J Bangladesh Agril Univ 17(4): 599–605, 2019 https://doi.org/10.3329/jbau.v17i4.44632

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau, www.banglajol.info/index.php/JBAU

Utilization of Jamun seed powder in composite cake formulation

Mushtari Akter Marufa[1], Pabitra Chandra Das[2], Abdullah Iqbal[1]✉

[1]Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
[2]Department of Chemical and Food Process Engineering, Rajshahi University of Engineering & Technology, Rajshahi-6204, Bangladesh

ARTICLE INFO

Article history:
Received: 03 July 2019
Accepted: 29 September 2019
Published: 31 December 2019

Keywords:
Jamun seed powder,
Composite cake,
Physico-chemical analysis

Correspondence:
Abdullah Iqbal
✉: iqbal21155@bau.edu.bd

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ABSTRACT

The study is concerned with the evaluation of the nutritional and functional properties of Jamun seed powder (JSP) extracted from fresh Jamun and to develop cakes by incorporating JSP with wheat flour (WF). The chemical analysis showed that JSP had 6.30% moisture, 6.24% protein, 2.19% ash, 1.18% fat, 84.09% carbohydrate and 371.94 Kcal energy/100 g of powder whereas WF contained 12.90% moisture, 11.00% protein, 1.35% ash, 1.50% fat, 73.01% total carbohydrate and 349.54 Kcal energy/100 g of powder. Four cake samples were prepared by using different proportion combination of WF and JSP such as A (100% WF), B (90% WF and 10% JSP), C (80% WF and 20% JSP) and D (70% WF and 30% JSP). The nutritional components of four cake samples gave the range of moisture 16.92-25.56%, protein 6.34-8.56%, ash 1.50-2.60%, fat 16.01-22.42% and total carbohydrate 41.96-58.13%. Weight (g) of processed cakes were increased whereas other physical attributes such as volume, height, specific volume were decreased due to supplementation of JSP. The increased level of JSP powder substitution changed the crust color of cakes from light brown to blackish and also changed the crumb color from brownish to reddish. Sensory evaluation indicated that the sample B (10% JSP and 90% WF) was the most acceptable by the panelists than those of other cakes. Above all, the study gave an indication that Jamun seed powder can be used as a good replacement of wheat flour in production of cakes which can help to get higher energy, mineral and carbohydrate.

Introduction

Jamun (*Syzygium cumini*) also known as *Syzygium jambolanum*, *Eugenia jambolanum* and *Eugenia cumini* is an evergreen tropical tree in the flowering plant family Myrtaceae and is native to Bangladesh, India, Nepal, Pakistan, Sri Lanka, the Philippines, and Indonesia (Razoanul *et al*., 2017). The fruit is a good source of iron, minerals, sugars and proteins. Besides its use as dessert fruit, Jamun is used for preparation of delicious beverages such as jellies, jam, squash, wine, vinegar etc. (Devi *et al*., 2016). According to statistical data of BBS (2015), the annual production of Jamun is approximately 51302 metric tons in Bangladesh from 386 acres land in the year 2013-2014 in which increasing production rate of Dhaka (approximately 13999 metric tons) is bigger than other division.

A full Jamun consist of its edible part, seed coat and kernel. The edible part of whole Jamun fruit is around 75%. 83.7% moisture, 0.7% protein, 0.3% fat, 0.9% crude fiber, 14% carbohydrate and 0.4% ash was found in edible part of Jamun (Chaudhary and Mukhopadhyay, 2012). The Jamun seed contains 6.63% protein, 0.66% lipid, carbohydrate 75.4% and insoluble dietary fiber 1.32%. Jamun seed powder is good sources of vitamin-C and vitamin-B complex as well as dietary fiber, potassium, iron and they are low in fat and cholesterol. It also contains some essential minerals such as potassium, calcium, sodium, magnesium and phosphorus (Priyanka and Mishra, 2015).

