Journal of Advances and Scholarly Researches in Allied Education
Vol. 21, Issue No. 1, January-2024, ISSN 2230-7540

Formulation of Energy Bars by using Sunflower Seeds

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Abstract - The study discusses the popularity and nutritional benefits of snack foods, with a focus on granola bars as a versatile and nutrient-dense option. The importance of energy bars for athletes and individuals with busy lifestyles is highlighted. The study aims to develop a high-protein, high-energy nutritional bar using plant sources. Oats are emphasized for their rich nutrient profile, including carbohydrates, fiber, proteins and various bioactive compounds. Dates and almonds contribute additional nutrients and health benefits. Sunflower seeds are recognized for their therapeutic benefits, while honey is for its antibacterial and nutritional properties. The energy bars, including a basic version and two variations, were analyzed for various nutritional parameters. The moisture content exhibited slight increments, measuring from 6.83±0.01, to 7.03±0.01, while the ash content showed minimal differences at 0.05±0.01. Energy content increased from 380±0.032 to 410±0.026, and protein content ranged from 9.17±0.01 to 9.19±0.01. Fat composition showed marginal variations while the fiber content was measured at 6.67±0.01, 6.77±0.01 and 6.78±0.01 grams. Ascorbic acid concentrations increased from 0.7±0.015 to 0.81±0.0026, while thiamine and riboflavin concentrations showed slight fluctuations. Sensory evaluation revealed that T2 (30% honey) scored highest in various categories, including color (8.5±0.527), taste (8.6±0.516), texture (8.2±0.788), flavor (8.5±0.707), appearance (8.5±0.527) and overall acceptability (8.6±0.516). T2 emerged as the most preferred, followed by T1 (25% honey) and T3 (35% honey).

Keywords - Energy Bars, Snack foods, Quantitative Analysis, Sensory Evaluation, Bioactive Compound Analysis, Granola.

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INTRODUCTION

Snack foods have always been popular among consumers for a variety of factors, including flavour, appearance and texture. Snack foods are unique dietary groupings that are always expanding and have long been essential to contemporary lifestyles. Granola is a very nutrient-dense snack food that can be made using a variety of ingredients, including cereal grains, rolled or flaked oats, barley, germ element of cereal grains, honey, almonds, raisins and more. Granola's nutritional value can be altered by varying its constituent parts. Across the world, making granola bars from cereal grains is a common habit. Cereal bars are an alternative snack that is convenient to eat and has practical qualities. They first appeared about ten years ago (Sharma *et al*., 2014).

Most consumers who use energy bars are athletes or sports enthusiasts who lack the time for a complete meal. Nevertheless, dieters, individuals on a restricted diet and those with erratic eating patterns can also utilise energy bars as a source of nutrition. Snack bars offer multiple nutritional benefits such as high-quality proteins, polyunsaturated fatty acids, minerals, vitamins and fibre, along with being a very versatile food source and a vital source of energy.

Essential fatty acids and phytosterols, which serve to improve the fatty acid composition of the product, can be found in nuts. By preserving an equilibrium between total cholesterol, LDL and HDL, the presence of these phytosterols and other bioactive substances aids in controlling the lipo-protein profile. Lowering the risk of certain malignancies can be achieved by managing certain characteristics (Hicks *et al*., 2015).

Granola bars and other goods can benefit from the addition of proteins to enhance their functionality and protein quality. High-grade, balanced protein is essential to the body's numerous regulatory functions. The primary sources are derived from plants and animals. The aim of this study was to develop a high-protein, high-energy nutritional bar that would provide balanced nutrients required for various bodily functions using plant sources.

Oats, scientifically known as Avena sativa L., stand out from other cereal crops due to their abundance

of nutrients that hold significant value for various purposes such as human consumption, animal feed, healthcare, and cosmetics. This particular cereal serves as a vital source of carbohydrates, dietary soluble fiber, well-balanced protein, lipids, a wide range of phenolic compounds, vitamins and minerals. While oats are predominantly utilized in breakfast cereals and snack bars, incorporating oats into diverse products would greatly enhance the well-being of consumers (Paudel *et al.*, 2021).

Antioxidants, vitamin E, phytic acid, phenolic acid and avenanthramides can all be found in good amounts in oats. Oats soluble fiber has been shown to lower high blood triglyceride, cholesterol and glucose levels. When present in sufficient quantities in diet, insoluble fiber, which serves as a water-holding capacity agent and can shorten intestinal transit time, is a good source of fiber found in oats (Ahmad *et al*., 2014).

