Himachal Journal of Agricultural Research 47(1): 66-76 (2021)

Development and storage stability of multi seed energy bars for sports persons

Diksha Sharma*, Sangita Sood, RanjanaVerma and Ankaj Thakur[1]

Department of Food Science,Nutrition and Technology
College of Community Science
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.

*Corresponding author: jgd.diksha043@gmail.com
Manuscript received: 10.11.2020; Accepted: 25.02.2021

Abstract

The present investigation was carried out to develop and characterize the energy bars for the sports person using different seeds viz., Flax seeds, Chia seeds, Pumpkin seeds. Bars were prepared by using multi seeds blended at various levels viz., 5, 10, 15 and 20 per cent by using finger millet as a base. Proximate parameters estimation was done to assess the nutritional profile of all the developed energy bars. The results revealed that Flaxseed blended energy bar with 15 per cent and 20 per cent composition obtained highest crude protein i.e. 12.93 & 13.28 per cent and energy 444.67 & 452.69 kcal/100g when compared to other treatments. The proximate parameters of all the energy bars varied non- significantly during the storage period up to thirty days. Therefore, Flaxseed energy bars with 15 per cent and 20 per cent composition can be recommended to the sports person to meet their nutritional requirement and as a quick source of energy.

Key words: Sports Nutrition, Energy bars, Flax seed, Chia seed, Pumpkin seed.

Nutrition plays a significant role in maintenance of health and activating the athletes to train and compete. A sports person is a fitter individual in society and the person needs enhanced nutrition. Sports nutrition has emerged as a strong decisive factor in optimizing performance of sports persons as sports, health and nutritional status are interrelated. Indian athletes have subnormal nutritional and dietary practices because they are lacking awareness of sports nutrition (Sangeetha *et al*. 2014).

Owing to their lack of time and low supply of nutritious food during practice, athletes are looking for such diets that can be quickly eaten, while at the same time supply the required nutrition. Now days the demand of nutritionally balanced snacks and drinks are increasing among the sportsperson (Burns *et al*. 2004; Itagi *et al*. 2012).Energy bars are cereal-containing supplementary bars and other high-energy foods aimed at individuals who need quick energy but do not have time for a meal. They are different from the energy drinks contain caffeine, and bars provide energy for food. The three key sources of energy in food come from: fat, protein, and carbohydrates. A typical energy bar weighs between 45 and 80 g and is likely to have approximately 200-300 calories (840-1,300 calories KJ), 3 to 9 g of fat, 7 to 15 g of protein, and 20 to 40 g of carbohydrates (Tiwari, 2017).

Finger millet which is commonly used for preparation of flour, pudding, porridge and roti has best quality protein along with the presence of essential amino acids {isoleucine (400 mg/g N), leucine (690 mg/g N), methionine (210 mg/g N) and phenyl alanine (310 mg/g N)}, vitamins {Thiamine (0.42 mg) , Riboflavin (0.19 mg), Niacin (1.1 mg)}and phosphorus (283 mg){Chaturvedi and Srivastava, 2008, Gopalan *et al*. 2004, USDA Food and Nutrient Database for Dietary Studies}. Flaxseed proteins were also reported to have potent multi-functional ingredients for food formulation owing to their techno functionalities (emulsifying, foaming ability and stability), food preservation capacity, and health benefits (Rabetafika *et al*. 2011). Flax contains about 40 per cent fat, 28 per cent dietary fibers, 4 per cent ash, 21 per cent proteins and 6 per cent carbohydrates

[1]Department of Livestock Farm Complex, DGCN COVAS, CSKHPKV, Palampur- 176 062, India.

such as sugars, lignins, phenolic acids, and hemicelluloses (AACC, 2000). Chia seeds were also reported to have protein content of 15-24 per cent (Ayerza and Coates, 2004; Ayerza and Coates, 2009). Chia seeds have a high nutritive value and extensive health promoting properties having protein (16.5 g/100g),energy (486.0 k cal) and carbohydrates (42.1 g/100 g) {USDA, 2018}. The percentage values of protein, fat, ash, fiber, moisture and carbohydrates in pumpkin seeds as 31.57, 29.01, 3.89, 6.36, 5.11 and 24.06 per cent respectively (Abd El-Ghany *et al*. 2010). Jaggery is also reported to purify blood, regulate liver function and keep the body healthy (Veldhyyzen-van, 1999). Energy bars were standardized using different level of seeds, honey, peanut butter and Jaggery addition. Therefore taking the advantage of nutritional values of ingredients, energy bars were developed using different types of seeds viz; Flax seeds, Chia seeds, Pumpkin seeds and the effect of storage period on proximate composition is studied.