Jamun contains high level of anthocyanins and other phenolic compounds, mainly flavonols and ellagitannis, which contribute to its high antioxidant capacity and other biological activities (Kannan and Puraikalan, 2016). The phenolic composition and concentration are known to be influenced by genetics, growing condition and maturation. Phenolic compounds found in Jamun include anthocyanins, gallic acid, folic acid, tannis, ellagic acid, ellagitannis and cyanidins (Huang *et al*., 2012). It contains oil which is rich in omega-3 (alpha-linolenic acid) and omega-6 fatty acid (linoleic acid) as well as carotenoids and ellagic acid. Additionally, the seeds are a great source of antioxidants (Shahnawaz *et al*., 2010).

Jamun fruits are universally accepted to be very good for medicinal purposes especially for diabetes because of its effect on the pancreas (Joshi, 2001). The fruit, its juice and the seed contain a biochemical called 'Jamboline' which is believed to check the pathological conversion

Cite this article

Marufa, M.A., Das, P.C., Iqbal, A. 2019. Utilization of Jamun seed powder in composite cake formulation. *Journal of Bangladesh Agricultural University*, 17(4): 599–605. https://doi.org/10.3329/jbau.v17i4.44632

of starch into sugar in case of increased production of glucose. Jamun seeds are known for their medicinal characters to cure diabetes, diarrhoea, dysentry and blood pressure (Chopra *et al*., 1956). Many researchers used JSP for replacement of wheat flour to produce different bakery products. Thorat and Khemnar (2015) worked with the whole WF and JSP blends in the preparation of functional cookies to improve the quantity and quality of protein, carbohydrate, and fiber content. They recommended that cookies can be produced by incorporating JSP in WF up to 20% to get suitable color, flavor, texture and overall acceptability.

Although wheat flour is a good source of calories and other nutrients, but the price of wheat flour is increasing day by day due to multipurpose uses. Mixing of JSP with WF, which increases nutritional quality, shelf life and also the excellent taste of preparing cake could be a good alternative to WF. Only Jamun flesh is utilized but large amount of Jamun seed being discarded every year. So, it will be a unique technique to prepare different value added products by mixing JSP and other ingredients for cakes, cookies, biscuits preparation. It can be used to develop nutritionally enriched bakery products. Keeping above views in mind, the study was carried out to fulfill the following objectives: (i) to compare the functional and chemical properties of JSP with WF and (ii) to assess physicochemical and organoleptic properties of developed cakes using various concentration of JSP.

Materials and Methods

Preparation of JSP

Fresh Jamuns were collected from the local market of Mymensingh. Collected Jamuns were washed and pulped to get the Jamun seed and rinsed immediately. Then the seed coat was manually removed to get the Jamun seed. These Jamun seeds were used for powder preparation. The seeds were washed properly to remove any adhering material. Then the Jamun seed were dried for 5-6 hours at 70˚C by using a mechanical dryer. The dried materials were grinded in lab grinder into flour and transformed into a very fine powder by sieving. The powdered sample was then stored in polybag and kept in desiccator for future using.

Formulation and preparation of JSP supplemented cakes

The formulation of JSP supplemented cakes for the present research is given Table 1 and the development method was as follows: All of the ingredients were weighed separately and were mixed in a bowl. Eggs were taken in the beater bowl and was beaten until it formed foam. Then sugar was added to it and was beaten again until it mixed properly. Then the flour mixture, baking powder, milk powder and salt were poured into the bowl with a spoon and the mix was beaten again until complete mixing occurred. Subsequently, flavor and oil was added to the mixture and was beaten to form a suitable mix for cake formulation. After waiting for 30 minutes and the mix was put in mould and was baked at 160˚C for 40 minutes.

