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Quality evaluation of millet based composite sports bar

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Abstract
Sports bar are considered to be the ideal and comfortable snack for athletes with proper combination of natural ingredients and easy to eat to meet their energy requirements between meals. The present study was undertaken to develop sports bar based on millets and to evaluate the acceptability, nutrient composition, shelf life and economic feasibility of millet based composite sports bar. Composite sports bar was prepared from five different trials and evaluated for higher acceptability. The highly accepted CSB developed from trial IV composition contained 6.33% moisture, 72.5g carbohydrate, 13.7g protein and 6.1g fat. The total ash content of the bar was 2.29g/100g. The calcium and iron content on analysis were found to be 159.5mg and 2.93mg respectively. The developed CSB provided 400 kcal of energy per 100g, which qualified the product as a good energy dense snack for the sportspersons. A gradual depletion in the overall acceptability scores from 38.3 to 13.1 was noticed at the end of 90 days. The microbial load of CSB was found to be below detectable limits during storage. The unit cost of preparation of the CSB was Rs.14.80 per 40g. It is evident that the developed millet based composite sports bar is a nutridense snack, easy to prepare, affordable and far more cost effective than the commercial sports bar.

Keywords: millet, composite sports bar, CSB

1. Introduction
Nutritional needs of sportspersons are higher than non-athletes. An intake of 4-6 meals and snacks with 6-10g of carbohydrates per kilogram bodyweight is recommended to meet energy demands and to replenish glycogen stores (NIN, 2000) [14]. Athletes due to their lack of time and poor availability of nutritious foods during competition seek for foods that to be easily consumed, at the same time provide with all the nutrients required by them (Arazi & Hosseini, 2012; Barzegari, Ebrahimi, Azizi, & Ranjbar, 2011) [3, 7, 4.] Nowadays, the demand and desire for a nutritionally balanced snacks and drinks that are palatable, portable, convenient and free from additives are increasing among sportspersons (Burns, Schiller, Mearick, 2007;Banu *et al*., 2012;Ijarotomi ept al.,2006) [8, 6, 10]. Sports snacks prepared from composite mixture of various ingredients assure a mutual complementation of nutrients to supply adequate energy and increase muscular endurance of sportspersons (Roopa, 2011; Padmashree) [17, 15]. Sports bars are convenient, low bulk, portable and easy to consume compact source of energy and nutrients.

Millets are tiny seeded grains packs more protein, dietary fiber, energy and minerals. India is one of the top most producers of millets with a share of 42% of world millet production (Anu *et al*., 2007; Vijayakumar *et al*., 2009; Ralley, 2007) [1, 18, 19, 16]. Sportspersons are often confused in choosing the right supplement and the higher cost of the commercial snacks makes it out of reach specifically to the sportspersons from low income (Costill, 2013) [9]. Hence millets being low in cost, nutritious and locally available indigenous food, the present study was aimed to develop a composite nutridense sports bar and to evaluate its overall sensory, nutritional and storage qualities.

2. Materials and Methods
2.1 Selection of ingredients
The ingredients selected for the preparation of sportsbar were different millets like Little millet/ *Panicum milaire*, Great millet/*Sorghum vulgare*, Pearl millet/*Pennisetum typhoideuma* and Foxtail millet/*Setarai italica*. Cereal flakes of oats/*Avena sativa*, wheat/ *Triticum aestivum* and red rice/*Oryza punctate*. The pulses like bengal gram/*Cicer arietinum*, green gram/ *Vigna radiata* and cowpea/*Vigna unguiculata.* Peanuts & Almonds, Flax seeds, sesame seeds, pumpkin seeds and sunflower seeds, palm jaggery, peanut butter, chocochips, skim milk powder and vanilla essence.

