Minerals and Phytic Acid Content in Different Varieties of Rice and Their Changes Due to Traditional Cooking Methods

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Abstract

Twelve different varieties of parboiled and raw milled rice have been analyzed for their content of essential minerals (i.e. Fe, Zn, Cu, Ca, Mg, P, Na and K) and phytic acid. Rice was cooked according to two different traditional cooking methods (with or without decantation of cooking water) and changes in minerals and phytic acid content have been determined. Iron, zinc and copper content in different varieties of rice were found in the range of 0.41-1.03mg, 0.51-1.04mg and 0.07-0.24mg/100g edible portion, respectively. Iron and zinc content were found relatively high in BR-10 variety. High amount of zinc was also found in BR-22 variety while raw, milled paijam variety contained highest amount of copper. Decrease in these micro minerals content was observed in cooked rice and iron content was severely affected when cooking water was decanted. On average only 44.0% of iron remained in parboiled milled rice. Raw, milled paijam variety lost most of its iron content when cooked by decantation of cooking water and retained only 4.0%. Zinc content was found to increase in rice cooked without decantation of cooking water (113.0% retention), due to addition of zinc from domestic tap water used for cooking. Copper content was found to decrease in both cooking methods. Macro minerals like Ca, Mg and Na present in low amount in rice and ranges between 0.43mg-1.90mg, 17.37mg-26.4mg and 2.6mg-13.78mg/100g E.P. respectively. Increase in Ca and Na content was found in cooked rice in both cooking methods due to addition of these minerals from domestic tap water. Decrease in Mg content was observed in rice by both cooking methods. The phosphorus and potassium content in uncooked rice were in the range of 117.83mg-171.15mg and 102.46mg-180.21mg/100g E.P. respectively. In both cooking methods, considerable loss of these minerals was found. A good amount of phytic acid was present in rice (91.97-176.02mg/100g dry wt. basis). Considerable amount of this phytic acid was destroyed due to cooking.

Key words : Essential Minerals, Phytic Acid, Decantation , Percent Retention.

Introduction

Rice is one of the leading food crops of the world and the staple food of over half the world population. Rice, Oryza sativae L. belongs to the family Gramineae and is the most common rice. About 20 species of the genus Oryza are recognized; all cultivated rice is O. sativae L. Rice is now grown in over 100 countries on every

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continent (1). The composition of rice differs with variety. It also varies according to soil in which it is grown, seasons, manuring and processing (2)

Rice is the staple food of Bangladesh. Cereals contribute 79.63 percent of daily calorie intake, out of which 69.35 percent is contributed by rice (3). Rice is not the source of essential minerals but it may contribute a significant amount of essential minerals as it is consumed in large quantity in this country. Rice contains phytic acid, which has inhibitory effect upon absorption of some minerals.

Cooking is essential if a population is to fed. In most cases cooking of food causes reduction of nutritive value of a food. Different analysis being done on washing and cooking losses of nutrients of rice and found that significant amount of water soluble nutrients may be removed during washing and cooking of rice (4). Decantation of cooking water of rice is the most common cooking practice of rice in most places of Bangladesh. In very few places rice is cooked without decantation of cooking water. At present, different high yield potential varieties of rice are being cultivated in Bangladesh, introduced by Rice Research Institute at Joydevpur. The newly introduced rice is named BR-1, BR-2, etc on the basis of two initials of the words Bangladesh Rice Research Institute. They have got other popular name too.

The present study concerns with the analysis of essential minerals content of different varieties of rice produced in Bangladesh and their changes due to traditional cooking methods. The study includes a) estimation of some of the essential minerals content (iron, zinc, copper, calcium, magnesium, phosphorus, sodium and potassium) in different varieties of rice and their changes due to traditional cooking methods and b) estimation of phytic acid content and the changes due to cooking are also included.

Materials and methods

Collection of samples.

Twelve samples of different varieties of rice were collected for this study. Of the twelve samples, ten samples of rice (parboiled, milled) were certified sample of Bangladesh Rice Research Institute (BRRI), Joydevpur, and other two samples were collected from open market of Dhaka city. These were raw, milled varieties of paijam and kalijira (flavoured rice)

Cooking methods.

