Original Research Article

NutritionalProperties of Fortified rice(PDS) Distributed at KGBV Hostels of Telangana State

Comment [AO1]: Rice

Abstract:

Rice is a vital staple crop that serves as the primary source of calories for over half of the global population, particularly in Asia. Despite its importance, rice is inherently deficient in several essential micronutrients, and the nutritional value is further diminished through processing. This study examines the nutritional composition of fortified rice provided through the Public Distribution System (PDS) in KGBV hostels, emphasizing its potential to address nutritional deficiencies. The analysis focused on key parameters including moisture, ash, fat, crude fiber, protein, carbohydrates, energy, and iron content. Results revealed that fortified rice contains 11.8% moisture, 1.57% ash, 0.78% fat, and 31.05 mg of iron, crude fiber content was 0.3%, protein levels were 7.7%, carbohydrate content was 71.14g, and energy content was 380.12 kcal. These findings highlight the superior nutritional profile of fortified rice, particularly in terms of its ash, energy, and iron content, making it a highly beneficial option for addressing nutritional deficiencies and improving public health outcomes.

Key words:rice, Micronutrients, Fortified rice (PDS), Nutritional composition.

Introduction:

Rice is an important grain crop, next to wheat in terms of production. Half of the global population and 90% of Asians consider it as a staple food. Rice is a staple meal for about half of the world's population (1) with over 440 million Metric Tons consumed globally each year. Rice makes up at least one-third of daily calorie intake, equivalent to 70 kg per capita per year or 200 g per day in17 Asian and Pacific countries, 6 Sub-Saharan African countries, and 1 Latin American and Caribbean country (2)(3). It is a significant source of caloriesfor many households.Rice is inherently low in some important micronutrients required for human health.(4).Rice has several macro and micronutrients in its un-milled form. Milling removes the fat and micronutrient-rich bran layers, resulting in the starch-rich white rice that is widely consumed.Rice accounts for 30% of calories on average, but can reach up to 70% in low-income nations(2).Rice has the capacity to provide micronutrients to a wide population and address micronutrient deficits.Fortifying rice with micronutrients can boost daily consumption of important vitamins and minerals, addressing prevalent nutritional shortages(5) and can effectively treat micronutrient deficits in nations where rice is a primary food. Improved new technologies may create grain-like structures similar to rice kernels with vitamins and minerals in terms of shine, taste, texture, and color(3).Rice can be fortified by adding micronutrient powders, spraying with vitamins and minerals, or extruding into grain-like structures. These methods can impart iron, folic acid, B vitamins, vitamin A, and zinc. Rice fortification with vitamin A can improve iron and vitamin A levels, while folic acid fortification boosts folate status. A staple food, consumed regularly provides significant calories and nutrients, with preparation varying by location and available foods (6). In india government provides subsidy rice to the low-income groups through public distributive system. Earlier the ricewas used to provide, to combat malnutrition government started to provide fortified rice because rice-based micronutrient delivery is only effective if fortified rice is affordable for low-income individuals (7).

2. Material and methods:

Fortified rice (PDS) was procured from the KGBV Hostels in Telangana state. The present study was conducted during 2023 at the Department of Foods and Nutrition, Post Graduate Research Centre (PG&RC),Professor Jayashankar Telangana State Agricultural university, Rajendranagar, Hyderabad.

2.1 Nutritional properties of rice

2.1.1Moisture:

To determine the moisture content of sample an empty petri dish with its lid was weighed. A 2.0 g sample of fortified rice was placed in the dish and spread evenly. The sample was dried in a hot air oven at 105°C for 2 hours with the lid open. After drying, the dish and sample were cooled in a desiccator, and the final weight was recorded.The following formula was used to determine the moisture content: Moisture (%) =(W2-W1)(g)/W (g) ×100. (8)

2.1.2 Ash:

Fortified rice samples are heated to temperature at 550 – 600^{o}C where the water and other volatile constituents evaporated. The organic constituents were burned in the presence of oxygen to carbon dioxide and oxides of nitrogen that were eliminated together with hydrogen as water. The inorganic residue as ash contains oxides, sulphates, phosphates and chlorides and it constitutes the minerals in food product (8). The ash content was evaluated by incineration in a muffle furnace. Samples were burnt on a hot plate in a pre-weighed silica crucible. The crucible was then heated to 550°C in a muffle furnace for four hours. After cooling in the desiccator, the crucible was weighed. The ash content of the sample was determined using the following formula. Ash (%) = Weight of the ash/weight of the sample taken x 100.

