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Effect of Jamun (*Syzygium cumini*) seed powder extract on physico-chemical and organoleptic properties of beverage

Desai GB, Kshirsagar RB and Sawate AR

Abstract
The present investigation aimed to assess the physicochemical and organoleptic properties of beverage. The beverage was prepared by varying the concentration of jamun seed powder extract @ 0, 5, 10, 15 and 20% by keeping the proportion of other ingredients such as aonla used 10% as fruit juice, orange juice 5% and ginger 2% constant. The prepared beverages were evaluated for consumer acceptability on the basis of organoleptic evaluation and found highest overall acceptability was showed for sample T_3C_7 (8.0) as compared to sample C (7.0), T_1A_7 (7.5) and T_2B_7 (7.4). The selected samples were analysed to assess the effect of jamun seed powder extract on physico-chemical characteristics and viscosity of beverages. The TSS were found in the beverages prepared from different juice blends all the beverages were maintained at 10 to 12° Brix. Among the treatments, the highest pH was noticed in control sample C_0 (3.54) which was decreased to T_2B_7 (3.18), T_1A_7 (3.21) and T_3C_7 (3.26). The percentage of acidity increased control (0.41 %) to sample T_3C_7 (0.2614) with the addition of 15% jamun seed extract. Total sugar was also increased from 3.29 to 5.28 %. The reducing and non-reducing sugars were increased from 2.21 to 4.07% and 1.08 to 1.31%, except the sample T_2B_7 had low amount of non-reducing sugar (0.91%) as compared to sample C (1.08%). The viscosity showed that decreasing due to addition of jamun seed extract. The viscosity at shear rate 50 rpm of sample C, T_1A_7, T_2B_7 and T_3C_7 were found to be 23.4, 18.0, 17.5 and 16.5 cP, respectively. At shear rate 100 rpm the viscosity of sample C, T_1A_7, T_2B_7 and T_3C_7 was 15.6, 13.8, 12.6 and 11.8 cP, respectively. Thus, it was concluded that the results obtained on physico-chemical properties were significantly affected among the treatments by varying the concentration of extract and the apparent viscosity was found decreasing due to addition of jamun seed extract.

Keywords: Jamun seed, extract, physicochemical, organoleptic, beverage

Introduction
Fruits and vegetables belong to an important class of foods that supply human diet with nutritive requirements including vitamins and minerals which are essential for normal body health and function. Jamun (*Syzygium cumini*) is one of the members of the family Myrtaceae and is a large perennial tree inherent to the Indian subcontinent, but now a day these trees are very common throughout the Asian subcontinent, Eastern Africa, South America and Madagascar (Warrier *et al*., 1996) [1]. The jamun fruits are produced once in a year and its availability is possible in the month of June-July (Shrivastava and Kumar, 2009) [2] and the jamun fruits are characterized as berries that are sweetish sour to taste (Warrier *et al*., 1996) [1]. Traditionally the jambul fruits, leaves, seeds and bark are all used in ayurvedic medicine. Jamun seed powder has been used for centuries as a natural form for balancing the healthy blood sugar level. It is a very delicious, detoxifying herb which has properties that helps to maintain natural urination and sweating. Jamun seeds contain a glycoside, named Jamboline which helps in the maintenance of glucose levels as in the normal limits (Kalse *et al.*, 2016) [3]. Beverages are considered to be an excellent medium for the supplementation of nutraceutical components for enrichment such as soluble fiber or herbal extract. The fusion of physiological benefits like health promoting and disease preventing with the basic function of supplying nutrients conceptualized the development of functional foods. The upcoming trends in the food industry focus on the theme of health and wellness of consumers in addition to demand of attractive and tasty food products. Hence, supplementation of such products with jamun seed extract would be the best way to improve nutritive value and cater to the health/ therapeutic needs of various sections of the population. As beverages are a part of daily diet consumed by majority of population and hence, could be used as a good carrier for supplementation,

value addition and feeding at mass scale.

