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RESEARCH PAPER

Formulation, Quality Evaluation and Shelf-life of Value Added Cereal Bar by incorporation of Defatted Soy Flour

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ABSTRACT

De-fatted soy cereal bar (DSCB) was prepared by substituting different proportions of defatted soy flour viz., 100:0(T0), 90:10 (T1), 80:20 (T2) 70:30 (T3), 60:40 (T4), 50:50 (T5), 40:50 (T6) with basic meal. Sensory evaluation was done for different treatments. T2 was highly acceptable from all the other treatments and was analyzed for proximate composition viz., moisture, protein, fat, fiber, ash, carbohydrate, energy, *in-vitro* protein digestibility (IVPD), total calcium and iron, *in-vitro* calcium and iron bioavailability and shelf-life. Protein content was significantly higher in DSCB compared to the control (CCB). IVPD, total Ca and Fe, *in-vitro* Ca and Fe bioavailability of DSCB was found to be significantly higher than the CCB. Storage studies showed that the DSCB and CCB were found stable and highly acceptable at the end of the storage period of three months in HDPE polypouches by vaccum packaging at ambient temperature (23-44°C). DSCB were developed to supply the public nutritious food alternatives with good nutrition combinations and good protein quality in cereal-legume complementation.

Keywords: Cereal bar, sensory evaluation, proximate composition, *in-vitro* protein digestibility, *in-vitro* Ca and Fe bioavailability

The production and consumption of Ready-to-Eat (RTE) foods have increased significantly in recent years, revealing a trend of change in lifestyle of the population due to the availability of pre-prepared, frozen and ready-to-eat foods. Because of the growing consumer demand for healthy, natural and convenient foods, attempts are being made to improve nutritional values of snack foods via modifying their nutritive composition (Kotagi, 2011). Ready-to-Eat (RTE) foods are the food products that are in the form that is edible without any additional preparations but do not include nuts in the shell and whole, raw fruits and vegetables that are intended for hulling, peeling or washing by the consumer. But these include a wide array of substances and may be grouped into different categories based on their method of preparation. In fact, Ready-to-Eat foods or RTE foods is the term used for very heterogeneous group of foods which vary in composition, shape, size, method of preparation, processing and even with regards to their functions in diet and literally range from simple fried to baked, popped or roasted foods. Food bars are amongst one of the popular RTE food products.

Cereal bars are bars made from cereal grains like oats, rye, rice and wheat. These are also called as breakfast bar as many people eat cereal bars in breakfast although this food can technically be eaten at any time. In addition to the key cereal ingredient, cereal bars usually have set of syrup which acts as a glue to pull the grain together so that it stays in a bar shape. Ingredients like fruits, nuts, candy etc may be added to a cereal bar to enhance the flavor and taste (Booth, 1990).

Soybean is a very rich source of essential nutrients and one of the versatile food stuffs which include a good quality protein comparable to other protein foods, suitable for the consumers of all the ages. The soy protein is highly digestible (92-100%) and contains all the essential amino acids except methionine which is relatively low but is a good source of lysine. For this reason, it is a good source of protein, amongst many others, for vegetarians and vegans or for people who want to reduce the amount of meat they eat. The U.S., Argentina, Brazil, China and India are the world's largest soybean producers and represent more than 90% of global soybean production (Soyatech, 2012) Defatted soy flour (DSF) is a cheaper, convenient, conventional and richest source of protein for the fast expanding population worldwide (Tripathi and Mishra, 2005). Several workers have studied the possibilities of using DSF with wheat in the formulation of various food products such as cookies (Ranhotra, 1980), crackers (Sathe *et al*., 1981) and biscuits (Singh *et al*., 1996). Food bars are the snack foods of good sensory characteristics due to their nutrient combinations. One of the strategies to produce the food bars with good protein quality is cereal-legume complementation. The aim of this work was to develop cereal bar by incorporation of DSF and to evaluate the organoleptic characteristics, proximate composition and shelf-life.

MATERIALS AND METHODS

Procurements of raw materials

Defatted soy flour (roasted) was procured from Sonic Biochem Extractions Ltd. Madhya Pradesh (India). All the other raw materials; corn syrup, canola oil, peanut butter, rice flakes, sesame seeds, sugar, salt, vanilla essence etc. were purchased in a single lot. Wheat, rice flakes, sesame seeds were cleaned and stored in closed bins until use for the study.

