International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 391-397

Received: 16-07-2019
Accepted: 18-08-2019

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Effect of different packing materials on nutritional and organoleptic properties of blended guava fruit bar during storage

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Abstract
Blended guava fruit bars prepared by adding different proportions of skim milk powder (SMP) and carrot puree (CP). The treatments consisted of these two fruit bars recipes viz., T_1 - 86% pulp + 4% SMP + 10% carrot puree, T_2 - 84% pulp + 6% SMP + 10% carrot puree. The nutritional and organoleptic qualities and microbial counts were evaluated initially in two fruit bar recipes. Based on the sensory scores these two fortified fruit bars were selected for storage stability for 3 months under ambnient conditions. These two fruit bar recipes were packed in four different packing materials viz., LDPE (low density polyethylene), HDPE (high density polyethylene), PP (polypropylene), MP (metallised polyester) and the bar, without packing was taken was kept as control. The fruit bars were stored under ambient conditions (27±1ºC and 60% RH) and the nutritional, organoleptic qualities & microbial counts were recorded initially & at monthly intervals upto 90 days. Among the two fruit bars in the treatments T_1 & T_2, the Guava- SMP fruit bar with composition of 84% guava pulp, 6% Skim milk powder & 10% Carrot puree (T_2) packed in metallised polyester had highest rating for sensory attributes like colour, flavor, taste, texture and overall acceptability and also good retention of nutrients after 90 days of storage under ambient storage. Thus it can be inferred from the study that, based on the sensory evaluation scores the fortified fruit bar of guava with 84% pulp, 6% SMP and 10% carrot puree (T_2) was rated as the best when packed in metalized polyester upto 90 days of storage under ambient conditions.

Keywords: Blended guava leather, packing materials, nutritional analysis, sensory evaluation, storage studies

Introduction
Guava (*Psidium guajava* L.) the "poor man's fruit" and "apple of tropics" is a popular tree fruit of tropical and sub tropical climate and is native to the Tropical America stretching from Mexico to Peru. It belongs to the family *Myrtaceae.* Guava is the fifth most widely grown fruit crop in India. It occupies 3.5 per cent of total fruit crop area in the country with 3.3 per cent production share. It is estimated that in India, it is grown in about 2.2 lakh ha with a total production of 25.10 lakh tonnes (NHB, 2013) [15]. The fresh fruit of guava has limited shelf life and post harvest losses of guava are around 20-25%. Therefore, to utilize the produce at the time of glut and to save it from spoilage, fresh fruit may be processed into juice, nectar, pulp, leather, jam, jelly, squash, fruit bar or dehydrated products, baby foods, puree, beverage base, syrup, ice-cream and toffee (Leite *et al.*, 2006; Shankar *et al*., 2006) [13].
Fruit leather is made by drying a very thin layer of fruit puree to obtain a product with a chewy texture (Andress and Harrison, 1999) [1]. When dried, the product is pulled from the surface, rolled and consumed as snack. Vijayanand *et al.* (2000) [21] prepared guava pulp with sucrose and potassium metabisulphite as preservative and observed that guava leather remained stable for three months storage period. Azeredo *et al*. (2006) [3] studied the drying conditions and storage period on physicochemical properties of mango leather. They concluded that mango leather remained microbiologically stable at 25 °C for 6 months, without chemical preservatives. Since dehydrated fruit products such as guava leather is a valuable commodity, it may be worth spending more on the package, such as a moisture-proof sealed bag. Packaging materials determine the quality and shelf life of fruit products. Plastic films and flexible packs are amongst the main packing materials developed for the packing of processed products. Flexible packs are plastic films characterized for having a high mechanical resistance to traction, perforation and low temperatures, in addition to presenting appropriate durability and sealability. Some of the main materials used for the elaboration of flexible packs are high

and low density polyethylene, Polyvinylchloride, Polypropylene and Polyamides (Cortez, 2004) [4]. There is a need for the utilization of fresh fruits such as guava to process into fruit leather. Keeping in view the above-mentioned facts, a study was carried out to produce guava leather and assess its nutritive and organoleptic characteristics during storage in different packaging materials.

