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## Biochemical estimation and acceptability trial of nutri bars developed for promoting health and better sports performance among college level athletes

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### Abstract

Sports performance and the way human body responds to exercise, training and various environmental stimuli is greatly influenced by the quality of nutrition they consume. However because of their busy routine and difficult exercise regime often their nutritional intake remains compromised. Hence it is important to develop and introduce some healthy ready to eat nutrient dense snacks to ensure regular supply of nutrients in their diets. Developing Nutri rich bars for college level athletes can be one such alternate to ensure regular supply nutrients. Hence in present research nutri bars were developed using locally available ingredients and their biochemical estimation and acceptability trial was performed. Two different type of mixes were developed Mix A with oats as base ingredient; Mix B with wheat puffs as base ingredient other ingredients common in both were whey protein powder, nuts, dates, chocolate, flax seeds and raisins. Roasting and processing methods were applied to make mixes of energy bars. Two types of bars and their variants developed by replacing base ingredient ie oats or wheat flakes with whey protein powder (10%, 20%,30%). Acceptability Trail was performed for the developed bars and the results highlighted that in case of oats protein bar variation A2(10%) and B2 (10%) from wheat protein bar was the most accepted one. Biochemical estimation of most acceptable variants was performed and the developed nutri bars contained 22.65g/100g protein of A2 Bar and 18.91g/100g protein of B2 Bar, fat content was 23.80g/100g of A2 Bar and 22.58g/100g of B2 Bar, fiber content was 25.26g/100g of A2 Bar and 31.58g/100g of B2 Bar, Carbohydrates content was 25.26g in A2 bar and 31.58g in B2 bar and the iron content of A2 bar was 2.3mg and B2 was 2.1mg. Thus, it can be concluded that developed nutri bars fulfilled the needs of various nutrients source for athletes and were acceptable in terms of all sensory attributes.

**Keywords:** Sports nutrition, nutri bars, acceptability trial, proximate composition

### Introduction

Sports Science and nutrition is an important part of sport performance for young athletes besides allowing for optimal growth and development Proper nutrition is vital for athletes to attain proper growth and perform optimally in sports. Young athletes need to learn what foods are good for energy, when to eat certain foods, how to eat during an event, and when and what to eat to replenish after activity. A well- balanced diet containing appropriate amounts of macronutrients (protein, carbohydrates and fat) and micronutrients (vitamins and minerals) is essential to provide enough energy for maintaining appropriate growth and activity levels. Fluids are also essential for hydration to support growth and athletic performance. Many Indian athletes are not aware of the need for right food for sports. The primary concern of many athletes is to supplement the diet with protein, vitamins and minerals and a range of more exotic compounds. Therefore knowledge of sports nutrition is an essential component for keeping athletes healthy, preventing fatigue and activating athlete to take appropriate training and compete accordingly.

General guidelines related to meal planning for athletes, include eating meals a minimum of 3 h before an event to allow for proper digestion and to minimize incidence of gastrointestinal upset during exercise. Meals should include carbohydrates, protein and fat however fiber should be limited. High- fat meals should be avoided before exercise because they can delay gastric-emptying, make athletes feel sluggish and thereby adversely affect performance.

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For early morning practices or events, having a Pre-game snacks or liquid meals 1 h to 2 h before exercise allow for digestion, followed by a full breakfast after the event, will help ensure sufficient energy to maximize performance (Meyer *et al.*, 2007) <sup>[11]</sup>. Snacks can include fresh fruit, dried fruits, a bowl of cereal with milk, juice or fruit-based smoothies. During an event, sports drinks, fruit or granola bars can be ingested to help refuel and keep energy levels high. Many athletes did not consider sports drinks and calorie replacement products as supplements.