Materials and Methods

Different types of energy bars were prepared viz. control bar, flax seed bar, chia seed bar and pumpkin seed bar using different proportions of seeds i.e. 5 per cent, 10 per cent, 15 per cent and 20 per cent. The control bar was prepared with finger millets, peanut butter, jaggery and honey only. Finger millets were used as base for all the bars. Standardization of method/recipes for development of energy bars is given in Fig. 1. Bars were prepared using different types of seeds viz; Flax seeds, Chia seeds, Pumpkin seeds at the blending level of 5, 10, 15 and 20 per cent (Fig. 2). All the developed energy bars (Fig 3) were analyzed in order to obtain the nutrient composition. The Macronutrients analyzed were moisture, ash, energy, protein, fat and carbohydrates. Proximate composition was done by standard method as described by AOAC (2010).

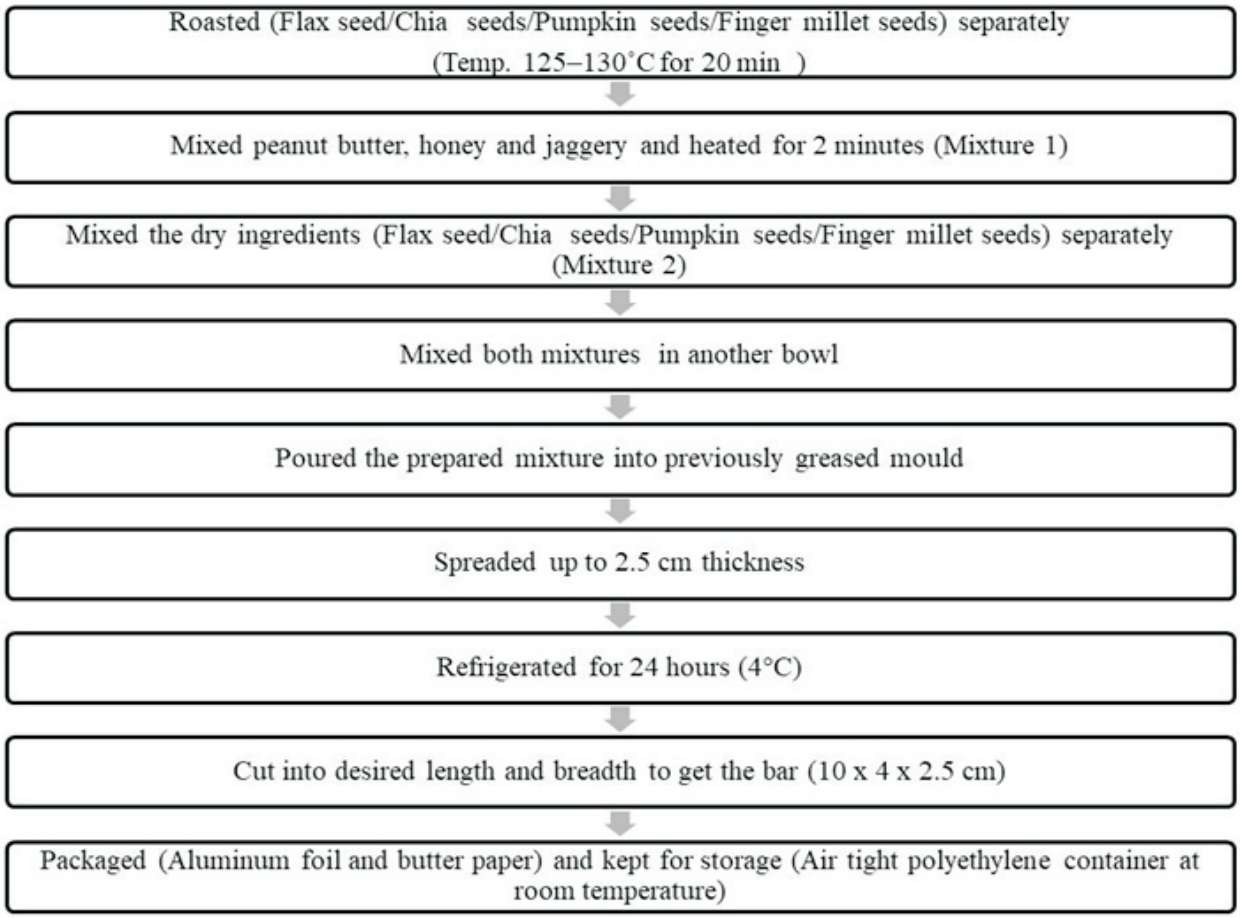

Fig.1. Flow chart of the standardization of method/recipes for development of energy bars at different level using different type of seeds i.e. Flax, Chia, Pumpkin, Finger millet

Bars	Interactions	Ingredients (in grams)						
		Finger millet	Flax seed	Chia seed	Pumpkin seed	Honey	Peanut butter	Jaggery
Control bar	B_0	15	0	0	0	5	15	15
Flax seed bars								
	FB_1	15	5	0	0	5	15	15
	FB_2	15	10	0	0			
	FB_3	15	15	0	0			
	FB_4	15	20	0	0			
Chia seed bars								
	CB_1	15	0	5	0	5	15	15
	CB_2	15	0	10	0			
	CB_3	15	0	15	0			
	CB_4	15	0	20	0			
Pumpkin seed bars								
	PB_1	15	0	0	5	5	15	15
	PB_2	15	0	0	10			
	PB_3	15	0	0	15			
	PB_4	15	0	0	20			

