REVIEW ARTICLE

A review on pharmacological activities of *Cinnamomum cassia* Blume

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The plant *Cinnamon cassia* Blume is commonly known as Chinese cinnamon. Mostly its bark and leaves are used in medicine. *C. cassia* is safe when used in small amounts as in foods and medicinal doses. The whole plant is medicinally important in Indian traditional system of medicine, particularly in Ayurveda. In this review, the reported pharmacological activities of *C. cassia* Blume to cure or prevent several diseases are summarised. Different pharmacological activities like anti-inflammatory, antioxidant, hepatoprotective activities of *C. cassia* Blume are discussed in this review.

Key words: Antibacterial, anti-diabetic, *Cinnamomum cassia* Blume, pharmacological activities

INTRODUCTION

During the Vedic period in India, herbal drugs as medicines for the treatment of a range of diseases were used.[1] Hence, use of herbal medicines in spite of the great advances observed in modern medicine in recent decades makes an important contribution to health care.[2]

Cinnamon is an ancient spice used in many countries. It consists of the dried inner bark of *Cinnamomum cassia* Blume (Lauraceae).

It contains about 1–2% of volatile oil called cassia oil. The primary constituents of the essential oil are 65–80% cinnamaldehyde and less amount of eugenol. It also contains mucilage, starch and tannins.[3]

Traditionally, cinnamon is used as a spice and an aromatic. Bark is used for its carminative, stomachic, diarrhea and antibacterial properties. Research has focused on different pharmacological activities, such as anti-inflammatory, antioxidant, hepatoprotective activities, of *C. cassia* Blume. The different pharmacological activities of *C. cassia* are summarised in Table 1.

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PHARMACOLOGICAL ACTIVITIES

Anti-inflammatory Activity

C. cassia has been reported to have anti-inflammatory activity through the potent inhibition of nitric oxide (NO) and cyclooxygenase.

Lee *et al*. evaluated the inhibitory effects of *C. cassia* bark derived material on NO production in RAW 264.7 cells through the evaluation of NO production and expression of inducible nitric oxide (iNOS). The activity was compared to the effects of three commercially available compounds, cinnamyl alcohol, cinnamic acid and eugenol. Potent inhibitory effects of cinnamaldehyde against NO production were found to be 81.5%, 71.7% and 41.2% at 1.0, 0.5 and 0.1 μg/μl, respectively. Little or no activity was observed for cinnamic acid and eugenol.[4] Also, *C. cassia* extract has shown potent inhibition of cyclooxygenase-2 (COX-2) activity with >80% inhibition at a dose of 10 μg/ml in lipopolysaccharide (LPS)-induced mouse macrophages RAW 264.7 cells. These active extracts mediating (COX-2) and iNOS inhibitory activities so future investigation for development of new cancer or anti-inflammatory agents is needed.[5]

Several of the cinnamaldehyde derivatives were synthesised from cinnamic acid, such as 2′-hydroxycinnamaldehyde (HCA) isolated from the bark *C. cassia*. Derivatives were investigated to compare their NO production and nuclear factor (NF)-kappa B activity from Raw 264.7 cell. The present results provided evidence that HCA, among the cinnamaledhyde derivatives, has the most inhibitory effect on NO production through inhibition of NF-kappa

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Table 1: Summery of pharmacological actions of *Cinnamon cassia* Blume

Pharmacological activity	Mechanism of action
Anti-inflammatory activity	Mediates COX-2 and iNOS inhibitory activities
	Inhibitory effect on NO production through inhibition of NF-kappa B activation
Antioxidant activity	Free-radical scavenging ability
Hepatoprotective activity	Hepatic lipid accumulation
	Decreases oxidative stress
	Decreases elevated serum AST and ALT enzymatic activities
Antiulcer activity	Potentiates the defensive factors through improvement of the circulatory disorder and gastric cytoprotection
	Inhibits the growth of *H. pylori* and urease activity
Antimicrobial activity	Toxic action against cell membranes and walls of bacteria
Antifungal activity	Inhibits the growth of fungi
Anticancer activity	Antimutagenic by modulatory effect on the xenobiotic bioactivation and detoxification processes
	Apoptosis inducer
	Enhanced pro-apoptotic activity and inhibition of NF-kappa B and AP1 activities
Anti-HIV activity	Blocks HIV type-1 infections
Antidiabetic activity	Increases the amount of proteins involved in insulin signalling and glucose transport
	Direct anti-diabetic potency
Renal activity: Anti-gout activity	Xanthine oxidase enzyme inhibition activity

B activation at IC (50) values of 8 and 22 μM, respectively, and thus can be used as an anti-inflammatory agent.[6]

