Castor Oil

Abhinav Mishra
131503
8th Semester

Castor Oil Plant
Ricinus communis

Post-bloom, with developing seed capsules

The green capsule dries up.

Capsule splits into three sections, forcibly ejecting seeds

Seeds

Introduction

Castor oil is derived from the bean of the castor plant, *Ricinus communis*, belonging to the family Euphorbiaceae.

The seeds of the castor plant are produced in racemes, or clusters of capsules.

The capsules each contain three seeds protected by a hull that is removed prior to processing.

The seeds are mottled to varying extents, most often with shades of dark brown overlaying shades of light brown. Seeds of commercial varieties range from 250 to 1800/kg.

Properties

- Castor oil is also known as **ricinus oil**, oil of **Palma Christi**, tangantangan oil, and neoloid. Typical of vegetable oils and most fats, castor oil is a triglyceride of various fatty acid.
- Its uniqueness stems from the very high (87–90wt%) content of Ricinoleic acid, $C_{18}H_{34}O_3$.

Table 1. **Fatty Acid Composition of Castor Oil**

Fatty acid	CAS Registry number	Molecular formula	Wt %[a]
ricinoleic acid	[141-22-0]	$C_{18}H_{34}O_3$	89.5
dihydroxystearic acid	[26248-43-1]	$C_{18}H_{36}O_4$	0.7
palmitic acid	[57-10-3]	$C_{16}H_{32}O_2$	1.0
stearic acid	[57-11-4]	$C_{18}H_{36}O_2$	1.0
oleic acid	[112-80-1]	$C_{18}H_{34}O_2$	3.0
linoleic acid	[60-33-3]	$C_{18}H_{32}O_2$	4.2
linolenic acid	[436-40-1]	$C_{18}H_{30}O_2$	0.3
eicosanoic acid	[506-30-9]	$C_{20}H_{40}O_2$	0.3

[a]These are typical values.

Table 2. **Industrial Castor Oil Standards**[a]

Property	Value
acid value, max	2.0
clarity	clear
Gardner color, max	2
hydroxyl value	160–168
loss on heating, wt % max	0.2
refractive index, 25°C	1.4764–1.4778
saponification value	176–184
solubility in alcohol[b]	complete
specific gravity, 25/25°C	0.957–0.961
unsaponifiable matter, wt % max	0.7
viscosity, mm^2/s (=cSt)	6.50–8.00
iodine value	84–88

[a]Ref. 5.

[b]Soluble 1:2 by vol in 95% ethanol at 20°C.

Table 3. **Properties of Castor Oil**

Property	Value
viscosity,[a] 25°C, $mm^2/s(=cSt)$	615–790
flash point, Cleveland open cup, °C	285
tag closed cup	230
surface tension, mN/m	39.0
20°C	39.0
80°C	35.2
Reichert-Meissl value	<0.5
Polenske value	<0.5
acetyl value	144–150
optical rotation (polarimeter, 200 mm)	+7.5 – 9.0
pour point, °C	−23
coefficient of expansion, mL/°C	0.00066

[a]Value corresponds to $U \pm \frac{1}{2}$ in Gardner-Holdt units (see Rheological measurements).

Commercial Processes

1. Preheating the seed in stack cookers prior to crushing in a hydraulic press or a continuous mechanical screw-type press commonly known as an expeller.

2. The press cake discharged from this mechanical processing contains 10–20wt % oil and is then processed in solvent extraction units to recover the residual oil.

A light colored, high quality medicinal type oil is recovered.

Castor oil recovered from hydraulic or continuous mechanical screw presses requires refining to remove toxic proteins, gums, and foreign matter while improving the color and reducing the free fatty acid content.

Table 4. **Castor Oil Quality and Specifications**[a]

Property	Pale oil	No. 1 oil	No. 2 oil	No. 3 oil
color, AOCS[b,c] tintometer,	10 yellow/1.0 red	20Y/2.0R	30Y/3.0R	40Y/4.0R
free fatty acids,[c] wt %	0.75	1.00	1.50	3.0
acid value,[c]	1.49	1.99	2.98	5.97
moisture and volatiles,[c] wt %	0.255	0.355	0.465	0.485
water content,[c] (Karl Fischer), wt %	0.25	0.35	0.46	0.48
insoluble impurities,[c] wt %	0.01	0.02	0.02	0.2
appearance, 25°C	brilliantly clear; free of suspended matter	characteristically clear; free from suspended matter	characteristically clear; and free from suspended matter	not exceeding slight haze; free of suspended matter
odor	very slight; characteristic	slight; characteristic	slight; characteristic	characteristic

[a]All oil has viscosity in the 680–900 mm^2/s (–cSt) range, equivalent to a U-V classification in Gardner-Holdt units.
[b]AOCS = American Oil Chemists Society.
[c]Values given are maximum allowable.

