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Development and Analysis of Nutri Bar Enriched With Zinc for Sports Athletes

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ABSTRACT: Sports athletes around the globe have widely been consuming Nutri bars. Nutri bar is a finger food with blend of Nutri dense ingredients to provide nutrition to different cadre of individuals (sports athletes) in an amount that aids for improving their overall nutrition. Previous research in athletes suggested regular training and zinc rich diet enhances the repair of muscles during post exercise and also has a positive hormonal benefit. Hence, this study aimed to develop and analyze a Nutri bar enriched with zinc by incorporating pumpkin seeds for sports athletes. A ready to eat Nutri bar was prepared with the locally available zinc rich ingredient pumpkin seeds in different amounts in addition with other cereals like oats, wheat flakes and sweetening agents such as honey and sugar along with almonds and raisins. The developed bar was evaluated for sensory attributes and the keeping quality was evaluated by standardized methods. The Organoleptic evaluation showed significant difference between the variations and the highly accepted product was chosen. Nutrient analysis per 100 g of bar revealed- 425.1 Kcals and 1.663 mg of Zinc thus, confirming that the developed bar was highly nutritious and contain high amount of Zinc. Developed Nutri bar which is an ideal supplement for athletes, rich in zinc, a ready to eat and easy to carry for pre and post event.

KEYWORDS: Sports Athletes, Nutri Bar, Zinc, Pumpkin seeds, Organoleptic

I.INTRODUCTION

Sports nutrition concentrates on athletic performance. It plays important role in keeping athletes healthy, preventing fatigues and illness associated with poor recovery.

The various varieties of bars available in the global market with good organoleptic properties. These bars are generally packed in metallised polyester films and have a limited shelf life of 3 to 4 months. (Ananthan Padmashree,2010).

Energy bars are a dietary supplement often consumed by athletes and other physically active people to maintain their Calorific needs. Energy bars provide the strength and vitality for sustained physical and mental activity. It is meant to be high in carbohydrates and moderate protein content.

The purpose of the energy bar is to provide energy conveniently and quickly during endurance training or any kind of sports or exercising events. A Typical energy bar weighs between 45g to 80g and is likely to supply about 200-300 kcals; 7-15g of protein; 3-9g of fat; and 20-40g of carbohydrates.

People concerned in getting healthier and keeping the good body fitness such as sporting and exercising individuals have changed their eating patterns which has promoted growth in the cereal bars market of 20% per year (Lin et al., 2010). Suitable energy intake is necessary for hormonal and metabolic function.

The consumption of carbohydrate immediately before and during exercise represents an effective strategy to provide an exogenous fuel source to the muscle and central nervous system (Louise M. Burke, 2011).

As the most efficient fuel for the exercising muscles, carbohydrates are the primary source of energy during both high and low-intensity activities. The researchers believe altered zinc metabolism, coupled with increased zinc



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excretion and stress levels lead to fatigue and decreased endurance. Zinc has been linked to improved immune function, and as an antioxidant and anti-inflammatory, all of which can benefit hard-training athletes.

Zinc is an essential mineral that is critical to the function of many proteins and biological functions. It plays a role in growth, building and repair of muscle tissue, energy production, and immune status. Diets low in animal protein, high in fibre and vegetarian diets, in particular, are associated with decreased zinc intake. Zinc status has been shown to directly affect thyroid hormone levels, BMR, and protein use, which in turn can negatively affect health and physical performance.

Dry fruits and dates have high concentrations of polyphenols with excellent nutritional value that enrich lipoprotein in plasma and protect it from oxidation. Zinc is a component of over 300 enzymes, some involved in functions important to physical performance, such as muscle energy production and protein synthesis.

Pumpkin seeds are a good source of Zinc. Nuts and seeds are widely used for their oils as well as butter and cookies. Therefore nuts and seeds are excellent nutrients for growing children and good snack for adults. A 100 gram serving of pumpkin seeds contains 7.81 milligrams of zinc. Pumpkin seeds contain big amount of zinc; a mineral very important in preventing osteoporosis. Pumpkin seeds are a very good source of Vitamin E and B vitamins. It has large amount of minerals that include copper, iron, manganese, magnesium and phosphorous. It also has antioxidant and anti-mutagenic properties and help in controlling cardiovascular diseases.

