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Research paper

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, Sawrna, Jeerashile, Nurjahan, Pari Shiddho, Paijam, 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±0.07to13.22±0.08%), Ash(0.30±0.02 to 0.57±0.02%), Dry Matter(86.78±0.08 to 89.78±0.07%), 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(0.09±0.01 to 2.90±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 0.40±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 (69.07±0.13 to 118.87±0.39 mg%), Potassium(0.38±0.02 to 3.41±0.47mg%), Calcium (1.1±0.1 to 1.85±0.03mg%), Magnesium (0.13±0.04 to 0.61±0.01mg%), Iron (0.0003±0.0005 to 0.0005±0.0002mg%), Phosphorus (0.52±0.03 to 2.33±0.03mg%) 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 (Rice 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(25) 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 of 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 (Itaniet.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 1985). It is consists of four fractions with different solvent 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

Moisture content was determined by standard official method of analysis of AOAC Eighteenth edition (2005) revision (2010).

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-fated samples of all varieties in 1.25% H_2SO_4 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 CCl_4) of AOAC Eighteenth edition (2005) revision (2010)and other varieties such asNurjahan, Parishiddho, Paijam, Basmoti, Govindavogh, Katarivogh, Nagirshail,Chinigura was determined by the method of (Bligh and Dyre .,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) methodby (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.S,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 in Chinigura (0.30±0.02%) varieties. Moreover, higher amount of moisture content present in Paijam (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.

Variety	Ash (gm %)	Moisture (gm %)	Dry matter (gm %)
Parija	0.52±0.02	10.45±0.06	89.55±0.06
Minikat	0.52±0.01	11.04±0.05	88.96±0.05
Sawrna	0.57±0.02	11.37±0.07	88.63±0.07
Jeerashile	0.48±0.02	10.21±0.07	89.78±0.07
Nurjahan	0.49±0.02	12.48±0.04	87.52±0.04
Pari shiddho	0.49±0.02	12.73±0.05	87.26±0.05
Paijam	0.34±0.02	13.22±0.08	86.78±0.08
Basmoti	0.50±0.01	12.43±0.04	87.56±0.04
Govindavogh	0.48±0.02	12.93±0.04	87.06±0.04
Katarivogh	0.47±0.02	12.44±0.06	87.56±0.06
Nagirshail	0.43±0.02	12.15±0.06	87.85±0.06
Chinigura	0.30±0.02	12.60±0.04	87.39±0.04

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 Paijam(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.Breese 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, Sotelo 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 3017.27 Kcal/Kg. The highest metabolizable energy found in Parija (3017.27 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 represents the Water soluble protein, Total sugar, Reducing sugar and Non-reducing sugar content of twelve varities of polished rice. It appears from the table that water soluble protein or albumin content range from 0.13 to 0.25% in different rice varieties showing highest value of albumin found in two varieties Paijam (0.25±0.02%) and Nagirshail(0.25±0.01%) and also lowest in two varieties Katarivogh (0.13±0.02%) and Chinigura (0.13±0.02) respectively.

These results are comparable with the findings of (Jin-Woong Kim., 2013,Z.Y. JU., 2001). Total sugar content of different rice varieties ranged from 0.06 to 0.40% ,showing highest value of total sugar content was found in Sawrna (0.40±0.01%) and lowest in Basmoti (0.06±0.01%) varieties. The results obtained in this study are in line with earlier studies reported by (Muhammad,2012).

Reducing sugar content of different varieties of polished ricer-anged from 0.01 to 0.09% , the highest value of reducing sugar content was found in two varieties Govindavogh (0.09±0.02%) and Nagirshail (0.09±0.01%) and lowest in Basmoti (0.01±0.01%) varieties. On the other hand, non-reducing sugar content of different varieties ranged from 0.05 to 0.36% , showing the highest value of non-reducing sugar content in Sawrna (0.36±0.01%) and lowest in Basmoti (0.05±0.01%) varieties. The study results of both reducing sugar and non-reducing sugar content of different varieties of polished rice are comparable with the earlier findings of (Muhammad., 2012, M.A.Hussein., 1976).