Fig. 2. The interactions, sub-interactions and ingredients used for the developed energy bars

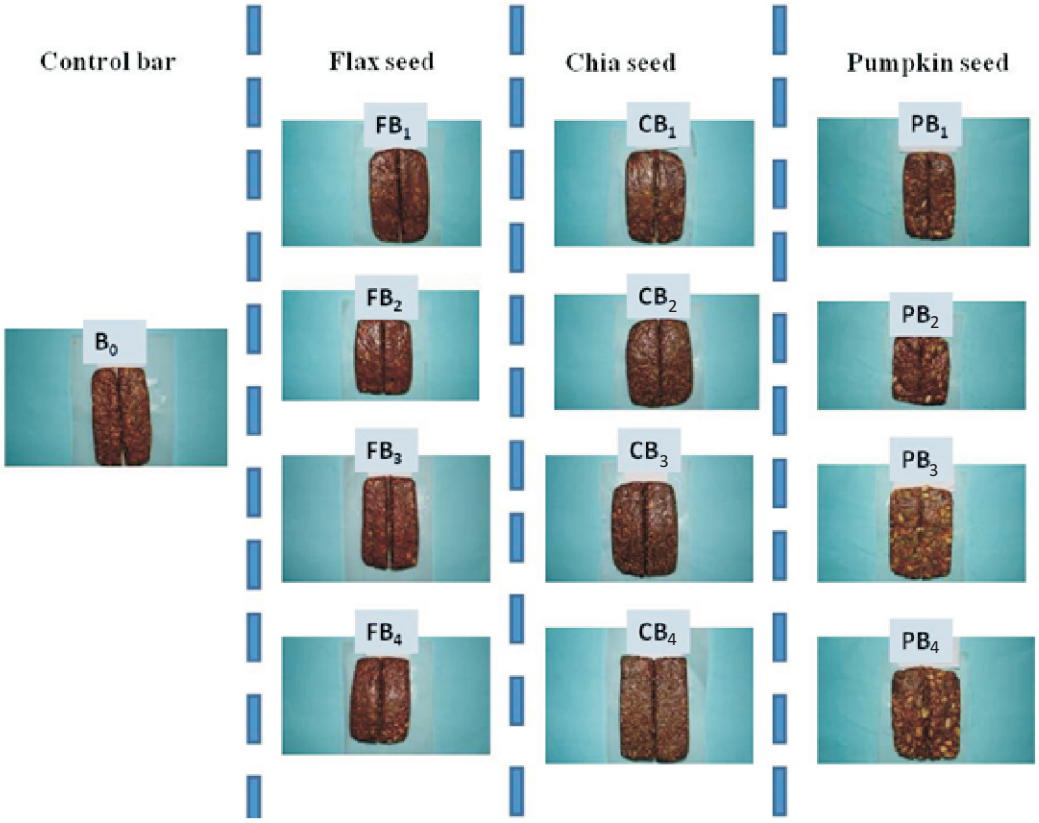

Fig. 3. Developed energy bars of Finger millet, Flax seeds, Chia seeds, Pumpkin seeds

Result and Discussions

Flax seed blended bar

Moisture

Flaxseed energy bars showed non-significant ($p \leq 0.05$) increase in moisture content during storage period of 30 days. This might have been due to hydroscopic nature of material which absorbs moisture from atmosphere. A significant ($p \leq 0.05$) difference in moisture content was observed in between the samples when these were compared with each other. Maximum moisture was observed in FB_1 i.e. 6.74 per cent, whereas minimum was found in FB_2 5.14 per cent in fresh sample. Ateequddin and Ingle (2015) reported the moisture content in the range of 14.61, 12.35, 14.64, 15.64, and 16.58 per cent in five different flax date bars, Whereas, Mridula *et al*. (2013) observed the moisture content in the range of 11.7 to 13.1 per cent in prepared omega-3 rich bars utilizing different proportions of flaxseed i.e. at 0, 5, 10, 15, and 20 per cent. However, Padmashree *et al*. (2012) reported 7.2 per cent of moisture in composite cereal bar which corroborate the present results.

Total ash

The total ash content during the storage period had a non-significant decrease in the ash content. A non-significant ($p \leq 0.05$) difference in ash content was observed in between the samples when these were compared with each other. Maximum ash content was found in fresh FB_4 i.e. 2.37. The decrease in ash content might be due to the increase in moisture content. Mridula *et al*. (2013) observed ash content in the range of 1.2-1.7 per cent in the omega-3 rich bars with increasing content of flaxseed from 0-20 per cent. The difference in ash content might be due to the different ingredients used in the development of bars at varying proportions.

