



E-ISSN: 2278-4136  
P-ISSN: 2349-8234  
JPP 2019; 8(3): 352-354  
Received: 28-03-2019  
Accepted: 30-04-2019

**Raghuwanshi VP**

MIT College of Food Technology,  
MIT Art, Design and Technology  
University, Loni- Kalbhor, Pune,  
Maharashtra, India

**Agrawal RS**

MIT College of Food Technology,  
MIT Art, Design and Technology  
University, Loni- Kalbhor, Pune,  
Maharashtra, India

**Mane KA**

MIT College of Food Technology,  
MIT Art, Design and Technology  
University, Loni- Kalbhor, Pune,  
Maharashtra, India

## Flaxseed as a functional food: A review

Raghuwanshi VP, Agrawal RS and Mane KA

**Abstract**

Flaxseed has recently gained attention as a functional food ingredient due to its rich potential health benefits associated with its biologically active components such as alpha-linolenic acid, lignans, and dietary fiber. Health benefits attributed to flaxseed include antioxidant, anti-diabetic, anticancer properties etc. As a functional food ingredient, flaxseed or flaxseed oil has been incorporated into baked foods, juices, milk and dairy products, muffins, dry pasta products, macaroni and meat products. The present review is an attempt to highlight the potential of flaxseed as functional food.

**Keywords:** Flaxseed, functional food, biologically active components, health benefits

**Introduction**

Flaxseed (*Linum usitatissimum*) also known as common flax or linseed belongs to the family Linaceae. In Indian languages it is also known as Alsi, Jawas, Aksebija. Flaxseed is one of the most important oilseed crops for food, feed, fiber and industrial purposes. Commercially, almost all parts of flaxseed plant are utilized directly or after processing. Flaxseed is crispy in texture and nutty in taste (Rubilar *et al.*, 2010) [12]. The latin name of flaxseed means "very useful" and it has two basic varieties: brown and yellow or golden. Both have similar nutritional characteristics and equal numbers of short-chain  $\omega$ -3 fatty acids. The exception is a type of yellow flaxseed called *solin* (trade name *Linola*), which has a completely different oil profile and is very low in  $\omega$ -3 fatty acids (Dribnenki *et al.*, 2007) [4].

Flaxseed is gaining importance in the world's food chain as a functional food due to growing interest of consumers for foods having more health benefits. Flaxseed has wonderful prospects as functional food due to its superb nutritional composition. The seeds are rich contents of  $\omega$ -3 fatty acid: alpha-linolenic acid (ALA), short chain polyunsaturated fatty acids (PUFA), soluble and insoluble fibers, phytoestrogenic lignans, proteins and an array of antioxidants. (Kajla *et al.*, 2015) [7]. Edible flaxseed products include the whole flaxseed, ground meal and extracted oil or mucilage. These products have been considered as nutritional additives in the preparation of a various food products such as baked cereal products, ready to eat cereals, fiber bars, salad toppings, meat extenders, bread, muffins and spaghetti (Singh *et al.*, 2011) [14].

**Flaxseed as Food****As Ingredient**

Flaxseed is utilized as a versatile ingredient in various types of food products. Flaxseed supplemented food products are gaining popularity because of its high content of polyunsaturated fatty acids, protein, soluble fiber and phytochemicals. Flaxseed can be used as whole, roasted or milled in batters, dough and other baked products. Flaxseed-water mixture acts as egg substitute in the diet of vegetarians especially in baked products pancakes, muffins and cookies. These baked products are slightly gummier and chewier, and have low loaf volume than normal. Flaxseed gum, prepares from flaxseed meal has many potential food and non-food applications (Kajla *et al.*, 2015) [7]. Flaxseed can be supplemented in bread and other goods such as cookies and muffins including gluten free products. The incorporation into bread results in an improved texture and crumb texture. Healthy functional snack foods such as high protein energy bars can also be prepared with flaxseed as ingredient (Chishty and Bissu, 2016) [2].

**Edible Oil**

Flaxseeds produce a vegetable oil known as flaxseed oil or linseed oil, which is one of the oldest commercial oils. Flaxseed oil is obtained by expeller pressing and sometimes followed by solvent extraction. For many years, flaxseed was used mainly in the manufacturing of drying oil, paints, coating, and printing inks etc (Choo *et al.*, 2007) [3]. But recently, there has been new beginning in the use of flaxseed oil for edible purposes owing to its nutraceutical

**Correspondence****Agrawal RS**

MIT College of Food Technology,  
MIT Art, Design and Technology  
University, Loni- Kalbhor, Pune,  
Maharashtra, India

values. Flaxseed contains high amount of alpha-linolenic acid and thus has multiple industrial applications. Plant breeders, food technologists and nutritionists are using conventional and molecular approaches for altering the fatty acid profile of flaxseed and create its competitive food market. In this respect, initiative was taken to reduce the alpha-linolenic acid of flaxseed oil, to less than 5%. Flax council has given the name solin for such cultivars containing less than 5% alpha-linolenic acid (Kajla *et al.*, 2015) [7].

