Cinnamon

Cinnamomum verum J. Presl

Family: Lauraceae (the laurel or avocado family). Approximately 250 species have been identified among the cinnamon genus with trees being scattered all over the world.[1] Formerly known by the synonym Cinnamomum zeylanicum. Not to be confused with cassia (Cinnamomum cassia (L.) J.Presl or synonym C. aromaticum Nees) which is cheaper, has a stronger flavour and is often marketed as 'cinnamon'. C. aromaticum J.Graham is a synonym for true cinnamon.[2,3]

Parts Used: Stem-bark outer

Description: Cinnamon has been known since remote antiquity. It is native to Sri Lanka, formerly known by the colonial name Ceylon. Other common names include true cinnamon (verum means true) and Sri Lanka, or Ceylon, cinnamon. It also grows throughout India, Bangladesh, Java, Sumatra, West Indies, Brazil, Egypt and Vietnam.

This small, evergreen, tropical tree reaches 10 to 15 metres in height and is covered with a thick, scabrous bark. The branches are numerous, strong, horizontal and declining, and the young shoots are speckled with dark green and light orange colours.[4] The leaves are ovate-oblong and range in size from seven to 18 centimetres long.

The inconspicuous flowers have a green-yellowish colour and can be longer than the leaves. They are arranged in panicles and have a distinct, unpleasant odour. The fruit is a purple-black berry measuring around one centimetre and contains a single seed. Cinnamon sticks are made from the bark of the tree and are rolled naturally into a quill shape when the bark is sun-dried. The oil is traditionally prepared by roughly pounding the bark, macerating it in seawater, and then quickly distilling the whole. It is of a golden-yellow colour with the characteristic odour of cinnamon and a very hot, aromatic taste.[5]

Traditional and Empirical Use: Cinnamon has a long history of use as a culinary spice in many cultures, being sought after in sweet and savoury dishes alike such as breads, cakes and curries. In ancient times cooks relied on spices such as cinnamon to preserve or disguise bad meat and to prevent food spoiling. It was used in Egypt for embalming, and during the Bubonic Plague sponges were soaked in cinnamon and cloves and placed in sick rooms. It has also been burned as incense. In addition to its culinary uses, in native Ayurvedic medicine cinnamon is considered a remedy for respiratory, digestive and gynaecological ailments. Cinnamon's history as a medicinal plant goes as far back as the Ancient Egyptians and it was included in Chinese medical texts four thousand years ago for heart problems, influenza, digestive and urinary problems. During the explorations of the fifteenth and sixteenth centuries cinnamon was a highly sought- after spice. The Portuguese found cinnamon trees growing in Sri Lanka (Ceylon) in the early 16th century and 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. As its availability across Europe increased it was then adopted by herbalists for medicinal uses. It was traditionally used as a warming, flavouring agent (adjuvant) anddigestivetonic.Itsastringentactionhasmadeituseful in cases of diarrhoea. It was also used for rheumatism and menstrual disorders such as menorrhagia.[6,7]

Germany's Commission E approves cinnamon for appetite loss, dyspeptic complaints such a mild, spastic conditions of the gastrointestinal tract, bloating and flatulence.[8]

Constituents: In addition to flavour, a critical difference between true cinnamon and cassia is the coumarin content of cassia. The levels of coumarins in cassia appear to be very high and pose health risks if consumed regularly in higher quantities. Coumarins are plant compounds with strong anticoagulant and suspected carcinogenic and hepatotoxic properties. Coumarin is known to cause liver and kidney damage in rats and mice and there are isolated incidents of similar hepatotoxicity in humans. Cassia contains high levels of coumarin (up to 1%), whereas true cinnamon contains either undetectable levels or only traces of coumarin (0.004%). In addition, according to currently available evidence, coumarin does not seem to play a direct role in the observed biological effects of cassia. Hence, although cassia has also shown many beneficial medicinal properties, its coumarin content is likely to be an obstacle against regular use as a pharmaceutical agent, unlike in the case of true cinnamon.[9,10,11]

