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Nutritional Composition of Traditional colored rice cultivars of Assam, India

Tiluttama Mudoi[1] and Priyanka Das*[2]
[1]Department of Post Harvest Technology, Central Coffee Research Institute, Chickmagalur-577117
[2]Department of Biochemistry and Agricultural Chemistry, Assam Agricultural University, Jorhat-785013
***Corresponding Author**
Email id: priyanka.aau@gmail.com

ABSTRACT
The nutritional compositions of twenty one indigenous red grained cultivars of Assam were evaluated. The amylose content in brown and polished rice ranged from 0.2-20.98% and 2.6-21.18%, respectively. The crude fat content ranged from 1.95-3.83% in brown rice and 1.11 to 3.25%, in polished rice. The crude protein content was in the range of 5.43-13.83 % in brown rice and 3.33-9.8% in polished rice. The cultivars "Jul Bao","Negheri Bao", "Bangalami" and "Rangali" contained high amount of protein. Ash content in brown and polished rice ranged from 0.73 -1.85 % and 0.44-1.51%, respectively.
Keywords: Nutritional Composition, Amylose, Rice Varieties

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal worldwide. Traditionally, it has been the staple food and main source of income for more than 50% of the world's population. Rice starch mainly differs in amylose content; amylose molecule determines the grain's gelatinization temperature, pasting behavior and visco elastic properties [1], and has been an important component to be considered in quality breeding of rice [2, 3].

Rice is generally consumed as white rice with the husk, bran, and germ removed. However, consumption of brown rice has been increasing in recent years, due to the increased awareness about its health benefits and good nutritional properties as it contains higher amounts of proteins, minerals and also phytochemicals such as tocopherols, tocotrienols, vitamin B, δ-oryzanols, and phenolic compounds [4, 5]. Whole grain consumption is associated with the prevention of chronic diseases, such as cancer and cardiovascular disease. Although, white rice is widely popular in South Eastern Asia, there are also some red, purple and black colored rice cultivars. The color of rice results from the high content of anthocyanins located in the pericarp layers [6,7]. Anthocyanin pigments have been reported to be highly effective in reducing cholesterol levels in the human body and also due to aldose reductase inhibitory activities, they are beneficial for diabetic prevention [8]. Colored rice varieties are reported as potent sources of antioxidants and functional food because of its high polyphenols and anthocyanin content [9, 10]. Colored rice is more nutritious than white rice, as a source of higher content of protein, vitamins and minerals [11]. Colored rice showed greater antioxidant capacity than white rice [12].

Several varieties of colored rice, particularly red and black rice, have been cultivated in North Eastern part of India also. There are more than one hundred germplasm of colored rice available in Assam, a North Eastern state of India, most of which are yet to be investigated for their nutritional and phytochemical properties. Therefore, the present study was undertaken to find out the nutritional composition of twenty one indigenous colored rice cultivars of Assam.

MATERIALS AND METHODS
Collection of colored rice samples

In total, twenty one colored rice varieties (Table-1) were collected from different regions of Assam. According to the season and ecology, the collected varieties are grown as 'baon' (deep water rice), 'Ahu' (autumn), 'Sali' (winter) and 'Boro' (spring/summer). Rice grains were de-husked using a de-husker (Satake Corporation, Hiroshima, Japan) and then polished using a polisher (Satake Corporation, Hioroshima, Japan). Bran was removed and was collected separately. Then, brown and polished rice grains were ground to flour and the moisture free samples were used for further analysis.

Amylose content was estimated according to Sowbhagya and Bhattacharya [13]. The crude fat and the ash content were determined according to the procedure given in AOAC method [14]. The nitrogen content in rice flour samples was estimated by following the Kjeldahl's method according to the procedure described in AOAC [14]. The protein percentage was calculated by multiplying nitrogen per cent with a factor 5.95. The total carbohydrates including the crude fibre (on dry basis) was estimated by subtracting percent (dry basis) crude fat, crude protein and ash content from 100. All the estimations were done in triplicates.

RESULTS AND DISCUSSION
Amylose content:
The amylose content (Table 2) in brown and polished rice of twenty one colored rice varieties of Assam ranged from 0.2-20.98% and 2.6-21.18%, respectively. The increase in amylose content in polished form of rice than brown form might be due to percent increase for removal of bran. The amylose content of rice is one of the most important criteria determining rice quality in terms of cooking and pasting properties [15]. According to International Rice Research Institute (IRRI) rice classification system [16], most of the studied varieties were categorized into very low (2-9%) and low amylose (10-20%) containing varieties. Cooked rice becomes moist and sticky due to low amylose content. The sticky rice is most preferred in North Eastern region of India. Among the varieties studied, only one variety *i.e.* "Rongasokua" was classified as intermediate amylose containing rice (20–25%). Intermediate amylose containing rice becomes dry and fluffy, while cooked and retains its soft texture upon cooling [17]. It has been reported [18] that most of the indigenous rice cultivars of North Eastern hills of India have lower amylose content (2.27% to 24.5%), which is in agreement with the results of our present study.

