

# Castor oil



Castor beans.



Castor oil in the light keeper's house at Split Rock Lighthouse in Minnesota.

**Castor oil** is a vegetable oil obtained by pressing the seeds of the castor oil plant (*Ricinus communis*).<sup>[1]</sup> The common name “castor oil”, from which the plant gets its name, probably comes from its use as a replacement for castoreum, a perfume base made from the dried perineal

glands of the beaver (*castor* in Latin).<sup>[2]</sup>

Castor oil is a colorless to very pale yellow liquid with a distinct taste and odor once first ingested. Its boiling point is 313 °C (595 °F) and its density is 961 kg/m<sup>3</sup>.<sup>[3]</sup> It is a triglyceride in which approximately 90 percent of fatty acid chains are ricinoleate. Oleate and linoleates are the other significant components.

Castor oil and its derivatives are used in the manufacturing of soaps, lubricants, hydraulic and brake fluids, paints, dyes, coatings, inks, cold resistant plastics, waxes and polishes, nylon, pharmaceuticals and perfumes.<sup>[4]</sup>

## 1 Composition

Castor oil is famous as a source of ricinoleic acid, a monounsaturated, 18-carbon fatty acid. Among fatty acids, ricinoleic acid is unusual in that it has a hydroxyl functional group on the 12th carbon. This functional group causes ricinoleic acid (and castor oil) to be more polar than most fats. The chemical reactivity of the alcohol group also allows chemical derivatization that is not possible with most other seed oils. Because of its ricinoleic acid content, castor oil is a valuable chemical in feedstocks, commanding a higher price than other seed oils. As an example, in July 2007, Indian castor oil sold for about US\$0.90 per kilogram (US\$0.41 per pound)<sup>[5]</sup> whereas U.S. soybean, sunflower and canola oilseeds sold for about US\$0.30 per kilogram (US\$0.14 per pound).<sup>[6]</sup>

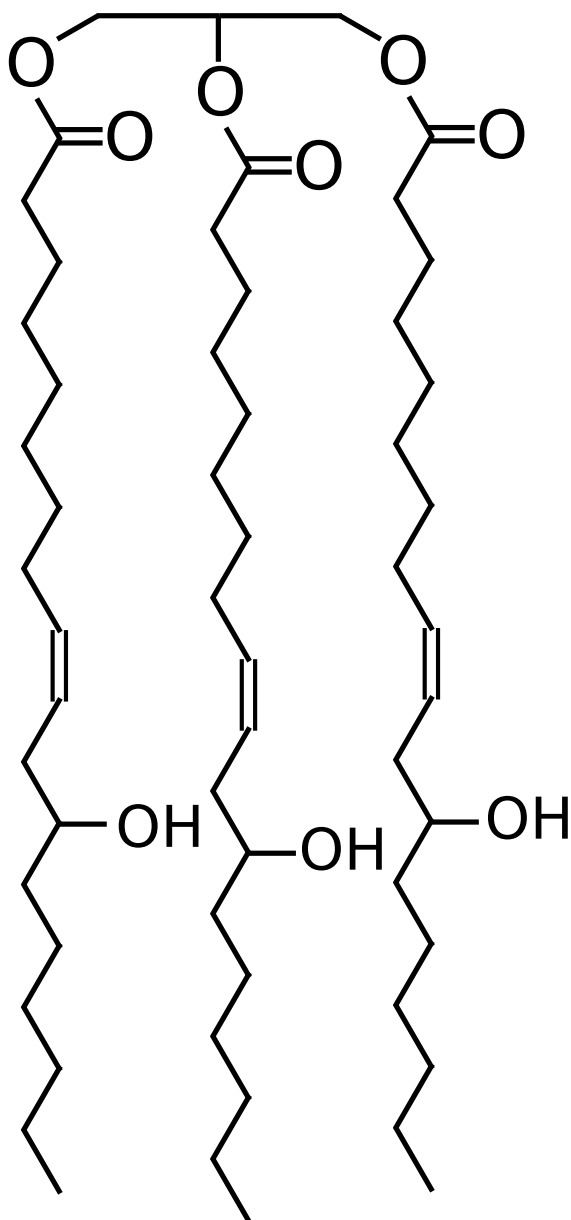
## 2 Uses

Annually 270,000–360,000 tonnes (600–800 million pounds) of castor oil are produced for a variety of uses.<sup>[4]</sup>

### 2.1 Food and preservative

In the food industry, castor oil (food grade) is used in food additives,<sup>[7]</sup> flavorings, candy (*e.g.*, polyglycerol polyricinoleate or PGPR in chocolate),<sup>[8]</sup> as a mold inhibitor, and in packaging. Polyoxyethylated castor oil (*e.g.*, Kolliphor EL)<sup>[9]</sup> is also used in the food industries.<sup>[10]</sup>

In India, Pakistan, Nepal and Bangladesh, food grains are preserved by applying castor oil. It stops rice, wheat, and pulses from rotting. For example the legume toor dal is commonly available coated in oil for extended storage.



