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Ready to Use Ethnic Rice Products of Assam, India: Potential source of Resistant Starch

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ABSTRACT
The present study was conducted to know the nutritional profile of ready to use ethnic rice products of Assam, India. The special rice products are bhoja bora chaul, komal chaul (soft rice), hurum, korai, sandah guri, puffed rice, popped rice and flaked rice. The highest amount (5.42%) of resistant starch was found in sandah guri and the lowest (3.24%) in puffed rice. The resistant starch content of eight traditional rice products was found in intermediate to high range. The highest amount (90.28%) of total carbohydrate was found in komal chaul and the lowest (85.44%) in popped rice. The highest amount (0.31%) of crude fat content was observed in korai and the lowest (0.11%) in hurum. The highest amount of crude protein was observed in popped rice (9.40%) and the lowest in puffed rice (7.74%). The average crude protein content of eight traditional rice products was 8.31%. The highest amount of crude fiber (1.04%) was found in bhoja bora chaul and sandah guri, the lowest (0.63%) was found in popped rice. The highest amount (4.33%) of ash was observed in popped rice and the lowest (0.61%) in bhoja bora chaul.
***Key words**: ethnic rice products; resistant starch; proximate composition, Assam*

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INTRODUCTION

Rice (*Oryza sativa*) is the most important food crop of the world after wheat. Assam is considered as one of the origins for rice and has got wide collection of rice cultivars. In Assam, the high amylose content rice varieties are consumed as staple food, and the waxy (0-8% amylose) and the intermediate amylose containing varieties are processed to make speciality products. The rice products of ethno-economic importance, such as *Bhoja bora chaul, hurum* and *korai [used as one of the components of mah (legume) karai]*are prepared from *bora (*waxy) varieties*.* The *chakua* group of Assam rice is characterized by its semi glutinous character with amylose ranging from 12-17%. *Komal chaul* and *sandah* are prepared from *chakua* varieties. Differences in parboiling result in distinctly different product characteristics. The parboiled and non parboiled (annealed) special rice products namely, *hurum*, *komal chaul, bhoja chaul, korai* and *sandah* having ethno-economic importance are yet to be extensively researched. Among the common masses, the puffed rice, flaked rice and popped rice prepared from local rice varieties of Assam are as popular as the same prepared from the local varieties of rice elsewhere of the world. However, the rice products *hurum, bhoja bora chaul, komal chaul*, *sandahguri* and *korai* are the specialty rice products of Assam, India. The processing methods for these ethnic products and their advantages of consumption without cooking are already described [1].
Rice contains 75 to 80 % starch, 1 to 7% resistant starch [2] , and only 7% protein with a full complement of amino acids [3]. In the traditional view, starch is thought to be completely digested; it is now recognized that a portion of starch resistant to digestion by human enzymes in the small intestine will pass into the large bowel, where they may or may not be fermented by gut bacteria [2]. Resistant starch has a pre biotic effect, acts on lipid metabolism, reduces cholesterol and reduces the risk of ulcerative colitis and colon cancer [4]. Physical methods to raise resistant starch content include hydrothermal treatments such as heat-moisture treatment and annealing [5,6]. Based on resistant starch content, the

foods are classified into various groups from negligible (less or equal to 1%, dry basis) to very high (more than 15%, dry basis) content [2].
The present study was conducted considering the importance of resistant starch in human health and to know the proximate composition including resistant starch content of the above mentioned hydro thermally treated ready to eat ethnic rice products of Assam, requiring no cooking.

