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Preparation and sensory evaluation of blended jam of carambola (*Averrhoa carambola* L.) and mango (*Mangifera indica* L.)

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Abstract
An investigation entitled "Preparation and sensory evaluation of blended jam of carambola (*Averrhoa carambola* L.) and Mango (*Mangifera indica* L.)" was undertaken at Post Harvest Technology Laboratory, College of Horticulture, Dr. BSKKV, Dapoli, during the year 2022. Study carried out in Completely Randomized Design (CRD) with the aim to standardize proportions of carambola and mango pulp for making mixed fruit jam There were six treatments (blending proportions of carambola and mango pulp), T_1(100% carambola pulp), T_2 (90% carambola pulp + 10% mango pulp), T_3 (80% carambola pulp + 20% mango pulp), T_4 (70% carambola pulp + 30% mango pulp), T_5 (60% carambola pulp + 40% mango pulp), T_6 (50% carambola pulp + 50% mango pulp).
Sensory qualities, colour, flavour, texture and overall acceptability showed a significant variation. Microbial growth was not observed in any treatment of jam. Jam prepared by using 90% carambola pulp and 10% mango pulp (T_2) gave best organoleptic qualities from 0, 3 and 6 months with benefit: cost ratio 2.11.

Keywords: Carambola, mango, pulp, proportions, preparation, blended jam

1. Introduction
Carambola (*Averrhoa carambola* L.) is an important underutilized fruit crop belonging to the family Oxalidaceae. Carambola fruit possesses anti-inflamatory, antifungal, antitumor, anti-ulcer and antimicrobial activities and hypotensive, hypoglycemic, hypocholesterolemic, nephrotoxic, neurotoxic effects (Saha *et al*, 2018) [9]. United States Department of Agriculture reported ascorbic acid (26.0- 53.1 mg), calories (35.7 g), moisture (89.0-91.0%), carbohydrates (9.38 g), calcium (4.4-6.0 mg), phosphorus (15.5-21.0 mg), per 100 g pulp of carambola (Toshinaro *et al.*, 2019) [10].
Carambola (*Averrhoa carambola* L.) is a drought resistant, evergreen and multipurpose tree. The word 'carambola' is derived from the Sanskrit word 'Karmaranga' which means "Food appetizer" (Manda *et al*., 2012) [4]. Carambola fruit has distinctive ridges running down its sides and when the fruit is cut in cross section it looks like a star, hence it is famous by the name 'Starfruit'.
The carambola is believed to have originated in Ceylon and Moluccas but it has been cultivated in Southeast Asia and Malaysia for many centuries. In India, it is distributed in Uttar Pradesh, Karnataka, Assam, West Bengal, Madhya Pradesh, Bihar and Tamil Nadu (Rathod *et al*., 2011) [8].
The carambola fruit is green in colour at unripe and turns yellowish orange when it gets ripe. The skin of star fruit is also edible. The pulp is juicy, sweet or sourish in taste and pale yellow in colour. Small, flat, brown coloured seeds are present in the carambola fruit. There are two distinct classes of carambola, one is 'sour' type and other is 'sweet type'. Sour type carambolas are richly flavoured with more oxalic acid where as sweet type have less oxalic acid. Ascorbic acid levels of the star fruit are may responsible for sweet or sour taste (Manda *et al*., 2012) [4].
For proper utilization of fruits with its health benefits, value added blended jam (carambola + mango) will give best profit for carambola growers. In the today's world people prefers ready-made but healthy food. Jam is made from fresh, firm fruits which is healthy to eat. Blended jam (carambola + mango) will help in preventing nutritional disorders. As carambola fruit is highly perishable, it will help to reduce the post-harvest losses to some extent.

Blending of carambola pulp with mango pulp can supplement their blended products with extra vitamins, minerals and antioxidants. To add appealing taste and aroma to the jam made from carambola fruits, it is necessary to go for blending it with a fruit which has good sensory acceptability. Blending carambola pulp with mango pulp could be a good solution. The main objective of the experiment conducted was to standardize proportions of carambola and mango pulp for making mixed fruit jam.

2. Materials and Methods

The blended jam was prepared as per the treatments with the addition of sugar in proportion 1:0.8 (1 kg pulp: 800 g sugar), 1.8 g citric acid /kg pulp, 1% pectin/ kg pulp and 200 ppm (236 mg) sodium benzoate/ kg jam. The experiment was conducted in Completely Randomized Design (CRD) with six treatments and replicated four times. The treatments are as given in Table 1. After preparation the blended jam was packed in glass jars and stored at ambient temperature for 6 months. The blended jam was analysed for different sensory attributes and also microbial count was taken at every 0-3-6 months of storage.

