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Review Article

Nutritional and Therapeutic Potential of Sesame Seeds

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The major issue of the current era is an unbalanced and poor diet like unhealthy fast foods, the main cause of various diseases. Most nutraceutical and pharma industries formulating the medicines from artificial sources are expensive and have several side effects. However, scientists are making efforts to find out the natural sources of medicines for the betterment of human health and treatment of diseases. Simultaneously, the worldwide preferences have shifted from artificial to natural resources and unconventional crops (i.e., oilseeds as protein source) and foods are becoming part of regular diet in most of the community, nutraceutical, and pharma industries. Sesame (*SesamumindicumL.*) is one of the unconventional crops providing multiple benefits due to its special bioactive components, such as sesamin, sesaminol, and gamma-tocopherol, and fatty acids composition like unsaturated fatty acids (i.e., oleic acid, linoleic acid, stearidonic acid, palmitoleic acid, and traces of linolenic acid). Sesame seed oil supplementation not only improves the quality of snack frying oils but also plays a key role in the formation of good quality healthy snack foods. Moreover, its seeds and oil play imperative role in the formulation of medicines utilized for different ailments. The current review highlights the importance and utilization of sesame seed and oil in pharmaceuticals, nutraceuticals, and food (especially snacks) industries.

1. Introduction

In developing countries, poverty is greatly hampering food accessibility. Furthermore, inadequate supply of animal protein is the leading cause of certain health ailments in the populations. The scientists are striving hard to explore low-cost plant protein sources, that is, for incorporation into food formulations for better nutritional quality [1]. In the past, much emphasis was on oilseeds including cotton, rapeseed, soy, sunflower, and peanut for the extraction and utilization of their protein isolates. Recently, researchers have probed defatted sesame flour for its incorporation in food products to enhance the protein contents and curtail associated health disorders [2].

Sesame seed belongs to the genus *Sesamum* of the family *Pedaliaceae*. The sesame crop was first among the oilseeds grown and utilized to produce edible oil. During last 3 decades, the worldwide growth and production of the sesame seed have significantly increased from 6.3 million ha (Mha) and 2.8 million tons (Mt) to 11 Mha and 6.2 Mt from 2002 to 2016, respectively [3]. It is mostly cultivated in Asia and Africa, and the top sesame cultivating countries in descending order are Tanzania, India, and Sudan producing 1.1 Mt, 0.8 Mt, and 0.7 Mt, respectively [4]. Due to increase in production level of sesame seeds during last few years, its importance to the consumers and its application in numerous valuable, healthy, and nutritious products have increased. Nutritionally, it is considered an important protein source owing to appreciable amounts of essential as well as nonessential amino acids as compared to other seed proteins. Additionally, it has plenty of nutrients essential for the maintenance of optimum health [5]. Sesame seeds contain more proteins (17 to 40%) as compared to meat (18–25%) and cereals (7 to 13%) [6]. Sesame flour is creamy, light brown, edible powder with maximum protein (27–32%) and oil contents (10–12%). In the addition of this, sesame has three times more calcium compared with an equivalent quantity of milk. Moreover, the defatted sesame cake after oil extraction is an excellent source of quality protein and numerous useful phytochemicals (bioactive nutrient plant chemicals that may provide desirable health benefits in addition to basic nutrition in order to reduce the risk of major diseases). Hence, sesame is considered an unconventional protein source owing to the fact that it is primarily utilized for oil extraction [7]. Sesame seeds and its components have the tendency to provide various health benefits to an individual including the nutraceutical as well as pharmaceutical benefits. Sesame seeds have been proven to exhibit anticancer, antioxidant, and cholesterol lowering properties.

The basic aim/goal of this manuscript was to highlight the importance of sesame seeds and its valuable components, that is, oil, defatted meal, proteins and bioactive compounds, and their effective utilization in numerous food products as highlighted in Figure 1. This review article also encompasses information about the nutraceutical and pharmaceutical benefits of sesame seeds based on its composition and functional properties.