MATERIALS AND METHODS

The ethnic rice products *viz* puffed rice, popped rice, flaked rice*, hurum, bhoja bora chaul, komal chaul, sandah guri* and *korai* were collected from local market, Jorhat, Assam. The products were stored in the desiccator at room temperature for further biochemical analysis.
The proximate compositions of rice products of Assam such as moisture, total ash, crude fat and crude protein and crude fibre were determined according to AOAC [7]. The amount of nitrogen was determined by Kjeldahl method. Crude protein was calculated multiplying the N% by 5.95. The total carbohydrate content on dry weight basis was calculated by subtracting the sum of the values (on dry weight basis) of crude protein, crude fat, ash and crude fibre content from 100. The gross food energy was estimated using [8] the equation: Food energy (kCal/100g) = $(CP \times 4) + (F \times 9) + (CHO \times 4)$, where CP means crude protein (%); F means crude fat (%); and CHO means carbohydrate content (%).
The resistant starch was estimated by the standard method [2], with the slight modification which included the final estimation glucose content by chemical (anthrone) method, instead of enzymatic method. The amylose was determined according to method given by Sowbhagya and Bhattacharya [9]. All the estimations were done in triplicates and the mean value was calculated out. The analysis of variance (ANOVA) was done with 8 treatments (rice products) and three replications using the Completely Randomized Design (CRD).

RESULT AND DISCUSSION

The proximate composition, resistant starch content and the energy values of the ethnic rice products are presented at Table 1.
The moisture content is an important factor governing storage, processing and marketing quality of the rice products. The moisture content is dependent upon many factors such as variety of rice, proportionate amount of chemical constituents of the grains, processing, environmental factors, etc. The highest moisture content was observed in the traditional product *bhoja chaul* (11.61%) and the lowest was in *sandah* (5.83%). The moisture content of the products analyzed in the present study were found to be in the range reported earlier [10], for rice based processed products.
The crude protein content of rice products ranged from 7.74% in puffed rice to 9.40% in popped rice. Earlier study [11] on physiochemical properties of popped rice from several Indian rice cultivars revealed that the crude protein content of popped rice varied from 7.06 -10.63%. In the present study too, the crude protein content of the popped rice was found to be 9.40%. However, the present findings on crude protein was slightly higher than those reported for some other rice products [10], which might be due to differences in varieties and method of processing, etc.
In the present investigation, the crude fat content of rice products ranged from 0.11% in *Hurum* to 0.31% in *karai*. The values observed in the present study for the crude fat content of rice products (0.11% to 0.31%) were found to be within the range (0.06% to 0.92%) reported for some of the raw rice varieties from India [12].
The crude fibre (0.62% in *Karai* to 1.04% in *bhaja bora chaul*) for the present investigation was found to be in agreement with those of the findings for some of the raw rice varieties from India [12].
Total ash content represents the total amount of mineral matters present in a food. Rice ash contains several minerals of nutritional importance in varying proportion. Though, it is present in very small amount, it plays very important role in human nutrition. In the present study, the total ash content of rice based products ranged from 0.61% in *bhaja chaul* to 4.33% in popped rice. Detection of higher ash content in popped rice, which is processed by direct roasting of the dried paddy followed by removal of husk, might be related to effect of processing. In comparison to raw seeds, the ash content significantly increased by 10 % during popping of *Amaranthus* seeds [13]. It was suggested [13] that the increase in ash content might be associated with loss of dry matter allowing the minerals to concentrate. Processing of food grains is commonly known to alter the bioavailability of both macro and micronutrients [10].
The total carbohydrate content of the rice products found in the present investigation was 85.44-90.28%, the lowest in popped rice and the highest in *komal chaul*.
Earlier study [10] revealed the total carbohydrate of some processed rice products to be 74.2-79%, respectively.

The energy value was observed to be the highest for flaked rice (395.66kCal/100g) and the lowest for popped rice (381.16 kCal/100g).

The amylose content (16.49% to 19.8%) of the traditional rice products of Assam was found to be almost similar (18.7% to 22.0%) to the same reported earlier for the processed products of rice [10]. The *chakua* rice is characterized by its semi glutinous character with intermediate amylose content. In the present study, for the products made from *chakua* rice namely *komal chaul,* and *sandah,* the amylose was found in between 16.80% to 17.30%. The higher amylose content detected in the present study for the rice products made from glutinous (*bora*) rice *(bhoja chaul, hurum and korai*) than the known amount present in raw *bora* rice (less than 8%), might be due to rupture of glycosidic linkages during processing (prolonged heating). Earlier, it was reported that severe heating for prolonged time might lead to rapture of glycosidic linkages [14]. From other study [15], too increase in amylose content upon roasting was reported and it was mentioned that, that might also be one of the factors for increased resistant starch content in cereals on roasting.

