical reagent grade and were obtained from the Department of Food Science and Technology, Rivers State University, Port Harcourt.

2.2 Sample Preparation

2.2.1 Preparation of rice flour samples

Rice grains obtained were sorted and cleaned before sample processing. Next, they were milled to fine powder using a laboratory blender. The flour from each rice variety were packaged in an air tight container and stored at room temperature (28^{o}C) until required for analysis.

2.3 Proximate Analysis

Moisture, ash, fat, crude protein and crude fibre contents of each rice flour sample was carried out according to AOAC [11] methods of analysis while carbohydrate content was evaluated by difference which involved the addition of crude protein, crude fat, ash, crude fibre and moisture, then subtracting their values expressed in percentages from 100%.

2.4 Mineral Analysis

The mineral content of the rice flour samples were determined by the AOAC [11] method. Two grams (2 g) of the flour sample was weighed into a crucible and ashed at 550^{o}C for 2 hrs. Five milliliters (5 ml) of concentrated hydrochloric acid (HCl) was added to the ashed sample to dissolve it followed by addition of 20 ml deionized water and heated to halt it content. The solution was allowed to cool and filtered through a Whatman No. 1 filter paper and made up to 50 ml volume. Stock solution of 1000 mg/kg of calcium, potassium, magnesium and iron were prepared using distilled water. From stock solution working standard solution of 100 mg/kg were prepared for each element using distilled water. Different dilutions comprising 0.5, 1.0, 2.0 and 3.0 mg/kg of each element were made with distilled water and together with the test sample. The mixtures were analyzed using an atomic absorption spectrophotometer while concentrations of the elements in the test samples were then calculated.

2.5 Anti-nutrient Analysis

2.5.1 Determination of total saponin

Total saponin of the rice varieties was determined using the method of Obdoni and Ochuko [12]. 2.0 g (W_0) of well blended sample was weighed into a conical flask followed by the addition of 2.5 ml of 20% aqueous ethanol. The content was heated in a hot water bath for 4 hrs with continuous stirring at 50^{o}C and filtered. 200 ml of ethanol was used to re-extract and both extracts combined. The volume of the extract was reduced to 20 ml by evaporating in a water bath at 90^{o}C. The concentrate was transferred into a 250 ml separating funnel and 0.5ml of diethyl ether (petroleum ether) added and shake vigorously. The clear ether layer was discarded and the aqueous layer kept. 50 ml of butanol was added to the aqueous layer in the separating funnel. The combined butanol layer was washed twice with 10.25 ml of 5% aqueous NaCl. The remaining solution was collected in a weighed petri dish (W_1). The petri dish was kept in an oven at about at about 90^{o}C to evaporate and re-weighed and recorded as W_2.

$$\text{Saponin content (\%)} = \frac{W2 - W1}{W0} \times 100$$

2.5.2 Flavonoid determination

Flavonoid content was determined by the method of Bohn and Kocipal Abyazan [13]. Ten grams (10 g) of the each sample was extracted repeatedly with 100 ml of 80% aqueous methanol at room temperature. The whole solution was filtered through Whatman filter paper (125 mm). The filtrate was later transferred into a crucible and evaporated into dryness over a water bath and weighed to a constant weight.

$$\text{Flavonoid (\%)} = \frac{W2 - W1}{W1} \times 100$$

Here,
W = Weight of rice
W1 = Weight of empty crucible
W2 = Weight of crucible plus precipitate

2.5.3 Determination of phenol

The phenolics in the sample were isolated according to the method of Shahidi and Naczk [14]. One gram, of the sample was extracted thrice with 10 ml of 70% (v/v) aqueous acetone at room temperature (30 ± 2^{o}C). This was centrifuged at 10,000 g for 10 min. The supernatant was collected, combined and evaporated to dryness at 30 $^\circ$C under vacuum. The extracted phenolics were then dissolved in 25 ml methanol and re-centrifuged. To 0.5 ml of the methanolic solution was added 0.5 ml of Folin-Denis reagent (Folin-Denis reagent: To 750 ml water, 100 g sodium tungstate and 20 g phosphomolybdic acid were added in a 2 litre standard flask. Thereafter, 50 ml orthophosphoric acid was added and the mixture refluxed for 2 hrs. The mixture was allowed to stand and made up to 1 litre. The solution is stored in the dark prior to use) followed by the addition of 1 ml sodium carbonate and 8 ml of deionised water. The mixture was gently swirled and the mixture allowed standing for 45 min to allow for colour development. The absorbance was measured in a colorimeter at 725 nm. Trans-sipanic acid was used to prepare the standard calibration curve where the concentration was extrapolated.

