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Development of jamun-bael blended fruit cheese as a functional food

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ABSTRACT

A highly nutritious fruit cheese as functional food was developed by blending jamun and bael fruits. The blended fruit cheese was analyzed for its bioactive components and sensory quality during storage under ambient conditions. Total phenols, antioxidant activity, vitamin C, and anthocyanin content in jamun-bael blended cheese increased with jamun pulp from 9.25 to 189.42 mg/100 g, 37.31 to 69.18 %, 1.65 to 6.24 mg/100 g, and 9.98 to 49.37 mg/100 g, respectively. However, the carotenoid content improved with adding bael pulp from 8.26 to 32.77 mg/100 g. Sensory evaluation of jamun-bael blended fruit cheese showed that the blend having 40:60::Jamun: Bael scored the best values among all the treatments concerning colour, taste, flavour, and mouthfeel. It was observed that the organoleptic properties of the blended product were more appealing compared to the treatments with a single fruit.

Keywords: *Syzygium cumini* L. (Jamun), *Aegle marmelos* Corr. (Bael), fruit cheese, functional food

INTRODUCTION

Confectionary items are energy dense products mainly prepared from sucrose, fructose, glucose or maltose syrups, fruit concentrates, artificial colour and flavours, similar to fruits, which makes them harmful for health. Besides it is a poor source of nutrients as well as functional components. Fruit cheese is becoming more and more popular because of high acceptability, higher nutritional value and longer storage life, which make it a potential food supplement for children and adults. Fruits have been used in sweet delights and confections for centuries. Fruits supplement our diet with macronutrients such as vitamins and minerals as well as other phytonutrients (anthocyanins, polyphenols, antioxidants and carotenoids). Fruit cheese is a product prepared by cooking fruit pulp or puree with nutritive sweeteners and salt until it obtains a consistency that sets on cooling. It may be prepared with single or combination of suitable fruits [10]. Jamun (*Syzygium cumini* L.) fruit is commonly known as black plum or Indian blackberry. It is a rich source of bioactive components such as flavonoids, anthocyanins, phenolic compounds and antioxidant activity. The ripe jamun fruit is sweet and tart to taste and contains major sugar as glucose and fructose [2]. Jamun fruit traditionally been used to manage diabetes mellitus and reported to have antidiabetic properties. The fruit has also gained attention due to some other medicinal properties including antibacterial, anti-inflammatory and preventing gastrointestinal problems and thus, Ayurveda has entitled it with name, herbal medicine [13].

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Bael (*Aegle marmelos* Corr.) is an aromatic and resinous fruit which is reported to have medicinal properties from prehistoric times. The fully ripened fruit is sweet, astringent and laxative and has beneficial effect on heart, brain and stomach [5]. The bael fruit is enriched with many therapeutic and bioactive compounds such as carotenoids, alkaloids, coumarins and terpenoid which may protect against chronic diseases [15]. Many products like jams, bars, jellies, leather, toffee, squash and chutney are prepared from different fruits but fruit cheese from jamun and bael is newer in taste and higher in nutritional quality. Apple, plum, pear banana, sapota and guava have been used for developing fruit cheese as discussed by Sucheta *et al*. [18]. A nutritious fruit cheese was prepared by Kumar *et al*. [10] from aonla and papaya fruits. Being highly perishable, jamun is relished as a raw fresh fruit because of its astringent taste. On the other hand, bael has a peculiar flavour which is unknown to most of the population due to its resinous and mucilaginous nature. So, this study was focused on exploiting the beneficial properties of these underutilized fruits. Efforts were made to formalise a functional food product by blending fruit pulp in different ratios. Therefore, the present study was based on development of fruit cheese from jamun and bael which was evaluated for bioactive components and sensory quality during ambient storage of 90 days.

MATERIALS AND METHODS

The present study was conducted in the Division of Food Science and Technology, at SK University of

Agricultural Sciences and Technology of Jammu in the session 2019-20. Jamun fruits were purchased from the local market of Jammu and bael fruits were procured from Rainfed Research Sub-Station for Sub-Tropical Fruits - Raya, Jammu and Kashmir. The other raw materials like sugar, citric acid, butter, salt and pectin (Purix®, E440) were also procured from local market of Jammu.

