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Nutritional and sensory quality assessment of plain cake enriched with beetroot powder

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Abstract

The study was aimed to develop cake supplemented by beetroot powder and to evaluate its quality parameter. Four samples were prepared to contain different proportions of beetroot powder (5, 10, 15, and 20% w/w) in combination with wheat flour. The nutritional and sensory properties of plain cakes were also evaluated. The cake supplemented with 15% (w/w) beetroot powder had significantly ($p<0.05$) improved the nutritional quality compared to control one (without beetroot powder). The mean sensory scores of highly acceptable beetroot powder cake S_3 (85:15) had better color (8.57±0.53), flavor (8.43±0.53), texture (8.29±0.49), taste (8.57±0.53) and overall acceptability (8.47±0.13) than other samples. The nutritional and sensory analysis suggested that the cake formulated by 15% (w/w) beetroot powder was comparatively more acceptable than other formulations (0, 5, 10 and 20% w/w).

1. Introduction

The demand for bakery products have been increased in the latter part of the 20th century due to the quickly growing economic world and eating practice of the working people due to a shortage of time (Pinki, 2014; Srivastava and Singh 2018). The commonly used baked products are bread, cakes and biscuits (Patil and Pol, 2014). Major contributing factors for increasing the demand for baking product consumption is urbanization, reasonable costs, better shelf life, the taste is good enough, and easy transportation for lightweight. The flours obtained from legumes, tubers, and other cereals products can use vegetable protein and dietary fiber sources for enriching the nutrient contents of this bakery produce (Chavan and Kadam, 1993).

The insufficiency of fiber, iron, calcium, antioxidants and folic acid in bakery products especially, in high sugar items such as cakes, can be made by incorporating beetroot powder with wheat flour to make it healthier and more nutritious. Beetroot is highly acceptable for its rich nutrient contents *viz*. dietary fiber, mineral contents such as iron, potassium, calcium, zinc, and sodium, and vitamin contents such as vitamin A, B6, folic acid, niacin, biotin and C (Pinki, 2014; Bach *et al*., 2015; da Silva *et al*., 2016; Singh *et al*., 2016). Some essential bioactive compounds like carotenoids (Dias *et al*., 2009), phenolic compounds, saponins, betaine (Jastrebova *et al*., 2003), betalains (antioxidants), polyphenols and flavonoids (Vali *et al*., 2007) also present in beetroot powder having anti-cancer and therapeutic properties (Neagu and Barbu, 2014). These compounds are having anti-oxidative (da Silva *et al*., 2016), hepatoprotective, anticancer and anti-inflammatory activity (Kavalcova *et al*., 2015), may improve many clinical outcomes such as hypertension, type-2 diabetes, atherosclerosis and dementia (Clifford *et al*., 2015). Beetroot contains both betaine and nitrate. Betaine is a trimethyl derivative of amino acid glycine which promotes muscular endurance, strength, and power (Hoffman and Ratamess, 2009).

Inclusion of dietary fiber (DF) to baking produce has many advantages, mainly decreases their caloric density and also increase dietary fiber intake (Elleuch *et al*., 2011). Incorporation of beetroot powder into the cereal and baking products *viz.* biscuits, cakes, bread, etc. can be a good source of dietary fiber (Pinki, 2014; Singh *et al*., 2016). In Bangladesh, there was no such study taken into consideration to assess the benefits of beetroot powder applications in easily consumable bakery products such as cake. Also considering the poor people in our country going through malnutrition, the study was designed to prepare the cakes by integrating 5-20% (w/w) of beetroot powder and assess the nutritional and sensory composition.

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2. Materials and methods

2.1 Materials

Wheat flour, eggs, sugar, vanilla essence, powder milk, baking powder, shortening (soybean oil) and other materials used in the study were brought from local market of Mymensingh, Bangladesh. Analytical Reagent grade chemicals and solvents were used in the study.

2.2 Processing of beetroot powder

Raw beetroot was brought from the local market and cleaned properly to remove foreign materials. Then trimmed properly and was sliced into thin pieces (3mm) with the help of slicer (Choudhury 1996). Sliced beetroot was blanched at 80°C, followed by drying at 55°C for 4 hours by a cabinet drier. Dried beetroot was ground to a fine powder (65 mesh size sieve) and packed in airtight colored glass bottles for further use (Srivastava and Singh 2016).

2.3 Proximate composition of beetroot powder

Proximate chemical composition analysis of both beetroot powder and wheat flour was done, including moisture and ash were measured following the method of the Association of Official Analytical Chemists (AOAC, 2000). Fat content was analyzed using the Soxhlet extraction method, protein content using Kjeldahl method (AOAC, 2005) and total dietary fiber using enzymatic–gravimetric method (AOAC, 2003).

