Flaxseed segregations as an imperative tool for its
neutraceutical implication

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ABSTRACT

Unique and effective qualities of flaxseed are impetus force behind this review. Neutraceutical functions of whole flaxseed (WF), flaxseed oil (FO), flaxseed gums (FGs) and flaxseed lignin (FL) are briefly discussed in this article. Its segregations exhibit antioxidant and stabilizing properties. Low cost, long shelf life, easy availability and more outcome of extraction make it a cheaper source for incorporation in food systems. We can combat complex diseases like bronchial asthma, male impotence, preeclampsia, cerebral ischemia, vasospasm, hypertension, a number of tumors and cancers. It is dire need of the hour to spread area of neutraceutical and pharmaceutical research regarding this tiny gift of nature. So currently there is lack of high quality research on its effective uses. WF consumption can decrease mammary tumor occurrence, tumor size and tumor number. The oil contains all fat-soluble vitamins, amino acids, and minerals. It provides essential fatty acids such as linoleic and linolenic polyunsaturated fatty acids (PUFA). The low viscosity of FO is utilized in dietary fiber supplementation. FO exhibits limiting effect on lead acetate induced renal cytotoxicity. Heterogeneous FGs are commercially applied as emulsifiers, thickeners or service provider contents in microencapsulation in the food processing industry and in food supply chains. These gums have gained attention due to their advantageous effects on diabetes mellitus, coronary heart diseases, in lowering cholesterol and various types of cancers. The FLs have significant antioxidant potential, so they provide many health and nutritional estrogen antagonistic activity. Lignins have retarding effect on cancers.

Key words: Flaxseed, Neutraceutical, Health claims, Lignan

INTRODUCTION

Flax is an Egyptian originated ancient plant especially grown for oil and fiber purposes in different parts of the world. Flax is a member of \textit{linaceae} family and its seeds are known as flaxseeds (Kaithwas & Majumdar, 2013). WF is used as diet purpose in Asia and Europe from thousands of years (Smykal \textit{et al.}, 2011). As the basic source of linen fiber, flaxseed has been grown since 5000 BC; and now, it is basically grown for oil production (Halligudi, 2012). In his book “Species Plantarum” Linnaeus botanically assigned its name as \textit{Linum usitatissimum} (Jhala & Hall, 2010). Annually self-pollinating plant possesses over 200 species with vegetarian period of 90-120 days. Recently 67 cultivars are being registered by European Union (Iva \textit{et al.}, 2013).

Varying in color from dark brown to yellow, flaxseed is oval shaped, flat, and has pointing tip (Coşkuner & Karababa, 2007). On the basis of seed coat color, two varieties of flaxseed are present. Amount of the pigment determines color of seed coat and it could be changed from one breed to another. Yellow and brown flax exhibit small nutritional differences as mentioned in Table 1. Flaxseed dimensions vary approximately from 0.5–1.6 mm, 2-3 mm and 4.0–6.0 mm in thickness, width and length respectively (Iva \textit{et al.}, 2013; Thompson & Cunnane, 2003).

In 2004, it is indicated that with 1,903 MMT seed production, linseed was cultivated on a wide area in 47 countries of the world. Canada is the world’s largest linseed producer with 1.014 metric tons from an area of cultivation expanded over 800,000 hectares. China, USA and India are also major countries in the list of flaxseed growers (Jhala & Hall, 2010).

Flaxseed consists of 63% kernel and 37% hull (Singh \textit{et al.}, 2011) and contains 40%, 30%, 20%, 6%, and 4% oil, dietary fiber, protein, moisture and ash respectively. Extrusion process enhances digestibility of these components (Y. Wang \textit{et al.}, 2008). There is a large market place for intended use of flaxseed in human diet and animal feed (Rebole \textit{et al.}, 2002). In these days flaxseed and flaxseed meal are widely used in food processing industry particularly in the preparation of products as salad dressings, cookies, and breads and acquired great acceptability in US market (Villeneuve \textit{et al.}, 2012). As a multifunctional food ingredient it serves as natural preservative and antifungal agent (Xu \textit{et al.}, 2008). Addition of flaxseed additive produces pasta...
products of high plasticity and low structural damage (Ivanov et al., 2011). In excess to more volumetric production, flaxseed meal provides a variety of the products and could be utilized in nutritional applications (Fregolente et al., 2008).

