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Studies on preparation of mango (*Mangifera indica* L.) bar from frozen Alphonso mango pulp

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ABSTRACT : The mango bar was prepared with 10, 20, 30 and 40 per cent dry sugar, 0.5 per cent citric acid and 0.1 per cent KMS from frozen Alphonso mango pulp and subjected to physico-chemical analysis and organoleptic evaluation at 0, 30, 60 and 90 days of storage. The data were analyzed using Factorial Completely Randomized Design. An increasing trend was observed in moisture, non-enzymatic browning, reducing sugars and acidity whereas, TSS, total sugars and β-carotene showed decreasing trend in mango bar irrespective of the treatments during 90 days of storage at ambient conditions. The mango bar prepared by adding 20 per cent dry sugar with 0.5 per cent citric acid and 0.1 per cent KMS was found to be the best treatment chemically as well as organoleptically.

KEY WORDS : Mango, Bar, Firmness, Non-enzymatic browning

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Mango (*Mangifera indica* L.), is known as 'the king of fruits' due to its exotic flavour, delicious taste and several other desirable characters. Mango, the national fruit of India is the most popular tropical fruit crop belongs to Anacardiacae family originated from South Asia, the Indo-Burma region. It has intimate association with cultural, religious, aesthetic and economic life of Indians since time immemorial (Chattopadhyay, 1976). India is the largest producer of mango accounting for about 54 per cent of the world production, followed by Mexico, Pakistan and Indonesia. In India, mango occupies about 37.60 per cent of an area and contributes 22.21 per cent of total production of fruit crops (Anonymous, 2010).

Alphonso is one of the leading mango cultivars of the Konkan region of Maharashtra, known for its outstanding flavour and taste. The Alphonso mango pulp can be stored under frozen condition at -18ºC temperature in deep freeze during summer months with the minimum changes in the chemical as well as organoleptic qualities, which could be used for further conversion into other value added products such as mango bar. Mango fruit bar, an important product of commerce, is generally prepared by drying mango pulp with proper amount of sugar and acid. To standardize the recipe for preparation of good quality mango bar from frozen pulp, the present investigation on preparation of mango bar was undertaken.

RESEARCH METHODS

Fully ripe mango fruits were selected, which were washed thoroughly to remove dust and dirt and then peeled. After extraction of pulp manually, the mango pulp was homogenized with mixer and then it was stored in deep freeze at -18^0 C temperature for a period of four months. The mango pulp was later on taken out from the deep freeze and used for the preparation of bar when the pulp had the normal room temperature. For the preparation of bar, the mango pulp was taken into a deep stainless steel vessel and the sugar as per the treatment and 0.5 per cent citric acid was added into the pulp. The mixture was then heated for five minutes with continuous stirring of pulp to avoid the charring of pulp. After heating, the mixture was cooled to room temperature and then 0.1 per cent of KMS was added into it. The properly washed, cleaned and dried trays were smeared with butter to avoid sticking of the product. The mixture was then spread into the trays to the desired level of thickness. These trays were kept in the cabinet drier at 60^0 C for about 10 to 12 hr until both the sides were non sticky and dried well. Later on, the same procedure was repeated for giving second, third and fourth layer above first layer and to prepare a bar of 1cm thickness.

Dried bar was then cut into rectangular pieces, wrapped in aluminium foil and packed in 400 gauge polyethylene bags (Fig. A). The mango bar was stored for three months and analyzed at monthly interval for the different quality parameters. The colour of mango bar was measured using Colorimeter (Colour Reader CR-10) and expressed as L*, a*, b* values. Firmness was analyzed using a texture analyzer (TA.XT2 Pro Touch System) fitted with a light weight blade set probe. A shear force was applied at a rate of 2 mm/s which cut the sample to a depth 5 mm from the contact point. The firmness was expressed as the force in N required for cutting the mango bar through a distance of 5 mm. 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) at 100ºC. Titratable acidity, reducing and total sugars and ascorbic acid were estimated by methods suggested by Ranganna (1997). The β-carotene and non-enzymatic browning were determined with the methods described by Srivastava and Kumar (2002). 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). The data were statistically analyzed by using Factorial Completely Randomized design (FCRD) described by Panse and Sukhatme (1985).

