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## Assessment of physico-chemical properties of antioxidant rich fruits and sensory attributes of jamun based RTS beverages

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**Abstract**

In present investigation, efforts have been made to assess physico-chemical properties of jamun and lemon fruit and to prepare antioxidant rich ready-to-serve (RTS) beverages from jamun and lemon juice blends. The physical properties like color and shape of jamun fruit was blackish purple and ovoid or round in shape. The average length, breadth and weight of jamun fruit were 3.16 cm, 2.17 cm and 10.7g respectively while pulp weight, seed weight, inedible waste weight and juice content were 7.45, 2.46, 0.79 and 2.31g of overall fruit weight. The calculated value of edible and waste index was 69.63 and 30.37%, respectively while juice yield was 21.67% of the total fruit weight. Physical properties of lemon fruit was light yellow in color and round in shape. The mean value of length, breadth and weight was 4.1cm, 3.8 cm and 23.0 g, respectively. The weight of pulp, seed, peel and juice content was 8.71, 0.58, 13.72 and 7.67 g, respectively of overall fruit weight. The edible and waste index was 37.85 and 62.15% whereas juice yield was 33.35% of total fruit weight. The experiment comprised of six treatments including one control and five blended RTS beverages. Among different blended ratios (100:0, 99:1, 98:2, 97:3, 96:4 and 95:5) of jamun and lemon juice for preparation of RTS beverages, the ratio 97:3 was reached the highest sensory scores for overall acceptability.

**Keywords:** Jamun, lemon, blended RTS beverage, physical properties, overall acceptability

**Introduction**

India is origin of many fruit crops and most of crops is limited to its growing region only. In spite of their high nutritional and medicinal properties their commercial cultivation is lacking. Most of underutilized fruits are in the core recipes of many ayurvedic formulations and jamun is one of the most important underutilized fruit. India ranks second in production of jamun in the World. Maharashtra State is the largest jamun producer followed by Uttar Pradesh, Tamil Nadu, Gujarat, Assam and others. In India, basically two types of *Syzygium* (Jamun) are found, firstly, Ra Jamun which have large, oval shaped fruits, dark-purple or bluish colored with pink pulp that is sweet to taste and small seeds; secondly, Kaatha with small, acidic fruits. It has been observed that fruits containing purple flesh are more astringent than the white-fleshed types (Ranjan *et al.*, 2011) [24]. The fruit, its juice and seed contain a biochemical called "Jamboline" and are gaining popularity due to its delicious taste, detoxifying and antioxidant properties. Besides antioxidant property, it has hyperlipidemic, cardioprotective and immunomodulatory properties. The detoxifying property of jamun helps to maintain natural urination and sweating. Jamun (*Syzygium cumini*) decoction is being used as Ayurvedha medicine in diabetes mellitus, because it has high antiglycation and antioxidant activities. Therefore, the antiglycation and antioxidant potentials of a ready to serve herbal beverage prepared with the water extract of *Syzygium cumini* bark targeting the diabetic population as this may have a better therapeutic potential. Jamun juice can be supplemented with lemon and aonla juice to increase its antioxidant property by increasing vitamin C and micronutrient levels.

Lemon (*Citrus limon*) is a therapeutic plant belonging to the family of *Rutaceae*. It is a small tree and originated probably from Asia. It used in making various foods, due to its distinctive flavor and ability to enhance spicy flavor in food products. Lemon juice is very rich in vitamin C, a vitamin act as an antioxidant and responsible for health benefits. It has anticancer and antibacterial potential in crude extracts of different parts (*viz.* leaves, stem, root and flower)

