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Development and optimization of ingredients for multigrain fibre and protein enriched composite bars using sensory evaluation

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Abstract

Ready to eat snacks bars tempt the school & college-going children, office workers and athletes to maintain their energy level throughout the day and can even be supplied to the target populations in the situation of an emergency. Multigrain cereal snack bars are ready-to-eat convenient food products and are easily accessible to consumers, providing them nutrition, satisfying their hunger also available in the market with different options for every different requirement, but are very expensive. So, whole grain cereal bars were prepared from locally available ingredients which are nutritious also. High fibre and protein bars were optimized by using various levels of ingredients. All prepared bars were sensory evaluated and best combination was selected. Among all compositions, combinations with oat-based bars were “liked very much” on the basis of sensory for rice puffed, maize flakes and popped amaranth. Among groundnut, flaxseed and sesame seed, groundnut in combination with both rice puffed and maize flake based bars was selected. For popped amaranth based bars, sesame seeds were adjudged best. Ingredients were selected because of sensory acceptance using jaggery at 40%, carrot powder at 6% and whey protein isolate at 6% level. Six composite bars, *i.e.* fibre enriched (CB1, CB2 and CB3) and protein enriched (CB4, CB5 and CB6) were “liked very much”. Among fibre enriched and protein-enriched composite bars, CB3 and CB6 got the highest sensory score.

Keywords: Multigrain, fibre, protein, snack bars, sensory, candies, powder

Introduction

The snack food bars contain good sensory and nutritional characteristics but many snack food products are available in the market like fried chips, crackers and deep dried doughnuts etc., which does not meet the requirement of a balanced diet. Such snacks are unhealthy offerings for consumers, especially school-going children. Therefore, food should be rich in vitamins, minerals and balanced regarding major nutrients like carbohydrates, proteins and fats. Increasing demand from consumers for nutritious snacks has provoked the food manufacturers to develop food bars that provide nutrition and convenience. As snacks are convenient, so they attract the attention of children, adolescents. However, the options available for the children to buy wholesome and nourishing food products are very limited

Food products prepared by utilizing dried fruits, processed cereals, legumes, millet and pseudocereals along with nuts would be a nutritious snack for the school going children, working professionals and sports person those needs daily requirement of high protein less calorie (Chavez-Jauregui *et al.*, 2003) [5]. To overcome this problem, there was need to develop such kind of food product which are not only ready-to-eat but completes the nutritional needs of consumer. Multigrain cereal bar with fruits and vegetable candies and flours are answer to this question of convenient and wholesomeness.

These high-energy cereal bars are highly nutritious and they play an important role for better mental and physical development. 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.

These are manufactured with cereal grains like amaranth, oat and finger millet with the addition of other ingredients such as whole-grain cereals, flaked grains, fruits, legumes, dehydrated or crystallized fruits, nuts, fruit and vegetable candies, chocolates, sugar etc. (Lobato *et al.*, 2012) [11].

Utilization of grains or a mix of a couple of grains, vegetables, and oilseeds is an ongoing pattern in the preparing cereal bars as it gives numerous health advantages together with improved taste, smell, appearance and variety (Indrani *et al.* (2010) [9]. Prior, numerous creators have utilized protein and fibre rich ingredients to improve the nourishing nature of bars. Mix of oats, pulses, millets, pseudocereal and oilseeds will give the joined impact of expanded quality protein and dietary fibre in the result; this combination improves the functional and overall nutritional quality of snack bars. (Okpala *et al.* (2011) [15]. To keep the product cost low, the locally and easily available ingredients can be used. However, the selection of ingredients depends on the targeted population group (Bower & Whitten, 2000) [4].

Fibre rich bars were prepared by addition of rolled oat, carrot powder and psyllium husk whereas protein was supplemented with the help of groundnut, whey protein isolate/ soy protein isolate. Bar was standardized using different levels of cane sugar, honey and jaggery addition with binding agent (gum acacia). However, other required ingredients are to be kept constant in all three types of bars. Organoleptic evaluation of different types of composite bars with control samples was carried out. A preliminary trial was conducted to standardize the quantity of different ingredients required for the preparation of bars.

Material and Method

The present study was carried out to develop and evaluate the protein and fibre enriched composite bars using Oat, Barley,

Sorghum, Chickpea, Groundnut and also other ingredients like fruits and vegetables candies, fruit and veg. powder, flaxseed, puffed rice, psyllium husk etc. This study was conducted in the Center of Food Science and Technology, CCS Haryana Agricultural University, Hisar.

