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The Important of Flax (*Linum usitatissimum* L.) In Terms of Health

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ABSTRACT
The flax is one of the oldest known cultivated plants of the World that benefited from seeds and fibers. It is an important nutrient because of the rich α-linolenic acid (ALA, omega-3 fatty acid), lignans, short chain polyunsaturated fatty acids, soluble and insoluble fibers, phytoestrogenic lignans (secoisolariciresinol diglycoside-SDG), waxy and mucilage compounds, protein and antioxidant compounds. In addition, the seed contains components effective in reducing cardiovascular disorders, diabetes, digestive system, urinary tract disorders, osteoporosis, cancer, arthritis, autoimmune and neurological diseases. Seed protein content varies between 20-30%, of which approximately 80% consists of globulins and 20% glutelines. The amino acid level is so rich and gluten-free. The unconscious consumption of seed may cause toxicity due to trypsin, myo-inositol phosphate inhibitors, cadmium and cyanogenic glycosides in the seed. The seed should be consumed as milled flour after absolute heat treatment. Side effects may be seen in pregnant and young men due to hormonal effects of lignan. It may be oxidized shortly after grinding due to the fatty acids present in the seed. Flax fibers (Linen) have been used in house and fabric textiles, sailing and tent making since 7040 BC. The fibers are gold-yellow in color, the qualitative and moisture absorption capacity is very low, easily creasing. For this reason, the linen keeps the skin cool and does not sweat. Fiber is also an important source for healthy insulation materials, biocomposites, structural application materials for automotive, contributing both to the environment and to human health. In this paper, the effects of flax on human health and methods of traditional uses in Turkey were discussed with references.

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Introduction

Flax (*Linum usitatissimum* convar. *usitatissimum*) is the only economic important genus of Linaceae family, annual, used both of fiber and seed. Flax, one of the oldest plants in the world means “very useful” [1]. The cultivation for flax fiber is need climate condition of relatively high humidity, warm and rainy in winters, cool in summers while for oil / seed production was suitable of drier and warmer climates [2]. Its homeland is region from the west of the Mediterranean to India. Flax, which is accepted as a medicinal plant for the European Pharmacopoeia, grows today in a wide range of areas

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including Tropical and moderate climates [3]. Its use by humans is based on the beginning of agriculture.

In recent years, dyed flax fibers found in excavations at the Dzudzuana cave in Georgia have shown that fibers over 30,000 years of age dating back to the Upper Palaeolithic period, prehistoric hunter collectors use flax fiber to produce or develop everyday objects [4, 5]. In the historical process, it has been stated that flax is grown and woven both by Ottoman historians, traveler historians such as Evliya Çelebi, Cuinet, Strabon and archives of the Republican Period. Excavations in different parts of Anatolia have indicated that prehistoric village inhabitants cultivated barley, wheat and flax on the banks of the Tigris River. The historical findings in Anatolia have shown that flax wovening was very old, back to 7040 BC. [6,7]. Flax is one of the most mentioned plants in the 800 recipes made of 77 herbal, animal and mineral drugs in papyrus at 1550 BC.[8]. It has been included in herbal prescriptions for the treatment of various diseases [9]. In this reviewed paper, the effects of flax on human health and methods of traditional uses in Turkey (Anatolia) were discussed with references.

Physical and chemical properties of flax fiber (Linen)

Flax fibers are the most used fiber source after cotton in the World. The linen obtained from the stems contain 75% cellulose, 5% hemicellulose, 4% lignin [10, 11], 3% fat and waxy substances, 0.5% ash and 12.5% water [12,13,14]. The degree of polymerization of flax fibers is 18000 and has a longer polymer chain than cotton. Each linen chain consists of 18000 cellulose units, which are 18000 micrometers long and 8.8 nanometers thick [2]. The length of a single fiber cell is 6-65 mm and the diameter is 0.02 mm [15,16]. The length of a fiber varies between 90-125cm. The tensile strength of the fibers is 6.5-8 gr / denier, elongation at break 1.8% (dry) and 2.2% (wet), specific gravity 1.54. The flax fibers are resistant to distortion up to 120^{o}C [12] .Wear resistance is moderate. Stability and thermal conductivity are good [17]. The fibers are brownish, ivory, gray, light, yellowish (4,12,15,18). Flax fiber is easily damaged by high concentrations of acids. However, it is not affected by low density acids if washed immediately. It has excellent resistance to alkalis and does not break down by strong alkalis. Fibers are not affected much by bleaches such as cold chlorine and hypochlorite, boiling water, sun and detergent [12,13,19] Flax fiber cannot be spun due to its fiber structure. Therefore, it can be used by mixing with fibers such as cotton, silk and wool

