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Comparisons of physiochemical, total phenol, flavanoid content and functional properties in six cultivars of aromatic rice in Bangladesh

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Various aromatic rice varieties such as Kalizira, Begun Bichi, BRRI dhan-34, BRRI dhan-37, BRRI dhan-50, Philipine Katari were analyzed for physiochemical, total phenol, flavonoid contents and functional properties. All aromatic rice varieties had moisture contents (11.25 to 15.13%), protein (3.23 to 6.21%), fat (0.68 to 1.45%) and ash (0.88 to 1.46%). The maximum amount of amylose and starch content were obtained in BRRI dhan-37 and BRRI dhan-50 (23.01 and 72.606%, respectively). Total phenolic content was higher in BRRI-37 (474 mg/100 g); whereas, lower value was observed in BRRI dhan-34 (268.67 mg/100 g) variety. Both Philipine Katari and kalizira variety possessed highest level of flavonoid content among all rice varieties. Highest water absorption index value was found in BRRI dhan-37 and lowest in Begun Bichi variety. On the other hand, water soluble index value was varied by 1.32 to 2.12% in all aromatic rice varieties. Therefore, the study indicates that aromatic rice could be used as functional food ingredients as well as sources of natural phytochemicals.

Key words: Aromatic rice, physiochemical, functional properties, total phenol, flavonoid.

INTRODUCTION

Rice (*Oryza sativa* L.) is a most grown cereal crop in the developing countries. It is used as staple food for more than three billion people in Asia (Bhattacharjee et al., 2002). Rice also provides 50 to 80% of daily calorie in Asia (Khush, 2005). The global production of rice includes about more than 508,697,332 metric tons per year, where as, in Bangladesh, about 38,060,000 metric tons of rice was harvested in 2009 to 2010 (Food and Agriculture Organization, 2012). Although, the rice is a rich source of carbohydrate, it contains a moderate amount of protein and fat and also a source of B vitamins like thiamin, riboflavin and niacin (Fresco, 2005). Rice carbohydrate is mainly starch which is composed of amylose and amylopectin. Physicochemical properties and cooking charecterstics of rice depends on amylose content (Saikia et al., 2012). 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. Various aromatic rice is available in market such as Kataribhog, Radhunipagal, Chinigura, Badshabhog and Kalizira.Bangladesh Rice research Institute (BRRI) discovered BRRI dhan-34, BRRI dhan-37 and BRRI dhan-50 aromatic rice.

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In Bangladesh northern region such as Rangpur, Dinajpur and Panchagarh district are famous for the production of aromatic rice. Generally, the price of the aromatic rice is three to four times greater than that of the non-aromatic or ordinary rice varieties in national and international markets. In Bangladesh, aromatic rice is cultivated during “Aman” season in November and December and its production was about 26,837 metric tons in 2009 (DAE, 2010). Aromatic rice is a good source of different phytochemical such as phenolic compounds, anthocyanin, flavonoids etc. 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). Usually, the use of synthetic antioxidants as Butylated Hydroxy-toluene (BHT) and butylated hydroxyanisole (BHA) in foods is discouraged due to their high levels of toxicity and carcinogenicity (Hirose et al., 1981). Therefore, natural antioxidants from plant extracts have attracted considerable attention due to their safety. In recent years, there has been a global trend toward the use of phyto-chemicals from natural resources such as vegetables, fruits, oilseeds and herbs, as antioxidants and functional ingredients. Besides, this research will give new information about bioactive compounds of aromatic rice in Bangladesh. Recently, farmers are encouraged to cultivate aromatic rice cultivars because of their potential to provide and promote human health by reducing the concentration of reactive oxygen species (ROS) and free radicals (Nam et al., 2006).

Based on the information as accumulated, a research was conducted to compare the physicochemical, func-tional and phytochemical properties of six verities of the aromatic rice grown in Bangladesh like Kalizira, Kataribhog, Bagun Bichi, BRRI dhan–34, BRRI dhan –37 and BRRI dhan –50.

MATERIALS AND METHODS

Three local and modern aromatic rice varieties namely Kalizira, Begun Bichi, Philipine Katari and BRRI dhan-34, BRRI dhan-37, BRRI dhan-50, respectively were purchased from a local market. The paddies were dried in the oven at 60°C for 1 h. Then, the paddies were husked manually and powder was made by using Blender machine (Jaipan CM/L- 7360065, Japan).