Nutritional, commercial and medicinal significance of aonla fruit makes it popular all over the world (Goyal *et al*., 2007) [4]. Aonla is an excellent source of ascorbic acid (300-900 mg/100 g), amino acid and minerals along with phytochemicals such as polyphenols, tannins, emblicol, linoleic acid, corilagin, phyllemblin and rutin (Baliga and Dsouza, 2011) [5]. Aonla fruit juice can be blended with other fruit juices like jamun seed extract, orange, ginger, etc. to improve nutritional quality, taste and consumer acceptance of beverages and make use of high vitamin C available in aonla fruits. Orange is quite popular as it has a greater variety of beverage. It is also used for industrial and medicinal purposes due to its attractive colour, distinctive flavour and being rich source of vitamin - C, vitamin - B, β-carotene, calcium and phosphorus. For improving the taste, aroma, palatability, nutritive value and reducing bitterness orange juice was blended with some other highly nutritive fruit juices namely aonla juice with spice extracts like ginger. All these fruits are valued very much for their refreshing juice with nutritional, medicinal properties and specially, these fruits and ginger are also famous for excellent quality with pleasant flavour, rich in sugar, vitamin-C and minerals.

Therefore, blending of two or more fruit juices with jamun seed extract for preparation of nutritive beverages is thought to be a convenient and economical alternative for utilization of these fruits. Since, no systematic study has been conducted on processing and potential use of jamun seed powder extract in various beverage, the present investigation has been undertaken to study the effect of jamun seed powder extract on physico-chemical and organoleptic properties of beverage was carried out in order to provide customers with a high intake of nutraceutically rich diet through prepared jamun seed extract based beverage.

Materials and Methods

The jamun fruits (*Syzygium cumini*), oranges, aonla and ginger were collected from the Department of Botany, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The proposed research was carried out in Department of food engineering, College of Food Technoogy, VNMKV, Parbhani.

Methods

Preparation of jamun seed powder

Evenly matured disease free and sound jamun fruits have to select. The pulp and seed of jamun fruit was separated by pulper. Then the seed washed in water and dried in tray dryer at 60°C for 48 hours still complete drying and ground the seed in pulveriser to fine powder of average particle size 0.58 mm.

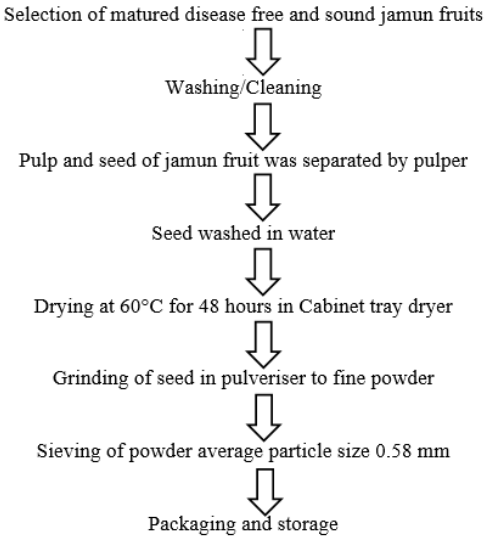

Fig 1: Preparation of jamun seed powder

Preparation of jamun seed extract

Aqueous extract of *Syzygium Cumini* seeds were prepared by using 40g of jamun seed powder mixed with 480 ml of distilled water this was left for 24 hours in sterile environment. The liquid extract was then filtered and filtrate was then kept in waterbath at 80-90 ^{0}C till the extract was dried out.

Process for extraction of aonla pulp

Fresh, fully ripe, sound aonla was used for extraction of pulp. The each fruit was cleaned, thoroughly washed, blanched fruits were sliced into small segments and seeds were separated manually and blended in a laboratory blender to a pulp and the extracted pulp was stored refrigerated temperature.