Health related benefits and Anti-nutritional Aspects of whole flaxseed:

FS is contemplated healthiest eating material because it is beneficial for health and is a powerful preventer of a number of diseases (Fukumitsu et al., 2010). Flax proteins (FP) are a rich source of glutamic acid, aspartic acid and arginine at the same time a poor source of cystine, methionine and lysine. Dietary fiber is constipation reducer, good bowel movement controller and an effective hypocholestermic agent (Ganorkar and Jain, 2012). Flaxseed protein (FPs) consists of 11.2 per cent arginine (Udenigwe & Aluko, 2010). It is highest amount of arginine as compared to other food protein sources as white egg, wheat, rapeseed, pea and soy which comprises of 5.48, 4.4, 7.0, 8.2, and 7.6 per cent. So annually 34 million kg arginine can be produced from flaxseed meal and large quantity of arginine enriched peptides of nutraceutical importance. Peptides are carriers for distribution of arginine into physiological systems because osmotic pressure of peptides is low and absorption efficiency is high as compare to individual amino acid (Udenigwe et al., 2012). Transportation of arginine containing peptides is independent of cellular carrier (Schmidt et al., 2010). This free amino acid is a part of clinical interventions for individuals with endothelial dysfunction. Long and short term incorporation results in dilation of vascular tissues in endothelial dependent patients but not in normal people. L-arginine nitric oxide pathway is major tool for minimizing vascular constriction, curing diseases like bronchial asthma, male impotence, preeclampsia, cerebral ischemia, vasospasm, and hypertension in humans (Heffernan et al., 2010). Most common phospholipids present in flaxseed are phosphatidyl ethanolamine, phosphatidylinositol and lysophosphatidyl choline which were highly unsaturated and accounts for 60% of total FAs (Herchi et al., 2012). FP’s have many nutritional and pharmaceutical uses. So production of pure vegetable protein isolates is dire need at industrial level these days. It is due to trust of health conscious consumers on natural vegetable sources (Kaur & Singh, 2007; Pereira et al., 2009)

The use of flaxseed as a source of food and laxative material was well known by the people of different ancient civilizations especially Egyptians and Greek (Jhala and Hall, 2010). It is also used as the functional food and nutraceutical food ingredient which results elevated body mass (Melanson et al., 2009) Regular incorporation of flaxseed in animal diet increases omega 3 fatty acid contents in the beef (Doreau et al., 2011). When ewes are feed on extruded flaxseed rich diet, high nutritional quality Pecorino cheese of improved color, texture, eyeness, and flavor is obtained without any adverse effects on sensory attributes (Branciari et al., 2012). Hypoglycemic, hypcholesterolemic, antiviral effects along with antibacterial activity are health advantages associated with the consumption of flaxseed and flaxseed meal (Ranich et al., 2001; Schumacher et al., 1997). It also prevents and performs well in the treatment of diabetes (Abuelgassim, 2010). Flaxseed dietary fibers have potential to combat the diseases such as postpyrandial lipemia. It reduces appetite as the potential is linked with its physiological effects in the gastrointestinal tract. Since energy intake is not affected (Kristensen et al., 2011). Free fatty acid concentration is reduced as result of which inhibition of lipolysis is prolonged. However, insulin the main modulater of lipolysis is also reduced (Tarini and Wolever, 2010). Some flaxseed components positively interfere with male reproductive system. A study conducted on rates indicates an elevation in the formation of 17b-estradiol hormone (de França Cardozo et al., 2012). Alpha-linooleic acid present in the flaxseed could be hydrolysed into eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which are found in fish oil. Rate of hydrolisis is more in female than male and it is highest in pregnancy. DHA is required for growth and development of mammalian brain (Sengupta and Ghosh, 2013).