2.2 Pre-processing of raw ingredients
All the required ingredients were purchased from the departmental stores at Chennai. The dehulled millets, cereal flakes and pulses were cleaned separately to remove the external dust and dirt particles. The cereal flakes were roasted in a non-stick pan separately to 22°C in a low flame to get roasted aroma, powdered coarsely and then sieved in 700µ sieve to obtain uniform size particles. The little millet and foxtail millet were roasted separately to 45°C in a low flame and powdered to a fine flour. The other millets and pulses were soaked separately in clean water for eight hours. After soaking, the water was drained and sprouted separately by tying in a clean muslin cloth and hung it for 12-18 hours.

The sprouted millets and pulses were shadow dried to completely remove moisture. The dried millets and pulses were roasted separately for 15 minutes at 40°C, until pleasant aroma developed. The roasted millets and pulses were pulverized into fine flour in an electric blender and sieved in 300µ sieve. Peanuts were dry roasted and the peel was removed manually by crushing between hands. The peanuts and were cut into small pieces and roasted to light brown colour. The flax, pumpkin, sesame and sunflower seeds were checked for purity, roasted up to 120°C and powdered coarsely. The seeds in dry dates were pitted and cut into small pieces. The raisins and papaya chunks were checked to remove foreign materials.

2.3 Preparation of Binder

Palm jaggery syrup was prepared by addition of 60 ml of water to 40g of the powdered palm jaggery and boiled to a temperature of 85°C until it melted completely. The syrup was then filtered through a muslin cloth to remove any impurities. The peanut butter was melted in a pan, the filtered jaggery syrup was added to it and heated to 105°C to thick consistent syrup of 90° brix and cooled to 40°C.

2.4 Preparation of Composite Sports bar

To the above processed ingredients, skim milk powder was added and roasted in a non-stick pan up to 110°C. To this roasted mixture chocochips and vanilla essence were added and combined thoroughly to a uniform mixture. The roasted mix was added to the binder mixture and folded to make dough. The dough mixture was transferred to a mildly greased rectangular tray, firm pressed with a wooden roller and then cut into bars of 14mm thickness with a serving size of 40 grams.

As per the Indian Council for Medical Research (ICMR, 2010) recommendation for athletes, the millets, cereals and pulses were mixed in different proportions such that the protein energy ratio of the mix was more than 15%. Therefore, the researcher attempted to develop the composite sports bar with different combinations of cereals, millets, pulses and skim milk powder, while other ingredients kept constant. Totally five composite sports bar trials were formulated.

Table 1: Composition of different composite sports bar trials

Ingredients	Trial I	Trial II	Trial III	Trial IV	Trial V
	Quantity per 100g				
Millets	50	40	45	40	35
Cereals	20	25	25	20	30
Pulses	15	20	15	25	20
Skim milk powder	15	15	15	15	15

In addition 40g palm jaggery, 10g peanut butter, an equal quantity of each 5g of nuts, seeds, dry fruits and chocochips were added to all the CNB trials.

2.5 Sensory Evaluation of the Composite Sports bar

The composite sports bar developed in five trials as given in Table 1 was evaluated for their sensory qualities of the bar such as colour, texture, flavor, taste and overall acceptability by a panel of 10 semi trained panel members and ten sportspersons selected at random using 9 -point hedonic scale.

2.6 Nutrient analysis of the Composite Sports bar

The proximate composition such as moisture, total ash, fat, protein, calcium and iron content were analysed in the highly accepted CNB using standard procedure by AOAC (2000). The moisture content of the samples was estimated using hot air oven. The total carbohydrates content by anthrone method, fat by soxhlet method and protein by kjeldahl method. The total mineral content was measured by ashing method, while calcium content was estimated using titrimetric method and calorimetrically iron content was determined.

2.7 Shelf life of the Composite Sports bar

The developed CNB was packed in metalized polyester polypropylene (MPP) pouch, heat sealed and stored at room temperature (37°C), under cool, dry conditions. Periodically at an interval of 15 days, the shelf life of the bar was assessed through sensory and microbial analysis. Bacteria, yeast and mould content were evaluated by "standard plate count" using respective procedures, the number of colony forming units were calculated and compared with the standard permissible limits.