All the twelve samples of rice were cooked according to the methods used in the household of Bangladesh. In Bangladesh, traditionally rice is cooked in two different methods. Usually before cooking dust, stones, husks, insects etc. are removed from rice and then washed 3-4 times with enough water. In one method rice is cooked with such amount of water so that no water will remain after cooking. In another method rice is cooked with excess water and after cooking, remaining water is decanted.

Table 2: (Continuation)

Methods used in the present study

Method A: To 100g-rice sample in a cooking pot around three glasses of water (660 ml) were added and boiled. Boiling was continued till the rice was cooked and no water remain to decant. It took about 15-20 minutes time.

Method B: To 100g rice sample in a cooking pot, around four glasses of water (880 ml) were added and boiled till the rice was cooked. Then the excess water was decanted. It took about 15-20 minutes time.

Analytical technique

All the twelve samples of rice (both cooked and uncooked) were grinded in a mechanical grinder and portion of each of them were used for the determination of minerals. Remaining portion of the samples was oven dried at 105° C and grinded again and sealed in plastic bags for phytate estimation. Domestic tap water used in cooking process were also analysed for macro and micro minerals. In this study all the analysis were done in triplicate and data were represented as dry weight basis (except otherwise mentioned).

The moisture content was determined by drying the grinded sample in an oven at 105° C for 5 h (5) and expressed on a percentage basis. For the estimation of minerals, 5.0g of sample was wet ashed using a mixture of 18 M sulfuric acid, 12 M perchloric acid and 16 m nitric acid (0.5: 1.0: 0.5 by volume). After proper dilution, the concentration of Fe, Zn, Cu, Ca, and Mg were determined by measureing atomic absorption while Na and K were determined by measureing atomic emission (6). An appropriate dilution was done with 0.4% lanthanum (w/ w) to overcome the ionic inteference during the estimation of Ca and Mg. Posphorus estimation was done colorimetrically using the method of Fiske and Subbarow(7).Phytate content was determined according to the method of described by E L Wheeler and Ferrel (8).

Results

Table 1 shows the mineral contents in uncooked rice (10 varieties of parboiled milled rice and two varieties of raw milled rice). Iron content in parboiled milled rice ranges between 0.41-1.03 mg / 100 g E. P. and in raw milled rice between 0.69-1.13 mg / 100 E. P. Differences between parboiled and raw milled rice in other essential mineral contents were not much more except potassium. Trace minerals such as iron, zinc and copper content in different varieties of rice and their changes due to cooking are presented in Table 2. Iron content decreased in all varieties of rice when cooked with or without decantation of cooking water with some exception. Percent retention of iron in cooking method A (without decantation of cooking water) was found in the range of 53.0-98.0 for parboiled milled varieties. BR-10 and Nizersail showed 100% retention. For raw milled varieties such as Kalijira percent retention was found 62.0 and for Paijam it was 18.0. In cooking method B (with decantation of cooking water) percent retention was found in the range of 18.0-70.0.In this cooking method, iron

could not be detected in raw milled Kalijira variety and in Pyjaim variety, percent retention was found very low (4.0%).