Genotype of barley (BH-393, BH-946), Sorghum (HJ-541, HC-308), chickpea (HC-1, C-235) Oat (HJ-8, OS-6) and were procured from the Department of Genetics and Plant Breeding, College of Agriculture, CCS HAU, Hisar. Groundnut (GNH-4, GNH-804) was procured from the Regional Research Station, Bawal. Other ingredients like fruits and vegetables, maize, finger millet, amaranth seeds, sesame seeds and puffed rice were procured from local market, Hisar.

All grains like barley, chickpea, oat, sorghum, and groundnut varieties were cleaned to remove extraneous grains, weeds, soil, dust and other foreign materials. Then grains were conditioned, dried and some of grains were grounded to flour for estimation of their properties. The main ingredient for the preparation of bars was cereal flakes and completely roasted or popped grains. The cereal grains were used at a level of 30 to 40 per cent in different treatments. Dried fruits like dehydrated Mango chunks, candies, powders and nuts like peanuts were used up to 10 per cent. For enriching the bars, carrot powder, bottle gourd powder, psyllium husk, whey protein concentrate, and soya protein concentrate are used

The standardized quantity of different ingredients used for the preparation of 100 g of composite bars using jaggery, honey and cane sugar are furnished in Table 1 and 2 respectively.

Table 1: List of ingredients used for optimization of composite bar

Cereal grain and Pulses	Oat, barley, sorghum, chickpea, maize, finger millet, rice (puffed), amaranth
Nuts and oil seeds	Ground nut, flaxseed and sesame seed
Functional & fibre source	Psyllium husk, carrot, bottle gourd, pumpkin, banana, mango, kinnow peel, lemon peel
Sugar source	Cane sugar, honey and jaggery
Protein source	Whey protein concentrate/ soy protein isolate/ soy protein concentrate.

Procedure for preparation of composite bar

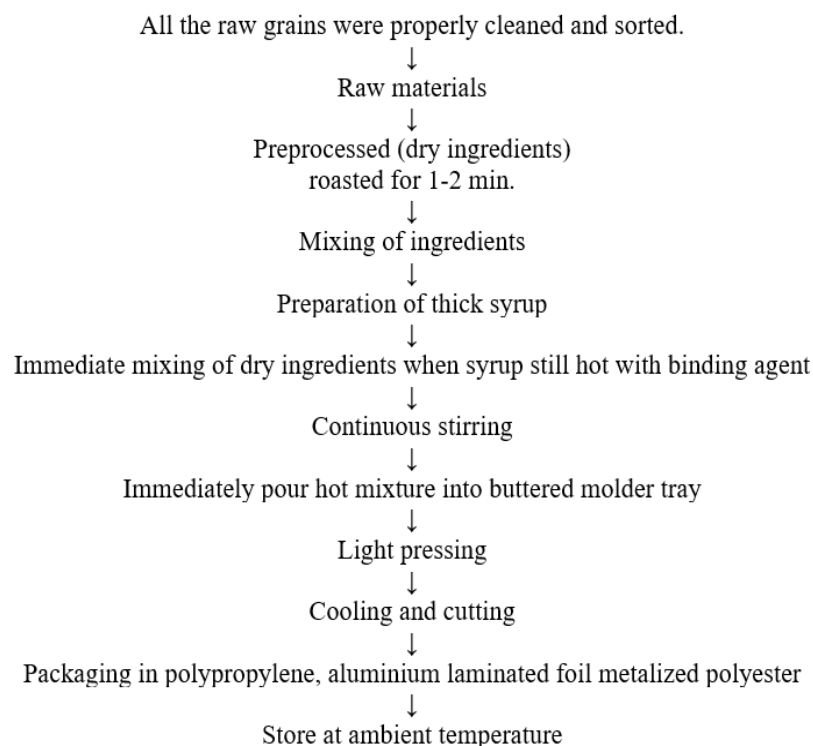


Table 2: Composition of ingredients in high fibre and high protein enriched composite bars (g/100 g)

