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Review article on *Linum usitatissimum* L., bioactive compounds and its medicinal importance.

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A B S T R A C T: Flaxseed has recently gained much importance as a functional food ingredient for human nutrition as its consumption has been demonstrated to provide health benefits including decreasing risk of cardiovascular disease, cancer, particularly of the mammary, prostate gland and colon cancers, anti-inflammatory activity, decreasing rate of tumor growth, reducing serum cholesterol level, laxative effect, and alleviation of menopausal symptoms and osteoporosis (Muir and Westcott, 2003; Hemmings et al., 2004; Hosseinian et al., 2006; Toure and Xueming, 2010). In addition to these effects, flaxseed confers beneficial renal function, mediates bone health and exerts strong phytoestrogenic and therapeutic effect in reducing the risk of hormone related cancers.

Key words: Flaxseed, Functional- food, Cardiovascular, Anti-inflammatory, Laxative effect, Phytoestrogenic, Therapeutic effect

Contents

1. Introduction:

Taxonomy and Nomenclature

ScientificClassification

Kingdom: Plantae

Division : Magnoliophyta

Class : Magnoliopsida

Order: Malpighiales

Family: Linaceae

G**enus:** *Linum*

Species: *usitatissimum*

2. General Discription of Plant

Flax (*Linum usitatissimum* L.) is an annual plant belonging to the *Linaceae* family, widely distributed in the temperate climate zone. Flax (*Linum usitatissimum*) is a blue flowering crop that produces small, flat seeds that range in color from golden yellow to reddish brown. Flaxseed is commonly found as whole seed, ground seed (powder or meal), or flaxseed oil. The generic name —*Linum* means thread and the species name - *usitatissimum* given by Carl Linnaeus, means very useful. On the basis of selective breeding has led to development of *Linum usitatissimum* two varieties that are specialized as either oilseed or fibre types. The varities grown for fibre and oilseed types may be identified by their phenotypic traits. Most probably flax is originated in the Middle East or Indian regions.

Oilseed accession of *Linum* is generally shorter in height, highly branched and possess more seed bolls compared to the relatives cultivated for fibre production (Jhala and Hall, 2010). Linseed and fibre flax perform best in different regions. Linseed is mainly grown in climates with low moisture and more sunlight, which is characteristic of highland and subtropical regions (Cullis, 2007). Northern temperate regions with high air humidity and low temperature are ideal locations for fibre flax cultivation, indicating less drought tolerance of fibre flax (Bunting, 1951). The terms linseed and flax have particular meanings on the basis of their properties. In Europe, linseed refers to oilseed flax grown for industrial and nutritional uses while flax refers to the seed grown for fibre (linen) production.

Linseed is one of the most versatile and useful crops that have been grown for thousands of years. It is cultivated as a commercial or subsistence crop in over 30 countries. Flax seeds are used for industrial, food and feed purposes. Seeds are rich source of both non-edible and edible oil. The industrial oil is an important ingredient in the manufacture of paint, varnish and linoleum. Edible linseed oil is used for human consumption and contains alpha-linolenic acid (ALA), a polyunsaturated fatty acid that has nutritional and health benefits (Neil and Alister, 2003).

Medicinal benefits due to consumption of flaxseed are believed to be due to the presence of three important components found in flaxseeds, α-linolenic acid (ALA), lignans, and fiber. Flaxseed has been playing a major role in the field of diet and disease research due to its potential health benefits associated with high content of α-linolenic acid (ALA)(57%), which is an essential omega-3-fatty acid and also because of a major lignan, namely secoisolariciresinol diglucoside (SDG)(Nahida et.al.2018). The three most physiologically important omega-3 fatty acids are alpha-linolenic acid (ALA, 18:3), eicosapentaenoic acid (EPA, 22:5), and docosahexaenoic acid (DHA, 24:6). ALA is the precursor fatty acid of EPA and DHA. ALA is an essential fatty acid that cannot be synthesized by the body.

