Cinnamon (Cinnamomum Species)  
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History
Cinnamon has been used as a spice for thousands of years; several references to it are found in the Bible. In Egypt, cinnamon was a spice used in embalming fluid. In Ayurvedic medicine, cinnamon bark was used as an antiemetic, antidiarrheal, antiflatulent, and general stimulant. The Portuguese found cinnamon trees growing in Sri Lanka (Ceylon) during the early 16th century; they subsequently imported cinnamon to Europe during the 16th and 17th centuries. The Dutch occupied Sri Lanka in the mid-17th century until the British captured the island in 1796. The East India Company then became the main exporter of cinnamon to Europe. The Dutch cultivated cinnamon in Java, and the exports of Ceylon cinnamon decreased as a result of heavy export duties. Nevertheless, Sri Lanka is the only regular supplier of cinnamon bark and leaf oils. The food industry prefers Ceylon cinnamon, but pharmaceutical manufacturers use both oils from Ceylon cinnamon (cinnamon oil) and from Chinese cinnamon (cassia oil) interchangeably. China is the main exporter of cassia oil.

Botanical Description
The genus Cinnamomum comprises over 250 aromatic evergreen trees and shrubs, primarily located in Asia and Australia.
- **Common Name:** Cinnamon, Ceylon cinnamon   
- **Scientific Name:** Cinnamomum verum J. Presl (Cinnamomum zeylanicum Blume, Laurus cinnamomum L.)   
- **Botanical Family:** Lauraceae (laurel family)   
- **Physical Description:** Large evergreen trees with young branches that are smooth and brown. The leaves are opposite, leathery, ovate to broadly ovate with three (and rarely, five) prominent veins. Young leaves are
reddish and later turn dark green. Small, pale yellow flowers are borne in axillary or terminal panicles. The fruit is a fleshy, ovoid drupe, which contains one seed and turns dark purple or black when ripe.

**Distribution and Ecology:** Ceylon cinnamon is an indigenous tree of Sri Lanka and southwestern India.

**Common Name:** Cassia, Chinese cinnamon, false cinnamon, cassia lignea, bastard cinnamon, cassia bark, cassia-bark tree, Chinese cassia, Saigon cinnamon

**Scientific Name:** *Cinnamomum aromaticum* Nees (*Cinnamomum cassia* Nees ex Blume, *Cinnamomum cassia* J. Presl)

**Botanical Family:** Lauraceae (laurel family)

**Physical Description:** This slender, evergreen tree grows up to 65 ft (20 meters) high. Young branches are smooth and brown. The leaves are subopposite, slender, lanceolate or oblanceolate with three prominent veins. These leaves are reddish when young and dark green when mature. The small, white flowers are borne in axillary or terminal panicles. The fruit is a green, fleshy, globose drupe, which contains one seed and turns dark purple or black when mature. This fruit is similar in size to a small olive.

**Distribution and Ecology:** Chinese cinnamon is an indigenous bush in the mountains of southern China, and cultivation for cassia oil production now occurs primarily in the southern Chinese provinces of Guangxi (Kwangsi) and Guangdong (Kwangtung). Other similar species occur on the Indonesian islands of Sumatra and Java (*C. burmannii* (Nees & T. Nees) Blume, Indonesia cassia), in Vietnam (*C. loureiroi* Nees, Vietnamese cassia), and in India and Nepal (*C. tamala* (Buch.-Ham.) Nees & Eberm., Indian cassia). Commercial cultivation of these cassia species occurs in all of these areas.