Antioxidant Activity

Murcia *et al*. have investigated the antioxidant properties of cinnamon compared with those of the common food antioxidants, butylated hydroxyanisole (BHA) (E-320), butylated hydroxytoluene (BHT) (E-321) and propyl gallate (E-310). The cinnamon exhibited a higher percentage of inhibition of oxidation as tested by the lipid peroxidation assay. It was a better superoxide radical scavenger with capacity approximately equal to that of propyl gallate.[7] It was also found that one-half millilitre of cinnamon leaf has free radical scavenging ability with an EC50 of 53 μ/ml and has a total phenolic content of 420 mg/g as the major chemical composition.[8]

Hepatoprotective Activity

The extract of *C. cassia* has been reported to have better hepatoprotective activity against alcohol and carbon tetrachloride induced hepatic injury. Its hepatoprotective property may be due to its free radical scavenging activity.

The effect of alcoholic extract of cinnamon bark was assessed in a mouse model of acute alcohol-induced steatosis and in RAW 264.7 macrophages, using the model of Kupffer cells. Pretreatment with cinnamon extract significantly reduced the hepatic lipid accumulation, which was increased >20-fold after acute alcohol ingestion. In an *in vitro* model, pretreatment with cinnamon extract suppressed LPS-induced iNOS and tumour necrosis factor (TNF)-a expression as well as NO formation almost completely. Results suggest that the extract of cinnamon bark may protect the liver from acute alcohol-induced steatosis.[9] Also, the effect of ethanol extract from *C. cassia* Blume (CCE) on the activation of hepatic stellate cells (HSCs) in addition with the effects of *C. cassia* (CC) powder in Sprague-Dawley rats with acute liver injury induced by dimethylnitrosamine (DMN) was investigated. CCE significantly reduced the expression of alpha-smooth muscle actin (a-SMA), connective tissue growth factor (CTGF), transforming growth factor beta 1 (TGF-β1) and tissue inhibitor of metalloproteinase-1 (TIMP-1). *In vivo*, the results were significantly inhibited by CC powder in the serum ultimately resulting in reduction of acute liver injury.[10]

Cinnamon AX is a neutral polysaccharide isolated from the dried bark of *C. cassia* and has shown remarkable reticuloendothelial system potentiating activity in a carbon clearance test.[11] Oral administration of 200 mg/kg of water and ethanolic extracts once daily for 7 days restored the carbon tetrachloride elevated serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) enzymatic activities induced, as compared to untreated rats. Furthermore, the ethanolic extract showed more potent hepatoprotective action than the water extract by lowering the malondialdehyde (MDA) level and elevating the activities of the antioxidant enzymes, superoxide dismutase (SOD) and catalase (CAT).[12]

Antiulcer Activity

C. cassia has effective antiulcer activity probably by potentiating the defensive factors through the improvement of the circulatory disorder and gastric cytoprotection.

Akira *et al*. found that the intraperitoneal administration of an aqueous extract of *C. cassia* to rats at a dose of 100 mg/kg body weight prevented the occurrence of stress ulcers under exposure to a cold atmosphere 3–5°C or on restraint in water 22–24°C. It also strongly inhibited gastric ulcers induced by a

subcutaneous injection of serotonin in rats.[13] The preventive effect of compounds 3-(2-hydroxyphenyl)-propanoic acid and its *O*-glucoside, which are isolated from the stem bark of *C. cassia* in serotonin-induced ulcerogenesis, was evaluated. The former compound at a dose of 40 µg/kg body weight also inhibited gastric ulcers induced by the other ulcerogens such as phenylbutazone, ethanol and water immersion stress, although it failed to prevent indomethacin-induced ulcers. 3-(2-hydroxyphenyl)-propanoic acid hardly inhibited the secretion of gastric acid, but promoted the gastric blood flow.[14]

Antral gastritis, duodenal ulcer and gastric lymphoma are frequently associated with *Helicobacter pylori* infection . So, eradication of *H. pylori* has been shown to prevent relapse of these diseases.

Ethanol and methylene chloride extracts of cinnamon were tested for their effect on *H. pylori* growth and urease activity. Methylene chloride extract was found to inhibit the growth of *H. pylori* at the concentration range of common antibiotics, while ethanol extract counteracted urease activity.[15] So, it may be helpful for prevention of ulcers induced by *H. pylori*.

Antibacterial Activity

Antibacterial activity of *C. cassia* is probably by bacteriostatic ability and toxicity to cytoplasmic membrane of bacteria.