2.5.4 Determination of phytate (Phytic acid)

Phytate content was determined using the method of Russel [15]. The sample (0.5 g) was weighed into a 250 ml conical flask followed by the addition of 25 ml of 2% concentrated HCl. This was allowed to soak for 3 hrs and filtered. The filtrate (10.5 ml) was pipetted into a 250 ml beaker followed by the addition of 25.75 ml of distilled water to improve acidity. Also, 2.5 ml of 0.35 ammonium thiocynate solution was added as indicator. This was titrated with standard iron III chloride ($FeCl_3$) which contains 0.00195g iron/ml until a brownish yellow colour appeared and persists for 5min. The phytic acid content was calculated below:

Phytic acid (g/kg) =

$$\frac{0.00195 \times volume\ of\ \mathrm{FeCl3\ consumed} \times \mathrm{DF}}{Sample\ weight} \times 1000$$

DF= Dilution factor

2.5.5 Determination of tannin

Tannin content was determined using the method of Jaffe [16]. One gram (1.0 g) of dry well blended sample was weighed into a flask and 10 ml of distilled water added and agitated. The mixture was left to stand for 30 min at room temperature and thereafter centrifuged at 2500rpm for 15min. One milliliters (1.0 ml) of supernatant was measured into a 10 ml volumetric flask followed by addition of 1 ml of folin-ceocalteu reagent. One milliliters (1.0 ml) of saturated Na_2CO_3 solution was also added and the solution diluted to 10 ml with distilled water. This was incubated for 30 min at room temperature and the standard tannic acid prepared. The method was repeated for tannic acid standards 20, 40, 60, 80, 100 and 120 mg/l from a stock of 500 ppm (50mg of tannic acid standard dissolved in 100ml of distilled water) excluding centrifugation. The absorbances of the tannic acid concentrations were read off at a wavelength of 725nm. The calibration curve for the tannic acid standards was drawn i.e. absorbance against concentration. The tannic acid concentration of the sample was extrapolated by tracing the absorbance of the sample down the concentration axis.

Tannic acid content (mg/kg) =

$$\frac{Concentration\ obtained\ in \frac{mg}{l} \times volume\ of\ sample\ \times DF}{Sample\ weight\ (1000mg)} \times 100$$

DF= Dilution factor

2.5.6 Statistical analysis

The data obtained was subjected to analysis of variance (ANOVA) using (SPSS) version 20.0 software 2007. All analysis was done in duplicate. The measure of central tendencies and dispersions was determined and Duncan Multiple Range Test (DMRT) was used to separate the mean.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of the Rice Varieties

Table 1 shows the proximate composition of the rice varieties. Moisture content of the rice varieties ranged from 11.52 % to 12.80% with sample UG recording the lowest value (11.52%) and sample TG as the highest (12.80%). Samples MP (Mama's pride) and DC (daily choice) had moisture contents of 11.97% and 12.77%, respectively. There was no significant (p>0.05) difference in the moisture content of the rice varieties. Moisture content serves as an index of flour storability [8]. Low moisture content gives better shelf life and enhanced keeping quality under storage. All the rice varieties contained less than 14% moisture which meets the moisture content requirement for safe storage of rice [17]. The moisture contents of the rice varieties from this study (11.52-12.80%) are close to the range of values (9.00-11.00%) obtained by Cameron and Wang [18], 10.52-12.26 % by Maisont and Narkrugsa [19], 11.20-12.20% by Diako *et al*. [20] and 10.04-12.88% by Thomas *et al*. [21]. These values also closely correspond to the results of 11.65% to 13.43% reported by Eshun [22].

Ash content of the rice varieties recorded 0.60%, 0.45%, 0.45% and 0.50%, respectively for samples MP, UG, DC and TG. Sample UG and DC recorded the lowest values (0.45%) while sample MP had the highest (0.60%). There was no significant (p>0.05) difference in the ash content of the rice varieties. Ash content in rice reflects the mineral elements [23]. Iwe *et al*. [24] also stated that ash content indicates the composition of inorganic constituents after organic materials and moisture has been removed by incineration [24]. The content of ash in all the rice varieties studied fell below 1.00%. The range of ash values obtained in this study fell within the range of values (0.18-0.97%) obtained by Shayo *et al*. [25] but below the value (1.77%) reported by Islam *et al*. [26]. Minerals are more concentrated in the bran and thus get lost during milling and polishing when the bran is removed from the grain [27]. The low ash content of <1.0% observed in the rice varieties in this study may be due to the degree of milling/polishing which is influenced by variety as seen in daily choice and ultimate gold rice with the lowest ash content due to polishing. According to Kwarteng *et al*. [28], rice bran contains much more minerals than the actual endosperm and the tendency of rice bran to stick to the grains during milling and polishing (which is a varietal trait) influences ash content.