Table 1: Minerals Content in different varieties of rice

Parboiled, milled									
Variety	**Moisture**	**Fe**	**Zn**	**Cu**	**Ca**	**Mg**	**P**	**Na**	**K**
BR-1	12.12±0.18	0.53±0.02	0.63±0.02	0.17±0.02	1.49±0.08	20.57±0.05	138.0±0.04	4.40±0.01	142.9±0.01
BR-10	12.14±0.02	1.03±0.01	1.04±0.02	0.18±0.00	1.85±0.06	20.77±0.05	117..2±0.04	4.22±0.01	119.7±0.05
BR-11	12.05±0.08	0.51±0.01	0.78±0.0	0.12±0.0	1.93±0.05	23.15±0.01	135.0±0.05	3.75±0.01	117.7±0.08
BR-12	12.02±0.09	0.8±0.0	0.92±0.02	0.24±0.01	0.72±0.01	22.13±0.05	133.8±0.82	5.48±0.03	132.7±0.06
BR-22	11.09±0.04	0.59±0.0	1.05±0.05	0.17±0.0	1.41±0.05	26.4±0.07	173.8±0.04	2.60±0.06	125.0±0.0
Purbachi	11.5±0.03	0.48±0.01	0.51±0.02	0.15±0.01	0.67±0.02	22.86±0.0	136.0±0.05	4.44±0.04	180.2±0.84
Nizersail	12.31±0.08	0.94±0.0	0.73±0.03	0.07±0.0	7.67±0.02	12.58±0.11	109.7±0.0	9.61±0.02	89.03±0.09
Paijam	11.07±0.07	0.56±0.02	0.67±0.02	0.14±0.01	1.39±0.02	20.33±0.8	134.1±0.07	7.10±0.16	119.7±0.04
Latisail	12.25±0.04	0.59±0.02	0.57±0.03	0.12±0.0	1.61±0.02	23.85±0.06	121.8±0.02	13.78±0.0	102.4. ±0.9
Rajasail	11.07±0.03	0.41±0.01	1.13±0.02	0.14±0.0	0.43±0.02	17.9±0.08	174.4±0.0	-	115.2±0.04
Raw, milled									
Kalijira	12.16±0.09	0.69±0.01	0.97±0.0	0.23±0.01	1.41±0.03	18.17±0.06	107.7±0.01	23.52±0.02	61.91±0.02
Paijam	12.51±0.11	1.14±0.02	0.97±0.01	0.25±0.7	1.43±0.02	30.29±0.02	118.5±0.28	6.24±0.08	70.86±0.02

[1] Results were expressed as mean ± SD of triplicate determination and as mg/100g E.P. except moisture which was expressed as g/100g E.P.; – not detected.

Table 2: Moisture, and trace minerals content in uncooked and cooked rice[1].

Variety Type		Moisture	Iron	Zinc	Copper
Perboiled, milled.					
BR-1	Uncooked	12.12±0.08	0.59±0.02	0.71±0.02	0.19±0.02
	Cooked (wdcw)[2]	75.48±0.12	0.58±0.01 (98.0)	0.76±0.07 (107.0)	0.16±0.01 (84.0)
	Cooked (dcw)	72.27±0.02	0.31±0.01 (52.0)	0.56±0.03 (78.0)	0.09±0.01 (47.0)
BR-10	Uncooked	12.14±0.02	1.17±0.01	1.17±0.02	0.2±0.00
	Cooked (wdcw)	70.68±0.11	1.17±0.01 (100.0)	1.46±0.03 (124.79)	0.18±0.01 (90.0)
	Cooked (dcw)	74.27±0.03	0.42±0.02 (36.0)	1.10±0.01 (94.0)	0.15±0.00 (75.0)
BR-11	Uncooked	12.05±0.08	0.57±0.01	0.88±0.0	0.13±0.00
	Cooked (wdcw)	69.75±0.07	0.49±0.01 (86.0)	0.92±0.02 (115.0)	0.11±0.00 (85.0)
	Cooked (dcw)	72.21±0.06	0.38±0.01 (67.0)	0.75±0.01 (94.0)	0.06±0.01 (46.0)

Table 2: (Continuation)