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of Lemon against bacterial strains. Beverages are prepared using lemon juice, considered to be an excellent source of nutraceutical components for enrichment. Blending could lead to the production of delicious beverages with improve organoleptic quality and high nutritive value. The nutritive value of fruit beverages is higher than the synthetic drinks, which are available in the market throughout the country. If synthetic drinks can be substituted with the fruit juice, it would be beneficial to the consumers as well as fruit growers. The usage of various synthetic/natural sweeteners in lieu of sugar is increasing day by day due to health concerns. In India, use of artificial sweeteners is limited but being economical, it is helpful to control different kind of degenerative diseases. A variety of artificial sweeteners are available in the market like, aspartame, cyclamate, sucralose, saccharin, and acesulfame-K (Potassium salt of Acesulfame) etc. These are the non-nutritive sweeteners which are not metabolized by the body and do not contribute any energy or calories to the diet. The use of low-calorie sweeteners could improve dietary quality if consumers used energy savings for the consumption of nutrient dense foods (ADA, 2004) [4]. Therefore, the aspartame can be used as a low calorie sweetener for developing functional ready-to-serve beverage, which will be an alternative way of consumption apart from regular traditional preparations.

Based on these concepts the experiment was undertaken to develop antioxidant rich blended ready-to-serve (RTS) beverage with the following objectives-

- To assess physico-chemical properties of jamun and lemon fruits
- To standardized antioxidant rich jamun based ready-to-serve (RTS) beverages
- To evaluate sensory quality of developed ready-to-serve (RTS) beverages

## Material and Methods

The present investigation was carried out at Department of Food Science and Nutrition, College of Community and Applied Sciences, MPUAT, Udaipur (Rajasthan). The jamun

and lemon fruits used for investigation procured from the local market. Fresh, disease free and uniform sized jamun and lemon fruits were sorted washed in running tap water and cut with knife for removal of seed. Jamun fruit were pulped with the help of mixer cum grinder and pulp 20% were taken to get jamun juice with addition of 80% double distilled water while lemon fruits were cut into two halves and tightly gripped for squeezing the juice by hand press method. The juice was filtered through four layer muslin cloth to get clear juice. The fresh extracted jamun and lemon juice was used for preparation of jamun based ready-to-serve (RTS) beverages.

## Development of antioxidant rich jamun based ready-to-serve (RTS) beverages

### Mixing the ingredients

Antioxidant rich jamun based ready-to-serve beverages were developed by blending the juices in five different formulations of jamun and lemon juices, 99:1 (T<sub>1</sub>), 98:2 (T<sub>2</sub>), 97:3 (T<sub>3</sub>), 96:4 (T<sub>4</sub>) and 95:5 (T<sub>5</sub>) respectively, while pure jamun ready-to-serve beverage formulated using jamun and lemon in the ratio of 100:0. The pulp/juice content was adjusted 20%, TSS 15% and acidity 0.3% for the development of beverages. Meanwhile, black salt added for enhancing the taste at the time of formulation of juice blends. Refined cane sugar was added as sweetening agent for enhancing the taste and zero calorie sweetener aspartame (based on sugar equivalents) were used for the development of low calorie jamun based RTS beverages. The acidity was maintained to 0.3% in the final product by the addition of required amount of citric acid (Table 1).

### Filtration

The developed carrot based RTS beverages were again filtered through a muslin cloth to obtain a beverage of uniform consistency.

### Pasteurization

The developed jamun based RTS beverages were pasteurized at 90 °C for 30 sec. and cooled at room temperature.

**Table 1:** Formulations of antioxidant rich jamun based ready-to-serve beverages

Sr. No.	Treatment symbols	Blending of juices (%)		Rock salt (g)	Non-calorie sweetener (Aspartame) %	Sugar (g)	Citric acid (g)	Sodium benzoate (g)
		Jamun	Lemon					
1.	Control (T <sub>0</sub> )	100	0	1.25	0.2	5.0	0.2	0.05
2.	JL1(T <sub>1</sub> )	99	1	1.25	0.2	5.0	0.2	0.05
3.	JL2 (T <sub>2</sub> )	98	2	1.25	0.2	5.0	0.2	0.05
4.	JL3 (T <sub>3</sub> )	97	3	1.25	0.2	5.0	0.2	0.05
5.	JL4 (T <sub>4</sub> )	96	4	1.25	0.2	5.0	0.2	0.05
6.	JL5 (T <sub>5</sub> )	95	5	1.25	0.2	5.0	0.2	0.05

