Research Article

Addition of Spinach Enhanced the Nutritional Profile of Apricot Based Snack Bars

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Abstract | Fruit based products are major part of healthy diet ever since human life began on earth. Now a day, consumers prefer ready to eat and convenient food. Food bars are healthy nutritious, small meals having sensory attributes as well. In the present study, apricot based snack bars were prepared with spinach powder addition to enhance micronutrient status of snack food bars. Four treatments were prepared by increasing the level of spinach in apricot bars and storage was done up to 3 months. Moisture and sugar content decreased with storage time while ash and fiber contents remained same during storage. The mineral and ash contents increased significantly ($p < 0.05$) among the treatments. Total sugars ranged from 64.77% to 67.29%. Reducing sugars were high than non-reducing sugars. It has been concluded that the addition of spinach has positive effect on acceptability and nutritional value of bars.

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Introduction

Food bars are considered as snack food with good sensory and nutritional characteristics due to their high content of proteins, carbohydrates, vitamins and minerals (Esteve et al., 2000). These bars contain different fruits, cereals and legumes as a major ingredient along with nuts, chocolate coatings or chips (Esteve et al., 2000). Fruit bar is a concentrated fruit product with good nutritive value. It is classified as a confectionary product with longer shelf life. It can be prepared by blending or mixing of fresh fruits, pulp/puree from ripe fruits or previously preserved nutritive fruits. Other appropriate ingredients such as nuts, sweeteners, butter or milk solids are added to form sheet which we use to make desirable size and shape of bars. They are manufactured hygienically, are attractively packed and are easy to transport (Parimita and Arora, 2015).

There are many ways of preserving fruits and making fruit bars is one such method. fruit bar is one of the processed products which are thick, pleasant and concentrated product made from fruit pulp having high calorie and rich source of the vitamins and minerals. Food can be fortified with nutrients either in powder or liquid form and the nutrients addition must impart desirable characteristics to the food i.e. change in color, taste, smell, texture and increase shelf life (Parekh et al., 2014). Apricot (*Prunus armeniaca*

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L.) is a native to Central Asia. It is one of the most delicious temperate fruit (Bhat et al., 2002). Besides of having striking color and typical flavor, apricots are also rich source of carbohydrates and minerals (Ghorpade et al., 1995). The major sugars such as sucrose, glucose, fructose and citric acid are the principal constituents present in it (Lal et al., 1989). It is a good source of mineral but deficient in protein and fat same as other fruits. The fruits are rich source of vitamin A and also contain more carbohydrates, protein, phosphorus and niacin than majority of other common fruits. Nutritive value of fruits as reported includes carotene (617 mg/100g), carbohydrates (73.61%) and vitamin A 3600 IU (Teskey et al., 1972).

Pakistan produces apricots abundantly and their production stood at 238 thousand tons in 2008 (Anon, 2009). Apricots are used fresh, dried or in processed form (Haciseferogullari, 2007). One hundred grams of dried apricots provide 62.64g carbohydrates, 3.39g protein, 2.57g ash, 0.51g fat (Drougoudi et al., 2008). Apricot fruit contains carotene and lycopene pigments that can play important role in maintenance of human health as it has antipyretic, antiseptic, and ophthalmic properties, it can protect the heart and eyes, as well as disease fighting effects of fiber can prevent digestive condition called diverculosis (Ghasemnezhad et al., 2010).

Spinach *(Spinacia oleracea*) is one of the most important leafy green vegetable, which contains essential nutrients (Tandi and Bangira, 2004). It is being widely cultivated throughout the world. Modern nutritionists recommend spinach as the best source of iron and other minerals (Yadav et al., 2002; Tandi and Bangira, 2004). Spinach is not only rich source of minerals (iron, P, Ca, Mg, Na, K, Cu, Zn, Mn; it contains folic acid and other vitamins (A, E, K, C and B complex) too. Spinach benefits include its diuretic, detoxifying calming, coagulant, soothing, demulcent, laxative and other properties. This leafy vegetable can be used for preparing a variety of meals and very therapeutic spinach juice. Galla et al. (2017) conducted an experiment. Spinach leaves were dried in a cabinet tray dryer at 55 °C and ground to to obtain spinach powder (SP). People mainly use spinach leaves because of its characteristic green color and nutritional content such as vitamin C, carotenes, and minerals. Sheetal et al. (2009) studied bioavailability of minerals from leafy green vegetables. They found that minerals from spinach exhibited bioavailability more than >25%.