Fat content ranged from 0.39% in sample TG to 1.39% in sample MP. Samples UG and DC had fat contents of 0.98% and 0.99%, respectively. Fat content of sample MP was significantly (p<0.05) different from others while samples UG and DC were not significantly (p>0.05) different. The content of crude fat for all the rice varieties fell below 1% except for sample TG with fat content of 1.39%. The range of crude fat values obtained in this study fell below the value (2.80%) obtained by Islam *et al*. [26]. The low fat content in the rice flours studied may be due to the fact that cereals store energy in the form of starch rather than lipids [24]. The observed differences in the fat content of the rice varieties from this study may also be attributed to the degree of milling as the milling process results in a loss of rice bran (which is an excellent source of fat) thereby contributing to the low fat content of the rice varieties [29]. The low crude fat levels in the rice varieties studied may be beneficial in ensuring longer shelf life for these rice varieties because all fats and fat-containing foods contain some unsaturated fatty acids and hence are potentially susceptible to oxidative rancidity [24].

Crude protein content of the rice varieties ranged from 5.73% in samples DC and MP to 6.07% in sample UG. Samples TG and MP recorded crude protein of 5.79% and 5.73%, respectively. There was no significant (p>0.05) difference in the crude protein content of the rice varieties. Protein is essential in the body as it forms the basic building blocks for cells and tissue repairs in the body [23]. Crude protein of the rice varieties studied obtained was slightly lower than the value (8.50) obtained by Islam *et al*. [26]. The range of protein contents in the rice varieties is within the range of 5.69-8.40 reported by Wireko-Manuand and Amamoo [30] for selected local Rice varieties and imported rice brands in Ghana. The differences in crude protein content might be due to varietal differences [28].

Crude fibre content ranged from 0.90 to 6.85% with sample UG recording the lowest value (0.90%) and sample TG as the highest (6.85%). Samples MP and DC had crude fibre values of 1.69% and 1.10%, respectively. Crude fibre content of samples MP, UG and DC were not significantly (p>0.05) different from each other. The content of fibre for the rice varieties (except for sample TG) fell below1.00%. The range of crude fibre values obtained in this study for samples UG and DC fell below the value (1.23%) obtained by Islam *et al*. [26]. The range of values for crude fibre observed in this study for samples UG, MP, and DC was within the range of 0.5 - 1.95% reported by Wireko-Manu and Amamoo [30] for selected local Rice varieties and imported rice brands in Ghana.

Carbohydrate content of the rice varieties ranged from 73.67% to 80.09% with sample TG recording the lowest value (73.67%) and sample UG as the highest (80.09%). Carbohydrate content of samples MP and DC were 78.63% and 78.97%, respectively. Carbohydrate content of sample MP was significantly (p<0.05) different from all other varieties. The rice varieties in this study had very high amounts of carbohydrates, which might mainly be starch [31]. The range of values of carbohydrates obtained in this study are in accordance with the value (77.31%) obtained by Islam *et al*. [26]. The observed high carbohydrate content of the rice varieties studied affirms that rice is majorly a carbohydrate rich source of food.

3.2 Mineral Composition of the Rice Varieties

The mineral composition of the rice varieties is shown in Table 2. Magnesium content of the rice varieties ranged from 6.28mg/100g to 9.63mg/100g with sample TG recording the lowest value (6.28mg/100g) and sample UG as the highest (9.63mg/100g). Samples MP and DC had magnesium contents of 8.68mg/100g and 7.04mg/100g, respectively. There was a significant ($p<0.05$) difference in the magnesium content of the rice varieties. The values of magnesium obtained for the rice varieties is lower than the values of 67.0 mg/100 g and 82.0 mg/100 g respectively for raw ´ofada´ and raw ´aroso´ rice varieties reported by Ebuehi and Oyewole [32]. The observed differences in the magnesium content of the rice varieties from this study could be due to genetic factors or the mineral content of the soil on which they were grown [27]. Magnesium is essential in the body as it helps in the formation of bones and teeth and in the absorption of calcium and potassium [23].

