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A Review on Pharmacological Activities and Clinical effects of Cinnamon Species

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ABSTRACT

Many herbal remedies have been employed in various medical systems for the treatment and management of different diseases. Cinnamon is the ever green tree of tropical area, a member of family Lauraceae, has been used in day to day routine as a spice. Literature review on cinnamon revealed that it mainly contains essential oils and important compounds like Cinnamaldehyde, eugenol, cinnamic acid and cinnamate. It has got good anti-inflammatory, anti-oxidant, anti-ulcer, anti-microbial, anti-diabetic, memory enhancer and many other activities. The present review attempts to encompass the up-to-date comprehensive literature analysis on Cinnamon with respect to its Phytochemistry and its various pharmacological activities.

Keywords: Cinnamon, Spice, Anti-diabetic, Cinnamaldehyde, Memory enhancer.

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INTRODUCTION

Herbs have been called part of "Nature's pharmacy." Although their action can in some ways be similar to modern drugs, herbal remedies are generally gentler and safer. Many of the drugs used in conventional medicine are derived from herbs. Herbalism uses the whole plant or whole parts of the plant, such as the leaves, the flowers, or the roots. Using the whole plant helps decreases the side effects that may occur when using isolated components. Herbs are plants actually grown fresh or purchased in dried form. They include the tropical aromatics, such as pepper, cinnamon and cloves etc.

Spices are mainly used for flavouring and they also have certain medicinal properties and are used in pharmaceutical, perfumery, cosmetics and several other industries. A spice is a dried seed, fruit, root, bark or vegetative substance used in nutritionally insignificant quantities as a food additive for flavour, colour, or as a preservative that kills harmful bacteria or prevents their growth. Many spices are used for other purposes, such as medicine, religious rituals, cosmetics, perfumery, or for eating as vegetables. Cinnamon is a spice obtained from the inner bark of several trees from the genus Cinnamomum that is used in both sweet and savoury foods. The word cinnamon comes from the Greek **kinnamomon.**

There are four main varieties of cinnamon, Ceylon cinnamon (Cinnamomum zeylanicum), and Cassia cinnamon (Cinnamomum cassia) are the most popular. **Ceylon cinnamon** is sometimes called **"true cinnamon".**

Cassia: Indonesian Cassia, Saigon (Vietnamese) Cinnamon, Chinese Cinnamon

- **Cassia cinnamon**, from the cassia tree, is native to Southeast Asia, especially southern China and northern Vietnam. It has the strong, spicy-sweet flavour.
- **Vietnamese cassia (Saigon cinnamon, Cinnamomum loureiroii) and Chinese cassia** (Cinnamomum aromaticum) are the sweetest and strongest varieties. Vietnamese cinnamon is considered as world's **finest cinnamon** and the Chinese cassia are not only sweeter, but more aromatic and more powerful ("spicier") than the Indonesian Korintje cassia.
- **Korintje cassia cinnamon comes from Indonesia**, usually Sumatra (Cinnamomum burmannii). It comes in A, B and C grades. C-grade cinnamon, and can be bitter and

astringent. A-grade Korintje cassia is sweet and mellow. According to the Food and Agriculture Association, Indonesia produces 40% of the world's Cassia cinnamon.

Ceylon Cinnamon or "True" Cinnamon

- **Ceylon or "true" cinnamon, from the cinnamon tree**, (Cinnamomum zeylanicum, also called Cinnamomum verum) has a much different flavor: a less sweet, more complex, citrusy flavor. Ceylon cinnamon is also known as **"old-fashioned cinnamon"**.
- Ceylon cinnamon has higher oil content and a sweeter flavor than cassia. Unlike cassia, this uses both the thick outer and the thin inner bark.
- The inner bark is then dried in the sun where it curls and becomes the familiar cinnamon stick or "quill."

The powdered bark is harder to distinguish, but if it is treated with tincture of iodine little effect is visible with pure Ceylon cinnamon, but when Chinese cinnamon is present, a deep-blue tint is produced. Cassia's effects on enhancing insulin sensitivity appear to be mediated by type-A polymeric polyphenols [8].