Jamun pulp was manually separated from seeds and grounded into a fine pulp. While, ripened bael fruits with a uniform outer yellow coat were taken and washed thoroughly. The hard coat of bael fruit was half opened using hammer. The pulp was scooped out with seeds and fibers. The scooped pulp was homogenised (1:1 pulp and water) by blending it manually and passed through stainless steel sieve to remove seeds. Then the pulp was heated to 80ºC for 1 minute with intermitted stirring followed by cooling. Finally, the cooled pulp was filled in pre-sterilized glass bottles, corked and stored till further use (Fig 1).

The extracted fruit pulp was blended into different treatments with ratios of jamun to bael as T_1 with 100:0 pulp %, T_2 with 80:20 pulp %, T_3 with 60:40 pulp %, T_4 with 40:60 pulp %, T_5 with 20:80 pulp % and T_6 with 0:100 pulp %, respectively. Jamun-bael fruit cheese was developed as per the standard procedure with certain modifications. The recipe remained constant for all the treatments which included 1 kg pulp (blended ratios), 750 g sugar, 70 g butter, 3 g citric acid and 3 g salt (Fig. 2). Two per cent pectin was also added for proper setting of fruit cheese. The mixture of jamun-bael blended pulp, sugar, butter and citric acid was cooked with constant stirring to obtain desired consistency. Pectin dissolved in lukewarm water was added to the cooking mass and finally salt was added when it started leaving sides of the vessel. End point was judged by sheet test and total soluble solids (72ºBrix). Fruit cheese was finally spread on butter smeared trays (0.60 cm) which was then left for setting. Cheese was cut into suitable size pieces and wrapped in butter paper and finally packed in 100 g capacity LDPE bags (150 gauge). The prepared fruit cheese was stored for 90 days (3 intervals) under ambient (24.8±5.02ºC and RH 62±5 %) conditions. The samples were analysed for various bioactive and organoleptic parameters at an interval of 30 days.

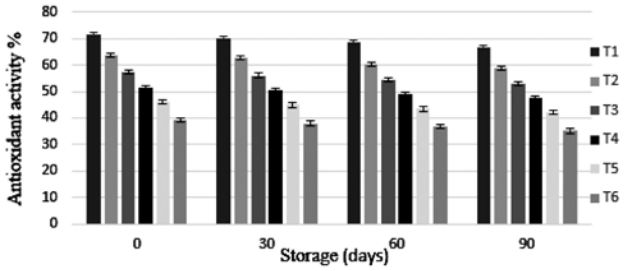

Fig. 2: Antioxidant activity (%) of jamun-bael blended fruit cheese

Carotenoid content was analyzed as per the method discussed by Carvalho *et al*. [7]. The total phenolic content of fruit cheese was estimated by Folin-Ciocalteau (FC) method [1] and expressed in mg Gallic acid equivalents (GAE)/100 g of sample. Ascorbic acid was determined by titrimetric method using 2,6- dichlorophenol indophenol dye [4]. Free radical scavenging activity was determined by DPPH (diphenyl picryl hydrazyl) method [11]. Total anthocyanins were determined according to the method given by Ranganna [14].

