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Review on Energy Bar by Utilizing Dates and Cantaloupe Seeds

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Energy bars are experiencing an increase in popularity attributable to their convenience and associated health advantages, with a particular emphasis on natural and functional ingredients. This study aimed to develops of energy bar by using dates (Phoenix dactylifera) and cantaloupe seeds (*Cucumis melon* L.) As primary constituents. Dates, known for their natural sweetness, high fiber content, and rich nutrient profile, give a quick and sustained energy release, making them an ideal base for energy bars.

They're abundant in essential minerals like potassium and magnesium, which support muscle function and electrolyte balance, and are also packed with antioxidants that help combat oxidative stress. Cantaloupe seeds, frequently overlooked in nutrition products, are rich in protein, healthy fats, and salutary fiber, farther enhancing the bar's nutritive value. This combination not only offers a natural and healthy source of energy but also supports digestive health, muscle recovery, and overall well- being. The bar is free from refined sugars and artificial

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complements, making it a wholesome, factory- grounded snack ideal for athletes and active individualities. This product provides a sustainable, functional volition to traditional energy bars, feeding to the growing demand for clean, nutrient- thick snacks in the health and heartiness request.

Keywords: Energy bar; dates; cantaloupe seeds; functional food; dietary fiber.

1. INTRODUCTION

Energy bars are an excellent option for breakfast or sports workouts. The variety of dry fruits, seeds, and soluble and insoluble dietary fiber in the bar, composition allows for their easy adoption into a diet as a source of slowly digestive carbohydrates, micro, and micronutrients (Verma et al., 2022). The development of energy bar by using dates as a core component, alongside the innovative application of cantaloupe seeds, presents a promising approach to meeting the nutritive requirements of athletes and active individualities Energy bar are a growing food choice that help to replace lost energy and daily energy needs without compromising taste, as they are made by mixing various ingredients. Energy bars provide the majority of their food energy in carbohydrates. Energy in food comes from all three main sources – fat, protein & carbohydrates but mostly from carbohydrates. To provide energy quickly, most of the carbohydrates are various types of jaggery powder and dry dates powder like fructose, glucose, dextrose, and others in various ratio (Subhash et al., 2024). In terms of nutritional composition, the energy bar is characterized by a considerable quantity of carbohydrates, proteins, lipids, and essential minerals. They are affirmed as a significant source of nutrition with exemplary sensory attributes, nutrient energy bar provides rapid nourishment to individuals engaged in brisk activities, thereby gaining prominence and elevation in moment's request and available under colorful names like granola bars, dry fruit bars, fruit bars, protein bars etc (Giri et al., 2016). Energy bars are emerging concepts designed to meet specific consumer demands, thereby necessitating the development of nutritionally balanced and convenient food bars (Izzo M. and Niness K., 2001). In the request wide kinds of bars are present these energy bars have different characteristic and gained fashionability in the global request with different purposes. The energy bar, commonly referred to as a snack bar, falls under the category of ready-to-eat (RTE) foods, thereby serving a significant role as a convenience food (Pablo da Silva et al. 2016). The seeds of watermelon are generally considered as agro-waste and are spitted out inspite of having its high nutritional value as well as therapeutic benefits. Watermelon seeds are a good source of low-molecular-weight polypeptides like globulin, glutenin and albumin. Seeds are also rich in aspartic acid, glutamic acid and serine. Nutritional or energy bars provide a convenient way to meet an individual's nutritional needs on an occasional basis (Rameesa and Bushaira, 2023).

Dates (*Phoenix dactylifera*), with their rich, nutrient- thick profile, serve as an ideal base for creating energy-rich bars. Known for their natural sweetness, high fiber content, and abundance of essential minerals, dates give both quick and sustained energy key for fueling performance and supporting recovery. They also offer fresh health benefits similar as promoting digestive health and reducing oxidative stress, thanks to their high antioxidant content (Vayalil, 2012; Tang et al., 2013). Dates are particularly salutary energy bars aimed at athletes, as they deliver a combination of simple sugars like sucrose, glucose, and fructose that give an immediate boost, alongside fiber that ensures a slow, steady release of energy (Van Toan & Vinh, 2018).