Micheletti notes that endurance athletes who adopt a diet rich in carbohydrate but low in protein and fat may decrease zinc intake, which over time may lead to a zinc deficiency with loss of body weight, latent fatigue, and decreased endurance.

The strain, an athlete puts on his/her body practicing and competing on a daily basis can lead to this deficiency, regardless of his or her age, if the zinc shortfall is not made up through diet and/or supplementation. This mineral aids in post-exertion tissue repair and in the conversion of food to fuel. Both male and female athletes have lower serum zinc levels compared with sedentary individuals. Studies correlate endurance exercise with periods of compromised immunity—zinc depletion may be one reason.

Decreases in Cardio-respiratory function, muscle strength, and endurance have been noted with poor zinc status. The Upper Limit for zinc is 40 mg. Athletes should be cautioned against single-dose zinc supplements because they often exceed this amount, and unnecessary zinc supplementation may lead to low HDL cholesterol and nutrient imbalances by interfering with absorption of other nutrients such as iron and copper.

Analysis of dietary intake of athletes was conducted with food works (XyrisPvt. Ltd., Bristane, Australia). The survey suggests that intake of the micronutrients Iron, Zinc, Calcium, Vit.A and Vit.C may be of concern for a number of athletes than the Dairy, Fruit and Vegetable intake.

The Nutri-bar was formulated keeping the sports athletes and individuals in mind along with the aim of providing adequate energy and quick for consumption Pre, Post, During training activity or the event i.e. Workout snack to provide with energy.

II. METHODOLOGY

A. SELECTION AND PROCUREMENT OF INGREDIENTS

The raw materials were selected on the basis of availability of the ingredients. The ingredients used in the nutri-bar are used in every household. The ingredients used for preparation of nutria bar are as follows:

- I. **Oats** (rolled & semi-cooked): Dry rolled flakes of oatmeal were purchased from a local Supermarket and stored in a clean, dry, airtight container at room temperature during preparation stages.



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- II. **Honey** (organic): Pure packed honey was purchased from the local Supermarket. The honey was stored in air tight bottles at room temperature to prevent spoilage.
- III. **Sugar**: Pure and Moisture free sugar was purchased from the local Supermarket. It was then stored in clean air-tight containers at room temperature.
- IV. **Wheat flakes**: Dry wheat flakes Where obtained from the local Supermarket and Then stored in airtight containers to avoid loss of Crispness.
- V. **Almonds**: Dry, whole almonds Where purchased from the local market and stored in a clean, airtight container.
- VI. **Raisins**: Whole raisins Where procured from a retail store in the local market and Where stored in an airtight container.
- VII. **Pumpkin Seeds** (de-husked) :The local variety of dehusked pumpkin seeds which appeared white, Where obtained from the local market and Where packed in an airtight container.

The ingredients were selected on these properties and health benefits along with the ease of availability.

B. PREPARATION AND STANDARDISATION OF THE NUTRI-BAR

The Nutri-bar was tried in different proportions and the best outcome was selected for further variations with pumpkin Seeds. Various recipes were looked through before finalizing on the recipe incorporated. The Standard was made using various basic ingredients such as oats, nuts and sugar. The product was then prepared using the below list of ingredients in clean and sterile equipments in the food processing laboratory.

NUTRI BAR

STANDARDIZED RECIPE:

Ingredients:

- Rolled oats – 25g
- Honey – 20g
- Sugar – 20g
- Wheat flakes – 20g
- Almonds – 5g
- Raisins – 5g
- Oil – 1tbsp

Method:

Weigh all the dry ingredients per the standardized formulation. In a separate container, Weigh of all the wet ingredients. Melt the sugar at 100° C. Then, add oil and honey, Mix properly until thread like consistency appears. Mix both the dry and the melted ingredients and keep aside. Using molds press the mixture into rectangular bars. Cool it in the freezer for 5-10 minutes, to ensure proper binding. Then store in an air-tight pouch or container (i.e stainless steel/plastic). The bar will stay for 45 to 60 days in the freezer.

