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# Antioxidant Potentials and Quality of Blended Pear-Jamun (Syzygium cumini L.) Juice

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# Abstract

Enriched beverage prepared by supplementing pear juice with jamun pulp was assessed for antioxidant activity and quality. Jamun pulp was supplemented at the levels of 5,10,15,20 and 25 per cent and optimized on the basis of sensory evaluation and color characteristics. Sensory scores were highest for pear juice supplemented with 20 per cent jamun pulp and was further chosen for storage studies. Color values (L\*,  $a^*$ ,  $b^*$  and hue angle) were significantly (p<0.05) affected by increasing supplementation level, resulting in darker product. Jamun pulp supplementation enhanced the bioactive composition of pear juice in terms of increased ascorbic acid, anthocyanins, total phenols and antioxidant activity increased by 15.31 and 20.52 percent, respectively after incorporation of jamun pulp at 20 per cent. Physico-chemical characteristics of pear juice were not affected much by incorporation of jamun pulp. Storage period of six months resulted in reduction of bioactive components and had a variable effect on physico-chemical characteristics of the blended pear-jamun juice. Overall, it can be concluded that jamun pulp can be used as a potential source to boost nutritional significance of the resultant beverage.

Keywords: Jamun (Syzygium cumini L.), bioactive components, pear juice, color.

# Introduction

Fruits and vegetables and their products are extremely important in human nutrition. Natural bioactive compounds such as polyphenols, anthocyanins and carotenoids derived from fruits offers health benefits such as protection against cancer, cardiovascular diseases, age related macular degeneration and other diseases of modern lifestyle<sup>1</sup>. Processed fruit juice beverages are one of the fastest growing segments within the beverage industry as these serve as dietary supplements and are rich in vitamins, minerals, vital micronutrients with many potential health benefits. Pear fruit is one of the commonly grown pome fruit in the temperate and sub tropical regions of the world. Pear fruit is rich in minerals (calcium and magnesium), polysaccharides, polyphenols and flavour compounds<sup>2</sup>. Fruit is known for maintaining desirable acid-base balance in human body, helpful in heart diseases and gastro intestinal tract disorders<sup>3</sup>.

Jamun (Syzygium cumini L.) fruit belongs to the family Myrtaceae and has been valued in Ayurveda and Unani system of medication for possessing variety of therapeutic properties<sup>4</sup>. Jamun fruit is rich in carbohydrates, minerals such as manganese, zinc, iron, calcium, sodium and potassium and vitamins<sup>3</sup>. The edible pulp contains various phytochemicals like Vitamin C, Vitamin A, riboflavin choline, anthocyanins and various other polyphenols<sup>6</sup>. Jamun fruit has long been used for the treatment of diabetes prior to the discovery of insulin and possess various pharmacological properties such as antibacterial, antifungal, antiviral, anti-genotoxic, anti-

inflammatory, anti-ulcerogenic, cardioprotective, anti-allergic, anticancer, chemopreventive, radioprotective, free radical scavenging, hepatoprotective, anti-diarrheal and hypoglycaemic<sup>7</sup>. *Jamun* fruits are processed to make jam, jellies, squash, vinegar and ice cream for its pleasing and attractive purple colour due to presence of anthocyanins. Thus, flavonoids present in the fruit play dual role as attractive natural colorants which also add nutrition to the food and helps improve overall quality of food.

Inspite of high nutritive value not much break through seems to have been made in efficient utilization of *jamun* fruit in the field of beverage industry. Pear juice has low acidity and insipid flavour, which is a constraint for large scale processing. Thus, blending of *jamun* pulp with pear juice offers many opportunities to develop balanced health product high in quality in respect of both sensory and nutritional aspects. Hence, the present study has been undertaken to study the incorporation of *jamun* pulp in pear juice and to evaluate the antioxidant status and quality of prepared product.

# **Material and Methods**

**Raw material:** *Jamun (Syzygium cumini* L.) fruit was obtained from local market, Ludhiana, Punjab, India and Pear fruit was obtained from Department of Fruit Science, Punjab Agricultural University, Ludhiana, Punjab.

