Original Research Article

Chemical and Functional Properties of Different Rice Varieties from Ebonyi and Anambra States Nigeria

ABSTRACT

The chemical and functional properties of selected rice varieties commercially cultivated in Ebonyi and Anambra States of Nigeria were evaluated. Four rice varieties each (IR-8, 1416, Faro 44 and 306) from these States were analyzed for their mineral, vitamin, functional and phytochemical properties. The mineral contents of the rice samples had a range of copper (0.01-0.06mg/100g); Calcium (0.31-0.55mg/100g); lead (0.04 to 0.12 µg/g);Iron (0.54-1.26mg/100g); Zinc (0.92-1.76mg/100g), Phosphorus (12.25-28.68mg/100g). Potassium (58.01-74.02mg/100g); Manganese (0.05-0.23mg/100g) and Magnesium (0.19-0.58mg/100g). Vitamin contents of the rice samples had a range of thiamine B_1(0.02-0.08mg/100g); Riboflavin B_2 (0.10-0.28mg/100g) and niacin B_3 (2.35-3.48mg/100g). The functional properties had a range of bulk density (0.71-0.83g/cm^3); water absorption capacity (2.60-4.00g/ml); swelling index (1.20-1.82); gelation temperature (82.00-90.00^{0}C); amylose (17.88-27.50%) and amylopectin (73.54-81.85%). The phytochemical contents of the rice samples had a range of tannin (0.01-02mg/100g); Phytate (4.27-9.28mg/kg); Oxalate (0.02-0.40mg/100g); flavonoid (1.14-5.58%) and carotenoid (473.59-4542.97mg/100g). The results of the mineral contents showed that the selected varieties were generally low in Copper, Iron, Zinc, Phosphorus, Manganese, Magnesium; high in calcium and potassium but low in lead content. The results of the vitamin contents showed that the selected varieties had low level of Thiamine (B_1), Riboflavin (B_2) and good level of Niacin (B_3). The result of the functional properties showed that the selected rice varieties were low in bulk density and water absorption capacity; moderate in swelling index and gelatinization temperature; however. 306 and1416 had good level of amylose whereas IR-8 and Faro 44 had good levels of amylopectin. Results also showed that the selected varieties were generally low in phytochemical contents and wouldn't pose nutritional risk when consumed. The result of this study can go a long way to an effective utilization of our indigenous varieties thus adding value to the crop.

Keywords: Rice variety, Amylose, Tannin, Minerals, Vitamins

1. INTRODUCTION

Rice (Oryza spp.) is known to be among the most important staple crops in different parts of the world. In Africa, there is rise in the demand for rice which is more than the local production strength. Most countries have gone into rice importation to meet the rise in demand. Low production rate together with low quality of rice production from local farmers have been challenged by competition from imported rice with superior quality. Most locally produced rice varieties have low milling recoveries, high incidence of chalkiness and poor cooking characteristics [1].

Rice provides 700 calories/day-person for almost 3000 million people in the world [2]. Knowledge about the nutritive value and health benefits of rice is of very important s rice is one of the most important cereals in human nutrition and is been taken by over 50% of the global population [3]. Rice is known to be high in carbohydrate, and it contains a relative amount of protein and fat, and also a source of vitamin-B complex such as thiamin ($B_{1)}$, riboflavin ($B_{2)}$ and niacin ($B_{3)}$ [4]. Minerals such as calcium (Ca), magnesium (Mg) and phosphorus (P) are all present in rice along with some traces of iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) [5]. Dietary minerals are needed in humans to maintain human