Decreased chances of cardiovascular illnesses are among the most reported health advantages of flaxseed and flaxseed meal because it improves lipid profile (Cardozo et al., 2010), anti-inflammatory activity (Dupasquier et al., 2007), antihypertensive, antioxidant (Hao and Beta, 2012). By regular consumption of flaxseed pre-diabetic obese patients can easily improve glycemic control (Hutchins et al., 2013). Crushed flaxseed is an authentic maltodextrin matrix it also delivers probiotics. It is found that the viability of Lactobacillus rhamnosus GG (LGG) in flaxseed matrix depends on moisture and it is slightly dependent (Vesterlund et al., 2012). In postmenopausal flaxseed consumption is a good approach in the prevention of hypercholesterolemia because it lowers low density lipoprotein (LDL) cholesterol level (Kontogianni et al., 2013). In the postmenopausal women supplemented with phytoestrogen along with flaxseed or soy flour increases maturation of vaginal cells and it shows estrogen activity (Kim and Ilich, 2011). Particularly vaginal dryness and hot flashes and menopause signs are reduced (Nedrow et al., 2006). The relation between flaxseed nutritional advantages and safety is not known exactly, due to its complicated
nature. Flaxseed consists of nutrient and antinutrient components (Wiesenfeld et al., 2003). Over consumption of flaxseed is deleterious because it has some anti-nutrient fragments that can have an acute health impact like linatine and Cyanogenic glycosides (Ganorkar & Jain, 2012). Which has capacity of binding B6 vitamin? So, consuming diets rich in flaxseed can cause a B6 vitamin deficiency as it is an important vitamin for the body. The deficiency of this vitamin results in higher homocystein production and renal complications (Nagrath, 2012). Approximately 50% of the total deaths could be linked to coronary heart diseases and blood flow problems. The required health advantages have led to the formation of a vast range of flaxseed supplemented foods including bakery products, snack foods, breakfast cereals and various kinds of soups in food supply chains (Thompson and Cunnane, 2003). Dietary intake of flaxseed in post weaning and perinatal periods perceived impairment in growth. Unbalanced ratio of omega 6/ omega 3 FAs results in retarding growth and exerts negative effects on inflammation response, immunity, fertility, interferes with hormones, thromboxanes, leukotrienes, and prostaglandins synthesis. So during lactation and pregnancy flaxseed intake should not be encouraged it may lead to chronic disease of in descendants (Fernandes et al., 2011). FS and its different combinations with edible materials have wide application in the treatment of nervous, cardiovascular, and gastrointestinal diseases. It is powerful wound healing agent. FS is useful postsurgical patients weakened children and elderly people. Normal healthy people, students, computer dealers and persons dealing with computers and those who are exposed to radiation require FS for physical and mental activities (Ivanov et al., 2011).

**Anticancer effects of whole flaxseed:**

The studies show that the flaxseed potential of protection against various diseases like colon cancer, breast cancer, atherosclerosis, insulin dependent diabetes mellitus (IDDM) and other chronic diseases (Ivanov et al., 2011; Prasad et al., 2000). Overall study has demonstrate that 80% of patients suffering from breast cancer use particular/alternative dose involving foods supplements to control the breast cancer and enhance health of the patients (Boon et al., 2007). Flaxseed is the third most generally consumed supplement but it is not clearly demonstrated that the components of flaxseed, especially alpha-linolenic acid containing flaxseed oil, participate beneficially with various known breast cancer therapies (Mason et al., 2010). While studying the impact on the mechanisms of flaxseed, various researchers have paid attention on the potential of flaxseed to antagonize the estrogen hormone breakdown and biological potential (Gencel et al., 2012). Hence, treatment strategies are urgently required to decrease the occurrence of breast cancer. Studies have suggested that flaxseed in the diet prevents the development of estrogen receptor of breast cancer. Supplementation of 10% flaxseed reduces decreases tumor growth and metastasis in rats (Dabrosin et al., 2002).

