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Karishma Sebastian
Department of Pomology and Floriculture, College of Agriculture, Vellayani, KAU, Kerala, India

Meagle Joseph P
Department of Post-Harvest Technology, College of Horticulture, Thrissur, KAU, Kerala, India

KB Sheela
Department of Post-Harvest Technology, College of Horticulture, Thrissur, KAU, Kerala, India

Jooby Jose
Department of Post-Harvest Technology, College of Horticulture, Thrissur, KAU, Kerala, India

Correspondence
Karishma Sebastian
Department of Pomology and Floriculture, College of Agriculture, Vellayani, KAU, Kerala, India

Post-harvest characterisation and value addition of sweet lovi-lovi fruits (*Flacourtia* spp.)

Karishma Sebastian, Meagle Joseph P, KB Sheela and Jooby Jose

Abstract
Sweet lovi-lovi, belongs to Flacourtiaceae family is an underexploited fruit having nutritive, therapeutic and medicinal values. But it has not being utilized for its full potential, hence an attempt has been made in this study. Sweet lovi-lovi accessions belonging to *Flacourtia cataphracta* and *Flacourtia montana*, were evaluated for physico-morphological and biochemical parameters and the suitability of these fruits to develop ready to serve beverage (RTS), preserve and wine were analysed. The physico-morphological and bio-chemical characters showed significant variation among the accessions. The desirable post-harvest qualities like high fruit weight, pulp percentage, less seed content along with highest total sugar (12.81%), non-reducing sugar (1.33%), anthocyanin (0.04 mg $100g^{-1}$), carotenoid (582.55 mg $100g^{-1}$), iron (33.23 mg $100g^{-1}$), crude fibre (2.92 g $100g^{-1}$) and lowest tannin (0.21 mg $100g^{-1}$) was observed in Accession no.2. Wine, preserve and RTS beverage prepared from sweet lovi-lovi (*Flacourtia* spp.) accessions according to FSSAI specifications was found to have good acceptability. The overall acceptability of sweet lovi-lovi wine and preserve increased during storage of three months whereas, the RTS beverage showed a reducing trend in overall acceptability during entire storage period.

Keywords: *Flacourtia* spp., underexploited fruit, physico-morphological, and bio-chemical

1. Introduction
Sweet lovi-lovi (*Flacourtia* spp.) belonging to Flacourtiaceae family has its origin in Indian peninsular region. It is found distributed in Western Ghats with semi evergreen and moist deciduous forests. Trees are medium sized, spreading with dark green leaves, and the fruits are red to dark purple in colour. The presence of good amount of total soluble solids (TSS) in the fruit makes it suitable for table purpose. The fruit is rich in vitamins like ascorbic acid, β-carotene, and minerals like calcium, magnesium and iron (George, 1999) [8]. The fruits also contain high amount of anthocyanin, which is valued as a bioactive compound. Sweet lovi-lovi trees are characterized by sharp spines on the trunk, resulting in a paucity in cultivation. In Kerala where the homesteads were big enough to contain biodiversity in its fullest form, these trees were very common. But, in the present situation of fragmented land holdings the occurrence of the tree has become scanty. The lack of knowledge on their nutrient value is also a factor that makes it an underutilized one. In this context, characterizing sweet lovi-lovi fruits based on physico-chemical and morphological parameters will help to increase the status of fruit.

Apart from their nutritive and medicinal values, the sweet lovi-lovi fruits have excellent flavour and very attractive colour. After full maturity, the fruit detach itself from the short pedicel and fall down. At this stage, the fruit possesses maximum organoleptic qualities. Since the pedicel is absent at this stage, the fruit starts browning from the opening at the proximal end of the fruit and favours rapid phenolic oxidation. The extent of browning is more in sweet lovi-lovi fruits when compared to sour lovi-lovi as they are harvested along with their short pedicels. In addition, high temperature and humidity, prevalent in tropical region cause deterioration of the fruits. Poor shelf life and browning of the fruits during storage make them popular only in the area of production. The crop have not undergone any conscious phase of domestication and its utilization is limited in processing sector mainly due to the short shelf life and limited availability of fruits. These limitations can be overcome by adopting proper post-harvest technology and processing the fruits into number of value added products. Dubey and Pandey (2013) [7] reported that fruits of *Flacourtia jangomas* can be exploited as dessert, made into juice, syrup, jam, marmalade and pickles and also used in chutneys.