Dates (Phoenix dactylifera) are a type of palm tree that belongs to the Arecaceae or Palmae family. The species name dactylifera, which means "date-bearing," is derived from the Greek words daktulos, meaning "date" and the stem of the Greek verb fero (Reem et al., 2017). With over 600 different varieties, dates come in various shapes and possess unique organoleptic properties (Shrinath *et al*., 2011).

Almonds or Prunus dulcis, belong to the Rosaceae family and are well known for providing vital nutrients. Proteins and certain minerals like calcium and magnesium can be found in almond seeds. In addition, they contain high levels of phytosterols, mono-unsaturated fats, vitamin B, dietary fiber, and vital minerals. Almonds' complex food matrices contain several nutrients and other phyto protective substances that are beneficial to human physiology. Every type of nut has a high fat content, mostly unsaturated fat and is high in energy (David *et al*., 2009). Almonds are helpful in the treatment of a number of skin conditions, including eczema and acne, as well as constipation, gastroenteritis, kidney pain, diabetes, facial neuralgia and gastric ulcers (Hari and Lakshmi, 2012).

A member of the Cucurbitaceae family, muskmelon (Cucumis melo L.) is a vining plant. From seed to marketable fruit, this warm-season crop needs a good amount of time to grow because it is susceptible to cold temperatures. One member of the cucumber (Cucurbitaceous) family is the muskmelon (Cucumis melo L). Another name for muskmelon is "Nut meg" melons (Chaudhari and Dhuppad, 2020).

Melon fruits are also rich in lutein, zeaxanthin and cryptoxanthin in addition to α and ß carotene. The majority of the necessary amino acids needed for normal functioning are found in muskmelon. These include arginine, glycine, lysine and proline in smaller amounts, as well as glutamic acid, alanine and aspartic acid in substantial proportions. More than 40 mg of ascorbic acid are present per 100g of fresh weight. Muskmelon is unique among fruits because it also has vitamins B1, B3 and B6, among other nutrients. Muskmelon and other melon fruits are also rich in folate which is also known as vitamin B9 (Upasana *et al*., 2022).

The sunflower plant (Helianthus annuus.) is a remarkable oil seed crop that is grown all over the world for its seeds. Nutrient-dense sunflower seeds may help with bacterial and fungal infections, cancer, heart disease, skin disorders and chronic inflammatory problems. Numerous studies have shown sunflower seeds to be therapeutically beneficial in a variety of clinical conditions (Ruchika *et al*., 2014). The composition of sunflower seed by-products reveals their potential as a viable food ingredient in the manufacturing of various food products (Josemar *et al*., 2021).

A process of dehydration inside the bee colony concentrates the upper aero-digestive tract of the bee, which produces honey as a byproduct. Honey's antibacterial properties are its most well-known effect (Eteraf and Najafi, 2013). Honey has many nutritional benefits, including the ability to reduce cough and promote wound healing. It also has anti-oxidant, anti-inflammatory and antibacterial qualities. A useful dietary addition is honey (Meo *et al*., 2017).

OBJECTIVES

1. To make an innovative nutritious product.
2. To determine the nutritional value by chemical methods.
3. To determine the consumer acceptability by sensory evaluation.

MATERIALS AND METHODS

Raw Materials:

Good quality almonds (*Purus dulcis*), muskmelon seeds (*Cucumis melo*), oats (*Avena sativa L*.), honey (*Apis mellifera*), sunflower seeds (*Helianthus annuus*) and dates (*Phoenix dactylifera*) were procured from local market of Guntur.

Granola Bar Preparation:

Different ingredients were used to prepare three variants of granola bar, the details of ingredients to make the treatments are mentioned in Table 1. All the dry ingredients i.e., oats, almonds, sunflower seeds and muskmelon seeds were roasted and crushed into small pieces to give uniformity in the final product. For agglutination of granolas, the slurry was prepared in a stainless steel container, where the ingredients (dates and honey) were blended and mixed with dry ingredients until a uniform mixture was obtained. This mixture was placed on a slab and leveled using a roller pin and butter paper. After

cooling, the mixture was cut into rectangular bars with a constant weight of approximately 25 g each.