Based on this basic recipe, the nutria bar was prepared with the incorporation of pumpkin seeds. the nutria-bar has been made added with sugar and honey for their binding properties and also due to their palatability.

The product was then developed and prepared using these ingredients that were procured.

VARIATIONS RECIPE (Pumpkin seeds):

Ingredients:

- Rolled oats – 25g
- Honey – 20g
- Sugar – 20g
- Wheat flakes – 20g
- Almonds – 5g
- Raisins – 5g
- Oil – 1tbsp

❖ **Pumpkin seeds:**

- Variation 1: **10g**
- Variation 2: **15g**
- Variation 3: **20g**

Method:

Weight all the dry ingredients per the standardized formulation. In a separate container, Weigh of all the wet ingredients. Melt the sugar at 100° C and then to this add oil and honey, mix properly until thread like consistency appears. Mix both the dry along with three sets of variations of pumpkin seeds (i.e 10g/15g/20g) and the melted ingredients and keep aside. Cool it in the freezer for 5 mins , to ensure proper binding.

The procedure for developing the product is as follows:

All the ingredients are weighed as per the formulation

mix all the dry ingredients and keep aside

Melt the sugar in honey at 100°C & add oil, mix properly

Using moulds press into bars of weight 35g each

Mix both the wet and dry ingredients

Cool to the ambient condition, then it is packed

C. ADDITION OF PUMPKIN SEEDS TO THE NUTRI BAR

The pumpkin seeds were roasted and the powder was added into three different types of variations:

- 10 gram
- 15 gram

- 20 gram

The additions were made to 100 grams of the Nutri-bar mixture respectively. 20 grams of pumpkin seeds was chosen as the higher limit beyond which it would more than 1/3rd of the daily requirement of the RDA for Zinc.



Plate. 1 Pumpkin seeds (roasted and ground)

D. FORMULATION OF THE NUTRI-BAR

Respective amounts of ingredients were used to make the standard and variations of the nutria-bar respectively. The nutria bar was made in a stainless steel vessel following the method used to make traditional Indian sweets.

Table. 1 Formulation of Nutri-bar

Ingredients	Amount (g)			
	Standard	Variation 1	Variation 2	Variation 3
Rolled oats	25	25	25	25
Honey	20	20	20	20
Sugar	20	20	20	20
Wheat flakes	20	20	20	20
Almonds	5	5	5	5
Raisins	5	5	5	5
Oil	5	5	5	5
Pumpkin seeds	-	10	15	20



Plate. 2 The Standard Nutri-bar

E. SENSORY EVALUATION

Sensory evaluation is defined as the scientific discipline used to evoke, measure, analyze, interpret those responses to products that are perceived by the senses of smell, touch, sight, taste and hearing (Stone and Sidel, 1993). Sensory evaluation is performed to find out the acceptance level of the product among the consumers.

It is used as a tool to evaluate, determine or improve the quality of products. Sensory evaluation for the Nutria bar developed was done using the 9-point hedonic scale. The 9-point hedonic scale is also called as the degree of liking scale and is commonly utilized to check the acceptability of the products amongst the consumers. The scale has equal intervals and ranges from “like extremely” to “dislike extremely”. It has a central point – “neither like nor dislike”. The minimum acceptability belongs to 1 (dislike extremely) and the maximum acceptability belongs to 9 (like extremely).



Plate. 3 Semi trained panelist evaluating the Nutri-bar

F. PROXIMATE ANALYSIS

The standard Nutri-bar and the variants were analyzed in order to obtain the nutrient composition. The Macronutrients analyzed were moisture, ash, energy, protein, fat and carbohydrates.

Estimation of Moisture (AOAC, 2000)

Moisture content is known to affect the physical and chemical properties of foods and it plays a major role in the shelf life of various products. An ideal product is required to contain low moisture. Moisture also affects the freshness and storage of foods as it can determine the quality of foods prior consumption.

Estimation of Total ash (AOAC, 2000)

Ash or mineral content is the portion of the food or any organic material that remains after it is burned at very high temperatures. Ash content represents the mineral content of a food product. The ash constituents includes calcium, potassium, sodium and magnesium, which are present in large amounts.