Ingredients	High fibre composite bar 1 (CB1)	High fibre composite bar 2 (CB2)	High fibre composite bar 3 (CB3)	High Protein composite bar 4 (CB4)	High Protein composite bar 5 (CB5)	High Protein composite bar 6 (CB6)
Puffed rice	10	-	-	10	-	-
Maize flakes	-	10	-	-	10	-
Puffed Amaranth	-	-	10	-	-	10
Oat	10	10	10	10	10	10
Chickpea	14	14	14	14	14	14
Groundnut	14	14	-	14	14	-
Sesame seed	-	-	14	-	-	14
Fruit and veg. candy	4	4	4	4	4	4
Carrot powder	6	6	6	-	-	-
Whey Protein isolate	-	-	-	6	6	6
Jaggery	40	40	40	40	40	40
Gum acacia	2	2	2	2	2	2
Total	100	100	100	100	100	100

Sensory evaluation of multigrain bars

The multigrain bar samples were subjected to sensory evaluations by 10 semi trained panelists using 9-point Hedonic scale (from Like extremely to dislike extremely) to determine the acceptability of product with respect to colour, flavour, taste, texture and overall acceptability (Obatolu *et al.*, 2006) [14].

Results

Sensory evaluation of bar prepared for standardization of jaggery, honey & cane sugar

Data regarding the sensory evaluation of standardized level of jaggery, honey, & cane sugar syrup is shown in figure 1. The graph in fig. 1 shows that three different percentages of each cane sugar, honey, and jaggery were used (30%, 40%, and 50%).

Sensory evaluation performed for colour and appearance, aroma, taste and texture. Out of the three, in terms of taste, texture, and overall acceptability bar prepared with 40% jaggery adjudged best. Therefore, 40% jaggery was selected for the further standardization.

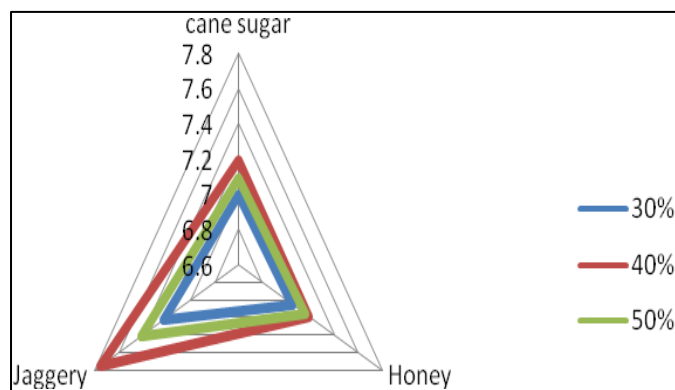


Fig 1: Sensory evaluation of bar prepared for standardization of jaggery, honey & cane sugar syrup

Sensory evaluation of bar prepared using various levels of powder from carrot, bottle gourd, & psyllium husk

The sensory evaluation of bar prepared using various levels of powder from carrot, bottle gourd, & psyllium husk with puffed rice and jaggery is shown in following figure 2. For fibre enrich samples, four different levels (0, 2, 4, and 6%) of each carrot powder, bottle gourd powder and psyllium husk were used. Carrot powder was liked upto 6% and psyllium husk incorporated in bars only up to 2%. Carrot powder was

liked most by the sensory panel. Maximum sensory score was observed for carrot powder (8.31) at 6% concentration as shown in figure 2.

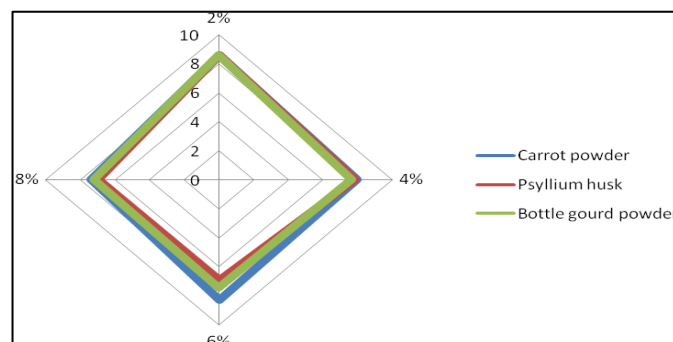


Fig 2: Sensory evaluation of bar prepared using various levels of powders

Sensory evaluations of bar prepared using levels of whey protein & soy protein isolate

Figure 3 depicts the sensory evaluation of bar prepared using various levels of whey protein & soy protein isolate. Whey protein and soy proteins were used as protein sources at levels of 0, 2, 4, 6 and 8%. Results showed that overall acceptability was observed maximum for bar incorporated with 6% whey protein because of color and appearance, taste, aroma and texture. Soya protein isolate was liked only up to 2% level. A considerable decline in taste score was recorded above 2% concentration soya protein isolate. Whey protein isolate showed at 6% level was selected for further preparation of protein enriched composite bars.

