

## Uses of Flax (*Linum usitatissimum*) After Harvest

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**Abstract:** Flax or flaxseed (*Linum usitatissimum*) is one of the oldest crop grown since the pre historic time of civilization. There is a great usefulness of seed, oil and fibre throughout the ages. Flaxseed or flax seed oil is very important for human nutrition because seed and oil of the flax are rich in lignans, fibres and Omega-3 fatty acids or Alpha-Linolenic Acid (ALA). These are an important essential fatty acid and maintain an appropriate balance of omega-3 fatty acid to omega-6 fatty acids. Lignans are benefit the heart, possess anti-cancer properties and it reduces growth of specific types of tumors. Row flax seeds contain the chemical hydrogen cyanide (HCN) or cyanogenicglucoside which can be toxic if consumed in large quantities. WHO gives to the flax seed, class of super star fast food. It is also used as edible oil in some part of country. Flaxseed cakes are very good manure and used as animal feed in throughout the country. The whole plant of flax has great economic value. The valuable fibre known as 'Linen' is obtained from the bark of its stem and traditionally used for bed sheets, underclothes and table linen.

**Keywords:** Flaxseed, flax fibre, medicinal use, industrial use.

### INTRODUCTION

Flax or flaxseed (*Linum usitatissimum*) is an important oldest food, fibre and as well oilseed crops in the world [9]. It is a member of the genus *linum* in the family *linaceae*. In India, it occupies a greater importance among oilseeds; owing to its various uses. It is believed that the center of origin of cultivated flax is the Middle East, although secondary diversity centers were identified in the Mediterranean basin, Ethiopia, Central Asia, and India [17, 18]. Flax is originated from Mediterranean region. It is commonly known as *Alsi* (Hindi), *Tisi* (Bengali), *AviseJinjalu* (Telugu), *Jawas* (Marathi), *Ali Vidai* (Tamil), *Agasi* (Kannada), *Pesi* (Oriya) and *CheruchanaVithu* (Malayalam). Flax is an erect annual plant growing to 10 -1.25 m tall, stem; slender, leaves; green, narrow, alternate, lanceolate,

flower; white, purple, blue, pink or red blossoms with five petals, fruit; round, dry capsule containing around 10 seeds.

In India the flax are cultivated for years exclusively for seed and vegetable oil known as flaxseed oil, which is one of the oldest commercial oil. The oil content of seed varies from 33-47%. The oil is used in manufacturing paints and varnishes, waterproof fabric, oilcloth and linoleum [4]. It is also used as edible oil in some part of country. Flaxseed cakes are very good manure and used as animal feed in throughout the country. The whole plant of flax has great economic value. The valuable fibre known as 'Linen' is obtained from the bark of its stem and traditionally used for bed sheets, underclothes and table linen. From ancient time, Flax seed are being used in extraction of oil and used in preparation of

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many medicines. In ayurvedas, flax seed is known as divine food. In 8<sup>th</sup> Century A.D. the king of France, Charles Magne was impressed from medicinal value of flax seed and he strictly passed a law for his subject to consumption of flax seed daily to keep healthy body and live long life. About 65 B.C. Hippocrates writes about using flax for the relief of abdominal pains. In the same era, Theophrastus recommends the use of flax mucilage as a cough remedy. About 15<sup>th</sup> Century A.D. Hildegard Von Bigen used flax meal in hot compresses for the treatment of both external and internal ailments. Mahatma Gandhi researched and studied on flax seeds and wrote about medicinal value of flax seed in a book "where flax seed will have use daily there will be a healthy society". Greeks and Roman were used seed of flax and corn by mixing together for making breads. The world famous Dr. Yohanawoodwiz were a great cancer scientist from Germany, she developed a technology for prevention of cancer from flaxseed oil, paneer, anti-cancerous fruit and vegetables. She gave treatment of all types of cancers by using flaxseed and paneer. She was selected for Noble prize seven times but she had not got due to controversy.