Flaxseed oil is rich in polyunsaturated fatty acid (73 % of total fatty acid), moderate in monounsaturated fat (18 %) and low amount of saturated fat (9 %). In addition, flaxseed is the seed with the highest (ALA) as alpha-linolenic acid, omega-3 fatty acid content, constitutes about 57%, whereas linoleic acid, an omega-6 fatty acid, constitutes about 16% of total fatty acids (Morris, 2001; Ramcharitar et al., 2005; Rubilar et al., 2010). In fact, the percent of fat as ALA in flaxseed oil is 5.5 times higher than the next highest sources, walnuts and canola oil.

3. Chemical Composition of Linseed (*Linum usitatissimum* L.)

Chemical constituents of flaxseed varies from 30-40% fat,20-28% dietary fibre, 4-8% moisture, 3-4% ash, and the oil contains vitamin A, B, D, E and minerals. Chemical composition may vary with genotype and environmental parameters (Coskuner & Karababa, 2007; Shim et al., 2014). Flaxseed is the richest source of the mammalian lignan precursor secoisolariciresinol diglucoside (SDG) with minor amount of pinoresinol and matairesinol (MAT).

4. Economic Importance of Flaxseed (*Linum usitatissimum* L.)

Mainly two basic available varieties of flaxseed are (1) brown, (2) yellow or golden. Both have equal numbers of short-chain ω-3 fatty acids and similar nutritional characteristics. The exception is a type of yellow flax called solin (trade name Linola), which has a completely different oil profile and is very low in ω-3 fatty acids (Dribnenki et al. 2007), which is enriched in linoleic acid (LA; 18:2*cis*Δ9, 12) and low in ALA content (<5%), has greater oxidative stability than regular flax. Second type of brown flax is better known as an ingredient in paints, varnish, fiber and cattle feed (Drouillard et al. 2000; Kozlowska et al. 2008; Singh et al. 2011; Faintuch et al. 2011).

5. Medicinal importance of *Linum usitatissimum* L. in terms of its bioactive compounds

Flaxseeds are available in the food market in various edible forms such as whole flaxseeds, roasted flaxseed, milled flaxseed and flax oil. Presence of plant bioactive substances such as oil, protein, dietary fiber, soluble polysaccharides, lignans, phenolic compounds, vitamins (A, B, D and E) and mineral (P, Mg, K, Na, Fe, Cu, Mn and Zn) in Flaxseed. According to its physicochemical composition, flaxseed is a multicomponent bioactive system. Due to presence of (ALA), Flaxseed oil is also recognized as a good source for the human diet. Fiber and lignans are other additional flax constituents (Czemplik and Szopa, 2009; Vaisey- Genser and Morris, 2003), may provide human health benefits. Reactive Oxygen species (ROS) formation is prevented by Lignan, thus effectively reducing atherosclerosis. Antioxidant activity of lignan is beneficial in the anticancer activity of flaxseed.SDG is converted to the lignans enterolactone and enterodiol in the colon by intestinal bacteria. Lignans have a very similar chemical structure to some of the therapies available for breast cancer, and recent research has focused on using lignans for cancer treatment and their role in cancer prevention.

6. Multicomponent bioactive system of *Linum usitatissimum* L.

In present scenario demand of flaxseed has new prospects because of the growing consumers' interest for functional food with health benefits. Raw material of flaxseed is potentially rich in biologically active compounds such as polyunsaturated fatty acids. PUFA is protective agent of the cardiovascular system. Antioxidative activity of lignans with anti-cancer properties (Tarpila et al., 2005). Functional food from flaxseed including oil, mucilage, and lignans are above all designed for the neutracetical markets (Oomah, 2003). To reduce the risk of cancer, bioactive components play an important role to interact with the immune response. Reduction of chronic inflammation or its downstream consequences may represent a key mechanism that can be reduced through antioxidant effects of signal transduction. Phytochemicals such as the Polyphenols**,** EGCG or curcumin, or isothiocyanates are some of the most potent immunomodulators. Threre are various kind of bioactive component present in *Linum usitatissimum* L. in form of fatty acid, Lignan (Polyphenol) and dietary fibre.

