

Cinnamon (*Cinnamomum* spp.)

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Synonyms/Common Names/Related Substances:

- American cinnamon, Batavia cassia, Batavia cinnamon, breyne, cannelle (French), cannellier de Ceylan (French), cannellier de Chine (French), cassia, cassia bark, cassia cinnamon, cassia lignea, cassia rou gui, catechins, Ceylon cinnamon, Chinese cinnamon, chinesischer Zimt (German), chinesischer Zimtbaum (German), cinnamaldehyde, cinnamate, cinnamic acid, cinnamom--dhal chini, Cinnamomi cassiae, Cinnamomi cassiae cortex, Cinnamomi ceylanici cortex, Cinnamomi cortex, Cinnamomi flos, Cinnamomi osmophloeum, Cinnamomi ramulus, Cinnamomom, *Cinnamomum aromaticum*, *Cinnamomum aromaticum* Nees., *Cinnamomum burmannii*, *Cinnamomum cassia*, *Cinnamomum cassia* Blume, *Cinnamomum cassia* J. Presl., *Cinnamomum cinnamon*, *Cinnamomum loureiroi*, *Cinnamomum mairei* Levl., *Cinnamomum migao*, *Cinnamomum obtusifolium*, *Cinnamomum osmophloeum* clones (A and B), *Cinnamomum osmophloeum* Kaneh., *Cinnamomum sieboldii*, *Cinnamomum sieboldii* Meissn, *Cinnamomum tamala*, *Cinnamomum tejpata*, *Cinnamomum verum*, *Cinnamomum verum* J. Presl., *Cinnamomum zeylanicum*, *Cinnamomum zeylanicum* bark, *Cinnamomum zeylanicum* Blume, *Cinnamomum zeylanicum* Nees, cinnamon bark, cinnamon bark essential oil, cinnamon bark oil, cinnamon cortex, cinnamon essential oil, cinnamon extract, cinnamon flower, cinnamon fruit stalks, cinnamon leaf, cinnamon leaf essential oil, cinnamon leaf oil, cinnamon twig, cinnamon water, cinnamophilin, condensed tannins, cortex cinnamomi, cortex cinnamomum, coumarin, (E)-cinnamaldehyde, echter Kanel (German), eugenol, false cinnamon, gixin, gui, guipi, guirou, guixin, guizhi, guizhi tang, gum, jungui, keishi (Japanese), keychi (Korean), Lauraceae (family), linalool, Malabar leaf, Malabathrum, Malobathrum, monoterpenes, mucilage, mugui, ocotea quixos, *Oleum Malabathri*, padang cassia, padang cinnamon, phenolic compounds, pinene, proanthocyanidins, qin, ramulus Cinnamomi (*Cinnamomum cassia* Presl), resin, rougui, Saigon cassia, Saigon cinnamon, sequiterpenes (pinene), Seychelles cinnamon, sweet wood, *trans*-cinnamaldehyde, *trans*-cinnamic acid, true cinnamon, xiao-jian-zhong, xiao-jian-zhong-tang, yin xiang, Zimt (German), Zimtblüten (German), Zimtrinde (German), Zimtrindle (German),
- **Traditional Chinese Medicine formula examples:** Bai hu jia gui zhi tang, da qing long tang, dang gui si ni tang, ge gen tang, gui zhi fu ling wan, gui zhi tang, ling gui zhu gan tang, ma huang tang, tao he cheng qi tang.
- **Note:** This monograph focuses on cinnamon varieties that are edible and does not include *Cinnamomum camphora*, or the camphor tree, which can be lethal to humans in large doses, or *Cinnamomum kotoense*, which is an ornamental species.

CLINICAL BOTTOM LINE/EFFECTIVENESS

Brief Background:

- Cinnamon has been used as a spice in several cultures for centuries. It was traditionally used mainly as a stomachic and carminative for gastrointestinal complaints and is still used for these conditions today. The bark of *Cinnamomum zeylanicum* and *C. cassia* is used as spice (cinnamon bark). These two species are the only approved medicinal herbs of the genus *Cinnamomum*.
- At this time, there are no high-quality human trials supporting the efficacy of cinnamon for any indication. However, recent *in vitro* and *in vivo* research has discovered new potential properties of several cinnamon species.

- The treatment of diabetes (type 2) seems to be the most promising field of research for cinnamon. Although there are conflicting results from two randomized studies, the results from *in vitro* and animal studies indicate significant hypoglycemic effects. Cinnamon was shown to be highly effective in improving glucose and insulin metabolism.
- Furthermore, due to the various potential effects of cinnamon and its constituents, including anti-inflammatory, antibacterial, antifungal, and antioxidant properties, it may prove effective in the supportive treatment of conditions such as cancer or severe virus infections.

Scientific Evidence for Common/Studied Uses:

Indication	Evidence Grade	 GRADING SYSTEM LINK
Candidiasis (oral, in advanced AIDS)	C	
Diabetes (type 2)	C	
Helicobacter pylori infection	C	

Historical or Theoretical Uses which Lack Sufficient Evidence:

- Abdominal pain, abortifacient, abscess, acaricidal, acne, analgesic ([1](#)), anesthetic, anthelmintic ([2](#);[3](#)), antibacterial ([4](#);[5](#);[6](#);[7](#);[8](#);[9](#);[10](#);[11](#);[12](#);[13](#);[14](#);[15](#);[16](#);[17](#);[18](#);[19](#);[20](#)), anticoagulant ([21](#)), antidepressant ([22](#)), antifungal ([23](#);[24](#);[25](#);[26](#);[27](#);[28](#);[29](#);[30](#);[31](#);[32](#);[33](#);[34](#);[35](#);[36](#);[37](#);[38](#);[39](#);[40](#)), anti-inflammatory ([41](#);[42](#);[43](#);[44](#);[45](#)), antimicrobial ([46](#);[47](#);[48](#);[49](#);[50](#);[51](#);[52](#);[53](#);[54](#);[55](#);[56](#);[57](#)), antimutagenic ([58](#);[59](#)), antioxidant ([60](#);[61](#);[62](#);[63](#);[64](#);[65](#);[66](#);[67](#);[68](#);[69](#);[70](#);[71](#)), antiparasitic ([72](#)), antiplatelet ([73](#)), antipyretic ([74](#)), antiseptic ([48](#)), antispasmodic, antitumor ([75](#);[76](#);[77](#)), antiviral, arrhythmia ([78](#);[79](#)), arthritis, asthma ([80](#)), bloating, blood purification, bronchitis, cancer ([81](#);[82](#);[83](#)), chest pain, chronic bronchitis ([84](#)), chronic diarrhea, colds/flu, colic, cough, cystitis, dental caries ([85](#)), dermatitis, diarrhea ([1](#)), digestive aid ([86](#)), digestive disorders, diuretic ([87](#)), dyspepsia, eczema, emmenagogue, flavoring, food poisoning ([88](#)), food preservation ([89](#)), food uses, gastric ulcer ([1](#);[86](#)), gastritis, gout ([90](#);[91](#)), gum disease ([92](#)), gynecologic disorders, HIV/AIDS ([93](#)), hypercholesterolemia ([94](#)), hypertension ([95](#)), hyperthyroid ([96](#)), immunostimulation ([97](#);[98](#);[99](#)), inflammatory conditions([100](#);[101](#)), insect bites, insect repellent ([102](#);[103](#);[104](#)), insecticide ([105](#);[106](#)), kidney disorders, lice ([107](#)), liver disease, long-term debility, loss of appetite, muscle aches, nausea, neuralgia, neuroprotective ([108](#)), premature ejaculation, respiratory tract infection ([109](#)), rheumatism, sciatica, sinusitis, skin conditions, snake repellent ([110](#)), sore throat, spermicide ([111](#)), toothache, urethritis, viral infections, weight gain, wound healing.

Expert Opinion and Folkloric Precedent:

- Cinnamon is a typical spice used in winter, along with nutmeg, clove, and anise, for baking foods, such as gingerbread, and it has also been used in aromatherapy for speculative mood uplifting effects ([22](#)). Cinnamon is also a reported folk remedy in Pakistan ([112](#)).
- As the smell of cinnamon has been determined to be affected in Parkinson patients, cinnamon has been used in selective olfactory deficit tests to help diagnose hyposmia in Parkinson disease ([113](#)).
- Cinnamon has been granted GRAS (Generally Recognized as Safe) status as a food additive by the U.S. Food and Drug Administration (FDA). GRAS substances are considered safe by the experts and not restricted, as is the case with other food additives. The FDA has sought fully up-to-date toxicology information on cinnamon (*Cinnamomum* species), including cinnamon bark oil, cinnamon oil, cinnamon leaf oil, and cinnamon oleoresin.

Brief Safety Summary:

- **Likely Safe:** When used orally and short-term (up to six weeks) in dosages up to 6g daily ([114](#)).
- **Possibly Unsafe:** When used in patients taking cytochrome P450 metabolized agents, as there is *in vitro* evidence that cinnamon or its constituents may interact with hepatic microsomal cytochrome P-450 ([115](#);[116](#);[117](#)). When used in diabetic patients ([118](#);[119](#);[120](#);[121](#);[122](#);[123](#);[124](#);[125](#);[126](#)). When used in

patients taking anticoagulants ([73](#);[127](#)). When used in patients taking cardiovascular agents ([21](#);[78](#);[79](#);[87](#);[128](#);[129](#)).

- **Likely Unsafe:** When used in pregnant women, lactating women, or children, due to insufficient available evidence. When used in patients prone to atopic reactions, due to predisposition towards allergic reactions with oral/topical cinnamon ([130](#);[131](#);[132](#);[133](#);[134](#);[135](#);[136](#);[137](#);[138](#);[139](#);[140](#);[141](#);[142](#);[143](#);[144](#);[145](#);[146](#);[147](#);[148](#);[149](#);[150](#);[151](#);[152](#);[153](#);[154](#);[155](#)). When used in patients hypersensitive to Balsam of Peru ([156](#);[157](#);[158](#);[159](#);[160](#)).

DOSING/TOXICOLOGY

General:

- Recommended doses are based on those most commonly used in available trials, or on historical practice. However, with natural products it is often not clear what the optimal doses are to balance efficacy and safety. Preparation of products may vary from manufacturer to manufacturer, and from batch to batch within one manufacturer. Because it is often not clear what the active components of a product are, standardization may not be possible, and the clinical effects of different brands may not be comparable.

Standardization:

- Information about standardization of cinnamon products is currently lacking, but several studies have focused on processing and storage procedures for cinnamon. Gamma-irradiation of cinnamon did not bring about any distinct qualitative or quantitative chemical changes based on spectrophotometric analysis ([161](#)). However, another study demonstrated significant losses of total ascorbate for cinnamon as well as a significant decrease of carotenoid content three months after gamma-irradiation ([162](#)). Factors influencing the variation of constituents of cinnamon volatile oils, specifically in terms of their effect on aroma, have been investigated. In one study, compared to packaging material and storage duration, storage temperature has been suggested as the most important factor in altering cinnamon volatile oil aroma ([163](#)). After disinfection by ethylene oxide and storage by ethylene oxide, a fast loss of residual ethylene oxide and ethylene glycol in cinnamon has been observed ([164](#)).
- Cinnamon bark is often confused with "Yin Xiang" ([165](#)). A botany study was conducted that found that the pattern of morphology and distribution of calcium oxalate crystals may be an index for the identification of the crude drug of Cinnamomi cortex ([166](#)).

Adult Dosing (age ≥18):

Oral:

- **Candidiasis:** In a pilot study, eight lozenges of a commercially available cinnamon candy (not further specified) were taken daily for one week and were shown to be effective in three out of five HIV patients ([167](#)).
- **Diabetes (type 2):** In a clinical trial, 1, 3, or 6g of cinnamon daily was used for 40 days and was shown to be effective ([114](#)). In a clinical trial, 1,500mg of cinnamon was used daily for six weeks and was shown to be ineffective ([168](#)).
- ***Helicobacter pylori* infection:** In a clinical trial, 80mg cinnamon extract daily was used for four weeks and was shown to be ineffective ([169](#)).

Pediatric Dosing (age <18):

- Insufficient available evidence.

Toxicology:

- Based on human study (two randomized trials, one controlled trial, and one pilot study) of the effects of cinnamon on type-2 diabetes, *Helicobacter pylori* infection, and candidiasis, no toxic effects were observed ([114](#);[167](#);[168](#);[169](#)).

