
FLAXSEED (LINUMUSITATISSIMUM)

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INTRODUCTION

Flaxseed is one of the oldest cultivated oilseed crops and is widely used in pharmaceutical, nutraceutical, and functional food industries because of its rich nutritional and therapeutic properties. Flaxseed contains important bioactive constituents such as alpha-linolenic acid (ALA), lignans, dietary fiber, proteins, vitamins, and antioxidants, which contribute to its medicinal value.

In pharmaceutical formulations, flaxseed is incorporated into capsules, tablets, powders, granules, functional foods, syrups, and cosmetic preparations due to its anti-inflammatory, cardioprotective, antioxidant, laxative, and cholesterol-lowering activities. Flaxseed oil is particularly valued as a natural source of omega-3 fatty acids and is commonly marketed for cardiovascular and neurological health support.

Research studies have shown that regular consumption of flaxseed in controlled concentrations may help in the management of constipation, diabetes, obesity, hypertension, hyperlipidemia, and hormonal imbalance. Because of these health benefits, flaxseed-based products are increasingly marketed as nutraceutical and preventive healthcare formulations worldwide.

In recent years, the growing incidence of lifestyle-related disorders such as cardiovascular diseases, diabetes mellitus, obesity, hypertension, gastrointestinal disorders, and hormonal imbalance has increased the demand for natural therapeutic agents. Flaxseed has become an important component in this area because research studies suggest that regular consumption in appropriate concentrations may help reduce serum cholesterol, improve blood glucose control, support digestive health, decrease oxidative stress, and enhance overall well-being.

The pharmaceutical and nutraceutical industries have successfully incorporated flaxseed into a

variety of marketed formulations including soft gelatin capsules, tablets, powders, granules, sachets, syrups, functional foods, bakery products, protein supplements, and cosmetic preparations. Flaxseed oil capsules are widely marketed as omega-3 supplements for cardiovascular and neurological support, while flaxseed powder and fiber formulations are commonly used for bowel regulation and weight management. In cosmetic formulations, flaxseed mucilage and oil are utilized for skin hydration, anti-aging activity, and hair conditioning.

USES OF FLAX SEED IN PHARMACEUTICAL PRODUCTS

Flaxseed is widely used in the pharmaceutical industry because of its medicinal properties, stability, and compatibility with the human body. It functions both as an active ingredient and as an excipient in many pharmaceutical and healthcare products.

- **Cardiovascular:** Flaxseed oil capsules rich in ALA shown in RCTs to reduce serum triglycerides and CRP levels. Used for dyslipidemia adjunct therapy.
- **Women's Health:** SDG extract tablets (100 mg/day) demonstrated in clinical trials to reduce menopausal hot flash frequency by 50%+ via ER- β binding.
- **Gastrointestinal:** Mucilage powder acts as bulk laxative. Studies show 10g/day increases stool frequency in chronic constipation by forming viscous gel in colon.
- **Sustained-Release Excipient:** Flaxseed mucilage used as HPMC alternative in matrix tablets. Research shows 12% w/w concentration sustains metformin release for 12h.
- **Dermatology:** Topical linseed oil formulations reduce TEWL and erythema in eczema models due to ALA-mediated anti-inflammatory pathways.
- **Oncology Research:** SDG and enterolactone studied for antiproliferative effects in hormone-dependent cancer cell lines; used in preclinical capsules.
- **Antidiabetic:** Flaxseed fiber and SDG shown to improve glycemic control and insulin sensitivity in type-2 diabetes trials; used in adjunct nutraceuticals.

CONCENTRATION OF FLAXSEED IN PHARMACEUTICAL PRODUCTS

The concentration of flaxseed used in pharmaceutical formulations varies depending on the type of product, method of administration, and therapeutic purpose. It may act as an active ingredient, carrier oil, solvent, or excipient in different preparations.