Table 1. Formulation of JSP supplemented cakes

Ingredients	Sample			
	A (control)	B	C	D
Wheat Flour (g)	100	90	80	70
Jamun seed powder (g)	0	10	20	30
Egg (piece)	1	1	1	1
Sugar (g)	85	85	85	85
Salt (g)	2	2	2	2
Milk powder(g)	25	25	25	25
Baking Powder(g)	4	4	4	4
Oil (g)	70	70	70	70
Vanilla Essence(drops)	2	2	2	2

Chemical analysis

Moisture and crude fiber contents were measured by the methods described in AOAC (2012) whereas ash, protein and fat contents were determined by the methods described by Ranganna (2005). Carbohydrate content was determined as total carbohydrate by following Pearson (1976) by subtraction method. Energy value was calculated as total energy per 100g as per method of Birch *et al.* (1980). Triplicate determinations were performed for all analysis.

Functional properties analysis

The JSP and WF were analyzed for functional properties as like bulk density, water absorbing capacity, oil absorption capacity and swelling index by using the method described by Okaka and Potter (1977), Khetarpaul *et al.* (2005), Sosulski *et al.* (1976) and Lin *et al.* (1974) respectively.

Analysis of physical properties of developed cakes

Weight of cakes was measured as average of values of four individual cakes with the help of digital weighing balance. The volume (cm^3) was measured by rapeseed replace method described in the (AACC, 1983). The specific volume was obtained by dividing the volume of cakes by their weights. Height of cakes was measured by using scale and an average value was taken.

Sensory evaluation

The consumer's acceptability of developed cakes was evaluated by a testing panel of 15 panelists. The hedonic rating test was used to determine the acceptability. The panelists were chosen from different social status. The panelists rated their acceptability of the product on a 01-09 point hedonic scale. The scale was arranged such that 9= like extremely, 7= like very much, 6= like slightly, 5= neither like nor dislike, 4= dislike slightly, 2= dislike very much and 1= dislike extremely.

Statistical analysis

The scores given by the panelists were analyzed by SAS (Statistical Analysis System, version 8.2). Fisher's LSD Multiple Range Test was used to detect mean differences at 5% level of significance.

Results and Discussion

Nutritional comparison between JSP and WF

The comparative analysis of the proximate composition and energy content of the JSP and WF is shown in Table 2.

Table 2. Nutritional composition of JSP and WF

Component	JSP	WF
Moisture (%)	6.30	12.90
Ash (%)	2.19	1.35
Protein (%)	6.24	11.00
Fat (%)	1.18	1.50
Crude fiber (%)	5.56	0.40
Total carbohydrate (%)	84.09	73.25
Energy (Kcal/100 (calculated)	371.94	350.50

It is seen that the JSP had higher amount of ash (2.19%), fiber (5.56%), carbohydrate (84.90%) and energy (371.94 kcal/100g) than the WF while the other component was higher in the WF such as moisture (12.90%), protein (6.24%) and fat (1.50%). Desai (2018) found 14.31% moisture, 1.02% crude fat, 3.01% crude protein, 4.21% crude fiber, 2.87% crude ash and 73.21% carbohydrate in JSP. Das *et al*. (2018) reported that the WF contained 14.37% moisture, 0.51% ash, 11.46% protein, 0.64% fat, 73.02% total carbohydrate and 343.70 Kcal energy per 100g flour. Obtained results of this research are more or less similar to that reported by the mentioned authors. Differences might be due to varietal variation, extent of drying, physicochemical conditions of the samples etc.

Comparison of functional properties between JSP and WF

Functional properties of JSP and WF such as bulk density, water absorption capacity, oil absorption capacity and swelling index are shown in Table 3.

Table 3. Functional properties of Jamun seed powder (JSP) and wheat flour (WF)

Properties	JSP	WF
Bulk Density (g/ml)	0.71	0.66
Water absorption capacity (%)	101.34	61.01
Oil absorption capacity (g oil/g sample)	0.856	1.145
Swelling index	1.344	3.404