Materials

Allahabad safeda is a commercial variety of guava. Fruits are medium, round, smooth with skin colour yellow on ripening, white pulped, with few medium soft seeds and have good keeping quality. Fully matured ripened guava fruits were obtained from the experimental orchard of Fruit Research Station, Sangareddy.

Method

Pulp extraction

15 kg of Allahabad Safeda fruits were used for extraction of pulp for fruit bar preparation. The fruits were washed in clean tap water. Then the fruits were dipped in hot water for 5 min at 90 ^{0}C. The blanched fruits were kept in cool water for some time and cut into pieces. By using junior pulp extractor/Fruit miller, guava pulp was extracted. The seed was separated from pulp by sieve installed in the fruit pulp extractor. From 15kgs fruits of Allahabad safeda variety of guava, 13kgs of pulp was extracted (92.5% pulp recovery). 2kgs of carrots are used for making carrot puree. Initially carrots were washed thoroughly. Then peeled with potato peeler. After cutting of these carrots into small pieces steam blanching was done. Then these pieces were grinded by adding water to prepare carrot puree.

Solar dehydration method was used for preparation of guava fruit bar. Solar Powered Solar Air Dryer of model SDM-50 with loading capacity of 50kgs of wet pulp was used for preparation of fruit bar.

Fruit Bar preparation

The fruit pulp was prepared from Allahabad Safeda by above procedure. The fruit pulp from this variety were blended at different proportions by using two concentrations of Skim milk powder (4%, 6 %) and carrot puree (10%). The pulp was loaded in aluminium trays and kept in SDM-50 solar dryer for drying. The treatment combinations are given below in table.

Treatment combinations

Treatments	Allahabad Safeda guava pulp (%)	Skim milk powder (%)	Carrot puree (%)
T_1	86	4	10
T_2	84	6	10

Results and Discussion

Nutritional properties of blended guava fruit bar

The results indicates that there was a significant difference in ascorbic acid content of two fruit bars from 0 days to 90 days of storage. During storage up to 90 days, the ascorbic acid content decreased in T_1 from 43.50 to 25.30 mg 100g^{-1} and in T_2 from 46.50 to 28.90 mg 100g^{-1}.

Among different packages, initially no significant difference was noticed. However, with the increase in storage period the ascorbic acid content of fruit bars differed significantly. The fruit bars packed in metallised polyester (P_4) recorded maximum retention of ascorbic acid content of 36.50 mg 100g^{-1} of fruit bar weight which was followed by the packing in polypropylene (P_3) with 32.50 mg 100g^{-1} and minimum retention of ascorbic acid content of 15 mg 100g^{-1} of fruit bar was recorded in control (P_0) i.e. without packing at 90 days of storage.

Table: The increase in storage period the ascorbic acid content of fruit bars differed significantly