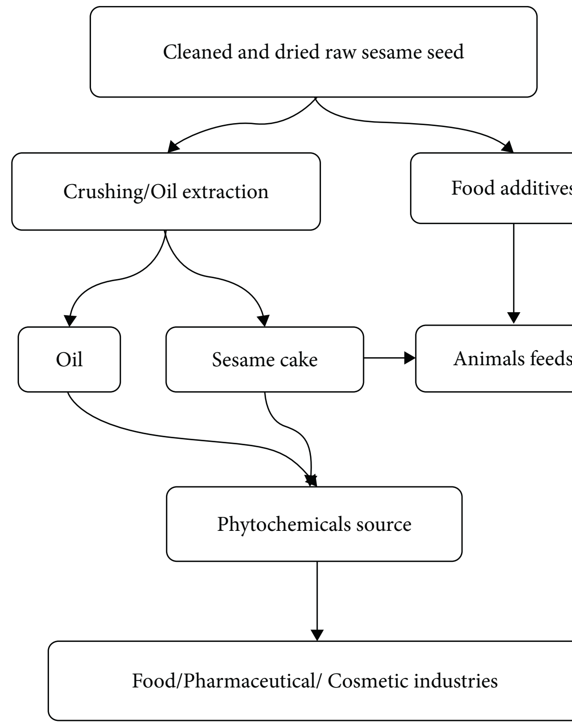

Figure 1: Sesame seed processing from waste to health.

2. Nutritional Facts of Sesame Seed

2.1. Compositional Properties. Sesame seed is unique in its composition having appreciable amounts of crude protein, moisture, crude fat, carbohydrates, crude fiber, and mineral fractions. Table 1 indicates the nutritional composition of whole as well as defatted sesame seeds. It can be observed that the defatted sesame seeds contain higher levels of moisture (7.34%), protein (40.90%), crude fiber (7.82%), ash (7.49%), and NFE (32.48%), while crude fat (41.20%) was higher in whole sesame seeds [1].

Furthermore, the defatted sesame seeds exhibit appreciable quantities of high-quality proteins with a balanced amino acid profile (Table 2) [9]. Moreover, sesame oil is mainly composed of unsaturated fatty acids. Likewise, sesame meal also exhibited substantial amounts of bioactive compounds like polyphenols and phytate phosphorus [10].

Raw sesame seeds contain many phytochemicals such as terpenoids, saponins, alkaloids, steroids, tannins, and flavonoids. It also contains other compounds such as sesamin, sesamol, sesamolin, and gamma-tocopherol, and some phenolic acids such as flavonol glycosides like 3-coumaroyl-quinic acid, protocatechuic acid, quinic acid, hydroxybenzoic acid, ellagic acid pentoside, quercetin 3,4-diglucoside, and quinic acid (Table 3) [11]. Furthermore, cephalin, lecithin, and free phenolic compounds are also present in sesame seeds [12].

2.2. Functional Properties. Black sesame seeds are mainly used for oil extraction. The full-fat sesame seed (*Sesamum indicum* L.) exhibits excellent functional properties like foam capacity and stability, oil and water absorption, bulk density, nitrogen solubility, and emulsion capacity and stability. The defatting process results in an increased amount of carbohydrates, crude protein, crude fiber, ash, and mineral contents [13]. Moreover, the defatted flour has relatively good foaming properties, water absorption, and emulsification, and, however, reduced oil absorption ability and bulk density owing to high amount of proteins. The nitrogen solubility index depends on the pH, ranging from 4 to 8 [13]. Furthermore, the sesame protein isolates exhibited excellent functional attributes including water and oil absorption capacities, and foaming and emulsion properties [2]. So, the functional properties of sesame seed favored their utilization in making diverse foods [14].

Compared with other vegetable oils (soybean, sunflower, coconut, and olive), sesame oil is more stable against oxidative rancidity due to the presence of distinctive tocopherols and lignans, for example, p-hydroxyphenyl-propane. Sesamin is quite heat stable as obvious from its 90% retention after baking [15, 16]. Sesame cake flour is abundant in lignans that are soluble in water but almost insoluble in oil. Sesamolin and sesamin are major phenolic compounds found only in sesame plants [17]. In one study, Chinese cultivars were examined for the lignin content. The amount of sesamin was higher than sesamolin in the white variety, while the proportion of sesamolin was more in the black variety [18]. The proteins present in other oilseeds do not contain certain amino acids like tryptophan and methionine. However, this deficiency can be fulfilled by adding sesame, soybean meal, and flour, which are rich sources of tryptophan and methionine. This helps to produce a balance in nutrition and diet [19]. Moreover, many of these bioactive

Table 1: Nutritional composition of sesame seeds [2, 8].