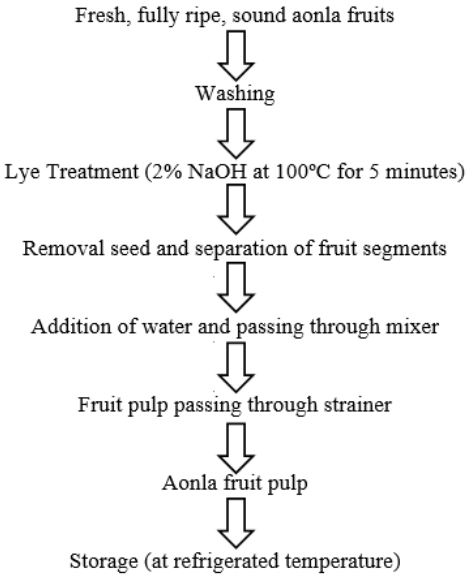

Fig 2: Process for extraction of aonla pulp

Process for extraction of orange juice

Fresh, fully ripe, sound oranges were used for extraction of juice. The fruits were cleaned, thoroughly washed, peeled with stainless steel and seeds were removed and blended in a laboratory blender to a pulp and the juice was extracted by filtering through muslin cloth and stored separately for future use (Puranik *et al.*, 2013) [6].

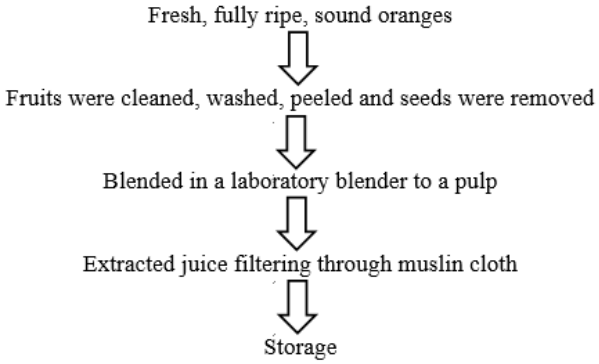

Fig 3: Process for extraction of orange juice

Process for extraction of ginger juice

The rhizome of ginger was cleaned and scrapped to remove superficial skin, cut into small pieces and then water was added to prepare ginger juice with the help of mixer-grinder. The juice was then filtered through muslin cloth to remove fibres (Dambalkar *et al.*, 2013) [7].

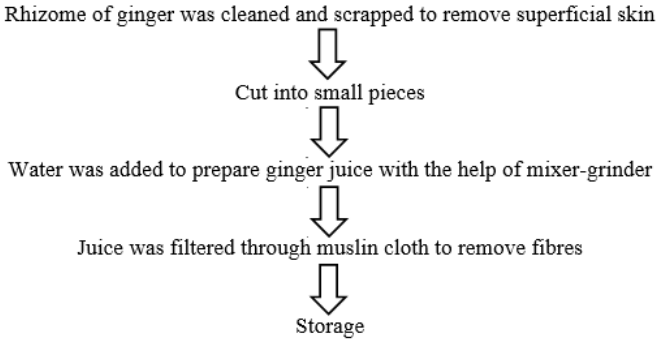

Fig 4: Process for extraction of orange jui

Standardization of recipe for preparation of beverage

The beverage was prepared by varying the concentration of jamun seed powder extract @ 0, 5, 10, 15 and 20%. The other ingredients such as aonla used 10% as fruit juice, orange juice 5% and ginger 2% were used to improve the nutritional value and acceptability of beverage. The standardized recipe for preparation of jamun seed powder extract added beverage is given in Table -1.

Table 1: Standardization of recipe for preparation of beverage

Ingredients	**Samples Jamun seed powder (sun dried T_1) extract added beverage**				
	C_0	**T_1A_5**	**T_1A_6**	**T_1A_7**	**T_1A_8**
JSE (%)	0	5	10	15	20
AP (%)	10	10	10	10	10
OJ (%)	5	5	5	5	5
GJ (%)	2	2	2	2	2
Ingredients	Jamun seed powder (shade dried T_2) extract added beverage				
	C_0	T_2B_5	T_2B_6	T_2B_7	T_2B_8
JSE (%)	0	5	10	15	20
AP (%)	10	10	10	10	10
OJ (%)	5	5	5	5	5
GJ (%)	2	2	2	2	2
Ingredients	Jamun seed powder (cabinet dried T_3) extract added beverage				
	C_0	T_3C_5	T_3C_6	T_3C_7	T_3C_8
JSE (%)	0	5	10	15	20
AP (%)	10	10	10	10	10
OJ (%)	5	5	5	5	5
GJ (%)	2	2	2	2	2