The total carbohydrates, including the crude fibre (Table 3) in brown rice was found to be in the range of 80.62% ('Jul Bao') to 90.80% ('Burali'). In polished rice, it varied from 86.86% ('Rangali') to 95.03% ('Ranga Dariya').

The crude fat in brown rice were significantly different among the varieties with a range of 1.95-3.83%, the highest and the lowest value being observed in 'Hurupi Bao' and 'Burali', respectively. Similarly, in case of polished rice also, crude fat varied from 1.11 ('Biroi') to 3.25% ('Jul Bao'). There was decrease of crude fat content in polished rice after removal of aleuron layer in rice seed. The higher fat content (1.9 to 2.4%) in traditional red rice varieties than common cultivars was already reported [19]. The crude fat content of present study were found to be similar to those reported earlier [20], in which the total fat was observed from 1.2 to 4.2% with the mean of 2.49% for 14 varieties of Manipur and Nagaland, India. The fat content influences the taste of cooked rice [21].

Protein influences the nutritional quality of rice. In this study, the crude protein content of brown rice was appreciably high which ranged from 5.43-13.83%. Brown form of "Jul Bao", "Negheri Bao", "Bangalami" and "Rangali" showed the higher protein values, and thus these are important from nutritional point of view. These cultivars are classified as high protein cultivars of rice, with 10% or more total crude protein following the classification of Resurrection *et al.*, 1979 [22]. The crude protein content of varieties selected for present study were found to be similar to those reported [23] earlier for traditional pigmented rice varieties (6.15 to 10.10%). Indigenous cultivars of the North Eastern hill states of India possess high protein content with a range of 6.14 to 12.07% [18, 24]. The protein content influences the texture of cooked rice, as high protein content reduces stickiness after cooking [25]. After polishing, there was decrease in crude protein content of most of the varieties which was observed to be in the range of 3.33 in 'Ranga Dariya' to 9.80 % in 'Rangali'. However, the increase in protein content of a few varieties after polishing might be due to increase in percent content after removal of bran and aleuron layer.

The ash content of a sample gives an idea of the mineral elements present in the sample. The values for ash content of brown rice ranged from 0.73- 1.85 % , "Jul Bao" with the highest ash content and "Betu" with the least value. In the present study, the ash content ranged from 0.44 ('Ranga Dariya') to 1.51% ('Amana Bao') in polished rice. The ash content were reported to be in the range of 1.42 to 1.61% for brown rice and 0.48 to 0.67% for white rice, respectively [15, 26, 27, 28].

The difference in proximate composition among rice varieties might be due to difference in the genetic architecture of rice varieties and also in soil status of different regions from where these were collected.

Table 1: The indigenous colored rice varieties with their cultivation pattern and place of cultivation

Sl No	Name of varieties	Place of collection (District of Assam)	Cultivation pattern/ season
1	Amana Bao	North Lakhimpur	Deep water
2	Ixojoy	North Lakhimpur	Autumn
3	Kolaguni	North Lakhimpur	Autumn
4	Bogaguni	North Lakhimpur	Autumn
5	Kopouguni	North Lakhimpur	Autumn
6	Hurupi Bao	North Lakhimpur	Deep water
7	Kotia Bao	North Lakhimpur	Deep water
8	Dal Bao	North Lakhimpur	Deep water
9	Biroi	North Lakhimpur	Winter
10	Kenkua Bao	North Lakhimpur	Deep water
11	Kenkua Bora	North Lakhimpur	Autumn
12	Ronga Dariya	North Lakhimpur	Autumn
13	Betu	Majuli	Autumn
14	Negheri Bao	North Lakhimpur	Deep water
15	Burali	North Lakhimpur	Autumn
16	Jul Bao	North Lakhimpur	Deep water
17	Ronga Chokua	North Lakhimpur	Autumn
18	Bangalami	RARS, Karimganj	Spring/ summer
19	Rangali	RARS, Karimganj	Autumn
20	Balighoogur	RARS, Karimganj	Autumn
21	Joria	RARS, Karimganj	Autumn