By keeping in mind importance of spinach, present study is planned to explicit the following objectives; to prepare apricot snack bar with spinach addition, to evaluate the chemical and microbial status of apricot spinach bars and to evaluate the impact of spinach on minerals status of apricot spinach bars.

Materials and Methods

The study was conducted at National Agriculture Research Center, Islamabad in the Food Science and Product Development Institute. Raw Material for the samples were collected from local market.

Procurement of raw material

Apricot, spinach, skim milk, coconut powder, peanuts, almonds, pistachio, chickpea, corn flour and brown sugar were purchased from local market of Islamabad.

Apricot paste preparation

Apricots were washed. Steam was given apricot for 30-40 minutes until they become soft in order to obtain the apricot paste, these were minced in mincing machine.

Preparation of other raw materials

Spinach was dried in hot air oven at 50°C and then ashing of dried spinach was done in muffle furnace. Nuts (almonds, pistachio, peanuts) were also crushed into minute pieces.

Procedure for development of apricot bars

After preparing the raw materials, all the ingredients (blanched spinach, corn flour, skim milk, almonds, pistachio, coconut powder, chickpea and brown sugar) were mixed with apricot paste properly and were material was transferred to cutting table. After this sheeting was done with the help of stainless-steel roller and were cut with cutter into bars of 3 cm width, 6 cm length and 1.5 cm height. Each bar of approximately 20±2 g was packed in polyethylene bag. All the ingredients in each treatment were in same quantity Figure 1. The formulation is given below in the Table 1. While treatment plan is given in Table 2.

Chemical analysis

Proximate analysis such as moisture, crude fiber and ash were examined by method described in (AACC, 1999). All experiments were performed in replicates.

Table 1: *Formulation of apricot bars.*

Ingredients	Quantity (g)
Apricot	500 g
Corn flour	100 g
Skim milk powder	50g
Chickpea	25 g
Almonds	15 g
Pistachio	15 g
Peanut	15 g

Table 2: *Research plan for apricot bars formation.*

Treatments	Spinach (ash) quantity/100g of apricot paste
T_o	Without
T_1	01g
T_2	02 g
T_3	04 g

Moisture determination by hot air oven

Cleaned moisture dishes were taken and dried in oven at 130°C for 30 minutes. Well-mixed sample (2-3g) were taken in moisture dishes and measured the weight. Moisture dishes were placed in hot air oven uncovered for 60 minutes at 130°C, drying period begins when oven temperature is at 130 °C. Samples were removed from oven and cover with lid then placed in a desiccator for cooling. sample were weighed again after reaching room temperature.

Moisture % = (initial weight – final weight/ weight of sample) ×100

Ash determination

Cleaned and desiccated crucibles (dry in oven at 130°C for 30 minutes) were taken and weighed soon after they reach room temperature. 2-3g of sample was taken in crucibles. Crucibles were placed in muffle furnace at 550°C. Samples were incinerated until light grey ash is obtained. (overnight). Crucibles were removed from furnace and cooled in a desiccator until they reach room temperature. Crucibles were weighed with ash accurately.

Ash % = (Weight after ashing –weight of crucible/ original weight of sample) ×100

Crude fiber

Crude fiber examined by treating samples with sodium hydroxide solution and 1.25% H2SO4. Then samples washed with hot water and ignited after filtration. The actual weight of sample was lost after ignition.

Brix and acidity determination

Total soluble solids (°Brix) was measured by Abbe refractometer. Titra table acidity was determined according to the standard method of AOAC (1999).

Sugars (Total sugars, reducing sugars and non-reducing sugars) determination

Total sugars, reducing sugars and non-reducing sugars were determined according to Lane and Eynon method No.935.64 given in AOAC.

Mineral analysis

Samples were ashed at 550 °C in furnace. Then digestion of dry ash was carried out by adding 6M HCL and 0.1M HNO_3 at equal ratio by placing crucibles on hot plates at 220°C for 20 to 30 mins. After dilution, mineral contents were measured by using atomic absorption spectrophotometric method according to AOAC.

Microbiological analysis

Total plate count (TPC) and yeast and mold count (Y and M) were determined according to method no. 42-11 and no. 42-50 of AACC.

Statistical analysis

The data obtained were analyzed statistically by using variance technique (ANOVA). Least significant Design used to evaluate the difference of means. The analysis done by statistics 9.0 software (Analytical software, Tallahassee, FL).