Incorporating cantaloupe seeds (*Cucumis melo L).* frequently-overlooked component, farther elevates the nutritive value of these bars. In terms of nutritional composition, the energy bar is characterized by a considerable quantity of carbohydrates, proteins, lipids, and essential minerals. Studies have shown that melon seeds aren't only nutritionally thick but also rich in minerals like potassium, magnesium, and iron, supporting electrolyte balance and muscle function during violent physical exertion (Kamble et al., 2022) The combination of dates and cantaloupe seeds provides a nutritious eco-friendly alternative to traditional energy bar, appealing to health-conscious consumers and those seeking a natural, whole- food option for fueling their active cultures.

2. RAW INGREDIENTS FOR ENERGY BAR

2.1 Cantaloupe Seeds

The extract obtained from melon seeds acts as an excellent substitute for functional foods that enhance health, thanks to its high concentrations of proteins, fats, and dietary fiber (Mehra et al., 2015). The dry seeds of Cucumis melon were examined and exposed similar fat contain as found in this study, but they had lower dietary fiber. lipid values that align with those identified in the present investigation, although the dietary fiber content was found to be inferior. A review study has demonstrated the protein concentrations present in Cucumis melo L. melon seeds ranged from 15% to 36%.

2.1.1 Botanical description

Melon (*Cucumis melo L.*) belongs to the *Cucurbitaceae* family, which also includes cucumbers, pumpkins, watermelons, and squash. This species is highly variable in terms of fruit characteristics, with a vast array of sizes, shapes, and flavors. The fruit's skin and flesh can vary greatly, often leading to confusion with watermelon (*Citrullus lanatus*) due to their similar size and sweet flavor (Petkova&Antova,2015).

In 1859, Naudin proposed a classification system for *Cucumis melo L.*, categorizing it into ten distinct varieties based on their fruit characteristics, highlighting the significant morphological diversity within the species.

2.1.2 Distribution and cultivation regions

The precise origin of the melon continues to be a contentious issue within the academic community. While some sources suggest Africa as the primary center of diversity, others argue that it originated in Asia, specifically from (Turkey to Japan) (Garg et al., 2007). Despite the ongoing debate about its origin, melons are now widely cultivated in regions with temperate and arid climates, including Africa, where nations such as (Angola, Cape Verde, and Egypt) exhibit optimal conditions for melon cultivation, developing in both temperate and arid climates.

In Asia, the various melon types found in (China, India, Japan, Nepal, and Indonesia) are well-known. Europe, particularly Mediterranean countries, provides favorable growing conditions that make it a desirable location for melon cultivation. Australia is recognized for its successful cultivation of melons within arid and semi-arid environments, which are particularly conducive to melon production. Melons are highly adaptable, growing well in environments with both temperate and dry conditions, making them a staple crop across diverse climatic zones.

Melon is known by a variety of common names depending on the region and language, further illustrating its global importance and widespread cultivation (Kamble et al., 2022).

List 1. Names of Melon in different languages

English	Sweet melon, Muskmelon, Cantaloupe
Hindi	Khajur, Chohara
Bengali	Sohara

2.2 Dates

A review study has indicated that the protein content in *Cucumis melo L* is noteworthy. The fundamental components of dates consist of carbohydrates, primarily in the form of saccharides, which may constitute as much as 78% of their overall composition (Makki et al., 1998). Fructose, which is twice as sweet as glucose and can produce a feeling of fullness while offering the human body an easily available source of energy, makes up over 50% of the dates' sugar content (Ali et al., 2009).

Dates contain both the soluble and insoluble fibers. The primary constituents of dates include cellulose, hemicellulose, pectin, lignin, and non-digestible proteins. Notably, proteins and lipids are present in minimal quantities within dates. Both the flesh and seeds of dates encompass a diverse array of saturated and unsaturated fatty acid While palmitoleic, oleic, linoleic, and linolenic acids are examples of capric, lauric, myristic, palmitic, stearic, margaric, arachidic, heneicosanoic, behenic, and tricosanoic acids are examples of saturated fatty acids, while unsaturated fatty acids are the opposite (Al-Shahib & Marshall, 2002, 2003). High concentrations of selenium, copper, potassium, and magnesium, as well as moderate amounts of manganese, iron, phosphorus, and calcium, and trace amounts of boron, are characteristics of dates.