Common Concentration Ranges

Pharmaceutical Product	Concentration of Flaxseed	Pharmaceutical Purpose
Flaxseed oil capsules	500-1400 mg/capsule	Omega-3 supplementation
Flaxseed powder	5-10 g/day	Laxative and digestive support
Tablets	500-1000 mg/tablet	Cholesterol management
Sachets	3-10 g/sachet	Fiber supplementation
Herbal syrups	5-10% extract	Immunity support
Cosmetic creams	2-5% oil or mucilage	Skin moisturizing effect

MARKET FORMULATION

Product Type	Example Marketed Formulations
Tablet formulation	Omega3 flaxseed tablets
Powder formulation	Raw flaxseed powder
Soft gelatin capsule	Naturemade flaxseed capsule
Sachets	Fiber supplements sachets
Syrups	Flaxseed herbal drink
Protein mixes	Flaxseed nutrition powder
Cosmetic formulation	Flaxseed hair gel and cream
Functional foods	Flaxseed biscuits
Nutritional supplements	dietary capsules and omega supplements
Herbal combination	Flaxseed with herbal extract

Harmful effects of Flax seed in Pharmaceutical Products with Concentration

Although flaxseed is used therapeutically for its ALA, lignans, and fiber, high concentrations can present safety risks. Key concerns include cyanogenic glycosides in raw seed, GI obstruction from excessive fiber without water, and drug interactions at elevated doses. Regulatory agencies have defined upper limits to guide safe pharmaceutical use.

Possible Harmful Effects According to Research studies

Research study	Harmful concentration reported	Observed Effects
National Center for Complementary and integrative health	High doses above normal dietary intake	Bloating, diarrhea, fullness and discomfort
European food and safety studies	Amount More than 40-50 g/day regularly	Increased exposure to cyanogenic Glycosides and possible toxicity
Human clinical dose trial (Edel et al., 2016)	Up to 40g/day Studied	Tolerated short term, but higher doses not recommended
Nutritional safety reviews	Excess flaxseed oil with Anticoagulant drugs	Increased bleeding tendency

Toxicological reviews	Raw or unripe flaxseed consumption	May contain toxic compounds causing adverse effects
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Literature Review

1. Kezimana et al. (2018)

Title: Secoisolariciresinol Diglucoside of Flaxseed and Its Metabolites: Biosynthesis and Potential for Nutraceuticals Detailed Summary:

This paper explained the pharmaceutical importance of flaxseed lignans, especially secoisolariciresinol diglucoside (SDG), which is the major lignan present in flaxseed. The study described how SDG is converted by intestinal bacteria into biologically active compounds such as enterodiol and enterolactone. These compounds possess antioxidant and estrogenic properties that help reduce oxidative stress and inflammation. The paper also highlighted the role of flaxseed lignans in preventing cardiovascular diseases, diabetes, and hormone-dependent cancers such as breast and prostate cancer. The study concluded that flaxseed lignans have strong nutraceutical and pharmaceutical potential.

2. Dzuor C.K.O, Taylor J.T, Acquah C. (2018)

Title: Bioprocessing of Functional Ingredients from Flaxseed

Detailed Summary:

This review discussed different techniques used to extract and process flaxseed bioactive compounds such as lignans, proteins, peptides, dietary fiber, and omega-3 fatty acids. Methods including fermentation, enzymatic hydrolysis, and solvent extraction were explained in detail. These techniques improve the stability, bioavailability, and therapeutic efficiency of flaxseed compounds. The paper also highlighted the antioxidant, anti-inflammatory, antihypertensive, and cholesterol-lowering effects of flaxseed components. It concluded that flaxseed is an important natural source for pharmaceutical and nutraceutical product development.

3. Yadav R.K, Singh M, Roy S. (2018)

Title: Modulation of Oxidative Stress Response by Flaxseed Oil: Role of Lipid Peroxidation and Underlying Mechanisms

Detailed Summary:

This study investigated the antioxidant effects of flaxseed oil, which is rich in alpha-linolenic acid (ALA), an important omega-3 fatty acid. The paper reported that flaxseed oil reduces oxidative stress by decreasing lipid peroxidation and increasing antioxidant enzyme activity. The study explained that oxidative stress is associated with chronic diseases such as

cardiovascular disorders, diabetes, inflammation, and neurodegenerative diseases. Flaxseed oil was found to protect cells and tissues from oxidative damage and improve cellular defense mechanisms. The study suggested that flaxseed oil may be useful in pharmaceutical formulations for managing oxidative stress-related disorders.