2.1.3 Fat:

Fat was estimated as crude ether extract of the dry material using automatic soxtherm extraction unit (8). The Soxhlet extraction process was used to determine total fat content. Weighed samples were extracted in a thimblewith petroleum ether in a Soxhlet apparatus. The fat extract was then transferred to a previously weighed beaker using a funnel. After evaporating the petroleum ether, the amount of fat was determined by weighing the beaker. The fat content of the sample was determined using the following formula. Fat (%) = weight of the beaker (g) / weight of the fat (g) x 100.

2.1.4 Crude fiber:

The crude fiber content of samples was determined by boiling the sample with 1.25% dilute H_2SO_4, washing with water, followed by boiling with 1.25% dilute NaOH and again washing with water. The remaining residue after digestion was taken as crude fiber(8). To determine crude fiber, 1.0 g powdered sample was placed in fiber bags with a glass spacer, then loaded into a sample carousel in a glass container. The container was filled with 500 ml of 1.25% H_2SO_4 and heated for 30 minutes, followed by boiling in 500 ml of distilled water for 30 minutes. This was succeeded by heating in 500 ml of 1.25% NaOH for another 30 minutes, then boiling again in 500 ml of distilled water for 30 minutes. The residue was transferred to a crucible, weighed (W1), dried at 100°C for 4 hours, cooled in a desiccator, and reweighed (W2). Finally, the crucible was incinerated at 600°C for 3 hours, cooled in a desiccator, and weighed again (W3).The crude fiber content of the sample was determined by using the following formula: crude fiber (%) =weight of the sample at 100^{o}C(g)– weight of the sample at 600^{o}C (g)/ Weight of the sample (g) x 100

2.1.5 Protein:

Micro kjeldahl method (9) was used to assess the nitrogen content of the sample. Crude protein was computed with a conversion factor 6.25.The nitrogen in protein or any other organic material is converted to ammonium sulphate by Sulphuric acid during digestion. This during steam distillation liberates ammonia which was collected in boric acid solution and titrated against standard acid. The nitrogen content present in the sample was multiplied by the conversion factor 6.25, expressed as the protein percent.For digestion, 0.5g of fortified rice was mixed with 1g of digestion mixture and 10mL of concentrated sulfuric acid ($H2SO4$) in digestion tubes, then heated until it is clear. A blank was run simultaneously. After cooling, the samples were subjected to distillation in an auto distillation unit with 40% NaOH, 4% boric acid, and distilled water, with 3-4 drops of mixed indicator in the collection flask. The process lasted for9 minutes, trapping ammonia in the boric acid, which turned green. The device was rinsed with distilled water for 2.5 minutes. For titration, the green boric acid solution was titrated against 0.1N HCl until it turned pink, with a blank executed simultaneously. The titre value determined the percentage of nitrogen (N) in the sample, which was multiplied by 6.25 to obtain find the protein content.

2.1.6 Carbohydrate:

The following formula is used to calculate the total carbohydrate content by difference method:

Total carbohydrate (g/100g) = 100 – [Protein(g) + Fat(g) + Ash(g) + Moisture(g)] (10).

2.1.7 Mineral Iron (Fe) by AAS:

To determine the iron contentfor fortified rice (PDS) analiquot of 500 ml from the 1000ppm iron standard was taken in 50 ml volumetric flask and volume was made upto 50 ml with ultrapure water and 10ppm stock solution was obtained. From this stock solution aliquots of 1.0ml, 2.5ml, 5.0ml, 7.5ml, 10.0ml and 25ml were taken into standard 50ml volumetric flask and volume was made upto 50ml with 0.5M nitric acid to get 0.2ppm, 0.5ppm, 1.5ppm, 2.0ppm, and 5.0ppm standard respectively (11).

3. Results and Discussion:

The present research was carried out to study the chemical properties of fortified (PDS) rice. Fortified rice which is prepared by adding micronutrients addresses the malnutrition in humans.Consuming fortified rice reduces anemia in several cases. Thenutritional properties of fortified (PDS) riceare presented inbelow

The percentage and mean valueof moisture, ash, fat, crude fiber, carbohydrate, energy and iron of fortified rice (PDS) compared to Normal rice were presented in the Table 1. The analysis of the nutritional composition of fortifiedrice revealed several key findings that highlight its potential benefits for dietary supplementation, particularly in addressing nutritional deficiencies.