6.1. Fatty Acid: Genotypic and Environmental factors are two major parameters due to which oil content of flax varies. (Van Uden *et al.*, 1994; Oomah and Mazza, 1997). Accordig to (**Canadian Grain Commission, 2001**), the oil content in flaxseed has been reported to range from 38% to 45.6% (Van Uden *et al.*, 1994; Oomah and Mazza, 1997). Cotyledons contains (75%) of flaxseed oil while the endosperm and seed coat contain 22% of the oil (Dorrel, 1970). Oil in the cotyledons and endosperm are stored in the form of oleosomes, or cell bound microscopic oil droplets. High concentration of polyunsaturated fatty acids (PUFAs) distinguishing *Linum usitatissimum* L. from other oilseeds. ALA constitutes about 52%, whereas, linoleic acid (LA) about 16% of the total fatty acids. Other fatty acids present in the oil include oleic (20%), palmitic (6%), and stearic acids (4%) (Green, 1990). Linoleic acid (LA) and ALA are essential fatty acids of flaxseed due to their important physiological and biochemical functions within the human body. ALA is playing as a role of precursor or an intermediate in producing long chain omega-3 PUFAs (EPA and DHA), that are known to regulate immune function and inflammation in higher animals (Mantzioris *et al.*, 1994, 1995).

6.2. Lignan:

Plant lignans are phenolic compound formed by the union of two cinnamic acid residues commonly known as phytoestrogen. Lignans are ubiquitous within the plant kingdom and are present in almost all plants (Tarpila et al. 2005). Lignans act as both antioxidants and phytoestrogens. Phytoestrogens can have weak estrogen activity in animals and humans. Flax contains up to 800 times more lignans than other plant foods (Mazur et al. 1996; Westcott and Muir 1996). Lignan content in flaxseed is principally composed of secoisolariciresinol diglucoside (SDG) (294–700 mg/100 g), matairesinol (0.55 mg/100 g), lariciresinol (3.04 mg/100 g) and pinoresinol (3.32mg/100 g) (Tourre and Xueming 2010; Milder et al. 2005). Johnsson et al. (2000) reported SDG content in the range of 11.7 to 24.1 mg/g and 6.1 to 13.3 mg/g in defatted flaxseed flour and whole flaxseed, respectively. Besides lignans, other phenolic compounds found in flaxseed are p-coumaric acid and ferulic acid (Strandas et al. 2008).

Secoisolariciresinol diglucoside (SDG) is another bioactive compound of flax. Once ingested, SDG is converted in the colon into active mammalian lignans, enterodiol and entero-lactone, which have been shown to reduce growth of cancerous tumors, especially hormone-sensitive ones such as those of the (e.g. breast and prostate cancer). The beneficial effects of flax seed are mediated mainly by its mammalian lignans, the precursor SDG, which upon the action of colonic microflora is converted to mammalian lignans, enterolactone (EL) and enterodiol (ED), which are subsequently absorbed and undergo enterohepatic circulation (Borriello et al., 1985). Mammalian lignans are positively linked to several bioactivities including antiestrogenic, anticarcinogenic and antioxidant activities. Antioxidant activities of SDG and its mammalian lignan metabolites are stronger than vitamin E (Prasad, 2000). Therefore SDG content can be one of the most important indicators of potential health benefit of flax in addition to ω-3 fatty acids.SDG have shown promising effects in reducing growth of cancerous tumors, especially hormone-sensitive ones such as those of the breast, endometrium and prostate (Tham et al. 1998).

