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Biochemical Investigation for Quality of Some Selected Rice Cultivars Produced in Piedmont Plain Soils

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Abstract: *A field experiment was conducted in October 2011- July 2012 to assess the biochemical characteristics to screen out the yielding potentiality and grain quality of some rice cultivars Bashful (V_1), Posursail(V_2), Gochi(V_3), Taipi(V_4), Paiza(V_5), Lafaya(V_6), Jirashail(V_7), BRRIdhan 28(V_8) and Banglamoti(V_9). Chlorophylls were determined from leaves and protein, starch contents were determined from the grains from the nine rice cultivars. The study showed that the total leaf chlorophyll, chlorophyll 'a', chlorophyll 'b', and total carotenoid content amongst the nine cultivars were variable. At 50 DAT Total chlorophyll, chlorophyll 'a', chlorophyll 'b' and carotenoid were significantly different amongst nine cultivars. Higher content of chlorophyll 'a' indicated better capability for photosynthetic rate of a cultivar (s) resulted in higher yield potentiality. The V_8 cultivars contained the highest total chlorophyll while the V_9 contained the lowest, similarly V_8 produced higher total chlorophyll and at 35 DAG. The V_1 obtained highest total chlorophyll whereas V_2 performed 2^nd^ highest total chlorophyll. Highest chlorophyll 'a' obtained from V_8 and V_2 at 50 DAT. The V7 and V2 produced higher amount of chlorophyll 'a' at 25 DAT. On the other hand V1 and V2 performed higher quantity of chlorophyll'a' at 35 DAG. Highest amount of Chlorophyll 'b' was obtained from V_7, V_8 and V_2 at 50 DAT, 25 DAT and 35 DAG respectively. V_4, V_3 and V_5 had the higher quantity of carotenoid at 50 DAT, 25 DAT and 35 DAG. Poshurshail from Hobigonj, Pariza and Jirashail, which were tolerant or moderately tolerant, to low temperature. Lafaya and BRRIdhan 28 performed very poorly at low temperature. Varieties from Hobigonj (Poshurshail) and Joypurhat(Pariza) showed consistent tolerance to low temperature at all growth stages. These varieties are potentially important gene donors for breeding and genetic studies. So the breeders can consider these cultivars during their varietals improvement. V_2, V_4 and V_6 was found having lowest starch and V_1, V_5, V_6 and V_2 found higher quantity of protein which is very important finding for selecting the variety for quality. The study summarized that, no a single cultivars was found which containing all the characters of yielding potentials and assured grains quality. Considering all the parameters, the V_2 is considered the potential local rice cultivar among the test for growing at the study area in boro(Winter) season.*

Key Words: *Biochemical, Local Variety, Characters, Breeding, Genetic etc.*

I. Introduction

Rice is an ancient food grain and has been used as food by human being for over 10000 years and has fed a great number of people for a longer period than any other crop. Rice is the staple food for more than half of the world population and grows in more than 100 countries (FAO, 2000). Among the leading rice growing countries of the world, Bangladesh ranked fourth in both rice area and production (IRRI, 1995). Rice production in Bangladesh was less than 10 million tons in 1970 and then exceeded 30 million tons in 2011 (BBS, 2011 and DAE, 2011). It is central to Bangladesh's economy and agriculture. Rice accounted for nearly 18% of the national GDP and provided about 70% of an average citizen's total calorie intake (BRRI, 2010). Rice area totaled about 10 million ha, and accounted for 75% of the total cropped area and 93% of total area under cereals (DAE, 2010 and BBS, 2010). Rice was the staple food for half the people of the world. About 90% of the world's rice was grown and consumed in Asia (FAO, 1998). From time immemorial, Bangladesh had been a cradle of rice culture. Rice is grown in three overlapping seasons with a large number of varieties that suited various agro-ecological and climatic nitches. Due to increases in population, average farm size had declined from 1.43 ha in 1961 to 0.87 ha in 2008 (DAE, 2009). The average rice yield remained low at about 2.7 t ha^{-1}. Although substantive, rice production growth was achieved during the 1976-93 period, the growth since then had been negligible. This was mainly due to continued drought, serious cold in most North-east and North-west areas in Bangladesh and excessive monsoon flooding in some parts of the country. Future growth in rice production would likely come from expansion of irrigated areas, use of new high-yielding varieties, introducing new varieties and higher amounts of fertilizer inputs, and improved crop management practices.