Parameter	Whole sesame seed	Defatted sesame flour
Moisture (%)	4.53	7.34
Crude protein (%)	22.41	40.90
Crude fat (%)	41.20	3.97
Crude fiber (%)	3.42	7.82
Ash (%)	4.27	7.49
NFE (nitrogen free extract %)	24.04	32.48
Sodium (mg/100 g)	76.30	133.88
Potassium (mg/100 g)	549.91	964.89
Calcium (mg/100 g)	1146.25	2011.32
Iron (mg/100 g)	9.45	16.59
Zinc (mg/100 g)	5.62	9.86
	Sesame seed oil	
Oleic acid (%)	35.9–47	
Linoleic acid (%)	35.6–47.6	
Stearic acid (%)	5.41–6.42	
Palmitoleic acid (%)	0.09–0.14	
Linolenic acid (%)	0.30–0.40	

Table 2: Amino acid profile of defatted sesame seeds.

Essential amino acids	Amount (g/100 g)	Nonessential amino acids	Amount (g/100 g)
Histidine	1.76–3.10	Alanine	0.78–5.27
Isoleucine	1.52–4.34	Arginine	1.87–4.83
Leucine	3.86–7.54	Asparagine	5.87–8.95
Lysine	1.11–3.34	Glutamic acid	12.23–18.67
Methionine	1.25–3.47	Glycine	1.19–5.96
Phenylalanine	2.24–4.48	Cysteine	0.57–3.15
Threonine	2.55–4.38	Proline	0.75–3.85
Tryptophan	0.81–2.57	Serine	0.23–3.90
Valine	2.55–5.20	Tyrosine	1.82–4.25

Table 3: Phytochemicals and phenolic compounds in sesame seeds [11].

Compound	Quantity/amount
Catechin	1.73 μg/g
Epicatechin	1.39 μg/g
Ellagic acid pentoside	4.98μg/g
Hydroxybenzoic acid	7.74μg/g
Kaempferol-3-feruloyl-sophoroside-7-glucoside	2.51 μg/g
Kaempferol-3-(p-coumaroyl-diglucoside)-7-glucoside	3.82 μg/g
Protocatechuic acid	3.57μg/g
Quinic acid	1.76μg/g
Quercetin-3, 4 diglucoside-3-(6-feruloy-glucoside)	5.25μg/g
Quercetin-3-(sinapoyl diglucoside)-7-glucoside	2.93 μg/g
Quercetin-3-O-D-galactopyranoside	1.89 μg/g
Quercetin-3-O-triglucoside	3.24 μg/g
Rosmarinic acid hexoside	12.6 μg/g
Sesamin	100.89 μg/g
Sesamol	240.96 μg/g
Sesamolin	40.72 μg/g
Syringic acid	4.31 μg/g
3-O-p-Coumaroylquinic acid	11.3 μg/g

compounds are now being used as food additives in the production of various functional foods, that is, nutraceuticals. Likewise, these are also being utilized in pharmaceutics, cosmetics, and fungicides owing to the antiseptic properties of sesame [20].

Sesame cake flour has also been studied for having good free radical scavenging potential of antioxidants [21]. Antioxidant activity of 2, 3-epoxysesamone, hydroxysesamone, and chlorosesamone toward *Cladosporium fulvum* was analyzed in a previous study. After roasting (200°C), the presence of 90% sesamin depicted its thermostable nature [22]. It shows its sustainability for food and nonfood applications. In another study, 80% of aqueous ethanol extracts of whole white and black sesame and their hull fractions were examined for Trolox equivalent antioxidant capacity assay. Results revealed a decrease in rate of low-density lipoprotein (LDL) cholesterol, free radical lowering capacity, metal chelating capacity, and total phenolic content (TPC). Black sesame hull exhibited greater antioxidant activity than white one [23]. Moreover, sesame seed peptides also held the properties of antihypertension and antioxidation; therefore, it can be used in the formulation of nutraceutical and functional foods [24].