Zhang *et al*. showed that the bacteriostatic ability of *C. cassia* on microorganisms inoculated and spontaneously contaminated is similar to or obviously superior to those of nipagin A and benzoic acid.[16] The spectral analysis results showed that cinnamaldehyde is a biologically active component of *C. cassia* bark which revealed potent inhibition against *Clostridium perfringens* and *Bacteroides fragilis*, but no inhibitory activity was obtained against *Bifidobacterium longum* or *Lactobacillus acidophilus* using an impregnated paper disc method and compared with the activities of tetracycline and chloramphenicol.[17] *C. cassia* extracts at the highest Minimum Inhibitory Concentration (MIC) 2640 mg inhibited *Escherichia coli* and *Salmonella infantis*.[18]

Sharma *et al*. evaluated the effect of ethanol extract of *C. cassia* against major urinary tract pathogens (*E. coli, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Enterococcus faecalis*) by disc diffusion method. It showed maximum antibacterial activity against *P. aeruginosa*, which supports its use in the treatment of urinary tract infections.[19] Antibacterial properties of *C. cassia* extract is shown by dipping raw sheep meat in extracts, packaging the samples in polyethylene and refrigerating them at 4°C. *C. cassia* at a concentration of 0.10% showed the most effective antibacterial activity.[20]

Oussalah *et al*. studied the mechanism of the antibacterial action of *C. cassia* essential oil on the cell membranes and walls of bacteria by the measurement of the intracellular pH with ATP concentration, the release of cell constituents and the electronic microscopy observations of the cells. *E. coli* O157:H7 and *L. monocytogenes*, two pathogenic foodborne bacteria, were used as gram-negative and gram-positive bacterial models, respectively. Essential oil reduced significantly the intracellular pH of *E. coli* O157:H7 and more significantly the intracellular pH of *L. monocytogenes*. Electron microscopy observations revealed that the cell membrane of both the treated bacteria was significantly damaged. These results suggest that the cytoplasmic membrane is involved in the toxic action of essential oils.[21]

Antifungal Activity

Both oil and pure cinnamaldehyde of *C. cassia* were found to be equally effective in inhibiting the growth of fungi, including yeasts (four species of *Candida*: *C. albicans, C. tropicalis, C. glabrata* and *C. krusei*), filamentous moulds, three *Aspergillus* spp., dermatophytes, *Microsporum gypseum, Trichophyton rubrum* and *Trichophyton mentagrophytes*.[22] Giordani *et al*. evaluated the antifungal activity of the essential oil from *C. cassia*, alone and combined with amphotericin B, against *C. albicans*, by a macrobroth dilution method followed by a modelling of fungal growth. The essential oil of *C. cassia* exhibited strong antifungal effect with an MIC 80% at a dose of 0.1 µl/ml and the strongest decrease (70%) was obtained when amphotericin B was combined with the 0.1 µl/ml of essential oil. The potentiating activity of amphotericin B *in vitro* may show promise for the development of less toxic and more effective therapies.[23]

Insecticidal Activity

The insecticidal and fumigant activities of *C. cassia* Blume bark-derived materials against the oak nut weevil (*Mechoris ursulus* Roelofs) were examined using filter paper diffusion and fumigation methods. In a test with the filter paper diffusion method, *trans*-cinnamaldehyde showed 100 and 83.3% mortality, and in the fumigation test, *Cinnamomum* bark-derived materials were effective in closed cups than in open ones against the damage caused by *M. ursulus* larvae.[24] Formulations of oil of *C. cassia* Blume, 20 and 50 g L^1 sprays and 100% oil-based fumigant were effective against adult *Dermatophagoides farinae* Hughes and *Dermatophagoides pteronyssinus* Trouessart using contact and vapour-phase toxicity bioassays.[25] Acaricidal principles of (E)-cinnamaldehyde at a dose of 25.8 mg/m^2 and salicylaldehyde at a dose of 17.3 mg/m^2 from cassia bark were 2.5 and 1.7 times more toxic than benzyl benzoate against adult *D. farinae*, respectively. Also, it was found that salicylaldehyde at a dose of 17.3 mg/m^2 and (E)-cinnamaldehyde at a dose of 19.3 mg/m^2 were

2.4- and 2.2-fold more active than benzyl benzoate against adult *D. pteronyssinus*.[26]

Anticancer Activity

C. cassia has been reported to be antimutagenic by its modulator effect on the xenobiotic bioactivation and detoxification processes. It also has apoptosis inducing activity by different mechanisms. Sharma *et al*. studied the antimutagenic properties of *C. cassia* against two mutagens, viz. benzo[a]pyrene (B[a P) and cyclophosphamide (CP) by the Ames test, *in vivo* chromosomal aberration (CA) and micronuclei tests. It was observed in the Ames test, bone marrow chromosomal aberration assay and micronucleus test that *C. cassia* exerted significant antimutagenic effects against B[a]P and CP in animals treated with the plant extract. *C. cassia* pretreatment decreased cytochrome P450 content, but increased the glutathione (GSH) content and the activity of glutathione-dependent antioxidant enzymes, viz. glutathione-*S*-transferase (GST), glutathione reductase (GR) and glutathione peroxidase (GPX).[27]

