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CINNAMON (*CINNAMOMUM ZEYLANICUM* L.)

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ABSTRACT

Cinnamon (*Cinnamomum zeylanicum* L.) is one of the most popular spices. It has been used for thousands of years for its medicinal properties. It has long been used for the treatment of diabetes, inflammation and stomach ulcers. It has also antibacterial, antifungal, antiparasitic and mosquito larvicidal activities. It is also used for the treatment of cough and cold, to treat gastrointestinal disturbances, bronchial asthama and asthenia of blood. Cinnamon consists of volatile acids (1-2%). It is mainly composed of cinnamic aldehyde (75-90%) and eugenol (8%).

Key words: Cinnamon, antibacterial, antifungal, antiulcerogenic, euginol.

INTRODUCTION

Cinnamon is one of the world's most popular and the oldest spices. Cinnamon is the bark of a small Southeast Asian evergreen tree and is available as an oil, extract or dried powder. There are more than 100 varieties of this fragrant, somewhat sweet spice (Platkin, 2005). Its medicinal uses have been recorded to date around 2700 BCE and somewhat later in ancient Greek and Latin text (Leung and Foster, 1996). Cinnamon also enjoys traditional use in Ayurvedic medicine. It is mentioned in the Book of Moses and has been cultivated in Ceylon and Sri Lanka since A.D. 1200, where much of the world's supply is still grown. In Europe, cinnamon was regarded as a rare and precious spice. Many pharmaceutical substances such as cough syrups and digestive tonics contained cinnamon. It was also used as incense and in perfumes. Cinnamon possesses antiseptic properties. It is gathered from the dried inner bark of the branches of a small, tropical, evergreen laurel tree. The bark is peeled off and, as the pieces are dried, they curl up into quills. These are the common cinnamon sticks that are used in herb teas and for baking (Zampieron and Kamhi, 2000). Cinnamon contains manganese, dietary fiber and iron. Two teaspoons have about 12 calories (Platkin, 2005).

CHEMISTRY

Cinnamon consists of volatile oils (1-2 %). It is mainly composed of cinnamicaldehyde (75-90 %) and eugenol (8 %). Other constituents include phenolic compounds (condensed tannins), flavonoid derivatives (proanthocyanidins and oligomers or cinnamtannins), mucilage, calcium oxalate, resins, sugars and coumarins (Bruneton, 1995; Leung and Foster, 1996; Newall *et al*., 1996). E-cinamaldehyde and delta-cadinene were found as the major constituents of cinnamon essential oil (Singh *et al.*, 2007). The eugenol, cinnamicaldehyde (Oiye and Murold, 2002), E-cinamaldehyde and proanthocyanidins have been reported as antibacterial components (Shan *et al.*, 2007). Nuclear magnetic resonance analysis of the purified fraction revealed that antiviral activity of cinnamon was due to the presence of cinnzeylanine (Orihara *et al.*, 2008).

MEDICINAL USES

Cinnamon has a large number of medicinal usages. Some best known usages are as follows.

(1) *Anti-diabetic activity*

Cinnamon extract has a direct anti-diabetic potency. Most of the animal studies described bebeficial effects of cinnamon on glycaemic control (Kleefstra *et al.*, 2007). It significantly helps peoples with type2 diabetes to improve their ability to respond to insulin, thus normalizing their blood sugar levels. The compounds in cinnamon not only stimulate insulin receptors, but also inhibit an enzyme that inactivates them, thus significantly increasing cell's ability to use glucose (Khan *et al*., 2003; Verspohl *et al*., 2005). According to Pham *et al.*, (2007) cinnamon has a modest effect on lowering plasma glucose level with poorly controlled type 2 diabetes. While in another study cinnamon did not appear to improve fasting blood glucose in patients with type 1 and type 2 diabetes (Baker *et al.*, 2008).

(2) *Anti-clotting and Anti-inflammatory activity*

The cinnamic aldehyde in cinnamon helps to prevent unwanted clumping of blood platelets. Cinnamic aldehyde inhibits the release of an inflammatory fatty acid called arachidonic acid from platelet membranes. It also reduces the formation of an inflammatory messaging molecule called thromboxane A2. Its ability to lower the release of arachidonic acid from platelet membrane also categorized it an "anti-inflammatory" food (Takenaga *et al*., 1987).

