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Development and Evaluation of Ripe Pumpkin (*Cucurbita moschata*) Based Fruit Bars Using Herb Extracts

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AKD designed the study, performed the statistical analysis and wrote the protocol. Author DK wrote the first draft of the manuscript. Authors PT and SA managed the analyses of the study. Author PR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Utilization of bulk availability of low cost ripe pumpkin into processed products with high nutritional and functional characteristics.
Place and Duration of Study: Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP, India, between the years 2015-2017.
Methodology: A fruit bar was developed using pumpkin (*Cucurbita moschata*) at different combinations of TSS (30, 35 and 40°Brix), citric acid (1, 1.5 and 2%) and pectin (1, 1.5 and 2%). Further, incorporation of different herbal extracts (ginger, mint, tulsi) @ 5, 10, 15 and 20% was standardized in order to enhance the functional characteristics of the product and best recipe was evaluated for quality and sensory characteristics during storage.
Results: Pumpkin bar prepared at 40°Brix, 1.5% citric acid and 2% pectin got maximum sensory score and was liked very much. In case of herbal extracts, substitution by 10 % was found to be the best to prepare pumpkin-ginger, pumpkin-mint and pumpkin-*tulsi* bar. During storage, the chemical and sensory parameters decreased significantly ($p<0.05$) but the bars of all the treatments were of

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good quality up to six months. ALP was observed to be better packaging material as compared to LDPE and PP boxes. The product was able to retain 61.06% antioxidant activity and reflected 14.7 and 12.25 mm antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli*, respectively when stored for six months under ambient conditions with minimal changes in quality attributes.

Conclusion: It can be revealed that ripe pumpkin along with herbal extracts can be utilized successfully for the production of good quality and nutritionally enriched bar of remunerative cost.

Keywords: Pumpkin products; fruit bar; aromatic plants; herbal extract; antimicrobial activity.

1. INTRODUCTION

According to FSSAI, Fruit bar/leather is an intermediate food product prepared from pulp/puree of fruits which is dehydrated into leathery sheets and further can be cut into desired shape and size [1]. It involve the destruction of original fruit structure by pureeing and restructuring in dehydrated sugar-acid-pectin gels that provide attractive colored product, with soft, rubbery texture and sweet taste [2]. The advantageous role of fruit leather production is easy to preserve fruits by drying and hence, controlling postharvest losses. Several types of fruit bars have been developed by using different fruits, singly or in combination. Common fruits used in the production of fruit leather include durian [3], guava [4], grapes [5], mangoes [6], kiwifruit [7] and papaya [8]. Most of the commercially available fruit bars (except mango leather) are synthetic in nature i.e. without fruit pulp. Fruit pulp based fruit bars are more nutritious and organoleptically acceptable since substantial quantities of dietary fibres, minerals and vitamins are the constituents of finished product [9]. [10] made guava and pawpaw fruit leathers by adding 20% sugar, 0.2% of citric acid and 0.1% of sodium benzoate in 80% of pulp. While, the recipe for preparation of mango leather as given by [11] include sugar (50 g), corn flour (5 g) lime juice (2 ml) where the TSS of pulp was adjusted to 16°Brix. [12] formulated seabuckthorn leather using carboxy methly cellulose (2.0%), sugar (20%), citric acid (0.2%) and potassium metabisulphite (700 ppm) to produce stable foam which can be easily turned into leather.

Other than these fruits, Pumpkin (*kashiphal* or *lal kaddhu*) is considered to be one of the important vegetable crops where immature and mature fruits are processed in one or the other form [13]. It is a rich source of protein, starch, pectin and dietary fiber along with minerals like calcium, selenium, iron, phosphorus, etc. [14]. Besides being nutritionally rich, pumpkin possesses many medicinal properties due to presence of phytonutrients such as carotenoids, zeaxanthin, vitamin E, ascorbic acids, phytosterols, selenium, and linoleic acid, which act as natural antioxidant in human nutrition [15]. Depending upon growth stage, Pumpkin is cooked as a vegetable when immature and mature fruits can be used in the manufacture of beverages such as pumpkin-apple soup [16]. According to [17], pectin can be extracted from pumpkin and then modified using an enzyme could offer an alternative for jam and confectionery. [18] have developed jam from pumpkin with different combinations of apple and quince. [19] used pulp of pumpkin rich in fibre to process it into flour, for supplementation in the preparation of crackers. Though the exploitation of dried fruits as a carrier of functional ingredients is relatively new concept and is gaining interest in past few years especially in the development of fruit leather. Therefore, the present investigation was proposed with an aim to develop fruit bar/leather from ripe pumpkin along with herb extracts to improve the nutritional and functional characteristics.

