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## Development of sweet potato (*Ipomoea batatas* L.) and mango (*Mangifera indica* L.) blended bar

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### Abstract

The experiment was conducted for different parameters with five main treatments viz., 100, 90:10, 80:20, 70:30 and 60:40 percent sweet potato and mango pulp proportion with storage period as sub treatment and were analyzed for changes in physico-chemical parameters and sensory qualities. The quality of the fruit bar could be improved by blending the sweet potato pulp with Alphonso mango pulp. From the present investigation, it was observed that the chemical parameters such as titratable acidity, reducing sugars content exhibited an increasing trend while decreasing trend was observed in TSS, total sugars, starch and  $\beta$ -carotene content of the sweet potato-mango blended bar irrespective of treatments during storage. As regard the organoleptic evaluation, the bar blended with 60% Sweet potato and 40% mango obtained highest sensory score at 90th day of storage.

**Keywords:** Sweet potato, alphonso mango, blended bar, konkan Ashwini, alphonso, storage

### Introduction

The sweet potato, *Ipomoea batatas* L., is a member of the South American-native Convolvulaceae family. A hardy crop that may be cultivated under conditions of drought is the sweet potato. It is frequently described as a food crop for the underprivileged. In the tropical and subtropical zone, it is a crucial crop. Its species is hexaploid, with chromosomal number  $2n=96$  (Palaswami and Raichand, 2008) [21]. Sweet potato is now being recognized as a health food due to several of its nutraceutical components and carotenoids. It contains magnesium, the key mineral for de-stressing and good mood. It also promotes artery, bone, muscle and nerve health. Mangoes are both nutritive and therapeutic. It contains a lot of minerals and vitamins A and C. They are a good source of dietary fibre, energy, and nutrients, and as a result, they may help guard against heart disease and cholesterol buildup, as well as improve immunological function and promote eye health.

Africa is the world's top producer of sweet potatoes, followed by Latin America, India, China, Japan, South East Asia and the southern United States of America. In India, 130.6 acres of land was planted with sweet potatoes in the years 2017-2018. Productivity is 11.5 MT/Ha, while production is 1500.5 MT. The Orissa has the highest acreage and production of sweet potatoes. The Kolhapur district in Maharashtra has the biggest acreage and production i.e., 3.14 hectares and 46.71 MT, respectively (Anon., 2018a) [5].

Rajendra Sakarkand-35 and Sree Bhadra (S-1010) are two cultivars that are grown in Maharashtra. Indira Naveen, Varsha (ideal for the kharif season) and Konkan Ashwini are the types that are most strongly suggested for the Konkan region out of all the available options. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli released "Konkan Ashwini" in the year 2000, which is appropriate for the Rabi season. It is a short-duration high yielding variety with a yield of 19-20 t/ha. This variety's long, elliptical tubers are highly preferred by consumers because of the dark purple colour of flesh (Khandekar *et al.*, 2000) [15]. In India, sweet potatoes are mostly grown for human consumption as boiled or baked tubers. A farmer in India needs 100g of tuber per day to replenish the energy he expends working hard (Gopalan *et al.*, 1980) [13].

Next to potatoes, sweet potatoes (*Ipomoea batatas* L.) are the most significant tuber crops grown worldwide. Due to their short lifespan and innate ability to produce enormous amounts of dry matter, tuber crops are thought of as the poor man's diet since they are