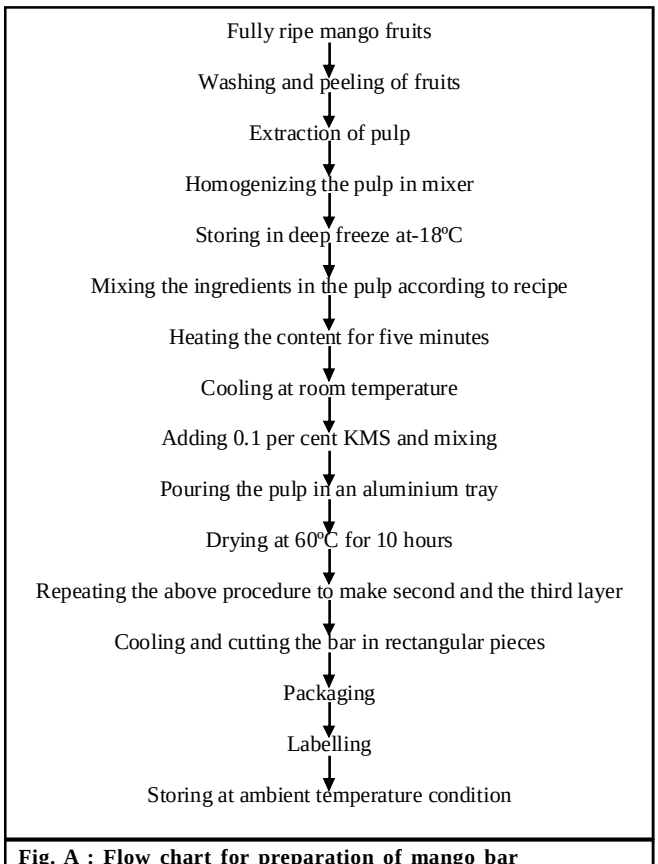

Fig. A : Flow chart for preparation of mango bar

RESEARCH FINDINGS AND DISCUSSION

The changes in physico-chemical composition of mango bar during storage are presented in Table 1 and 4. Among the treatments, T_1 (10% sugar) exhibited maximum mean colour value L*, while it was minimum in the treatment T_4 (40% sugar). It is evident from the data that the a* value for colour of the mango bar varied significantly due to level of dry sugar added in the product and the a* value increased with increasing the sugar concentration in the product. A significant increase in the a* value for colour with decrease in L* and b* value for colour of mango bar was noticed during storage. It indicates that the mango bar was darker in colour at the end of the storage period of 3 months. The firmness of the mango bar declined with increase in the sugar levels in the product. It could be due to rise in the moisture content of the product during storage. The pliable texture was due to better binding of moisture in presence of higher sugar content (Narayana *et al*., 2007). The observations are in accordance with findings reported by Mir and Nath (1993) in fortified mango bar.

Studies on the qualitative changes during storage of mango bar revealed that the moisture content was increased during storage. The gain in moisture might be due to absorption of moisture from the atmosphere by the package as at ambient condition there was higher relative humidity (90-95%) during storage. The total soluble solid content of the mango bar showed a decreasing trend during storage period of 90 days. This might be due to pickup of the moisture from the atmosphere by the mango bar which lowered the concentration of total soluble solids of the mango bar. It is evident from the data that the titratable acidity of mango bar varied significantly with different recipe treatments as well as storage period. The acidity of mango bar witnessed an increasing trend during storage period of 90 days. Similar trend of increase in acidity during storage has been recorded by Mir and Nath (1993) in mango bar and Aruna *et al.* (1999) in papaya fruit bar. It was observed that as dry sugar level in the product increased, the corresponding increase in the level of reducing sugars of mango bar was also noticed. The increase in reducing sugar was probably due to acid hydrolysis of sucrose during storage. Similar trend of increase in reducing sugars during storage has been recorded by Mahajan *et al*. (2011) in pineapple bar. Total sugars of mango bar decreased significantly during storage. The decrease in total sugars was 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). The β-carotene content of mango bar decreased during the storage. The loss could be due to non-oxidative changes (thermal degradation) which altered the β-carotene content, the colour of the product and lowered the flavour and nutritive value of the product (Eskin, 1979). The NEB of mango bar increased during the storage. This increase in non-enzymatic browning might be attributed to decrease in sulphur dioxide

Table 1 : Changes in colour values of mango bar during storage at ambient conditions

Treatments	Colour values of mango bar														
	L* value for colour					a* value for colour					b* value for colour				
	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_1	38.25	37.03	35.83	34.93	36.51	11.45	13.48	14.23	15.68	13.71	22.75	21.60	19.15	17.95	20.36
T_2	36.53	34.55	33.25	32.50	34.21	16.40	17.35	18.08	19.15	17.74	21.25	19.23	18.15	16.90	18.88
T_3	33.78	32.93	31.60	30.90	32.30	21.30	22.33	23.63	24.38	22.91	18.78	17.45	16.30	15.20	16.93
T_4	30.65	29.60	28.40	27.70	29.09	23.33	24.35	25.80	26.90	25.09	12.03	11.25	10.45	9.28	10.75
Mean	34.80	33.53	32.27	31.51	33.03	18.12	19.38	20.43	21.53	19.86	18.70	17.38	16.01	14.83	16.73
	S.E ±	C.D. (P=0.05)					S.E. ±	C.D. (P=0.05)				S.E. ±	C.D. (P=0.05)		
Treatment	0.113	0.321				Treatment	0.113	0.322			Treatment	0.137	0.389		
Storage	0.113	0.321				Storage	0.113	0.322			Storage	0.137	0.389		
T x S	0.226	NS				T x S	0.226	NS			T x S	0.274	0.778		