Table 2: CF, CP, Fat, NFE, and MEContent of Twelve Varities of Polished Rice

Variety	CF (gm%)	CP(gm%)	Fat(gm%)	NFE(gm%)	ME(Kcal/Kg)
Parija	0.21±0.01	7.37±0.02	2.90±0.02	78.54±0.04	3017.27
Minikat	0.23±0.01	6.31±0.01	0.13±0.01	81.76±0.06	2882.34
Sawrna	0.17±0.01	7.44±0.02	0.09±0.01	80.36±0.12	2870.48
Jeerashile	0.19±0.02	7.08±0.02	0.16±0.01	81.87±0.05	2913.56
Nurjahan	0.63±0.02	7.35±0.02	0.42±0.02	78.61±0.03	2834.31
Pari shiddho	0.24±0.01	7.51±0.01	1.32±0.01	77.69±0.07	2876.33
Paijam	0.15±0.02	7.50±0.01	1.42±0.02	77.37±0.08	2872.54
Basmoti	0.63±0.02	7.22±0.02	0.72±0.01	78.49±0.07	2848.65
Govindavogh	0.50±0.02	7.93±0.02	1.7±0.01	76.39±0.04	2880.37
Katarivogh	0.30±0.02	8.31±0.01	1.8±0.02	76.60±0.11	2907.22
Nagirshail	0.36±0.01	8.11±0.02	2.61±0.01	76.33±0.13	2946.59
Chinigura	0.26±0.01	7.61±0.01	1.92±0.02	77.29±0.08	2910.92

[CF]CrudeFibre, [CP]Crude Protein, [NFE]Nitrogen Free Extract, [ME]Metabolizable Energy.

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

Variety	WSP (gm %)	TS (gm%)	RS(gm%)	NRS(gm%)
Parija	0.22±0.02	0.31±0.03	0.06±0.01	0.25±0.02
Minikat	0.20±0.03	0.28±0.02	0.04±0.01	0.24±0.01
Sawrna	0.23±0.03	0.40±0.01	0.04±0.02	0.36±0.01
Jeerashile	0.19±0.02	0.17±0.01	0.04±0.01	0.13±0.01
Nurjahan	0.18±0.01	0.28±0.03	0.07±0.01	0.21±0.01
Pari shiddho	0.17±0.02	0.18±0.02	0.04±0.01	0.14±0.01
Paijam	0.25±0.02	0.25±0.03	0.05±0.02	0.20±0.02
Basmoti	0.18±0.01	0.06±0.01	0.01±0.01	0.05±0.01
Govindavogh	0.15±0.01	0.32±0.01	0.09±0.02	0.23±0.01
Katarivogh	0.13±0.02	0.17±0.02	0.07±0.01	0.1±0.01
Nagirshail	0.25±0.01	0.33±0.03	0.09±0.01	0.24±0.01
Chinigura	0.13±0.02	0.12±0.02	0.02±0.01	0.09±0.01

[WSP]Water soluble protein, [TS]Total sugar, [RS]Reducing sugar and [NRS]Non-reducing sugar.

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 found higher than as reported by (Muhammad.,2012, Stuttgart et.al.,1991,Soteloet.al.,1990) .

The highest Potassium (K) content was found in Parija (3.41±0.47 mg%) and lowest was in Nurjahan (0.38±0.02 mg %) and Basmoti(0.38±0.05 mg%) respectively. The finding results was lower than the reported value of (Muhammad., 2012, Soteloet.al., 1990,Sabbir., 2008). The Calcium(Ca) content of all varieties ranged from 1.1 to 1.85mg% , showing highest amount found in Paijam (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, Soteloet.al., 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% 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 (Adilabbas 2011).

Table 4: Minerals Composition of Twelve Varities of Polished Rice

Variety	Na(mg/100gm)	K(mg/100gm)	Ca(mg/100gm)	Mg(mg/100gm)	Fe(mg/100gm)	P(mg/100gm)
Parija	91.84±0.58	3.41±0.47	1.73±0.25	0.41±0.11	0.078±0.002	1.87±0.06
Minikat	118.87±0.39	2.45±0.09	0.90±0.1	0.15±0.05	0.044±0.001	1.73±0.03
Sawrna	46.03±0.12	1.97±0.02	1.13±0.11	0.25±0.05	0.076±0.001	2.33±0.03
Jeerashile	69.07±0.13	1.98±0.03	1.1±0.1	0.13±0.04	0.093±0.001	1.83±0.11
Nurjahan	105.6±2.04	0.38±0.02	1.48±0.04	0.42±0.01	0.0005±0.0002	0.63±0.02
Pari shiddho	91.69±0.34	0.96±0.03	1.55±0.01	0.61±0.01	0.003±0.001	0.81±0.01
Paijam	98.26±0.32	1.37±0.02	1.85±0.03	0.45±0.03	0.004±0.001	0.84±0.04
Basmoti	108.23±0.22	0.38±0.05	1.16±0.02	0.36±0.02	0.0006±0.0002	0.62±0.03
Govindavogh	95.19±0.02	0.39±0.02	1.27±0.1	0.37±0.01	0.0002±0.0006	0.52±0.03
Katarivogh	94.07±0.10	0.4±0.01	1.12±0.07	0.48±0.05	0.001±0.005	0.95±0.07
Nagirshail	99.7±0.2	0.41±0.02	1.31±0.5	0.42±0.01	0.0003±0.0005	0.74±0.08
Chinigura	113.27±0.22	0.39±0.01	1.41±0.02	0.54±0.1	0.01±0.02	0.79±0.06

