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Physico-Chemical Properties of Jamun (*Syzygium cumini* L.) Fruits and Its Processed Products

Akhila, H.[1] and Umadevi S. Hiremath[2]

[1]Department of Food Science & Nutrition UAS, GKVK, Bangalore-560065,

[2]Professor, Department of Food Science & Nutrition UAS, GKVK, Bangalore-560065,

*Corresponding Author E-mail: akhidbl726@gmail.com

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ABSTRACT

Processed jamun fruits gaining popularity among the consumers due to nutritional and antioxidant properties. Physico-chemical properties of the jamun fruit pulp and variations of different products developed from fruit pulp such as jam, squash and nectar was analysed, fruit pulp revealed average weight was 9.1g. The mean fruit length and width was 2.73 and 2.28 cm. The pH of the juice was 3.77 and total soluble solid (TSS) was 15 °Brix. The titrable acidity of fruits was 1.26%. Pulp contains 82.10% moisture, 0.31% fat, 0.25% crude fibre, 0.36% total ash, 19.4 mg/100g vitamin C, 12.6% total sugars, 8.9% reducing sugars, 3.7% non-reducing sugars, 157 mg/100g anthocyanins, 415 mg/100g GAE of total phenolic content and 92 mg/100g vitamin C Eq. of antioxidant activity. Organoleptically evaluation shown among the developed products nectar- N_3T_3 (30% pulp with 15 °Brix) was best accepted followed by squash S4T4-(40% pulp with 40 °Brix) and jam-J_4T_4 (60% pulp with 68.5 °Brix) which is rich in vitamin C content (7.7 mg/100g), total sugars (61.50%), non-reducing sugars (43.35%), anthocyanins (132 mg/100g). Higher antioxidant activity found in nectar (85mg/100g vitamin C equivalents). The reducing sugars (21.55%) and total phenolics content (300 mg/100g GAE) found in squash.

Key words: *Jamun fruits, Vitamin C, Anthocyanins, Phenolics, Antioxidant activity.*

INTRODUCTION

Jamun (*Syzygium cumini* L.) is an indigenous minor fruit of India, which belongs to the family Myrtaceae commonly known as jamun, jaman, duhat (Hindi) and black plum, Indian black berry, jambolan, jambolan plum, javaplum, Malabar plum, Portuguese plum in English[1]. Jamun is large, evergreen widely distributed forest tree of India, Srilanka, Malaysia and Australia which is also cultivated for its edible fruits. The tree was introduced from India and tropical Asia to southern Africa for its edible and attractive fruits[2]. The tree produces large quantity of fruits during May to July. The fruit is oblong, ovoid starts greening and turns pink to shining crimson black as it matures. Jamun fruit contains fair amount of mineral (Ca, K), vitamin (B-complex, vitamin C) and free sugar (glucose, mannose, sucrose).

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Purple colour of the fruit is due to anthocyanin pigment. Astringency of the fruit is due to presence of phenolic compounds (215 mg/100g). Jamun have significant antioxidant activity compared to non-anthocyanin fruit such as sapota, papaya, banana, and guava. The antioxidant activity is attributed due to presence of antioxidant vitamins, tannin and anthocyanins[3].

The availability of jamun fruit is only for 30 to 40 days during monsoon months. Most of the fruits lost as littering waste beneath the trees. The perishable nature of the fruit makes its postharvest management further difficult. Therefore the fruits are processed into various products. Jamun has a long history of medicinal as well as culinary uses in Asia and currently has a vast market for different products of the fruit, used especially for diabetics, chronic diarrhoea, enteric disorders and as an antimicrobial[4,5]. A variety of products are made from the ripe fruits such as juice, squashes, jam, jellies, vinegar and wines. Different parts of the plant like seed, barks and leaves are also used in therapeutics and feeds[6]. The leaf and seed extracts are reported to be beneficial for treatment of diabetics, hypoglycemic action, preventing radiation induced DNA damage and have antioxidant properties[7].