Crude protein

A perusal of the data presented in Table 1 reveals that the protein content was found to be maximum in FB_4 samples i.e.13.28 per cent whereas control bar had minimum protein content i.e. 8.31 per cent. The protein content increased significantly with the increase in proportion of flax seeds. The protein content decreased non-significantly ($p \leq 0.05$) from fresh to 30 days storage intervals in control sample i.e. 8.31 and 8.28. The protein content decreased as the storage period was increased but it was statistically non-significant which indicates no deterioration in the quality of the product during storage period. Mridula *et al*. (2013) also observed similar trend where increase in the amount of flaxseed increased the protein content of the omega-3 rich energy bar. The protein values ranged between (10.3-9.1 %), on 0 per cent proportion in 5 (10.9-9.9 %), 10 (11.32-10.2 %), 15 (11.8-10.8 %), 20 (11.9-11.4 %) of flaxseed supplementation. The variation might be due to the varietal difference of seed or different proportion of ingredients used.

Crude fat

Increasing the storage interval had a non-significant ($p \leq 0.05$) decrease in fat content. The Maximum fat content was observed in FB_4 i.e. 16.28 followed by 16.08 in fresh and 30 days of storage interval respectively. A significant ($p \leq 0.05$) difference in fat content was observed in between the samples when these were compared with each other. The results are in line with the findings of Ateequddin and Ingle (2015) who found higher content of fat ranging from 12.48- 16.58 per cent, whereas, Mridula *et al*. (2013) observed crude fat in the range from 4.3- 11.9 per cent when the flaxseed content was increased from 0-20 per cent. The variation in the fat content might be due to the use of hydrogenated fat or nuts.

Crude fiber

The data pertaining to the fiber content of flax seed bars presented in Table 1 reveals that the fiber content was found to be maximum in FB_4 samples i.e. 1.57 per cent whereas control bar (B_0) had minimum fiber content i.e.1.13 per cent. The fiber content decreased non-significantly ($p \leq 0.05$) from fresh to 30 days storage intervals in control sample i.e. 1.13 and 1.10. Fiber content was decreased significantly ($p \leq 0.05$) in all the samples from fresh to 30 days of storage intervals. The present findings are in agreement with the findings of Mridula *et al*. (2013) who reported the crude fiber content in the range of 0.9-2.1 per cent when the proportions of flaxseed was increased from 0-20 per cent. The increase in fiber content might be due to the increase in the blending level of seeds

Carbohydrate

B_0 bars contained the highest carbohydrate content i.e. 71.75 per cent and the minimum was found in FB_3 bars i.e. 62.52 per cent. The carbohydrate content was found to increase significantly ($p \leq 0.05$) in between the

samples. Mridula *et al*. (2013) reported carbohydrate content of rich energy bar in the range of (71.5-60.4%). Whereas, Ateequddin and Ingle (2015) reported carbohydrate content such as 57.60, 57.64, 51.85 and 55.83 per cent in flaxseed –Date bar with 0, 5, 10, 15 and 20 per cent flaxseed flour, respectively.

Energy

It is apparent from the data presented in Table 1 that the FB_4 bars contains the maximum energy value i.e. 452.69 kcal and B_0 had the minimum energy value i.e. 424.92 kcal. The energy content of all the samples non- significantly ($p \leq 0.05$) decreased as the storage intervals increased to 0 and 30 days whereas, a significant ($p<0.05$) difference in energy content was observed in between the samples when these were compared with each other. Ateequddin and Ingle (2015) also observed similar trend where the energy content increased as 353.75, 364.72, 370.00, 373.71 and 377.08 per cent with 0, 5, 10, 15 and 20 per cent of flaxseed respectively. Mridula *et al*. (2013) observed energy content as 367.4 to 390.5 per cent which is less as compared to the present findings.

Table 1. Proximate composition of developed flax seed blended bar (% dw basis)

Parameter	Days	B_0	FB_1	FB_2	FB_3	FB_4	Mean
Moisture content (%)	0	5.61	6.74	5.14	5.68	5.78	5.79
	30	5.69	6.77	5.37	5.97	5.81	5.92
	Mean	5.65	6.76	5.26	5.82	5.79	
	CD for comparison of storage periods – NS CD for comparison of samples - 0.73 CD for comparison of interaction- NS						
Ash content (%)	0	1.86	2.07	1.98	2.08	2.37	2.07
	30	1.82	2.04	1.95	2.06	2.35	2.04
	Mean	1.84	2.05	1.96	2.07	2.36	
	CD for comparison of storage periods – NS CD for comparison of samples - NS CD for comparison of interaction- NS						
Crude protein (%)	0	12.17	10.68	11.81	12.93	13.28	12.17
	30	8.81	10.89	11.78	12.90	13.12	11.50
	Mean	10.49	10.78	11.79	12.91	13.20	
	CD for comparison of storage periods – NS CD for comparison of samples – 1.31 CD for comparison of interaction- NS						
Crude fat (%)	0	11.38	14.90	15.61	15.86	16.28	14.81
	30	11.37	15.20	15.59	15.84	16.08	14.82
	Mean	11.38	15.05	15.61	15.85	16.19	
	CD for comparison of storage periods – NS CD for comparison of samples – 1.53 CD for comparison of interaction- NS						
Crude fiber (%)	0	1.13	1.24	1.37	1.51	1.57	1.37
	30	1.10	1.24	1.35	1.49	1.53	1.34
	Mean	1.12	1.24	1.36	1.50	1.55	
	CD for comparison of storage periods – NS CD for comparison of samples - 0.25 CD for comparison of interaction- NS						
Carbohydrate (%)	0	71.75	65.77	64.59	62.52	63.23	65.57
	30	71.72	66.80	64.22	62.49	62.06	65.46
	Mean	71.74	66.29	64.41	62.51	62.65	
	CD for comparison of storage periods – NS CD for comparison of samples - 0.75 CD for comparison of interaction- NS						
Energy(kcal/100g)	0	424.94	440.07	447.61	444.67	452.69	442.00
	30	424.97	449.47	447.64	444.61	448.00	442.94
	Mean	424.96	444.77	447.63	444.65	450.35	
	CD for comparison of storage periods –NS CD for comparison of samples – 7.44 CD for comparison of interaction- NS						