Variety	Type	Moisture	Iron	Zinc	Copper
BR-12	Uncooked	12.02±0.09	0.90±0.0	1.03±0.02	0.27±0.01
	Cooked (wdew)	71.89±0.06	0.48±0.4 (53.0)	1.10±0.02 (107.0)	0.22±0.00 (81.0)
BR-22	Cooked (dew)	62.09±0.04	0.16±0.03 (18.0)	0.91±0.02 (88.0)	0.20±0.01 (74.0)
	Uncooked	11.09±0.04	0.65±0.00	1.17±0.02	0.19±0.00
	Cooked (wdew)	72.00±0.09	0.45±0.01 (69.0)	1.26±0.01 (108.0)	0.16±0.00 (84.0)
Purbachi	Cooked (dew)	76.74±0.08	0.26±0.01 (40.0)	0.97±0.02 (83.0)	0.13±0.00 (68.0)
	Uncooked	11.5±0.03	0.53±0.01	0.58±0.02	0.17±0.01
	Cooked (wdew)	66.28±0.04	0.45±0.01 (85.0)	0.67±0.02 (116.0)	0.16±0.01 (94.0)
Nizersail	Cooked (dew)	70.85±0.05	0.25±0.02 (47.0)	0.51±0.02 (88.0)	0.16±0.00 (94.0)
	Uncooked	12.31±0.08	1.06±0.00	0.82±0.02	0.08±0.00
	Cooked (wdew)	72.60±0.03	1.06±0.00 (100.0)	1.03±0.02 (126.0)	0.07±0.01 (88.0)
	Cooked (dew)	75.03±0.03	0.58±0.01 (55.0)	0.38±0.02 (46.0)	0.06±0.01 (75.0)
Paijam	Uncooked	11.07±0.07	0.63±0.02	0.75±0.02	0.16±0.01
	Cooked (wdew)[2]	64.33±0.05	0.48±0.00 (76.0)	0.87±0.01 (116.0)	0.15±+0.01 (94.0)
	Cooked (dew)[3]	70.66±0.05	0.21±0.01 (33.0)	0.70±0.01 (93.0)	0.09±0.01 (56.0)
Latisail	Uncooked	12.25±0.04	0.67±0.02	0.65±0.03	0.13±0.00
	Cooked (wdew)	64.33±0.05	0.48±0.00 (72.0)	0.71±0.02 (109.0)	0.08±0.00 (62.0)
	Cooked (dew)	70.66±0.05	0.34±0.02 (51.0)	0.58±0.02 (89.0)	0.07±0.00 (54.0)
Rajasail	(uncooked)	11.71±0.03	0.46±0.01	1.25±0.02	0.15±0.00
	Cooked (wdew)	64.30±0.04	0.34±0.02 (74.0)	1.34±0.03 (107.0)	0.14±0.01 (93.0)
	Cooked (dew)	70.07±0.05	0.32±0.02 (70.0)	1.18±0.07 (94.0)	0.12±0.00 (80.0)
Raw, milled.					
Kalajira	Uncooked	12.10±0.09	0.78±0.01	1.09±0.01	0.26±0.01
	Cooked (wdew)	75.69±0.06	0.48±0.01 (62.0)	1.10±0.01 (101.0)	0.20±0.00 (77.0)
	Cooked (dew)	73.07±0.08	e	0.85±0.01 (78.0)	0.16±0.00 (62.0)
Paijam	Uncooked	12.51±0.11	1.29±0.02	1.10±0.01	0.29±0.00
	Cooked (wdew)	74.82±0.01	0.23±0.02 (18.0)	1.12±0.01 (102.0)	0.26±0.00 (90.0)
	Cooked (dew)	75.16±0.07	0.05±0.02 (4.0)	1.06±0.01 (96.0)	0.25±0.00 (86.0)

[1] Results were expressed as mean ± SD of triplicate determination and as mg/100g dry wt. basis except moisture which was expressed as g/100gE.P.; [2] without decantation of cooking water ; [3]decantation of cooking water; figures in parentheses indicate percent retention; e not detected.

In cooking method-A,cooked rice showed a slight increase in zinc content, percent retention ranges between 101.0-126.0. But zinc content decreased in cooking method B, percent retention ranges between 46.0-96.0. Copper content decreased in all

varieties of cooked rice whether it was cooked with or without decantation of cooking water.