Table 1: Treatment details

Treatments	Proportions of pulp	
	Carambola pulp (%)	Mango pulp (%)
T_1	100	-
T_2	90	10
T_3	80	20
T_4	70	30
T_5	60	40
T_6	50	50

2.1 Flow chart of carambola and mango blended jam

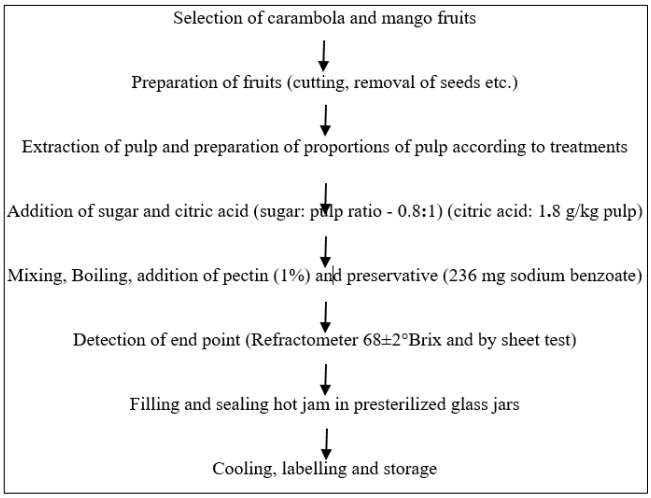

Fig 1: Flow chart of carambola and mango blended jam

2.2 Preparation of blended jam (Carambola and Mango)

The blended jam of carambola and mango was prepared using the following steps,

1. Selection of fruits

The ripe fruits of carambola having good colour, flavour was selected. Uniform ripe mango fruits cv. Alphonso were selected for preparation of jam

2. Preparation of fruits

The selected fruits (mango and carambola) were washed with water and dried in air. Leaves, stalk and other undesirable portions were removed. Seeds and cores were also removed. The fruits were cut into small pieces with stainless steel knife.

3. Extraction of pulp

The cut pieces were grinded in mixer for extraction of pulp.

4. Preparation of proportions of pulp according to treatments

Both carambola and mango pulp were mixed in a beaker according to treatments.

5. Addition of sugar and citric acid

One kg pulp was mixed with sugar (800 g) and citric acid (1.8 g).

6. Mixing and boiling

All the ingredients i.e., sugar, citric acid and pulp were mixed properly. Mixture was cooked slowly. For addition of pectin first it was mixed with 150 g of prepared proportion of pulp then after proper mixing it was added in boiling mass followed by occasional stirring and crushing till cooking mass approaches the desired consistency. Then 236 mg of sodium benzoate/kg jam was added as preservative.

7. End point

End point of the jam was judged by assessing its total soluble solids at 68±2 °Brix by hand refractometer and sheet test i.e., a spoon was dipped into mass of boiling jam and on cooling, the jam was allowed to fall down in the vessel, when jam falls down in the form of sheets it indicated that end point has reached and the jam was ready for filling into glass jar.

8. Filling and sealing

Prepared hot jam was filled into clean dry and sterilized glass bottles. After filling, glass bottles, screw capped properly, cooled in air and stored at room temperature for further studies.

9. Cooling, labelling and storage

Jars were cooled before labelling. The filled containers were labelled according to specifications and stored at ambient temperature.

3. Results and discussion

The jam was examined for its sensory qualities. The evaluation of sensory qualities in terms of colour, flavour, texture and overall acceptability was done at every 3-month interval by 9-point hedonic scale.

3.1 Colour

The data on the changes in the sensory score for colour of blended jam of carambola and mango during storage are presented in Table 2. It is observed from the data that there was a decreasing trend in the sensory score for colour. The highest score for colour acceptance during '0' month of storage was observed in T_2 (7.95) and it was at par with T_3 (7.91) and T_4 (7.91). Minimum score for colour was recorded under T_1 (6.90). After '3' months of storage, highest score for colour acceptance was observed in T_2 (7.85) it was at par with T_3 (7.81) and T_4 (7.80). However, minimum score for colour was recorded in T_1 (6.80). After 6 months of storage, highest score for colour acceptance was observed in T_2 (7.83) and it

was at par with T_3 (7.80), minimum score recorded by T_1 (6.75). Different pulp proportion under study have significant effect on colour of jam. The change in colour of jam might be due to difference between colour of mango pulp (yellowish orange) and carambola pulp (pale yellow). The gradual decrease in colour throughout the storage was of jam might be due to non-enzymatic browning and degradation of β-carotene. Similar results were obtained by Khan *et al.* (2012) [2] during sensory evaluation of strawberry jam. Rahman *et al.* (2018) [7] observed that scores for colour of guava jam decreased significantly during the storage time.