2.3. Food Applications. In industries, sesame seeds are being processed to produce different commodities like sesame oil, roasted seeds, sesame paste (tahini), and sesame paste halva also known as tahini halva. When sesame seeds pass through different complicated processing stages, the bran and hull are separated out containing about 15 to 18% of its total weight that are being utilized in animal feeds [25]. The sesame seed bran is approximately 0.36 MT (million tonnes) obtained from ~6 MT sesame seed processed in a year. According to calculations, 54000T protein can be extracted from this bran as it contains 15% protein. Moreover, different methods can be used for the extraction of proteins such as iso-electric precipitation, ultrasound, viscozyme L, and ultrasound-assisted enzymatic and alcalase extractions [26].

From the technological point of view, proteins extracted from sesame seeds have exceptional functional characteristics like foaming and emulsifying properties, oil and water holding capacity, and solubility [2]. These specific functional properties make sesame seed a good option for food applications reflecting the structure, composition, and physicochemical properties of numerous value-added food products [27]. Researchers are being encouraged to fortify various bakery products by utilizing proteins extracted from plant sources, that is, sesame seeds. It enhances the nutritive value and functional characteristics of the baked commodities [28].

Seeds and oils of sesame have various edible applications such as toping and spreading on cookies and bread. Likewise, paste of seeds is used in various products such as desserts including sweet balls, salads, and salad dressing. Moreover, the nonedible applications include the use of various sesame components as ingredients in medicine, soap, lubricants, and cosmetics [29, 30]. Brown or black seeds are mainly used for oil extraction. In a previous research, the defatted sesame powder was replaced with millet flour in different proportions to prepare sesame enriched biscuits. The results depicted a significant increase in the protein contents of resultant products and showed improvements in flavor and crispness of the biscuits [31]. In another study, sesame biscuits were prepared by blending defatted sesame powder (5–8%) in a regular recipe and assessed for their microbiological and chemical properties. The results showed an increase in protein contents as compared to traditional products. Moreover, the sensory evaluation of end products indicated their wide acceptability by the consumers [32, 33]. The process of frying with sesame oil has a significant effect on the color, texture, shape, and nutritional as well as compositional properties of the product. These effects were due to different mechanisms such as evaporation of water, degeneration of proteins, gelatinization of starches, oxidation of lipids, and production of flavors and colors. Furthermore, damage to antioxidants can also affect these characteristics [34, 35].

Sesame meal, obtained after extraction of oil, has exceptional nutritional attributes due to the presence of high-quality protein. An outstanding balance of amino acids is present in defatted sesame flour. Sesame protein is rich in cysteine and methionine (6.1%), the sulfur-containing amino acids. These are typically limiting amino acids in leguminous plants having low lysine content (3.1%) [36]. Sesame seed cake is commonly used as a protein supplement in animal feed industries [37]. Additionally, it is used as an excellent source of supplementation in numerous food products to increase the protein quality and content. The nutritional worth of food products has been effectively increased by supplementing sesame seeds along with peanut and soybean. These are also being used to increase the nutritional status of some weaning foods for infants [38].

Refined sesame oil is considered a good quality oil, because it has a bunch of antioxidants that extend its shelf life and increase the flavor and taste of other products. This makes it an ideal ingredient in various food products. After roasting, sesame oil becomes resistant to rancidity because of the existence of different natural antioxidants [39]. Moreover, the roasted flavor of sesame further increases the taste of fried products. In Asian countries and especially in Africa, sesame seeds are used as a seasoning [40]. Likewise, seed oil is used for frying meat and vegetables and in different confectionery industries. In European countries, sesame oil is used as an alternative to olive oil. Moreover, sesame oil is also considered suitable for seasoning salad. It is also used by the Japanese for cooking various food items (fish). Furthermore, sesame oil is also used as a carrier for drugs and skin softeners in the manufacturing of soap and margarine [41].