**Exposure**

**Sources**

Cinnamon leaf and bark are spices and sources of cinnamon oil, primarily from the *Cinnamomum verum* J. Presl (Ceylon cinnamon). However, most of products are extracted from cinnamon trees cultivated at altitudes up to about 1500 ft (460 meters). Cortex cinnamomi is the dried inner bark of shoots from *Cinnamomum verum* J. Presl or the stripped trunk bark of *Cinnamomum cassia* Blume. *Cinnamomum aromaticum* Nees (Chinese cinnamon) is the main source of internationally traded cassia oil, which is a distillate from a mixture of leaves, twigs, and bark fragments. Limited commercial production of cassia oil occurs in
other regions including Indonesia \([C. \textit{burmannii}}\) (Nees & T. Nees) Blume], Vietnam \((C. \textit{loureiroi}}\) Nees), and India \([C. \textit{tamala}}\) (Buch.-Ham.) Nees & Eberm.].

Commercial production of cinnamon usually begins about 3-4 years after planting and pruning of the stems to force the growth of young stems. These stems are cut during the rainy season to facilitate the peeling of the bark. After scraping the outer skin of the bark, workers rub off the bark with a brass block. The bark is then split from end to end with a special round knife. The long strips of bark are then formed into the familiar compound quills (cinnamon) or hollow quills (cassia) of the spices that are stuffed with fragments of bark and then dried. Bleaching with sulfur dioxide disinfects the material and imparts a golden hue to the quills.

**Uses**

**Traditional.** The herbal use of cinnamon includes application as an astringent, germicide, and antispasmodic. Cinnamon was one of the early treatments for chronic bronchitis.\(^1\) Other traditional uses include the treatment of impotence, frigidity, dyspnea, inflammation of the eye, leukorrhea, vaginitis, rheumatism, and neuralgia, as well as wounds and toothaches.\(^2\)

**Current.** Cinnamon \(\textit{bark}}\) oil has a delicate aroma along with a sweet, pungent taste that results in use primarily as a flavoring in dental and pharmaceutical preparations, seasonings, sauces, baked goods, drinks, and tobacco. Investigational uses of cinnamon \(\textit{bark}}\) include use as a hypoglycemic and cholesterol lowering agent,\(^3\) promotion of wound healing,\(^4\) antimicrobial agent,\(^5\) and an antiinflammatory compound.\(^6\) The flavoring agent cinnamaldehyde in cinnamon oil is added to toothpaste to mask the taste of pyrophosphate, which is an unpleasant tasting compound that inhibits plaque calcification by interrupting the conversion of amorphous calcium phosphate to hydroxyapatite. The skin sensitizing properties of cinnamon \(\textit{bark}}\) oil limits use of this essential oil in cosmetic and other topical products.\(^7\) Cinnamon \(\textit{leaf}}\) oil has a warm, spicy, and somewhat harsh odor that lacks the smooth consistency of cinnamon \(\textit{bark}}\) oil. Major uses of this essential oil include as flavoring in seasonings and a fragrance in soaps and insecticides. Cinnamon \(\textit{leaf}}\) oil is also a source for eugenol. Cassia oil is used medicinally as a carminative, antidiarrheal, antimicrobial, and antiemetic. Traditional uses for dried cassia include digestive complaints such as flatulence, colic, dyspepsia, diarrhea, and nausea, as well as colds, influenza, fevers, arthritis, and rheumatism. The major commercial uses of cassia oil are the flavoring of cola-type drinks.
and, to a lesser extent, bakery goods, sauces, confectionery products, and liquors. Like cinnamon bark oil, the use of cassia oil in topical preparations is limited by its skin-sensitizing properties. Cassia oil is a constituent of tiger balm. Smoking cessation products frequently involve the use of candies, chewing gum, or fresheners that often contain cinnamon flavoring. A few clinical studies suggest that cinnamon supplementation may lower blood glucose concentrations in patients with diabetes type 2; however, the sample sizes of these studies were small and there are inadequate data to recommend the regular use of cinnamon in diabetic patients.8