Table 2: Changes in colour of blended jam during storage

Treatments	Storage period (months)		
	0 month	3rd month	6th month
T_1 (C: 100%)	6.90	6.80	6.75
T_2 (C: 90% + M: 10%)	7.95	7.85	7.83
T_3 (C: 80% + M: 20%)	7.91	7.81	7.80
T_4 (C: 70% + M: 30%)	7.91	7.80	7.78
T_5 (C: 60% + M: 40%)	7.80	7.77	7.75
T_6 (C: 50% + M: 50%)	7.73	7.74	7.69
Mean	7.70	7.63	7.60
S.Em±	0.03	0.02	0.01
CD at 1%	0.12	0.07	0.04

3.2 Flavour

The changes in flavour score of blended jam as influenced by various treatments during the storage clearly depicted in Table 3. from data it was observed that treatments significantly influenced the flavour of jam. In general, flavour score for blended jam declined throughout the storage period, the pattern of decline varied according to treatments. Among the treatments, the highest sensory score for flavour at 0 month of storage was recorded under treatment T_2 (8.07) which was significantly superior over rest of the treatments and lowest score for flavour was recorded by treatment T_1 (7.67). After 3 and 6 months of storage, maximum sensory score for flavour recorded by treatment T_2 (7.91 and 7.88) respectively however it was at par to treatment T_3 (7.84 and 7.81) respectively. Minimum sensory score for flavour during 3 and 6 months after storage was recorded in treatment T_1 (7.63 and 7.60) respectively. Gradual decrease in flavour of jam with increase in storage period may be due to decrease in aromatic compounds in jam during storage. Similar results were reported by Nafri *et al.* (2021) [6] in ripe and unripe papaya jam during storage at ambient temperature and Rahman *et al.* (2018) [7] in guava jam.

Table 3: Changes in flavour of blended jam during storage

Treatments	Storage period (months)		
	0 month	3rd month	6th month
T_1 (C: 100%)	7.67	7.63	7.60
T_2 (C: 90% + M: 10%)	8.07	7.91	7.88
T_3 (C: 80% + M: 20%)	7.88	7.84	7.81
T_4 (C: 70% + M: 30%)	7.83	7.77	7.73
T_5 (C: 60% + M: 40%)	7.77	7.72	7.68
T_6 (C: 50% + M: 50%)	7.70	7.69	7.65
Mean	7.82	7.76	7.73
S.Em±	0.01	0.02	0.02
CD at 1%	0.05	0.10	0.07

3.3 Texture

The data pertaining to changes in textural score of blended jam as influenced under treatments during the storage are furnished in Table 4. It is apparent from the data that the textural score of jam was significantly influenced by different treatments. It is observed from the data that the texture score of jam was increased from 0 to 3 and 6 months of storage. The highest sensory score for texture was observed in the treatment T_1 (8.35, 8.38 and 8.39) from 0, 3 and 6 months of storage respectively. Treatment T_1 was significantly superior over rest of the treatments during whole storage period. However, minimum scores for texture were observed in treatment T_6 (7.42, 7.47, 7.48) with respect to 0, 3 and 6 months of storage. It was observed that during storage study up to six months, score for texture was decreased from treatment T_1 (100% carambola pulp) to T_6 (50% carambola pulp + 50% mango pulp). The main reason for decreasing trend from T_1 to T_6 was carambola fruit is pectin rich so pectin in carambola pulp was maximum. Pectin helps in setting of jam and hold the fruit tissues in a position. From treatment T_1 to T_6 carambola pulp proportion was decreasing as a result texture score was also found in decreasing trend. The increase in texture scores of jams throughout the storage might be due to decrease in moisture content during storage of jam.

