

## Review Article

## Bioactive Compound in De-fatted Flaxseed Meal: A Review

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**Abstract**

The most important and abundant source of various phenolic compounds such as lignin, tannins, flavonoids, phenylpropanoids, and phenolic acids is “Flaxseed”. Large scale study has been done for exhibiting phenolics of flaxseed as natural compounds of anti-oxidants. The main objective of this study is to draw attention to different phenolic acid types of compounds present in flaxseed. The abundant quantity of ALA (alpha-linolenic acid), lignans, and fibre make the importance of flaxseed a functional food. Lignin is suggested to have anti- carcinogenic properties. In animals and humans, the property of chemo-protection is seen because of the benefits provided by omega-3 and phytoestrogen of lignin. This study relates with the detailed benefits of flaxseed cake which is a by-product of the de-oiling process of flaxseed is a type that has been used for centuries. Greatly researched as an abundant source of protein i.e., 40% and also for the high number of bioactive compounds.

**Keywords:** Flaxseeds, lignins, phenolics, antioxidants, Flavinoids

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**Introduction**

Flaxseed (*Linum usitatissimum*) is an annual herb belongs to the family Linaceae that produces yellowish golden to reddish-brown seeds having highly crisp, nutty and pleasant flavour. Earlier it was cultivated for linen fibre but today it is grown mainly for its oil [1]. Canada exports the most flaxseed in the world as well as producer. Cultivation takes place predominantly in Madhya Pradesh, Maharashtra, Chhattisgarh, and Bihar in India. India is ranked first in terms of land area, accounting for 23.8 per cent of global land area, and third in terms of linseed production, accounting for 10.2 per cent of global production. Total phenolic acids present in flaxseed is 8-10 g/kg along with a good amount of minerals such as Ca, K, P and Mg [2]. It has also been reported that flaxseed is a prosperous source of lignin (secoisolariciresinol diglucoside) which is a phytoestrogen so it can be used as an alternative to hormone therapy by supplementing in people lives.

Flaxseed provides certain protection to different types of cancers like breast, endometrium, and prostate [3]. Flaxseed is utilized in the cereal industry as an additive in bread and pasta for improvising their nutritional quality. The fibre content in the flaxseed is used to treat constipation as well as helpful in removing toxins from the human body [4]. Evidence suggests that flaxseed's dietary fibre reduces the risk of heart disease, cardiovascular diseases, reduces the weight and deposition of fat in the body. Lignin provides our blood vessels protection against damage by inflammation [5].

**Health benefits of Flaxseed Cake**

The major components of flaxseeds are protein (22%), lipids (43%), and minerals (3%) which shows their nutritional benefits. The characterization of protein is met by the abundance of arginine, aspartic acid as well as glutamic acid [6]. After extracting the oil from flaxseed through screw pressing, the remaining flaxseed cake as a by-product can be used as an edible part. The lignin present in flaxseed cake such as secoisolariciresinol diglucoside has an enormous amount of health benefits [7]. Besides lignin in the flaxseed cake, it also contains fibre like cellulose and mucilage gums [8]. Flaxseed cake is free of gluten which can cause the flour mixture to have minimum gluten when using flaxseed cake as raw material. The health benefits provided by the flaxseed meal is as follows:

**Cardiovascular Health Benefits**

Alpha-in oleic acid present in flaxseed meals can help in protecting the blood vessels from the damage of inflammation. The dietary fibre content in the flaxseed even when it is grounded in powder form and incorporated in the muffins as well as other baked products have been seen to elevate the blood levels of ALA. There are two other flaxseed contains omega-3 fatty acids, which increases the stream of blood.

### ***Diabetes Prevention***

Food with a low glycemic index that contains soluble fibre has been seen to lower the resistance of insulin. Insulin maintains the plasma glucose homeostasis with the help of flaxseed's fibre as well as other fractions of flaxseed. It also causes a reduction in the response of postprandial blood glucose in humans.

### ***Breast Cancer***

As per the previous studies, flaxseed minimizes the tumor size in mammals and reduces the cell proliferation of the tumor and create a positive impact. On the stages of initiation of the tumor growth. Colon bacteria convert SDG into lignin of mammals which are enter diol (ED) and enterolactone (EL).