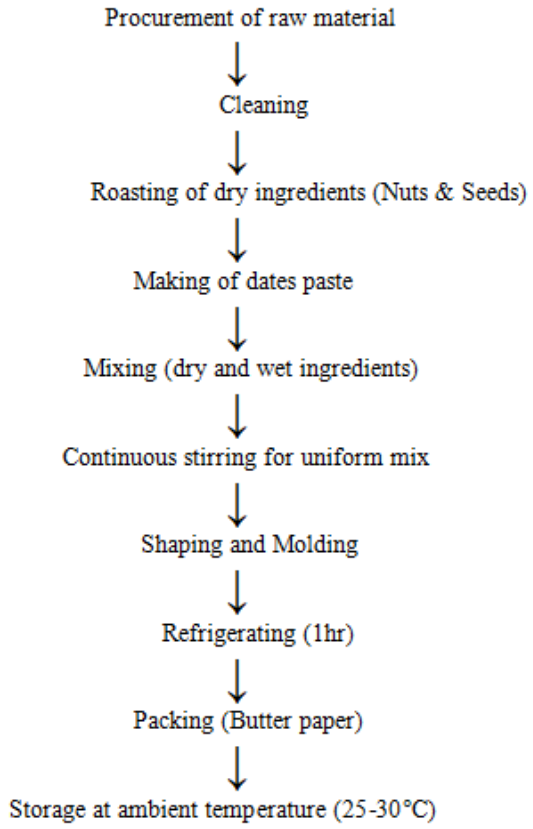

Figure 1: Flowchart of energy bars production process

Table 1: Variations with details of ingredients to prepare energy bar

S.No	Ingredients	Basic	Variation-1	Variation-2
1.	Almonds	10	10	10
2.	Oats	10	10	10
3.	Dates	30	30	30
4.	Sunflower seeds	15	15	15
5.	Muskmelon seeds	10	10	10
6.	Honey	25	30	35

Sensory Evaluation:

The formulated cereal bars were evaluated for overall acceptability (texture, colour, taste, flavour and appearance) and the sensory evaluation was carried out as per 9 point Hedonic scale; the panel was formed by ten semi trained judges.

Quantitative Analysis:

Moisture content was determined using approximately 3.0 g of the ground granola bar in a oven at 105ºC until the weight constant (AAOC,1984). The ash content of potato chips was determined by muffle furnace (AAOC, 1984). Energy was computed as follows for all the samples. Energy [kcal] [protein [g] x 4] + [carbohydrate [g]×4]+ [fat [g] x 9] (AOAC,1980). Protein content is determined by Folin- Lowry method by colorimetric technique/assay. It involves a reaction in which deep blue colour solution is obtained and its absorbance is measured at 660nm. The unknown concentration of the sample is determined by calibration curve method. Fat determination is done by Soxhlet extraction method. As it is known, that fats are soluble in organic solvents hence, petroleum ether is used as the extracting solvent. Here powdered form of the sample is required for extraction. Determination of fiber content is done by enzymatic-gravimetric method. Here the defatted sample is treated with the digestive enzymes and the residue after digestion is weighed. This gives the amount of crude fiber present in the sample.

Bioactive Compound Analysis:

The ascorbic acid content was estimated by visual titration method using 2,4-Dichloro-phenol-Indophenol dye method. Results were expressed as milligrams of ascorbic acid/100 g fresh weight. Ascorbic acid (mg/100gm) = Titre value × Dye factor ×Volume made×100 / Aliquot taken ×sample weight. Thiamine and riboflavin were extracted after acid hydrolysis of snack bars in an autoclave (15 min, 120 °C) followed by enzymatic dephosphorylation with Taka-Diastase (3 h, 45 °C), and quantified separately by reverse-phase high performance liquid chromatography (HPLC). Results were expressed in µg/100 g dm.

RESULTS AND DISCUSSION

The results of ANOVA mean analysis presented in a bar graph. The bar graph explains the total average of nutritional content of energy bars in 100gms.

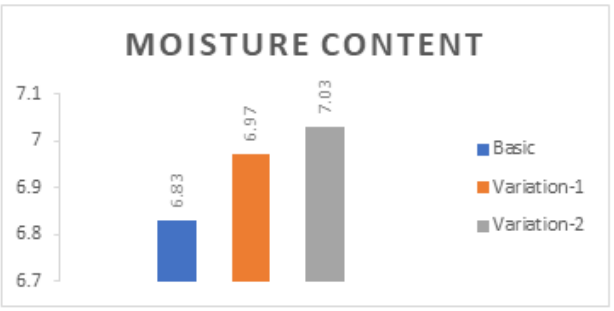

Figure 2: Nutrition-related claims in energy bar products (Moisture)

The moisture content in basic and two variations of energy bar was found to be 6.83±0.01, 6.97±0.01 and 7.03±0.01 respectively (Figure-2). The moisture content was maximum in variation-2 it may be due to the presence of ingredients like honey, dates and oats. According to the study (Humera Ansari *et al*., 2021) presence of oats with dates shows show more moisture content as oats

have higher water holding capacity which helps in retaining the moisture. The result reported by (Upasana *et al*., 2022) found 7.28% of moisture content in an energy bar.