Among the nutritional composition of fruit, as food quality, Total Soluble Solids (TSS) of fruit represent various chemical substances present in it in soluble form[8]. Vitamin C is one of the most crucial vitamins in human diet that plays a large role in hundreds of the body's functions. The most plentiful tissue in the body is collagen, which is a connective tissue. The primary role of Vitamin C is to help this connective tissue. Collagen is the defense mechanism against disease, infection. So, Vitamin C helps to build collagen, it makes sense that it is also a remedy for scurvy by contributes to hemoglobin production. Vitamin C can protect indispensable molecules in the body, such as proteins, lipids (fats), carbohydrates and nucleic acids (DNA and RNA) from damage by free radicals and reactive oxygen species that can be generated during normal metabolism as well as through exposure to toxins and pollutants (e.g. smoking). Vitamin C may also be able to regenerate other antioxidants such as vitamin E[9,10]. Similarly, in fruits, various sugars are also present in certain forms like reducing and non-reducing in varying amount[8]. Among these nutritional compositions, crude fiber also has pivotal role in human diet. Crude fiber is considered as the material left after making digestion of the tissue. Furthermore, fats are one of the major constituents of foods and are important in our diet for a number of reasons. They are a major source of energy and provide essential lipid nutrients[11]. Anthocyanins act as phytochemical antioxidants with potential health related benefits. Some positive therapeutic effects of Anthocyanins are more or less related to the antioxidant mechanisms.

The fruit is reported to be a good source of minerals, vitamin C, sugars, phenolic compounds (Gallic acid, tannins, flavonoids, anthocyanins) and other antioxidant components[12,6,13]. Plant flavonoids, anthocyanins, tannins and other phenolic constituents are excellent antioxidant and have a high biological value[14]. Antioxidants are important in eliminating the effect of free radicals which cause oxidative damage to bioactive molecules like carbohydrates, proteins, lipids and DNA in foods and other living systems[15]. Free radicals are responsible for accelerating aging, cancer, cardiovascular diseases, Neuro-degenerative diseases and inflammations[16,17]. Utilization of foods from plant origin has been shown to lower the risk of chronic diseases such as cancer and cardiovascular diseases[18]. The positive health effects may be attributed to the high contents of certain phenolic compounds in these foods[19]. Phytochemicals have recently been studied for their positive health benefits and has attracted great attention researchers and consumers[20]. These compounds play a crucial role in preventing chronic diseases[21]. Foods containing high concentration of antioxidants are effective in prevention of cardiovascular diseases, cancers[22] and neurodegenerative

diseases[23] as well as inflammation and problems caused by cell and cutaneous aging[24].

The present study was therefore undertaken to determine the physico-chemical properties of the pulp; development of products and organoleptic evaluation of jamun fruit products such as jam, squash and nectar.

MATERIAL AND METHODS

Jamun fruits were procured from the local market of Bangalore. Fruits of good quality were graded and selected. Randomly selected twenty fruits were measured for length and width by using Vernier Calipers, fruits were weighed using an electronic balance and the mean weight was computed and recorded. Moisture, crude fat, crude fibre was determined by using the method followed by *American Officinales of Analytical Chemistry*[25]. Ash was determined by igniting a weighed sample in a muffle furnace at 550 °C to a constant weight. pH was measured using digital pH meter of analog model. Total soluble solids (TSS) were determined with the help of Pocket Refractometer. Titrable acidity, vitamin C, anthocyanins and sugars were determined as outlined by[26]. Total phenolic content was determined colorimetrically. Antioxidant activity was determined by DPPH (2, 2-diphenyl-1 dipicrylhydrazyl) radical scavenging activity method.