Where,			
JSE	Jamun Seed Extract	OJ:	Orange Juice
AP:	Aonla pulp	GJ:	Ginger Juice

Process for preparation beverage

The jamun seed extract was added to orange, aonla and ginger juice and required sugar syrup and citric acid as per given proportion to maintain of 13^0Bx TSS (Total Soluble Solids) of RTS beverage. The prepared syrup was filtered through muslin cloth and cooled to room temperature. Then, adding the syrup to blend and filled into pre-sterilized bottles which were pasteurized at 80^0C for 30 min. The bottles were cooled, labeled and stored.

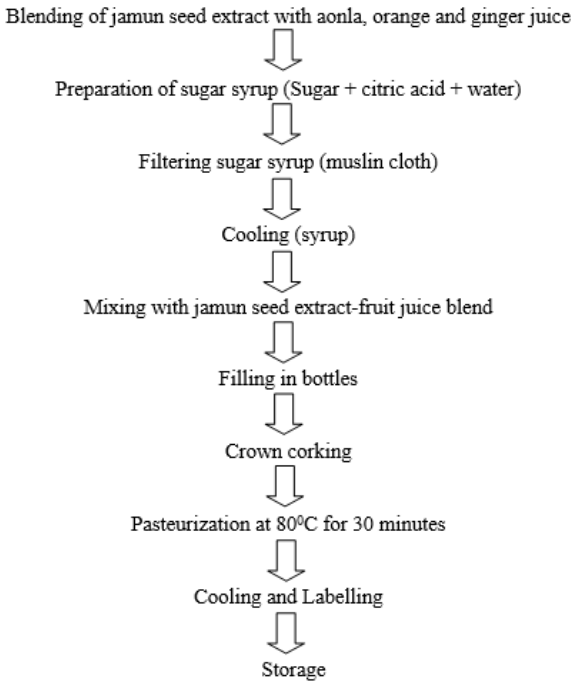

Fig 5: Process for preparation beverage

Determination of Physico-chemical characteristics

i. Total Soluble Solid (TSS)

Total soluble solid (TSS) of juice was determined by Digital Hand Refractometer (Model No. SK-109R, Jamnagar (Gujrat), India) of range 0-30^0Bx. The reading was corrected to 20^0C and the mean value was expressed as the per cent ^{0}Bx (AOAC, 2000) [8].

ii. pH

The pH values were determined with the help of a digital pH meter (Labman, Mumbai Maharashtra, India after calibrating it with buffer solution of pH 4 and 9.2 (AOAC, 2000) [8].

iii. Titratable Acidity

Titratable acidity was estimated by titrating 5 ml aliquot of the sample against standard 0.1N sodium hydroxide solution using phenolphthalein as an indicator. The total titratable acidity was expressed as per cent citric acid present in 100 ml liquid sample (Ranganna, 2011) [9]. It was calculated by formula.

$$\text{Total sugars (\%)} = \frac{\text{Glucose equivalent x Total vol. made up x Volume made up after inversion}}{\text{Titre x weight of sample x aliquot taken for inversion}} \text{ x } 100$$

iv. Reducing sugar

The reducing sugar content was determined by the method given by (Ranganna 2011) [9] using Fehling's A and Fehling's B solution.

Standardization of Fehling's Solution

Equal quantities (20 mL each) of Fehling's solution A and B were mixed in a 250 mL conical flask with 100 mL water. The mixed Fehling's solution was then titrated with standard glucose solution (1%) till blue colour just disappears. Content in the flask was then heated on a hot plate with wire gauge. When liquid begin to boil, 3 drops of methylene blue indicator were added without removing flask from hot plate. Then further titration is continued with glucose solution till the brick red colour is observed and dye colour is decolorized. The volume of glucose solution required to reduce the Fehling's solution was noted as titre value.

$$\text{Fehling's factor} = \frac{\text{Titre value of std. glucose solution x 2.5}}{1000}$$

Preparation of sample

25 g of macerated sample was taken and homogenized with few quantity of distilled water and then transferred to 250 mL volumetric flask. The sample was neutralized with 0.1 N NaOH and decolorized by adding 2 mL lead acetate. After shaking, the sample was allowed to stand for 10 min. The excess lead was removed by adding potassium oxalate and final volume was made up to 250 mL with distilled water.