Proximate composition of rice flour

Moisture, crude protein, fat and ash content of flours were deter-mined by official methods (AOAC, 1998).

Physiochemical properties

Determination of starch

The starch content was determined by Lane and Eynon (1923) method with some modification. Rice powder (5 g) was taken in a beaker and 30 ml of water was added. It was transferred to the water bath and heated at 60°C for 25 min. Then, 100 ml of 95% ethanol was added and stirred for 15 min. It was filtered through Whatman filter paper no. 2 and residue was soaked in the 50% ethanol solution for 1 h. After that, the residue was filtered and washed with 50% ethanol solution for 4 h. The residue was collected to a round bottom flask and 100 ml of water and 20 ml of HCl (6M) added. The flask was attached with the condenser and heated for 2.5 h. Then, it was allowed to cool and neutralized by adding NaOH solution (40%). After that, 10 ml of Fehling solution was taken into a conical flask and titrated against neutralized sample solution. When copper sulfate like color was observed, then, 3 drops of methylene blue indicator was added and continued titration.

The end point was indicated by brick- red color. The starch content was calculated by the following formula:

$$\% \text{ reducing sugar} = \frac{\text{Factor for Fehling's solution} \times \text{dilution}}{\text{Titre value} \times \text{weight of powder}} \times 100$$

$$\% \text{ starch} = \% \text{ reducing sugar} \times 0.9$$

Determination of amylose content

Amylose content was determined by Sompong et al. (2011) method with some modification. Rice powder (0.02 g) was taken into a volumetric flask. Then, 0.2 ml of ethanol (95%) was added. After that 1.8 ml of 1N NaOH was added and made 20 ml total volume by adding distilled water. It was kept 20 min at room temperature and boiled for 10 min at 45°C. It was filtered using Whatman filter paper no. 2. Then, 1 ml filtrate was transferred to a 50 ml tube and 0.2 ml of 1M acetic acid and 0.4 ml Lugol’s solution were added and made total volume of 20 ml by adding distilled water. The mixture was mixed and kept for 20 min at room temperature. Then, the absorbance was taken at 620 nm using spectrophotometer (T80 U/VIS, United Kingdom). The amylose content was determined using potato amylose standard curve and was expressed as g/100 g extract.

Determination of phenol content

Determination of the phenolic content was done by Saikia et al. (2012) method with some modification. Rice powder (1 g) was extracted with 20 ml of 25% ethanol for 15 min and filtered through Whatman no. 2 filter paper. After that, 1 ml sample, 1 ml Folin reagent and 5 ml Na_2CO_3 were transferred to a volumetric flask and it was kept for 1 h at room temperature. Then the absorbance was taken at 765 nm using spectrophotometer (T80 U/VIS, United Kingdom). Total phenolics were calculated on the basis of standard curves of gallic acid, and expressed as mg/100 g.

Determination of flavonoid

Flavonoid content was done by Ali and Chang (2008) method with some modification. Rice powder of 10 mg was extracted with 10 ml of methanol. After that, 1 ml was taken into a test tube and 5 ml distilled water was added. Then, 0.1 ml of potassium acetate was added. After 5 min, 0.3 ml of $AlCl_3$ was added and solution was kept for 30 min at room temperature. The absorbance was taken at 415 nm using spectrophotometer (T80 U/VIS, United Kingdom). The flavonoid content was determined using Rutin standard curve and was expressed as mg/100 g.

Functional properties

Determination of water solubility index (WSI) and water absorption index (WAI)

WAI and WSI were determined following the method described by Anderson (1982). Each sample (0.83 g) was suspended in 10 ml of distilled water and stirred for 30 min. Subsequently, the dispersions

Table 1. Proximate compositions of the different varieties of aromatic rice.