For the products development, fruits were cleaned washed with running water and after removal of the seeds, pulp was grinded using mixer grinder and used for the preparation of jam; juice was extracted from the grinded pulp and used for the preparation of squash and nectar. Products were developed as per FPO specifications[27] for the jam minimum fruit content 45 per cent minimum TSS 68.5^{o} Brix and minimum preservative So2- 400 ppm and permitted colours. Jam was prepared with pulp containing 45% fruit pulp, 68.5 °Brix (TSS) and 0.5% acidity, squash was prepared with 25% fruit pulp, 40 °Brix (TSS) and 1% acidity and nectar was prepared with 20% fruit pulp, 15 °Brix (TSS) and 1% acidity. According to FPO specifications[27] squash should possess minimum juice 25 per cent, minimum TSS- 50^{o} Brix, minimum acidity 3.5 per cent and minimum preservative So2- 350ppm or benzoic acid 600ppm. Anon[27] specified that nectar is prepared from the diluted fruit pulp with water and suitably blended with sugar and citric acid to get a product of 15- 20^{o} Brix. For nectar minimum TSS - 15^{o} Brix, minimum fruit content 20 per cent. Acidity was maintained by adding citric acid. Different variations of the jam, squash and nectar were made with varying 5% fruit pulp in all the three products. Sodium benzoate was used as a preservative. Organoleptic evaluation of the products was carried out by semi-trained panel members of the Food Science and Nutrition, Dept. Agricultural Entomology, Dept. Post-Harvest Technology. Of UAS, GKVK, Bangalore. The results were analysed by statistical methods and data are reported as means ± standard deviation of the means. Differences at $p \leq 0.05$ were considered as statistically significant. All the experiments and product development was carried out in department of Food Science and Nutrition, UAS, GKVK, Bangalore in 2014.

RESULTS AND DISCUSSION

The results presented in Table 1 indicate the physico-chemical properties of the jamun fruits pulp. Twenty fruits were taken for analysis and results revealed that average weight of the jamun fruits was 9.1g, fruit length 2.73 cm and fruit width 2.28 cm. pH of the fruit was 3.77. The lower pH values indicate acidic nature of the fruit. TSS (Total Soluble Solids) of the jamun fruit juice was 15 ^{o}Brix. Titrable acidity of jamun fruits was 1.26 per cent. Vitamin C (19.4mg/100g) Vitamin C, is a water soluble vitamin. Unlike most mammals, humans do not have the ability to make their own vitamin C. Therefore we must obtain vitamin C through our diet. Titrable acidity and ascorbic acid were higher in jaman fruit. Both the acid content and sugars play an important role in determining the taste of fruit. The higher levels of TA and ascorbic acid suggest that jaman fruit carries good contents of organic acids. Ascorbic acid as an

antioxidant vitamin has a greater biological valve. It has many health benefits and improves the defense mechanism in living systems. The appreciable content of ascorbic acid in jaman fruit signifies it as a healthy food. These results are in agreement with the findings of Muhammad and Sheikh[28].

Jamun fruits pulp contain moisture (82.10%), crude fat (0.31 %), crude fibre (0.25 %), total ash content (0.36 %) FAO/WHO (1974) described the human nutritional requirements obtained from plant Kingdome; Ash is the inorganic residue remaining after the water and organic matter have been removed by heating in the presence of oxidizing agents, which provides a measure of the total amount of minerals within a food. Similar results also found by Gopalan. Reducing sugars (8.9 %), non-reducing sugars (3.7 %), and total sugars (12.6 %).

Anthocyanin content of fruit pulp was 157 mg/100g. Total phenolic content was 415 mg/100g and antioxidant activity was found to be 92mg/100g of vitamin C equivalents. Similar findings were reported by Mishra[29]. Phenolics and anthocyanins are the most important antioxidant components which possess health promoting effects[2]. The findings of the present study indicate the significance of jaman fruit as a potential nutraceutical source as previously obtained by Chaudhary and Mukhopadhyay[2].

Among the different variations of jam J4T4 (60% fruit pulp with 68.5 ° Brix) was best accepted with respect to organoleptic parameters like appearance, colour, texture, flavour, taste and overall acceptability which is depicted in Table 2(Fig 1). Significant changes were observed for organoleptic parameters. Mean organoleptic scores of squash were presented in Table 3(Fig 2). From the table results revealed that among the different variations of squash S4T4 (40% pulp with 40 ° Brix) was best accepted squash with respect to organoleptic parameters like appearance, colour and overall acceptability. Mean organoleptic scores of nectar were depicted in Table 4(Fig 3). Among the different variations of nectar N3T3 (30% pulp with 15 ° Brix) was best accepted nectar with respect to organoleptic parameters like appearance, colour and overall acceptability.