Experimental plan

The basic recipes were standardized and served as a control (CCB). Six treatments i.e. incorporation of defatted soy flour on different levels referred to as T1, T2, T3, T4, T5 and T6 as detailed in Table 1.

Table 1: Details of control and treatments

Formulations	Mixing ratio
CCB*	50gWheat flour + 50gRice flakes
T1	45gWheat flour + 45gRice flakes+10g DSF**
T2	40gWheat flour + 40gRice flakes+20g DSF
T3	35gWheat flour + 35gRice flakes+30g DSF
T4	30gWheat flour + 30gRice flakes+40g DSF
T5	25gWheat flour + 25gRice flakes+50g DSF
T6	20gWheat flour + 20gRice flakes+60g DSF

* CCB (Control Cereal Bar), **DSF (Defatted soy flour)

Cereal bar preparation

Cereal bars were developed in the laboratory of Foods and Nutrition, College of Home Science, Udaipur. Batches of 600g of cereal bars were produced. A baking procedure for bar preparation was adopted by modified method of Brisske *et al.* (2004). The process was carried out in three stages: weighing of the dry ingredients (roasted rice flakes, wheat flour, and sesame seeds) on an electronic food balance (F12ATCO), heating of the syrup (corn syrup/honey, sugar, peanut butter, canola oil, water to 95°C) and finally mixing of the dry ingredients with the syrup. The prepared mixture was molded then, it was cut into rectangular pieces of approximately 25g each unit and baked at 180°C for 20 minutes in preheated oven; after baking left to rest for cooling and packed into HDPE (High Density Polyethylene) packaging. After packaging, developed RTE Cereal Bars were stored under ambient storage conditions (temperature ranging between 23°C to 44°C) for a period of 90 days.

Nutrient Analysis

Proximate composition of developed cereal bar (percent moisture, protein, fat, ash, fiber, energy, carbohydrate) and minerals (calcium and iron) were analyzed as per the standard AOAC (2005) procedures.

In-vitro protein digestibility (IVPD) was determined by the modified methods of Mertz *et al.* (1984). *In-vitro* calcium and iron bioavailability were determined by Lock and Bender (1980) method and the result were expressed in terms of mg/100g.

Free fatty acid and peroxide value (expressed in terms of percent and meq/kg) was determined by Cox and Pearson (1962) and standard AOAC (2000) method. The colour of cereal bar at different storage intervals was measured according to the method described by Rocha *et al.* (2003).

Sensory analysis

The formulated cereal bars and the storability of the developed ready to eat cereal bars were evaluated at regular interval i.e. 0th, 30th, 60th, and 90th day for overall acceptability (texture, colour, taste, flavour and appearance) and the sensory evaluation was carried out as per 9 point Hedonic scale (Srilakshmi, 2007); the panel was formed by ten semi trained judges.

Statistical Analysis

Statistical analysis was performed using software SPSS (Statistical Package for the Social Sciences) version 15 for PC windows. Data were presented as mean ± SD.

Two-way Analysis of (ANOVA) was used to assess the effect of storage on sensory characteristics, chemical constituents and colour values of developed RTE cereal bars. Least significant difference (LSD) test was used to separate the means of the sensory evaluation, chemical constituents and colour parameter of data. The level of significance used was 5% ($p<0.05$).

RESULTS AND DISCUSSION

Nutritional composition of Defatted Soy Cereal Bar (DSCB)

Table 2 shows the nutrient composition of control cereal bar and value added cereal bar prepared by incorporating defatted soya flour. Control was discerned to contain moisture 0.27 ± 0.09%, protein 9.32 ± 0.30%, fat 9.68 ± 0.06%, ash 1.24 ± 0.00% and energy 439 ± 0.68 kcal/100g. Which was noted to be significantly lower than the DSF added cereal bar ($p\leq 0.05$) *i.e.*, moisture 0.31 ± 0.03%, protein 19.61 ±0.00%, fat 9.91 ± 0.05%, ash 1.63 ± 0.00% and energy 440.37 ± 0.19 kcal/100g. But the carbohydrate content of the DSCB (68.17 ± 0.09 %) was observed to be significantly lower than the control (78.56 ± 0.25 %).

