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Effect of sucrose and antioxidant preservatives on some quality attributes of apricot fruit bars during storage

Ijlal Hussain[1*], Alam Zeb[1], Muhammad Ayub[1], Saleem Khan[2], Ihsanullah[3]

[1]*Department of Food Science and Technology, University of Agriculture, Peshawar, Pakistan*

[2]*Department of Human Nutrition, University of Agriculture, Peshawar, Pakistan*

[3]*Nuclear Institute of food and agriculture, Tarnab, Peshawar, Pakistan*

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Abstract

Intermediate moisture products gaining popularity among the consumers due to ease of use as fast foods and high energy concentrates. Apricot fruit bar were developed by blending various concentrations of sucrose, preservatives and antioxidant and each concentration was called a treatment. There were twelve treatments as; Ts_1, Ts_2, Ts_3 upto Ts_{12}. The samples were stored for six month at ambient conditions and analyzed for functional composition i.e. water activity, acidity, sugars, ascorbic acid, phenolics contents and total carotenoids. The obtained results revealed that higher sucrose concentrations along with antioxidants and preservatives significantly ($P<0.05$) maintained functional attributes of apricot bars. Maximum overall quality attributes were retained in Ts_{12} and Ts_{11} followed by Ts_6, Ts_5 and Ts_2. Total sugars, ascorbic acid, total phenolics and carotenoid contents of at the termination of 6 months storage revealed that apricot bars have appreciable amounts of the tested parameters in the best treatments. It is concluded that higher sucrose concentrations and antioxidant preservatives maintained nutritional quality of intermediate moisture apricot fruit bars. It offer a best option for entrepreneurs for developing rich nutritional fruit bars for improving the economy of the farming communities by utilize this abundant fruit in to saleable commodity.

* **Corresponding Author:** Ijlal Hussain ✉ ijlalhussain71@gmail.com

Introduction

Apricot has an important place in terms of its nutritional and health promoting components. It is rich in sugars, organic acids, minerals (calcium, magnesium, iron, potassium, phosphorus, sodium and zinc), vitamins and antioxidant compounds (Ali *et al.,* 2011). Sugars, organic acids, phenolic compounds and carotenoids, being the natural components of many fruits and vegetables, play important roles in maintaining fruit quality and determining their nutritive value (Ashoor and Knox, 1984). Available evidence provides support that a diet rich in fruits and vegetable can reduce the risk of several chronic diseases such as cancer, cardiovascular disease, hypertension, inflammation, arthritis, immune system decline, brain dysfunction and cataracts. Such foods are particularly rich in antioxidants, vitamin C, pro-and non-pro-vitamin A, folates, phenolics and a range of bioactive phytonutrients (Southon and Faulks, 2002).

Fruits are integral part of human diet and used as fresh or processed in to value added products. Among different products; fruit bars, fruit leathers and slabs are confectionery products prepared from fruit pulp like mango, guava, banana, papaya and are preferred by consumers.

The traditional method of preparation of fruit bar generally involves extraction of pulp, mixing with sugars in the ratio of 1:2 to 1:4 and sun dried on bamboo mats adding layer by layer after the previous one is dried. These slabs of sun dried produce are cut into slices of uniform sizes, wrapped in cellophane paper and marketed.

The leather are eaten as a confection or cooked as a sauce. Commercial manufacture of fruit leather was started as a means of producing an emergency field food ration for the armed forces. The bars are made from a wide variety of fruits, the more common being apricot, apple, banana, mango, black currant, cherry, grape, peach, pear, pineapple, plum, mulberry, raspberry and strawberry. The bar should have to be high nutritional value and should neither freeze at – 18°C nor become unduly soft at 40°C.

The current research work was conducted to develop intermediate moisture (IM) apricot fruit bars using various chemical preservatives, sweeteners and antioxidants. The main objectives of the study were firstly to develop an approved procedure for the development of shelf stable and highly nutritional IM apricot fruit bars from the apricot, widely grown in Gilgit-Baltistan (GB). Secondly, to study the influence of sweeteners, antioxidants and chemical preservatives on the quality attributes of IM fruit bar during ambient storage and assess consumer acceptability.