effective providers of calories. A good source of carbohydrates, sweet potatoes can also be used in place of rice and wheat (Boruch, 1985) <sup>[10]</sup>. The majority of sweet potatoes produced each year are sold as fresh, with only a minor part being sold in processed form. Little has been done to modernise the processing and use of sweet potatoes; they are still processed and consumed in the traditional ways. Sweet potato is now being recognized as a health food due to several of its nutraceutical components and carotenoids. It contains magnesium, the key mineral for de-stressing and good mood. It also promotes artery, bone, muscle and nerve health. Sweet potato varieties may be 'firm' or 'soft'. It is the soft varieties that are often labelled as yam in United States. Herbal medicines appear to be quite effective in treating various clinical disorders furthermore, these herbal drugs are essentially safe (Parle and Monika, 2015) <sup>[38]</sup>. Since sweet potato tubers have a low glycemic index and can help to stabilise blood sugar levels and reduce insulin resistance in animals, they play a significant role in monitoring blood glucose levels in diabetics. Since sweet potatoes may be cultivated all year round in climates that are suitable for it, they are sometimes known as an "insurance crop" (Preedy *et al.*, 2011) <sup>[26]</sup>. Sweet potatoes are sometimes referred to as "space food" since the National Aeronautics and Space Administration (NASA) has chosen them as a particular crop to be grown and included in the diet for astronauts on space missions due to its health benefits (Bovell-Benjamin, 2007) <sup>[11]</sup>.

One of the most important tropical fruit crops is the mango (*Mangifera indica*), which is grown in all tropical nations worldwide. The genus *Mangifera* has roughly 49 species, of which 8 have uncertain status and 41 are recognised species. The mango is the member of the anacardiaceae family. The mango is native of South East Asian region that is regarded as the king of fruits and the most popular fruit both in India and overseas (Yadav and Singh, 2017) <sup>[37]</sup>.

India is the top mango producing country in the world, followed by China, Thailand, Mexico, Pakistan, Brazil, Nigeria, Indonesia and Egypt. In India, there were 2258.1 thousand ha under mango in the year 2017-18, which resulted in an output of 21822.3 thousand metric tonnes at a productivity of 9.7 Mt/ha. Andhra Pradesh is the top-producing state in India with a 363000-ha area, followed by Uttar Pradesh with 265620 ha, Odisha with 199080 ha, Karnataka with 183230 ha, Maharashtra with 166760 ha, Gujarat with 162770 ha, Tamil Nadu with 152570 ha, Bihar with 149280 ha and Telangana with 115990 ha. (Anon., 2018b) <sup>[6]</sup> As regards production, Uttar Pradesh is leading state having 455183 MT mango production, followed by Andhra Pradesh (4373610 MT), Karnataka (176000 MT), Bihar (244347 MT), Tamil Nadu (123400 MT), Gujarat 120778 MT, Telangana (108014 MT), West Bengal (918350 MT), Odisha (805770 MT) and Maharashtra (791360 MT) (Anon., 2018b) <sup>[6]</sup>.

Mangoes are exported from India to more than 40 nations globally (APEDA, 2018) <sup>[7]</sup>. With income of Rs. 400.21 crores from fresh fruit exports of 49,658 tonnes and Rs. 584.31 crores from exports of mango pulp of 85,725 tonnes, mango is an important source of foreign exchange earnings in India. India exports 5.20 percent of the world's mangoes. In the years 2020-21, India exported 21,033.58 MT of fresh mangoes to the world for a total of 36.23 USD million (APEDA, 2020) <sup>[7]</sup>.

In Maharashtra, Ratnagiri is the top district with 60050 ha under mango plantation with 19000 MT annual production, followed by Sindhudurg with 23500 ha and 70380 MT output. In Raigad, Pune, Beed and Osmanabad, the area and output of mangoes vitamins A and C. In each 100 g of mango, there are 75-82 g of water, 13.7 g of sugar, 1.6 g of dietary fibre, 0.82 g of protein, 36.4 mg of vitamin C and 250 KJ of energy. Almost 17% of its calories come from carbohydrates. Mangoes are a good source of dietary fibre, energy, and nutrients, and as a result, they may help guard against heart disease and cholesterol buildup, as well as improve immunological function and promote eye health (Anon., 2015) <sup>[4]</sup>.

The post harvest processing of sweet potato has not been practiced to a great extent in India, unlike other countries like the United States, where canned sweet potato, sweet potato puree and sweet potato flakes are common and popular. There is very good scope not only for these products but also for the flour-based products and industrial products such as liquid glucose, high fructose syrup and alcohol. The only processed product of sweet potato in India is sweet potato flour (Nair *et al.*, 1987) <sup>[20]</sup>.