This slight or more difference might be as a result ofenvironment, 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 riceis 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

[1] AOAC. (2005). Official Method of Analysis. Ash Analysis 923.03.*The Official Methods of Analysis of AOAC International*. 18th Ed.Current through revision, (2010).

[2] AOAC. (2005). Official Method of Analysis. Fiber Analysis 962.09E. *The Official Methods of Analysis of AOAC International*. 18th Ed. Current through revision, (2010).

[3] AOAC. (2005). Official Method of Analysis. Protein Analysis984.13. *The Official Methods of Analysis of AOAC International*. 18th Ed. Current through revision, (2010).

[4] AOAC. (2005). Official Method of Analysis. Fat Analysis 920.39C.*The Official Methods of Analysis of AOAC International*. 18th Ed. Current through revision, (2010).

[5] AOAC. (2005). Official Method of Analysis. Moisture Analysis 925.09. The Official Methods of Analysis of AOAC International. 18th Ed. Current through revision, (2010).

[6] Abdul-Hamid, A., R. R. Sulaiman, A. Osman and N. Saari. 2007. Preliminary study of the chemical composition of rice milling fractions stabilized by microwave heating. *Journal of food composition and analysis*, 2: 627-637. http://dx.doi.org/10.1016/j.jfca.2007.01.005.

[7] AadilAbas, ShahzadMurtaza, FaizaAslam, Ayesha Khawar, Shakeela Rafique, Sumera Naheed.,2011.Effect of Processing on Nutritional Value of Rice (Oryza sativa).*World Journal of Medical Sciences* .6 (2): 68-73.

[8] Anjum, Pasha I, Bugti MA and Butt MS (2007). MineralComposition of different rice varieties and their milling fractions. Pakistan Journal of Agricultural Sciences, 44(2): 322-336.

[9] Amir Hayat, Taaj Muhammad Jahangir and Malik Alamgir.,2013 Effect Of Germination Conditions On Proximate Chemical Composition Of Some Pakistani Brown And Polished Rice Varieties., Amir Hayat et al. Stud. J.Chems. 1(3) pages 98-106.

[10] Bhuiyan, N. I., D. N. R. Paul and M. A. Jabber. 2002. Feeding the extra millions by 2025- challenges for rice research and extension in Bangladesh. A keynote paper presented on national workshop on rice research and extension 2002. Held on 29-3 1 January, 2002, BRRJ. P.9.

[11] BBS (Bangladesh Bureau of Statistics). 2005. Statistical Year Book of Bangladesh Statistical Division, Ministry of Planning, Govt. of Bangladesh.

[12] Bean MM, Nishita KD. 1985. Rice flours for baking. In Juliano BO,editor. Rice: chemistry and technology, 2nd ed. St. Paul:AmerAssoc of Cereal Chemists. P539-556.

[13] BLIGH, E.G. AND DYER, W. J. 1959. Total lipid extraction and purification. Can. J. Biochem. Physiol., 37: 911.http://dx.doi.org/10.1139/o59-099.

[14] Chen, H, Siebenmorgen, T.J, Griffin, K. 1998. Qualitycharacteristics of long grain rice milled in two commercial systems. Cereal Chemistry 75 (4) 560-565. http://dx.doi.org/10.1094/CCHEM.1998.75.4.560.

[15] D.Breese Jones, Charles E.F.Gersdorff., 1927. "The Globulins of Rice,Oryza Sativa". J.Biol.Chem.74:415-426. http://dx.doi.org/10.1016/s0016-0032(27)92071-7.

[16] Grist, 1986. Rice. New York: Longman.

[17] G.L.Miller, (1959); Use of dinitrosalicylic acid reagent for determination of reducing sugar. Anal. Chem. 31(3):426-428. http://dx.doi.org/10.1021/ac60147a030.