### ***Post-menopausal Benefits***

Flaxseed is found to have a positive influence on clinically trialed women who were above the age of fifty to have hormonal moderation.

## **Bioactive Compounds in Flax Cake**

### ***Lignin***

The amount of lignin varies widely in food products and the highest source being the flaxseed itself. Secoisolariciresinol diglucoside (SDG) is the existing lignin found in flaxseed, and Secoisolariciresinol is the aglycone of SDG (SECO). The first isolation of SDG was carried out by Bakke and Klosterman (1956). SDG has the chemical formula  $C_{32}H_{46}O_{16}$  and a molecular weight of 686.71. In defatted flaxseed powder, the quantity of SDG ranges from 6-29 g/kg. The amount of lignin differs according to the growing conditions of flaxseed. Apart from SDG other lignin present in the flaxseed include matairesinol, isolariciresinol, lariciresinol and pinoresinol [9,10] concluded that phytoestrogens, such as lignans, which behave as estrogen agonists or antagonists, have sparked interest due to their potential application in hormone replacement treatment and cancer prevention. It was also concluded that activity of gut bacteria on precursors like the plant lignan SDG produces mammalian lignans. Flaxseed lignans are natural antioxidants with potential health benefits, therefore they have antioxidant potential. The antioxidant properties of flaxseeds are better understood in this review, which shows that flaxseed lignans could be employed as natural antioxidants. More in vivo research is needed to determine the beneficial effects of lignans secoisolariciresinol and to determine whether there are any risks associated with probable overdosing.

### ***Phenolic Acids***

Cinnamic acid and benzoic form the derivatives of phenolic acid. Phenolic acids are mainly of two types i.e. Hydroxybenzoic acid and Hydroxycinnamic acid. It has been reported that total phenolic acids present in flaxseed are 8-10 g/kg, 5 g/kg for esterified phenolic acids, and 3-5 g/kg for etherified phenolic acids. The function they have played in society has been one of the driving forces behind analytical inquiries [11].

Foods' organoleptic qualities (flavor, astringency, and hardness) are influenced by phenolics. Furthermore, the concentration and profile of phenolic acids have been studied by the food sector acids, their impact on fruit maturation, and preventing enzymatic degradation browning, as well as their use as food preservatives. Their participation in food oxidation reactions complicates their analysis even more.

### ***Flavonoids***

General flavonoids present in flaxseed are anthocyanins, flavanols, flavones, flavanones and flavanones and flavanols. One kg of flaxseed contains about 0.3-0.71 g flavonoids. Another form of flavonoids in flaxseed is herbaceous 3, 7- O dimethyl ether, and kaempferol 3, 8-O-diglucopyranoside, 7-O-dimethyl ether 7- O diglucopyranoside is a kind of diglucopyranoside [12]. Flavonoids are powerful reactive oxygen species scavengers that battle pollution on a constant basis. Temperature extremes, drought, freezing injury to cell membranes, and anomalous salinity all benefit from these metabolites. Flavonoids act as signal molecules, causing them to take protective measures against pathogenic microbial attack. Flavonoids are responsible for the distinct hues of flowers and fruit, which are required for pollination and, as a result, fruit dispersal in various locations, assisting in reproduction. The importance of flavonoids in plant physiology is unrivalled, and additional research into their biosynthetic features may be required in order to better understand their production, mechanisms of action, and safety.

### ***Phenylpropanoid glucoside***

Naturally occurring phenolic compounds are phenylpropanoids that have a three-carbon side chain attached to an aromatic ring. [13] concluded that the quantities of cyanogenic glycosides in flaxseed do not appear to be high enough to have any biological effect. Cyanogenic glycosides and selenium toxicity interaction. Flaxseed has not been examined thoroughly enough to be used as a therapy for selenium toxicity. Although the presence of the vitamin B antagonist linatine in flaxseed has never been linked to toxicity in humans, substantial levels of flaxseed eating have been linked to signs of reduced vitamin B availability in pigs. It's unclear whether flaxseed consumption will cause vitamin B deficiency in people who have a vitamin B deficiency.

### ***Tannins***

Flaxseed's n-butanol fraction contains tannins with phenolic acid's glycosides [14].