Fruit bars are essentially dried sheets of fruit pulp with a sweet flavour and a soft, rubbery texture. Fruit puree is dehydrated into a sheet to make these fruit bars. To enhance the physicochemical and sensory properties of fruit, the edible section is pulped, pureed or combined with other components. After that, they are heated, shaped and dried on flat trays to create cohesive fruit bars. Fruit bars can be used in a range of food preparations and as snacks (Raab and Oehler, 1999) <sup>[27]</sup>.

## Materials and Methods

### Materials

The fresh and mature Sweet Potatoes were procured from Tuber crop Scheme, CES Wakavli and brought to laboratory for conducting the research. The Alphonso mangoes were brought from the APMC Market Vashi. Pectin, citric acid and sugar were used for the preparation of blended bar.

### Methods

The colour of mango bar was measured using Colorimeter (Colour Reader CR-10) and expressed as L\*, a\*, b\* values. Total soluble solids content was measured using Atago hand refractrometer. The moisture content of mango bar was determined using a Contech moisture analyser (model CA-123). Titratable acidity, reducing and total sugars, starch estimated by methods suggested by Ranganna (1997) <sup>[28]</sup>. The  $\beta$ -carotene was determined with the methods described by Srivastava and Kumar (2002) <sup>[34]</sup>. It was also evaluated during storage for sensory attributes like colour, flavour, taste and overall acceptability by panel of 5 judges on 9 point hedonic scale (Amerine *et al.*, 1965) <sup>[3]</sup>. The data were statistically analyzed by using Factorial Completely Randomized design (FCRD) described by Panse and Sukhatme (1985) <sup>[22]</sup>.

### Preparation of blended bar

Mature sweet potato tubers and ripe mango fruits were selected for preparation of blended bar. The fruits were washed with sodium hypochlorite to remove dust and dirt. The sweet potato tubers were then boiled to render them soft. After peeling, the boiled sweet potatoes were grated and the pulp was passed through 1mm sieve to remove

fibres. The ripe Alphonso mango fruits were peeled and the pulp was extracted manually. Then, the pulp of sweet potato and mango was mixed as per the treatments. The pectin, citric acid and sugar was added at the rate of 0.25, 0.5 and 20 percent in the pulp and the mixture was heated at 75°C for 5 minutes and stirred it continuously. After addition of 100 ppm KMS per treatment, hot blended pulp mixture was poured on aluminium tray and dried at 60°C for 10-12 hours in cabinet dryer. The procedure was repeated for 2nd and 3rd layer. The bar thus prepared was cut into rectangular pieces, wrapped in butter paper and then packed into HDPE pouches and stored at ambient.

**Results**

The changes in physico-chemical composition of sweet potato-mango blended bar during storage are presented in Table 1 and 2. Among the treatments, T<sub>1</sub> [sweet potato (100%)] exhibited maximum mean colour value L\*, while it was minimum in the treatment T<sub>5</sub> [sweet potato (60%): mango (40%)]. The treatments T<sub>5</sub> [sweet potato (60%): mango (40%)] showed the highest a\* value for colour, while treatment T<sub>1</sub> [sweet potato (100%)] showed the lowest. Maximum b\* value for colour of sweet potato-mango blended bar was recorded in the treatment T<sub>5</sub> while the minimum in the treatment T<sub>1</sub>. Treatment T<sub>5</sub> [sweet potato (60%): mango (40%)] had the highest moisture content, while treatment T<sub>1</sub> [sweet potato (100%)] showed the lowest. Within all treatments, the total soluble solid content was lowest in treatment T<sub>1</sub> [sweet potato (100%)] and highest in treatment T<sub>5</sub> [sweet potato (60%): mango (40%)].