Table 2: Comparison of nutrient composition (per 100 gm) in CCB and DSCB

Nutrient constituents	CCB	DSCB	CD5%
	Mean ± S.D	Mean ± S.D	
Moisture (%)	0.27 ± 0.09	0.31 ± 0.03	0.09*
Protein (%)	9.32 ± 0.30	19.61 ± 0.00	0.86*
Fat (%)	9.68 ± 0.06	9.91 ± 0.05	0.24*
Ash (%)	1.24 ± 0.00	1.63 ± 0.00	0.04*
Fibre (%)	0.89 ± 0.00	0.89 ± 0.00	0.01*
Carbohydrate (%)	78.56 ± 0.25	68.17 ± 0.09	0.89*
Energy (kcal)	439 ± 0.68	441 ± 0.19	1.21*
In-vitro Protein digestibility (g)	12.50± 0.12	25.6±0.01	0.71*

NS: Non significant at 5 per cent significance level, *- Significant at 5 percent significance level, Values are expressed on 100g dry weight basis. * CCB (Control Cereal Bar), **DSF (De fatted soy flour)

The protein content of DSCB was found to be 19.61 ± 0.00 g/100g. The results are in agreement with the findings of Aleem *et al.* (2012), who found that the protein content of DSF incorporated cookies was 15.73%. The fat content of DSCB was found to be 9.91 ± 0.05%. The result are in accordance with the findings of Aly *et al.* (2012), who found that the fat content of DSF added biscuits ranged between 9.17%

to 12.28% depending on the level of incorporation. The ash content of DSCB was noted to be 1.63 ± 0.00%. The results are in consistent with the findings of Aly *et al.* (2012), who found that the ash content of DSF added biscuit was 1.65%. But Aleem *et al.* (2012) and Amit *et al.* (2014) have reported relatively higher ash value (1.75 % and 1.9%) in DSF incorporated cookies.

The fiber content of DSCB was observed to be 0.89 ± 0.00%, Similar were the findings of Aleem *et al.*(2012), who found that the fiber content of DSF incorporated biscuit was 0.8%. But Aly *et al.* (2012) have reported relatively higher value of fibre in DSF biscuits i.e. 1.29%. While Amit *et al.* (2014) reported a slightly lower value of fibre i.e. 0.70%, than the current findings.

Table 3: Total Calcium, Iron and *In-vitro* Calcium and Iron bioavailability of CCB and DSCB

Treatments	Calcium (mg/100g)	Ca bioavailability (mg/100g)	% available Calcium
	Mean ± S.D.	Mean ± S.D.	
CCB	190.88±0.00	147.89±0.01	77.47
DSCB	232.69±0.08	178.51±0.05*	76.71
CD5%	0.03	0.04	
Treatments	**Iron (mg/100g)**	**Iron bioavailability (mg/100g)**	**% available Iron**
	Mean ± S.D.	**Mean ± S.D.**	
CCB	7.60 ±0.01	1.40±0.01	18.42
DSCB	8.42±0.00	1.66±0.01*	19.71
CD5%	0.02	0.03	

NS: Non significant at 5% significance level, *- Significant at 5% significance level, Values are expressed on 100g dry weight basis. CCB represents (Control Cereal Bar), DSCB represents (De fatted Soya Cereal Bar)

The carbohydrate content of DSCB was noted to be 68.17 ± 0.09%. The results are in line with the findings of Aleem *et al.* (2012), who found that the carbohydrate content of DSF incorporated biscuit was 65.92%. But Amit *et al.* (2014) reported a slightly lower value of carbohydrate i.e. 61.9%, while Aly *et al.* (2012) have reported relatively higher value of carbohydrate in DSF added biscuit i.e. 74.41 per cent, than the current findings. The energy content of DSCB was found to be 440.37 ± 0.19 kcal/100g. The results are in agreement with the findings of Aleem *et al.* (2012), who reported that the energy content of the DSF incorporated biscuit was 462.30 kcal/100g. The IVPD of DSCB was observed to be 25.61 ± 0.01 g/100 g higher than the CCB 12.50 ± 0.12 g/100g. Statistically significant ($p \leq 0.05$) difference was found between IVPD of CCB and DSCB. It was evident from the results that processing of legumes improves the IVPD by destroying protease inhibitors, thermal denaturation of protein to open the protein structure and destroying or digesting globulins which are highly resistant to protease in natural form (Siddhuraju and Becker (2001); Fagbemi *et al.* (2005).