- Ethanolic extracts of *Cinnamomum zeylanicum* bark showed no acute or chronic oral toxicity in mice (170). However, *C. zeylanicum* treatment caused reduction in liver weight of the treated animals compared to the control. Hematological studies revealed a significant fall in hemoglobin level. The extract also induced a significant increase in reproductive organ weight, sperm motility, and sperm count, and it failed to illicit any spermatotoxic effect.
- The effect of cinnamon and eugenol on human spermatozoa motility *in vitro* has been studied (111). The volatile oils studied revealed a potent spermicidal action, whereas the fixed oils were devoid of action on spermatozoa.
- Cinnamon has been shown to affect xanthine dehydrogenase, aldehyde oxidase, and pyridoxal oxidase activity during development in *Drosophila melanogaster* (171). High doses of cinnamon oil caused a depressive effect in rats, probably due to toxicity; the authors note that at the lowest dose it caused weak or "doubtful" effects (172).
- The ethanol extract of cinnamon has shown no *in vitro* mutagenic activity (173). Cinnamaldehyde, cinnamyl alcohol, methyl eugenol, eugenol, isoeugenol, as well as cinnamon bark oil, were positive in the *Bacillus subtilis* DNA-repair test (Rec assay) without S9. All samples tested were negative in the *Escherichia coli* WP2 uvrA reversion test. The essential oil was positive in the DNA-repair test (174). *Cinnamomum mairei* extract was positive in the chromosomal aberration and micronucleus assays in mice (175). *Cinnamomum zeylanicum* bark showed low mutagenic activity in *Bacillus subtilis* strains H17 (rec+) and M45 (rec-) (173).
- Raw cinnamon (*Cinnamon zeylanicum*) has been shown to be tumorigenic in high doses (176). A case report mentions a 24 year-old woman who developed a squamous cell carcinoma of the tongue following persistent and prolonged exposure to cinnamon-flavored gum (155).
- Cinnamon oil ingestion lead to toxic manifestations in a child, according to a case report (177).
- Molecules similar to cinnamic acid, such as styrene and the related aldehyde, alcohol, and esters, are all considered more toxic than cinnamic acid (178).
- Cinnamon oil has been used recreationally by children and adolescents to "get high." Nausea or abdominal pain but no systemic effects have been reported (179;180).

PRECAUTIONS/CONTRAINDICATIONS

Allergy:

- Known allergy/hypersensitivity to cinnamon, its constituents, members of the Lauraceae family, or Balsam of Peru (156;157;158;159;160). However, scratch-chamber testing often leads to false-positive irritant reactions. A positive test to Balsam of Peru may indicate a spice allergy, but the absence of such reaction does not rule it out (157).
- Cinnamon is one of the 10 major food allergens (181). Cinnamaldehyde seems to be considered the "true" allergen, while cinnamyl alcohol and cinnamic acid are transformed in the skin to cinnamaldehyde before contact allergic reactions can occur (182;183). Studies confirmed the sensitivity of patients to cinnamic aldehyde in a toothpaste (184).
- Immunologic reactions to spices such as cinnamon may be related to acute symptoms and lung function changes, but not to chronic changes (185). Concerning allergic reactions to cinnamon dust, it may be the cellulose content that is responsible for the histological reactions (186). Cinnamon powder has shown low cross-reactivity in patients with positive skin tests to birch and/or mugwort pollens and celery (187). Alcohol as a vehicle was shown to have a higher sensitization potential than petrolatum, when cinnamon bark oil was used in predictive tests (188).

Adverse Effects/Post Market Surveillance:

- **General:** No adverse effects were observed in a pilot trial with five HIV patients (167). In two randomized trials on the effects of cinnamon on type-2 diabetes, no adverse effects were observed (114;168). One controlled trial reported minor adverse effects in five out of 15 patients (169).
- As with any spice or drug, cinnamon can be contaminated by microorganisms during storage. The microbiological quality of cinnamon was evaluated in several studies. Cinnamon showed mainly

satisfactory microbiological quality ([189;190](#)). However, contamination by aflatoxin-producing fungi can constitute health hazards in humans, as the aflatoxin level is not reduced by domestic cooking ([191;192;193](#)). Furthermore, cinnamon can contain detectable ethylene oxide ([194](#)).

- **Dermatologic:** Allergic hypersensitivity has been reported in several case reports, but rarely in clinical trials. Dermatitis, stomatitis, glossitis, gingivitis, perioral dermatitis, oral lesions, and cheilitis have been noted in case reports after external application of cinnamon (e.g., cinnamon oils) as well as after the use of flavored chewing-gums, mints, or toothpastes ([130;131;132;134;135;136;137;138;139;140;143;144;145;146;147;148;149;150;152;153;154](#)). Cinnamaldehyde may provoke oro-facial granulomatosis, urticaria, dermatitis, and stomatitis ([133;141;142;151](#)). A case report mentions a 24 year-old woman who developed a squamous cell carcinoma of the tongue following persistent and prolonged exposure to cinnamon-flavored gum ([155](#)).
- **Hematologic:** Cinnamon bark caused a significant decrease in platelet counts in normal rats after long-term use ([127](#)).
- **Pulmonary/Respiratory:** Asthma and other chronic respiratory symptoms were seen in spice-factory workers ([185;195;196](#)).

Precautions/Warnings/Contraindications:

- Use cautiously in patients prone to atopic reactions, due to predisposition towards allergic reactions with oral/topical cinnamon ([130;131;132;133;134;135;136;137;138;139;140;141;142;143;144;145;146;147;148;149;150;151;152;153;154;155](#)).
- Use cautiously in patients hypersensitive to Balsam of Peru ([156;157;158;159;160](#)).
- Use cautiously in patients taking cytochrome P450 metabolized agents, as there is *in vitro* evidence that cinnamon or its constituents interact with hepatic microsomal cytochrome P-450 ([115;116;117](#)).
- Use cautiously in patients using anticoagulants ([73;127](#)); cinnamon bark caused a significant decrease in platelet counts in normal rats after long-term use ([127](#)).
- Based on *in vitro* and animal studies, cinnamon may lower blood glucose levels and act as an insulin mimetic ([118;119;120;121;122;123;124;125;126](#)).
- In theory, cinnamon may enhance the effect of antibiotics ([9;12;27;29;49;56;88;89;92;109;167;197;198](#)).
- In theory, cinnamon may interact with cardiovascular agents, due to its several effects on blood and the cardiovascular system (e.g. antiarrhythmic properties) ([21;78;79;87;128;129](#)).