Estimation of Protein (AOAC, 2000)

Proteins are important constituents of foods for a number of different reasons. They are the major source for muscle building, as well as containing essential amino acids, which are essential to human health. The protein content of the sample was estimated using the Kjeldahl method.

Estimation of Fat (AOAC, 2000)

Lipids are one of the major constituents of foods, and are important in the diet and contribute to essential lipid nutrients like vitamins. Lipid component plays a major role in determining the overall physical characteristics, such as mouth feel, taste, texture and flavor. Fat was estimated as crude extract with the solvent evaporated and residue was weighed.

**Computation of carbohydrates (AOAC, 2000)**

Carbohydrates are an essential source of energy; Carbohydrates also contribute to the sweetness, textural characteristics and appearance of many foods. Carbohydrates in foods can be calculated only after the other components have been estimated. The content was computed using differential method.

$$\text{Carbohydrate (g/100g)} = 100 - [\text{Protein (g)} + \text{Fat (g)} + \text{Fibre (g)} + \text{Ash (g)} + \text{Moisture (g)}]$$

Computation of energy (AOAC, 2000)

Energy needs to be estimated in order to know if the food product is an energy dense product or not. It was computed by factorial method for the samples.

$$\text{Energy (Kcal)} = [\text{Protein (g)} \times 4] + [\text{Carbohydrate (g)} \times 4] + [\text{Fat (g)} \times 9]$$

Estimation of Zinc (AOAC, 1980)

Zinc is a Macronutrient that is involved in numerous aspects of cellular metabolism. It is required for the catalytic activity of approximately 100 enzymes and it plays a role in immune function, protein synthesis, wound healing, DNA synthesis and cell division. Zinc also supports normal growth and development during pregnancy, childhood, and adolescence and is required for proper sense of taste and smell. A daily intake of zinc is required to maintain a steady state because the body has no specialized zinc storage system.

G. SHELF LIFE STUDY

The standard Nutri-bar and variants were analyzed in order to obtain the shelf life and storage stability of the product. The analysis done composed of shelf life and storage stability of the product. The analysis done composed of storage and microbial analysis and peroxide value determination.

Shelf life is the length of time that foods are given before they are considered unsuitable for sale, use or consumption. Shelf life is recommendation of time that products can be stored, during which the defined quality of specified proportion of the goods remains acceptable under expected conditions of distribution, storage and display.

Shelf life is most influenced by several factors: exposure to light and heat, transmission of gases, mechanical stresses and contamination by things such as microorganisms. Microorganisms contaminate food during the stages of handling, processing and transportation. A food is said to be spoiled when the presence of yeast, fungi, or bacteria contaminate the food to such an extent that makes it unfit for the human consumption. In order to obtain statistically relevant data, the microbial evaluation of the food sample was done by the SPC, counting the total number of colony forming units and studying the colony characteristics. for isolation and identification of microorganisms in the countable range, the Nutri-bar was diluted in distilled water. A serial dilution technique using 10 fold dilutions was done. Using the appropriate diluted sample, spread plate and pour plate methods were used for isolation of microorganisms on suitable media.

Microbial Analysis

Microbial analysis is done in order to study the shelf life of the product. The Institute of Food Science and Technology (IFST, 1993) defined shelf life as the period of time during which the product will- Remain safe, Comply with any label declaration of nutritional data, when stored under the optimal conditions and Be certain to retain the desired sensory, physical, chemical and microbiological characteristics

Pour plate method was performed using 1 ml of dilutions 10^{-7} , 10^{-8} , 10^{-9} and incubated at 35°C to 37°C for 24 hours. This is used to estimate the CFU for Bacteria. Spread plate method was done using 0.1 ml of the dilutions 10^{-4} , 10^{-5} , 10^{-6} and incubated at room temperature (25°C to 28°C) for 24 to 48 hours. This estimates the Fungal count of the foods.

Determination of Peroxide value

Peroxide value (PV) is used as a measurement of the extent to which rancidity reactions have occurred during storage. Other methods are also available but peroxide value is the most widely used. Peroxide Value, which is the concentration of Peroxide in oil or fat, is useful for assessing the extent to which spoilage has occurred.