It is evident from the Table 3 that the total calcium content of DSCB observed to be 232.69 ± 0.08 mg/100 g relatively higher than the CCB. Whereas calcium bioavailability of DSCB (178.51± 0.05 mg/100g) was higher than the CCB but per cent availability of calcium of DSCB 76.71% was slightly lower than the CCB (77.47%). The reason for this difference in the calcium content and calcium bioavailability content of cereal bar might be due to the effect of processing on legumes, decrease in anti-nutritional content of legumes. Investigation in the area of RTE cereal bar total calcium content and calcium bioavailability has been very limited, so due to lack of literature the product could not be compared. Total iron content of DSCB was found to be relatively higher than the control cereal bar. Statistically significant difference ($p \leq 0.05$) was noted in the total iron content of legume supplemented RTE cereal bars.

The *in-vitro* iron bioavailability and per cent availability of iron of DSCB was observed to be 1.66 ± 0.01 mg/100g and 19.71% higher than the control cereal bar. Statistically significant ($p \leq 0.05$) difference was observed in *in-vitro* iron bioavailability and per cent availability of iron of CCB and DSCB. Scanty of research in the area of *in-vitro* iron bioavailability of RTE cereal bar and most importantly use of such product as functional foods have led to lack of literature for present comparison.

Sensory evaluation of Defatted soy cereal bar

Table 4 presents the sensory scores of different level of addition of DSF in cereal bars. Data clearly indicated that scores of the products ranged between "neither liked nor dislike" to "like very much". Further it is clear from the data color and flavor scores ranged between 6.04 ± 1.82 to 8.36 ± 0.11 and 6.30 ± 2.01 to 8.36 ± 0.11, respectively and were "like slightly" to "like very much". The scores of color and flavor was found to be almost similar for the control i.e., 8.36 ± 0.11 (color), 8.36 ±0.11 (flavor) and approximately same for T3 (30%) i.e., 8.00 ± 0.26 (color), 8.03 ± 0.40 (flavor). While for overall acceptability, it was observed that control scored maximum i.e., 8.39 ± 0.08 followed by T2 (20% DSF) with a score of 7.18 ± 1.38 and T6 (60% DSF) scored least i.e., 5.10 ± 0.83. With increase in the incorporation level i.e., (30%, 40%, 50% and 60%) of DSF there was decrease in all sensory attributes.

Perusal of the data in the Table 4 also recommends that among the treatments T2 (20% DSF) was "liked moderately" by the panel members obtaining a score of 8.00 ± 0.26 for color, 8.03 ± 0.40 for flavor, 7.76 ± 0.40 for texture, 7.50 ± 0.79 for taste, 7.36 ± 1.10 for appearance and 7.18 ± 1.38 for overall acceptability and scored higher than all the other treatments *i.e.,* 10, 30, 40, 50 and 60 percent incorporation of DSF. Hence, T2 (20% DSF) was selected for further study. Similar results were documented by Amit *et al.* (2011). The cookies with 20 per cent substitution of DSF and SLP scored maximum for all the sensory quality attributes. Aleem *et al.* (2012) also observed that sensory panel liked the biscuit very much prepared by adding 20% level of de-fatted soy flour.

Thus it is evident from Table 4 that rate of addition of corn syrup differed from one treatment to another. This difference was owing to the blending of flavor and taste of the products to be prepared. In the RTE cereal bars where an appropriate blend was attained, good acceptability score was obtained even at higher rate of addition. It can be discerned from the results in the Table 4 that cereal bars prepared by adding DSF were found to be acceptable at 20 percent (DSF) level, more the higher level of incorporation of legume flour, all the sensory attributes were continuously decreased in the present findings.

