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Research article

Development and quality evaluation of low calorie cake and biscuit prepared with jackfruit seed flour

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A B S T R A C T

Cake and biscuits are the most consumed bakery products all over the world due to their nature, affordable cost and availability in different varieties. As high ratio bakery products contain high calories, the challenge is to find new sources that will reduce calorie content as well as add to the nutrition of the products. In our study we made composite jackfruit seed flour (JSF) to formulate low calorie cakes and biscuits. Each of the products was prepared with 10%, 20% and 30% JSF and compared the calorific value and proximate component of the products with control (without JSF). The crude fiber, crude protein, ash and nitrogen free extract (NFE) content of cake samples significantly increased with the addition of JSF where 30% JSF blended cake had the highest value at these proximate component as 2.06%, 8.65%, 1.69% and 47.9%, respectively and control cake had the lowest value as 0.15%, 8.4%, 1.44% and 46.6%, respectively. The calorie content, crude fat and moisture content were found to be gradually lowered in JSF treated cake samples and the lowest value was found in 30% JSF blended cake sample as 4.23 Kcal/g, 9.27% and 30.35%, respectively where as the control cake sample had 4.87 Kcal/g, 10.86% and 33.25% respectively. In the case of biscuits, the calorific value was found lower in 20% JSF blended cake (4.21 Kcal/g) compared to the control cake (4.39 Kcal/g). The moisture, protein and fat content were found lower in JSF treated biscuit samples where the lowest value found in the 30% blend at 2.83%, 10.85% and 12.19% compared to control biscuit as 3.16%, 11.2% and 12.57%, respectively. All the proximate components statistically varied ($p<0.05$) and no microorganisms (total viable count (TVC) and Yeast and mold) were detected in JSF treated samples within the 7 days. The sensory parameter indicated that up to 30% incorporation of JSF in cake and biscuit were not significantly different ($p<0.05$) from control. But 10% JSF treated sample scored the highest general acceptance value in the case of both products. The overall acceptability judged by organoleptic evaluation is as follows- C_1> C_3> C_2> C_0 (cake) and B_1> B_2> B_3> B_0 (biscuit).

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1. INTRODUCTION

Bakery products are a subject of interest to everyone in the world where cakes and biscuits are very important products in the bakery industry and are well linked with consumers all over the world. Scientists have become interested in bakery products because of their potential as functional foods. This is due to the possibility of using other ingredients in place of wheat flour, such as roots, tubers, leaves, seeds, and legumes (Khan et al., 2016). Numerous high-fiber additions, particularly in baked goods, have been used as ingredients in a variety of food products (Shrivastava and David, 2015). A wide variety of tropical and subtropical fruits are abundant in Bangladesh. Mango, jackfruit, pineapple, banana, litchi, lemon, guava, papaya, tamarind, melon, watermelon, cashew nut, pomegranate, plum, etc. are some of the most extensively produced fruits. The largest fruit that is edible and a member of the Moraceae family is the jackfruit (*Artocarpus heterophyllus* Lam (Goswamil et al., 2010). The national fruit of is called jackfruit. (Kirtikar and Basu, 2003). It ranks third in an area under cultivation and second in production among the fruits of Bangladesh. Jackfruit is found all over the country; but mainly in the month of *Jaishtha* and *Ashar* (two names of Bangla month). It grows plenty amount in the hilly areas of Chattogram and Sylhet city and the highland of Dhaka, Mymensingh, Comilla and Jessore city of Bangladesh. About 9977 hectares of land have an annual production of 935965 tons jackfruit (BBS, 2011).

Jackfruit is composed of edible bulbs of yellow-flesh, seeds and rind. The ripe fruits are eaten or processed into snacks and canned products. Seeds make up around 10 to 15% of the total fruit weight and have high carbohydrate and protein contents (Ockloo et al., 2010). Carbohydrates are the chief component of the seed in the form of starch for human consumption (Roy et al., 1990). The seeds are boiled or roasted and can be used in many culinary preparations (Rajarajeshwari and Jamuna, 1999). They are good sources of thiamine and riboflavin (Morton, 1987). They also contain trace amounts of zinc, iron, potassium, copper, and manganese. Other important nutrients in the seeds include phytochemicals, like saponins which act as antioxidants and have anti-cancer and anti-microbial activities (Gupta et al., 2011). As the seeds germinate immediately after maturity therefore, it is difficult to store fresh seeds for a long time due to the lack of processing and preservation techniques. A huge amount of jackfruit seeds is destroyed every year in Bangladesh (BBS, 2011). Conversion of seeds to flour gives extra benefit as the jackfruit has a shorter shelf life and is seasonal. So it can be used in inter-mediatory products and blended with other flours for value addition. The addition of jackfruit seed flour to deep fat products has reduced the fat content remarkably (Shrivastava and David, 2015). So, the seeds can be easily blended with traditional wheat flour to prepare more nutritious bakery items like cakes, breads, and biscuits etc. which have a low-calorie value.

Typically, a primary ingredient in the bread and confectionary sectors is wheat flour. However, because of its versatile uses in the baking sector, the cost of it is rising constantly. An alternative component to utilize in baking recipes is jackfruit seed flour (JSF) (Hasidah and Noor Aziah, 2003). To boost nutrient content in products while also ensuring customer acceptance, it can be substituted to a certain extent. The discarded jackfruit seed, which may be used as a cheap source of fiber in place of whole grains, has commercial potential (Ockloo et al., 2010). Our study's primary goal is the development of a low-calorie, high-nutrient composite jackfruit seed flour cake and biscuit.

