A comparative analysis in the macro and micro nutrient compositions of locally available polished rice (Oryza sativa L.) in Bangladesh

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Abstract

Rice (Oryza sativa L.) is the most important food crop of the developing world and the staple food of more than half the global population. An investigation was carried out to identify chemical and minerals composition of twelve varieties of locally produced polished rice namely, Parija, Minikat, Savrna, Jeerashile, Nurjahan, Pajjam, Basmoti, Govindavogh, Katarivogh, Nagirshail and Chinigura. We analyzed Moisture, Ash, Dry Matter, Crude Fibre(CF), Crude Protein(CP), Water soluble protein, Fat, Total Carbohydrate, Metabolizable Energy (ME), Total sugar, Reducing sugar, non-reducing sugar, and minerals when the rice varieties are in polished form and obtained comparative data on their chemical composition and nutritive values. The results revealed the presence of nutrient constituent among the twelve varieties comprising Moisture (10.21±0.07 to 13.22±0.08%), Ash (0.30±0.02 to 0.57±0.02%), Dry Matter (86.78±0.08 to 9.79±0.7%), Crude Fibre (0.15±0.02 to 0.63±0.02%), Crude Protein (6.31±0.01 to 8.31±0.01%), Water soluble protein (0.13±0.02 to 0.25±0.02%), Fat (0.9±0.01 to 2.9±0.02%), Total Carbohydrate (76.33±0.13 to 81.87±0.05%), Metabolizable Energy (2834.31 to 3017.27 Kcal/Kg), Total sugar (0.06±0.01 to 0.4±0.01%), Reducing sugar (0.01±0.01 to 0.09±0.02%), Non-reducing sugar (0.05±0.01 to 0.36±0.01%) and minerals such as Sodium (69.01±0.13 to 118.87±0.39 mg%), Potassium (3.41±0.47 mg%), Calcium (1.1±0.1 to 1.85±0.03 mg%), Magnesium (0.13±0.04 to 0.61±0.01 mg%), Iron (0.0005±0.0005 to 0.0005±0.0005 mg%), Phosphorus (0.52±0.03 to 2.33±0.03 mg%) respectively.

Keywords: Polished Rice; Moisture; Ash; CF; CP; Water Soluble Protein; NFE; Fat; Mineral Content.

1. Introduction

Rice (Oryza sativa L.) apparently originated more than 6,000 years ago in Southeast Asia. More than 3,000 varieties have been collected by the IRRI (International Rice Research Institute). Rice is an important staple food crop for human health because it provides the bulk of calories for more than half the world’s population. Rice is currently grown in over 100 countries and more than 1 billion people depend on it for their livelihood (Almanac., 2002).

Rice contributes more than 80 percent to the total food supply. More than 95% of population consumes rice and it alone provides 76% of calories and 66% of total protein requirement of daily food intake (Bhuiyan, 2002). Rice, a grass belong to the genus Oryza, Linncomprise twenty five species cultivated mostly in the tropical areas of the world. Of these species two viz, Oryza sativa and Oryza glaberima are widely distributed. Rice (Oryza sativa L.) is grown worldwide whereas Oryza glaberima is restricted to Africa (Grist, 1986).

In Bangladesh rice is a major cereal food and the total production of rice was 25188 thousand metric tons under the cultivated area of 26615 thousand acres in the year 2002-2003 (BBS, 2005). Rice is an important source of energy, vitamins, mineral elements and some amino acids. Brown rice is hulled directly.

From rough rice, consisting of bran layers (6-7% of its total weight), embryo (2-3%) and endosperm (about 90%) (Chen., 1998). It contains more nutrient components such as proteins, lipids, dietary fibers, vitamins and minerals than white rice (Itani.et al, 2002). These nutrients mainly exist in the germ and bran layers of the rice grains. However, they are almost removed during milling process from brown rice to yield white rice which is commonly consumed.

Rice protein is valuable because it has unique hypoallergenic properties and ranks high in nutritive quality (rich in the essential amino acid lysine) among the cereal proteins (Bean and Nishita, 1994). It is consists of four fractions with different solubility: albumin (water-soluble), globulin (salt-soluble), glutelin (alkali-soluble), and prolamin (alcohol-soluble) (Juliano, 1994).

In the last two decades, new research findings generated by the nutritionists have brought to light the importance of micronutrients, vitamins and proteins in maintaining good health, adequate growth and even acceptable levels of cognitive ability apart from the problem of protein energy malnutrition (Nageshet.al, 2012). However, a wide range of production, the quality of polished rice in the local market is questioned. Because, rice bran contains all valuable nutrients which has been removed during polishing. Therefore, the present study was aimed to investigate the chemical composition of different varieties of polished rice which are produced by locally and available in the local market of Bangladesh.
2. Materials and methods

2.1. Sample collection

Samples were collected by randomly from local market of Chittagong, Bangladesh. Approximately 500gms of each polished rice was purchased from a grocery shop. Samples were wrapped up by a polythene bag and preserved in the laboratory for chemical analysis.

