

*Research article*

## Development and quality evaluation of rice-wheat composite flour cake using special rice variety BR14

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### ABSTRACT

The study was conducted to develop and evaluate the nutritional, physical and sensory quality along with storage attributes of cake enriched with a special rice variety released from Bangladesh Rice Research Institute, BR14. The percentages of rice flour used in the cake formulations were 20%, 50%, and 100% to replace wheat flour. The moisture, protein, fat, ash, crude fiber and carbohydrate content of composite flour cake samples were found in the range of 21.67-28.33%, 5.60-6.50%, 14.41-21.07%, 0.95-1.02%, 0.49-1.27% and 49.81-54.03% respectively. The composite flour cake samples with different level of rice flour were found nutritionally better than the control sample although there were remarkable changes in specific volume, crumb and the crust color with different levels of rice flour supplementation. In addition, a significant variation in color, flavor, texture, taste and overall acceptability of cake samples were also observed. Cake sample with 50% rice flour substitution was the most acceptable in terms of color, flavor, texture and overall acceptability compared to other samples. The cake samples were packed in low density polythene bags and changes in moisture content were evaluated storing in room temperature (25<sup>0</sup> C). Thus, acceptable cake formulations in comparison with wheat flour cake were developed with special rice flour supplementation.

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### 1. INTRODUCTION

From the beginning of modern civilization, consumption of various bakery products is the demand of time due to change in food habit. Cake is one of the palatable baked products. Preparation of cake from wheat flour is the conventional practice. Now-a- days the use of composite flour is common fashion in many developing countries to prepare nutritionally balanced cake. Rice is the most abundantly cultivated food crop in Bangladesh which

contains mainly carbohydrate as well as considerable amount of protein, mineral and vitamins. Quality attributes of cakes depend on many factors such as the ingredients used for batter making, aeration of batters and processing. Usually wheat flour, margarine, eggs, sugar and baking powder are used for cake preparation (Das et al., 2019; Itthivadhanapong and Sangnark, 2016). Wheat flour is widely used flour in cake formulation since its higher gluten content (Asimah et al., 2016). Gluten helps in improvement of product quality

impacting on cell formation, volume, crumb and crust texture (Jaganath, 2016).

Rice (*Oryza sativa L.*) is one of the leading food crops in the South East Asia and main cultivation regions included South Asia, China, Korea, Thailand and Japan (Itthivadhanapong et al., 2016). Bangladesh depends almost entirely on rice to ensure food security of increasing population. Scientists of different research institutions including Bangladesh Rice Research Institute (BRRI) are trying to improve rice varieties for better yield and fulfillment of specific properties. consequence, several rice varieties are being used as a substitute for wheat to produce baking items, desserts and noodles (Jangchud et al., 2004).

Currently, glutinous rice flour (GRF) has been widely used in both novel and traditional foods such as baked foods, sweet soup balls, infant foods, puffed grains etc. (Gujral et al., 2003). BR14 is one of the special varieties of glutinous rice released by the BRRI. It has good amount of protein (7.5%), thiamin (0.59 mg/100g) and riboflavin (0.095mg/100g) along with around 27% amylose (Sozib et al., 2018). BR14 rice flour becomes very sticky when heated and has a unique chewy texture (Sozib et al., 2018). As a result, it is a good substitution for wheat flour in bakery products. Based on above considerations, this study was conducted under the following objectives: (a) to develop formulations of rice-wheat flour composite cake, (b) to determine the nutritional, physical and sensory quality of the developed cake samples and (c) to study the storage stability of the cakes in terms of moisture.

## 2. MATERIALS AND METHODS

### Preparation of rice flour

Rice flour was processed from the BR14 rice variety (raw, un-parboiled). The clean and fresh milled rice was soaked into water for 10 minutes before grinding and then it was ground by a huller mill (Model MRH04) to find rice flour. Then the flour was dried to remove extra water. Thereafter, the dried flour was sieved to get fine rice flour by passing through a sieve of 30 mesh size. After preparing rice flour, it was packed in high density polyethylene bags, sealed and stored.

