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Linseed oil

Linseed oil, also known as **flaxseed oil** or **flax oil** (in its edible form), is a colourless to yellowish oil obtained from the dried, ripened seeds of the flax plant (*Linum usitatissimum*). The oil is obtained by pressing, sometimes followed by solvent extraction. Linseed oil is a drying oil, meaning it can polymerize into a solid form. Owing to its polymer-forming properties, linseed oil can be used on its own or blended with combinations of other oils, resins or solvents as an impregnator, drying oil finish or varnish in wood finishing, as a pigment binder in oil paints, as a plasticizer and hardener in putty, and in the manufacture of linoleum. Linseed oil use has declined over the past several decades with increased availability of synthetic alkyd resins—which function similarly but resist yellowing.[1]

Flax, flax seeds, linseed oil, linseed cake

Linseed oil is an edible oil in demand as a dietary supplement, as a source of α-Linolenic acid, (an omega-3 fatty acid). In parts of Europe, it is traditionally eaten with potatoes and quark. It is regarded as a delicacy due to its hearty taste and ability to improve the bland flavour of quark.[2]

Contents

Structure and composition

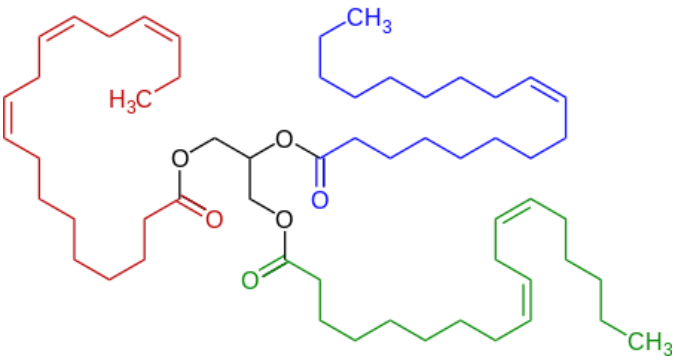
Linseed oil is a triglyceride, like other fats. Linseed oil is distinctive for its unusually large amount of α-linolenic acid, which has a distinctive reaction with oxygen in air. Specifically, the fatty acids in a typical linseed oil are of the following types:[3]

- The triply unsaturated α-linolenic acid (51.9–55.2%),
- The saturated acids palmitic acid (about 7%) and stearic acid (3.4–4.6%),
- The monounsaturated oleic acid (18.5–22.6%),
- The doubly unsaturated linoleic acid (14.2–17%).

Drying properties

Having a high content of di- and tri-unsaturated esters, linseed oil is particularly susceptible to polymerization reactions upon exposure to oxygen in air. This polymerization, which is called "drying", results in the rigidification of the material. To prevent premature drying, linseed oil-based products (oil paints, putty) are stored in airtight containers.

Rags soaked with linseed oil stored pose fire hazard because they provide a large surface area for rapid oxidation. The oxidation of linseed oil is exothermic, which may lead to spontaneous combustion.[4] In 1991, One Meridian Plaza, a high rise in Philadelphia, was severely damaged in a fire, in which three firefighters perished, thought to be caused by rags soaked with linseed oil.[5]



Representative triglyceride found in a linseed oil, a triester (triglyceride) derived of **linoleic acid**, **alpha-linolenic acid**, and **oleic acid**.

Applications

Most applications of linseed oil exploit its drying properties, i.e., the initial material is liquid or at least pliable and the aged material is rigid but not brittle. The water-repelling (hydrophobic) nature of the resulting hydrocarbon-based material is advantageous.

Paint binder

Linseed oil is the carrier used in oil paint. It can also be used as a painting medium, making oil paints more fluid, transparent and glossy. It is available in varieties such as cold-pressed, alkali-refined, sun-bleached, sun-thickened, and polymerised (stand oil). The introduction of linseed oil was a significant advance in the technology of oil painting.

"Your country needs flax .." U.S. WWII poster soliciting linseed oil for use in paint

Putty

Traditional glazing putty, consisting of a paste of chalk powder and linseed oil, is a sealant for glass windows that hardens within a few weeks of application and can then be painted over. The durability of putty is owed to the drying properties of linseed oil.

Wood finish

When used as a wood finish, linseed oil dries slowly and shrinks little upon hardening. Linseed oil does not cover the surface as varnish does, but soaks into the (visible and microscopic) pores, leaving a shiny but not glossy surface that shows off the grain of the wood. A linseed oil finish is easily scratched, and easily repaired. Only wax finishes are less protective. Liquid water penetrates a linseed oil finish in mere minutes, and water vapour bypasses it almost completely.[6] Garden furniture treated with linseed oil may develop mildew. Oiled wood may be yellowish and is likely to darken with age. Because it fills the pores, linseed oil partially protects wood from denting by compression.