Materials and methods

Collection of sample

Fresh apricots were collected from GB. Fruits at ripening stage were harvested from 2 to 3 trees of same the variety at the harvesting stage. The samples were immediately shifted to the Food Processing Unit, Directorate of Agriculture GB. Fruits were cleaned and washed to remove all foreign matter such as dust and dirt. The fruit was sorted for immature and damaged fruits so as to conduct a systematic study.

Pulp extraction

Fruit pulp was extracted with the help of a pulping machine. This pulp was used to prepare the apricot bar. The treatment combinations were as under:

The product after drying was packed in different packaging (aluminum laminated and other different densities of polyethylene) and stored at room temperature for a period of six months. The samples were analyzed for the following physico-chemical attributes during storage.

Physico-chemical analysis

Water activity (a_w)

Water activity (a_w) of the samples was determined by using Novasina Thermo constanter TH 200 (Axaid Ltd, ptaffikon, Switzerland) (Kiltic *et al.*, 1986). Before recording the values the instrument was switched on and left for a minimum of two hours to equilibrate. The samples materials were crushed and homogenized. The plastic sample bowls were filled to the rim and placed into the stainless steel measuring bowls under the water activity sensors by pulling up the appropriate sensor knob. After closing the chamber door securely, the instrument was allowed to reach equilibrium and water activity (a_w) was noted to three decimal places. All the analyses were carried out in triplicate.

Total sugar

Total sugar was determined by Lane Eynon titration method as reported in AOAC (2000).

Titratable acidity (%)

Titratable acidity was determined by standard method of AOAC (2000), by titrating against standard alkali solution.

Ascorbic acid

The ascorbic acid was determined by titration with 2, 6 dichlorophenol indophenol method as described in AOAC (2000).

Total phenolic contents

Total phenolic contents (TPC) were estimated by Folin-Ciocalteu (FC) method as reported by Sponas and Wrolstad (1990). Randomly selected apricots were homogenized to prepare a representative sample. Five gram representative sample was diluted with 30 mL deionized water, clarified followed by centrifugation for 15 minutes at 10000 g. The clarified extract was then filtered through a membrane filter (0.45 mm). From this filtrate 0.5 mL was taken in a 25 mL volumetric flask. To the same flask 5 mL of 0.2 N FC reagent and 4 mL of sodium carbonate solution (7.5%) was added and volume made up to the mark with deionized water. This content was incubated at 50°C for 8 minutes and absorbance was recorded at 765 nm by using a Spectrophotometer (CE-2021, CECIL® Instruments, England). TPC were calculated as milligram GAE per 100 g on dry weight basis from a calibration curve using gallic acid as reference compound.

Total carotenoids (mg/100gm)

Total carotenoids (TC) of apricot were estimated by following the procedure described by Rodriguez-Amaya (1999). Carotenoids were extracted by taking 5 g homogenized sample with a 100 mL methanol and petroleum ether (1:9 v/v) and then poured in to a separating funnel.

The layer of petroleum ether was separated through sodium sulfate and methanolic extract was taken in a 100 mL volumetric flaks and volume made up. Carotenoid contents were estimated spectrophotometerically at 450 nm wave length and expressed as milligrams per 100 g of β-carotene on dry weight basis.

Statistical analysis

Anova was carried out by using statistix 8.2 software and the means were compared through least significance difference test (LSD) at $P<0.05$.

Results and discussion

Water activity

The obtained results regarding water activity of apricot fruit bars demonstrated a partially significant ($P<0.05$) declining trend during storage. Similar behavior was noticed for interaction, treatments and storage means also (Table 2).

Maximum water activity was found in control set and the minimum was observed in Ts_{12} for treatments at the end of 180 days storage. Water activity plays an important role in food preservation. Each microorganism has different survival ranges of different a_w for growth under a given set of environmental conditions.

Food stability decreases with increase in a_w, while lower water activity reduces the pace of chemical and microbiological degradation of intermediate moisture foods (Fernadez-Salguero *et al.* 1993). Thus an unfavorable a_w of food will result in decreased microbial activities and biochemical reactions which ultimately increase the shelf life of foods. It has been found that different additives affect a_w of processed food. Kaya and Kahyaoglue, (2005) determined water activity range on grape leather (a_w 0.60) which was in close line with our findings.