2. MATERIALS AND METHODS

2.1 Standardization of Method for Preparation of Pumpkin Bar

The ripe pumpkin pulp was prepared according to the method standardized by [20]. The pumpkin bars were prepared using different combinations of TSS (30, 35 and 40°Brix), citric acid (1, 1.5 and 2%) and pectin (1, 1.5 and 2%). The pumpkin pulp was mixed with powdered sugar in order to get the pulp of desired TSS. Mild heat treatment was given to mix the sugar thoroughly with pulp on low flame. The mixed mass was cool down at room temperature and poured in pre greased aluminium trays of 3 mm thickness. The trays were kept in mechanical dehydrator set at a temperature of 60°C for drying. After drying the sheet was cut into pieces of uniform size and made into bars. The product was subjected to sensory evaluation for the

selection of best recipe to prepare flavored pumpkin bar.

2.2 Standardization of Recipe for Preparation of Pumpkin Bar Flavored with Herbal Extract

To enhance the sensory and nutritional properties of the bar, the pumpkin pulp was blended with ginger, mint and tulsi extracts. The product was subjected to sensory evaluation by a panel of ten judges. The combination which got the highest overall acceptability score was selected and referred as T_1, T_2 and T_3, respectively for storage studies. The detail of the optimization of herbal extracts is discussed below:

2.2.1 Ginger flavored pumpkin bar

The fresh ginger rhizomes were washed with water and peel off using stainless steel knife. Again the rhizomes were washed to remove adhered foreign matter. After grating, ginger was blended in a mixer cum grinder by adding water (1:2) to obtain pulp [21]. The pulp was then filtered by using a double layered muslin cloth. The bar flavored with ginger extract was prepared by replacing the pumpkin pulp with ginger extract at various concentrations (5, 10, 15, and 20 %).

2.2.2 Mint flavored pumpkin bar

The mint extract was prepared by blending fresh mint leaves in a mixer cum grinder using @ 20 % of water, followed by squeezing the mass through a double layered muslin cloth. The bar of different treatment was prepared by replacing the pumpkin pulp with mint extract at various concentrations (5, 10, 15, and 20 %).

2.2.3 *Tulsi* flavored pumpkin bar

The fresh *tulsi* leaves were separated from stem, washed and then blended in a mixer cum grinder with a small quantity of water (@ 20%). The pulp was then obtained by squeezing the grounded mass through a double layered muslin cloth**.** The pumpkin bars flavored with *tulsi* extract at various concentrations (5, 10, 15, and 20%) was prepared by replacing the pumpkin pulp with *tulsi* extract.

The selected treatments were packed in LDPE pouches, polypropylene boxes (PP boxes) and Aluminium Laminated Pouches (ALP). The product was stored under ambient conditions (21-28°C) for further investigation at different storage intervals (0, 3, and 6 months). During storage, the pumpkin bars were evaluated for various chemical, sensory, and microbiological characteristics.

2.3 Chemical/Nutritional Analysis

Pumpkin-flavored bars were analyzed for different nutritional characteristics at a storage interval of 0, 3, and 6 months when kept at ambient conditions. The chemical parameters include moisture content, TSS, titrable acidity, total sugars, reducing sugars, ascorbic acid, β-carotene and non-enzymatic browning were evaluated as per the analytical method [22]. Water activity was estimated by computer digital water activity meter (HW_3 model, Rotronic International, Switzerland), where direct measurements were taken at room temperature. Digital pH meter (CRISON Instrument, Ltd Spain) was used to determine pH.