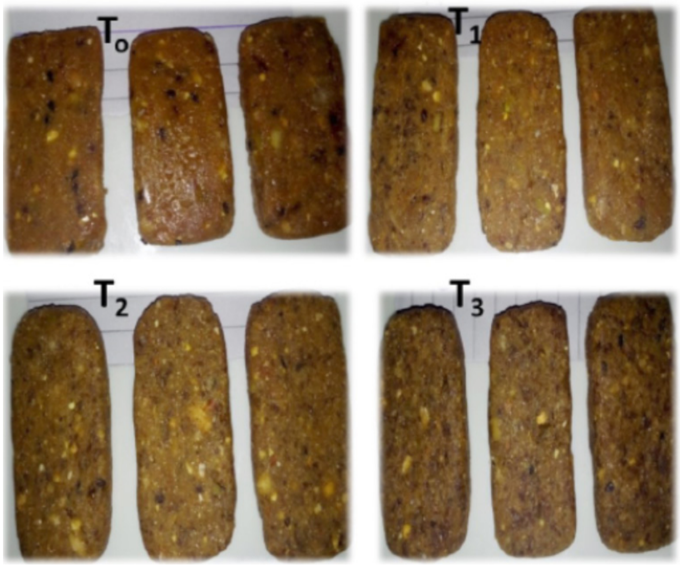

Figure 1: *T_0 (Apricot bars without addition of spinach); T_1 (Apricot bars with 1g spinach addition); T_2 (Apricot bars with 2g spinach addition); T_3 (Apricot bars with 3g spinach addition).*

Results and Discussion

Effect of different treatments on acidity (%)

Acidity of all samples was T_0 (4.1%), T_1 (4.2%), T_2 (4.0%) and T_3(3.9%) as shown in Figure 2. Our results are in line with findings of Parimita et al. (2015).

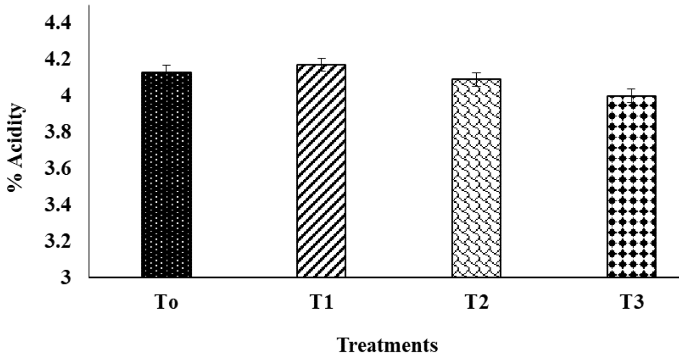

Figure 2: *Effect of treatments on the acidity (%); T_0 (Apricot bars without addition of spinach); T_1 (Apricot bars with 1g spinach addition); T_2 (Apricot bars with 2g spinach addition); T_3 (Apricot bars with 3g spinach addition).*

Effect of different treatments on moisture (%)

From results it was observed that moisture contents of bars at first day of storage was almost similar, there was no significant difference among treatments for moisture contents as shown in Table 3. The results of moisture content in apricot bars for 90 days were T_1(20.76%), T_2(22.75%), T_3(21.36%) and T_0 (20.69%). Moisture contents of bars at 90 day of storage was decreased as compared to freshly prepared bars. Decrease in moisture contents during storage may be due to moisture migration. Zahra et al. (2014) also found moisture contents in apricot bar which ranged from 11 to 16%. Difference in results might be due to change in apricot variety, bar composition and processing techniques. Amount of moisture is dependent on amount of dried apricot utilized. Our findings are in close agreement with results of Rehman et al. (2012).

Effect of different treatments on ash and fiber (%)

Ash contents increased significantly with increasing the concentrations of spinach ash in apricot Bars as shown in Table 3. Ash contents for zero days and 90 days' increases from T_o (3.08 ± 0.05) to T_3 (6.47 ± 0.08) with increasing the concentrations of spinach ash. Our findings are in close agreement with results of Zahra et al. (2014). There was no significant increase in fiber content was observed from T_0 to T_3. There was difference between all the treatments which is different percentage of spinach ash. Our findings are in close agreement with results of Munir et al. (2016). Increasing addition of spinach has shown good enhancement ash contents of apricot bars. Our findings are in close agreement with results of Galla et al. (2017) who prepared biscuits by using spinach as mineral source.