Table 2: Nutrients and nutritional value of energy bar (100g)

Proximate composition (g/100gm)	Basic	Variation-1	Variation-2
Moisture content(gm)	6.83±0.01	6.97±0.01	7.03±0.01
Ash content (gm)	2.89±0.01	2.92±0.01	2.94±0.01
Energy content(gm)	380±0.032	395±0.026	410±0.026
Protein content(gm)	9.17±0.01	9.18±0.01	9.19±0.01
Fat content(gm)	13.48±0.01	13.49±0.01	13.5±0.011
Fiber content(gm)	6.67±0.01	6.77±0.01	6.78±0.01
Ascorbic acid content(mg)	0.7±0.015	0.8±0.0020	0.81±0.0026
Thiamine content(mg)	0.34±0.01	0.342±0.0008	0.344±0.001
Riboflavin content(mg)	0.34±0.02	0.345±0.001	0.347±0.001

Values are mean ±SD, analysed individually in triplicate, and expressed as g/100 g

Based on the analysis, the ash content found almost similar with a very slight difference in all the energy bar treatments i.e., 2.89±0.01, 2.92±0.01 and 2.94±0.01 respectively (Figure-3). The outcomes align with the research conducted by (Adriana *et al*., 2015) who observed a rise in ash content in snack bars containing oats. As quantity of oats is same in all treatments there is no much difference in ash content.

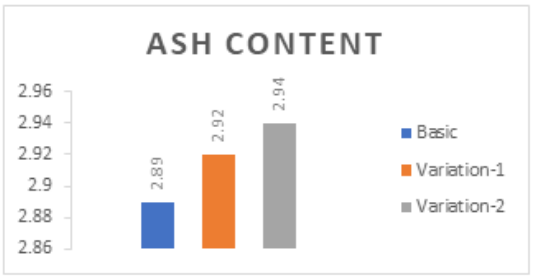

Figure 3: Nutrition-related claims in energy bar products the (Ash)

The energy content of the energy bars is 380±0.032, 395±0.026 and 410±0.026 respectively (Figure-4). Since honey provides rapid energy, the outcomes improved as the quantity of honey rose. These findings align with those of (Constantin and Istrati, 2018) who observed the energy values in snack bar are between 363-464kcal.

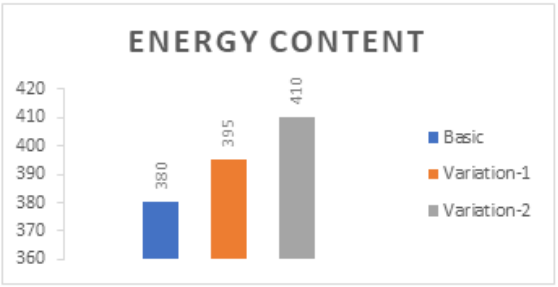

Figure 4: Nutrition-related claims in energy bar products (Energy)

The protein content in energy bars are 9.17±0.01, 9.18±0.01 and 9.19±0.01 respectively (Figure-5). According to (Coello.K.E *et al*., 2022) snack bars have a protein composition ranging from 7.87 to 11.62. These results are consistent with their observations.

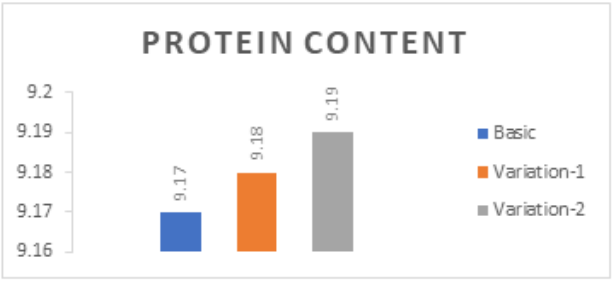

Figure 5: Nutrition-related claims in energy bar products (Protein)

The fat composition in energy bars are 13.48±0.01, 13.49±0.01 and 13.5±0.011 respectively (Figure-6). These results concur with those of (Upasana *et al*., 2022) who found that energy bars have a fat level of about 13.47%.