The treatment T<sub>1</sub> [(sweet potato (100%))] had the lowest mean value for titratable acidity, while the highest in the treatment T<sub>5</sub> [(sweet potato (60%): mango (40%))]. The highest reducing sugars was obtained in the treatment T<sub>5</sub> [sweet potato (60%): mango (40%)] and lowest in the treatment T<sub>1</sub> [sweet potato (100%)]. Maximum total sugar content was observed in the treatment T<sub>5</sub> [sweet potato (60%): mango (40%)] whereas, minimum in the treatment T<sub>1</sub> [sweet potato (100%)]. The treatment T<sub>1</sub> [sweet potato (100%)] was recorded the highest starch content, while the lowest starch content in the treatment T<sub>5</sub> [sweet potato (60%): mango (40%)]. Minimum β-carotene content was observed in the treatment T<sub>1</sub> [sweet potato (100%)] and maximum in the treatment T<sub>5</sub> [sweet potato (60%): mango (40%)].

The sensory score for sweet potato- mango blended bar was graphically illustrated in fig 1 to 4. The treatment T<sub>5</sub> [sweet potato (60%): mango (40%)] was the highest sensory score for colour, while treatment T<sub>1</sub> [sweet potato (100%)] was the lowest for sweet potato-mango blended bar. The sensory score for flavour of sweet potato-mango blended bar was found to be increased with increase in the levels of mango pulp. A better retention of texture of bar was observed in treatment T<sub>5</sub> [sweet potato (60%): mango (40%)]. Within all treatments, the treatment T<sub>5</sub> [sweet potato (60%): mango (40%)] was recorded maximum score for overall acceptability, while it was minimum score in the treatment T<sub>1</sub> [sweet potato (100%)] for sweet potato- mango blended bar.

**Table 1:** Effect of different proportions of sweet potato and mango pulp on L\*, a\* and b\* value for colour of blended bar during storage at ambient temperature

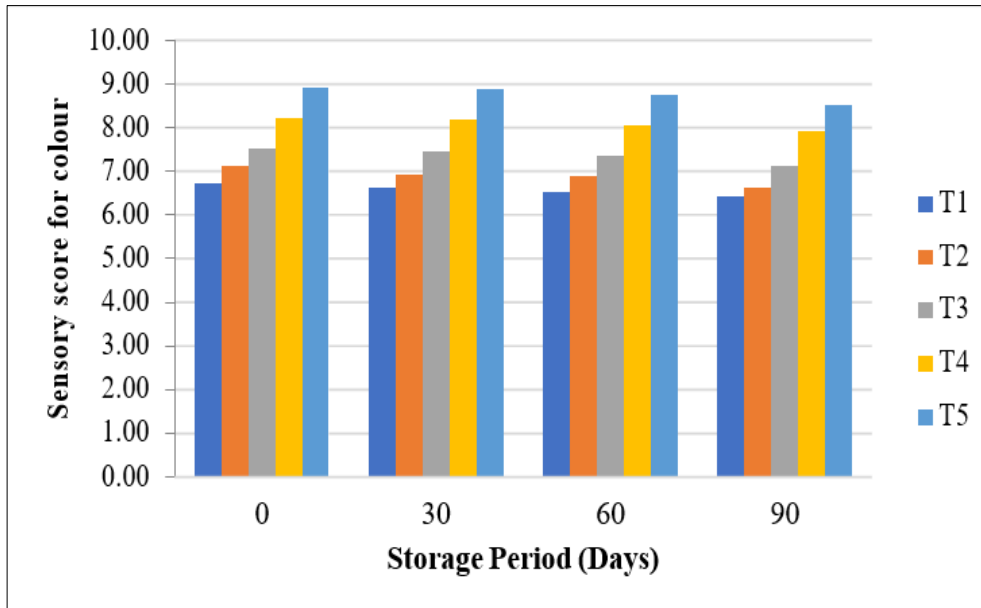
	L* value of colour					a* value of colour Storage period (Days)					b* Value of colour				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T <sub>1</sub>	52.37	51.67	51.28	50.95	51.57	5.25	5.49	5.90	6.02	5.66	29.37	29.14	28.77	28.49	28.94
T <sub>2</sub>	50.87	50.67	49.75	49.31	50.15	12.42	12.67	13.00	13.32	12.85	39.87	39.59	39.25	38.95	39.42
T <sub>3</sub>	48.87	47.26	46.70	46.02	47.21	17.37	17.52	17.77	17.99	17.66	46.67	46.36	46.09	45.87	46.25
T <sub>4</sub>	44.37	43.87	43.03	42.68	43.49	21.67	21.83	21.99	22.24	21.93	50.05	49.83	49.63	49.39	49.72
T <sub>5</sub>	41.45	41.03	40.64	40.15	40.82	25.56	25.80	26.02	26.36	25.94	55.33	55.09	54.90	54.67	55.00
Mean	47.59	46.90	46.28	45.82		16.45	16.66	16.94	17.19		44.26	44.00	43.73	43.47	44.26
	S.Em ±		CD at 5%			S.Em ±		CD at 5%			S.Em ±		CD at 5%		
Treatment (T)	0.04		0.11			0.006		0.016			0.006		0.017		
Storage (S)	0.03		0.09			0.005		0.014			0.005		0.015		
Interaction (TxS)	0.07		0.22			0.011		0.032			0.012		0.034		