In the present investigation, the range of resistant starch was found to be 3.24% to 5.42%, the lowest in puffed rice and the highest in *sandah guri*. The resistant starch content of rice products in the present study was higher than the values reported earlier [10, 15]. It was reported [10] that the resistant starch content for raw rice to be 0.2% as compared to its processed products such as puffed rice to be 2.4%, parched rice to be 2.6%, thick flaked rice to be 1.8%, thin flaked rice to be 1.9% and vermicelli rice to be 2.1%. The resistant content of puffed rice and flaked rice were reported to be 1.3% and 1.2%, respectively [15]. It was reported that the damaged starch and resistant starch are the outcome of processing treatments [10]. The heat moisture treatment and annealing may be used to enhance resistant starch levels while maintaining granular structure [16,17].

The differences observed in resistant starch content of the rice products might be due to the varietal differences present in the raw rice in amylose content and methods of processing (involving variation in soaking, temperature and period of heating or parboiling and period of cooling, etc). Earlier, it was reported [15]that of all the processing techniques applied to study the alterations in resistant starch content of various cereal products, roasting, baking and boiling not only retained the maximum resistant starch but showed an increase in its content followed by shallow frying. They also reported that steaming and frying showed a decrease in resistant starch content.

Table 1. Proximate composition, energy values, resistant starch and amylose content of ethnic rice products of Assam, India.

Samples	Moisture (%, fresh weight basis)	Total carbohydrate (%, dry weight basis)	Crude protein (%, dry weight basis)	Ash (%, dry weight basis) content	Crude fiber (%, dry weight basis)	Crude fat (%, dry weight basis)	Energy value (kCal/100g)	Resistant starch (%, dry weight basis)	Amylose content (%, dry weight basis)
Komal chaul	11.52	90.28	7.77	0.83	0.90	0.22	394.18	4.91	16.89
Bhoja Bora chaul	11.61	88.67	9.28	0.61	1.04	0.28	394.32	5.26	19.53
Flaked rice	10.71	89.48	8.85	0.72	0.69	0.26	395.66	3.64	19.80
Hurum	6.79	89.33	8.08	1.85	0.63	0.11	390.63	5.12	16.80
Sandah guri	5.83	90.07	7.85	0.86	1.04	0.18	393.30	5.42	17.30
Puffed rice	10.14	89.05	7.74	2.33	0.66	0.23	389.23	3.24	19.13
Popped rice	7.79	85.44	9.40	4.33	0.63	0.20	381.16	4.95	16.49
Korai	7.11	89.30	7.83	1.63	0.62	0.31	391.31	4.11	19.64
CD $_{(0.05)}$	0.07	2.96	0.28	0.21	0.12	0.07	-	0.66	0.85

The present study reveals that the analyzed rice products flaked rice, popped rice, puffed rice, *komol chaul* and *karai* contained intermediate (2.5-5%, dry basis) amount of resistant starch, whereas, the same in *sandah guri, bhaja bora chaul* and *hurum* contained resistant starch in high group (5% to less than 15%). Detection of an appreciable amount of resistant starch imparts nutritional importance to these traditional rice products, already having ethno economic importance. Though, considering malnutrition, food with the highest starch digestibility and low resistant starch should be used, diabetic patients should consume cereals with high resistant starch content eliciting a low postprandial glycemic response [15].

CONCLUSION

Evaluation of biochemical composition of traditional rice products of Assam with special reference to resistant starch revealed that these products are important sources of resistant starch, carbohydrate, crude protein and minerals. It was observed that the popped rice was the better source of minerals, and crude protein as compared to other products. The highest levels of crude fibre and resistance starch were detected in traditional rice product *sandah*.

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