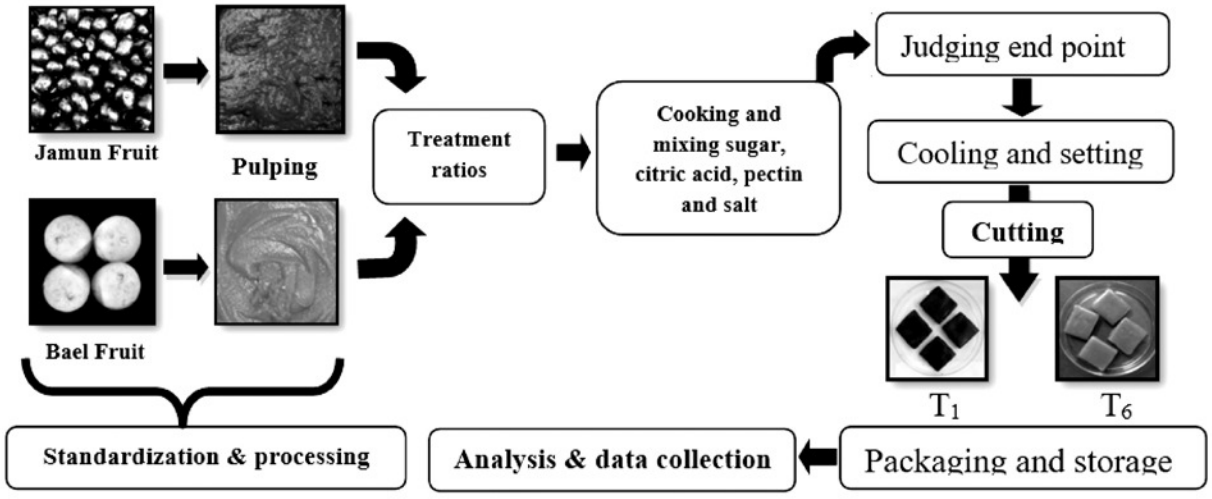

Fig. 1: Preparation of jamun-bael blended fruit cheese.

Sensory evaluation of samples were done on the basis of colour, taste, flavour and mouthfeel by a panel of semi-trained members (9-10 judges) using a 9 point Hedonic scale. A score of 9.0 denotes "like extremely" whereas "dislike extremely" score was denoted by 1.0. Average score of 5.5 and above was considered acceptable [3]. The mean values of triplicates were interpreted through analysis of variance and data obtained were analysed statistically [8] in a factorial completely randomized design (CRD) layout using SPSS 16.0 version.

RESULTS AND DISCUSSION

The carotenoid content (Table 1) of jamun-bael fruit cheese decreased from 20.90 to 20.05 mg/100 g during storage. The interaction between treatments and storage conditions at $p \leq 0.05$ was non-significant. During storage, these losses could be due to non-oxidative changes (thermal degradation) or oxidative changes as reported by Kumar [10]. Sucheta *et al.* [17] observed significant difference among the treatments during storage of guava-mango cheese. Highest carotenoid (32.77 mg/100g) content was recorded in treatment T_6 (0:100::Jamun:Bael) and the lowest carotenoid content (8.26 mg/100g) was recorded in treatment T_1 (100:0::Jamun:Bael). This increase in carotenoid content was statistically significant with increasing concentration of bael pulp in the treatments.

During storage, total phenolic content decreased by 6.83 % by the end of third interval. The treatments were statistically significant at $p \leq 0.05$. Treatment with 100 % jamun (T_1) showed highest total phenolic content of 189.42 mg/100g. However, with the blending of jamun, the phenolic content increased in other treatments but lowest content (9.25 mg/100g) was recorded in T_6 (0:100::Jamun:Bael). Phenolic compounds are highly unstable and easily oxidises to give brown products of high molecular weight. The decrease in total phenolic content during storage might be due to their condensation into brown pigments (enzymatic browning). Sucheta *et al*. [17] also reported similar decrease in total phenols in mixed fruit cheese.

Ascorbic acid also known as vitamin C is one of the important nutritive components of human diet. Ascorbic acid content of T_1 (100:0::Jamun:Bael) was 2.78 times higher than that in T_6 (0:100::Jamun:Bael) (Table 2). There was significant difference among the treatments with respect to ascorbic acid which might be due to variation in composition of fruits. Vitamin C content in fruit cheese decreased from 4.67 to 3.30 mg/100g by the end of third interval of storage. This might be due to its sensitivity to heat and it also oxidizes quickly in presence of oxygen. These findings are in accordance with Akhila and Hiremath [2] who reported decrease in ascorbic acid content in jamun jam during 90 days storage of product.

With the advancement of storage, Anthocyanin content decreased significantly by 18.68 % by the end of 90 days (Table 2). The treatments were statistically significant at $p \leq 0.05$. The interaction between treatment and storage was also significant ($p \leq 0.05$). Treatment T_1 (100:0::Jamun:Bael) reported highest anthocyanin content of 49.37 mg/100g and lowest was found in T_5 (0:100:: Jamun: Bael) whereas, no anthocyanin content was found in T_6 (0:100::Jamun:Bael) at 0 day. This decrease might be due to their condensation into brown pigments [12]. Bhardwaj *et al*. [6] in guava-jamun jam also reported

Table 1. Carotenoids (mg/100g) and total phenolic content (mg/100g) of jamun-bael blended fruit cheese