From the Table 3, it is seen that the bulk density of JSP (0.71 g/ml) was higher than WF (0.66 g/ml) which indicates that JSP had higher weight per unit volume than WF. Das (2017) and Suresh and Samsher (2013) found that the bulk density of WF as 0.58 and 0.762 g/ml respectively. The water absorption capacity indicated that JSP absorbed more water than WF to form a standard dough. From research findings of Lee *et al.* (2001) it was found that dough other than wheat flour had higher water absorption rate than that of wheat flour. From the table, it is also notable that WF absorb more oil than JSP which is similar to the results found by Das (2017), who observed that mango kernel flour has comparative lower oil absorption capacity than WF. The calculated value of swelling index of JSP was 1.344 and the swelling index of WF was 3.404. The swelling index of WF was higher than JSP. Shariful *et al.* (2015) found that the swelling index of jackfruit flour was 1.46 while Menon *et al.* (2014) reported the swelling index value as 4.00 for WF. From the above study, it can be said that the functional properties of the JSP and WF varied from each other and this variation might be due to difference between the category of two sample, particle size of flours and milling process, nutritional properties and chemical structure as well (Das, 2017).

Storage stability of JSP

The existence of any product without any change in the quality can be analyzed by the process of storage study. Moisture is one of the important parameter which interferes the quality of any food product during storage. The storage stability in terms of moisture gain by storing the JSP at room (30˚C) and refrigeration temperature (5˚C) was investigated to get the change in moisture content by gravimetrical determination. JSP with initial moisture of 6.30% was packed in the single layer polythene and kept in laboratory at room temperature and refrigeration temperature and the obtained changed is shown in Figure 1.

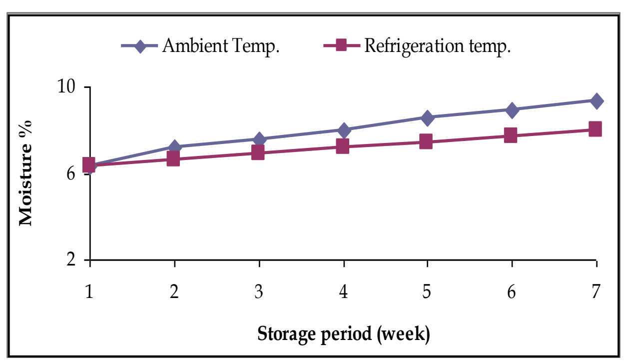

Fig. 1 Effect of storage condition on moisture uptake and storage stability of JSP

The study showed that the moisture uptake by JSP were increased continuously throughout the investigation period for both the storage condition. The moisture was increased both at room and refrigeration temperature. The increasing rate of moisture was higher at room temperature than refrigeration temperature but up to two months of storage, no deterioration was occurred or no visible changes were observed in quality of JSP. However, there was a gradual increase in moisture level over the period of extended life, higher increase in the samples stored at ambient temperature. The result was consistent with Reddy (2011) who observed that sorghum flour could be stored only for 28 days, further more imposed in loss of its functional properties. The extended life of JSP beyond the period of 2 months due to its lowest fat value 1.18% compared to sorghum flour 1.90%.

Chemical composition formulated cakes

The formulated cakes were analyzed for their chemical components such as moisture, protein, ash, fat and total carbohydrate content and the values are presented in Table 4. Also the energy content per 100 g of sample is depicted on Table 4.

Table 4. Chemical compositions of JSP supplemented cakes

Component	Cake Samples			
	A	B	C	D
Moisture (%)	25.56	22.05	19.67	16.92
Protein (%)	8.56	7.20	7.04	6.34
Ash (%)	1.50	2.08	2.35	2.60
Fat (%)	22.42	20.05	17.56	16.01
Total Carbohydrate (%)	41.96	48.62	53.38	58.13
Energy (calculated Kcal/100gm)	403.86	403.73	399.72	401.97

Where, A = 100% WF or control; B = 90% WF and 10% JSP; C = 80% WF and 20% JSP; D = 70% WF and 30% JSP

Moisture

From the table, it is seen that the range of moisture in composite cakes were 16.92 to 25.56%. The control sample had the highest moisture content which reduced with the increasing of JSP supplementation. Khan *et al.* (2016) carried out an experiment to determine the chemical composition of jackfruit seed powder supplement cake and the moisture of composite cake was 26.93 to 22.12% whereas Das (2017) found of the moisture percentage of the Mango Kernel Flour (MKF) composite cake as 15.02 to 13.73% and the control sample was 18.32%. Variation of moisture of cakes may be due the initial moisture of flour, properties of flour and nutritional properties of flour.