**Processing of** *jamun* **fruit into pulp:** *Jamun* fruit was processed into pulp by heating gently for 10 min. at  $60^{\circ}$ C in its

own juice. Seeds were removed manually and pulp was collected by passing the seedless material through fruit strainer. Pulp was further heated to  $82^{\circ}$ C for 3 min., filled hot in presterilized clean glass bottles (200 ml) and processed in boiling water for 20 min. followed by cooling to room temperature. The bottles were stored at  $4-7^{\circ}$ C till further use.

**Product preparation:** Pear fruit was washed thoroughly. peeled and trimmed. Peeled fruits were dipped in 0.05 per cent solution of potassium metabisulphite (KMS) to prevent enzymatic browning till further processing. Peeled fruits were cut in to pieces and passed through screw type juice extractor. The extracted juice was wrapped in nylon cloth and squeezed to strain out the juice. The pear juice after extraction and filtration was blended with jamun pulp at the levels of 5, 10, 15, 20 and 25 per cent and immediately analyzed for titratable acidity and <sup>o</sup>B. Brix-adjustment was made by adding refined white sugar to fresh pear juice until 14°B and acidification was achieved at 0.25 per cent by adding citric acid. Pear juice blended with jamun pulp was pasteurized at 82°C for 3 min. Hot juice was filled in pre-sterilized glass bottles (200 ml capacity) and corked immediately followed by processing in boiling water for 20 minutes. Bottles were cooled quickly to room temperature and stored at ambient conditions. Final product was optimized on the basis of sensory evaluation score for different attributes.

**Sensory evaluation:** *Jamun* supplemented pear juice was evaluated for sensory attributes (appearance, color, flavor, body and overall acceptability) using 9- point hedonic scale<sup>8</sup>. Seven semi-trained panellists in the age group of 22-55 years having no medical disorder from the department of Food Science and Technology, PAU, Ludhiana were selected to evaluate the sensory properties of *jamun* blended pear juice.

**Color analysis:** Color analysis was performed using Hunter Lab Colorimeter, MiniScan XE Plus (Hunter Lab, Reston, VA). Colour readings were expressed by Hunter values for  $L^*$ ,  $a^*$  and  $b^*$ . The  $a^*$  value ranged from -100 (greenness) to +100 (redness), the  $b^*$  value from -100 (blueness) to +100 (yellowness), whereas the  $L^*$  value, indicating the measure of lightness, ranged from 0 (black) to 100 (white)<sup>9</sup>. Hue angle was calculated using the formula tan<sup>-1</sup>  $b^*/a^*$ .

**Proximate composition:** Processed *jamun* pulp and fresh pear juice was evaluated for total soluble solids using hand refractrometer. Titratable acidity was evaluated by titrating known volume of aliquots against 0.1 N NaOH and expressed as percent malic acid<sup>10</sup>. Total sugars and reducing sugars were estimated using Lane and Eynon method<sup>11</sup>. Crude fibre was estimated using Fibertec (FOSS), ash and protein content were estimated as per<sup>11</sup>.

**Bioactive composition:** Ascorbic acid has been determined using direct colorimetric method<sup>10</sup> and expressed as mg/100g. The samples were analyzed for total anthocyanins content by spectrophotometric method<sup>12</sup> and expressed as mg/100g.Total phenolic content was determined according to Folin-Ciocalteu spectrophotometric method<sup>13</sup>. Methanolic extract of the sample

was analyzed for total phenols spectrophotometrically at 765nm (Spectronic 20, Bausch and Lomb, USA). The results were expressed as mg GAE/100g by taking gallic acid as reference material to construct standard curve.

Antioxidant activity: Antioxidant activity was determined by DPPH (di phenyl picryl hydrazyl) method according to Brand-Williams et al.<sup>14</sup> with some modifications. To the methanolic extract of the sample, tris HCl buffer (pH 7.4) and 0.1mM DPPH was added. The contents were mixed immediately and the degree of reduction of absorbance was recorded continuously for 30 min. at 517 nm (Spectronic 20, Bausch and Lomb, USA). Antioxidant activity was calculated according to following formula.