Effect of different treatments on total sugars and reducing sugars (%)

Initially the total sugars content of all samples was T_0 (67.29±1.09), T_1(65.08±1.12), T_2(64.51±1.70) andT_3(64.77±0.91) for 0 days as present in Table 3. It is clearly indicated from the results that there was a gradual decrease in total sugars contents for 0 days and 90 days. There was gradual increase in reducing sugars for both 0 and 90 days as shown in Table 3. Initially the content of all samples reducing sugar contents were T_0 (39.63±0.08), T_1 (39.00±1.01), T_2 (38.78± 0.92), T_3 (39.40±1.09) for 0 days. Our results are in line with Deepika et al. (2016). Sharma et al. (2013) also reported same decreasing trend of total sugars and increasing trend of reducing sugars in wild apricot fruit bars. This might be because of participation of sugars in Maillard reactions.

Microbial count of apricot bar

The mean values for TPC of apricot bars samples (Table 4) vary from 3.0±0.11a to 2.2±0.1 Log10 cfu/g. The maximum value was observed in T_0 (3.0±0.11Log10 cfu/g) and minimum was observed in T_3(2.2±0.1 log10 cfu/g). The results of this study are strengthened by the earlier findings of Al-Hooti et al. (1997) who observed that TPC significantly varied from 1.00 to 2.18 Log10 cfu/g in date bar samples. The mean values for mold count of apricot bars samples ranged from 2.1±0.9a to 1.4±0.10 Log10 cfu/g having the maximum count (2.1±0.9 Log10 cfu/g) for T_0 and minimum count (1.4±0.10a Log10 cfu/g) in T_3.

Effect of different treatments on minerals (%)

Apricot itself is rich source of trace elements but in this bars Amount of minerals contents are dependent on amount of spinach ash is utilized. It is clearly indicated from the results that there was a gradual increase in minerals contents with increasing concentration of spinach ash in bars and vice versa. Our findings are in close agreement with results of Rehman et al. (2012). Since poverty is the main cause of poor nutritional status, therefore, exploration of cheaper sources of natural Fe becomes very important in the management of micronutrient deficiency.

Table 3: *Physicochemical composition of apricot bar during storage.*

Components	Storage days	Treatments			
		T_0	T_1	T_2	T_3
Moisture (%)	0	23.10± 0.61a	22.37± 0.45a	23.28± 0.14a	23.39± 0.34a
	90	20.69± 0.13b	21.76± 0.31b	21.75± 1.01b	21.36± 0.52b
Ash (%)	0	3.08 ± 0.05g	3.88 ± 0.11e	5.44 ± 0.32c	6.47 ± 0.08a
	90	3.01 ± 0.10h	3.81 ± 0.12f	5.25 ± 0.14d	6.38 ± 0.11b
Fiber (%)	0	8.33± 0.10a	8.08± 0.12a	8.21± 0.04a	8.72± 0.38a
	90	8.20± 0.02b	8.00± 0.10b	8.15± 0.16b	8.14± 0.49b
Total Sugar (%)	0	67.29± 1.09a	65.08± 1.12a	64.51± 1.70a	64.77± 0.91a
	90	65.81± 1.38b	62.23± 1.03b	61.13± 0.89b	61.34± 1.01b
Reducing Sugar (%)	0	39.63± 0.08a	39.00± 1.01b	38.78 ± 0.92c	39.40 ± 1.09d
	90	41.15± 0.32e	42.46 ± 0.90f	41.33 ± 0.54ef	40.11 ± 0.74g

Values are mean ± standard deviation. T_0(Apricot bars without addition of spinach), T_1(Apricot bars with 1g spinach addition), T_2(Apricot bars with 2g spinach addition), T_3(Apricot bars with 3g spinach addition).

Table 4: *Mean values for total plate count and mold count (LOG_{10}cfu/g) of Snack bars.*

Treatment	TPC	Yeast and mold
T0	3.0±0.11[a]	2.1±0.9[a]
T_1	2.9±0.10[a]	1.9±0.10[a]
T_2	2.3±0.3[0]a	1.6±0.20[a]
$_T3$	2.2±0.10[a]	1.4±0.10[a]

T_0(Apricot bars without addition of spinach), T_1(Apricot bars with 1g spinach addition), T_2(Apricot bars with 2g spinach addition), T_3(Apricot bars with 3g spinach addition).