Protein

The protein content of different cake samples such as A (100% WF), B (90% WF and 10% JSP), C (80% WF and 20% JSP) and D (70% WF and 30% JSP) were 8.56, 7.20, 7.04 and 6.34% respectively. The protein content of control sample (100% WF) was lower than the other samples. Khan *et al.* (2016) found that the protein content of composite cakes were 6.91 to 8.32% and the protein content of control sample was found 6.21%. Das (2017) was found that the protein content of composite flour was 7.24 to 6.92%). The protein content of developing composite cakes were more or less similar by other researchers. Protein content of the developed cakes varied due to variation of protein content of the flours. Increasing of temperature results in breakdown of protein and sugar in foods, which subsequently causes denaturation of protein (Pascual *et al.,* 2002). This protein denaturation may also responsible for the difference of protein content (Akter and Alim, 2018).

Ash

The ash content of the cake samples were in the range of 1.50 to 2.60%. From the Table 4, the sample D (70% WF and 30% JSP) gave the highest amount of ash as 2.60%, followed by sample B (90% WF and 10% JSP) as 2.08%, sample C (80% WF and 20% JSP) as 2.35% and sample A (100% WF) as 1.50%. The ash content of the cake samples increased with increased amount of JSP. This might be due to JSP contain higher amount of ash than wheat flour.

Fat

From the Table 4, the highest fat content of the sample A (100% WF) was found to be 22.42% and the lowest fat content of the sample D (70% WF and 30% JSP) was as 16.01%. The fat content of cake samples were decreased in addition of different percentage of JSP. Akter and Alim (2018) found the fat content of composite cake was 25.63 to 32.25% prepared from wheat-potato-peanut. From the above result, the fat content of composite samples were more or less similar to other researchers. This might be due to JSP contain lower amount of fat than wheat flour.

Total carbohydrate content

The total carbohydrate content of the sample D having 70% WF and 30% JSP was the highest among the samples while the 100% WF containing sample had the lowest carbohydrate content. The variation in the carbohydrate contents among cakes samples may addition of different percentage of JSP. The variation in the total carbohydrate contents among cakes samples may result from the difference in the amount of protein, fat, ash and moisture content.

Energy

The energy content of control cake (100% WF) was 403.86 Kcal/100g and the energy content of other cake samples such as B (90% WF and 10% JSP), C (80% WF and 20% JSP) and D (70% WF and 30% JSP) were 403.73, 399.72 and 401.97Kcal/100g. Kiin-Kabari and

Banigo (2015) found that the energy values of cakes prepared by plantain flour and Bambara groundnut protein concentrate to be range of 328.2 to 359.5 Kcal/100g of cake. The energy content of JSP were decreased due to the lower fat content.

Physical properties of formulated cakes

The processed cakes were analyzed for their physical characteristics such as weight, height, specific volume (Table 5). The height of the formulated cakes decreased with the increasing of JSP supplementation and was range from 4.04 to 4.70 cm. From the Table 5, it is seen that addition of different percentage of JSP resulted the increasing weight of cakes. The specific volume, the ratio of volume and weight is an important parameter for physical analysis of bakery products also decreased with the increasing of JSP amount as shown in Table 6. Similar results were obtained by Das (2017) in all of above cases where cakes were prepared from mango kernel flour.

Table 5. Physical properties of formulated composite cakes

Sample No.	Height (cm)	Weight (gm)	Specific volume (cc/g)
A	4.70	168.00	1.85
B	4.46	173.00	1.60
C	4.20	177.50	1.50
D	4.04	185.20	1.46

Where, A = 100% WF or control; B = 90% WF and 10% JSP; C = 80% WF and 20% JSP; D = 70% WF and 30% JSP.

