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Shelf stable iron fortified fruit bar's development, proximate estimation and organoleptic characterization

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Abstract

No bake, vegan, easy to develop, shelf stable and convenience food "Fruit bars" are an excellent vehicle to provide nutrients especially iron as well as energy to its consumers. Eight treatments of fruit bars fortified with alternative ratio of indigenous iron fortificants (spearmint and apricot kernel) were developed with incorporation of (dried apricot, quince fruit paste, barley flour, dried milk powder) along with placebo and synthetic iron fortified fruit bars. Product was analyzed for proximate composition and Fe, for shelf stability water activity and free fatty acids were done, while were finally statistically analyzed after organoleptic judgment. Apricot kernel and spearmint had Fe 29.62 ± 0.47 and 87.32 ± 0.71 mg/ 100 g. During the storage study of 60 days, the Fe followed a non-significantly decreasing trend in all treatments. Ash content (%) was maximum in T_2 followed by T_1. Maximum Fe was determined in T_3. At 0th day in all treatments NFE content ranged from 56.05 to 60.17, moisture content ranged from 11.00 to 25.93, and ash content ranged from 2.96 to 4.07 %. Except moisture content all nutritional contents were non-significant during storage of 60 days. Water activity ranged within safe range of water activity for foods while free fatty acid ranged from 0.047 to 0.079 % in storage. T_3 was termed as best treatment after organoleptic evaluation. These fortified bars if developed commercially will be an exclusive solution to mitigate iron deficiency.

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Introduction

Food/fruit/cereal bars/granola/leathers are reflected as snacking commodities having decent sensory and nutritional features because of elevated content of proteinuos matter, nitrogen free extract, minerals and vitamins (Estevez *et al.*, 2000). Different fruits are being processed to formulate fruit bars, which are ready to use, and attract all age groups to meet their energy and protein needs (Nanjundaswamy *et al.*, 1976). Dried apricot is high in bioavailable active phytonutrients that have assured parts in the biological system and prevent oxidative stresses (Leccese *et al.*, 2011). It has a realistic level of dietary fiber from 1.5-2.4 g/100 g (Ali *et al.*, 2011). It comprise diverse level of vital minerals, main elements are K, P, Ca, Mg and Se (Munzuroglu *et al.*, 2003; Ali *et al.*, 2011). On the other hands, Na, Mn, Zn and Cu are also found in minute amounts (Lichou *et al.*, 2003; USDA, 2010). Likewise, multivitamins present in apricot's flesh are water soluble like A, C, K, E and B-complex. Apricot holds organic acids i.e. citric and malic acid are 30 to 50 mg/100 g and 500 to 900 mg/100 g, respectively (Gurrieri *et al.*, 2001). Femenia *et al.* (1995) study stated that apricot kernel consists of proteins, 11 albumin globulin, prolamin and glutelin 84.7 %, 7.65 %, 1.17 % and 3.54 %. 32 to 34 % of essential amino acids. Content of carbohydrate in kernel of apricot is 25.5 % (w/w) (20), 17.3% (6), and 18.1–27.9% (Kamel and Kakuda, 1992). Spearmint is also renowned for its memory enhancement capability (Adsersen *et al.*, 2006). In addition to being a sedative (Papachristos and Stamopoulos, 2002), it has various biochemical applications, for example as pesticide (Samarth and Kumar, 2003), antimicrobial (Ozgen *et al.*, 2006), antioxidant (Choudhury *et al.*, 2006), antispasmodic, and anti-platelet (Tognolini *et al.*, 2006).

Rasheed *et al.* (2018) investigated that quince pulp had the following characteristics: pH (3.43), total soluble solids (14.22 ° Brix), acidity (1.25 %), while nitrogen free extract (13.38), reducing sugar (5.15), non-reducing sugar (4.61), moisture-content (84.27), mineral ashes (0.62), lipids (0.24), proteineous matter (0.49), fiberous substances (1.65) in grams / 100 grams, alongwith vitamin C (15.46 mg), and total phenolic (68.13 mg gallic acid equivalent) per 100 grams and antioxidant activity (50.05 %).

Din (2009) concluded that barley has 7.01 % fiber, 12.5 % proteinous matter, 2.32 % mineral contents in ash form, 79 % carbohydrates calculated as nitrogen free extract and a verly less quantity of lipids 2.5 %. Because of vast health and nutritional benefits barley has found its addition to different products in form of fermented as wells non-fermented barley. It is being used in baking biscuits, cookies (Erkan *et al.*, 2006).

Keeping in view the literature on fortification of Fe, apricot kernels and spearmint were used as fortificants, while barley, quince and dried apricot were used as energy providers as well as strengthening the formulation of bar.

Materials and methods

Preparation of raw-material

The apricot kernels, dried apricots, preserved quince fruit, spearmint were separately ground, pasted and powdered, respectively. Barley was roasted and ground to flour. The prepared raw materials were packed separately in coded BOP bags and kept safe in plastic containments at ambient storage temperature till advance processing. Ferrous Sulphate (Cat # F8263-SIGMA, from Sigma-Aldrich, U.S.A.) and other food grade chemicals for analyses were acquired from Shahid Scientific Stores, Faisalabad, Punjab-Pakistan.

Preparation of treatments

For development of T_0 and T_1 dried apricot paste was taken according to recipe, dried milk powder was added to make the consistency of bars, synthetic fortificant for T_1 treatment was added according to Table 1. Indigenous Fe fortified fruit bars (T_2-T_{10}) were developed by following method given by (Zahra *et al.*, 2014) with slight alterations to dimensions of bars, fixed ingredients (Dried apricot paste, quince fruit and barley flour) and variable ingredients (spearmint and apricot kernel) were used according to treatment plan. Prepared ingredients were blended thoroughly in Csrex 120 Quarts Kitchen Equipment Commercial Spiral Kneader (Model: CS-M25, Qingdao, Shandong, China) to get evenly dispersed ingredients in dough, milk powder was added just to make required consistency while processing sheeting, cutting and packaging of the fruit bars. After blending, dough was divided into medium sized balls and then turned into sheets by rollers on sheeting table; bars of 2-3 cm width and 5.5-6.5 cm were lengthwise sliced from sheet of dough. Each bar consisted approximately 25-26 g. Bars were then packed and refrigerated.

In indigenous Fe fortified fruit bars, quince fruit preserve paste, dried apricot paste and roasted barley flour was added to provide texture, strength and energy dense nutrients to fruit bars.

Evaluation of raw materials and treatments

The proximate and iron content analyses of raw materials were carried out at just 0th day, placebo and Fe-fortified fruit bars were analyzed for proximate composition, minerals profile, calorific values, sensory characteristics and storage stability at baseline and interval of 15 days till completion of sixty days.

Storage stability

All the treatments were analyzed for proximate composition, Fe-content, gross energy value and organoletic parameters, free fatty acids and water activity at the 15 days interval for two months of storage at room temperature by their respective methods as described earlier.

Proximate composition

Moisture content

Moisture content of the treatments were determined through Forced Air Draft Oven (Model: DO-1-30102, PCSIR, Pakistan) at 102 ± 7 °C following the method no. 44- 15 A as given in AACC (2000).

Crude proteinous matter

For crude proteinous matter estimation, nitrogen contained in the treatments was analysed through Kjeltec (Model: D-40599, Beh Labor Tecknick, GmbH Germany) 54 following method no. 46-10 as reported in AACC (2000) and crude proteinous matter was determined by multiplying nitrogen value with constant factor of 6.25.

Crude fat content

The crude fat of treatments was analysed through Soxtec (Model: H-2 1045 Extraction unit, Hoganas, Sweden) following method no. 30-10 as given in AACC (2000).

Crude fiber content

Defatted treatments were heated with 1.25 % H_2SO_4 for 30 minutes and then with 1.25 % NaOH in the same way. Fiber content was analysed through Labconco Fibertec (Labconco Corporation Kansas, USA) by method no. 32-10 as reported in AACC (2000).

Ash content

The treatments were charred on flame until smoke free and ash content was quantified through muffle furnace (MF-1/02, PCSIR, and Pakistan) at 550 ± 5 °C by Method No. 08-01 as given in AACC (2000).

Nitrogen free extract

The Nitrogen free extract of treatments was calculated by this formula as reported in AACC (2000).

NFE (%) = 100 - (Σ % crude proteinous matter, % crude fat content, % crude fiber content and % ash content).

Determination of Fe

Mineral like Fe in all the treatments was considered to study during storage so quantified through AOAC Method No. 985. 35 (AOAC, 2005). Flame used for Fe, K, Na, Mg and Zn was oxidiizing air-C_2H_2 and absorbance wavelength used was 248.3.

Gross energy of treatments

The extent of heat released during the complete oxidation of a commodity is its gross energy value.

Testing samples were imperiled to Oxygen Bomb Calorimeter (Model: 1341, Parr Instrument Company, Werke IKA). Gross energy value of was quantified as reported by Krishna and Rajhan (1981).

Organoleptic investigation

Organoleptic investigation of treatments for color, appearance, flavor, texture, taste and overall acceptability was piloted at intervals of 15 days for 2 months of storage by panel of proficient judges through 9-point hedonic scale as explained by Meilgaard *et al.* (2006).

Water activity (aw)

Water activity in fruit bars was determined by the standard water activity meter method (AOAC, 2005) using an electronic hygropalm water activity meter (Model. AwWin, Rotronic, equipped with a Karl-Fast probe).

Free fatty acid determination

Fruit bar samples were analyzed for free fatty acid values during storage using the procedure described in method no. 940.28 AOAC (2005). The free fatty acids were expressed as oleic acid by using the following expression:

1mL 0.1N NaOH = 0.028g oleic acid.

Results and discussion

Chemical analyses of ingredients

Maximum content of moisture was present in preserved quince fruit pulp and dried apricot while minimum moisture was in dry milk powder. Maximum ash (21.9 ± 1.35 %) and fiber 29.78 ± 0.07 % were found in spearmint powder. Maximum protein and fat content were as 23.27 ± 0.34, 49.05 ± 0.20 % in apricot kernel while it contained ash content as 2.58 ± 0.78 %. Maximum NFE 69.06 ± 0.28 % was present in roasted barley flour as presented in Table 2.

Table 1. Treatment plan of Fe fortified fruit bars (100 g).

Trts.	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
$FeSO_4.7H_2O$(g)	0.09	-	-	-	-	-	-	-	-	-	-
SP (g)		-	10.00	7.50	10	5	5	7.50	3.96	7.50	11.03
AK (g)		-	30	25	20	20	30	17.92	25	32.07	25

Minimally 50 % RDA – Fe of adult females (18mg/day) should be met in intervention as per FAO/WHO Food Fortification Guidelines

SP = Spearmint AK = Apricot Kernel

To (Dried apricot and Dried milk powder),

T_1 (Dried apricot, Dried milk powder and $FeSO_4.7H_2O$-EDTA),

T_2 - T_{10} (Fixed ingredients (Dried apricot, Quince fruit and Barley flour), variable ingredients used according to treatment plan (SP and AK) and dried milk powder was added to adjust consistency).

Elemental investigation for iron in raw material as depicted in Table 3, revealed that iron content in apricot kernel and spearmint powder was 29.62 ± 0.47 and 87.32 ± 0.71 mg/ 100 g, respectively.