Table 2: Amylose content of coloured rice varieties of Assam, India

Samples	Amylose content (%, dry basis)		Class assigned
	Brown Rice	Polished rice	
Jul Bao	8.85	9.55	**Very low**
Dal Bao	11.78	12.98	**low**
Kotia Bao	6.28	2.60	**Very low**
Bogaguni	11.77	6.97	**low**
Kolaguni	2.74	11.37	**low**
Hurupi Bao	5.74	13.36	**low**
Burali	10.48	14.10	**low**
Biroi	9.92	13.15	**low**
Kenkua bora	2.21	2.58	**Very low**
RangaDariya	0.66	4.68	**Very low**
Betu	1.07	4.21	**Very low**
Negheri Bao	4.61	10.17	**low**
Kenkua Bao	2.22	16.42	**low**
Kopouguni	1.57	4.04	**Very low**
Rongasokua	20.98	21.18	**intermediate**
Amana Bao	12.29	12.36	**low**
Ixojoy	12.33	12.49	**low**
Balighoogur	9.15	8.29	**Very low**
Bangalami	1.09	8.75	**Very low**
Joria	0.20	6.11	**Very low**
Rangali	8.18	9.73	**Very low**

Table 3. Proximate composition (on dry weight basis) of colored rice varieties of Assam

Sl No	Name of variety	Form	Total Carbohydrates (%)	Crude Fat (%)	Crude protein (%)	Ash (%)
1	Jul Bao	Brown rice	80.62	3.70	13.83	1.85
		Polished rice	88.15	3.25	7.35	1.25
2	Dal Bao	Brown rice	88.09	3.10	7.54	1.27
		Polished rice	89.76	1.40	8.18	0.66
3	KotiaBao	Brown rice	88.10	3.05	7.35	1.50
		Polished rice	89.57	1.70	8.15	0.58
4	Bogaguni	Brown rice	89.01	2.80	6.83	1.36
		Polished rice	90.12	1.95	6.48	1.45
5	Kolaguni	Brown rice	87.52	2.80	8.23	1.45
		Polished rice	89.06	2.10	7.62	1.22
6	Hurupi Bao	Brown rice	87.96	3.83	6.91	1.30
		Polished rice	89.06	2.23	7.56	0.70
7	Burali	Brown rice	90.80	1.95	5.95	1.30
		Polished rice	91.67	1.80	5.95	0.58
8	Biroi	Brown rice	87.37	3.6	7.81	1.22
		Polished rice	88.55	1.11	9.60	0.74
9	Kenkua bora	Brown rice	88.85	2.30	7.52	1.33
		Polished rice	89.19	2.30	7.28	1.23
10	RangaDariya	Brown rice	90.41	2.70	5.43	1.46
		Polished rice	95.03	1.2	3.33	0.44
11	Betu	Brown rice	90.48	2.77	6.02	0.73
		Polished rice	92.44	1.40	5.60	0.56
12	Negheri Bao	Brown rice	85.13	3.10	10.03	1.74
		Polished rice	87.85	1.55	9.35	1.25
13	Kenkua Bao	Brown rice	87.54	2.18	8.97	1.31
		Polished rice	89.65	1.12	8.65	0.58
14	Kopouguni	Brown rice	87.37	2.90	8.23	1.50
		Polished rice	88.52	1.80	8.23	1.45
15	Rongasokua	Brown rice	88.45	3.20	7.00	1.35
		Polished rice	91.77	1.70	5.78	0.75
16	Amana Bao	Brown rice	88.53	3.60	6.44	1.43
		Polished rice	89.24	2.20	7.05	1.51
17	Ixojoy	Brown rice	86.11	2.70	9.88	1.31
		Polished rice	89.78	1.67	7.92	0.63
18	Balighoogur	Brown rice	86.55	2.48	9.61	1.36
		Polished rice	89.09	1.67	8.12	1.02
19	Bangalami	Brown rice	83.11	2.49	13.62	0.78
		Polished rice	88.66	1.88	8.35	1.11
20	Joria	Brown rice	89.98	2.65	5.95	1.42
		Polished rice	93.18	1.74	3.91	1.17
21	Rangali	Brown rice	84.68	2.43	11.41	1.48
		Polished rice	86.86	1.98	9.80	1.36
	CD $_{0.05}$		3.34	3.33	3.54	0.59

CONCLUSION
All the presently studied varieties are red colored and have been categorized into very low, low and intermediate amylose containing varieties. The varieties 'Jul Bao', 'Negheri Bao', 'Bangalami' and 'Rangali' possessed significantly higher content of protein. Among the varieties, the brown form of 'Jul bao' was found to contain the highest amount of crude protein and ash. Further study is required for cooking quality and phytochemical composition analysis of these cultivars.

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