Table 3: Macro minerals content in uncooked and cooked rice[1]

Variety	Type	Ca	Mg	P	Na	K
Parboiled, milled.						
BR-1	Uncooked	1 68±0 08	23 07±0 05	154±0 04	4 94±0 91	160 3±0 01
	Cooked (wdew)[2]	6 29±0 06 (374.0)	14 99±0 01 (65.0)	113 9±0 02 (74.0)	13 5±0 82 (273.0)	148 1±0 00 (92.0)
	Cooked (dew)[3]	8 15±0 03 (485.0)	11 28±0 06 (49.0)	84 9±0 02 (55)	6 0±0 85 (122.0)	48 82±0 00 (31.0)
BR-10	Uncooked	2 08±0 06	23 3±0 05	142 6±0 04	4 79±0 01	134 1±0 05
	Cooked (wdew)	7 94±0 02 (382.0)	16 12±0 02 (69.0)	135 5±0 02 (95.0)	14 6±0 07 (306.0)	106 9±0 00 (80.0)
	Cooked (dew)	8 39±0 07 (399.0)	12 79±0 02 (55.0)	108 3±0 03 (76.0)	11 7±0 09 (246.0)	62 9±0 02 (47.0)
BR-12	Uncooked	0 81±0 01	24 86±0 05	149 9±0 82	6 14±0 03	148 6±0 06
	Cooked (wdew)	6 69±0 02 (826.0)	14 50±0 04 (58.0)	123 3±0 04 (82.0)	12 8±0 01 (210.0)	105 9±0 00 (72.0)
	Cooked (dew)	8 51±0 01 (1053.0)	11 03±0 03 (44.0)	107 2±0 08 (72.0)	11 3±0 01 (149.0)	60 5±0 04 (41.0)
BR-22	Uncooked	1 57±0 05	29 40±0 07	193 8±0 04	2 54±0 08	138 9±0 00
	Cooked (wdew)	8 20±0 04 (522.0)	13 49±0 07 (45.0)	138 2±0 02 (71.0)	7 66±0 08 (313.0)	91 7±0 02 (66.0)
	Cooked (dew)	9 79±0 07 (624.0)	12 18±0 06 (41.0)	124 2±0 02 (64.0)	8 64±0 08 (352.0)	61 3±0 01 (44.0)
Purbachi	Uncooked	0 75±0 02	25 49±0 00	162 9±0 05	4 96±0 04	203 6±0 84
	Cooked (wdew)	6 47±0 07 (863.0)	20 3±0 02 (80.0)	143 0±0 07 (88.0)	6 4±0 06 (130.0)	182 5±0 03 (89.0)
	Cooked (dew)	7 5±0 04 (1000.0)	18 63±0 02 (73.0)	124 5±0 03 (76.0)	10 08±0 07 (203)	123 9±0 01 (61.0)
Nizersail	Uncooked	2 11±0 02	20 31±0 83	124 3±0 06	3 48±0 02	116 8±0 03
	Cooked (wdew)	8 62±0 02 (401.0)	14 13±0 11 (70.0)	123 3±0 00 (92.0)	10 8±0 02 (311.0)	102 4±0 09 (88.0)
	Cooked (dew)	8 95±0 02 (424.0)	10 47±0 29 (52.0)	106 9±0 05 (80.0)	13 92±0 03 (382.0)	70 49±0 15 (60.0)
Paijam	Uncooked	1 55±0 02	23 12±0 83	149 58±0 07	7 84±0 16	133 0±0 04
	Cooked (wdew)[2]	9 63±0 02 (621.0)	15 29±0 08 (66.0)	140 2±0 04 (94.0)	19 89±0 07 (254.0)	96 27±0 82 (72.0)
	Cooked (dew)[3]	10 05±0 03 (648.0)	12 41±0 02 (54.0)	112 6±0 02 (75.0)	12 68±0 02 (162.0)	65 0±0 02 (49.0)
Latisail	Uncooked	1 81±0 02	26 78±0 06	147 9±0 02	15 7±0 04	119 7±0 02
	Cooked (wdew)	6 15±0 03 (339.0)	16 47±0 05 (62.0)	140 2±0 02 (95.0)	18 86±0 049 (120.0)	95 1±0 04 (79.0)
	Cooked (dew)	9 11±0 02 (503.0)	12 76±0 06 (48.0)	99 1±0 04 (67.0)	19 5±0 04 (120.0)	44 49±0 08 (37.0)
Rajasail	Uncooked	0 49±0 02	19 90±0 08	193 8±0 04	-	148 1±0 04
	Cooked (wdew)	6 29±0 02 (1283.0)	16 04±0 01 (81.0)	166 3±0 04 (86.0)	–	110 09±0 07 (74.0)
	Cooked (dew)	6 48±0 02 (1322.0)	13 64±0 09 (69.0)	152 3±0 02 (79.0)	–	65 61±0 06 (44.0)
Raw, milled.						
Kalijira	Uncooked	1 59±0 03	20 39±0 06	120 9±0 01	3 52±0 08	69 44±0 02
	Cooked (wdew)	11 00±0 0 (692.0)	12 03±0 78 (59.0)	89 18±0 07 (74.0)	5 71±0 01 (162.0)	52 0±0 02 (75.0)
	Cooked (dew)	9 45±0 04 (594.0)	9 39±0 07 3 (46.0)	80 13±0 02 (66.0)	8 51±0 00 (24.0)	20 03±40 06 (29.0)
Paijam	Uncooked	1 62±0 02	34 08±0 07	133 7±0 28	7 14±0 08	79 73±0 02
	Cooked (wdew)	7 61±0 02 (470.0)	16 21±0 09 (47.0)	92 3±0 02 (69.0)	12 47±0 9 (173.0)	55 67±0 06 (70.0)
	Cooked (dew)	8 32±0 03 (514.0)	13 20±0 04 (39.0)	85 7±0 04 (64.0)	15 4±0 04 (215.0)	34 4±0 03 (43.0)