4. Ansari R, Zarshenas M, Mand D, Adabakhsh A.H. (2019)

Title: A Review on Pharmacological and Clinical Aspects of *Linum usitatissimum* L. Detailed

Summary:

This review highlighted the medicinal and clinical importance of flaxseed because of its rich content of lignans, omega-3 fatty acids, proteins, phenolic compounds, and dietary fiber. The paper discussed several pharmacological properties including antioxidant, anti-inflammatory, anticancer, antidiabetic, and cardioprotective activities. Flaxseed was also reported to help reduce serum cholesterol, regulate blood glucose levels, and improve digestive health.

Clinical studies mentioned in the papers showed beneficial effects in obesity management, hyperlipidemia, constipation, and menopausal symptoms. The review concluded that flaxseed is a valuable medicinal plant with significant pharmaceutical and nutraceutical applications.

5. De Silva S.F. and Alcorn J. (2019)

Title: Flaxseed Lignans as Important Dietary Polyphenols for Cancer Prevention and Treatment

Review Detailed Summary:

This paper focused on the role of flaxseed lignans in cancer prevention and treatment. The study explained that flaxseed lignans possess antioxidant, anti-estrogenic, antiproliferative, and anti-inflammatory properties. These lignans help regulate cellular signaling pathways involved in tumor growth and cancer progression. The review highlighted their beneficial effects against breast, prostate, colon, and ovarian cancers. The paper also discussed the supportive role of flaxseed lignans when combined with chemotherapy and hormonal therapy.

Experimental studies showed that flaxseed supplementation reduced tumor growth and slowed cancer progression. The review concluded that flaxseed lignans may act as natural pharmaceutical agents for cancer prevention and supportive treatment.

6. Karami N, and Akbari-Adgerani H. (2019)

Title: Bioactive Protein/Peptides of Flaxseed: A Review Detailed Summary:

This review discussed the pharmaceutical importance of flaxseed proteins and bioactive peptides produced after enzymatic hydrolysis. The paper reported several therapeutic activities including antioxidant, antihypertensive, antimicrobial, antidiabetic, and immunomodulatory effects. Flaxseed peptides were found to possess ACE inhibitory activity,

which may help reduce hypertension and cardiovascular risk. The review also explained that these peptides protect cells from oxidative damage by neutralizing free radicals. Different extraction and purification methods were discussed along with their pharmaceutical applications in functional foods and nutraceutical formulations. The study concluded that flaxseed peptides have promising applications in chronic disease management.

7. Rothwell J.A. and Scalbert A. (2019)

Title: Dietary Flaxseed as a Strategy for Improving Human Health Detailed Summary:

This paper reviewed the role of dietary flaxseed in improving human health and preventing chronic diseases. The study explained that flaxseed contains omega-3 fatty acids, lignans, dietary fiber, phenolic compounds, and high-quality proteins that contribute to its health benefits. The paper discussed how flaxseed consumption improves cardiovascular health by lowering cholesterol levels, reducing inflammation, and improving endothelial function. It also highlighted the antioxidant properties of flaxseed lignans and their role in reducing oxidative stress. The review suggested that flaxseed may help reduce the risk of obesity, diabetes, breast cancer, colon cancer, and cardiovascular diseases. The study concluded that regular flaxseed intake can improve overall health and act as a preventive nutritional strategy.

8. Hadi A., Askarpour Mand Miraghajani M. (2020)

Title: Effect of Flaxseed Supplementation on Lipid Profile: Systematic Review and Meta-analysis

Detailed Summary:

This meta-analysis evaluated the effects of flaxseed supplementation on lipid profiles using data from several randomized clinical trials. The study investigated the effects of whole flaxseed, flaxseed oil, and lignan extracts on total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides. The results showed that flaxseed supplementation significantly reduced total cholesterol and LDL cholesterol levels, especially in individuals with obesity, hyperlipidemia, and metabolic disorders. The paper explained that flaxseed fiber, omega-3 fatty acids, and lignans collectively improve lipid metabolism and cardiovascular health. The study concluded that flaxseed supplementation is beneficial for cardiovascular disease prevention and may be used as a supportive dietary and pharmaceutical strategy.