Snack bar or nutri bars can be a convenient and healthy ready to eat food which supplies balance nutrients (protein, fat, minerals, vitamins, calories, and carbohydrates) and to abate hunger (King, 2006) <sup>[9]</sup>. Snack bars initially marketed to athletes as a source of energy. However, the growing luxury groups and health conscious consumers had increased the sales performance of snack bars (Wyatt, 2011; Euro Monitor International, 2015) <sup>[16, 7]</sup>. International data available on Statista (2015) reported that retail sales of nutri energy bars in the U.S. is increasing year to year (from 2005 to 2014) from 0.57 billion U.S. dollars in year 2005 to 1.2 billion U.S. dollars in year 2014. Due to the growing consumer demand for natural, convenient, and nutritious food products, there is a need to modify, innovate and improve the nutritional composition of snack bars for health benefits (Williams *et al.*, 2006) <sup>[15]</sup>. Athletes are physically active individuals hence it is advisable that they should take sufficient amounts of carbohydrates before exercising, 'top-up' body's limited supply during workouts, and consume adequate amounts immediately after activity so as to replenish endogenous stores (Ali *et al.*, 2011) <sup>[11]</sup>.

Most of the scientific research investigating the effects of protein intake on exercise performance has focused on supplemental protein intake, from a broad prospective on endurance exercise performance and resistance exercise performance. A condition referred to as sports anemia has been reported in athletes it appears to be most associated with increased red blood cell destruction and decreased concentration of hemoglobin (the iron-rich part of red blood cells) at the beginning of a strenuous conditioning program. It has also been hypothesized that "sports anemia" may be caused by an inadequate protein intake particularly in the early stages of training. The demand to form additional muscle tissue may compete with the demand to form additional hemoglobin, thus causing anemia. Hence in the present research two nutri bars with varying composition were developed and tested for enhancing sport performance and ensuring better nutrient supply to the college level athletes with following objectives:

- To identification ingredients for formulation of Nutri bar.
- To formulate and standardize Nutri bars.
- To conduct acceptability trial of nutri bars.
- To perform biochemical Estimation of most acceptable Nutri bars.

## Methods

### Selection and procurement of ingredients suitable for preparation was done according to the

- Availability and nutraceutical properties of the ingredients.
- Procurement of the ingredients was done from local market. For processing of ingredients Mainly roasting and processing techniques were used.

### Formulation and standardization of nutri bar:

Composition of Nutri bars mix was worked out in laboratory after trying several permutation combinations of the shortlisted ingredients. Finally two types of standard bar mixes are developed and the ingredients used included:-

Experimental Bar A : Oats (Base Ingredient), Dates, Flax Seeds, Nuts and Chocolate.

Experimental Bar B : Wheat Puffs (Base Ingredient), Dates, Flax Seeds, Nuts and Chocolate

# In both the bars commercially available whey protein concentrate was used for value addition at varying proportion by replacing the base ingredient.

The ingredients used for formulation of bars were shortlisted on the basis of their taste, availability as well as nutraceutical properties. In case of cereals oats and wheat were shortlisted to ensure supply of protein with balanced composition of amino acids. There are phenol compounds with considerable antioxidant potential. They are even rich in ceratin enzyme protease, maltase, a-amylase, lichenase etc. Presence of B glucans (a type of soluble dietary fiber) makes it fiber rich. Dates are high energy fruit and a good source of sugars, vitamin C, provitamin A, mineral elements such as K, Na, Ca, Mg, Zn, Fe and P and fibers. It contains both essential and non- essential amino acids. They are also rich in phytochemicals like flavonoids, tannins, saponins, cardiac glycosides and steroids in both flesh as well as seed.