(3) *Anti-ulcerogenic activity*

Animal studies suggest that an extract of cinnamon bark taken orally might help to prevent stomach ulcers (Tanaka *et al.,* 1989). For example, an aqueous extract has demonstrated anti-ulcerogenic activities in rats as effectively as cimetidine (Akira *et al.,* 1986).

(4) *Antioxidant activity*

Cinnamon is s powerful antioxidant (Jayaprakasha *et al.,* 2006; Singh *et al.,* 2007). When it was compared to other antioxidant spices (anise, ginger, nutmeg and vanilla) and the chemical food preservatives (butylated hydroxyanisol, butylated hydroxytoluene and propyl gallate), cinnamon was found most effective among all other spices and the chemical antioxidants tested (Murcia *et al*., 2004).

(5) *Antibacterial activity*

Cinnamon oil and extract also have antibacterial properties (Oussalah *et al.,* 2006). Cinnamon oil was found to be inhibiting both Gram-positive and Gram-negative bacteria (Prabuseenivasan *et al*., 2006). *In vitro* studies have shown the effectiveness of cinnamon extract against *Helicobacter pylori* (Quale *et* al., 1996; Nir *et al.,* 2000). In contrast, in another study, cinnamon was not found effective against *H. pylori* (Dugoua *et al.,* 2007).

Besides, the oil of cinnamon significantly decreases the production of enterotoxin A and B by *Staphylococcus aureus* (Smith-Palmer *et al.,* 2004). Cinnamon essential oil was found to be active against *Escherichia coli* and *S. aureus*. It was found that bacteria treated with essential oil of cinnamon exhibited a wide range of significant abnormalities; these include formation of blebs, coagulation of cytoplasmic constituents, collapse of the cell structure and lack of cytoplasmic material (Becerril *et al.,* 2007). Besides, in the presence of 0.05% of the oil, most of cells of *E. coli* were killed after 30 min, suggesting that the antibacterial activity of essential oil is bactericidal against *E. coli*. The minimal inhibitory concentration (MBC) of the essential oil from cinnamon was around 625 ppm against *E. coli* O157:H7 and *E. coli* ATCC 25921, around 1250 ppm against *E. coli* ATCC25922 and around 2500 ppm against *E. coli* ATCC11105 (Senhaji *et al.,* 2007).

In another study, antibacterial activity of cinnamon essential oil was evaluated against a wide range of bacteria, including Gram-negative bacteria (*E. coli, Yersinia enterocolitica, Pseudomonas aeruginosa* and *Salmonella cholaraesuis*) and Gram-positive bacteria (*Listeria monocytogenes, S. aureus, Bacillus cereus* and *Enterococcus faecalis*). Cinnamon showed strong antibacterial activity against these tested bacteria (Lopez *et al.,* 2007).

The antimicrobial study of essential oil of cinnamon bark and cinnamon leaf against *Listeria monocytogenes* was studied in semiskimed milk. The MIC was 500 ppm 3000 ppm for cinnamon bark and leaf essential oil respectively. The MBC was 3000 ppm for cinnamon bark and 11000 ppm for cinnamon leaf essential oil. These results indicated that cinnamon essential oils can be used as antimicrobials in milk beverages (Cava *et al.,* 2007).

In a study, the antibacterial activity, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) of cinnamon stick extract were evaluated against five common foodborne pathogenic bacteria (*Bacillus cereus, Listeria monocytogenes, Staphylococcus aureus, Escherichia coli, and Salmonella anatum*). Cinnamon stick extract exhibited significant antibacterial properties against all tested organisms (Shan *et al.,* 2007).

In addition, the essential oil of Cinnamomum zeylanicum bark enhanced the bactericidal activity of clindamycin and decreased the minimum inhibitory concentration of clindamycin required for a toxicogenic strain of *Clostridium difficile*. Low concentrations of trans-cinnamaldehyde elevate the antimicrobial action of clindamycin, suggesting a possible clinical benefit for utilizing these natural products for combination therapy against *C. difficile* (Shahverdi *et al.,* 2007).