2. MATERIALS AND METHODS

Collection of seed

The mature jackfruit seeds were collected from the local market “Riajuddin Bazar” of Chattogram city of Bangladesh.

Collection of ingredients for cake and biscuit

The necessary ingredients for cake and biscuit preparation such as fresh brand wheat flour and sugar, flora margarine, ‘foster clark’ baking powder and vanilla essence, salt, Newzeland brand low-fat liquid milk, ‘Dano’ skim milk powder etc. were purchased from Basket Super Market of Chattogram city in Bangladesh.

Preparation of jackfruit seed flour

The jackfruit seeds were processed into flour by the following method David,(2016) and Ockloo et al., (2010).

Seed treatment

After collecting jackfruit seeds the defected, immature and germinated ones were sorted out. They were washed properly to remove any foreign particles. Then the seeds were divided into two parts for cake and biscuit preparation respectively. Only white aril was removed from the seeds which were intended for cake preparation and the white aril and the spermoderm (the thin brown layer which covers the fleshy white cotyledon of jack seed) were peeled off manually from the seeds intended for biscuit preparation. Then the seeds were blanched at 70°C for 10 minutes.

Flour preparation

The pretreated seeds were sliced into pieces using a knife. Then they were dried in a cabinet dryer at 60°C for 24 hours followed by grinding into powder nearly 0.2 mm using a grinder. The powder was sieved by 60 mesh and packed in high density polyethene bags and stored in a refrigerator (<5°C) for further study (David, 2016).

Peeling epidermis of jackfruit seeds
↓
Blanching for 10 minutes
↓
Chopping jackfruit seeds into slices
↓
Drying of jackfruit seeds (60°C/24h)
↓
Grinding of jackfruit seeds to fine flour
↓
Filtering of jackfruit seed flour to 60 mesh particle size
↓
Jackfruit seed flour (JFSF)

Flow chart 1. Flow chart for preparation of jackfruit seed flour (JSF)

Value addition of JSF into cake and biscuit

Four cake samples and four biscuit samples were prepared of which one sample was considered as control and the rest three samples were considered as JSF treated samples. The ratio of whole wheat flour and JSF in different samples was as follows- 100:0 (control sample); 90:10, 80:20, and 70:30 (treated samples). The cake was prepared using JSF (with spermoderm) and the biscuit was prepared using JSF (without spermoderm).

Cake preparation

The chocolate cake was prepared by a single bowl mixing method (Neville and Setsar, 1986). The formulation has been adopted from the recipes reported by Siti-Faridah and Noor-Aziah (Siti-Faridah and Noor-Aziah, 2012) and is shown in Table 1. The eggs and sugars were mixed for 2-5 minutes. The mixture was then mixed for 2 minutes to get lighter, creamier and floppy batter. After mixing, the sifted wheat flour, JFS flour and cocoa powder were added to a mixing bowl and mixed for 2 minutes. Milk and margarine (as they contain lower Calorie content than butter) were heated together in a saucepan until melted. The mixture was poured into a bowl and mixed at speed 2 for 1 minute. The batter was then transferred to the greased non-stick cake pan and baked in an electric oven at 170°C for 35 minutes. The cakes were then removed from the oven and allowed to cool for 2 hours and were later packed in a low-density polyethyne package at room temperature for 24 hours before physical quality analysis. Samples were replicated thrice at every stage.

Biscuit preparation

The basic formulation used for the preparation of cracker biscuits has been adopted from the recipes used by Hoseney,(1986) and Kent, (1984). A replacement of wheat flour in this formulation was made with jackfruit seed flour. The formulation is given in Table 2. Sugar was grounded and mixed well with egg and margarine. Then the dry ingredients including JSF were added and mixed with the egg-sugar mixture until the perfect dough is made. The dough is rolled in a clean polythene paper in desired thickness and then biscuit shape was given by using a biscuit cutter. Then the biscuits were baked in an electric oven for 20 min at 160° C. All the ingredients were weighed accurately for each sample.

Table 1. Formulation of reduced calorie cake with JSF on 100g flour basis

Ingredients	**Sample 1 (C_0)**	**Sample 2 (C_1)**	**Sample 3 (C_2)**	**Sample 4 (C_3)**
Wheat flour	115 g	103.5 g	92 g	80.5 g
Jackfruit seed flour	0	11.5 g	23 g	34.5 g
Sugar	130 g	130 g	130 g	130 g
Salt	0.6 g	0.6 g	0.6 g	0.6 g
Baking powder	3.5 g	3.5 g	3.5 g	3.5 g
Egg	100 g	100 g	100 g	100 g
Low-fat Milk	125 g	125 g	125 g	125 g
Margarine	45 g	45 g	45 g	45 g
Cocoa powder	25	25	25	25
Vanilla essence	1 g	1 g	1 g	1 g

Here, $\mathbf{C_o}$ = Control; $\mathbf{C_1}$ = 10% JSF blended cake; $\mathbf{C_2}$ =20% JSF blended cake; $\mathbf{C_3}$ = 30% JSF blended cake

Table 2. Formulation of low calorie biscuits with JSFs on 100g flour basis

Ingredients	**Sample 1 (B_0)**	**Sample 2 (B_1)**	**Sample 3 (B_2)**	**Sample 4 (B_3)**
Wheat flour	100 g	90 g	80 g	70 g
Jackfruit seed flour	0	10 g	20 g	30 g
Sugar	47 g	47 g	47 g	47 g
Salt	0.6 g	0.6 g	0.6 g	0.6 g
Baking powder	1.6 g	1.6 g	1.6 g	1.6 g
Egg	30 g	30 g	30 g	30 g
Milk powder	2 g	2 g	2 g	2 g
Margarine	32 g	32 g	32 g	32 g
Vanilla essence	1 g	1 g	1 g	1 g