Assay

The neutralized and decolorized sample was filled in burette and titrated against mixture of Fehling's solution as did for standardization of Fehling's solution. The per cent reducing sugar present in sample was determined by using following formula.

$$\text{Reducing sugar (\%)} = \frac{\text{Fehling's factor x Dilution of sample made x 10}}{\text{Titre value of sample x Wt. of sample x 100}}$$

v. Total sugar

For the estimate of total sugars, the titrate obtained in the estimation of reducing sugars was used. An aliquot from the filtrate was taken. 10 mL of dilute HCl was added and the

inversion was carried out at room temperature for 24 h. Subsequently, contents were cooled and neutralized with 40% sodium hydroxide solution using phenolphthalein as indicator and the final volume was made. The solution was filtered and titration was carried out using filtrate as detailed for reducing sugars. The total sugars content was expressed as percentage in terms of invert sugars according to the formula (Ranganna, 2011) [9].

$$\text{Total sugars (\%)} = \frac{\text{Glucose equivalent x Total vol. made up x Volume made up after inversion x 100}}{\text{Titre x weight of sample x aliquot taken for inversion}}$$

vi. Non-reducing sugar

Non reducing sugar was calculated by the formula given below.

$$\text{Non- Reducing sugars (\%)} = \text{Total sugar (\%)} - \text{Reducing sugar (\%)}$$

viii. Viscosity

Viscosity of the prepared beverages was measured using a Brookfield LVDV-E Viscometer (Brookfield Engineering Laboratories, Middleboro, MA) with LV Spindle #1 (61). All measurements were recorded at 50 and 100 r.p.m speed.

Organoleptic evaluation

The samples such as cookies and RTS beverage were evaluated for their organoleptic attributes namely colour, flavour, taste, mouthfeel and overall acceptability by semi-trained panel of 10 judges by using 9-point Hedonic rating scale (Amarine *et al*., 1987) [10].

Statistical analysis

The analysis of variance of the data obtained was done by using Completely Randomized Design (CRD) and interpreted in the results and discussion.

Result and Discussion

Organoleptic evaluation of jamun seed powder (Sun dried) added beverage

The sensory evaluation of jamun seed (sun dried) powder extract added beverages was performed for different quality attributes such as colour, flavour, taste, mouthfeel and overall acceptability. The results of the organoleptic evaluation were depicted in Table 2. It is evident from the results that, the highest score of colour was observed for T_1 A_7 (7.3) sample which was at per with sample T_1 A_6 and statistically significant over T_1 A_5, T_1 A_8 and C_0. The sample T_1 A_7 was significant over C, T_1 A_6, T_1 A_5 and T_1 A_8 with respect to flavour, taste, mouthfeel and overall acceptability.

Table 2: Organoleptic evaluation of jamun seed powder (Sun dried) added beverage

Samples	Sensory Attributes				
	Colour	Flavour	Taste	Mouthfeel	Overall Acceptability
C (Control)	6.5	7.0	7.1	7.0	7.0
T_1 A_5	7.0	7.4	7.4	7.1	7.2
T_1 A_6	7.2	7.6	7.5	7.4	7.4
T_1 A_7	7.3	7.7	7.6	7.5	7.5
T_1 A_8	6.7	6.9	6.8	6.9	6.8
SE±	0.06689	0.07679	0.06061	0.12904	0.13007
CD at 5%	0.19619	0.22522	0.17779	0.37849	0.38151

C_0 - (JSE 0% + AP 10% + OJ 5% + GJ 2%)
T_1 A_5- (JSE 5% + AP 10% + OJ 5% + GJ 2%)
T_1 A_6 - (JSE 10% + AP 10% + OJ 5% + GJ 2%)
T_1 A_7 - (JSE 15% + AP 10% + OJ 5% + GJ 2%)
T_1 A_8 - (JSE 20% + AP 10% + OJ 5% + GJ 2%)