	(Control	Absorbance	e (0	min)	—
	Sample	Absorbance	(30	min)	х
Antioxidant activity (%) -	100)				
Antioxidant activity $(70) =$					_

Control Absorbance (0 min)

**Statistical analysis:** Analyses were carried out using three independent determinations and expressed as mean value except for sensory evaluation where seven independent readings were expressed as mean value. Data were analyzed by student's t-test for fresh and processed *jamun* pulp. Data collected from '*jamun*' pulp supplemented pear juice were subjected to ANOVA (Analysis of variance), comparing averages using Duncan's test at 95% confidence interval using the SPSS software, version 18.0 (Statsoft Inc. USA).

#### **Results and Discussion**

Physico-chemical composition of fresh jamun fruit and processed jamun pulp: Physico-chemical composition of fresh jamun and processed jamun pulp is depicted in Figure-1. Total soluble solids were found to be  $10.2^{\circ}$  B in fresh *jamun* and  $11.9^{\circ}$ B in processed *jamun* pulp. Similar results were established by Ali et al.,<sup>15</sup> where the authors reported 9.11° B of TSS in fresh jamun pulp. Total solids of fresh and processed jamun pulp that comprised mainly of reducing and total sugars, acids, crude fibre, protein and ash were noted as 12.62 and 13.37 per cent, respectively. Increased total solids in processed jamun pulp as compared to fresh jamun fruit might be due to concentration effect of pulp during processing. Titratable acidity values of 0.86 and 0.88 per cent were recorded for fresh jamun fruit and jamun pulp, respectively indicating acidic nature of the fruit. Total sugars values correspond to 12.95 and 11.99 per cent, respectively for fresh jamun and processed jamun pulp. The results are in line with Joshi et al.<sup>16</sup> where the authors reported 12.44 per cent total sugars in *jamun* fruit. Slightly higher values of reducing sugars were found in whole fruit (9.35%) than jamun pulp (7.89%). Crude fiber and ash content of fresh jamun was found to be 0.86 and 0.34 per cent, respectively. Similarly, for processed pulp it was 0.64 and 0.27 per cent, respectively. Values of ash content correspond with the findings made by Shahnawaz et al<sup>17</sup> in freshly extracted jamun pulp. Protein content has been noted as 0.99 and 0.92 per cent in fresh fruit and processed *jamun* pulp, respectively.



Figure-1 Physico-chemical composition of fresh *jamun* fruit and processed *jamun* pulp

**Bioactive composition of fresh** *jamun* and processed *jamun* **pulp:** The bioactive composition of fresh *jamun* and processed *jamun* pulp detailed in Table-1 revealed ascorbic acid content as 21.77 mg/100 g for fresh *jamun* fruit and 18.29 mg/100 g for processed *jamun* pulp. Ascorbic acid is a reducing agent and is vulnerable to light induced oxidation in addition to thermal degradation that may have occurred during processing of *jamun* pulp. Joshi *et al*<sup>16</sup> reported 26.80 mg/100g of ascorbic acid in *jamun* fruit and Shahnawaz *et al*<sup>17</sup> established 19.14 mg/100g of vitamin C in fresh *jamun* pulp. The anthocyanin content of fresh

*jamun* fruit and processed *jamun* pulp was found as 126.54 mg/100g and 112.56 mg/100g, respectively (table-1). Benherlal and Arumughan<sup>18</sup> also observed similar values of anthocyanins in *jamun* pulp (134 mg/100g) and Chowdhury and Ray<sup>19</sup> depicted 140 mg/100g anthocyanins in *jamun* fruit. Temperature is one of the factors that affect the stability of anthocyanins and degradation of anthocyanins occurs with increase in temperatures<sup>20</sup> resulting in lower anthocyanin content in *jamun* pulp. Total phenolic content of processed *jamun* pulp was noted to be slightly lower (2158.89 mg GAE/100g) than fresh fruit

(2250.91 mg GAE/100g) (table-1). Rai *et al*<sup>21</sup> determined the total phenolics in the range of 1175.17mg/100g to 2097.82 mg/100g in *jamun* fruit packaged under different modified atmosphere. Fresh *jamun* had 91.83 per cent antioxidant activity and processed *jamun* pulp recorded antioxidant activity as 88.68 per cent. The results of present study corroborates with the one recorded by Ali *et al*<sup>15</sup> where the authors reported 85.22 per cent of free radical scavenging capacity in *jamun* pulp. Rai *et al*<sup>21</sup>, however, observed higher DPPH inhibition per cent in *jamun* fruit (96.55%). Processing slightly altered the antioxidant activity of fresh *jamun* fruit which may be due to degradation of ascorbic acid, anthocyanins and phenolic compounds on processing.