### Nutritional composition of Flaxseed

According to its physico-chemical composition, flaxseed is a multicomponent system with bio-active plant substances such as oil, protein, dietary fiber, soluble polysaccharides, lignans, phenolic compounds, vitamins (A, C, F and E) and mineral (P, Mg, K, Na, Fe, Cu, Mn and Zn) (Bhatty, 1993) [1]. Flaxseed has potential health benefits besides the nutrition, due to mainly 3 reasons: first, due to its high content of  $\omega$ -3  $\alpha$ -linolenic acid; second, being rich in dietary soluble and insoluble fibers; and third, due to its high content of lignans,

acting as anti-oxidants and phytoestrogens. The chemical composition of flaxseed can vary with growing environment, genetics, method of analysis and processing conditions (Morris, 2007) [10].

### Omega-3-fatty acids

Alpha-linolenic acid is the main functional component of flaxseed. It serves as an exclusive source of omega-3 fatty acid in the vegetarian diets (Riediger *et al.* 2009) [11]. Of all lipids in flaxseed (approximately 30%), 55% are  $\alpha$ -linolenic acid (ALA), 17% linoleic acid (LA), 19% oleic acid, 3% stearic acid, and 5% palmitic acid, which provides an excellent n-6: n-3 fatty acid ratio of approximately 0.3:1 (Simopoulos, 2002) [13]. Fatty acid profiles of various oilseeds are reported in Table 1. It is evident from the data that flaxseed contains highest amount of linolenic acid followed by soybeans and mustard oil, while sunflower and safflower oils contain large amount of linoleic acid which may leads to various diseases.

**Table 1:** Fatty acid profile of various oilseeds

Fatty acid	Flaxseed	Mustard	Soyabean	Rice Bran	Corn	Sesame	Safflower	Olive	Sunflower
Saturated	10	8	15.7	21.3	14.8	15.7	9.1	15.3	12.8
Monounsaturated	18.5	62.4	24.2	42.4	28.1	40.1	13.9	73.8	22.4
Polyunsaturated	71.8	31.5	59.8	35.9	57.1	45.7	77.3	10	66
Linoleic acid (n6)	16.8	21.6	52.1	34.6	56.1	45.3	76.5	9.4	65.6
Linolenic acid (n3)	55	9.9	7.8	1.2	1	0.4	0.8	0.6	0.5
N6/n3	0.3	2.2	6.7	2	56	113	7.4	16	131

Dubois *et al.*, 2007 [5].

A large number of clinical studies have recognized the tremendous potential of n-3 polyunsaturated fatty acids in the prevention of coronary heart diseases, atherosclerosis, rheumatoid arthritis and asthma (Kremer, 2000) [8]. Flaxseed and its oil reduce the growth of tumors at the later stage of carcinogenesis. The role of flaxseed oil in tumors prevention is attributed to its high alpha-linolenic acid.

### Lignans

Flaxseed is considered as good source of plant lignans (Thompson *et al.*, 1996) [15]. Lignans are phytoestrogens that are abundantly available in fiber rich plants, cereals, legumes, vegetables, fruits and alcoholic beverages. Flaxseed contains about 75 to 800 times more lignans than cereal grains other legumes, fruits, vegetables or cereals (Mazur *et al.*, 2000) [9]. The major lignan in flaxseed is called Secoisolariciresinol diglucoside (SDG). Flaxseed lignan is also a source of useful biologically active components found in plant foods, such as phytochemicals, and it is considered a functional food.

### Protein

The average protein content of flaxseed varies from 20 to 30%, constituting approximately 80% globulins and 20% glutelin. Majority of the protein is concentrated in the cotyledons. (Hall *et al.*, 2006) [6]. The amino acid pattern of flaxseed protein is similar to that of soybean protein and contains no gluten, which is seen as one of the most nutritious of the plant proteins. Flaxseed protein is rich in arginine, aspartic acid and glutamic acid, while lysine is limiting. High cysteine and methionine contents improve the antioxidant levels, thus helps in reducing risk of cancer. The processing conditions, dehulling and defatting affect the protein content. Flaxseed protein is effective in lowering plasma cholesterol and triglycerides compared to casein protein and soya protein (Singh *et al.*, 2011) [14].

### Carbohydrate

Flaxseed contains less carbohydrate (sugars and starches), providing only 1 gram (g) per 100 g. Due to this, flaxseed contributes little to total carbohydrate intake. Flaxseed polysaccharides composed of two major fraction:- Neutral arabinoxylan (75%) and an acidic Rhamnagalacturonan (25%).

### Lipids

The lipid content of flaxseed varies from 37 to 45 g/100 g of the seed as reported by various scientists (Morris, 2007) [10]. Cotyledons are the major oil storage tissues, containing 75% of the seed oil. Flaxseed oil constitutes 98% triacylglycerol, phospholipids and 0.1% free fatty acids (Singh *et al.*, 2011) [14].