The results for colour attributes increasing trend with increase in concentration of jamun seed extrat till the level at 15%. In case of flavour, the sample T_1 A_7 showed the highest score 7.7 as compared to other samples. The flavour of beverage was accepted by panellists at the 15% concentration of jamun seed extrat. The mouthfeel of T_1 A_7 was found the best with score 7.5 followed by C (7.0) and lowest score was observed for sample T_1 A_8 due to high concentration of jamun seed extrat. The panellists gave the highest overall acceptability for T_1 A_7 (7.5) sample. It was cleared from the data that, the jamun seed extract (sun dried) was acceptable at 15% concentration in beverages.

Organoleptic evaluation of jamun seed powder extract (Shade dried) added beverage

The sensory evaluation was done on the basis of colour, flavour, taste, mouthfeel and overall acceptability. There were five samples of jamun seed (shade dried) powder extract added beverage and results of the organoleptic evaluation was depicted in Table 3.

Table 3: Organoleptic evaluation of jamun seed powder extract (Shade dried) added beverage

Samples	Sensory Attributes				
	Colour	Flavour	Taste	Mouth feel	Overall Acceptability
C (Control)	6.5	7.0	7.1	7.0	7.0
T_2 B_5	6.8	7.2	7.3	7.1	7.1
T_2 B_6	7.0	7.4	7.6	7.3	7.3
T_2 B_7	7.2	7.6	7.5	7.4	7.4
T_2 B_8	6.3	6.8	6.5	6.4	6.5
SE±	0.1075	0.09707	0.11366	0.11547	0.15085
CD at 5%	0.3153	0.28471	0.33337	0.33868	0.44245

C_0 - (JSE 0% + AP 10% + OJ 5% + GJ 2%)
T_2 B_5 - (JSE 5% + AP 10% + OJ 5% + GJ 2%)
T_2 B_6 - (JSE 10% + AP 10% + OJ 5% + GJ 2%)
T_2 B_7 - (JSE 15% + AP 10% + OJ 5% + GJ 2%)
T_2 B_8- (JSE 20% + AP 10% + OJ 5% + GJ 2%)

The data from Table 3. revealed that the highest overall acceptability was obtained for sample T_2B_7 (7.4) which had 15% jamun seed extract followed by T_2B_6 (7.3) sample. The sample T_2B_7 had highest score for colour, flavour, taste and mouthfeel. The shade dried jamun seed extract showed higher acceptability by panellists as compared to the control sample. The lowest score was observed in sample T_2B_8 for colour (6.3), flavour (6.8), taste (6.5), mouthfeel (6.4) and overall acceptability (6.5). The results for sample T_2B_7 were found statistically ($P< 5$) significant with sample C, T_2B_5, T_2B_6 and T_2B_8.

Organoleptic evaluation of jamun seed powder extract (Cabinet dried) added beverage

The sensory evaluation was done on the basis of colour, flavour, taste, mouthfeel and overall acceptability. There were five samples of jamun seed (cabinet dried) powder extract added beverage and results of the organoleptic evaluation was depicted in Table 4.

Table 4: Organoleptic evaluation of jamun seed powder extract (Cabinet dried) added beverage

Samples	Sensory Attributes				
	Colour	Flavour	Taste	Mouth feel	Overall Acceptability
C (Control)	6.5	7.0	7.1	7.0	7.0
T_3C_5	7.3	7.4	7.6	7.3	7.4
T_3C_6	7.5	7.7	7.8	7.4	7.6
T_3C_7	7.8	8.1	8.3	7.9	8.0
T_3C_8	6.7	7.1	6.9	6.8	6.9
SE+	0.03311	0.14907	0.05604	0.10513	0.09676
CD at 5%	0.09712	0.43724	0.16438	0.30835	0.28381

C_0 - (JSE 0% + AP 10% + OJ 5% + GJ 2%)
T_3C_5- (JSE 5% + AP 10% + OJ 5% + GJ 2%)
T_3C_6 - (JSE 10% + AP 10% + OJ 5% + GJ 2%)
T_3C_7 - (JSE 15% + AP 10% + OJ 5% + GJ 2%)
T_3C_8 - (JSE 20% + AP 10% + OJ 5% + GJ 2%)

