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Organoleptic acceptability and shelf life of developed energy rich sorghum based cereal bars

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Abstract
Sorghum provides good to excellent sources of phytochemicals such as phenolic acids, anthocyanins, phytosterols and policosanols etc. and antioxidants which are believed to help lower the risk of cancer, diabetes, heart disease and some neurological diseases. Regarding shelf life all the three types of cereal bars were found to be acceptable up to 60 days of storage. Fat acidity level increased during storage in energy rich cereal bars having the sorghum varieties namely HC 308 and HJ 513. The peroxide value of control cereal bars ranged from 12.82 to 15.17 meq peroxide/1000g during storage period and that of HC 308 and HJ 513 energy rich cereal bars ranged from 12.49 to 13.41 and 12.45 to 13.53 meq peroxide/1000g, respectively. The water activity of all types of cereal bars irrespective of the sorghum variety as well as of control decline during 0 to 60 days of storage. Therefore, it is studied that all the types of sorghum (HC 308 and HJ 513) based energy rich cereal bars were not only nutritious but had added advantage of good amount of dietary fibre and high total polyphenols which are known to possess antioxidant properties. Moreover, they are ready to eat nutritious snacks no mess while eating too, ideal for all age groups, easily transportable and have good shelf life.

Keywords: Organoleptic acceptability, shelf life, sorghum based cereal bars

Introduction
Sorghum provides good to excellent sources of phytochemicals such as phenolic acids, anthocyanins, phytosterols and policosanols etc. and antioxidants which are believed to help lower the risk of cancer, diabetes, heart disease and some neurological diseases. The wax surrounding the sorghum grain contains compounds, policosanols that may have an impact on human cardiac health Snack food-a portion of food which is often smaller than a regular meal and generally eaten between meals (Chaplin *et al.*, 2006) [1] now forms integral part of eating habits of the majority of world's population. The snack foods which are available in the market such as potato chips, pizza, *pakora*, *samosa*, toast etc. cannot meet daily requirements as per the balanced diet. In this connection, cereal bars could be advantageous over the routine snack foods as the cereal bars can become handy to eat when there is no ample time to sit down and eat a food item in case of school going children, college adolescents, working men and women or in case of sports person.

The nutritious cereal bars have gained more importance and popularity in the global market in recent years and today the market due to the concentrated source of nutrient present in it and is offering a wide variety of bars under different names. The various varieties of bars available in the global market with good organoleptic properties and consumer appeal are referred by names such as chewy cereal granola bars, organic bars, choco bar, muffin bar, fruit filled bars and so on. Chocolates, sugars, and flavourings create an appealing taste and flavour. Nuts, wafers, nuggets, etc. may be added for novel texture. Vitamins, minerals and fibre are often added for enhanced nutritional value (Loveday *et al*., 2009) [2]. These bars are generally packed in metallised polyester films and have a limited shelf life of 3 to 4 months (Padmashree *et al*., 2012) [3].

Nutritionally sorghum was found to possess 13 per cent protein, high amounts of zinc, iron, and dietary fibre, with an additional benefit of presence of significantly high total polyphenols content, which are known to possess antioxidant properties (Anonymous. 2011; Hemalatha *et al*., 2012) [4, 5]. The usage of the product has to be increased by producing novel health food in the form of cereal snack bar as per today's consumer demands.

Sorghum is one of the crops grown in many countries primarily as food crop with less than 5percent of the annual production commercially processed by the industry.

Sorghum grain ranks third among the domesticated cereals for human consumption and is a staple food in many African countries, India and China.

It is quite evident that the utilization of sorghum alone and in combination with other cereals, legumes, oilseeds etc in development of value added foods may result in their wide spread utilization among non-traditional sorghum consumers. This will also result in improving status of sorghum among cereals in economic upliftment of millet producers and will contribute for the health of the population. Since sorghum is drought resistant food security crop, there is great potential for its increased production in our country and hence, diversification of its utilization is highly desired.