Here, $\mathbf{B_o}$ = Control; $\mathbf{B_1}$ = 10% JSF blended biscuit; $\mathbf{B_2}$ =20% JSF blended biscuit; $\mathbf{B_3}$ = 30% JSF blended biscuit

Sensory evaluation of finished products

The sensory characteristics of the cake and biscuit samples were evaluated. Samples were evaluated for color, flavor, texture and overall acceptability. A 1-9 point hedonic rating test was performed to assess the degree of acceptability of the samples containing jackfruit seed flour. A set of 20 panelists was selected from the teacher, students and employee of the Department of Applied Food Science and Nutrition, Chattogram Veterinary and Animal Sciences University and briefed on the procedure before evaluation. One slice from each sample of cake and one piece from each sample of biscuit were presented to 20 panelists. 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(Amerine et al., 1965).

Proximate composition of jackfruit seed flour and value-added products

The seed flour and finished products (cake and biscuit) were analyzed for proximate composition e.g. moisture, crude protein, crude fat, crude fiber and total mineral matter and expressed in percentage. The analysis was carried out following AOAC (2005). Total Carbohydrate contents of the samples were determined by subtracting method (Pearson, 1976). All the analyses were done in triplicates.

Determination of the proximate components of the product

Estimating moisture is done simply by heating at 104-105°C for 3-4 hours in the oven and is cooled in a desiccator to absorb moisture. The process is repeated several times until the constant weight shows by the sample. The protein content of food stuff is obtained by estimating the nitrogen content of the material and multiplying the nitrogen factor by 6.25.In almost all cases known quantity of sample is

digested with H_2SO_4 in presence of a digestion mixture ($CuSO_4$ and K_2SO_4 in the ratio of 1:20). The digested sample is distilled after neutralizing excess acid with alkali (40% NaOH, w/v) and the released ammonia is trapped in a 2% boric acid solution. The collected distillate is titrated against standard (0.1N) HCl solution. The percent nitrogen is determined and crude protein is calculated by multiplying the factor 6.25. Fat is estimated by dissolving food samples into organic solvents (chloroform: methanol) separating the filtrate by filtration. Placing the filtrate into separating funnels and the separated mixture is dried to measure the extract and finally the percentage of fat is estimated. The ash fraction contains all the mineral elements jumbled together. This method performs the oxidization of all organic matter by incineration and determines the weight of the remaining ash. Crude fiber is the water insoluble fraction of carbohydrates that consists mainly of cellulose, hemicellulose and lignin. It is estimated through digestion of fat free known amount of food sample by boiling it in a weak solution of acid (1.25% H_2SO_4) for 30 minutes followed by boiling in weak solution of alkali (1.25% NaOH) for 30 minutes at constant volume and then deducting ash from the residue obtained.

Determination of calorie content of finished products

The calorie content of the finished products (cake and biscuit) treated with JSF and of the control products were determined by using Bomb Calorimeter (parr-6200) at PRTC of CVASU. The original method used to determine the number of kcals in a given food directly measured the energy it produced. The food was placed in a sealed container surrounded by water-an apparatus known as a bomb calorimeter. The food was completely burned and the resulting rise in water temperature was measured. (McGill et al., 2004).

Microbiological assessment of finished products

Microbiological assessment of finished products was performed at Poultry Research and Training Centre (PRTC), Chattogram Veterinary and Animal Sciences University, to get an idea about the initial microbial load of the finished products. The assessment was done by estimating aerobic mesophilic count (total viable count), yeast and mold count according to (FAO, 1997). The enumeration was performed using a digital colony counter and the result was expressed as colony forming units per ml (CFU/ml) for bacteria and as a present or not, for yeast and mold growth.

Statistical analysis

Proximate and sensory data were collected in Microsoft Excel 2010 spread sheet. Afterwards data were exported to The Statistical Package for the Social Sciences (SPSS Inc. 233 South Wacker Drive, 11th floor, Chicago, IL 60606-6412). Data were sorted, coded and recorded before statistical analysis in SPSS 20 software. Proximate and sensory data were analyzed by a one-way ANOVA test to assess the significance level of variation at a 95% confidence interval (CI). A Post hoc (Tukey) test was done to identify the variation between the sample groups because this one is simple to compute and reduces the probability of making a Type I error. Descriptive statistics (frequency, percentage, mean, standard deviation and standard error mean) were performed for different cake and biscuit samples.

3. RESULTS

Nutritional composition of wheat flour and jackfruit seed flour

The proximate analysis of wheat flour and jackfruit seed flour (with spermoderm and without spermoderm) is presented in Table 3 and Figure 1. The proximate analysis evidenced that jackfruit seed flour contained a better level of all nutrients than that wheat flour. Between two types of JSF (with and without spermoderm), the JSF (with spermoderm) contained an increased level of moisture, fiber, ash and fat and decreased level of protein and carbohydrate.

Nutritional composition and Calorie content of control and JSF blended cakes

Table 3 and Figure 2 show the outcomes of proximate analysis performed on control cakes and cakes treated with increasing concentrations

of JSF. According to the proximate analysis, cakes treated with JSF had considerably higher levels of all nutrients than the control cake, which is manufactured with only 100% wheat flour (p 0.05). With more JSF being added, the moisture levels of cake samples steadily reduced. Fat content had a comparable outcome. With increasing amounts of JSF added, it was discovered that the samples had higher levels of fiber, ash, and carbohydrates. With the exception of sample C1, the protein level of the cake samples rose after JSF was added.The results of Calorie determination of control cake and cakes treated with different percentages of Jackfruit seed flour are also presented in Table 3. The analysis evidenced that in JSF treated cake samples, the Calorie contents were reduced gradually ($p<0.05$). In sample C_1 (with10% JSF), the calorie content was reduced to 4.44 Kcal/g from 4.87 Kcal/g in control cake (with 100% WF). In case of sample C_2 and C_3, the calorie content difference was little although they have lowered the Calorie content than that of the control cake.