2.2.1 Botanical description

The date palm, or (*Phoenix dactylifera L*)., belongs to the Arecaceae family, and is a

monocotyledonous plant. This dioecious plant features separate male and female trees, characterized by an unbranched trunk and a canopy of large, pinnate leaves (Chao & Krueger, 2007). It is a perennial tree that can grow up to 15-25 meters in height with a stout trunk covered by persistent leaf bases arranged in a spiral manner. The leaves are pinnately compound, measuring 3-5 meters in length, and bear numerous narrow, linear-lanceolate leaflets. The fruit is classified as a one-seeded drupe and has an oblong to cylindrical shape. The cultivar affects the fruit's size and color. The ripening process occurs through four principal stages- kimri (unripe), khalal (crunchy and mature), rutab (soft and ripe), and tamr (fully ripe and desiccated).

2.2.2 Distribution and cultivation regions

It is thought that the Middle East and North Africa (MENA) region is where the date palm first appeared. This species is extensively cultivated in arid and semi-arid climatic regions across the globe. The date palm grows best in climates with prolonged summer heat and minimal rainfall (Zaid & de Wet, 2002). which contributes the majority of global production. Among the leading producers are Egypt, Iran, Saudi Arabia, Iraq, Algeria, and the United Arab Emirates. The Food and Agriculture Organization (FAO) states that Egypt is the world's largest producer of dates, accounting for around 17% of global production, with Saudi Arabia and Iran being in second and third, respectively (FAO, 2021).

Beyond the MENA region, date palms are also cultivated in various regions of South Asia, particularly in India, as well as in California (USA) and Mexico, where specific climatic conditions conducive to date palm cultivation prevail. In India, the states of Rajasthan, Gujarat, and specific regions of Maharashtra have progressively adopted the cultivation of date palms through the implementation of sophisticated irrigation and agronomic methodologies. Date palms necessitate deep, well-drained soils and demonstrate salinity tolerance, rendering them well-suited for regions characterized by otherwise challenging agricultural conditions.

2.3 Almond

Almonds (*Prunus dulcis*) (Gradziel et al., 2008). represent a nutrient-dense food source, and extensive research conducted over the past decade regarding the potential health benefits of almonds has correlated their consumption with a decreased risk of chronic diseases. Almonds can be eaten whole (fresh or roasted) and in spreads like almond adulation or they can be used in a wide range of food products and fashions. Almonds have complex food matrices containing different nutrients and other Phyto protective substances that favourably impact mortal physiology. The adipose acid composition of almonds is salutary because monounsaturated adipose acids (MUFA) predominate and the impregnated fat content (3.7 g per 100 g almonds) is the smallest of all nuts. The addition of nuts similar as almonds to low calorie diets for weight loss may increase satisfaction and affect in deficient intestinal immersion of fat. (Novotny et al. 2012). Almonds are naturally high in vitamin E, riboflavin (vitaminB2) and the minerals calcium, magnesium, phosphorus, potassium, zinc, and manganese.

2.4 Cashewnut

Cashew nuts (*Anacardium occidentale*) are nutrient- thick seeds extensively consumed for their rich flavor and health benefits. They serve as an exceptional source of beneficial fats, proteins, vitamins, and minerals. Cashew nuts have historically played a significant role in the diets of various cultures, due to their high energy density and nutritional value, as well as their diverse array of flavors and distinctive taste. Despite being the third most widely produced nut globally, there has been remarkably limited research conducted on cashew nuts. Phenolic lipids are significant in terms of their nutritional profile (Shobha et al., 1992). They are rich in Phytosterols, tocopherols, squalenes, and both unsaturated and essential fatty acids. Bioactive compounds such as β-carotene, lutein, zeaxanthin, α-tocopherol, γ-tocopherol, thiamin, stearic acid, oleic acid, and linoleic acid have been documented (Trox et al., 2010). Additionally, iron, which is instrumental in the prevention of anemia, is present.