Three of the main components of the essential oils obtained from cinnamon are trans-cinnamaldehyde, eugenol and linalool, which represent 82.5% of the total composition. Trans-cinnamaldehyde accounts for approximately 49.9 to 62.8% of the total amount of bark oil. Cinnamaldehyde and eugenol are also the major components. Cinnamomum verum is stated to contain the highest amount of eugenol.12 Cassia usually produces only one main type of oil, almost 95% of this oil consists of cinnamaldehyde with slight variation between the different parts of the plant. Other constituents include methoxycinnamaldehyde, benzaldehyde, coumarin, limonene, eugenol and cinnamyl acetate. Methods of distinguishing true cinnamon oil from cassia oil are based on the presence of increased content of benzaldehyde, methoxycinnamaldehyde and coumarin in cassia oil.[13,14],

Other constituents are oligopolymeric procyanidins, cinnamic acid, phenolic acids, pentacyclic diterpenes cinnzeylanol and it's acetyl derivative cinnzeylanine and the sugars mannitol, L-arabino-D-xylanose, L-arabinose, D-xylose, α-D-glucan as well as mucilage polysaccharides. Each 100 grams contains vitamin A: 260 IU, thiamine: 0.02 mg, riboflavin: 0.14 mg, niacin: 1.3 mg, ascorbic acid: 28 mg, Ca: 1.228 mg, P: 61 mg, Fe: 38 mg, Mg: 56 mg, Na: 26 mg, K: 500 mg, Zn: 2 mg.[15]

Actions: Hypoglycaemic, hypoinsulinaemic, antioxidant, anticancer, antimicrobial, antifungal, antiviral, immunomodulator, astringent, antidiarrhoeal, carminative, hypolipidaemic.

Pharmacological Activity: The available in vitro and in vivo evidence suggests that cinnamon has many beneficial health effects. However, since data on humans is sparse, randomised controlled trials in humans will be necessary to determine whether these effects have public health implications.[16]

Metabolic Activities: Glucose and Insulin Modulation

The mechanism of action by which cinnamon reduces blood glucose has been well studied in vitro and in vivo. It seems that cinnamon reduces intestinal glucose absorption by inhibiting enzymes, stimulating cellular glucose uptake, glycogen synthesis, insulin release, potentiating insulin receptor activity and inhibiting gluconeogenesis by effects on key regulatory enzymes.[17]

A recent meta-analysis, and a systematic review, on the effects of cinnamon on diabetes demonstrate numerous beneficial effects both in vitro and in vivo. The beneficial effects of cinnamon in vivo include attenuation of weight loss associated with diabetes, reduction of Fasting Blood Glucose, reducing LDL and increasing HDL cholesterol, reducing HbA1c and increasing circulating insulin levels. In vitro cinnamon has demonstrated a potential for reducing post-prandial (following a meal) intestinal glucose absorption by inhibiting the activity of enzymes involved in carbohydrate metabolism (pancreatic

α–amylase and α–glucosidase), stimulating cellular glucose uptake by membrane translocation of glucose transporter 4 (GLUT- 4) and stimulating glucose metabolism. Cinnamtannin B1 was identified as the potential active compound responsible for these effects. In addition, cinnamon also showed beneficial effects against diabetic neuropathy and nephropathy.[18,19]

The results of a 2014 study suggest that cinnamon may provide a natural and safe solution for the reduction of postprandial hyperglycaemia (high blood sugar after eating) and therefore help to reduce the risks of developing metabolic disorders. Postprandial hyperglycaemia is a known risk factor for the development of several health disorders including type 2 diabetes, obesity, oxidative stress and cardiovascular diseases. One encouraging approach for better control of postprandial hyperglycaemia is to reduce carbohydrate digestion. Cinnamon extracts have been known for managing blood glucose. However, their effects on inhibiting digestion of carbohydrate have been poorly analysed. The aim of this study was to investigate the acute effect of a specific Ceylon cinnamon hydro-alcoholic extract (CCE) on carbohydrate digestion and post-meal blood glucose reduction. In vitro enzymatic assays and in vivo starch tolerance tests in rats were designed as preclinical assays. Then a randomised, double-blind, placebo-controlled, cross-over clinical trial was conducted in 18 healthy female and male volunteers. Following the intake of one gram of CCE the subjects ate a standardised meal. Blood samples were collected during the two hours following the meal to measure glucose and insulin concentrations. In the in vitro study CCE demonstrated that it inhibited pancreatic α-amylase activity with an IC50 of 25 µg/mL. In the in vivo study, CCE was shown to acutely reduce the glycaemic response to starch in a dose-dependent manner in rats. This effect was significant from the dose of 12.5 mg/kg of body weight. In both the in vitro and in vivo studies the hydro-alcoholic extract was more efficacious than the aqueous extract. In the human clinical trial, one gram of CCE lowered the area under the curve of glycaemia between 0 and 120 minutes by 14.8% ($p = .15$) and between 0 and 60 minutes by 21.2% ($p < .05$) compared to the placebo. This effect occurred without stimulating insulin secretion. No adverse effects were reported. [20]