### Formulation and preparation of composite flour cake

The composite flour cake was as prepared according to Atkins (1971) as presented in Table 1. In the composite rice-wheat flour cakes, wheat flour was replaced with different proportion of BR14 rice flour. The replacements of wheat flour in the formulations were made with 20g/100g, 50g/100g and 100g/100g rice flour. To prepare cakes, all of the ingredients were weighed accurately. Sugar and shortening were mixed in a mixing machine for 20 minutes to make a cream. Then, oil, egg and other ingredients and finally the flour were mixed using a mixer machine for 10 minutes to ensure even distribution of the components. Finally, 150g of butter was scaled into pre-greased cake pan. Baking oven was used for baking all the cakes for 40 minutes at 170°C.

Table 1. Formulation of the cake samples

Ingredients	Quantity(g)			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
Powder sugar (%)	70	70	70	70
Rice bran oil (%)	40	40	40	40
Baking powder (%)	3.5	3.5	3.5	3.5
Egg (%)	50	50	50	50
Wheat flour (%)	100	80	50	0
Rice flour (%)	0	20	50	100

S<sub>1</sub>= Formulation contains 100% wheat flour (Control)

S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80% wheat flour

S<sub>3</sub>= Formulation contains 50% BR14 rice flour+50% wheat flour

S<sub>4</sub>= Formulation contains 100% BR14 rice flour

### Chemical analysis of flour and cake

The rice flour, wheat flour and developed cake samples were analyzed for different parameters such as moisture, protein, fat, ash and crude fiber according to AOAC (2004). Carbohydrate content was calculated by allowing the subtraction techniques mentioned by Pearson (1976) as carbohydrate = 100 – (protein + fat + ash + moisture content).

### Physical analysis of cake samples

The developed cake samples were analyzed for physical parameters such as volume, weight and specific volume as affected by different rice-

wheat flour combinations. The cake volume was determined by seed displacement method (Ott, 1987). Weight of cake samples were taken by digital weight machine (OIML Ntep Approved Digital Weight Machine). Specific volume of baked cakes was also measured by dividing volume by weight.

### Sensory (Subjective) evaluation of cake

Cake samples were evaluated organoleptically for color, flavor, texture and overall acceptability. A 9-point hedonic rating test was used to assess the degree of acceptability of cake samples. One slice from each lot of cake was presented to 10 trained panelists as randomly coded samples. The taste panelists were asked to rate the sample for color, flavor, texture and overall acceptability on a 1–9-point scale, where 1 = dislike extremely; 2 = dislike very much; 3= dislike moderately; 4= dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7= like moderately; 8 =like very much; 9 = like extremely.

### Statistical analysis

The obtained data were analyzed for two factor Analysis of Variance (ANOVA) by using Microsoft Office Excel. Fisher's LSD Multiple Comparison Test procedures of the Method of Statistical (MSTAT) system was performed to determine significant difference among the various samples by taking 5% level of significance by following Gomez et al. (1984).

## 3. RESULTS AND DISCUSSION

### Composition of wheat flour and BR14 rice flour

The wheat flour and BR14 rice flour were analyzed for moisture, ash, protein, fat, crude fiber and total carbohydrate contents (Table 2). Wheat flour was high in moisture (12.47%), ash (0.387%), protein (12.47%), fat (0.893%), crude fiber (0.4%) content than BR14 rice flour although BR14 rice flour had greater amount of total carbohydrate content (80.60%) than the wheat flour (74.214%).