Flax seeds are potent source of omega 3 and omega 6 fatty acids including Linolenic acid, eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA). The protein content in flaxseed has been reported to be between 10.5% and 31% (Oomah and Mazza, 1993) <sup>[13]</sup>. Albumin and globulin are major proteins in flaxseeds, they are rich source of dietary fiber including both soluble as well as insoluble which have natural laxative effect (Cui *et al.*, 1994) <sup>[12]</sup>. Secoisolariciresinol diglucoside (SDG) is the predominant lignin in flaxseed with minor amount of pinoresinol and matairesinol (MAT) (Meagher *et al.*, 1999; Thompson *et al.*, 1991) <sup>[10, 14]</sup>. Flax helps in reducing cardiovascular diseases, favourably affected breast cancer risk reduce prostate cancer risk by dampening inflammatory reactions preventing the formation of cancerous tumours, and efficient in digestive system. Besides all these ingredients addition of nuts and chocolate was done in order to enhance taste and improve acceptability. Whey protein concentrate was used for value addition at varying proportion by replacing the base ingredient

**Table 1:** Composition of Oats protein bars

	Oats (g)	Protein Powder (g)	Dates (g)	Dry Nuts (g)	Chocolate (g)	Flax seeds (g)
Control (standard)	25	0	15	15	40	5
A1	15	10	15	15	40	5
A2	5	20	15	15	40	5
A3	0	30	15	15	40	5

**Table 2:** Composition of Wheat protein bars

	Puffed Wheat (g)	Protein Powder (g)	Dates (g)	Dry Nuts (g)	Chocolate (g)	Flax seeds (g)
Control (standard)	25	0	15	15	40	5
B1	15	10	15	15	40	5
B2	5	20	15	15	40	5
B3	0	30	15	15	40	5

### Acceptability Trial of prepared Nutri bars Selection of panel members

The threshold test was conducted using dilution techniques it is one of the subjective test useful in selecting and training the panel. The test was conducted by preparing three dilutions of sugar using 100ml water. All solutions were marked and arranged in random manner. The members were asked to mark the solutions in ascending order of sweetness. On the basis of the results of dilution test a team of five athletes was shortlisted for evaluating acceptability of nutri bars on the basis of organoleptic attributes. The panel consisted of five female athletes of IIS University who were unfamiliar with the nutri bars. A five point hedonic scale was used to assess the acceptability of the bars.

The judges were requested to fill up the score card sheets giving a maximum of five marks for each five factors (color, texture, flavor, taste and over all acceptability) thus making the total score of 25 marks. At the time one control (standard) bar and three variations of both the experimental bars were made and refrigerated. The three variations of oats were marked as A1, A2 and A3, and wheat bars were marked as B1, B2 and B3. The preparations were laid down on the table and the athletes were asked to evaluate them by giving score in their score cards sheet. Only one athlete was brought at the table at a time so as to avoid discussing and exchange of idea on the table and hence biased marking was avoided.

### Biochemical estimation of most acceptable variation from both the experimental categories

Biochemical estimations of the bars were carried out with the basic aim to evaluate nutrient composition of the Bars mixes by using standard techniques. All the methods were first standardized in the laboratory and then readings were taken in triplicate following method were used for estimating nutrient

composition.

**Table 3:** Method of estimating nutritional components

Nutrient	Method	Reference
Protein (g)	Micro Kjeldhal method	NIN, 2003
Fat (g)	Ether extract	AOAC, 2014
Fiber (g)	Acid-alkali method	AOAC, 2014
Carbohydrates (g)	Composite method	NIN, 2003
Iron (g)	Wong's method	NIN, 2013

Preparation and estimation of nutri bars was performed in Food Science and processing lab of Foods and Nutrition Department of IIS University. One control (standard) and three variants of Oats protein Bar i.e. (A1 10%, A2 20%, A3 30%) and wheat protein Bar (B1 10%, B2 20%, B3 30%) was prepared.

### Results

Nutri Bars are quiet popular around the world as modern supplement product among athletes. Sensory evaluation is a scientific discipline used to determine, analyze, and interpret the reactions of the consumers to the characteristics of foods and other materials perceived by the senses of sight, smell, touch, taste, and hearing. Sensory quality evaluation is important for marketing purposes; the results give in-depth insight on the preference and overall acceptance towards product. In present research oat protein Bars were prepared by substituting oats with protein powder at various levels of incorporation (10%, 20%, and 30%) and in case of wheat protein Bars puffed wheat was used which was further substituted by protein powder incorporated at various levels (10%, 20%, and 30%) in the three variants. The results of acceptability trial are presented below.