2.3.1 Antioxidant activity

DPPH (2, 2-diphenyl-l-picrylhydrazyl) was used as a source of free radical to measure antioxidant activity in bar [23]. A quantity of 610-5 mol/L DPPH in methanol (3.9 mL) and sample extract (0.1mL) was put in cuvette and decrease in absorbance was measured at 515 nm for 30 minutes. Methanol was used as blank and 610-5 mol/L DPPH in methanol was used as control. The antioxidant activity was calculated using following equation:

> Antioxidant activity (%) = (Absorbance of control - Absorbance of sample / Absorbance of control) X 100

2.3.2 Antimicrobial activity

Well Diffusion method was used to measure the antimicrobial activity of samples against common microorganisms i.e. *Staphylococcus aureus* and *Escherichia coli* under aerobic conditions as discussed by [24]. The test microorganisms were uniformly swabbed with the help of sterilized cotton buds on a nutrient agar plate separately. Wells of 6 mm diameter were placed on the solid medium after loading them with 100 µL of the sample. Plates were incubated at 37°C for 24 hours to obtain a zone of inhibition. The diameter of the inhibition zone (mm) formed by samples against the respective test microorganism was measured.

2.4 Sensory Score Evaluation

A panel of 10 semi trained judges evaluated the pumpkin bar for its color, texture, flavor, and overall acceptability on a 9-point Hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely) [25]. The panel comprised of faculty members and post graduate students of Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) were selected with care to evaluate the product. Coded samples were presented to the judges in separate chambers or places to get unbiased judgments. Plain water was given to the judges to rinse their mouth in between the evaluation of samples. No discussion during sensory evaluation was allowed.

2.5 Statistical Analysis

All the experiments were performed in three replications and the results of those replicates were determined with standard deviations. The data for quantitative analysis of various chemical attributes were analyzed by Completely Randomized Design (CRD) while the data about sensory evaluation was analyzed by Randomized block design (RBD) using OPSTAT software.

3. RESULTS AND DISCUSSION

3.1 Optimization of Sugar, Citric Acid and Pectin Concentration for the Preparation of Pumpkin Bar

In total twenty-seven different combinations were used to prepare bar from the ripe pumpkin by varying TSS, acid and pectin. The bar was prepared in three batches each having 9 different combinations. The pumpkin bar of each batch was subjected to sensory evaluation by a panel of ten judges. The data have been presented in Tables 1, 2 and 3. The sensory evaluation scores of the bar prepared by raising the TSS to 30ºBrix and using a varied combination of acid and pectin showed that an identical mean score for color (8.47) was awarded to all the combinations. Among all the treatments, the maximum score for flavor (8.47), texture (8.49), and overall acceptability (8.56) were received by T_3 (30ºBrix, 1% acidity and 2% pectin). In the case of a bar of TSS 35ºBrix the highest scores for different parameters such as flavor (8.44), texture (8.56), and overall acceptability (8.66) were received by T_6 (35ºBrix, 1.5% acidity, and 2% pectin) while the lowest scores were awarded to T_1 (35ºBrix, 1% acidity, and 1% pectin) and color score (8.32) was non-significant ($p<0.05$) for all the treatments. The sensory score of bar of TSS 40ºBrix had the highest scores of 8.66, 8.48, and 8.78 for texture, flavor, and overall acceptability, respectively when bar was prepared with 1.5% acidity and 2% pectin (T_6).

Among the three batches pumpkin fruit bar prepared with 40ºBrix, 1.5% acidity and 2% pectin was observed to get maximum score for overall acceptability by the panelist and was selected for the preparation of pumpkin-flavored bar. The papaya-apricot leather was developed by [8] maintaining TSS of 25°Brix and acidity of 0.5%. The fruit bar prepared using wild apricot pulp, 60% sugar and 0.30% pectin obtained the highest score for color, taste, and overall acceptability as 7.95, 7.95 and 7.58, respectively [9].

3.2 Standardization of Recipe for Preparation of Pumpkin Bar Flavored with Herbal Extracts

It is clear from the data (Fig. 1) that the concentration of different herbal extracts had a significant effect on the sensory parameters of flavored pumpkin bars. The increase in the concentration of herbal extract had a significant decline in the sensory score of bars. The color of the pumpkin bar was liked very much up to a level of 10% incorporation of herbal extract but with an increase in the concentration of mint extract color of the bar was liked moderately. The flavor of the herbal extract was acceptable up to a level of 15% however, at 20% concentration the flavor of the bar was slightly liked. For texture and overall acceptability, the pumpkin bar of all the treatments was liked very much except for treatment containing 20% ginger extract, 20%, and 20% *tulsi* extract was moderately liked. This could be due to intense flavor different herbs extract that might had caused bitter flavor, hence the likeness of the bar was decreased significantly. Though the scores for all the sensory parameters of different treatments were well above the acceptable limits except for bar prepared using 10% ginger extract, 10% mint extract, and 10% *tulsi* extract got the highest score for overall acceptability. Therefore, theses treatments were selected and referred as T_1, T_2 and T_3, respectively for further storage studies.