Antioxidant activity of flaxseed lignans, primarily as hydroxyl radical scavengers and ability to complex divalent transition metal cations (Kitts et al., 1999; Toure and Xu, 2010). It also shows structural similarity to 17-b-estradiol for estrogenic and antiestrogenic compounds (Adlercreutz et al., 1992). The behavior of the lignans depends on the biological levels of estradiol. At normal estradiol levels, the lignans act as estrogen antagonists, but in postmenopausal women (at low estradiol levels) they can act as weak estrogens therefore, inhibit hormone dependent cancers (Hutchins and Slavin, 2003).

6.3 Dietary fibers: Flaxseed is a rich source of dietary fiber. A variety of plant substances that are not easily digested by the enzymes responsible for digestion in humans is known as dietary fiber. Dietary fiber may help reduce the risk of heart disease, diabetes, colorectal cancer, obesity and inflammation when used in regular diet. Dietary fiber consisting of soluble and insoluble fibers. Insoluble fiber consists of cellulose, hemicellulose and lignin. Natural laxative effect of dietary fiber of flaxseed adds bulk to waste products in the gut and increases bile movement in the gastrointestinal tract. A gum like material composed of acidic and neutral polysaccharides associated with hull is flaxseed mucilage. The neutral fraction of flaxseed mucilage contains xylose (62.8%), whereas the acidic fraction of flaxseed mucilage is comprised mainly of rhamnose (54.5%) followed by galactose.

Dietary fiber content of flaxseed

Dietary Fiber Amount (g/100g)

1 Total Dietary 40

2 Soluble fiber 10

3 Insoluble fiber 30

Healthy female volunteers consumed 50 g ground, raw flaxseed/day for 4 weeks which provided 12-13% of energy intake (24-25 g/100 g total fat). Similar findings were observed in post menopausal women fed 40 g/day flaxseed fortification diet. Bread containing 25% flaxseed gave a glycemic response that was 28% lower than the control (no flaxseed) bread. Only 10 g of flaxseed in the daily diet increases the daily fiber intake by 1 g of soluble fiber and by 3 g of insoluble fiber. Insoluble fiber helps improve laxation and prevent constipation, mainly by increasing fecal bulk and reducing bowel transit time. On the other hand, water-soluble fiber helps in maintaining blood glucose levels and lowering the blood cholesterol levels.

7. Health benefits

7.1Cancer

Interest in research on the association between flaxseed ingestion and risk of cancer emerged when epidemiologic evidences suggested a beneficial relationship. Populations that ingested greater quantities of flaxseed tended to present lower rates of hormonal dependent cancers. It is believed that the association between ingestion of flaxseed and cancer is explained by the bioactivity of lignans. The effects of flaxseed and its bioactive compounds in relation to prevention or treatment of some cancer types are presented in experimental evidence in animals has shown anticarcinogenic effects of flaxseed or pure lignans in many types of cancer. Flaxseed oil inhibited the growth and development of tumors in the breast of laboratory animals. In fact, it has been demonstrated that lignans can modulate development of breast cancer in MCF-7 and MDA-MB-231

cell lines. Furthermore, expression of the estrogen receptor is modulated by lignan extracts from flaxseed in a concentration-dependent manner in MCF-7. Decrease of risk biomarkers for breast cancer in premenopausal women after administration of the plant lignan SDG has been observed and in ovariectomized mice receiving 10% flaxseed in their diet for 2 or 25 weeks. Despite acting as an inhibitor to the development of cancer, recent evidence has shown that lignan and flaxseed oil reduced the growth of tamoxifen treated tumors by mechanisms involving signaling pathways, suggesting their potential use to aid in chemotherapy of some cancer types.

The action of estrogens in the male reproductive system may confirm a protection factor for prostate cancer in humans. Therefore, flaxseed has been cited as a useful food in the strategy of dietary intervention to reduce risk and improve the prognostic of prostate cancer. Lignans presented antimitotic, antioxidant, and antiangiogenic effects, as well as actuating in the reduction of testosterone by means of inhibiting enzymes, which resulted in a decrease in tumor growth in studies with humans, animals, and cell cultures.