Quality of rice grain is another important factor for popularization to consumer. Because of its low sodium content, a rice diet is also commonly prescribed to patients suffering from hypertension (high blood pressure) (FAO, 2000). Moreover, improvements in grain quality that do not lower yields will generally benefit all rice consumers by lowering the cost of better-quality rice (Unnevehr et al., 1985). Rice research on the basis of soil and soil environmental aspects which in the past had as its primary objective increasing yields and land productivity, to preserve the scarce land resources of Bangladesh. Now it is urgently need to screen out the better performer local land races on the basis of their physiological and biochemical characteristics and give a fruitful suggestion to the rice researchers, academicians, planners and others to meet up the additional quantity of food in the country.

Dutta et al., (1998) and Dutta et al., (2002) characterized a lot of local rice cultivar both on morphology and their physico-chemical quality and pointed out some physiological and biochemical limitations which should be considered for the improvement of those cultivars. Sharma and Haloi (2001) characterized some local scented rice of Assam on the basis of their physiological and assimilate partitioning behavior. They pointed out the improvement of partitioning efficiency as one of the best criteria for improvement of scented rice. Dutta et al., (1997) also revealed some physiological limitations of modern indica-japonica type of rice and suggested improvement over IRRI scientist's proposed new model for rice improvement (That and Tran, 1989).

There very little attempts have been made to characterize the local cultivars as to their genetic, physiological and biochemical expressions and limitations. This experiment was undertaken with a view to assess the biochemical characteristics and adaptability in North-west Bangladesh using nine rice cultivars. The main objectives of this investigation were to assess the cultivars in regarding of their biochemical characteristics to screen out the yielding potentiality and grain quality.

II. Materials And Methods

A field experiment was conducted at the Agricultural chemistry farm, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period from October 2011 to July 2012. The materials used and methodologies followed in the study. The experimental site is located between 25.13º N latitude and 88.23º E longitude and at an elevation of 37.5 m above the mean sea level. The land belongs to the Himalayan Piedmont Plain, Agro-ecological Zone (AEZ-1) (UNDP and FAO, 1988). The experimental field is a medium high land having sandy loam soil with pH 5.60. The experimental area possesses sub-tropical climate usually no or less the rainfall during Rabi season). The air temperature was low-moderately low during the rabi season and increases as the season proceeds towards kharif season with occasional gusty winds. Seeds of nine selected rice varieties were used in the study. Seven varieties were local and rest tow of them were HYV varieties. The varieties were 1. Bashful 2. Pashursail (Hobigonj-6) , 3. Gochi 4. Taipi 5. Pariza 6. Lafayaa 7. Jirashail 8. BRRI dhan-28. and 9. Banglamoti. The experiment was laid out in Randomized Complete Block Design (RCBD). The 40 days old seedlings were transplanted in the experimental plots. Intercultural operations such as weeding by hand picking and applications of pesticides by hand sprayer at the vegetative growth stages were done as and when necessary. Fertilization were done as per recommendation. Data collections of the following parameters from the experiment on different growth stages were done: Leaves from nine cultivars for determination of leaf chlorophyll. ii. Grains for determination of protein and starch etc. To determine the leaf chlorophyll contents, plants leaves samples were collected at 35 DAG (days after germination) from the seed bed, 25 DAT and 50 DAT (days after transplanting) from main field. After harvesting, grains were collected to determine starch and proteins.

Procedure for Chlorophyll estimation from plant leaves sample

Determination of Chlorophyll Pigments from Rice Leaves followed by (Lichtenthaler and Wellburn, 1983).