health, and their deficiencies can result to unwanted pathological conditions [6]. Rice is also a good source of bioactive compounds like phenolic compounds, γ-oryzanol, and dietary fibers, as well as antioxidants [7]. So many researchers have proved that rice has many health benefits, such as antioxidative properties, anti-hyperglycemia, anti-hypocholesterolaemia, and cardioprotective effects [8].
Rice is one of the most important food in Nigeria due to many reasons such as being a major contributor to internal and sub-regional trade [9]. Three varieties of rice are known, these varieties include long, medium, and short-grained rice. The long grain rice are known to be high in amylose content and the grain tends to remain intact after cooking; medium-grain rice are known to be high amylopectin content and it becomes stickier on cooking [10]. In Ebonyi state of Nigeria, rice is mostly grown commercially in different communities like Ikwo, Akaeze and Izzi and in Anambra state it is grown in communities ike Igbariam, Omor and Igbasi. Locally produced rice retains a lot of its natural characteristics because they are not produced through chemical means. It proves to be highly nutritious than foreign rice. Factors such as poor cultivation and postharvest practices, poor physical and cooking qualities, presence of stones, shaft, dirty appearance and husk etc. have contributed to underutilization of our indigenous rice [11].

A sound knowledge and success of this work will improve the cultivation of rice thus providing food for the populace. This will add value to the crop, enhance their effective utilization and provide Nigerians rice consumers with better choice of consumption. It is hoped that this study will enable Nigerians to appreciate the importance of Nigerian indigenous rice consumption thus boosting rice farming and solving some nutritional problems that may be associated with foreign rice consumption. Variety with best grain properties remains the most important determinant of market grading and end use qualities. To encourage traditional rice cultivation in Nigeria, there is need for a study that would reveal nutritional qualities from traditional rice varieties and would stand the world market competitiveness. Therefore, the present research work was undertaken to analyse the chemical and functional properties of four varieties of indigenous rice commercially grown in Ebonyi and Anambra States respectively.

2. MATERIALS AND METHODS

2.1 Source of raw materials

Four varieties of rice namely IR-8, 1416, Faro 44 and 306 were purchased in the local rice mills located in Ikwo and Akaeze towns in Ebonyi state and Igbariam and Achalla towns of Anambra State Nigeria. The rice samples were identified by a rice breeder at National Cereal Research Institute, Amakama-Umuahia.

2.2 Preparation of raw materials

The rice grains were sorted to remove bad grains and other solid contaminates and packaged until needed for analysis.

2.3 Determination of mineral properties

The mineral properties of the rice varieties were determined according to the method described by Hernandez *et al.* [12].

2.4 Determination of vitamin contents

Thiamine, riboflavin and niacin were determined according to the method described by Onwuka [13]

2.5 Determination of functional properties

Functional properties were determined according to the method of Onwuka [13]

2.6 Determination of phytochemical properties

Tannins and phytate was determined according to the method of Amadi *et al.* [14].

Flavonoid was determined using the method described by Vichapong [15].

Oxalate was determined using the method described by Savage [16].

2.7 Data analysis

Analysis of variance was used for the determination of significant differences ($p<0.05$) among treatment means and separation of means was carried out using the SPSS version 20.0. Separation of means was carried out by Duncan Multiple range test and values were reported as means and standard deviation.

3. RESULTS AND DISCUSSIONS

3.1 Mineral properties of the rice varieties

The result of the mineral properties of the selected rice varieties from Ebonyi and Anambra states of Nigeria respectively is shown in Table 1. Results of the copper contents of the rice varieties ranged from 0.01-0.06 mg/100g. Faro 44 recorded the highest value whereas 306 Achalla the lowest value. Copper plays a critical role in body's metabolism, largely because it allows many critical enzymes to function properly. It also aids in the utilization of iron and in haemoglobin synthesis [17].

The results of the calcium content of the rice varieties showed that 1416 Igbariarn recorded the highest value of 0.55 mg/100g whereas IR-8 lkwo and Igbariam had the lowest values of 0.31 mg/g and 0.37 mg/g respectively, The calcium content of the samples was high when compared to the range of 0.01 to 0.03 mg/g reported by Kennedy *et al.* [18]. Calcium is essential for bone formation and development and the rate of absorption is dependent on the quantity of phosphorus present in a food sample [19]. Its deficiencies result in bone and teeth diseases. It is also necessary for clotting of blood for the function of certain enzymes and for the fluids through cell membrane [17]. Presence of Calcium in rice is a clear

indication that when taken will aid normal development and maintenance of bones and teeth, clotting of the blood, nerve irritability in the blood.