9. MueedA,ShibliS.(2022)**Title:FlaxseedBioactiveCompounds:ChemicalComposition,FunctionalProperties, Food Applications and Health Benefits-Related Gut Microbes****DetailedSummary:**

This review paper explained that flaxseed is rich in biologically active compounds including omega-3 fatty acids, lignans, proteins, peptides, mucilage, carbohydrates, and minerals. The researchersdescribedflaxseedasanimportantfunctionalfoodandpharmaceuticalingredient because of its antioxidant, anti-inflammatory, anticancer, cardioprotective, and antidiabetic properties.Thepaper alsohighlighted theroleofgut microbiotain metabolizingflaxseed lignansintobeneficialcompoundsthat supportdigestiveandimmunehealth.Researchers concluded that flaxseed has broad applications in nutraceuticals, pharmaceutical formulations,cosmetics,andfunctionalfoodsbecauseofitstherapeuticpotentialand nutritional value.

10. PuligundlaP,LimS.(2022)**Title:ADescriptiveReviewonNutraceuticalConstituents,Detoxification Methods and Potential Health Benefits of Flaxseed****DetailedSummary:**

Thisreviewfocusedonnutraceuticalcompoundspresentinflaxseedandmethodsusedto reducetoxicconstituents.Researchersexplainedthatflaxseedcontainsalpha-linolenicacid, lignans, proteins, fibers, vitamins, and minerals that contribute to health promotion. The paperdiscussedthebeneficialroleofflaxseedinreducingcardiovascular diseases, inflammation,diabetes,andcancerrisk.Theauthorsalsoemphasizedthatflaxseedcontains cyanogenic glycosides and antinutritional compounds which may become harmful when consumed excessively without proper processing. Different detoxification methods such as roasting, heating, and fermentation were described to improve safety and pharmaceutical applicability of flaxseed products.

11. PuligundlaP,LimS.(2022)**Title:AREviewofExtractionTechniquesandFoodApplicationsofFlaxseedMucilage”****Detailed Summary:**

Theresearchersreviewedextractionmethodsandpharmaceuticalapplicationsofflaxseed mucilage. Flaxseed mucilage was described as a natural polysaccharide with excellent viscosity, emulsifying, and stabilizing properties. The paper explained that mucilage has importantapplicationsincontrolleddrugdeliverysystems,pharmaceuticalhydrogels,edible coatings,andbiomaterials.Differentextractiontechniquesincludinghotwaterextraction and

enzymatic methods were discussed for improving yield and quality. Researchers concluded that flaxseed mucilage has strong commercial and pharmaceutical potential because of its biodegradability, biocompatibility, and non-toxic nature.

12. Ahmad I.Z, Shakil H. (2023)

Title: A Systematic Review on the Pharmacological Potential of *Linum usitatissimum* L. A Significant Nutraceutical Plan

Detailed Summary:

This systematic review explained the medicinal importance of flaxseed and its pharmacological activities. Researchers reported that flaxseed contains bioactive compounds such as omega-3 fatty acids, lignans, phenolic compounds, proteins, and dietary fibers that contribute to multiple therapeutic effects. The paper discussed antioxidant, anticancer, anti-inflammatory, antimicrobial, antidiabetic, antihypertensive, and hepatoprotective activities of flaxseed. Researchers also highlighted the use of flaxseed in nano-formulations, nutraceutical products, and pharmaceutical drug delivery systems. The study concluded that flaxseed is a promising natural therapeutic agent with wide applications in modern healthcare and pharmaceutical sciences.