**Table 4:** Acceptability Trial of Oats Protein Bars

	Appearance	Color	Taste	flavor	Over all acceptability
A(control)	4.8±0.45	4.4±0.55	4±0.90	3.4±1.2	4.2±0.75
A1	4.8±4.5	5±0	4±0	3.6±0.49	4.5±0.45
A2	5±0	5±0	4.6±0.49	4±0.63	4.6±0.49
A3	4.6±0.49	4.8±0.4	4.2±0.75	3.6±0.49	4.2±0.49

Finally the results of acceptability trial present in Table No 4 highlighted that among the three variants of oats protein Bars (10%, 20%, and 30%), variant A2 with 20% of incorporation was best acceptable in terms of all sensory attributes. On

evaluating the results it could be analysed that the color of A2 bar was liked even better than control ie bar with no whey protein addition besides this the over all acceptability score of A2 was 4.6±0.49.

**Table 6:** Organoleptic evaluation of wheat protein bars

	Appearance	Color	Taste	After taste	Over all acceptability
B	4.8±0.4	4.6±0.49	3.6±0.8	3.4±1.01	4.3±0.75
B1	4.8±0.4	4.8±0.4	4.4±0.49	3.8±0.75	4.4±0.49
B2	4.8±0.4	5±0	4.6±0.49	4.2±0.4	4.9±0.2
B3	4.6±0.49	4.8±0.4	4.2±0.75	4±0.63	4.6±0.49

Similar results were reported in case of Wheat Protein Bar as the variant B2 was reported to be best acceptable in terms of all sensory attributes with 20% incorporation level of protein powder. With respect to appearance the B2 variant scored 4.8

which is almost similar to the other variants. With respect to color also there was not much variation in all the three variants and the control sample too as the scores ranged between 4.6- 5.0 with not much significant variation. Overall

acceptability is an attribute determined by a combination of all sensory perception i.e. appearance, color, taste, flavor of a product. The mean score for the overall acceptance in case of B2 variant was 4.9 hence it was the most liked variant.

In case of both the nutri bars as the (percentage) incorporation of protein powder increased the textural attributes of bars were adversely affected as the binding properties reduced the bars got crumbled easily. Slight flavor change was also reported because of protein powder was also reported. The protein powder used for value addition was hydrolyzed whey

protein powder and it is an instant source of protein which is easily absorbed and easily digestible. These nutri bars can be consumed as snacks in between meals for improving the nutritional status of athletes.

### Biochemical Estimation of nutri rich bars

The biochemical estimations were performed in the research lab of Home Science using the standardized procedures. The results of same are presented below.

**Table 6:** Biochemical estimation of most acceptable Nutri Bars

Nutritional estimation	A (Standard oat Bar)	A2 (Oats Protein Bar)	B (Standard wheat Bar)	B1 (Wheat protein Bar)
Protein content(g/100g)	13.33±0.67	22.65±0.56	14.01±0.65	18.91±0.98
Fat content (g/100g of dry wt.)	19.8±0.71	23.80±0.63	20.87±0.45	22.58±0.56
Total fiber content (g/100g)	5±1.08	4.63±0.98	5.75±0.67	4.33±0.45
Carbohydrate content (g/100g)	36.87±0.98	25.26±0.8.9	35.13±0.45	31.58±0.34
Iron content (mg/100g)	2.5±0.76	2.3±0.23	3.3±0.34	2.1±0.22

### Protein Content (g/100)

The quality of protein ingested and its amount depends upon the mode and intensity of the exercise. Supplemental proteins are safe and convenient way of ingesting high quality dietary protein. Hydrolyzed whey protein supplement purported to provide antimicrobial activity, immune modulation, improved muscle strength and body composition. For the supplemental purpose the estimated protein content was 22.65g/100g in variant A2 (Oat Protein Bar) and 18.91g/100g of B2 (Wheat Protein Bar) however in standard Oats and Wheat bars it was 13.33 g/100g and 14.01g/100g respectively.