### Physical properties of the developed cakes

The result from this study cake volume, weight and specific volume of cake are represented in

Table 3. It was observed that the S<sub>4</sub> cake formulation gave higher cake volume (540cm<sup>3</sup>) than the other samples. The volume of cake samples was in the range of 470-540cm<sup>3</sup> which increased with increasing of BR14 rice flour percentage. This occurred may be due to absorbing oil and fiber components which conducting to enhancement of cake volume (Akter, N. et al., 2018). Similar kind of effect was observed in case of weight of different cake samples. The cake volume is a quantitative measurement which correlates well with dough handling properties, crumb, texture, freshness and technological versatility (Pomeranz, 1980). Weight of the cake samples were in the range of 194.70- 284.26 g where sample S<sub>1</sub> had the lower weight than that rest of composite flour cake samples. The highest weight was observed in case of sample S<sub>4</sub>, perhaps due to the higher fiber content of BR14 rice flour in composite flour cake which holds the water and contributes higher weight (Cauvain and Cyster, 1996).

Specific volume is another important physical attribute for cake. From the Table 3 it was observed that the range of specific volume of the cake samples 2.424-1-899g/cm<sup>3</sup>. It was observed that specific volume was gradually decreased with the increase of BR14 rice flour in cake dough which was proposed by Akter and Alim (2018). Marina et al, (2016) reported that the specific volume of the baked cake indicated the amount of air that retained in the final products.

Table 2. Chemical composition of Wheat Flour and BR14 Rice flour

Components	Wheat Flour (%)	BR14 Rice Flour (%)
Moisture	12.04	11.86
Ash	0.387	0.35
Protein	12.47	7.5
Fat	0.893	0.53
Crude fiber	0.4	0.25
Total Carbohydrate	74.219	80.60

S<sub>1</sub>= Formulation contains 100% wheat flour (Control)

S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80% wheat flour

S<sub>3</sub>= Formulation contains 50% BR14 rice flour+50% wheat flour

S<sub>4</sub>= Formulation contains 100% BR14 rice flour

Table 3. Physical properties of the developed cakes

Cake sample	Volume (cm <sup>3</sup> )	Weight (g)	Specific Volume (cm <sup>3</sup> /g)
S <sub>1</sub>	470	194.70	2.414
S <sub>2</sub>	510	251.18	2.030
S <sub>3</sub>	520	261.18	1.991
S <sub>4</sub>	540	284.26	1.899

S<sub>1</sub>= Formulation contains 100% wheat flour (Control)

S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80% wheat flour; S<sub>3</sub>= Formulation contains 50% BR14 rice flour+50% wheat flour; S<sub>4</sub>= Formulation contains 100% BR14 rice flour

### Chemical composition of the developed cakes

The cake samples analyzed for proximate composition are shown in Table 4. It was observed that the range of moisture content was 21.67-28.33g/100g. The moisture content gradually increased with the increasing levels of BR14 rice flour and sample S<sub>4</sub> showed the highest moisture content (28.33g/100g). This observation is quite similar with Eke et al. (2008).

It was observed that the protein content of cake sample S<sub>1</sub> was higher (6.5g/100g) while the sample S<sub>4</sub> had the lowest protein content (5.68g/100g). Protein content of cake samples decreased with the increasing rice flour proportions since rice flour contains lower level of protein. The fat content of the samples decreased (S<sub>1</sub> to S<sub>4</sub>) with increasing BR14 rice flour in cake dough which is similar to Amin (2009). The range for fat content of the composite cake was (21.07-14.02g/100g). The ash contents of the cake containing rice flour were substantially higher than that of control cake. The range of ash content of cake samples were (0.95-1.47g/100g). The ash content of different cake samples was increased with increasing of rice flour substitution levels, which is similar to (Akter, N. et al., 2018).

Sample S<sub>2</sub> was obtained the highest fiber content (1.05g/100g) and the control cake contain lowest fiber content (0.42g/100g). The amount of carbohydrates of different cakes was varied from (49.73 g/100g to 54.03g/100g). It was observed that carbohydrates were highest for control cake (49.81g/100g) and the lowest

for the cake S<sub>4</sub> (44.03g/100g). The variation of carbohydrate content among different samples were occurred due to the variations of other components in different samples.