Non-alcoholic fatty liver disease (NAFLD) is the most prevalent cause of hepatic injury in the world. One of the most important therapeutic strategies for this disease is modulating insulin resistance and oxidative stress. A 2014 study investigated the hypothesis that supplementation with cinnamon exerts an insulin sensitiser effect in patients with NAFLD. The study suggests that taking 1500 mg cinnamon daily may be effective in improving NAFLD characteristics. In a double-blind, placebo-controlled trial with two parallel groups, fifty patients with NAFLD were randomised to receive daily supplementation with either two capsules of cinnamon (each capsule contain 750 mg cinnamon) or two placebo capsules, daily for 12 weeks. During the intervention, all patients were given advice on how to implement a balanced diet and physical activity into their daily lives. In the treatment group ($p < .05$), significant decreases in HOMA (Homeostatic Model Assessment) index, FBS (fasting blood glucose), total cholesterol, triglyceride, ALT (alanine aminotransferase), AST (aspartate aminotransferase), GGT (gamma glutamine transpeptidase), and high-sensitivity C-reactive protein were seen, but there was no significant change in serum high-density lipoprotein levels ($p = .122$). In both groups, low-density lipoproteins decreased significantly ($p < .05$).[21]

Treatment of diabetic subjects with cinnamon has demonstrated an improvement in blood glucose concentrations and insulin sensitivity but the underlying mechanisms remain unclear. A 2014 study intending to elucidate the impact of cinnamon effects on the brain, by using isolated astrocytes and an obese and diabetic mouse model, has found that cinnamon extract improved insulin action in the brain, as well as brain activity and locomotion. This specific effect may represent an important central feature of cinnamon

in improving insulin action in the brain, and mediates metabolic alterations in the periphery to decrease liver fat and improve glucose homeostasis.[22]

The results of a 2014 study indicate that cinnamon ameliorates type 2 diabetes by inducing GLUT4 translocation via the AMPK (an enzyme) signalling pathway. The study also found insulin antagonistically regulates the activation of AMPK. It was previously demonstrated that cinnamon ameliorates type 1 diabetes induced by streptozotocin in rats through the up-regulation of GLUT4 translocation in both muscle and adipose tissues. This study was aimed at clarifying the detailed mechanisms with which cinnamon increases the glucose uptake in vivo and in cell culture systems. The results showed that cinnamon stimulated the phosphorylation of AMPK and acetyl-CoA carboxylase. For the first time it was found that insulin suppressed AMPK activation in the adipocyte.[23]

Cinnamon has been studied in randomised controlled trials (RCTs) for its glycaemic-lowering effects but studies have been small and show conflicting results. A prior meta-analysis did not show significant results but several RCTs have been published since then. In 2013 an updated systematic review and meta-analysis of RCTs evaluating cinnamon's effect on glycaemia and lipid levels was conducted. In a meta-analysis of 10 RCTs (N = 543 patients), cinnamon doses of 120 mg/d to 6 g/d for four to 18 weeks reduced levels of fasting plasma glucose, total cholesterol, LDL-C and triglycerides. Cinnamon also increased levels of HDL-C. The consumption of cinnamon is associated with a statistically significant decrease in levels of fasting plasma glucose, total cholesterol, LDL-C and triglyceride levels, and an increase in HDL-C levels however no significant effect on haemoglobin A1c was found. The high degree of heterogeneity may limit the ability to apply these results to patient care because the preferred dose and duration of therapy are unclear.[24]