**Regulatory Status.** In the United States, cinnamon has GRAS (generally recognized as safe) status as a food additive.

**Principal Toxins**

**Chemical Composition**

Volatile oils are distilled products from the bark, leaves, flowers, or buds of *Cinnamomum* species, and the chemical composition of these oils varies depending on the part of the plant used for the distillation process. Cinnamon bark and leaf oil are steam distillation products obtained from the inner bark and leaves, respectively, of Ceylon cinnamon (*Cinnamomum verum*).9 Other sources of cinnamon include Japanese cinnamon, Java cinnamon, and Taiwan cinnamon. Most of the chemical constituents of the essential oils from cinnamon are monoterpenes, sesquiterpenes, and related oxygen derivatives of these two types of compounds. The major monoterpene hydrocarbons in volatile components of cinnamon extracts are α-pinene, camphene, and limonene.10 The main constituent of cinnamon bark oil is cinnamaldehyde (Fig 1), whereas eugenol is the main constituent (ie, about 81-85%) of cinnamon leaf oil.11 A commercial sample of essential oils from *Cinnamomum verum* contained approximately 63% cinnamaldehyde, 8% limonene, 7% eugenol, 5.5% cinnamaldehyde propylene, and <1-2% of a variety of terpenoid compounds (α-pinene, camphene) as measured by gas chromatography/mass spectrometry.5 Cinnamon leaf oil

![FIG 1. Chemical structure of cinnamaldehyde.](image)
contains a variety of constituents including eugenol (CAS RN: 97-53-0, C_{10}H_{12}O_{2}) and cinnamaldehyde (CAS RN: 104-55-2, C_{9}H_{8}O), which is a local mucous and dermal membrane irritant. In a study of the essential oils from leaves of Cinnamomum osmophloeum (Taiwan cinnamon), terpenoid compounds accounted for approximately 90% of the chemical compounds with 1,8-cineole, spathulenol, santolina triene, and caryophyllene oxide being the most common compounds.6 The essential oils from leaves of Cinnamomum species accounts for about 0.5% dry weight. Analysis of a steam-distilled volatile oil from cinnamon fruit stalks yielded 27 compounds with cinnamyl acetate (36.59%) and caryophyllene (22.36%) being the major components.12 Analysis of the hydro-distilled volatile oil from buds of Cinnamomum verum (C. zeylanicum) yielded terpene hydrocarbons (78%) and oxygenated terpenoids (9%) with the sesquiterpenes, α-bergamotene (27%) and α-copaene (23%), being the most common compounds.13 Minor compounds included α-humulene, α-muurolene, and δ-cadinenes. The volatile oil of the buds contains more monoterpene and sesquiterpene compounds than oils from the flowers and fruits, whereas the concentration of trans-cinnamyl acetate is much higher in the volatile oils from flowers and fruit than from the buds. A study of cinnamon essential oil from C. verum grown in Madagascar indicated that the major constituent was trans-cinnamaldehyde (41.3%).14 Cassia oil is extracted from the leaves, bark, twigs, and stalks of C. cassia by steam distillation.

**Physicochemical Properties**

Cinnamon leaf oil has a fragrant odor and a very pungent taste. Experimental studies suggest that cinnamon has some mosquito larvicidal activity15 and some antibacterial properties when added to certain food products.16 However, there is no conclusive evidence that the antimicrobial properties of cinnamon produce clinically efficacious results.17 Table 1 lists some of the physical properties of cinnamaldehyde.

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Melting point</td>
<td>~7.50°C</td>
</tr>
<tr>
<td>Boiling point</td>
<td>246°C</td>
</tr>
<tr>
<td>log P (octanol-water)</td>
<td>1.9</td>
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<tr>
<td>Water solubility</td>
<td>1420 mg/L (25°C)</td>
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<tr>
<td>Henry’s Law Constant</td>
<td>1.60 E-06 atm m$^3$/mole (25°C)</td>
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<tr>
<td>Atmospheric OH rate constant</td>
<td>3.79 E-11 cm$^3$ molecule/sec (25°C)</td>
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DM, June 2009
**Dose Response**

**Medicinal Use.** The average daily dose of the crude drug (cortex cinnamomi) is 2-4 g or 0.05-0.2 g of the essential oil.

