Development of High Energy Cereal and Nut Granola Bar

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Abstract: *Granola is the nutritious product prepared with a different level of cereals, chickpeas, nuts, and raisins because they are the valuable source of protein and can be used as a complementary protein source of each other. The products were analyzed for nutritional quality, texture, and sensory attributes. Moisture content was same in all bars. The product is having a high concentration of oats, puffed rice, nuts and chickpea show maximum level of calories (421.88 kcal) with a high percentage of crude protein (12.51%), fat (10.4%), ash (1.51%), and crude fiber (3.45%) content. A significant amount of minerals was present in all the treatments especially magnesium. Formulation D with 15 % level of each ingredient like puffed rice, chickpea, nuts and oat flakes have a rich amount of protein and fats and is a good source of calories. Highest mean score regarding all sensory attributes was given to formulation D and C for their nutty and crunchy taste. To some extent, all these bars provide energy and basic nutrients to the consumer.*
Keywords *Cereal, Granola bar, Nutrition, Protein, Fat, Sensory evaluation*

INTRODUCTION

Granola is highly nutritious product categorized as snack food and can be prepared using diversified ingredients. Some of these ingredients may include: cereal grains, rolled or flaked oat and barley, cereal grain germ part, honey, nuts, raisins and some other ingredients. It is baked or cooked product and during baking and cooking mixture is continuously stirred to maintain a loss consistency. For convenient consumption of granola, it is converting it into a pressed bar shape. By changing the ingredients nutritional value of granola can be modified. Making granola bar using cereal grains is a common practice in all areas of this globe. This is owed to the popularity of cereals attributed to its nutraceutical and functional properties and has been used in the formulation of different products. For more convenient consumption of cereal, there is a growing trend to introduce readily to eat cereal-based products in the market for a busy consumer that not only provide nutrition but also help in maintaining the health of people. Nutritionally, combining cereals with other ingredients are valuable to provide a balanced amount of protein especially sulfur-containing amino acids and lysine that are otherwise deficient in most of the cereal grains. This deficiency often fulfilled by adding legume in the product. Similarly, to improve the fatty acid composition of the product, nuts play a vital role to supply essential fatty acids along with the provision of some phytosterols. Presence of these phytosterols along with other bioactive helps in regulating lipoprotein profile by maintaining a balance among total cholesterol, LDL, and HDL. Controlling these parameters helps to lower the risk of various types of cancers (Hicks et al., 2015). Similar is the case with protein that may be added to granola bars and other products to enhance functional properties as well as the protein quality. Balanced and high-quality protein is required for various regulatory functions of the body. Animal protein is thought to be a good source of protein but it is costly, and most people cannot afford to buy. Therefore product development using plant sources of protein is usually preferred. The objective of this research was to develop a high protein and high energy nutritious bar using plant source that would provide balance nutrients, required for various body functions.

MATERIALS AND METHODS

Raw Materials:

Different type of raw materials was used to prepare the granola bar. The details of this raw material areas under Cornflakes (gifted by Fauji cereals company), oat flakes (Quaker oats), puffed rice (gifted by Fauji cereals company), wheat germ (Sahala mill Rawalpindi), roasted chickpea (gifted by Fauji cereals company, Rawalpindi, Pakistan). Other ingredients include glucose syrup, raisins, vegetable oil and brown sugar, that was purchased from the local market.

Granola Bar Preparation:

Different ingredients were used to prepare five variants of granola bar, the details of ingredients to make the treatments are mentioned in Table 1. Dry ingredients were mixed separately before mixing, nuts and chickpea were crushed into small pieces to give uniformity in the final product. For agglutination of granolas, the slurry was prepared in a stainless steel container, where the ingredients (brown sugar, glucose syrup, and oil) were heated and mix with dry ingredients until a uniform mixture was obtained. This mixture was placed on a slab and leveled with a roller pin. After cooling, the mixture was cut into rectangular bars with a constant weight of approximately 25 g each.