Table 1. Sensory evaluation scores of pumpkin bar of 30ºBrix TSS

Treatment (Acid:Pectin)	Color	Flavor	Texture	Overall acceptability
T_1 (1 : 1)	8.47	8.41	7.26	8.45
T_2 (1 : 1.5)	8.47	8.45	7.94	8.41
T_3 (1 : 2)	8.47	8.47	8.49	8.56
T_4 (1.5 : 1)	8.47	7.88	7.28	8.54
T_5 (1.5 : 1.5)	8.47	7.85	7.96	8.53
T_6 (1.5 : 2)	8.47	7.94	8.46	8.53
T_7 (2 : 1)	8.47	6.93	7.25	8.51
T_8 (2 : 1.5)	8.47	6.93	7.92	8.52
T_9 (2 : 2)	8.47	6.92	8.47	8.50
$CD_{0.05}$	NS	0.04	0.03	0.04

Table 2. Sensory evaluation scores of pumpkin bar of 35ºBrix TSS

Treatment (Acid:Pectin)	Color	Flavor	Texture	Overall acceptability
T_1 (1 : 1)	8.32	7.86	7.35	8.55
T_2 (1 : 1.5)	8.32	7.88	7.84	8.55
T_3 (1 : 2)	8.32	7.96	8.51	8.56
T_4 (1.5 : 1)	8.32	8.33	7.35	8.58
T_5 (1.5 : 1.5)	8.32	8.36	7.87	8.61
T_6 (1.5 : 2)	8.32	8.44	8.56	8.66
T_7 (2 : 1)	8.32	8.40	7.36	8.64
T_8 (2 : 1.5)	8.32	8.43	7.85	8.63
T_9 (2 : 2)	8.32	8.42	8.54	8.60
$CD_{0.05}$	NS	0.03	0.04	0.04

Table 3. Sensory evaluation scores of pumpkin bar of 40ºBrix TSS

Treatment (Acid:Pectin)	Color	Flavor	Texture	Overall acceptability
T_1 (1 : 1)	8.36	7.35	7.34	8.38
T_2 (1 : 1.5)	8.36	7.42	7.75	8.48
T_3 (1 : 2)	8.36	7.94	8.61	8.47
T_4 (1.5 : 1)	8.36	7.88	7.37	8.53
T_5 (1.5 : 1.5)	8.36	8.37	7.76	8.62
T_6 (1.5 : 2)	8.36	8.48	8.66	8.78
T_7 (2 : 1)	8.36	8.47	7.36	8.76
T_8 (2 : 1.5)	8.36	8.46	7.76	8.75
T_9 (2 : 2)	8.36	8.45	8.64	8.73
$CD_{0.05}$	NS	0.04	0.04	0.04

3.3 Chemical Characteristics of Flavored Pumpkin Bar during Storage

The flavored pumpkin bar represented a significant difference in its storage quality when packed in different packaging material for 6 months (Table 4). There was a slight decrease in water activity during six months of storage of flavored pumpkin bar. The results for water activity in pumpkin bar of various treatments during six months of storage shows a non significant difference. Among different packaging materials, the bar packed in ALP recorded the maximum mean value of 0.622 followed by PP boxes and LDPE with a value of 0.596 and 0.586, respectively for water activity. The decrease in water activity during storage might be due to association of sugars and water through hydrogen bonding. The trend of decrease in water activity from 0.44 to 0.37 in pear fruit leather and 0.66 to 0.60 in guava leather was revealed by [26] and [27], respectively. Similarly, depending upon the packaging material, water activity increased significantly ($p<0.05$) to greater extent in ALP (Aluminium Laminated Pouches) in comparison to PET (Polyethylene terephthalate) in dried papaya powder [28]. In case of carrot slices