Parameter	Storage period (Days)	Treatments	Packing material					TT	S.Em±			CD at 5%		
			P1	P2	P3	P4	P_0		P	T	PXT	P	T	PXT
Ascorbic acid content (mg/100g^{-1})	0	T1	43.50	43.50	43.50	43.50	43.50	43.50	0.67	0.42	0.95	N.S.	1.23	N.S.
		T2	46.50	46.50	46.50	46.50	46.50	46.50						
		PM	45.00	45.00	45.00	45.00	45.00							
	30	T1	30.00	30.50	37.00	42.50	26.50	33.30	5.74	3.63	8.12	1.90	1.20	2.69
		T2	34.50	37.50	39.50	43.50	24.50	35.90						
		PM	32.50	34.00	38.25	43.00	25.50							
	60	T1	27.00	28.50	34.50	38.50	21.00	29.90	0.64	0.41	0.91	1.87	1.18	2.65
		T2	30.00	35.50	37.50	39.50	19.50	32.40						
		PM	28.50	32.00	36.00	39.00	20.25							
	90	T1	20.50	24.50	30.50	36.50	14.50	25.30	0.67	0.42	0.95	0.95	0.60	1.35
		T2	25.50	32.50	34.50	36.50	15.50	28.90						
		PM	23.00	28.50	32.50	36.50	15.00							
β-carotene content (µg/100g^{-1})	0	T1	1178.07	1178.07	1178.07	1178.07	1178.07	1178.07	0.57	0.36	0.81	N.S.	1.05	N.S.
		T2	1176.00	1176.00	1176.00	1176.00	1176.00	1176.00						
		PM	1177.03	1177.03	1177.03	1177.03	1177.03							
	30	T1	1126.50	1129.50	1134.50	1149.50	1105.77	1129.15	0.57	0.36	0.81	1.66	1.05	2.35
		T2	1112.50	1119.50	1127.50	1130.15	1105.77	1119.08						
		PM	1119.50	1124.50	1131.00	1139.82	1105.77							
	60	T1	1114.50	1129.50	1127.50	1139.50	1088.19	1119.83	0.81	0.54	1.15	1.66	1.05	2.35
		T2	1101.50	1107.25	1117.00	1122.50	1083.43	1106.33						
		PM	1108.00	1118.37	1122.25	1131.00	1085.81							
	90	T1	1100.00	1109.50	1119.50	1129.50	1069.50	1105.60	0.57	0.36	0.81	1.66	1.05	2.35
		T2	1199.00	1100.00	1114.50	1120.00	1060.50	1098.80						
		PM	1199.50	1104.75	1117.00	1124.75	1065.00							
protein content (g)	0	T1	1.30	1.30	1.30	1.30	1.30	1.30	0.07	0.04	0.09	N.S.	0.12	N.S.

		T2	2.40	2.40	2.40	2.40	2.40	2.40						
		PM	1.85	1.85	1.85	1.85	1.85							
	30	T1	0.69	0.75	0.94	1.08	1.23	0.93						
		T2	1.47	1.55	2.03	2.04	2.07	1.83	0.00	0.00	0.01	0.02	0.01	0.03
		PM	1.08	1.15	1.48	1.56	1.65							
	60	T1	0.51	0.65	0.72	0.91	0.97	0.75						
		T2	1.45	1.45	1.95	1.95	2.04	1.76	0.00	0.00	0.00	0.16	0.10	0.02
		PM	0.98	1.05	1.33	1.43	1.50							
	90	T1	0.50	0.65	0.65	0.85	0.97	0.72						
		T2	1.33	1.43	1.93	1.93	2.01	1.72	0.00	0.00	0.00	0.01	0.01	0.02
		PM	0.91	1.04	1.29	1.39	1.49							

Interactions between the packing and treatments were not significant on ascorbic acid content at 0 days however significant difference was observed with increasing the storage period up to 90 days. The interaction effects between the packages and fruit bars showed that the guava-SMP fruit bar with composition of 86 percent guava pulp, 4 percent SMP and 10 percent CP (T_1) packed in MP (P_4) recorded minimum decrease in ascorbic acid content i.e. from 43.50 to 36.50 mg $100g^{-1}$ during entire storage period which was on par with guava-SMP fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP (T_2) packed in MP (P_4) in which ascorbic content was decreased from 46.50 to 36.50 mg $100g^{-1}$. Whereas guava-SMP fruit bar with composition of 86 percent guava pulp, 4 percent SMP and 10 percent CP (T_1) kept under control i.e. without packing (P_0) recorded maximum loss in ascorbic acid content i.e. from 43.50 to 14.50 mg $100g^{-1}$.

The reduction in the ascorbic acid of fruit bars stored in ambient conditions was remarkable in unpacked storage (control), could be attributed to exposure to light, air over a length of storage period. Similar findings were reported by Fennema, (1996) [5] and Aruna *et al*. (1999) [2] in papaya bar during storage.

