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Review Article

Anti-inflammatory effect of cinnamon (*Cinnamomum verum*)

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ABSTRACT

Inflammation happens when a physical factor triggers an immune reaction. When not treated it begins to contribute to several chronic diseases and lead to tissue breakdown and impairment of the immune system. Cinnamon is a popular spice often used to flavor baked treats. Studies have shown that the spice has anti-inflammatory, anti-bacterial, antioxidant, anti-diabetic and many other activities. The present review is conducted to evaluate the anti-inflammatory effect of various cinnamon species which can ease swelling and prevent inflammatory diseases. It was found effective in which its chemical constituents present in cinnamon is mainly responsible for anti-inflammatory property of the spice.

1. Introduction

Cinnamon is a flavor additive which helps in improving odor, taste and color of meals for a long time. It is derived from the inner bark of several tree species from the genus Cinnamomum widely spread in the Mediterranean region, Sri Lanka and India. Cinnamon is high in antioxidants such as polyphenols and glutathione; therefore, it could be regarded as a powerful anti-inflammatory agent and may protect against cancer.[1] Overall, approximately 250 species have been identified among the cinnamon genus, with trees being scattered all over the world.[2] *Cinnamomum verum* (also known as Cinnamomum zeylanicum, Ceylon cinnamon, or true cinnamon) and Cinnamomum cassia (also known as Cassia cinnamon or Chinese cinnamon) are the most popular species in the world. Almost every part of the cinnamon tree including the bark, leaves, flowers, fruits and roots, has some medicinal or culinary use. CZ, also known as Ceylon cinnamon (the source of its Latin name, zeylanicum) or 'true cinnamon' is indigenous to Sri Lanka and southern parts of India. Cinnamon possesses beneficial health effects such as anti- inflammatory properties, anti-microbial activity, reducing cardiovascular disease, boosting cognitive function and reducing risk of colonic cancer.[3]

1.1. Vernacular names of cinnamon

Language	Names
Bengali	Dalchini
Gujarati	Dalchini
Hindi	Dalchini
Kannada	Dalchini
Marathi	Dalchini
Malayalam	Lavanga pattai
Tamil	Lavanga pattai
Telugu	Lavanga pattai

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1.2. Botanical classification of cinnamon

1. Kingdom : Plantae
2. Division: Magnoliophyta
3. Class: Magnoliopsida
4. Order: Laurales
5. Family: Lauraceae
6. Genus: Cinnamomum
7. Species: *Cinnamomum verum* ,Cinnamomum cassia,Cinnamomum loureirii

2. Anti-inflammatory Activity

Inflammation plays an important role in the host immune defense response to harmful stimuli such as damaged cells, irritants, and pathogens. This complex process not only eliminates the primary cause of infection or tissue injury, it also eradicates apoptotic/necrotic cells and damaged tissue and initiates tissue repair. Immune cells, including macrophages, neutrophils, and lymphocytes respond to infectious agents by modulating an inflammatory response.[4]

2.1. In-vitro studies

Periodontal diseases are bacteria-induced inflammatory disorders that lead to the destruction of the tooth-supporting tissues. This study was performed to characterize the anti-inflammatory properties of a polyphenolic cinnamon fraction. Chromatographic and mass spectrometry analyses of composition of the cinnamon fraction revealed that phenolic acids, flavonoids (flavonols, anthocyanins, flavan-3-ols), and procyanidins make up 9.22%, 0.72%, and 10.63% of the cinnamon fraction, respectively. Macrophage model stimulated with lipopolysaccharides (LPS) from E.coli was used to show that the cinnamon fraction dose-dependently reduced IL-6, IL-8, and TNF-α secretion. The result showed that the cinnamon fraction reduces LPS binding to monocytes, which may contribute to its anti-inflammatory properties. It was concluded that cinnamon exhibit a therapeutic potential for the treatment of periodontal diseases due to its anti-inflammatory properties.[5]