Numerous in vitro and in vivo studies have elucidated cinnamon's effect on insulin signal transduction. A hydroxychalcone from cinnamon was shown to function as an insulin mimetic in adipocytes (fat cells). The treatment stimulated glucose uptake and glycogen synthesis to a similar level as insulin.25 Bioactive compounds extracted from cinnamon potentiated insulin activity, as measured by glucose oxidation in the rat epididymal fat cell assay. The cinnamon compound, like insulin, affects protein phosphorylation-dephosphorylation reactions in the intact adipocyte.26 Another study suggested that cinnamon would improve insulin action via increasing glucose uptake in vivo, at least in part through enhancing the insulin-signalling pathway in skeletal muscle.27 Early administration of cinnamon to rats fed a high fructose diet prevented the development of insulin resistance at least in part by enhancing insulin signalling.[28]

Some studies have examined the effects of chromium and cinnamon in metabolic syndrome and diabetes. In a double-blind placebo-controlled study it has been demonstrated that glucose, insulin, cholesterol and HbA1c are all improved in patients with type 2 diabetes following Crsupplementation.Ithasalsobeenshownthatcinnamon polyphenols improve insulin sensitivity in in vitro, animal and human studies. Subjects with metabolic syndrome who consume an aqueous extract of cinnamon have been shown to have improved fasting blood glucose, systolic blood pressure, body fat and increased lean body mass compared with the placebo group.[29]

Positive results were found in one trial examining cinnamon in 60 people with type 2 diabetes. Groups consumed between 1-6 g of cinnamon daily or placebo. The results found 1, 3, or 6 g of cinnamon per day reduces serum glucose, triglyceride, LDL cholesterol, and total cholesterol in people with type 2 diabetes and suggest that the inclusion of cinnamon in the diet of people

with type 2 diabetes will reduce risk factors associated with diabetes and cardiovascular diseases.[30]

Cinnamon equivalent to three grams of powder per day was examined for its effects on fasting plasma glucose level compared to placebo. There was a significantly higher reduction in the cinnamon group (10.3%) than in the placebo group (3.4%). No significant differences were observed regarding HbA1c or lipid profiles. The decrease in plasma glucose correlated significantly with the baseline concentrations, indicating that subjects with a higher initial plasma glucose level may benefit more from cinnamon intake. No adverse effects were observed. The cinnamon extract seems to have a moderate effect in reducing fasting plasma glucose concentrations in diabetic patients with poor glycaemic control.[31]

Studies utilising an aqueous extract of cinnamon, high in type A polyphenols, have also demonstrated improvements in fasting glucose, glucose tolerance and insulin sensitivity in women with insulin resistance associated with the polycystic ovary syndrome.[32]

Unfortunately, other human trials have found less favourable effects but may have been limited by specific variables (diet, ethnicity, BMI, glucose levels, cinnamon dose and concurrent medication). The effect of cinnamon (1g/day) or placebo on glycaemic control in adolescents with type 1 diabetes was examined. No significant differences in final A1C, change in A1C, total daily insulin intake, or number of hypoglycaemic episodes were found between the cinnamon and placebo arms.33 Another study examined the effect of cinnamon (1g/day) on glucose and lipid levels in American adults. There was no difference between the cinnamon group and placebo after three months.34 The blood lipid profile of fasting subjects did not change after cinnamon supplementation. It was concluded that cinnamon supplementation (1.5 g/d) did not improve whole-body insulin sensitivity or oral glucose tolerance and did not modulate blood lipid profile in postmenopausal patients with type 2 diabetes.[35]

The effect of cinnamon on the rate of gastric emptying, the postprandial blood glucose response, and satiety was examined in healthy subjects. The addition of cinnamon to the meal (rice pudding) significantly delayed gastric emptying and lowered the postprandial glucose response. The effect of cinnamon on satiety was not significant. Inclusion of cinnamon in the diet lowers the postprandial glucose response, a change that is at least partially explained by a delayed gastric emptying.[36]