In the world flax growing countries are USSR, Belgium, Holland, China, Japan, Egypt, Australia, new Zealand, Kenya, Uganda, Ireland, Neatherland, England, Sweden, argentina, Eastern Europe, Poland, Rumania, Greece, Germany, Italy, France, Spain, Portugal, USA, Canada, Uruguay, Asia Minor, Afganistan, and small pocket of India. India is forth producer of flax seed after Canada and China (Table 1). In India flax is grown as oilseed flaxseed is grown all over country (Excepting Kerala), like Madhya Pradesh, Rajsthan, Bihar, Maharastra, Channai, Manipur, Tripura, Assam, Andaman and Nicobar Island, Uttar Pradesh, Himanchal Pradesh and Uttrakhand [5].

At present, India spends more than 6 crores of rupees annually for import of flax fibre from China, Canada, Belgium, Holland and France to meet indigenous demand particularly of our defence sector. There is therefore an urgent need to increase production and productivity of flax (as fiber and seed) grown in India to meet the needs of our industry and to save valuable foreign exchange.

**Table 1**  
**World top ten flax producer**

Sl. No.	Country	Production (metric tons)
1.	Canada	368,300
2.	China	350,000
3.	Russia	230,000
4.	India	147,000
5.	United Kingdom	71,000
6.	United States	70,890
7.	Ethiopia	65,420
8.	Kazakhstan	64,000
9.	Ukraine	51,100
10.	Argentina	32,170

Source: Sekhri S. (2011)

However, at present there is hardly any acreage under flax as fibre in India [3]. Only single variety for fiber namely, JRF-2 (Tiara) is released in the year 2015 by Sunnhemp Research Station (ICAR-CRIJAF), Pratapgarh, Uttar Pradesh, India. Flax is very much profitable crop. For the further development of Indian economy, flax have very much important role as oil and fibre. Flax seed can be used for manufacture of fabrics, flax oil extraction, paper industry, construction, pharmaceutical, motor industry and elsewhere and it can be play very much important role to lift the economy of our country.

## MATERIALS AND METHODS

The flax seeds were grown at Sunnhemp Research Station (ICAR-CRIJAF), Pratapgarh, Uttar Pradesh, India during the year 2010 -11 and 2011-12 in *rabi* season. The Research Station is located at latitude of 25° 34 N and longitude of 81° 19 E and at an

**Table 2**  
**Fatty Acid Composition of Flaxseed Oil (%)**

Sl. No.	Composition	% of total fatty acids
1.	Saturated fatty acids	9
2.	Monounsaturated	18
	Polyunsaturated fatty acids	
3.	Omega-3 fatty acids	57
4.	Omega-6 fatty acids	16

Source: Rex Newkirk (2015)

altitude of 137m above sea level. The soil of experimental field is sandy loam in texture. The soil reaction is slightly alkaline with pH 7.6. Different seed colour (Brown, dark brown, coffee and yellow) genotypes were sown for economic use of flax. Seeding rate was applied at the rate of 40 kg/ha whereas fertilizers doses were applied at the rate of N:60 kg/ha, P:40 kg/ha and K:40 kg/ha. Weeds were controlled by hand weeding once or as per need. Seeds are sown in rows with row-to-row spacing of 3 cm at 1 to 2 cm depth. Each genotype was grown in 20 row plots having row length of 4.5m. Crop was kept free from weed upto 45 days after date sowing through manual weeding. Two to three irrigations were applied at 15 to 25 days interval. The experiment was harvested in 120-125 days for seed. The observations were recorded at plant basis are plant height (cm), number of primary branches/plant and basal diameter (mm). Whereas days to first flower, days to 50% flower, days to maturity, and seed yield (g/plot) were taken on plot basis.

## RESULTS AND DISCUSSIONS

The flax seed are small, flat, oval, smooth, brown to yellow in colour, glossy appearance with mucilage and flax fibre is soft, lustrous, flexible and bright. Flaxseed are used in medicine, in industries and as animal meal.