**Table 2:** Effect of different proportions of sweet potato and mango pulp on moisture, TSS and titratable acidity of blended bar during storage at ambient temperature

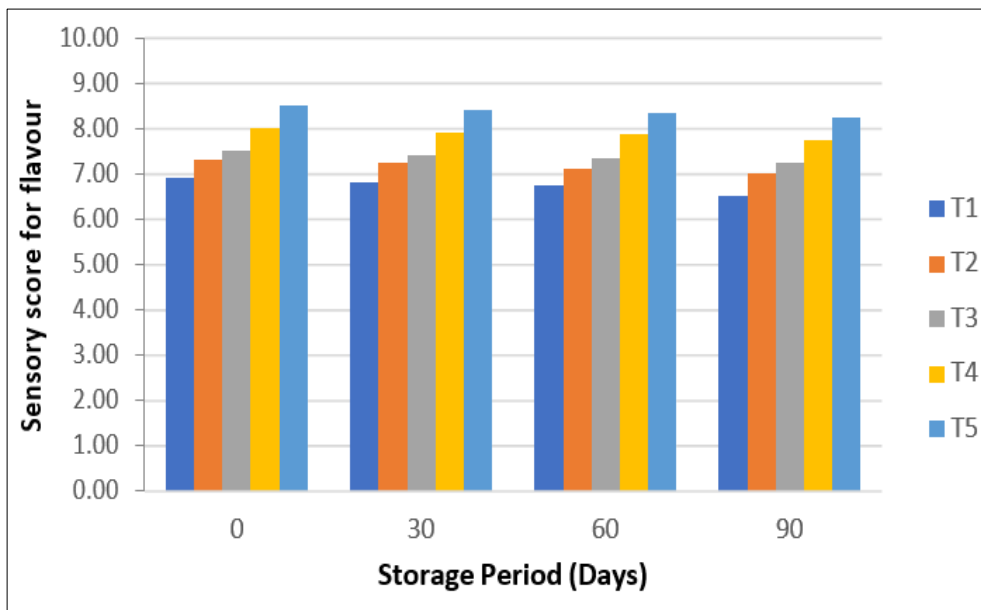
Treatment	Moisture (%)					Total soluble solids(°B)					Titratable acidity (%)				
	Storage period (Days)					Storage period (Days)					Storage period (Days)				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T <sub>1</sub>	16.02	16.13	16.25	16.42	16.21	44.95	44.81	44.21	44.04	44.50	0.702	0.719	0.935	0.957	0.828
T <sub>2</sub>	16.33	16.53	16.74	16.97	16.64	48.90	48.73	48.58	48.32	48.63	0.918	0.929	0.941	0.962	0.938
T <sub>3</sub>	17.22	17.48	17.65	17.88	17.56	52.87	52.74	52.61	52.47	52.67	0.948	0.959	0.972	0.986	0.966
T <sub>4</sub>	17.82	17.95	18.03	18.16	17.99	54.44	54.37	54.23	54.12	54.29	0.973	0.984	0.997	1.230	1.046
T <sub>5</sub>	18.48	18.62	18.97	19.11	18.79	60.95	60.87	60.73	60.62	60.79	1.100	1.220	1.340	1.520	1.295
Mean	17.17	17.34	17.53	17.71		52.42	52.30	52.07	51.92		0.928	0.962	1.037	1.131	
	S.Em ±		CD at 5%			S.Em ±		CD a 5%			S.Em ±		CD at 5%		
Treatment (T)	0.0033		0.010			0.008		0.022			0.002		0.007		
Storage (S)	0.0030		0.009			0.007		0.020			0.002		0.006		
Interaction (TXS)	0.006		0.020			0.015		0.044			0.005		0.014		