T_1– 10% sugar, T_2– 20% sugar, T_3 – 30% sugar, T_4 – 40% sugar NS=Non-significant

Table 2 Changes in firmness, moisture and TSS content of mango bar during storage at ambient conditions

Treatments	Firmness (N)					Non-enzymatic browning (OD at 440nm)					Moisture (%)				
	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_1	16.80	13.70	12.33	11.15	13.49	0.05	0.10	0.12	0.14	0.10	9.50	10.17	12.43	14.91	11.75
T_2	10.48	8.18	7.33	6.33	8.08	0.18	0.21	0.24	0.26	0.22	9.24	9.84	10.44	11.00	10.13
T_3	7.50	6.45	5.73	4.85	6.13	0.26	0.29	0.31	0.34	0.30	8.26	8.50	8.73	9.08	8.64
T_4	4.88	3.83	2.45	1.83	3.24	0.43	0.45	0.48	0.51	0.47	8.11	8.28	8.49	8.83	8.43
Mean	9.91	8.04	6.96	6.04	7.74	0.23	0.26	0.29	0.31	0.27	8.78	9.20	10.02	10.95	9.74
	S.E. ±	C.D. (P=0.05)				S.E. ±	C.D. (P=0.05)				S.E. ±	C.D. (P=0.05)			
Treatment	0.120	0.343				0.001	0004				0.073	0.209			
Storage	0.120	0.343				0.001	0004				0.073	0.209			
T x S	0.241	0.685				0.003	0007				0.147	0.418			

T_1– 10% sugar, T_2– 20% sugar, T_3 – 30% sugar, T_4 – 40% sugar NS=Non-significant

Table 3 : Changes in TSS, titratable acidity and reducing sugar content of mango bar during storage at ambient conditions

Treatments	TSS (°B) Storage period (days)					Titratable acidity (%) Storage period (days)					Reducing sugars (%) Storage period (days)				
	0	30	60	90	Mean	0	30	60	90	Mean	0	30	60	90	Mean
T_1	83.30	78.50	70.00	61.80	73.40	2.02	2.05	2.10	2.13	2.07	22.91	27.77	28.32	29.16	27.04
T_2	86.85	81.30	75.10	73.45	79.18	1.53	1.58	1.64	1.73	1.62	29.38	31.06	31.95	32.69	31.27
T_3	92.90	87.50	84.00	80.80	86.30	1.22	1.37	1.44	1.53	1.39	39.32	44.84	45.66	47.62	44.36
T_4	95.90	91.50	89.85	86.70	90.99	0.63	0.75	0.82	0.91	0.78	47.67	49.12	50.60	52.43	49.95
Mean	89.74	84.70	79.74	75.69	82.47	1.35	1.44	1.50	1.58	1.46	34.82	38.20	39.13	40.48	38.16
	S.E. ±	C.D. (P=0.05)				S.E. ±	C.D. (P=0.05)				S.E. ±	C.D. (P=0.05)			
Treatment	0.763	2.169				0.008	0.023				0.328	0.932			
Storage	0.763	2.169				0.008	0.023				0.328	0.932			
T x S	1.526	4.338				0.016	0.047				0.656	1.864			