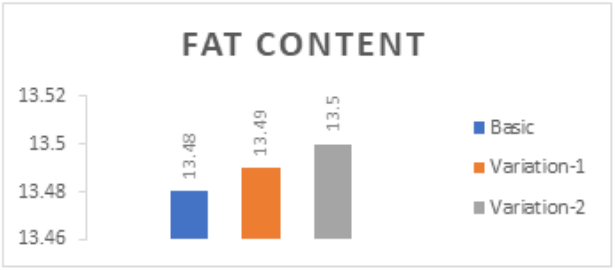

Figure 6: Nutrition-related claims in energy bar products (Fat)

Energy bars include 6.67±0.01, 6.77±0.01 and 6.78±0.01 grams of fiber, respectively (Figure-7). Protein bars range in fiber composition from 5.81 to 7.16 (Jabeen et al., 2022). Their observations are supported by these results.

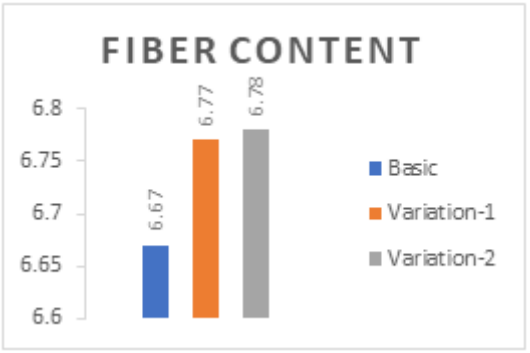

Figure 7: Nutrition-related claims in energy bar products (Fiber)

According to (Figure-8), the ascorbic acid concentration of the energy bars is 0.7±0.015, 0.8±0.0020 and 0.81±0.0026. Protein bars range in vitamin C content from 0.07 to 1.10, according to Tamara *et al*. (2022). Their observations are supported by these results.

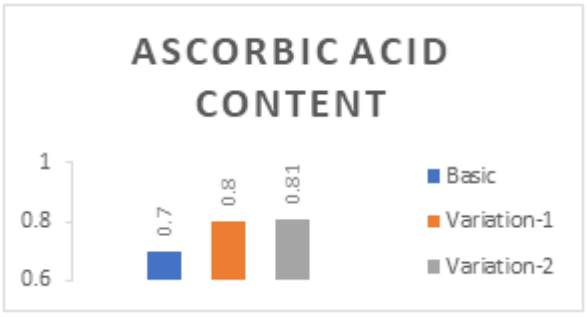

Figure 8: Nutrition-related claims in energy bar products (Ascorbic acid (Vit-C))

Thiamine concentrations in the energy bars are 0.34±0.01, 0.342±0.0008 and 0.344±0.001 mg, respectively (Figure-9). The thiamine composition of protein bars ranges from 3.33 (Jovanov et al., 2021). These findings corroborate their observations.

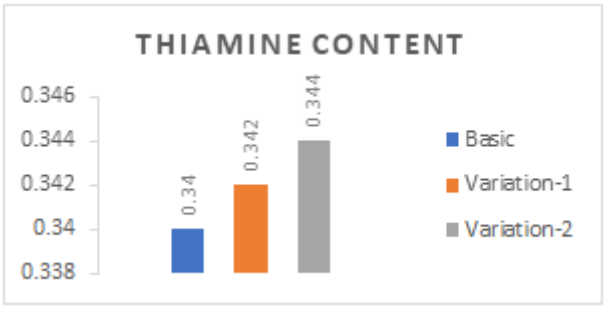

Figure 9: Nutrition-related claims in energy bar products (Thiamine (Vit-$B1$))

The riboflavin concentrations of the energy bars are 0.34±0.02, 0.345±0.001 and 0.347±0.001, as shown in (Figure-10). Riboflavin level in protein bars varies from 0.11 to 3.3, per (Constantin and Istrati, 2018). These findings corroborate their observations.