### Fat content (g/100)

Fat is one of the major nutrients and has several functions a certain amount of fat has to be present in the diet to meet the minimum requirements of the two essential fatty acid, linoleic acid and linolenic acids, at the same time excess of fat in the diet is also considered harmful, so for ensuring supply of essential fatty acid we added flax seeds in our bars as they are potent source of  $\alpha$ -linolenic acid (omega 3 fatty acid) and omega 3 and omega 6 fatty acids they are nutritionally very important. Fat content was 23.80g/100g of A2 variant Oat Protein Bar and 20.87g/100g of B2 variant Wheat Protein Bar. The fat content of standard bars ranged between 19-20g/100g.

### Total fiber content (g/100)

Fiber refers to the indigestible carbohydrate component that is present in the plants. The name is derived from the fact that it

has naturally fibrous structure. Its primary purpose in the plant is to form parts of the structure in the cells, but it is also useful for human diet. Dietary fiber is a complex mixture of different components. It may or may not include the fibrous structure. Total fiber on the other hand is the term used to describe the dietary fiber and functional fiber that is left over after it has been dissolved in the laboratory with certain harsh chemical solvents such as sulphuric acid and sodium hydroxide.

The total fiber content of the nutri rich bars was found to be 4.63g/100g of A2 variant Oat Protein Bar and 4.33g /100g of B2 Wheat Protein Bar. In case of standard samples the fiber content was 5 and 5.75 g/100g for Oats and Wheat respectively.

### Iron content (mg/100)

Iron is an essential element in our body as it is needed for a number of highly complex processes that continuously take place at the molecular level being indispensable to human life. Iron is required for the normal production of red blood cells and it is also a part of hemoglobin binding to the oxygen and facilitates the respiration mechanism of the body. Iron also works in immune system and normal cognitive functioning. Although deficiency of iron is most common and in a major concern for anemia. In the field of sports anemia has been reported in athletes, mainly in female athletes. The iron content of the nutri rich bars was found to be 2.3 mg of A2 Oat Protein Bar and 2.1mg of B2 Wheat Protein Bar.

**Table 7:** Comparison of Nutritive Value of Value added Nutri Bars with Commercial Bars (values as per 50g of Bar)

Nutrient Composition	Oats protein Bar (50g)	Wheat protein Bar (50g)	Commercial Bars		
			Work-out Bar (50g)	Nutri-Gain Bar (50g)	Health Bar (50g)
Protein (g)	11.32	9.45	10	2	5.39
Fat (g)	11.9	11.29	7.6	3	7.08
Fiber (g)	2.31	2.16	4	3	4.92
Carbohydrates(g)	12.63	15.79	24	24	23.76
Iron (mg)	1.15	1.05	-	-	-
Energy (kcal)	202.9	202.57	210	120	180

The above mentioned table highlighted comparison of value added Nutri Bars developed in the present research with commercially available bars in terms of nutritive value. From the table it can be interpreted that Workout Bar had protein content of 10g which was comparable to the developed Nutri

Bars, however the other two commercial Bars (Nutri grain Bar and Health Bar) had low protein content. The fat content of the developed Nutri Bars was slightly higher than commercial counterparts however this fat was quality wise better as it was mainly in form of omega 3 and omega 6 fatty

acid. Dietary fiber content of commercially available Bars was 4g and 4.92g, however in oats protein bar and Wheat protein bar it was 2.31g and 2.16g which was slightly lower than commercial bars. Carbohydrate content was high in commercial bars in comparison to developed nutri bars, this may be because we had substituted the basic flour i.e. oats and puffed wheat with protein powder in our Bars.