Where JL – Jamun & lemon

### Physical properties of fruits

Physical Characteristics like color and shape was observed visually. Fruit weight (in grams) was determined using a digital electronic balance while length and breadth measured with the help of a digital vernier caliper. The edible index, waste index and juice content were determined by the method given by Shamsudin *et al.*, 2009 [27].

### Chemical properties

The physico-chemical properties of the jamun and lemon fruits were analyzed using recommended standard methods.

**Moisture content:** The moisture content of the fruits was determined by gravimetric method (AOAC, 2012) [1, 2, 3].

**Specific gravity:** Specific gravity was determined by weight of fruit divided by volume of fruit.

### Total solids

Total solids were estimated by deducting percentage moisture from 100 as described by James (1995) [14].

### Total soluble solids

The total soluble solids (TSS) of the fruits were determined by the standard method (AOAC, 2012) [1, 2, 3].

### pH

For determination of pH (hydrogen ion concentration) in the juice, a method of AOAC (2000) [1, 2, 3] was adopted.

### Titration acidity

Titration acidity was determined by titrating a known volume of the sample against N/10 NaOH solution using phenolphthalein as an indicator. The titration acidity was calculated and expressed as percent citric acid (AOAC, 2000) [1, 2, 3].

### Total and reducing sugar

The total and reducing sugars were estimated by the volumetric method of Lane and Eynon (1923) as reported by Ranganna (1986).

### Total carotenoids

Total carotenoid content of fruit pulp/juices were determined spectrophotometrically by slight modification of method described by Rodriguez-Amaya (2004) [25].

### Ascorbic acid

The ascorbic acid content of fruit pulp/juices were estimated by using 2,6-dichlorophenol-indophenol (dye) visual titration method with slight modification of the method given by Ranganna (2014).

### Total antioxidant activity

The percentage of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activities of fruit pulp/juices and RTS drink was determined by the slight modification of the spectrophotometric method as suggested by Shimada *et al.* (1992) [28, 29].

### Sensory evaluation of jamun based ready-to-serve beverages

A panel of ten judges comprising of the staff and research scholars were randomly selected from the Department of Food Science and Nutrition, College of Home Science, MPUAT, Udaipur for the evaluation of acceptability of the ready-to-serve (RTS) beverages developed during the study. Coded samples were presented to panellist in separate chambers or places to get unbiased judgments with score cards for evaluating the sensory characteristics. The overall acceptability was measured on 9 point Hedonic Scale by 10 panel members.

### Statistical analysis

The data generated during experimentation were recorded and statistically analyzed using standard procedure for analysis of completely randomized block design (CRD) as per the method suggested by (Panse and Sukhatme, 1985) [21].

Mean  $\pm$  SD for physico-chemical properties of juices and ready-to-serve beverages. Analysis of variance (One way ANOVA) was used to assess sensory acceptability scores of antioxidant rich ready-to-serve beverages, were calculated.

## Results and Discussion

### Physical properties of jamun and lemon fruit

#### Jamun

The physical properties of jamun and lemon fruit was observed and presented in Table 2.

The data depicted the result of physical properties of jamun fruit in Table 2. The color and shape of jamun fruit was blackish purple and ovoid or round in shape. The average length and breadth of jamun fruit was 3.16 and 2.17 cm, respectively. Similar observations were recorded by Shahnawaz and Sheikh (2011) [26] that indigenous jamun fruit cultivar was ovoid in shape and blackish-purple in color. The

length and width of indigenous fruit cultivars was 2.73 and 2.10 cm, respectively. The result showed that the overall fruit weight of jamun was recorded 10.7g, while pulp, seed and inedible waste had 7.45, 2.46 and 0.79 g weight of overall fruit weight. The fruit had 2.31g juice content, which was 21.67% juice yield of the total fruit weight. The calculated value of edible and waste index was 69.63 and 30.37%, respectively.