Rehman *et al.* (2012) explicitly reported composition nutrition wise for dried apricots and indicated that apricots contained 23.3, 4.17, 0.65, 8.21, 4.30 and 59.37 % moisture content, crude proteineous matter, crude fat and fiber, ash (minerals) and NFE (carbs.), respectively. The results of proximate nutrient content of dried apricot are consistent with previous findings retrieved from nutritional database as (USDA, 2010) explicated that dried apricots consist of 62.64, 30.89, 2.57, 3.39 and 0.61 g carbohydrates, moisture, ash, protein and fat per 100 g. Nutritional composition could be 71 varied due to hybrid, nutrient composition of ground in which grown and environmental conditions. Rasheed *et al.* (2018) examined the pulp of quince fruit picked from various locations in AJK and reported results such as carbohydrate (13.38), ash (0.62), (84.27) moisture, (0.24) fat, while protein (0.49) and fiber (1.65) g/ 100 g.

Table 2. Mean values for proximate composition of raw materials.

Raw Material	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Ash (%)	NFE (%)
AK	6.11 ± 0.13^{D}	23.27 ± 0.34^{A}	49.05 ± 0.20^{A}	3.13 ± 0.29^{E}	2.58 ± 0.78^{B}	15.37 ± 0.69^{E}
BF	11.02 ± 0.09^{C}	9.24 ± 0.30^{D}	0 ± 0^{E}	9.99 ± 0.09^{B}	0.90 ± 0.001^{C}	69.06 ± 0.28^{A}
DA	29.63 ± 0.44^{B}	2.5 ± 0.27^{E}	0 ± 0^{E}	7.31 ± 0.33^{D}	2.67 ± 0.57^{B}	59.59 ± 0.59^{B}
DMP	2 ± 0.2^{E}	19.23 ± 0.27^{C}	18.19 ± 0.29^{B}	0 ± 0^{F}	0.016 ± 0.001^{D}	59.22 ± 0.69^{B}
QFP	56.43 ± 0.45^{A}	1.48 ± 0.04^{F}	0.317 ± 0.015^{D}	7.75 ± 0.09^{C}	0.002 ± 0.001^{D}	33.5 ± 0.54^{D}
SP	11.2 ± 0.22^{C}	19.81 ± 0.14^{B}	6.06 ± 0.192^{C}	29.78 ± 0.07^{A}	21.9 ± 1.35^{A}	51.99 ± 0.23^{C}

Means with different letters in each column differs highly significantly at P<0.01

Mean ± SD, SD = Standard deviation

AK = Apricot Kernel, DMP = Dried Milk Powder

BF = Barley Flour, QFP = Quince Fruit Paste

DA = Dried Apricot, SP = Spearmint.

According to the USDA Nutrient Database (USDA, 2008), dried spearmint contains 19.93, 6.03 and 29.8 % protein, fat and fiber, while minerals like Ca 1488, iron 87, 47, magnesium 602, potassium 1924, sodium 344 and zinc 2.41 (mg/ 100 g). Sangwan *et al.* (2012) explored leaves of mint in powdered form dried by 4 types of methods *viz.* under-shade, solar drying, microwave and oven reported that moisture was 2.66, 2.40, 2.56 and 2.48 %, respectively. Protein content and crude fibre content ranged from 18.85 to 19.79 % and 7.78 to 8.21 % in oven and under-shade dried powder of mint leaves. Fat and ash content of shade, solar, oven and microwave dried mint leaves powder ranged from 0.59 to 0.81 and 10.95 to 11.41 %, respectively. The total iron and copper content of spearmint leaves powder dried by employing all four methods ranged from 44.68 to 45.77 and 0.88 to 0.97 mg/ 100 g, respectively.100 g of apricot kernels in ground form contains approximately 16.04 g of protein,4.29 g of fiber, 57.12 g of fat and 22.55 g of carbohydrates (Abdel-Rehman *et al.*, 2011).Alijošius *et al.* (2016) explored different varieties of barley for proximate composition and crude protein fat and fiber, NFE and ash were reported ranging from 10.35 to 11.68, 1.33 to 2.00, 3.57 to 5.12, 65.45 to 69.08 and 1.94 to 2.09 %.

Table 3. Mean values for Fe content in raw materials.

Raw Material	Fe Content (mg/ 100g)
AK	29.62 ± 0.47^{B}
BF	1.89 ± 0.08^{C}
DA	0 ± 0^{D}
DMP	0 ± 0^{D}
QFP	0.62 ± 0.07^{D}
SP	87.32 ± 0.71^{A}

Means with different letters in each column differs highly significantly at P<0.01

Mean ± SD, SD = Standard deviation

AK = Apricot Kernel, DMP = Dried Milk Powder

BF = Barley Flour, QFP = Quince Fruit Paste

DA = Dried Apricot, SP = Spearmint.

Proximate composition of fruit bars

Moisture content

In all treatments initial moisture content ranged from 11.00 ± 0.05 to 25.93 ± 0.13 %. During the storage study of 60 days, the moisture content followed a significantly decreasing trend in all treatments. Maximum moisture content was found in T_0 which decreased from 25.93 ± 0.13 to 24.99 ± 0.00 %, in T_1 moisture content decreased from 24.63 ± 0.02 to 24.24 ± 0.09 % in T_3 it decreased from 13.50 ± 0.08

to 12.20 ± 0.09 %, while the minimum moisture content was in T_9 which decreased from 11 to 9.0 %, as shown in Table 4.

In T_0 and T_1, moisture content was high because both treatments were entirely prepared from about 90 gram of dried apricot as milk powder was added to adjust consistency of bars. While moisture content was slightly lower in all remaining treatments due to addition of natural dried fortificants spearmint powder and apricot kernel, as well as barley flour used to give palatabilty to bars.

Table 4. Effect of treatments and storage on moisture content (%) of fruit bars.

Treatments	Days					Means±SD
	0	15	30	45	60	
T_0	25.93±0.13^{a}	25.65±0.08^{ab}	25.47±0.15^{bc}	25.20±0.06^{cd}	24.99±0.00^{d}	25.45±0.10^{A}
T_1	24.63±0.02^{e}	24.48±0.12^{ef}	24.28±0.10^{fg}	24.01±0.01^{gh}	23.82±0.10^{h}	24.24±0.09^{B}
T_2	11.40±0.03st	11.10±0.00^{tu}	10.87±0.04^{uvw}	10.60±0.08^{wx}	10.30±0.05^{xy}	10.85±0.10^{I}
T_3	13.50±0.08^{i}	13.20±0.02^{ij}	12.90±0.03^{jk}	12.50±0.01^{lmn}	12.20±0.09^{nop}	12.86±0.13^{C}
T_4	12.50±0.04^{lmn}	12.20±0.03^{nop}	11.80±0.07^{qr}	11.40±0.02st	11.10±0.05^{tu}	11.80±0.14^{F}
T_5	13.50±0.01^{i}	13.20±0.08^{ij}	12.80±0.03^{kl}	12.50±0.02^{lmn}	12.10±0.02^{opq}	12.82±0.13^{C}
T_6	12.50±0.05^{lmn}	11.70±0.03^{rs}	11.39±0.01st	11.10±0.04^{tu}	10.90±0.01^{uvw}	11.52±0.15^{H}
T_7	13.00±0.06^{jk}	12.70±0.05^{klm}	12.30±0.04^{nop}	12.00±0.07^{pqr}	11.80±0.05^{qr}	12.36±0.12^{D}
T_8	12.00±0.03^{pqr}	12.20±0.07^{nop}	11.70±0.07^{rs}	11.40±0.02st	11.10±0.04^{tu}	11.68±0.11^{G}
T_9	11.00±0.05^{uv}	10.70±0.04^{vw}	10.30±0.02^{xy}	10.00±0.02^{yz}	9.80±0.02^{z}	10.36±0.12^{J}
T_{10}	12.70±0.00^{klm}	12.40±0.07^{mno}	12.00±0.07^{pqr}	11.70±0.06^{rs}	11.40±0.06st	12.04±0.13^{E}
Means±SD	14.79±0.89^{A}	14.50±0.89^{B}	14.16±0.90^{C}	13.86±0.91^{D}	13.59±0.91^{E}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

$T_2 - T_{10}$ (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Yousif and Alghamdi (2001) reported similar results: 12.3 % moisture was found, which declined to 10.3 % by 120 days of conservation in bars developed by using the variety of date "Rezeiz". Similar results were documented by Estevez *et al.* (1995) who identified that throughout storage at ambient temperature, moisture dropped from 13.9 to 10.2 % in bars made from combination of nuts and cereals. Ahmed *et al.* (2005) found that throughout storage, the water content of bars formed by papaya varied significantly from 21.1 to 19.66 %, which is compliant with the outcomes of this research. The results of moisture content are also compatible with the report of Kamran *et al.* (2008), who noted that moisture content throughout shelflife study in mango slices dropped from 6.75 to 5.69 percent in 6 months. As supported there was a steady declining trend in all fruit bars listed by Bhatt and Jha (2015), which may have been due to the evaporation of moisture from the bars throughout the storage research. It was not even necessary to add moisture-fixing chemicals to the bars. Nadeem *et al.* (2018) recorded comparable findings in moisture reduction during shelf-life study of bars produced from roasted maize flour (17.34 to 16.36 %) and chickpea flour (19.78 to 18.19 %) and mixed flour (17.11 to 16.18 %). Kumar *et al.* (2017) had prepared fruit bars with pulp of guava and papaya and found the highest moisture content in T_1 (15.05 to 15.02 %) bar and the lowest moisture content in T_5 (14.99 to 14.96 %) in 60 days shelf-life study. There was a slight decrease in moisture during storage, regardless of pulp's mixing ratio. The results of both studies resembled results on leather made from guava by Safdar *et al.* (2014).

Table 5. Effect of treatments and storage on fat content (%) of fruit bars.

Treatments	Days					Means±SD
	0	15	30	45	60	
T_0	1.23±0.05^{h}	1.23±0.06^{h}	1.23±0.03^{h}	1.22±0.07^{h}	1.22±0.05^{h}	1.22±0.05^{G}
T_1	1.23±0.04^{h}	1.22±0.04^{h}	1.22±0.05^{h}	1.22±0.03^{h}	1.21±0.03^{h}	1.22±0.03^{G}
T_2	12±0.68^{efg}	11.96±0.31^{efg}	11.95±0.25^{efg}	11.93±0.16^{efg}	11.91±0.42^{efg}	11.95±0.35^{E}
T_3	15±0.46^{a}	14.96±0.61^{a}	14.93±0.38^{a}	14.86±0.88^{a}	14.85±0.68^{a}	14.92±0.53^{A}
T_4	12.71±0.3^{bcde}	12.7±0.68^{bcde}	12.69±0.71^{bcde}	12.61±0.63^{bcde}	12.59±0.6^{bcde}	12.66±0.51^{CD}
T_5	14±0.48^{ab}	13.93±0.33^{ab}	13.92±0.18^{ab}	13.85±0.54^{abc}	13.81±0.47^{abcd}	13.9±0.36^{B}
T_6	12.5±0.63^{cde}	12.43±0.59^{de}	12.39±0.37^{ef}	12.39±0.36^{ef}	12.38±0.4^{ef}	12.42±0.41^{DE}
T_7	13.13±0.16^{bcde}	13.07±0.48^{bcde}	13.05±0.14^{bcde}	12.98±0.2^{bcde}	12.97±0.27^{bcde}	13.04±0.24^{C}
T_8	12.2±0.59^{efg}	12.19±0.15^{efg}	12.15±0.52^{efg}	12.13±0.29^{efg}	12.13±0.44^{efg}	12.16±0.36^{E}
T_9	10.99±0.41^{fg}	10.98±0.37^{fg}	10.92±0.36^{g}	10.9±0.27^{g}	10.88±0.29^{g}	10.94±0.3^{F}
T_{10}	13±0.55^{bcde}	12.98±0.16^{bcde}	12.96±0.36^{bcde}	12.75±0.42^{bcde}	12.73±0.59^{bcde}	12.88±0.39^{CD}
Mean±SD	10.73±4.67^{A}	10.7±4.65^{A}	10.67±4.64^{A}	10.62±4.62^{A}	10.61±4.62^{A}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Kourany *et al.* (2017) explained their research on protein-enriched mango fruit bars, for six months storage stability, the moisture level decreased from 17.09 to 16.17 %, results similar to those of Munir *et al.* (2016). Aguayo *et al.* (2003) noted that fresh Amarillo cut-melon was placed in modified atmospheric packaging (MAP) at 5 °C for 2 weeks, such as microperforated polypropylene (MPP), biorented polypropylene (BOPP) and oriented polypropylene (OPP) and a smallest weight loss of (0.02 %) in BOPP and OPP packaging was revealed.