Chia seed blended bar

Moisture content

In Chia seed bars with increase in storage interval, a non-significant ($p \leq 0.05$) increase in moisture content was observed. Maximum increase in moisture content in all the treatment was observed in 30 days of storage which might have been due to hydroscopic nature of material which absorbs moisture from atmosphere. A non-significant ($p \leq 0.05$) difference in moisture content was observed in between the samples when these were compared with each other. Maximum moisture was observed in sample CB_4 i.e. 5.76 per cent, whereas minimum was found in CB_2 5.50 per cent in fresh sample. Nadeem *et al*. (2011) obtained comparatively low moisture content in bars prepared from different ingredients.

Total ash

There was a non-significant decrease in the ash content of chia seed bars after storage period of thirty days. A non-significant ($p \leq 0.05$) difference in ash content was observed in between the samples when these were compared with each other. Maximum ash content was found in fresh CB_4 i.e. 2.37. The decrease in ash content might be due to the increase in moisture content.

Crude protein

The protein content was found to be maximum in CB_4 samples i.e.12.28 per cent whereas controls bar (CB) had minimum protein content i.e. 8.84 per cent. The protein content decreased non-significantly ($p \leq 0.05$) from fresh to 30 days storage intervals in control sample i.e. 8.84 and 8.81. Protein content was decreased significantly ($p \leq 0.05$) in all the samples from fresh to 30 days of storage intervals.

Crude fat

In chia seeds bars a non-significant ($p \leq 0.05$) decrease in fat content was observed with the storage period of thirty days. The Maximum fat content was observed in CB_4 i.e. 16.72 followed by 16.70 in fresh and 30 days of storage interval respectively. A significant ($p \leq 0.05$) difference in fat content was observed in between the samples when these were compared with each other. The high amount of crude fat in present investigation is attributed to the use of peanut butter. Nadeem *et al*. (2011) in their study reported lower values for lipid 8.37 per cent which is much less as compared to test samples. This might be the use of difference in the basic ingredients.

Crude fiber

The data pertaining to the fiber content of chia seed bars presented in Table 2 reveals that the fiber content was found to be maximum in CB_4 samples i.e. 5.26 per cent whereas control bar (B_0) had minimum fiber content i.e.1.14 per cent. The fiber content decreased non-significantly ($p \leq 0.05$) from fresh to 30 days storage intervals in control sample i.e. 1.14 and 1.10. The amount of crude fiber varied in the bars with the amount of chia seeds added in the developed bars. Ding *et al*. (2018) reported that Chia seeds comprised 56.4 gm/100gm of dietary fire which imparts good water holding capacity and high emulsifying activity. Romankiewicz *et al*. (2017) also reported dietary fiber content increases as high as 7.19 per cent with 8 per cent Chia seed addition. Singh *et al*. (2020) also reported that fiber content varied from 7.87 ± 0.13 to 13.28 ± 0.08 in the nutri bar which shows high fiber content in the product.

Carbohydrate

The B_0 bars contained highest carbohydrate content i.e. 71.75 per cent and the minimum was found in CB_4 bars i.e. 58.35 per cent. The carbohydrate content was found to increase significantly ($p \leq 0.05$) in between the samples. The results are in line with the findings of Mridula *et al*. (2013) who reported carbohydrate content ranging from 60.4 to 71.5 per cent in energy bar.

Energy

The CB_3 bars contain the maximum energy value i.e. 435.26 kcal/1 g and B_0 had the minimum energy value i.e. 424.94 kcal/100g. The energy content of all the samples non- significantly ($p \leq 0.05$) decreased as the storage intervals increased to 0 and 30 days. A non-significant ($p \leq 0.05$) difference in energy content was observed in between the samples when these were compared with each other. Mridula *et al*. (2013) observed energy content in the range of 367.4 to 390.5 per cent, which is less as compared to the present findings. The difference may be attributed to the high amount of protein and fat content.