**Flaxseed Oil:**

Flaxseed also known as linseed has been gaining its fame from its traditional use as a raw ingredient in oil production due to its health advantages (Viklund, 2011). Oil consists of 59 per cent α-linolenic acid which is effective bioactive component and helpful in the treatment of osteoporosis, diabetes, diseases of GI track cardiovascular diseases as well as in reduction of inflammation (Villeneuve et al., 2012). Yield of oil also depends on different extraction techniques as shown in Figure 1. The oil contains all fat-soluble vitamins, amino acids, and minerals (Houston, 2012). Different cultivars of flaxseed are grown to enhance production of oil and to replace fish oil which is a source of a rich source of docosahexaenoic acid (DHA, C22:6) and eicosapentaenoic acid (EPA, C20:5) (Jhala and Hall, 2010). Lipid contents of different flaxseed cultivars vary. The low viscosity of flaxseed oil is utilized in dietary fibre supplementation in the diet without causing over-texturization, when there is prominent concentration of fiber necessary to demonstrate health advantages (Qian et al., 2012). The flaxseed oil contains a significant amount of phospholipids and other lipid components which are important in structure especially in the cell membranes (L. Wang et al., 2006). Oil is main source of triacylglycerides and has an important role in the formation of oil bodies’ oleosin proteins linkage (Salas et al., 2006). Flaxseed oil has also the major part of lecithin that is the product separated while extracting the edible oil and is an important ingredient of various industrial diet formulæ (Song et al., 2005). There is a problem for the essential fatty acids which can be oxidized and hence the flaxseed oil has a very low shelf life (Tonon et al., 2011). Oxidative degradation of oil is mainly due to high content of alpha-linolenic acid (ALA) which results in quality deterioration component which makes it susceptible to oxidative degradation. It is observed that after extraction even after cold extraction that is done to avoid early chances of rancidity, flaxseed oil is mostly combined with vitamin E, saved in black glass jars and might not be used for cooking purposes (Łukaszewicz et al., 2004). There is a major role of antioxidants in controlling and decreasing rancidity of fat, the antioxidants can enhance the commercial worth of food products and they have advantageous impacts on the
human health. However, when they are consumed simultaneously along with essential unsaturated fatty acids might reduce the various disease risks (Romieu and Trenga, 2001). Flaxseed oil is a best substitute of fish oil hence reducing pressure of marine fish and aquaculture industry (Li et al., 2013).

Flaxseed oil is a good source of linolenic acid (LNA, n-3 C18:3) and linoleic acid (LA, n-6 C18:2) and is necessary in a balanced diet plan (Kuhn & Cunha, 2012). Alpha linolenic acid is well known for its positive effects in the treatment of obesity, kidney and skeletal disorders. DHA and EPA are modulators of calcium metabolism, inflammatory processes, eicosanoid production, osteoblastogenesis, and osteoclastogenesis hence they are responsible for good bone health especially in older adults by reducing bone resorption. By increasing Omega-3 FAs and decreasing Omega-6 FAs, FO improves plasma lipid profiles and other tissues. These results in the improvement of bone mineral density (BMD), bone mineral contents (BMC), bone turnover and bone strength (Kim & Ilich, 2011). Flaxseed oil is not recommended for frying and cooking operations it is because of its high content of polyunsaturated fatty acids. High quantity of PUFAs makes flax seed oil vulnerable to oxidation and decreases its life expectancy. It is widely used in food products such as salad dressings where the chances of oxidative deterioration are minimum (Aladedunye & Przybylski, 2013). Oil contains antioxidant and bioactive components too as described in Table 2. Derived substances from cinnamic and benzoic acid are called phenolic acids. Flaxseed is richest source of phenolic acids such as phenolic acids, lignins, phenylpropanoids, flavonoids and tannins. Flaxseed contains 8-10 g/kg phenolic acids from which etherified and esterified phenolics are 3-5 g/kg and 5 g/kg respectively. Various types of flavonoids such as flavanones, flavonols, flavones and anthocyanins are also present. It can possess 0.3-0.71 g/kg flavonoids depending upon growing practices. Plant phenolics protect from photo-oxidation and combat diseases (D. Kasote, 2012). Flaxseed oil is source of some most important phenolic acids such as vanillic and ferulic acid (Siger et al., 2008). Different phenolic compounds such as ferulic acidity and its methyl esters,  

### Table 1: A comparison of yellow and brown flax

<table>
<thead>
<tr>
<th>Constituents g/100g</th>
<th>Yellow flax</th>
<th>Brown flax</th>
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<tbody>
<tr>
<td>Protein contents</td>
<td>29.2</td>
<td>22.3</td>
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<tr>
<td>Oil content</td>
<td>43.6</td>
<td>44.4</td>
</tr>
<tr>
<td>Saturated fatty acids (SFA)</td>
<td>9.0</td>
<td>7.8</td>
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<tr>
<td>Monounsaturated fatty acids (MFA)</td>
<td>23.5</td>
<td>18.0</td>
</tr>
<tr>
<td>Linoleic acid</td>
<td>15.8</td>
<td>14.6</td>
</tr>
<tr>
<td>α-Linolenic acid</td>
<td>50.9</td>
<td>58.2</td>
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### Table 2: Antioxidant and bioactive components in flaxseed oil