In summary, despite experimental evidence of the bioactivity of lignans in the progression of cancerous lesions, epidemiological results are controversial because the determinants of plasma enterolactone are very different between populations. Other factors may be involved in the protective mechanism, including the source of the lignans and synergic effects with other bioactive components contained in flaxseed. The treatment of human colon cancer with SDG or its metabolites, either isolated or combined, resulted in a decrease in the number of cancerous cells. Inhibition of cell growth by lignans and their metabolites appear to be mediated by apoptotic and cytostatic mechanisms. Rosa et al. (2010) demonstrated that the addition of flaxseed oil to the standard diet of Wistar rats diminished the adherence of lymphocytes in the intestinal mucus when compared to the addition of other oils. Because it contains elevated levels of dietary fibers, flaxseed may also offer protection against cancer, principally colon cancer. N-3 fatty acids in general, as well as EPA and DHA, may also be related to the reduced development of colon tumors induced in rats, where n-6 fatty acids exerted the opposite effect. Enhanced tumor-reducing effects were observed with flaxseed oil-trastuzumab interaction in breast cancer, suggesting the anti- carcinogenic effect of ALA by means of inhibiting enzyme activity adhered to the membrane of the cells. Various mechanisms are proposed for the action of flaxseed on reducing the risk of cancer. In general, the strongest evidences are related to the action of its bioactive compounds, diminishing proliferation and progression of tumors. From the current knowledge available, there are strong suggestions that the bioactivity of flaxseed for protection against cancer, especially breast cancer is attributed to the lignans.

7.2 Flaxseed and Hormonal Modulation

An additional benefit of lignans is hormonal modulation, causing a decrease in hot flashes which are characteristic of menopause. This is a result of the weak estrogenic activity of lignans. Lignans may reduce the level of free circulating testosterone and when bonded together are excreted in the bile, potentially reducing the risk of polycystic ovary syndrome in susceptible women, since this syndrome is associated to high levels of androgens. This therapeutic use has yet to be tested. Competition of lignans with estrogen for receptor sites causes dual effects. Considering that lignan possesses a weak hormonal action, during phases of life when there is a large production of estrogen, the chronic ingestion of flaxseed may exert an antiestrogenic production because it competes with estrogen for the same receptors.

By means of this mechanism, flaxseed may protect women with risk of cancer by decreasing hormonal signalization involved in the beginning of tumor development. Sturgeon et al. (2008) reported that flaxseed may modestly reduce levels of estrone, principally circulating estrogen during the postmenopause period in overweight and obese women. But the question arises as to whether this weak estrogenic action in women presenting no risk of cancer has some adverse effect.

O'Neil et al. showed that estrogenic activity or antiestrogenic activity of flaxseed, in the form of flour, is dependent on the tissue, exposure to estradiol, and duration of flaxseed utilization. The accumulation of lignans in tissues is also different between the genders, showing that there are many variables involved in the action of such compounds on the organism. Therefore, more studies on this subject are required to determine the beneficial effects, or even potential risk, of flaxseed.

The masculine reproductive system also is influenced by phytoestrogens present in the diet, being responsive to estrogens as a fetus until reaching adulthood as long as estrogen receptors are expressed and exposure to such hormones may result in abnormal development of the reproductive system. In rat embryos, estrogen receptors (ER-β and ER-α) were encountered in precursor cells of oocytes and spermatogonia, and in somatic cells, respectively. Neonatal exposure of rats to estrogens resulted in the reduction of the spermatic concentration, plasmatic testosterone, the number and function of sertoli cells, the distension of the rat testis and the epithelial height of the efferent duct, and increased apoptosis of germinative cells due to expression of gonadal testosterone, thus decreasing sperm production. Female Wistar rats were fed with diets containing low concentrations of phytoestrogens in the period prior to conception until weaning of the pups. After weaning, the male pups continued receiving this diet until reaching adulthood, at which time they began to receive a diet with high concentrations of phytoestrogens during 24 hours. The group that received high doses of phytoestrogens as adults presented higher spermcounts, decreased number of rounded and elongated spermatids, increased in seminiferous