Varieties	Parameters (g/100 g)			
	Moisture	Protein	Fat	Ash
Kalizira	11.55±0.01[d]	5.18±0.015[c]	0.937±0.01[c]	0.923±0.00[c]
Begun Bichi	12.39±0.02[b]	5.74±0.035[b]	0.680±0.01[e]	1.070±0.01[b]
BRRI dhan-34	11.48±0.01[e]	5.44±0.548[c]	1.331±0.05[a]	1.210±0.01[c]
BRRI dhan-37	15.13±0.01[a]	5.69±0.075[b]	0.782±0.02[d]	1.050±0.02[a]
BRRI dhan-50	11.25±0.01[f]	6.21±0.015[a]	0.873±0.05[b]	1.460±0.05[e]
Philipine Katari	12.11±0.02[c]	3.23±0.005[d]	1.450±0.02[a]	0.887±.064[e]

All values are express as mean ± SD.
Mean followed by different superscript letters in each column are significantly different (p<0.05).

were centrifuged at 4000 rpm for 30 min. The supernatants were poured into pre weighed petri dish and the residue was weighed after oven drying overnight at 70°C. WAI and WSI were calculated using following equations:

$$\text{WAI} = \frac{\text{Weight of sediment}}{\text{Weight of dry solids}}$$

$$\text{WSI} = \frac{\text{Weight of dissolved solids in supernatant}}{\text{Weight of dry solids}} \times 100$$

Statistical analysis

All measurements were carried out in triplicate for each of the sample. Data were statistically analyzed (SPSS for windows version 17.0) by one-way analysis of variance (ANOVA). Mean comparisons were performed using Duncan's multiple range tests for significant effect at P < 0.05.

RESULTS AND DISCUSSION

Proximate analysis

Proximate compositions of different varieties of aromatic rice are shown in Table 1. Moisture content of different aromatic rice varieties varied between 11.25/100 g to 15.13/100 g. These values were similar to those reported by Saikia et al. (2012) who found that moisture content in rice is 11.6 to 13.7/100 g and also by Sompong et al. (2011) found that moisture content in pigmented and non pigmented aromatic rice was 9.3 to 13.1/100 g. The highest value (15.13%) of moisture was found in BRRI dhan-37, while lowest value (11.25/100 g) was found in BRRI dhan-50. The difference in moisture value in different aromatic rice varieties might be due to the variation in moisture content in paddy after harvesting. Protein content of different aromatic rice varieties varied from 3.23 to 6.21/100 g that was lower than that found by Saikia et al. (2012) who reported protein value in pigmented and non pigmented aromatic rice 6.66 to 9.97/100 g and also by Sompong et al. (2011) who reported protein value in rice as 7.16 to 10.85/100 g. BRRI dhan-50 variety had highest protein value (6.21/100 g) compared with other aromatic rice varieties.

On the contrary, Philipine Katari variety had the lowest value of protein (3.23/100 g) than other varieties. The variation in protein value in different aromatic rice varieties could be due to the application of fertilizer (nitrogen content), growing conditions and time and also location of growing areas (Buresova et al., 2010). Fat values were appreciably different among the aromatic rice varieties and highest was found in Phillipine Katari (1.45/100 g), where lowest content (0.68/100 g) were studied in Begun Bichi. This observation was comparable to that found by Saikia et al. (2012) who reported fat value in pigmented and non pigmented aromatic rice 1.00 to 2.10/100 g.

The variation in fat value in different aromatic rice varieties may be due to oxidation of the fat because most of the fat content in rice grain is unsaturated and undergo oxidation easily by atmospheric oxygen. The ash content of different aromatic rice varieties varied between 0.88/100 to 1.46/100 g. This result was consistent to be found by Sompong et al. (2011) who reported ash content in rice as 0.82 to 1.74/100 g. Lowest ash value was found in Kalizira (0.88/100 g) variety while highest value (1.46/100 g) was studied in BRRI dhan-34 variety.

Physiochemical properties

Amylose and starch

The amylose content in rice is one of most important criteria of rice quality in terms of cooking and gelling properties (Abu-Kwarteng et al., 2003). BRRI (2004) reported that amylose content is a major factor that influences the eating quality of rice. In this study, the variation of amylose content among different aromatic rice varieties was 15.69 to 23.01/100 g (Table 2). This value was comparable to that found by Saikia et al. (2012) who reported amylase content in pigmented and non pigmented aromatic rice as 2.2 to 28.8/100 g. The highest amylose (23.01/100 g) content was found in BRRI dhan-37 variety and lowest value (14.23/100 g) in BRRI dhan-34. On the other hand, starch content of

Table 2. Physiochemical properties of different aromatic rice varieties.