Total sugars (%)

The effect of treatments and storage on total sugar contents revealed partially significant differences ($p<0.05$) among all treatments (Table 3). The mean data obtained for 190 days storage indicated that higher total sugar content was found in Ts_{12}, Ts_{11} and Ts_6 followed by Ts_5 and Ts_2. Minimum amounts were observed in control, Ts_9, Ts_{10}, Ts_7, Ts_4 and Ts_3 respectively. The mean valves for storage were non-significant, while interaction means were partially significant at $P<0.05$. With the advancement of ambient storage total sugars may increases in apricot bars (Choudhury, 2004). The partial increase in sugar contents may be due to water losses from the apricot bar consequently enhanced sugar concentrations.

Table 1. Treatment combinations.

Treatments	Apricot: Sucrose	Pectin (%)	Starch (%)	Antioxidant	Preservative
Ts_1	9 : 1	0.2	10	Nil	Nil
Ts_2	9 : 1	0.2	10	Citric acid	Nil
Ts_3	9 : 1	0.2	10	Nil	PMS
Ts_4	9 : 1	0.2	10	Nil	Sorbate
Ts_5	9 : 1	0.2	10	Citric acid	PMS
Ts_6	9 : 1	0.2	10	Citric acid	Sorbate
Ts_7	8 : 2	0.2	10	Nil	Nil
Ts_8	8 : 2	0.2	10	Citric acid	Nil
Ts_9	8 : 2	0.2	10	Nil	PMS
Ts_{10}	8 : 2	0.2	10	Nil	Sorbate
Ts_{11}	8 : 2	0.2	10	Citric acid	PMS
Ts_{12}	8 : 2	0.2	10	Citric acid	Sorbate + PMS

PMS= potassium metabisulfite.

Table 2. Effect of various food additives (sucrose, pectin, starch and preservatives) on water activity of apricot bars during ambient storage.

Treatment	Storage period (days)							Means
	0	30	60	90	120	150	190	
Ts_1	0.62ab	0.63a	0.62ab	0.62ab	0.61bc	0.61bc	0.60cd	0.62a
Ts_2	0.62ab	0.61bc	0.60cd	0.61bc	0.61bc	0.60cd	0.61bc	0.61b
Ts_3	0.63a	0.62ab	0.62ab	0.60cd	0.60cd	0.60cd	0.61bc	0.61ab
Ts_4	0.62ab	0.62ab	0.61bc	0.60cd	0.61bc	0.60cd	0.60cd	0.61b
Ts_5	0.63a	0.62ab	0.60cd	0.61bc	0.61bc	0.60cd	0.60cd	0.61ab
Ts_6	0.63a	0.61bc	0.60cd	0.60cd	0.61bc	0.61bc	0.61bc	0.61ab
Ts_7	0.63a	0.62ab	0.60cd	0.60cd	0.61bc	0.60cd	0.61bc	0.61ab
Ts_8	0.62ab	0.62ab	0.61bc	0.60cd	0.61bc	0.59d	0.61bc	0.61b
Ts_9	0.61bc	0.62ab	0.61bc	0.60cd	0.60cd	0.60cd	0.60cd	0.61bc
Ts_{10}	0.62ab	0.61bc	0.61bc	0.60cd	0.60cd	0.60cd	0.60cd	0.61bc
Ts_{11}	0.61bc	0.61bc	0.61bc	0.61bc	0.60cd	0.61bc	0.60cd	0.61bc
Ts_{12}	0.61bc	0.61bc	0.60cd	0.60cd	0.60cd	0.59d	0.60cd	0.60c
Means	0.62a	0.62a	0.61b	0.60bc	0.61b	0.608c	0.60bc	

LSD T=2.30 S=1.70 TS=1.30

The values are means of three replication and the means having different letter (s) with in the same row are statistically significant at $P<0.05$.