2.2. Sample preparation

Samples were subjected to grinder to make it homogenous powder. Individual samples were identified by marker and subjected to chemical analyses.

2.3. Proximate chemical analysis of polished rice

2.3.1. Determination of moisture


2.3.2. Determination of ash

Ash content of each sample was determined by taking 5gm sample and placing it in Muffle Furnace at 600°C for 3hrs after ignition at open flame of AOAC Eighteenth edition (2005) revision (2010).

2.3.3. Determination of crude fiber

Crude fiber (CF) was carried out by digesting the de-fatted samples of all varieties in 1.25% H₂SO₄ followed by 1.25% NaOH solutions according to their respective method given in AOAC Eighteenth edition (2005) revision (2010).

2.3.4. Determination of crude protein

Crude protein (CP) content was determined by the method of Micro-Kjeldhal of AOAC Eighteenth edition (2005) revision (2010).

2.3.5. Determination of fat

Fat content of Parija, Minikat, Sawrna, Jeerashile varieties was extracted by Soxhlet apparatus (solvent CCL₄) of AOAC Eighteenth edition (2005) revision (2010) and other varieties such as Nurjahan, Patishiddho, Pajjam, Basmoti,Govindavogh, Katarivogh, Nagirshail, Chinigura was determined by the method of (Bligh and Dyer, 1959).

2.3.6. Determination of Water soluble protein

Water soluble protein content of all varieties was determined by (Lowry, 1951) method using BSA as standard.

2.3.7. Determination of total sugar

Total sugar was carried out colorimetrically by Anthrone method (Jayaraman, 1987).

2.3.8. Determination of reducing sugar

Determination of total sugar content of each varieties was carried out by Dinitrosalicylic acid (DNS) method by (Miller, 1972).

2.3.9. Determination of non-reducing sugar

Total non-reducing sugar content of all varieties was calculated from the formula as reported by (Ranganna, 1979).

\% of non-reducing sugar = (% of total sugar - % of total reducing sugar).

2.4. Determination of dry matter

Dry matter content was calculated by from the data obtained for percentage of moisture content.

2.4.1. Determination of total carbohydrate

Nitrogen free extract (NFE) or total carbohydrate content was determined by subtracting the contents of moisture, protein, ash, fat and fiber from 100; the standard method analysis of the AOAC Eighteenth edition (2005) revision (2010).

Carbohydrate(%)= 100 – (% Moisture + % CP + % CF + % Fat + % Ash).

2.4.2. Calculation of metabolizable energy (ME)

ME was calculated separately for all 12 different polished rice samples. Calculation was performed by mathematical formula as per (Ludhi et al., 1976).

2.4.3. Determination of Minerals

The dry homogenous powder were kept in an incubator at 105°C for overnight due to presence of moisture and digested by nitric acid and Perchloric acid as 2:1 and heated upto 1.5 hr according to the analytical method of (Peterson, 2002).

2.4.4. Statistical analysis

All analytical determinations and measurements were performed in triplicates. Values of different parameters are expressed as the mean ± standard deviation. Statistical analysis of all the assay results was done using the Microsoft Excel program (2007).

3. Results and discussions

3.1. Chemical analysis

The amount of ash, moisture and dry matter content present in twelve varieties of polished rice are shown in Table-1. It appears from the table that the ash content varies from 0.30 to 0.57% , moisture content range from 10.21 to 13.22% and dry matter range from 86.78 to 89.78%. From this study, we found that higher amount of ash content present in Sawrna (0.57±0.02%) and lower amount of dry matter (86.78±0.04%) and in Chinigura (0.30±0.02%) varieties. Moreover, higher amount of moisture content present in Pajjam (13.22±0.08%) but it contained lower amount of dry matter (86.78±0.08%) and lower in Jeerashile (10.21±0.07%) but it contained higher amount of dry matter (89.78±0.07%) respectively. These results are confirmed with earlier results reported by (Anjum et al., 2007, Stuttgart et al., 1991, D.Breese Jones et al., 1927).