As we incorporated flax seeds in our nutri bars along with Dates and Nuts, hence this enhance iron content of our bars which was 1.15mg and 1.05mg in both variations i.e. Oats protein bar and Wheat protein bar however presence of iron in commercially available bars had not been reported. Iron supplement is important for athletes to ensure regular supply of iron on daily diet for combating Sports Anemia. Sports anemia is most commonly caused by iron deficiency despite of dietary advice, causes hemoglobin destruction and results in fatigue and lowers the performance level.

### Discussion

Numbers of researches have been done for the development and organoleptic evaluation of nutribars by various researchers. An Anti-oxidant rich nutrient Bar for track field athletes was developed by using rolled oats, pumpkin seeds, dehydrated carrots, flax seeds, peanuts, almonds, honey and dates syrup. Acceptability test was conducted for the prepared bars in three variations and the organoleptic evaluation highlighted that variant A3 bar was most acceptable as it scored highest in attributes of appearance, color, flavor, texture, taste and overall acceptability. Thus the product was accepted well with the highest score. Results of nutritional estimation highlighted that bars were able to meet 14% of energy, 29% of protein, 10% of carbohydrate, 32% of fat, 2.1% of vitamin –A, 22% of vitamin– C, >100 percentage of vitamin – E and Total antioxidant levels were fixed at 115.6 mg/100 gm.

Akma Mazaitul *et al*, 2016 researched on development of novel energy snack bar by utilizing local Malaysian ingredients (banana, glutinous rice flour, and coconut milk). Their results showed that the developed snack bar contained 13.23% of moisture, 1.13% of ash, 6.36% of crude protein, 22.39% of crude fat, 1.16% of crude fiber, 56.89% of total carbohydrate, and 454.51 kcal of energy. The “energy” snack bar was highly acceptable with desirable sensory quality by all consumers.

Tanskanen, 2012 worked on Effects of Easy-to-Use Protein-Rich Energy Bar on EnergyBalance, Physical Activity and Performance during eight Days of sustained physical exertion and they conclude that easy to use protein rich energy bars did not prevent energy deficit nor influence physical activity during 8 days of training. But the high content of protein in the bars have induced satiation decreasing energy intake from field rations.

Research was conducted by Oliver and Tremblay to study the Effect of Sports nutrition Bar on endurance running performance. The bar claimed to contain adenisine antagonists and precise mixture of macronutrients that purported to improve aerobic performance by increasing fat metabolism and provide sustained exogenous energy and results highlighted that the use of access sports nutrition Bar had no effect on endurance running performance.

### Conclusion

Sport performance placed under excessive strain, strength and power for athletes who are primarily interested in enhancing power relative to body weight and thus almost all undertake

some form of resistance training. Nutrition plays a number of important roles for athletes competing in sports where the expression of explosive power and strength are critical to competitive success. Scientific studies investigating the effects of protein intake on exercise performance has focused on supplemental protein intake along with maintenance of iron status during exercise. In modern era in the field of sports nutrition, there are 61.4% calorie replacement products of all types, including supplemental energy bars also. Sixty five percent of female athletes use some type of nutritional supplement during their college athletic career. Among athletes, the most popular protein supplement are protein powders. Nutri Bars also provide easy consumability during training and post competition for athletes. Bars are convenient and healthy ready to eat food which supplies balance nutrients both macro and micronutrients (protein, fat, minerals, vitamins, calories, and carbohydrates) and they are marketed to the athletes as a source of energy. The prepared Nutri rich bars can be consumed by athletes during events or after the events to abate hunger and provide a supportive energy. Nutri rich bars are low in saturated fats and high in essential fatty acids, along with high dietary fiber and rich in easily digestible protein and iron which improves the strength as well as iron status in the athletes. We had compared the prepared Nutri Bars with commercially available bars and found that Nutri Bars have higher nutraceutical value and was most acceptable by athletes.

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