Lead concentrations in these rice samples ranged from 0.04 to 0.12 µg/g. Faro 44 Akaeze and 1416 Ikwo had the least value of 0.04 µg/g Achalla had the highest value of 0.12 µg/g. Significant differences exist among the rice samples. The concentration in these rice samples are low and when compared with the set limit for cereals by WHO/FAO [20] at 2 µg/g, lead concentrations are within the permissible limit. The differences observed in the values may be attributed to level of soil contamination by heavy metals and human activities such as mining, overuse of fertilizers and pesticides.

The Iron (Fe) content of the tested varieties ranged from 0.61 mg/g to 1.26 mg/g with the lowest and highest obtained from 306 Achalla and 1416 Ikwo rice respectively. This is within the range of 0.2 to 2.8 mg/g reported by Kennedy *et al.* [18]. Iron is essential for the formation of haemoglobin of red blood cells [21]. Off all the nutrients required by man, shortage of iron may be the most common inadequacy in the diets of industrialized world [17]. Iron deficiency includes dizziness, tireness and mental confusion.

The result of the zinc content showed that 1416 Igbariam recorded the highest value of 1.76 mg/g whereas IR-8 recorded the least value of 0.92mg/g. This is below the value of 3.12-3.54 mg/g obtained by Oluwaniyi & Fagbohun [19] and may be due their samples were stored before analysis. Zinc is an essential constituent of enzymes involved in carbohydrate and protein metabolism and nucleic-acid synthesis. It deficiency results in impaired growth and development, skin lessons and loss of appetite [17].

The result of the phosphorus content showed that 1416 Igbariam recorded the lowest value whereas Faro 44 Achalla recorded the highest value. This is one of the minerals humans require in greatest amount. It is an essential part of every living cell. It is involved in the enzyme-controlled energy yielding reactions of metabolism [17].

The results of the potassium content ranged from 12.55- 28.68 mg/100g. 1416 Igbariam had the lowest value whereas Faro 44 Achalla had the highest value. This is the principal intracellular cation and with sodium helps regulate osmotic pressure and pH equilibria. It is also involved in cellular enzyme function [17].

The magnesium contents of the rice samples ranged from 0.19-0.58 mg/l00g. IR-8 had the least value whereas Faro 34 Akaeze had the highest value. Magnesium is essential to the function of several enzymes systems and is important in maintaining electrical potential in nerves and membranes. It is involved with liberation of energy for muscle contraction and is required for normal metabolism of calcium

and phosphorus. Its deficiency is common in farm animals than in humans whose diet is generally high in magnesium [17].

Table 1: The mineral composition of selected rice varieties

Samples (mg/g)	Copper	Calcium	Lead	Iron	Zinc	Phosphorus	Potassium	Manganese	Magnesium
IR-8 Ikwo	0.05^{ab}	0.31^{h}	0.54^{d}	0.92^{f}	25.08^{c}	58.01^{g}	0.09^{d}	0.10^{b}	
IR-8 Igbariam	0.05^{c}	0.37^{e}	0.07^{d}	0.95^{ab}	1.47^{bc}	13.25^{g}	69.05^{b}	0.19^{b}	0.22^{g}
306 Achalla	0.01^{f}	0.34^{g}	0.61^{cd}	1.58^{ab}	20.26^{e}	65.10^{d}	0.08^{d}	0.10^{b}	
306 Afikpo	0.03^{d}	0.46^{c}	0.05^{e}	0.80^{bc} 1.27^{cd}		17.19^{f}	59.19^{f}	0.18^{b}	0.46^{c}
Faro 44 Achalla	0.05^{bc}	0.54^{b}	0.12^{a}	0.69^{bc}	1.19^{de}	28.68^{a}	74.02^{a}	0.13^{c}	0.52^{b}
Faro 44 Akaeze	0.06^{a}	0.38^{e}	0.04^{c}	0.68^{bc}	1.39^{bc}	27.7^{b}	67.13^{d}	0.23^{a}	0.58^{a}
1416 Igbariam	0.02^{e}	0.55^{a}	0.09^{e}	1.02^{ab}	1.76^{a}	12.25^{h}	61.15^{e}	0.05^{f}	0.34^{f}
1416 Ikwo	0.05^{b}	0.41^{d}	0.04^{f}	1.26^{a}	1.00^{ef}	21.16^{d}	68.13^{b}	0.08^{e}	0.39^{e}