2. Materials and methods
The present investigation was carried out in the Department of Processing Technology, College of Horticulture, Vellanikkara, Thrissur during 2015 - 2017. For the study the sweet

lovi-lovi accessions (Acc.) belonging to *Flacourtia cataphracta* and *Flacourtia montana* were collected from three centres at Vellanikkara namely College orchard of Department of Fruit Science, Central nursery of Kerala Agricultural University and regional station of National Bureau of Plant Genetic Resources (Table 1).

Table 1: Details of *Flacourtia* spp. used for study

Accessions	Species	Location
Accession 1	*Flacourtia cataphracta*	College orchard, Dept. of Fruit Science,
Accession 2	*Flacourtia cataphracta*	College orchard, Dept. of Fruit Science
Accession 3	*Flacourtia cataphracta*	College orchard, Dept. of Fruit Science
Accession 4	*Flacourtia cataphracta*	Central Nursery, Kerala Agricultural University
Accession 5	*Flacourtia montana*	Regional Centre, NBPGR, Vellanikkara

In recent years, studies on physico - morphological properties have been conducted in various agricultural products for assessing the qualities for processing. Thus sweet lovi-lovi accessions were characterised based on physico-morphological and bio-chemical characters. Fruit length and fruit diameter of ten fruits under each accessions was measured using vernier caliper and the average of these values were expressed in centimeters. Individual fruit weight was recorded and expressed in gram as the average of ten fruits. The volume of the fruit was estimated by water displacement method and expressed in millilitres as the average of ten fruits. Specific gravity was computed by dividing weight with volume of the ripe fruit. The number of seeds in ten sweet lovi-lovi fruits was counted and mean worked out. Weight of skin, pulp and seed were recorded separately and relative proportion of each of the component to total weight was worked out to obtain the physical composition.

The colour of rind, flesh and juice was visually observed and identified with the help of Universal Colour Language (UCL), which is a colour menu defined by the Inter-society Colour Council, National Bureau of Standards (1946) and approved by Royal Horticultural Society (Anonymous, 1999) [1].

Biochemical parameters were estimated using standard procedures (Table 2).

Table 2: Details of procedures followed in the study

Sl. No.	Parameter	Method
1	Acidity, total sugars, reducing and non-reducing sugars, carotenoids, calcium and iron	Ranganna, (1997) [21]
2	Total Soluble Solids	Hand refractometer
3	Ascorbic acid and starch	Sadasivam and Manickam, (1996) [22]
3	Anthocyanin	Iland *et al*., (1996) [9]
4	Tannin	Schanderl (1970) [23]
5	Magnesium	Perkin-Elmer (1982) [19]
6	Crude fibre	Chopra and Kanwar (1978) [5]
7	Protein	Lowry *et al*., (1951) [14]

The red ripe fruits were collected from the trees when they were fully ripe during the main harvesting season (February-April) for making value added products. Fruits were sorted to remove the damaged and undesirable ones and selected fruits were carefully transported to the laboratory of the Department of Processing Technology in polythene bags. They were then washed in clean water in order to minimize the field heat. The wine was prepared with fruit, sugar and water in the ratio 1:0.75:1. The contents were stirred during alternate days and allowed to ferment upto 21 days. The wine was kept for clarification and the clear wine was collected after 10 days. Sensory attributes of wine prepared from all accessions were evaluated on a nine point hedonic scale by a panel of 15 semi trained judges. The best wine was stored for a period of three months and organoleptic evaluation was conducted at monthly intervals. Total Soluble Solids (TSS) of sweet lovi-lovi wine was determined by using hand refractometer. Phenol content of sweet lovi-lovi wine was determined using Folin- Ciocalteau reagent method suggested by Malick and Singh, (1980) [16]. Alcohol content of wine was found using distillation method.

The preserve was prepared from all the accessions and sensory attributes of preserve were evaluated on a nine point hedonic scale initially with a panel of 15 semi trained judges. The best preserve was stored for three months under ambient conditions and organoleptic evaluation was conducted at monthly intervals. The microbial counts were observed during the initial and final months.