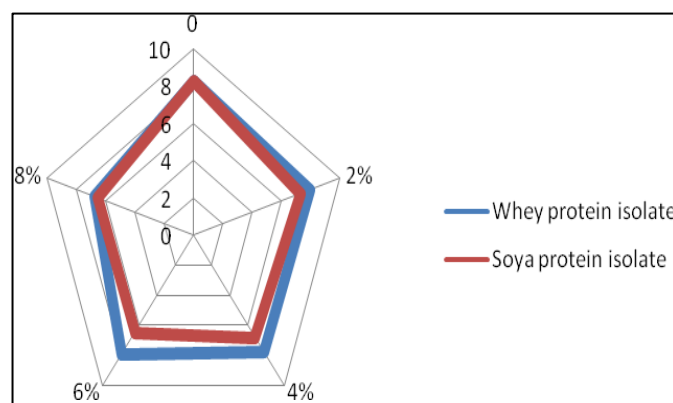


Fig 3: Sensory evaluations of bar prepared using protein isolates

Sensory evaluations of bar prepared using oat, barley, sorghum, finger millet and rice, maize and amaranth as base

Sensory evaluation of bar prepared using different combinations of cereals and millets with rice, maize, and amaranth as base is presented in figure 4. Different combinations of puffed rice, maize, amaranth, oat, barley, sorghum, finger millet, and chickpea were prepared. Out of all the combinations, (Rice puffed + chickpea + oat) recorded with maximum overall acceptability score (8.61) followed by (Amaranth + chickpea +oat; 8.50) and (Maize flakes +chickpea +oat; 8.37), respectively. From all three type bars rice puffed, maize flakes and amaranth puffed with chickpea along with oats adjudged very best with highest sensory score as shown in figure 4

Sensory evaluation of bar prepared using different combination of grains with nut and oilseed

Bars with combinations of puffed rice, maize, amaranth, oat, groundnut, sesame, and chickpea were analyzed and represented in figure 5 Out of all the combinations, maximum overall acceptability was observed in rice puffed + chickpea + oat + groundnut (8.03), maize flakes + chickpea + oat + groundnut (7.90), amaranth + chickpea + oat + sesame seed (7.88) respectively. So for both rice puffed based bar and maize flakes based bar, groundnut was selected whereas for amaranth puffed based bars, sesame seeds were selected on the basis of high sensory score.

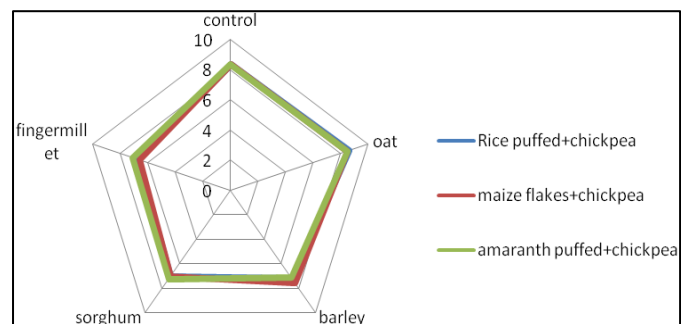


Fig 4: Sensory evaluations of bar prepared using various grains and taking rice, maize and amaranth as base

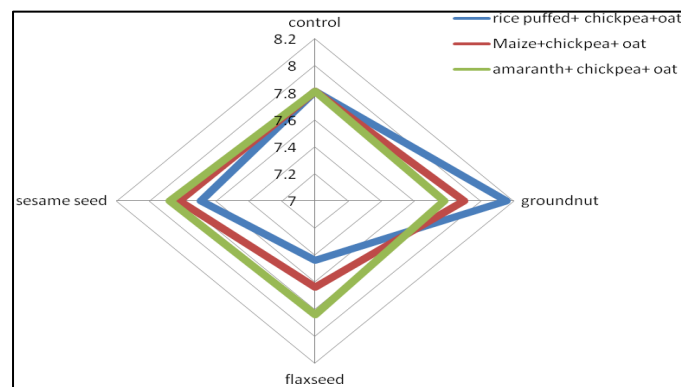


Fig 5: Sensory evaluation of bar prepared using different combination of grains, nut, and oilseed

Sensory evaluation of candies and chunk prepared from fruits, fruit peel, and vegetables

Data of sensory evaluation of candies prepared from fruits, fruit peel and vegetables candy (lemon, kinnow, carrot, pumpkin) and chunks of mango is expressed in figure 6. Out of all the samples, maximum overall acceptability was

observed in lemon peel candy (8.53) followed by carrot candy (7.87). Both candies were further used in preparation of protein and fibre enriched composite bars.