Chemical Analysis:

Moisture, protein (multiplying the nitrogen with 6.25 factors), fat, crude fiber and ash content of granola bar was determined according to the procedure described in AACC (2000). Total Carbohydrates as represented by nitrogen-free extract (NFE) was calculated as the difference of rest of proximate composition percentage. For calories determination, a factor of 4, 4, 9 a was used for multiplying amounts of carbohydrates, protein and fat, respectively. To determine the mineral profile (Fe, Ca, Mg, Mn and Zn) standard method of AACC (2000) was followed using Atomic Absorption Spectrophotometer (Model GBC 932 PLUS, UK). Sample preparation was carried out following method of Richard (1969). Briefly, a wet digestion method was adopted before analyzing the samples for machine analysis.

Table 1: Treatments with details of ingredients to prepare granola bar

Ingredients	Treatments				
	A	B	C	D	E
Oat flakes	15	10	0	15	20
Corn flakes	10	15	15	0	10
Puffed rice	05	05	15	15	0
Chickpea	10	13	9	15	10
Nuts	10	12	6	15	7
Raisin	10	05	10	0	13
Wheat germ	4	4	4	4	4
Brown sugar	10	10	10	10	10
Oil	10	10	10	10	10
Glucose syrup	10	10	10	10	10
Water	6	6	6	6	6
	100%	100%	100%	100%	100%

Sensory Evaluation:

Sensory evaluation of prepared granola bar was carried out by a panel of trained judges for the parameters of color, taste, flavor, texture and overall acceptability. For scoring, the hedonic scale was adopted with a score range of 1 to 9 as described by Larmond (1977).

Statistical Analysis:

Means and Standard deviations were determined for all the parameters is reported**.** The significant difference of mean values was asses through analysis of variance (ANOVA) using a software STATISTIC version 8.1. For the significant difference, DMRT was applied.

RESULTS AND DISCUSSION

The moisture content of five bars was low having a non-significant difference (Table 2). This was because all granola bars have similar processing time and temperature conditions with a constant level of brown sugar because variation in sugar content may increase or decrease the moisture content. Different level of ingredients does not bring variation in the moisture content of all treatments. In ready to eat products, just like cereal bar low moisture content is exploited an advantage for better quality to store longer period without using preservatives. This technique is very effective against developing rancidity even after several months in the product. The stability of these kinds of bars is highly related to low moisture content and water activity (Pallavi et al., 2015). Significant variation in fat and protein content was found in five tested formulations. The granola bar with high protein content also contained a high level of fat contents. The protein content of granola bars was in the range of 9.7-12.51 percent, and fat content was 5.83-10.34 percent (Table 2). Treatment D contained a

significantly high percentage of protein (12.51%) and fat (10.34%) due to the presence of high concentration of nuts, oats, and chickpea. Treatment C contained a minimum level of protein (9.7%) and fat (5.83%) content among all the treatments, having a minimum concentration of chickpea and nuts, except oat corn flakes and puffed rice was added from cereal portion. A combination of diversified ingredients as used in this research project is highly effective to combat deficiency of lysine that is otherwise deficient in cereal grains. Using chickpea and other legumes make a complimentary combination to improve the protein quantity and quality in granola bar product. So, these products may serve a good alternative to animal protein products. In addition to these, it may be a good source of limiting amino acids such as lysine, arginine, and sulfur-containing amino acid cysteine (Iqbal *et al.*, 2006). Thus, using a combination of cereals and legumes provide a balanced composition of essential amino acids as per requirement of human being. Chickpea improves the nutritional value of a product and provides 12.63 proteins (Tarar, 2009). The inclusion of nuts into granola bar ensures better nutrition due to the presence of a combination of monounsaturated and polyunsaturates along with saturated fatty esters with glycerol molecules. Nutritionally, this composition has a better impact to protect against cardiovascular disease and ensure the good working of vital organs (brain and eyes). It was also observed by some scientist that inclusion of oat fiber into food products improve nutraceutical properties due to the presence of natural fibers in it., similarly is true for its fat that is although low in amount but contain a good proportion of monounsaturated and polyunsaturates having relatively high digestibility as compared to other cereals (Gambuś et al., 2011; Ahmad *et al*., 2009). This composition of fibers and unsaturated fatty acids is ideal for the patients suffering from obesity, higher weights, and elevated blood pressure. Similar health benefits can be achieved by using nuts as was practiced in this research to prepare the granola bar. Al-Hooti et al., (1997) developed an energy bar and showed 11. 56 percent fat contents which are in close proximity to our findings. The crude fat in the bars also facilitate the agglomeration of cereal bar, but too much crude fat in finished product may reduce the product shelf life (Freitas and Moretti, 2006; Mridula *et al*., 2011). Children require 34-grams protein and 10-grams fat (Story and Stang, 2005) on a daily basis. The prepared granola bar treatments in different formulations in this research may have an ability to provide 3-5 gram protein and 2.5-3 gram fat per serving.