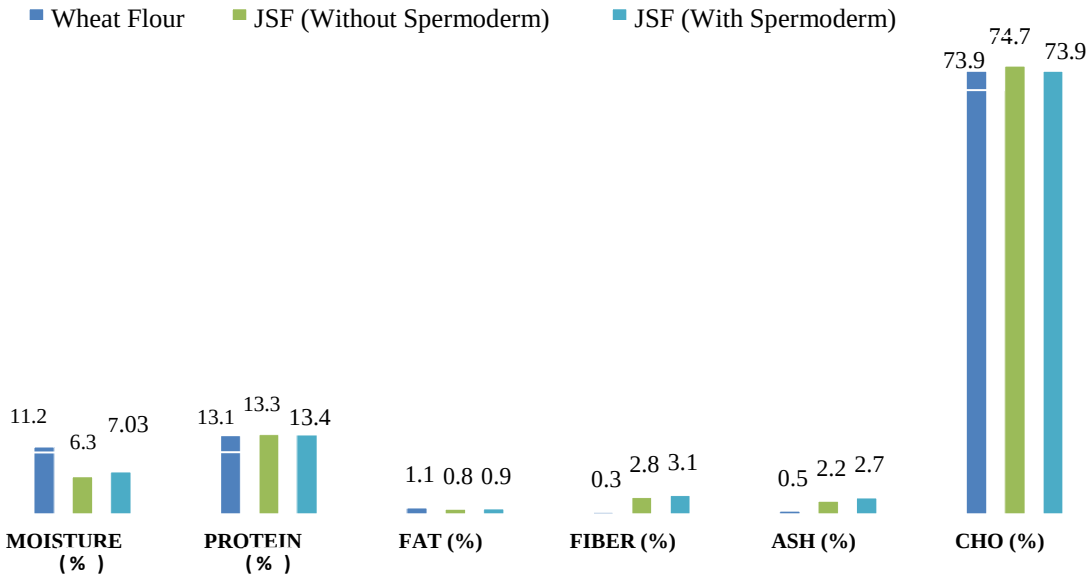

Figure 1. Comparison of nutrient contents among wheat flour and jackfruit seed flour

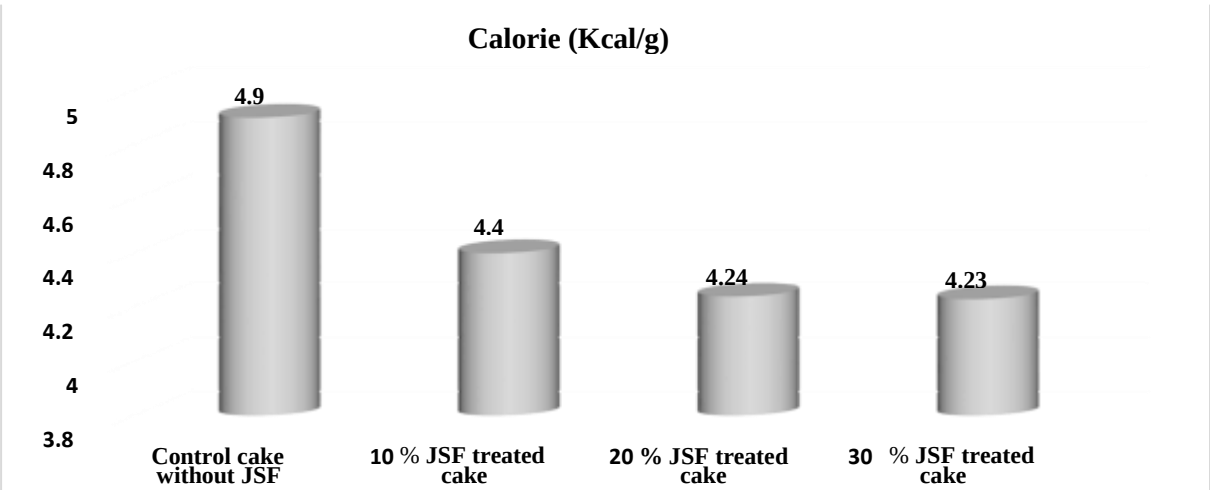

Figure 2. Calorie contents of wheat flour and JSF blended cake sample

Table 3. Proximate component and calorie content of wheat flour and JSF treated cake samples