Determination of Starch in Rice (Leaves and grains): Chemical/ Reagents Required: i) Ethanol (80%), ii) Copper sulfate, iii) Sodium potassium tartarate, iv) HCl acid, v) Na_2CO_3, vi) Glucose (standard), vii) Methylene blue indicator viii) Litmus paper

Working Procedure:

i). 5.0 g ground sample were taken in a Petridis. ii). The samples were oven dried in oven dry at 60^0c for 72/48 hrs. iii). Dried samples were taken in desiccators. iv). Measure was cut. v). Moisture % was calculated. vi) 1.0 gm samples were taken in a conical flask. vii) About 40 ml 70-80% alcohol was added. viii). Then the samples were put over night with alumina foil. ix). The tube was vortexed for 30 minutes. x) The mixture was Filtrated with filter paper (whatman no- 40). xi). The residue with filter paper were dried at 60^0c over 72/48 hrs. xii). Residue was picket up and weight. xiii). Digested with 40 ml HCl (10% HCl) in digestion chamber about 6 hrs. xiv). Sample was cooled at room temperature. xv). The samples were neutralized with Na_2CO_3 and litmus paper. xvi). Titration was done with Fehling solution. xvii). The amount of glucose was calculated and the value of glucose multiplied with 0.9 = Amount of starch was calculated.

Protein content in rice grain: Firstly total N content in seed was determined by kjeldahl method. The seed samples (1.0 g) were digested with H_2SO_4, hydrogen peroxide and K_2SO_4-catalyst mixture. At 200^0C until clear solution was obtained. Nitrogen was estimated by distilling the digest with 10N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4 (Page et al., 1982).
Total nitrogen: Total N content in soil was determined by micro- Kjeldahl method. The soil was digested with 30% H_2O_2, conc. H_2SO_4 and catalyst mixture (K_2O_4: $CuSO_4$. $5H_2O$: Se = 10:1:0.1). Clean bluish extract indicated the completion of the digest. After digestion and cooling, the digests were diluted with distilled water and were quickly mixed with sodium hydroxide for distillation. The distilled ammonia was received in boric acid and mixed indicator solutions Bromocresol green and methyl red and was titrated against a standardized sulphuric acid until the end point appeared from green to pink colour according to the procedure mentioned by PCARR, (1980). The reactions involved were as follows:

I**. Digestion-**

$$\text{Organic matter (in soil)} + H_2SO_4 \xrightarrow[\text{Catalyst mixture}]{\text{Heat}} (NH_4)_2SO_4$$

II. Distillation- $(NH_4)_2SO_4 + NaOH \longrightarrow Na_2SO_4 + NH_3 + H_2O$

III. Titration - $(NH_4)_3BO_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + H_3BO_3$

Protein content of rice grain was determined by multiplying the total N content with 6.25. The obtained data on different parameters under the experiment0020were statistically analyzed to obtain the level of significance using MSTAT-C (Russel,1986), followed by LSD and by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984)

III. Results And Discussion

The data presented in this study provided unique information of leaf chlorophyll, and starch content, protein content in grains of nine varieties. A detail discussion on the results presented in this chapter along with statistical analysis of data had been made under the following heads.

Leaf chlorophyll content is one of the important physiological traits closely related to photosynthetic ability in rice (Teng et al., 2007). The result showed that chlorophyll a, chlorophyll b, total carotenoid and total chlorophyll content were variable among the nine genotypes during the experiment (Table-1).
Total chlorophyll content: Table-1 showed that the highest total chlorophyll content (3.49 mg g^{-1}) was produced by V1 (Bashful local cultivars at 35 DAG, cultivated in AEZ-1 soil, while at 25 DAT, the highest total chlorophyll was obtained from V8 cultivar and at 50 DAT, the highest total chlorophyll obtained from V8 cultivars (Table -1). The lowest total chlorophyll content was 1.68 mg g^{-1} recorded from V6 at 35 DAG and 50.99 mg g^{-1} in V5 at 25 DAT while at 50 DAT lowest total chlorophyll was determined from V3 cultivars. (Figure-1)