[20,21]. Compared to hemp fibers, it is relatively thin and soft and has low elasticity. It ranks first among natural bast fibers in terms of durability. The best sweat absorbing after cotton [22,16]. The linen fabrics keep the body dry and cool because of these properties. Whereas polyester worn over the skin has been shown to result in skin with higher relative humidity than fabrics made from cotton and linen [23]. Linen, which is a natural bast fibre, has unparalleled characteristics such as a feel of freshness and a magnificent brilliance. It is very hygienic and imparts an air of satisfaction and style to the wearer [24]. 100%-linen and linen-blended fabrics are more permeable to air than cotton fabrics, which confirms the suitability of linen fabric for winter wear. Linen and linen-blended fabrics have higher thermal insulation values than cotton fabrics. Linen fabric has a higher moisture vapour transmission rate [25,16].

Many healthy products such as shirts, jackets, dresses, blouses, trousers, home textile products, bed linen, ornaments, bedding, towels are made of flax fibers [18]. In addition to, it is used in the production of environmentally friendly materials such as surgical thread, sewing thread, wall coverings, wallpaper, high-quality papers (money, cigarettes), lightweight fabrics for aeronautics, automotive interior coating materials [26], noise-resistant materials in construction and automotive industry, insulation material, biocomposites, bioplastics, pulp [21,27].

Chemical structure of flaxseed

The chemical content of the flaxseed varies according to the environmental conditions in which the plant grows and the characteristics of the genotypes. The flaxseeds consist of about 35-45% lipids [28,18], 30% dietary fibre, between 20 to 30 % protein [29,30], 10% musilaj and glycoside linamarin 5-6% gum [31]. Major lignan present in flaxseed is secoisolariciresinol diglycoside (SDG) [32]. The total protein content composed of mainly 80% globulins (linin and conlinin) and 20% glutelin [30,29]. Flax protein is relatively rich in arginine, aspartic acid and glutamic acid. However lysine, methionine and cysteine are the limiting amino acids and gluten-free [33]. Flaxseed oil is composed of 73% polyunsaturated fatty acids, 18% monounsaturated fatty acids and 9% saturated fatty acids. It is also the richest known plant source of the omega 3 (n-3) fatty acid, α-linolenic acid (ALA), which comprises 55% of the total fatty acids [34,35,36]. Flaxseed oil is mainly found as triacylglycerols (98%) with lower contents of phospholipids (0.9 %) and free fatty acids (0.1%) [37]. In addition to, cellulose,

hemicellulose and lignin are insoluble fiber constituents abundantly found in flaxseed while mucilage gums form is the soluble fiber fraction [38]. Flaxseed is an equally good source of minerals, particularly, phosphorus, magnesium, calcium, iron, zinc and very little amount of sodium [39]. However, flaxseed contains toxic components such as trypsin, myo-inositol phosphate inhibitors, cadmium, cyanogenic glycosides [40].

Flaxseed and Health

The flax is a valuable plant from which we benefit from both seed and fiber. Flaxseed is an important source of edible oil [41] as well as traditional treatment (medicinal purposes). In traditional treatment throughout history, the flaxseeds have been used to reduce inflammation, calming, colds, coughing and fever [42], to treat of lung diseases, severe colds and cough, as muscle relaxant by American Indian [1] to heal abdominal pain in ancient Egypt and Rome [43]. Flaxseed consumption in the diet prevents serious diseases like coronary diseases, cancer, diabetes, obesity, gastrointestinal, renal and bone disorders [39]. Effects of flaxseed on gastrointestinal problems, constipation, glucose tolerance, hypocholesterolemic effect and fermentation have been described comprehensively in many articles [44,45, 46].

Flaxseed is the good source of functional food or functional components [47,37,39] due to such components as lignans (secoiso-laricrecinol diglucoside-SDG), polysaccharides [35], α-linolenic acid [48] and soluble flaxseed gum (FG; Flax musilage) [30] which are positively effective in preventing many diseases. Ibrügger et al. [49] have reported that flaxseed fiber may be applicable to control appetite, thus the ingestion of the flaxseed fiber, both as a powder and tablets, have caused to increase satiety and decrease energy intake at a subsequent meal. Flaxseed is one of the richest sources of lignan [50] and there are many studies showing that it is a source of quality phytoestrogens [51,52,53]. The major lignan in flaxseed is secoisolariciresinol diglucoside (SDG), phenolic compounds are coumaric acid and ferulic acid. The lignans of flaxseed have possess a high activity especially as antioxidant and antibacterial [54]. Also, researchers have reported that flaxseed might be have health-promoting effects due to these properties [55,56]. Lignans have been shown as a supplementary food source that can serve as an alternative to traditional estrogen therapies in the prevention and treatment of hormone-based cancers [57]. In vivo studies have been observed that the addition of flaxseed to 10% in mice feeding diets [53] and 5% in mammals reduces tumor growth rate and

metastasis [57]. The high content of SDG (secoiso-lariciresinol Diglucoside) lignin in flaxseed has got possibly a breast tumor-reducing effect [58]. However, the researchers have determined of flaxseed lignan SDG appears to be a promising naturally-occurring therapeutic agent for insulin resistance and type-2 diabetes. It has shown significant-beneficial effects on glucose tolerance and insulin sensitivity [59,60].