Parameter (g/100 g)	Varieties					
	Kalizira	Begun Bichi	BRRI dhan-34	BRRI dhan-37	BRRI dhan-50	Philipine Katari
Amylose	15.69±0.30[d]	17.80±0.48[c]	19.70±0.36[b]	23.01±0.43[a]	14.23±0.14[e]	16.34±0.62[d]
Starch	68.07±5.63[abc]	70.147±1.30[ab]	63.323±1.02[c]	65.457±1.05[bc]	72.606±0.97[a]	63.193±1.65[c]

All values are express as mean ± SD.
Mean followed by different superscript letters in each raw are significantly different (p<0.05).

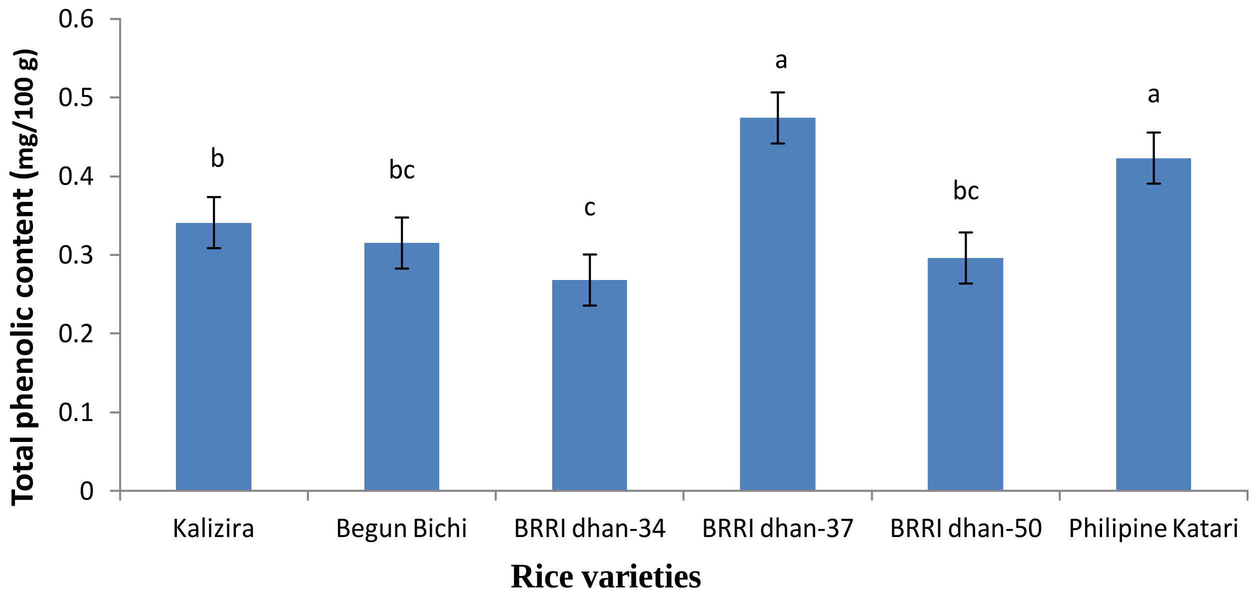

Figure 1. Total phenolic content among six aromatic rice varieties. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

different aromatic rice varied between 63.193 to 72.60/100 g (Table 2). This value was comparable to that found by Saikia et al. (2012). The highest starch content (72.60/100 g) was found in BRRI dhan-50, while lowest value (63.32/100 g) was found in BRRI dhan-34. The variation in amylose and starch content in different aromatic rice varieties might be due to the application of fertilizer (nitrogen content), growing conditions, time and also location of the growing areas (Buresova et al., 2010).

Total phenolic contents

Total phenolic content (TPC) of the examined aromatic rice varieties are presented in Figure 1. Variations were found within the aromatic rice varieties, ranging from 295.34 to 474 mg /100 g GAE, with BRRI dhan-34 (268.67 mg/100 g) rice having the lowest value while the highest value came from BRRI dhan -37(474 mg/100 g). This result was similar to that obtained by Saikia et al. (2012), was in the range of 230 to 579 mg/100 g gallic acid equivalent (GAE) of aromatic pigmented and non-pigmented rice varieties. Another study showed that, total phenolic content of rice bran extract was 251 to 359 mg/100 g GAE by Igbal et al. (2005). The variation of total phenol content in different aromatic rice varieties may be affected by genotype, cultivation techniques and ripening process environmental variation (Mpofu et al., 2006). Also, Beta et al. (2011) reported that total phenolic content may vary because of moisture content. In this study, significant differences were found in moisture content among all aromatic rice varieties.