According to the International Herald Tribune, 2006 Sri Lanka produced 90% of the world's true cinnamon.

Habitat: The spice is derived from the brown bark, which forms quills with longitudinal striations. The plant is native to Sri Lanka, South eastern India, Indonesia, South America, and the West Indies.

Plant hierarchy:

Order	:	Laurales.
Family	:	Lauraceae.
Genus	:	Cinnamon.

Scientific Names: Cinnamomum verum, Cinnamomum cassia, Cinnamomum zeylanicum, Cinnamomum loureirii

Common Name(s): Cinnamon, Cinnamomon, Ceylon cinnamon, Chinese cinnamon, Chinese cassia, Saigon cinnamon

Macroscopic characteristics:

It is an evergreen aromatic tree. The tree is commonly planted for ornamental purposes.

- **Seeds:** These trees are mainly propagated by seeds.

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- **Bark:** It is a golden red bark and thick up to 1.5 cm that is dried and is the cinnamon spice. Small or medium sized tree usually up to 20 – 40 ft.
- **Leaves:** These are oblong – elliptic, ovate shapes dark glossy green and with a three prominent nerves from the base. Leathery and approximately 7 – 20 cm in length.
- **Flowers:** These are small in lax, yellow in colour, inconspicuous, paniculate.
- **Fruit**: Fruits are black, pulpy, aromatic, elliptical, drupes with single seed.
- **Hardiness:** The true cinnamon tree is subtropical or tropical. It will survive short frosts and temperatures to 32^0F, but should be protected from hard freezes and prolonged cool weather.

Table 1: Different Categories of Cinnamon Seeds

Category	Length	Width
Large	>12.5 mm	>9.9 mm
Medium	8.5 - 12.5 mm	6.1 - 9.9 mm
Small	<8.5 mm	<6.1 mm

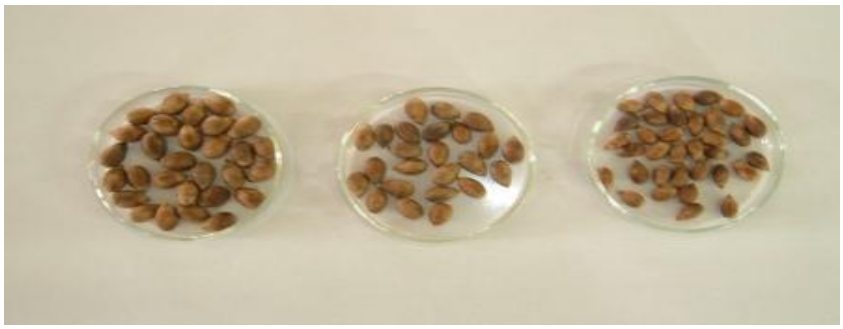

Fig 1: Different sizes of seeds of Cinnamon

Fig 2: Flowers

Fig 3: Fruits

Phytochemistry:

One of the most popular spices used worldwide, cinnamon is known for its aromatic fragrance and sweet, warm taste. The spice is derived from the bark of an evergreen tree, which belongs to the family Lauraceae. Mostly cinnamon is used as a spice, cinnamon has great medicinal value. It has been found to be extremely helpful in the treatment of Type 2 diabetes mellitus [1], [42], [11] and insulin resistance. The scientific studies have proved that a variety of

biologically active chemicals have been found in Cinnamon which have immense medical potential. It contains a number of compounds, including essential oils that provide the spice's flavor.