The RTS beverage was prepared by standard procedure according to FSSAI specification (TSS 15°Brix and 15 per cent juice, 0.3 per cent acidity) and sensory attributes were evaluated on a nine point hedonic scale initially with a panel of 15 semi trained judges and the best RTS beverage were stored for three months under refrigerated conditions and organoleptic evaluation was conducted at monthly intervals. The microbial counts were observed during the initial and final months.

3. Results and discussion

The fruit characters of sweet lovi-lovi accessions were studied with regard to length, diameter, weight, volume, specific gravity and seed number. The shape of the fruit is determined by the length and breadth of the fruit and it is one of the most important quality parameters valued by consumers. The physical properties of fruits helps in sorting and grading of fruits and are also important for the design of equipment needed for harvesting and post-harvest operations like transporting, storing, cleaning, separating, sorting, sizing, packaging and value addition. The physical composition gives an idea about the pulp recovery from the fruit. Physical characters of sweet lovi-lovi accessions are given in the Table 3.

Fruit length and diameter of sweet lovi-lovi accessions showed significant variation and it ranged from 1.30 to 1.59 cm. and 1.44 to 1.87 cm respectively. It was in accordance with findings of Morton (1987) [17] wherein *Flacourtia ramontchi* fruits have a diameter of 1.25 - 2.5 cm. The aspect

ratio was found out and it showed that the value ranged from73.33 to 94.08. This indicates that the shape is spherical having rolling ability. It is applicable in relation to the designing of equipment used for value addition.

The parameters like weight, volume, specific gravity and number of seeds are indicators used for deciding the processing quality of fruits. The weight of sweet lovi-lovi fruits from different accessions also varied significantly. The highest fruit weight (3.92 g) was for Acc. 2 and the lowest (2.29 g) was recorded in Acc. 5. The fruit volume which showed significant difference among the different accessions ranged from 1.95 to 3.6 ml. Specific gravity did not show any significant difference among sweet lovi-lovi accessions. The genotype and phenotype contribute to the variability observed.

The aspect ratio (Ra) of sweet lovi-lovi fruits was calculated by the equation given by Maduako and Faborode, (1990) [15].

$$Ra = (W/L) \times 100$$

Where, Ra = aspect ratio (%)
L = length (mm)
W = width (mm)

Table 3. Physical characters of sweet lovi-lovi accessions

Accessions	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (ml)	Specific gravity	Seed number	Aspect ratio (%)
Acc. 1	1.59	1.69	3.68	3.35	1.14	11.6	94.08
Acc. 2	1.41	1.87	3.92	3.55	1.13	11.8	75.40
Acc. 3	1.34	1.68	2.72	2.75	1.05	10.3	79.76
Acc. 4	1.48	1.82	3.75	3.60	1.17	11.2	81.32
Acc. 5	1.30	1.44	2.29	1.95	1.30	11.9	90.28
SE	0.04	0.05	0.24	0.26	0.14	0.38	80.00
CD (0.05)	0.11	0.15	0.69	0.74	NS	1.10	73.33

The significant difference observed in the physical composition among the accessions (Table 4) renders a choice in utilizing the fruits for specific purposes. The pulp percentage ranged from 70.12 to 78.78 per cent. More pulp percentage can be served as a marker in selecting the accessions for table purpose and making value added products like preserve. The skin percentage ranged from 8.18 to 11.09 per cent. Seed percentage ranged from 12.38 to 21.69 per cent. Number of seeds showed significant variation among accessions, ranging from 10.30 to 11.90. These findings are in conformity with reports of Bhowmick (2011) [3] in which fruits of *Flacourtia jangomas* are many seeded with eight to ten in number. The seediness may not be a hindrance in the making of unfermented beverages as well as wine.