Table 2: (Continuation)

[1] Results were expressed as mean ± SD of triplicate determination and as mg/100g dry wt basis ; [2] without decantation of cooking water ; [3] decantation of cooking water ; figures in parentheses indicate percent retention ; - not done.

Major minerals such as Ca, Mg, P, Na, and K content in different varieties of rice and their changes due to cooking are presented in Table- 2. Increase in calcium content was observed in all varieties of rice cooked with or without decantation of cooking water (method A and method B). Higher percent retention was found in cooking method B. On the other hand, decrease in Mg content in different varieties of rice was found in both cooking methods. Higher percent retention was found in method A. Similar trend in percent retention of phosphorus content of cooked rice was observed. Sodium content increased for all varieties of rice in both cooking methods whereas potassium content decreased and percent retention was found lower in cooking method B. Phytic acid content of cooked and uncooked rice is presented in Table- 4. Phytic acid content was found to be in the range of 92.12±0.02 mg – 225.29+0.02 mg/ 100g E. P in different varieties of uncooked rice. Decreased in phytic acid content was observed whether rice was cooked with or without decantation of cooking water. Percent retention of phytic acid was lower in cooking method B. during cooking in this study.

Table 4: Phytic acid content of uncooked and cooked rice [1].

Variety	Uncooked rice	Cooked rice(WDCW)[2]	% Retention	Cooked rice(DCW)[3]	% Retention
BR-1	138.64±0.82	89.35±1.67	64.0	76.68±0.88	55.0
BR-10	119.05±0.04	112.16±0.02	94.0	106.38±0.07	89.0
BR-11	118.98±0.02	96.27±0.02	81.0	91.34±0.03	77.0
BR-12	135.62±0.10	108.57±0.02	80.0	77.53±0.02	57.0
BR-22	225.29±0.02	158.33±0.02	70.0	145.80±0.02	65.0
Purbachi	150.49±0.01	128.66±0.03	85.0	109.40±0.03	74.0
Nizersail	208.96±0.04	178.24±0.02	85.0	154.50±0.01	73.0
Paijam	129.41±0.02	99.53±0.02	77.0	84.10±0.04	65.0
Latisail	92.12±0.02	80.43±0.01	87.0	69.40±0.01	75.0
Rajasail	173.23±0.02	154.39±0.01	89.0	110.92±0.02	64.0
Raw, milled					
Kalijira	91.97±0.02	44.70±0.04	49.0	43.75±0.04	48.0
Paijam	176.6±0.02	92.33±0.02	52.0	62.15±0.02	35.0

[1] Results were expressed as mean ± SD of triplicate determination and as mg/100g dry wt. basis; [2] without decantation of cooking water; [3] decantation of cooking water.