Pregnancy & Lactation:

- Not recommended due to lack of sufficient data.
- The effect of cinnamon and eugenol on human spermatozoa motility *in vitro* has been studied ([111](#)). The volatile oils studied revealed a potent spermicidal action, whereas the fixed oils were devoid of action on spermatozoa.

INTERACTIONS

Cinnamon/Drug Interactions:

- **General:** There is no evidence for interactions from available randomized clinical trials ([114;168](#)), controlled trials ([169](#)), or pilot studies ([167](#)).
- **Antibiotics:** In theory, the antibacterial properties of cinnamon seen *in vitro* may enhance the effect of commonly used antibiotics ([9;12;56;88;89;92;109](#)).
- **Antidiabetic agents:** Based on *in vitro* and animal study, cinnamon may lower blood glucose levels and act as an insulin mimetic ([118;119;120;121;122;123;124;125;126](#)).
- **Antiplatelet agents:** Based on animal study, cinnamon bark may cause a significant decrease in platelet counts after long-term use ([73;127](#)).
- **Antifungals:** In theory, the antifungal properties of cinnamon seen *in vitro* may enhance the effect of

commonly used antifungals ([27](#);[29](#);[49](#);[167](#);[197](#);[198](#)).

- **Antioxidants:** Cinnamon bark has been shown to contain very high concentrations of antioxidants ([60](#)). Several animal *in vitro* studies demonstrate the antioxidant effects of the essential oil obtained from the bark of *Cinnamomum zeylanicum* and its main components ([63](#);[65](#);[70](#);[71](#);[100](#);[199](#);[200](#)). Etheric, methanolic, and aqueous cinnamon extracts have also inhibited oxidative processes *in vitro* ([45](#);[61](#);[62](#);[64](#);[66](#);[67](#);[68](#);[90](#)).
- **Antispasmodics:** Based on secondary sources, cinnamon may have antispasmodic effects.
- **Antivirals:** Based on clinical study, *Cinnamomum cassia* bark extract may be effective against HIV-1 and HIV-2 replication in terms of inhibition of virus induced cytopathogenicity in MT-4 cells infected with HIV ([93](#)).
- **Cardiovascular agents:** In theory, cinnamon may interact with cardiovascular agents due to its several effects on blood and the cardiovascular system (e.g. antiarrhythmic properties) demonstrated in animal studies ([21](#);[78](#);[79](#);[87](#);[128](#);[129](#)).
- **Cytochrome P450 metabolized agents:** Based on *in vitro* studies, cinnamon or its constituents may interact with hepatic microsomal cytochrome P-450 ([115](#);[116](#);[117](#)). Cinnamon bark was found to inhibit aminopyrine N-demethylation in rat liver microsomes. The component inhibiting drug oxidations catalyzed by CYP1A2 and CYP2E1 was isolated from Cinnamomi cortex and was identified as o-methoxycinnamaldehyde (OMCA) ([201](#)).
- **Immunomodulators:** Based on *in vitro* and animal studies, cinnamon may act as an immunomodulator ([98](#);[99](#);[202](#);[203](#)).

Cinnamon/Herb/Supplement Interactions:

- **Antibacterials:** In theory, the antibacterial properties of cinnamon seen *in vitro* may enhance the effects of commonly used antibiotics ([9](#);[12](#);[56](#);[88](#);[89](#);[92](#);[109](#)).
- **Anticoagulants and antiplatelets:** Based on animal study, cinnamon bark may cause a significant decrease in platelet counts after long-term use ([127](#)).
- **Antifungals:** In theory, the antifungal properties of cinnamon seen *in vitro* may enhance the effects of commonly used antifungals ([27](#);[29](#);[49](#);[167](#);[197](#);[198](#)).
- **Antioxidants:** Cinnamon bark has been shown to contain very high concentrations of antioxidants ([60](#)). Several animal and *in vitro* studies demonstrate the antioxidant effects of the essential oil obtained from the bark of *Cinnamomum zeylanicum* and its main components ([63](#);[65](#);[70](#);[71](#);[100](#);[199](#);[200](#)). Etheric, methanolic, and aqueous cinnamon extracts also inhibited oxidative processes *in vitro* ([45](#);[61](#);[62](#);[64](#);[66](#);[67](#);[68](#);[90](#)).
- **Antispasmodics:** Based on secondary sources, cinnamon may have antispasmodic effects.
- **Antivirals:** Based on clinical study, *Cinnamomum cassia* bark extract may be effective against HIV-1 and HIV-2 replication in terms of inhibition of virus induced cytopathogenicity in MT-4 cells infected with HIV ([93](#)).
- **Cardiovascular agents:** In theory, cinnamon may interact with cardiovascular agents due to its several effects on blood and the cardiovascular system (e.g. antiarrhythmic properties) demonstrated in animal studies ([21](#);[78](#);[79](#);[87](#);[128](#);[129](#)).
- **Cytochrome P450 metabolized herbs and supplements:** Based on *in vitro* studies, cinnamon or its constituents may interact with hepatic microsomal cytochrome P-450 ([115](#);[116](#);[117](#)). Cinnamon bark was found to inhibit aminopyrine N-demethylation in rat liver microsomes. The component inhibiting drug oxidations catalyzed by CYP1A2 and CYP2E1 was isolated from Cinnamomi Cortex and was identified as o-methoxycinnamaldehyde (OMCA) ([201](#)).
- **Hypoglycemics:** Based on *in vitro* and animal studies, cinnamon may lower blood glucose levels and may act as an insulin mimetic ([118](#);[119](#);[120](#);[121](#);[122](#);[123](#);[124](#);[125](#);[126](#)).
- **Immunomodulators:** Based on *in vitro* and animal studies, cinnamon acts as immunomodulator ([98](#);[99](#);[202](#);[203](#)).

Cinnamon/Food Interactions:

- Cinnamon as a food item may cause aggravation of certain symptoms. Ingested cinnamon flavored foods might cause systemic contact reactions in some patients with allergy to Balsam of Peru ([158;204](#)).