Table 4. Composition of cakes containing different levels of composite flour

Components (%)	Cake samples			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
Moisture	21.67	23.86	26.67	28.33
Protein	6.5	6.11	6.02	5.60
Fat	21.07	19.31	17.82	14.02
Ash	0.95	0.99	1.47	1.20
Crude fiber	0.42	1.05	0.88	0.71
Total carbohydrates	49.81	49.73	51.72	44.03

S<sub>1</sub>= Formulation contains 100% wheat flour (Control)

S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80% wheat flour; S<sub>3</sub>= Formulation contains 50% BR14 rice flour+50% wheat flour; S<sub>4</sub>= Formulation contains 100% BR14 rice flour

### Effects of composite flour on external and internal characteristics of cakes

#### Crust characteristics:

Color characteristics of cakes containing rice flour comparative to the control are shown in Table 5. There were no significant differences with control samples and BR14 rice flour composite cakes. However, the crust color of the cake sample S<sub>2</sub> (containing 80% wheat flour, 20% BR14 rice flour) was deeper than those of control cake and other cake samples. The crust color is influenced by non-enzymatic browning (Millard reaction) and Caramelization reactions (Purlis, E. et al., 2009).

#### Crumb characteristics of cakes

As comparing in Table 5, sample S<sub>3</sub> (50% wheat flour + 50% BR14 rice flour) and S<sub>4</sub> (100% BR14 rice flour) provided better crumb color than those obtained from cakes of different levels of composite flour.

Crumb texture of the cakes sample S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub> and S<sub>4</sub> were presented in Table 4. It was observed that the texture differences increased at sample S<sub>3</sub>. The texture differences between control and rice flour cakes were less perfect and be free from lumps and harshness. A smooth silky surface (Raffaella, 2005) was obtained in the control cake sample S<sub>1</sub> and samples S<sub>2</sub>.The

flavor differences of the cake containing different levels of composite flour relative to control are provided in Table 4. The acceptable flavor (i. e. fresh, sweet, natural, appetizing) was found in cake sample S<sub>3</sub> (containing 50%

wheat flour and 50% BR 14 rice flour).

As per considering crumb grain the sample S<sub>3</sub> (50% wheat flour and 50% BR14 rice flour) was acceptable compare with the control cake.

Table 5. Crust and crumb characteristics of the developed cakes.

Cake sample	Crust characteristics		Crumb characteristics					
	Color	Consistency	Color	Texture		Flavor	Grain	
				Lumps and hardness	Surface		Close or airy	Shape and size
S <sub>1</sub>	Light brown	Tender	Yellow	Slightly free	Smooth, silky	Appetizing	Close	Uniform
S <sub>2</sub>	Deep brown	Medium tender	Light yellow	Slightly free	Smooth	Appetizing	Close	Uniform
S <sub>3</sub>	Brownish	Medium tough	Medium deep yellow	Free	Light smooth	More Appetizing	Close	Uniform
S <sub>4</sub>	Brownish	Medium tough	Deep yellow	Present	Rough	Slightly fresh	Close	Less uniform

S<sub>1</sub>=Formulation contains 100% wheat flour (Control); S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80% wheat flour; S<sub>3</sub>= Formulation contains 50% BR14 rice flour+50% wheat flour; S<sub>4</sub>= Formulation contains 100% BR14 rice flour

### Sensory evaluation of the developed cakes

The mean scores for color, flavor, texture and overall acceptability found from the sensory evaluation are presented in Table 6. The analysis of variance (ANOVA) on sensory qualities of cakes samples were carried out and results indicated that there were significant ( $p < 0.05$ ) differences in color acceptability among the cake samples. It was observed that the color of cake sample S<sub>3</sub> was more acceptable than other samples. On basis of DMRT test it was observed that there was significant difference for color preference between the cakes containing rice flour cake and control cake. Depending on flavor, texture and overall acceptability sample S<sub>4</sub> scored highest marks between all samples. The sample S<sub>3</sub> also showed significant differences among other cake samples. The control cake S<sub>1</sub> scored better color acceptability than cake sample S<sub>3</sub>.