Treatment (Jamun : Bael)	Carotenoids (mg/100g)					Total phenols (mg/100g)				
	Storage period (days)				Mean	Storage period (days)				Mean
	0	30	60	90		0	30	60	90	
T_1 (100 : 0)	8.80	8.26	8.07	7.92	8.26	193.42	190.18	188.75	185.32	189.42
T_2 (80 : 20)	13.51	13.04	12.86	12.69	13.02	155.67	153.45	151.34	148.71	152.29
T_3 (60 : 40)	17.67	17.19	16.98	16.78	17.16	116.54	114.36	112.62	109.87	113.35
T_4 (40 : 60)	23.06	22.54	22.35	22.17	22.53	84.26	82.11	80.11	77.48	80.99
T_5 (20 : 80)	29.12	28.63	28.47	28.30	28.63	43.41	41.27	39.23	36.62	40.13
T_6 (0 : 100)	33.25	32.79	32.60	32.44	32.77	12.18	10.22	8.54	6.06	9.25
Mean	20.90	20.41	20.22	20.05		100.91	98.60	96.76	94.01	
			$CD_{(0.05)}$					$CD_{(0.05)}$		
Treatment (T)			0.05					0.03		
Storage (S)			0.04					0.03		
T×S			NS					0.07		

Table 2: Vitamin C and anthocyanin content (mg/100g) of jamun-bael blended fruit cheese

Treatment (Jamun : Bael)	Vitamin C (mg/100g)					Anthocyanin (mg/100g)				
	Storage period (days)				Mean	Storage period (days)				Mean
	0	30	60	90		0	30	60	90	
T_1 (100 : 0)	7.50	6.68	5.60	5.18	6.24	52.69	50.41	48.07	46.32	49.37
T_2 (80 : 20)	6.03	5.57	5.15	4.69	5.36	41.52	39.76	37.95	35.87	38.78
T_3 (60 : 40)	5.12	4.73	4.29	3.87	4.50	30.89	28.93	26.72	24.95	27.87
T_4 (40 : 60)	4.09	3.67	3.23	2.82	3.45	19.76	17.84	15.87	13.78	16.81
T_5 (20 : 80)	3.17	2.78	2.36	1.97	2.57	12.47	10.59	9.84	7.03	9.98
T_6 (0 : 100)	2.11	1.79	1.45	1.24	1.65	ND	ND	ND	ND	ND
Mean	4.67	4.20	3.68	3.30		26.22	24.59	23.07	21.32	
			$CD_{(0.05)}$					$CD_{(0.05)}$		
Treatment (T)			0.03					0.04		
Storage (S)			0.03					0.03		
T×S			0.07					0.08		

significant decrease in anthocyanin content during storage.

The treatments showed statistically significant difference at $p \leq 0.05$. The Antioxidant activity was recorded highest in treatment T_1 (100:0::Jamun:Bael) with 69.18 % and the lowest (37.31 %) in treatment T_6 (0:100::Jamun:Bael) (Fig. 2). Jamun fruit possessed higher antioxidant activity which might be the reason for decrease in antioxidant activity from treatment T_1 to T_6. The interaction between treatments and storage were statistically significant ($p \leq 0.05$). With the advancement of 90 days of storage period, the mean antioxidant activity decreased from 54.92 to 50.51 %. The loss in antioxidant activity could be attributed to oxidation and loss of ascorbic acid and phenolic compounds with passage of time. Kopjar *et al.* [9] also reported decrease in antioxidant activity of strawberry jam during storage.

The sensory evaluation of fruit cheese, presented in Table 3 and 4, showed significant difference among treatments ($p \leq 0.05$). Fruit cheese had lower sensory scores for colour (7.42), taste (7.25), flavour (7.08) and mouthfeel (7.09) in treatment T_1 (100:0::Jamun:Bael). The highest score for colour (8.01) was reported in T_4 (40:60::Jamun:Bael). The colour value decreased with decreasing level of bael pulp as the product became darker due to increase in jamun pulp in treatments. During storage, colour