Table 2. Proximate composition of developed chia seed blended bar (% dw basis)

Parameter	Days	B_0	CB_1	CB_2	CB_3	CB_4	Mean
Moisture content (%)	0	5.61	5.74	5.50	5.61	5.76	5.64
	30	5.65	5.77	5.52	5.64	5.79	5.67
	Mean	5.63	5.76	5.51	5.62	5.77	
	CD for comparison of storage periods – NS CD for comparison of samples - NS CD for comparison of interaction- NS						
Ash content (%)	0	1.86	2.07	1.98	2.08	2.37	2.07
	30	1.82	2.04	1.95	2.06	2.35	2.04
	Mean	1.84	2.06	1.97	2.07	2.36	
	CD for comparison of storage periods – NS CD for comparison of samples - NS CD for comparison of interaction- NS						
Crude protein (%)	0	8.84	10.20	10.99	11.40	12.28	10.74
	30	8.81	10.18	10.59	11.38	12.24	10.64
	Mean	8.82	10.19	10.79	11.39	12.26	
	CD for comparison of storage periods – NS CD for comparison of samples – 0.50 CD for comparison of interaction- NS						
Crude fat (%)	0	11.39	14.59	15.08	15.87	16.72	14.73
	30	11.36	14.88	15.05	15.89	16.70	14.78
	Mean	11.37	14.73	15.06	15.88	16.71	
	CD for comparison of storage periods – NS CD for comparison of samples – 1.51 CD for comparison of interaction- NS						
Crude fiber (%)	0	1.14	2.37	3.76	4.70	5.26	3.45
	30	1.10	2.34	3.75	4.87	5.24	3.46
	Mean	1.12	2.35	3.75	4.78	5.25	
	CD for comparison of storage periods – NS CD for comparison of samples - 0.40 CD for comparison of interaction- NS						
Carbohydrate (%)	0	71.75	65.74	63.16	60.74	58.35	63.95
	30	71.73	65.46	62.88	60.71	58.32	63.82
	Mean	71.74	65.60	63.02	60.73	58.34	
	CD for comparison of storage periods – NS CD for comparison of samples - 0.65 CD for comparison of interaction- NS						
Energy(kcal/100g)	0	424.94	435.18	432.42	435.26	431.81	431.92
	30	424.98	435.22	432.45	431.37	431.83	418.62
	Mean	424.96	435.20	432.44	433.31	431.82	
	CD for comparison of storage periods –NS CD for comparison of samples - NS CD for comparison of interaction- NS						

Pumpkin seed blended bar

Moisture content

Storage interval had a non-significant ($p \leq 0.05$) increase in moisture content was observed. Maximum increase in moisture content in all the treatment was observed in 30 days of storage which might have been due to hydroscopic nature of material which absorbs moisture from atmosphere. A non-significant ($p \leq 0.05$) difference in moisture content was observed in between the samples when these were compared with each other. Maximum moisture was in PB_4 i.e. 6.21 per cent, whereas minimum was found in PB_3 5.60 per cent in fresh sample. Gutkoski *et al*. (2007) evaluated oat-based CBs, and found average values of moisture content as 13.42 g 100 g^{-1}. Fonseca *et al*. (2011) studied CBs prepared with pineapple peels and reported average moisture contents of 4.61 g 100 g^{-1}. Variation in moisture content is probably due to the ingredients used in the preparation of the bars.

Total ash

In pumpkin seed bars with increase in storage there was a non-significant decrease in the ash content observed in bars. A non-significant ($p \leq 0.05$) difference in ash content was observed in between the samples when these were compared with each other. Maximum ash content was found in fresh PB_2 i.e. 2.26 per cent. The decrease in ash content might be due to the increase in moisture content.

Crude protein

The protein content was found to be maximum in PB_4 samples i.e.12.24 per cent whereas control bars (B_0) had minimum protein content i.e. 8.84 per cent. The protein content decreased non-significantly ($p \leq 0.05$) from fresh to 30 days storage intervals in control sample i.e. 8.84 and 8.81. Protein content was increased significantly ($p < 0.05$) in all the samples. The protein content increased as the proportion of the seeds increased in the bars. Gutkoski *et al*. (2007) developed an oat-based CB and reported average protein content of 11.43 g 100 g^{-1} and ether extract content of 6.57 g 100 g.

Crude fat

The data in Table 3 shows the effect of storage on crude fat content in the bars prepared by using pumpkin seeds at different proportions of pumpkin seed bars up to 30 days storage interval. As is clear from the data that with increase in storage interval a non-significant ($p \leq 0.05$) decrease in fat content was observed. The Maximum fat content was observed in PB_4 i.e. 13.82 per cent followed by 13.80 per cent in fresh and 30 days of storage interval respectively. A significant ($p \leq 0.05$) difference in fat content was observed in between the samples when these were compared with each other.