Table 4: Physical composition (%) of sweet lovi-lovi accessions

Accessions	Physical composition (%)		
	Skin	Pulp	Seed
Acc. 1	11.09	71.28	17.61
Acc. 2	8.82	78.77	12.38
Acc. 3	10.71	73.07	16.20
Acc. 4	9.80	76.69	13.50
Acc. 5	8.17	70.12	21.69
SE	0.53	1.63	1.43
CD (0.05)	1.51	4.65	4.06

Fruits come in different colours and the final colour visually observed is a result of the combination of certain antioxidants, phytonutrients and nutrients. In sweet lovi- lovi the skin, pulp and juice have different colours contributing to its nutritive value mainly due to the presence of anthocyanin. For the purpose of describing the accessions the data on colour of skin, flesh and juice of sweet lovi-lovi accessions were collected and presented in Table 5. The skin colour was deep pink (51 B) in Acc. 1 and Acc. 3, deep pink (50 B) in Acc. 2, whereas it was deep yellowish pink (47 C) in case of Acc. 4 and strong pink (50 C) in Acc. 5. Pale yellow was the commonly observed colour in all sweet lovi-lovi accessions and it was pale yellow (18 C) in Acc. 1 and Acc. 4, pale yellow (19 D) in Acc. 2, pale yellow (18 D) in Acc. 3 and pale yellow (20 C) in Acc. 5. The juice colour of sweet lovi-lovi was described as Vivid purplish red in all accessions as per Universal Colour Language (UCL) and it was Vivid purplish red (61 C) in Acc. 1 and Acc. 3, Vivid purplish red (61 B) in Acc. 2, Vivid purplish red (63 A) in Acc. 4 and Vivid purplish red (63 B) in Acc. 5.

Table 5: Colour of rind, flesh and juice of sweet lovi-lovi accessions

Accessions	Colour of skin	Colour of flesh	Colour of juice
Acc. 1	Deep Pink – 51 B	Pale Yellow – 18 C	Vivid Purplish Red – 61 C
Acc. 2	Deep Pink – 50 B	Pale Yellow – 19 D	Vivid Purplish Red – 61 B
Acc. 3	Deep Pink – 51 B	Pale Yellow – 18 D	Vivid Purplish Red – 61 C
Acc. 4	Deep Yellowish Pink – 47 C	Pale Yellow – 18 C	Vivid Purplish Red – 63 A
Acc. 5	Strong Pink – 50 C	Pale Yellow – 20 C	Vivid Purplish Red – 63 B

Biochemical parameters often determines the fruit quality. Acids and sugars are important components, which provide characteristic taste and flavour to fruits and their products. The quality of the fruit juice is often expressed in terms of the sweetness-to-sourness ratio (°Brix/acid). The important parameters related to the fruit quality are given in the Table 6.

Table 6: Biochemical characters of sweet lovi-lovi accessions

Accessions	TSS (^{0}Brix)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	Ascorbic acid (mg 100g^{-1})	Anthocyanin (mg 100g^{-1})	Tannin (mg 100g^{-1})
Acc. 1	18.67	1.42	12.81	12.13	0.68	18.21	0.03	0.23
Acc. 2	18.33	1.28	12.81	11.49	1.33	20.04	0.04	0.21
Acc. 3	17.67	0.92	9.74	8.91	0.83	16.83	0.03	0.27
Acc. 4	17.00	1.07	8.92	7.95	0.97	19.09	0.03	0.23
Acc. 5	21.33	1.42	7.36	6.68	0.67	20.63	0.03	0.24
SE	0.70	0.05	0.16	0.16	0.12	1.79	0	0
CD (0.05)	2.20	0.17	0.50	0.50	0.37	NS	0.003	0.01

Table 6: Contd…

Accessions	Antioxidant (µg ml^{-1})	Carotenoids (mg 100g^{-1})	Minerals			Crude fibre (g 100 g^{-1})	Starch (g 100 g^{-1})	Protein (g 100 g^{-1})
			Ca (mg 100g^{-1})	Mg (mg 100g^{-1})	Fe (mg 100g^{-1})			
Acc. 1	0.18	441.03	193.33	13.53	25.08	2.18	3.93	1.74
Acc. 2	0.19	582.55	210.00	10.38	33.23	2.92	2.73	1.05
Acc. 3	0.23	488.14	202.00	13.55	32.19	2.35	3.6	0.80
Acc. 4	0.16	347.02	213.33	13.39	29.57	2.58	3.4	1.18
Acc. 5	0.20	476.82	202.67	10.35	27.55	1.2	4.6	2.33
SE	0	4.00	3.83	0.20	0.65	0.19	0.20	0.08
CD (0.05)	0.02	12.60	12.07	0.62	2.05	0.59	0.64	0.25