2.4 Formulation of cakes

Beetroot powder incorporating cakes were prepared by replacing wheat flour with different proportions of beetroot powder. Using wheat flour and beetroot powder (BRP), four different types of beetroot cakes were made by using wheat flour and beetroot powder (BRP) in a ratio of 95:05 (S_1), 90:10 (S_2), 85:15 (S_3) and 50:20 (S_4). All the ingredients used for the preparation of cakes were given in Table 1. For preparing cakes, at first, sieved wheat flour and beetroot powder were mixed at different proportion (5, 10, 15 and 20% w/w). Baking soda was mixed thoroughly with the mixture along with other ingredients (wheat flour, beetroot powder, sugar, baking soda, oil, milk powder, eggs and vanilla essence). The batter was poured in a pre-greased mould and baked at 160-180°C for 20-30 mins (Srivastava and Singh, 2018).

2.5 Nutritional analysis of cakes containing beetroot powder

Beetroot powder cakes were analyzed for obtaining nutritional composition (AOAC, 2000). The energy value of cakes in kcal per 100 g was also determined following Mudambi *et al*. (1989).

2.6 Sensory characteristics

The panel of ten panelists judged the cakes for sensory evaluation are the students of the Department of Food Technology and Rural Industries have enough knowledge of sensory characteristics. The panelists evaluated the cakes according to the Score Card method to assess the sensory parameters *viz.* color, texture, flavor, taste, and overall acceptability (Amerine *et al*., 2013). The obtained values from the panelists were then evaluated by one-way ANOVA.

2.7 Statistical analysis

The obtained data were analyzed statistically summarized in the form of the mean and standard deviation to find out correlations among the parameters (Panse and Sukhatme 1961). The effects of beetroot powder on the chemical composition and sensory characteristics of the formulations were analyzed using one-way ANOVA. To describe the significant differences between the control one and samples incorporated with different percentages of beetroot powder, a multiple range test (Fisher's least significant differences) procedure was applied.

3. Result and discussion

3.1 Chemical composition of beetroot powder

The nutritional compositions of beetroot powder and wheat flour are shown in Table 2. Data in Table 2 suggested that wheat flour contains higher fat content than beetroot powder. The similar result was obtained by

Table 1. Formulation of cakes using Beetroot powder

Ingredients	Control Cake	Beetroot powder incorporated cakes			
		Wheat flour: Beetroot powder			
	S_0 (control)	S_1 (5% BRP)	S_2 (10% BRP)	S_3 (15% BRP)	S_4 (20% BRP)
Wheat flour (g)	100	95	90	85	80
Beetroot powder (g)	0	5	10	15	20
Sugar (g)	80	80	80	80	80
Oil (mL)	82	82	82	82	82
Milk powder (g)	4.5	4.5	4.5	4.5	4.5
Egg (nos.)	4	4	4	4	4
Baking powder (g)	1.8	1.8	1.8	1.8	1.8
Vanilla Essence (mL)	1	1	1	1	1

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Kohajdova *et al*. (2018). Beetroot powder contains a significantly higher amount of protein, ash, and dietary fiber than wheat flour. Elleuch *et al*. (2011) also found the same results. Beetroot powder may be considered as a dietary fiber (55.18%) product as it contains more than 50% total dietary fiber and less than 9% moisture content (7.20%) reported by Larrauri (1999) and Figuerola *et al*. (2005). Beetroot powder is also a good source of ash (3.57%), which might indicate a good source of minerals.

Table 2. Proximate composition of wheat flour and beetroot powder

Nutrients	Wheat flour (mass %)	Beetroot powder (mass %)
Moisture	11.72±0.63	7.20±1.15
Protein	10.73±0.40	13.01±0.01
Fat	1.78±0.04	1.58±0.27
Ash	0.52±0.02	3.57±0.48
Total Dietary fiber	1.97±0.18	55.18±0.33