Honey from Mexican cactus flower is combined with hulled sesame seed to form honey sesame bits. Products such as 7 whole grain honey puffs sesame cereal, sesame crackers, sesame seed candy, unhulled sesame, and sesame blues chips are being exported to US Food Stores with sesame seed as an important ingredient. Likewise, various other products have sesame seeds as an ingredient, for example, sesame spread, tangerine, cookies, sprouts, bagels, hummus, granola, mustard sauce, broccoli rice, pastry, ginger chicken, green beans, and sesame seed sauce [19]. Moreover, cereal bars made with peanuts and sesame flour showed strong storage stability because of inherent antioxidants. These bars showed more consumer acceptability as well as storage stability at 37°C for 15 days [42].

In a previous research exploration, Sisay et al. [43] formulated a snack using sesame protein concentrates with tomato powder, teff, and wheat. The sesame concentrate with 59% protein was separated from seed after oil extraction. Moreover, the protein concentrates helped to increase protein and reduce carbohydrate levels in products specially produced by the extrusion process. The results further indicated that samples containing 10% sesame proteins showed significant acceptability for color in comparison with others.

Sesame and its by-products have been utilized in numerous foods. Whole seeds are considered healthful food ingredients, while its meal is also being used in confectionery and bakery products [19]. Likewise, sesame seeds are also sprinkled over various types of desserts, margarine and salads. These are also being used for garnishing various East Asian Foods [44]. Sesame seeds are also used in micro-atomized protein foods for weaning babies. Moreover, clear white sesame seeds are produced by adopting a special hulling process. The resultant sesame seeds are then dried, washed twice, and used on hamburger buns. The white color of the seeds remains intact on the buns due to this special hulling and cleaning process even after baking [45]. McDonald's, an American fast-food restaurant chain, purchases about 1/3rd of the imported crop from Mexico for developing sesame seeds enriched buns. Likewise, these are also sprinkled over bread and then consumed in Sicily, Italy. Moreover, sesame seeds are commonly used in cakes in Greece, while these are the main ingredient of African soup known as *Togo* [46].

Nutty flavor of sesame makes it an excellent ingredient to add texture, flavor, and taste in numerous bakery products, that is, bread, sesame bars, cookies, breadsticks, doughnuts, crackers, cereal mixes, cakes, and buns. It has also been widely used for making a paste of milled sesame seeds known as *tahini* or sesame butter, which is used with crackers, pastry, rolls, bread, cakes, and breadsticks [47, 48]. The seeds are also being utilized in confectionery and candies inground and processed forms and mixed with honey or sweet syrup, in Middle East, East Asia, and South Asia [49]. Likewise, sesame paste and starch are the main ingredients to make special sesame tofu known as *Goma dofu* in Japan. Sesame proteins especially in hydrolyzed form improve the self-assembling properties at the hydrophilic and hydrophobic interface and help in the stabilization of the emulsion. Therefore, different industries are using these hydrolyzed proteins in the formulations and preparation of different food products [50]. The manufacturing of snacks and other products needs expert technologists to find and fix damages caused due to heat during extrusion and drying process of the main product as well as by-products, respectively.

Customers are very much conscious about their well-being and fitness these days. Therefore, they are demanding snacks that can accomplish their desires for eating and provide nutrients, proper health, and even more health benefits than that of novel foods [51]. Commonly snacks are interrelated with children's diet. In the previous era, snacks were prominently explored by various countries and used by governmental and nongovernmental societies for elevating the nutritional requirements of school-going children. Likewise, the manufacturing of iron-based snacks was encouraged to enhance the iron status in the females. Moreover, a new evolving notion is the "*snack in terms of food for geriatrics.*" Researchers have shown that if the caloric requirements of 25–70 years of people are calculated, there is a decrease of 600–800 kcal/day for women and 1,000–1,200 kcal/day for men [52]. The main mortality-causing factor for the elderly is the inadequate intake of carbohydrates, protein, vitamins, minerals, and fats. Resultantly, there is an undesirable loss in body weight as well as micronutrient deficiencies that further elevate risks of chronic diseases. With the help of special formulations, the nutritional needs of these groups can be fulfilled [53].