Mean values in each column with the same superscript are not significantly different ($p<0.05$) from each other

3.2 Vitamin content of the rice varieties

The results of the vitamin contents of the rice varieties from Ebonyi and Anambra States of Nigeria respectively are shown in Table 2. Thiamine (B_1) content of the rice samples ranged from 0.02mg/100g (1416 Igbariam) to 0.08 mg/100g (1416 Ikwo). This is similar to thiamine range of 0.02 to 0.11 mg/g for rice as reported by ingredients 101.com but below the recommended daily adult allowance of 1.0-1.5 mg/g. Rice is a poor source of thiamine. This is important in the utilization of carbohydrates to supply energy, where it functions as the coenzyme thiamin-pyrophosphate in the oxidation of glucose. Its deficiency is known as beriberi and is common where polished rice is a major dietary item [17].

Riboflavin (B_2) content ranged from 0.10 mg/100g (Faro 44 Akaeze) to 0.28 mg/100g (1416 Igbariam), though both 1416 Igbariam and Ikwo are statistically the same. The result was also comparable to the range of 0.23-0.29 mg/100g, reported by Alaka *et al*. [22] but as lower than the recommended daily allowance value of 1.2-1.7 mg/g for adults. All the results recorded showed low riboflavin content, but the differences recorded among the same variety may be attributed to location. It functions in the oxidative

processes of living cells and is essential for cellular growth and cell maintenance. Its deficiency results in skin conditions, such as cracking at the corners of the life [17].

The Niacin contents of the rice samples ranged from 2.64- 3.48mg/100g. 1416 Igbariam had the lowest value whereas 1416 Ikwo had the highest value. The Niacin content was higher than the range of 1.3 to 2.4mg/100g reported by Kennedy *et al.* [18]. The results obtained was lower than adult recommended daily allowance value of 13-20 mg/g. Statistically, all the varieties showed significant difference ($p<0.05$) in the values of vitamins but 1416 Ikwo generally recorded the best results in terms of vitamin content. Its deficiency adversely affects tissue respiration, oxidation of glucose and results in the disease deficiency mil as Pellagra in humans.

Table 2: The vitamin composition of selected rice varieties

Samples (mg/g)	Thiamine (B_1)	Riboflavin (B_2)	Niacin (B_3)
IR-8 Igbariam	0.04^{b}	0.16^{cd}	2.74^{e}
IR-8 Ikwo	0.03^{bc}	0.14^{de}	2.92^{c}
306 Achalla	0.03^{bc}	0.20^{bc}	2.35^{g}
306 Afikpo	0.04^{b}	1.18^{cd}	3.20^{b}
Faro 44 Achalla	0.03^{bc}	0.24^{ab}	2.70^{e}
Faro 44 Akaeze	0.04^{b}	0.10^{e}	2.85^{d}
1416 Igbariam	0.02^{c}	0.28^{a}	2.64^{f}
1416 Ikwo	0.08^{a}	0.25^{a}	3.48^{a}

Mean values in each column with the same superscript are not significantly different ($p<0.05$) from each other