Titratable acidity (%)

The effect of different concentrations of sucrose on titratable acidity (TA) of apricot fruit bars revealed a decreasing trend during storage (Table 4).

The losses in acidity were noticed in all treatments, but the ratio was different in each treatment. Maximum acidity value was observed in Ts_6 followed by Ts_{12} (2.18), Ts_{11}, Ts_5 and Ts_2, while minimum values were observed in Ts_1 followed by Ts_3, Ts_9, Ts_{10}, Ts_4 and Ts_7 during storage. The obtained results revealed that different concentrations of sucrose along with antioxidants and preservatives significantly ($P<0.05$) affected acidity of apricot fruit bar.

Table 3. Effect of various food additives (sucrose, pectin, starch and preservatives) on sugars content (g/100g) of apricot bars during ambient storage.

Treatment	Storage period (days)							Means
	0	30	60	90	120	150	190	
Ts_1	66.20e	66.21e	66.22e	66.24e	66.28e	66.30e	66.30e	66.25f
Ts_2	71.00bcd	71.02bcd	71.07bcd	71.09bcd	71.12bcd	71.12bcd	71.12bcd	71.08c
Ts_3	66.60e	66.62e	66.63e	66.64e	66.67e	66.66e	66.65e	66.64e
Ts_4	66.40e	66.42e	66.45e	66.45e	66.48e	66.51e	66.54e	66.46ef
Ts_5	70.70d	70.73d	70.76d	70.80d	70.84d	70.87cd	70.90bcd	70.80d
Ts_6	71.50abc	71.52ab	71.54ab	71.54ab	71.54ab	71.54ab	71.52ab	71.53b
Ts_7	66.40e	66.41e	66.33e	66.34e	66.35e	66.40e	66.45e	66.38f
Ts_8	70.60d	70.62d	70.62d	70.60d	70.58d	70.62d	70.62d	70.61d
Ts_9	70.70d	70.73d	70.76d	70.80d	70.84d	70.87cd	70.90bcd	66.26f
Ts_{10}	66.20e	66.22e	66.26e	66.28e	66.29e	66.32e	66.33e	66.27f
Ts_{11}	71.80a	71.80a	71.82a	71.81a	71.83a	71.82a	71.80a	71.81a
Ts_{12}	71.78a	71.81a	71.82a	71.82a	71.84a	71.84a	71.80a	71.82a
Means	68.79a	68.82a	68.83a	68.81a	68.83a	68.85a	68.85a	

LSD T=0.24 S=0.19 TS=0.64

The values are means of three replication and the means having different letter (s) with in the same row are statistically significant at P<0.05.

Table 4. Effect of various food additives (sucrose, pectin, starch and preservatives) on titratable acidity (%) of apricot bars during ambient storage.

Treats.	Storage period (days)							Means
	0	30	60	90	120	150	190	
Ts_1	1.70f-i	1.70f-i	1.60ghi	1.60ghi	1.60ghi	1.50hi	1.40i	1.59e
Ts_2	2.20a-d	2.20a-d	2.10b-e	1.40i	2.10b-e	2.10b-e	2.00c-f	2.01d
Ts_3	1.80e-h	1.70f-i	1.60ghi	1.60ghi	1.60ghi	1.50hi	1.50hi	1.61e
Ts_4	1.70f-i	1.80e-h	1.70f-i	1.70f-i	1.70f-i	1.50hi	1.50hi	1.66e
Ts_5	2.30abc	2.10b-e	2.10b-e	2.10b-e	2.00c-f	2.20a-d	1.90d-g	2.10bcd
Ts_6	2.40ab	2.10b-e	2.40ab	2.20a-d	2.20a-d	2.30abc	2.20a-d	2.26a
Ts_7	1.70f-i	1.90d-g	1.70f-i	1.70f-i	1.70f-i	1.60ghi	1.40i	1.67e
Ts_8	2.20a-d	2.40ab	1.60ghi	2.10b-e	2.10b-e	2.20a-d	1.80e-h	2.06cd
Ts_9	1.90d-g	1.80e-h	1.60ghi	1.60ghi	1.60ghi	1.50hi	1.40i	1.62e
Ts_{10}	1.80e-h	1.80e-h	1.60ghi	1.60ghi	1.60ghi	1.60ghi	1.50hi	1.64e
Ts_{11}	2.10b-e	2.20a-d	2.20a-d	2.30abc	2.40ab	2.00c-f	2.00c-f	2.17abc
Ts_{12}	2.20a-d	2.30abc	2.10b-e	2.50a	2.20a-d	1.87efg	2.10b-e	2.18ab
Means	2.00a	2.00a	1.86b	1.87b	1.90b	1.82b	1.73c	