Conventional snacks usually have more carbohydrates, but they have fewer quantities of protein, fiber, minerals, and vitamins. Moreover, they contain more calories and due to lack of essential nutrients, they have been considered as less valuable foods. Nowadays, the consumer is interested in snacks that are low in sugar and fat, rich in dietary fiber, and fortified with minerals and vitamins along with the provision of hunger satisfaction. So, the manufacturers must modify the conventional formulations to a new balanced one by the addition of healthy elements [54].

The supplementation of sesame or its compounds in snacks can help to improve the health of suffering communities by imparting excellent functional as well as nutritional properties to the products. The sesame seed hydrolysates are considered one of the best sources in manufacturing and development of functional foods owing to the presence of higher amounts of various peptides and their antioxidative properties [55]. Likewise, unique properties and phenolic components (i.e., sesamolin, sesamin, and γ-tocopherols) of sesame seed can improve various characteristics of these snacks including the enhancement of antioxidant activities [56]. These properties of sesame make it unique to incorporate in products, which could be used as therapeutic agents in the development of health enhancing foods for the prevention and management of chronic diseases [24]. In order to produce the healthy snacks, supplementation of sesame seed in numerous cereal-based snacks is one of the best choices.

3. Health Benefits of Sesame Seed

3.1. Nutraceutical Benefits. Numerous nutraceutical benefits of sesame and its bioactive components have been reported in the literature. Sesame seeds showed various noticeable health benefits like reduction in high blood pressure, antioxidant activities, and anticancer property and showed hypocholesterolemic effects [30]. Furthermore, these seeds are widely used to treat respiratory tract infections, infant cholera, diarrhea, and other intestinal and bladder diseases. Sesame powder is also used to control amenorrhea, dysmenorrhea, ulcers, and hemorrhagic acne [57]. Lignans of sesame possess antioxidant properties and health-enhancing activities [58]. These lignans include sesamolin, sesaminol, sesamolinol, and sesamin. These physiologically active ingredients have many health promoting attributes, that is, lower blood cholesterol and lipid levels; provide anti-inflammatory properties; and enhance hepatic fatty acid oxidase and neuroprotective effects on brain damage or hypoxia [59]. The sesame seed oil has significant potential against diazinon-induced stress due to its free radical scavenging, antioxidative, and anti-inflammatory properties [60]. The dietary components of sesame seed oil also have improving outcomes in blood pressure reduction and work significantly in the variation of the electrolytes, increasing antioxidants, and decreasing the lipid peroxidation [61]. Likewise, several scientists have reported the presence of antioxidant and free radical lowering activities of sesamol by using the radiolysis technique of nanosecond pulse [62]. In an investigation, the spread butter was formulated by using a combination of sesame, chia, and olive oils. Their antioxidant properties were observed by detecting the free radical scavenging activities such as DPPH, TPC, and FRAP. The

Table 4: Nutraceutical and pharmaceutical benefits of sesame seed components.

Compound	Effect	Reference
Lignans (sesamolin, sesaminol, sesamolinol, and sesamin)	Lower blood cholesterol and lipid levels, provide anti-inflammatory properties, increase hepatic mitochondrial and peroxisomal fatty acid oxidation rate and neuroprotective effects on brain damage or hypoxia	Soleymani et al., 2020
Cephalin	Hemostat activity	Rohillaand Bhatt 2018
Lecithin	Antioxidant and hepatoprotective activity and successful treatment for dermatitis and dry skin	Rohillaand Bhatt 2018
Myristic acid	Cancer preventive capability	Zhang et al., 2021
Phytate	Antioxidant, anticancer	
Sesame oil	Used as remedy for toothaches and gum disease; reduces cholesterol; helps lower blood pressure, treatment of blurred vision, dizziness, and headaches	Farouk et al., 2021
Fiber	Antidiabetic, antitumor, antiulcer, cancer preventive, cardioprotective, and laxative	Bukvickiet al., 2020

TPC detected in this butter was $68.73 \pm 0.01\,\mu$gGAE/mL. Due to its good antioxidative property, it was suggested to be used in medicinal and nutritional sectors [63].