Parameters / **Samples**	**Moisture (%)** [Mean ± SD]	**Crude Protein (%)** [Mean ± SD]	**Fat (%)** [Mean ± SD]	**Crude Fiber (%)** [Mean ± SD]	**Ash (%)** [Mean ± SD]	**Total Carbohydrate (%)** [Mean ± SD]	**Calorie (Kcal/g)** [Mean ± SD]
C_0	33.3 ± .01^{ab}	8.4 ± .005^{a}	10.1± .03^{a}	0.2 ± .02^{a}	1.4 ± .02^{ab}	46.7 ± .03^{abc}	4.9 ± .02
C_1	32.9 ± .02^{ab}	8.3 ± .005^{b}	8.7 ± .01^{b}	1.5 ± .01^{b}	1.5± .005^{ab}	47.7 ± .5abcd	4.4 ± .007
C_2	31.2 ±.5^{c}	8.5 ± .003^{c}	9.4 ± .01^{c}	1.8 ± .01^{c}	1.7 ± .05^{cd}	47.4 ± .03^{abcd}	4.2 ± .01 ^{cd}
C_3	30.4 ± .01^{d}	8.7 ± .01^{d}	9.3 ± .02^{d}	2.1 ± .02^{d}	1.7 ± .03^{cd}	47.9 ± .03^{bcd}	4.2 ± .006 ^{cd}
Significance	***	***	***	***	***	*	*
P (Post hoc test)	C_0 vs C_1 >0.05	All sample <0.001	All sample <0.001	All sample <0.001	C_0 vs C_1, C_2 vs C_3 > 0.05	C_0 vs C_3< 0.05	C_2 vs C_3> 0.05

C_0 – Cake (control) prepared from 100% wheat flour; C_1 – Cake treated with 10% JSF; C_2 – Cake treated with 20% JSF; C_3 – Cake treated with 30% JSF;
*= significant (p<0.05); **= significant (p<0.01); ***= significant (p<0.001); NS= Not significant
Data are average value ± standard deviation. Values with different superscripts within a column are significantly different and the same superscripts are not significantly different at (p <0.05).

Nutritional composition and Calorie content of control and JSF blended biscuits

The results of proximate analysis on control biscuits and biscuits treated with different percentages of JSF are presented in Table 4. The study showed that biscuits treated with JSF contained a higher level of all nutrients than control biscuit that is prepared from 100% wheat flour (p< 0.05). The moisture contents of biscuit samples decreased from 3.16 % in the control biscuit to 2% in the B1 (10% JSF) sample. In samples B_2 and B3, the moisture content was observed at 2.76% and 2.83% respectively which are lower than the control biscuit. A similar result was found in the case of fat% where it decreased gradually with the addition of JSF. The protein content of sample B_1 was found higher among the biscuit samples. However, samples B_2 and B_3 lowered the protein contents in comparison with the control biscuit. A satisfactory result was found in the case of fiber and ash content where a gradual increase was observed. The results of calorie determination of control biscuits and biscuits blended with different percentages of Jackfruit seed flour are also presented in Table 4 and Figure 3. The analysis evidenced that in JSF treated biscuit samples, the calorie contents were reduced markedly. In the case of samples B_1 (with10% JSF) and B_2 (with 20% JSF) the reduction was gradual. But in sample B_3, the calorie content was greater than in samples B_1 and B_2 although it was lower than that of the control biscuit.

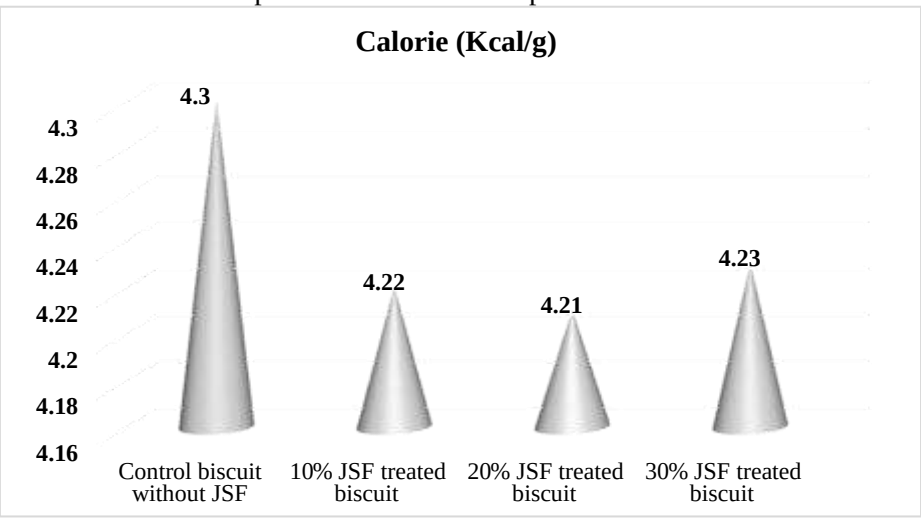

Figure 3. Calorie contents of wheat flour and JSF blended biscuit samples

Table 4. Proximate component and Calorie content of wheat flour and JSF treated biscuit samples

Parameter in percentage [Mean ± SE]	**Sample type**				
	B_0	**B_1**	**B_2**	**B_3**	**Significance**
Moisture	3.2 ± .01	2.04 ± .06	2.8 ± .02^{cd}	2.8 ± .02^{cd}	***
Protein	11.2 ± .01^{a}	11.4 ± .01^{b}	10.8 ± .01^{c}	10.9 ± .01^{d}	***
Fat (%)	12.6 ± .02^{ab}	12.5± .01^{ab}	12.3 ± .03	12.2 ± .01	***
Fiber (%)	0.4 ± .02^{a}	0.5 ± .01^{b}	1.1 ± .01^{c}	1.7 ± .01^{d}	***
Ash	1.2 ± .01^{a}	1.3 ± .007^{b}	1.4 ± .005^{c}	1.5 ± .02^{d}	***
Total Carbohydrate	71.5 ± .02^{ac}	72.2 ± .09^{bc}	71.6 ± .03^{abc}	70.6 ± .5	***
Calorie (Kcal/g)	4.3 ± .01abcd	4.2± .003^{abcd}	4.2 ± .01^{abcd}	4.2 ± .01^{abcd}	NS

B_0 = Biscuit (control) prepared from 100% wheat flour; B_1 = Biscuit treated with 10% JSF; B_2 = Biscuit treated with 20% JSF; B_3 = Biscuit treated with 30% JSF; *= significant ($p<0.05$); **= significant ($p<0.01$); ***= significant ($p<0.001$); NS= Not significant. Data are average value ± standard error. Values with different superscripts within a row are significantly different and the same superscripts are not significantly different at ($P<0.05$).