Cinnamon/Lab Interactions:

- **Coagulation panel:** Based on animal studies, cinnamon bark may cause a significant decrease in platelet counts after long-term use ([73;127](#)).
- **Serum glucose:** Based on *in vitro* and animal studies, cinnamon may lower blood glucose levels and may act as an insulin mimetic ([118;119;120;121;122;123;124;125;126](#)).

MECHANISM OF ACTION

Pharmacology:

- **Constituents:** Cinnamon has been shown to contain allylbenzenes and their isomers, the propenylbenzenes ([22](#)). Cinnamon also contains monomeric and oligomeric proanthocyanidins ([205;206](#)), e.g. procyanidin B-2 and procyanidin B-3 ([207](#)). Quercetin, kaempferol, luteolin, and pelargonidin have been identified as the major flavonoids ([31;69](#)). Inorganic constituents of Cinnamomi cortex include potassium, calcium, iron, manganese, and strontium. A feature of the metals profile of Cinnamomi Cortex is high Mn-content ([208](#)).
- Cinnamon species contain volatile oils ([209;210](#)). At least 94 volatile components are present in cinnamon bark ([211](#)). Fifty-four constituents were identified in the essential oil from Cinnamon bark and twigs ([212](#)). The main components of the essential oil obtained from the bark of *Cinnamomum zeylanicum* are eugenol, cinnamaldehyde, and linalool ([198;199;213;214;215;216;217](#)). Each cinnamon plant part has a different primary constituent: cinnamaldehyde (bark oil), eugenol (leaf oil), and camphor (root-bark oil) ([218](#)). *Cinnamomum cassia* bark contains cinnamaldehyde, cinnamic acid, cinnamyl alcohol, and coumarin. Other *Cinnamomum* species, *C. wilsonii*, *C. japonicum*, *C. mairei*, and *C. burmanii*, contain low contents of cinnamaldehyde (<2.00mg/g) ([219](#)).
- The volatile oil from *Cinnamomum zeylanicum* fruit stalks contains hydrocarbons (44.7%) and oxygenated compounds (52.6%). Twenty-seven compounds constituting ca. 95.98% of the volatile oil have been characterized. (E)-Cinnamyl acetate (36.59%) and (E)-caryophyllene (22.36%) are found to be major compounds ([200](#)). *Cinnamomum zeylanicum* buds contain 34 compounds representing approximately 98% of the oil and consist of terpene hydrocarbons (78%) and oxygenated terpenoids (9%). Alpha-bergamotene (27.38%) and alpha-copaene (23.05%) are found to be the major compounds ([220](#)). The steam-distilled oil of *Cinnamomum zeylanicum* flowers consists of 23% hydrocarbons and 74% oxygenated compounds. A total of 26 compounds constituting approximately 97% of the oil have been characterized. (E)-Cinnamyl acetate (41.98%), trans-alpha-bergamotene (7.97%), and caryophyllene oxide (7.2%) were found to be major compounds ([221](#)). The essential oil isolated from *Cinnamomum osmophloeum* leaves contains six chemotypes: cinnamaldehyde type, cinnamaldehyde/cinnamyl acetate type, cinnamyl acetate type, linalool type, camphor type and mixed type ([41;197;222](#)). The major constituents of *Cinnamomum osmophloeum* leaf essential oil are the monoterpenes 1,8-cineole (17.0%) and santolina triene (14.2%) and the sesquiterpenes spathulenol (15.7%) and caryophyllene oxide (11.2%) ([223](#)).
- **Antibacterial properties:** Extracts of cinnamon, as well as the major components cinnamaldehyde and eugenol, have demonstrated activity against *Campylobacter jejuni*, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella enterica in vitro* ([9;56;89](#)). Cinnamon bark oil and its major components showed antibacterial effects on the major respiratory and gastrointestinal tract pathogens *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Streptococcus pyogenes*, *Staphylococcus aureus* and *Porphyromonas gingivalis in vitro* ([12;92;109](#)). Furthermore, cinnamon exhibited significant inhibitory effects both *in vitro* and *in vivo* on *Morganella morganii* ([88](#)).
- **Anti-cancer/antitumor properties:** The antitumor activity of *Cinnamomum* cortex is considered to be based on stimulation of the reticuloendothelial system (RES) and has been shown to be closely related to TNF production ([75](#)). A genotoxicity assay (micronucleus test) demonstrated dose-related antigenotoxic effects after urethane was co-administered orally with an aqueous extract of cinnamon to mice ([58](#)). *Cinnamomum cassia* induced the death of HL-60 cells demonstrated by reduction of

mitochondrial transmembrane potential and increase of caspase-3 activity (77). Cinnamaldehyde is also a potent inducer of apoptosis. It has been shown to transduce the apoptotic signal via reactive oxygen species (ROS) generation, thereby inducing mitochondrial permeability transition (MPT) and cytochrome c release to the cytosol. Thus, the anticancer effects of cinnamaldehyde may result from the induction of ROS-mediated mitochondrial permeability transition and resultant cytochrome c release (76).

