DR-1892
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RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume Issue : ()

Phytic Acid and Micronutrient Profiling of a Few Ethnic Rice Products of Assam, India

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10.18805/ajdfr.DR-1892

ABSTRACT

Background: Different ethnic rice products are obtained from specialty rice varieties of Assam, India. A unique characteristic of these rice products is that the products can be used instantly. Considering lack of study relating to biochemical changes during processing, the present study was conducted.

Methods: The specialty rice products (*bhaja bora, hurum, sandahguri, Korai*, flaked rice and *komal chaul* including two intermediate forms in preparation of *bhaja bora* and *hurum*) prepared through traditional method and their respective raw forms were collected in Jorhat, Assam. The phytic acid, total phenols and a few minerals were estimated with standard methods.

Result: Among the products, the phytic acid phosphorus and total phenol content ranged between 92.74-272.65 mg/100 g and 61.67-69.59 mg catechol equivalent/100 g, respectively. The total ash (%) and the minerals (mg/100 g) like sodium, calcium, potassium, phosphorus, zinc and iron ranged between 0.84-1.34, 37.33-56.67, 11.32-20.67, 64.32-134.33, 250.26-333.45, 3.24-4.08 and 2.47-6.91, respectively. The higher concentration of total ash, iron and zinc were observed in the products than their respective raw forms. However, the observation of decrease in phytic acid content in all these products reveals that the processing may improve availability of certain minerals.

Key words: Ethnic rice products, Micronutrients, Phytic acid, Phenols.

INTRODUCTION

In food industry worldwide, different processing methods are used to produce various rice products with desirable quality based on cultural and cooking demand and nutritional considerations. These processes results in variable degree of macro and micro nutrient content, stability, retention, *etc* depending on nutritional quality of rice variety. Brown rice is richer in protein, minerals, vitamins and lysine content compared with milled rice. Rice milling is the major processing method that significantly changes rice nutritional quality (Atungulu *et al*. 2014).

Phytic acid (PA; myo-inositol hexaphosphate) is a ubiquitous biomolecule present abundantly in plants and PA phosphorus constitutes the major portion of total phosphorus in several seeds and grains. It accounts for 50-80% of the total phosphorus in different cereals. Phytic acid forms insoluble complexes with cations like zinc and iron due to reactive phosphorus groups attached to its inositol ring which, in turn renders these essential nutrients unavailable for human intestinal absorption. Wet processing like soaking, germination and fermentation of food crops reduced phytic acid content and increased the solubility of nutrients (Mahesh *et al*. 2015)

In Assam, a variety of traditional ready to eat products from rice are processed, in which parboiling is involved. Due to processing, alteration of nutritional quality takes place either by changes in nutrients or by an improvement in digestibility of nutrients. *Hurum, komal chaul, bhoja bora*, puffed rice, popped rice, flaked rice, *korai, sandahguri* are the rice products obtained from specialty rice varieties of Assam, particularly *bora* (low amylose containing) and *chakua* (intermediate amylose containing). A unique characteristic of these rice products is that the products can be used instantly.

However, no reports can be traced on biochemical changes taking place during processing of specialty rice products of Assam. Considering limited information on the phytic acid and micronutrient composition of the traditional rice products of Assam having ethno economic importance together with the changes involved during processing, the present work was carried out.

MATERIALS AND METHODS

The specialty rice products *bhaja bora, hurum, sandahguri, Korai*, flaked rice and *komal chaul* including two intermediate forms in preparation of *bhaja bora* (intermediate form 1) and

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How to cite this article: Bhattacharjee, S., Das, P., Pathak, K. and Nath, T. (2022). Phytic Acid and Micronutrient Profiling of a Few Ethnic Rice Products of Assam, India. Asian Journal of Dairy and Food Research. DOI: 10.18805/ajdfr.DR-1892.

Submitted: 11-02-2022 **Accepted:** 15-07-2022 **Online:** 02-08-2022

hurum (intermediate form 2) prepared through traditional method and their respective raw forms were collected in Jorhat, Assam during 2019. The details of processing of these products was described earlier (Bhattacharjee *et al*. 2019). The phytic acid, total phenols and a few minerals in those products and intermediates including in the respective raw brown rice were estimated with standard methods at the Assam Agricultural University.