Flavonoids

Figure 2 shows flavonoid contents among six aromatic rice varieties were varied from 660 to 1280 mg /100 g Rutin equivalent (RE). This result was similar to flavonoid content in aromatic rice varieties reported by Saikia et al. (2012). BRRI dhan-37 rice had the lowest value (680 mg/100 g RE) while the highest value (1280 mg/100 g RE) came from philiphine katari rice. Even though, there were no significantly differences among all varieties. The variation of flavonoid content in different aromatic rice varieties may be affected by genotype and environmental variation.

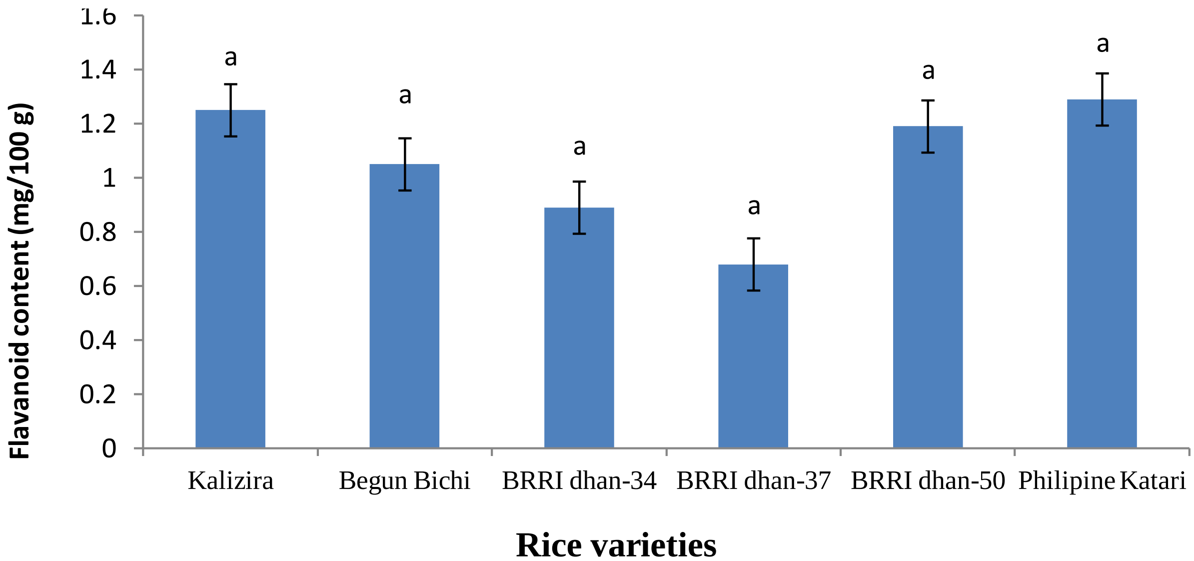

Figure 2. Flavanoid content among six aromatic rice varieties. Same superscript letters above the bars indicate statistically not significant at (p<0.05).