The results obtained shows that the sample T_3C_7 had highest score compared to other sample. The colour, flavour, taste, mouthfeel and overall acceptability scores for sample T_3C_7 were 7.8, 8.1, 8.3, 7.9 and 8.0, respectively. The sample T_3C_7 was most acceptable by panellists with their sensory attributes than the T_3C_6 (7.43) sample and found significantly superior over other treatments. The lowest scores were obtained in sample T_3C_8 for colour (6.7), flavour (7.1), taste (6.9), mouthfeel (6.8) and overall acceptability (6.9) due to jamun seed extract added beverages at the level 20% was not acceptable to panellists.

Organoleptic evaluation of selected beverages

Three samples were selected on the basis of organoleptic evaluation from each treatment and were compared with each other for selection of best sample among them. The comparable data were presented in Table 5.

Table 5: Organoleptic evaluation of selected beverages

Samples	Sensory Attributes				
	Colour	Flavour	Taste	Mouthfeel	Overall Acceptability
C (Control)	6.5	7.0	7.1	7.0	7.0
T_1A_7	7.3	7.7	7.6	7.5	7.5
T_2B_7	7.2	7.6	7.5	7.4	7.4
T_3C_7	7.8	8.1	8.3	7.9	8.0
SE+	0.07906	0.0825	0.06383	0.08416	0.09354
CD at 5%	0.23188	0.24197	0.18721	0.24686	0.27436

C_0 - (JSE 0% + AP 10% + OJ 5% + GJ 2%)
T_1A_7 - (JSE 15% + AP 10% + OJ 5% + GJ 2%)
T_2B_7 - (JSE 15% + AP 10% + OJ 5% + GJ 2%)
T_3C_7 - (JSE 15% + AP 10% + OJ 5% + GJ 2%)

The results from Table 4.33 revealed that, the sample T_3C_7 (7.8) had highest score for colour followed by T_1A_7 (7.3), T_2B_7 (7.2) and C_0 (6.5). There is no significant difference between the colour attributes scores for samples. Colour is an important sensory attribute of any food, because of its influence on quality attractive colour of product is a must have in fast moving consumer goods to appeal consumer for consumption. In terms of flavour the highest score was observed for sample T_3C_7 (8.1) and lowest score for sample C_0 (7.0). The prepared beverage with cabinet dried jamun seed extract (15%) showed best taste among the sun and shade dried jamun seed extract added beverage.

The taste score was found highest for sample T_3C_7 (8.3) followed by T_1A_7 (7.6), T_2B_7 (7.5) and lowest score was observed for sample C_0 (7.1). The sample T_3C_7 (7.9) got the highest score for mouth feel and for sample C_0 (7.0) has the lowest score. The highest overall acceptability was showed for sample T_3C_7 (8.0) as compared to sample C (7.0), T_1A_7 (7.5) and T_2B_7 (7.4).

Hence, on the basis of overall acceptability score (8.0) of jamun seed powder extract added beverage, treatment T_3C_7, was considered significantly superior over other samples and it was standardized for preparation of beverage and selected for further analysis.

Effect of jamun seed powder extract on physico-chemical properties of beverage

The jamun seed extract added beverage prepared were blended in different proportions with fruit juice as per the respective treatment combinations and the observations were

recorded for different blends and presented in Table 6.

Table 6: Effect of jamun seed powder extract on physico-chemical properties of beverage

Physico-chemical properties				
Parameters	**C (Control)**	**T_1 A_7**	**T_2 B_7**	**T_3 C_7**
TSS (^{0}Bx)	10	12.5	11.7	10.5
pH	3.54	3.21	3.18	3.26
Acidity (%)	0.241	0.2460	0.2580	0.2614
Total sugar (%)	3.29	5.28	4.98	5.03
Reducing sugar (%)	2.21	3.97	4.07	3.94
Non-reducing sugar (%)	1.08	1.31	0.91	1.09