Increasing demands from consumers for nutritious snacks providing healthy nutrition and to enhance the utilization of sorghum in daily diets of people, it is desirable to develop novel and value added products from sorghum. Keeping these facts in considerations, present study was planned with the following specific objectives:

1. To develop energy rich sorghum based cereal bars and to study their organoleptic acceptability
2. To assess the shelf life of developed energy rich cereal bars.

Procurement of raw material

The locally available varieties of sorghum *i.e* HC 308 and HJ 513 were procured from the Department of Genetics and Plant Breeding, CCSHAU, Hisar. Other ingredients viz. cocoa butter, cocoa powder, corn syrup and glucose syrup were procured from a local market of Chandigarh in a single lot. The grains of sorghum and wheat were cleaned and made free of dust, dirt and foreign material and stored in air tight containers. Other ingredients were cleaned and stored in hygienic conditions till further use. Sorghum and wheat grains were ground in junior mill to pass through 60 mesh sieve size to obtain fine flour for further analysis.

Standardization and development of bars

Energy rich bars from two different varieties of sorghum HC308 and HJ 513 were standardize and developed as per the methods given below.

Energy rich sorghum based cereal bars

Three different energy rich cereal bars (I, II, III) proportions of sorghum (30, 40 and 50%) were prepared from two different varieties of sorghum *viz* HC 308 and HJ 513 each using ingredients as given below in Table: 1.

Table 1: Ingredients used for making energy rich cereal bars

Ingredients	Energy rich sorghum based cereal bars (Amount)		
	I	II	III
Sorghum flour (g)	30	40	50
Peanut butter (g)	25	25	25
Coca butter (g)	5	5	5
Cocoa powder (g)	8	6	4
Binder* (g)	8	6	4
Almonds (g)	8	6	4
Oat flakes (g)	8	6	4
Gingelly seeds (g)	8	6	4

*****Binder contained sugar (30 g), honey (50 g), corn syrup (10g), glucose syrup (10 g) and water (60 ml)

Procedure

1. Sorghum grains were soaked overnight, sun dried and were then popped up using HTST method (240° C for 120 sec.). Popped sorghum grains were powdered coarsely.
2. For preparation of a binder, 30 g of sugar was dissolved in 60 ml of water. It was filtered through muslin cloth to remove any impurities. Then 50g of honey, 10g of corn syrup and 10g of glucose syrup were added to have thick consistent syrup.
3. Almonds, oat flakes and gingelly seeds were roasted and powdered coarsely.
4. Peanut butter and cocoa butter were put on a flame and they were melted. To it sorghum flour, cocoa powder, binder and powdered almonds, oat flakes and gingelly seeds were added and mixed well.
5. The mixture was cooled and rolled to desirable thickness.
6. The mixture was cut into desirable shapes of cereal bars and was wrapped in aluminium foil.

Wheat based cereal bars (control)

Wheat based cereal bar which served as the control was prepared by using the following ingredients:

Table 2: Ingredients used for making wheat control cereal bars

Ingredients	Amount
Wheat flour (g)	40
Peanut butter (g)	25
Coca butter (g)	5
Cocoa powder (g)	12
Binder (g)	12
Milk Powder (g)	6

*****Binder contained sugar (30 g), honey (50 g), corn syrup (10g), glucose syrup(10 g) and water (60 ml)

Procedure

1. Wheat grains (C 306) were ground into fine flour.
2. For preparation of a binder, 30 g of sugar was dissolved in 60 ml of water. It was filtered through muslin cloth to remove any impurities. Then 50g of honey, 10g of corn syrup and 10g of glucose syrup were added to have thick consistent syrup.

3. Peanut butter and cocoa butter were put on a flame and they were melted. To it milk powder, cocoa powder, binder and wheat flour were added and mixed well.
4. This mixture was cooled, rolled into desired thickness and was cut into desirable shapes of cereal bars and was wrapped in aluminium foil.