Phytic acid content was determined by the method of Wheeler and Ferrel, (1971). The phenol content of the sample was determined by using the Folin-Ciocalteu reagent method reported by Malick and Singh, (1980). The ash content was estimated according to the method as described by A.O.A.C (1970). Phosphorous content was determined according to the method described by Fiske and Subbarow, (1925). Iron content was determined according to the method of Wong (1928) using UV-VIS spectrophotometer. Zinc in mineral solution was estimated by using a double beam atomic absorption spectrometer (AAS, Chemito-AA203D, India). Calcium, sodium and potassium content in the sample were determined by flame photometric method (A.O.A.C. 1980).

All the estimations were done in triplicate and the mean was calculated. The data were subjected to statistical analysis using completely randomized design.

RESULTS AND DISCUSSION

The phytic acid phosphorus and the phenol content of brown rice and products are presented in Table 1. The content of ash and the important minerals are presented in Table 2.

The phytic acid P

The phytic acid P content of brown form of specialty rice were found to be lower than the values (5.61-9.12 g/kg or 561- 912 mg/100 g) reported for some selected rice varieties. The phytic acid P content of different products and their intermittent forms varied from 92.74 mg/100 g-313.33 mg/100 g, the lowest was observed in *bhoja bora* and the highest in intermittent form 2. Bagchi *et al*. (2016) reported that the phytic acid content of raw rice and their respective popped rice of some Indian rice cultivars ranged between 0.15%-0.27% or 150- 270 mg/100 g and between 0.18%-0.8% or 180-800 mg/100 g, respectively. They stated that higher phytic acid observed in popped rice than their respective raw form was due to disintegration of starch and higher exposer of phytic acid to extraction medium. The observed difference of our observation with that of Bagchi *et al*, (2016) might be due to differences in processing as in the present study, all products involved wet processing, instead of dry processing required for popped rice. During wet processing, some of the phytic acids was lost; as the water where paddy was soaked, was discarded.

Soaking appeared to be most effective in decreasing phytic acid content. It activates the endogenous phytase enzyme that hydrolyses phytic acid to free myo-inositol and inorganic phosphate (Kumar *et al*. 2017). Decrease in phytic acid P due to heat treatment was also reported (Mahgoub and Eihag, 1998). In the present study also, phytic acid P content were decreased in almost all the specialty rice products than their respective raw forms. However, the observed increase in *sandah guri* than the same in *komal chaul* might be due to changes in percentage, not actual increase, as *sandah guri* was made from *komal chaul* by grinding and discarding the granules which did not pass through 50 micron sieve.

In the brown form of specialty rice, the phytic acid P content as percentage of total P was found to be 69.95-88.94%; the lowest was in *bakul bora* and the highest in *ronga chakua*. It was reported that phytic acid P accounts for 50-80% of the total phosphorus in different cereals (Mahesh *et al*.2015)

Table 1: Phytic acid P (mg/100g, dry weight) and phenol (mg catechol equivalent/100 g) content of specialty rice and their products.

Rice forms	Phytic acid P	% of total P	Total phenol
Michi bora (brown)	274.20	81.29	92.99
Korai	249.10	88.72	65.32
Intermittent form 1	139.07	41.87	75.92
Bhoja bora	92.74	37.06	61.67
Bakul bora (brown)	345.92	69.95	84.44
Intermittent form 2	313.33	81.77	80.29
Hurum	272.65	81.75	66.92
Flaked rice	243.71	83.26	68.48
Rongachakua (brown)	303.46	88.94	103.30
Komalchaul	233.84	74.09	65.16
Sandahguri	260.94	83.24	69.59
Mean	248.94	73.81	75.82
CD(0.05)	0.639		3.314
SE(m)	0.217		1.150
SE(d)	0.306		1.627

Table 2: Micronutrient (minerals) profiling (mg/100, dry weight basis) of specialty rice and their products.