Effect of storage

Chemical constituents and colour parameter

It is evident from the data presented in Table 5 that the moisture content of DSF added cereal bar increased from 0.31 ±0.03 to 0.96±0.02 per cent during the storage. There was no significant effect on free fatty acid during storage i.e., 0.00±0.00 to 0.03±0.00%. Peroxide value of the control and DSF incorporated cereal bar ranged between 0.71±0.00 to 1.31±0.01 meq/kg and 0.72±0.00 to 1.11±0.01 meq/kg from initial to 90th day of storage respectively. An increasing trend was noticed for moisture and peroxide value of the product as the duration of storage progressed except free fatty acid.

Table 4: Sensory evaluation of defatted soy cereal bars (DSCB)

Treatments	Parameters					
	Color	Texture	Flavor	Taste	Appearance	Overall Acceptability
T0(Control)	8.36 ± 0.11	8.26 ±0.11	8.36 ± 0.11	8.53 ± 0.15	8.4 ± 0.10	8.39 ± 0.08
T1 (10%)	7.80 ± 0.36	7.66 ±0.05	7.83 ± 0.49	7.43 ± 0.56	7.20 ± 0.78	7.06 ± 1.00
T2 (20%)	8.00 ± 0.26	7.76 ±0.40	8.03 ± 0.40	7.50 ± 0.79	7.36 ± 1.10	7.18 ± 1.38
T3 (30%)	7.53 ± 0.20	7.03 ±0.15	7.46 ± 0.89	6.76 ± 0.28	6.76 ± 0.85	6.47 ± 1.11
T4 (40%)	7.30 ± 0.52	6.33 ±0.65	7.00 ± 1.21	6.13 ± 0.32	6.23 ± 0.50	5.90 ± 0.77
T5 (50%)	7.30 ± 0.69	6.70 ±0.52	7.20 ± 1.04	6.63 ± 0.25	6.46 ± 0.40	6.32 ± 0.56
T6 (60%)	6.04 ± 1.82	5.44 ±1.82	6.30 ± 2.01	5.50 ± 1.06	5.14 ± 1.10	5.10 ± 0.83

Table 5: Effect of storage on chemical constituents of CCB and DSCB

Attributes	Groups	Storage period				CD (P≤0.05)
		0th day	30th day	60th day	90th day	
		Mean ±S.D				
Moisture (%)	CCB	0.27±0.09	0.43±0.07	0.63±0.02	0.91±0.01	0.02*
	DSCB	0.31±0.03	0.44±0.01	0.70±0.03	0.96±0.02	0.05*
Free fatty acid (%)	CCB	0.01±0.00	0.01±0.00	0.02±0.00	0.03±0.00	0.01^{NS}
	DSCB	0.00±0.00	0.01±0.00	0.01±0.00	0.03±0.00	0.03^{NS}
Peroxide value (meq/kg)	CCB	0.71±0.00	0.92±0.00	1.03±0.01	1.13±0.01	0.00
	DSCB	0.72±0.00	0.92±0.02	1.03±0.00	1.11±0.01	0.01*

NS-Non significant, *- significant, values are expressed on dry weight basis, * CCB (Control Cereal Bar), **DSF (De fatted soy flour)

Table 6: Effect of storage on colour parameter of CCB and DSCB

Attributes	Groups	Storage period				CD (P≤0.05)
		0th day	30th day	60th day	90th day	
		Mean ±S.D				
Colour 'L' value	CCB	48.61±0.02	48.46±0.01	48.15±0.01	47.91±0.00	0.18*
	DSCB	53.82±0.09	50.11±0.01	48.14±0.02	45.29±0.02	0.46*
Colour 'a' value	CCB	13.21±0.02	13.51±0.02	13.76±0.01	13.91±0.01	0.03*
	DSCB	11.13±0.01	12.21±0.01	13.24±0.02	14.33±0.02	0.098*
Colour 'b' value	CCB	41.60±0.28	35.95±0.01	31.63±0.01	25.51±0.01	0.23*
	DSCB	33.54±0.64	31.15±0.02	31.05±0.03	29.21±0.01	0.56*

NS-Non significant, *- significant, values are expressed on dry weight basis, * CCB (Control Cereal Bar), **DSF (De fatted soy flour)