Crude fiber

The fiber content was found to be maximum in PB_2 samples i.e. 1.53 per cent whereas control bar (B_0) had minimum fiber content i.e.1.13 per cent. The fiber content decreased non-significantly ($p \leq 0.05$) from fresh to 30 days storage intervals in control sample i.e. 1.13 and 1.10. There was non-significant difference observed among the samples also. Lima *et al*. (2010) evaluated CBs containing baru pulp and almond and reported crude fiber in the range of 14.86 to 16.73 g $100g^{-1}$. The variations were probably due to the components used in the preparation of the bars.

Carbohydrate

The data depicted in Table 3 show carbohydrate content of the pumpkin seed bars. The data reveals that the PB_1 bars contained highest carbohydrate content i.e. 73.89 per cent and the minimum was found in PB_4 bars i.e. 64.32 per cent. The carbohydrate content was found to increase significantly ($p \leq 0.05$) in between the samples. The results are in accordance with Seth and Kochhar (2016) who reported that the nutritional value of control and experimental cookies supplemented with 10 per cent level of partially defatted peanut flour per 100 g as carbohydrates 66.25 and 62.87 per cent.

Energy

The PB_1 bars contains the maximum energy value i.e. 443.66 kcal and PB_2 had the minimum energy value i.e. 422.14 kcal. The energy content of all the samples non- significantly ($p \leq 0.05$) decreased as the storage intervals increased to 0 and 30 days. There was also a non-significant ($p \leq 0.05$) difference in energy content between the samples when these were compared with each other. Seth and Kochhar (2016) observed that the nutritional value of control and experimental cookies supplemented with 10 per cent level of partially defatted peanut flour per 100 gas following: energy 531 and 534 Kcal/100g.

Table 3. Proximate composition of developed pumpkin seed blended bar (% dw basis)

Parameter	Days	B_0	PB_1	PB_2	PB_3	PB_4	Mean
Moisture content (%)	0	5.61	5.90	6.09	5.60	6.21	5.88
	30	5.65	5.93	6.13	5.64	6.24	5.92
	Mean	5.63	5.91	6.11	5.62	6.22	
	CD for comparison of storage periods – NS CD for comparison of samples - NS CD for comparison of interaction- NS						
Ash content (%)	0	1.86	2.14	2.26	1.93	2.09	2.06
	30	1.83	2.09	2.23	1.92	2.06	2.03
	Mean	1.85	2.12	2.25	1.93	2.08	
	CD for comparison of storage periods – NS CD for comparison of samples - NS CD for comparison of interaction- NS						
Crude protein (%)	0	8.84	9.64	10.49	11.53	12.24	10.55
	30	8.81	9.41	10.46	11.62	12.22	10.50
	Mean	8.83	9.53	10.48	11.58	12.23	
	CD for comparison of storage periods – NS CD for comparison of samples – 1.44 CD for comparison of interaction- NS						
Crude fat (%)	0	11.39	12.16	12.27	12.21	13.82	12.37
	30	11.37	11.89	12.23	12.26	13.80	12.31
	Mean	11.38	12.03	12.25	12.24	13.81	
	CD for comparison of storage periods – NS CD for comparison of samples – 1.40 CD for comparison of interaction- NS						
Crude fiber (%)	0	1.13	1.25	1.53	1.42	1.51	1.37
	30	1.10	1.29	1.52	1.41	1.47	1.36
	Mean	1.12	1.27	1.53	1.42	1.49	
	CD for comparison of storage periods – NS CD for comparison of samples - NS CD for comparison of interaction- NS						
Carbohydrate (%)	0	71.75	73.89	67.43	66.88	64.32	68.85
	30	71.73	72.31	67.41	67.08	64.29	68.56
	Mean	71.74	73.10	67.42	66.98	64.31	
	CD for comparison of storage periods – NS CD for comparison of samples – 5.96 CD for comparison of interaction- NS						
Energy(kcal/100g)	0	424.94	443.66	422.14	423.58	430.68	429.00
	30	424.98	434.45	422.18	428.13	430.72	428.09
	Mean	424.96	439.05	422.16	425.85	430.70	
	CD for comparison of storage periods –NS CD for comparison of samples - NS CD for comparison of interaction- NS						

Conclusion

Increasing the level of inclusion of seeds in the energy bars significantly increased the macro nutrient profile. Flaxseed energy bar with 15 per cent and 20 per cent composition was having highest crude protein and energy when compared to all the energy bars. Storage of blended energy bars for thirty days showed no significant change in the nutrient profile. Hence, flaxseed energy bar can be recommended to the sports person which may help in enhancing their sports performance.

Acknowledgement

The authors are thankful to the Department of Food Science, Nutrition and Technology, CSKHPKV, Palampur and Department of Animal Nutrition, DGCN COVAS, for providing necessary laboratory facility and support for carrying out the study.

Conflict of interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

AACC. 2000. Approved Methods of the American Association of Cereal Chemists. The American.

Abd El-Ghany BF, Arafa RA, El-Rahmany TA and El-Shazly MM. 2010.Effect of some soil microorganisms on soil properties and wheat production under North Sinai conditions. Journal of Applied Sciences Research **4** (5):559-579.