tubules in the lumen, apoptosis of spermatocytes, and rounded spermatids. However, there was no decrease in the levels of testicular testosterone and plasmatic gonadotropin.The results suggested a negative effect of phytoestrogens on the independent spermatogenesis of the hypothalamus-pituitary-testicular axis. Ruhlen et al. (2008), however, observed an increase in the endogenous estradiol of pups whose mothers received low doses of phytoestrogens in the diet, when compared to those whose mothers received high doses. This caused adverse effects on the reproductive system, including the reduction in size of the testicles, epididymis, and seminal vesicle, and increase in size of the prostate. Females of the offspring presented precocious puberty and greater uterine responsiveness to estrogens. Lipids present in flaxseed may also exert influences on the spermatogenic process. Lipids are the principal components of sperm and changes in its composition may cause modifications in physiological events related to sperm production. Decrease in the n-6:n-3 fatty acid ratio promoted by the ingestion of flaxseed results in a rearrangement in the spermatic composition, positively affecting fluidity, which is increased, as well as the integrity and viability of the spermatozoids membrane associated to its fusion with the Oocytes and greater velocity, showing the positive effect of n-3 fatty acid.

A positive effect may also be attributed to the ingestion of antioxidants, including vitamin E and the phenolic compounds present in flaxseed, associated to greater sperm count and greater motor force of spermatozoa in men. Therefore, based on the results shown in studies with animals, it is concluded that the utilization of flaxseed in the diet must be performed with caution during gestation, since the exact effects that flaxseed phytoestrogens may cause on the male reproductive system are not known. Studies on humans are also necessary to increase understanding of the positive and negative effects of flaxseed on males related to the reproductive system and fertility.

7.3 Prostate Cancer: There are numerous reports on the potential tumour inhibiting influence of lignans. Furthermore, flaxseed has been shown to reduce total testosterone and free androgen index levels in men with prostate cancer. In addition to estrogenic activity, flaxseed can interfere with steroid metabolism and bioavailability, and also inhibit enzymes, such as tyrosine kinase and topoisomerase, which are crucial to cellular proliferation and hence may contribute to lower incidences of prostate cancer.

7.4 Hormone supplement in Sexual System-Female: Phytoestrogen

(Plant-derived compound), isoflavlones is one of the most important beneficial component of flaxseed that can mimic the human sex hormone estrogen with the potential to act like estrogen on bone tissue. (Miksicek RJ, 1994). It is useful in infertility, menstrual cramps, endometriosis and menopausal problems. Flaxseed Oil alleviates some cases of Pré-Menstrual Syndrome (PMS). Flax

seed Oil makes Pregnancy less event full, makes deliveries easier and produces healthier offspring. Some studies investigated that potential phytoestrogens isolated from flaxseed significantly stimulate estrogen production in MCF7 breast cancer cells. They also observed a down-regulation of ERβ receptor expression and down-regulation of PR expression in MCF7 cells after treatment.

7.5 Cardio-protective: Flaxseed oil is very important in the treatment of cardiac disorders and cholesterol. It acts as a blood thinning agent. Hence, it is useful in preventing and treating atherosclerosis (cholesterol and clot development in blood pipes of the heart).