3. Results and Discussion

3.1 Sensory Analysis of Composite Sports bar of different variations

The CSB developed under 5 different trials were evaluated for higher acceptability through sensory analysis. The data was analyzed statistically using One way ANOVA followed by Tukey's post hoc test (Table 2).

Table 2: Sensory Scores of Composite Sports Bar

Trial	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability (Maximum Score=45)
I (a)	6.5^{d}	6.1^{c}	5.4^{cde}	4.6	5.6^{bcd}	28.2^{cde}
II (b)	6.5^{d}	6.5^{ade}	4.8^{acde}	6.0	5.9^{ad}	29.7^{de}
III (c)	7.2^{d}	7.0^{de}	5.7^{bd}	5.4	5.7^{ad}	31.0^{ade}
IV(d)	8.1^{abce}	8.2^{ac}	8.0^{abc}	8.4^{e}	8.3^{abc}	41.0^{bce}
V (e)	7.2^{d}	8.2^{ac}	7.6^{bc}	8.4	6.9^{abc}	38.3^{acd}
F value	12.97***	33.39***	36.74***	58.5***	18.08***	131.12***

All values are depicted as mean, significantly different by ANOVA. The superscript denotes the significant difference between the attributes represented by alphabets of a particular variable based on Tukey's Honest Significant Difference (HSD) test on multiple comparisons. ***Significant at $p < 0.001$ level

Appearance is the very first quality that improves a product's acceptability. The highest mean score for appearance of 7.7 was obtained by the bars prepared from Trial III and IV, followed by trial I. For colour, all the bars samples from five trials scored nearly similar score of 7.5.With respect to flavour, a maximum score of 7.8 was secured by trial IV, followed by trial III. As far as texture was concerned, trial IV got the maximum score of 8.2 and the least score was for Trial V. For taste criteria, trial IV scored the highest and trial I the least. The overall acceptability scores revealed that trial IV obtained the maximum score of 40 out of 45, followed by trial V and I. All the sensory qualities between the trials were found to be highly significant ($p<0.000$). Based on the highest acceptability, the bar developed from trial IV mix was selected for quality evaluation.

3.2 Physical Characteristics of CSB

The physical characteristics such as weight, diameter, width and dispersibility of the developed sports bar were evaluated and presented in Table 3.

Table 3: Physical characteristics of CSB

Physical Parameters	Value
Weight (g)	40
Diameter (cm)	8.5
Width (cm)	1.6
Dispersibility (%)	79.7

The weight of the prepared CSB was 40g with the diameter and width of 8.5cm and 1.6cm respectively. The dispersibility of 79.7% showed the quick dissolution in gastric juice and easy digestion.

3.3 Proximate Composition of Composite Sports bar

The moisture content in the prepared CSB was found to be 6.33g/ 100g, indicating low moisture content. The developed CSB provided 400 kcal of energy per 100g, which qualified the product as a good energy dense snack for the sportspersons. The bar consisted of 72.5g carbohydrate, 13.7g protein and 6.1g fat. The total ash content of the bar was 2.29g/100g. The calcium and iron content on analysis were found to be 159.5mg and 2.93mg respectively.

The findings are in line with the results of Padmashree *et al*. (2012), Vijayakumar and Simon (2009) [15, 19] that showed 7.2% of moisture in composite cereal bar. The energy contribution of the developed CSB was on par with the millet ladoo developed by Meti and Saraswati (2006) [11] and little millet based sports food prepared by Roopa (2011) [17] which provided 412 kcal and 377 kcal of energy respectively.

Table 4: Nutrient Analysis of the highly accepted Composite Sports bar

Nutrient Contents	Per 100g	Per Serving (40g)
Moisture(g)	6.33	2.53
Energy(kcal)	400	160
Carbohydrate(g)	72.5	29.0
Protein (g)	13.7	5.48
Fat (g)	6.1	2.44
Total Ash(g)	2.29	0.92
Calcium(mg)	159.5	73.8
Iron (mg)	2.93	1.172

3.4 Shelf life Analysis of Composite Sports bar

The sensory analysis of the composite sports bar analysed during storage a gradual depletion in all the sensory characteristics (Table 5). The mean scores for overall acceptability reduced from 38.3 to 13.1. At the end of 90 days of storage least score of 1.4 for taste and 1.9 for flavor were observed (Figure 1). The results indicated that the prepared bar may be stored for a period of 45 days at room temperature.

