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Rahul Sur
Department of Post-Harvest Technology, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Chandan Paik
Department of Post-Harvest Technology, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Surajit Mitra
Department of Post-Harvest Technology, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Ivi Chakraborty
Department of Post-Harvest Technology, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Corresponding Author:
Rahul Sur
Department of Post-Harvest Technology, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Standardization of recipes for preparation of sweet potato jam

Rahul Sur, Chandan Paik, Surajit Mitra and Ivi Chakraborty

Abstract
A comparative study was done to determine the most suitable combination of two cultivars of sweet potato for jam preparation. Two best cultivars of sweet potato selected for preparation of jam with varing sugar concentration, one is purple flesh V1 Cultivar (TSP-12-14) and another is orange flesh V2 Cultivar (ST-14), and study the storage life and biochemical constitute of jam during storage period 0 days to 30 days.
T1 V1 = 1KG PULP (cv. TSP-12-14) + 1KG SUGAR, T2 V1=1KG PULP (cv. TSP-12-14) + 900 GM SUGAR, T3 V1=1KG PULP (cv. TSP-12-14) + 800 GM SUGAR, T4 V1=1KG PULP (cv. TSP-12-14) + 700 GM SUGAR, T5 V2 = 1KG PULP (cv. ST-14) + 1KG SUGAR, T6 V2=1KG PULP (cv. ST-14) + 900 GM SUGAR, T7 V2 =1KG PULP (cv. ST-14) + 800 GM SUGAR, T8 V2=1KG PULP (cv. ST-14) + 700 GM SUGAR.
During observation best results found in T_1 V_1 = 1 KG PULP (cv. TSP-12-14) + 1 KG SUGAR T_2 V_1=1 KG PULP (cv. TSP-12-14) + 900 GM SUGAR, T5 V_2 = 1 KG PULP (cv. ST-14) + 1 KG SUGAR, T_6 V_2=1 KG PULP (cv. ST-14) + 900 GM SUGAR
This 4-sugar concentration performs good.

Keywords: Recipes sweet potato jam purple flesh V1 cultivar

Introduction
Sweet potato *(Ipomoea batatas)* is n dicotyledonous plant which belongs to the family of *Convolvulacea* (Tortoe, 2010) [21]. Grown as a starchy food crop throughout the tropical, sub-tropical and frost-free temperate climate zones in the world (ICAR, 2007) [8]. It is among the world's most important versatile and underutilized food crop grown generally for its storage roots (Tortoe, 2010) [21]. It is a minor root crop in tropical Africa and despite its industrial potentials as indicated by its growth in terms of production. Among the root and tuber crops, it is the only one that had a positive per capita annual rate of increase in production in Sub-Saharan Africa. It has been a life saver for centuries in many tropical, sub-tropical and warmer temperate areas of the world, warding off famine in times of both climatic disaster and war. produces storage roots rich in carbohydrates and β-carotene, a precursor of vitamin A, and its leaves are rich in proteins. The roots also contain vitamins C, B complex, and E as well as potassium, calcium, and iron. Purple-fleshed ones contain antioxidants such as anthocyanins. In world crop statistics, the sweet potato is ranked seventh, just after cassava, with an annual production around 9 Mt and a cultivated area of 110 Mha (FAO, 2009) [3].
Sweet potato originated in the Central or South American low lands. Some remains were also found in the Casma valley of Peru as far back as 2000 B.C. Today, it is cultivated in more than a 100 countries in the world. Sweet potato is cultivated extensively tor its nutritious and health-promoting values (FAO, 2012 [4]; Lee *et al.*, 2013 [9]) and also plays an important role in food security. The production reached over 100 million tons in 2014 (FAOSTAT, 2016) [5].
Sweet potato is ranked one of the most important food crop after rice, wheat, potato, maize, and cassava (Shekhar *et al*., 2015) [19]. The total production in India is about 1338 thousand tons and area is 110.63 thousands hectare. In West Bengal the area under sweet potato cultivation is 22.85 thousands hectare and production of sweet potato is about 442.28 thousand tons. It grows under many ecological conditions.
It is a low input crop and it is used as a vegetable, dessert, source of starch and it is eaten as a substitute for yam due to its lower cost of production. Sweet potato is comparatively a nutritional heavy weight; rich in complex carbohydrates, vitamins C and E, and also contains good quantities of vitamins A and B, calcium and iron. India has a long history of cultivation of sweet potato *(Ipomoea batatas)* which is one such crop rich in β-carotene, a precursor of vitamin A. Sweet potato has been reported to contain both organic and mineral nutrients