3.3 Functional properties of the rice varieties

The result of the functional properties in the rice samples evaluated from Anambra and Ebonyi states are shown in Table 3. The result of bulk density of the varieties of rice grain ranges from 0.83 g/ml (IR-8 Ikwo) which had the highest value followed by other varieties which were statistically related to one another. The slight variation in bulk density could be because of the variation in starch content among the rice varieties. Iwe & Onuh [23]; Iwe & Onadipe [24] reported that starch content increases bulk density. Bulk density is also dependent on factors such as method of measurement, geometry, size, solid density and surface properties of the materials and could be improved when the particles are small, compatible, properly tapped and with a suitable packaging material. Bulk density reflects the relative volume of packaging material required. The higher the bulk density, the denser the packaging material required. It

indicates the porosity of a product which influences the package design and could be used in determining the type of packaging material required [24].

The result of the water absorption capacity of the varieties of rice grain ranges from 0.60 g/ml (Faro 44 Achalla) to 4.00 g/ml (1416 Ikwo). The water absorption capacity is an essential functional property of cereals which may be defined as the amount of water retained by a known weight of flour under specific conditions. The water absorption capacity depends on capillary, pore size and charges of the protein molecules. This is due to strong correlation of extent of protein hydration with polar constituents along with the hydrophilic interaction through hydrogen bonding. The rice samples evaluated generally had a low water absorption capacity which may be attributed to low protein content. Higher protein content of flour is responsible for high hydrogen bonding and high electrostatic repulsion [25].

The swelling index of the varieties of rice grain analyzed showed that IR-8 Igbariam had the highest value of 1.82 and was closely followed by 306 Afikpo (1.69) whereas 1416 Igbariam (1.62) had the least value. This result may be due to the variety of the rice grains and various processing method adopted. Swelling index is regarded as a quality criterion in some good formulations as bakery products. It is an evidence of non-covalent bonding between molecules within starch granules and a factor of the ratio of amylose and amylopectin ratios.

Gelatinization temperatures were 90.00°C for both Faro 44 Achalla and 306 Achalla which recorded the highest values followed by 88.00°C (Faro 44 Akaeze) whereas 78.00°C (IR-8 Igbariam) recorded the least value. The values for the gelatinization temperature recorded in this study were higher than the values 70 - 74℃ reported by Enyi *et al.* [26] for milling, cooking and thermal properties on selected varieties of rice in Ebonyi State, Nigeria. In overall, gelatinization temperature differed significantly ($p<0.05$) between the rice varieties analyzed. Variation in the gelation characteristics of the rice varieties could be attributed to the relative ratio of protein, carbohydrates and lipids that make up the flours and the interaction between such components [27]. This property of starch granules to form a gel when subjected to heat is important in the formulation of baked goods. The flours from Faro 44 Achalla and 306 Achalla could be employed in baking.

306 Afikpo had the highest amylose content of 27.50%, closely followed by 1416 Igbariam (26.46%), 306 Achalla (26.20%) and 1416 Ikwo (25.80%) respectively. The values for the amylose content recorded in this study were lower than the values 31.2 – 66.8 % reported by Enyi *et al.* [26] for milling, cooking and thermal properties on selected varieties of rice in Ebonyi State, Nigeria. Differences in amylose content may be attributed to characteristics of the varieties and in part to the environmental conditions in which the crop was grown, particularly temperature. Rice varieties with a greater proportion of starch in the form of amylose tend to have a lower glycemic index. Amylose contents determine the texture of cooked rice

and rice varieties with amylose content of more than 25% absorb more water and have a fluffy texture after cooking [28]. Since 306 and 1416 varieties had reasonable levels of amylose, this means that the two varieties mentioned may be ideal for the use by diabetic patients. Since starchy foods with high amylose level are associated with lower blood glucose level and slower emptying of the human gastrointestinal tract compared to those with low levels of this macromolecule [28]. Feeding with cooked rice high in amylose instead of cooked rice low in amylose may be effective to control serum blood glucose and lipid. More so, Cristiane *et al.* [29] reported that serum triglyceride and cholesterol levels significantly decreased after consumption of a diet rich in amylose compared to a diet rich in amylopectin (Low amylose). Rice varieties high in amylose would invariably be low in amylopectin content.