**Table 3:** Effect of different proportions of sweet potato and mango pulp on reducing sugars, total sugars, starch and β - carotene content of blended bar during storage at ambient temperature

Treatment	Reducing Sugars (%)					Total sugar (%)					Starch (%)					β - carotene (µg/100g)				
	Storage period (Days)					Storage period (Days)					Storage period (Days)					Storage period (Days)				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T <sub>1</sub>	16.07	17.62	18.25	19.37	17.83	42.03	42.25	41.82	41.69	41.95	14.25	14.02	13.68	13.32	13.81	1.66	1.55	1.44	1.26	1.48
T <sub>2</sub>	16.34	17.76	18.68	19.68	18.09	42.81	42.71	42.56	42.41	42.62	13.12	12.96	12.78	12.54	12.85	987.66	850.20	819.00	703.80	840.16
T <sub>3</sub>	18.25	19.68	20.58	21.42	19.98	43.24	42.79	43.01	42.93	42.99	12.36	12.22	12.04	11.88	12.12	1,973.6	1,700.6	1,638.0	1,407.6	1,679.9
T <sub>4</sub>	20.67	21.42	22.72	23.69	22.13	44.53	44.41	44.36	44.26	44.39	11.72	11.54	11.36	11.19	11.45	2,960.4	2,550.6	2,457.0	2,111.4	2,519.8
T <sub>5</sub>	22.74	23.83	24.68	25.14	24.10	45.24	45.11	45.02	44.93	45.08	11.02	11.54	10.64	10.46	10.91	3,947.2	3,401.2	3,276.0	2,815.2	3,359.9
Mean	18.81	20.06	20.98	21.84		43.57	43.45	43.35	43.24		12.49	12.45	12.10	11.87		1,974.1	1,700.8	1,638.2	1,407.8	
	S.Em ±		CD at 5%			S.Em ±		CD at 5%			S.Em ±		CD at 5%			S.Em ±		CD at 5%		
Treatment (T)	0.0030		0.0087			0.05		0.15			0.04		0.11			0.19		0.58		
Storage (S)	0.0026		0.0078			0.04		0.13			0.03		0.10			0.17		0.50		
Interaction (MS)	0.0056		0.0165			0.106		NS			0.07		0.21			0.38		1.09		