Table 6. Effect of treatments and storage on protein content (%) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	6.64±0.2^{a}	6.64±0.09^{a}	6.62±0.24^{a}	6.61±0.22^{a}	6.6±0.12^{a}	6.62±0.16^{A}
T_1	6.31±0.17^{a}	6.28±0.26^{a}	6.26±0.2^{a}	6.24±0.2^{a}	6.21±0.14^{a}	6.26±0.17^{B}
T_2	2.91±0.1^{efgh}	2.9±0.15^{efgh}	2.9±0.05^{efgh}	2.89±0.09^{efgh}	2.88±0.15^{efgh}	2.9±0.1^{H}
T_3	5.51±0.12^{b}	5.49±0.22^{b}	5.48±0.12^{b}	5.46±0.12^{b}	5.46±0.11^{b}	5.48±0.13^{C}
T_4	3.51±0.12^{d}	3.49±0.1^{d}	3.47±0.08^{d}	3.45±0.14^{d}	3.44±0.26^{d}	3.47±0.1^{F}
T_5	4.65±0.18^{c}	4.63±0.23^{c}	4.62±0.18^{c}	4.59±0.18^{c}	4.57±0.07^{c}	4.61±0.18^{D}
T_6	3.25±0.15^{de}	3.25±0.14^{de}	3.24±0.1^{de}	3.23±0.05^{def}	3.22±0.24^{defg}	3.24±0.09^{G}
T_7	4.37±0.12^{c}	4.36±0.1^{c}	4.34±0.15^{c}	4.33±0.21^{c}	4.31±0.13^{c}	4.34±0.15^{E}
T_8	3.21±0.09^{defgh}	3.19±0.16^{defgh}	3.19±0.08^{defgh}	3.18±0.07^{defgh}	3.17±0.03^{defgh}	3.19±0.1^{G}
T_9	2.72±0.11^{fgh}	2.71±0.06^{gh}	2.72±0.06^{gh}	2.71±0.09^{h}	2.71±0.15^{h}	2.71±0.06^{I}
T_{10}	4.31±0.18^{c}	4.3±0.07^{c}	4.3±0.19^{c}	4.28±0.17^{c}	4.27±0^{c}	4.29±0.13^{E}
Mean±SD	4.31±1.32^{A}	4.3±1.32^{A}	4.28±1.31^{A}	4.27±1.31^{A}	4.26±1.31^{A}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Fat content

Fat content followed decreasing trend in 60 days as as displayed in Table 5. Highest fat content was in T_3 and T_5 which decreased from 15.00 ± 0.26 to 14.85 ± 0.39 % and 14.00 ± 0.82 to 13.81 ± 0.27 %. While the minimal fat content was obtained in T_0 and T_1 as 1.23 ± 0.02 and 1.23 ± 0.03 % which decreased to 1.21 ± 0.02 and 1.22 ± 0.03 % over storage interval of 60 days. In T_9 fat content decreased from 10.99 ± 0.24 to 10.88 ± 0.17 % while in T_2 fat content decreased from 12.00 ± 0.39 to 11.91 ± 0.24 %.

Table 7. Effect of treatments and storage on fiber content (%) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	$6.33±0.1^{fgh}$	$6.33±0.24^{fgh}$	$6.34±0.26^{fg}$	$6.36±0.21^{fg}$	$6.37±0.18^{f}$	$6.35±0.17^{G}$
T_1	$6.29±0.28^{fghijk}$	$6.31±0.23^{fghij}$	$6.32±0.21^{fghi}$	$6.35±0.33^{fg}$	$6.37±0.16^{f}$	$6.33±0.21^{G}$
T_2	$6.57±0.12^{f}$	$6.62±0.17^{f}$	$6.64±0.19^{f}$	$6.67±0.34^{f}$	$6.68±0.14^{f}$	$6.64±0.18^{G}$
T_3	$11.23±0.37^{a}$	$11.23±0.25^{a}$	$11.27±0.56^{a}$	$11.28±0.46^{a}$	$11.31±0.51^{a}$	$11.26±0.38^{A}$
T_4	$7.88±0.4^{de}$	$7.92±0.37^{de}$	$7.93±0.1^{de}$	$7.96±0.25^{de}$	$8.01±0.43^{de}$	$7.94±0.28^{E}$
T_5	$10.54±0.43^{ab}$	$10.59±0.5^{a}$	$10.67±0.37^{a}$	$10.69±0.12^{a}$	$10.7±0.28^{a}$	$10.64±0.31^{B}$
T_6	$7.23±0.17^{ef}$	$7.26±0.34^{ef}$	$7.27±0.2^{ef}$	$7.3±0.43^{ef}$	$7.33±0.18^{ef}$	$7.28±0.24^{F}$
T_7	$9.47±0.47^{c}$	$9.5±0.27^{c}$	$9.5±0.47^{bc}$	$9.52±0.32^{bc}$	$9.54±0.5^{bc}$	$9.51±0.35^{C}$
T_8	$7.23±0.33^{ef}$	$7.24±0.09^{ef}$	$7.24±0.28^{ef}$	$7.26±0.24^{ef}$	$7.27±0.12^{ef}$	$7.25±0.19^{F}$
T_9	$5.26±0.14^{k}$	$5.27±0.05^{jk}$	$5.29±0.1^{ijk}$	$5.3±0.12^{hijk}$	$5.33±0.12^{ghijk}$	$5.29±0.1^{H}$
T_{10}	$8.57±0.34^{cd}$	$8.58±0.49^{cd}$	$8.6±0.25^{cd}$	$8.65±0.36^{cd}$	$8.67±0.21^{cd}$	$8.61±0.29^{D}$
Mean±SD	$7.87±1.85^{A}$	$7.89±1.85^{A}$	$7.92±1.86^{A}$	$7.94±1.86^{A}$	$7.96±1.86^{A}$	

Means sharing similar letter in a row or in a column are statistically non-significant ($P>0.05$). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSO_4.7H_2O$ (Fe=18 mg)

$T_2 - T_{10}$ (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Fat content impacted significantly amongst treatments due to variation in ingredients and corresponding ratios used in treatment composition, for T_0 and T_1 maximally dried apricot was used for development of bars, while in development of T_2-T_{10} mixture of natural Fe fortificants and energy providing ingredients were added, apricot kernel being richest fat source incorporated fat content in bars. The results of current exploration are validated by the comparable outcomes of other food researchers.

Nutribar was developed by Jan *et al.* (2012), they developed 6 treatments in which semolina (73 g carbohydrates, 3 g fiber and 13 g protein) and makhana were variables and cashew nuts, almonds, fenugreek, cocnut were fixed ingredients, with decreasing the amount of semolina in bars the percent fat content increased treatment wise.

Nadeem *et al.* (2018) reported that chemical analyzes of date bar samples did not reveal any significant variation in crude fat content among the different bar samples during storage. However, it was found that the fat content was highest in bars with roasted flour of corn and dates. Outcomes were also substantiated by Estevez *et al.* (2000), Escobar *et al.* (1998) and de Penna *et al.* (1993). Onwuka and Abasiekong (2006) found that putting legume flour augmented fat in chocolate bars.

Table 8. Effect of treatments and storage on ash content (%) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	$3.77±0.11^{ab}$	$3.77±0.13^{ab}$	$3.78±0.05^{ab}$	$3.8±0.2^{ab}$	$3.83±0.15^{ab}$	$3.79±0.12^{B}$
T_1	$4.07±0.14^{a}$	$4.08±0.13^{a}$	$4.08±0.21^{a}$	$4.11±0.12^{a}$	$4.14±0.14^{a}$	$4.1±a0.13^{A}$
T_2	$3.05±0.12^{f}$	$3.06±0.05^{f}$	$3.07±0.1^{f}$	$3.09±0.07^{f}$	$3.09±0.12^{f}$	$3.07±0.08^{FG}$
T_3	$3.49±0.19^{bcde}$	$3.5±0.07^{bcde}$	$3.51±0.06^{bcde}$	$3.52±0.1^{bcd}$	$3.53±0.08^{bc}$	$3.51±0.09^{C}$
T_4	$3.15±0.15^{cdef}$	$3.17±0.15^{cdef}$	$3.17±0.06^{cdef}$	$3.18±0.15^{cdef}$	$3.18±0.05^{cdef}$	$3.17±0.1^{EF}$
T_5	$3.29±0.11^{cdef}$	$3.3±0.06^{cdef}$	$3.31±0.06^{cdef}$	$3.31±0.04^{cdef}$	$3.33±0.16^{cdef}$	$3.31±0.08^{D}$
T_6	$3.14±0.1^{def}$	$3.15±0.04^{cdef}$	$3.17±0.05^{cdef}$	$3.18±0.08^{cdef}$	$3.18±0.06^{cdef}$	$3.16±0.06^{EF}$
T_7	$3.28±0.09^{cdef}$	$3.29±0.09^{cdef}$	$3.29±0.13^{cdef}$	$3.3±0.05^{cdef}$	$3.3±0.14^{cdef}$	$3.29±0.09^{DE}$
T_8	$3.08±0.16^{f}$	$3.1±0.1^{f}$	$3.1±0.1^{f}$	$3.12±0.07^{ef}$	$3.13±0.09^{ef}$	$3.11±0.09^{FG}$
T_9	$2.96±0.15^{f}$	$2.96±0.12^{f}$	$2.97±0.14^{f}$	$2.97±0.16^{f}$	$2.99±0.06^{f}$	$2.97±0.11^{G}$
T_{10}	$3.18±0.14^{cdef}$	$3.18±0.04^{cdef}$	$3.2±0.11^{cdef}$	$3.23±0.05^{cdef}$	$3.23±0.14^{cdef}$	$3.2±0.09^{DEF}$
Mean±SD	$3.32±0.34^{A}$	$3.32±0.33^{A}$	$3.33±0.34^{A}$	$3.35±0.34^{A}$	$3.36±0.35^{A}$	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Garcia *et al.* (1998) examined bars made with cereals comprising various concentrations of toasted rice bran had acquired lipids between 7.43 to 9.57%, while Silva *et al.* (2009); Guimarães and Silva (2009) and Gutkoski *et al.* (2007) found fats in ranges from 7.5 to 7.8, 4.26 to 5.32 and 4.94 to 6.57 % respectively. Dutcosky *et al.* (2006) achieved lipids between 2.60 to 4.13 % in bars of cereals with banana flavor and 1.28 to 2.85 % for passion fruit tasting bars made from cereals.