Table 1: Ash, Moisture and Dry Matter Content of Twelve Varieties of Polished Rice.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ash (gm %)</th>
<th>Moisture (gm %)</th>
<th>Dry matter (gm %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parija</td>
<td>0.52±0.02</td>
<td>10.43±0.06</td>
<td>89.55±0.06</td>
</tr>
<tr>
<td>Minikat</td>
<td>0.52±0.01</td>
<td>11.04±0.05</td>
<td>88.96±0.05</td>
</tr>
<tr>
<td>Sawrna</td>
<td>0.57±0.02</td>
<td>11.37±0.07</td>
<td>88.63±0.07</td>
</tr>
<tr>
<td>Jeerashile</td>
<td>0.48±0.01</td>
<td>10.21±0.07</td>
<td>89.78±0.07</td>
</tr>
<tr>
<td>Nurjahan</td>
<td>0.49±0.02</td>
<td>12.48±0.04</td>
<td>87.52±0.04</td>
</tr>
<tr>
<td>Pari shiddho</td>
<td>0.49±0.02</td>
<td>12.73±0.05</td>
<td>87.26±0.05</td>
</tr>
<tr>
<td>Pajjam</td>
<td>0.34±0.02</td>
<td>13.22±0.08</td>
<td>86.78±0.08</td>
</tr>
<tr>
<td>Basmoti</td>
<td>0.50±0.01</td>
<td>12.43±0.04</td>
<td>87.56±0.04</td>
</tr>
<tr>
<td>Govindavogh</td>
<td>0.48±0.02</td>
<td>12.93±0.04</td>
<td>87.06±0.04</td>
</tr>
<tr>
<td>Katarivogh</td>
<td>0.47±0.02</td>
<td>12.44±0.06</td>
<td>87.56±0.06</td>
</tr>
<tr>
<td>Nagirshail</td>
<td>0.43±0.02</td>
<td>12.15±0.06</td>
<td>87.85±0.06</td>
</tr>
<tr>
<td>Chinigura</td>
<td>0.30±0.02</td>
<td>12.60±0.04</td>
<td>87.39±0.04</td>
</tr>
</tbody>
</table>

As shown in the Table-2 represents the Crude fiber (CF), Crude protein (CP), Fat, NFE and ME contents of twelve varieties of polished rice. Fiber, especially that found in whole grains are not digested by enzymes in the intestinal tract. Increase in fiber con-
tent in rice and rice bran may improve the human health by lowering the plasma cholesterol (Abdul-Hamid et al., 2007). It appears from the table that crude fiber content ranged from 0.15 to 0.63% in different rice varieties showing highest value of fiber content in Nurjahan (0.63±0.02%) and Basmoti (0.63±0.02%) and the lowest one in Pajjam (0.15±0.02%). These results are comparable with the findings of (Anjum et al., 2007, Stuttgart et al., 1991, Muhammad., 2012) who found the fiber content ranged from 0.71 to 0.92%. Crude protein content in different rice varieties ranged from 6.31 to 8.31% showing highest value of protein content was found in Katarivogh (8.31±0.01%) and lowest in Minikat (6.31±0.01%) varieties. The results obtained in this study are in line with earlier studies reported by (Anjum et al., 2007, D.Breee Jones et al., 1927, Amir Hayat et al., 2013).

Fat content in different rice varieties ranged from 0.09 to 2.90%, the highest value of fat content was present in Parija (2.90±0.02%) and lowest in Sawrna (0.09±0.01%) varieties. The results of the present study are in agreement with earlier results reported by (Anjum et al., 2007, Sotoelo et al., 1990, Muhammad., 2012) who also gave fat range from 0.5 to 2.70% in different varieties.

NFE or total carbohydrate values in different rice varieties ranged from 76.33 to 81.87%. The highest value of NFE was found in Jeerashile (81.87±0.05%) and lowest in Nagirshail (76.33±0.13%). These findings are confirmed with earlier results reported by (James et al., 1983, Amir Hayat et al., 2013). Metabolizable energy (ME) content in different rice varieties ranged from 2834.31 to 3172 Kcal/Kg. The highest metabolizable energy found in Parija (3172 Kcal/Kg) and lowest in Nurjahan (2834.31 Kcal/Kg) varieties. The results obtained in this study are inline with earlier reported by (Rohman et al., 2014).

Table 3: Water Soluble Protein, Total Sugar, Reducing Sugar and Non-Reducing Sugar Content of Twelve Varieties of Polished Rice.