### Storage stability of the developed cakes

#### Moisture change during storage

Composite cake with initial moisture content was packed in single layer polythene paper and

Table 6. Mean sensory scores of control cake and the cakes containing rice flour

Cake sample	Color	Flavor	Texture	Overall acceptability
S <sub>1</sub>	6.7 <sup>bc</sup>	6.8 <sup>b</sup>	5.9 <sup>c</sup>	6.3 <sup>c</sup>
S <sub>2</sub>	5.8 <sup>c</sup>	6.0 <sup>b</sup>	6.1 <sup>c</sup>	5.9 <sup>c</sup>
S <sub>3</sub>	7.7 <sup>a</sup>	8.0 <sup>a</sup>	8.2 <sup>a</sup>	8.2 <sup>a</sup>
S <sub>4</sub>	7.0 <sup>ab</sup>	7.0 <sup>b</sup>	7.1 <sup>b</sup>	7.3 <sup>b</sup>
LSD (P<0.05)	0.779	0.81	0.78	0.711

Values with the same superscript within the same column indicate no significant difference at  $p \leq 0.05$ . S<sub>1</sub>= Formulation contains 100% wheat flour (Control) S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80% wheat flour; S<sub>3</sub>= Formulation contains 50% BR14 rice flour+50% wheat flour; S<sub>4</sub>= Formulation contains 100% BR14 rice flour

stored in the laboratory at room temperature (30°C). The moisture content of different composite cake was determined gravimetrically (from initial known moisture content) at 0<sup>th</sup>, 5<sup>th</sup> and 10<sup>th</sup> days. Results are shown in Figure 1. Freshly prepared control cake S<sub>1</sub> had 21.67 g/100g moisture but in storage periods moisture increased from 21.67% to 29.33%. The S<sub>2</sub>, S<sub>3</sub> and S<sub>4</sub> had moisture content which ranged from

at 23.99-27.33g/100g, 26.83-27.31g/100g and 28.44-29.31g/100g respectively. It was observed that the rates of moisture content changes were decreased with the increasing of BR14 rice flour into plain cake probably due to lower moisture content of BR14 rice flour compared to wheat flour (Sozib et al., 2018).

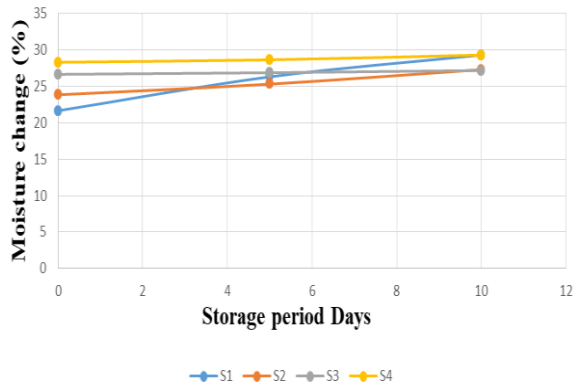


Figure 1. Changes of moisture content during storage of composite cakes

S<sub>1</sub>= Formulation contains 100% wheat flour (Control)

S<sub>2</sub>= Formulation contains 20% BR14 rice flour+80%

wheat flour; S<sub>3</sub>= Formulation contains 50% BR14

rice flour+50% wheat flour; S<sub>4</sub>= Formulation contains 100% BR14 rice flour

#### 4. CONCLUSION

The study was elucidated that the addition of BR14 Rice with Wheat flour to develop composite flour cake formulation and evaluation of the quality attributes. The replacement of 50% of wheat flour by BR14 rice has no negative textural and nutritional quality but also nutritional quality. So, BR14 rice flour can be a possible substitution for wheat flour in baked foods. Further study is recommended in this field.

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