It makes blood platelets less sticky due to the conversion of linseed oil's Alpha-linolenic - acid to Eicosapentaenoic Acid (EPA) and Series3 Prostaglandin's, which lowers elevated blood pressure and shows hypertensive effects. Although ALA is a precursor of EPA and DHA, it may have independent effects on blood pressure and blood lipids studies show a diet high in ALA reduces the risk of heart disease by lowering cholesterol and by preventing the buildup of harmful deposits in arteries. Epidemiologic and experimental data have provided evidence for a beneficial effect of omega-3 fatty acids in the prevention of Cardiovascular Disease. The American Heart Association released a scientific statement endorsing the use of omega-3 fatty acids in both primary and secondary prevention (Etherton PM, et al., 2002). Doses of 2–6 g/d omega-3 fatty acids appear capable of lowering plasma triglyceride levels and increasing HDL in contrast to LDL and cholesterol that remain constant or even decrease slightly (Mensink RP, et al., 1990).

7.6 Anti- inflammatory: Flaxseed oil shows anti-inflammatory properties in form of EPA (Simopoulos AP, 2004). The clinical significance of omega fatty acids lies primarily in the role they play in inflammatory events in the body. Indeed, the interplay between pro-inflammatory molecules derived from omega-6 fatty acid PUFAs and the anti- inflammatory actions of molecules derived from omega-3 PUFAs underlies significant cardiovascular benefits attributable to increasing ones consumption of omega-3 PUFAs while at the same time decreasing consumption of omega-6 PUFAs (Kapoor and Huang YS., 2006).

7.7 Hepato-protective : Flaxseed oil is the rich sources of omega 3-fatty acids and is so potent antioxidants. Raw and baked flaxseed products induce hypolipidemic, hypoglycemic and hypocholesterolaemia effects which may be attributed mainly to seed oil rich in alpha linolenic acid.

7.8 Musculoskeletal System: Muscle fatigue recovery time is shorten and healing of sprain could be accelerated by the application of Flaxseed oil. Symptoms of Rheumatoid Arthritis also alleviated

by the application of flaxseed Oil. Excessive bone turn-over is prevented by ALA (alpha-linoleic-acid), when consumption of foods rich in this omega-3 fatty acids in the diet. (Griel AE, et al., 2006).

7.9 Metabolism: The metabolism of Omega-3-fatty acid from **EPA, DHA** and **ALA** play important role in the production of the same eicosanoids (thromboxane, leukotrienes, prostaglandins), this metabolism is directed to its effect on chronic vascular disease. (Andrew P, et al., 2006).Flaxseed Oil increases the body's production of energy. Flaxseed Oil facilitates weight loss in persons afflicted with Obesity. Flax Seed Oil improves stamina (by increasing the production of Energy).

7.10 Prevention of some forms of cancer: Dietary fiber and omega-3 fats in the form of ALA of flaxseed can help reduce the risk of cancer. Furthermore, with the addition of flaxseed in regular diet, women newly diagnosed with breast cancer showed a slowing of tumour growth. Moreover it has been reported that Omega-3 fatty acids can modulate the expression of certain oncogenes. In general it contributes to the reduction of biochemical factors associated to cancer. (Kimura Y, 2001).

7.11 Diabetes Studies showed that linseed lowers blood glucose in healthy, young adults. The effect of flax in the diets of people with type 2 diabetes is currently being investigated, helps glucose control in diabetics. (Cunnane, 1993). In March 2007 edition of the journal of Atherosclerosis, Japanese men with unhealthy blood sugar levels were randomly assigned to receive 1800 mg daily of eicosapentaenoic acid (EPA) with the other half being a control group.

7.12 Bio-membrane composition: Omega-3 fatty acids are capable of altering cellular functions determined by physical characteristics of biomembranes, such as composition of phospholipids and cholesterol content (Galli C, et al., 1971).

7.13 Digestive System: Studies in older adults show eating linseed helps increase the frequency of bowel movements and relief from constipation. Linseed oil often improves the function of the liver.

7.14 Excretory system: Linseed Oil is useful in the treatment of some cases of Edema.

7.15 External Application: Local application of Linseed pastes is useful in healing wounds and abscesses faster. It promotes the health of hair and nails and has substances called lignans, which have a beneficial effect on the hormonal system of the body.