Calcium content of the rice varieties ranged from 3.74mg/100g in sample TG to 8.23 mg/100g in sample UG. Calcium content of samples MP and DC were 5.23mg/100g and 5.23mg/100g, respectively. There was a significant ($p<0.05$) difference in the calcium content of the rice varieties. The calcium content of the rice varieties from this study compares well with the values of 5.19-7.81mg/100g obtained by Vunain *et al*. [33] for white rice varieties in Malawi. Differences in calcium contents among the flours may be due to differences in the rate of calcium uptake by each plant. Calcium is required in the body as it is a constituent of bones and teeth, regulation of nerve and muscle function. It is also required by children as calcium deficiency may cause rickets and in adults, it causes osteomalacia and may also contribute to osteoporosis [34].

Iron content of the rice varieties ranged from 1.50mg/100g in sample DC to 5.48mg/100g in sample UG. There was a significant ($p<0.05$) difference in the iron content of the rice varieties. Similar values (4.54-7.34 mg/100g) were also reported by Thomas *et al*. [21] for imported and local rice varieties in Nigeria. Iron is essential for the formation of haemoglobin in red blood cells [35].

3.3 Anti-nutrient Content of the Rice Varieties

Table 3 shows the anti-nutrient composition of the rice varieties. Flavonoid content of the rice varieties observed were 2.86%, 2.29%, 2.80% and 2.77% for samples MP, UG, DC and TG, respectively. Flavonoid content of sample UG was significantly ($p<0.05$) different from samples MP, DC and TG. The result was within the range of 0.50-3.0% reported by Oselebe *et al*. [36] for rice varieties and hybrids grown in Ebonyi State, Nigeria. The variation of flavonoid content in the rice varieties may be affected by genotype and environmental variation. Flavonoids are a complex group of polyphenolic compounds found in a wide range of plant species. They are known to have very complex roles in plant insect interactions and may have a positive or negative role in the life of the herbivorous larvae depending on the species of pests and the type of chemical composition [37]. The result indicates that ultimate gold, daily choice and tomato gold rice varieties can provide antioxidant properties. The high quantity of flavonoid in these rice varieties also show that they are good free radical scavenger, and will help in preventing oxidative cell damage, and protect against all stages of carcinogen in individuals whose diet is majorly on it [38] since flavonoids act as potent antioxidants and metal chelators with anti-inflammatory, anti-allergic, hapatoprotective, anti-thrombotic, anti-viral, and anti-carcinogenic activities [36].

Phenol content of the rice varieties ranged from 9.92mg/100g to 14.58mg/100g with sample MP recording the lowest value (9.92mg/100g) and sample TG as the highest (14.58mg/100g). Samples UG and DC recorded values of 13.47mg/100g and 13.41mg/100g, respectively. Sample UG was not significantly ($p>0.05$) different from sample DC while sample TG was significantly ($p<0.05$) different from sample MP. High content of phenol in tomato gold (TG) more than the other rice varieties indicate that it is a good antimicrobial agent. This is because phenols and phenolic compounds have been extensively used in disinfectant and remain the standard with which other bactericides are compared [39]. High content of phenol also suggested that the rice variety could act as anti-inflammatory, anti-clothing antioxidant, immune enhancers and hormone modulator [40].

Phytate content of the rice varieties ranged from 1.22g/kg in sample TG to 1.53g/kg in sample UG. Samples MP and DC both recorded values 1.52g/kg. There was no significant ($p>0.05$) difference in the phytate content of the rice varieties. Phytic acid is the major storage form of phosphorous in legumes, cereals, nuts, and oil seeds. Phytic acid is known as a food inhibitor which chelates micronutrient and prevents it to be bioavailable for monogastric animals, including humans, because they lack enzyme phytase in their digestive tract [41].

Table 1. Percentage (%) proximate composition of the rice varieties

Rice variety	Moisture	Ash	Fat	Crude protein	Crude fibre	Carbohydrate
MP	11.97±0.43[a]	0.60±0.14[a]	1.39±0.01[a]	5.73±0.49[a]	1.69±0.71[b]	78.63±0.62[b]
UG	11.52±0.06[a]	0.45±0.07[a]	0.98±0.00[b]	6.07±0.01[a]	0.90±0.14[b]	80.09±0.28[a]
DC	12.77±0.15[a]	0.45±0.07[a]	0.99±0.01[b]	5.73±0.49[a]	1.10±0.14[b]	78.97±0.56[b]
TG	12.80±1.20[a]	0.50±0.00[a]	0.39±0.00[c]	5.79±0.58[a]	6.85±0.45[a]	73.67±2.24[b]