In another study carried out by Ooi *et al.* (2006) both cinnamon essential oil and cimmanaldehyde were found effective in inhibiting the growth of various isolates of bacteria including Gram-positive (1 isolate, *Staphylococcus aureus*), and Gram-negative (7 isolates, *E. coli, Enterobacter aerogenes, Proteus vulgaris, Pseudomonas aeruginosa, Vibrio cholerae, Vibrio parahaemolyticus and Samonella typhymurium*).

Fabio *et al.* (2007) evaluated the antibacterial activity of cinnamon essential oil against *Streptococcus pyogenes, agalactiae, pneumoniae and Klebsiella pneumoniae, Haemophilus influenzae, Staphylococcus aureus* and *Stenotrophomonas maltophilia* isolated from clinical specimens. Cinnamon oil showed strong action against all isolates.

(6) *Antifungal activity*

The aqueous decoction and oil of cinnamon bark has an inhibitory effect against fungi *in vitro* (Chang and But, 1986; Singh *et al*., 1995; Matan *et al.,* 2006). Guynot *et al*. (2003) has demonstrated the antifungal effect of cinnamon leaf essential oil against species of common fungi causing spoilage of bakery products viz., *Eurotium amstelodami*, *Eurotium herbariorum*, *Eurotium repens*, *Eurotium rubrum*, *Aspergellus flavus*, *Aspergellus niger* and *Penicillium carylophilum*. Furthermore, 1% of cinnamon extract has significant inhibitory effect on the growth of *Aspergillers paraciticus* spores and aflatoxin production (Bullerman, 1974). In another study, antibacterial activity of cinnamon essential oil was evaluated against some molds (*Penicillium islandium* and *Aspergillus flavus*) and a yeast (*Candida albicans*). Cinnamon showed strong antifungal activity against these fungi (Lopez *et al.,* 2007). Cinnamon essential oil and cinnamaldehyde also found to be effective against fungi including yeasts (four species of *Candida, C. albicans, C. tropicalis, C. glabrata, and C. krusei*), filamentous molds (4 isolates, three *Aspergillus* spp. and one *Fusarium* sp.) and dermatophytes (three isolates, *Microsporum gypseum, Trichophyton rubrum and T. mentagraphytes*) (Ooi *et al.,* 2006).

In case of *Candida* species, cinnamon oil is the most effective oil against pathogenic *Candida* species, especially against *Candida albicans*, the fungus responsible for vaginal yeast infections and thrush (Abdel-Mallek *et* al., 1994; Veal, 1996).

(7) *Antiviral activity*

Cinnzeylanine, an active compound of cinnamon, inhibits the proliferation of herpes simplex virus type 1 (Orihara *et al.,* 2008).

(8*) Antiparasitic activity*

Cinnamon also has antiparasitic properties (Oishi *et al*., 1974). It has been found to be active against head lice, *Pediculus humanus capitis* (Veal, 1996). The toxicity of cinnamon, *Cinnamomum zeylanicum*, bark essential oil compounds against eggs and adult females of human head louse, *Pediculus humanus capitis*, was examined using direct contact and vapour phase toxicity bioassays and compared with the lethal activity of their related compounds, benzyl alcohol, cinnamic acid, cinnamyl acetate, 4-hydroxybenzaldehyde and salicylaldehyde, as well as two widely used pediculicides, d-phenothrin and pyrethrum. In a filter-paper contact toxicity bioassay with female lice at 0.25 mg/cm(2), benzaldehyde was 29- and 27-fold more toxic than pyrethrum and d-phenothrin, respectively, as judged by median lethal time (LT(50)) values. Salicylaldehyde was nine and eight times more active than pyrethrum and d-phenothrin, respectively. Pediculicidal activity of linalool was comparable with that of d-phenothrin and pyrethrum. Cinnamomum bark essential oil was slightly less effective than either d-phenothrin or pyrethrum. Benzyl alcohol and (E)-cinnamaldehyde exhibited moderate pediculicidal activity. After 24h of exposure, no hatching was observed with 0.063 mg/cm(2) salicylaldehyde, 0.125 mg/cm(2) benzaldehyde, 0.5mg/cm(2) Cinnamomum bark essential oil, 1.0 mg/cm(2) (E)-cinnamaldehyde, and 1.0 mg/cm(2) benzyl cinnamate. Little or no ovicidal activity was observed with d-phenothrin or pyrethrum. In vapour phase toxicity tests with female lice, benzaldehyde and salicylaldehyde were much more effective in closed containers than in open ones, indicating that the mode of delivery of these compounds was largely due to action in the vapour phase. Neither d-phenothrin nor pyrethrum exhibited fumigant toxicity. Cinnamomum bark essential oil and test compounds described merit further study as potential pediculicides or ovicides for the control of *P. h. capitis* (Yang *et al.,* 2005).