The variations in the physical properties of jamun fruit might be due to varietal differences, species, rootstock used, edapho-climatic conditions of growing, agro inputs applied to the trees bearing that fruit. The market value of the fruit depends on the weight and the color of the fruit. The maturity of the fruit was determined by the dimension of the fruit. Similar results were also reported by Shahnawaz and Sheikh (2011) [26] analyzed physical properties of indigenous fruit cultivar and found fruit weight was 6.71g, whereas edible matter/pulp, non-edible matter/seed and juice 39.19, 60.81 and 38%, respectively of whole fruit weight. Ghosh *et al.* (2017) [11] reported weight of the whole fruit was 8.99 $\pm$ 1.89gm. The whole fruit length, width and thickness was 28.1 $\pm$ 0.31, 22.7 $\pm$ 0.14, 20.8 $\pm$ 0.21 mm respectively. From the yield recovery, it was observed that the whole fruit had 79.81 and 19.25% consumable and non-consumable portion (seed). The juice yield from the consumable portion was measured as 54.1%.

**Table 2:** Physical properties of jamun and lemon fruit

Physical properties	Jamun	Lemon
Color	Blackish-purple	Light yellow
Shape	Ovoid/round	Round
Length (cm)	3.16 $\pm$ 0.01	4.1 $\pm$ 0.02
Breadth (cm)	2.17 $\pm$ 0.01	3.8 $\pm$ 0.01
Weight (g)	10.7 $\pm$ 0.04	23.0 $\pm$ 0.05
Pulp weight (g)	7.45 $\pm$ 0.03	8.71 $\pm$ 0.04
Seed weight (g)	2.46 $\pm$ 0.01	0.58 $\pm$ 0.01
Peel weight (g)	-	13.72 $\pm$ 0.04
Inedible waste (g)	0.79 $\pm$ 0.01	-
Juice content (g)	2.31 $\pm$ 0.01	7.67 $\pm$ 0.04
Edible index (%)	69.63 $\pm$ 0.10	37.85 $\pm$ 0.09
Waste index (%)	30.37 $\pm$ 0.07	62.15 $\pm$ 0.11
Juice yield (%)	21.67 $\pm$ 0.12	33.35 $\pm$ 0.08

Mean $\pm$ SD of three independent variables

#### Lemon

Physical properties of lemon fruit under the study presented in Table 2. Data with respect to physical properties revealed that lemon fruit was light yellow in color and round in shape. The mean value of length and breadth was 4.1 and 3.8 cm, respectively. The average weight of lemon fruit was 23.0 g. However, the weight of pulp, seed, peel and juice content was 8.71, 0.58, 13.72 and 7.67 g, respectively of overall fruit weight. The mean value of edible and waste index was 37.85 and 62.15%, whereas juice yield was calculated as 33.35% of total fruit weight.

These results were in the conformity with Mansoor *et al.* (2018) found that highest individual fruit weight of orange, lemon and grapefruit remained 222.26, 22.11 and 295.21g, respectively. The highest peel (%) was obtained in orange 27.90% (T<sub>2</sub>), lemon 18.28% (T<sub>1</sub>), while in grapefruit it was 26.79% (T<sub>1</sub>). Highest pulp (%) for orange fruit 27.09% (T<sub>3</sub>), However, lemon and grapefruit showed highest pulp 27.34 (T<sub>3</sub>) and 27.04% (T<sub>3</sub>), respectively. The highest juice % was obtained as 55.75% (T<sub>2</sub>) for orange, 47.26% (T<sub>1</sub>) for lemon and 44.84% (T<sub>2</sub>) for grapefruit.

