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Changes of Dry Matter Content and Nutrients in Developing Rice Grain

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Abstract: The study was conducted to find the rate of accumulation of dry matter, protein, amylose and total amino acid in developing grain in boro season of 1997. Moisture content in paddy varied from 24.0 –57.0% in Hbj IV and 24.0 – 61.0% in BR3. At 4 DAF, HbjIV and BR3 had 5.4 and 4.4 mg/paddy dry matter respectively and the accumulated dry matter in paddy was 22.5 and 29.3 mg respectively in HbjIV and BR3 after 20 DAF. Moisture content was higher in brown rice than paddy during grain development. Accumulated dry matter in brown rice varied from3.1-16.7 mg in Hbj IV and 1.3 –22.7 mg in BR3. Amylose content accumulation rate in brown rice was slower in BR3 compared to Hbj IV during first 8 days. Total protein and total free amino acid in grains of brown rice increased up to 16 DAF in the tested varieties.

Key words: BR3, HbjIV, dry matter, protein, amylose

Introduction

Grain filling periods influences dry matter accumulation and the physicochemical and cooking properties of rice (Biswas and Choudhury, 1984). Protein is the second highest component in rice. It varies from 4.3 to 18.2% in brown rice (Gomez, 1979). Brown rice is the deulled rice containing bran and endosperm. Brown rice of different panicles in same hill may differ in protein content particularly when a high rate of nitrogen fertilizer is applied (Gomez and De Datta, 1975). The protein content in matured rice grain is consistently high in some varieties compared to some other varieties (Juliano *et al*., 1968). This difference in grain protein content may be due to difference in rate of protein accumulation in grain rather than difference in soil nitrogen absorption (Perez *et al*., 1973). There is need to develop a variety with shorter grain filling period, high dry matter and high protein. Therefore, a study was undertaken to find the changes in dry matter, protein content, total amino acid and amylose content in developing rice grain.

Materials and Methods

Two rice varieties-BR3 and Hbj IV were grown in a 22.0 m x 5.0m plot during Boro season, 1997 at Bangladesh Rice Research Institute farm. BR3 and HbjIV were long and short duration varieties respectively. Fertilizer was applied @ 80-60-40 kg per hector NPK as urea, TSP and MP respectively. All phosphate and potash fertilizers and one-third of nitrogen fertilizer were applied on the day of final land preparation. Forty five day old seedlings were transplanted in 20x20 cm spacing. The rest of the nitrogen fertilizers were equally divided into two and were top dressed at the maximum tillering and at panicle initiation stages. When the panicles in a hill started emerging, spikelets were examined daily and panicles were tagged individually when completed flowering. The paddy samples were harvested starting from 4 to 20 days after flowering (DAF) at a 4-day intervals. After harvest, paddy samples were kept in a polyethylene bag on ice to minimize moisture loss. Duplicate sample (100 g) was harvested and collected for each treatment. The bulk of the sample was sun dried to 14% moisture content. One half of the bulk sample was dehulled to brown rice.

Moisture content (%): Four gram paddy samples were immediately dehulled by hand after harvest, keeping them on polyethylene paper which was placed on ice block. Two gram each of paddy and brown rice was weighed and placed onto a glass petridish in duplicate and dried in an oven at 105°C for 48 hours. Moisture content was determined by subtracting final weight of grain from initial weight and dividing by initial weight and multiplied by 100.

Grain weight: Thousand paddy and thousand brown rice weight was determined and was expressed in gram. Weight of a single grain was estimated by dividing weight of 1000 grains by 1000.

Protein content: Nitrogen content of the samples was determined following micro Kjeldahl method and multiplying it by 5.95 to get protein content.

Amylose content: Amylose content was estimated by simplified assay procedure of Juliano (1971).

Total free amino acid content: Total free amino acid content was determined following procedure of Cruz *et al.*, 1970.

All the analysis were done in duplicate and mean values were cited.

Result and Discussion

Moisture content: Moisture content was high at 4DAF in both paddy and brown rice (Table 1). HbjIV and BR3 paddy had 57 and 61% moisture content respectively. There was progressive drop of moisture content from 57% at 4DAF to 35% at 16 DAF in HbjIV and from 61% at 4DAF to 34% in BR3 paddy at 12 DAF. At 20 DAF, the moisture content was similar in both the varieties. By contrast, the moisture content in brown rice decreased from 71% at 4 DAF to 24% at 20 DAF in HbjIV and that from 81% at 4 DAF to 23% at 20 DAF in BR3 (Table 1). There was around 20% moisture content difference between paddy and brown rice at 4 DAF but it narrowed at 12 DAF. Rosario *et al.* (1968) and Matsushita (1959) reported similar grain moisture content for IR8 and a Japanese rice variety, respectively.