Oxidation of lipids is one common and frequently undesirable chemical change that may impact flavor, aroma, nutritional quality and in some cases, and even the texture of products. The chemicals produced from oxidation of lipids are responsible for rancid aroma and flavor. Vitamins and other nutrients may be partially or entirely destroyed by highly reactive intermediates in the lipid oxidation process. Oxidized fats can interact with proteins and carbohydrates causing changes in texture.

The Peroxide Value test is used to assess and study the shelf life of the product.

III. RESULTS AND DISCUSSION:

A.SENSORY EVALUATION

The sensory evaluation was conducted using a 9 point Hedonic scale with the attributes such as color, texture, appearance, flavor, taste and overall acceptability. The results were calculated and tabulated.

Table. 2 Sensory attributes of Nutri-bar

Nutri-bar	Color	Texture	Appearance	Flavor	Taste	Overall acceptability
Standard	7.50±1.02	6.84±1.26	7.08±1.29	7.34±1.31	7.29±1.14	7.19±0.91
Variation 1	7.04±1.03	6.70±1.27	6.79±1.53	5.84±1.27	5.99±1.34	6.47±0.94
Variation 2	6.80±1.19	6.70±1.14	6.60±1.31	6.40±1.47	6.55±1.38	6.57±1.06
Variation 3	7.66±1.13	7.46±1.18	7.59±1.23	7.03±1.89	7.08±1.77	7.33±1.20

It is observed that the Nutri-bar with variation 3 was preferred and considered best among all the variations with the highest mean of 7.33 for all attributes. The standard was preferred next followed by variation 2 and variation 1 with a mean of 6.57 and 6.47 respectively.

Table. 3 Overall acceptability between the Nutri-bar Variations

Variation	Mean	Std. Deviation	F statistic	P value
Standard	7.19	0.91	3.191	1*
Variation 1	6.47	0.94		
Variation 2	6.57	1.06		
Variation 3	7.33	1.20		

*Significance at 1% and 5%

The Table shows that there was a significant difference (F = 3.191, P = 1) at 1 %. The means of overall acceptability was significant between the Standard and all the Variations. But, it was noted that there was a significant difference of 5% between Standard and Variation 3 with a mean of 7.33.

It is observed that the Nutri bar with Variation 3 was preferred and considered best among all the Variations with the highest mean of all attributes. The Standard was preferred next followed by Variation 2 and Variation 1 with a mean of 6.57 and 6.47 respectively.

B. NUTRITIVE VALUE OF NUTRI-BAR

Table. 4 Calculated Nutritive value of Nutri-bar (100g)

Nutrient	Nutritive Value
Energy (kcal)	584.65
Protein (g)	17.74
Fat (g)	25.5
CHO (g)	71.07
Zinc (mg)	1.87
Magnesium (mg)	18.65
Calcium (mg)	54.75

The above table represents the calculated nutritive value of the Nutri-bar.

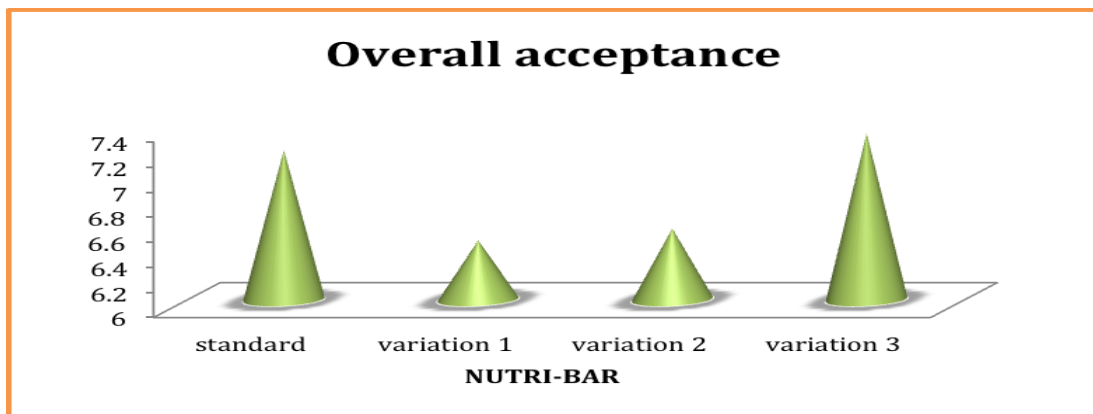


Fig. 1 Over view of Sensory evaluation of the Nutri-bar

The above figure depicts the sensory attributes for the standard and variants of Nutri-bar. Variation 3 was the most preferred when compared to the overall acceptability of the product.