The fruit bars packed in metallised polyester (P_4) retained maximum ascorbic acid after 90 days of storage which was mainly due to the fact that metallised films have are reflective silver surface which never allows the oxygen and heat to enter into the packet compared to other packing materials (LDPE, HDPE, PP) which is similar to packing in aluminium foil this coating reduces the permeability of the film to light, water and oxygen. The results of present investigation in accordance with the findings of Manimegalai *et al.* (2001) [14] in jackfruit bar and John (2011) [11] in multilayer packaging for food and beverages.

In the present study, fruit bars in metalized polyester pouches were better compared to other packing material in retaining ascorbic acid during storage upto 90 days of storage under ambient conditions.

In the present study, equal quantity of carrot puree (10Percent) was added to all fruit bar recipes except control for enrichment of β-carotene. The results indicate that there was a significant difference in β-carotene content of two fruit bars and it varied from 0 days to 90 days of storage. Initially (0 days of storage) highest β-carotene content of 1178.07 µg $100g^{-1}$ was recorded in T_1 followed by (T_2) and it ranged from 1176 µg $100g^{-1}$. Upon further storage up to 90 days, the β-carotene content decreased from 1178.07 to 1105.60 µg $100g^{-1}$ in T_1 and maximum decrease from 1176 to 1098.80 was observed in T_2.

Among different packages, initially no significant difference was noticed. However, with the increase in storage period the β-carotene content decreased significantly. The minimum loss in β-carotene was recorded in fruit bars packed in metallised polyester (P_4) up to 90 days of storage i.e. from 1177.03 to 1124.75 µg $100g^{-1}$ which was followed by β-carotene content of fruit bars packed in Polypropylene (P_3) from 1177.03 to 1117 µg $100g^{-1}$.The maximum loss in β-carotene content was recorded in unpacked control (P_0) i.e. from 1177.03 to 1065 µg $100g^{-1}$ upto 90 days.

Interactions between the packages and treatments were not significant on β-carotene at 0 days of storage however, significant difference was observed with increase in the storage period up to 90 days. Among all treatments, the fruit bars in metalized polyester pouches were better compared to other packing material in retaining β-carotene upto 90 days of storage under ambient conditions. Whereas fruitbars stored without packing (P_0) recorded maximum loss in β-carotene content throughout the storage studies.

The fruit bars packed in MP retained high β-carotene content was mainly due to the fact that metallised polyester films have less permeability to heat and oxygen compared to other packing materials (LDPE, HDPE, PP).

The maximum loss of β-carotene in unpacked control during storage under ambient conditions could be attributed to exposure of product to oxygen and light and prolonged heating in the presence of oxygen during processing. Similar results were reported by results of present investigation in accordance with Fennema, (1996) [5].

Thus, the fruit bar samples wrapped in MP exhibited least β-carotene losses under ambient conditions even after 90 days of storage. The protein content of fruit bars differed significantly among the treatments from 0 days to 90 days of storage. On the first day of storage the highest protein content 2.40 (g) was recorded T_2 and minimum protein content of 1.3g was recorded in T_1. During storage up to 90 days, maximum decrease in protein content from 2.40 to 1.72g was observed in T_2 followed by T_1 i.e. from 1.30 to 0.72g.

The protein content of fruit bars differed significantly with package type. Although, no significant difference was observed initially (0 days of storage) with advancement of storage period, significant changes were observed in protein content of fruit bars in different packing materials from 30 to 90 days of storage. Maximum decrease in protein content was observed in fruit bars kept packed in LDPE (P_1) from 1.85 to 0.91g while minimum decrease in protein content was recorded in fruit bars kept under control i.e. without packing (P_0) from 1.85 to 1.49g followed by protein content of fruit bars packed in MP (P_4) in which protein content decreased from 1.85 to 1.39g.