The TSS express the sweetness of a commodity. The TSS of guava, sapota, and papaya are 9.7, 11.8, and 8.2 respectively (Athmaselvi *et al*., 2014) [2]. In sweet lovi-lovi accessions TSS ranged from 17 to 21.33°Brix. This result is in conformity with the findings of Prasad (1998) [20] who reported 20°Brix for sweet lovi-lovi fruits. Significant variation in titrable acidity was observed among sweet lovi-lovi accessions which ranged from 0.92 to 1.42 per cent. This was in accordance with the findings of Joy (2003) [10] and Mundaragi and Thangadurai (2015) [18]. Flavour quality of the commodity which determines fruit value to consumers, depends on the content of sugars, organic acids, *etc*. (Sonu and Rao, 2013) [26]. Reducing, non-reducing and total sugar showed significant variation among different sweet lovi-lovi accessions and it ranged from 6.68 to 12.13 per cent, 0.67 to 1.33 per cent and 7.36 to 12.81 per cent respectively. The inherent sugar content adds to the quality during processing. This result is in concordance with the study conducted by George (1999) [8]. Although there was no significant difference in ascorbic acid content among sweet lovi-lovi accessions it is having considerable amount of ascorbic acid ranging from 16.83 to 20.63 mg 100g^{-1} adding to the nutritive value of the fruit. Anthocyanin and tannin contributes to the antioxidant property of the fruit. Sweet lovi-lovi accessions differed significantly in anthocyanin content and it ranged from 0.03 to 0.04 mg 100g^{-1}. Considerable variation in tannin content was recorded ranging from 0.21 to 0.27 mg 100g^{-1}. The carotenoid content recorded high and it varied significantly among the accessions of sweet lovi-lovi. It ranged from 347.02 to 582.55 mg 100g^{-1}. Thus due to the effect of tannins, anthocyanin and carotenoids the antioxidant content ranged from 0.16 to 0.23 µg ml^{-1} making it an important fruit to be included in our diet.

The mineral content in fruits were also analyzed and recorded. Calcium content in sweet lovi-lovi accessions ranged from 193.33 to 213.33 mg 100g^{-1}. This is in concurrence with the study conducted by George (1999) [8] in which the calcium content was 218 mg 100g^{-1} after 80 days from fruit set. The magnesium content varied significantly among different sweet lovi-lovi accessions. The magnesium content of sweet lovi-lovi accessions ranged from 10.35 to 13.55 mg 100g^{-1}. The iron content of sweet lovi-lovi accessions ranged from 25.08 to 33.23 mg 100g^{-1}.

Crude fibre which is an essential dietary component is, considered high during these days. Content of fibre in sweet lovi-lovi accessions ranged from 1.2 to 2.92 g 100g^{-1}. This result is in conformity with the findings of Joy (2003) [10] who reported 1.10 g 100g^{-1} crude fibre content for sweet lovi-lovi fruits. Acc. 5 is a good source of fibre.

Starch content was also high in sweet lovi-lovi. From a lowest value of 2.73 g 100g^{-1} in Acc. 2 it reached up to a highest value of 4.6 g 100g^{-1} in Acc. 5. According to Joy (2003) [10] the starch content of sweet lovi-lovi fruit is 2.97 g 100g^{-1}. Protein content of sweet lovi-lovi accessions ranged from 0.80 to 2.33 g 100g^{-1}. Since these two parameters contribute to the energy value of food commodity, this fruit can be considered as a good energy source also.

The value added products like wine, preserve and RTS beverage were prepared from sweet lovi-lovi fruits and evaluated using a nine point hedonic scale to assess the colour, appearance, flavour, taste, texture, after taste and overall acceptability of the products by a panel of 15 semi trained judges.

The mean rank scores for flavour (7.43), texture (7.13), odour (7.37), taste (7.33) and after taste (7.30) were highest for wine prepared from Accession 5 (Table 7). Accession 3 and Accession 4 bagged highest score (7.57 and 7.47) for appearance and colour respectively. The overall acceptability was also maximum for Accession 5 (7.50) with a total score of 58.09. Thus sweet lovi-lovi wine prepared from Acc. 5 was selected for storage studies. On storage, all the attributes showed an increasing trend and the total score raised from 58.09 to 61.77 after three months (Table 8). Kalyani (2011) [11] reported that the overall acceptability of karonda (*Carissa carandas* L.) wine increased during storage due to the development of pleasant colour, improvement of aroma, taste and reduction in acidity and phenols.