Organoleptic acceptability of sorghum based cereal bar

The products as mentioned above were subjected to sensory evaluation with respect to colour, appearance, flavour, taste, texture and overall acceptability using a 9-point Hedonic Rating Scale. On the basis of mean scores of sensory characteristics obtained and their physical characteristics, the most acceptable energy rich cereal bars were selected for further nutritional analysis and shelf life.

Shelf life of most acceptable cereal bars

Organoleptic acceptability

The most acceptable energy rich cereal bars were packed in aluminum foil and stored at room temperature for two months. The samples were drawn at an interval of 15 days i.e 0, 15, 30, 45, 60 days and subjected to sensory evaluation by using nine-point Hedonic Scale by a panel of ten judges selected from I.C. College of Home Science, CCS Haryana Agricultural University, Hisar. Fat acidity, peroxide value and water activity of the stored bars were analyzed at 0, 15, 30, 45 and 60th day of storage.

Fat acidity

The fat acidity was determined by the standard method of analysis (AOAC, 2000).

Peroxide value

Peroxide value of stored products at 0, 15, 30, and 45, 60, 75 and 90 days was determined by the method of AOAC (2000).

Water activity

Water activity (a_w) is generally defined as an indication of the amount of free water in a food. This is the most important parameter of water in terms of food safety. Water activity or a_w is the partial vapor pressure of water in a substance divided by the standard state partial vapor pressure of water. The water activity of most acceptable cereal bars during storage was assessed with the help of water activity meter by Rotronic Hydro Lab. Samples were placed in the sample dish of instrument covered and allowed to equilibrate till a constant value. Then equilibrated samples were kept inside the instrument which measure water activity in the samples after 15 min.

Standardization and development of energy rich sorghum based cereal bars

Sorghum based energy rich cereal bars

Organoleptic acceptability of sorghum based energy rich cereal bars

The data pertaining to organoleptic acceptability of energy rich cereal bars has been presented in Table 3. The mean acceptability scores of colour, appearance, aroma texture, taste and overall acceptability of Sorghum based energy rich cereal bars in comparison to wheat control cereal bars are given in Table 3. The wheat control cereal bars fell in the category of 'liked moderately' with mean scores of 7.4, 7.4, 7.3, 7.2 and 7.48 in terms of appearance, aroma, texture, taste and overall acceptability, respectively. Mean score of 8.1 with regard colour only makes the wheat control cereal bars fell in 'liked very much' category.

Table 3: Mean scores of organolpetic acceptability of sorghum based energy rich cereal bars

Type of cereal bars	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Control	8.1±0.21	7.4±0.04	7.4±0.12	7.3±0.08	7.2±0.13	7.48±0.12
Sorghum based energy rich cereal bars (HC 308)						
Type-I (30% sorghum)	7.6±0.25	7.7±0.23	7.9±0.23	7.7±0.21	7.7±0.22	7.72±0.22
Type-II (40% sorghum)	8.3±0.23	8.2±0.09	8.4±0.13	8.3±0.09	8.5±0.16	8.40±0.13
Type-III (50% sorghum)	7.2±0.22	7.0±0.33	7.2±0.22	7.2±0.24	7.2±0.21	7.14±0.21
(C.D. (p≤0.05)	0.16	0.12	0.16	0.17	0.15	0.32
Sorghum based energy rich cereal bars (HJ 513)						
Type-I (30% sorghum)	7.4±0.22	7.5±0.15	7.7±0.21	8.2±0.25	7.5±0.22	7.54±0.23
Type-II (40% sorghum)	8.1±0.22	8.1±0.08	8.2±0.14	8.1±0.12	8.4±0.18	8.20±0.14
Type-III (50% sorghum)	7.0±0.21	7.0±0.23	7.1±0.15	8.2±0.22	7.1±0.24	7.02±0.24
(C.D. (p≤0.05)	0.17	0.23	0.16	0.18	0.16	0.30