Table 2: Nutrients and nutritional value of granola bars (100g)

Granola bar	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Ash (%)	Crude Fiber (%)	NFE (%)	Calories kcal
A	2.68±0.21	11.38b±0.35	7.64b±0.37	1.73b±0.03	3.14b±0.03	73.43c±0.77	409.21b±1.66
B	2.69±0.14	11.56b±0.17	7.91b±0.32	1.75ab±0.04	3.22b±0.03	72.78c±0.47	410.11b±1.53
C	2.69±0.22	9.7d±0.25	5.83d±0.32	1.54c±0.03	2.05c±0.04	77.39a±0.32	400.45c±1.74
D	2.70±0.15	12.51a±0.44	10.34a±0.2	1.81a±0.03	3.45a±0.04	69.39d±0.28	421.88a±0.88
E	2.69±0.24	10.28c±0.25	6.48c±0.22	1.76ab±0.55	3.25b±.03	75.34b±0.32	402.01c±1.1

The composition of barley and oats may increase the dietary and crude fiber in respective products (Ahmad et al., 2008; Ahmad et al., 2009). By increasing the level of oats, nuts and chickpea would result in high ash (1.81%), and crude fiber (3.45%) in treatment D and by reducing the concentration of these ingredients would result in a lower percentage of ash (1.24%), and crude fiber (2.05%) in treatment C (Table 2). Adding oats, walnut, wheat germ and beans in a product provides 1.24-2.1 percent ash and 3.3 percent fiber content (Maurer *et al*., 2005). This product provides a combination of simple and complex carbohydrates. Puffed rice that is

used in this research is providing starch and rapidly digestible carbohydrates, that may cause a sharp rise of glucose in the blood. This is balanced using oats, chickpea, and nuts in granola bar containing a high amount of fiber and delays digestion process thus controlling the sharp increase of glucose in the blood. The fiber content provided by these ingredients also help to control cholesterol levels in blood thus minimize the occurrence of heart-related problems. Some of the ingredients used in granola bar development are meant for energy purposes. Apart from energy provision, these are also imparting favorable conditions to improve functional properties of the final product. Among these ingredients, the inclusion of wheat germ and nuts play a vital role to provide carbohydrates, protein and fat providing a high level of calories (approximately 421.88 calories) with the overall contribution of fat (10.34%), carbohydrate (80.30%), and protein (12.51%) for providing energy. For the kids, the recommendation for calories is 1200 to 1500, small granola bar prepared in this research provides about 105.47 calories per serving with good amounts of fiber components. Sufficient higher calories (423.1 kcal) was reported by Nazni and Bhuvaneswari, (2011) in a product made by selective cereals and nuts as a raw material to produce the final product.

Results of minerals (Zn, Fe, Mg, Mn and Ca) significantly differ as shown in Table 3. Mineral readings in all the treatments depend on the ingredients used in them. Treatment D contained significantly the highest value of Zn (2.49 mg), Fe (3.54 mg), Mg (97.87 mg) Mn (3.73 mg) and Ca (15.00 mg) whereas treatment C showed the lowest value of Zn (1.63 mg), Fe (3.54 mg), Mg (71.00 mg), Mn (1.66 mg) and Ca (7.43 mg). Because of oats, chickpea, and nuts were present in higher concentration, in treatment D which are the main contributor of minerals in the product and treatment C contained a lower concentration of these ingredients. Among minerals, magnesium was present in significantly high level comparing to other minerals. Presence of magnesium is considered very important as it is used in several metabolic processes for the release of energy from nutrients such as protein, carbohydrates, and fats. In these reactions, it usually acts as co-factor with enzymes. It also got several regulatory functions; the notable is maintaining blood sugar level in relation to supply and functioning of insulin. About 240 mg magnesium is recommended per day (Story and Stang, 2005) and per serving of granola bar prepared in this research provides about 24.47 mg magnesium.