including vitamins A and C, zinc, potassium, sodium, manganese, calcium and magnesium.

Jam

Jam is defined as a semisolid food made from not less than 45% (by weight) fruit and 55% (by weight) sugar (Desrosier and Desrosier, 1978) [2]. This substrate is concentrated to 65% or above soluble solids. Flavoring and coloring agents may be added. Pectin and acid may be added to overcome the deficiencies that occur in the fruit itself.

Sweet potato contains water-soluble pectin, which enables its use in making jams and jellies. The process consists of cooking a mixture of 20.7% sweet potato, 45% sugar.34% water, and 0.3% citric acid until solids content of 68° Brix was reached (Truong *et al.*, 1986) [23].

Due to high starch content of sweet potato, compared to fruits, the jam has a slightly different consistency (Truong, 1987) [22], Lila and Babu Nambisan (1991) [10] have reported the abundance of nutrients in sweet potato.

Sensory evaluation of fruit flavored sweet potato jam scored high for taste, but gelling consistency was slightly softer than fruit jam due to the high content of starch in the roots. The high carotene content of orange fleshed variety Kamala Sundari of sweet potato is utilized to develop naturally colored jam in Bangladesh (Shah Chaudhury, 1992) [16].

According to Shanthi (1995) [18] sweet potato jam containing sweet potato 39.4%, sugar 43.3% and fruit pulp of banana and apple 10% was most acceptable by the laboratory taste panel and the orange fleshed type produced an orange product rich in vitamin A. Jam is prepared from sweet potato pulp (1.0kg), sugar (01.00kg), citric acid 1% and pectin (0.5%) or alternatively using sugar cane or date molasses instead of sugar. Sweet potato pulp is mixed with fruit pulp like mango, banana or apple for making jams in India, which will also help to mask the typical sweet potato flavor (Padmaja and Premkumar, 2002) [12]. The prepared sweet potato jam was rich in calcium (90.0mg/g), magnesium (75mg/g), zinc (32mg/g), beta carotene (132 I.U.) and sugar (32.25%).

Manivasagan *et al.* (2004) [11] showed that total soluble solid, ascorbic acids and organoleptic rating of karonda jam decreased consciously during storage (120 days) respectively of jam. Browning and acidity content from pink karonda was more acceptable as compared to jam prepared from green karonda.

Singh *et al.* (2005) [20] revealed that during storage of the jam, the total soluble solids and total sugars increased up to three months. Throughout the storage period of six months, the reducing sugars and browning increased, whereas, acidity and non-reducing sugars showed a decreased trend.

Shakir *et al.*, (2014) [17] reported that comparative study was carried out on mixed fruit jam or (apple + pear) pulp, incorporated within the ratios 50:50 (T1), 60:40 (T2), 40:60 (T3). 100% apple (T4) and 100% pear (T5). All the jam samples were stored in sterilized glass jars and evaluated physic chemically for ascorbic acid, acidity, and pH, total soluble solids. Reducing sugars and non-reducing sugars for an interval of 15 days during 3 months storage period. All the samples were significantly different at ($P < 0.05$) during storage.

According to FPO specification the maximum TSS (°Brix) content of jam should be 68° Brix.