Table 9. Effect of treatments and storage on NFE content (%) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	$56.05±1.86^{a}$	$56.33±3.15^{a}$	$56.51±1.44^{a}$	$56.65±3.37^{a}$	$56.75±1.15^{a}$	$56.46±2.02^{DE}$
T_1	$57.38±2.3^{a}$	$57.44±1.47^{a}$	$57.65±3.23^{a}$	$57.72±1.69^{a}$	$57.84±3.25^{a}$	$57.61±2.12^{BCDE}$
T_2	$56.72±2.74^{a}$	$56.99±1.55^{a}$	$57.48±0.76^{a}$	$57.63±2.22^{a}$	$57.67±0.86^{a}$	$57.3±1.57^{CDE}$
T_3	$60.11±2.85^{a}$	$60.17±2.12^{a}$	$60.67±1.81^{a}$	$60.92±1.49^{a}$	$61.2±2^{a}$	$60.61±1.83^{A}$
T_4	$57.89±3.21^{a}$	$57.92±1.13^{a}$	$57.95±2.86^{a}$	$57.96±2.97^{a}$	$58.15±1.15^{a}$	$57.97±2.07^{BCDE}$
T_5	$59.6±1.09^{a}$	$59.68±2.38^{a}$	$59.87±2.56^{a}$	$60.2±1.72^{a}$	$60.31±1.57^{a}$	$59.93±1.67^{AB}$
T_6	$57.75±1.33^{a}$	$57.82±0.89^{a}$	$57.92±1.92^{a}$	$57.96±1.14^{a}$	$58.17±2.56^{a}$	$57.93±1.43^{BCDE}$
T_7	$58.72±2.63^{a}$	$58.84±2.17^{a}$	$58.98±1.66^{a}$	$59.2±1.69^{a}$	$59.31±3.13^{a}$	$59.01±1.98^{ABC}$
T_8	$57.2±1.77^{a}$	$57.4±1.38^{a}$	$57.46±3.19^{a}$	$57.62±3.78^{a}$	$57.71±2.5^{a}$	$57.48±2.27^{BCDE}$
T_9	$56.14±1.16^{a}$	$56.2±0.79^{a}$	$56.32±2.25^{a}$	$56.33±0.91^{a}$	$56.58±1.09^{a}$	$56.31±1.15^{E}$
T_{10}	$58.51±2.25^{a}$	$58.73±1.21^{a}$	$58.93±0.79^{a}$	$58.97±1.62^{a}$	$59.13±0.89^{a}$	$58.85±1.25^{ABCD}$
Mean±SD	$57.82±2.24^{A}$	$57.96±1.94^{A}$	$58.16±2.24^{A}$	$58.29±2.3^{A}$	$58.44±2.17^{A}$	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Proteinous matter

In all treatments initial protein content was ranging from 2.72 ± 0.0 to 6.64 ± 0.10 %. During the storage study of 60 days, the protein content followed a non-significant decreasing trend in all treatments, as shown in Table 6. Minimal proteinous matter was found in T_9 and T_2 which decreased from 2.72 ± 0.02 to 2.71 ± 0.05 % and 2.91 ± 0.08 to 2.88 ± 0.05 %. Whereas the max proteinous matter was observed in T_0 and T_1 as 6.64 ± 0.10 and 6.31 ± 0.07 % which decreased to 6.60 ± 0.13 and 6.21 ± 0.12 % respectively over storage interval of 60 days. In T_5 and T_3 it decreased from 4.65 ± 0.15 to 4.57 ± 0.11 and 5.51 ± 0.09 to 5.46 ± 0.07 %, respectively.

Table 10. Effect of treatments and storage on Fe (mg) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	0.00±0.00^{o}	0.00±0.00^{o}	0.00±0.00^{o}	0.00±0.00^{o}	0.00±0.00^{o}	0.00±0.00^{J}
T_1	18±0.19^{a}	17.97±0.19^{a}	17.95±0.2^{a}	17.9±0.19^{a}	17.87±0^{a}	17.94±0.2^{B}
T_2	11.56±0.03^{k}	11.55±0.04^{k}	11.52±0.05^{klm}	11.49±0.06^{kl}	11.48±0.34^{klm}	11.52±0.05^{H}
T_3	18.35±0.17^{a}	18.3±0.18^{a}	18.28±0.2^{a}	18.23±0.18^{a}	18.21±0.06^{a}	18.27±0.18^{A}
T_4	14.68±0.31^{efg}	14.65±0.32^{efg}	14.61±0.29^{fgh}	14.57±0.3^{fgh}	14.56±0.27^{gh}	14.62±0.28^{E}
T_5	17.76±0.33^{a}	17.7±0.29^{ab}	17.69±0.3^{ab}	17.66±0.33^{ab}	17.62±0.4^{abc}	17.69±0.31^{B}
T_6	12.66±0.36^{j}	12.62±0.34^{j}	12.59±0.33^{j}	12.57±0.44^{j}	12.52±0.5^{j}	12.59±0.32^{G}
T_7	16.99±0.01^{bcd}	16.91±0.04^{cd}	16.87±0.04^{d}	16.85±0.05^{d}	16.81±0.39^{d}	16.89±0.07^{C}
T_8	13.85±0.07^{hi}	13.82±0.08^{i}	13.78±0.1^{i}	13.75±0.26^{i}	13.72±0.01^{i}	13.78±0.16^{F}
T_9	10.78±0.01^{lmn}	10.75±0.00^{mn}	10.7±0.03^{n}	10.67±0.25^{n}	10.65±0.03^{n}	10.71±0.05^{I}
T_{10}	15.35±0.04^{e}	15.31±0.03^{ef}	15.28±0.01^{efg}	15.25±0.03^{efg}	15.22±0.2^{efg}	15.28±0.09^{D}
Mean±SD	13.64±5.06^{A}	13.6±5.05^{A}	13.57±5.04^{A}	13.54±5.03^{A}	13.51±5.03^{A}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Protein content varied due to varying number and concentrations of ingredients among treatments, perhaps due to addition of Fe-fortificants and the barley flour which was used to impart palatabilty to bars.

The declining trend in protein during storage was may be due to Millard reaction (Anju *et al.*, 2014). Estevez *et al.* (2000) established the upsurge in proteinous matter of treatments fortified with soy and peanut flour plus mesquite cotyledon. Apple bars developed by augmention of soy aiming the proteinous matter enhancement were declared to be a healthy snacking option (Agrahari *et al.*, 2004). The decrease in protein during storage was delineated by results of Kumar *et al.* (2017) for bars of guava and papaya pulp in which protein decreased in all treatments made with pulp in ration: T_1 (100 % pulp of papaya), T_2 (80:20, pulps of papaya:guava), T_3 (60:40, pulps of papaya:guava), T_4 (50:50, pulps of papaya:guava) and T_5 (40:60, pulps of papaya:guava) from 0.86 to 0.74, 0.89 to 0.64, 0.95 to 0.66, 1.00 to 0.71, 1.02 to 0.73, 0.01 to 0.01 and 0.04 to 0.03 %, respectively. Sharma (1997) reported similar trend of protein during storage of plum-soya products. The change of proteins during storage was in accord to the conclusions of Rokhsana *et al.* (2007) who stated non-significant change in proteins; 19.396 to 19.256 % in legume and vegetable based soup powder's 180 days storage. De Penn *et al.* (1993) and Escobar *et al.* (1998), reported non-significant effect on protein during storage.

Table 11. Effect of treatments and storage on gross energy (Kcals) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	261.86±11.24^{e}	262.93±6.36^{e}	263.56±11.89^{e}	264.03±5.9^{e}	264.34±9.09^{e}	263.34±7.57^{F}
T_1	265.84±6.98^{e}	265.92±14.38^{e}	266.64±7.85^{e}	266.8±12.41^{e}	267.16±16.49^{e}	266.47±8.91^{F}
T_2	346.55±9.4^{cd}	347.25±4.66^{cd}	349.04±7.24^{cd}	349.45±6.91^{cd}	349.43±16.1^{cd}	348.35±8.4^{D}
T_3	397.45±14.46^{a}	397.27±9.82^{a}	399.01±2.46^{a}	399.25±1.46^{a}	400.23±15.09^{a}	398.64±9.12^{A}
T_4	359.96±11.08^{bcd}	359.9±18.3^{bcd}	359.85±17.2^{bcd}	359.16±10.57^{bcd}	359.68±1.02^{bcd}	359.71±12.49^{CD}
T_5	383.03±11.83^{ab}	382.68±12.82^{ab}	383.28±2.75^{ab}	383.81±2.82^{ab}	383.85±0.65^{ab}	383.33±6.79^{B}
T_6	356.52±1.17^{bcd}	356.14±4.91^{bcd}	356.15±1.75^{bcd}	356.25±6.88^{bcd}	356.95±10.11^{bcd}	356.4±3.32^{D}
T_7	370.47±13.48^{abc}	370.42±5.77^{abc}	370.72±7.96^{abc}	370.95±10.94^{abc}	371.19±2.25^{abc}	370.75±8.46^{C}
T_8	351.4±7.23^{bcd}	352.07±18.1^{bcd}	351.95±17.4^{bcd}	352.43±5.79^{bcd}	352.66±1.04^{bcd}	352.1±10.14^{D}
T_9	334.39±0.56^{d}	334.51±12.03^{d}	334.41±1.42^{d}	334.3±7.29^{d}	335.03±3.48^{d}	334.53±5.37^{E}
T_{10}	368.26±7^{abc}	368.94±6.12^{abc}	369.59±3.42^{abc}	367.74±2.39^{abc}	368.12±0^{abc}	368.53±4.12^{C}
Mean±SD	345.07±43.03^{A}	345.28±42.81^{A}	345.84±43.18^{A}	345.83±42.7^{A}	346.24±42.51^{A}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2–T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Fiber content

In all treatments initial fiber content ranged from 5.33 ± 0.07 to 11.31 ± 0.30 %. During the storage study of 60 days, the fiber content followed a non-significant increasing trend in all treatments, minimum fiber content was found in T_9 and T_1 which increased from 5.26 ± 0.08 to 5.33 ± 0.07 %, and 6.29 ± 0.16 to 6.37 ± 0.09 %. Whereas the maximum fiber content was observed in T_3 and T_5 as 11.23 ± 0.21 and 10.54 ± 0.25 % which increased to 11.31 ± 0.30 and 10.70 ± 0.16 % respectively over storage interval of 60 days. In T_0 fiber content increased from 6.33 ± 0.06 to 6.37 ± 0.10 % as shown in Table 7. Spearmint powder, quince fruit and dried apricot pulp being rich in fiber probably imparted the fiber content to naturally Fe-fortified treatments.