Rice forms	Ash (%)	Sodium	Calcium	Potassium	Iron	Zinc	Phosphorus	%share in total ash
Michi bora (brown)	0.66	58.67	21.67	216.33	2.13	2.44	337.33	96.75
Korai	0.98	42.33	16.68	78.67	6.91	3.75	280.77	43.79
Intermittent form 1	0.75	44.67	15.33	204.33	4.13	3.15	332.18	80.51
Bhoja bora	0.84	37.33	11.32	64.32	4.53	3.49	250.26	44.20
Bakul bora (brown)	1.00	62.67	26.33	220.33	2.89	2.14	494.50	80.89
Intermittent form 2	1.15	52.33	23.34	212.31	4.23	2.93	383.20	59.99
Hurum	1.34	49.67	20.67	124.67	5.34	4.08	333.45	40.14
Flaked rice	1.12	56.33	18.68	134.33	6.09	3.85	292.71	45.71
Rongachakua (brown)	0.92	63.31	27.67	218.33	3.39	2.51	341.21	71.35
Komalchaul	0.97	45.32	12.33	77.32	2.47	3.24	315.63	47.07
Sandahguri	1.07	56.67	18.33	70.67	5.23	3.84	313.48	43.76
Mean	0.98	51.76	19.30	147.42	4.31	3.22	334.07	
CD(0.05)	0.016	0.766	1.084	1.295	0.136	0.012	0.648	
SE(m)	0.006	0.266	0.376	0.449	0.048	0.004	0.219	
SE(d)	0.008	0.376	0.532	0.636	0.067	0.006	0.310	

The phytic acid P content as percentage of total P of different products and their intermittent forms was found to be 37.06-88.72%, the lowest was in *bhoja bora* and the highest in *korai*.

It was observed that during processing of *bhaja bora* from raw *michi bora*, the highest amount (total 66.23%) phytic acid P was reduced. Though, decrease in the P content during the processing of the same was 25.81% only. It reflects that part of the P attributed by the degradation of phytic acid during heating are retained in the products analyzed in the present study, including *bhaja bora*. However, the observed decrease of total P during soaking was the loss probably due to water soluble nature of phytic acid.

The total phenol content

The total phenol content of brown form of specialty rice was found to be lower than the value (232.94±11.45 to 2223.68±33.48 mg catechol/100 g) reported for few indigenous rice including pigmented rice germplasms of Assam (Mudoi and Das, 2019).

The total phenol content of different products and their intermittent forms varied from 65.16 mg/100 g-80.29 mg catechol equivalent /100 g, the lowest was observed in *komal chaul* and the highest in intermittent form 2.

The phenolic compounds are localized mainly in the external layers of the grain (Walter and Marchesan, 2011); the bran contains between 70 and 90% of the phenolic acids in light brown pericarp of rice grains (Zhou *et al*. 2004). The bran contains approximately 85% of the anthocyanins in the rice grains with black pericarp, with little variation depending on the cultivar and the compounds considered (Hu *et al*. 2003). As phenolic compounds are water soluble, soaking might be the reason for the observed decrease in the total phenol content in *hurum, komal chaul,* flaked rice and the two intermediate forms. However, the decrease observed in *korai* and the slight increase for *sandah guri* might be due to change in percentage as the hard portions were eliminated by sieving.

The total ash content of brown form was found to be 0.66% to 0.92%. Similar observations on ash content were reported for some brown form of *chakua* rice varieties (0.66% -1.52%) (Das *et al*. 2018) and for some indigenous red cultivars of brown rice of Assam (0.73%-1.85) (Mudoi and Das, 2018) respectively.

The ash content of different products and their intermittent forms varied from 0.75%-1.34%, the lowest was observed in intermittent product 1 and the highest in *hurum*. Similar observations were reported for some traditional rice products of Assam (Banik *et al*. 2018). Soaking changed fibre, ash and mineral compositions in rice and also brought diffusion of color pigments, fat globules, etc, from husk and bran layers into starchy endosperm (Kale *et al*. 2015).

The observed higher ash content in *korai* than the respective raw form might be mainly due to increase in percentage as during sieving, a hard portion which was greater in size (more than 50 μ) was rejected. The hard portion might be composed of starch as during this step, significant decrease in starch content was also observed (Bhattacharjee *et al*. 2019). As *sandah guri* was also collected after sieving, the increase in ash content can be justified as mentioned above.

The phosphorus content of brown form of specialty rice were found to be 337.33 to 494.50 mg/100 g. The phosphorus content of some brown form of *chakua* rice varieties of Assam ranged from 173.95 mg/100 g (*Lahi chakua*) to 328.78 mg/100 g (*Pozo chakua*) (Das *et al*. 2018).