- A strong MMP-9 inhibition was found in the butanol fraction of *Cinnamomum cassia* (83). Matrix metalloproteinase-9 (MMP-9) degrades type IV collagen constituting the major structural component of the basement membrane and extra cellular membrane; the enzymatic activity is found to be elevated in tumor tissues. 2'-Hydroxy-cinnamaldehyde and 2'-benzoyloxycinnamaldehyde isolated from *Cinnamomum cassia* strongly inhibited *in vitro* growth of 29 kinds of human cancer cells and *in vivo* growth of SW-620 human tumor xenograft in nude mice. HCA prevented adherence of SW-620 cells to the culture surface but did not inhibit oncogenic K-Ras processing, implying its antitumor mechanisms at the cellular level (82). HCT15 and SK-MEL-2 cells were very sensitive to the cinnamaldehyde analogues cinnamic acid, cinnamates and cinnamyl alcohols (81).
- **Antifungal properties:** Cinnamon oil had a significant inhibitory effect against several fungi *in vitro* (49; 197). Trans-cinnamaldehyde, a component in the oil of *C. zeylanicum*, was the most active against 17 micromycetes (198). The essential oils of several *Cinnamomum* species showed anticandidal and antidermatophytic activity *in vitro* (27;29). *C. zeylanicum* has shown potent *in vitro* activity against fluconazole-resistant and -susceptible *Candida* isolates (167).
- **Anti-inflammatory properties:** Cinnamon bark showed anti-inflammatory properties *in vitro* (44;74) and *in vivo* in the carbon clearance test (97). Eugenol and cinnamaldehyde were found to inhibit COX-2 *in vitro* in a rapid semi-homogeneous cyclooxygenase-2 (COX-2) enzymatic assay (43). Two *Cinnamomum* species (*C. altissimum* and *C. pubescens*) showed significant inhibitory effects on platelet aggregation (73). *Cinnamomum massoiae* cortex extract inhibited IgE-dependent histamine release (80). Extracts obtained from *C. osmophloeum* leaf essential oil have shown *in vitro* anti-inflammatory activity in anti-inflammatory activity assays (41;223).
- **Antimutagenic properties:** *Cinnamomum cassia* exerted significant antimutagenic effects against benzo[a]pyrene (B[a]P) and cyclophosphamide in mice pretreated with the plant extract as was observed in the Ames test, bone marrow chromosomal aberration assay, and micronucleus test (59). *C. cassia* pretreatment decreased liver cytochrome P450 content but increased glutathione content and the activity of glutathione-dependent antioxidant enzymes glutathione S-transferase, glutathione reductase, and glutathione peroxidase. These findings might demonstrate that the antimutagenic potential of *C. cassia* may be attributed to its modulatory effect on xenobiotic bioactivation and detoxification processes.
- **Antinociceptive properties:** An ethanolic extract of *Cinnamomum zeylanicum* was shown to possess an antinociceptive effect against both acetic acid-induced writhing and hot plate-induced thermal stimulation in mice (5). However, cinnamaldehyde is a specific TRPA1 (mammalian transient receptor potential (TRP) ion channel) activator, and has been shown to excite a subset of sensory neurons highly enriched in cold-sensitive neurons and elicit nociceptive behavior in mice (224;225).
- **Antioxidant properties:** Cinnamon bark has been shown to contain very high concentrations of antioxidants (60). Several animal *in vitro* studies have demonstrated the antioxidant effects of the essential oil obtained from the bark of *Cinnamomum zeylanicum* and its main components (63;65;70; 71;100;199;200). Etheric, methanolic, and aqueous cinnamon extracts also inhibited oxidative processes *in vitro* (45;61;62;64;66;67;68;90).
- **Antiviral properties:** *Cinnamomum cassia* bark extract was highly effective against HIV-1 and HIV-2 replication in terms of inhibition of virus induced cytopathogenicity in MT-4 cells infected with HIV (93).
- **Cardiovascular properties:** *Cinnamomum cassia* bark has been shown to affect the blood and cardiovascular system (128). *Cinnamomum cassia* increased the level of atrial natriuretic factor (ANF) in the plasma of mice (87); ANF acts to reduce the water, sodium, and adipose loads on the circulatory system, thereby reducing blood pressure. In experimental arrhythmia, *Cinnamomum migao* reduced the incidence of ventricular fibrillation caused by chloroform in mice and the ventricular tachycardia induced by adrenalin in rabbits, delayed the onset time of this arrhythmia, increased the arrhythmic doses of strophanthine-K in guinea pigs, reduced the incidence of some arrhythmias caused by barium chloride in

rats, and slowed down their heart rate (79). *Cinnamomum migao* oil reduced systolic and diastolic arterial blood pressure, slowed down the heart rate, decreased carbon monoxide levels, and reduced left ventricular pressure in anesthetized open-chest cats after i.d. application (129). Cinnamophilin, a thromboxane A₂ antagonist isolated from *Cinnamomum philippinense*, inhibited sodium inward current, calcium inward current, and transient outward current, in rat cardiac tissue and converted episodes of ischemia-reperfusion arrhythmia to normal sinus rhythm (78). Cinnamophilin dose-dependently inhibited human platelet-rich plasma (PRP) aggregation induced by arachidonic acid (AA), collagen, and U-46619 (21).

- **Gastroprotective properties:** Chinese cinnamon (the stem bark of *Cinnamomum cassia*) prevented serotonin-induced ulcerogenesis and inhibited gastric ulcers in rats after p.o. administration. In a pharmacological study, it hardly inhibited the secretion of gastric acid, but promoted gastric blood flow (86).
- **Hypocholesterolemic effects:** A study on the hypocholesterolemic effect of *Cinnamomum zeylanicum* did not show any cholesterol lowering-effect as seen in serum and liver cholesterol levels of rats when included in the diet at about 5-fold the normal human intake level (94).
- **Hypoglycemic properties:** Based on anecdote, cinnamon has been used to control blood sugar (226). Recent pharmacological studies have shown that cinnamon may play a possible role in improving glucose and insulin metabolism (127). Cinnamon was highly active in the insulin-dependent utilization of glucose using a rat epididymal adipocyte assay (119). Bioactive compounds extracted from cinnamon may potentiate insulin activity (118;120;123). A hydroxychalcone from cinnamon functioned as an insulin mimetic in 3T3-L1 adipocytes (121). Cinnamaldehyde exhibited strong inhibition against aldose reductase (125), an enzyme in carbohydrate metabolism that converts glucose to its sugar alcohol form, sorbitol, using NADPH as the reducing agent. Aqueous extracts of cinnamon significantly lowered the absorption of alanine, an important amino acid for gluconeogenesis, from the rat intestine (124). Blood glucose-lowering effects within two weeks have been shown for *Cinnamomum tamala* in alloxan diabetic albino rats (122). However, another pharmacological study demonstrated that consumption of diets containing *Cinnamomum tamala* did not alter diabetes parameters in streptozotocin diabetic mice (126).
- **Hypouricemic properties:** Oral administration of *Cinnamomum cassia* oil significantly reduced serum and hepatic urate levels in hyperuricemic mice (91). In normal mice, urate levels in liver, but not in serum, were altered with dose-dependent decrease after *C. cassia* oil treatment.
- **Immunomodulatory properties:** *In vitro*, an extract of *Cinnamomum cassia* markedly stimulated human lymphocytes to proliferate (99). Cinnamaldehyde derivatives inhibited the lymphoproliferation and induced a T-cell differentiation through the blockade of early steps in signaling pathways leading to cell growth (98). *Cinnamomum cassia* has shown anticomplement action and has inhibited the complement dependent allergic reaction (202). In rat nephrotoxic serum (NTS) nephritis, *Cinnamomum cassia* clearly inhibited the excretion of protein into the urine and the increase of peripheral leukocyte counts (203).
- **Inhibition of ATPase:** ATPases are a class of enzymes that catalyze the decomposition of adenosine triphosphate (ATP) into adenosine diphosphate (ADP) and a free phosphate ion. Water extracts of cinnamon inhibited the activity of rat liver Na⁺/K⁺ ATPase and Cu²⁺-ATPase but, as cinnamaldehyde and eugenol, stimulated rat mitochondrial F₀F₁ATPase, reduced mitochondrial membrane potential, inhibited NADH oxidase or complex I of the respiratory chain, and had no effect on succinate dehydrogenase activity (216;217). These effects result in a decrease in ATP level, defects in proton and ion transports leading to electrolyte imbalance, and derangements in mitochondrial function. Furthermore, cinnamon water extract most potently inhibited the *in vitro* activity of the rat jejunal Na⁽⁺⁾-K⁽⁺⁾-ATPase, the *in vitro* Na⁽⁺⁾-K⁽⁺⁾-ATPase activity in a crude kidney homogenate, and the activity of an isolated dog kidney Na⁽⁺⁾-K⁽⁺⁾-ATPase. The alcoholic extract of cinnamon, compared to the aqueous extract, had a stronger inhibitory action on the jejunal enzyme, as did cinnamaldehyde. Eugenol is the major inhibitory component in both alcoholic and aqueous extracts (124).
- **Larvicidal properties:** Larvicidal tests demonstrated that the leaf essential oils of cinnamaldehyde type and cinnamaldehyde/cinnamyl acetate type had an excellent inhibitory effect against the fourth-instar larvae of *Aedes aegypti* (222). Results of the 24-h mosquito larvicidal assays also showed that the effective constituents in leaf essential oils were cinnamaldehyde, eugenol, anethole, and cinnamyl