Materials and methods

The experiment was carried out in the department of Post-Harvest Technology, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia West Bengal, during the period from 2017-2019. Tubers were harvested from the field of (All India Coordinated Research Project on Tuber Crops) AICRP, Horticulture Research Station, Bidhan Chandra Krishi Vishwavidyalaya, Mandouri, Nadia West Bengal.

The research work was undertaken in Post graduate lab, Department of Post-Harvest Technology, BCKV.

Two best cultivars of sweet potato selected for preparation of jam with varing sugar concentration, one is purple flesh V1 Cultivar (TSP-12-14) and another is orange flesh V2 Cultivar (ST-14), and study the storage life and biochemical constitute of jam during storage period 0 days to 30 days.

T1 V1 = 1KG PULP (cv. TSP-12-14) + 1KG SUGAR, T2 V1=1KG PULP (cv. TSP-12-14) + 900 GM SUGAR, T3 V1=1KG PULP (cv. TSP-12-14) + 800 GM SUGAR, T4 V1=1KG PULP (cv. TSP-12-14) + 700 GM SUGAR, T5 V2 = 1KG PULP (cv. ST-14) + 1KG SUGAR, T6 V2=1KG PULP (cv. ST-14) + 900 GM SUGAR, T7 V2 =1KG PULP (cv. ST-14) + 800 GM SUGAR, T8 V2=1KG PULP (cv. ST-14) + 700 GM SUGAR

Storage condition: Normal room temperature

Methodology of jam processing

Recipe

Sl. No.	Ingredients	Quantity (per kg pulp)
1.	Sweet potato pulp	1 kg (1000g)
2.	Sugar	According to treatment
3.	Citric acid	10 g
4.	Pectin	5 g

Flowchart

Selection of optimum quality tubers
↓
Washing and cleaning
↓
Removal of skin (peeling)
↓
Cooking till softening
↓
Pulp extraction
↓
Heating the pulp
↓
Continuous addition of sugar till 53-68^{O}B is obtained
↓
Addition of citric acid
↓
Addition of pectin before end point is achieved
↓
Determination of end point by sheet/drop test
↓
Storing in sterilized glass jar

Observations recorded

Physico-chemical properties observed

1. Total soluble solids (°B)
2. Total sugar content (%)
3. Reducing sugar content (%)
4. Non reducing sugar content (%)
5. Titratable acidity (%)

Sensory evaluation
1. Colour 2. Taste 3. Texture 4. Appearance 5. Overall acceptability

Total soluble solid (°B): A total soluble solid was determined by using a Hand Refractrometer.
Total sugar (%): Sugar level was determined by copper reduction Lane and eynon method (Ranganna, 2000) [13].
Reducing sugar (%): Sugar level was determined by copper reduction Lane and eynon method (Ranganna, 2000) [13].
Non reducing sugar (%): Non reducing sugar content was determined by deducting the reducing sugar from the total sugar content.

Titratable acidity (%)
It was estimated as per Sadasivam and Manickam (1996) which provide a measure of organic acids in the fruits (expressed as % anhydrous citric acid).

Statistical analysis
The analysis of data obtained in experiment was analyzed by Completely Randomized Design method by adopting the statistical procedures of Gomez and Gomez, (1984) [6].

Result and Discussion
Physico-chemical analysis of sweet potato jam (cv. TSP-12-14) jam & (cv. ST-14) jam**:**

Total soluble solid
TSS one of the key elements of jams. TSS of jams were successfully controlled according to the desired ranges. In the initial stage the TSS was maintained 68% but in case of my circumstance I use various concentration of sugar with 1 kg pulp (cv. TSP-12-14) & (cv. ST-14).
So that TSS may varies,
Highest TSS value recorded T1V1 [69.3 (^{O}Brix)] followed by T5V2 [69.22 (^{O}Brix)], it is observed 30 days of storage. Lowest value of TSS recorded T8V2 [53.38 (^{O}Brix)], it is observed 0 day of storage. The increase in TSS of jam during storage might be due to conversion of polysaccharides into soluble sugars. Similar inferences were drawn by the findings of Manivasagan *et at.,* (2004) [11] in karonda jam. Similarly, Sarvanan *et al*., (2004) [15] reported the increase in TSS of papaya during storage. Riaz *et al*. (1999) [14] observed an increase in total soluble solids of strawberry jam during storage. It might be due to solubilization of pulp constituent hydrolysis of polysaccharides.