The interaction effects were not significant between the packing and treatments initially. However, significant difference was observed with increasing storage period. The interaction effects between the packages and treatments on protein content showed that guava-SMP fruit bar with composition of 86 percent guava pulp, 4 percent SMP and 10 percent CP (T_1) kept under control I.e. without packing (P_0) recorded minimum decrease in protein content i.e. from 1.30 to 0.97g during entire storage period followed by guava-SMP

fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent Carrot puree (T_2) kept under control i.e. without packing (P_0) in which protein content decreased from 2.40 to 2.01g. Whereas guava-SMP fruit bar with composition of 86 percent guava pulp, 4 percent SMP and 10 percent CP (T_1) packed in LDPE (P_1) recorded maximum decrease in protein content from 1.30 to 0.50g.

In the present study, it was observed that the protein content of fruit bars decreased in all packaging material due to the increase of moisture in the samples. Due to high permeability of LDPE, the fruit bars gained moisture under ambient conditions hence the protein content decreased in LDPE packed fruit bars. Further the decrease in protein content during storage might be due to participation of proteins in maillard reaction. The results of present investigation are in accordance with the findings of Sharma (1997) [17] and Thakur (1997) [19].

In the present investigation, unpacked fruit bars with composition of 86 percent guava pulp, 4 percent Skim milk powder & 10 percent Carrot puree recorded high protein content. However the texture was very poor.

Organoleptic properties of blended guava fruit bar

Initially (0 days) the two blended fruit bars (T_1 & T_2) are found superior in colour with a maximum score of 8.10. After 90 days of storage the fruit bars still retained attractive colour and scored 7.58 & 7.80 respectively under ambient conditions. Similar findings were reported by Jain and Nema (2007) [10] in guava leather colour prepared from cv. Allahabad Safeda.

Table: The protein content of fruit bars decreased in all packaging material due to the increase of moisture in the samples

Parameter	Storage period (Days)	Treatments	Packing material					TT	S.Em±			CD at 5%		
			P1	P2	P3	P4	P_0		P	T	PXT	P	T	PXT
colour	0	T1	8.00	8.00	8.00	8.00	8.00	8.00	0.05	0.03	0.08	N.S.	N.S.	N.S.
		T2	8.10	8.10	8.10	8.10	8.10	8.10						
		PM	8.05	8.05	8.05	8.05	8.05							
	30	T1	7.90	7.90	8.00	8.10	7.70	7.92	0.05	0.03	0.08	0.16	0.10	N.S.
		T2	7.90	7.90	8.00	8.10	7.70	7.92						
		PM	7.95	8.00	8.15	8.95	7.80							
	60	T1	7.80	7.80	7.80	8.00	7.50	7.78	0.05	0.03	0.08	0.16	0.10	N.S.
		T2	7.90	8.00	8.00	8.00	7.80	7.94						
		PM	7.85	7.90	7.90	8.00	7.65							
	90	T1	7.50	7.50	7.70	7.80	7.40	7.58	0.05	0.03	0.08	0.16	0.10	N.S
		T2	7.60	7.80	8.00	8.00	7.60	7.80						
		PM	7.55	7.65	7.85	7.90	7.50							
Texture	0	T1	7.50	7.50	7.50	7.50	7.50	7.50	0.08	0.05	0.11	N.S.	N.S.	N.S.
		T2	7.60	7.60	7.60	7.60	7.60	7.60						
		PM	7.55	7.55	7.55	7.55	7.55							
	30	T1	7.30	7.30	7.40	7.40	5.00	6.88	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.30	7.27	7.40	7.40	5.00	6.89						
		PM	7.30	7.28	7.40	7.40	5.05							
	60	T1	7.00	7.20	7.30	7.40	4.95	6.76	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.10	7.30	7.30	7.40	5.00	6.82						
		PM	7.05	7.25	7.30	7.40	4.95							
	90	T1	6.90	7.10	7.20	7.30	4.80	6.66	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.00	7.20	7.30	7.40	4.90	6.76						
		PM	6.95	7.50	7.25	7.35	4.85							

Among the different packages, fruit bars packed in metallised polyester (P_4) recorded maximum scores for colour and the scores ranged from 8.05 to 7.90 which was on par with the colour of fruit bars packed in polypropylene (P_3) in which colour score ranged from 8.05 to 7.85.The least score for colour was recorded in fruit bars kept in open (P_0) i.e. from 8.05 to 7.50 up to 90 days of storage.