The flaxseed gum (FG) diet by affecting the abundance of some specific bacteria in the stomach of obese rats, via suppressing appetite has created the effect of anti-obesity. Thus, A proper dose flaxseed gum (FG) consumption could be reduced the body weight, body fat and total triacylglycerols [61]. Alzueta et al. [62] was indicated that flaxseed gum (FG) is a potential prebiotics due to could selectively stimulate the growth of Lactobacilli in vivo.

The researchers have shown that the use of degreased and ground flaxseed has statistically significant decrease in total cholesterol and LDL cholesterol levels [63,64]. So, addition of flaxseeds to diets can be reduced the risk of cardiovascular disease by improving fat profile in hyperlipidemic patients [39,65].

Flaxseed is one of the richest of sources of phytoestrogens to reduce menopause complaints of menopausal women [66]. It has reasoned significant reductions in menopausal symptoms of women, to consume phytoestrogen-rich soy products and diet products containing flaxseed in 145 women suffering from menopause during the 12-weeks [67]. The researchers have determined that may be ability to protect from breast, colon and ovarian cancer by preventing the formation of tumor in vivo studies conducted on rats of flaxseed eat [68]. The flaxseed oil has proven to be a good cytotoxic agent on the oral cancer cell lines by experiments. It can be used as a biomedicine against cancer which can reduce the adverse effects of cancer treatment and to be a life saving drug for oral cancer suffering people which can help many in the future [69].

ALA, which is abundant in linseed oil, is a fatty acid that cannot be synthesized in the body and must be taken from the outside. It is an 18-carbon n-3 (Omega-3) fatty acid that is essential for humans [70]. Omega-3 fatty acids exhibit anti-inflammatory [71,72,73], anti-thrombotic, vasodilatory, anti-atherogenic properties and can modulate lipid metabolism in a beneficial way [74]. Natalucci-Hall and Starr [75] have suggested the homeopathic usage of omega-3 which is effective food supplement for reducing

Attention Deficit Disorder without Hyperactivity symptoms in patients. ALA-rich flaxseed oil has health benefits in obesity due to its ability to improve adipocyte function [76]. The flaxseed oil diet has also proved to be better at reducing hepatic nitric oxide concentrations in diabetic rats. These diets have also significantly lowered hepatic expression of inflammatory biomarkers. The omega-3 diets have proved to be beneficial in protecting against injury and potential complications in liver tissue of diabetic rats [70,71]. In addition to Tomaz et al. [77] found that adding 20% flaxseed to daily diet may be important to prevent cardiovascular diseases according to their experiment with healthy rats. However, Rajaram [78] has stated that although there has been an increase in studies that ALA provides protection against cardiovascular diseases for the last 10 years, there are still deficiencies, and it would be beneficial not to make specific recommendations for prevention of public cardiovascular diseases until strong evidence is revealed in the future. The flaxseed have potentials [32]. Nowadays, flaxseed oil is often used as nutritional supplements [79]. Expecially for vegans, flaxseed oil or flaxseeds are one of the major sources of omega-3 fatty acids [70,39]. Therefore it may be prudent to include foods containing ALA in the diet [78].

Traditional Uses of Flaxseed In the Turkey

Flaxseed is known by local names such as, sârek, seyrek, zârek [80] bızıktan seed, siyalek, zergenek [81] in Turkey and has been consumed in many different ways since ancient times. Flaxseed has used for especially for pain relief, wound healing, bronchitis, cough treatment [82,11] and burn treatment [83], as ointment and mush [84]. The water obtained by boiling flaxseed (infusion method) has a curative effect on stomach and intestinal disorders, gastritis treatment, asthma and bronchitis when drunk on an empty stomach [85,11]. It has strong laxative effect [11] if ground flaxseed is consumed with spinach [86]. Especially it is very effective against chronic constipation because of the mucilage substances in the seed. In order to overcome this problem, it is reported to be beneficial to consume morning and evening, ground flaxseeds, 2 tablespoons, on an empty stomach and withplenty of warm water. It is recommended that the consume be continued for several weeks in order to regulate the defecation [87]. The yellow colored flax oil obtained from flaxseed by the cold-press method has used to against eczema, hemorrhoids and shortness of breath [88]. When one tablespoon of ground flax seed (about 30-40 g) is mixed in 1 bowl of yogurt and eaten, It is mentioned

that this mixture balances blood pressure, sugar, is good for bone resorption, stomach, cough, lost weight among the local public [81]. The same mixture is also frequently consumed by breast cancer patients in recent years [86].