Total sugar (%)
Total sugar content of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam gradually increase during initial days of storage to 30 days of storage for all sugar concentration.
Highest value of total sugar (%) recorded T1V1 (33.81%) it is observed 30 days of storage.
Lowest value of total sugar (%) recorded T8V2 (17.65%) it is observed 0 day of storage.
The data present in table shows that total sugar % increase vary slowly for all sugar concentration during initial day to 15 days and 30 days intervals.
This trend of total sugar (%) may due to a function of breakdown of insoluble polysaccharides in to simple sugars. Such identical increase in total sugars in various products have been reported by Chattopadhyay *et al.,* (2006) [1] in sweet potato.

Reducing sugar (%)
Reducing sugar content of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam rapid increase during initial days of storage to 30 days of storage for all sugar concentration.
Highest value of reducing sugar (%) recorded T1V1 (23.15%) it is observed 30 days of storage.
Lowest value of reducing sugar (%) recorded T8V2 (6.38%) it is observed 0 day of storage.
The data present in table shows that reducing sugar% increase vary rapidly for all sugar concentration during initial day to 15 days and 30 days intervals.
The increasing, might be assigned to the more conversion on non-reducing sugars into invent sugar through the break down process. The similar results are also observed by Chattopadhyay *et al.,* (2006) [1] and Gowda *et al.,* (1994) [7].

Non reducing sugar (%)
Non reducing sugar content of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam decrease during initial days of storage to 30 days of storage for all sugar concentration.
Highest value of non-reducing sugar (%) recorded T1V1 (14.42%) it is observed 0 day of storage. Lowest value of non-reducing sugar (%) recorded T8V2 (5.69%) it is observed 30 days of storage.
The data present in table shows that non-reducing sugar % decrease vary rapidly for all sugar concentration during initial day to 15 days and 30 days intervals.

Titratable acidity (%)
Titratable acidity % of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam gradually decrease during initial days of storage to 30 days of storage for all sugar concentration.
Highest value of titratable acidity (%) recorded T8V2 (1.109%) it is observed 0 day of storage. Lowest value of titratable acidity (%) recorded T1V1 (0.267%) it is observed 30 days of storage.
The data present in table shows that titratable acidity % decrease vary slowly for all sugar concentration during initial day to 15 days and 30 days intervals.

Table 1: Total soluble solids (^{O} Brix) of sweet Potato (cv. TSP-12-14) jam & (cv. ST-14) jam

Treatments	Storage interval (days)		
	0 Days	15 Days	30 Days
T1 V1	68.46	68.74	69.3
T2 V1	62.19	62.84	63.22
T3 V1	58.48	58.97	59.33
T4 V1	54.16	54.82	55.32
T5 V2	68.66	68.96	69.22
T6 V2	61.92	62.38	62.63
T7 V2	58.42	58.72	59.02
T8 V2	53.38	53.91	54.13
MEAN	60.71	61.17	61.52
S.Em(±)	0.164	0.085	0.075
CD 5%	0.496	0.258	0.227

Table 2: Total sugar content (%) of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam

Treatments	Storage interval (days)		
	0 Day	15 Days	30 Days
T1 V1	32.89	33.33	33.81
T2 V1	28.92	29.65	30.03
T3 V1	26.66	26.97	27.30
T4 V1	22.85	23.30	23.52
T5 V2	32.00	32.44	32.89
T6 V2	26.87	27.30	27.93