Table 2: Constituents of Cinnamon

Bark	Cinnamldehyde – 65 to 80% Eugenol – 5 to 10%
Leaves	Cinnamldehyde –1 to 5% Eugenol –70 to 95%
Root Bark	Camphor – 60%
Fruit	Trans – cinnamyl acetate and β - caryophyllene
Cinnamomum zeylanicum buds	Terpene hydrocarbons - 78% Alpha Bergamotene - 27.38% Alpha - Copaene - 23.05% Oxygenated terpenoids - 9%
Cinnamomum zeylanicum flowers	(E)-Cinnamyl acetate - 41.98% Trans-alphabergamotene - 7.97% Caryophyllene oxide - 7.2%

Other compounds which are present in lesser percentages those are Cinnamic acid, Hydroxyl Cinnamaldehyde, Cinnamyl alcohol, Coumarin, Cinnamyl acetate, Borneol etc.

Chemical Structures of some important chemical constituents of Cinnamon are

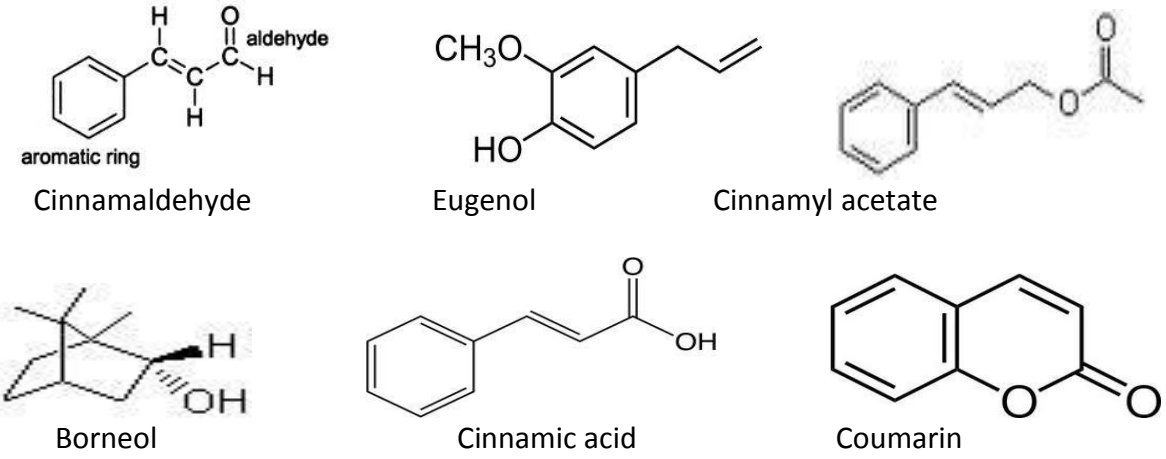

Figure 4: Chemical structures of the active compounds of Cinnamon

Cinnamon Nutrition Facts:

Cinnamon contains proteins, carbohydrates, vitamins (A, C, K, B3), Minerals like Calcium, Iron, Magnesium, Manganese, Phosphorous, Sodium, Zinc, Choline.

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Choline

Consuming cinnamon also provides our body with a trace amount of choline. This nutrient helps our brain to synthesize acetylcholine, a chemical used in nerve cell communication. It also helps the body metabolize fats, makes up a part of healthy cell membranes and helps drive a number of chemical reactions within your cells. Consuming 1 table spoon of cinnamon provides our body with 0.9 mg of choline.

Uses and Benefits Cinnamon
Ayurvedic uses:

- In Ayurvedic medicine Cinnamon oil is used for rheumatism, aching joints and stiffness. It is also used for toothache and sore gums.
- Ayurvedic makes use of Cinnamon for the respiratory tract and urinary problems.
- It is a good addition to tea for coughs and colds and is sometimes used in steam inhalations for respiratory conditions.

Medicinal uses:

Cinnamon is the best spice available in terms of its nutrition and health. It contains unique healthy and healing property due to the presence of active components. The health benefits may also come from eating Cinnamon. Those are