Cholesterol Lowering Activity: The mechanism for the lipid lowering effects of cinnamon is not clearly described in literature. Its high dietary fibre content could result in reduced intestinal lipid absorption and the high vitamin/anti-oxidant content is likely to result in increased lipid metabolism. Insulin plays a key role in lipid metabolism and it is possible that increased serum insulin levels following cinnamon administration also contribute towards reducing lipid levels.[37]

A recent study demonstrated that cinnamon reduced total cholesterol, LDL cholesterol and triglycerides while increasing HDL cholesterol in diabetic rats. Similar results have also been observed in hyperlipidaemic albino rabbits. However, feeding cinnamon to animals at levels corresponding to the average human dietary intake has not shown to reduce lipid levels significantly.[38,39,40]

Another recent study examined the effects of cinnamon on mean arterial blood pressure (BP) of normotensive (normal blood pressure-NR) rats, salt-loaded hypertensive rats (SLHR), L-NAME hypertensive rats (LNHR) and spontaneously

hypertensive rats (SHR). Immediately after intravenous administration a significant drop of BP was shown in NTR, SLHR and LNHR in a dose dependent manner, the drop in BP was not dose dependent in SHR.[41]

Similar effects were demonstrated in another study in NTR and SLHR, they also showed that cinnamon has a vaso- relaxant effect on the rat thoracic aortic ring segments, suggesting that cinnamon might be inhibiting extracellular Ca2+ through L-type voltage-sensitive channels.42 The effect of cinnamate on lipid metabolism and antioxidant enzyme activities in rats fed a high cholesterol diet was examined. Supplementation with cinnamate resulted in significantly lower hepatic cholesterol and triglyceride levels, higher HDL levels and a lower atherogenic index compared to either the control or lovastatin groups. These results suggest that dietary cinnamate inhibits hepatic HMG-CoA reductase activity, resulting in lower hepatic cholesterol content, and suppresses lipid peroxidation via enhancement of hepatic antioxidant enzyme activities.[43]

Anti-inflammatory and antioxidant activity: The results of a 2014 study suggest that cinnamon can induce cognitive improvement in scopolamine (SCOP)- treated rats and this effect can be attributed to a certain extent to decreased oxidative stress. The study was designed to assess the effect of extract of cinnamon bark on cognitive performance of SCOP-treated rats and on associated altered oxidative stress markers in the brain of rats. The SCOP-treated group showed significantly impaired acquisition and retention of memory as compared to the saline- and vehicle-treated groups. Pre-treatment with cinnamon extract (200 and 400 mg/kg) for 21 days significantly reversed SCOP-induced amnesia.[44]

The disease modifying potential of cinnamon was demonstrated in a 2013 in vivo study. Cinnamon bark's potential for improving inflammation, pain and the immune system makes it a good candidate as an anti-arthritic agent. However, the component(s) responsible for these activities is not known. Cinnamon bark polyphenol extract has shown anti-inflammatory properties in vitro and therapeutic potential for prevention and treatment of inflammation related diseases. Procyanidins are classified as Types A, B or C procyanidine polyphenols, based on the linkage between the successive monomeric units. Type-A procyanidine polyphenols (TAPP) from cinnamon bark have exhibited activities against microorganisms, suggesting a potential role in regulating immune function with an unknown mechanism. Further, TAPP has shown anti-inflammatory effects in cell culture studies in vitro.

A 2013 study demonstrated ameliorative effects of TAPP from cinnamon bark in an animal model of allergic asthma. The objective of the study was to evaluate the potential of TAPP in animal models of inflammation and rheumatoid arthritis in rats. Carrageenan-induced rat paw oedema and adjuvant induced established arthritis in rats were used as the experimental models for inflammation and arthritis respectively. The TAPP was a standardised extract of cinnamon with pentameric type-A procyanidine flavonoid as a marker compound (75.9% purity). The authors reached the conclusion that TAPP isolated from cinnamon showed anti-inflammatory and anti-arthritic effects in animal models without ulcerogenicity potential. Lack of analgesic activity in the study, and reports of immunomodulatory potential, suggested TAPP could be a potential disease-modifying anti-rheumatic drug. Further studies are required to explain the mechanism of action of TAPP toward autoimmune and inflammatory disease processes.[45]