Mean values are of triplicate determinations. Mean values within a column with different superscripts are significantly different at (p <0.05)
Key: MP=Mama's pride
UG= Ultimate gold
DC= Daily choice
TG= Tomatoes gold

Table 2. Mineral composition (mg/100 g) of the rice varieties

Rice variety	Magnesium	Calcium	Iron
MP	8.68±0.86[b]	5.23±0.14[b]	4.04±0.42[b]
DC	7.04±0.42[d]	5.23±0.22[b]	1.50±0.55[d]
TG	6.28±0.03[c]	3.74±0.44[c]	3.40±0.18[c]
UG	9.63±0.88[a]	8.23±0.13[a]	5.48±0.13[a]

Mean values are of triplicate determinations. Mean values within a column with different superscripts are significantly different at (p <0.05)
Key: MP=Mama's pride
UG= Ultimate gold
DC= Daily choice,
TG= Tomatoes gold

Table 3. Anti-nutrient composition of the rice varieties

Rice variety	Phenol (mg/100 g)	Phytate (g/kg)	Saponin (%)	Tannins (mg/kg)	Flavonoids (%)
MP	9.92±0.06[c]	1.52±0.43[a]	5.94±0.01[a]	59.56±1.46[b]	2.86±0.13[a]
UG	13.47±0.24[b]	1.53±0.43[a]	6.37±0.00[b]	47.03±0.72[d]	2.29±0.16[b]
DC	13.41±0.18[b]	1.52±0.43[a]	5.92±0.01[b]	52.04±0.08[c]	2.80±0.01[a]
TG	14.58±0.20[a]	1.22±0.00[a]	5.86±0.00[c]	66.89±0.16[a]	2.77±0.01[a]

Mean values are of triplicate determinations. Mean values within a column with different superscripts are significantly different at (p <0.05)
Key: MP=Mama's pride
UG= Ultimate gold
DC= Daily choice
TG= Tomatoes gold

Saponin content of the rice varieties ranged from 5.86%) to 6.37% with sample TG recording the lowest value (5.86%) while sample UG had the highest (6.37%). Samples MP and DC recorded saponin contents of 5.94% and 5.92%, respectively. Saponin content of sample MP was significantly ($p<0.05$) different from sample TG while sample UG and DC were not significantly ($p>0.05$) different from each other. Saponins exhibit a variety of biological activities such as anti-inflammatory, hypocholesterolemic and immune-stimulating properties [42]. High quantity of saponin found in ultimate gold rice variety more than the other rice varieties studied may be suggestive of their therapeutical significance, since some of the general characteristics of saponins include formation of foams in aqueous solution, haemolytic activities and cholesterol binding properties [43].

Tannin content of the rice varieties ranged from 47.03mg/100g) to 66.89mg/100g with sample UG recording the lowest value (47.03mg/100g) while sample TG had the highest (66.89mg/100g). Samples MP and DC recorded tannin contents of 59.56 and 52.04mg/100g, respectively. Tannins are a complex group of polyphenolic compounds which play relevant roles in plant resistance against herbivorous insects [44]. Barbehebb *et al*. [45] reported that tannins may sometimes act as toxins for herbivorous insects but as facilitators of digestion. The results from this study revealed a significant difference among the four rice varieties in their tannins content. Thus, the fact that the contents of these compounds is higher in tomato gold rice variety leads to the supposition that they may be more resistant to herbivorous insects and ultimate gold rice variety, with the lowest content in total phenols be relatively sensitive to herbivorous insects.

4. CONCLUSION

This study has revealed that the four rice varieties have considerable amount of nutrients such as carbohydrate, which is a good energy source, protein, crude fibre as well as fat and mineral elements. The findings of the study also showed that Mama's pride rice variety contained higher ash and fat contents while Tomatoes gold had significantly higher crude fibre. On the other hand, ultimate gold rice variety contained higher protein and carbohydrate; however, ash, protein and moisture contents did not vary significantly between the rice varieties. Furthermore, the concentration of magnesium, calcium, potassium and iron were found to be superior in ultimate gold rice variety. Ultimate gold rice variety also contained higher concentrations of phenol and tannins while saponin content was higher in daily choice rice variety. Phytate content on the other hand did not vary significantly between the rice varieties. Due to the nutritive value of the four rice varieties, the production and consumption of these rice varieties especially ultimate gold rice variety is recommended to farmers and consumers for derivation of nutrients.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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