C. cassia has been evaluated for its apoptosis-inducing activity in order to develop a new apoptosis inducer. The effects of cinnamaldehyde, an active compound isolated from the stem bark of *C. cassia*, have been studied on the cytotoxicity, induction of apoptosis and the putative pathways of its actions in human promyelocytic leukemia cells. Results showed that cinnamaldehyde is a potent inducer of apoptosis and it transduces the apoptotic signal via reactive oxygen species (ROS) generation, thereby inducing mitochondrial permeability transition (MPT) and cytochrome *c* release to the cytosol.[28] It induced the death of HL-60 cells by the mechanism of mitochondrial transmembrane potential and the activity of caspase-3. The reduced mitochondrial transmembrane potential and increased caspase-3 activity were observed within 12–36 h after administration.[29]

Koppikar *et al*. reported the anti-neoplastic activity of the aqueous cinnamon extract (ACE-c) in cervical cancer cell line, SiHa. Cinnamon alters the growth kinetics of SiHa cells in a dose-dependent manner. Cells treated with ACE-c exhibited reduced number of colonies compared to the control cells. The treated cells exhibited reduced migration potential that could be explained as due to the down-regulation of matrix metalloproteinase (MMP)-2 expression. Interestingly, the expression of Her-2 oncoprotein was significantly reduced in the presence of ACE-c. Cinnamon extract induced apoptosis in the cervical cancer cells through increase in intracellular calcium signalling as well as loss of mitochondrial membrane potential, so it could be used as a potent chemopreventive drug in cervical cancer.[30] It strongly inhibited tumour cell proliferation *in vitro* and induced active cell death of tumour cells by up-regulating pro-apoptotic molecules while inhibiting NF-kappa B and AP1 activity and their target genes such as *Bcl-2*, *BcL-xL* and survivin. Oral administration of cinnamon extract in melanoma transplantation model significantly inhibited tumour growth with the same mechanism of action observed *in vitro*. It suggests that the anti-tumour effect of cinnamon extracts is directly linked with enhanced pro-apoptotic activity and inhibition of NF-kappa B and AP1 activities and their target genes in *in vitro* and *in vivo* mouse melanoma model.[31]

Anti-HIV Activity

C. cassia bark was highly effective against HIV-1 when HIV replication was monitored in terms of inhibition of virus-induced cytopathogenicity in MT-4 cells.[32] Compounds present in the extracts of cinnamon bind and block HIV type-1 (HIV-1) infection in target cells, with 50% inhibitory concentration values ranging from 0.5 to 201 µg/ml for four different HIV-1 serotypes tested using direct binding assay with mass spectrometry technique (direct analysis in real-time time-of-flight mass spectrometry). It is rich in certain flavonoid compounds which are shown to block HIV-1 entry and infection in ghost cells. Further studies on the isolation of active principles are required.[33]

Anti-diabetic Activity

Verspohl *et al*. evaluated the effects of *C. cassia* bark or its extracts on blood glucose and plasma insulin levels in rats under various conditions. The *cassia* extract was slightly more efficacious than an equivalent amount of *cassia* bark. A decrease in blood glucose levels was observed in glucose tolerance test (GTT), whereas it was not obvious in rats that were not challenged by a glucose load. The elevation in plasma insulin was direct since a stimulatory *in vitro* effect of insulin release from INS-1 cells (an insulin secreting cell line) was observed. Results suggested that the *cassia* extract has a direct anti-diabetic potency.[34]

Cinnamon improves glucose and lipid profiles of people with type 2 diabetes. Water-soluble cinnamon extracts (CE) and high-performance liquid chromatography (HPLC)-purified cinnamon polyphenols (CP) with doubly linked procyanidin type-A polymers display insulin-like activity. The objective of this study was to investigate the effects of cinnamon on the protein and mRNA levels of insulin receptor (IR), glucose transporter 4 (GLUT4) and tristetraprolin (TTP/ZFP36) in mouse 3T3-L1 adipocytes. Immunoblotting showed that CP increased IR-b levels and that both CE and CP increased GLUT4 and TTP levels in the adipocytes. Quantitative real-time polymerase chain reaction (PCR) indicated that CE (100 µg/ml) rapidly increased TTP mRNA levels by approximately sixfold in the adipocytes. CE at higher concentrations decreased

IR-β protein and IR mRNA levels, and its effect on GLUT4 mRNA levels exhibited a biphasic pattern in the adipocytes. These results suggest that cinnamon exhibits the potential to increase the amount of proteins involved in insulin signalling, glucose transport and anti-inflammatory/anti-angiogenesis response.[35]