### 1. Medicinal Uses of Flaxseed

Flaxseed has been consumed for centuries for its good flavour and for its nutritional properties. In recent years, as people have become more concerned about health, demand for flax in food and beverages, functional foods and dietary supplements has risen dramatically. Typically flaxseed contains between 42.66% fat, 28% dietary fibre, 21% protein, 4% ash, and 6% carbohydrates [11]. Flaxseed also contains antioxidants like lignan, lycopin, lutin and ziyaxanthin and as well as traces of Manganese, Silicon, Copper, Fluorine, Nickel, Cobalt, Iodine, Molybdenum and Chromium (Table 3).

Hundred gram flaxseed contains 35.0g oil, with low levels (approximately 13.66g) of saturated fat, moderate levels (7.527g) of monounsaturated fat, and high concentrations (28.73 g) of polyunsaturated fatty acids (PUFAs). The PUFA content

**Table 3**  
**Flax seed nutritional value**

Elements	Quantity
<i>Flax seed: 100 grams contains...</i>	
Flaxseed oil	35g
Energy	2,234 kJ (534 kcal)
Carbohydrates	28.88 g
Sugars	1.55 g
Dietary fiber	27.3 g
Fat	42.16 g
Saturated	3.663 g
Monounsaturated	7.527 g
Polyunsaturated	28.730 g
Omega-3	22.8 g
Omega-6	5.9g
Protein	18.29 g
<i>Vitamins</i>	
Thiamine (vit. B1)	1.644 mg (143%)
Riboflavin (vit. B2)	0.161 mg (13%)
Niacin (vit. B3)	3.08 mg (21%)
Pantothenic acid (B5)	0.985 mg (20%)
Vitamin B6	0.473 mg (36%)
Folate (B9)	0 µg (0%)
Vitamin C	0.6 mg (1%)
<i>Minerals</i>	
Calcium	255 mg (26%)
Iron	5.73 mg (44%)
Magnesium	392 mg (110%)
Phosphorus	642 mg (92%)
Potassium	813 mg (17%)
Zinc	4.34 mg (46%)
Antioxidants: Lignan, lycopin, lutin and ziyaxanthin	
Traces of Manganese, Silicon, Copper, Fluorine, Nickel, Cobalt,	
Iodine, Molybdenum, Chromium	

Source: USDA Nutrient Database

comprises about 16% omega-6 fatty acids, primarily as linoleic acid (LA), and 57% alpha-linolenic acid (ALA), an omega-3 fatty acid (Table 3). Both LA and ALA are essential fatty acids (EFAs) since they cannot be produced by the body and must come from the diet. ALA can be converted in the body to eicosapentaenoic acid (EPA) and docosahexaenoic

acid (DHA) [2, 7]. EPA and DHA are also found in marine oils, primarily in fish oil. Omega-3 fatty acids have been shown to have numerous health benefits including a reduction in inflammation, blood pressure and decreased blood triglyceride levels and incidence of coronary heart disease. Omega-3 fatty acids are a special class of lipids which have a double bond at the 3 carbon from the methyl end. The unsaturated oil in most plant sources is rich in fatty acids with the first double bond 6 carbons from the methyl end of the molecule (omega-6). EPA is a precursor to eicosanoids compounds produced by the body that exert hormone-like activity. These are involved in the mediation of inflammatory responses, production of pain and fever, blood pressure regulation, induction of blood clotting, control of reproductive functions and regulation of the sleep/wake cycle. Eicosanoids produced from omega-6 fatty acids tend to promote inflammation, increased blood pressure and blood clotting, whereas those produced from omega-3 fatty acids, especially EPA, do not.