Structure of the major component of castor oil.

## 2.2 Medicine

The United States Food and Drug Administration (FDA) has categorized castor oil as "generally recognized as safe and effective" (GRASE) for over-the-counter use as a laxative with its major site of action the small intestine where it is digested into ricinoleic acid.<sup>[11]</sup> Despite castor oil being widely used to start labor in pregnant women, to date there is not enough research to show whether it is effective to ripen the cervix or induce labor.<sup>[12]</sup> Therapeutically, modern drugs are rarely given in a pure chemical state, so most active ingredients are combined with excipients or additives. Castor oil, or a castor oil derivative such as Kolliphor EL (polyethoxylated castor oil, a nonionic surfactant), is added to many modern drugs, including:

- Miconazole, an antifungal agent;<sup>[13][14]</sup>
- Paclitaxel, a mitotic inhibitor used in cancer chemotherapy;<sup>[15]</sup>
- Sandimmune (cyclosporine injection, USP), an immunosuppressant drug widely used in connection with organ transplant to reduce the activity of the patient's immune system;<sup>[16]</sup>
- Nelfinavir mesylate, an HIV protease inhibitor;<sup>[17]</sup>
- Tacrolimus, an immunosuppressive drug (contains HCO-60, polyoxyl 60 hydrogenated castor oil);
- Xenaderm ointment, a topical treatment for skin ulcers, is a combination of Balsam of Peru, castor oil, and trypsin;<sup>[18][19]</sup>
- Aci-Jel (composed of ricinoleic acid from castor oil, with acetic acid and oxyquinoline) is used to maintain the acidity of the vagina.<sup>[20]</sup>

### 2.2.1 Alternative medicinal use



Advertisement of Castor oil as a medicine by Scott & Bowne company, 19th century

In naturopathy castor oil has been promoted as a treatment for a variety of human health conditions. The claim has been made that applying it to the skin can help cure cancer. However, according to the American Cancer Society, "available scientific evidence does not support claims that castor oil on the skin cures cancer or any other disease."<sup>[21]</sup>

## 2.3 Coatings

Castor oil is used as bio-based polyol in the polyurethane industry. The average functionality (number of hydroxyl groups per triglyceride molecule) of castor oil is 2.7, so it is widely used as rigid polyol and coating.<sup>[1]</sup>

Castor oil is not a drying oil, meaning that it has a low reactivity toward air compared to say linseed oil and tung oil. Dehydration of castor oil gives linoleic acids, which does have drying properties.<sup>[1]</sup>

## 2.4 Precursor to industrial chemicals

Castor oil can be broken down into other chemical compounds that have numerous applications.<sup>[22][23][24]</sup> Transesterification followed by steam cracking gives **undecylenic acid**, a precursor to specialized polymer **nylon 11**, and **heptanal**, a component in fragrances.<sup>[25]</sup> Break down of castor oil in strong base gives **2-octanol**, both a fragrance component and a specialized solvent, and the **dicarboxylic acid sebacic acid**. Hydrogenation of castor oil saturates the alkenes, giving a waxy lubricant.<sup>[11]</sup>

The production of **lithium grease** consumes a significant amount of castor oil. Hydrogenation and saponification of castor oil yields **12-hydroxystearic acid** which is then reacted with **lithium hydroxide** or **lithium carbonate** to give high performance lubricant grease.<sup>[26]</sup>

Since it has a relatively high **dielectric constant** (4.7), highly refined and dried castor oil is sometimes used as a **dielectric fluid** within high performance high voltage capacitors.

### 2.4.1 Lubrication

Vegetable oils, like castor oil, are typically unattractive alternatives to petroleum-derived lubricants, because of their poor oxidative stability.<sup>[27][28]</sup> Castor oil has better low temperature **viscosity** properties and high temperature lubrication than most vegetable oils, making it useful as a lubricant in **jet**, **diesel**, and **race car engines**.<sup>[29]</sup> The viscosity of castor oil at 10 °C is 2,420 centipoise.<sup>[30]</sup> However, castor oil tends to form gums in a short time, and its use is therefore restricted to engines that are regularly rebuilt, such as **race engines**. In case of an accidental release. The lubricants company **Castrol** took its name from castor oil.