Sensory evaluation

A one-way analysis of variance (ANOVA) was carried out for both cake and biscuit samples. The results of the sensory evaluation of cake samples are presented in Table 5(a), which revealed that there were no significant variations ($p<0.05$) among the cake samples in case of color, consistency, texture, flavor, taste, appearance, shape, air cell and general acceptance. The mean score of color and taste significantly varied among the cake samples and the post hoc test showed that sample C_2 was found to have the lowest mean score compared with the control sample. The mean score of general acceptance was found higher for sample C_1.

In the case of biscuit samples, the ANOVA showed that there was also no significant difference ($p< 0.05$) among the biscuit samples which is presented in Table 5(b). The mean score of crust color, texture and taste was found lower in sample B_3 and the mean score of general acceptance was higher for sample B_1 and lower for sample B_0 (control).

Microbiological analysis

The microbial count showed that the finished products (cake and biscuit) contained no total viable count. The result also shows the absence of yeast and mold in the samples until 7 days although biscuit has a higher shelf life and it needs to be further analyzed. The microbial count of finished products indicates that cake and biscuit prepared by blending wheat flour and jackfruit seed flour were hygienic for human consumption despite adding no preservatives.

4. DISCUSSION

The demand for food products that are nutritionally enriched is rising quickly as awareness of health, nutrition, and diet among the general public spreads. To add some further qualities without modifying the sensory parameters, it is more practical to modify the existing items with locally accessible raw materials. An earlier study's findings were corroborated by the proximate analysis of jackfruit seed flour, which showed that it had higher nutritious contents than wheat flour (Ocloo et al., 2010). According to earlier studies, the nutritional components of wheat flour were as follows: moisture 13.63%, ash 1.15%, protein 11.44%, fat 0.88%, and total carbohydrate 72.9% (Mollik, 2006).In this current study on JSF, the content of crude protein, crude fiber and ash significantly increased and the content of moisture and fat decreased significantly in comparison with wheat flour and these results are similar to many earlier studies (Berry and Kalra, 1988; Begum et al., 1989; Sing et al., 1991; Tulyathan et al., 2002). The differences observed in these compositions of JSF may be due to varietal differences, agro-ecological condition, fertilizer use, methods of analysis etc. (Khan et al., 2016).

Table 5 (a). Hedonic sensory score of control cake and JSF blended cake samples

Parameters [Mean ± SE]		**Sample (N=20)**				
		C0	**C1**	**C2**	**C3**	**Significance**
Crust Characteristics	Color	8.1 ± 0.9	8.3 ± 0.7	7.9 ± 0.8	7.9 ± 0.9	NS
	Consistency	7.3 ± 1.1	7.9 ± 0.9	7.5 ± 0.7	7.6 ± 0.9	NS
Crumb Characteristics	Texture	7.6 ± 0.9	7.9 ± 0.8	7.5 ± 0.8	7.7 ± 0.9	NS
	Flavor	7.7 ± 1.1	7.9 ± 0.9	7.9 ± 0.9	7.7 ± 1	NS
Taste		7.7 ± 0.8	8 ± 0.9	7.7 ± 0.8	7.9 ± 0.8	NS
Appearance		8 ± 0.9	8.2 ± 0.6	8.1 ± 0.8	8.1 ± 0.6	NS
Shape		8.1 ± 0.8	8.3 ± 0.7	8.2 ± 0.7	8.3 ± 0.7	NS
Air Cell		7.1 ± 1.4	7 ± 1.2	7.1 ± 1.1	7.1 ± 1.4	NS
General Acceptance		7.5 ± 1.1	7.9 ± 0.9	7.6 ± 1	7.8 ± 0.8	NS

C_0 – Cake (control) prepared from 100% wheat flour; C_1 – Cake treated with 10% JSF; C_2 – Cake treated with 20% JSF; C_3 – Cake treated with 30% JSF; NS = Not significant. Data are average value ± standard error. Values in the same row are not statistically significant at ($P < 0.05$).

Table 5 (b): Hedonic sensory score of control biscuit and JSF blended biscuit samples

Parameters [Mean ± SE]	**Sample (N=20)**				
	B_0	**B_1**	**B_2**	**B_3**	**Significance**
Crust Color	7.6 ± .7	7.8 ± .8	7.7 ± .8	7.6 ± 1	NS
Texture	7.7 ± 1.4	7.8 ± 1	7.5 ± .9	7.2 ± 1.2	NS
Flavor	7.5 ± 1.3	7.7 ± .9	7.6 ± 1	7.5 ± 1	NS
Crunchiness	7.7 ± 1.4	7.8 ± .7	7.7 ± .8	7.7 ± .8	NS
Taste	7.8 ± 1.1	7.8 ± 1	8 ± .8	7.5 ± 1	NS
General Acceptance	7.5 ± 1.3	7.9 ± 1	7.9 ± .9	7.8 ± .7	NS

B_0 = Control biscuit prepared from 100% wheat flour; B_1 = Biscuit treated with 10% JSF; B_2 = Biscuit treated with 20% JSF; B_3 = Biscuit treated with 30% JSF; NS = Not significant .Data are average value ± standard error. Values in the same row are not statistically significant at ($P < 0.05$)