Kim *et al*. have purified hydroxyl cinnamic acids from cinnamon, synthesised a series of derivatives, screened them for glucose transport activity *in vitro* and tested them for glucose-lowering activity *in vivo*, and studied the mechanisms involved. A naphthalene methyl ester of 3,4-dihydroxyhydrocinnamic acid (DHH105) showed the highest glucose transport activity *in vitro*. Treatment of streptozotocin-induced diabetic C57BL/6 mice and spontaneously diabetic ob/ob mice with DHH105 decreased blood glucose levels to near normoglycaemia. Further studies revealed that DHH105 increased the maximum speed of glucose transport and the translocation of GLUT4 [now known as solute carrier family 2 (facilitated glucose transporter), member 4 (SLC2A4)] in adipocytes, resulting in increased glucose uptake. In addition, DHH105 enhanced phosphorylation of the insulin receptor-β subunit and insulin receptor substrate-1 in adipocytes, both *in vitro* and *in vivo*. This resulted in the activation of phosphatidylinositol 3-kinase and Akt/protein kinase B, contributing to the translocation of GLUT4 to the plasma membrane. Results suggested that DHH105 may be a valuable candidate for a new anti-diabetic drug.[36]

The effects of *C. cassia* extract have been evaluated in diabetic C57BL/Ks db/db mice. Treatment of *C. cassia* extract at a dose of 200 mg/kg/day for 12 weeks significantly decreased blood glucose, increased the levels of reduced glutathione and the activities of GR, GST, GPx, CAT and SOD in the liver. Extract treatment also significantly decreased lipid peroxidation. So, it may be effective for correcting hyperglycaemia and preventing diabetic complications.[37]

CNS Activity

It was reported to have anxiolytic activity by regulating the serotonergic and GABAergic system without any adverse effects on locomotor activity and prevents neuronal cell death through the inhibition of Ca^{2+} influx.

A single dose of 50% EtOH extract of *C. cassia* at 750 mg/kg, p.o. significantly increased the number of entries with the time spent in the open arms of the elevated plus maze (EPM) and a repeated treatment with *C. cassia* at a dose of 100 mg/kg for 5 days, p.o. significantly increased the time spent in the open arms of the EPM. Effect of *C. cassia* is blocked by bicuculline and flumazenil compared with the controls which shows that *C. cassia* might be an effective anxiolytic agent.[38]

The protective effect of a water extract from the bark of *C. cassia* Blume on glutamate-induced neuronal death by MTT assay and its action on Ca^{2+} influx using cultured rat cerebellar granule cells was studied. This extract at a dose of (10^{-5}–10^{-4} g/ml) significantly protected against glutamate-induced cell death and also inhibited glutamate-induced Ca^{2+} influx in a dose-dependent manner.[39]

Renal Activity

Nagai *et al*. evaluated the effect of the aqueous extract of *C. cassia* (CCAq) on experimental glomerulonephritis in rats and compared with that of cobra venom factor (CoVF). CCAq inhibited the excretion of protein into urine, the increase of peripheral leucocyte counts and the elevation of blood urea nitrogen (BUN). The histological score was slightly inhibited by a low dose of CCAq and a high dose of CoVF in the study with rats. In case of NZB/NZW F1 mice, the proteinurea, the elevation of BUN level and the production of antibodies were clearly inhibited by a low dose of CCAq and a high dose of CoVF.[40]

Methanol extract of the twig of *C. cassia* has xanthine oxidase enzyme inhibition activity with IC (50) of 18 µg/ml.[41] Also, the hypouricemic effects of cassia oil extracted from *C. cassia* in hyperuricemic mice and its inhibitory actions against liver xanthine dehydrogenase (XDH) and xanthine oxidase (XOD) activities were investigated. Oral administration of cassia oil significantly reduced serum and hepatic urate levels in hyperuricemic mice in a time- and dose-dependent manner and at 600 mg/kg it was found to be as potent as allopurinol. In addition, cassia oil significantly exhibited marked reductions in liver XDH/XOD activities, with an apparent dose-dependence in the normal and hyperuricemic mice. Allopurinol was much highly potent than that of cassia oil.[42] These studies showed that *C. cassia* can be used in the treatment of gout.

Other Activities

Other activities of *C. cassia* like antiallergic, immunomodulatory, nematicidal and skin whitening activity have been studied. It has also been reported for treatment of oral cavity infections.