stored for 6 months permeability of moisture was more in (High Density Poly Ethylene) HDPE than ALP [29]. There was a significant increase in TSS and titrable acidity of flavored pumpkin bar packed in LDPE, PP boxes and ALP during storage. The increase in TSS during storage was more in (T_3) *tulsi* flavored pumpkin bar followed by T_1 and T_2, respectively. Similar trend of results shown by Bhatt et al. [30], in bar developed by wood apple. The mean titrable acidity was found to increase from 1.59% to 2.05, 1.95 and 1.74% in pumpkin bar packed in LDPE, PP boxes and ALP, respectively during a period of six months. There was a non-significant difference in the values of titrable acidity of different treatments during storage period. An increase in TSS might also be due to the formation of acids by the degradation of polysaccharides and oxidation of reducing sugars or by breakdown of pectic substances [31]. The increase in titrable acidity during storage might be due to a rise in the concentration of weekly ionized acids and their salts due to the reduction in moisture content during storage. A similar increasing trend in titrable acidity during storage has been reported by Parekh et al. [32] in mango bar and [33]. Bhat et al. [34] stated that titratable acidity decreased during the storage period with a lesser rate was observed in ALP than Polypropylene pouches.

In the case of functional components, a non-significant effect of treatments was observed on the *β*-carotene, ascorbic acid content and non-enzymatic browning of flavored pumpkin bar which means that addition of different herb extracts did not change the concentration these components. The overall effect of packaging material indicated that maximum (8.62, 7.03 mg/100 g) retention of *β*-carotene and ascorbic acid in bars packed in ALP while minimum (7.33, 5.44 mg/100 g) in LDPE, respectively. Further, the mean value was found to decrease with maximum rate in LDPE, followed by PP boxes and ALP, respectively. The interaction among treatment, storage interval and packaging material was recorded to be non significant. The reduction in *β*-carotene may be due to the photosensitive nature, isomerization and epoxide forming nature of carotene and oxidative degradation of carotenoids during storage. While, loss of ascorbic acid occurred by oxidation to dehydroascorbic acid followed by the hydrolysis of dehydroascorbic acid to 2,3-diketogluconic acids, which then undergoes polymerization to other nutritionally inactive products. The decreased content of *β*-carotene and ascorbic during storage has been supported by [35] in papaya-apple fruit leather, [27] in guava bar and [36] in aonla fruit bar. Degradation of *β*-carotene and ascorbic acid content in carrot slices during 6 months storage was more in HDPE in comparison to ALP [29]. On the other hand, there was an increase in non-enzymatic browning during storage and the mean value was found to increase from 0.274 to 1.638, 1.065 and 0.307 OD in LDPE, PP boxes and ALP, respectively. However, the overall effect of storage period reflects an increase from 0.274 to 1.004 OD during 6 months but the combined effect of treatments, storage and packaging on non-enzymatic browning was found to be non significant. A significant increase in non-enzymatic browning during storage was recognized due to formation of furfural and hydroxyl furfural by aerobic and anaerobic degradation of ascorbic acid or interaction between ascorbic acid, sugars and organic acid. [37] and [36] investigated a similar trend of increase in non enzymatic browning of osmo dehydrated pumpkin cubes and bar from aonla fruit, respectively.

The functional properties i.e. antioxidant activity and antimicrobial activity (against *Staphylococcus aureus* and *Escherichia coli*) of flavored pumpkin bar revealed a significant difference among different treatments during storage of six months. Both antioxidant and antimicrobial activity was found to be higher in ginger flavored pumpkin bar. Among different packaging material the mean maximum antioxidant activity was recorded in ALP (61.06 %) and minimum was noticed in LDPE (59.37 %). The mean decrease in antimicrobial activity against *Escherichia coli* was from 14.33 to 9.33, 10.03 and 12.33 mm in Low Density Polyethylene pouches (LDPE), Polypropylene boxes (PP) and Aluminium laminated pouches (ALP), respectively. The combined effect of treatments, storage interval and packaging material on antioxidant and antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli* were found to be non-significant. The decrease in antioxidant activity might be due to degradation of total phenolic compounds, vitamin C and carotenoids due to oxidation and other reactions during storage. The findings for antioxidant activity are in accordance with the results of [38] who observed 7.07% decrease in apple, pear, peach and persimmom fruit rolls and [39] indicated decrease from 34.1 to 28.27% in pumpkin candy.