**Fig 1:** Changes in sensory score for colour of sweet potato-mango blended bar



**Fig 2:** Changes in sensory score for flavour of sweet potato-mango blended bar

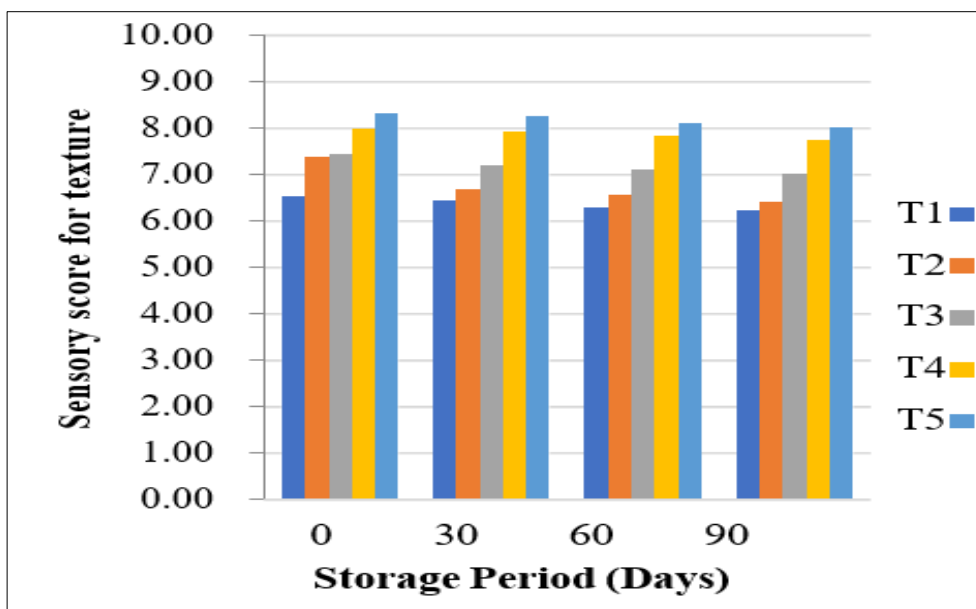


Fig 3: Changes in sensory score for texture of sweet potato-mango blended bar

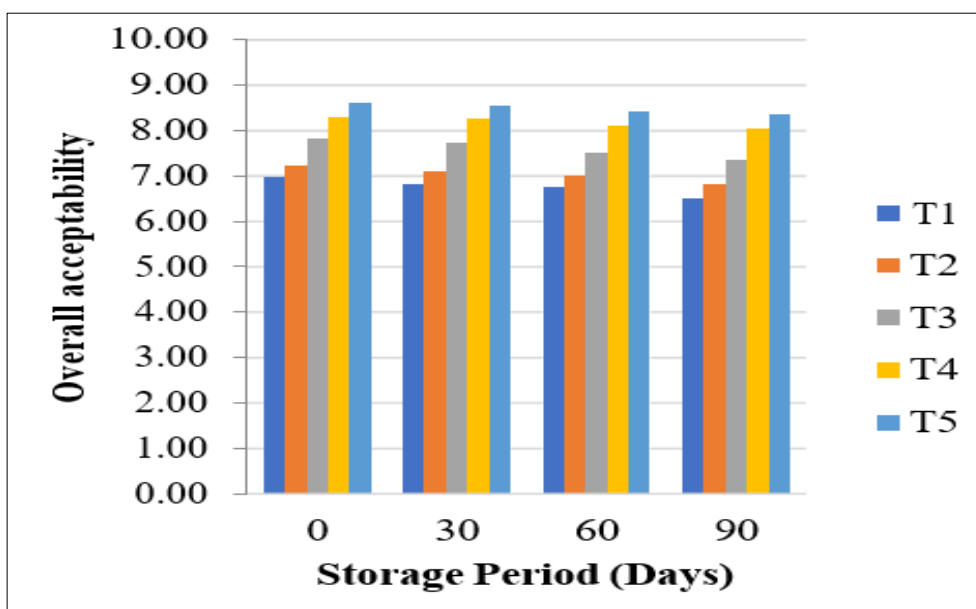


Fig 4: Changes in sensory score for overall acceptability of sweet potato-mango blended

## Discussion

In the present study it was observed that darkness of the colour in bar increased with increase in storage period. It might be due to changes in colour of mango pulp due to browning reactions that proceeds oxidative and enzymatically controlled processes during storage. The results in accordance with these findings were reported by Parab *et al.* (2014) [23] in mango bar; Mahawar *et al.* (2019) [18] in mango apple fruit bar; Pawar (2019) [25] in guava-pineapple blended bar and Singh *et al.* (2019) [32] in banana-soy fruit bar. With respect to the storage, the maximum mean  $a^*$  value for colour was observed at the end of 90 days of storage of the product while it was minimum mean initially. This indicates an increasing trend in  $a^*$  value for the colour on 90 days of storage. The  $a^*$  value for colour was increased due to browning reactions that proceeds oxidative and enzymatically controlled processes. Identical findings were content of sweet potato-mango blended bar. The gain in moisture might be due to absorption of moisture from the atmosphere by the package. Identical findings were