### Physico-chemical properties of jamun and lemon juice

The data for physico-chemical properties of jamun and lemon are presented in Table 3.

#### Jamun juice

The data revealed that freshly extracted jamun juice had physical properties *viz.* moisture (82.90%), specific gravity (1.27) and total solids (17.09%). Among the chemical properties of fresh jamun juice, the mean value of total soluble solids, pH and titrable acidity were 14.1°Brix, 3.82 and 1.59%, respectively (Table 3). Similar findings were reported by Kesharwani *et al.* (2015), Ghosh *et al.* (2017) [11], Akhila and Umadevi (2018) [5] and Lavanya *et al.* (2018) [18]. The results that jamun juice contained 12.60% total sugar, 5.92% reducing sugar and 6.96% non-reducing sugar. The results are in agreement with the previous findings of Barman and Barooah (2016) [6], who reported that fresh jamun juice had total sugar (13.92 g/100g) and reducing sugar (5.59 g/100g). Similarly, Devi (2002), Barman and Barooah (2016) [6], Akhila and Umadevi (2018) [5] and Lavanya *et al.* (2018) [18] observed that jamun juice contained total, reducing and non-reducing sugars between the ranges of (12.60 - 14.22%), (5.70 - 8.90%) and (3.07 - 8.90%) respectively.

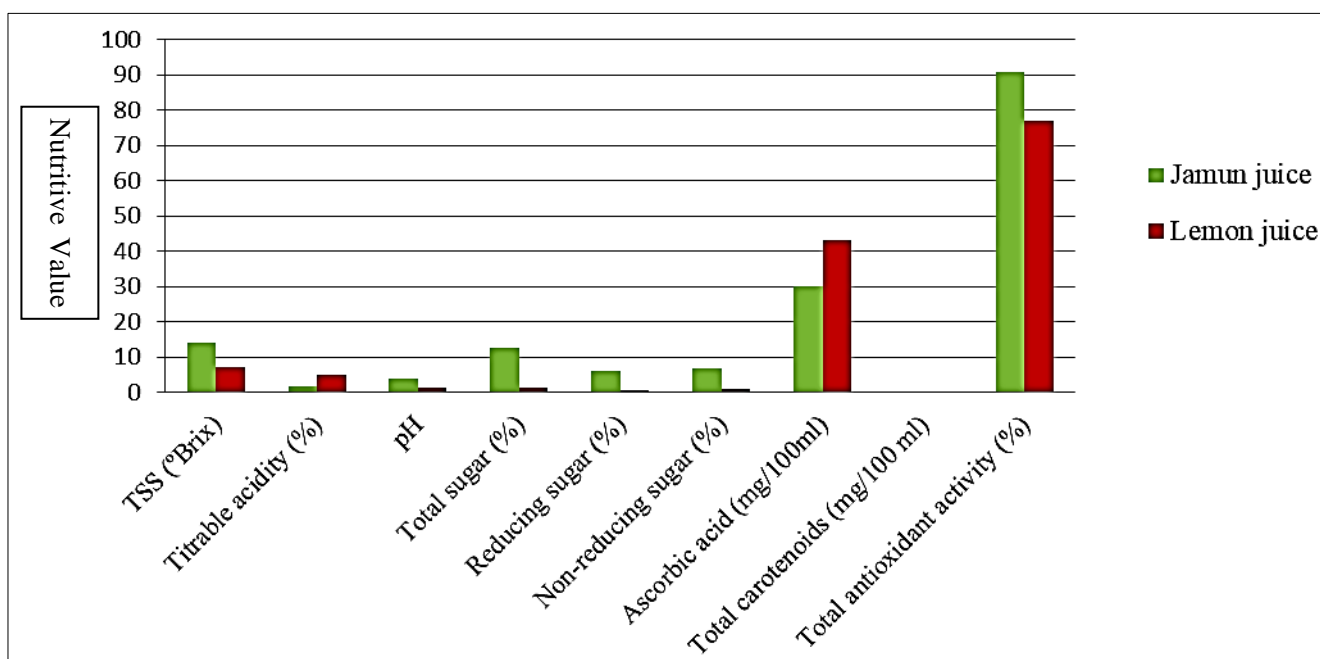
Some bioactive compounds *viz.* total carotenoid, ascorbic acid and total antioxidant activity were 0.078 mg/100g, 29.94 mg/100g and 90.71% respectively in jamun juice (Table 3). The carotenoids are natural pigment that give both appearance and attractiveness to beverages as well as add nutritional value due to antioxidant activity. The result regarding ascorbic acid of fresh jamun juice was in agreement with

