DOI 10.5958/0976-1926.2017.00007.9

Comparisons of Major Biochemical Constituents and Mineral Composition in Six Cultivars of Aromatic Rice in Manipur

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(Received: 04 November 2015; Revised: 05 March 2016; Accepted: 25 May 2016)

Six aromatic rice varieties collected from the valley districts of Manipur were analyzed for their morpo-physiochemical and mineral composition of the grains. All aromatic rice varieties had protein contents in the range of 4.25 to 7.54%, soluble sugar from 7.5 to 10.27 mg/g and total phenolics in the range of 0.52 to 3.90 mg/g with the highest phenol content recorded in Ching Chakhao (3.9 mg/g). Starch was uniformly distributed to all the aromatic varieties ranging from 34.23 to 37.79%. Higher content of K (680.37), Ca (70.17), Mg (34.43), Mn (1.73) and Zn (4.37) was recorded in Chakhao while higher content in Cu and Fe was equally shared by Ching Chakhao and Chakhao Anganba. Among the varieties, Lamsang Chakhao recorded minimum amounts of K (408) while, Chakhao Amubi recorded least amounts in Ca (11.30), Mg (32.63) and Cu (0.57), Phumlou Chakhao in Mn (0.87) and Zn (0.57 mg/100 g). Trace amounts of Co were detected in all the aromatic varieties with the highest being observed in Lamsang Chakhao (0.43 mg/100 g).

Key Words: Aromatic rice, Biochemical constituents, Mineral composition, Physiochemical

Introduction

There are several types of rice around the world, which are categorized on the basis of color like white rice, brown rice, red rice, black rice etc. Rice can also be classified as aromatic and fine (non-aromatic) rice on the basis of aroma.

Generally, the price of the aromatic rice is three to four times higher than that of the non-aromatic or ordinary rice varieties in the state. Although, rice is a rich source of carbohydrate, it contains moderate amounts of protein, fat and B vitamins (Fresco, 2005). Rice carbohydrate is mainly starch which is composed of amylose and amylopectin. As rice being the staple food for more than three billion people in Asia (Bhattacharjee *et al*., 2002), understanding of the biochemical and mineral composition of the different varieties of rice becomes imperative for improve breeding programmes. Moreover, it is generally assumed that aromatic rice is a good source of different phytochemicals (Asaduzzaman *et al*., 2013). These components are most likely involved in the reduction of degenerative human diseases due to their antioxidative and free radical scavenging properties (Basu *et al*., 2012). In recent years, there has been a global trend toward the use of phytochemicals from natural resources such as vegetables, fruits, oilseeds and herbs, as antioxidants and functional ingredients. Therefore, natural antioxidants from plant extracts especially from rice would be of considerable importance due to their safety and easy availability. Based on the above information, a research experiment was conducted to compare the physiological, biochemical and mineral composition of six genotypes of aromatic rice available in the valley districts of Manipur.

Materials and Methods

The cultivars collected from the four valley districts were grown in the experimental field of the College of Agriculture. One hill of each genotype was transferred along with the field soil and raised in the plastic pots. First flowering, 50% flowering and 100% flowering were recorded. Plant height, number of tillers, number of panicles and panicle length were studied. Freshly harvested paddy samples in duplicate were manually dehulled and dried at 50ºC. While dehulling, it was attempted not to disturb the bran as far as possible. The grains were powdered and stored under reduced pressure until analysis. Crude protein was determined by estimating the total nitrogen (Kjeldahl method) in a Kel-Plus Supra-LX nitrogen auto analyzer following the procedure of Humphries (1956). Total soluble sugar was determined as per the method of Morris (1948).

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Starch and total phenols were estimated following the procedures of Hedge and Hofreiter (1962) and Bray and Thorp (1954). For evaluation of minerals, wet digestion method of Capar *et al*. (1978) was followed. K was estimated in a systronics-105 flame photometer. Ca, Mg, Fe, Zn, Mn, Cu and Co were analyzed in a Perkin Elmer Atomic Absorption Spectrophotometer, Analyst AA-200. Calibration curves of each element were prepared from standards of E. Merck Germany.