2.5 Walnuts

Globally, walnuts (*Juglans regia L*.) are the most often consumed tree nut. kernels are known for having a high protein and oil content are characterized by high protein and oil content. (Juglandacea) make this fruit necessary for mortal nutrition. Consequently, the walnut is classified as a fundamental species for human nutrition and is included in the FAO's list of priority crops (Gandev et al., 2007). Walnuts are

considered nutrient-dense foods due to their high concentrations of fats, proteins, vitamins, and minerals. They're also good source of flavonoids, sterols, pectic substances, phenolic acids and related polyphenols. Walnuts possess significant quantities of omega-6 and omega-3 polyunsaturated fatty acids (PUFAs), which are vital for human health. Clinical research indicates that omega-3 polyunsaturated fatty acids (PUFAs) play a critical role in the prevention of coronary heart disease (Davis et al., 2007).

Walnut proteins contain all essential AAs needed for the requirements of a mortal grown-up. The lysine/arginine ratio in walnut proteins is inferior to that observed in other prevalent vegetable proteins, and this characteristic has been viewed as a favorable aspect associated with a halting the advancement of atherosclerosis (Sza-Tao et al., 2000). Walnuts contain high situations of potassium, phosphorus and magnesium and lower sodium. These rudiments play an important part for numerous enzymes exertion especially as cofactor.

2.6 Pistachio

pistachio nuts (*Pistacia vera L*). Pistachios represent an excellent source of carotenoids, phenolic acids, flavonoids, anthocyanins, monounsaturated fatty acids, protein, dietary fiber, as well as essential minerals and vitamins. Pistachios, like all nuts, have a high fat content, which is composed mainly of mono and poly-unsaturated adipose acids as well as lower amount of the impregnated adipode acids, specifically oleic and linoleic acids, account for further than fifty percent of the total fat content in pistachios (Dreher, 2012; Bulló et al., 2015). Pistachios exhibit a superior essential amino acid composition compared to most commonly consumed nuts, particularly concerning branched-chain amino acids (Bailey et al., 2020). also, pistachios are rich in manganese, vitamin B6, thiamin, potassium, phosphorus, chromium, vitamins E and K (phylloquinone), riboflavin, folate, magnesium, iron, zinc, and selenium, while also containing lower quantities of other micronutrients. likewise, pistachios are abundant in lutein and zeaxanthin (xanthophyll carotenoids), as well as a different array of bioactive phenolic composites, specially including genistein-7-O-glucoside, genistein, and daidzein.

2.7 Oats

Oat (*Avena sativa L*.) is distinguished among cereal crops due to its rich nutrient profile, which holds substantial significance for mortal consumption. Oats are generally employed in breakfast cereals and snack bars, and their objectification into colorful products would mainly profit consumers due to their health-promoting parcels (Sang et al., 2017; Paudel et al., 2018). this cereal grain constitutes a significant source of carbohydrates, salutary answerable fiber, balanced protein, lipids, colorful phenolic composites, vitamins, and minerals (Joyce et al., 2019). It is thought to be the main ingredient in oats with vibrant functional and nutritional packages, significantly reducing cholesterol (Whitehead et al., 2014), and causing antidiabetic effects. Minor constituents found in oats include antioxidant compounds such as tocols, phenolic compounds, and sterols, which are associated with health-promoting properties. Vitamin E exertion is substantially contributed by tocopherols and tocotrienols, which together make tocols (Sterna et al., 2016). Avenanthramides (AVAs), p-hydroxybenzoic acid, vanillic acid, tricin, ferulic acid, caffeic acid, protocatechuic acid, syringic acid, p-coumaric acid, sinapic acid, tricin, apigenin, luteolin, kaempferol, and quercetin are among the several phenolic composites that have been connected.