DHA is also required for the normal growth and development of the fetus and infant. Traditionally, the primary source of omega-3 fatty acids in the diet was fatty fish but the amount consumed in Western cultures tends to be limited by availability and dietary preferences, so researchers have developed creative ways to incorporate the omega-3 ALA, EPA and DHA into foods. Flaxseed contains approximately 28% dietary fibre in a ratio of soluble to insoluble fibre between 2 :8 and 4 :6 [6]. Flaxseed is also rich in lignans, providing 75 to 8 times higher levels than other plant sources [16], phytoestrogens which have chemical structures similar to the human hormone estrogen that, despite being much weaker than human estrogens, can help balance hormone levels in the body. Lignans and other flax components also have antioxidant properties and hence, may reduce the activity of cell-damaging free radicals [1].

The major lignan in flax is seicoisolaricires in old iglucoside, commonly referred to as SDG. Once ingested, SDG is converted in the colon to enterodiol and enterolactone, which have shown promise in reducing growth of cancerous tumors, especially hormone-sensitive ones such as those of the breast, endometrium and prostate [15].

## 2. Industrial Uses of Flaxseed Oil

The principal use of oilseed flax in the past has been for its flaxseed oil which is used in paints and coatings and other industrial uses. Recently flaxseed oil has been used as a diluent in paints and coatings. Paints and coatings containing flaxseed oil still are the highest quality and most durable of products. Up until World War 1, flaxseed oil was the main vehicle available for protective coatings and other manufactured products. It can be used as a drying oil vehicle in paints, varnishes, lacquers, enamels, oil cloth, linoleum, oil clothing, tarpaulins and tenting, patent leather, textiles, printing inks, soap, shoe polish and other specialty items. Flaxseed oil is a drying oil, a vegetable oil which undergoes oxidation and forms a natural, plastic-like film. The reactivity of flaxseed oil can be improved by the addition of metal catalysts, called driers, which promote oxidation, and by partially pre-oxidizing the flaxseed oil through exposure to the air. Flaxseed oil has a comparatively slow curing rate, and has a tendency to soften paint films. As a diluent it cannot reduce volatile organic compound (VOC) levels to the degree required by proposed VOC regulations while still providing the desired film properties for many applications. Dilulin, a new flaxseed oil based reactive diluent manufactured by Cargill (Minneapolis, Minnesota), overcomes these problems. The use of modified other vegetable oils and petroleum products in place of flaxseed oil led to the reduced flax crop area [1].

## 3. Flaxseed Uses as Animal and Poultry Meal

Flaxseed meal is a byproduct of flaxseed after it is crushed for flaxseed oil. The product is used as a high-protein animal and poultry feed. Flaxseed meal has a unique combination of amino acids in the protein, which produces a glossy, healthy coat for animals. Because of this, horse breeders throughout the United States use flaxseed meal.

Flaxseed once ground or processed can be fed as an ingredient to poultry. So-called "Omega eggs" are being produced by two companies in the US and 11 companies in Canada [8]. "Omega eggs" contain increased amounts (3 mg/egg) of omega-3 fatty acids and decreased amounts of saturated fatty acids [12]. The increase in yolk polyunsaturated fatty acid

(PUFA) is accompanied by substantial decrease in saturated fatty acid, resulting in a healthy fat profile and more nutritional egg. Omega eggs have been consistently lower in cholesterol content from 21 mg/egg (Standard USDA egg level) to 18 mg/egg (Omega egg). Feeding flaxseed to laying hens increases the omega-3 fatty acid in the egg by 6 to 8 times, making one egg equal to 113 g (4 oz) of cold water fish as a source of the omega-3 fatty acids.

Several researchers have looked at the use of flaxseed in dairy cattle diets in an attempt to influence milk-fat composition. However, more research is needed before feeding flaxseed to dairy cattle will be a commercial reality. Researchers suggest that feeding flaxseed to breeding chickens and sows can increase the level of unsaturated fatty acids in the young chick and piglet. It is felt that these young animals may have tissue deficiencies in omega-3 fatty acids. Their health and livability may improve as a consequence of receiving more omega-3 fatty acids *via* their mothers. In the pet food industry, flaxseed is attracting attention from researchers. Feeding flaxseed may improve pet health in a similar manner as it does human health.