Statistical Analyses

All data were analyzed by the Analysis of Variance (ANOVA) procedure using SPSS software version 10 (for windows). Dendrograms were generated using average linkage between groups. Interrelationships among traits values were estimated using the Pearson correlation coefficient.

Results and Discussion

The physiological and yield parameters of the different cultivars are indicated in Table 1. First flowering and first 50% flowering was recorded in Lamsang Chakhao, however, early date of maturation was recorded in Chakhao Anganba (146 days) which was followed by Lamsang Chakhao (148 days). All the other varieties took 152 days to maturation. Chakhao was the shortest plant (112.7 cm), while Chakhao Amubi was the tallest with 127.2 cm high. Maximum length of panicle was recorded in Chakhao Amubi (26.5 cm) and Ching Chakhao (23.4cm) however, higher number of panicles were recorded in Phumlou Chakhao (8) and Chakhao (8). The biochemical composition of the genotypes is given in Table 2. Protein content ranged from 4.52 to 7.54% with a mean value of 6.49±0.49. These values were in agreement with the reports of Saikia *et al.* (2012) and Sompong *et al.* (2011). Starch content in rice is one of the most important criteria of rice quality in terms of cooking and gelling properties, especially the amylose fraction (Abu-Kwarteng *et al.*, 2003). Starch content in the local aromatic varieties ranged from 68.46 to 77.96% with a mean of 73.56±1.34. These values were in agreement with the report of Asaduzzaman *et al.* (2013) who reported starch content of six aromatic rice varieties in Bangladesh to be in the range of 63.193 to 72.60/100 g. Chakhao Amubi recorded higher content of soluble sugar (10.27 mg/g), followed by Phumlou Chakhao (8.85 mg/g) and Chakhao (8.77 mg/g). Total phenolic content ranged from 0.52 to 3.9 mg/g with maximum content being recorded in Ching Chakhao (3.90 mg/g). Except Ching chakhao, all the other varieties had very less total phenol content ranging from 0.52 to 1.15 mg/g with the least being recorded in Lamsang Chakhao. Variations in total phenol content among the aromatic

Table 1. Important morphological observations in six cultivars of aromatic rice collected from the valley districts of Manipur

S. No.	Cultivar's Name	Date of Sowing	Date of Transplanting to the pod	1ST Flowering	50 % Flowering	Date of Harvesting	Total Duration in Maturity (days)	Plant height (cm)	Panicle Length (cm)	Panicle No.	No. of tillers
1	Lamsang Chakhao	03/07/10	04/08/10	24/09/10	03/10/10	19/11/10	148.0	122.2	21.3	7	8
2	Ching Chakhao	03/07/10	04/08/10	27/09/10	07/10/10	23/11/10	152.0	119.8	23.4	7	8
3	Phumlou Chakhao	03/07/10	04/08/10	26/09/10	04/10/10	23/11/10	152.0	120.5	22.3	8	10
4	Chakhao Anganba	03/07/10	04/08/10	03/10/10	10/10/10	17/11/10	146.0	122.2	21.2	6	7
5	Chakhao	03/07/10	04/08/10	27/09/10	12/10/10	23/11/10	152.0	112.7	22.6	8	9
6	Chakhao Amubi	03/07/10	04/08/10	28/09/10	13/10/10	23/11/10	152.0	127.2	26.5	7	7
Mean± S.Em		-	-	-	-	-	150.33±1.09	120.77±1.93	22.88±0.80	7.17±0.31	8.17±0.48
C.V.		-	-	-	-	-	1.77	3.91	8.55	10.5	14.31

Table 2. Major biochemical constituents in six aromatic rice cultivars collected from valley districts of Manipur (Mean±SD)