T7V2	22.02	22.22	23.15
T8 V2	17.65	18.18	18.47
MEAN	26.23	26.67	27.14
S.Em(±)	0.243	0.378	0.583
CD 5%	0.734	1.144	1.761

Table 3: Reducing sugar content (%) of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam

Treatments	Storage interval (days)		
	0 Day	15 Days	30 Days
T1 V1	18.47	20.74	23.15
T2 V1	16.66	18.47	20.74
T3 V1	13.96	16.22	19.04
T4 V1	10.91	13.65	15.38
T5 V2	18.75	20.74	22.65
T6 V2	15.01	17.17	19.39
T7 V2	10.72	12.25	15.75
T8 V2	6.38	8.57	12.78
MEAN	13.86	15.98	18.61
S.Em(±)	0.245	0.455	0.725
CD 5%	0.741	1.377	2.193

Table 4: Non reducing sugar content (%) of sweet potato (cv. TSP-12-14) jam & (cv. ST-14) jam

Treatments	Storage interval (days)		
	0 Day	15 Days	30 Days
T1 V1	14.42	12.59	10.67
T2 V1	12.48	11.18	9.29
T3 V1	12.38	10.75	8.26
T4 V1	11.94	9.65	8.14
T5 V2	13.25	11.70	10.23
T6 V2	11.85	10.13	8.54
T7 V2	11.30	9.97	7.39
T8 V2	11.27	9.61	5.69
MEAN	12.36	10.70	8.53
S.Em(±)	0.444	0.477	0.974
CD 5%	1.341	1.442	N/A

Table 5: Titratable acidity content (%) of sweet Potato (cv. TSP-12-14) jam & (cv. ST-14) jam

Treatments	Storage interval (days)		
	0 Day	15 Days	30 Days
T1 V1	0.427	0.341	0.267
T2 V1	0.747	0.651	0.533
T3 V1	0.917	0.811	0.651
T4 V1	0.981	0.885	0.789
T5 V2	0.640	0.565	0.491
T6 V2	0.789	0.693	0.629
T7 V2	0.937	0.875	0.800
T8 V2	1.109	0.960	0.875
MEAN	0.818	0.723	0.629
S. Em(±)	0.024	0.014	0.12
CD 5%	0.073	0.041	0.036

Table 6: Sensory profile of sweet potato jam: cv. TSP-12-14) jam & (cv. ST-14) jam: It was done using the 9 points hedonic score as given by Ranganna (2000)

Treatment	Colour			Taste			Texture			Appearance			Acceptability		
	0	15	30	0	15	30	0	15	30	0	15	30	0	15	30
T1V1	9	9	8	9	9	8	9	8	7	9	9	8	9	9	8
T2V1	9	9	8	9	9	8	9	8	7	9	9	8	9	9	8
T3V1	8	8	7	8	8	7	9	8	7	8	8	7	8	8	7
T4V1	8	8	7	7	7	6	9	8	7	8	8	7	7	7	6
T5V2	9	9	8	9	9	8	9	8	7	9	9	8	9	9	8
T6V2	9	9	8	9	9	8	9	8	7	9	9	8	9	9	8
T7V2	9	9	8	8	8	7	9	8	7	9	9	8	8	8	7
T8V2	9	9	8	7	7	6	9	8	7	9	9	8	7	7	6

Sensory profile shows that quality is deteriorated during storage of sweet potato jam after 15 days to 30 days of normal condition storage period.

Conclusion

T_1 V_1 = 1 KG PULP (cv. TSP-12-14) + 1 KG SUGAR, T_2 V_1=1 KG PULP (cv. TSP-12-14) + 900 GM SUGAR, T_5 V_2 = 1 KG PULP (cv. ST-14) + 1 KG SUGAR, T_6 V_2=1 KG PULP (cv. ST-14) + 900 GM SUGAR. This 4-sugar concentration perform good, but 900gm sugar perform best than other treatment, so that 900 gm sugar is recommend for preparation of jam. 1 kg of sugar also perform good.

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