The processed cakes also were analyzed for their crust and crumb characteristics like color, consistency, flavor, texture etc and the obtained results are depicted in Table 6.

From the Table 6 and Figure 2, it is seen that the addition of JSP had an effect on the characteristics of crust and crumb of the composite cakes which lead to reveal that acceptability of JSP supplemented cakes could be decreased due to higher percentage of JSP supplementation.

Table 6. Effect of JSP on crust and crumb characteristics of cake

Sample	Crust's characteristics		Crumb's characteristics					
			Texture				Grain	
	Color	Consistency	Color	Lumps and Hardness	Surface	Odor	Close or airy	Shape and size
A	Light	Mild	Brownish	Slightly free	Smooth, silky	appetizing	Airy	Uniform
B	brown	Medium mild	Light radish	Slightly free	Light smooth	Light appetizing	Less airy	Less uniform
C	Deep brown	Medium stiff	Deep radish	Free	Rough	Fruit flavor	Close	Less uniform
D	Blackish	Stiff	Radish	Present	Rough	Fruit flavor	Close	Less uniform

Fig. 2 Pictorial view of the processed cakes; Left to right: Sample A (100% WF); Sample B (90% WF and 10% JSP); Sample C (80% WF and 20% JSP) and Sample D (70% WF and 30% JSP)

Sensory evaluation of cakes

The color, flavor, texture, taste and overall acceptability of 4 samples of the formulated cakes were evaluated by taste testing panel. The mean scores for color, flavor, texture and overall acceptability of different samples were presented in Figure 3. A two way analysis of variance indicated that the color, flavor, texture, taste and overall acceptability of the different cakes were significantly different (P<0.05).

From the score sheet and LSD multiple comparison test, it was found that the JSP supplemented cakes obtained lower score than the control cake sample. Based on this sensory evaluation, it can be concluded that JSP addition to cakes could not get better choice to the consumer. But as all the scores of all samples were higher than 6, so it can be revealed that all cake samples were liked by the taste panelists.

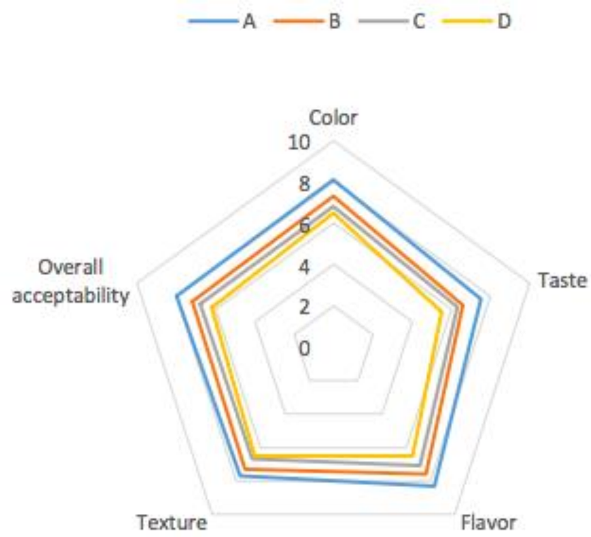

Fig. 3 Sensory scores of developed cakes (LSD at P<0.05 were 0.618, 0.543, 0.506, 0.581 and 0.685 for the sample A, B, C and D respectively)

Conclusion

Utilization of Jamun seed powder in different food products can help in effective utilization of wastage of Jamun seed as well as to get nutritionally better products. In this study, it was found that Jamun seed powder had higher energy content, fiber and mineral than wheat flour which is commonly used in bakery products. Analysis on replacement of wheat flour with Jamun seed powder in composite cake processing showed that composite cakes provide more energy than control one, also good physical characteristics and consumer acceptability up to 10% supplementation. Further research can be conducted to analyze the specific micronutrients, antioxidant activity, cost estimation and minimization etc.