Physico-chemical properties of the best accepted products revealed that jam is rich in vitamin C content (7.7mg/100g), total sugars (61.50%) non-reducing sugars (43.35 %), anthocyanins (132mg/100g). Squash had shown higher values for reducing sugars (21.55%) and total phenolic content (300mg/100g GAE). Higher antioxidant activity was found in nectar (85mg/100g vitamin C equivalents) (Table 5). The results of the pH, TSS, titrable acidity, vitamin C, total sugars, reducing sugars, and non-reducing sugars are in accordance with the Muhammad[30] *et al*.,.

Among the developed products significantly higher TSS was recorded in jam (68.5° Brix), followed by squash (40° Brix) and nectar (15° Brix). It is due to the addition of higher percentage of sugar to prepare jam. Squash exhibited highest total phenolic content (300mg/100g GAE) followed by nectar (260 mg/100g GAE) and jam (218 mg/100g GAE). Jam, squash and nectar showed antioxidant activity (73, 82, 85mg/100g vitamin C Eq. respectively). Nectar exhibited higher antioxidant values followed by squash and jam. Nectar and squash is pasteurized at comparatively low temperatures for short time than jam which is almost cooked at high temperature which may have caused damage to the antioxidant activity and total phenolic content. The antioxidant activity of nectar and squash was quite high compared to jam. It could be due to length of pasteurization during processing. These findings are in agreement with Sheikh[28]. Anthocyanins are responsible for attractive colour of the products and they have been recognised as important antioxidants[31]. Jam had higher values for anthocyanins (130mg/100g), followed by squash (128mg/100g) and nectar (97mg/100g).

The present investigation clearly shows the potential value of the jamun fruit and its products, as jamun fruits are significant source of phenolic compounds. Antioxidant activity

and total phenolic content was high in nectar followed by squash and jam. This may be due length of pasteurization during pasteurization. Consequently, jamun fruit can be considered as good source of natural antioxidants and fruit has high potential for commercialization in fruit juice and other nutraceutical supplement formulations.

Table 1: Physico-Chemical properties of the jamun fruit

Physico-Chemical Properties	Values
Fruit weight (g)	9.1
Fruit length (cm)	2.73
Fruit width (cm)	2.28
pH	3.77
TSS ^{o}Brix	15
Titrable acidity (%)	1.26
Moisture (%)	82.10
Crude fat (%)	0.31
Crude fibre (%)	0.25
Total ash (%)	0.36
Vitamin C (mg/100g)	19.4
Reducing sugars (%)	8.9
Non-reducing sugars (%)	3.7
Total sugars (%)	12.6
Anthocyanins (mg/100g)	157
Total phenolic content (mg/100g GAE.)	415
Antioxidant activity (mg/100g vitamin C Eq)	92

Table 2: Mean organoleptic scores of jam

JAM	Mean organoleptic scores					
	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
J1T1	6.4285	6.8571	6.3333	6.4285	6.4761	6.2857
J2T2	7.4285	7.8571	6.7619	6.9047	7.1904	7.1428
J3T3	7.4285	7.5238	7.0952	7.3333	7.2381	7.1904
J4T4	7.7142	7.8571	7.619	7.5714	7.5714	7.5238
F value	*	*	*	*	*	*
CV	12.501	13.5341	15.1913	14.4077	15.6598	14.1538
SE	0.1977	0.2222	0.2304	0.2219	0.2432	0.2173
CD at 5%	0.7764	0.8723	0.9048	0.8713	0.955	0.8531

J1T1- 45 per cent fruit pulp with 68.5 ^{o} Brix
J2T2- 50 per cent fruit pulp with 68.5 ^{o} Brix
J3T3- 55 per cent fruit pulp with 68.5 ^{o} Brix
J4T4- 60 per cent fruit pulp with 68.5 ^{o} Brix
*Significant @ 5% level, NS-Non-significant
No. of panel members: 21