acetate. Cinnamaldehyde exhibited the strongest mosquito larvicidal activity.

- **Mood altering effects:** Cinnamon has been found to contain allylbenzenes and their isomers, the propenylbenzenes, which have been speculated to act as potential metabolic precursors of amphetamines, which may be responsible, in part, for potential mood uplifting effects (22). Humans may be exposed to amphetamines derived from these precursors during baking and cooking; however, the authors note that the biotransformation, pharmacodynamics, and pharmacokinetics of these aromatic allylbenzene compounds are not well understood in human clinical or laboratory studies.
- **Neuroprotective properties:** A water extract from the bark of *Cinnamomum cassia* significantly protected against glutamate-induced cell death and also inhibited glutamate-induced (45)Ca(2+) influx using cultured rat cerebellar granule cells (108). The authors suggest that *Cinnamomum cassia* bark may have a protective effect on glutamate-induced neuronal death through the inhibition of Ca(2+) influx.

Pharmacodynamics/Kinetics:

- **Absorption:** A pharmacokinetic study was performed measuring the absorption of orally administered procyanidin B-2 and procyanidin B-3 isolated from Cinnamomomi cortex (the bark of *Cinnamomum cassia*) in rat plasma (207). Intestinal absorption of cinnamaldehyde in anesthetized dogs administered i.d. occurred very early and was long-lasting (227).
- **Metabolism:** The metabolism of o-methoxycinnamaldehyde (intragastrically) was studied in rats. The major metabolic pathway (approx. two-thirds of the dose) was oxidation to the corresponding cinnamic and phenylpropionic acids (C6-C3 acids), which were largely excreted as glycine conjugates. Intermediate amounts (approx. 10% of the dose) of the O-demethylated C6-C3 acids were excreted. Urinary excretion of metabolites was rapid (91% in 24 h and 98% in 48 h) (228).

HISTORY

- Cinnamon has been mentioned in historical documents as a well-known spice in the New World and Europe (229).
- Cinnamon is commonly cultivated in tropical and subtropical regions such as Sri Lanka, India, Java, Sumatra, the West Indies, Brazil, Vietnam, and Madagascar. Cinnamon is a major product of Seychelles, an archipelago located east of mainland Africa (230).

EVIDENCE TABLE

Condition	Study Design	Author, Year	N	Statistically Significant?	Quality of Study 0-2=poor 3-4=good 5=excellent	Magnitude of Benefit	ARR	NNT	Comments
Candidiasis (oral, in advanced AIDS)	Pilot study	Quale, 1996	5	No	0	NA	NA	NA	Pilot study; unblinded. Small sample size.
Diabetes (type 2)	Randomized controlled trial	Vanschoonbeek, 2006	25	No	2	NA	NA	NA	Small sample size, limited collective, inadequate description of blinding; 1,500mg of cinnamon daily.
Diabetes (type 2)	Randomized controlled trial	Khan, 2003	60	Yes	1	Small	NA	NA	Unblinded; no information on standardization of dosing. 1, 3, or 6g of cinnamon daily.
<i>Helicobacter pylori</i> infection	Controlled trial	Nir, 2000	23	No	1	NA	NA	NA	Pilot study, unblinded; 40mg cinnamon extract daily.

EVIDENCE DISCUSSION

Candidiasis

- **Summary:** *In vitro* evidence of the activity of cinnamon against fluconazole-resistant and -susceptible *Candida* isolates led to a pilot study in patients with HIV infection and oral candidiasis (167). Due to the small sample size, general assumptions are not possible. Clinical trials will be necessary to determine the usefulness of cinnamon for the treatment of mucosal candidiasis.
- **Evidence:** Quale et al. conducted a pilot study in five patients with HIV infection and oral candidiasis to investigate the activity of cinnamon (*Cinnamomum zeylanicum*) against fluconazole-resistant and -susceptible *Candida* isolates (167). All included patients had pseudomembranous candida infection confirmed by culture. Patients were given eight lozenges of cinnamon candy no. 1 daily (no further information given). The commercially available extract was administered for one week. No adverse effects were reported. No toxic effects were reported. There were no dropouts. No interactions were reported. Improvement of oral candidiasis served as the outcome measure. Three of the five patients had improvement of their oral candidiasis (no further details given). The pilot study was neither randomized nor blinded, and the sample size was very small.