Table 3: Sensory scores on colour and taste of jamun-bael blended fruit cheese

Treatment (Jamun:Bael)	Colour					Taste				
	Storage period (days)				Mean	Storage period (days)				Mean
	0	30	60	90		0	30	60	90	
T_1 (100 : 0)	7.73	7.58	7.36	7.01	7.42	7.51	7.37	7.19	6.92	7.25
T_2 (80 : 20)	7.85	7.69	7.48	7.08	7.53	7.86	7.70	7.54	7.29	7.60
T_3 (60 : 40)	8.00	7.83	7.51	7.21	7.64	8.03	7.88	7.69	7.45	7.76
T_4 (40 : 60)	8.39	8.21	7.93	7.52	8.01	8.23	8.14	7.87	7.65	7.97
T_5 (20 : 80)	8.26	8.07	7.78	7.32	7.85	8.15	8.00	7.75	7.60	7.88
T_6 (0 : 100)	7.98	7.81	7.49	7.12	7.60	7.65	7.49	7.34	7.12	7.40
Mean	8.03	7.87	7.59	7.21		7.91	7.76	7.56	7.34	
			$CD_{(0.05)}$					$CD_{(0.05)}$		
Treatment (T)			0.03					0.03		
Storage (S)			0.02					0.02		
T×S			0.07					0.05		

Table 4: Sensory scores on flavour and mouthfeel of jamun-bael blended fruit cheese

Treatment (Jamun:Bael)	Flavour					Mouthfeel				
	Storage period (days)				Mean	Storage period (days)				Mean
	0	30	60	90		0	30	60	90	
T_1 (100 : 0)	7.21	7.10	7.04	6.97	7.08	7.38	7.16	7.01	6.81	7.09
T_2 (80 : 20)	7.46	7.39	7.19	7.05	7.27	7.42	7.28	7.14	6.93	7.20
T_3 (60 : 40)	8.19	8.00	7.65	7.50	7.83	7.60	7.44	7.31	7.16	7.38
T_4 (40 : 60)	8.33	8.21	8.13	8.02	8.17	8.26	8.12	7.96	7.81	8.04
T_5 (20 : 80)	8.24	8.14	7.79	7.68	7.96	8.15	8.04	7.82	7.69	7.93
T_6 (0 : 100)	7.56	7.40	7.20	7.00	7.29	8.06	7.89	7.64	7.43	7.76
Mean	7.83	7.71	7.50	7.37		7.81	7.65	7.48	7.30	
			$CD_{(0.05)}$					$CD_{(0.05)}$		
Treatment (T)			0.03					0.04		
Storage (S)			0.05					0.03		
T×S			0.06					0.08		

score decreased from 8.03 to 7.21, which might be due to browning reactions occurring with the interaction of sugars and protein in the product. Degradation of coloured pigments (anthocyanins) resulted in decrease of colour values as reported by Vukoja *et al*. [19] during cherry jam storage studies. Similar results were found by Singh *et al*. [17] in jam prepared from three mango cultivars.

The interaction between storage and treatments was statistically significant at $p \leq 0.05$. Treatment T_4 (100:0::Jamun:Bael) recorded highest mean score for taste (7.97), flavour (8.17) and mouthfeel (8.04). The decrease in sensory scores of blended cheese during 90 days of storage might be due to loss of freshness and volatile compounds from the product [13]. Similar findings were observed by Sinha *et al*. [16] in guava-jamun blended cheese and Narayana *et al*. [12] in banana fruit bar.

Based on the results of our study, it is concluded that jamun and bael fruits can be blended in appropriate ratio to formulate fruit cheese with improved nutritional quality. For the development of good quality fruit cheese jamun pulp (40 %) can be substituted with bael pulp upto 60 %. The blended cheese (40:60 jamun: bael) comprised of carotenoids 22.53 mg 100 g, total phenols 80.99 mg 100 g, vitamin C 3.45 mg 100 g and anthocyanin 16.81 mg 100 g. The prepared cheese can be stored at ambient conditions for 90 days without much loss in nutritional quality. Therefore, by preparing jamun-bael blended value added products the processing industry can fulfil the dual purpose of better use of these perishable fruits (having high therapeutic value) thus lowering post-harvest losses and will also give good returns to the growers.

AUTHORS' CONTRIBUTION

Conceptualization of research: M. Sood, G. Yadav Designing of the experiments: M. Sood, J. D. Bandral, N. Gupta Contribution of experimental materials: M. Sood, J. D. Bandral, G. Yadav, N. Gupta Execution of field/lab experiments and data collection: G. Yadav, M. Sood Analysis of data and interpretation: G. Yadav, M. Sood Preparation of the manuscript: G. Yadav, M. Sood

DECLARATION

The author declares that there is no conflict of interest.

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