<table>
<thead>
<tr>
<th>Compounds</th>
<th>Quantity in flaxseed oil</th>
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<tbody>
<tr>
<td>b-Carotene (mg/100 g)</td>
<td>0.06</td>
</tr>
<tr>
<td>g-Tocopherol (mg/100 g)</td>
<td>37.0</td>
</tr>
<tr>
<td>Chlorophyll content, as mg of pheophytin a/kg of oil</td>
<td>6.78</td>
</tr>
<tr>
<td>Total flavonoids, as luteolin equivalents (mg/100 g)</td>
<td>18.75</td>
</tr>
</tbody>
</table>

**Source:** Teh, S.-S. and Birch, J. (2013), "Physicochemical and quality characteristics of cold pressed hemp, flax and canola seed oils", *Journal of Food Composition and Analysis*, Vol. 30 No. pp. 26-

### Health Benefits of flaxseed oil:

Flax seed oil has become more popular in the world’s healthy food business because of its revealed advantageous and illness prevention effects on heart problems and different kinds of melanoma. Oil is well known due to its pleasing effects on neurons and hormones (Halevie Goldman, 2011). Focus is also on the effect of fat composition in the diet on energy demand for the body and weight balance (Field et al., 2007). Flaxseed oil is a good source of linolenic acid (LNA, n-3 C18:3) and linoleic acid (LA, n-6 C18:2) and is necessary in a balanced diet plan (Kuhn & Cunha, 2012). Alpha linolenic acid is well known for its positive effects in the treatment of obesity, kidney and skeletal disorders. DHA and EPA are modulators of calcium metabolism, inflammatory processes, eicosanoid production, osteoblastogenesis, and osteoclastogenesis hence they are responsible for good bone health especially in older adults by reducing bone resorption. By increasing Omega-3 FAs and decreasing Omega-6 FAs, FO improves plasma lipid profiles and other tissues. These results in the improvement of bone mineral density (BMD), bone mineral contents (BMC), bone turnover and bone strength (Kim & Ilich, 2011). Flaxseed oil is not recommended for frying and cooking operations it is because of its high content of polyunsaturated fatty acids. High quantity of PUFAs
Flaxseed also contains polysaccharide gums. These gums are hydrocolloid with excellent water-holding capacity which leads to great swelling potential, and in aqueous solutions they behave in viscous manner. A heterogeneous polysaccharide, flaxseed gum consists of sugar, xylose, galactose, arabinose, rhamnose, fructose and galacturonic acid (Chen et al., 2006). These gums are commercially applied as emulsifiers, thickeners, stabilizers or service provider contents in microencapsulation in the food processing industry and in food supply chains (Soma et al., 2009; Y. Wang et al., 2010). Distinguishing properties of flaxseed gums which make them most suitable components for food systems are emulsifying capability, great viscosity and stability (Thakur et al., 2009). Polysaccharides and proteins combinations are largely used in food and nutrition industry due to their specific characteristics of making good texture, stability, resistance and nutritional features of the products made (Chung et al., 2013). Flaxseed is a good source of soluble dietary fiber as well as insoluble type because it contains mucilage. Mucilage is mainly present in outermost covering of the seed. It easily delivered mucilage on soaking in water (Mueller et al., 2010). Flaxseed makes 8% of total flaxseed weight (Y. Wang et al., 2011). This gum has gained attention due to its advantageous effects on diabetes mellitus and coronary heart diseases. Flaxseed gum is a water soluble type dietary fiber, which is an effective gum in lowering cholesterol and blood sugar in a person suffering from diabetes patients and it is also considered to be advantageous in coronary heart diseases and various types of cancer (Rastogi, 2010).

**Flaxseed gums**

Flaxseed gum could be utilized as emulsifying agent and stabilizing agent as alternative for most of the non-gelling gums recently in used in manufacturing of food (Chen et al., 2006; Y. Wang et al., 2009). To fulfill the requirements of modern industry edible film and coating from flaxseed gum are prepared. An alternative to plastic material edible films could be used on large scale. They are ecofriendly and prevent carbon emission into environment. Shelf life of food material is increased by reducing the loss of water vapours, carbon dioxide, oxygen, and aroma from their outer surface by edible films (Ghanbarzadeh & Oromiehi, 2009; Mikkonen et al., 2007).