2.8 Liquid Glucose

Liquid glucose, a crucial component in energy bars, serves multiple functional and nutritive places that enhance product quality, shelf stability, and consumer acceptability. Liquid glucose is a simple sugar made by breaking down starch. It provides quick energy source due to its high glycemic index (Malecki et al., 2022). delivering fast glucose elevation which is ideal for pre or post exercise. Its low density and hygroscopic nature contribute to the soft, leathery texture of energy bars by preventing crystallization and retaining humidity, therefore perfecting mouthfeel and delectability. from a shelf-life perspective, liquid glucose reduces water exertion (layoff) in energy bars, inhibiting microbial growth and delaying staling, which is critical for marketable products taking extended storehouse. Energy bar using glucose syrup become hard or overly stick during storage (Malecki et al., 2022).

3. HEALTH BENEFITS

3.1 Cantaloupe Seeds

3.1.1 Antiulcer activity

The methanolic extract of Cucumis melo seeds demonstrated anti-ulcerogenic properties. The

mechanism of its gastro-protective activity may be attributed to reduction in vascular permeability, scavenging of free radicals and diminished lipid peroxidation along with strengthening of mucosal barrier. Presence of triterpenoids and sterols are responsible for these actions (Gill et al., 2011).

Cantaloupe seeds possess antiulcer properties, attributed to their high antioxidant content and ability to reduce inflammation and exhibited considerable antiulcer potential. Research indicates that their ethanol extracts may aid in diminishing gastric lesions and safeguarding the gastric mucosa, attributable to the presence of phenolic compounds that manifest cytoprotective and anti-secretory properties.

3.1.2 Anti-inflammatory and analgesic activity

The extracts obtained from seeds exhibit significant anti-inflammatory and analgesic effects. Research indicates that cantaloupe seed oil contains linoleic acid and other omega-6 fatty acids that modulate the inflammatory response by inhibiting pro-inflammatory mediators such as prostaglandins. Additionally, the seeds have shown potential in reducing pain perception and inflammation, this is likely due to the presence of various bioactive compounds in the seeds, including phenolic compounds and flavonoids (Milind et al. 2011).

3.1.3 Antidiabetic activity

Cantaloupe seeds may exert antidiabetic effects by improving glucose metabolism and reducing blood sugar levels. Their fiber content, combined with antioxidant compounds, contributes to slowing down carbohydrate digestion and glucose absorption.

3.1.4 Anti-cancer activity

Cucumis melo has been investigated for its potential anti-cancer properties, with the extract demonstrating promising anti-cancer efficacy in both in vitro and in vivo studies across eight distinct cancer types: cervical, colon, prostate, leukemia, multiple myeloma, breast, hepatoma, and ovarian cancer. A thorough analysis shows that some of the IC50 values were significantly low, especially in cases of colon and prostate cancer, indicating a significant anti-cancer effect. The substantial anti-cancer benefits of Cucumis melo fruit extracts point to the necessity for additional investigation into their potential for cancer therapy on each form of cancer (Soh et al. 2024).

3.1.5 Antibacterial activity

Cantaloupe seeds possess antibacterial properties, likely due to the presence of bioactive compounds like phenols and flavonoids. Studies have shown that extracts from cantaloupe seeds can inhibit the growth of various bacteria, including Staphylococcus aureus, Escherichia coli, and Salmonella typhi. These antibacterial effects may be attributed to the presence of methionine, a sulfur-containing amino acid, and other phytochemicals (Wahdan et al. 2016).

3.1.6 Antioxidant activity

Cantaloupe seeds are recognized as a substantial source of antioxidants, encompassing vitamin E, flavonoids, and phenolic acids. These bioactive compounds operate to neutralize free radicals, reduce oxidative stress, and prevent cellular damage. The methanolic extract of cantaloupe has exhibited DPPH and hydroxyl radical scavenging activity, attributed particularly to the presence of phenolic compounds, especially flavonoids. Notably high antioxidant activity has been recorded in both the leaf and stem of cantaloupe (Ismail et al., 2010).

3.2 Dates

3.2.1 Antioxidant properties

Dates represent a significant source of antioxidants predominantly phenolic compounds, which effectively neutralize free radicals and safeguard cellular integrity against oxidative damage (Saafi et al., 2010; Pitsch et al., 2010). These antioxidants not only function as scavengers of free radicals but also facilitate the modulation of cellular processes, thereby providing a protective barrier against pathological conditions such as cancer, atherosclerosis, and diabetes (Sanzari et al., 2011). Moreover, dates enhance the body's intrinsic antioxidant mechanisms, presenting a dietary strategy to mitigate oxidative stress. Consequently, dates emerge as a vital aliment for the prevention and management of oxidative pathologies,

thereby contributing to sustained health and well-being.