**Sensory evaluation:** Sensory scores for appearance, colour, body, flavour and overall acceptability on 9 point hedonic scale for different supplementation levels of *jamun* pulp in pear juice have been presented in table-2. The overall acceptability scores were significantly (p<0.05) affected with the supplementation of *jamun* pulp from 5 to 25 per cent in pear juice. Appearance and flavour appeared to have a prominent effect in determining the acceptability of *jamun* pulp supplemented pear juice ranging from 7.60 to 8.30 and 7.50 to 8.50, respectively. Maximum scores for sensory characteristics were found in pear juice containing 20 per cent of *jamun* pulp and minimum for 25 per cent supplementation level. Pear juice containing *jamun* pulp at higher levels was slightly astringent. Therefore, optimum sensory properties with respect to astringency were established at 20 per cent level.

**Colour analysis:** Product colour is one of the most important quality factors of fruit juice and appetite is stimulated by the

colour perceived by the consumer<sup>22</sup>. The colour values of *jamun* pulp supplemented pear juice have been elucidated in table-3. Statistically significant ( $p \le 0.05$ ) difference was observed in L\* values of *jamun* supplemented pear juice. L\* values lowered with increasing supplementation levels resulting in darker product. The L\* value for control was noted as 42.47 while for supplemented juice the values were found in the range of 40.53 to 34.70 at 5-25 per cent levels resulting in decreased brightness. Pear fruit leather was found to have L\* values in the range of 41.55 to 56.07 for different percentage of pectin and corn syrup added<sup>23</sup>.

The a\* values indicating redness/greenness increased with increasing supplementation levels and the value for control sample was recorded as 0.45. Among the supplemented juice, highest values were found at 25 per cent supplementation level (2.94) and lowest for 5 per cent jamun pulp incorporated pear juice (0.76). The b\* values decreased with increasing supplementation level from 5.12 at 5 per cent supplementation level to 1.85 at 25 per cent supplementation level indicating increased blue coloration of the samples due to increasing anthocyanin content with increasing pulp concentration. Similarly hue angle  $(^{0})$  reduced with increasing supplementation levels from 85.16 at 0 percent level to 32.25 at 25 per cent level. Similar observations were recorded by Camire *et al*  $(2007)^{24}$ where the authors reported negative correlation of anthocyanin with L\* and b\* values (-0.850 and -0.714, respectively) indicating darker and more blue product and positive correlation with  $a^*$  values (0.717) indicating increased redness with increasing anthocyanin concentration in corn puffed breakfast cereals.

Table-1								
Bioactive composition of fresh jamun and processed jamun pulp								
	Ascorbic acid	Anthocyanin	Total phenols	Antiovidant activity (%)				
	(mg/100g)	Antioxidant activity (%)						
Jamun fruit	21.77 <sup>a</sup> ±0.25	126.54 <sup>a</sup> ±0.67	2250.91 <sup>a</sup> ±0.55	91.83 <sup>a</sup> ±0.57				
Processed jamun pulp	18.29 <sup>b</sup> ±0.36	$112.56^{b} \pm 0.62$	2158.89 <sup>b</sup> ±0.64	88.68 <sup>b</sup> ±0.51				

Table-2

GAE: Gallic acid equivalent, means with different letters in the same column are significantly different ( $p \le 0.05$ )