S.No.	Cultivar name	% Protein (N%×6.25)	% Starch (in terms of glucose × 0.95)	Soluble sugars in terms of glucose (mg/g)	Phenolics in terms of catechol (mg/g)
1	Lamsang Chakhao	4.25±1.29^{a}	74.10±4.23^{a}	7.50±0.50^{a}	0.52±0.20^{a}
2	Ching Chakhao	6.87±1.44^{b}	68.46±3.88^{b}	8.03±0.55$^{a, b}$	3.90±0.20^{b}
3	Phumlou Chakhao	7.54±2.18^{b}	77.96±5.87^{c}	8.85±0.80^{b}	0.90±0.15^{c}
4	Chakhao Anganba	6.12±1.60^{b}	73.68±3.56^{a}	7.60±0.56^{a}	0.57±0.11^{a}
5	Chakhao	7.07±2.34^{b}	71.56±2.0^{a}	8.77±0.78^{b}	0.87±0.08^{d}
6	Chakhao Amubi	7.08±1.96^{b}	75.58±4.27$^{a, c}$	10.27±0.97^{c}	1.15±0.15^{e}
	Mean±S. Em	6.49±0.49	73.56±1.34	8.50± 0.42	1.32±0.52
	S.Ed±	0.77	-	0.45	0.06
	CD at 5%	1.73	2.86	1.01	0.12
	CD at 1%	2.46	4.06	1.44	0.17

Note: Different letters in the column indicate significance at 5% level

Table 3. Correlation matrix of four biochemical constituents among the six aromatic rice cultivars

	Protein	Starch	Phenolics	Sugars
Protein	–	0.076	0.276	.643
Starch		–	-0.717	0.359
Phenolics			–	-.057
Sugars				–

rice varieties were also reported by Asaduzzaman *et al*. (2013). These values were in agreement with the reports of Saikia *et al.* (2012). The lesser amount of biochemical constituents in different aromatic rice varieties might be due to none application of nitrogenous and other fertilizers as they had been subjected to the field soil only (Buresova *et al*., 2010).

The correlation coefficients among the biochemical constituents is shown in Table 3, however, none of the values were statistically correlated. Such observations were also reported in other studies (Eggum, 1979). The dendrogram (Fig. 2) indicated different groupings of the genotypes due to biochemical variations. Out of the 3 clusters, cluster-I consists of maximum number of genotypes (Lamsang Chakhao, Chakhao Anganba and Chakhao) while, cluster-II consists of 2 genotypes (Phumlou Chakhao and Chakhao Amubi) and cluster-III consist of only one genotype (Ching Chakhao). The separation of Ching Chakhao into a different cluster is justified due to the fact that it is the only genotype originated from the hills (Ching = Hills; Chakhao = Tasty rice) others are all valley originated.

Genotypes varied considerably in macro mineral composition (Table 4). K, Mg and Ca were the major elements found in all the genotypes. Higher content of K (680.37 mg/100 g), Mg (70.17 mg/100 g) and Ca (34.43 mg/100 g) were recorded in Chakhao, which was followed by Ching Chakhao (645.33 mg/100 g K, 64.97 mg/100 g Mg and 26.90 mg/100 g Ca) and Chakhao Anganba (643.33 K and 27.37 mg/100 g Ca).

Among the minor elements, Mn, Zn, Fe and Cu were found to be fairly uniformly distributed in all the genotypes (Table 4). Higher content of Mn (1.73 mg/100 g) and Zn (4.37 mg/100 g) was recorded in Chakhao, which was followed by Ching Chakhao (1.30 mg/100 g) and Chakhao Amubi in Mn (1.30 mg/100) and Chakhao Anganba in Mn (1.33 mg/100 g) and Zn (4.13 mg/100 g). Higher contents of approximately equal values of Cu and Fe were recorded in Ching Chakhao (4.63 and 33.87 mg/100 g) and Chakhao Anganba (4.63 and 33.17 mg/100 g), which was followed by Phumlou Chakhao in Cu (3.83 mg/100 g) and Chakhao (24.83 mg/100 g), Chakhao Amubi (23.97 mg/100 g) and Lamsang Chakhao (23.33 mg/g) in Fe. Trace amounts of Co were detected in all the aromatic varieties ranging from 0.10 to 0.43 mg/100 g with a mean of 0.21±0.05 with the highest being observed in Lamsang Chakhao (0.43 mg/100 g).