LSD T=0.12 S=0.09 TS=0.32

The values are means of three replications and means having different letter (s) with in the same row are statistically significant at P < 0.05.

The interaction means for treatments and storage also showed a partially significant pattern ($P<0.05$). A slightly decreasing trend in TA might be ascribed to chemical changes associated with processing of apricot bars (Abbasi *et al.*, 2011). Similar decreasing trends in acidity of apricot bars during controlled atmospheric storage have also been reported by Pretel *et al.* (1999). Similarly, a slight increase in acidity of some samples might be due to sugar fermentation during extended storage. Our findings are also in agreement with the findings of Sarojini *et al.* (2009) who reported a decreasing behavior in the TA of three types of fruit bars i.e. mango, guava and carrot.

Table 5. Effect of various food additives (sucrose, pectin, starch and preservatives) on ascorbic acid (mg/100g) of apricot bars during ambient storage.

Treat.	Storage period (days)							Means
	0	30	60	90	120	150	190	
Ts_{1}	12.00d-j	11.20g-l	11.20g-l	10.40j-n	8.00p-t	6.80s-w	5.40vwx	9.29c
Ts_{2}	14.20ab	13.60a-d	13.60a-d	12.60b-g	8.80n-q	7.40q-u	6.60t-x	10.97ab
Ts_{3}	14.00abc	13.20a-f	13.20a-f	12.20d-i	8.40p-s	7.60q-u	6.00u-x	10.66b
Ts_{4}	12.60b-g	11.40g-k	11.40g-k	10.60i-m	8.60o-r	7.00r-v	5.20wx	9.54c
Ts_{5}	14.20ab	13.20a-f	13.20a-f	12.00d-j	9.60l-p	8.00p-t	7.00r-v	11.03ab
Ts_{6}	14.60a	14.00abc	14.00abc	13.40a-e	9.40m-p	8.00p-t	6.20ux	11.37a
Ts_{7}	12.60b-g	12.00d-j	12.00d-j	11.40g-k	8.80n-q	6.80s-w	5.00x	9.80c
Ts_{8}	12.80b-g	11.60f-k	11.60f-k	10.50j-m	8.20p-t	7.20q-u	6.20u-x	9.73c
Ts_{9}	12.40c-h	11.40g-k	11.40g-k	10.20k-o	8.40p-s	6.60t-x	5.40vwx	9.40c
Ts_{10}	12.80b-g	11.80e-k	11.80e-k	10.80h-m	8.00p-t	6.80s-w	5.40vwx	9.63c
Ts_{11}	14.80a	13.40a-e	13.40a-e	12.80b-g	10.20k-o	8.80n-q	7.40q-u	11.54a
Ts_{12}	14.60a	14.00abc	14.00abc	13.20a-f	10.80h-m	7.60q-u	6.80s-w	11.57a
Means	13.48a	12.57b	12.57b	11.68c	8.93d	7.38e	6.05f	

LSD T=0.61 S=0.46 TS=1.61

The values are means of three replication and the means having different letter (s) with in the same row are statistically significant at $P<0.05$.

Table 6. Effect of various food additives (sucrose, pectin, starch and preservatives) on total phenolic content (mgGAE/100g) of apricot bars during ambient storage.