Table 4: Changes in texture of blended jam during storage

Treatments	Storage period (months)		
	0 month	3rd month	6th month
T_1 (C: 100%)	8.35	8.38	8.39
T_2 (C: 90% + M: 10%)	8.28	8.31	8.30
T_3 (C: 80% + M: 20%)	8.11	8.14	8.22
T_4 (C: 70% + M: 30%)	7.90	7.94	7.97
T_5 (C: 60% + M: 40%)	7.70	7.73	7.75
T_6 (C: 50% + M: 50%)	7.42	7.47	7.48
Mean	7.96	8.00	8.02
S.Em±	0.01	0.004	0.004
CD at 1%	0.04	0.02	0.02

3.4 Overall acceptability

The data pertaining to the changes in sensory score for overall acceptability of carambola and mango blended jam during storage are presented in Table 5. It is observed from the data that the overall acceptability score of blended jam was decreased during 6 months of storage period. Among the treatments, the highest mean score for overall acceptability during 0, 3 and 6 month of storage was observed in the treatment T_2 (8.10, 8.02 and 8.00) respectively. At '0' month storage the minimum score for overall acceptability was recorded by T_6 i.e. 7.62. At 3rd and 6th month storage the minimum score for overall acceptability was recorded by treatment T_1 i.e., 7.60 and 7.58 respectively. At '0' and 3rd month storage T_2 (8.10, 8.02 respectively) was significantly superior over rest of the treatments and at 6th month storage T_3 (7.94) was at par with T_2 (8.00). However, the results were significant throughout the storage period. The gradual decrease in overall acceptability throughout the storage is due to reduction in colour, flavour of carambola and mango blended jam during storage. Similar results were obtained by Imtiaz and Iftikhar (2010) [1] during comparative study on apricot and apple blended jam. Nafri *et al.* (2021) [6] reported that score for overall acceptability of ripe and unripe papaya jam decreased during storage when stored at ambient temperature. Rahman *et al.* (2018) [7] analysed that the overall acceptability scores of the guava jam reduced considerably during storage.

Table 5: Changes in overall acceptability of blended jam during storage

Treatments	Storage period (months)		
	0 month	3rd month	6th month
T_1 (C: 100%)	7.64	7.60	7.58
T_2 (C: 90% + M: 10%)	8.10	8.02	8.00
T_3 (C: 80% + M: 20%)	7.97	7.93	7.94
T_4 (C: 70% + M: 30%)	7.88	7.84	7.83
T_5 (C: 60% + M: 40%)	7.76	7.74	7.73
T_6 (C: 50% + M: 50%)	7.62	7.63	7.61
Mean	7.83	7.79	7.78
S.Em±	0.003	0.02	0.03
CD at 1%	0.01	0.08	0.14

4. Microbial count

In the present study of blended jam, bacterial and fungal count was not detected during analysis of blended jam. Jam was prepared in hygienic conditions and was filled immediately in presterilized glass jars stored at clean dry and place. 80% sugar concentration might be responsible for prevention of microbial growth. The results of this study supported by findings of Kushala *et al.* (2017) [3] was revealed that there was no visible spoilage of product during storage study of jackfruit jam blended with avocado and kokum. Mumtaz *et al.* (2019) [5] while studying on jams and jellies available in Bangladesh.

5. Cost of production of best accepted jam

Cost of production for organoleptically best accepted product is given in Table 6

Table 6: Cost of production of best accepted jam:

Sr. No.	Particulars	T_2 (C: 90% + M: 10%)
1	Carambola fruits @ ₹ 25 kg^{-1}	₹ 26.75 **(**1.07 kg**)**
2	Mango Fruits @ ₹ 150 kg^{-1}(February 2022)	₹ 25.5 (0.17 kg)
3	Labour charge @ ₹ 300 per skilled $labour^{-1}$ (₹ 0.625 min^{-1})	₹ 19.28 (30.847 min)
4	Electricity charges @ ₹ 8 $unit^{-1}$ (₹ 0.267 min^{-1})	₹ 0.51 (1.911 min)
7	Total cost (total variable cost + total fixed cost) (₹)(1kg jam)	₹ 170.21
8	Cost of production of 200 g jam	₹ 34.04
9	Sell price for 200 g jam	₹ 72 (as per standard jam ₹ 360/kg)
10	Benefit: cost ratio	2.11

The blended jam of 90% carambola pulp + 10% mango pulp (T_2) is economically feasible with benefit cost ratio 2.11. From ratings of sensory evaluation it was concluded that jam could be stored successfully at room temperature for 6 months without any microbial growth.

6. Conclusion

From the above findings, it was concluded that best quality blended jam of carambola and mango can be prepared from T_2, (90% carambola pulp + 10% mango pulp). However, T_3, (80% carambola pulp + 20% mango pulp was at par with it with respect to sensory quality.

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