Effect of different supplementation levels of <i>jamun</i> pulp on sensory scores of pear juice								
Supplementation levels (%)	Appearance	Colour	Body	Flavour	Overall acceptability			
Control	$7.60^{\circ}$	7.80 <sup>a</sup>	$7.80^{b}$	7.50 <sup>c</sup>	$7.70^{d}$			
5	$8.00^{ m abc}$	8.10 <sup>a</sup>	$8.10^{ab}$	7.70 <sup>c</sup>	7.97 <sup>bc</sup>			
10	$8.10^{abc}$	8.10 <sup>a</sup>	$8.20^{ab}$	$8.00^{bc}$	8.10 <sup>b</sup>			
15	8.30 <sup>ab</sup>	8.20 <sup>a</sup>	8.30 <sup>ab</sup>	8.20 <sup>ab</sup>	8.20 <sup>b</sup>			
20	8.30 <sup>ab</sup>	8.20a	$8.40^{a}$	$8.50^{\mathrm{a}}$	8.35 <sup>a</sup>			
25	7.70 <sup>bc</sup>	7.90 <sup>a</sup>	7.90 <sup>ab</sup>	7.80 <sup>bc</sup>	7.82 <sup>cd</sup>			

Means with different letters in the same column are significantly different ( $p \le 0.05$ )

Table-3						
Effect of jamun	pulp additi	on on colou	r values o	of pear	juice	

Supplemen- tation level (%)	L*	a*	b*	Hue angle ( <sup>0</sup> )
Control	$42.47^{a}$	0.45 <sup>d</sup>	5.38 <sup>a</sup>	85.16 <sup>a</sup>
5	40.53 <sup>b</sup>	0.76 <sup>cd</sup>	5.12 <sup>a</sup>	81.46 <sup>ab</sup>
10	39.73 <sup>b</sup>	1.16 <sup>c</sup>	4.29 <sup>b</sup>	74.66 <sup>b</sup>
15	37.25 <sup>c</sup>	1.73 <sup>b</sup>	3.56 <sup>c</sup>	64.27 <sup>c</sup>
20	36.19 <sup>d</sup>	$2.40^{a}$	2.12 <sup>d</sup>	41.61 <sup>d</sup>
25	34.70 <sup>e</sup>	2.94 <sup>a</sup>	1.85 <sup>d</sup>	32.25 <sup>e</sup>

Means with different letters in the same column are significantly different ( $p \le 0.05$ ).

Physico-chemical composition and storage of *jamun* pulp supplemented pear juice: On the basis of sensory evaluation and colour characteristics, 20 per cent supplementation level of jamun pulp in pear juice was chosen for further studies. Physico-chemical composition of jamun pulp blended pear juice is depicted in table-4. Total soluble solids for both the control (C) and pear *jamun* juice were found to be 14°B. During storage period non-significant (p<0.05) increase was found in control pear juice from 14 to 14.13°B and from 14 to 14.20°B in blended pear jamun juice. Increase in TSS might be attributed to breakdown of the complex carbohydrates into simple soluble carbohydrates<sup>25</sup>. Titratable acidity after processing of pear juice was found to be 0.28 per cent for control juice and 0.32 per cent for pear jamun juice. Pear juice extracted by different processes was found to have titratable acidity in the range of 0.33-0.41 per cent<sup>26</sup>. Chakraborty *et al*  $(2011)^{27}$  reported titratable acidity of blended jamun-litchi nectar to be 0.30 per cent. During progression of storage period titratable acidity increased from 0.28 to 0.32 per cent in control pear juice and from 0.32 to 0.37 per cent in case of pear jamun juice which may be due to chemical interaction between the organic constituents of the product.

Gradual increase in the reducing sugars content was noted in control and pear *jamun* blended beverage. Reducing sugars increased significantly (p<0.05) from 7.81 to 8.83 mg/100g representing an increase of 13.06 per cent in control pear juice and from 7.94 to 9.05 mg/100g in pear *jamun* juice after 6 months of storage. The increasing trend could be attributed to

the inversion of non-reducing sugars to reducing sugars upon prolonged storage under ambient conditions and acid content of the product. The result corresponds to the findings of Kumar and Manimegalai  $(2001)^{28}$  in pineapple-pear-pomegranate blended RTS. Slightly higher total sugars (3.32%) were found in pear *jamun* juice than control pear juice. Pear juice extracted from different varieties recorded total sugars in the range of 8.09-9.0 per cent<sup>29, 30</sup>. Total sugars decreased non-significantly (p<0.05) during storage period of 6 months and values were found in the range of 10.58-9.70 per cent for control and *jamun* pulp blended pear juice. Total sugar reduced by 5.27 per cent in control samples and by 6.33 per cent in blended samples.