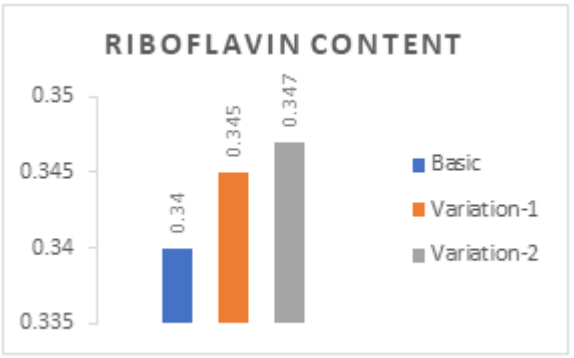

Figure 10: Nutrition-related claims in energy bar products (Riboflavin (Vit-B2))

Sensory Analysis:

The table-3 presents the findings of the organoleptic assessment conducted on energy bars that were infused with varying amounts of honey. The sensory scores obtained from this evaluation indicate that the cereal bars were rated as being “liked very much” to “liked moderately” by ten semi trained judges.

Table 3: Sensory evaluation of energy bars

Sensory Parameters	Basic	Variation-1	Variation-2
Color	7.4±0.699	8.5±0.527	7.6±0.966
Taste	7.9±0.99	8.6±0.516	7.7±0.674
Texture	7.2±1.032	8.2±0.788	7.1±0.737
Flavour	8±0.94	8.5±0.707	7.8±0.632
Appearance	8.1±0.737	8.5±0.527	8±0.666
Overall acceptability	8.2±0.632	8.6±0.516	7.8±0.7888

Values are mean ±SD, analysed individually in triplicate, and expressed as g/100 g

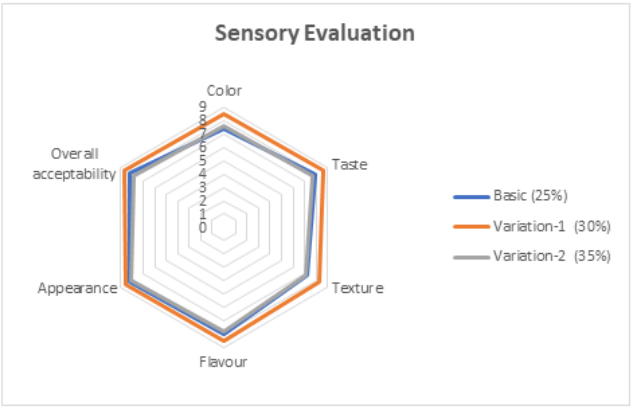

Figure 11: Examination of sensory parameters using radar charts

Upon examination of the sensory scores presented in (Table-3 and Figure-11), it becomes evident that T2 (30% honey) obtained the highest scores in various categories. For color, it received a score of 8.5±0.527, for taste it received a score of 8.6±0.516, for texture it received a score of 8.2±0.788, for flavor it received a score of 8.5±0.707, for appearance it received a score of 8.5±0.527, and for overall acceptability it received a score of 8.6±0.516, all of which were higher compared to the other treatments. The data also indicates that T2 scored the highest in terms of overall acceptability with a score of 8.6±0.516, followed by T1 (25% honey) with a score of 8.2±0.632, and T3 (35% honey) with a score of 7.8±0.7888. In terms of overall acceptability, T2 was the most preferred among all the treatments, while T3 scored the lowest. Therefore, T2, which consisted of a 30% incorporation of honey in the energy bar, was chosen for further analysis. These results align somewhat with the findings of Latika and Vibha (2015), who reported using 30% honey in cereal bar preparation. However, it should be noted that the percentage of honey used in the cereal bar was slightly higher than the findings of Edmilson et al. (2011), who used 26% honey in their cereal bar formulation.

CONCLUSION

The research study titled 'Development of innovative nutritious energy bars' aims to fulfill the needs of consumers by providing them with a high-quality product. This product is a great alternative to unhealthy junk food and can help individuals make healthier choices instantly. By incorporating ingredients such as oats, dates, almonds and sunflower seeds, the nutritional value of the energy bar has been enhanced. It offers a well-balanced combination of proteins, fats, carbohydrates, and minerals, contributing to the overall health improvement of consumers through the supply of bioactive and functional compounds. Moreover, this product is suitable for consumption by people of all age groups, as it fulfills a portion of their daily nutrient requirements. The quality of the energy bar has been further improved by maintaining low moisture content, ensuring its freshness and longevity. From a sensory perspective, consumers tend to favor a crunchy and nutty texture in energy bars, which has been taken into consideration during the development process. In conclusion, this product provides an adequate amount of carbohydrates, fats, proteins, fiber and most importantly, energy, making it a suitable option as a meal replacement bar.

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