Linseed oil is a traditional finish for firearm stocks, though very fine finish may require months to obtain. Several coats of linseed oil is the traditional protective coating for the raw willow wood of cricket bats; it is used so that the wood retains some moisture. New cricket bats are coated with linseed oil and knocked-in to perfection so that they last longer.[7] Linseed oil is also often used by billiards or pool cue-makers for cue shafts, as a lubricant/protectant for wooden recorders, and used in place of epoxy to seal modern wooden surfboards.

Additionally, a luthier may use linseed oil when reconditioning a guitar, mandolin, or other stringed instrument's fret board; lemon-scented mineral oil is commonly used for cleaning, then a light amount of linseed oil (or other drying oil) is applied to protect it from grime that might otherwise result in accelerated deterioration of the wood.

Gilding

Boiled linseed oil is used as sizing in traditional oil gilding to adhere sheets of gold leaf to a substrate (parchment, canvas, Armenian bole, etc.) It has a much longer working time than water-based size and gives a firm smooth surface which is adhesive enough in the first 12–24 hours after application to cause the gold to attach firmly to the intended surface.

Linoleum

Linseed oil is used to bind wood dust, cork particles, and related materials in the manufacture of the floor covering linoleum. After its invention in 1860 by Frederick Walton, linoleum, or 'lino' for short, was a common form of domestic and industrial floor covering from the 1870s until the 1970s when it was largely replaced by PVC ('vinyl') floor coverings.[8] However, since the 1990s, linoleum is returning to favor, being considered more environmentally sound than PVC.[9] Linoleum has given its name to the printmaking technique linocut, in which a relief design is cut into the smooth surface and then inked and used to print an image. The results are similar to those obtained by woodcut printing.

Nutritional supplement and food

Raw cold-pressed linseed oil – commonly known as flax seed oil in nutritional contexts – is easily oxidized, and rapidly becomes rancid, with an unpleasant odour, unless refrigerated. Linseed oil is not generally recommended for use in cooking. Alpha linolenic acid (ALA) while bound to flaxseed ALA can withstand temperatures up to 175 °C (350 °F) for two hours.[10]

Food-grade flaxseed oil is cold-pressed, obtained without solvent extraction, in the absence of oxygen, and marketed as edible flaxseed oil. Fresh, refrigerated and unprocessed, linseed oil is used as a nutritional supplement and is a traditional European ethnic food, highly regarded for its nutty flavor. Regular flaxseed oil contains between 57% and 71% polyunsaturated fats (alpha-linolenic acid, linoleic acid).[11] Plant breeders have developed flaxseed with both higher ALA (70%)[11] and very low ALA content (< 3%).[12] The USFDA granted generally recognized as safe (GRAS) status for high alpha linolenic flaxseed oil.[13]

Nutrient content

Typical fatty acid content	% [14]	% European[15]
Palmitic acid	6.0	4.0–6.0
Stearic acid	2.5	2.0–3.0
Arachidic acid	0.5	0–0.5
Palmitoleic acid	-	0–0.5
Oleic acid	19.0	10.0–22.0
Eicosenoic acid	-	0–0.6
Linoleic acid	24.1	12.0–18.0
Alpha-linolenic acid	47.4	56.0–71.0
Other	0.5	-

Nutrition information from the Flax Council of Canada.[16]

Per 1 tbsp (14 g)

- Calories: 126
- Total fat: 14 g
- Omega-3: 8 g
- Omega-6: 2 g
- Omega-9: 3 g

Flax seed oil contains no significant amounts of protein, carbohydrates or fibre.

Comparison to other vegetable oils

Properties of vegetable oils[17][18]