Addition of white maize had improved the fiber content of cereal bars as revealed by (Urtilla-Coello *et al.*, 2011). Likewise, legume flour augmented fiber in bars made with chocolate as reported by (Onwuka and Abasiekong, 2006). Results were supported with study shown by Maurer *et al.* (2005) in which increasing trend in fiber of granola bars was obvious when supplemented with black and red beans.

Ash content

In all treatments initial ash content ranged from 2.96 ± 0.09 to 4.07 ± 0.08 %. During the storage study of 60 days, the ash content followed a non-significant increasing trend in all treatments, minimum ash content was found in T_9 and T_2 which increased from 2.96 ± 0.09 to 2.99 ± 0.03 %, and 3.05 ± 0.07 to 3.09 ± 0.07 %. Whereas maximum ash content was observed in T_1 and T_0 as 4.07 ± 0.08 and 3.77 ± 0.06 % which increased to 4.14 ± 0.08 and 3.83 ± 0.09 % respectively over storage interval of 60 days.

In T_5 ash content increased from 3.29 ± 0.06 to 3.33 ± 0.09 % while in T_3 ash content inclined from 3.49 ± 0.11 to 3.53 ± 0.05 %, as shown in Table 8.

The ash content may had been high due to addition of natural dried fortificants spearmint powder and apricot kernel, as well as barley flour which was used to give a texture to bars, while revealed from proximate composition analyses of raw materials major source of ash was apricot kernel.

Table 12. Effect of treatments and storage on water activity (a_w) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	$0.581±0.001^{a}$	$0.575±0.004^{a-d}$	$0.572±0.003^{a-e}$	$0.567±0.002^{b-g}$	$0.567±0.000^{b-h}$	$0.573±0.002^{A}$
T_1	$0.578±0.003^{ab}$	$0.573±0.001^{a-e}$	$0.569±0.001^{a-f}$	$0.565±0.003^{c-i}$	$0.561±0.001^{e-j}$	$0.569±0.002^{A}$
T_2	$0.536±0.002^{n-r}$	$0.531±0.001^{p-t}$	$0.528±0.005^{r-u}$	$0.523±0.001^{stu}$	$0.519±0.002^{tu}$	$0.527±0.002^{G}$
T_3	$0.577±0.003^{abc}$	$0.572±0.003^{a-e}$	$0.568±0.003^{b-g}$	$0.563±0.004^{d-i}$	$0.562±0.001^{e-i}$	$0.568±0.002^{AB}$
T_4	$0.556±0.002^{g-k}$	$0.549±0.000^{j-m}$	$0.542±0.002^{l-q}$	$0.538±0.004^{m-r}$	$0.532±0.003^{o-s}$	$0.543±0.002^{E}$
T_5	$0.575±0.001^{a-d}$	$0.566±0.003^{b-h}$	$0.562±0.002^{e-i}$	$0.561±0.000^{e-j}$	$0.556±0.002^{g-k}$	$0.564±0.002^{B}$
T_6	$0.544±0.000^{k-o}$	$0.536±0.001^{n-r}$	$0.531±0.000^{p-t}$	$0.527±0.000^{r-u}$	$0.526±0.000^{r-u}$	$0.533±0.002^{F}$
T_7	$0.568±0.002^{b-g}$	$0.564±0.001^{d-i}$	$0.558±0.001^{f-j}$	$0.554±0.001^{h-l}$	$0.553±0.003^{i-l}$	$0.559±0.002^{C}$
T_8	$0.538±0.002^{m-r}$	$0.536±0.003^{n-r}$	$0.532±0.001^{o-s}$	$0.530±0.001^{q-u}$	$0.527±0.001^{r-u}$	$0.533±0.001^{F}$
T_9	$0.533±0.004^{n-s}$	$0.526±0.001^{r-u}$	$0.522±0.001^{stu}$	$0.519±0.000^{tu}$	$0.518±0.004^{u}$	$0.524±0.002^{G}$
T_{10}	$0.556±0.002^{g-k}$	$0.552±0.000^{i-l}$	$0.549±0.002^{j-m}$	$0.545±0.003^{k-n}$	$0.543±0.003^{l-p}$	$0.549±0.002^{D}$
Mean±SD	$0.558±0.003^{A}$	$0.553±0.003^{B}$	$0.548±0.003^{C}$	$0.545±0.003^{D}$	$0.542±0.003^{D}$	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSO_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Huma *et al.* (2004) demonstrated that whole wheat flour which was fortified with iron; the addition of iron fortificant had an important effect on the content of ash. Results were in compliance with study of Kourany *et al.* (2017) in which ash content non-significantly increased in guava protein fortified bar bar during storage of sixty days. Srebernich *et al.* (2016) reported non-significantly increased value of ash in their study (1.54 to 1.57 %), these values were of high ration than the values of Brito *el al.*, (2004). Ash content ranged from 1.15 to 1.38 % in bars made with cereals in combination of dried fruit and buriti in varying proportions (Guimarães and Silva, 2009).

Moreover, Garcia *et al.* (1998) established ash level was between 2.61 and 3.68 %. Non-significant variation in ash because of storage was also recorded by Nadeem *et al.* (2018).

NFE content

In all treatments initial NFE content ranged from 56.05 ± 1.07 to 60.17 ± 1.64 %. During the storage study of 60 days, NFE content followed a non-significant increasing trend in all treatments, minimum NFE content was found in T_0 and T_9 which increased from 56.05 ± 1.07 to 56.75 ± 0.66 %, and 56.14 ± 0.67 to 56.58 ± 0.63 %. Whereas maximum NFE content was observed in T_3 and T_5 as 60.11 ± 1.64 and 59.60 ± 0.63 % which increased to 61.20 ± 1.15 and 60.31 ± 0.91 % respectively over storage interval of 60 days. In T_1 NFE content increased from 57.38 ± 1.33 to 57.84 ± 1.87 % as depicted in Table 9.

Srebernich *et al.* (2016) obtained NFE by difference, ranged between 79.80 and 80.08 %. Mourão *et al.* (2009) got NFE level from 62.93 and 79.83 % and Garcia *et al.* (1998) attained NFE values ranging 67.37 and 72.11 %.

Huma *et al.* (2004) declared that in whole wheat flour fortified with iron, the packaging materials and storage had not affected NFE level considerably.

Nadeem *et al.* (2018) also stated non-significant rise in mean NFE from 86.14 ± 0.07 to 86.15 ± 0.07 for bars during storage.

Table 13. Effect of treatments and storage on FFA (%) of fruit bars.

Treatments	Days					Mean±SD
	0	15	30	45	60	
T_0	$0.047±0.000^{v}$	$0.049±0.000^{u}$	$0.059±0.000^{st}$	$0.061±0.000^{r}$	$0.068±0.000^{q}$	$0.057±0.002^{K}$
T_1	$0.051±0.000^{u}$	$0.058±0.000^{t}$	$0.063±0.000^{r}$	$0.068±0.000^{q}$	$0.071±0.000^{op}$	$0.062±0.002^{J}$
T_2	$0.059±0.000^{st}$	$0.071±0.000^{op}$	$0.088±0.000^{m}$	$0.099±0.001^{jk}$	$0.119±0.000^{g}$	$0.087±0.006^{H}$
T_3	$0.079±0.000^{n}$	$0.091±0.000^{l}$	$0.118±0.000^{g}$	$0.129±0.000^{d}$	$0.140±0.000^{a}$	$0.111±0.006^{A}$
T_4	$0.067±0.000^{q}$	$0.081±0.000^{n}$	$0.100±0.000^{jk}$	$0.112±0.000^{h}$	$0.126±0.000^{e}$	$0.097±0.006^{E}$
T_5	$0.072±0.000^{o}$	$0.088±0.001^{m}$	$0.112±0.001^{h}$	$0.129±0.001^{d}$	$0.137±0.000^{b}$	$0.108±0.007^{B}$
T_6	$0.061±0.000^{rs}$	$0.071±0.000^{op}$	$0.098±0.000^{k}$	$0.108±0.000^{i}$	$0.122±0.000^{f}$	$0.092±0.006^{G}$
T_7	$0.069±0.000^{pq}$	$0.086±0.000^{m}$	$0.110±0.000^{hi}$	$0.122±0.001^{f}$	$0.132±0.000^{c}$	$0.104±0.006^{C}$
T_8	$0.059±0.000^{st}$	$0.071±0.000^{op}$	$0.099±0.000^{jk}$	$0.112±0.001^{h}$	$0.124±0.000^{ef}$	$0.093±0.007^{F}$
T_9	$0.057±0.000^{t}$	$0.068±0.000^{q}$	$0.081±0.000^{n}$	$0.093±0.000^{l}$	$0.099±0.001^{jk}$	$0.080±0.004^{I}$
T_{10}	$0.069±0.000^{pq}$	$0.081±0.000^{n}$	$0.101±0.001^{j}$	$0.118±0.001^{g}$	$0.129±0.001^{d}$	$0.100±0.006^{D}$
Mean±SD	$0.063±0.002^{E}$	$0.074±0.002^{D}$	$0.094±0.003^{C}$	$0.105±0.004^{B}$	$0.115±0.004^{A}$	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SD, SD = Standard deviation

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Fe-content analyses during storage

In all treatments initial Fe ranged from 0.00 ± 0.00 to 18.35 ± 0.04 mg. During the storage study of 60 days, the Fe followed a significantly decreasing trend in all treatments, minimum Fe value was found in T_0 and T_9 which decreased from 0.00 ± 0.00 to 0.00 ± 0.00 and 10.78 ± 0.01 to 10.72 ± 0.04 mg, while maximum Fe value was in T_3 and T_1 which decreased from 18.35 ± 0.04 to 18.26 ± 0.11 and 18.00 ± 0.11 to 17.88 ± 0.08 mg, in T_2 it decreased from 11.56 ± 0.02 to 11.50 ± 0.04 mg and in T_5 it decreased from 17.76 ± 0.05 to 17.69 ± 0.007 mg as shown in Table 10.

Pereira *et al.* (2012) found that during storage the FeC content varied insignificantly, which could be due to safe packaging and handling.

Bilgicli and Akbulut (2009) determined the micro and macro elements present in control cakes and supplemented with pekmez. The cakes pekmez placebo, mulberry, apricot, elecampane, grape and watermelon contained 1.80, 4.27, 11.99, 22.70 and 21.71 mg Fe / 100 g, respectively.

Pilon *et al.* (2006) reported that carrots and green peppers were packaged and stored in biaxially oriented polypropylene / low density polyethylene (BOPP / LDPE) plastic films in air, vacuum and modified atmosphere (2 % O_2, 10 % CO_2 and 88 % N_2), 1 ° C ± 1 ° C, the chemical composition of the vegetables remained stable during storage. Trend supported as in the minimally processed carrots, all treatments showed insignificant changes in Fe during storage. Similarly, among the processed green peppers, the Fe concentration also changed insignificantly.