Table 5: Mean Sensory Scores of Composite Sports bar during Storage

Period of Storage (Days)	Appearance	Colour	Flavour	Texture	Taste	Overall Acceptability (Maximum Score =45)
0	8.0	8.2	8.7	8.7	8.0	38.3
15	7.0	8.0	7.5	8.0	7.7	37.2
30	7.4	7.7	7.0	8.0	7.5	34.7
45	7.3	7.2	5.7	7.0	5.9	31.0
60	4.8	4.3	4.1	7.4	4.3	23.9
75	4.7	3.3	3.4	4.8	3.3	19.4
90	3.7	2.3	1.9	3.9	1.4	13.1

The microbial analysis done at periodic interval during storage indicated no microbial load until 45 days in the sample. The aerobic bacterial growth was observed only after 60 days of storage ($4x10^3$/g). The other bacteria, yeast and mould growth were not found till 90 days of storage. The microbial load of CNB was found to be below detectable limits (<50,000cfu/g) according to Prevention of Food Adulteration Act (1954). The prepared composite bar was found to be microbial safe, when compared to Mridula *et al*., 2013; Nadeem *et al*., 2012 [12, 13], where total bacterial counts (log cfu/g) in flaxseed enriched bar increased from 3.4 to 4.7 during 90 days storage.

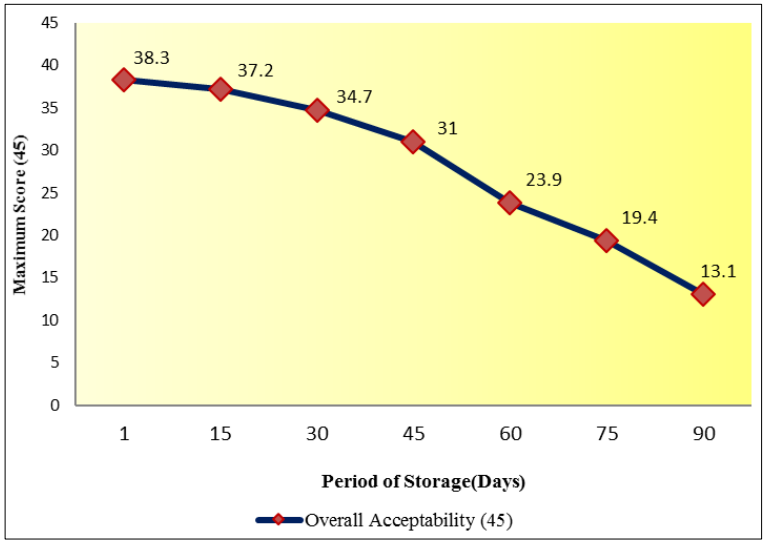

Fig 1: Changes in Overall Acceptability of CNB during Storage

3.5 Cost Benefit Analysis of the Composite Sports bar

The total cost expended for the preparation of CNB was Rs.44.50 per 100g. From the total quantity of ingredients, three bars with a serving size of 40g were obtained and the unit cost was Rs.14.80 per 40g. It is evident that the developed millet based composite sports bar is affordable and far more cost effective than the commercial sports bar.

4. Summary and Conclusion

The millet based composite sports bar developed along with other nutritious ingredients showed that the bar is highly acceptable, easy to digest, contained high amount of energy and protein with a shelf life of 45 days at room temperature. The development of composite sports bar using low cost, locally available ingredients is nutridense and convenient snack for sportspersons.