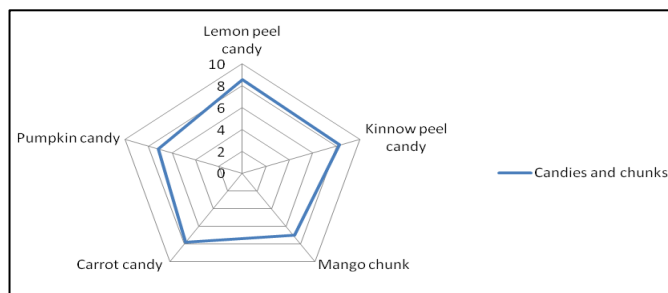


Fig 6: Sensory evaluation of candies and chunk prepared from fruits, fruit peel, and vegetables

Sensory evaluation for fibre and protein enriched composite bar

Sensory evaluation for fibre and protein enriched composite bar is presented in figure 7. Six different samples of composite bar along with control were analyzed for colour and appearance, aroma, taste and texture. Overall acceptability observed maximum for CB6, followed by CB3, CB4, CB2, CB1, and control, respectively.

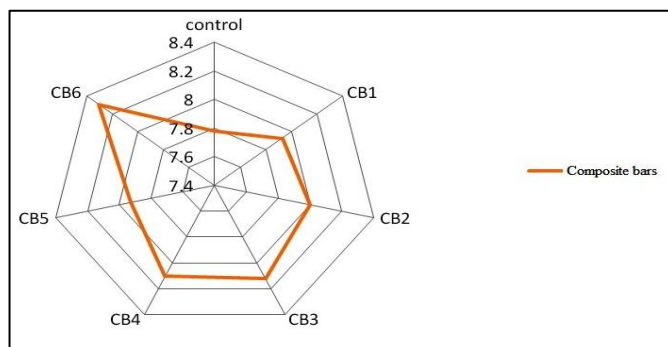


Fig 7: Sensory evaluation for fibre and protein enriched composite bar

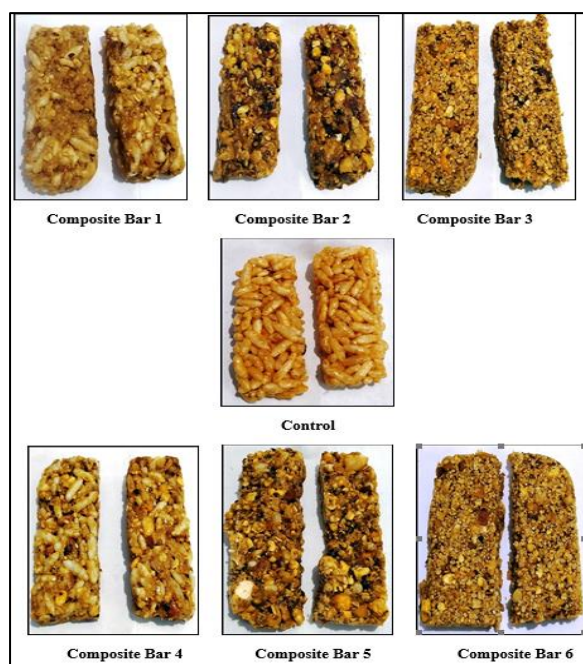


Fig 8: Fibre and protein enriched composite bars prepared from various cereals, pulses, nuts and oilseed

Discussion

Standardization of composite bars is a tryout process where a product is tested a number of times until the desired final product is obtained (Quadri & Rao, 2018) ^[18]. Data regarding the sensory evaluation of standardized level of jaggery, honey & cane sugar syrup shown in figure 1. The graph in figure 1 shows that three different percentages of each cane sugar, honey and jaggery were used (30%, 40% and 50%). Puffed rice used for the preparation of bar and standardization for level of sweetener. Sensory evaluation was done for colour and appearance, aroma, taste and texture. Out of the three (jaggery, honey & cane sugar), 40% jaggery showed the highest score (7.75) and was selected for the further standardization. In terms of taste, texture and overall acceptability of bar prepared with 40% jaggery was adjudged best. Ravindra & Sunil (2018) ^[19] developed and evaluated the puffed cereal bar with 38 g of jaggery, similar to present study with 40% jaggery level in bar, all the samples were adjudged "liked very much" organoleptically. Bars were made based on the combinations and other ingredients like jaggery, binding agent, oats flakes, rice flakes etc were kept constant and bars developed. All the processed ingredients were added to jaggery syrup, spread on a tray, cooled and cut to bars of required size.