Table 3: Mean organoleptic scores of squash

Squash	Mean organoleptic scores						
	Appearance	**Colour**	**Aroma**	**Body**	**Astringency**	**Sweetness**	**overall acceptability**
S1T1	7.4761	7.238	7.3333	7.3809	6.8571	7.1904	7.238
S2T2	7.1904	7.3333	6.9523	7.1428	6.9523	6.7142	7.0476
S3T3	7.5714	8.0952	7.3809	7.2857	6.9523	6.7619	7.1428
S4T4	8.5238	8.1428	7.1428	7.3333	7.2857	6.9523	7.8571
F value	*	*	NS	NS	NS	NS	*
CV	12.409	13.052	12.907	12.511	12.222	13.183	11.819
SE	0.208	0.219	0.2028	0.198	0.187	0.198	0.188
CD @5%	0.817	0.861	0.796	0.78	0.734	0.779	0.7413

S1T1 - 25 per cent fruit pulp with 40 ° Brix
S2T2 - 30 per cent fruit pulp with 40 ° Brix
S3T3 - 35 per cent fruit pulp with 40 ° Brix
S4T4 - 40 per cent fruit pulp with 40 ° Brix
*Significant @ 5% level, NS-Non-significant
No. of panel members: 21

Table 4: Mean organoleptic scores of nectar

Nectar	Mean organoleptic scores						
	Appearance	**Colour**	**Aroma**	**Body**	**Astringency**	**Sweetness**	**overall acceptability**
N1T1	7.9523	8.0476	7.9047	7.8571	7.2857	7.5714	7.5714
N2T2	8.0952	8.1904	7.8571	7.8571	7.8095	7.8095	7.9523
N3T3	8.8571	8.7142	8	8.0476	7.7142	7.8571	8.523
N4T4	8.238	8.0952	8.0952	8.0952	7.6666	7.9523	8.0476
F value	*	*	NS	NS	NS	NS	*
CV	10.02	9.206	9.784	10.496	13.164	12.158	9.06
SE	0.181	0.165	0.172	0.124	0.218	0.206	0.158
CD @ 5%	0.711	0.651	0.678	0.716	0.859	0.812	0.622

N1T1 - 20 per cent fruit pulp with 15 ° Brix
N2T2 - 25 per cent fruit pulp with 15 ° Brix
N3T3 - 30 per cent fruit pulp with 15 ° Brix
N4T4 - 35 per cent fruit pulp with 15 ° Brix
*Significant @ 5% level, NS-Non-significant
No. of panel members: 21

Table 5: Physico-chemical properties of best accepted products from jamun fruit pulp

Physico-chemical properties	Jam	Squash	Nectar
pH	3.01	2.45	2.51
TSS ° Brix	68.5	40	15
Titrable acidity (%)	1.90	0.95	0.69
Vitamin C (mg/100g)	7.7	3.65	9.86
Total sugars (%)	61.50	9.85	5.73
Reducing sugars (%)	18.20	21.55	14.45
Non-reducing sugars (%)	43.35	12.31	9.50
Anthocyanins (mg/100g)	132	128	97
Total phenolic content (mg/100g GAE)	218	300	260
Antioxidant activity (mg/100g vit C Eq.)	73	82	85