Tannins are a natural chemical that can be found in a variety of forms, particularly in plants. The two main forms of tannins are condensed and hydrolyzable tannins, which can be found in barks, leaves, fruits, fruit shells, seeds, shoots, and stems. In addition, tannins have expanded their uses in supplement meals, medications, bio-based foams, 3D printing, and biomedical device development. All of the possibilities, however, require further research, which could open up new avenues for tannin applications. This effort will aid in overcoming/at the very least establishing criteria for research into advanced applications and the extraction of hardwood tannins in general. [15] All plants include phenolic compounds, which are well-known phytochemicals. Simple phenols, benzoic and cinnamic acids, coumarins, tannins, lignins, lignans, and flavonoids make up these compounds. Over the last 25 years, significant advances have been made in research focused on the extraction, identification, and quantification of phenolic compounds as medicinal and/or nutritional components. The most common method for extracting phenolics is organic solvent extraction. Total phenolics are detected using chemical processes, whereas individual phenolic compounds are identified and quantified using spectrophotometric and chromatographic techniques.

For accurate measurement of phenolics, sample preparation and removal of undesirable compounds are critical, but the extraction technique is the most significant factor in phenolic separation and recovery. As previously stated, the nature of the sample, particle size, solvent type, and extraction procedures used all have an impact on extraction.

Traditional methods for recovering phenolics from solid samples include Soxhlet, hot reflux extraction, and maceration. The Soxhlet and hot reflux procedures are typically carried out at 90°C for several hours, whereas maceration is carried out at room temperature over several days. These procedures are straightforward, involve minimal equipment, and yield acceptable phenolic extraction rates. Soxhlet extraction procedures were used to get the maximum overall phenolic content of Guava seed extract. The Soxhlet technique was used to extract phenolic components from seeds of three wild grapevines in another investigation. The Soxhlet technique was used to extract phenolic components from seeds of three wild grapevines in another investigation. While this method has many advantages, it also has a number of drawbacks, including the need to use large amounts of hazardous organic solvents, which are both environmental and health hazards; (2) long extraction times; and (3) interference with and degradation of targeted components due to both internal and external factors such as light, air, high temperatures, and enzymatic reactions.

## **Flaxseed Cake Total Phenols, Flavonoids, and Anti-Radical Activity**

### ***Exact preparation***

10 mL of 80 per cent methanol was used to extract the samples (0.5 g). After 30 minutes of sonication, The mixture was spun down in a centrifuge (15 min, 3500 rpm). The supernatant was removed and stored at 4°C after filtering with a syringe filter (0.45 µm).

### ***Total Phenols Evaluation***

Tadhani et al used to assess the total phenols content. The results were calculated using gallic acid equivalents (GAE) per gramme of material (dm).

### ***Total Flavonoid Evaluation***

The aluminium chloride colourimetric method was used to determine total flavonoids, as described by using a catechin standard curve, the results were expressed as mg of catechin equivalents (CAE) per gramme of material using a 510 nm absorbance measurement.

### ***Determination of Anti-Radical Activity Traditional***

Traditional assays can only give an estimate of the extracts' true antioxidant potential, so the free anti-radical activity of flaxseed cake, flour 0, and bread samples was determined using two different methods: the DPPH free radical method described by and a 2,2-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid antioxidant assay described by Tadhani et al (ABTS) For the DPPH assay, a Trolox standard curve in the range of 0–200 mol L<sup>-1</sup> was used, and 0.2–1.5 mM for the ABTS assay, The data was expressed in mmol Trolox equivalents (TE) per gramme of material.

### **Antioxidant potential of Flax-Phenols**

According to several research-based studies, Flaxseed is one of the most antioxidant-rich foods available. There have been certain “Experiments in vitro and in vivo to confirm the anti-oxidant capacity of flaxseed’s phenolic components. In the majority of flaxseed’s related studies, there has been a co-relation of phenolic content with flaxseed’s whole or some parts of the extract’s capacity of anti-oxidation effect. Studies of extract of methanol’s antioxidant activity of flaxseed in bleaching method of  $\beta$ -carotene. Various methods have been assessed for the extraction of in vitro antioxidant activity of ethanol from flaxseed, which are: Superoxide scavenging, hydroxyl radical scavenging, hydrogen peroxide scavenging, and metal chelating are all examples of DPPH radical scavenging [16].