Lago *et al* 2004 who reported that jamun juice contains ascorbic acid 18 mg/100g. Similarly other researchers Kesharwani *et al.* (2015), Panda *et al.* (2016) [20], Ghosh *et al.* (2017) [11] and Lavanya *et al.* (2019) observed 31.5%, 31.8 mg/100g, 49.78 mg/100g and 19.0 mg/100g ascorbic acid in fresh jamun juice. The result showed total antioxidant activity of fresh jamun juice was 90.71% scavenging of DPPH, which are in agreement with findings of Barman and Barooah (2016), Ghosh *et al.* (2017) [11] and Akhila and Umadevi (2018) [5] reported that fresh jamun juice contained total antioxidant activity of 92.20%, 31.29% and 92.0% scavenging of DPPH, respectively.

**Table 3:** Physico-chemical properties of jamun and lemon juice

Physical properties	Jamun juice	Lemon juice
Moisture (%)	82.90±0.05	93.08±0.07
Specific Gravity	1.27±0.02	0.23±0.01
Total solids (%)	17.09±0.04	7.08±0.03
Chemical properties		
TSS (°Brix)	14.10±0.03	7.02±0.02
Titrable acidity (%)	1.59±0.01	5.17±0.02
pH	3.82±0.02	1.52±0.01
Total sugar (%)	12.60±0.04	1.42±0.02
Reducing sugar (%)	5.92±0.02	0.56±0.01
Non-reducing sugar (%)	6.96±0.04	0.86±0.02
Ascorbic acid (mg/100ml)	29.94±0.06	43.21±0.09
Total carotenoids (mg/100 ml)	0.078±0.01	-
Total antioxidant activity (%)	90.71±0.11	76.80±0.09

Mean±SD of three independent variables



**Fig 1:** Physico-chemical properties of jamun and lemon juice

#### Lemon juice

The data revealed that freshly extracted lemon juice had physical properties *viz.* moisture (93.08%), specific gravity (0.23) and total solids (7.08%). Among the chemical properties of fresh lemon juice, the mean value of total soluble solids, pH, titrable acidity, total sugar, reducing sugar and non-reducing sugars were 7.02°Brix, 1.52, 5.17%, 1.42%, 0.56% and 0.86% respectively (Table 3). Similar findings were reported by Deka (2000) [7] analyzed physico-chemical properties *viz.* moisture (92.55%), total soluble solids

(8.35°Brix), titrable acidity (6.78%), pH (2.24), total sugar (1.12%) and reducing sugar (0.61%) respectively. Similarly Jain and Khurdiya (2004) [13] reported physico-chemical properties were 7.0°Brix total soluble solids, 5.76% acidity and 43.29 mg/100g ascorbic acid. The bioactive compounds *viz.* ascorbic acid and total antioxidant activity were 43.21 mg/100g and 76.80% scavenging of DPPH. The result showed there was no total carotenoid was found in lemon juice. The results were in line with observations made by Deka (2000) [7] found fresh lemon juice that contains ascorbic

acid (32.40 mg/100 ml) whereas no total carotenoids was detected in lemon juice. Kumar *et al.* (2013) [16] observed (40.48 mg/100g) vitamin C and Hajimahmoodi *et al.* (2012) [12] reported antioxidant activity 795.65 mg VEE L<sup>-1</sup> scavenging of DPPH in fresh lemon juice.