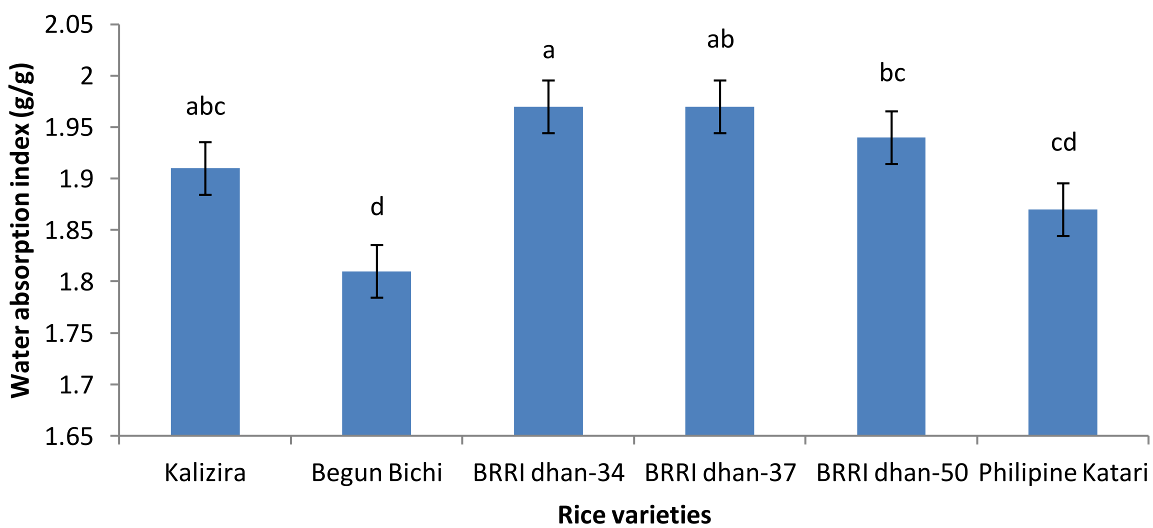

Figure 3. Water absorption index among six aromatic rice varieties. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

Functional properties

The functional properties of different varieties of aromatic rice are represented in Figures 3 and 4. The study showed that the value of water absorption index (WAI) in different aromatic rice varied between 1.81 to 1.97 g/g (Figure 3). However, BRRI dhan -34 variety had highest WAI value while lowest value found in Begun Bichi variety. The variation in WAI might be due to the disparity in the amount of engagement of OH^- groups to form hydrogen and covalent bonds between starch chains and also depend on loss of starch crystalline structure (Gunarante and Hoover, 2002). The water soluble index (WSI) in different aromatic rice varieties was 1.32 to 2.12 g/g (Figure 4). Kalizira variety had highest WSI value while lowest value found in BRRI dhan-37. WSI value could be attributed to the semi crystalline structure and disruption of starch granules (Eliasson and Gudmundsson, 1996).

Conclusion

In this study, the physiochemical, phytochemicals content and functional properties of different aromatic rice varieties were investigated. The results show that various

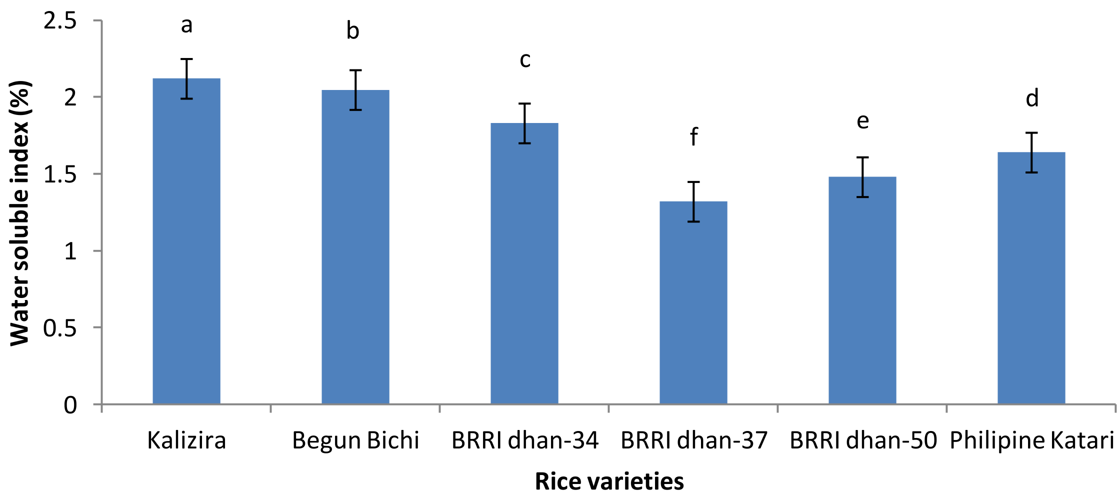

Figure 4. Water soluble index among six aromatic rice varieties. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

aromatic rice varieties exhibit good physiochemical, functional and phytochemicals characteristics. Phytochemicals in aromatic rice grains have recently been ascribed to positive nutritional properties as for example prevention of cardiovascular diseases and cancer. On the other hand, non-aromatic rice grains have lack of phyto-chemicals. Therefore, the study reveals that aromatic rice could enhance the nutritional properties of functional food ingredients in terms of the present of various healths promoting phytochemicals such as phenolic and flavonoids contents.

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