[17] concluded that in the TGSO model, flaxseed extract, its alkaline hydrolysate, and SDG are unable to effectively block lipid autoxidation. In a  $\beta$ -carotene- linoleate emulsion system, both extracts operate as natural antioxidants. SECO had a higher level of activity than SDG. Flaxseed extract and hydrolysate can be utilized as natural antioxidants for meat, mayonnaise, and dressing due to antioxidant qualities in the emulsion system, extending shelf life.

### **Flax-Cake as a Functional Food**

Because of the presence of two major bioactive components in flaxseed cake: alpha- lignans, and dietary fibre, it is considered a functional food.

#### ***Lignans***

Plant lignans are found in abundance in flaxseed. Lignans are phytoestrogens found in Fiber-rich plants, cereals (wheat, barley, and oats), legumes (bean, lentil, soybean), vegetables (broccoli, garlic, asparagus, carrots), fruits, berries, tea, and alcoholic beverages are just a few examples. There are 75800 times more lignans in flaxseed than in cereal grains, lentils, or fava beans. Lignans can be found in seeds, legumes, cereals, vegetables, berries, seaweed, tea, and alcoholic beverages. The first plant lignans found in foods were secoisolariciresinol and matairesinol. Plant lignans such as pinoresinol and lariciresinol have just lately been discovered, but they contribute significantly to total dietary lignan consumption.

The interaction of two coniferyl alcohol residues found in higher plant cell walls produces lignans, which are phenolic compounds [18]. Secoisolariciresinol glycoside is the main lignan in flaxseed (SDG), which also contains a combination of matairesinol, pinoresinol, lariciresinol, and isolariciresinol. SDG levels in defatted flour range from 11.7 to 24.1 mg/g while whole flaxseed flour has SDG ranging from 6.1 to 13.3 mg/g. Lignans have antioxidant properties and may contribute to flaxseed's anticancer properties. However, a variety of elements could play a role in flaxseed's anticancer properties. The biological amount of estradiol influences the behaviour of lignans. When estradiol levels are normal, lignans act as an oestrogen.

#### ***Dietary Fiber (Mucilage or Gum)***

Dietary fibre is a term that refers to several plant compounds that are difficult to digest by the enzymes that aid digestion in humans (Eastwood and Passmore, 1983). Flaxseed meals can be found in a variety of forms, including crude, acid detergent, neutral detergent, and complete fibres (cellulose, lignin and hemicellulose). Fibre content ranges from 22 to 26 per cent, more than double that of high fibre beans. Between 20% and 25% of your daily fibre needs are met by a half-ounce of dry whole flaxseed. Flaxseed has a mixture of soluble and insoluble dietary fibres in a ratio of 20:80 to 40:60. The main insoluble fibre fractions are cellulose and lignin, while the soluble fibre fractions are mucilage gums. [19] Total fibre is the total of dietary fibre and fumigation fibre. Flaxseed mucilage, which is found in the flaxseed hull, is a gum-like substance made up of acidic and neutral polysaccharides. The neutral fraction of flaxseed includes 62.8 per cent xylose, while the acidic fraction contains mostly rhamnose (54.5 per cent) and then galactose.

## Conclusion and Future aspects

This paper acknowledges flaxseed cake as the main source of phenolic activity as an anti-oxidant. The current research reveals that phenolics are present in flaxseed and their antioxidant capacity. Antioxidants like BHT and Vitamin-E can be replaced through the anti-oxidants present in flaxseed like SDG, SECO, ED and EL. These flax anti-oxidants are somewhat alike or more powerful than other antioxidants and that is why these phenolic compounds can prove to be a great alternative in commercial products. The stability of oil can be attained through natural antioxidants like that of flaxseed lignans [20].

The lignin present in flaxseed cake can have enormous applications in the food and health industry as a stabilization of food products as well as in nutraceutical companies. Thus, there should be a proper investigation regarding the effectiveness and safety of these molecules for them to become exceptional natural compounds of antioxidants. Other phenolic compounds like flavonoids, phenolic acid, phenylpropanoids and tannins have positive effects on one's body and can be used in various supplements.

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