It did not affect the nephritis caused by the F(ab')2 portion of the nephrotoxic IgG antibody, but it was found to be effective in inhibition of complement-dependent reactions on experimental allergic reaction. High concentration of CCAq inhibited the immunological haemolysis, chemotactic migration of neutrophils and the generation of chemotactic factors. All of the above results suggest that CCAq inhibits the complement-dependent allergic reaction by virtue of its anti-complement activity.[40]

A formulation was prepared by extracting a mixture of 10 medical herbs (*Rehmannia glutinosa*, *Paeonia lactiflora*, *Liqusticum wallichii*, *Angelica sinesis*, *Glycyrrhiza uralensis*, *Poria cocos*, *Atractylodes macrocephala*, *Panax ginseng*, *Astragalus membranaceus* and *Cinnamomum cassia*) which tone the blood and vital energy, and strengthen health and immunity. This potent and popular prescription has traditionally been used against anaemia, anorexia, extreme exhaustion, fatigue, kidney and spleen insufficiency, and general weakness, particularly after illness.[43]

Kong *et al*. evaluated the nematicidal activity of two *cassia*, *C. cassia*, oils (Especial and true), four cinnamon, *Cinnamomum zey-lanicum*, oils (technical, #500, bark and green leaf), and their compounds (e.g. *trans*-cinnamaldehyde and *trans*-cinnamic acid) towards adult *Bursaphelenchus xylophilus* by a direct contact bioassay. LC (50) values within 24 h for two *cassia* oils (0.084–0.085 mg/ml) and four cinnamon oils (0.064–0.113 mg/ml) were toxic towards adult *B. xylophilus*. Potent nematicidal activity was observed at a concentration range (0.224–0.502 mg/ml) of 4-methoxycinnamonitrile, *trans*-4-methoxycinnamaldehyde, *trans*-2-methoxy-cinnamaldehyde, ethyl a-cyanocinnamate, cinnamonitrile and cinnamyl bromide.[44]

Cinnamic acid, which is mainly found in *C. cassia*, has recently been reported to exert tyrosinase inhibitory effect on melanin biosynthesis within the melanocytes and brown guinea pigs. Treatment with 100 ppm of cinnamic acid resulted in a significant reduction of melanin production in the melan-a cell at 29.0 with a potent inhibitory effect on tyrosinase activity and reduced tyrosinase expression in the melan-a cells. Moreover, cinnamic acid exhibits depigmenting activity on the UV-B–induced hyperpigmentation of brown guinea pig skin. Findings suggest that it might act as a skin whitening agent by virtue of its inhibition of tyrosinase activity and expression within the melanocytes.[45]

It was found that administration of *C. cassia* improves the symptoms and reduces the number of viable *Candida* cells in the oral cavity. Cinnamaldehyde in the *cassia* preparation was the principal component responsible for the inhibitory activity of *Candida* mycelial growth. So, it can be a better option as a clinical candidate to be used as a prophylactic or therapeutic tool against oral *Candida* infection.[46]

CONCLUSIONS

C. cassia has shown various pharmacological activities like anti-inflammatory, antioxidant, anticancer activities, etc. It has been shown to possess many pharmacological actions for the treatment of various diseases. In conclusion, its use is promising in treating various diseases such as cancer, diabetes; bacterial infections, etc. It is expected that further investigations will lead to a better understanding of some other roles that C. *cassia* plays in preventing and treating diseases.