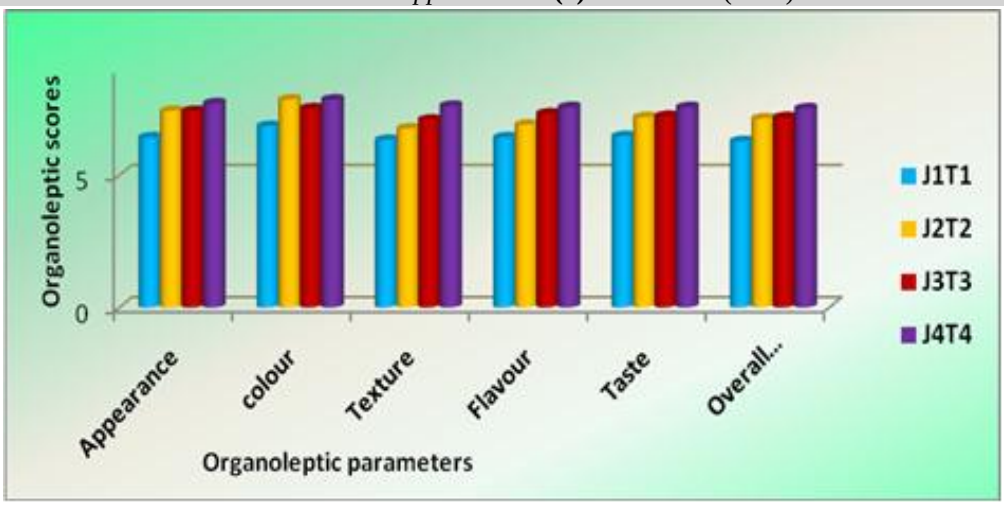

Fig. 1: Mean organoleptic scores of jam

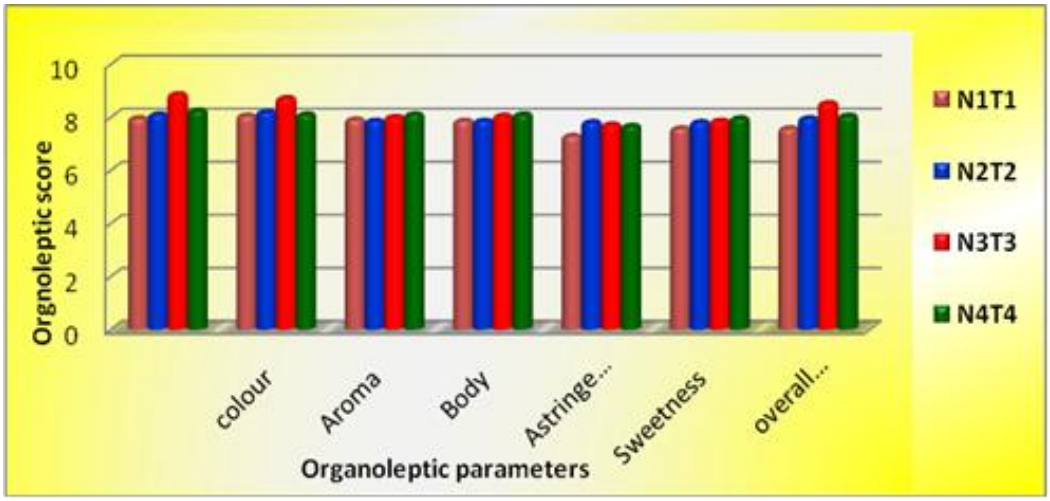

Fig. 2: Mean organoleptic scores of squash

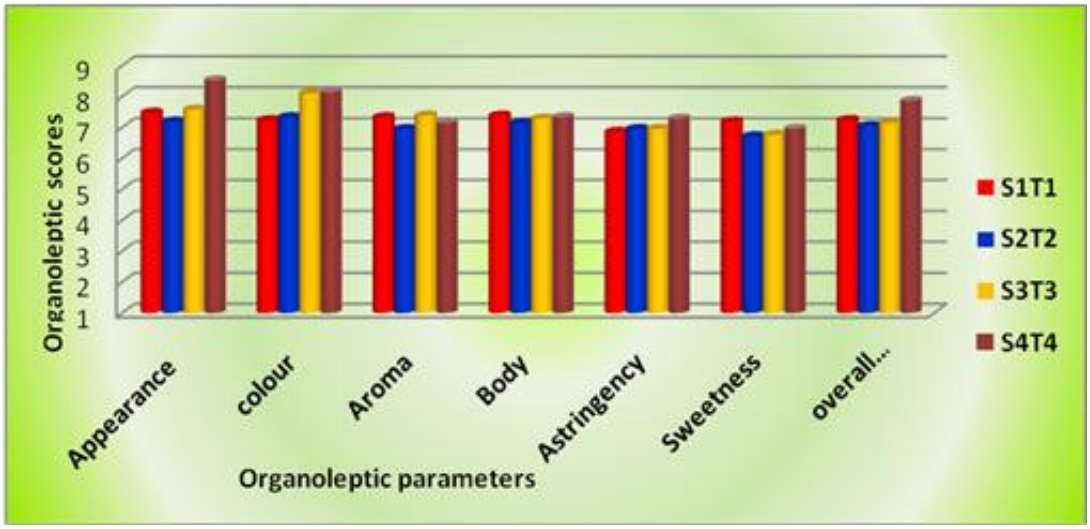

Fig. 3: Mean organoleptic scores of nectar

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