The sensory evaluation of the bar prepared using various levels of powder from carrot, bottle gourd & psyllium husk with puffed rice and jaggery is shown in figure 2. Four different levels of each 0, 2, 4 and 6% of carrot powder, bottle gourd powder and psyllium husk, were used for fibre rich composite bars. Bottle gourd powder was liked upto 6% and psyllium husk incorporated bar was only liked up to 2% by sensory panel. Maximum sensory score was observed for carrot powder (8.31) at 6% concentration as shown in figure 2. Smita & Karuna (2014) ^[21] reported that steam blanched bottle gourd powder at 60 °C was found superior with quality attributes. Phebean *et al.* (2017) ^[17] reported that carrot powder up to 10% with 15% cowpea powder and 75% wheat flour could be added in preparation of cookies without affecting the sensory properties. Kumari & Grewal (2007) ^[10] reported that incorporation of carrot powder increased the sensory attributes by the addition of carrot powder upto 20% whereas 30% carrot powder significantly decreased the mean scores for some sensory attributes of sweet biscuits and all the sensory attributes of sweet 'n' salty biscuits. Ferreira *et al.* (2015) ^[8] Formulated and characterization of functional foods based on fruit and vegetable residue flour. According to Decker *et al.* (2014) ^[7], different processing was done for oat grain *viz.* groats, milling, flaking rolling, flour.

Figure.3 depicts the sensory evaluations of bar prepared using various levels of whey protein & soy protein isolate. 0, 2, 4, 6 and 8 percentage levels of Whey protein and soy proteins were used as protein source. Results showed that overall acceptability was maximum for 6% whey protein isolate based on color and appearance, taste, aroma and texture.

Sensory evaluation of the bar prepared using a different combination of cereals and millets with rice, maize and amaranth as base given in figure 3. Different combinations of puffed rice, maize flakes, puffed amaranth, rolled oat, barley, puffed sorghum, puffed finger millet and roasted chickpea were observed. Out of all the combinations, maximum overall acceptability was observed in (Rice puffed + chickpea + oat) showing 8.61 overall sensory score, (Maize flakes + chickpea + oat) 8.37, (Amaranth + chickpea + oat) 8.50 overall sensory score respectively. For all the three rice puffed, maize flakes

and amaranth puffed with chickpea, oats were judged very best with the highest sensory score as shown in figure 4. Rawat & Darappa (2015) ^[20] reported that bar prepared baked energy bars (BEB), BF (banana flour) was partially replaced with fibre enrich ingredient mixture (FRIM) containing banana flour, oats, psyllium husk, partially defatted coconut flour and protein rich ingredient mixture (PRIM) containing chickpea flour, sesame, soya protein isolate and whey protein concentrate respectively, results confirm that the BEB with 50% FRIM and PRIM remained chemically stable and showed good sensorial characteristics. Pereira *et al.* (2019) ^[16] analyzed the cereal bar with enhancement in functional properties of bar by incorporating *Bifidobacterium animalis subsp.* with whey protein isolate was more appreciated by consumers than alginate coating, without affecting sensory characteristics.