The phenolic constituents of cinnamon are likely to be responsible for the anti-oxidant and free radical scavenging activity observed. Cinnamon extracts are known to increase Tristetraprolin mRNA and protein levels. Tristetraprolins have

anti-inflammatory effects due to destabilising of pro-inflammatory mRNA. This could be the reason for the anti-inflammatory actions observed.[46]

Eighteen operating room personnel were treated with cinnamon (100mg/300mL tea) daily for 10 days and blood samples were analysed for biomarkers of oxidative stress including Lipid Peroxidation Level (LPO), Total Antioxidant Power (TAP) and Total Thiol Molecules (TTM). Treatment of subjects with cinnamon induced a significant reduction in plasma LPO, however no statistically significant alteration was found for plasma TAP and TTM after 10 days treatment with cinnamon.47 Treatment of 54 healthy volunteers with cinnamon (100mg/30mL of tea) daily were significantly effective in the reduction of lipid peroxidation and increasing TAP and TTM in comparison with controls. The extent of increase in plasma TBARS and TAP for the cinnamon group was significantly higher than in those given regular tea only.[48]

The effects of ionizing radiation on natural cinnamon antioxidants showed that irradiation in the dose range applied did not have any effect on the antioxidant potential of the cinnamon compounds.[49] Cinnamon was found to be potent in free radical scavenging activity especially against DPPH radicals and ABTS radical cations, while the hydroxyl and superoxide radicals were also scavenged by the tested compounds.50 Similar findings were found in another study which showed that cinnamon has 65.3% anti-oxidant activity and strong free radical scavenging activity.[51]

Cinnamaldehyde (CNA) was examined for its modulation of inflammatory NF-kappaB activation via the redox-related pathways through the reduction of oxidative stress. CNA effectively inhibited age-related NF-kappaB activation, inflammatory NOS, and COX-2 suggesting that the antioxidant effect and the restoration of redox balance were responsible for its anti-inflammatory action.[52,53] Another study found that phenolic compounds from a range of spices including cinnamon were able to inhibit 5-lipoxygenase, the key enzyme involved in biosynthesis of inflammatory leukotrienes.[54] Cinnamon has been found in many studies to have antioxidant actions making it a suitable and palatable addition to preserve food and promote health. The etheric (0.69mg), methanolic (0.88mg) and aqueous (0.44mg) cinnamon extracts inhibited the oxidative process in 68%, 95.5% and 87.5% respectively.[55,56]

Cinnamon bark contains the potent antioxidants catechin, epicatechin and proanthocyandin. Studies have found these compounds to show significant inhibitory effects on the formation of advanced glycation end products (AGEs). Their antiglycation activities were not only brought about by their antioxidant activities but also related to their trapping abilities of reactive carbonyl species.57,58 Cinnamon has also been shown to inhibit peroxynitrite-mediated damage to proteins, lipids and DNA while phenols and other components from cinnamon were found to have free radical scavenging activity against primary and secondary oxidation products.[59,60,61]

Anticancer activity: Cinnamon compounds strongly inhibited in vitro growth of 29 kinds of human cancer cells and in vivo growth of human tumour xenograft without the loss of body weight in nude mice.[62]

In vitro and in vivo cinnamon was found to strongly inhibit the expression of pro-angiogenic factors and master regulators of tumour progression not only in melanoma cell lines but also in experimental melanoma model. In addition, cinnamon treatment increased the anti-tumour activities of CD8+ T cells by increasing the levels of cytolytic molecules and their cytotoxic activity.[63]

A cinnamon derivative trans-cinnamic aldehyde was shown to impair melanoma cell proliferation and tumour growth.[64]

Cinnamaldehyde from cinnamon offers significant in vitro anti-proliferative effects on cultured human colon cancer cells. The everyday dietary availability of the concentrations used in this study strongly suggest that regular intake of low doses of phytochemicals offer preventive effects against colon cancer.[65]

A series of cinnamyl compounds related to cinnamaldehyde were synthesised and assessed for their antitumor effects against human cancer cells. One compound inhibited the growth of human cancer cells and human colon tumour xenograft in nude mice. Its antitumour effects belong to the induction of apoptosis and arresting cell cycle.[66]