The proximate analysis of finished products (cake and biscuit) evidenced that the moisture and fat content decreased in JSF added cake and biscuit samples. (Amin, 2009) used jackfruit seed flour in cake samples and observed that cakes substituted with jackfruit seed flour had decreased fat content compared to the control cake. This is due to the higher fat absorption capacity (72%) of JSF (Islam et al., 2015). In the case of protein, carbohydrate, fiber and ash, JSF added cake samples were superior. This may be due to the presence of higher protein, carbohydrate, fiber and ash content in Jackfruit seed flour. The proximate outcomes of this study are in-line with previous results (David, 2016). The protein content in biscuit samples (B_2 and B_3) was found to decrease with the addition of JSF and this result is similar to an earlier study (Islam et al., 2015). This may be due to the addition of JSF without spermoderm in the biscuit, whereas the cake was prepared with JSF with spermoderm. Moreover, the protein content varies from seed to seed and it may also depend on the ripening stage of the seed (Anonymus, 1970). As moisture content reduces with addition of the JSF, so it will be an added benefit for the shelf-life of biscuit.

The determination of the calorific value of the samples revealed that JSF treated cake and biscuit samples gradually reduced the Calorie content compared to that of control samples. This is due to the low-calorie content of Jackfruit seed (Kumar et al., 1988). The reduction rate was significant in 10% JSF treated cake and biscuit. There was an exception in the case of biscuit sample B_3 where the calorie content of B_3 was higher than B_2. Like the protein, fat and carbohydrate content were lower in B_3 as compared to other samples, so it was expected to find lower Calorie content in sample B_3. Thus, further research is recommended in this case.

The integration of jackfruit seed flour was found to be acceptable according to the results of the sensory evaluation. The general acceptability of

JSF mixed goods in comparison to the control product did not change significantly (p 0.05). Cakes were the subject of the sensory study, which revealed that C1 had the highest mean value of universal acceptance and C0 had the lowest value. In the case of biscuits, B1 had the highest mean value and B0 had the lowest mean value for universal approval. The acceptability decreased as the jackfruit seed inclusion increased. Samples C1 and C3 and B1 and B2 received greater favor from the sensory panelists than the other samples.All the products were as good as a control sample. The overall acceptability judged by organoleptic evaluation is as follows- C_1> C_3> C_2> C_0 (cake) and B_1> B_2> B_3> B_0 (biscuit). Several studies (Hasan et al., 2010; Islam et al., 2015; David, 2016; Khan et al., 2016; Miah et al., 2017) have found similar findings.

The products passed the microbial analysis and were free from microorganisms (TVC, yeast and mold) where the safety range is up to 10,000 cfu/g total viable count for bakery products (Elevitch and Manner, 2006) and its may be due to the anti-microbial effect of jackfruit seed (Theivasanthi and Alagar, 2011).

The current study shows that, the incorporation of Jackfruit seed flour is more satisfactory in the cake than in biscuits, However, two types of separate JSF for cake and biscuit respectively were used in this research. From the above parameters and data observed it may be concluded that Jackfruit seed flour can be utilized for various applications as it can be stored for a long period (Chowdhury et al., 2012) and satisfactorily added to common flour to improve dietary fiber and to produce low calorie products.

5. CONCLUSION

This study suggests JSF as a possible replacement for baked goods with added nutrients. The aforementioned criteria and data suggest that jackfruit seed flour can be successfully added to regular flour to increase dietary fiber and create low-calorie goods. 30% JSF incorporation was determined to be the optimum treatment from a nutritional standpoint. The nutritional and organoleptic aspects of the 10% and 20% JSF treated items were likewise higher, however the panelists gave the 10% JSF treated products the highest mean score for overall approval. Producers and customers will both profit from the products' decreased calorie content as a result of JSF.The surplus jackfruit seeds from peak season can be utilized satisfactorily by the bakery industries for value added food production without altering the nutritional contents except for protein. Thus, considering the economy, nutritional value and consumer preference, bakery products from Jackfruit seed flour will be superior to products from wheat flour.

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REFERENCES

Amin, M.F.S. 2009. Optimization of jackfruit seed (*Artocarpus heterophyllus* Lam.) flour and polydextrose content in the formulation of reduced calori chocolate cake. MS Thesis, Department of food technology, UniversitiSains, Malaysia.

Anonymus. 1970. Chemical studies on mango kernel and jack fruit-part 1. Indian Food Packer, 22(2): 39-42.

AOAC. 2005. Official Methods of Analysis. 18th ed. Association of Official Analytical Chemists. AOAC International. Washington DC, USA.

BBS. 2011. Yearbook of Agricultural Statistics of Bangladesh. Planning Division, Ministry of Planning, Peoples Republic of Bangladesh, Dhaka.

Begum, K., Umapathy,P,K., Daniel, V,A. and Swaminathan, M. 1989. Nutritive value of jack fruit (*Artocapusintegrifola*) seed meal and effect of supplementing with methionine and tryptophan or milk proteins. The Indian Journal of Nutrition and Dietetics,. 26: 68-74.

Berry, S.K. and Kalra, C.L. 1988. Chemistry and technology of jack fruit (Artocarpus heterophyllus) - a review. Indian Food Packer, 42(3): 62-76.

Burkil, H.M. 1997. The Useful Plants of West Tropical Africa. Royal Botanic Gardens, Kew, 4(2):160-161.

Chowdhury, A.R., Bhattacharyya, A. and Chattopadhyay, P. 2012. Study on functional properties of raw and blended Jackfruit seed flour (a non-conventional source) for food application. Indian Journal of Natural Products and Resources, 3: 347353.