Colour values of DSCB presented in Table 6. The colour 'L' value of control cereal bar and DSCB decreased during storage from 48.61±0.02 (initially) to 47.91±0.00 (90^{th} day) and 53.82±0.09 (initially) to 45.29±0.02 (90^{th} day). But the colour 'a' value of control cereal bar and DSCB increased during storage from 13.21±0.02 (initially) to 13±0.01 (90^{th} day) and 11.13±0.01 (initially) to 14.33±0.02 (90^{th} day), while the colour 'b' value of control cereal bar and DSCB decreased during storage from 41.60±0.28 (initially) to 25.51±0.01 (90^{th} day) and 33.54±0.64 (initially) to 29.21±0.01 (90^{th} day). Statistically significant difference was observed at different intervals of storage. Significant difference was also noted between control and treatment for all chemical constituents and colour value (p≤0.05).

Similar reason as that of DSCB cereal bars can be accorded to the difference noticed. The results in the above Table 5 and 6 are in conformity with the findings of several researchers. Castro (2005) studied the storage quality of soy and wheat germ fortified cereal bars and reported that the moisture content of the bars packed in PET/PEBD films increased considerably during 6 months storage. Ananthan *et al.* (2013) evaluated the cereal bar prepared by adding DSF and reported that after 9 months peroxide content increased significantly from 0.90 (initially), 13.2 (3 month), 22.3 (6 month) and 25.3 (9 months) meq/kg. They also found that free fatty acids increased after storage from 1.9 percent (initially) to 3.2 percent (3^{rd} month). Lara *et al.* (2004) evaluated crunchy bars for storage quality and indicated that the bars packed in polypropylethin metal film and polyester polyethylene bags stored for 90 days under ambient condition exponential increased peroxide value. Monika and Mridula (2015) studied the effect of storage period on the nutritious bar and noticed a significant increase in free fatty acid content which was within the acceptable limit for 3 months. Omer (2009) evaluated the nutrient dense food bars prepared by legume supplementation after 120 days storage period. Colour values showed that the 'L' and 'b' decreased and 'a' value increased significantly during time. In nut shell it was observed in the present study that during storage, the acceptability scores showed a decreasing trend however on the basis of appearance, colour, flavor and texture all the products (treatments) were liked by the panelists till the end of the storage period (90 days).

The major reason for this might have been the bitter taste of DSCB, which was observed to be highest in these products due to the use of de-fatted soya flour as a major ingredient in DSCB cereal bars added to it. Chemical analysis further revealed the fact that increase in the moisture content during the storage period accompanied by increase in the peroxide value but all the chemical constituents were in acceptable range up to 90 days. Moreover, the colour 'L' and 'b' was found to decrease and 'a' value increased in all cereal bars. No such deterioration was observed in control and RTE DSCB cereal bar. The legume flours in the cereal bar added in the form of defatted were able to make product protein rich and increased shelf-life up to 90 days periods whereas control was also observed to be acceptable up to 90th day of storage. Treatments and control, both showed better keeping quality, as proven by the chemical analysis; this was due to the packaging of product in HDPE pouches by vacuum packaging. RTE cereal bars prepared during the study could be stored even beyond the period of 90 days but as a delimitation of the study further shelf-life was not investigated which can be a prospective for the further study.

Sensory Evaluation

Perusal of Table 7 clearly indicates that cereal bar prepared by DSF was liked moderately at all stages of storage study for appearance as the scores ranged between 8.53±0.05 to 8.50±0.43 and 7.73±0.20 to 7.66±1.02 respectively. Colour of the