C. PROXIMATE ANALYSIS

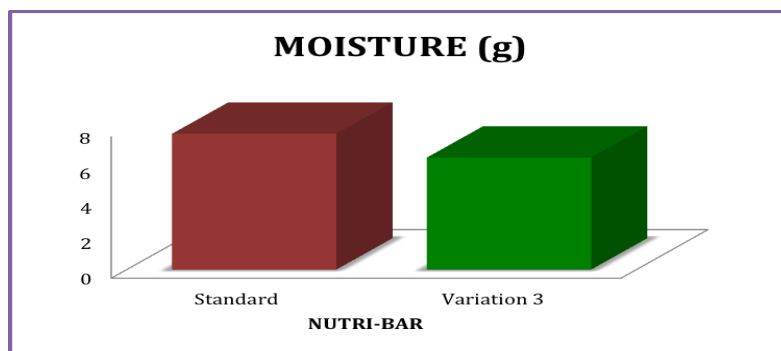


Fig. 2 Comparison of Moisture content (g/100g) of the standard and variations using Pumpkin seeds

The moisture level was seen to be the highest in Standard with 7.69 g/100g. Variation 3 had a moisture level of 6.34 g/100g. The moisture of the Standard was comparatively higher on par with the Variation.

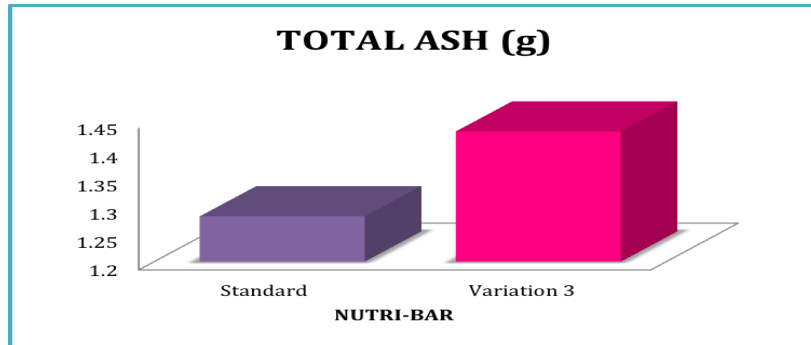


Fig. 3 Comparison of Total Ash content (g/100g) of the standard and variations using Pumpkin seeds

The ash content of the standard was estimated to be 1.23 g/100g. Variation 3 had 1.48 g ash per 100g.

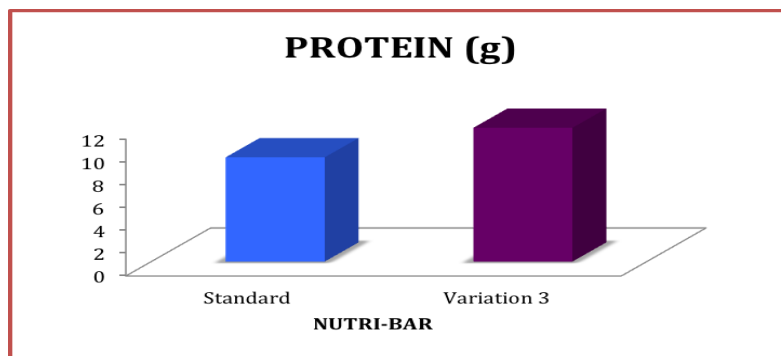


Fig. 4 Comparison of Protein content (g/100g) of the standard and variations using Pumpkin seeds

The protein content was similar in all variants. The Standard had 9.16 g/100g protein while variation 3 had higher amounts of protein at 11.75 g/100g.