Xuesheng and Tory studied the effect of cinnamon (*Cinnamomum zeylanicum*) bark essential oil (CBEO) on human dermal fibroblast system, a model of chronic inflammation and fibrosis. CBEO significantly inhibited the production of several inflammatory biomarkers, including vascular cell adhesion molecule-1, intercellular cell adhesion molecule-1, monocyte chemoattractant protein-1, interferon gamma induced protein 10, interferon-inducible T-cell alpha chemoattractant, and monokine induced by gamma interferon. It also significantly inhibited the production of several tissue remodeling molecules, including epidermal growth factor receptor, matrix metalloproteinase-1, and plasminogen activator inhibitor-1. In addition, it also inhibited macrophage colony-stimulating factor, which is an immunomodulatory protein molecule. Furthermore, CBEO significantly modulated global gene expression and altered signaling pathways, many of which are important in inflammation, tissue remodeling, and cancer biology.[6] Khaled and others studied anti-inflammatory effect of cinnamon ethanolic extracts on Lipopolysaccharide (LPS)-induced Interlukin-6 (IL-6) and Tumor Necrosis Factor-α (TNF-α) by polymorphonuclear Cells (PMNCs). 50 gm of cinnamon powder mixed in 500 ml of 96% ethanol and kept shaking for one week at room temperature. The concentrations of TNF-α and IL-6 in the supernatant were measured after 24 h and compared using paired-samples t test. Cinnamon extract showed significant reduction in the both Il-6 and TNF-α level. HPLC analysis of cinnamon extract revealed that major compound in the extract was cinnamic acid. Reduction in the levels of IL-6 and TNF-α indicates anti-inflammatory effect.[7]

2.2. Animal studies

Li et al studied the anti-inflammatory effect of cinnamon essential oil on 6, 6-week-old female dextran sodium sulphate (DSS) induced colitis mouse. They were fed with 10mg/kg body weight orally. IBD symptoms were assessed by measuring hemoglobin content, myeloperoxide activity, histopathological observation, cytokines and TLR4 expression. The alteration of fecal microbiome composition was analyzed by 16S rRNA gene sequencing. Results indicated that oral administration of CEO effectively alleviated the development of DSS-induced colitis. The mice fed with CEO improved the diversity and richness of intestinal microbiota and decreased Helicobacter and Bacteroides and increase in Bacteroidales S24-7 family and short chain fatty acid producing bacteria. Moreover, correlation analysis showed TLR4 and TNF-α was positively correlated with Helicobacter but inversely correlated with SCFA producing bacteria.[8]

The bacterial translocation induced by colitis may cause the organ failure and sepsis. The study aims to examine E-coli anti-translocation activity of cinnamon oil and its ability to reduce colonic damage in mice with TNBS (2,4,6-trinitrobenzenesulfonic acid) induced colitis. Female mice of imprinting control regions weighing 23-28g received cinnamon essential oil in four various concentrations (0.5%, 0.25%, 0.125% and 0.063%) in the powdery commercial rodent diet, starting 21 days before induction of TNBS colitis. The colonic damage was analyzed using the colon macroscopic scoring system (Wallace score). E. coli translocation was evaluated by serial dilutions method for counting bacteria. Bacterial translocation was significantly reduced in first and third group (15.2% or 42.8% in cinnamon oil groups versus 100% in TNBS group). Cinnamon oil was effective against the colonic damage in all cinnamon oil groups (macroscopically scores of grades 9 in TNBS group versus 5.25, 5.63, 5.13 and 3.25 in