Table 4. Effect of packaging on nutritional characteristics of pumpkin flavored fruit bar during storage

Parameters	Packaging material	LDPE Storage interval (month)			Mean	PP Boxes Storage interval (month)			Mean	ALP Storage interval (month)			Mean	$CD_{0.05}$
		0	3	6		0	3	6		0	3	6		
Water activity	T_1	0.658	0.584	0.512	0.585	0.658	0.599	0.536	0.598	0.658	0.617	0.593	0.623	**P=0.006**
	T_2	0.658	0.585	0.514	0.586	0.658	0.595	0.536	0.596	0.658	0.616	0.592	0.622	**S=0.006**
	T_3	0.657	0.585	0.517	0.586	0.657	0.595	0.537	0.596	0.657	0.618	0.592	0.622	**S×P=0.01**
	Mean	0.657	0.585	0.515	**0.586**	0.658	0.596	0.535	**0.596**	0.658	0.617	0.593	**0.622**	
Total soluble solids (°B)	T_1	72.40	75.16	77.53	75.03	72.40	74.63	76.50	74.51	72.40	73.13	74.36	73.30	**P=0.13**
	T_2	72.60	75.66	77.56	75.27	72.60	74.66	76.56	74.61	72.60	73.36	74.73	73.56	**S=0.13**
	T_3	72.25	75.80	77.43	75.16	72.25	74.50	76.43	74.39	72.25	73.46	74.80	73.50	**S×P=0.23**
	Mean	72.41	75.54	77.50	**75.13**	72.41	74.59	76.49	**74.49**	72.41	73.31	74.63	**73.44**	
Titrable acidity (%)	T_1	1.59	1.84	2.05	1.83	1.59	1.75	1.96	1.76	1.59	1.67	1.73	1.66	**P=0.01**
	T_2	1.60	1.86	2.06	1.84	1.60	1.76	1.97	1.77	1.60	1.65	1.74	1.67	**S=0.01**
	T_3	1.60	1.85	2.05	1.83	1.60	1.75	1.94	1.76	1.60	1.69	1.76	1.68	**S×P=0.02**
	Mean	1.59	1.85	2.05	**1.83**	1.59	1.75	1.95	**1.77**	1.59	1.67	1.74	**1.67**	
***β*-carotene (mg/100g)**	T_1	9.79	6.51	5.58	7.29	9.79	7.69	6.65	8.05	9.79	8.42	7.39	8.54	**P=0.11**
	T_2	9.81	6.59	5.58	7.33	9.81	7.75	6.34	7.97	9.81	8.46	7.44	8.57	**S=0.11**
	T_3	9.85	6.53	5.41	7.26	9.85	7.66	6.66	8.06	9.85	8.42	7.66	8.64	**S×P=0.20**
	Mean	9.81	6.54	5.52	**7.33**	9.81	7.7	6.55	**8.03**	9.81	8.43	7.49	**8.62**	
Ascorbic acid (mg/100g)	T_1	8.79	4.50	3.08	5.46	8.79	5.43	4.55	6.26	8.79	6.92	5.59	7.10	**P=0.10**
	T_2	8.74	4.49	3.06	5.43	8.74	5.38	4.65	6.26	8.74	6.73	5.67	7.04	**S=0.10**
	T_3	8.73	4.46	3.07	5.42	8.73	5.44	4.19	6.12	8.73	6.64	5.46	6.94	**S×P=0.18**
	Mean	8.75	4.48	3.07	**5.44**	8.75	5.41	4.46	**6.23**	8.75	6.76	5.57	**7.03**	
Non- enzymatic browning	T_1	0.274	0.824	1.653	0.917	0.274	0.751	1.064	0.697	0.274	0.294	0.308	0.292	**P=0.06**
	T_2	0.272	0.822	1.682	0.925	0.272	0.752	1.085	0.703	0.272	0.295	0.305	0.291	**S=0.06**
	T_3	0.274	0.807	1.547	0.876	0.274	0.751	1.017	0.681	0.274	0.296	0.307	0.293	**S×P=0.10**
	Mean	0.274	0.817	1.638	**0.910**	0.274	0.751	1.065	**0.697**	0.274	0.295	0.307	**0.292**	
Antioxidant activity (free radical scavenging activity %)	T_1	64.17	59.13	55.37	59.56	64.17	60.13	56.37	60.22	64.17	61.35	58.35	61.29	**P=0.08**
	T_2	63.80	58.72	54.73	59.08	63.80	59.37	55.73	59.63	63.80	60.56	57.73	60.69	**S=0.08**
	T_3	63.57	58.55	54.55	58.89	63.57	59.24	55.55	59.45	63.57	60.36	57.46	60.46	**S×P=0.13**
	Mean	63.84	58.80	54.88	**59.17**	63.84	59.58	55.88	**59.76**	63.84	60.75	57.84	**60.81**	