Bars with combinations of puffed rice, maize, amaranth, oat, groundnut, sesame, and chickpea were analyzed and represented figure 4. Out of all the combinations, maximum overall acceptability was observed in (Rice puffed + chickpea + oat) showing 8.61 overall sensory score, (Maize flakes + chickpea + oat) 8.37, (Amaranth + chickpea + oat) 8.50 overall sensory score respectively. Ravindra & Sunil (2018) ^[19] reported that bars prepared with puffed cereal bars using popped sorghum, popped amaranth, chickpea seed and cornflakes with different compositions of chocolate and gulkand were "liked very much" for sensory evaluation. Verma *et al.* (2018) ^[23] reported that protein enriched cereal and energy enriched cereal bars were "liked very much" without affecting the sensory qualities. Ahmad *et al.* (2017) ^[2] evaluated a high energy cereal bar for sensory evaluation, highest scores were given to oat flakes formulation C and corn flakes formulation D, it's because of presence of nuts, oat and puffed rice in high concentrations. Treatments with higher levels of oat flakes in bars containing high concentration of fibre show better results for taste parameter. Agbaje *et al.* (2016) ^[1] evaluated cereal bars prepared with puffed glutinous rice, dates, figs and raisins with glucose syrup. Sree *et al.* (2020a) also reported that cereal fruit bars with 20% jaggery addition were best accepted for equal quantity of beetroot and dates with sensory scores for appearance, taste, colour, flavour, texture, chewiness and overall acceptability. Ahmad *et al.* (2017) ^[2] produced different formulations of cereal bar; cereal bar with oat flakes formulation C and corn flakes formulation D were found to be most liked by sensory panel.

Bars with combinations of puffed rice, maize, amaranth, oat, groundnut, sesame, and chickpea were analyzed and represented in figure 5 Out of all the combinations, maximum overall acceptability was observed in (rice puffed+chickpea+oat) + groundnut (8.03), (Maize flakes+chickpea+oat) + groundnut (7.90), (Amaranth+chickpea+oat) + sesame seed (7.88) respectively. Ahmad *et al.* (2017) ^[2] evaluated that the cereal bar with highest sensory score scores were given to oat flakes formulation C and corn flakes formulation D; it is because of presence of nuts, oat and puffed rice in high concentrations, similar to present study.

Figure 6 presented data of sensory evaluation of candies prepared from fruits, fruit peel and vegetables including candy (lemon, kinnow carrot, pumpkin and bottle gourd) and chunks of mango. Out of all the samples, maximum overall acceptability was observed in lemon peel candy (8.53) and carrot candy (7.87) respectively. Both the candies are further

used for the preparation of protein and fibre enriched composite bars. Ahmad *et al.* (2017) ^[2] developed and evaluated high-energy cereal bars for sensory evaluation, highest scores were given to oat flakes formulation C and corn flakes formulation D. Verma *et al.* (2018) ^[23] reported that protein enriched cereal and energy enriched cereal bars were “liked very much” without affecting the sensory qualities.

Ferreira *et al.* (2015) ^[8] reported that cereal bars prepared with incorporation of fruit and vegetable powder were “liked very much” and consumers intended to purchase.

Sensory evaluation for fibre and protein enriched composite bar are presented in figure 7. Six different samples of composite bar along with control were analyzed for colour and appearance, aroma, taste and texture. Overall acceptability was observed maximum for CB6, followed by CB3, CB4, CB2, CB1, CB5 and control respectively. Nadeem *et al.* (2012) developed high protein cereal bars whose sensory evaluation revealed that protein level, texture, and taste were very much enhanced by adding 6.05% whey protein concentrate and 4.35% vetch protein isolates in date bar without disturbing any sensory parameters. Verma *et al.* (2018) ^[23] and Ahmad *et al.* (2017) ^[2] both prepared cereal bars by using different cereal, pseudo cereals, millet and legumes which are preprocessed *viz.* puffing, roasting and flaking similar to present study. Tanska *et al.* (2007) ^[22] reported that the best treatment from a rheological and organoleptical point of view was 5% addition of carrot pomace in wheat bread. Chilkawar *et al.* (2017) ^[6] reported sensory evaluation of protein rich multigrain bar, puffed amaranth based at the rate 0, 10, 20 and 30% instead of rice crisp, reported results indicated that bar with 30% puffed amaranth was most acceptable in all sensory characteristics. Appelt *et al.* (2015) ^[3] reported that cereal bars were developed using oat flakes and rice flakes with fruits and vegetables by product, showed higher moisture content, fibre, fat, lower protein, and ash content.

Conclusion

The study concluded that all the bars were organoleptically acceptable but CB6, CB3 and CB4 bars were highly acceptable. Among fibre enriched and protein-enriched composite bars, CB3 and CB6 got the highest sensory score. The developed nutritional bar was found to be high in energy, protein, and carbohydrates with good amounts of dietary fibre and high protein. Hence, it is recommended that multigrain foods are better in terms of sensory attributes, rich in nutrients and are inexpensive than the synthetic powders and have no ill effect on health. Hence the developed bar could be recommended for school-going, homemakers and sports persons.

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