The variability observed in the mineral composition was neither restricted to the ecological zones from which they were collected nor peculiar to the colour of the varieties. The values of all the cultivars studied seemed to be elevated which may be due to the fact that the grains used for analyses were dehuled manually thereby most of the rice bran responsible for higher minerals was not disturbed (Pederson and Eggum, 1983). These findings were in agreement with the reports of Oko *et al.* (2012) and Anjum *et al.* (2007). Table 5 indicated correlation coefficients of 8 elements. Among the macro elements, Ca is found to be positively correlated with Mg, while K and Mg to Cu and Zn. The correlation with respect to Ca and Mg is very high reaching up to 84% ($p<0.01$). Similarly, the correlation coefficients between Mn and Zn is also very high (90%) indicating to be highly positively correlated ($p<0.01$). Correlations between K-Cu and Mg-Zn were also observed though of moderate degree.

Table 4. Mineral content in six aromatic rice cultivars of Manipur (Mean±SD)

S. No.	Cultivar name	K (mg/100g)	Ca (mg/100g)	Mg (mg/100g)	Mn (mg/100g)	Zn (mg/100g)	Cu (mg/100g)	Fe (mg/100g)	Co (mg/ 100g)
1	Lamsang Chakhao	408±12.17^{a}	24.07±1.02^{a}	58.47±2.10^{a}	1.03±0.06^{a}	2.37±0.15^{a}	4.30±0.50$^{a, b}$	23.33±2.27^{a}	0.43^{a}
2	Ching Chakhao	645.33±10.78^{b}	26.90±0.75^{b}	64.97±3.31^{b}	1.30±0.00^{b}	3.07±0.06^{b}	4.63±0.29^{a}	33.87±0.75^{b}	0.30$^{a, b}$
3	Phumlou Chakhao	578.67±10.07^{c}	22.0±0.70^{a}	44.00±2.65^{c}	0.87±0.06^{c}	0.57±0.06^{c}	3.83±0.38^{b}	32.93±0.38^{b}	0.10^{b}
4	Chakhao anganba	643.33±7.64^{b}	27.37±0.29^{b}	57.00±2.51^{a}	1.33±0.12^{b}	4.13±0.06^{d}	4.63±0.12^{a}	33.17±0.12^{b}	0.13^{b}
5	Chakhao	680.37±12.80^{d}	34.43±0.91^{c}	70.17±3.65^{d}	1.73±0.00^{d}	4.37±0.11^{e}	3.80±0.00$^{b, c}$	24.83±0.35^{a}	0.20^{b}
6	Chakhao amubi	582±12.17^{c}	21.30±0.46^{a}	32.63±0.23^{e}	1.30±0.00^{b}	2.80±0.00^{f}	3.07±0.06^{d}	23.97±0.76^{a}	0.10^{b}
	Mean± S.Em	589.62± 39.74	26.01± 3.13	54.54± 5.67	1.26±0.12	2.89±0.56	4.04±0.25	28.68±2.09	0.21±0.05
	S. Ed±	4.80	0.94	1.98	0.05	0.07	0.22	0.86	0.09
	CD at 5%	10.69	2.09	4.42	0.12	0.17	0.49	1.92	0.20
	CD at 1%	15.21	2.97	6.28	0.17	0.24	0.69	2.74	0.29