T_1 – 10% sugar, T_2 – 20% sugar, T_3 – 30% sugar, T_4 – 40% sugar

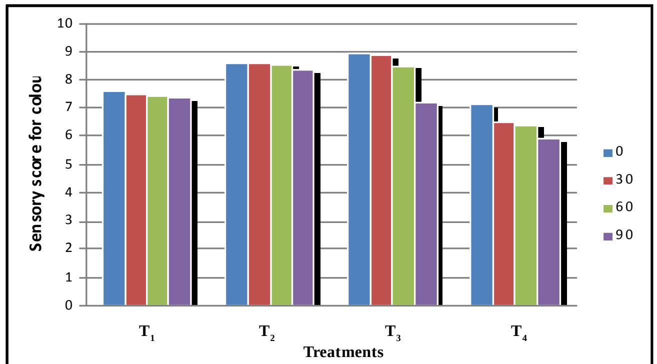

Fig. 1 : Changes in sensory score for colour of mango bar

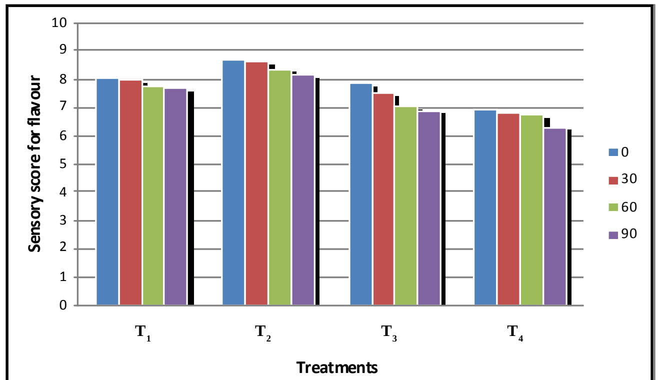

Fig. 2 : Changes in sensory score for flavour of mango bar

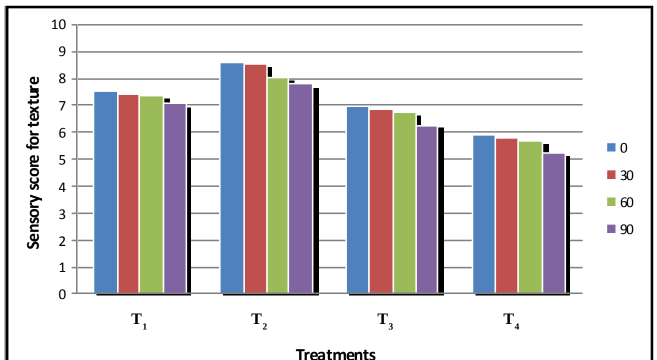

Fig. 3 : Changes in sensory score for texture of mango bar

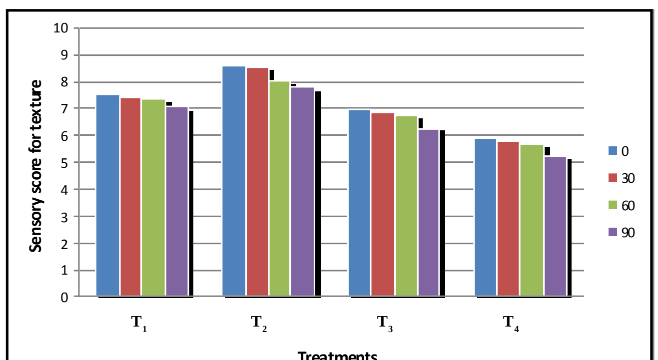

Fig. 4 : Changes in sensory score for overall acceptability of mango bar

Table 4 : Changes in total sugars and β-carotene of mango bar during storage at ambient conditions

Treatments	Total sugars (%)					β-carotene (µg/100g)				
	Storage period (days)					Storage period (days)				
	0	30	60	90	Mean	0	30	60	90	Mean
T_1 – 10% sugar	58.28	55.81	51.24	49.21	53.63	10415	9853	9585	8775	9657
T_2 – 20% sugar	63.06	60.38	58.41	56.76	59.65	9868	8503	8190	7038	8399
T_3 – 30% sugar	70.67	69.67	68.68	65.99	68.75	5330	5110	4280	3615	4584
T_4 – 40% sugar	79.37	77.05	74.52	69.56	75.12	3238	2900	2080	1210	2357
Mean	67.84	65.73	63.21	60.38	64.29	7213	6591	6034	5159	6249
	S.E. ±	C.D. (P=0.05)				S.E. ±	C.D. (P=0.05)			
Treatment	0.397	1.129				68.97	196.11			
Storage	0.397	1.129				68.97	196.11			
T x S	0.794	2.259				137.94	392.22			

(Swaminathan, 1987), concomitant with heat and loss of sulphur dioxide content of the product (Rao and Roy, 1980) during storage.

Organoleptic quality determines the storage stability of the product. The mango bar prepared with 20 per cent dry sugar, 0.5 per cent citric acid and 0.1 per cent KMS *i.e.* treatment T_2 recorded highest score for colour, flavour texture and overall acceptability which was significantly superior to all other recipes (Fig. 1 to 4). A significant decrease in the colour score during storage was due to increase in the non-enzymatic browning during three months of storage. A decline in the sensory score for texture might be due to the significant increase in the moisture content of the mango bar during storage at ambient temperature. The decrease in the overall acceptability of the product was due to loss of colour, flavour as well as the texture of the mango bar during storage. A decline in the overall acceptability score of the product during storage is reported by Mahajan *et al*. (2011) in pineapple bar and Khadtar (2012) in jackfruit bar.

Conclusion:

From the present investigation, it could be concluded that the mango bar recipe *i.e.* 20 per cent dry sugar, 0.5 per cent citric acid and 0.1 per cent KMS was found to be the best recipe for mango bar with highest sensory score for organoleptic qualities. The product, mango bar could be successfully stored at ambient temperature condition without any deterioration for the period of three months.

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