noticed by Aanchal *et al.* (2019) [2] in guava- orange bar and Singh *et al.* (2020) [31] in guava- papaya leather. The highest total soluble solid was observed at initial stage of storage and lowest at the end of 90 days of storage. It would be due to pickup of the moisture from the atmosphere by the sweet potato-mango blended bar which lowered the concentration recorded by Mahawar *et al.* (2019) [18] in mango apple fruit bar and Singh *et al.* (2019) [32] in banana-soy fruit bar. According to Parab *et al.* (2014) [23], the  $a^*$  value for colour was increased up to 90 days of storage of mango bar. Initially the  $b^*$  value for colour was maximum mean and it decreased during storage with minimum mean  $b^*$  value at 90 days of the storage. It might be due to browning reactions that proceeds oxidative and enzymatically controlled processes. The increasing trend was observed in the moisture accordance with this findings was recorded by Vennilla (2004) [36] in guava-papaya bar; Sivakumar *et al.* (2005) [33] and Parab *et al.* (2014) [23] in mango bar. There was a significant decrease in the titratable acidity during storage because the formation of organic acids by the



degradation of the ascorbic acid as it decreased with the storage period of the fruit bar (Kumar and Deen. 2017) [16] and hydrolysis of pectin (Crues 1958; Seth 1985) [12, 29], ascorbic acid degradation or conversion of sulphur dioxide into sulphurous acid and formation of acid from sugars resulting in increased acidity content. It is clear from the data that the sweet potato- mango blended bar exhibited an increase in the reducing sugar content with rise in the levels of mango pulp in the product. This could be due to the higher levels of acids in the product rich in the mango pulp. Hence, there was more conversion of non-reducing sugars into reducing sugars in the product with higher proportion of mango pulp. Sharma *et al.* (2013) [30] recorded an increase in reducing sugar content in apricot fruit bar. The total sugars showed significantly decreasing trend up to 90 days of storage period might be due to significant increase in the moisture. Presence of moisture in food stuffs has been reported to cause a decrease in the concentration of nutrients (Labuza, 1973) [17] and may be due to breakdown of carbohydrates and also because utilization of sugars in the non-enzymatic browning. Similar trend was observed by Vennilla (2004) [36] in guava-papaya fruit bar and Aruna *et al.* (2014) [8] in dried peach bar. As regards the storage, the highest starch content was noticed at initial stage and lowest at the end of storage. A decreasing trend in starch content of sweet potato- mango blended bar was observed during 90 days of storage. The decrease in starch content was probably due increase in the moisture percentage in the sweet potato-mango blended bar during storage. At the 0 day of storage, the maximum  $\beta$ -carotene content was found while minimum at 90 days of storage. It decreased with increase in storage period up to 90 days of storage. It might be due to oxidative and non-oxidative changes (thermal degradation) which altered the  $\beta$ - carotene content, the colour of the product and lowered the flavour and nutritive value of the product (Parab *et al.* (2014) [23] in mango bar and Avhad *et al.* (2019) [9] in papaya guava fruit bar).

### Conclusion

In conclusion, the comprehensive analysis of physico-chemical changes and sensory attributes of sweet potato-mango blended bars during storage provides valuable insights into product stability and quality. The varying proportions of sweet potato and mango pulp significantly influenced color, moisture, total soluble solids, acidity, sugars, starch, and  $\beta$ -carotene content over the storage period. Notably, treatments with higher mango pulp content exhibited enhanced color intensity, moisture retention, and sensory appeal, while also displaying increased acidity and reducing sugars. However, prolonged storage led to alterations in these parameters, such as decreased starch content and  $\beta$ -carotene levels, likely due to oxidative processes. These findings contribute to our understanding of formulation effects on blended bar characteristics and underscore the importance of monitoring storage conditions to maintain product quality. Further research is warranted to explore optimization strategies for extending shelf life and enhancing nutritional value in sweet potato-mango blended bars.

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