Values are expressed as mean±standard deviation

3.2 Effect of incorporation of beetroot powder on the nutritional composition of plain cakes

Data from Table 3 indicates the highest carbohydrate percentage recorded in the sample of S_0 (40.43), followed by S_1 (37.40), S_2 (35.42), S_3 (33.30), and S_4 (31.86). For protein content, it was observed that the samples (S_1-S_4) protein contents (13.57-15.83%) were higher than the control sample S_0 (13.43%). Pinki (2014) reported that protein content was increased up to 12.42 (g/100 g) as the level of BRP increased from 0 to 25 per cent. Fat content is higher in sample S_4 (24.02%) and lower in sample S_0 (21.13%). Higher ash content was recorded in the sample of S_4 (3.18) and lowest in control sample S_0 (1.02) as beetroot powder is an enormous source of minerals (Kohajdova *et al*., 2018). In terms of moisture content, the highest moisture percentage was recorded in the sample of S_1 (23.40), followed by S_0 (22.76), S_2 (22.97), S_3 (22.58) and S_4 (23.02). The dietary fiber content is higher in sample S_4 (2.43) and lower in sample S_0 (0.53). Thus, the nutritional composition of cakes figured that protein content increased from 13.43% to 15.83%, ash content from 1.02% to 3.18% and dietary fiber from 0.53% to 2.43% as the percentage of beetroot powder increased from 0 to 20%. The similar results were also observed by Nazni and Karuna Thara (2011) where ash and fibre contents were increased with the increment of beetroot powder percentages in the cake. Fat content and energy decreased from 21.63% to 21.59% and energy from 410.07 to 394.75 (kcal/100 g), respectively, as the percentage of beetroot powder increased from 0 to 20%.

3.3 Sensory evaluation

Consumer acceptability based on color, flavor, texture, taste, and overall acceptability of the samples, are shown in Table 4. Values in Table 4 are shown as mean with standard deviation. It was also noted that the cake prepared with 15% beetroot powder (w/w) was highly acceptable among other proportions of beetroot cakes and control one. Pinki (2014) reported that cake prepared with 15-20 per cent beetroot powder incorporation had better physical and sensory properties.

3.4 Cost estimation of cakes

Cakes were estimated to assess the cost of whether the formulated cake is affordable by general consumers or not if the cakes produced commercially. The

Table 3. Nutritional composition of cakes incorporating beetroot powder

Chemical analysis (%)	Beetroot powder incorporated cakes				
(Parameters)	S_0 (control)	S_1 (5% BRP)	S_2 (10% BRP)	S_3 (15% BRP)	S_4 (20% BRP)
Carbohydrate	40.42	38.09	36.45	35.57	34.28
Moisture	22.76	23.40	22.97	22.58	23.02
Protein	13.43	13.57	14.77	15.61	15.83
Fat	21.63	21.61	21.61	21.60	21.59
Ash	1.02	1.72	2.28	2.45	2.84
Dietary fibre	0.73	1.60	1.91	2.18	2.43
Energy (kcal/100 g)	410.07	401.13	399.37	399.12	394.75

Table 4. Sensory analysis of beetroot powder formulated cakes

Sensory Attributes	Beetroot powder incorporated cakes					LSD at 5%	S.Em±
	S_0 (control)	S_1 (5% BRP)	S_2 (10% BRP)	S_3 (15% BRP)	S_4 (20% BRP)		
Color	7.86±0.38	5.43±0.53	6.14±0.77	8.57±0.53	8.14±0.38	0.566	0.610
Flavor	8.57±0.53	5.43±0.53	6.29±0.75	8.43±0.53	8.43±0.53	0.626	0.656
Texture	8.57±0.53	6.14±0.69	6.57±0.98	8.29±0.49	7.71±0.49	0.707	0.475
Taste	8.43±0.53	5.86±0.69	6.14±0.77	8.57±0.53	8.00±1.15	0.897	0.580
Overall acceptability	8.36±0.34	5.72±0.35	6.29±0.20	8.47±0.13	8.07±0.30	0.400	0.573

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estimated cost of production for control (S_0) was Tk. 19.50/100 g while for S_1, S_2, S_3 and S_4 were Tk. 23.5/100 g, Tk. 27.6/100 g, Tk. 31.6/100 g and Tk. 35.7/100 g, respectively. Cost of cupcake made from wheat flour fortified with beetroot and wheatgrass powder (90:5:5) was reported by Sharma *et al* (2019) as Rs. 29.4 /100 g which was quite similar to the cost of 5% incorporated beetroot powder cake of the study.

4. Conclusion

Beetroot powder, an abundant source of dietary fiber and mineral content can be used in the production of bakery and confectionery products. Protein, fat, ash and fiber contents of different percentages of beetroot powder cakes increased with the increase of beetroot powder. The cake containing 15% beetroot powder had a better appearance, taste, and texture compared to other cakes. This study suggested that cakes prepared with beetroot powder of 15% (w/w) had comparatively better nutritional and sensory characteristics over control one. Therefore, cake with 15% beetroot powder is advised to consume in our everyday diet for health benefits.

Conflict of interest

The authors declare no conflict of interest.

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