References

AACC. 1983. Cereal Laboratory Methods, Method 46-09. American Association of Cereal chemist, (American Association of Cereal Chemistry., St Paul, MN), 7th Ed.

Akter, N. and Alim, M. A. 2018. Preparation of wheat-potato-peanut composite flour cakes. *Journal of Bangladesh Agricultural University,* 16(2): 315–321. https://doi.org/10.3329/jbau.v16i2.37988

AOAC. 2012. Official Methods of Analysis of the Analytical Chemist, 19th Edition, Washington, D.C. USA.

BBS (Bangladesh Bureau of Statistics). 2015. Estimation of major and minor crops. Statistical year book of Bangladesh, static division, Ministry of planning, Govt. of Peoples Republic of Bangladesh, Dhaka. pp. 199–200.

Birch, G. G., Spencer, M. and Cameron, A. G. 1980. Food Science (2nd edition, pp. 29-37). Oxford, UK: Pergamon Press Ltd.

Chaudhary, B. and Mukhopadhyay, K. 2012. Jamun (*Syzygium cumini*) skeels: A potential source of nutraceuticals. *International Journal of Phermacy and Biological Science*, *(IJPBS)*, 2(1): 46–53.

Chopra, R. N., Nayar, S. L. and Chopra, I. C. 1956. Glossary of Indian medicinal plants. International Research of cereal science, New Delhi p.161 & 238.

Das, P. C. 2017. Development of flour from Mango kernel and its utilization in composite cake preparation. MS Thesis, Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh.

Das, P. C., Rana, M. S., Saifullah, M. and Islam, M. N. 2018. Development of composite biscuits supplementing with potato or corn flour. *Fundam Appl Agric*, 3(2): 453–459. https://doi.org/10.5455/faa.2924381

Desai, G.B., Sawate, A.R., Taur, A. T., Thorat, P.P., Deshmukh, N. M., Kshirsagar, R.B. and Patil, B. M. 2018. Effect of fortification of Jamun seed (*Syzygium cumini*) powder on nutritional and sensory quality of herbal multigrain cookies. *International Journal of Chemical Studies (IJCS),* 6(2): 1083–1087.

Devi, C. A., Swamy, G. S. K. and Naik, N. 2016. Studies on Storage and Viability of Jamun Seeds (Syzygium cuminii Skeels). *Biosciences Biotechnology Research Asia,* 16(4): 2371-2378. http://dx.doi.org/10.13005/bbra/2408

Huang, Y. P., Choi, J. H., Yun, H. J., Han, E. H., Kim, H. G., Kim, J. Y., Park, B. H., Khanal, T., Choi, J. M., Chung, Y. C. and Jeong, H. G. 2012. Anthocyanins from purple sweet potato attenuate dimethyl nitrosamine induced liver injury in rats by inducing Nrf2-mediated antioxidant enzymes and reducing COX-2 and Inos expression. *Food Chemistry and Toxicology*, 49(1): 93-99. https://doi.org/10.1016/j.fct.2010.10.002

Joshi, S. G. 2001. Medicinal plants. New Delhi: Oxford & IBH Publishing Co.

Kannan, A. and Puraikalan, Y. D. 2016. Development and effects of Jamun seed powder incorporated cookies. *International Journal of Science and Research,* 5(4): 1934–1935. https://doi.org/10.21275/v5i4.NOV163016

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. https://doi.org/10.3329/jbau.v14i2.32697

Khetarpaul, N., Grewal, R. B. and Jood, S. 2005. Quality control in bread making, In: Bakery Science and Cereal Technology. Daya Publishing house, New Delhi. pp - 71.

Kinn-Kabari, D. B., Banigo, E. B. 2015. Quality characteristics of cakes prepared from wheat and unripe plantain flour blends enriched with Bambara groundnut protein concentrate. *European Journal of Food Science and Technology*, 3(3): 1–10.