3.2.2 Antimicrobial properties

Dates are abundant in bioactive compounds, including phenolics, which demonstrate pronounced antiviral, antibacterial, and antifungal activities (Zohary & Hopf, 1993). These antimicrobial properties render dates not only a superior food source but also a potential therapeutic agent for combating infections. Dates include bioactive components that help protect against microbial contamination, creating a natural defense against harmful diseases. Eating dates regularly may help reduce the risk of chronic inflammation and strengthen immune system.

3.2.3 Anti-hyperlipidemic properties

The consumption of dates, particularly those supplemented with defatted date seed flour, can facilitate a reduction in plasma triglycerides, total cholesterol, and low-density lipoprotein (LDL) cholesterol levels. Furthermore, dates assist in the regulation of lipid profiles, imparting protective effects against cardiovascular diseases (Baliga et al., 2011). The fiber content inherent in dates plays a significant role in the reduction of blood cholesterol levels, rendering them a heart-healthy food that mitigates the risk of atherosclerosis (Evans et al., 1992; Kattak, 2002).

3.2.4 Immunomodulatory properties

Dates also offer significant immunomodulatory effects due to their high content of phenolics and dietary fibers. These compounds help reduce inflammation, improve immune function, and lower the risk of cardiovascular diseases. Moreover, dates are believed to inhibit oxidative damage to low-density lipoproteins (LDL), reduce blood pressure, and prevent platelet aggregation, all of which are vital for maintaining cardiovascular health (Muldoon et al., 1996).

3.2.5 Hepatoprotective activity

The date extracts, especially from the flesh and pits, can guard the liver against oxidative damage, improve liver enzyme function, and restore normal liver activity in cases of toxin-induced hepatotoxicity (Bruck et al., 2001). The hepatoprotective effects of dates are attributed to antioxidants like selenium, quercetin, and other polyphenols (Al-Qariwi et al., 2005; Pitsch et al., 2010). making dates a natural remedy for liver health.

3.2.6 Functional and nutraceutical benefits

Dates are not only a rich source of essential nutrients but also offer functional and nutraceutical benefits. They are abundant in vitamins, minerals, and antioxidants that promote general health. Dates are increasingly being recognized as a functional food, with the potential to reduce the risk of degenerative diseases like cancer, cardiovascular diseases, and brain dysfunction (Lu, Z., et al., 2009).

4. APPLICATION OF FOODS AND OTHERS

4.1 Cantaloupe Seeds

4.1.1 Protein and oil extraction

Cantaloupe (Cucumis melo) seeds contain 20–30% protein and 30–40% oil, rich in unsaturated fatty acids like linoleic and oleic acids, making them suitable for food and cosmetic uses (El-Adawy & Taha, 2001).

4.1.2 Bakery and snack product fortification

Cantaloupe seed flour can fortify bakery products like cookies and breads, enhancing protein, fiber, and minerals without compromising sensory quality (Akubor & Ukwuru, 2003).

4.1.3 Functional foods and energy bar

Cantaloupe seeds are rich in protein, dietary fiber, and essential fatty acids (Mehra et al., 2015). Due to their nutritional properties, they are used in functional foods and energy bars thereby, promoting satiety, sustained energy, and metabolic benefits.

4.1.4 Antioxidant and antimicrobial use

Cantaloupe seed extracts are rich in phenolics, flavonoids, and tocopherols, exhibiting strong antioxidant and antimicrobial activities useful for natural food preservation and nutraceutical applications (Mehra et al., 2015).

4.2 Dates

4.2.1 Natural sweetener

Dates serve as a natural sweetener with a low glycemic index and are rich in fiber, minerals, and antioxidants, making them a healthier alternative to refined sugars in various food products (Al-Farsi & Lee, 2008).