Type	Processing treatment[19]	Saturated fatty acids	Monounsaturated fatty acids		Polyunsaturated fatty acids				Smoke point
			Total[17]	Oleic acid (ω-9)	Total[17]	α-Linolenic acid (ω-3)	Linoleic acid (ω-6)	ω-6:3 ratio	
Almond oil									
Avocado[20]		11.6	70.6	52-66[21]	13.5	1	12.5	12.5:1	250 °C (482 °F)[22]
Brazil nut[23]		24.8	32.7	31.3	42.0	0.1	41.9	419:1	208 °C (406 °F)[24]
Canola[25]		7.4	63.3	61.8	28.1	9.1	18.6	2:1	238 °C (460 °F)[24]
Cashew oil									
Chia seeds									
Cocoa butter oil									
Coconut[26]		82.5	6.3	6	1.7				175 °C (347 °F)[24]
Corn[27]		12.9	27.6	27.3	54.7	1	58	58:1	232 °C (450 °F)[28]
Cottonseed[29]		25.9	17.8	19	51.9	1	54	54:1	216 °C (420 °F)[28]
Flaxseed/Linseed[30]		9.0	18.4	18	67.8	53	13	0.2:1	107 °C (225 °F)
Grape seed		10.5	14.3	14.3	74.7	-	74.7	very high	216 °C (421 °F)[31]
Hemp seed[32]		7.0	9.0	9.0	82.0	22.0	54.0	2.5:1	166 °C (330 °F)[33]
Vigna mungo									
Mustard oil									
Olive[34]		13.8	73.0	71.3	10.5	0.7	9.8	14:1	193 °C (380 °F)[24]
Palm[35]		49.3	37.0	40	9.3	0.2	9.1	45.5:1	235 °C (455 °F)
Peanut[36]		20.3	48.1	46.5	31.5	0	31.4	very high	232 °C (450 °F)[28]
Pecan oil									
Perilla oil									
Rice bran oil									
Safflower[37]		7.5	75.2	75.2	12.8	0	12.8	very high	212 °C (414 °F)[24]
Sesame[38]	?	14.2	39.7	39.3	41.7	0.3	41.3	138:1	
Soybean[39]	Partially hydrogenated	14.9	43.0	42.5	37.6	2.6	34.9	13.4:1	
Soybean[40]		15.6	22.8	22.6	57.7	7	51	7.3:1	238 °C (460 °F)[28]
Walnut oil									
Sunflower (standard)[41]		10.3	19.5	19.5	65.7	0	65.7	very high	227 °C (440 °F)[28]
Sunflower (< 60% linoleic)[42]		10.1	45.4	45.3	40.1	0.2	39.8	199:1	
Sunflower (> 70% oleic)[43]		9.9	83.7	82.6	3.8	0.2	3.6	18:1	232 °C (450 °F)[44]

Type	Processing treatment[19]	Saturated fatty acids	Monounsaturated fatty acids		Polyunsaturated fatty acids				Smoke point
			Total[17]	Oleic acid (ω-9)	Total[17]	α-Linolenic acid (ω-3)	Linoleic acid (ω-6)	ω-6:3 ratio	
Cottonseed[45]	Hydrogenated	93.6	1.5		0.6	0.2	0.3	1.5:1	
Palm[46]	Hydrogenated	88.2	5.7		0				
The nutritional values are expressed as percent (%) by weight of total fat.									

Additional uses

- Animal care products
- Bicycle maintenance as a thread fixative, rust inhibitor and lubricant
- Composition ornament for moulded decoration
- Earthen floors
- Animal feeds
- Industrial lubricant
- Leather treatment
- Oilcloth
- Particle detectors[47]
- Textiles
- Wood preservation (including as an active ingredient of Danish oil)
- Cookware seasoning

Modified linseed oils

Stand oil

Stand oil is generated by heating linseed oil near 300 °C for a few days in the complete absence of air. Under these conditions, the polyunsaturated fatty esters convert to conjugated dienes, which then undergo Diels-Alder reactions, leading to crosslinking. The product, which is highly viscous, gives highly uniform coatings that "dry" to more elastic coatings than linseed oil itself. Soybean oil can be treated similarly, but converts more slowly. On the other hand, tung oil converts very quickly, being complete in minutes at 260 °C. Coatings prepared from stand oils are less prone to yellowing than are coatings derived from the parent oils.[48]

Boiled linseed oil

Boiled linseed oil is a combination of raw linseed oil, stand oil (see above), and metallic oil drying agents (catalysts to accelerate drying).[48] In the Medieval era, linseed oil was boiled with lead oxide (litharge) to give a product called boiled linseed oil.[49] The lead oxide forms lead "soaps" (lead oxide is alkaline) which promotes hardening (polymerisation) of linseed oil by reaction with atmospheric oxygen. Heating shortens its drying time.

Raw linseed oil

Raw linseed oil is the base oil, unprocessed and without driers or thinners. It is mostly used as a feedstock for making a boiled oil. It does not cure sufficiently well or quickly to be regarded as a drying oil.[50] Raw linseed is sometimes used for oiling cricket bats to increase surface friction for better ball control.[51] It was also used to treat leather flat belt drives to reduce slipping.

See also

- Danish oil
- Flax seed

- National Linseed Oil Trust
- Smoke point

Notes

Further reading

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