Gross energy

In all treatments initial gross energy content ranged from 261.84 ± 6.98 KCal to 397.45 ± 14.46 Kcal. During the storage study of 60 days, gross energy content changed non-significantly, minimum gross energy content was found in T_0 and T_1 which increased from 261.86 ± 11.24 to 264.34 ± 9.09 KCal, and 265.84 ± 6.98 to 267.16 ± 16.49 KCal. Whereas maximum gross energy content was observed in T_3 and T_5 as 397.45 ± 14.46 and 383.03 ± 11.83 KCal which increased to 400.23 ± 15.09 and 383.85 ± 0.65 KCal respectively over storage interval of 60 days. In T_9 gross energy content increased from 334.39 ± 0.56 to 335.03 ± 0.348 Kcal as displayed in Table 11.USDA National Nutrient Database (2014) indicated that dried Apricots (09032) had 241 KCal/100 g. The results were supported by the work of de Penna *et al.* (1993) in study of soy-based protein bars with added soy, claimed non-significant gross energy change through two months storage.

Table 14. Effect of treatments and storage on color of fruit bars.

Treatments	Days					Mean±SE
	0	15	30	45	60	
T_0	$6.60±0.17^{g-m}$	$6.57±0.07^{g-m}$	$6.30±0.10^{i-q}$	$6.25±0.12^{j-r}$	$5.97±0.08^{l-u}$	$6.34±0.08^{CD}$
T_1	$6.50±0.04^{h-o}$	$6.47±0.12^{h-p}$	$6.40±0.04^{h-q}$	$6.10±0.14^{k-s}$	$5.83±0.03^{n-v}$	$6.26±0.08^{CDE}$
T_2	$6.50±0.17^{h-o}$	$6.32±0.11^{i-q}$	$5.41±0.01^{s-w}$	$5.33±0.12^{t-x}$	$4.67±0.13^{xyz}$	$5.65±0.19^{G}$
T_3	$8.03±0.19^{a}$	$7.83±0.14^{ab}$	$7.71±0.19^{a-d}$	$7.46±0.21^{a-e}$	$6.89±0.03^{e-j}$	$7.58±0.12^{A}$
T_4	$6.73±0.08^{e-k}$	$6.47±0.13^{h-p}$	$6.12±0.15^{k-s}$	$5.70±0.10^{q-v}$	$5.16±0.08^{v-y}$	$6.04±0.16^{EF}$
T_5	$7.81±0.17^{abc}$	$7.43±0.19^{a-f}$	$7.03±0.13^{d-i}$	$6.56±0.15^{g-n}$	$6.20±0.17^{j-r}$	$7.01±0.17^{B}$
T_6	$6.73±0.16^{e-k}$	$6.43±0.14^{h-q}$	$5.52±0.07^{r-w}$	$5.32±0.05^{u-x}$	$4.89±0.08^{w-z}$	$5.78±0.19^{FG}$
T_7	$7.29±0.02^{b-g}$	$6.60±0.19^{g-m}$	$6.16±0.11^{j-r}$	5.95±0.12m-u	5.80±0.090-v	$6.36±0.15^{CD}$
T_8	$6.70±0.17^{f-l}$	$6.47±0.09^{h-p}$	$6.09±0.11^{k-s}$	5.76±0.15p-v	5.53±0.10r-w	$6.11±0.13^{DE}$
T_9	$6.56±0.08^{h-n}$	$5.25±0.11^{u-y}$	$4.59±0.14^{yz}$	4.35±0.08z	4.13±0.05z	$4.97±0.24^{H}$
T_{10}	$7.09±0.12^{c-h}$	$6.67±0.14^{g-m}$	$6.36±0.07^{h-q}$	6.06±0.11k-t	5.76±0.14p-v	$6.39±0.13^{C}$
Mean±SE	$6.96±0.10^{A}$	$6.59±0.11^{B}$	$6.15±0.14^{C}$	$5.89±0.14^{D}$	$5.53±0.13^{E}$	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SE, SE = Standard error

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSO_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

The results concerning the calories value change were consistent with the results of Rehman *et al.* (2012) and Shaheen *et al.* (2013); they detected that the calories level changed in a significant way for bars made with apricot and date. Munir *et al.* (2016) examined the consequence of adding altered sources of proteins in fruit bars and found that calories differed significantly between different treatments.

Munhoz *et al.* (2014) studied calorific values provided by bars developed with two formulations containing corn glucose, 60 % sucrose solution, oat flakes and bran, bocaiuva pulp and kernels, brown sugar and soy lecithin, by varying the amount of ingredients except skipping sucrose solution in Formulation A. It was revealed that the cereal bars brought about 353.23 KCal and 373.59 KCal 100 g-1, which corresponds 12 and 19 % of the daily caloric requirements of an adult (2,000 KCal) (Brasil, 2003).

Dutcosky *et al.* (2006) established that bars fortified with prebiotics yielded energy of 291.24 to 364.36 KCal/100 g in. Guimarães and Silva (2009) described calories of 349.61 to 358.77 KCal in100 g of bars developed from cereals.

Water activity (A_w)

In all treatments initial water activity was ranging from 0.533 ± 0.004 to 0.581 ± 0.001 a_w. During the storage study of 60 days, the water activity followed a significantly decreasing trend in all treatments, minimum water activity was found in T_9 and T_2 which decreased from 0.533 ± 0.004 to 0.518 ± 0.004 and 0.536 ± 0.002 to 0.519 ± 0.002 a_w, while maximum water activity was in T_0 to T_1 which decreased from 0.581 ± 0.001 to 0.567 ± 0.000 and 0.578 ± 0.003 to

0.561 ± 0.001 a_w, in T_3 it decreased from 0.577 ± 0.003 to 0.562 ± 0.001 a_w as shown in Table 12.

The water activity in edible commodity is a useful indicator for predicting the spread of bacterial, yeasts and molds growth. The decrease in water activity helps to enhance the storage-life of edible commodities.

It is well-known that the water activity of food bars varies depending on the ingredients and associated shelf life (Freitas and Moretti, 2005).

Table 15. Effect of treatments and storage on appearance of fruit bars.

Treatments	Days					Mean±SE
	0	15	30	45	60	
T_0	$7.55±0.19^{a-d}$	$6.73±0.19^{d-n}$	$6.53±0.04^{f-n}$	$6.32±0.17^{i-o}$	$6.07±0.15^{m-s}$	$6.64±0.15^{C}$
T_1	$6.97±0.12^{c-k}$	$6.67±0.22^{e-n}$	$6.16±0.11^{k-q}$	$5.32±0.07^{r-u}$	$4.87±0.10^{tuv}$	$6.00±0.22^{DE}$
T_2	$6.90±0.20^{c-l}$	$6.75±0.05^{d-n}$	$6.17±0.17^{k-q}$	$5.25±0.11^{stu}$	$4.91±0.12^{tuv}$	$5.99±0.22^{DE}$
T_3	$8.10±0.25^{a}$	$7.89±0.17^{ab}$	$7.81±0.12^{ab}$	$7.71±0.18^{abc}$	$7.27±0.22^{b-g}$	$7.76±0.10^{A}$
T_4	$7.11±0.10^{b-j}$	$6.79±0.19^{d-n}$	$6.42±0.14^{h-n}$	$6.17±0.04^{k-q}$	$6.12±0.12^{l-r}$	$6.52±0.11^{C}$
T_5	$7.48±0.05^{a-e}$	$7.34±0.10^{a-f}$	$6.86±0.15^{d-m}$	$6.73±0.08^{d-n}$	$6.59±0.10^{f-n}$	$7.00±0.10^{B}$
T_6	$7.07±0.23^{b-j}$	$6.66±0.05^{e-n}$	$5.99±0.10^{n-s}$	$5.42±0.03^{q-u}$	$5.41±0.13^{q-u}$	$6.11±0.18^{D}$
T_7	$7.17±0.14^{b-h}$	$7.14±0.12^{b-i}$	$6.61±0.21^{f-n}$	$6.45±0.10^{g-n}$	$5.31±0.04^{r-u}$	$6.54±0.19^{C}$
T_8	$6.91±0.24^{c-l}$	$6.72±0.19^{d-n}$	$6.38±0.14^{h-n}$	$5.53±0.09^{o-t}$	$5.49±0.05^{p-u}$	$6.20±0.17^{D}$
T_9	$6.72±0.09^{e-n}$	$6.61±0.10^{f-n}$	$6.48±0.12^{g-n}$	$4.67±0.11^{uv}$	$4.27±0.05^{v}$	$5.75±0.28^{E}$
T_{10}	$7.16±0.15^{b-h}$	$6.86±0.18^{d-m}$	$6.59±0.18^{f-n}$	$6.31±0.12^{j-p}$	$6.16±0.11^{k-q}$	$6.62±0.11^{C}$
Mean±SE	$7.19±0.08^{A}$	$6.92±0.08^{B}$	$6.54±0.09^{C}$	$5.99±0.15^{D}$	$5.68±0.15^{E}$	

Means sharing similar letter in a row or in a column are statistically non-significant ($P>0.05$). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SE, SE = Standard error

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSO_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Water activity is a significant tool for predicting the free water available in food. Its level defines the spread of undesirable micro-organisms' growth, food-related hazards, food standards for preservation of foods, and packing necessities (Fontana, 2000).

The results of this inquiry were supported by the conclusions of Estevez *et al.* (1995) who found that during storage-life study cereals and nuts bars depicted a decrease from 0.71 to 0.52. A trend similar to the decline in water activity had also been stated by Zahra *et al.* (2014) and Rehman *et al.* (2012). The water activity levels of all date bars were ranging from 0.550 ± 0.003 to 0.567 ± 0.003, with the minimal score for T_3 and the maximal score for T_1. Collectively, it was found that the water activity level of all bars decreased throughout the course of storage, which was may be due to moisture loss in storage and migration of moisture molecules as a result of absorption in cereal flour (Nadeem *et al.*, 2018).

Rehman *et al.* (2012) revealed that treatments had a significant effect on water activity. Due to the addition of dried apricot paste in various treatments, the moisture level had increased. Moisture is proportional to the water activity level. The highest water activity (0.55) was observed in T_4, which contained the largest amount of dried apricot paste (30 g/ 100 g of date paste) compared to the lowest (0.53) T_1, containing the lowest amount of dried apricot paste (15 g/ 100 g paste date). The upward trend has been observed in case of treatment. The results concerning the change of water activity levels are coinciding with Estevez *et al.* (1995), who established that decreasing trend of water activity from 0.71 to 0.52 in 60 days storage-life study of cereals-nuts bars.

Free fatty acids

In all treatments initial free fatty acid ranged from 0.047 ± 0.000 to 0.079 ± 0.000 %. During the storage study of 60 days, the free fatty acid followed a significant inclination in all treatments, minimum FFA was found in T_0 and T_1 which increased from 0.047 ± 0.000 to 0.068 ± 0.000 and 0.051 ± 0.000 to 0.071 ± 0.000 %, while maximum FFA value was in T_3 to T_5 which increased from 0.079 ± 0.000 to 0.140 ± 0.000 and 0.072 ± 0.000 to 0.137 ± 0.000 %, in T_9 it increased from 0.057 ± 0.000 to 0.099 ± 0.00 %, as depicted in Table 13.

The results comprehending the modification of free fatty acids throughout shelf-life study in treatments is consistent with the findings of Jeyarani *et al.* (1997) who stated that free fatty acids increased from 0.98 to 1.1 in storage-life study of 150 days, though legume-based sweet bars were kept at ambient room temperature.

Table 16. Effect of treatments and storage on flavor of fruit bars.