<table>
<thead>
<tr>
<th>Variety</th>
<th>CF (gm%)</th>
<th>CP (gm%)</th>
<th>Fat (gm%)</th>
<th>NFE (gm%)</th>
<th>ME (Kcal/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parija</td>
<td>0.21±0.01</td>
<td>7.37±0.02</td>
<td>2.90±0.02</td>
<td>78.54±0.04</td>
<td>3107.27</td>
</tr>
<tr>
<td>Minikat</td>
<td>0.23±0.01</td>
<td>6.31±0.01</td>
<td>0.13±0.01</td>
<td>81.76±0.06</td>
<td>2882.34</td>
</tr>
<tr>
<td>Sawrna</td>
<td>0.17±0.01</td>
<td>7.44±0.02</td>
<td>0.09±0.01</td>
<td>80.36±0.12</td>
<td>2870.48</td>
</tr>
<tr>
<td>Jeerashile</td>
<td>0.19±0.02</td>
<td>7.08±0.02</td>
<td>0.16±0.01</td>
<td>81.87±0.05</td>
<td>2913.56</td>
</tr>
<tr>
<td>Nurjahan</td>
<td>0.63±0.02</td>
<td>7.35±0.02</td>
<td>0.42±0.02</td>
<td>78.61±0.03</td>
<td>2834.31</td>
</tr>
<tr>
<td>Pari shiddho</td>
<td>0.24±0.01</td>
<td>7.51±0.01</td>
<td>1.32±0.01</td>
<td>77.69±0.07</td>
<td>2876.33</td>
</tr>
<tr>
<td>Pajjam</td>
<td>0.15±0.02</td>
<td>7.50±0.01</td>
<td>1.42±0.02</td>
<td>77.37±0.08</td>
<td>2872.54</td>
</tr>
<tr>
<td>Basmoti</td>
<td>0.63±0.02</td>
<td>7.22±0.02</td>
<td>0.72±0.01</td>
<td>78.49±0.07</td>
<td>2848.65</td>
</tr>
<tr>
<td>Govindavogh</td>
<td>0.50±0.02</td>
<td>7.93±0.02</td>
<td>1.7±0.01</td>
<td>76.39±0.04</td>
<td>2880.37</td>
</tr>
<tr>
<td>Katarivogh</td>
<td>0.30±0.02</td>
<td>8.31±0.03</td>
<td>1.8±0.02</td>
<td>76.39±0.11</td>
<td>2902.22</td>
</tr>
<tr>
<td>Nagirshail</td>
<td>0.36±0.01</td>
<td>8.11±0.02</td>
<td>2.61±0.01</td>
<td>76.33±0.13</td>
<td>2946.59</td>
</tr>
<tr>
<td>Chingura</td>
<td>0.26±0.01</td>
<td>7.61±0.01</td>
<td>1.92±0.02</td>
<td>77.29±0.08</td>
<td>2910.92</td>
</tr>
</tbody>
</table>

\[\text{CrudeFibre, } \text{Crude Protein, } \text{NFE} \text{ Nitrogen Free Extract, ME} \text{Metabolizable Energy.}\]

3.2. Mineral content

The results pertaining in mineral contents during the study are presented in Table-4. It appears from the table that Sodium (Na) was found as highest in amount in mineral analysis. The Sodium (Na) content varies from 69.07 to 118.87mg% in different varieties showing highest value of Na found in Minikat (118.87±0.39 mg%) and lowest in Jeerashile (69.07±0.13 mg%). The amount of Na of all varieties are highest than as reported by (Muhammad., 2012, Stuttgart et al., 1991,Soteloea., 1990,Sabir., 2008). The Calcium(Ca) content of all varieties ranged from 1.1 to 1.85mg%, showing highest amount found in Paia (1.85±0.03mg%) and lowest amount in Jeerashile (1.1±0.1mg%). The study result was approximately to the findings of (Stuttgart et al., 1991, Soteloea., 1990) but lower to the finding of (Thomas et al., 2015). The highest magnesium (Mg) content was found in Pari shiddho(0.61±0.01mg%) and lowest was found in Jeerashile (0.13±0.04mg%). The findings of present study are approximately to earlier findings of (Stuttgart et al., 1991) but less than the reported value of (Muhammad., 2012, Thomas et al., 2015).
Iron deficiency is the most common nutritional disorder in the globe affecting between 2 to 5 billion people. In Bangladesh 49% of pregnant woman and 53% of preschool children are anemic due to iron deficiency (Hossain and Hussain, 2004). The Iron(Fe) content of all varieties of polished rice was so lower than significant value as reported by (Muhammad ..2012, Thomas et.al., 2015, Stuttgart et.al., 1991, Anjum et.al., 2007). The Phosphorus (P) content ranged from 0.52 to 2.33mg/kg in different varieties showing highest amount of Phosphorus (P) was found in Sawrna (2.33±0.03mg%) and lowest amount found in Govindavogh (0.52±0.03mg%) varieties. The findings of present study are in line with earlier reported by (Adilabas 2011).

This slight or more difference might be as a result of environment, fertilizer, rate of parboiling and the amounts of soil nutrients all of which affect the mineral contents of rice. Rivero et.al (2006) reported that as greater amount of rice bran are removed from grain during milling and polishing, more vitamins and minerals are lost.

4. Conclusion

In the present investigation revealed that the significant variation of mineral and proximate compositions among the rice varieties examined in polished form in Bangladesh. When rice is over polished and refined, valuable nutrient content like fibre, protein and minerals also reduced leading to higher density of carbohydrate content. Regular consumption of such rice is related to some health problems as suggested by current researches.

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References