The phosphorus content of different products and their intermittent forms was found to be 250.26 to 383.20 mg/ 100 g, the lowest was observed in *bhoja bora* and the highest in intermittent product 2.

The decrease in phosphorus content in *komal chaul* and flaked rice and in both the intermittent forms might be attributed to soaking leading to loss of this mineral in the form of phytic acid. However, both the decrease of phosphorus in *korai* than *Michi bora*, in *sandahguri* than *komal chaul,* in *bhoja bora* than intermittent form 1 and in *hurum* than the respective intermittent form 2 might be attributed to change in percentage only due to associated increase in other dry matter components.

The iron content of brown form was found to be 2.13 to 3.39 mg/100 g, which was found to be lower than the values (2.12-54.40 mg/100 gm) reported for pigmented rice varieties of Assam (Mudoi and Das, 2019).

The iron content of different products and their intermittent forms varied from 2.47-6.91 mg/100 g, the lowest was observed in *komal chaul* and the highest in *korai*.

It was reported that the higher iron content detected after soaking might be due to absorption of water containing iron (Kumar and Prasad, 2018). However, the present observation of gradual increase in iron content in both intermittent forms and final products might be due to decrease in percentage of other minerals (P, Ca, Na and K), not actual increase.

The zinc content of brown form was found to be 2.14 to 2.51 mg/100 g. The zinc content of present investigation was found to be lower than the values (2.42- 26.57 mg/100 g) reported for some indigenous red rice germplasm of Assam (Mudoi and Das, 2019 and Mudoi and Das, 2022).

The zinc content of different products and their intermittent forms was found to be 2.93 to 4.08 mg/100 g, the lowest was observed in intermittent form 2 and the highest in *hurum*.

The present observation of gradual increase in zinc content in both intermittent forms and final products might be due to decrease in percentage of other minerals (P, Ca, Na and K), not actual increase.

The calcium content of brown form was found to be 21.67-27.67 mg/100 g. The calcium content of different products and their intermittent forms was found to be 11.32 -23.34 mg/100 g. The calcium content of roasted rice and flaked rice were 18.43 mg/100 g±0.20 and 18.40±0.26 mg/100 g, respectively (Kumar and Prasad, 2018).

The observed gradual decrease of calcium in all the products except in processing of *sandahguri* from *kumal chaul* and *korai* from *michi bora* might be attributed to loss of calcium during soaking. The processing of paddy involved soaking and heating, during which the minerals were either leached out or removed from the grain (Kumar and Prasad, 2018). However, the decrease in calcium content in *korai* than michi bora might be attributed to discarding calcium containing components during sieving and increase in *sandahguri* than *kumal chaul* might be associated with decrease in percentage of other components only, not actual change.

The sodium content of brown form was found to be 58.67 (*Michi bora*) to 63.31 mg/100 g (*Ronga chakua*). It was reported that the sodium content of some brown form of *chakua* rice varieties of Assam ranged from 14.82 mg/100 g -22.70 mg/100 g (Das *et al*. 2018). The sodium content of different products and their intermittent forms was found to be 37.33 (*bhoja bora*) to 56.67 mg/100 g (*sandah guri*). The potassium content of brown form of specialty rice was found to be 216.33 (*Michi bora*) to 220.33 mg/100 g (*Bakul bora*). Das *et al*. 2018 reported that the potassium content of some brown form of *chakua* rice varieties of Assam ranged from 84.71 mg/100 g-287.6 mg/100 g.

The potassium content of different products and their intermittent forms was found to be 64.32 (*bhoja bora*) to 212.31 mg/100 g (intermittent form 2). Kumar and Prasad, 2018 reported that the potassium content of roasted rice and flaked rice were 119.0±1.73 mg/100 g and 154.0±6.24 mg/100 g, respectively and the processing of paddy involving soaking and heating, might cause the minerals either leached out or removed from the grain.

Conclusion

Due to processing, phytic acid P content decreased in all the specialty rice products than their respective raw forms. It reduced up to 66.23% in *Bhaja bora*. However, there is loss of certain micronutrients like phenols and minerals (Na, K, P, Ca) due to processing in all the products. Among different products, *Bhaja bora* was found to contain the least phytic acid, phenol and other minerals analyzed, except iron and Zn. However, the processing improved the concentration of iron and zinc in all the products except iron content in *komal chaul*.

Conflict of interest: None.

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