Treatments	Days					Mean±SE
	0	15	30	45	60	
T_0	6.79±0.09^{g-o}	6.69±0.09^{j-q}	6.53±0.15^{k-r}	6.48±0.16^{l-s}	6.31±0.09^{l-s}	6.56±0.06^{EF}
T_1	6.98±0.08^{e-m}	6.54±0.18^{k-r}	6.41±0.10^{l-s}	6.34±0.11^{l-s}	6.21±0.20^{m-s}	6.50±0.09^{EFG}
T_2	6.44±0.08^{l-s}	6.31±0.20^{l-s}	6.20±0.14^{m-s}	6.17±0.04^{n-s}	5.81±0.11^{rs}	6.19±0.07^{H}
T_3	8.13±0.14^{a}	8.06±0.13^{ab}	7.86±0.16^{abc}	7.56±0.09^{a-h}	7.34±0.14^{b-j}	7.79±0.09^{A}
T_4	7.48±0.17^{a-i}	6.86±0.18^{f-n}	6.44±0.10^{l-s}	6.37±0.11^{l-s}	6.24±0.14^{m-s}	6.68±0.13^{DE}
T_5	7.82±0.19^{a-d}	7.71±0.06^{a-e}	7.62±0.18^{a-f}	7.51±0.23^{a-i}	6.84±0.16^{f-n}	7.50±0.11^{B}
T_6	7.04±0.12^{d-l}	6.34±0.18^{l-s}	6.24±0.16^{m-s}	6.20±0.08^{m-s}	6.00±0.17^{p-s}	6.36±0.11^{FGH}
T_7	7.71±0.10^{a-e}	7.57±0.07^{a-g}	7.27±0.15^{c-k}	6.65±0.12^{j-q}	5.93±0.05^{qrs}	7.03±0.18^{C}
T_8	7.03±0.09^{e-l}	6.78±0.09^{h-p}	6.44±0.14^{l-s}	6.31±0.11^{l-s}	6.19±0.13^{n-s}	6.55±0.09^{EF}
T_9	6.41±0.10^{l-s}	6.77±0.09^{i-p}	6.22±0.16^{m-s}	6.01±0.12^{o-s}	5.73±0.11^{s}	6.23±0.10^{GH}
T_{10}	7.65±0.13^{a-e}	7.37±0.09^{a-j}	6.68±0.16^{j-q}	6.55±0.15^{k-r}	6.48±0.05^{l-s}	6.95±0.13^{CD}
Mean±SE	7.23±0.10^{A}	7.00±0.10^{B}	6.72±0.11^{C}	6.56±0.09^{D}	6.28±0.09^{E}	

Means sharing similar letter in a row or in a column are statistically non-significant ($P>0.05$). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SE, SE = Standard error

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg)

Ryavanki and Hemalatha (2018) studied free fatty acid of red sorghum flakes based low glycemic index snack bar for 15 days with interval of 3 days, in humidity oven (accelerated conditions of temperature and relative humidity) FFA (%) ranged from 1.36 ± 0.42 to 6.16 ± 0.45 in contrast to snack bars stored at ambient temperature it was 1.36 ± 0.42 to 2.37 ± 0.25. Q_{10} rule also predicted 2.5 months storage life for snack bars at ambient temperature as there was no significant increase in FFA of snack bar stored at ambient temperature. Nadeem *et al.* (2012) studied FFA percentage in cereal bars developed from Date paste, dried apricot paste, skim milk powder, roasted gram flour, peanuts and sodium chloride by keeping all ingredients constant except varying dried apricot (15, 20, 25 and 30 g). Results revealed FFA % 0.060, 0.078, 0.079 and 0.081 in bars with varying dried apricot concentration, respectively. It established that with increase in paste of dried apricot FFA % increased.

Organoleptic analyses during storage

Color score

In all treatments initial score for color ranged from 6.50 ± 0.04 to 8.03 ± 0.19. During the storage study of 60 days, the color score followed a significantly decreasing trend in all treatments, minimum color score was found in T_1 and T_2 which decreased from 6.50 ± 0.04 to 5.83 ± 0.03 and 6.50 ± 0.17 to 4.67 ± 0.13, while maximum color score was in T_3 and T_5 which decreased from 8.03 ± 0.19 to 6.89 ± 0.03 and 7.81 ± 0.17 to 6.20 ± 0.17, in T_0 it decreased from 6.60 ± 0.17 to 5.97 ± 0.08 and in T_9 it decreased from 6.56 ± 0.08 to 4.13 ± 0.05 as shown in Table 14.

A decreasing trend indicates the change from light to dark color over time that may result from the enzymatic oxidation browning when stored at room temperature. These trends also resemble the values of Maurer *et al.* (2005).

Nadeem *et al.* (2018) studied that date bars subjected to a sensory evaluation, for 90 days of room temperature storage. The results showed that the color of the date bars was significantly affected by the diversity of ingredients and storage intervals. The judges preferred corn date bars (T_1), roasted date bars (T_2) and date bars with composite flour (T_3). The color score was gradually reduced during the storage period.

Table 17. Effect of treatments and storage on texture of fruit bars.

Treatments	Days					Mean±SE
	0	15	30	45	60	
T_0	7.06±0.13^{f-l}	6.77±0.19^{g-o}	6.56±0.06^{j-q}	6.48±0.15^{j-q}	6.36±0.10^{k-r}	6.65±0.08^{D}
T_1	8.01±0.12^{a-d}	7.26±0.09^{c-j}	7.08±0.19^{e-l}	6.76±0.17^{g-o}	5.96±0.09^{p-t}	7.01±0.19^{C}
T_2	6.63±0.09^{i-p}	6.40±0.12^{k-q}	6.06±0.06^{o-t}	5.61±0.07^{r-u}	5.36±0.08^{tuv}	6.01±0.13^{F}
T_3	8.33±0.16^{a}	8.04±0.15^{abc}	7.93±0.23^{a-d}	7.43±0.18^{b-h}	6.79±0.12^{g-o}	7.70±0.16^{A}
T_4	7.50±0.05^{b-g}	6.96±0.23^{g-n}	6.76±0.13^{g-o}	6.36±0.12^{k-r}	5.61±0.07^{r-u}	6.64±0.18^{D}
T_5	8.16±0.19^{ab}	7.86±0.18^{a-e}	7.36±0.14^{c-i}	6.86±0.11^{g-n}	6.70±0.19^{h-p}	7.39±0.16^{B}
T_6	7.26±0.05^{c-j}	6.57±0.13^{j-q}	6.29±0.10^{l-s}	5.79±0.16^{q-u}	5.56±0.12^{stu}	6.29±0.17^{E}
T_7	7.97±0.09^{a-d}	7.23±0.12^{d-j}	7.04±0.15^{g-m}	6.41±0.13^{k-q}	4.62±0.07^{v}	6.65±0.31^{D}
T_8	6.93±0.09^{g-n}	6.75±0.18^{g-o}	6.63±0.18^{i-p}	6.23±0.17^{n-s}	5.61±0.09^{r-u}	6.43±0.14^{DE}
T_9	6.73±0.05^{g-p}	6.29±0.04^{l-s}	5.81±0.16^{q-u}	5.12±0.05^{uv}	3.43±0.09^{w}	5.48±0.31^{G}
T_{10}	7.83±0.08^{a-f}	7.13±0.14^{e-k}	7.01±0.21^{g-n}	6.63±0.16^{i-p}	6.26±0.08^{m-s}	6.97±0.15^{C}
Mean±SE	7.49±0.11^{A}	7.02±0.10^{B}	6.77±0.11^{C}	6.33±0.11^{D}	5.66±0.17^{E}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SE, SE = Standard error

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

$T_2 – T_{10}$ (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

The color change during storage in various treatments is consistent with the findings of Al-Hooti *et al.* (1997) who reported a decrease in color of date bars from 6.8 to 6.2 at 0 and 180 days during storage. Similarly, Ahmad *et al.* (2005) concluded that storage periods have a significant effect on the color of papaya bars. It was recorded that the acceptability of the color ranged from 6.6 to 6.2 during storage at room temperature. This finding is consistent with the results of this study. Akhtar *et al.* (2014) reported that storage periods have no significant effect on the color of fruit bars.

Appearance score

In all treatments initial appearance ranged from 6.72 ± 0.09 to 8.10 ± 0.25. During the storage study of 60 days, the appearance followed a significantly decreasing trend in all treatments, minimum appearance value was found in T_9 and T_2 which decreased from 6.72 ± 0.09 to 4.27 ± 0.05 and 6.90 ± 0.20 to 4.91 ± 0.12, while maximum appearance value was in T_3 and T_0 which decreased from 8.10 ± 0.25 to 7.27 ± 0.22 and 7.55 ± 0.19 to 6.07 ± 0.15, in T_5 it decreased from 7.48 ± 0.05 to 6.59 ± 0.10 and in T_1 it decreased from 6.97 ± 0.12 to 4.87 ± 0.10 as depicted in Table 15. The change in appearance of fruit bars during storage for various treatments is consistent with the findings of Al-Hooti *et al.* (1997) who reported a decrease in physical appearance from 6.9 to 5.9 at 0 and 180 days of storage in date bars. Sharma *et al.* (2013) reflected that quality attributes of fruit bar were less impacted in vacuum aluminum bags than in normal atmosphere poly bags during 180 days.

Table 18. Effect of treatments and storage on taste of fruit bars.

Treatments	Days					Mean±SE
	0	15	30	45	60	
T_0	6.96±0.19^{e-q}	6.65±0.14^{h-s}	6.44±0.12^{k-t}	6.36±0.17^{l-t}	6.31±0.11^{n-t}	6.54±0.09^{EF}
T_1	7.25±0.14^{b-j}	7.13±0.17^{c-m}	7.05±0.22^{e-o}	6.91±0.20^{e-r}	6.81±0.13^{f-s}	7.03±0.08^{C}
T_2	7.09±0.13^{e-n}	6.63±0.10^{h-t}	6.51±0.19^{j-t}	6.17±0.18^{q-u}	5.85±0.15^{tuv}	6.45±0.13^{FG}
T_3	8.14±0.16^{a}	8.01±0.15^{ab}	7.89±0.08^{a-d}	7.56±0.09^{a-f}	7.27±0.20^{b-j}	7.77±0.10^{A}
T_4	7.21±0.08^{c-k}	6.97±0.05^{e-p}	6.83±0.11^{f-s}	6.49±0.12^{j-t}	6.26±0.15^{o-t}	6.75±0.10^{CDE}
T_5	7.92±0.06^{abc}	7.41±0.05^{a-h}	7.32±0.21^{b-i}	7.13±0.13^{c-m}	7.07±0.07^{e-n}	7.37±0.09^{B}
T_6	7.15±0.08^{c-l}	6.72±0.07^{g-s}	6.68±0.06^{h-s}	6.14±0.14^{r-u}	6.05±0.11^{s-v}	6.55±0.11^{EF}
T_7	7.68±0.20^{a-e}	7.10±0.14^{d-n}	6.91±0.21^{e-r}	6.12±0.10^{r-u}	5.41±0.07^{uv}	6.64±0.22^{DEF}
T_8	7.12±0.12^{d-m}	6.99±0.19^{e-p}	6.87±0.05^{f-r}	6.45±0.10^{k-t}	6.24±0.05^{p-t}	6.73±0.10^{DE}
T_9	6.75±0.08^{g-s}	6.55±0.20^{i-t}	6.43±0.06^{k-t}	6.31±0.14^{n-t}	5.26±0.10^{v}	6.26±0.15^{G}
T_{10}	7.48±0.17^{a-g}	7.06±0.10^{e-n}	6.94±0.06^{e-q}	6.54±0.18^{i-t}	6.34±0.07^{m-t}	6.87±0.12^{CD}
Mean±SE	7.34±0.08^{A}	7.02±0.08^{B}	6.90±0.08^{B}	6.56±0.09^{C}	6.26±0.11^{D}	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SE, SE = Standard error

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSo_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg).