4.2.2 Functional food ingredient

Dates, rich in fiber and polyphenols, are used in functional foods like energy bars and cereals to improve digestion, satiety, and glycemic control while enhancing flavor and shelf life (Baliga et al., 2011).

4.2.3 Bakery and confectionery products

Dates enhance the nutritional profile of bakery product like cakes by adding fibers which improves digestion and lowers glycemic index (Alqahtani et al., 2024).

5. NUTRITIONAL POTENTIAL OF RAW INGREDIENTS FOR ENERGY BAR PREPARATION:(PER 100 GM)

The ingredients (Given in the Table 1) provide not only a combination of macronutrients and micronutrients but also functional benefits essential for energy bar preparation.

Table 1. Nutritional potential of raw ingredients for energy bar preparation

Ingredient	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fats (g)	Fiber (g)	Key Micronutrients	Functional Benefits	References
Dates (dried)	282	75	2.5	0.4	8	High in K, Mg, Fe, B6	Natural sweetener, binding agent	Al-Farsi et al. (2008)
Cantaloupe Seeds	557	15	28	44	6	Rich in Zn, Mg, folate	High protein, healthy fats	Mehra et al. (2015)
Almonds	579	22	21	50	12	Vitamin E, Ca, Mg	Heart health, satiety	Berryman et al. (2015)
Cashews	553	30	18	44	3.3	Cu, Mg, P	Creamy texture, energy-dense	Rico et al. (2016)
Walnuts	654	14	15	65	7	Omega-3 (ALA), Mn, Cu	anti-inflammatory, and brain health	Lockyer et al. (2023)
Pistachios	562	28	20	45	10	B6, K, antioxidants	Antioxidants that contribute to muscle recovery and are fiber-rich	Dreher et al. (2012)
Oats (rolled)	389	66	17	7	11	β-glucan, Mn, Fe	slow-release energy and cholesterol reduction	Rasane et al. (2015)
Liquid Glucose	300	82	0	0	0	None significant	Binder, texture modifier, quick energy	Malecki et al. (2022)

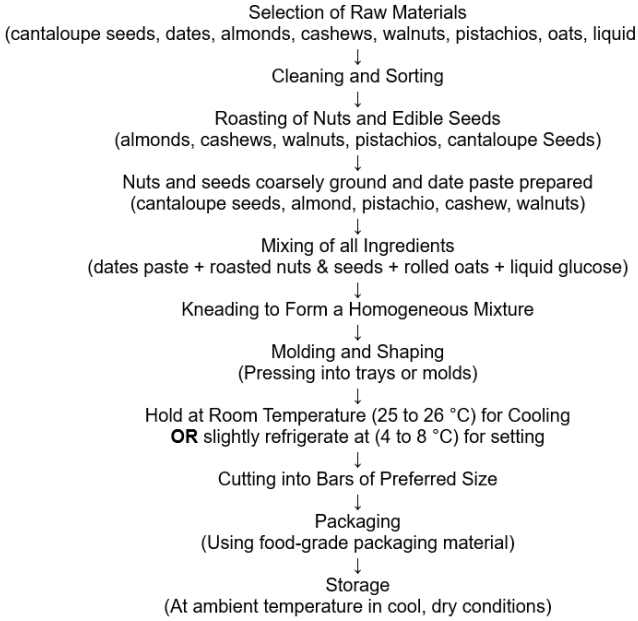

Chart 1. Flow chart of energy bar

6. FORMULATION OF ENERGY BAR

The energy bar formulation entails a process of careful choice of raw materials of high quality, such as cantaloupe seeds, dates, almonds, cashews, walnuts, pistachios, oats, and liquid glucose, selected based on their nutritional values, functional attributes, and sensory qualities. All these are carefully cleaned and sorted out to eliminate impurities and for uniformity. Nuts and edible seeds are subjected to roasting at controlled temperatures to enhance flavor, texture, and shelf stability. The roasted nuts and seeds are then roughly ground to yield a desirable crunch, while dates are made into smooth paste for use as a natural binder and sweetener. The prepared foods are combined in the right proportions to yield a good taste and texture profile. The mixture is then kneaded to create a uniform dough, so that all constituents are evenly distributed.