1. **Lowers Cholesterol:** Cinnamon may significantly lower LDL (Low Density Lipo Protein) or "bad" cholesterol and triglycerides and total cholesterol.
2. **Reduces blood sugar levels** and treating Type 2 Diabetes [1], [11], [42]. By taking as little as ½ teaspoon of cinnamon per day it can improves the insulin resistance and it can help in weight control.
3. **Heart Disease:** The calcium and fibre which are present in cinnamon provides protection against heart diseases. Cinnamon in the food helps those suffering from coronary artery disease and high blood pressure.
4. **Fights Cancer:** Cinnamon reduced the proliferation of leukaemia [15] and lymphoma cancer cells. Due to the presence of calcium and fibre in cinnamon which can help to remove bile, which prevents damage to colon cells, thus prevents colon cancer [31], [34].
5. **Mouth freshener:** Small pieces of cinnamon can be chewed or gargled with cinnamon water which serves as a good mouth freshener.
6. **Cures Respiratory Problems:** Cinnamon is very useful home remedy for common or severe colds. It will cure most chronic cough, cold and clear the sinuses.
7. **Brain Tonic:** Cinnamon boosts the activity of the brain and hence acts as a good brain tonic. It helps in removing nervous tension and memory loss**.**

8. **Infections:** Due to its antifungal [19], [33], [36], [41] antibacterial [3], [19], [32], [35], [45] antiviral, antiparasitic and antiseptic properties [23] it is effective in fighting vaginal yeast infections, oral yeast infections and stomach ulcers and head lice.
9. **Eases menstruation cycles:** Cinnamon has also been found useful for women's health as it helps in providing relief from menstrual cramping and other feminine discomforts.
10. **Birth Control:** Cinnamon also helps in natural birth control. Regular consumption of cinnamon after child birth delays menstruation and thus helps in avoiding conception.
11. **Breastfeeding:** It is also believed that cinnamon aids in the secretion of breast milk.
12. **Reduces Arthritis Pain:** Cinnamon spice contains anti-inflammatory compounds [20], [24], [49] which can be useful in reducing pain and inflammation associated with arthritis.
13. **Digestive Tonic**: Cinnamon is very effective for indigestion, nausea, vomiting, upset stomach, diarrhoea and flatulence. It is very helpful in removing gas from the stomach and intestines. It also removes acidity, diarrhoea and morning sickness. It is often referred to as a digestive tonic.
14. **Reduces Urinary tract infections:** People who eat cinnamon on a regular basis report a lower incidence of urinary tract infections. Cinnamon is diuretic in nature and helps in secretion and discharge of urine.
15. **Anti clotting Actions:** The Cinnamaldehyde in cinnamon helps prevent unwanted clumping of blood platelets.
16. **Natural Food Preserver:** When added to food, it prevents bacterial growth and food spoilage, making it a natural food preservative.
17. **Headaches and migraine:** Headache due to the exposure to cold wind is readily cured by applying a thin paste of powdered cinnamon mixed in water on the forehead.
18. **Pimples and Blackheads:** Cinnamon helps in removing blood impurities. Therefore it is often recommended for pimples.
19. **Thinning of the blood and improves blood circulation:** Cinnamon is a blood thinning agent which also acts to increase circulation. Significantly reduce the chance of getting a heart attack by regularly consuming cinnamon.
20. **Toning of tissues:** Cinnamon may have the ability to tone and constrict tissues in the body.
21. **Muscle and joint pain relief:** Those who eat cinnamon on a regular basis often report that their muscle and joint pain, as well as stiffness, is reduced or even eliminated.
22. **Immune System:** Honey and cinnamon paste is good for boosting the immune system, removing regular fatigue and increasing the longevity of an individual. It is also known to have anti-aging properties.
23. **Itching:** Paste of honey and cinnamon is often used to treat insect bites.
24. **Healing:** Cinnamon helps in stopping bleeding. Therefore it facilitates the healing process.
25. Cinnamon which inhibits development of Alzheimer's disease [8].
26. Recent research documents observed that anti-melanoma activity of Cinnamaldehyde [5].
27. Cinnamon leaf oil has been found to be very effective in killing mosquito larvae.

Food Industry:

- It is widely used in cakes, chocolates, and other baked recipe, especially apples and peals.

- It is also used in mulled wines, creams and syrups.
- It is used in dessert dishes.