Values are mean ±SE of ten independent determinations

On the other hand, out of three energy rich sorghum based cereal bars i.e. Type-I (30% sorghum), Type-II (40% sorghum) and Type-III (50% sorghum), energy bars having 40 percent sorghum was found to fall in the category of 'liked very much' with mean scores 8.3 and 8.1; 8.2 and 8.1; 8.4 and 8.2; 8.3 and 8.1; 8.5 and 8.4; 8.4 and 8.2 in terms of colour, appearance, aroma, texture, taste and overall acceptability of HC 308 and HJ 513, respectively. Hence, the overall acceptability scores clearly depicted that Type-II energy rich cereal bars prepared in case of both the sorghum varieties having 40 percent of them fell in the 'liked very much' category in comparison to Type-I, Type-III energy rich cereal bars and wheat control cereal bars which fell in the category of 'liked moderately'. Hence, incorporation of 40 percent sorghum irrespective of the variety in energy rich cereal bars was the most acceptable one as compared to that containing wheat or any of the sorghum variety at 30 and 50 percent levels.

Shelf life of most acceptable sorghum based cereal bars

Organoleptic acceptability of stored sorghum based energy rich cereal bars

In case of both the sorghum varieties, Type-II energy, protein and iron rich cereal bars containing 40 per cent of sorghum were the most acceptable and hence studied for shelf life and subjected to orgenoleptic acceptability at different time intervals i.e. 0, 15, 30, 45 and 60 days using nine- point Hedonic scale. The data related to orgenoleptic acceptability of energy rich cereal bars during storage has been presented in Table 5. The acceptability scores for colour of control, HC

308 and HJ 513energy rich bar declined gradually during storage period i.e. 8.1 (0 day) to 7.5 (60th day) in control, 8.3 (0 day) to 7.8 (60th day) in HC 308 and 8.1 (zero day) to 7.7 (60th day) in HJ 513 based energy rich cereal bars but the decline was non - significant in each case.The mean scores for appearance in HC 308 and HJ 513 showed non - significant decline from 8.2 (0 day) to 7.7 (60th day) and 8.1 (0 day) to 7.6 (60th day), respectively. However, wheat control cereal bar showed significant decline from 7.4 (0 day) to 7.0 (60th day) in comparison to both the types of energy rich cereal bars. Both the sorghum (HC 308 and HJ 513) based energy rich cereal bars as well as control bar were in the category of 'liked moderately' for scores of appearance during two months of storage.The mean scores of aroma of wheat control cereal bar were in the categories of 'liked moderately' from zero to sixty days of storage and showed non-significant difference during storage period. The mean scores of aroma of HC 308 and HJ 513 based energy rich cereal bars declined from 8.4 (0 day) to 7.5 (60th day) and 8.2 (0 day) to 7.6 (60th day), respectively. But there was no significant decline when compared to that of wheat control cereal bar.

The mean scores of texture of control, HC 308 and HJ 513 based energy rich cereal bars declined from 7.3 (0 day) to 7.0 (60th day), 8.3 (0 day) to 7.8 (60th day) and 8.1 (zero day) to 7.7 (60th day) respectively; however, the decline was non – significant in each case.

The acceptability scores of taste in control, HC 308 and HJ 513 based energy rich cereal bars were declined non-significantly from zero to 60th day of storage. Mean scores in taste of control, HC 308 and HJ 513energy bars decreased from 7.2 (0 day) to 7.0 (60th day), 8.5 (0 day) to 7.7 (60th day) and 8.4 (0 day) to 7.7 (60th day), respectively.

Table 5: Effect of storage period on mean scores of organoleptic characteristics of sorghum based energy rich cereal bars.