Table 7: Mean sensory score of sweet lovi-lovi wine

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 1	7.27	7.27	7.13	7.00	7.20	6.87	6.67	7.20	56.61
Acc. 2	7.30	6.80	6.80	7.07	6.67	6.87	6.87	7.33	55.71
Acc. 3	7.57	7.37	6.50	6.63	7.00	6.63	6.40	6.60	54.70
Acc. 4	7.13	7.47	6.83	6.80	6.57	6.57	6.53	7.17	55.07
Acc. 5	7.00	7.03	7.43	7.13	7.37	7.33	7.30	7.50	58.09
Kendal's W	0.06	0.03	0.07	0.04	0.12	0.08	0.14	0.11	

Table 8: Effect of storage on organoleptic qualities of sweet lovi-lovi wine

Initial									
	Appearance	**Colour**	**Flavour**	**Texture**	**Odour**	**Taste**	**After taste**	**Overall acceptability**	**Total score**
Acc. 5	7.00	7.03	7.43	7.13	7.37	7.33	7.30	7.50	58.09
Kendal's W test	0.06	0.03	0.07	0.04	0.12	0.08	0.14	0.11	
1 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 5	7.6	7.6	7.07	7.37	7.23	7.56	6.9	7.53	58.86
Kendal's W test	0.07	0.06	0.10	0.07	0.07	0.09	0.16	0.10	
2 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 5	7.1	7.37	7.57	7.5	7.03	7.23	7.03	7.57	58.4
Kendal's W test	0.10	0.07	0.10	0.04	0.19	0.23	0.15	0.10	
3 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 5	8.10	7.53	7.47	7.70	7.73	7.67	7.57	8.00	61.77
Kendal's W test	0.05	0.10	0.10	0.10	0.10	0.15	0.15	0.15	

The wine made from Acc. 2 was screened initially and three months after storage for biochemical characters like TSS, phenol and alcohol content (Table 9).

The TSS was 24°Brix in the beginning, which was reduced to 23°Brix after three months of storage. Interaction of various components during maturation brings about precipitation of soluble solids which might be the reason for decrease of TSS on storage (Sharma and Joshi, 2003) [24]. TSS of karonda (*Carissa carandas* L.) wine showed a decrease from 9.25°Brix to 7.83°Brix four months after storage (Kalyani, 2011) [11]. The phenol content of sweet lovi-lovi wine increased during storage which witnessed 0.22 mg $100g^{-1}$ initially and 0.33 mg $100g^{-1}$ three month after storage. A phenol content of 0.22g 100 $ml^{-1}$was reported in jamun (*Syzgium cumini* L.) wine (Chowdhury and Ray, 2007) [6]. Phenolic compounds have an important impact on organoleptic properties of wine (Lorrain *et al.,* 2013) [13] and reported to have multiple biological activities, including cardioprotective, anti-inflammatory, anti-carcinogenic, antiviral and antibacterial properties attributed mainly to their antioxidant (Teissedre *et al*., 1996) [27] and antiradical activity. The alcohol content of 8.06 per cent was noticed initially and it was elevated to 8.71 per cent three months after storage. Chikkasubbanna *et al.* (1990) [4] reported that the alcohol percentage of the grape wine increased due to a decrease in total soluble sugars due to the activity of yeast during fermentation. Ulla (2011) [28] reported that pomegranate wine prepared using arils and 20 per cent sugar syrup yield 7.28 per cent alcohol initially which rise to 7.41 per cent three month after storage.