Lee, M. R., Swanson, B. and Gand, B. 2001. Influence of amylase content on properties of wheat starch and bread making qualities of starch and gluten blends. *Cereal Chemistry*, 78: 701-706. http://dx.doi.org/10.1094/CCHEM.2001.78.6.701

Lin, M. J. Y., Yao, Q., Wang, S. and Susulki, F. W. 1974. Certain functional properties of sunflower seed proteins. *Journal of Food Science*, 39**:** 368-370. https://doi.org/10.1111/j.1365-2621.1974.tb02896.x

Menon, L., Majumder, S. D. and Ravi, I. 2014. Mango (Mangifera indica L.) kernel flour as a potential ingredient in the development of composite flour bread. *Indian Journal of Natural Products and Resources*. 5(1): 75–82.

Okaka, J. C. and Potter, N. N. 1977. Functional properties of wheat flour blend in bread making. *Journal of Food Science*, 42: 828–833. https://doi.org/10.1111/j.1365-2621.1977.tb12614.x

Pascual, E. C., Goodman, B. A. and Yeretzian, C. 2002. A new mechanism of the Maillard Reaction involving sugar fragmentation. *Journal of Agricultural and Food Chemistry*, 50: 6114–6122. https://doi.org/10.1021/jf020352k

Pathak, R. K. and Pathak, R. A. 1993. Improvement of minor fruits, (In) Advances in Horticulture (Chadha, K.L and Pareek, O. P.-Eds), Malhotra Publishing House, New Delhi, 1: 407–422.

Pearson, D. 1976. *The Dictionary of Nutrition and Food technology*. 5th edition. Butter warth publication, London.

Priyanka, A.A.M. and Mishra, A. A. 2015. Development and quality evaluation of Jamun powder fortified biscuits using natural sweeteners. *International Journal of Science, Engineering and Technology,* 3(3): 796–801.

Ranganna, S. 2005. Handbook of analysis of quality control for fruit and vegetable products. Second edition, Tata McGraw Hill Publications Company Limited, New Delhi. pp. 1–30.

Razoanul, H., Mariya, K. S., Najmuj, S., Omar, S. S., Tanjir, T. I. S., Saddam, H., Anisul, I., Anowar, K. P., Ali, A. T. and Shuvra, K. D. 2017. Antimicrobial activity of jambul (*Syzygium cumini*) fruit extract on enteric pathogenic bacteria. *Advances in Microbiology*, 7(3): 195–204. https://doi.org/10.4236/aim.2017.73016

Reddy, M. 2001. Influence of processing effects of sorghum genotypes on roti making quality. MH.Sc. (Thesis). University of Agricultural Science, Dharwad.

Roy, A. C., Bhattacharyya, A. K. 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(3)**:** 347–353.

Shahnawaz, M., Sheikh, S. A., Bhangar, M. I. and Ahmed, E. 2010. Total phenolic compounds and antioxidant activity of jamun fruit (Eugenia jambolana) products. *Pakistan Journal of Food Science*, 20(1-4): 31–41.

Shariful, I. M., Rokeya, B., Morshada, K. and Kamalesh, C. D. 2015. A Study on nutritional and functional properties analysis of jackfruit seed flour and value addition to Biscuits. *International Journal of Engg. Resource and Technology (IJERT)*, 4(12)**:** 139–147.

Sosulski, F. W., Humbert, E. S., Bui, K. and Jones, J. O. 1976. Functional properties of rapseed flour concentrates and isolate. *Journal of Food Science*, 41: 1348–1354. https://doi.org/10.1111/j.1365-2621.1976.tb01168.x

Suresh, C. and Samsher. 2013. Assessment of functional properties of different flours. *African Journal of Agricultural Research*, 8(38**):** 4849–4852. https://doi.org/10.5897/AJAR2013.6905

Thaper, A. R. 1958. Farm Bulletin, No. 42, ICAR, New Delhi.

Thorat, A. V. and Khemnar, M. B. 2015. Development and sensory evaluation of Jamun seed powder fortified cookies. *International Journal of Science and Research (IJSR),* 4(10): 184–187.