The amylopectin content of the selected rice varieties evaluated shows that Faro 44 Akaeze (82.12%) had the highest content whereas 306 Afikpo (72.50%) had the lowest value. The values for the amylopectin content recorded in this study were higher than the values reported by Enyi *et al.* [26] for milling, cooking and thermal properties on selected varieties of rice in Ebonyi State, Nigeria. Amylopectin is mainly composed of glucose molecules with branched links and is less resistant to digestion. This means that rice varieties with a higher proportion of starch in the form of amylopectin tend to have a higher glycemic index (GI). The starch of waxy rice varieties consists of amylopectin only. These varieties absorb less water upon cooking and have a sticky texture [28]. Adequate care should be taking when cooking Faro 44 and IR-8 Igbariam to avoid stickiness. Foods with a higher glycemic index (GI) are, in principle, more quickly digested than those with a lower GI value. Therefore, 306 Afikpo, 306 Achalla, IR-8 Igbariam and IR-8 Ikwo with least levels of Amylopectin may be better than other varieties evaluated as it has better levels of Amylose content which indicates relatively lower Glycemic index and could be recommend for consumption by diabetics.

Table 3: The functional properties of selected rice varieties

Samples	Bulk density (g/cm^3)	Water absorption capacity (g/ml)	Swelling index	Gelation temperature (^0C)	Amylose (%)	Amylopectic (%)
IR-8 Igbariam	0.71^{b}	3.70^{c}	1.82^{a}	78.00^{f}	21.56^{d}	78.44^{c}
IR-8 Ikwo	0.83^{a}	3.60^{d}	1.49^{d}	84.00^{d}	20.80^{e}	79.20^{b}
306 Achalla	0.77^{ab}	2.60^{g}	1.50^{d}	90.00^{a}	26.20^{b}	73.80^{de}
306 Afikpo	0.76^{ab}	2.80^{e}	1.69^{b}	82.00^{e}	27.50^{a}	72.50^{f}
Faro 44 Achalla	0.77^{ab}	2.60^{g}	1.49^{d}	90.00^{a}	18.15^{f}	81.85^{a}
Faro 44 Akaeze	0.71^{b}	2.70^{f}	1.34^{e}	88.00^{b}	17.88^{f}	82.12^{a}
1416 Igbariam	0.71^{b}	3.85^{b}	1.20^{f}	84.51^{d}	26.46^{b}	73.54^{e}
1416 Ikwo	0.77^{ab}	4.00^{a}	1.55^{c}	86.00^{b}	25.82^{c}	74.18^{d}

Mean values in each column with the same superscript are not significantly different ($p<0.05$) from each other

3.4 Phytochemical contents of the rice varieties

The result of the phytochemical contents of the rice varieties from Ebonyi and Anambra states of Nigeria respectively is shown in Table 4. Tannin content (mg/100g) of all the selected rice samples ranged from 0.01 to 0.02 mg/100g. Tannin content of the rice samples evaluated were statistically the same ($P<0.05$). Tannins are concentrated mainly in the husk; preliminary de-husking constitutes the simplest method for their removal and may have contributed to the low values recorded.

The result of the phytate content of the rice evaluated showed that 306 Achalla had the highest value of 9.28 mg/g whereas 1416 Ikwo had the lowest value of 4.27 mg/g. The variation in phytate content noticed among the rice samples may be attributed to the difference in milling, genotype and environmental effects [30]. Phytic acid also has a strong binding capacity and forms complexes with multivalent cation, including Ca, Mg, Fe and Zn and render them biologically unavailable [31]. Thus, the phytic acid present in the rice samples evaluated is not of nutritional concern.