Treatment	Storage (days)							Means
	0	30	60	90	120	150	180	
Ts_{1}	2122.0m	2121.0mn	2120.0no	2119.0op	2119.0op	2118.0pq	2117.0q	2119.4i
Ts_{2}	2207.0gh	2206.0hi	2206.0hi	2206.0hi	2206.0hi	2205.0ij	2205.0ij	2208.0c
Ts_{3}	2143.0b	2142.0bc	2141.0cd	2140.0de	2139.0ef	2138.0fg	2137.0g	2140.0g
Ts_{4}	2134.0h	2133.0hi	2132.0ij	2131.0jk	2130.0k	2128.0l	2128.0l	2130.9h
Ts_{5}	2208.0fg	2208.0fg	2208.0fg	2208.0fg	2208.0fg	2207.0gh	2207.0gh	2208.6bc
Ts_{6}	2210.0de	2209.0ef	2209.0ef	2209.0ef	2209.0ef	2208.0fg	2208.0fg	2208.9b
Ts_{7}	2156.0s	2156.0s	2155.0st	2154.0tu	2153.0uv	2153.0uv	2152.0vw	2151.9f
Ts_{8}	2167.0n	2165.0o	2164.0o	2161.0p	2160.0pq	2159.0qr	2158.0r	2162.0e
Ts_{9}	2151.0wx	2151.0wx	2151.0wx	2150.0xy	2149.0yz	2148.0za	2147.0a	2151.9f
Ts_{10}	2205.0ij	2204.0jk	2204.0jk	2204.0jk	2203.0kl	2202.0l	2200.0m	2204.1d
Ts_{11}	2212.0bc	2211.0cd	2211.0cd	2210.0de	2210.0de	2210.0de	2210.0de	2209.0b
Ts_{12}	2214.0a	2214.0a	2213.0ab	2213.0ab	2212.0bc	2212.0bc	2212.0bc	2212.85a
Means	2179.3a	2177.8b	2176.6c	2175.2d	2174.4e	2173.0f	2171.7g	

LSD T=0.61 S=0.46 TS=1.61

The values are means of three replication and the means having different letter (s) with in the same row are statistically significant at $P<0.05$.

Ascorbic acid

The results pertaining to ascorbic acid of apricot fruit bars revealed a decreasing trend during storage (Table 5). Among different treatments maximum ascorbic acid content was recorded in Ts_{12}, Ts_{11} and Ts_6 with no significant difference (P<0.05), followed by Ts_6, Ts_5 and Ts_2 significantly differed at P < 0.05 (Table 2). The minimum ascorbic acid content was observed in control, Ts_9, Ts_{10}, Ts_8 and Ts_7 and at the 190th day of storage. The overall results revealed that various concentrations of sucrose and antioxidant preservatives significantly (P<0.05) affected the ascorbic acid content of apricot fruit bars during storage.

Table 7. Effect of various food additives (sucrose, pectin, starch and preservatives) on total carotenoid (mg β-carotene/100g) content in apricot bars during ambient storage.

Treat	Storage (days)							Means
	0	30	60	90	120	150	180	
Ts_1	12.00lm	12.00lm	11.00mn	11.00mn	10.00no	10.00no	10.00no	16.14f
Ts_2	21.00cd	21.00cd	21.00cd	21.00cd	21.00cd	20.00de	20.00de	18.00ab
Ts_3	16.00hi	16.00hi	16.00hi	16.00hi	16.00hi	16.00hi	16.00hi	17.14de
Ts_4	10.00no	10.00no	9.00o	9.00o	9.00o	9.00o	6.00p	16.14f
Ts_5	20.00de	20.00de	19.00ef	19.00ef	19.00ef	19.00ef	18.00fg	17.86abc
Ts_6	22.00bc	22.00bc	22.00bc	22.00bc	21.00cd	21.00cd	21.00cd	18.00ab
Ts_7	17.00gh	17.00gh	17.00gh	17.00gh	17.00gh	16.00hi	16.00hi	17.29cde
Ts_8	18.00fg	18.00fg	18.00fg	18.00fg	18.00fg	17.00gh	17.00gh	17.43bcd
Ts_9	16.00hi	16.00hi	15.00ij	15.00ij	15.00ij	15.00ij	15.00ij	16.71ef
Ts_{10}	14.00jk	14.00jk	14.00jk	13.00kl	13.00kl	13.00kl	13.00kl	16.14f
Ts_{11}	24.00a	24.00a	23.00ab	23.00ab	23.00ab	23.00ab	22.00bc	18.29a
Ts_{12}	24.00a	24.00a	24.00a	24.00a	24.00a	24.00a	24.00a	18.29a
Means	22.83a	22.50a	18.75b	17.08c	16.25d	13.33e	10.25f	

LSD T= 0.61 S = 0.46 TS = 1.61

The values are means of three replication and the means having different letter (s) with in the same row are statistically significant at P<0.05.