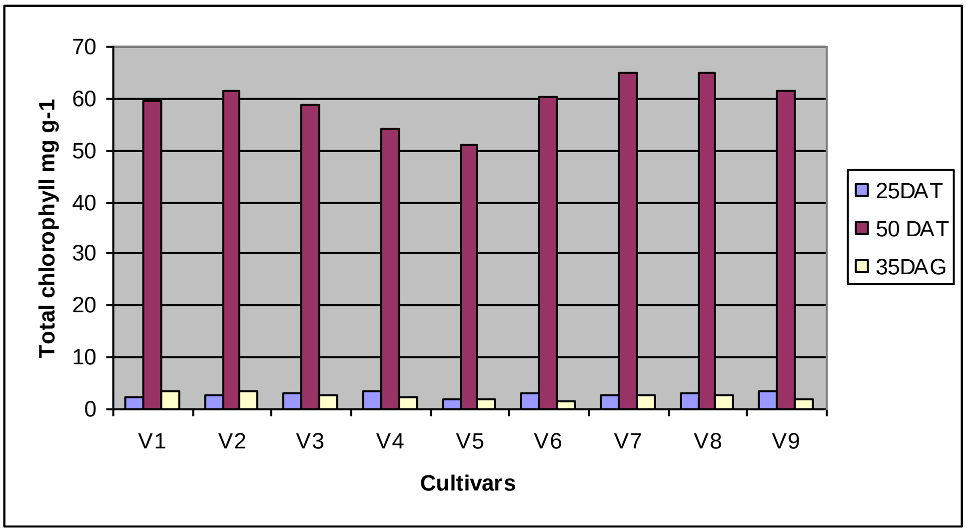

Figure-1: Total chlorophyll content in some selected rice cultivars

Chlorophyll 'a' Content: **C**hlorophyll 'a' is a vital component for the survival of plants as well as the yield of crops. So the higher content of chlorophyll 'a 'indicated that the cultivar may perform better as their physiological growth and may give higher yield. Table-1 and Figure-2 showed that at 35 DAG the highest chlorophyll 'a' content was obtained in V1 (Bashful) local Haor cultivars (1.65 mg g^{-1}) and the lowest was 0.74 mg g^{-1} in V5 cultivar.

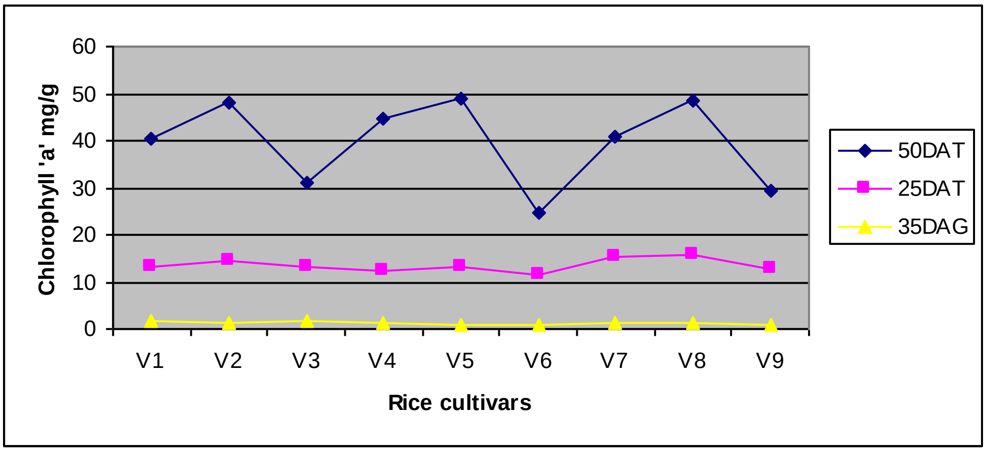

Figure- 2: Chlorophyll 'a' content of some selected rice cultivars

On the other hand, Figure-4.3 showed that V2, V7 and V8 obtained higher amount of chlorophyll ‘a’ and V6 contained lower quantity of chlorophyll ‘a’ at 25 DAT. In 50 DAT, V2, V5 and V8 produced higher chlorophyll content while V6 and V3 contained lower amount of chlorophyll ‘a’. The different cultivars synthesised chlorophyll content differently and was found significantly variable at 1% level of probability (Table-1).