Table 1: Moisture content (%) of paddy and brown rice at different stages of development

	HBJ IV		BR3	
DAF	Paddy	Brown rice	Paddy	Brown rice
4	57.0	71.0	61.0	81.0
8	14.0	45.0	55.0	58.0
12	35.0	30.0	34.0	33.0
16	27.0	25.0	30.0	29.0
20	24.0	24.0	24.0	23.0

Table 2: Dry matter accumulation (mg grain^{-1} sample) at different stages of development

	Hbj IV		BR3	
DAF	Paddy	Brown rice	Paddy	Brown rice
4	5.4	3.1	4.4	1.3
8	14.6	9.0	14.7	8.5
12	20.6	15.0	25.7	19.0
16	21.8	16.2	28.5	21.7
20	22.5	16.7	29.3	22.7

Grain weight: The changes in dry matter content of paddy and brown rice in BR3 and HbjIV varieties are shown in Table 2. The dry matter increased progressively during grain development. At 4 DAF, BR3 and HbjIV had 4.4 and 5.4 mg paddy^{-1} dry matter respectively and increased rapidly up to 8 DAF in HbjIV and 12 DAF in BR3. At 20 DAF, dry matter content was 22.4 mg paddy^{-1} in paddy of HbjIV and 29.3 mg paddy^{-1} in paddy of BR3. At 20DAF, BR3 had 31% higher paddy weight than that of HbjIV. Paddy weight of matured BR3 and HbjIV, found in the study was also similar to the weights reported by BRRI (1990). By contrast, dry matter content of brown rice was 3.1 mg in HbjIV and 1.3 mg in BR3 per grain of brown rice at 4 DAF. The dry matter content increased progressively up to 12 DAF in HbjIV and 16 DAF in BR3 and continued slowly up to 20 DAF. Biswas and Choudhury (1984) observed that dry matter accumulation increased very little beyond 20 DAF. On calculation, it was observed that maturity of hull was completed within 8DAF in HbjIV and 12DF in BR3. The increase in grain weight was more rapid in Hbj IV and completed earlier than BR3 probably for its shorter growth duration. On the contrary, BR3 was a long duration variety. Rosario *et al.* (1968) and Matsushita (1959) reported similar grain weight for IR8 and a Japanese variety, respectively.

Protein content: The protein accumulation in paddy and brown rice is shown in Table 3. The protein content increased most rapidly from 4 DAF to 16 DAF in HbjIV and to 12 DAF in BR3 during grain development. Then it almost leveled off. HbjIV paddy had 0.47 mg at 4 DAF and rapidly increased to 1.41 mg per grain of paddy at 12 DAF. Similarly BR3 paddy had 0.19 mg at 4 DAF and increased rapidly up to 12 DAF and slowly increased there after. Protein in brown rice also increased from 0.66 mg at 4 DAF to 1.79 mg at 20 DAF in HbjIV and 0.19 mg at 4 DAF to 1.75 mg at 20 DAF in BR3. Protein content progressively increased up to 12 DAF. Dry matter accumulation was at a faster rate at 4 DAF to 12 DAF in BR3. Percent protein in HbjIV brown rice decreased from 12.3% at 4 DAF to 9.6% at 20 DAF. Palmiano *et al.* (1968) and Cruz *et al.* (1970) also observed the same trend for protein accumulation in rice.

Amylose content: Amylose content in brown rice was 32.3% in HbjIV and only 23.1% in BR3 brown rice at 4 DAF (Table 4). The content decreased to 20.0% in HbjIV and 7.1% in Br3 at 8DAF and then started to increase progressively. The content increased slowly to 25.1% at 20 DAF in HbjIV. On the other hand, in BR3 brown rice, amylose content increased to 25.6% at 20 DAF. Amylose accumulation was higher in BR3 in percent. On the contrary, absolute amylose content per grain increased from 1.0 to 4.2 mg in HbjIV and from 0.03-5.8 mg in BR3 during 4-20 DAF.

Total amino acid: The total amino acid in rice was high at 4 DAF. Hbj IV had 2.51 μg and BR3 had 4.1 μg grain^{-1} brown rice (Table 5). Accumulation of total amino acids decreased gradually with increasing grain filling period. At 20 DAF, amino acid accumulation was 1.14 μg for HbjIV and 1.36 μg for BR3. Accumulation rate was higher for BR3 compared to HbjIV. At 4DAF, there was low rate of accumulation of non-protein components. After, 4DAF, non-protein components in the grain mainly, starch started to accumulate at a faster rate and protein and amino acids remaining almost steady. Consequently, percentage of protein, total amino acids and amylose showed decreasing trend.

Table 3: Protein accumulation in paddy and brown rice at different stages of development

	HBJ IV			BR3		
DAF	Paddy mg paddy^{-1}	%	Brown rice mg brown^{-1} rice	Paddy mg paddy^{-1}	%	Brown rice mg brown^{-1} rice
4	0.47	21.3	0.66	0.19	23.0	0.3
8	1.06	12.0	1.38	0.76	12.0	1.02
12	1.41	10.6	1.60	1.70	9.1	1.73
16	1.48	10.9	1.77	1.73	8.0	1.74
20	1.49	10.7	1.79	1.75	7.8	1.76

Table 4: Amylose content in brown rice at different stages of development

	Hbj IV		BR3	
DAF	%	mg brown^{-1} rice	%	mg brown^{-1} rice
4	32.3	1.0	23.08	0.03
8	20.0	1.8	7.1	0.6
12	20.6	3.1	18.9	3.6
16	25.9	4.2	21.0	4.6
20	25.1	4.2	25.6	5.8

Table 5: Total amino acids accumulation (μg grain^{-1} of brown rice) at different stages of development

DAF	HBJ IV (μg brown^{-1} rice)	BR3 (μg brown^{-1} rice)
4	2.51	4.21
8	4.12	6.70
12	1.54	2.65
16	1.47	2.00
20	1.14	1.36

The study showed that Dry matter and amylose content accumulation was completed by 20 DAF. Protein and total amino acid accumulation was completed within first 8-12 days of flowering depending on the growth period.

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