Table 5. **Commercial Castor Oil Specifications**

Property	Pale pressed and No. 1 oils	No. 2 and No. 3 oils	AOCS test method[a]
specific gravity, at 25°C	0.955–0.965	0.950–0.965	Cc 10–25
refractive index at 25°C, n_D	1.476–1.479	1.475–1.480	Cc 7–25
acetyl value,[b]	142	140	Cd 4–40
iodine value	82–88	80–88	Cd 1–25
saponification value	176–184	174–184	Cd 3–25
unsaponifiable matter,[c] wt %	0.7	0.8	Ca 6a–40

[a]AOCS = American Oil Chemists Society.
[b]Minimum value given.
[c]Maximum value given.

Oil Recovery

According to the specifications of ICOAI

1 Degumming

- Oil/dissolved/dispersed proteinaceous materials are treated with 3–5 wt % water at a temperature of 70–80 C and passed through a decanter-type centrifuge to separate the gums from solation

2 Removal of free fatty acids

- Use of caustic soda solutions to neutralize the excess free fatty acids

3 Deodorization

- Volatile components present are removed by nitrogen or steam stripping operations carried out at 160C under less than 1.5 kPa (11 mm Hg) pressure.

Economic Aspects

- India is the largest producer of castor seeds in the world. China and Brazil follow.
- Historically India, Brazil, and China have been the key producing countries meeting global requirements.
- India production ranges between **250,000-350,000 t/year**.

Health and Safety Factors

The toxicological properties of this castor oil have not been fully investigated :

1. Castor oil may cause **eye and skin irritation** and irritation of the digestive tract.
2. Castor oil is **not listed as a carcinogen** by ACGIH, IARC, NTP or Ca Prop 65

- During fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion.
- Runoff from fire control or dilution may cause pollution.

➢ Use water spray, dry chemical, carbon dioxide, or chemical foam to extinguish fire.

- Store in a tightly closed container.
- Store in a cool, dry well-ventilated area away from incompatible substances

Uses

1. Castor oil is unique among all fatty oils. It is the **only renewable vegetable oil resource** having a **hydroxyl group** structure.
2. Many years ago, castor oil was primarily used for **medicinal purposes** and as a **general industrial lubricant**.
3. Later derivatives of castor oil were produced and the many more uses were found for the oil. Castor oil and its derivatives are important commodities to the chemical industry.

- **Polyamides (Nylon – 11)** [Air brakes/Powder Metal Coatings]

VESTAMID Terra DS and HS - both polymers derived from castor oil

- **Urethanes Foams** (Thermal insulations and structural support)
- **Coatings** (High abrasion resistance on steel plates and flexibility on aluminum plates and PVC cloth)
- **Lubricants** (Non - volatile, high temperature lubricants for jet engines)

✓Castrol B353 is a blended SAE 40 formulation employing castor oil - avoids combustion chamber deposits and sludge build-up

- **Textiles**

Enhance fiber finish, Uniform Shade Levels

- **Cosmetics**

✓ Basic lipstick contains 20–44wt % castor oil, which also acts as an ideal dispersant for pigments [nonirritating and noncomedogenic]

✓ Haircare [Foam enhancement and conditioning]

✓ Antiperspirant sticks

- **Surfactants and Detergents**

✓ PEG-40 castor oil , a surfactant that has co-solvent properties and is utilized as a fragrance solubilizer

✓ Pearlescence in Shampoos

✓ Sulfated castor oil is also used in dishwashing compounds as a hand softener

- **Biofuels**

Evogene Ltd announced that biosynthetic paraffin kerosene (bio jet fuel) produced from the company's castor varieties meets key international standards for alternative fuels (in collaboration with NASA and U.S. Air Force). **ASTMD7566** is written for Fischer Tropsch process fuel

References

Naughton, F. C. (1974). Production, chemistry, and commercial applications of various chemicals from castor oil. *Journal of the American Oil Chemists Society*, *51*(3), 65-71. doi:10.1007/bf00000015

Naughton, F. C. (2011). Castor Oil *Kirk-Othmer Encyclopedia of Chemical Technology*: John Wiley & Sons, Inc., 1-20. doi:10.1002/0471238961.030119201401210 7.a01.pub2

Thank you !