**Flaxseed lignins**

Phyto-oestrogens are chemically derived from plant precursors, having many classes of chemical compounds such as lignins, isoflavones and coumestans that are similar in structure as of endogenous oestrogens having both types of effects e.g anti-oestrogenic and oestrogen (Cederroth et al., 2010). The whole flaxseed (Linum usitatissimum L) and its derivatives like lignin extracts, flax fiber, defatted flax and ground flax has a wide range of applications and its use depend on our interest (Fischer et al., 2011). Lignins are present in plant cell walls. Flaxseed contains lignins in high concentration (>600 mg kg⁻¹) as compared to other plants and most commonly found fractions are idrossimataresinol (HYDMA), isolariciresinol (ISO), secoisolariciresinol diglucoside (SDG), lariciresinol (LARI), pinoresinol.
(PINO), matairesinol (MATA), and secoisolariciresinol (SECO). Chemically, they are diphenolic compounds of plants from higher rank which are formed by coupling of the two coniferyl alcohol residues present in cell wall of the plants. These are mostly observed in plants as glycosides, and are broken down into estrogen like compounds such as enterolactone, enterodiol and equol by intestinal microflora (Perretti et al., 2013). Among the grains and cereals flaxseed contains highest amounts of lignins present in it (D. Kasote, 2012). Lignins in most edible plants are the major source of edible phytoestrogens (Zamora-Ros et al., 2012). Flaxseed is a significant source of edible lignin especially secoisolariciresinol (SECO) in the form of secoisolariciresinol diglucoside (SDG) which is normally present in the plants (Ganorkar, P. M (Ganorkar & Jain, 2012). SDG was isolated with a yield of 3 per cent from defatted linseed meal extract Bakke and Klosterman in 1956 (D. Kasote, 2012). (SDG) is up to 13 mg/g flaxseed (Hall et al., 2006). Most important lignin (SDG) symbolizes around 976 g/kg of the complete lignins in flax seed (Liu et al., 2006). Fortification of SDG results in the reduction of macrophage infiltration, epithelial proliferation, cystic changes, interstitial fibrosis and oxidant injury. Liver damage is also prevented by SDG. It increases the level of γ-glutamyltranspeptidase (γGT) in the liver. It is also productive in the prevention of diabetes (Landete, 2012).

However the plant based lignins are different from the mammalian lignins because hydroxyl group is present at the meta position of the phenolic aromatic rings in the plants as compared to the presence of 3-methoxy-4-hydroxyl derivatives on the rings of parent molecules (Hu et al., 2007). The mammalian metabolites and the flaxseed lignins are investigated and it has been made clear that they have guarding effect against food related acute and chronic diseases through various processes involving antioxidant and phytoestrogenic potentials (Cederroth et al., 2010).

**Health benefits of lignins**

Biologically lignins are participating antioxidants that have reported to trim down the onset of diabetes and heart diseases. Moreover, they precludes the prostate and breast cancer. The end result revealed the significance in quantification in each of those aglycones and even unhydrolyzed glucosides to get the absolute lignin assessment (Popova et al., 2009). Phytoestrogens are noticeably associated with flaxseed. Phytoestrogens seem to have got further functions which could give rise to reduction regarding cancer malignancy chance, prevention of tyrosine kinase activity, retardation in impaired cell growth and also DNA activity. Cognitive capacity and longevity are well improved by phytoestrogen intake (Sumien et al., 2013). Phytoestrogens are used in improving few menopausal symptoms. Lignins have tendency to prevent atherosclerotic plaque deposition in the arteries and in the presence of high level of cholesterol it prevents the endothelium-dependent vascular relaxation (Landete, 2012). Estrogens are usually optimistic modulators of memory and learning (Sherwin and Henry, 2008). In women, age-connected cognitive decrease reaches minimum partly due to cessation associated with estrous cycling as well as decreasing estrogen amounts (Boulware et al., 2012). Chromosomal damage occurring in mice is prevented by flaxseed lignin, as it is among the better food sources (Trentin et al., 2004). The precise cause of that in vivo chromosomal damage has not known but that might be linked with the antioxidant potential of flaxseed fragments (Kangas et al., 2002). A preventive action on diseases such as diabetes, hypercholesterolemia and atherosclerosis can be seen by ENL, SECO, SDG, and ENL (Prasad et al., 2000). The antioxidant potential of monophenol can be raised by adding ortho hydroxyl radical to original monophenol as evident in the classical antioxidant mechanisms. Parent lignin has lower or different activity than few of the mammalian lignin metabolites. Flaxseed lignins promote the growth of skeletal muscle (Zhou et al., 2009). Enhance thyroid functioning, fertility rate, and reduce blood glucose level in postprandial conditions (Perretti et al., 2013).