Total ash and protein content of control pear juice was noted to be 0.43 and 0.12 per cent, respectively and in pear *jamun* juice it was recorded as 0.45 and 0.14 per cent, respectively. Minor losses were observed in ash content with progression of storage which might be due to binding of certain minerals with organic substances<sup>31</sup>. Slight decrease in protein content was observed after 6 months. However, storage period had non-significant (p<0.05) effect on the protein content of control and blended samples.

Bioactive composition and storage of *jamun* pulp supplemented pear juice: Effect of jamun pulp incorporation and storage on bioactive components of pear juice has been described in table-5. Higher ascorbic acid content was found in pear jamun juice (9.15 mg/100g) compared to control juice (8.64 mg/100g) which may be due to initially high concentration of ascorbic acid in jamun pulp (table-1). The results are in accordance with Sumaya-Martinez *et al*<sup>32</sup> where 92 mg/L of ascorbic acid in white pear fruit was reported. Storage period was found to have significant effect on ascorbic acid content of control and jamun pulp blended pear juice. A reduction of 52.08 per cent and 47.75 per cent was noted in ascorbic acid content for control and *jamun* supplemented pear juice, respectively after 6 months of storage period (table-5). Pear-jamun blended juice exhibited better retention of ascorbic acid which might be due to the antioxidant properties of phenolic compounds in jamun pulp (anthocyanins)<sup>33</sup>. Losses of ascorbic acid during storage were attributed to oxidation of dehydroascrobic acid which is directly affected by temperature and light exposure.

Storage months	TSS (°B)		Titratable acidity (% malic acid)		Reducing sugars (mg/100g)		ducing sugars (mg/100g) Total sugars (mg/100g) Total ash (*		Total ash (%)		Crude (%	protein %)
	С	PJJ	С	PJJ	С	PJJ	С	PJJ	С	PJJ	C I	PJJ
0	$14.00^{a}$	$14.00^{b}$	0.28 <sup>b</sup>	0.32 <sup>b</sup>	7.81 <sup>b</sup>	7.94 <sup>a</sup>	$10.24^{a}$	10.58 <sup>a</sup>	0.43 <sup>a</sup>	0.45 <sup>a</sup>	0.12 <sup>a</sup>	0.14 <sup>a</sup>
2	$14.00^{a}$	$14.06^{ab}$	$0.29^{ab}$	$0.34^{ab}$	8.01 <sup>ab</sup>	8.15 <sup>a</sup>	$10.15^{a}$	$10.42^{a}$	$0.43^{ab}$	0.45 <sup>a</sup>	0.11 <sup>a</sup>	0.14 <sup>a</sup>
4	14.13 <sup>a</sup>	$14.13^{ab}$	0.31 <sup>ab</sup>	$0.35^{ab}$	$8.52^{ab}$	8.73 <sup>a</sup>	9.92 <sup>a</sup>	10.14 <sup>a</sup>	$0.39^{ab}$	$0.43^{ab}$	$0.10^{a}$	0.13 <sup>a</sup>
6	14.13 <sup>a</sup>	$14.20^{a}$	0.32 <sup>a</sup>	0.37 <sup>a</sup>	8.83 <sup>a</sup>	9.05 <sup>a</sup>	$9.70^{a}$	9.91 <sup>a</sup>	0.38 <sup>b</sup>	0.39 <sup>b</sup>	0.09 <sup>a</sup>	0.12 <sup>a</sup>

 Table-4

 Physico-chemical characteristics of *jamun* pulp supplemented pear juice

Means with different letters in the same column are significantly different (p≤0.05), C- Control PJJ- Pear jamun juice

Anthocyanins, a class of polyphenols are reported to have a positive influence on human health<sup>34</sup> and play a dual role as attractive natural colorants along with adding nutrition to the food, thus acting as a nutraceutical. Hence incorporation of jamun pulp can help improve nutritional status of pear juice and cater to the health demands of consumer. Data revealed that pear juice supplemented with *jamun* pulp contained anthocyanin content as 12.61 mg/100g whereas anthocyanins were not detectable in control pear juice. The decrease in anthocyanin content from initial values was recorded as 23.86 per cent in pear *jamun* juice after storage period of 6 months. This may be due to hydrolysis of protective 3-glucoside linkages to give unstable anthocyanins<sup>3</sup>