An equal amount of flaxseed and hemp seeds are lightly roasted. Then a powder mixture is obtained by grinds together with the seizure sugar. Consuming three meals /a tablespoon per day from this powder mixture is found very effective for eliminating breast swelling of the puerperal women in the post-natal and to increase breast milk [80].

It has stated that the mixture prepared by grinding roasted flaxseed, hazelnut and seizure sugar together, consuming 1 tablespoon on an empty stomach in the morning, is beneficial for people with weak and stomach discomfort. In addition to, in the morning, consumption of 1 tablespoon from roasted-ground flaxseed and honey mixture has mentioned to show good effect for lung diseases. In interviews with consumers, they have said that when roasted-ground flaxseed is mixed with tahini (ground sesame) and grape molasses, it keeps the body warm and delays hunger and energizes the body. Also, it has a lowering effect on cholesterol, if flaxseed is boiled and drunk [86].

Nowadays, still in traditional treatment of flaxseed mush has known to use to ripen swollen wounds. Fistly, ground flaxseed is cooked with milk, then is applied to the swollen swelling which does not flow after being mush as warmish. This process is repeated several times in day [80, 86] Also, It has reported that applying hot flaxseed mush on the chest is a cough remover [11, 89].

The Oleum lini (flaxsed oil) has reddish brown and special scented which is obtained by the pressing after roasting of flax seeds. Oleum lini and lime water mixture has very effected to use as externally for wound and burn treatment [11] In addition, this oil has used in veterinary medicine especially as a laxative and to lubricate buffalo skins [84]. It can be used by friction in all skinless skin diseases, including calluses by human [89].

The Anti-nutrients and Toxicity in Flaxseed

Whole flaxseeds and cold press flaxseed contain anti-nutrients which may pose adverse health effects as cyanogenic glycosides (250–550 mg/100 g) [90,91]. Hydrogen cyanide released from flaxseed is minimal and lower than the toxic or lethal dose while the phytic acid content of flaxseed meal is 2.3–3.3% which result in decreased absorption of nutrients. The release of hydrogen cyanide from recommended daily intake of flaxseed

(1–2 tablespoons/day) is approximately 5–10 mg. This value is very low considering that the toxic dose is 50-60mg [39]. Also, human beings can detoxify cyanide levels below 30–100 mg/day [92]. Althought, no reports on cyanide poisoning after consumption of linseed were found in the literature [40,89] the more research is needed on this subject.

Roasting is generally done to remove cyanogenic glycosides [93,94,95]. The seed should be consumed as milled flour after absolute heat treatment (approximately min. 35^{o}C) for safe consumption. Side effects may be seen in pregnant and young men due to hormonal effects of lignan. It may be oxidized shortly after grinding due to the fatty acids present in the seed. It should be stored in the refrigerator after grinding fresh [86]. Flaxseed meal obtained after cold press is toxic because it contains cyanogenetic glycosides and should not be given directly to animals [84,96]. It should not be taken just before bedtime [89].

In adults, high-quality studies have indicated that daily ground flaxseed intake may range from 38 g [97] to 40 g [98,99] to lead a healthy life under the specified conditions. Althought, It is need to determined of the minimum consumption amount of flaxseed to explore its therapeutic potential for all population groups including pregnant and lactating women and to learn possible problems posed by its overdose via in vivo research (100).

Conclusion

The present review shown that flaxseed, fiber and its oil have different uses and many health benefits of since ancient times with reference to evidence based literatures, it has still consumed in traditional. Today, many people suffer from many diseases such as cardiovascular diseases, diabetes, hypertension, osteoporosis, cancer, arthritis, autoimmune and neurological diseases, obesity. According to literature, flaxseed has seen as a product that can be take into place in the diet of people to reduce to negative effect of diseases. However, there is a need to increase the researches on the mentioned effects especially in traditional usage and to support them with scientific data. In the reviewed literature, even if no toxicity cases have been recorded to date for flaxseed, warnings about its use due to cyanogenic glycosides and anti-nutritions should be taken into consideration until their effects are proven by scientific data.

Competing Interests
The authors declare that they have no competing interests.

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