Pharmacological Activities:

Different biological activities of Cinnamon in various In vitro and In vivo test models have been carried out based on the presence of active components. A summary of the findings of some of the pharmacological studies is presented below.

Table 3: Pharmacological studies of Cinnamon

Pharmacological activity	Type of extract	Laboratory animal/ organism used	References
Antioxidant	1) Ethanolic extract 2) Methanol extract 3) Bark Oil	1) Rats	29 14 9,10
Antimicrobial	1) Bark powder Ethanol extract 2) Root oil	1) Bacillus subtilis, B.cereus 2) Staphylococus aureus, Escherichia coli, Pseudomonas aeruginisa	6 40
Anti-inflammatory	1) Bark powder a. Ethanolic extract b. Methanolic extract 2)Oil from Twigs of Cinnamon	Rats Rats Murine macrophage cell line &HepG2 cells, Human hepato cellular, carcinoma cell line	20 24 49
Anti-bacterial	1) Leaf oil 2) Cinnamon stick 3) Essential oil	E.coli, Pseudomonas aeruginisa, Enterococcus faecalis. Bacillus cereus, E.coli, Salmonella anaticum. Bacillus cereus grown in carrot broth	35 3 45 32,19
Anti-fungal	Leaf oil	1) Laetiporus sulphreus, Coriolus versicolor. 2) Pencillium roqueforti, P.corylophilum, Aspergillus flavus. 3) Trametes versicolor, lenzites betulina, L.sulphureus.	36 41 33 19
Anti-cancer (colorectal cancer)	1) Aqueous extract 2) Alcoholic extract of Cinnamon leaf	1) Mice 2) Human cancer cell lines	34,39 31
Anti-diabetic	1) Cinnamon sticks 2) Bark extract 3) Casssia and Zeylanicum Bark extract	Mice Rats	1 42 11
Anti-obesity			2
Anti leukemic	Cinnamon extract	Type 2 diabetic patients	15
Anti allergic			26,30,44

Anti HIV activity	Acetone and Ethanolic70% extracts		47
Anti mutagenic	Water, Methanol, Acetone and ethyl acetate extracts of Cinnamon fruit	Salmonella typhimurium	16
Cytotoxic effect	1)Leaf essential oil (C. osmophloeum) 2) Petroleum ether and Chloroform extract (C.zeylanicum) 3) Essential oil	1) Human leukemia cell lines U937, K562 Hep-1 2) KB & L1210 cell cultures 3) Human cancer cell	25 7 48
Genotoxic effect	Cinnamon bark oil	HCT 116 colon cells	12
Nematicidal activity	1) Leaf and Bark oils 2) Ethanol extract 3) Essential oil	1)Bursaphelenchus xylophilus 2) Meloidogyne javanica (Treub) 3) Pine wood nematode (Bursaphelenchus xylophilus)	17 37 27
Anti septic	Leaf oil		23
Anti parasitic	1) C.verum essential oil 2) spice oil 3) Essential oil	Pseudomonas aeruginisa, Staphylococus aureus	4 18 13
Anti fagocytic	Leaf oil		23
Alzheimer's Disease	Aqueous extract of C. zeylanicum		8

CONCLUSION

Medicinal plants are the richest bioresource of drugs for traditional systems of medicine, modern medicines, Nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs. Aromatic plants are a source of fragrances, flavours, cosmeceuticals, health beverages and chemical terpenes. Medicinal plants are important for pharmacological research and drug development. Over three-quarters of the world population relies mainly on plants and plant extracts for health care. One fifth of all the plants found in India are used for medicinal purpose. Out of these the bark of Cinnamon is widely used as a spice due to its distinct odour of different compounds. The detailed information as presented in this review on its Phytochemistry and various pharmacognistic and pharmacological properties of the spice. Moreover the mechanisms of some compounds are identified so far. Hence extensive research is required to find out the mechanism of action of other compounds in cinnamon and exploit their therapeutic potential to combat various diseases. Therefore, Cinnamon plays an important role in modern system of medicine as a multipurpose medicinal spice.

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