Sesame seeds hydrolyzed by three different enzymes, that is, papain, pepsin, and alcalase, tend to produce more hydrolysates by enhancing the rate of hydrolysis. These hydrolysates exhibited low-molecular-weight bioactive peptides with excellent functional attributes including antioxidant properties, antihypertensive effects, and improved digestibility mechanism. The proteins of sesame can be used in the formulation of functional foods for averting and treating different people suffering from different chronic metabolic ailments [51]. These have been found to increase the liver mitochondrial function and peroxisome oxidation of fatty acids in rats. Consumption of sesame seeds has been shown to increase the plasma tocopherol and stimulating the activity of vitamin E that helps in the prevention of cancerous and cardiac diseases [64]. Anticancerous activity is also found in myristic acid found in sesame seeds [65]. Traditionally, sesame fibers have been used as antidiabetic, antitumor, anti-ulcer, cardioprotective, chemoprotective, and laxatives [66]. Sesame flour and cereal-based flour bars have been examined against cancer to check their therapeutic potential. The commercially available low glycemic index snack bars have proven effective in lowering the risks of prolonged diseases in healthy adults [67].

Cephalin in sesame seed has been reported to have good hemostatic activity. Sesame seeds contain lecithin, which has hepatoprotective and antioxidant activity. Lecithin may also be effective in decreasing liver steatosis in patients with long-standing parenteral nutrition and successfully treating dermatitis [68]. The consumption of the dietary sesame seed oil might efficiently reduce the cerebrovascular ischemia and work synergistically with the medication against diabetics, resulting in the provision of the significant curing of hyperglycemia [69, 70].

3.2. Pharmaceutical Benefits. Developing countries produce huge amounts of sesame seed and generate ample amounts of sesame meal as a by-product after extracting oil by hydrolysis from sesame seed containing protein lumps and many bioactive peptides, which have a significant role in pharmaceuticals [51]. Sesame oil is abetted in the pharmaceutical industry and is utilized as a solvent in intramuscular injections. It has nutritional, soothing, and ointment characteristics and also works as a laxative. Chinese are also using this oil for the treatment of toothache and gum diseases for many centuries. It is also known that the consumption of sesame oil lowers cholesterol due to high polyunsaturated fat content. Other properties include the treatments of headache, dizziness, and blurred vision. Indians also use this oil as an antibacterial mouthwash to relieve anxiety and insomnia [71]. Table 4 shows the nutraceutical and pharmaceutical benefits of sesame seed components.

Moreover, sesame oil has large amounts of esters of linoleic, which can selectively inhibit the growth of malignant melanoma [59]. In a study, the consumption of sesame lignans causes a reduction in Fe^{2+}-induced oxidative stress in rats. Furthermore, rats consuming sesame oil have shown lower levels of serum glutamate pyruvate transaminase, activities of oxaloacetate transaminase, and thiobarbituric acid reactive substances in the liver. These enzyme levels depict safety against Fe^{2+}-induced oxidative stress [72]. In Africa, sesame flour is used in cologne and perfumes. Myristic acid (C14 : 0) is used as an important element in cosmetics. Sesamin and sesamolin have insecticide and bactericide actions. These are also used as a synergist for pyrethrum insecticides [73].

4. Conclusion and Outlook

In this era of knowledge and better means of communication, the basic reasons for nutritionally poor foods with availability issues are lack of resources, ineffective policies and programs, and poor compliance of commitments. We have now better expertise to produce more nutritious products as advanced strategies such as fortification, supplementation, and enrichment have made it very easy to develop nutrient-dense products. Globally, this is the right time to initiate good approaches by involving all stakeholders from academia, research, farming, industry, health, and policy sectors. Nutrient-dense conventional crops should be made part of regular diets. On this account, the current review suggested that the supplementation of sesame seed in the functional foods could be proved significant addition in emerging trends. This review study summarized the various sesame seed compounds such as proteins, peptides, amino acids, unique fatty acids, and bioactive components based on functional foods that could be utilized in treatment of various disorders as alternate source of clinical approaches. In this way, people could live a healthy life. In return, they can work more powerfully for the social and economic welfare of mankind. However, more research is required on the particle size and quantity of by-products to be used in different products. Likewise, comprehensive work is required to be done on the economic conditions and environmental effects on products formulated with by-products. Further researches are required to explore the nutritional benefits of other crops and their by-products in order to improve the health sectors through the addition of more functional foods in regular diet of the people.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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