The interaction effects were not significant up to 90 days. The guava-SMP fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP (T_2) packed in metallised polyester (P_4) was rated high for colour i.e. from 8.10 to 8 upto 90 days of storage. Results are in accordance with the findings of Kumar *et al*, (2007) [12] in storage stability of guava leather.

Metallised films have a reflective silver surface which will not permit the oxygen and water vapour to enter into it. So fruit bars packed in MP maintained good colour up to 90 days of storage compared to other packing materials.

Significant difference were observed in colour and appearance of guava fruit bar after 90 days of storage due to increase in the non-enzymatic browning and thus resulted in decrease in the mean scores of colour and appearance. Similar results were observed by Yousif *et al.* (1990) in date jelly, Aruna *et al*. (1999) [2] in papaya fruit bar and Salim-ur-Rehman *et al*. (2012) [16] in apricot-date bar.

Among the fruit bars, at 0 days of storage, T_2 with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP recorded higher values for texture i.e. 7.6 followed by T_1 with score of 7.5 with composition of 86 percent guava pulp, 4 percent SMP and 10 percent Carrot puree. The scores for texture decreased from 7.5 to 6.66 in T_1 and decreased from 7.6 to 6.76 in T_2.

Among the different packages, fruit bars packed in MP (P_4) recorded minimum decrease in texture from 7.55 to 7.35 which was on par with texture of fruit bars packed in polypropylene (P_3) in which score for texture was decreased from 7.55 to 7.25.The least score for texture was recorded in fruit bars kept under control (P_0) i.e. from 7.55 to 4.85 up to 90 days of storage.

The interaction effects were not significant up to 90 days. The findings are similar to that of Kumar *et al*, (2007) [12] in storage stability of guava leather in different packing materials.

Metallised films have a reflective silver surface which will not permit the water to enter into it. So fruit bars packed in MP maintained good texture up to 90 days compared to other packing materials.

Deteriorative changes were noticed in unpacked control fruit bars i.e without packing due to the stickiness developed with increase in storage period.Some of the panel members judged the fruit bars as slightly hard in texture with a sticky mouthfeel. The stickiness might be due to the increase in acidity in the fruit bars. The oraganoleptic acceptability decreased with increase in storage period from 0 to 90 days.

Initially the two guava fruit bars in T_2 & T_1 recorded a score of 7.6 and 7.5 respectively. The flavour decreased on storage upto 90 days from 7.5 to 6.66 in T_1 and from 7.6 to 6.76 in T_2 respectively.

Table: The oraganoleptic acceptability decreased with increase in storage period from 0 to 90 days.