[18] Hossain, M., Husain, M. and Datta, S.K. 2004. Rice Biotechnology:Opportunity, Perceived Risks and Potential Benefits to Bangladesh. Centre for Policy Dialogue, CPD Occasional Paper Series 37.

[19] Itani, T., Tamaki, M., Arai, E., &Horino, T. (2002). Distribution of amylose, nitrogen, and minerals in rice kernels with various characters. Journal of Agricultural and Food Chemistry 50 (19), 5326–5332. http://dx.doi.org/10.1021/jf020073x.

[20] J.Jayarman, (1981); Laboratory manual in Biochemistry, 1st Ed., Wiley Eastern Ltd. New Delhi,75.

[21] James, C. and D. McCaskil. 1983. Rice in American diet. Cereal Foods World 18 (11):667-669.

[22] Juliano BO. 1994. Polysaccharides, proteins, and lipids of rice. In: Rice: Chemistry and Technology. St. Paul, Minn.:AmerAssoc of Cereal Chemists. P 98-141.

[23] Jin-Woong Kim, Byung-Chul Kim, Jae-Heung Lee, Duck-Ryul Lee, ShafiqRehman,SongJoong Yun1.,(2013).Protein Content And Composition Of Waxy Rice Grains. *Pak. J. Bot*., 45(1): 151-156.

[24] Lowry, O.H., Rosebrough N.J, Farr A.L and Randall R.L,(1951).Protein measurement with the folin phenol reagent. J.Biol.Chem, 183:265-275.

[25] Lodhi GN, Daulat Singh and Ichhponani JS (1976). Variation innutrient content of feeding stuffs rich in protein and reassessment of the chemical method for metabolizable energy estimation for poultry. Journal of Agricultural Science, 86(2): 293-303 http://dx.doi.org/10.1017/S0021859600054757.
[26] M.A.Hussein, A.Saleh, M.Noman., 1976. "Effect of adding broken rice flour on the physical and chemical properties of bread".University of Mansoura, Egypt. Page: 295-305.
[27] Muhammad Zubair.,(2012).Characterization Of Selected Varieties Of Rice (Oryza Sativa) And Its By-product (Rice Bran) For Valuable Nutrients And Antioxidants. Pakistan Research Repository. PhD Thesis, Department Of Chemistry & Biochemistry, Faculty of Sciences / University Of Agriculture, Faisalabad, Pakistan.
[28] Nagesh V., Ravindrababu, G., Usharani and Reddy, T.D. 2012. Grain iron and zinc association studies in rice (Oryza sativa L.) F1progenies. Archives of Applied Science Research, 4 (1):696-702.
[29] Petersen, L. 2002. Analytical Methods- Soil, Water, Plant material, Fertilizer. Soil Resources Management and Analytical Services, Soil Resource Dev., Inst. Dnida, Dhaka. P.61-70.
[30] Rice Almanac: source book for the most important economic activity on Earth. Wallingford, United Kingdom: CABI Publishing; 2002.
[31] Ranganna,S. (1979). Manual of analysis of fruits and vegetables products. Tata MeGraw-Hill Publishing Company Ltd., New Delhi, India, Page: 634.
[32] Rohman, SitiHelmiyati, MirzaHapsari, DwiLarasati Setyaningrum.,(2014).Rice in health and nutrition. *International food research journal*. 21(1): 13-24.
[33] Stuttgart.(1991). DeutscheForschungsanstaltfürLebensmittelchemie,GarchingbeiMünchen (ed), Der kleine "Souci-Fachmann-Kraut" Lebensmitteltabellefür die Praxis, WVG.
[34] Sotelo, A., V. Saisa, I. Montolvo, M. Hernandez and L. Hernandez. 1990. Chemical composition of different fractions of 12 Mexican varieties of rice obtained during milling. Cereal Chem. 67 (2): 209-212.
[35] Shabir, Anjum, Zahoor, Nawaz. 2008. Mineral and PastingCharacterization of Indica Rice Varieties with Different Milling Fractions. *International Journal of Agriculture & Biology*.vol.10: 556–60.
[36] Thomas, R.,RajeevBhat,Kuang, Y.T.,2015.Composition of amino Acids, fatty acids, minerals and dietary fiber in some of the local and import rice varieties of Malaysia. *International Food Research Journal* 22(3): 1148-1155.
[37] Z.Y. JU, N.S. Hettiarachchy, N. Rath., (2001).Extraction, Denaturation and Hydrophobic Properties of Rice Flour Proteins. *Journal Of Food Science*,Vol. 66, No.2:229-232. http://dx.doi.org/10.1111/j.1365-2621.2001.tb11322.x.