Parameter	Energy rich cereal bars	Days						CD(P ≤0.05)
		0	15	30	45	60	Mean	
	Control	8.1±0.21	7.9±0.22	7.8±0.21	7.7±0.22	7.5±0.23	7.8	NS
Colour	HC 308	8.3±0.23	8.2±0.23	8.1±0.22	8±0.21	7.8±0.20	8.08	NS
	HJ_513	8.1±0.22	8.1±0.21	8±0.23	7.9±0.22	7.7±0.16	7.96	NS
	Control	7.4±0.04	7.4±0.13	7.3±0.11	7.2±0.16	7.0±0.14	7.26	NS
Appearance	HC 308	8.2±0.09	8.2±0.11	8.1±0.09	7.9±0.04	7.7±0.15	8.02	NS
	HJ 513	8.1±0.08	8.1±0.10	8±0.05	7.8±0.08	7.6±0.16	7.92	NS
Aroma	Control	7.4±0.12	7.4±0.16	7.3±0.14	7.2±0.14	7.1±0.14	7.28	NS
	HC 308	8.4±0.13	8.3±0.15	8.2±0.15	7.8±0.16	7.5±0.13	8.04	NS
	HJ 513	8.2±0.14	8.1±0.18	8±0.15	7.7±0.13	7.6±0.12	7.92	NS
Texture	Control	7.3±0.08	7.3±0.14	7.2±0.12	7.2±0.24	7.0±0.22	7.2	NS
	HC 308	8.3±0.09	8.3±0.11	8.2±0.14	8±0.23	7.8±0.23	8.12	NS
	HJ 513	8.1±0.12	8.1±0.22	8±0.15	7.9±0.21	7.7±0.24	7.96	NS
Taste	Control	7.2±0.13	7.2±0.23	7.1±0.22	7.1±0.20	7.0±0.25	7.12	NS
	HC 308	8.5±0.16	8.4±0.21	8.2±0.23	7.9±0.22	7.7±0.25	8.14	NS
	HJ 513	8.4±0.18	8.3±0.16	8.1±0.24	7.9±0.23	7.7±23	8.08	NS
Overall acceptability	Control	7.48±0.12	7.44±0.16	7.34±0.14	7.28±0.14	7.12±0.14	7.33	NS
	HC 308	8.4±0.13	8.3±0.15	8.2±0.15	7.8±0.16	7.5±0.13	8.04	NS
	HJ 513	8.2±0.14	8.1±0.18	8±0.15	7.7±0.13	7.6±0.12	7.92	NS

Mean scores of overall acceptability in control, HC 308, HJ 513energy rich bars showed non-significant differences during storage. The acceptability scores for control declined from 7.48 (0 day) to 7.1 2 (60th day), 8.4 (0 day) to 7.5 (60th day) and 8.2 (0 day) to 7.6 (60th day).

On the basis of overall acceptability score it is clearly depicted that however, both of the sorghum based energy rich cereal bars and control bar fell in 'liked moderately' category but the mean scores of the developed energy rich cereal bars were higher than the control bar.

Conclusion

Regarding shelf life all the three types of cereal bars were found to be acceptable up to 60 days of storage. Fat acidity level increased during storage in energy rich cereal bars having the sorghum varieties namely HC 308 and HJ 513. The peroxide value of control cereal bars ranged from 12.82 to 15.17 meq peroxide/1000g during storage period and that of HC 308 and HJ 513 energy rich cereal bars ranged from 12.49 to 13.41 and 12.45 to 13.53 meq peroxide/1000g, respectively. The water activity of all types of cereal bars irrespective of the sorghum variety as well as of control decline during 0 to 60 days of storage.

Therefore, it is concluded that all the types of sorghum (HC 308 and HJ 513) based energy rich cereal bars were not only nutritious but had added advantage of good amount of dietary fibre and high total polyphenols which are known to possess antioxidant properties. Moreover, they are ready to eat nutritious snacks no mess while eating too, ideal for all age groups, easily transportable and have good shelf life.

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