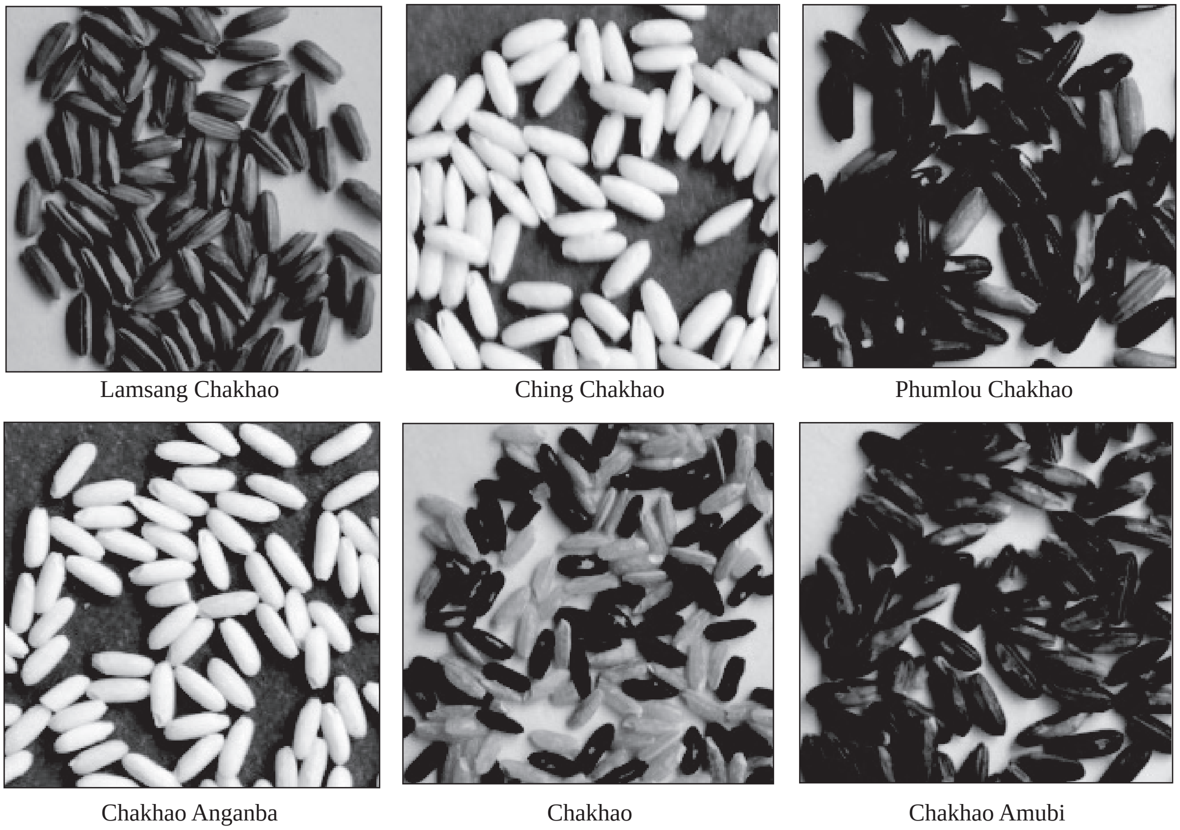

Fig. 1. Photographs of the dehulled grains of six aromatic cultivars of rice collected from four valley districts of Manipur