Table 7: Effect of storage on sensory scores of CCB and DSCB

Attributes	Treatments	Storage period				CD (P≤0.05)
		0th day	30th day	60th day	90th day	
		Mean ± S.D				
Colour	CCB	8.26±0.05	8.30±0.00	8.26±0.05	8.26±0.05	0.20 ^{NS}
	DSCB	7.36±0.15	7.36±0.20	7.36±0.11	7.26±0.41	0.51 ^{NS}
Flavor	CCB	8.43±0.05	8.40±0.26	8.36±0.40	8.33±0.37	0.38 ^{NS}
	DSCB	7.40±0.34	7.33±0.72	7.30±0.70	7.23±0.72	0.94 ^{NS}
Texture	CCB	8.16±0.05	8.13±0.15	8.06±0.15	7.83±0.11	0.26*
	DSCB	8.83±0.25	7.70±0.26	7.66±0.49	7.23±0.75	0.63*
Taste	CCB	8.70±0.10	8.63±0.20	8.53±0.46	8.50±0.60	0.34 ^{NS}
	DSCB	7.43±0.15	7.43±0.50	7.40±0.78	7.36±1.10	0.85 ^{NS}
Appearance	CCB	8.53±0.05	8.53±0.38	8.53±0.46	8.50±0.43	0.35 ^{NS}
	DSCB	7.73±0.20	7.70±0.78	7.70±0.79	7.66±1.02	0.88 ^{NS}
Overall	CCB	8.43±0.05	8.43±0.19	8.43±0.37	8.42±0.46	0.35 ^{NS}
Acceptability	DSCB	7.41±0.01	7.40±0.45	7.39±0.51	7.05±0.48	0.86 ^{NS}

NS- non significant, *- significant, * CCB (Control Cereal Bar), **DSF (De fatted soy flour) control and DSF added cereal bar ranged between like very much to like moderately *i.e.,* 8.26±0.05 to 7.36±0.15. Results demonstrate that the appearance and colour maintained the visual appeal during the storage span inspite of the significant decrease in the scores. However no significant difference was found between control and DSCB for appearance since 60th day on wards and by the 90th day of storage significant difference was observed in control and DSCB ($p \leq 0.05$). It was also observed that control cereal bar were like more than the DSF incorporated cereal bar.

But gradually flavour, texture and taste reduced from 8.43±0.05 (initially) to 8.33±0.37 (90th day), 8.16±0.05 (initially) to 7.83±0.11 (90th day), 8.70±0.10 (initially) to 8.50±0.60 (90th day) for control and for DSCB 7.49±0.34 (initially) to 7.23±0.72 (90th day), 7.83±0.25 (initially) to 7.23±0.72 (90th day), 7.43±0.15 (initially) to 7.36±1.10 (90th day) of storage. For taste and texture attributes, similar results as of flavor were obtained. Overall acceptability ranged between 8.43±0.05 (initially) to 8.42 ±0.46 (90th day) for control and 7.41 ±0.01 (initially) to 7.05 ±0.48 (90th day) for DSCB.

Control and DSCB on an overall basis differed significantly between the likings; Scores indicated that control was preferred more when compared to the DSCB. Statistically significant difference was also observed for all the attributes during the storage period ($p \leq 0.05$). Similar results were reported by Amit *et al.* (2014). The researchers noted that the scores of 20% DSF substituted cookies packed in HDPE for colour, flavor, texture, taste appearance and overall acceptability decreased during storage. However, no undesirable change was noticed in any sensory quality attributes of the cookies by them. Haroon and Sekhon (2014) developed DSF incorporated (5 to 30%) pretzel snack and observed that the overall acceptability decreased significantly during the storage period (90 days).

CONCLUSION

It can be concluded from the result that cereal bars made with the incorporation of de-fatted soya flour can improve the nutritional quality of the cereal bars and was found acceptable by the panel members. Defatted soya cereal bar packed in HDPE by vaccum packaging was found stable and acceptable upto three months of storage.

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REFERENCES

Aleem, Z.M., Genitha, T.R. and Hashmi, S.I. 2012. Effects of defatted soy flour incorporation on physical, sensorial and nutritional properties of biscuits. *J Food Process Technol.,* **3**: 149.

Aly, M., Saleh, A.E., Salah, H.B. and Essam, I.A. 2012. Effect of partial substitution of wheat flour with either defatted soybean or chickpea flours at different ratios on rheological and physical properties of dough, and quality characteristics of biscuits. *J Applied Sci. Research,* **8**: 5806-5817.

Amit, A.K., Vithal, D.P., Pramod, M.K., Uttam, D.C. and Venkatraman, V.B. 2014. Development of high protein and low calorie cookies. *J Food Sci. Technol.,* **51**: 153–157.

Ananthan, P., Gopal, K.S. and Thimma, G. 2013. Development and evaluation of shelf stability of flaxoat nutty bar in different packaging materials. *Food and Nutrition Sci.,* **4**: 538-546.

AOAC, 2005. Official Methods of Analysis. 17th ed. Association of official analytical chemists, Arlington, VA, USA.