Table 9: Effect of storage on biochemical constituents of sweet lovi-lovi wine (Accession 5)

Biochemical constituents	Initial	3 MAS
TSS (°brix)	24	23
Phenol content (mg/g)	0.22	0.33
Alcohol content (%)	8.06	8.71

The highest mean scores of sweet lovi-lovi preserve for flavour (7.54), texture (7.27), odour (7.27), taste (8.00), after taste (7.54) and overall acceptability (7.86) were recorded for Accession 2 and for appearance and colour highest mean score were noticed in Accession 3 (Table 10). Highest score (58.02) for preserve was recorded in Accession 2, followed by Accession 3 (57.07), Accession 4 (49.90), Accession 5 (49.45) and least score (49.09) was noticed in Accession 1. Hence preserve prepared from Accession 2 was selected for storage studies. Organoleptic evaluation conducted at monthly interval showed that the total score increased from 58.02 to 58.47 (Table 11). Joy (2003) [10] reported that mean scores for flavour, texture, taste and overall acceptability of lovi-lovi preserve increased during storage for six months, whereas mean scores for appearance and colour was found to decrease. The murrabbas which is preserved by its high sugar concentration principle is valued for its medicinal and curative properties achieved by its long term storage. The medicinal value is attributed to the polyphenolicsubstances present in them (Siddappa and Sastry, 1959) [25].

Table 10: Mean sensory score of sweet lovi-lovi preserve

Accessions	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 1	5.09	5.73	6.27	5.91	6.91	6.82	6.27	6.09	49.09
Acc. 2	6.09	6.45	7.54	7.27	7.27	8.00	7.54	7.86	58.02
Acc. 3	6.73	6.54	7.36	7.18	7.18	7.54	7.18	7.36	57.07
Acc. 4	5.36	5.82	6.82	6.00	6.54	6.73	6.27	6.36	49.90
Acc. 5	5.64	6.18	6.36	6.18	6.64	6.45	6.09	5.91	49.45
Kendal's W	0.25	0.18	0.28	0.39	0.29	0.34	0.41	0.61	

Table 11: Effect of storage on organoleptic qualities of sweet lovi-lovi preserve

Initial									
	Appearance	**Colour**	**Flavour**	**Texture**	**Odour**	**Taste**	**After taste**	**Overall acceptability**	**Total score**
Acc. 2	6.09	6.45	7.54	7.27	7.27	8.00	7.54	7.86	58.02
Kendal's W test	0.25	0.18	0.28	0.39	0.29	0.34	0.41	0.61	
1 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 2	7.13	7.37	7.23	7.23	7.13	7.73	7.67	7.5	58.99
Kendal's W test	0.32	0.19	0.19	0.19	0.13	0.13	0.15	0.17	
2 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 2	6.57	6.9	7.67	7.5	6.77	7.83	7.25	7.9	58.39
Kendal's W test	0.23	0.15	0.23	0.10	0.05	0.10	0.05	0.05	
3 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 2	6.47	6.37	7.37	7.63	7.0	8.3	7.5	7.83	58.47
Kendal's W test	0.23	0.10	0.10	0.03	0.10	0.15	0.05	0.10	

Highest mean score for appearance (7.44), colour (7.12), texture (7.44), taste (7.81), and overall acceptability (7.78) was recorded for RTS beverage prepared from Acc. 3 whereas the RTS beverage prepared from Acc. 5 bagged highest mean score for flavour (7.37), odour (7.25), and after taste (7.37) (Table 12). The RTS beverage prepared from Acc. 3 attained a total score of 59.09 which was highest and were selected for three months storage. On storage, all the attributes showed a reducing trend and the total score reduced from 59.09 to 55.43 after three months (Table 13). Kavitha (2011) [12] reported that ber RTS beverage prepared using 15 % pulp with 15°Brix TSS stored at low temperature was rated excellent for organoleptic qualities, but the overall acceptability was found reduced during storage. The loss of flavour and conversion of vitamin C and polyphenols into di or polycarbonyl compounds may be contributing towards decreasing trend in organoleptic scores.

Table 12: Mean sensory score of sweet lovi-lovi RTS beverage

Accessions	**Appearance**	**Colour**	**Flavour**	**Texture**	**Odour**	**Taste**	**After taste**	**Overall acceptability**	**Total score**
Acc. 1	7.00	6.75	6.25	6.75	6.69	6.12	5.87	6.12	51.55
Acc. 2	6.87	6.81	6.75	6.87	6.69	7.06	6.50	6.81	54.36
Acc. 3	7.44	7.12	7.19	7.44	7.12	7.81	7.19	7.78	59.09
Acc. 4	7.06	7.00	7.12	7.12	7.06	7.19	6.75	7.25	56.55
Acc. 5	7.00	7.12	7.37	7.00	7.25	7.69	7.37	7.50	58.30
Kendal's W	0.09	0.06	0.22	0.10	0.09	0.43	0.34	0.27	