**Toxicity.** The ingestion of an estimated 60 mL of cinnamon oil was associated with burning sensation in the gastrointestinal tract along with lethargy, double vision, vomiting, and lightheadedness.\(^\text{18}\) The symptoms resolved spontaneously within 5 hours with no complications.

**Toxicokinetics**

There are few human toxicokinetic data for the constituents in cinnamon oil. Rodent studies indicate that the major metabolic pathway of \(\alpha\)-methoxycinnamaldehyde involves oxidation to the corresponding cinnamic and phenylpropionic acids with subsequent urinary excretion of benzoic and hippuric acids.\(^\text{19}\)

**Clinical Response**

Most case reports of toxicity from cinnamon oil involve local irritation and allergic reactions to cinnamon oil as a constituent of personal hygiene (toilet soaps, mouthwash, toothpaste, perfumes, mud baths),\(^\text{20}\) beverages (colas, vermouth, bitters), or baking products.\(^\text{21-23}\) Allergic reactions include contact dermatitis, perioral dermatitis, cheilitis, stomatitis, gingivitis, glossitis, chronic lichenoid mucositis, contact urticaria,\(^\text{24}\) and rarely immediate hypersensitivity reactions (asthma, urticaria).\(^\text{25,26}\) Clinical manifestations of intraoral reactions include pain, swelling, erythema, ulcerations, fissures, vesicles, and white patches.\(^\text{27}\) These reactions are local, and distal skin involvement is rare.\(^\text{28}\) Occupational allergic contact dermatitis from spices is rare, and typically involves the hands.\(^\text{29}\) More common food sensitizers include carrot, cucumber, tomato, melon, fish, potato, orange, green pepper, onion, red cherry, and garlic. Cinnamon oil contains local mucous membrane irritants such as cinnamaldehyde and cinnamic acid. Prolonged skin contact (48 hours) from a cinnamon oil spill produced superficial partial-thickness burns.\(^\text{30}\) Chronic use of cinnamon-flavored gum can produce submucosal inflammation and alteration of the surface epithelium resembling oral leukoplakia, manifest on biopsy by acanthosis, hyperkeratosis, parakeratosis, plasma cell infiltration, fibrosis of the lamina, and focal atypia.\(^\text{31}\) These changes are not pathognomonic for cinnamon-induced mucositis. The differential diagnosis of chronic mucositis associated with hypersensitivity to cinnamon includes local trauma, smokeless tobacco keratosis (snuff dipper’s lesion), hyperkeratosis, lichen planus, lupus erythematosus, candidiasis, premalignant lesions, lichenoid mucositis, and carcinoma.
The severity of the local mucosal reaction depends on the duration of cinnamon-gum chewing. In contrast to the diffuse gingival reaction associated with cinnamon-flavored toothpaste, oral lesions associated with gum chewing occur on the lateral border of the free tongue or adjacent buccal mucosa. Sequelae of contact dermatitis associated with cinnamon include desquamation and hyperpigmentation. Although a case report associated the development of squamous cell carcinoma of the tongue with prolonged use of cinnamon gum, the International Agency for Research on Cancer (IARC) and the US National Toxicology Program do not list cinnamon as a potential carcinogen.

School-aged children abuse cinnamon oil by sucking on toothpicks or fingers dipped in the oil. Reported effects include facial flushing, sensation of warmth, and intraoral hyperesthesias. Although nausea and abdominal pain may occur, systemic symptoms do not usually result from this type of exposure. Ingestion of cinnamon oil may cause central nervous system depression, predisposing the patient to aspiration pneumonia.

**Diagnostic Testing**

Analytical methods for the identification of the constituents of cinnamon oil include high performance liquid chromatography and gas chromatography/mass spectrometry.

**Treatment**

Treatment is supportive. Patients with leukoplakia after chronic use of cinnamon-containing gums should be observed for resolution after cessation of use. Persistent oral lesions should be evaluated for oral cancer.

**REFERENCES**


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