**Antioxidant potential of flaxseed lignin**

Natural antioxidants are classified as chain breaking (primary) and preventive (secondary) antioxidants. Chain breaking antioxidants directly react with lipid radicals by converting them into stable products and preventive antioxidants act by lowering the oxidation rate by taking different pathways of action. Different assessment studies can be conducted to monitor the reduction of free radical formation, to observe efficient scavenging activity of lignins and to analyze the formation of oxidative products which are the ultimate results of the oxidative chain reactions (Decker et al., 2005). The flaxseed lignins has significant antioxidant potential, so they provide many health and nutritional estrogen antagonistic activity (Ganorkar and Jain, 2012). The flaxseed lignin when exposed to air, polyunsaturated fatty-acids are converted into hydro peroxides and cause the formation of degradation products. These products produce oxygen radical species that might result in irreversible damage while reacting with biological compounds like DNA, proteins and lipids (Choe and Min, 2006). Degeneration of human health by free radicals is very common in the world we reside in. Contaminants, radiations, drugs, metal ions, high intake of polyunsaturated essential fatty acids, mitochondrial disorders, smoking and strenuous
exercise are the main sources of free radicals that affect human health adversely. Membrane lipids, nucleic acids, proteins, and carbohydrates undergo harmful effects which can lead to eye diseases, cancer, premature aging, vascular diseases, neurological diseases, autoimmune illnesses, lung diseases, and diabetes (Lachance et al., 2001). Flaxseed lignins and metabolites exhibit protective effects against AAPH induced oxidation process specially in current literature (Hosseinian et al., 2007; Hu et al., 2007), emphasizes the importance of these plant and mammalian lignins in protecting against the effects of DPPH and AAPH peroxyl radical induced damage (Eklund et al., 2005).

Anticancer effects of lignins

On the basis of investigations performed, it has been evident that the lignins could be a significant part in the treatment of different types of cancers associated with human body. The existence of lignins in MCF-7 tumors and the evident lignin binding to ER suggests that the lignin efficiency may be ER-mediated (Saarinen et al., 2000). Moreover, they preclude the prostate and breast cancer (Popova et al., 2009). However, breast cancer can be prohibited by the lignins, overall activity can be changed by minor structural variations. So, many advantages must be the outcomes of particular structural properties necessary for lignins to bind to ER (Saarinen et al., 2005). Anticancer activity especially against prostate cancer is significant with the help of lignin (Kangas et al., 2002). Enterolactone, enterodiol and lignin are considered to be slightly accountable for the inhibition of the development of three cell lines of prostate cancer in humans (Corsini et al., 2010). Prostate cancer is controlled by feeding men 30g of flaxseed per day which cause decrease cancer cell prevalence and increase apoptosis indicated in a low level study (Demark-Wahnefried et al., 2001). A low fat diet has also a prominent effect on the studies as an important aspect. Those authors favors that the potential of flaxseed along with low fat diet in controlling prostate development (Cheetham and Katz, 2011). They also stated that cancer cell prevalence and specific antigen of prostate are decreased. In a cancer suffering mice, injecting 10mg/kg enterolactone three times each week by a subcutaneous injection retard the colon cancer (Touré and Xueming, 2010).

Conclusion

Whole flaxseed and its separated, purified and processed constituents are valuable substances of nutraceutical importance. It is a house of essential fatty acids, amino acids, proteins and all types of fat soluble vitamins. The effect of FS and its segregation is known on only a few diseases today. It is dire need of the hour to spread area of nutraceutical and pharmaceutical research regarding this tiny gift of nature. Whole flaxseed, meal, oil, hull oil, mucilage, gums and lignin require component oriented research efforts. Their applications will be wider than today if they would be focused.

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