Iron is required to produce red blood cells (a process known as hematopoiesis), but it's also part of hemoglobin (that is the pigment of the red blood cells) binding to the oxygen and thus facilitating its transport from the lungs via the arteries to all cells throughout the body (Abbaspour et al., 2014). According to Dietary guidelines for Americans 2010, recommended dietary allowance of iron for children is 7mg and for adults 18 mg iron. Whereas, our bar findings suggest that T_0 (control treatment) contains 75.09±0.01ppm iron. T_1 showed 76.47±0.13ppm iron. T_2 showed significant result by having 86.11±0.32ppm iron. T_3 contains the 93.61±0.02ppm iron (Table 5). These results are also in accordance with findings of (Endes et al., 2015) who found gradual increase in iron contents among treatments in bread fortified with dried gojiberries. Zinc is a component of every living cell and plays a role in hundreds of bodily functions, from assisting in enzyme reactions to blood clotting, and is essential to taste, vision, and wound healing (Norman and Joseph, 2007). Our findings suggest that T_3 had (18.17±0.05ppm) and T_2 had 15.34±0.12ppm followed by T_1 containing 11.78±0.05ppm and T_0 had 10.77±0.02ppm. These findings are like findings of (Naozuka et al., 2011). Magnesium provides elasticity to prevent injury. Magnesium also works with calcium to assist in blood clotting, muscle contraction and the regulation of blood pressure (Norman and Hotchkiss, 2007). Significant concentration of Mg (2878.90± 0.13ppm) was found in T_3, followed by T_2 with 2287.34±0.42ppm and T_1 with 1746.93±0.59ppm (Table 5).

Manganese trace mineral is still crucial in assisting with bone formation and metabolic functions. T_3 had the highest value of manganese with 10.15±0.11ppm, followed by T_2 with 5.20± 0.01ppm. Lowest value of manganese was found in T_1 with 2.16± 0.02ppm. Similar trend has been reported by (Prakash and Gupta, 2005) who studied on the Nutritional and sensory quality of micronutrient-rich traditional products incorporated with green leafy vegetables. Calcium is needed to move muscles, clot blood and bone building. Recommendations for calcium intake vary with age. Adequate intake of calcium for adults is 1000 milligrams. (Norman and Hotchkiss, 2007). T_3 were being significant showed the highest level of calcium with 28.45±0.32ppm in apricot bar. Followed by T_2 with 27.48±0.05ppm and lowest were found in T_0 with 21.25±0.10ppm. Our results are in line with calcium contents of spinach powder on physio-chemical, rheological, nutritional and sensory characteristics of chapati premixes by (Shirpa et al., 2012). These results are in line with findings of Dachana et al. (2010) who studied that there is significant increase in mineral content of chapaties with incorporation of spinach powder.

Table 5: *Influence of spinach addition over various mineral content of apricot bar.*

Treatments	Minerals (ppm)							
	Fe	Zn	Mg	Mn	Ca	K	Na	P
T_o	75.09±0.01	10.77±0.02	1470.52±0.18	N/A	21.25±0.10	14916± 0.32	2333.30± 1.79	737.3248± 1.43
T_1	76.47±0.13	11.78±0.05	1746.93±0.59	2.16± 0.02	22.99±0.29	16249± 0.49	4416.60±1.32	804.9213± 1.08
T_2	86.11±0.32	15.34±0.12	2287.34±0.42	5.20± 0.01	27.48±0.05	20666± 0.77	8583.29± 0.78	957.0135± 0.98
T_3	93.61±0.02	18.17±0.05	2878.90± 0.13	10.15±0.11	28.45±0.32	18083± 0.89	8416.63± 0.91	990.8118± 1.32

Values are mean ± standard deviation. T_0 (Apricot bars without addition of spinach), T_1 (Apricot bars with 1g spinach addition), T_2 (Apricot bars with 2g spinach addition), T_3 (Apricot bars with 3g spinach addition).

Conclusions and Recommendations

This study showed that with addition of spinach powder we improve status of micronutrients in bars. Apricot itself is valuable fruit with lots of health benefits. Because of mineral contents with a delicious sweet taste, these novel apricot bars would be attractive for consumers as alternative to conventional snacks available in the market. Economical raw material and easy manufacturing method would boost and motivate the food manufacturers and farmers for cottage as well as international industry.

Author's Contribution

Masooma Munir and Muhammad Nadeem gave idea of study. Asra Gull and Ahad Khan performed experiments in labs. Nouman Rashid Siddique, Amer Mumtaz, Naeem Safdar supervised experiments in labs and arranged the data. Masooma Munir and Aqsa Qayyum wrote the manuscript. Barkat Ali added his inputs in reviewing the manuscript.

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