Flavor score

In all treatments initial score for flavor ranged from 6.41 ± 0.10 to 8.13 ± 0.14. During the storage study of 60 days, the flavor score followed a significantly decreasing trend in all treatments, minimum flavor score was found in T_9 and T_2 which decreased from 6.41 ± 0.10 to 5.73 ± 0.11 and 6.44 ± 0.08 to 5.81 ± 0.11, while maximum score for flavor was in T_3 and T_5 which decreased from 8.13 ± 0.14 to 7.34 ± 0.14 and 7.82 ± 0.19 to 6.84 ± 0.16, in T_2 it decreased from 6.44 ± 0.05 to 5.81 ± 0.11 and in T_1 it decreased from 6.98 ± 0.08 to 6.21 ± 0.20 as shown in Table 16. The results of Nadeem *et al.* (2018) regarding the taste of the bars revealed that the judges greatly appreciated the date bar and that it recieved the maximum score amongst other factors. A gradual decrease in flavor was observed during 90 days of storage in all types of date bars. The change in taste during storage was may be due to certain physicochemical changes in the product. Mean values for bar taste revealed that the judges had placed the date corn bar at the top, followed by gram flour and composite flour bars. The storage behavior of these bars with respect to flavor change was found to be consistent with the findings of Al - Hooti *et al.* (1997) who observed a decrease in flavor values (6.8 to 6.3) of date bars during storage. It was also stated that the flavors had a significant impact on consumer taste, followed by taste and appearance.

Similarly, Ahmed *et al.* (2005) concluded that storage periods have a significant effect on the flavor of papaya bars. It has been recorded that the acceptability of flavors ranged from 7.1 to 6.9 when stored at room temperature. This finding is consistent with the results of this study.

Table 19. Effect of treatments and storage on overall acceptability of fruit bars.

Treatments	Days					Mean±SE
	0	15	30	45	60	
T_0	$7.58±0.14^{a-e}$	$7.21±0.05^{b-g}$	$6.38±0.17^{i-r}$	$6.16±0.14^{l-s}$	$4.89±0.09^{vw}$	$6.44±0.25^{CD}$
T_1	$7.12±0.17^{b-j}$	$7.03±0.20^{d-k}$	$6.72±0.18^{f-o}$	$6.20±0.20^{l-r}$	$5.25±0.06^{tuv}$	$6.46±0.19^{CD}$
T_2	$6.91±0.09^{e-l}$	$6.33±0.16^{k-r}$	$6.03±0.11^{n-s}$	$5.67±0.07^{r-u}$	$4.87±0.11^{vw}$	$5.96±0.19^{FG}$
T_3	$8.04±0.12^{a}$	$7.82±0.12^{abc}$	$7.52±0.12^{a-e}$	$7.41±0.15^{a-f}$	$6.46±0.07^{g-p}$	$7.45±0.15^{A}$
T_4	$7.21±0.17^{b-g}$	$6.57±0.06^{g-o}$	$6.21±0.13^{l-r}$	$6.06±0.08^{n-s}$	$5.26±0.04^{tuv}$	$6.26±0.18^{DE}$
T_5	$7.86±0.09^{ab}$	$7.36±0.11^{a-f}$	$7.17±0.23^{b-h}$	$6.75±0.05^{f-n}$	$6.26±0.11^{l-r}$	$7.08±0.15^{B}$
T_6	$7.15±0.20^{b-h}$	$6.36±0.16^{j-r}$	$6.04±0.12^{n-s}$	$5.68±0.09^{q-u}$	$4.93±0.10^{uvw}$	$6.03±0.20^{EF}$
T_7	$7.78±0.18^{a-d}$	$7.14±0.05^{b-i}$	$6.53±0.22^{g-o}$	$6.10±0.10^{m-s}$	$5.42±0.12^{s-v}$	$6.59±0.23^{C}$
T_8	$7.09±0.10^{c-k}$	$6.45±0.19^{g-p}$	$6.12±0.10^{m-s}$	$5.72±0.06^{p-t}$	$5.25±0.09^{tuv}$	$6.13±0.17^{EF}$
T_9	$6.75±0.26^{f-n}$	$6.56±0.06^{g-o}$	$5.71±0.09^{p-t}$	$5.21±0.06^{t-w}$	$4.48±0.15^{w}$	$5.74±0.23^{G}$
T_{10}	$7.72±0.07^{a-d}$	$6.86±0.13^{e-m}$	$6.44±0.07^{h-q}$	$6.12±0.09^{m-s}$	$5.96±0.15^{o-t}$	$6.62±0.17^{C}$
Mean±SE	$7.38±0.08^{A}$	$6.88±0.09^{B}$	$6.44±0.10^{C}$	$6.10±0.10^{D}$	$5.37±0.11^{E}$	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Mean ± SE, SE = Standard error

T_0 (100 g) = Placebo fruit bars = Dried apricot, milk powder (Fe = 0 mg)

T_1 (100 g) = Synthetic Fe fortified fruit bars = Dried apricot, milk powder, $FeSO_4.7H_2O$ (Fe=18 mg)

T_2 – T_{10} (100 g) = Indigenous Fe fortified fruit bars = Dried apricot, milk powder, barley flour, quince fruit, spearmint powder, apricot kernel (Fe=10.75- 18.29 mg.

Texture score

In all treatments initial score for texture ranged from 6.63 ± 0.09 to 8.33 ± 0.16. During the storage study of 60 days, the texture score followed a significantly decreasing trend in all treatments, minimum texture score was found in T_2 and T_9 which decreased from 6.63 ± 0.09 to 5.36 ± 0.08 and 6.73 ± 0.05 to 3.43 ± 0.09, while maximum score for texture was in T_3 and T_5 which decreased from 8.3 ± 0.16 to 6.79 ± 0.12 and 8.16 ± 0.19 to 6.70 ± 0.19, in T_0 it decreased from 7.06 ± 0.13 to 6.36 ± 0.10 and in T_1 it decreased from 8.01 ± 0.12 to 5.96 ± 0.09 as displayed in Table 17.

Jan *et al.* (2012) described a gradual decrease in the texture (8.00 to 7.10) of nutri bars for lactating women. Silva *et al.* (2016) showed that texture values non-significantly decreased from 7.14 to 7.11 in bars made with jeriva fruit flour in Brazil. Texture is the perception of the rheological and structural characteristics of a product that can be judged by mechanical, tactile, visual and auditory receivers. The texture change during storage for various treatments is consistent with the findings of Al-Hooti *et al.* (1997)

who reported a decrease in mouth feel / texture from 7.0 to 5.9 at 0 and 180 days during storage in date bars.

Similarly, Ahmed *et al.* (2005) concluded that storage period significantly affected texture of papaya fruit bars. It was recorded that texture varied from 6.3 to 5.3 during storage at ambient temperature.

Taste score

In all treatments initial score for taste ranged from 6.75 ± 0.08 to 8.14 ± 0.16. During the storage study of 60 days, the taste score followed a significantly decreasing trend in all treatments, minimum taste score was found in T_9 and T_0 which decreased from 6.75 ± 0.08 to 5.26 ± 0.10 and 6.96 ± 0.19 to 6.31 ± 0.11, while maximum score for taste was in T_3 and T_5 which decreased from 8.14 ± 0.16 to 7.27 ± 0.20 and 7.92 ± 0.06 to 7.07 ± 0.07, in T_2 it decreased from 7.09 ± 0.13 to 5.85 ± 0.15 and in T_1 it decreased from 7.25 ± 0.14 to 56.81 ± 0.13 as displayed in Table 18.

Taste is perceived by the taste buds, while the composition of food, flavor and texture can modify it. A food is generally accepted or rejected by taste. Bower and Whitten, (2000) confers that the preference in the choice of bar type is also associated with the softness, the filling taste, the soft and crunchy texture.

Nadeem *et al.* 2018, observed a downward trend in treatments of bars for taste during days (7.35 to 6.80) corresponding to Al-Hooti *et al.* (1997).

Sharma *et al.* (2013) prepared bars from wild apricot pulp and found that quality attributes were less affected in vacuum aluminum bags than polythene pouches in normal environments. At room temperature, the products showed stability up to 6 months.

Overall acceptability score

In all treatments initial score for overall acceptability ranged from 6.75 ± 0.26 to 8.04 ± 0.12. During the storage study of 60 days, the overall acceptability score followed a significantly decreasing trend in all treatments, minimum overall acceptability score was found in T_9 and T_2 which decreased from 6.75 ± 0.26 to 4.48 ± 0.15 and 6.91 ± 0.09 to 4.87 ± 0.11, while maximum score for overall acceptability was in T_3 and T_5 which decreased from 8.04 ± 0.12 to 6.46 ± 0.07 and 7.86 ± 0.09 to 6.26 ± 0.11, in T_0 it decreased from 7.58 ± 0.14 to 4.89 ± 0.09 and in T_1 it decreased from 7.12 ± 0.17 to 5.25 ± 0.06 as displayed in table 19.

Silva *et al.* (2016) explained that the formulations had higher scores for overall acceptance attribute (6.98 to 7.11), the partial substitution of corn starch biscuit by flour de jerivá improved the sensory acceptability of food bars. The scores for the fortified bars were higher than those for the other nutrient bars (Bower and Whitten, 2000; Silva *et al.*, 2014 and Rosell, 2007).

The change in overall acceptance during storage is consistent with the findings of Al-Hooti *et al.* (1997) who reported a decrease in overall acceptability from 6.9 to 6.1 at 0 and 180 days during storage in date bars.

Similarly, Ahmad *et al.* (2005) concluded that storage periods had a significant effect on the overall acceptability of papaya bars. Overall acceptability was reduced from 7.45 to 6.82 when stored at room temperature.

Sharma *et al.* (2013) prepared a wild apricot fruit bar and described that the bar quality attributes least affected in vacuum aluminum bags compared to polyethylene bags of normal atmosphere. At room temperature, the products showed stability up to 6 months, which supports study results. Thus, among the 13 recipes evaluated for the preparation of wild apricot fruit bars, the T_8, that is to say containing fruit pulp with 60 % sugar and 30 % pectin, had been judged as best compared to the other recipes used. The lower score obtained by fruit bars prepared using 40 % and 50 % sugars (T_1 to T_6) was probably due to the high acidity of the product. On the contrary, products made using 70 % sugar (T_{10} to T_{12}) were not liked because of their greater softness. As a result, the recipe containing pulp with 60 % sugar and 0.30 % pectin was optimized for further studies.

Conclusion

T_3 (Spearmint: AK:: 7.50: 25) g / 100 g revealed significantly good values of nutritional components, organoleptic factors, gross energy, Fe content stability, physical texture and water activity along with free fatty acids competing to T_0, T_1, T_2, T_4, T_5, T_6, T_7, T_8, T_9 and T_{10}, providing sufficient iron as per WHO's guidelines on fortification to recover anemic condition.

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