Antimicrobial, antifungal and antiviral activity: The antimicrobial action of cinnamon is considered to arise mainly from the potential of hydrophobic essential oils to disrupt the bacterial cell membrane and its structures which leads to ion leakage. Antibacterial assays of the column chromatography fractions clearly indicated that cinnamaldehyde is the primary compound responsible for major antibacterial activity. Trans-cinnamaldehyde is also known to inhibit bacterial acetyl-CoA carboxylase.[67]

In 2014 there were more than 30 different studies evaluating the in vitro anti-microbial properties of cinnamon. It has shown potential antimicrobial action against a wide variety of bacteria including Escherichia coli, Helicobacter pylori, Listeria monocytogenes, Salmonella typhi, Staphylococcus aureus and Streptococcus agalactiae. In addition there seems to be activity against numerous fungi including Aspergillus fiavus and Candida albicans. Cinnamon has also demonstrated activity against the human rota-virus.[68]

Cinnamon has been shown to have antifungal activity against some strains of spp.69 A small trial of five patients with HIV infection and oral candidiasis received a commercially available cinnamon preparation for one week. Three of the five patients had improvement of their oral candidiasis. Further clinical trials will be necessary to determine the usefulness of cinnamon for the treatment of mucosal candidiasis.[70]

Cinnamon has been studied along with other essential oils for its role in preventing bacterial contamination and extending shelf life of fresh and packaged foods including meats, fruits, juices, soups and grains.[71,72,73,74,75,76] The antimicrobial activity of essential oils of cinnamon bark, cinnamon leaf and clove were found to be effective against Listeria monocytogenes in milk.[77]
Cinnamon was one herb studied for its effects against three strains of Mycobacterium avium subsp. paratuberculosis. The most effective compound was trans-cinnamaldehyde followed by cinnamon oil.[78]

Cinnamaldehyde and carvacrol exhibited rapid antimicrobial activity against both antibiotic-resistant and non-resistant Campylobacter jejuni strains, at concentrations of approximately 0.1% and higher. The antimicrobial efficacy of cinnamaldehyde was greater than that of carvacrol.[79]

Cinnamon had mild bactericidal activities against Helicobacter pylori, but total inhibition of growth was not achieved in this study.[80] Another study examined the cytotoxic effects of various essential oils that also have antibacterial activity against E coli. High doses of individual oils possessing antibacterial activity also had undesirable cytotoxic effects on intestinal cells. However, a combination of low dose oils had the most safe and effective profile.[81]

A butanol fraction of cinnamon showed moderate inhibitory activity in wild type severe acute respiratory syndrome coronavirus and HIV/SARS-CoV S pseudovirus infections. Cinnamon was thought to work by interfering with endocytosis and its procyanidin constituent also inhibited the infection.[82]

The inhibitory effect of trans-cinnamaldehyde (CA), one of the principal constituents of cinnamon, on the growth of influenza A/PR/8 virus in vitro and in vivo was studied. CA inhibited the virus growth in a dose-dependent manner and the virus yield was reduced to an undetectable level. Results showed that mice infected with the lung-adapted PR-8 virus, exposed to inhalation and nasal inoculation of CA significantly increased survival rates in the eight days to 100% and 70%, respectively, compared to 20% survival in the controls. The findings were thought to provide evidence for the empirical use of cinnamon in Kampo medicines for acute respiratory infectious diseases.[83]

Cinnamon and other essential oils were found to be effective against the fungus Trichophyton mentagrophytes and thus had potential for treating tinea pedis.[84]

Indications: Digestive disorders including flatulent dyspepsia, nausea and diarrhoea; Bacterial and viral infections including the common cold and influenza; Fungal infections including tinea pedis and candida; Diabetes, obesity and metabolic syndrome; Hyperlipidaemia; Possible cancer prophylaxis and treatment adjuvant; Oxidative stress and inflammatory disorders.

Toxicity: None known.

Use in Pregnancy: There are no known problems with the use of cinnamon during pregnancy and lactation provided that doses do not greatly exceed the amounts used in food.[85]

Contraindications: None known.

Drug Interactions: None found.

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