5. References

1. Anu S, Sehgal S, Kawatra A. Development and nutritional evaluation of pearl millet rich banana cake. Journal of dairying, foods & home sciences, 2009; 27(2):138-141. Retrieved from http://www.arccjournals.com/uploads/articles/jdfhs272012.pdf.
2. AOAC. Official Method of Analysis (17th ed.). Association of Analytical Chemists International, Maryland, USA. 2000, 2.
3. Arazi H, Hosseini R. A comparison of nutritional knowledge and food habits of collegiate and non-collegiate athletes. Sport Logia, 2012; 8(2):100-107. Retrieved from http://www.sportlogia.com/no6engl/eng2.pdf.
4. Azizi M, Rahmani-Nia F, Malaee M, Malaee M, Khosravi N. A study of nutrition knowledge and attitudes of elite college athletes in Iran. Brazilian Journal of Biomotricity. 2010; 4(2):105-112.
5. Ballolli U, Chimmad BV, Bharati P, Nagnur S. Development of Nutty Barnyard millet *(Echinochloa frumantacea Link)* cookies. NAIP: National Symposium Recapturing Nutritious Millets for Health and Management of Diseases. 2011; 42:16-17. University of Agricultural Sciences, Dharwad.
6. Banu H, Itagi N, Singh V. Preparation, nutritional composition, functional properties and antioxidant activities of multigrain composite mixes. Journal of Food Science and Technology. 2012; 49(1):74-81. doi: 10.1007/s13197-011-0267-6.
7. Barzegari A, Ebrahimi M, Azizi M, Ranjbar K. A Study of nutrition knowledge, attitudes and food habits of college students. World Applied Sciences Journal. 2011; 15(7):1012-1017.
8. Burns RD, Schiller R, Merrick MA, Wolf KN. Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dieticians in nutrition counselling. Journal of the American Dietetic Association. 2007; 104:246-249. Retrieved from. http://www.ncbi.nlm.nih.gov/ pubmed/14760575.
9. Costill D. Inside running: Basics of sports physiology. Indianapolis, IN: Benchmark Press. 2013. Retrieved from http://www.Ohiostatealumni.Org/ Awards/Pages/Davidcostill.Aspx.
10. Ijarotimi, Steve O, Ayobami AO. Nutritional composition, sensory and biological evaluation of a potential weaning diet from low cost materials (Sorghum Bicolor and *Cajanus Cajan*). Journal of Food Technology. 2006; 4(3):178-184.
11. Meti R, Saraswathi G. Impact of nutrition education and carbohydrate supplementation on performance of high school football players. Indian Journal of Nutrition and Dietetics. 2006; 43(50):197-207.
12. Mridula D, Singh KK, Barnwal P. Development of Omega-3 Rich energy bar with flaxseed. Journal of Food Science and Technology. 2013; 50(5):950-957.
13. Nadeem M, Rehman S, Anjum S, Murtaza MA, Din GM. Development, characterization, and optimization of protein level in date bars using response surface methodology. Scientific World Journal. 2012, 518702. doi: 10.1100/2012/518702, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3385624/.
14. NIN. Dietary Guidelines for Indians A Manual (2nd ed.). 2000. National Institute of Nutrition, Hyderabad.
15. Padmashree A, Sharma GK, Srihari KA, Bawa AS. Development of shelf stable protein rich composite cereal bar. Journal of Food Science and Technology. 2012; 49(3):335–341.
16. Ralley K. Whole grains: millet, http;//cheyday.com/millet.html,2007.
17. Roopa V. Physico-Chemical and Functional Properties of Little Millet (Panicum Miliare), Development and Efficacy of Little Millet Based Sports Foods (Published Doctoral thesis). University of Agricultural Sciences, 2011, Dharwad. Retrieved from http://etd.uasd.edu/abst/th10320.pdf.
18. Vijayakumar P, Mohankumar JB. Formulation and characterization of millet flour blend incorporated composite flour. International Journal of Agricultural Sciences. 2009; 1(2):46-54.
19. Vijayakumar P, Chappalwar M, Peter D, Bobde H, John SM. Quality characteristics of cookies prepared from oats and finger millet based composite flour. The International Journal of Computer Science, Information Technology & Security. - Engineering Science and Technology: An International Journal. 2013; 3(4):677-683.