Parameter	Storage period (Days)	Treatments	Packing material					TT	S.Em±			CD at 5%		
			P1	P2	P3	P4	P_0		P	T	PXT	P	T	PXT
Flavour	0	T1	7.50	7.50	7.50	7.50	7.50	7.50	0.08	0.05	0.11	N.S.	N.S.	N.S.
		T2	7.60	7.60	7.60	7.60	7.60	7.60						
		PM	7.55	7.55	7.55	7.55	7.55							
	30	T1	7.30	7.30	7.40	7.40	5.00	6.88	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.30	7.20	7.40	7.40	5.00	6.89						
		PM	7.30	7.28	7.40	7.40	5.05							
	60	T1	7.00	7.20	7.30	7.40	4.95	6.76	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.10	7.30	7.30	7.40	5.00	6.82						
		PM	7.05	7.25	7.30	7.40	4.95							
	90	T1	6.90	7.10	7.20	7.30	4.80	6.66	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.00	7.20	7.30	7.40	4.90	6.76						
		PM	6.95	7.50	7.25	7.35	4.85							
Taste	0	T1	7.50	7.50	7.50	7.50	7.50	7.50	0.05	0.03	0.08	N.S.	N.S.	N.S.
		T2	7.60	7.60	7.60	7.60	7.60	7.60						
		PM	7.55	7.55	7.55	7.55	7.55							
	30	T1	7.20	7.30	7.40	7.40	6.55	7.06	0.05	0.03	0.08	0.16	0.10	N.S.
		T2	7.30	7.40	7.50	7.50	6.20	7.18						
		PM	7.25	7.35	7.45	7.45	6.10							
	60	T1	7.00	7.00	7.20	7.30	5.90	6.88	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	7.10	7.20	7.30	7.30	6.00	6.98						
		PM	7.05	7.10	7.25	7.30	5.95							
	90	T1	6.90	6.90	7.10	7.30	5.80	6.80	0.05	0.03	0.08	0.16	N.S.	N.S.
		T2	6.82	6.82	7.20	7.30	5.90	6.81						
		PM	6.86	6.86	7.15	7.30	5.85							
Overall acceptability	0	T1	7.62	7.62	7.62	7.62	7.62	7.62	0.00	0.00	0.00	N.S.	0.01	N.S.
		T2	7.72	7.72	7.72	7.72	7.72	7.72						
		PM	7.67	7.67	7.67	7.67	7.67							
	30	T1	7.42	7.45	7.55	7.57	5.92	7.18	0.00	0.00	0.00	0.01	0.01	0.02
		T2	7.45	7.46	7.57	7.60	6.57	7.33						
		PM	7.43	7.45	7.56	7.58	6.24							
	60	T1	7.20	7.30	7.40	7.52	5.82	7.04	0.00	0.00	0.00	0.01	0.01	0.02
		T2	7.30	7.40	7.47	7.52	5.95	7.13						
		PM	7.25	7.37	7.43	7.52	5.88							
	90	T1	7.05	7.15	7.30	7.42	5.70	6.92	0.00	0.00	0.00	0.01	0.01	0.02
		T2	7.10	7.25	7.45	7.52	5.82	7.02						
		PM	7.07	7.20	7.37	7.47	5.76							

Among the different packages, fruit bars packed in MP (P_4) recorded minimum decrease in flavour from 7.55 to 7.35 which was on par with that packed in polypropylene (P_3) pouches in which the scores ranged from7.55 to 7.25.The least score for flavour was recorded in fruit bars kept under control (P_0) i.e. decreased from 7.55 to 4.85 up to 90 days of storage.

The interaction effects were not significant up to 90 days. The guava-SMP fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP (T_2) packed in metallised polyester (P_4) was rated high for flavour i.e. from 7.6 to 7.4 up to 90 days because metallised polyester films will not permit the heat and air which causes volatilization of flavour compounds. Similar results in accordance with the findings of Kumar *et al*, (2007) [12] in storage stability of guava leather in different packing materials.

Metallised films have a reflective silver surface which will not permit the heat to enter into it. So fruit bars packed in MP maintained good flavor up to 90 days compared to other packing materials.

Among the fruit bars, at 0 days of storage guava-SMP fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP (T_2) recorded higher values for taste i.e. 7.6 least values 7.5 recorded by guava-SMP fruit bar with composition of 86 percent guava pulp, 4 percent SMP and 10 percent CP (T_1). The scores for taste decreased from 7.5 to 6.8 in guava-SMP fruit bar with composition of 86 percent guava pulp, 4 percent SMP and 10 percent CP (T_1) and in guava-SMP fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP (T_2) decreased from 7.6 to 6.81.

Among the different packages, fruit bars packed in MP (P_4) recorded minimum decrease in taste from 7.55 to 7.30 which was on par with taste of fruit bars packed in polypropylene (P_3) in which score for taste was decreased from 7.55 to 7.15.The least score for taste was recorded in fruit bars kept

under control (P_0) i.e. from 7.55 to 5.85 up to 90 days of storage.