#### Organoleptic acceptability of antioxidant rich jamun based RTS beverages

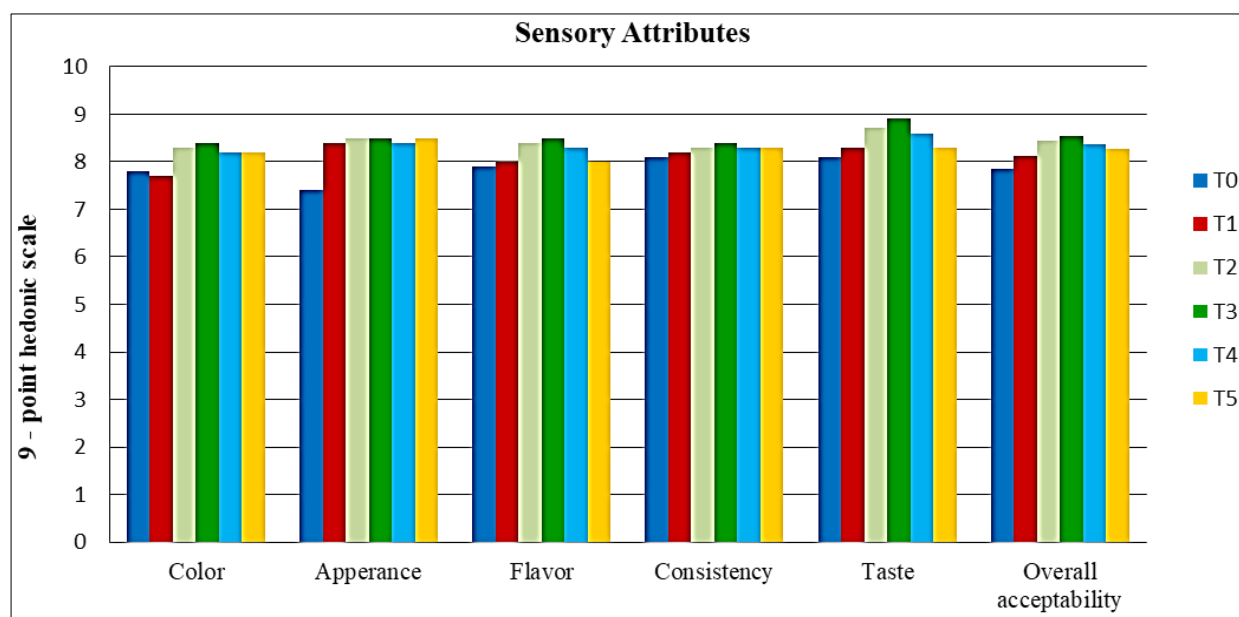
The data showed mean scores of the organoleptic characteristics of jamun-lemon juice blends used for development of antioxidant rich ready-to-serve beverages (Table 4). The overall acceptability scores are very important aspects that determine the acceptability and marketability of beverages. Organoleptic evaluation of six treatments, developed in the ratio of, T<sub>0</sub> (jamun-lemon, 100:0), T<sub>1</sub> (jamun-lemon, 99:1), T<sub>2</sub> (jamun-ginger, 98:2) T<sub>3</sub> (jamun-lemon,

97:3), T<sub>4</sub> (jamun-lemon, 96:4), T<sub>5</sub> (jamun-lemon, 95:5) and analyzed for color, appearance, flavor, consistency, taste and overall acceptability. The overall characteristics of the prepared ready-to-serve beverages were graded as “like extremely to dislike very much” with score values as 9-1. The data indicated that the color score of different treatments of fresh jamun RTS beverages ranged from 7.80 to 8.20, appearance scores from 7.40 to 8.50, flavor scores from 7.90 to 8.00, consistency scores from 8.10 to 8.30 and taste score from 8.10 to 8.30 while overall acceptability scores from 7.86 to 8.26. The organoleptic scores of all the treatments differed significantly ( $P \leq 0.05$ ) in sensory attributes of appearance, taste and overall acceptability and fell in the category of “liked very much” to “liked extremely” while color, flavor and consistency scores showed non-significant differences among all six treatments.