7.16 Brain health and Nervous System:

Flaxseed essential fatty acid helps in the transmission of nervous impulses. This makes flaxseed oil very useful for numbness and tingling as well as for preventing serious nerve ailments like Parkinson's and Alzheimer's disease. It is very useful in treating intelligence related disorders such as ADHD. Bipolar disorder, depression, menopausal symptoms. Linseed oil effectively treats some cases of depression, improves the mental Function of elderly people. Linseed oil is beneficial in the treatment of and often improves the symptoms of Multiple Sclerosis. This oil improves the behavior of Schizophrenics.

7.17 Memory

Higher levels of flaxseed nutritional as well as non-nutritional components like antioxidants in the form of ω-3 fatty acids i.e. ALA, docosahexaenoic acid (DHA) and dietary fibers i.e. lignans, in addition to reduction of body mass reduces levels of lipid peroxide in the hippocampus. Memory loss is very much associated with accumulation of lipid peroxide in the hippocampus of brain. Loss in spatial memory is very much associated with accumulation of lipid peroxide in the hippocampus. Studies on flax feed dam suggest that improvement in hippocampus ALA and DHA concentration results in reduction of spatial memory inhibitors thus increases learning ability of flaxseed feed dams. (Khan et.al.2017).

7.18 Antioxidant

A study was carried out to evaluate the antioxidant activity of secoisolariciresinol diglucoside (SDG), a plant lignan isolated from linseed. It is platelet activating receptor antagonists that would inhibit the production of oxygen radicals by polymorph nuclear leucocytes. The anti-oxidant activity of ethanolic extract of *Linum usitatissimum* EE-LU (100, 200, 300, 400 and 500 µg/ml) in an *In-vitro* model has been evaluated. The result indicated significant dose dependent inhibition against DPPH radical, reducing power, superoxide anion radical scavenging, hydroxyl radical scavenging, metal chelating and hydrogen peroxide scavenging by EE-LU and α-tocopherol.

7.19 Adverse Effects of Flaxseed Components

The presence of phytoestrogens with adverse health effects and toxic compounds in flaxseed cannot be neglected. Flaxseed contains the inhibitors: trypsin, *myo*-inositol phosphate, cadmium, and cyanogenic glycosides. Flaxseed possesses small quantities (13.3 mg/ g crude protein) of protease inhibitors, which are reduced to trace quantities after germination. It is known that trypsin inhibitors present in the diet have been known for decades to diminish growth in animals, since they decrease the digestion and consequent absorption of proteins by the inhibition of proteases. Protease inhibitors are thermolabile, given the increase in digestibility of flaxseed proteins in animals after thermal treatment.

8.Conclusions and Future Perspectives: Linseed (*Linum usitatissimum* L.) is very useful crop for potential isolation of novel bioactive compounds and these bioactive compounds are valuable substances of neutraceutical importance. Linseed, a store house of essential fatty acids, amino acids, proteins and all types of fat soluble vitamins. These bioactive compounds play a very vital role for health benefits and for the development of new drugs to improve health care in certain medical fields. It is the need of the present scenario to spread the neutraceutical and pharmaceutical research regarding the medical importance of *Linum usitatissimum* L. in terms of their anticancerous, antioxidant, anti-inflammatory, cardioprotective and hepatoprotective properties.

The health beneficial effects of SDG, the most predominant lignan in *Linum usitatissimum* L., where it can protect against several diseases, including cardiovascular diseases, cancer, diabetes, and mental stress, and affect the reproductive system. From the preceding review, it can be concluded that bioactive derivatives of Linseed (*Linum usitatissimum* L. are active against different type of cancers like breast, ovarian, liver colon and prostate cancers. On the basis of above mentioned qualities of Linseed, there is hope in the pharmaceutical industry, that even more powerful commercial drugs can be developed sooner, using Linum bioactive compounds, to effectively treat cancer and save human being.

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