(9) *Mosquito larvicidal activity*

According to Cheng *et al*. (2004), among cinnamic aldehyde, eugenol, anethole and cinnamylacetate, isolated from cinnamon, cinnamic aldehyde exhibit the strongest mosquito larvicidal activity. In another study, the larvicidal activity of cinnamon oil was tested against 3 mosquito species; *Aedes albopictus, Aedes aegypti* and *Culex pipiens*. Cinnamon oil seemed to be effective and demonstrated the larvicidal effects for these three species of mosquito (Zhu *et al.,* 2006).

OTHER USES

Cinnamon is used for the treatment of cough, cold and fever. It is used in the form of its aqueous infusion or decoction, alcoholic fluidextract and/or tincture, dry powder in capsule and tablets and essential oils. Cinnamon has been used to treat gastrointestinal disturbances, bronchial asthma and asthenia of blood. It has also been used as a digestive or stomachic component of herbal preparations (Chang and But, 1986).

The British Herbal Pharmacopia indicates its use for flatulent colic and diarrhea. The German Standard License for cinnamon bark tea infusion recommends it for a feeling of distention, flatulence, and mild cram-like gastrointestinal

disorders due to reduced production of gastric juice (Anonymous, 2000). Furthermore, Germany's Commission E approves cinnamon for improving appetite, dyspeptic complaints and relieving indigestion (Blumenthal, 1998).
In a study Khan *et al.,* (2003) reported that intake of 1, 3, or 6g of cinnamon per day reduces serum glucose, triglyceride, LDH, and total cholesterol in people with type 2 diabetes. Two different herbal formulae containing cinnamon in an aqueous decoction, prescribed in Traditional Chinese Medicine, stimulate the blood circulation (Chang and But, 1986).

In addition, oral administration of cinnamaldehyde (20 mg/kg bw) significantly decreased glycosylated hemoglobin (HbA(1C)), serum total cholesterol, triglyceride levels and at the same time markedly increased plasma insulin, hepatic glycogen and high-density lipoprotein-cholesterol levels. Also cinnamaldehyde restored the altered plasma enzyme (aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, alkaline phosphatase and acid phosphatase) levels to near normal (Subash *et al.*, 2007).

DOSAGE ADMINISTRATION

According to Leung and Foster (1996) typical recommended dosages of cinnamon are:

Ground bark: 2-4 g per day.
Infusion or decoction: 0.7-1.3 g in 150 ml water, three times daily.
Fluidextract 1:1 (g/ml): 0.7-1.3 ml, three times daily.
Tincture 1:5 (g/ml): 3.3-6.7 ml, three times daily.
Essential oil: 0.05-0.2 g per day.

CONTRAINDICATIONS

During pregnancy and lactation, women should avoid taking cinnamon oil or high dose of the bark (McGuffin *et* al., 1997; Blumenthat, 1998). In some instances a hypersensitivity reaction to cinnamon can elicit lesions consistent with orofacial granulomatosis (Endo and Rees, 2007).

SAFETY ISSUE

As a widely used food, cinnamon is believed to be safe. However, cinnamon essential oil is much more concentrated than the powdered bark commonly used for baking. There is some evidence that high doses of cinnamon oil might depress the central nervous system (Harada and Ozaki, 1972). Besides, when use topically, cinnamon oil may cause flushing and a burning sensation (Perry *et al*., 1990). In addition, some peoples have reported strong sensation on mouth ulcers after chewing cinnamon-flavored gum or candy. However, these reactions disappeared within days of discontinuing the cinnamon-flavored chewing gum (Allen and Blozis, 1988; Mihail, 1992).

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