Chlorophyll ‘b’ content**:** The highest chlorophyll ‘b’ was obtained in V1 and V2 (Bashful and Poshursyle) cultivars (1.42 mg $g^{-1}$and 1.40 mg g^{-1}) at 35 DAG and the lowest was in V6 (0.44 mg g^{-1} land races (Table-1). The synthesis of chlorophyll b ranges from 28.36 mg g^{-1} (V8) to 19.37 mg g^{-1} (V4) at 25 DAT and ranges from 32.15 mg g^{-1} to 18.54 mg g^{-1} at 50 DAT (Table-1) respectively. The table4.2 showed that V1, V2, V5 and V8 cultivars produced higher amount of chlorophyll 'b' while V3, V4 and V6 lower quantity of chlorophyll 'b' in their leaves at 50 DAT. The difference in chlb content in different cultivars was attributed. The chlorophyll ‘b’ content was significantly varied by different cultivars (Table-1).

Total Carotenoid Content: At 35DAG, highest carotenoid was obtained in V5 (0.65 mg g^{-1}) and followed by V9, V4, V2, V7, V8, V3, V6 AND V1 respectively, while 25DAT highest carotenoid was determined in V6 and lowest amount was found in V5. Again higher quantity of carotenoid yield was obtained from V4 and V6 at 50 DAT, while lowest was found in V1 and V5 cultivars (Figure-3).

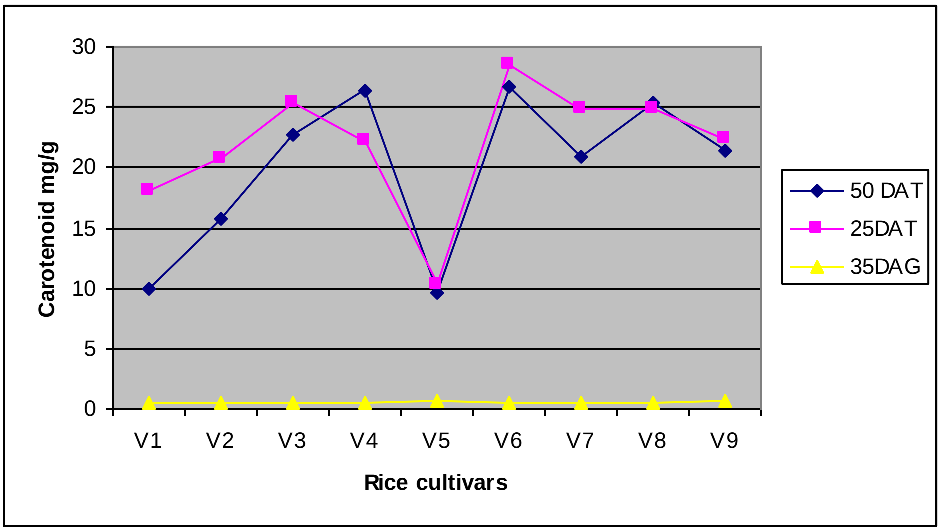

Figure-3: Carotenoid content of some selected rice cultivars

The carotenoid content was significantly different in tested cultivars (Table-1). The lesser carotenoid has the higher ability to solve energy to plants. Leaf Chlorophyll content across different developmental stages of rice has significant implications for improving photosynthetic ability in rice.

Chlorophyll content in leaves is one of the major components in photosynthesis. Chlorophyll’a’ content showed a significant variation for different cultivars (Table-1).