REFERENCES

1. Dhiman RK, Chawla YK. Herbal medicines for liver diseases. Dig Dis Sci 2005;10:1807-12.
2. De Smet PA. The role of plant-derived drugs and herbal medicines in healthcare. Drugs 1997;54:801-40.
3. Trease GE, Evans WC. Trease & Evans' Pharmacognosy. 13th ed. London: Bailliére Tindall; 1989.
4. Lee HS, Kim BS, Kim MK. Suppression effect of *Cinnamomum cassia* bark-derived component on nitric oxide synthase. J Agric Food Chem 2002;50:7700-3.
5. Hong CH, Hur SK, Oh OJ, Kim SS, Nam KA, Lee SK. Evaluation of natural products on inhibition of inducible cyclooxygenase (COX-2) and nitric oxide synthase (iNOS) in cultured mouse macrophage cells. J Ethnopharmacol 2002;83:153-9.
6. Lee SH, Lee SY, Son DJ, Lee H, Yoo HS, Song S, *et al*. Inhibitory effect of 2′-hydroxycinnamaldehyde on nitric oxide production through inhibition of NF-kappa B activation in RAW 264.7 cells. Biochem Pharmacol 2005;69:791-9.
7. Murcia MA, Egea I, Romojaro F, Parras P, Jiménez AM, Martínez-Tomé M. Antioxidant evaluation in dessert spices compared with common food additives. Influence of irradiation procedure. J Agric Food Chem 2004;52:1872-81.
8. Wang HF, Wang YK, Yih KH. DPPH free-radical scavenging ability, total phenolic content, and chemical composition analysis of forty-five kinds of essential oils. J Cosmet Sci 2008;59:509-22.
9. Kanuri G, Weber S, Volynets V, Spruss A, Bischoff SC, Bergheim I. Cinnamon extract protects against acute alcohol-induced liver steatosis in mice. J Nutr 2009;139:482-7.
10. Lim CS, Kim EY, Lee HS, Soh Y, Sohn Y, Kim SY, *et al*. Protective effects of *Cinnamomum cassia* Blume in the fibrogenesis of activated HSC-T6 cells and dimethylnitrosamine-induced acute liver injury in SD rats. Biosci Biotechnol Biochem 2010; 74:477-83.
11. Kanari M, Tomoda M, Gonda R, Shimizu N, Kimura M, Kawaguchi M, *et al*. A reticuloendothelial system-activating arabinoxylan from the bark of *Cinnamomum cassia*. Chem Pharm Bull (Tokyo) 1989;37:3191-4.
12. Moselhy SS, Ali HK. Hepatoprotective effect of cinnamon extracts against carbon tetrachloride induced oxidative stress and liver injury in rats. Biol Res 2009;42:93-8.
13. Akira T, Tanaka S, Tabata M. Pharmacological studies on the antiulcerogenic activity of Chinese cinnamon. Planta Med 1986;52:440-3.
14. Tanaka S, Yoon YH, Fukui H, Tabata M, Akira T, Okano K, *et al*. Antiulcerogenic compounds isolated from Chinese cinnamon. Planta Med 1989;55:245-8.
15. Tabak M, Armon R, Neeman I. Cinnamon extracts' inhibitory effect on Helicobacter pylori. J Ethnopharmacol 1999;67:269-77.
16. Zhang Z, Su C, Chen D. Comparison of bacteriostatic ability of oleum of Perilla frutescens (L.) Britt., *Cinnamomum cassia* Presl and Nipagin A. Zhongguo Zhong Yao Za Zhi 1990;15:95-7, 126-7.
17. Lee HS, Ahn YJ. Growth-inhibiting effects of *Cinnamomum cassia* bark-derived materials on human intestinal bacteria. J Agric Food Chem 1998;46:8-12.
18. Alzoreky NS, Nakahara K. Antibacterial activity of extracts from some edible plants commonly consumed in Asia. Int J Food Microbiol 2003;80:223-30.