Castor oil has been suggested as a lubricant for **bicycle pumps**, because it does not dissolve natural rubber seals.<sup>[31]</sup>

**Early aviation and aeromodelling** Castor oil was the preferred lubricant for **rotary engines**, such as the **Gnome engine** after that engine's widespread adoption for aviation in Europe in 1909. It was used almost universally by the rotary engined Allied aircraft in **World War I**. Germany had to make do with inferior **ersatz** oil for its rotary engines, which resulted in poor reliability.<sup>[32][33][34]</sup>

The **methanol-fuelled two-cycle glow plug engines** used for aeromodelling, since their adoption by model airplane hobbyists in 1948, have used varying percentages of castor oil as a lubricant. It is highly resistant to degradation when the engine has its fuel-air mixture leaned for maximum engine speed. Gummy residues can still be a problem for aeromodelling powerplants lubricated with castor oil, however, usually requiring eventual replacement of **ball bearings** when the residue accumulates within the en-

gine's bearing races. One British manufacturer of **sleeve valved** four-cycle model engines has stated the "varnish" created by using castor oil in small percentages can improve the pneumatic seal of the sleeve valve, improving such an engine's performance over time.

**Turkey red oil** Turkey red oil, also called **sulphonated** (or **sulfated**) castor oil, is made by adding **sulfuric acid** to vegetable oils, most notably castor oil.<sup>[35]</sup> It was the first synthetic **detergent** after ordinary soap. It is used in formulating lubricants, softeners, and **dyeing assistants**.<sup>[36]</sup>

### 2.4.2 Biodiesel

Castor oil, like currently less expensive vegetable oils, can be used as feedstock in the production of **biodiesel**. The resulting fuel is superior for cold winters, due to its exceptionally low cloud and pour points.<sup>[37]</sup>

Initiatives to grow more castor for energy production, in preference to other oil crops, are motivated by social considerations. Tropical subsistence farmers would gain a cash crop.<sup>[38]</sup>

## 2.5 Punishment

Parents often punished children with a dose of castor oil.<sup>[39][40]</sup> Physicians recommended against the practice because they did not want medicines associated with punishment.<sup>[41]</sup>

A heavy dose of castor oil could be used as a humiliating punishment for adults, especially political dissenters. Colonial officials used it in the **British Raj** (India) to deal with recalcitrant servants.<sup>[42]</sup>

The most famous use as punishment came in **Fascist Italy** under **Benito Mussolini**. It was a favorite tool used by the **Blackshirts** to humiliate their opponents.<sup>[43][44][45]</sup> Political dissidents were force-fed large quantities of castor oil by Fascist squads. This technique was said to have been originated by **Gabriele D'Annunzio**. Victims of this treatment did sometimes die, as the dehydrating effects of the oil-induced diarrhea often complicated the recovery from the nightstick beating they also received along with the castor oil; however, even those victims who survived had to bear the humiliation of the laxative effects resulting from excessive consumption of the oil.<sup>[46]</sup>

It is said Mussolini's power was backed by "the bludgeon and castor oil". In lesser quantities, castor oil was also used as an instrument of intimidation, for example, to discourage civilians or soldiers who would call in sick either in the factory or in the military. It took decades after Mussolini's death before the myth of castor oil as a panacea for a wide range of diseases and medical conditions was totally demystified, as it was also widely administered to pregnant women, elderly or mentally-ill patients



in hospitals in the false belief it had no negative side effects.

Today, the Italian terms *manganello* and *olio di ricino*, even used separately, still carry strong political connotations (especially the latter). These words are still used to satirize patronizing politicians, or the authors of disliked legislation. They should be used with caution in common conversation. The terms *Usare l'olio di ricino*, (“to use castor oil”) and *usare il manganello* (“to use the bludgeon”) mean “to coerce or abuse”, and can be misunderstood in the absence of proper context.

As a means of punishment or torture, force-feeding castor oil still lives on in animated cartoons such as Tom and Jerry.

### 3 Safety

The castor seed contains ricin, a toxic protein. Heating during the oil extraction process denatures and inactivates the protein. However, harvesting castor beans may not be without risk.<sup>[47]</sup> Allergenic compounds found on the plant surface can cause permanent nerve damage, making the harvest of castor beans a human health risk. India, Brazil, and China are the major crop producers, and the workers suffer harmful side effects from working with these plants.<sup>[48]</sup> These health issues, in addition to concerns about the toxic byproduct (ricin) from castor oil production, have encouraged the quest for alternative sources for hydroxy fatty acids.<sup>[49][50]</sup> Alternatively, some researchers are trying to genetically modify the castor plant to prevent the synthesis of ricin.<sup>[51]</sup>

### 4 See also

- Castor oil plant
- Castor wax
- Child discipline
- Linseed oil
- List of ineffective cancer treatments

### 5 References

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## 6 Further reading

- Naughton, Frank., "Castor Oil", *Kirk-Othmer Encyclopedia of Chemical Technology*, New York: John Wiley, doi:10.1002/0471238961.0301192014012107.a01.pub2, ISBN 9780471238966 – overview of chemical properties and manufacturing of castor oil

## **7 External links**

- International Chemical Safety Card 1452
- Castor biofuel farming starts in Ethiopia

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