Parameters	Packaging material	LDPE Storage interval (month)			Mean	PP Boxes Storage interval (month)			Mean	ALP Storage interval (month)			Mean	$CD_{0.05}$
		0	3	6		0	3	6		0	3	6		
Antimicrobial activity (mm) against *Staphylococcus aureus*	T_1	21	18	15	18.0	21	19	16	18.7	21	20	18	19.7	**P=0.26**
	T_2	17	13	10	13.3	17	14	11	14.0	17	15	13	15.0	**S=0.26**
	T_3	15	10	7	10.7	15	11	9	11.7	15	13	11	13.0	**S×P=0.46**
	Mean	17.66	13.66	10.66	**13.99**	17.66	14.66	12.00	**14.77**	17.66	16.00	14.00	**15.88**	
Antimicrobial activity (mm against *Escherichia coli*	T_1	17.00	14.00	12.00	14.33	17.00	15.00	13.00	15.00	17.00	16.00	15.00	16.00	**P=0.01**
	T_2	14.00	11.00	9.00	11.33	14.00	12.00	10.00	12.00	14.00	13.00	12.00	13.00	**S=0.01**
	T_3	12.00	9.00	7.00	9.33	12.00	10.00	8.00	10.00	12.00	11.00	10.00	11.00	**S×P=0.03**
	Mean	14.33	11.33	9.33	**11.66**	14.33	12.33	10.33	**12.33**	14.33	13.33	12.33	**13.33**	

Where, T1= Ginger flavored pumpkin bar, T2=Mint flavored pumpkin bar, T3= Tulsi flavored pumpkin bar, P= Packaging material, S= Storage interval, $CD_{0.05}$= Critical difference

Table 5. Effect of packaging on sensory scores of pumpkin flavored fruit bar during storage

Parameters	Packaging material	LDPE Storage interval (month)			Mean	PP Boxes Storage interval (month)			Mean	ALP Storage interval (month)			Mean	$CD_{0.05}$
		0	3	6		0	3	6		0	3	6		
Color score	T_1	8.79	8.12	7.28	8.06	8.79	8.23	7.37	8.13	8.79	8.33	7.76	8.29	**P=0.06**
	T_2	8.47	7.67	6.57	7.57	8.47	8.26	6.87	7.86	8.47	8.21	7.12	7.93	**S=0.06**
	T_3	8.43	7.53	6.33	7.43	8.43	7.94	6.64	7.67	8.43	8.00	7.00	7.81	**S×P=0.11**
	Mean	8.56	7.77	6.72	**7.68**	8.56	8.14	6.96	**7.88**	8.56	8.18	7.29	**8.01**	
Texture score	T_1	8.42	7.32	6.34	7.36	8.42	7.43	6.89	7.58	8.42	8.16	7.55	8.04	**P=0.09**
	T_2	8.42	7.32	6.34	7.36	8.42	7.43	6.89	7.58	8.42	8.16	7.55	8.04	**S=0.09**
	T_3	8.42	7.32	6.34	7.36	8.42	7.43	6.89	7.58	8.42	8.16	7.55	8.04	**S×P=0.16**
	Mean	8.42	7.32	6.34	**7.42**	8.42	7.43	6.89	**7.58**	8.42	8.16	7.55	**8.04**	
Flavor score	T_1	8.81	7.32	7.10	7.74	8.81	7.56	7.28	7.88	8.81	8.32	8.00	8.37	**P=0.21**
	T_2	8.37	6.33	5.70	6.80	8.37	6.79	6.07	7.07	8.37	7.74	7.10	7.73	**S=0.21**
	T_3	8.32	6.20	5.21	6.57	8.32	6.42	5.88	6.87	8.32	7.00	6.85	7.39	**S×P=0.37**
	Mean	8.50	6.61	6.00	**7.04**	8.50	6.92	6.41	**7.27**	8.50	7.68	7.31	**7.83**	

Parameters	Packaging material	LDPE Storage interval (month)			Mean	PP Boxes Storage interval (month)			Mean	ALP Storage interval (month)			Mean	$CD_{0.05}$
		0	3	6		0	3	6		0	3	6		
Overall acceptability score	**T_1**	8.90	7.67	7.23	7.94	8.90	7.87	7.34	8.04	8.90	8.41	8.15	8.49	**P=0.06**
	T_2	8.38	7.45	6.89	7.58	8.38	7.65	7.16	7.73	8.38	8.13	7.35	7.95	**S=0.06**
	T_3	8.22	7.32	6.34	7.29	8.22	7.50	7.07	7.60	8.22	8.07	7.20	7.83	**S×P=0.11**
	Mean	8.50	7.48	6.82	**7.60**	8.50	7.67	7.19	**7.78**	8.50	8.20	7.56	**8.09**	