**Table 4:** Organoleptic evaluation of antioxidant rich jamun based ready-to-serve beverages

Treatments	Sensory attributes					
	Color	Appearance	Flavor	Consistency	Taste	Overall acceptability
T <sub>0</sub>	7.8±0.13	7.4±0.22	7.9±0.18	8.1±0.10	8.1±0.10	7.86±0.13
T <sub>1</sub>	7.7±0.26	8.4±0.22	8.0±0.21	8.2±0.20	8.3±0.21	8.12±0.16
T <sub>2</sub>	8.3±0.21	8.5±0.16	8.4±0.22	8.3±0.15	8.7±0.15	8.44±0.15
T <sub>3</sub>	8.4±0.16	8.5±0.11	8.5±0.16	8.4±0.22	8.9±0.10	8.54±0.13
T <sub>4</sub>	8.2±0.25	8.4±0.20	8.3±0.26	8.3±0.26	8.6±0.16	8.36±0.12
T <sub>5</sub>	8.2±0.20	8.5±0.17	8.0±0.25	8.3±0.15	8.3±0.26	8.26±0.13
CD ( $P \leq 0.05$ )	NA	0.58	NA	NA	0.49	0.39

Mean±SD of ten independent variables



**Fig 2:** Organoleptic acceptability of jamun based RTS beverages

The statistical analysis of sensory scores showed significant difference for overall acceptability of jamun based RTS beverages (Table 4). Maximum mean score was attained by T<sub>3</sub> (8.40) followed by T<sub>2</sub> (8.44) while minimum score was recorded in sample T<sub>0</sub> (7.86). In the present study, results indicated that color, appearance, flavor, consistency, taste and overall acceptability of blended ready-to-serve beverages were found to be superior as the portion of lemon juice increased. The results were in agreement with the findings of Din *et al.* (2011) who reported that the judges concluded that decreased in level of substitution of lemon juice decreased the overall acceptability for the drinks.

Similar findings reported by Sookh *et al.* (1995) [30] that blending the fruit juices of kinnow, pear and grapes with a

small quantity of strongly flavoured vitamin rich fruit juice, blends can be prepared for commercial exploitation by the processing industry. However, (Deka, 2000; Deka and Sethi, 2001) [7, 8] found that two or more fruit juice / pulp may be blended in various proportions for the preparation of nectar, RTS beverages etc. The blending of juice may also improve aroma, taste and nutrients of the beverages.

#### Conclusion

The aim of the present study was to assess the physico-chemical properties of antioxidant rich fruits and organoleptic acceptability of antioxidant rich jamun based RTS beverages. The physical properties help in development of processing technology and to minimize the effect of an inadequate use of

equipment that could affect the quality of the fruit and its juices. Jamun and lemon fruits contain higher antioxidant activity and adequate amount of vitamin-c. Among the various developed antioxidant rich RTS beverages, blended jamun based RTS beverages (jamun-lemon, 97:3) had maximum scores of overall acceptability. Therefore, it can be concluded that jamun and lemon fruits are rich in antioxidant and medicinal properties and can be used as a valuable ingredients for the development of fruit based RTS beverages. Hence it can be proved that the standardized antioxidant rich RTS beverages could be a good addition to varieties of commercially produced health drinks. The future possibilities lies in utilizing jamun fruit juice for the production of beverages to boost nutritional requirement and to promote the utilization of minor fruit crops.

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