Table 5: Mineral content in domestic tap water (mg/l).

Elements	Range
Fe	N. D.
Zn	0.09-0.02
Cu	N. D.
Ca	5.37-8.01
Mg	3.0-3.70
P	N. D.
Na	6.60-10.6
K	1..40-2.11

Discussion

Rice is the main staple food of Bangladesh and the cooking methods commonly used are i) cooked with such amount of water so that no water will remain after cooking, and ii) large amount of water is used and excess water is decanted after cooking. The latter one is most common. Preliminary treatment of washing prior to cooking is common practice in household. In this present study, twelve different varieties of rice obtained from BRRI and local market, were cooked by two different cooking methods. All the varieties of rice, both cooked and uncooked, were analyzed for moisture, minerals and phytic acid content. Profound changes in minerals and phytic acid content have been observed due to two cooking methods of rice.

In this study, iron content in uncooked rice (parboiled, milled) was found in the range of 0.41mg-1.03mg/100g E. P. which was much lower than the previous findings (3mg/ 100g) of India (9) and Bangladesh (10). Previously colorimetric method was used which was not much accurate, but in the present study, atomic absorption was used to measure the mineral content in rice. A latest study in India (11) reported 1mg of iron present /100g E. P. Juliano (12) and Pederson (13) also reported 0.2-2.8mg iron / 100g E. P. Zinc content in uncooked rice (both parboiled and raw) is related to previous findings of our country(14). Copper content is found a little bit higher than value reported from India (9).Calcium content in uncooked rice varies from 0.43-1.90mg /100g E. P. which was much less than studies (9mg /100g E. P.) of India (11). Similarly magnesium content found in this study is not in agreement with the study of India (9). Phosphorus content in raw milled rice was found less than parboiled milled rice which is just opposite to Indian value (9). Sodium and potassium content in uncooked rice were found in agreement with values reported from India (9).

Decrease in iron content was observed in cooked rice in both cooking methods. Percent retention of iron was found lower when rice was cooked with decantation of cooking water (method B). Only 45% of iron in rice retains in this cooking method. For raw milled varieties of rice, decrease in iron content was found more severe. Paijam variety of rice retained only 4.0% of iron in this cooking method. Decrease in

Table 2: (Continuation)

iron content in cooked rice in method A may be due washing prior to cooking and further decrease in iron content in method B may be due to both washing and decantation of cooking water. Previous studies reported 75% iron loss due to washing and decantation of cooking water (15). Rice cooked without decantation of cooking water (method A) showed a slight increase in zinc content. This may be due to presence of zinc in domestic tap water used for cooking. But decrease in zinc content was observed in case of rice cooked with the decantation of cooking water. This loss may be due to loss of soluble protein, while zinc is associated with protein (14). All varieties of rice, cooked with or without decantation of cooking water showed a decrease in copper content and this decrease was found higher when cooking water was decanted.

In this study it was observed that calcium content increased in cooked rice due to presence of calcium in domestic tap water. This is in agreement with other findings of Kennedy et al (16). On other hand decrease in magnesium and phosphorus content in cooked rice was found in both cooking methods. Mg and P present in outer layer of rice grain, these loss due to washing and decantation of cooking water. Sodium content increased and potassium content decreased in cooked rice. This trend observed in all varieties of rice. Since domestic tap water contain fair amount of sodium, may be this Na added during cooking. Retention of Na by cooked rice was also observed by R. B. Toma (17). Decrease in K content may be due to washing and also for decantation of cooking water.

All the rice varieties tested in this study contained appreciable amount of phytic acid that are allied to other findings (9,12). Phytic acid content in rice reduced after cooking as we found in this study. It was found that decrease in phytic acid content was higher when cooking water was decanted. Oberleas (18) related the destruction of phytic acid during cooking due to heat.

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