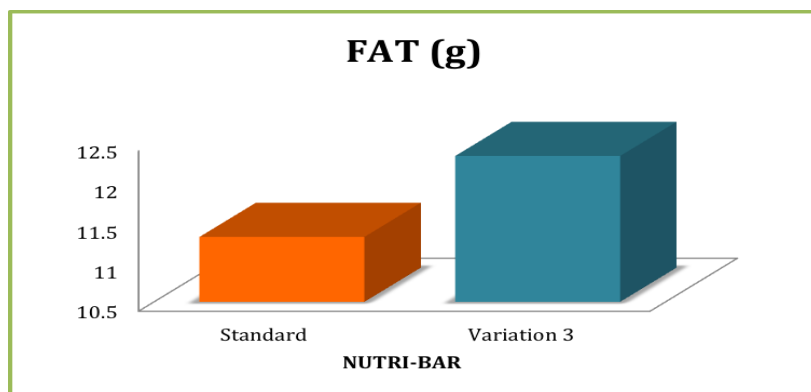


Fig. 5 Comparison of Fat content (g/100g) of the standard and variations using Pumpkin seeds

The figure depicts the amount of fat per 100g of Nutri-bar. The fat content of the standard was found to be 11.31 g/100g. Variation 3 had a slightly higher fat content 12.32 g.

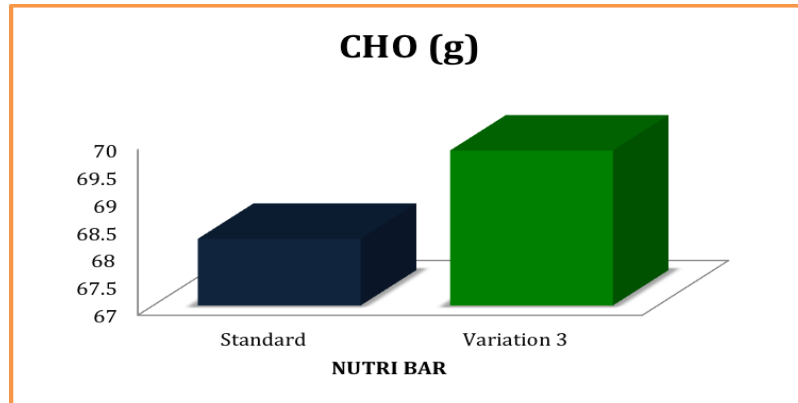


Fig. 6 Comparison of Carbohydrate content (g/100g) of the standard and variations using Pumpkin seeds

The carbohydrate content of the standard was 69.21 g/100g. Variation 3 had the highest amount at 68.81 g/100g.

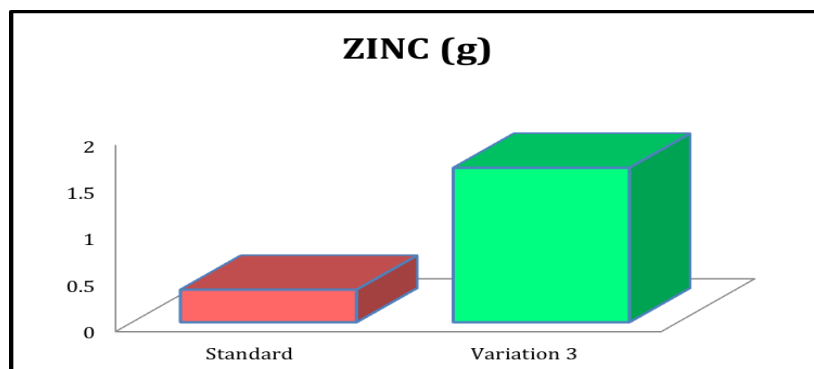


Fig. 7 Comparison of Total zinc content (g/100g) of the Standard and Variations 3

The amount of Zinc in the Variation 3 was relatively high as 1.66 mg Compared to the Standard with a value of 0.35mg.