13. Sangiorgio P, Errico S. (2023)

Title: Bioactive Lignans from Flaxseed: Biological Properties and Patented Recovery Technologies

Detailed Summary:

This review focused on flaxseed lignans, especially secoisolariciresinol diglucoside (SDG), and their pharmaceutical applications. Researchers explained that lignans possess antioxidant, anti-inflammatory, anticancer, estrogenic, antiviral, and cardioprotective activities. The paper also described patented technologies used for extraction and purification of lignans for industrial pharmaceutical production. Modern techniques such as ultrasound-assisted extraction and microwave-assisted extraction were discussed for improving recovery efficiency. Researchers concluded that flaxseed lignans have significant commercial value and therapeutic potential in pharmaceutical, nutraceutical, and cosmetic industries.

14. Hu Y, Meda V. (2024)

Title: A Review of Flaxseed Lignan and the Extraction and Refinement of Secoisolariciresinol Diglucoside

Detailed Summary:

This review paper focused on secoisolariciresinol diglucoside (SDG), the major lignan found in flaxseed. Researchers explained advanced extraction and purification methods used for

obtaining high-purity SDG from flaxseed. The study highlighted antioxidant, anti-inflammatory, estrogenic, anticancer, and cardioprotective properties of lignans. The authors also discussed industrial applications of flaxseed lignans in nutraceutical products and pharmaceutical formulations. Researchers concluded that SDG has strong therapeutic potential and can be used as an important natural bioactive compound in healthcare industries.

15. Hirekar S. et al. (2026)

Title: Review on The Multifunctional Role of Flaxseed (*Linum usitatissimum*) in

Pharmacotherapeutics: Bioactive Constituents and Clinical Evidence

Detailed Summary:

This review discussed the multifunctional pharmaceutical role of flaxseed and explained that flaxseed is rich in omega-3 fatty acids, lignans, dietary fibers, proteins, vitamins, and minerals. The researchers highlighted antioxidant, anti-inflammatory, cardioprotective, antidiabetic, anticancer, and antimicrobial activities of flaxseed bioactive compounds. The paper discussed clinical evidence supporting the use of flaxseed in cardiovascular diseases, obesity, diabetes mellitus, hormonal imbalance, and gastrointestinal disorders. Researchers also explained that flaxseed is increasingly used in nutraceutical products, omega-3 capsules, functional foods, and herbal pharmaceutical formulations because of its therapeutic efficacy and lower side effects compared to synthetic drugs. The review concluded that flaxseed has strong potential for future pharmaceutical and biomedical applications.

CONCLUSION

Flaxseed (*Linum usitatissimum*) has emerged as one of the most important plant-based functional ingredients in pharmaceutical and nutraceutical research because of its remarkable nutritional composition and therapeutic potential. The presence of biologically active compounds such as alpha-linolenic acid (ALA), lignans, dietary fiber, proteins, phenolic compounds, vitamins, and minerals makes flaxseed a valuable natural source for the prevention and management of several chronic diseases. Over the past decade, extensive scientific studies have demonstrated that flaxseed possesses antioxidant, anti-inflammatory, antidiabetic, anticancer, cardioprotective, antihypertensive, antimicrobial, and neuroprotective activities. These pharmacological properties have increased the importance of flaxseed in pharmaceutical sciences and healthcare industries.

The review of recent research studies clearly indicates that flaxseed and its bioactive constituents have wide applications in pharmaceutical formulations, functional foods, nutraceutical products, and biomedical technologies. Researchers have focused on the

extraction and purification of lignans, especially secoisolariciresinol diglucoside (SDG), because of their strong antioxidant and hormone-modulating properties. Similarly, flaxseed mucilage has attracted considerable attention as a biodegradable and biocompatible biomaterial useful in hydrogels, wound dressings, tissue engineering, and controlled drug delivery systems.

Advanced extraction technologies and bioinformatics approaches have further improved the understanding of the medicinal mechanisms and therapeutic potential of flaxseed.

Overall, flaxseed represents a promising natural therapeutic ingredient with broad pharmaceutical potential. Its multifunctional properties, natural origin, and increasing scientific support make it an important component for future pharmaceutical research, nutraceutical development, and preventive healthcare applications.

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