3.1 Moisture:

The moisture content of fortified rice was 11.8% and similar findings was reported by Chaudhari et al. (12) in normal rice approximately between the range 1.25 to 15.3%. There was significant difference between fortified rice and normal rice.A study reported normal rice at different moisture contents in the range of 10-14%(13).Study conducted by verma et al. (14) showed moisture levels of all normal rice accessions varied between 8.90%–13.57%.

3.2 Ash:

Ash content of fortified rice (PDS) was 1.57%and in comparison, with normal rice similar findings were stated by Zubair et al. (15) which is 0.33%.Normal rice varieties had ash content ranging from 0.88 to 1.46%(12).Nutritional analysis of normal rice had determined an ash content of 1.3% (16). Significant difference had been observed between fortified rice andnormal rice.

3.3 Fat:

Fat content of fortified rice, analyzed was 0.78%and that of normal rice reported by Zubair et al. (15) was0.24% respectively.Rice varieties hadfat content ranging from 0.68 to 1.45% (12).There was a significant difference between fortified rice and normal rice.

3.4 Crude fibre:

Results had shown that fibre content of fortified rice (PDS) was 0.3% and the fiber content in normal ricewasaround 0.5% to 1.0% described by Verma et al. (14). Significant difference was not found between normal rice and fortifiedrice (PDS).

3.5 Protein:

Protein content of fortified rice (PDS) was 7.70% and according to FAO,(1993) rice has protein content that contains 7.2% (17).There was no significant difference between fortified rice (PDS) andnormal rice.

3.6 Carbohydrates:

Results had shown that fortified rice (PDS) has carbohydrate content of 71.14g/100gand normal rice contains 77-89g which was reported by chaudhari et al. (12) respectively. There wasa significantdifference in CHO content in both fortified rice andnormal rice, the normal rice showed higher carbohydrate content than fortified rice (PDS).

3.7 Energy:

Energy content offortified rice (PDS) was 380.12 kcal, and chaudhari et. al reported normal rice contains 349-373 kcal (12).There was a significant difference between fortified rice (PDS) which shows more energy value as compared to normal rice.

3.8 Iron:

Fortified rice which is prepared by adding micronutrients contains about 31.05 mg of iron, whereas, in normal rice the iron content was in between0.2-2.8mg (12) respectively.Fortified rice Kernels (FRKs) whichcontain micronutrient iron was (28-42 mg/kg) (18). There was a significant difference between fortified rice (PDS) and normal rice in which iron content is rich in fortified rice (PDS) i.e., of about 31.05mg.

S. No	Parameters	Fortified-normal rice (PDS)	Normal rice
1.	Moisture (%)	11.8 ± 0.68	1.25 to 15.3.[12]
2.	Ash (%)	1.57 ± 0.07	0.33[15]
3.	Fat (%)	0.78 ± 0.05	0.24[15]
4.	Crude fiber (%)	0.3 ± 0.05	0.5 to 1.0[14]
5.	Protein (%)	7.7 ± 0.1	7.2[17]
6.	Carbohydrate (g/100)	71.14 ± 0.47	77-89[12]

Comment [AO2]: This number is wrong and hence the calculation of the elements in this table is wrong

7.	Energy (kcal)	380.12 ± 0.29	349-373 [12]
8.	Iron (mg/kg)	31.05 ± 0.05	0.2-2.8[12]

Table 1: Nutritional composition of Fortified Normal rice (PDS)

Note: The above values are expressed as mean ± standard deviation of three determinations in fortified rice and normal rice was expressed in percentages.

Conclusion:

The nutritional analysis of fortified rice (PDS) demonstrates its superior nutritional profile compared to normal rice, particularly in addressing dietary deficiencies. There wasno significant difference in crude fiber, and protein levels in both fortified and normal rice, but exhibits significant differencein moisture, ash, fat,energy, carbohydrate, and iron levels which are essential for overall health. Specifically, the iron content in fortified rice is significantly elevated, making it a potent option for combating iron deficiency anemia. Although fortified rice has lower carbohydrate content, its enhanced nutritional attributes, especially in minerals and energy, highlight its potential as a valuable dietary supplement.Zinc, folic acid and other micronutrients can be recommended for further nutritional analysis in fortified rice in whichthese nutrients help in combating anemia.

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