David, J. 2016. Antioxidant Properties of Fiber Rich Dietetic Chocolate Cake Developed by Jackfruit (*Artocarpus heterophyllus* L.) Seed Flour. International Journal of Food Engineering. 2:2.

Dikeman,C,L., Murphy, M,R. and Fahey, G,C. 2006. Dietary fibers affect viscosity of solutions and simulated human gastric and small intestinal digesta. Journal of Nutrition, 136: 913–919.

Elevitch, C.R. and Manner,H,I. 2006. Species profiles for pacific island agroforestry: Artocarpus heterophyllus (jackfruit). In: Traditional Trees of Pacific Islands: Their Culture, Environment and Use. C.R. Elevitch, ed. pp. 1–17.

Goswamil, C., Hossain,M,A., Mortuza, M.G. and Islam, R. 2010. Physicochemical parameters of jackfruit (*Artocarpus heterophyllus* Lam) seeds in different growing areas. Bioresource, 2(10):01-05. ,

Gupta, D., Mann, S., Gupta,R,K. and Sood, A. 2011. Phytochemical, nutritional and antioxidant activity evaluation of seeds of jackfruit (*Artocarpousheterolphyllus* Lam.). International Journal of Pharma and Bio Sciences, 2(4):336-345.

Hasan,S,M,K., Hossain, M,A., Hossain, M,J. and Roy.Sarker,M,S,H. 2010. Preparation of biscuit from jackfruit (*Artocarpus heterophyllus*) seed flour blended with wheat flour. The Agriculturists, 8(1): 10-18.

Hasidah,M,Y. and Noor-Aziah, A,A. 2003. Organoleptic and physico-chemical evaluation of breads supplemented with jackfruit seed (*Artocarpus heterophyllus*) flour.

Hoseney,R,C. 1986. Principle of Cereal Science and Technology. American Association of Cereal Chemists. St. Pual.

Islam,M,S., Begum, R., Khatun, M. and Dey, K,C. 2015. A study on nutritional and functional properties analysis of jackfruit seed flour and value addition to biscuits. International Journal of Engineering Research and Technology, 4(12): 22780181.

Kent,N,L. 1984. Technology of Cereals: An Introduction for students of Food Science and Agriculture. 3rd ed. Pergamon press. Oxford.

Khan,S,A., Saqib, M,N. and Alim, M,A. 2016. Evaluation of quality characteristics of composite cake prepared from mixed jackfruit seed flour and wheat flour. Journal of Bangladesh Agricultural University, 14(2): 219–227.

Kirtikar,K,R. and Basu, B,D. 2003. Sudhindranathbasu "Indian medical plants". International Book Distributors. pp.156.

Kumar, S., Singh,A,B., Abidi, A,B., Upadhyay, R,G. and Singh, A. 1988. Proximate composition of jack fruit seeds. Journal of Food Science and Technology, 25:308-9.

McGill., Kenneth, C., Yasechko., Michelle, L., Nkari. and Wendy, K. 2004. Determination of Calories in Food via Adiabatic Bomb Calorimeter. The Corinthian. 6:9.

Miah, M,Y., Bhattacharjeel, S., Sultana, A., Bhowmik, S., Kumar, A., Sarker., Paul, S,C., Islam, M,S. and Zaman, A. 2017. Evaluation of amino acid profile of jackfruit (*Artocarpusheterophyllus*) seed and its utilization for development of protein enriched supplementary food. Journal of Noakhali Science and Technology University, 1(1): 77-84.

Mollik, M. 2006. Processing and preservation of chapattis from whole meal flour. MS Thesis, Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh.

Neville, N, E. and Setser, C. S. 1986. Textural optimization of reduced calorie layer cakes using response surface methodology. Cereal Foods World, 31(10): 744-749.

Ockloo,F,C,K., Bansa, D. and Boit, R,T. 2010. Physicochemical, functional and pasting characteristics of flour produced from jackfruit seeds. Agricultural and Biological Journal of North America, 1(5):903-908.

Pearson, D. 1976. The Dictionary of Nutrition and Food Technology. 5th ed. Butterworth Pub. London.

Roy,S,K., Rahman, S,L. and Majumder, R. 1990. In vitro propagation of jackfruit (*Artocarpus heterophyllus* Lam.). Journal of Horticultural Science, 65(3): 355-358.

Shrivastava, A. and David, J. 2015. Effects of different levels of Jackfruit Seed Flour on the Quality Characteristics of Chocolate cake. Research Journal of Agriculture and Forestry Science, 3(11): 6-9.

Singh, A., Kumar, S. and Singh,I,S. 1991. Functional properties of jack fruit seed flour. Lebensm-Will U Technology, 24: 373-4.

Siti-Faridah,M,A. and Noor-Aziah, A, A. 2012. Development of reduced calorie chocolate cake with jackfruit seed (*Artocarpus heterophyllus* Lam.) flour and polydextrose using response surface methodology (RSM). International Food Research Journal, 19(2): 515-519.

Theivasanthi, T. andAlagar, M. 2011. An insight analysis of nano sized powder of jackfruit seed. Nano Biomedical Engineering, 3(3):163–8.

Tulyathan, V., Tanauwong, K., Sangjinda, P. and Jabiboon, N. 2002. Some Physico-chemical properties of jack fruit (*Artocarpus heterophyllus* Lam) seed flour and starch. Science Asia, 28:37-41.

Vassallo, M., Saba, A., Arvola, A., Dean, M., Messina, F., Winkelmann, M., Claupein, E., Lahteenmaki, L. and Shepherd, R. 2009. Willingness to use functional breads: applying the health belief model across four European countries. Appetite.52:452–460.