Arazi H and Hosseini R. 2012. A comparison of nutritional knowledge and food habits of collegiate and non-collegiate athletes. Sport Logia **8** (2):100-107.

Ateequddin MS and Ingle MP. 2015. Physicochemical evaluation of flaxseed-date bar. International Journal of Engineering Research and Applications **5** (9):54-57.

Ayerza R and Coates W. 2009. Influence of environment on growing period and yield, protein, oil and á-linolenic content of three chia (*Salvia hispanica* L.) selections. Industrial Crops and Products **30** (2):321-324.

Ayerza RH and Coates W. 2004. Composition of chia (*Salvia hispanica*) grown in six tropical and subtropical ecosystems of South America. Tropical Science **44** (3):131-135.

Burns RD, Schille MR, Merrick MA and Wolf KN. 2004. Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counseling. Journal of the American Dietetic Association **104** (2):246-249.

Chaturvedi R. and Srivastava S. 2008. Genotype variations in physical, nutritional and sensory quality of popped grains of amber and dark genotypes of finger millet. Journal Of Food Science And Technology-Mysore **45** (5):443-446.

Ding Y, Lin HW, Lin YL, Yang DJ, Yu YS, Chen JW and Chen YC. 2018. Nutritional composition in the chia seed and its processing properties on restructured ham-like products. Journal of Food and Drug Analysis **26**(1): 124-134.

Fonseca RS, Del Santo VR, Souza GB and Pereira CAM. 2011. Elaboração de barra de cereais com casca de abacaxi. Archivos Latinoamericanos de Nutrición **61** (2): 216-223.

Gopalan C, Rama Sastri BV and Balasubramanian SC. 2004. Nutritive value of Indian foods (Revised and updated, Narasinga Rao BS, Deosthale YG and Pant KC). ICAR-National Institute of Nutrition, Hyderabad.

Gutkoski LC, Bonamigo JMA, Teixeira DMF and Pedó I.2007. Desenvolvimento de barras de cereais à base de aveia com alto teor de fibraalimentar. Food Science and Technology **27**(2):355-363.

Itagi HBN and Singh V. 2012.Preparation, nutritional composition, functional properties and antioxidant activities of multigrain composite mixes. Journal of Food Science and Technology **49** (1):74-81.

Lima JCR, Freitas JB, Czeder LP, Fernandes DC and Naves MMV. 2010. Qualidademicrobiológica, aceitabilidade e valor nutricional de barras de cereaisformuladas com polpa e amêndoa de baru. Boletim do Centro de Pesquisa de Processamento de Alimentos **28** (2): 331-343.

Mridula D, Singh KK and Barnwal P. 2013. Development of omega-3 rich energy bar with flaxseed. Journal of Food Science and Technology **50** (5): 950-957.

Nadeem M, Anjum FM, Hussain S, Khan MR and Shabbir MA. 2011. Assessment of the antioxidant activity and total phenolic contents of sunflower hybrids. Australian Journal of Basic and Applied Sciences **5** (11): 978-983.

National Nutrient Database for Standard Reference, Release 28. 2018. Available online: http: //www.ars.usda.gov/ba/bhnrc/ndl (accessed on 3 May 2019).

Padmashree A, Sharma GK, Srihari KA and Bawa AS. 2012. Development of shelf stable protein rich composite cereal bar. Journal of Food Science and Technology **49** (3):335-341.

Rabetafika HN, Van Remoortel V, Danthine S, Paquot M and Blecker C. 2011. Flaxseed proteins: food uses and health benefits. International journal of Food Science & Technology **46** (2):221-228.

Romankiewicz D, Hassoon WH, Cacak-Pietrzak G, Sobczyk M, Wirkowska-Wojdyla M, Cegliñska A and Dziki D. 2017. The effect of chia seeds (*Salvia hispanica* L.) addition on quality and nutritional value of wheat bread. Journal of Food Quality 2017 Article ID 7352631, 7 pages, https:// doi.org/ 10.1155/ 2017/7352631

Sangeetha KM, Ramaswamy L and Jisna PK. 2014.Assessment of Nutritional status, Nutritional knowledge & Impact of Nutrition education among selected sports persons of Coimbatore district. International Journal of Scientific Research **3** (11): 970-978.

Seth K and Kochhar A.2016. Evaluation of nutritional values in biscuits and cookies developed using partially defatted peanut flour. Journal of Eco-friendly Agriculture **11**: 170-174.

Singh J, Sharma B, Madaan M, Sharma P, Kaur T, Kaur N and Rasane P. 2020. Chia seed-based nutri bar: optimization, analysis and shelf life. Current Science **118** (9): 1394-1400.

Tiwari P, Agrahari K, Jaiswal M and Singh A.2017. Standardization and development of different types of energy bars. International Journal of Home Science **3** (1):370-372.

Veldhyyzen-van Zenten .1999. New uses for panela. Food Chain **25**: 11-13.