Table-1: Chlorophyll Content in Some Selected Rice Cultivars (mg/g)

Age	50 DAT				25DAT				35DAG			
Variety	Chla	Chlb	Carotenoid	Total chlo	Chla	Chlb	Carotenoid	Total chlo	Chl_a	Chl_b	Carotenoid	Total
V1	40.42	23.61	10.02	74.05	13.15	28.14	18.12	59.41	1.65	1.42	0.42	3.49
V2	48.08	21.5	15.71	85.29	14.61	26.34	20.71	61.66	1.47	1.4	0.53	3.4
V3	31.08	18.54	22.72	72.34	13.16	20.37	25.42	58.95	1.59	0.64	0.49	2.72
V4	44.78	24.85	26.28	95.91	12.54	19.37	22.28	54.19	1.4	0.53	0.58	2.51
V5	48.87	32.15	9.66	90.68	13.32	27.43	10.24	50.99	0.74	0.62	0.65	2.01
V6	24.68	23.92	26.61	75.21	11.36	20.37	28.54	60.27	0.85	0.44	0.45	1.68
V7	40.67	25.12	20.88	86.67	15.52	24.41	24.86	64.79	1.41	0.84	0.51	2.76
V8	48.61	29.46	25.33	103.4	11.79	28.36	24.82	68.97	1.4	0.86	0.5	2.76
V9	29.37	19.39	21.46	70.22	12.74	26.16	22.45	61.35	0.91	0.54	0.61	2.06
LSD	4.88	3.76	5.32	7.37	2.36	5.56	2.44	5.61	0.226	0.075	0-75	0.21
CV%	5.37	8.33	10.33	3.74	7.54	10.55	8.55	3.95	7.57	4.70	3.49	3.55
SE	1.18	1.11	0.12	1.78	0.57	0.52	1.15	1.36	0.031	0.12	0.06	0.03

DAT= Days after transplanting
DAG= Days after germination

Chlorophyll'b' content also showed significantly differences while compared amongst them at 35 DAG. 25 DAT and 50 DAT (Table-1). Genotypic differences (P<0.01) were observed among the rice varieties for leaf chlorophyll contents in across the location.

The statistical result also showed significant differences of Total carotenoid amongst nine cultivars. At the transplanted field, V7, V2, V5 and V3 had the highest values for chlorophyll "a" contents throughout the sampling periods at 25 DAT, whereas in V8, V7, V2 and V9 produced the highest values for leaf total chlorophyll contents. Again V8, V5, V4 and V7 content higher quantity of chlorophyll a and total chlorophyll at 50 DAT after planting. There were correlations between chlorophyll content and grain yield (r=0.54, n=9). The results of this study suggested that V2, V5, V7 and V8, had higher chlorophyll content. These varieties should be made available to farmer for planting in these locations. Also, this study indicates that V2, V5, V7 and V8 varieties with high chlorophyll contents will have high photosynthetic ability resulting in high grain yield.

Chlorophyll is one of the major chloroplast components for photosynthesis, and relative chlorophyll content has a positive relationship with photosynthetic rate. The decrease in chlorophyll content under drought and cold stress has been considered a typical symptom of oxidative stress and may be the result of pigment photo-oxidation and chlorophyll degradation. Photosynthetic pigments are important to plants mainly for harvesting light and production of reducing powers. Both the chlorophyll a and b are prone to soil dehydration (Farooq et al., 2009). Decreased or unchanged chlorophyll level during drought stress has been reported in many species, depending on the duration and severity of drought (Kpyoarissis et al., 1995; Zhang and Kirkham, 1996).

Starch and Protein Content:

The granule particle size, the amylose/amylopectin ratio, starch protein interaction, lipid complexes and the level of resistant starch etc indicate the quality of rice. Figure- 4 showed the high (>70.4%) starch content for all tested varieties. V3 (86.56%) was the highest performer while the lowest starch obtained from V6 cultivars (Figure-4). The V2 cultivars contained 71.03% starch and followed by V4, V9, V1, V5, V7 and V8, respectively. Low starch is inversely related with high value of protein, minerals etc.

The nutritional value depends on the total quantity and quality of protein. The result showed the highest and the lowest protein content was found in V1 and V7 cultivars, respectively. The protein content is higher with wider plant spacing, where more nitrogen is available to plants. It also increases with better water management and better weed control, probably because of higher efficiency in nitrogen utilization.