Diabetes (type 2)

- **Summary:** The insulin-sensitizing effect of cinnamon was established in *in vitro* cell line studies with adipocytes as well as in *in vivo* animal studies (118;119;120;121;123;124;125;127). The first published *in vivo* study on cinnamon supplementation in humans reported a substantial reduction of fasting serum glucose concentration and improvement in blood lipid profile in patients suffering from type 2 diabetes (114). However, a very recent study in postmenopausal women could not substantiate these effects, in which cinnamon supplementation did not improve whole-body insulin sensitivity or oral glucose tolerance and did not modulate blood lipid profile (168). More research on the proposed health benefits of cinnamon supplementation is warranted.
- **Evidence:** Vanschoonbeek et al. conducted a randomized, placebo controlled trial of 25 postmenopausal patients to investigate the effects of cinnamon supplementation on insulin sensitivity and/or glucose tolerance and blood lipid profile in patients with type 2 diabetes (168). Postmenopausal women diagnosed with type 2 diabetes were included. Exclusion criteria were impaired liver or renal function, cardiovascular disease, and exogenous insulin therapy. All subjects were using either oral blood glucose-lowering agents or diet only. The subjects received either 1,500mg cinnamon (*Cinnamomum cassia*) or 1,500mg placebo daily. The cinnamon was consumed for six weeks. One capsule (500mg) was to be ingested at each meal. No information is given concerning standardization of the drug. No allergies or adverse effects were reported. No toxic effects were observed. No dropouts were mentioned. No interactions were observed. Outcome measures were whole-body insulin sensitivity or oral glucose tolerance after two and six weeks of supplementation. In addition, glycosylated hemoglobin (HbA_{1c}) and blood lipid profiles were determined. During the intervention period, there were no interactions for plasma HbA_{1c}, fasting glucose, insulin concentrations, or fasting blood lipid concentrations ($p>0.05$). Limitations of the study include inadequate description of blinding or randomization and withdrawals, as well as a small sample size and a limited patient collective, which may have allowed for the introduction of bias.
- Khan et al. conducted a randomized, placebo controlled trial of 60 patients (30 men, 30 women) to determine whether cinnamon improves blood glucose and triglyceride, total cholesterol, HDL cholesterol, and LDL cholesterol levels in patients with type 2 diabetes (114). Selection criteria for the study included the following for patients with type 2 diabetes: age >40 years, not on insulin therapy, not taking medicine for other health conditions, and fasting blood glucose levels between 7.8 and 22.2mM/L (140-400mg/dl). All subjects were taking sulfonylurea drugs, i.e. glibenclamide; medications did not change during the study. The subjects were randomly divided into six groups. Groups 1, 2, and 3 consumed 1, 3, or 6g of cinnamon daily, respectively, and groups 4, 5, and 6 were given placebo capsules corresponding to the number of capsules consumed for the three levels of cinnamon. The

cinnamon was consumed for 40 days followed by a 20-day washout period. No information is given concerning standardization of the drug. No allergies or adverse effects were reported. There were also no problems with compliance or problems associated with the consumption of ≤6g of cinnamon per day. No toxic effects were observed. There were no dropouts. No interactions were observed. Outcome measures were the reduction of blood glucose, triglyceride, total cholesterol, HDL cholesterol, and LDL cholesterol levels. After 40 days, all three levels of cinnamon reduced the mean fasting serum glucose (18-29%) and triglyceride (23-30%), LDL cholesterol (7-27%), and total cholesterol (12-26%) levels (p<0.05 for each). No significant changes were noted in the placebo groups. Changes in HDL cholesterol were not significant. Limitations of the study include inadequate description of standardization of dosing, blinding, or randomization, withdrawals, as well as failure to conduct an intention-to-treat analysis, and lack of dietary standardization.

Helicobacter pylori infection

- **Summary:** Based on *in vitro* studies, which have shown the effectiveness of cinnamon extracts against *Helicobacter pylori* (231;232), a pilot study was conducted in order to test the activity of an alcoholic extract of cinnamon in a group of patients infected with *H. pylori*. Unfortunately, the cinnamon extract, at a concentration of 80mg/day as a single agent, was ineffective in eradicating *H. pylori*. However, the combination of cinnamon with other antimicrobials, or cinnamon extract at a higher concentration, may prove useful. Further studies are warranted.
- **Evidence:** Many different plant extracts have been tested for *in vitro* antibacterial activity. A review critically evaluated controlled clinical trials of herbal medicines with antibacterial activity (233). Seven clinical trials met the inclusion criteria. The only clinical trial with cinnamon is described.
- Nir et al. conducted a controlled trial of 23 patients (18 women, 5 men) to test the activity of an alcoholic extract of cinnamon for *Helicobacter pylori* infection (169). Patients were eligible for the study if they had a positive *Camphylobacter* urease test (CUT) for *H. pylori*. Patients with a bleeding duodenal ulcer or poor general condition were excluded as well as pregnant women (or women planning pregnancy), patients using nonsteroidal anti-inflammatory drugs (NSAIDS), steroids, bismuth preparations, alcohol, or illicit drugs, or those having used antibiotics in the preceding months. Fifteen patients (11 women, 4 men) received 40mg cinnamon extract, eight patients (7 women, 1 man) received placebo. The extract or the placebo was administered twice daily for four weeks. The concentration of the major growth inhibitory component (cinnamaldehyde) was 1.68mg/mL. The cinnamon extract was well tolerated. Five patients reported minor side effects (no further information given). No toxic effects were observed. Seven patients were excluded from the final analysis for the following reasons: negligible count on urea breath test despite presence of bacteria (1), noncompliance (3), and antibiotic treatment (3). No interactions were observed. The amount of *H. pylori* colonization measured by the 13C urea breath test served as the outcome measure. The mean urea breath test counts in the study and control groups before and after therapy were 22.1 and 23.9 vs. 24.4 and 25.9, respectively. Results were not significant. This pilot study was neither randomized nor double-blind.

PRODUCTS STUDIED

Brands used in statistically significant clinical trials:

- Not applicable.

Brands shown to contain claimed ingredients through third-party testing:

- **Consumer Lab:** NA. Last accessed 6/19/07.
- **Consumer Reports:** NA. Last accessed 6/19/07.
- **Natural Products Association:** NA. Last accessed 6/19/07.
- **NSF International:** NA. Last accessed 6/19/07.
- **U.S. Pharmacopeia:** NA. Last accessed 6/19/07.

U.S. equivalents of most commonly recommended European brands:

- Not applicable.

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