### Dietary Fiber

Flaxseeds serve as a good source of both soluble and insoluble dietary fiber. It contains 35–45% of fibre and two-third is insoluble and one third is soluble fiber. Insoluble fiber consists of cellulose, hemicellulose and lignin. Most of the soluble fiber of flaxseed appears to be the mucilage of seed coat. High water binding capacity of flaxseed is attributed due to the presence of polysaccharides in the seed coat (Morris, 2007) [10]. Flaxseed fibre plays an important role in lowering the blood glucose level.

### Minerals and vitamins

Flaxseed contains good source of minerals especially, phosphorus, magnesium, calcium and has low amount of sodium. It also contains small amounts of water-soluble and fat-soluble vitamins. Vitamin E is present as  $\gamma$ -tocopherol, amounting to 39.5 mg/100 g.  $\gamma$ -tocopherol acts as a antioxidant preventing fat from oxidation Vitamin C is absent in flaxseed (Morris, 2007) [10].

### Value added flaxseed based food products

A large number of nutritional attributes present in flaxseeds are attracting the health professionals and nutritionist to consider the flaxseed in the formulation of functional foods and in the choice of a healthy diet. Flaxseed is potentially utilized as a versatile ingredient in various types of food products. Flaxseed supplemented food products are gaining popularity due to its high content of polyunsaturated fatty acids, protein, soluble fiber and phytochemicals.

Flaxseed has been valued in bakery sector for preparation of baked food products like bread, cookies, muffins etc. Various studies have been carried out on the composite flour technology with special reference to improve the wheat flour quality by blending it with other flours. Flaxseed-water mixture serve as egg substitute in the diet of vegetarians especially in baked products pancakes, muffins and cookies. Flaxseed gum can be used for stabilization of emulsion in case of salad dressings.

### Conclusion

Flaxseed can contribute in improving the availability of healthy food choices, specifically with the improvement in nutrient profile of foods by reductions in the salt, sugar and saturated fat content; and by increasing the content of  $\omega$ -3 fatty acids and other bioactive compounds. Various research studies revealed that the flaxseed constituents provide disease preventive and therapeutic benefits. This encourages development of new branded healthy and functional foods using flaxseeds, oil and cakes.

### References

1. Bhatti RS. Further compositional analyses of flax: mucilage, trypsin inhibitors and hydrocyanic acid. *Journal of the American Oil Chemists Society*. 1993; 70:899-904.
2. Chishty S, Bissu M. Health benefits and nutritional value of flaxseed: a review, *Indian Journal of Applied Research*. 2016; 6(1):243-245.
3. Choo W, Birch J, Dufour JP. Physicochemical and quality characteristics of cold-pressed flaxseed oils. *Journal of Food Composition and Analysis*. 2007; 20:201-211.
4. Dribnenki JCP, McEachern SF, Chen Y, Green AG, Rashid KY. 2149 Solin (low linolenic flax) Canadian *Journal of Plant Science*. 2007; 87(2):297-299.
5. Dubois V, Breton S, Linder M, Fanni J, Parmentier M. Fatty acid profiles of 80 vegetable oils with regard to their nutritional potential. *European Journal of Lipid Science and Technology*. 2007; 109:710-732.
6. Hall C, Tulbek MC, Xu Y. Flaxseed. *Advances in Food and Nutrition Research*. 2006; 51:1-97.
7. Kajla P, Sharma A, Sood DA. Flaxseed: a potential functional food source, *Journal of Food Science and Technology*. 2015; 52(4):1857-1871.
8. Kremer JM. n-3 fatty acid supplements in rheumatoid arthritis, *American Journal of Clinical Nutrition*. 2000; 71:349-351.
9. Mazur W, Uehara M, Wahala K, Adlercreutz H. Phytoestrogen content of berries and plasma concentrations and urinary excretion of enterolactone after a single strawberry-meal in human subjects. *British Journal of Nutrition*. 2000; 83:381-387.
10. Morris DH. Flax- health and nutrition primer, 4th edition. Available from: [www.flaxcouncil.ca](http://www.flaxcouncil.ca) 2007
11. Riediger ND, Othman R, Fitz E, Pierce GN, Suh M, Moghadasian MH. Low n6:n3 fatty acid ratio, with fish

- or flaxseed oil, in high fat diet improves plasma lipids and beneficially alters tissue fatty acid composition in mice. *European Journal of Nutrition*. 2009; 47:153-160.
12. Rubilar M, Gutiérrez C, Verdugo M, Shene C, Sineiro J. Flaxseed as a source of functional ingredients. *Journal of Soil Science and Plant Nutrition*. 2010; 10:373-377.
13. Simopoulos AP. The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomedicine and Pharmacotherapy*. 2002; 56(8):365-379.
14. Singh KK, Mridula D, Rehal J, Barnwal P. Flaxseed: a potential source of food, feed and fiber. *Critical Reviews in Food Science and Nutrition*. 2011; 1:210-222.
15. Thompson LU, Rickard SE, Orcheson LJ, Seidl MM. Flaxseed and its lignan and its oil components reduce mammary tumor growth at a late stage of carcinogenesis. *Carcinogenesis*. 1996; 17:1373-1376.