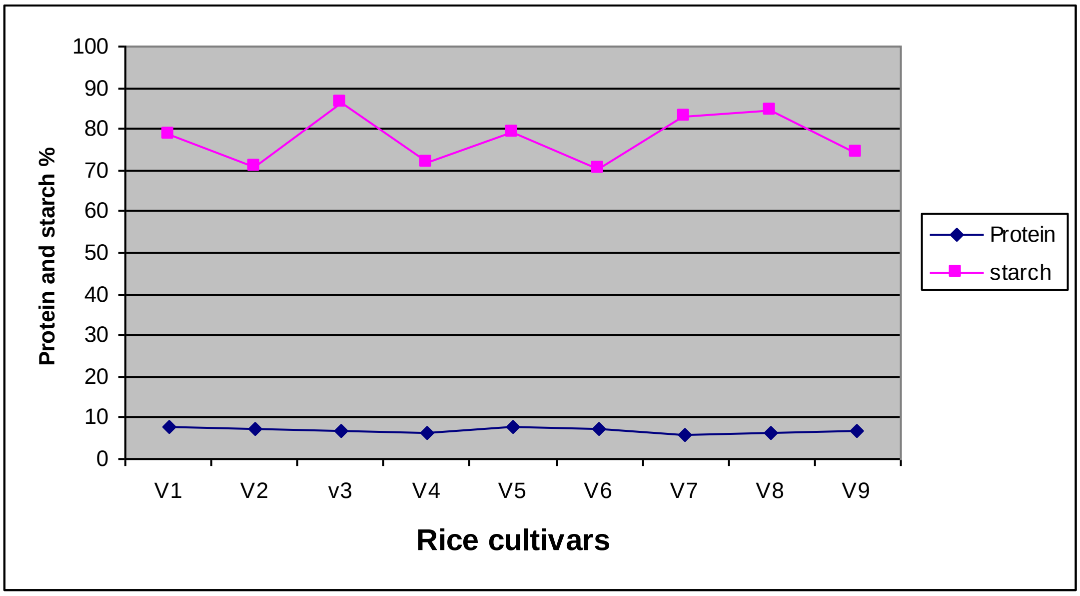

Figure-4: Protein and starch content in grains of some selected rice cultivars

Though the protein content between HYV and local varieties did not vary significantly (P>0.05), but V5 local land race was significantly different from other cultivars and contained higher amount of protein in their grains. The difference in protein content in different cultivars might be due to genetical attribution. The V1, V2, V3 and V6 were statistically similar regarding protein content. V4, V7 and V8 cultivars had lower amount which was statistically similar. V5 local variety the highest and V4 the lowest protein content were found in V5 (7.8%) and V4 (6.2%), respectively (Figure- 4). It (Figure- 4) showed negative relationship between starch and protein content amongst the nine cultivars. V3, V7 and V8 cultivars contained lower amount of protein and higher quantity of starch. On the other hand V2 and V6 found higher amount of protein and lower quantity of starch. High protein content in rice is related to the high dietary protein. But bioavailability of protein depends on its digestibility. The chemical composition of rice grain varies considerably depending on the genetic factor of the rice variety, and also on environmental conditions, such as location, season and fertilizer application, as well as on post-harvest operations, such as the degree of milling and conditions of storage. On average, however, milled rice grain contains about 80% starch, 7.5% protein, 0.5% ash and 12% water (FAO, 2000).

Many researches mentioned the variability of protein contents in different varieties of rice up to 15% (Sotelo et al., 1990; Lam-Sanchez et al., 1993; Kennedy and Burlingame, 2003) which verify the precision of the study that showed that protein content of tested rice varieties ranged from 5.98 to 7.75%, respectively.

IV. Conclusion

According to the present study and the data available from the literature, considerable local varieties are suitable for cultivation under low temperature ecosystems in Bangladesh. These varieties are potentially important gene donors for breeding and genetic studies. Because, they synthesized higher quantity of leaf chlorophyll during low temperature. Therefore, considering the yield potentiality and grain quality, Poshurshail local cultivar (V_2) from Hobigonj is suitable for cultivation in boro (Winter) season at the North-west piedmont soils of Bangladesh with modern agronomic practices.

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