19. Sharma A, Chandraker S, Patel VK, Ramteke P. Antibacterial activity of medicinal plants against pathogens causing complicated urinary tract infections. Indian J Pharm Sci 2009;71:136-9.
20. Luo H, Lin S, Ren F, Wu L, Chen L, Sun Y. Antioxidant and antibacterial capacity of Chinese medicinal herb extracts in raw sheep meat. J Food Prot 2007;70:1440-5.
21. Oussalah M, Caillet S, Lacroix M. Mechanism of action of Spanish oregano, Chinese cinnamon, and savory essential oils against cell membranes and walls of Escherichia coli O157:H7 and Listeria monocytogenes. J Food Prot 2006;69:1046-55.
22. Ooi LS, Li Y, Kam SL, Wang H, Wong EY, Ooi VE. Antibacterial activities of cinnamon oil and cinnamaldehyde from the Chinese medicinal herb *Cinnamomum cassia* Blume. Am J Chin Med 2006;34:511-22.
23. Giordani R, Regli P, Kaloustian J, Portugal H. Potentiation of antifungal activity of amphotericin B by essential oil from *Cinnamomum cassia*. Phytother Res 2006;20:58-61.
24. Park IK, Lee HS, Lee SG, Park JD, Ahn YJ. Insecticidal and fumigant activities of *Cinnamomum cassia* bark-derived materials against Mechoris ursulus (Coleoptera: Attelabidae). J Agric Food Chem 2000;48:2528-31.
25. Kim SI, Kim HK, Koh YY, Clark JM, Ahn YJ. Toxicity of spray and fumigant products containing cassia oil to Dermatophagoides farinae and Dermatophagoides pteronyssinus (Acari: Pyroglyphidae). Pest Manag Sci 2006;62:768-74.
26. Kim HK, Yun YK, Ahn YJ. Fumigant toxicity of cassia bark and cassia and cinnamon oil compounds to Dermatophagoides farinae and Dermatophagoides pteronyssinus (Acari: Pyroglyphidae). Exp Appl Acarol 2008;44:1-9.
27. Sharma N, Trikha P, Athar M, Raisuddin S. Inhibition of benzo[a] pyrene- and cyclophoshamide-induced mutagenicity by *Cinnamomum cassia*. Mutat Res 2001;480-1:179-88.
28. Ka H, Park HJ, Jung HJ, Choi JW, Cho KS, Ha J, *et al*. Cinnamaldehyde induces apoptosis by ROS-mediated mitochondrial permeability transition in human promyelocytic leukemia HL-60 cells. Cancer Lett 2003;196:143-52.
29. Nishida S, Kikuichi S, Yoshioka S, Tsubaki M, Fujii Y, Matsuda H, *et al*. Induction of apoptosis in HL-60 cells treated with medicinal herbs. Am J Chin Med 2003;31:551-62.
30. Koppikar SJ, Choudhari AS, Suryavanshi SA, Kumari S, Chattopadhyay S, Kaul-Ghanekar R, *et al*. Aqueous cinnamon extract (ACE-c) from the bark of *Cinnamomum cassia* causes apoptosis in human cervical cancer cell line (SiHa) through loss of mitochondrial membrane potential. BMC Cancer 2010;10:210.
31. Kwon HK, Hwang JS, So JS, Lee CG, Sahoo A, Ryu JH, *et al*. Cinnamon extract induces tumor cell death through inhibition of NFkappaB and AP1. BMC Cancer 2010;10:392.
32. Premanathan M, Rajendran S, Ramanathan T, Kathiresan K, Nakashima H, Yamamoto N. A survey of some Indian medicinal plants for anti-human immunodeficiency virus (HIV) activity. Indian J Med Res 2000;112:73-7.
33. Fink RC, Roschek B Jr, Alberte RS. HIV type-1 entry inhibitors with a new mode of action. Antivir Chem Chemother 2009;19:243-55.
34. Verspohl EJ, Bauer K, Neddermann E. Antidiabetic effect of *Cinnamomum cassia* and Cinnamomum zeylanicum *in vivo* and *in vitro*. Phytother Res 2005;19:203-6.
35. Cao H, Polansky MM, Anderson RA. Cinnamon extract and polyphenols affect the expression of tristetraprolin, insulin receptor, and glucose transporter 4 in mouse 3T3-L1 adipocytes. Arch Biochem Biophys 2007;459:214-22.
36. Kim W, Khil LY, Clark R, Bok SH, Kim EE, Lee S, *et al*. Naphthalenemethyl ester derivative of dihydroxyhydrocinnamic acid, a component of cinnamon, increases glucose disposal by enhancing translocation of glucose transporter 4. Diabetologia 2006;49:2437-48.
37. Kim SH, Hyun SH, Choung SY. Anti-diabetic effect of cinnamon extract on blood glucose in db/db mice. J Ethnopharmacol 2006;104:119-23. Epub 2005 Oct 5.
38. Yu HS, Lee SY, Jang CG. Involvement of 5-HT1A and GABAA receptors in the anxiolytic-like effects of *Cinnamomum cassia* in mice. Pharmacol Biochem Behav 2007;87:164-70.
39. Shimada Y, Goto H, Kogure T, Kohta K, Shintani T, Itoh T, *et al*. Extract prepared from the bark of *Cinnamomum cassia* Blume prevents glutamate-induced neuronal death in cultured cerebellar granule cells. Phytother Res 2000;14:466-8.
40. Nagai H, Shimazawa T, Matsuura N, Koda A. Immunopharmacological studies of the aqueous extract of *Cinnamomum cassia* (CCAq). I. Anti-allergic action. Jpn J Pharmacol 1982;32:813-22.
41. Kong LD, Cai Y, Huang WW, Cheng CH, Tan RX. Inhibition of xanthine oxidase by some Chinese medicinal plants used to treat gout. J Ethnopharmacol 2000;73:199-207.
42. Zhao X, Zhu JX, Mo SF, Pan Y, Kong LD. Effects of cassia oil on serum and hepatic uric acid levels in oxonate-induced mice and xanthine dehydrogenase and xanthine oxidase activities in mouse liver. J Ethnopharmacol 2006;103:357-65.
43. Zee-Cheng RK. A potent Chinese biological response modifier in cancer immunotherapy, potentiation and detoxification of anticancer drugs. Methods Find Exp Clin Pharmacol 1992;14:725-36.
44. Kong JO, Lee SM, Moon YS, Lee SG, Ahn YJ. Nematicidal activity of cassia and cinnamon oil compounds and related compounds toward bursaphelenchus xylophilus (Nematoda: Parasitaphelenchidae). J Nematol 2007;39:31-6.
45. Kong YH, Jo YO, Cho CW, Son D, Park S, Rho J, *et al*. Inhibitory effects of cinnamic acid on melanin biosynthesis in skin. Biol Pharm Bull 2008;31:946-8.
46. Taguchi Y, Takizawa T, Ishibashi H, Sagawa T, Arai R, Inoue S, *et al*. Therapeutic effects on murine oral candidiasis by oral administration of cassia (*Cinnamomum cassia*) preparation. Nihon Ishinkin Gakkai Zasshi 2010;51:13-21.

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