Where, T1= Ginger flavored pumpkin bar, T2=Mint flavored pumpkin bar, T3= Tulsi flavored pumpkin bar, P= Packaging material, S= Storage interval, $CD_{0.05}$= Critical difference

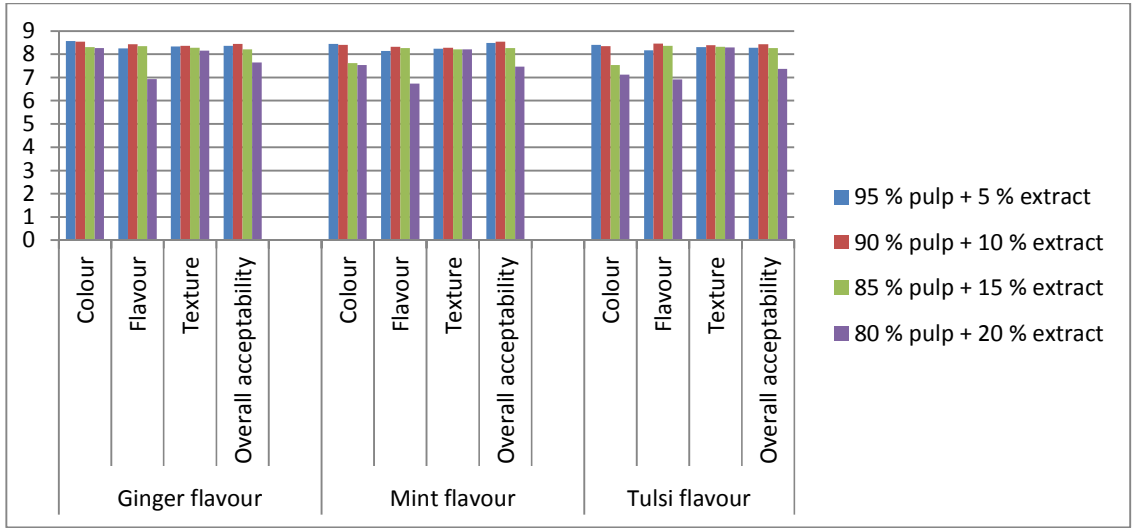

Fig. 1. Sensory score of pumpkin flavored fruit bar prepared using different extract

3.4 Sensory Score of Flavored Pumpkin Bar during Storage

The results pertaining to the effect of packaging on sensory score of flavored pumpkin bar during storage is given in Table 5. The data for sensory score of flavored pumpkin bar revealed a non-significant difference among various treatments. Among all treatments, ginger flavored pumpkin bar was found to be liked very much with a maximum overall acceptability score. The scores for color, texture, flavor and overall acceptability of bar for all the treatments indicated a significant decrease during storage. Among different packaging material, the highest score was observed in bar packed in ALP, LDPE scored the least while intermediate value was observed in PP boxes during storage for six months. However, combined effect of treatments, storage interval and packaging material on texture score was non-significant. The decline in color score of flavored pumpkin bar might be due to maillard and enzymatic browning. The deterioration in texture quality may be attributed to the loss in moisture through packaging material which causes hardening of fruit bars. The change in flavor was the most sensitive index to quality deterioration during storage and the decrease in flavor scores might be due to fluctuations in acids, pH and sugar/acid ratio and the loss of aromatic compounds as reported by Safdar et al. [31]. The overall acceptability of a product is generally related to various quality attributes and the decrease in scores during storage might be due to loss of color, flavor, and texture as well as change in chemical composition. Similar findings have been reported by Akhtar et al. [40] in apple-date fruit bar, [33] in guava leather, [32] in mango bar and [27] in guava bar.

4. CONCLUSION

This study confirmed that ripe pumpkin can be utilized in the form of bar with high sensory score. Addition of herbal extract in pumpkin bar helps in improving sensory attributes. Among all treatments, ginger flavored pumpkin bar was found to have higher nutritional characteristics and also suitable in maintaining the antioxidant and antimicrobial activity during storage as well.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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