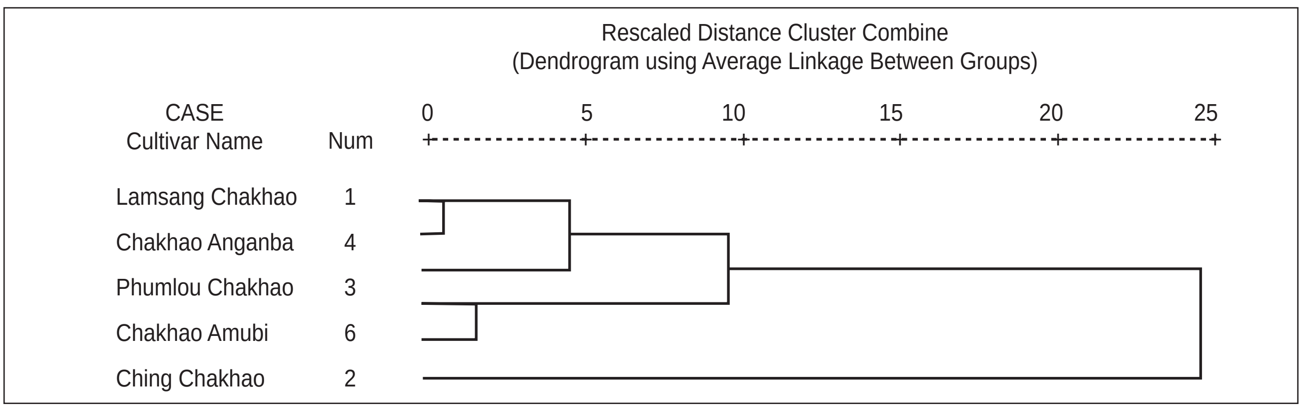

Fig. 2. Dendrogram showing relationship among varieties in respect of 4 biochemical constituents

The dendrogram at Fig. 3 indicated clusters of the genotypes due to variations in mineral composition. Out of the 2 clusters, cluster I consists of 4 genotypes, while cluster II consists of 2. Cluster I is the grouping of genotypes with superior mineral composition out of which genotype, Chakhao recorded highest values in K, Ca, Mg, Mn and Zn, while Ching Chakhao and Chakhao Anganba recorded highest values in Cu and Fe. Significant correlation among the mineral elements suggested that their inter-relationship must be considered, while selecting in a breeding program meant for the improvement of mineral content in rice (Oko *et al.*, 2012).

Acknowledgement

Authors are thankful to the Directorate of Research, Central Agricultural University for providing the

Table 5. Pearson correlation of eight elements among six aromatic rice cultivars

	Potassium	Calcium	Magnesium	Manganese	Zinc	Copper	Iron	Cobalt
Potassium	–	0.649	0.601	-0.152	-0.072	0.809*	0.436	0.660
Calcium		–	0.836**	0.489	0.493	0.606	0.209	0.301
Magnesium			–	0.626	0.723*	0.623	-0.030	0.588
Manganese				–	0.895**	-0.073	-0.253	-0.097
Zinc					–	0.224	-0.167	0.058
Copper						–	0.580	0.492
Iron							–	-0.290
Cobalt								-

* Significant at 5% level; ** Significant at 1% level.

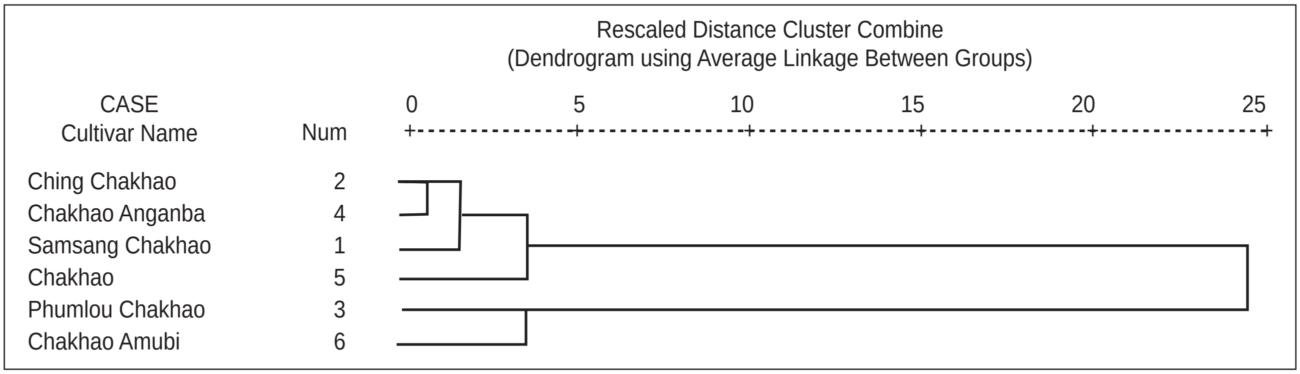

Fig 3. Dendrogram showing relationship among varieties in respect of 8 mineral elements

financial support and the Dean, College of Agriculture, for extending the facilities to do this work.

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