The interaction effects were not significant up to 90 days. The guava-SMP fruit bar with composition 84 percent guava pulp, 6 percent SMP and 10 percent CP (T_2) packed in metallised polyester (P_4) was rated high for taste i.e. from 7.6 to 7.3 up to 90 days because as it maintained the the good texture and flavor. Similar results in accordance with the findings of Kumar *et al*, (2007) [12] in storage stability of guava leather in different packing materials.

Initially at 0 days of storage, guava-SMP fruit bar in T_2 treatment recorded higher values for overall acceptability i.e. 7.72 and T_1 treatment scored 7.62. At 90 day after storage the scores are 6.92 and 7.02 in guava-SMP fruit bar in T_2 and T_1 respectively.

Among the different packages, fruit bars packed in MP (P_4) had highest overall acceptability (7.47) which was on par with overall acceptability of fruit bars packed in polypropylene (P_3) in which score for overall acceptability of 7.37.Among all the treatments, the lowest score for fruit bars (5.76) was recorded for unpacked control.

Thus guava-SMP fruit bar with composition 84Percent guava pulp, 6Percent SMP and 10Percent Carrot puree (T_2) packed in metallised polyester (P_4) was rated high for overall acceptability i.e. from 7.72 to 7.52 up to 90 days because fruit bars packed in metallised polyester maintained good colour, texture, flavor and taste. Similar results in accordance with the findings of Kumar *et al*, (2007) [12] in storage stability of guava leather in different packing materials.

The results of sensory evaluation showed that the sensory attributes like colour, flavour, texture and taste & overall acceptability of the samples of guava fruit bars prepared with different composition of guava pulp, SMP & carrot puree and packed in metallised polyester were most acceptable upto 90 days of storage at room temperature. Overall acceptability of bar samples indicated that products packed MP pouches were more acceptable than samples in LDPE, HDPE or unpacked control.

As increase in storage period, there was decrease in sensory values. Similar results were observed by Sreemathi *et al.* (2008) [18] in sapota-papaya fruit bar and Harnam *et al.* (2013) [6] in guava papaya mixed fruit toffee.

The microbial changes noted in stored samples were presented in table 4.2.12. By following serial dilution method the microbial content in the fruit bars was observed. The microbial counts of bars packed in all packing materials were nil initially. This may be due to the addition of potassium meta bi sulfite and presence of high percentage of sugar content in the fruit bars and heating or processing treatment given to the guava fruit bar. The microbial count increased slightly from 60 to 90 days after storage in all the treatments. Similar observations were reported earlier by Sreemathi *et al*. (2008) [18] in sapota-papaya bar and Manimegalai *et al*. (2001) [14] in jack fruit bar.

Among the different packing materials, the microbial counts were nil upto 90 days of storage in fruit bars packed in MP. However with increasing storage period, the yeast and mould growth were observed at 60 and 90days of storage in all the treatments. This increase in microbial count is however found to be under permissible limit up to 90 days of storage in fruit bars. Under different packing materials the fruit bars accumulated moisture which resulted in increase in microbial growth.

According to Troller (1980) [20], most of the micro-organisms can rarely survive a water activity lower than 0.60. Similar results of microbial counts was reported by Huang (2005) [7], Irwandi and Che Man (1996) [8] and Irwandi *et al*. (1998) [9].

In this study the addition of Skim milk powder and carrot puree improved the nutritional profile of guava fruit bars. β-carotene content, Protein level, texture, and taste were considerably improved by incorporating 6 percent SMP and 10 percent carrot puree along with 84 percent guava pulp without affecting any sensory characteristic.

Further storage of fruit bars in different packing material of different thickness resulted in different permeability's. Packing of fruit bars in metalized polyester could be an ideal method of storage under ambient conditions upto 3months.

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