Total phenolic content of control pear juice was found to be 112.44 mg GAE/100g. The results are in accordance with Cansino *et al*<sup>36</sup> where the authors reported 98.22 mg GAE/100g of total phenols in pear juice. The slight variation might be due to difference in cultivar and growing conditions. Pear jamun juice was found to have 15.31 per cent higher total phenols than control pear juice. After storage period of 6 months, the values for phenolic content were noted as 96.14 and 106.10 mg GAE/100g depicting 14.49 and 18.17 per cent reduction in control and pear *jamun* juice, respectively. Similar results were quoted by Raj *et al*<sup>25</sup> in blended sand pear-apple beverage during storage of 6 months. The loss of phenolic compounds during storage may be due to polymerization of phenolic compounds with increasing storage<sup>37</sup>

Antioxidant activity of control pear juice and jamun pulp supplemented pear juice was noted as 68.94 and 83.09 per cent, respectively. Higher antioxidant activity of the pear jamun blended juice may be due to initial high concentration of ascorbic acid and total phenols in jamun pulp (table-1) and additional presence of anthocyanins in blended juice. Antioxidant activity is found to have positive correlation with phenolic compounds<sup>38</sup> and ascorbic acid<sup>39</sup>. Thus, the presence of higher bioactive compounds in blended juice is responsible for its higher antioxidant activity. Storage period resulted in significant (p<0.05) reduction of antioxidant activity from 68.94 to 59.13 per cent in control pear juice and from 83.09 to 78.40 per cent in pear jamun juice. The decrease in the antioxidant activity may be linked to a decrease in phenolic compounds and vitamin C during storage<sup>40</sup>.

# Conclusion

Blending of pear juice with jamun pulp resulted in addition of anthocyanins and enhancement of ascorbic acid content, total phenolics and antioxidant activity. On the basis of sensory evaluation, supplementation levels of jamun pulp from 5 to 25 per cent in pear juice were found to be acceptable but 20 per cent level received highest consumer acceptability scores and was chosen for further studies. Colour characteristics were significantly affected by supplementation levels, resulting in darker product with increasing levels of *jamun* pulp in pear juice. Jamun supplemented pear juice had slightly higher sugars, ash and protein content. Bioactive compounds were also found to be higher in pear *jamun* juice as compared to control juice. During storage period all the bioactive compounds and antioxidant activity decreased significantly ( $p \le 0.05$ ) in control and supplemented samples. Overall, jamun pulp can be successfully blended with pear juice and can improve functional and bioactive properties of the resultant beverage. The future possibilities lie in blending fruit pulps to enhance nutritional components and to encourage the utilization of minor fruit crops.

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Bioactive composition and storage of <i>jamun</i> pulp supplemented pear juice									
Storage months	Ascorbic acid (mg/100g)		Anth (m	ocyanins g/100g)	Total (mg GA	phenols AE/100g)	Antioxidant	activity (%)	
	C	PJJ	С	PJJ	С	PJJ	С	PJJ	
0	8.64 <sup>a</sup>	9.15 <sup>a</sup>	-	12.61 <sup>a</sup>	112.44 <sup>a</sup>	129.66 <sup>a</sup>	68.94 <sup>a</sup>	83.09 <sup>a</sup>	
2	6.86 <sup>b</sup>	7.66 <sup>b</sup>	-	10.44 <sup>b</sup>	104.96 <sup>b</sup>	121.36 <sup>b</sup>	65.14 <sup>b</sup>	81.25 <sup>b</sup>	
4	5.98 <sup>c</sup>	6.96 <sup>c</sup>	-	9.82 <sup>b</sup>	98.73°	113.79 <sup>c</sup>	61.27 <sup>c</sup>	79.77 <sup>c</sup>	
6	4.14 <sup>d</sup>	$4.78^{d}$	-	9.60 <sup>b</sup>	96.14 <sup>d</sup>	$106.10^{d}$	59.13d	$78.40^{d}$	

Table-5	
Bioactive composition and storage of <i>jamun</i> pulp supplemented	1 pear juice

Means with different letters in the same column are significantly different (p≤0.05), C- Control, PJJ- Pear *jamun* juice

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