#### 4. Flax Use as Fibre

Flax fibre has low elasticity and is resistant to high temperature, moisture and mildew. It contains 8-9% cellulose and is valued for strength and durability as it is stronger than cotton, rayon or wool [3]. The fibre is as strong as ramie (Table 4). The scientific production technology of fibre extraction is given.

**Table 4**  
Ranking various textile fibres on the basis of physical characters

Characters	Ranks			
	First	Second	Third	Fourth
Durability	Ramie	Flax	Hemp	Jute
Tensile strength	Ramie	Hemp	Flax	Jute
Length of fibre cells	Ramie	Flax	Hemp	Jute
Cohesiveness	Flax	Hemp	Jute	Ramie
Fineness	Ramie	Flax	Hemp	Jute
Uniformity	Flax	Ramie	Hemp	Jute
Pliability	Flax	Ramie	Jute	Hemp
Colour	Ramie	Flax	Hemp	Jute

Source: Singh D.P. (1997)

#### Harvesting

The fibre crop matures in around 120-125 days. It is harvested before maturation of capsules. The optimum stage for harvesting is the time when two-third of the plant portion of the crop turns yellow and two-third leaves have fallen. The fibre degrades once the plant gets brown colour. Harvesting is done by pulling out the plants from the ground. Plants are tied in small bundles of 15-20 cm diameter for retting. Early harvesting may result in tender and fine fibre with low yield, while late harvesting may result in more yield but relatively poor quality of fibre.

#### RETTING

After harvesting retting is traditionally carried out by placing the bundles in water pond and keeping them dipped properly through heavy weight so that bundles can absorb the moisture. Bundles are kept side by side horizontally and immersed in water 20-25 cm deep with bamboo or stone or wooden logs. The retting process is completed within three days (72 hours). *Clostroridium* bacteria associated with the soil of stem help in early retting of bundles. After three days the bundles are washed thoroughly with fresh water. After washing, these bundles are kept on ground for sun drying.

#### Fibre Extraction

Flax fibre is extracted from the bast or skin of stem of the flax plant. The upper tender portions of retted plants are cut so those capsules are removed from plants. After that flax fibre is ready for scutching, which is a process in which the fibres get separated from stem. The scutching of fibre can be done by following two methods.

#### Manual Method

In this method the small bundle of dried stalk are beaten by hand mallet (mungri). This leads to splitting of wooden part of the stalk and fibre can be separate easily. But this method is used at small scale at farmer's house.

#### Mechanical Method

In this method the flax stalks go through the scutching machine developed by CRIJAF (ICAR), Barrackpore for extraction of flax fibre. The machine

is indigenously designed on the principle of passing a handful flax stalk through fluted rollers to break the woody core into straw and separate the fibre in a short time. The fibre is then worked through a comb for separating long fibres from short ones. The separated fibre strands are then rolled into bundles. Farmer can get yield 15-17q/ha as flax fibre from improved production technology.

## SUMMARY

In India flaxseed has been under cultivation from prehistoric times. There is no acreage under flaxtype varieties for fibre. Some efforts were made to grow flax in India in 19<sup>th</sup> century but its cultivation did not pick up. Although flax has many advantages as a fibre crop, its overwhelming disadvantage is the amount of labor, skilled and otherwise, required from sowing to harvest. Processing flax is an extremely labor-intensive process that can help in providing skilled and unskilled employment in the country. With the available technology, farmers can grow flax fibre successfully.

It is likely that the use and demand for oilseed flax will continue to increase and be utilized as a healthful food additive plus its use for animal feeding. New industrial uses of both the flaxseed oil and the fibers of oilseed flax also will increase the demand for this multi-use oilseed crop.

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