Table 13: Effect of storage on organoleptic qualities of sweet lovi-lovi RTS beverage

Initial									
	Appearance	**Colour**	**Flavour**	**Texture**	**Odour**	**Taste**	**After taste**	**Overall acceptability**	**Total score**
Acc. 3	7.44	7.12	7.19	7.44	7.12	7.81	7.19	7.78	59.09
Kendal's W test	0.09	0.06	0.22	0.10	0.09	0.43	0.34	0.27	
1 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 3	7.28	7.07	7.28	7.43	7.13	7.37	7.08	7.41	58.05
Kendal's W test	0.10	0.10	0.19	0.17	0.10	0.07	0.19	0.23	
2 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 3	6.97	7.03	7.23	7.27	7.00	7.30	7.13	7.2	57.13
Kendal's W test	0.38	0.17	0.06	0.07	0.04	0.20	0.15	0.05	
3 MAS									
	Appearance	Colour	Flavour	Texture	Odour	Taste	After taste	Overall acceptability	Total score
Acc. 3	6.9	6.86	6.9	6.9	6.83	7.27	6.87	6.9	55.43
Kendal's W test	0.13	0.10	0.10	0.05	0.10	0.10	0.28	0.15	

The products prepared from best accession was observed for microbial count initially and finally. The yeast population was found nil in sweet lovi-lovi wine during initial month and a count of 6 cfu/g X 10^3 was witnessed after three months of storage (Table 14). In sweet lovi-lovi preserve during initial month, the bacterial population was nil and during final month the count was 18 cfu/g X 10^6. The yeast population in sweet lovi-lovi preserve was found to be insignificant during initial and final month. The fungal population was found to be nil during initial month and the count is 2 cfu/g X 10^3 after three month storage in sweet lovi-lovi preserve (Table 15). In the initial and final month the bacterial and yeast population were found insignificant in RTS beverage prepared from sweet lovi-lovi fruits. The fungal population was nil during initial month and the count was 1 cfu/g X 10^{-3} three month after storage. The *E. coli* count of RTS beverage prepared from Acc. 3 was checked out initially and at the end of storage, since pathogenic *E. coli* was found to cause illness through contaminated water. The *E. coli* population was nil during the initial and final month of storage (Table 16).

Table 14: Effect of storage on yeast population of sweet lovi-lovi wine (Accession 5)

Product	Initial	3 MAS
	Yeast (10^3 CFU/g)	Yeast (10^3 CFU/g)
Wine	0	6

Table 15: Effect of storage on microbial population of sweet lovi-lovi preserve (Accession 2)

Product	Initial			3 MAS		
	Bacteria (10^6 CFU/g)	Yeast (10^3 CFU/g)	Fungi (10^3 CFU/g)	Bacteria (10^6 CFU/g)	Yeast (10^3 CFU/g)	Fungi (10^3 CFU/g)
Preserve	0	0	0	18	0	2

Table 16: Effect of storage on microbial population of sweet lovi-lovi RTS beverage (Accession 3)

Product	Initial				3 MAS			
	Bacteria (10^6 CFU/g)	Yeast (10^3 CFU/g)	Fungi (10^3 CFU/g)	*E. coli*	Bacteria (10^6 CFU/g)	Yeast (10^3 CFU/g)	Fungi (10^3 CFU/g)	*E. coli*
RTS beverage	0	0	0	0	0	0	1	0

MAS: Months after storage

4. Conclusion

Sweet lovi-lovi accessions screened for physico-chemical attributes showed that Acc. 2 is having good processing attributes like highest fruit weight, pulp percentage and lesser seed percentage. With regard to biochemical parameters, highest total sugar (12.81%), non-reducing sugar content (1.33%), anthocyanin content (0.04 mg $100g^{-1}$), carotenoid content (582.55 mg $100g^{-1}$), iron content (33.23 mg $100g^{-1}$), crude fibre content (2.92 g $100g^{-1}$) and lowest tannin (0.21 mg $100g^{-1}$) was also observed in Acc. 2. Also it may be concluded that sweet lovi-lovi fruits are having good prospects for value addition and the organoleptic score of sweet lovi-lovi wine and preserve increased during storage.

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