Total soluble solids were found in the beverages prepared from different juice blends all the beverages were maintained at 10 to 12°Brix. Similar results were obtained by (Jakhar, *et al.*, 2013) [11]. There were significant differences with regard to pH among the treatments, the average pH over all treatments was found to show significant decrease on the addition of jamun seed extract in fruit beverages. Among the treatments, the highest pH 3.54 was noticed in control sample (C_0) which was decreased to 3.18, 3.21 and 3.26 in T_2 B_7, T_1 A_7 and T_3 C_7 respectively. The increase in acidity of the drink attributed to the increase in release of hydrogen ions. Therefore the corresponding decrease was noticed in pH (Akhtar *et al.*, 2013) [12]. The results obtained on acidity showed that there were significant differences among the treatments. The percentage of acidity significantly increased from the control (0.41 %) to sample T_3 C_7 (0.2614) with the addition of 15% jamun seed extract. The increase in titrable acidity might be due to the formation of organic acids by the degradation of ascorbic acid (Sharma *et al.*, 2009) [13]. Total sugar was also increased from 3.29 to 5.28 %. However, the increasing trend in total sugars was observed by earlier workers and was ascribed due to inversion of sugars and hydrolysis of polysaccharides into simple sugars (Sonia *et al.*, 2010) [14].

Similarly reducing and non-reducing sugar in samples T_1 A_7, T_2 B_7 and T_3 C_7 were high as compared to sample C. The reducing and non-reducing sugars were increased from 2.21 to 4.07% and 1.08 to 1.31%, except the sample T_2 B_7 had low amount of non-reducing sugar (0.91%) as compared to sample C (1.08%). Sakhale *et al.*, (2012) [15] reported that the increase in reducing sugars might be due to the conversion of nonreducing sugars into reducing sugars in presence of citric acid. Results for physico-chemical parameters are in line with the observations made by (Vaghashiya *et al.*, 2016) [16]; (Boghani *et al.*, 2012) [17].

Effect of jamun seed extract on viscosity of beverages

The effect of jamun seed extract on viscosity of prepared beverage were recorded for different blends and presented in Table 7.

The results obtained on viscosity showed that there were significant differences among the treatments. Table 4.38 shows that the apparent viscosity was found decreasing due to addition of jamun seed extract. The viscosity at shear rate 50 rpm of sample C, T_1 A_7, T_2 B_7 and T_3 C_7 were found to be 23.4, 18.0, 17.5 and 16.5 cP, respectively.

The apparent viscosity was observed to be decreased with increase in the shear rate. At shear rate 100 rpm the viscosity of sample C, T_1 A_7, T_2 B_7 and T_3 C_7 was 15.6, 13.8, 12.6 and 11.8 cP, respectively. Hence, it is clear that the beverage is psuedoplastic in nature. The similar trend was also reported by (Santos, *et al.*, 2016) [18] in case of Malay apple juice which shows its psuedoplastic nature and greater influence of soluble solids concentration on samples apparent viscosity.

Table 7: Effect of jamun seed extract on viscosity of beverages

Viscosity of beverages			
Sample	**Shear rate (rpm)**	**Torque (%)**	**Viscosity (cP)**
C (Control)	50	3.9	23.4
	100	5.2	15.6
T_1 A_7	50	3.0	18.0
	100	4.6	13.8
T_2 B_7	50	2.7	17.5
	100	4.5	12.6
T_3 C_7	50	2.6	16.5
	100	4.4	11.8

Conclusion

In the present investigation, the jamun seed powder was prepared by using traditional (sun and shade drying) and cabinet drying methods. The beverage was prepared by varying the concentration of jamun seed (sun, shade and cabinet dried) powder extract @ 0, 5, 10, 15 and 20% by keeping the proportion of other ingredients such as aonla used 10% as fruit juice, orange juice 5% and ginger 2% constant. The prepared beverages were evaluated for consumer acceptability on the basis of sensory evaluation and again these selected samples (T_1A_7, T_2B_7 and T_3C_7) were compared on the basis of sensory scores and found sample T_3C_7 was most acceptable and The results obtained on physico-chemical properties were significantly affected among the treatments by varying the concentration of extract and the apparent viscosity was found decreasing due to addition of jamun seed extract.

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