The result of the oxalate content revealed that Faro 44 Achalla exhibited the highest level of oxalates (0.40 mg/100g) and 1416 Ikwo recorded the lowest (0.02 mg/100). This was lower than the value of 1.76 mg/100g obtained by [32]. Oxalic acid is primarily located in the outer layers of cereal grains [33]. The

lower value recorded among the rice samples may be attributed to leaching during parboiling of the rice paddy prior to milling of the rice samples. The nutritional standard for tolerable oxalate content of grains is <3mg/100g, thus the oxalic acid present in the rice samples evaluated is not of nutritional concern.

Results of the flavonoid indicate that Faro 44 Akaeze and Faro 44 Achalla had the highest value (5.58 and 5.09%) respectively but varieties evaluated generally recorded low amount of flavonoid content. Flavonoids are the major polyphenolic components of foods. Flavonols and favones are of importance because they possess antioxidant and free radical scavenging activity in foods [34]. Flavonols like quercetin have been reported to inhibit the proliferation of a wide variety of cancer cell lines. The mechanism of action of flavonoid are through scavenging or chelating process [35,36].

306 Afikpo had the highest cartenoid content of 4542.97 mg/100g whereas IR-8 Ikwo recorded the lowest value of 473.59 mg/100g. Carotenoid compounds are found in plants and enhance the human health immune response, reduce risk of degenerative diseases such as cancer, cardiovascular diseases etc. and these have been attributed to their scavenging and free radical activities [37]. In recent times, there has been a great need for the supply of foods that contain significant quantities of carotenoids especially for young children or the fortification of existing foods. This is because there are reports that nearly 50% of pre-school children living in developing countries are vitamin A deficient [38].

Table 4: The phytochemical contents of selected rice varieties

Samples	Tannin (mg/g)	Phytate (mg/g)	Oxalate (mg/g)	Flavonoid (%)	Carotenoid (mg/g)
IR-8 Igbariam	0.01^{ab}	5.50^{de}	0.05^{cd}	3.67^{d}	975.97^{g}
IR-8 Ikwo	0.01^{ab}	5.75^{d}	0.06^{c}	2.66^{f}	473.59^{h}
306 Achalla	0.01	7.33^{bc}	0.05^{cd}	4.55^{c}	1842.00^{d}
306 Afikpo	0.01^{a}	9.28^{a}	0.08^{b}	2.15^{g}	4542.97^{a}
Faro 44 Achalla	0.01^{a}	6.00^{d}	0.40^{a}	5.58^{a}	1037.43^{f}
Faro 44 Akaeze	0.01^{ab}	8.00^{b}	0.13^{b}	5.09^{b}	2219.33^{c}
1416 Igbariam	0.01^{ab}	6.40^{cd}	0.40^{a}	1.14^{h}	1796.54^{e}
1416 Ikwo	0.02^{a}	4.27^{e}	0.02^{e}	2.87^{e}	2781.98^{b}

Mean values in each column with the same superscript are not significantly different ($p<0.05$) from each other

4. CONCLUSIONS

The present stud has provided reliable data on glycemic index, nutritional, functional and phytochemical properties of selected rice varieties commercially cultivated in Ebonyi and Anambra States of Nigeria. The results of the mineral contents showed that the selected varieties were generally low in copper, iron, zinc, phosphorus, magnesium, high in calcium and potassium but low in lead content. The results of the vitamin contents showed that the selected varieties had low level of Thiamine (B_1), Riboflavin (B_2) and good level of Niacin (B_3). The result of the functional properties showed that selected rice varieties were low in bulky density and water absorption capacity; moderate in swelling index and gelatinization temperature; however 306 and 1416 had good levels of amylase whereas IR-8 and Faro 44 had good levels of amylopectin. The results also showed that the selected varieties were generally low in phytochemical contents and wouldn't pose a nutritional risk when consumed. The results obtained from this study were comparable with the findings of some researchers who investigated indigenous rice varieties in Nigeria.

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