The interaction means for treatments and storage also showed a partially significant pattern. The overall losses in ascorbic acid contents were 50% as compared to the first day data. Ascorbic acid is highly unstable in nature. Storage temperature affects the rate of loss of ascorbic acid. It has been established that the genotypic variations influence the amount of ascorbic acid during ambient storage (Munzurolgu *et al.,* 2003; Leccses *et al.,* 2007). The higher losses of ascorbic acid in the current study might be attributed to oxidation during drying and dehydration of apricot fruit bars.

Total phenolic contents

Total phenol content shown in Table 6 revealed a slightly decreasing trend during ambient storage. The mean values for treatments are significantly different from each other. Experimental results also showed that interaction means for treatment and storage also showed declining trend during storage. Among different treatments maximum total phenols were retained in Ts_{12} followed by Ts_{11}, Ts_6, Ts_5 and Ts_2 while minimum total phenol content was found in control followed by Ts_4, Ts_3, Ts_7, Ts_8, Ts_9, Ts_{10}, and Ts_7 (Table 10). The storage means were also found significantly different at P<0.05. The decreasing trend in total phenolic contents might be related to the oxidation during storage. Furthermore, enzymes are also liberated and start enzyme mediated browning reactions which are responsible for the depletion of phenolics, since these compounds are utilized as substrates (Ruangchakpet and Sajjaanantakul, 2007).

Fig. 1. Apricot bar preparation (Fresh).

Total carotenoid content

The obtained results for total carotenoids demonstrated a partially significant ($p<0.05$) differences among all treatments (Table 7) Total carotenoid decreased slightly among all treatments during ambient storage in apricot fruit bars. Maximum total carotenoid was observed in Ts_{12}, Ts_{11}, Ts_6 and Ts_5 followed by Ts_2 while the minimum was observed in Ts_1 followed by Ts_4, Ts_3, Ts_9, Ts_{10}, Ts_7 and Ts_8 respectively (Table 7). The initial values of total carotenoid declined very slightly with the advancement of storage.

Fig. 2. Apricot bar preparation (Dry).

Various treatments and storage intervals were found significantly different; however, maximum interaction means were non-significant. Carotenoids contents decreases with advancement of storage days as stated by de Regal *et al.* (2000). Carotenoids are responsible for different colors of fruits. Their partial decomposition releases several volatiles and aromatic compounds of nutritional and industrial importance (Uejono and Pastore, 2010; Bureau *et al.*, 2009).

The decreasing pattern in total carotenoid for all the treatments is related to oxidation of carotenoid that resulted in to faded color (Katayama *et al.*, 1971). Carotenoids have been shown stable in their natural environment; however they are labile to postharvest handling and processing (De Regal *et al.*, 2000). The results of the present study revealed that higher sucrose concentrations and antioxidant preservatives maintained higher carotenoid contents. The losses of total carotenoid content might be due to low permeability during ambient storage of apricot fruit bars that resulted in to rising of humidity and temperature inside the packaging as well as oxidation and tissue browning due to enzymes. Anurag *et al.* (2013) also established the fact that carotenoid in apricots bars decreases during ambient storage.

Conclusion

This research endeavor was undertaken to develop a shelf stable intermediate moisture product to utilize the abundant fruit of Gilgit-Baltistan. The theme was to economize the local fruit resources and offer a choice to the consumers to get health products in off seasons with optimum nutritional benefits. The results demonstrated that sucrose combination with antioxidant preservatives significantly retained functional components of the product for six months at ambient storage. It is concluded that apricot fruit bar offers a best option for entrepreneurs in developing rich nutritional fruit bars for improving the economy of the farming communities by utilize the fruit in to saleable commodity.

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