The dough is then shaped in slabs of equal thickness and cooled or refrigerated for hard setting. The set slabs are then cut in bars of desired size and packaged with moisture-resistant, food-grade materials to avoid contamination and increase shelf life. Correct storage in cool, dry conditions preserves the quality and stability of the product. This well-organized process guarantees the manufacture of healthy, tasty, and shelf-stable energy bars for health-conscious consumers.

7. MARKET POTENTIAL FOR ENERGY BAR

The energy bar market in India is experiencing robust growth, driven by increasing health consciousness, rising disposable incomes, and a shift toward convenient, nutritious snacking options. Market analysis reveals that the valuation of the Indian energy bar market was projected to be approximately USD 3.91 million in 2024 and is expected to escalate to USD 8.83 million by 2029, demonstrating a pronounced upward trajectory. The compound annual growth rate (CAGR) is anticipated to attain 17.69% during the forecast interval (Mordor Intelligence, 2024). The COVID-19 pandemic has further accelerated this trend, as consumers have increasingly prioritized foods that enhance immunity and are rich in protein, leading brands such as Fit to adapt accordingly. Sport Nutrition Foods to expand into e-commerce and international markets (*Business Standard, 2021*). A key factor fueling demand is the growing fitness culture, with more Indians engaging in gym activities, sports, and outdoor exercises. Energy bars are gaining substantial popularity among athletes and fitness enthusiasts as a convenient source of energy and protein (*IMARC Group, 2023*). Additionally, because gyms and sports clubs frequently suggest these bars as dietary supplements, the growing number of health and fitness facilities has increased product visibility. Another significant driver is the preference for healthy snacking, particularly among urban consumers. The demand for fortified energy bars that are rich in protein, fiber, and natural ingredients is surging, with consumers demonstrating a willingness to invest in functional foods.

8. FUTURE SCOPE FOR ENERGY BAR

The future of energy bars, especially those derived from natural ingredients like dates and underutilized components such as cantaloupe seeds, is promising due to increasing consumer demand for healthy, sustainable, and functional foods. There is significant scope for optimizing the nutritional profile of such bars through the inclusion of plant-based proteins, dietary fibers, and bioactive compounds derived from fruits, seeds, and nuts. Cantaloupe seeds, often discarded as waste, are rich in proteins, healthy fats, and minerals, and their incorporation aligns with the growing emphasis on waste valorization and sustainable food production (El-Adawy & Taha, 2001). Advances in food processing technologies can further enhance the shelf life, texture, and palatability of these bars, making them suitable for a broader market. Furthermore, energy bars can be tailored for specific populations, such as athletes, children, or the elderly, by modifying the formulation to meet their dietary requirements (Haug et al., 1983). Research into the synergistic effects of combining different functional ingredients could lead to the development of energy bars with targeted health benefits, such as improved gut health, immunity, or cognitive function. Moreover, there is an opportunity for large-scale commercialization and market penetration, particularly if consumer education and awareness campaigns highlight the nutritional and environmental benefits of such products. Future studies should also focus on consumer acceptance, sensory evaluation, and clinical validation of health claims to support the functional food status of these innovative bars.

9. CONCLUSION

In conclusion, the formulation of energy bar incorporating dates and cantaloupe seeds represents a novel and nutritious alternative for athletes and health-conscious individuals. Dates furnish a natural source of sweetness, dietary fiber, and essential minerals that underpin energy levels, muscle functionality, and recovery processes, while cantaloupe seeds provide valuable protein, beneficial fats, and additional fiber, thereby enhancing the overall nutritional profile of the bar. Collectively, these ingredients yield a comprehensive snack that delivers both immediate and prolonged energy without dependence on refined sugars or synthetic additives. The antioxidant and anti-inflammatory parcels of both dates and cantaloupe seeds significantly contribute to overall health, making this energy bar an exemplary option for enhancing physical performance and promoting recovery. As consumers increasingly pursue natural, sustainable, and nutrient-rich snacks, this product presents a promising resolution, amalgamating the advantages of whole-food ingredients with the convenience of a ready-to-consume, functional snack.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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