AOAC, 2000. Official Methods of Analysis. 17th ed. Association of official analytical chemists, Arlington, VA, USA.

Booth, R.G. 1990. Snack Food. An Avi book publishers, New York, pp. 291-295.

Brisske, L.K., Lee, S.Y., Klein, B.P. and Cadwallader, K.R. 2004. Development of a prototype high-energy, nutrient-dense food product for emergency relief. *J Food Science,* **69**: S361-S367.

Castro, F.D. 2005. Cereal bars with soy protein and wheat germ, physicochemical characteristics and texture during the storage. *Archivos Latinoamericanos de Nutrición.* **55**: 299-304.

Cox, H.E. and Pearson, D. 1962. The Chemical Analysis of Foods. Chemical Publishing Co.Inc. New York, pp. 421.

Fagbemi, T.N., Oshodi, A.A. and Ipinmoroti, K.O. 2005. Processing effects on some anti-nutritional factors and in vitro multienzyme protein digestibility (IVPD) of three tropical seeds: breadnut (*Artocarpus altilis*), cashewnut (*Anacadium occidentale*) and fluted pumpkin (*Telfairia occidentalis*). *Pakistan J. of Nutrition* **4**: 250-256.

Haroon, R.N. and Sekhon, K.S. 2014. Influence of defatted soy flour addition on the quality and stability of pretzel type product. *J. Food Sci. Technol.,* **51**:571–576.

Kotagi, S.K. 2011. Little millet (*Panicum Miliare*) flakes: development, value addition, quality evaluation, consumer acceptability and commercialization. Ph.D Thesis, Department of Food Science and Nutrition, University of Agriculture Sciences, Dharwad.

Lara, N., Mejia, A. and Cangas, A. 2004. Popped amaranth grain and its products breakfast cereal and crunchy bars: popping process, nutritive value and shelf-life. Department of Nutrition and Quality, Santa Catalina Experimental Station of the Agriculture Research Institute (INIAP), Quito.

Lock, S. and Bender, A.E. 1980. Measurement of chemically-available iron in foods by incubation with human gastric juice in vitro. *British Journal of Nutrition* **43**: 413–420.

Mertz, E.T., Hassen, M.M., Cairns-Whittern, C., Kirleis, A.W., Tu, L. and Axtell, J.D. 1984. Protein digestibility of proteins in sorghum and other major cereals. In: Proc. of the National Academy of Sciences, United States of America, pp. 1-2.

Monika, S. and Mridula, D. 2015. Development and quality evaluation of maize based fortified nutritious bar. *Agricultural Research* **4**: 93-101.

Omer, M.T. 2009. Development, characterization and shelf-life optimization of a prototype nutrient dense food bar. Ph.D. Thesis, University of Agriculture, Faisalabad, Pakistan.

Ranhotra, G.S. 1980. Nutritional profile of high protein cookies. *Cereal Food World* **25**: 308–309.

Rocha, M.C., Emilie, C. and Morais, M.M. 2003. Effect of vaccum packaging on the physical quality of minimally processed potatoes. *Food Service Technol.,* **3**: 81-88.

Sathe, S.K., Tamhane, D.V. and Salunkhe, D.K. 1981. Studies in saltine crackers. I. Composition and certain physico-chemical changes during baking. *Cereal Food World,* **26**: 404–406.

Siddhuraju, P. and Becker, K. 2001. Effect of various domestic processing methods on anti-nutrients and *in vitro* protein and starch digestibility of two indigenous varieties of Indian tribal pulse, *Mucuna pruriens* var. *utilis*. *J Agric Food Chem.,* **49**: 3058-3067.

Singh, R., Singh, G. and Chauhan, G.S. 1996. Effect of incorporation of defatted soy flour on quality of biscuits. *J Food Sci. Technol.,* **33**: 355–357.

Soyatech, 2012. "How the Global Oil Seed and Grain Trade Works". Trade flow manual.

Srilakshmi, B. 2007. Food Science. New Age International Publishers, New Delhi, pp. 280.

Tripathi, A.K. and Mishra, A.K. 2005. Soybean: a consummate functional food: a review. *J Food Sci. Technol.,* **42**: 111–119.