Table 3: Minerals profile of granola bars (mg/100g)

Granola bar	Zinc	Iron	Magnesium	Manganese	Calcium
A	1.38c±0.44	3.45b±0.38	82.81c±0.85	2.53b±0.43	11.91c±0.48
B	2.25ab±0.74	3.78b±0.26	87.77b±0.63	2.49b±0.37	9.53d±0.42
C	1.63bc±0.41	3.54b±0.32	71.00e±0.26	1.66c±0.26	7.43e±0.57
D	2.49a±0.34	4.87a±0.34	97.87a±0.75	3.73a±0.62	15.00a±0.73
E	2.42ab±0.24	3.53b±0.24	81.08d±0.62	2.74b±0.14	13.57b±0.37

Sensory Analysis

Mean sensory scores for color varied non-significantly for all the samples whereas flavor, taste, texture and

overall acceptability show a significant difference (Table 4). Formulation C was ranked by the judges to have the highest color score (7.5), flavor (7.67) taste (7.5), texture (7.5) and overall acceptability (7.54). The formulation C was observed to closely related with formulation D with nonsignificant differences for the parameters studied such as color (7.5), taste (7.5), flavor (7.83), texture (7.33) and overall acceptability (7.54). Whereas, formulation A, B, and E received the lowest score for almost all attributes except color which did not differ significantly with formulation C and D.

Development of color attributed to Maillard reaction and may vary depending upon the type of sugar used. Added sugar in the formulations during formation of granola bar contains a good amount of reducing sugars that may contribute towards browning of the product. In addition to this, added brown sugar (non-reducing sugar) impart a bright golden color to the granola bar. Moisture of the bar, although low in amount but play a vital role in these coloring reactions. Such degree of color is important for industry and is in accordance with the consumer demand because the color is a first attribute of the product that attracts the consumer to buy the product.

Table 4: Sensory characteristics of granola bars

Granola bar	Color	Flavor	Taste	Texture	Overall Acceptability
A	7.5±0.55	6.33b±0.52	6.33b±0.52	6.50ab±0.55	6.67a±0.13
B	7.5±0.55	6.50b±0.55	6.17b±0.41	6.83ab±0.75	6.75a±0.32
C	7.5±0.55	7.67a±0.52	7.50a±0.55	7.50a±0.84	7.54b±0.46
D	7.5±0.55	7.83a±0.41	7.50a±0.55	7.33ab±0.52	7.54b±0.3
E	7.3±0.82	6.67b±0.52	6.67ab±0.82	6.33b±0.52	6.75a±0.22

The highest score was given to formulation C and D by the panelist for flavor, texture, taste and overall acceptability, this may be because of the presence of nuts, oat and puffed rice in high concentration. These ingredients are responsible for crisp nature and crunchy texture of granola bar, in addition to providing better taste and fruitful flavor to the final product (Bower and Whitten, 2007). Consumer perceives the slightly higher sweet taste of the granola bar, that was attributed to high concentration of sugar and low moisture content of granola bar.

Treatments with a higher level of oat flakes in bars contain a high level of fiber showed better results for taste parameters (6.9-7.7), texture (7.4 to7.6) and overall acceptability (7.1 to 8.1). The organoleptic scores were close in formulation C and D. Our bar products was observed organoleptically better as compared to similar bar products reported by Fretias and Moretti, (2005) with flavor scores of 5.1 to 6.4, texture (4.1 to 5.3), color (5.3 to 6.6) and overall acceptability (4.7 to 6.1) then each of the formulation.

Conclusion

Nutritional value of the energy bar was increased by adding oats, chickpeas, nuts and wheat germ. It

provides balance nutrition regarding protein, fat, carbohydrates and minerals and also helps in improving the health of the individual by supplying bioactive and functional compounds. This product can be consumed by all segments of the population which would fulfill some portion of daily nutrient requirements. Keeping the quality of the product was increased due to the presence of low moisture content. For sensory point of view consumer mostly prefer crunch and nutty bar.

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