Table 1: Anti-inflammatory activity of *Cinnamon*

Extract	Model	Dose	Parameters	Result	Reference
Aqueous extract of *C. burmannii* bark	Macrophage model stimulated with lipopolysaccharides [U937 3XKB LUC]	250 μg/ml	ELISA	↓Secretion of IL-6, IL-8 & TNF-α ↓LPS binding to monocytes	6
Leaf essential oil of *C. osmophloeum*	50 patients with migraine	3 capsules/day each containing 600mg of C for 2 months	Serum levels of IL-6, CGRP & NO	↓Serum conc of IL-6 & NO	3
C. bark essential oil [*C. cassia*]	6, 6week old female dextran sodium sulfate [DSS] induced colitis mouse (KM)	10 mg/kg BW orally	Hemoglobin content Myeloperoxidase activity Histopathological observation	↓intestinal microbiota, Helicobacter & Bacteroides ↑ Bacteroidales S24-7 family & SCFA producing bacteria	8
70% aqueous ethanol of bark of *C. verum*	Patients suffering from allergy/asthma to grass pollen	1 ml/kg body weight orally	Basophil extraction test WST-8 cell proliferation assay kit	↓dendritic cell maturation	9
C. zeylanicum bark powder	36 women with rheumatoid arthritis	500 mg C. powder daily for 8weeks	Fasting blood sugar Lipid profile Liver enzyme Tumor necrosis factor-α Serum levels of C-reactive protein	↓ serum levels of CRP Diastolic BP	10
Bark of EO of *C. zeylanicum*	Cell culture of human dermal fibroblasts (HDF3CGE)	0.0012 %	Protein-based readouts RNA isolation	Inhibited all 17 biomarkers production of inflammatory cytokines ↓ levels of macrophage colony-stimulating factor	7
Ethanolic extract of *C. verum*	Lipopolysaccharide stimulated polymorphonuclear cells	50 g C. powder	Trypan blue exclusion test Immunoassay HPLC analysis	↓ production of IL-6 & TNF-α	11
C. cassia bark	H. pylori (193C) infected gastric epithelial cells	50 μg/ml	ELISA Immunoblast analysis Western blotting	↓ IL-8 expression Inhibition of NF-*K*b activation	12
C. zeylanicum essential oil	Female mice of imprinting control regions weighing 23-28 g	0.5 %, 0.25%, 0.125%, 0.063% for starting 21 days	Colon macroscopic scoring system Serial dilution	↓ bacterial translocation in 0.125 & 0.063% ↓colonic tissue injury	13
Extraction of TAPP from bark of *C. zeylanicum*	24 carrageenan induced wistar rat paw edema in rats of either sex (130-200)	2, 4,8 & 25 mg/kg BW orally 1hour before carrageenan injection	Randall selitto assay Serum turbidity measurement	Should AI effect at 4,8 & 25 mg/kg BW Inhibition of edema	14
Aqueous extract of C. cassia bark	male BALB mice	20, 100, 500 mg/kg BW for 6 days orally	Serum levels of TNF-Serum levels of TNF-α & interleukin (IL)	↓LPS induced TNF-α in serum	5

cinnamon oil groups). It was concluded that administration of cinnamon oil possesses therapeutic effects on bacterial translocation and intestinal wall injury in colitis.[12]

2.3. Mechanism of anti-inflammatory activity of Cinnamon

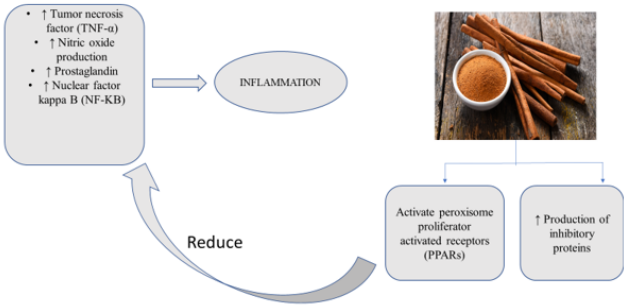

Fig. 1: Mechanism of anti-inflammatory activity of Cinnamon

3. Conclusion

Cinnamon is used both in the food and medicinal industries. It can be used as an anti-inflammatory agent for various inflammatory diseases. Inflammation is a localized protective host response to injury or infection. An acute response, which is fast and short-lived, is associated with the elimination of the primary cause of the inflammation and the repair of the affected tissue. However, if the inflammation is not resolved, this results in a chronic state that plays a central role in numerous diseases, including rheumatoid arthritis, asthma, and periodontal disease.[15]

4. Source of Funding

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5. Conflict of Interest

None.

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