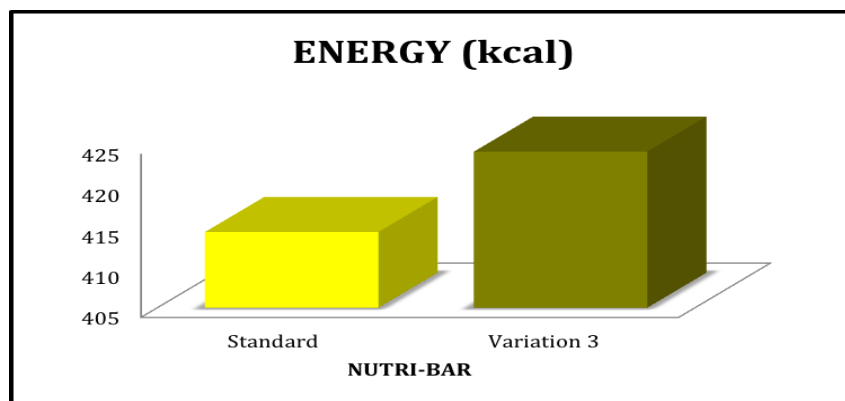


Fig. 8 Comparison of Total Calorie content (g/100g) of the standard and variations using Pumpkin seeds

The calorie content of the standard constituted of 412.28 kcal/100g. Variation 3 had Calorific values of 424.12Kcal/100g.

Table. 5 Proximate value of Standard Nutri-bar (100g)

Nutrient	Proximate value
Energy (kcal)	414.28
Protein (g)	9.16
Fat (g)	11.31
CHO (g)	68.96
Zinc (mg)	0.35

The table above shows the compiled proximate analysis of the Standard Nutri-bar.

Table. 6 Comparison between Calculated value and Proximate value of Nutri-bar (100g) along with Pumpkin seeds (20g)

Nutrient	Calculated value (CV)	Proximate value (PV)
Energy (kcal)	584.65	425.12
Protein (g)	17.74	11.75
Fat (g)	25.5	12.32
CHO (g)	71.07	66.81
Zinc (mg)	1.87	1.663

From the above table, it can be observed that the proximate values are lesser when compared to the calculated values of the Standard Nutri-bar. It suggests that the shelf life can affect the nutritive value of the developed product.

D. SHELF LIFE STUDY:

MICROBIAL ANALYSIS (DAY 15 TO DAY 30)

Microbial analysis was carried out on the 1st day, 15th day and the 30th day for standard and all the variations. The method followed to isolate microbes was Pour plate method (Nutrient Agar) and Spread plate method (Potato Dextrose Agar).

In pour plate method, the dilutions 10^{-7} , 10^{-8} , and 10^{-9} were used to observe the bacterial growth while dilutions 10^{-4} , 10^{-5} , and 10^{-6} were used to observe the fungal growth in spread plate method. All Dilutions were performed in triplicates and the Colony forming units were counted after 24 – 48 hours of incubation.

The shelf life study demonstrated a good keeping quality for all the products for 15 days. This is contributed by aseptic preparation and storage of the product.

Table. 7 Microbial analysis of Standard and Variation of Nutri-bar

VARIATION OF NUTRI-BAR	DAY	APPEARANCE OF BACTERIAL AND FUNGAL COLONIES
Standard	1	None
	15	None
	30	Visible
Variation	1	None
	15	None
	30	Visible

The table depicts the microbial analysis of standard and variation 3 of the Nutri-bar for 30 days.

Table. 8 Microbial analysis of standard Nutri-bar

DAY	TEST	RESULT
30	Total Bacterial Count	700 cfu/100g
	Total Fungal Count	15 cfu/100g

The above table shows the total bacterial count and fungal count was estimated on the 15th and 30th day respectively.

E. DETERMINATION OF PEROXIDE VALUE

Table. 9 Peroxide values of the Standard and Variation of Nutri-bar

Variation Of Nutri-Bar	Day	Peroxide Value (mEq/Kg)
Standard	1	4.2
	15	4.8
	30	5.1
Variation	1	4.0
	15	4.5
	30	5.0

The peroxide value was estimated on the 1st, 15th and 30th day and the values were found to be well within the Bureau of India Standard (BIS) limits.

IV. CONCLUSION

The research study titled “ Development and Analysis of Nutri bar enriched with zinc for sports athletes” was carried out with the objectives of successfully developing the product and assessing the acceptability of the product developed. It can be concluded that the developed Nutri bar provided adequate amounts of carbohydrates, protein and fat. It is also a good source of zinc.

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