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Cinnamomum: review article of essential oil compounds, ethnobotany, antifungal and antibacterial effects

Abstract

Aromatic as well as medicinal plant species have played important roles in the lives of tribal people living in the Himalaya by providing products for both food and medicine. This review presents a summary of ethonobotanical, antibacterial, antifungal and volatile compounds of essential oils of some *Cinnamomum* species from the Nepal, Assam, Karnataka, and Indian Himalaya. This review illustrates the various prospective of cinnamon and its use in daily life.

Keywords: *Cinnamomum*, ethonobotany, antifungal, antibacterial, essential oil, India, food and medicine

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Introduction

Spices played an important role in the history of exploration and development, are no longer luxury items of great cost. With the advent of refrigeration, there is less demand in the west to preserve and flavour foods at home, but they are widely used by the meat, sauce, canning, frozen food industries, and food manufacturing industry generally. They are also used in the cosmetic and perfumery industries, including its use in soap and toothpaste. Spices, or their essential oil, are of some importance in the preparation of liqueurs and cordials. They are also used in various ayurvedic and allopathic medicine. Bakers use it liberally in cookies and in hot drinks. *Cinnamomum* are said to be among the oldest spices *Cinnamomum* has fragrant, sweet and warm taste. Commercial essential oil production industry used several aromatic plant species for extracting high quality essential oil. Cinnamon is a highly valued spice whose bark is widely used as a spice. It is mainly used in cookery as a spice and by various industries for foodstuff, flavouring agent for fragrance and essence perfumes, and medicinal products.[1] *Cinnamomum* stands out of all spices in its "warmth" and ranks as second to pepper. As spices, cinnamon is considered one of the finest sweet spices.

It is indigenous in Sri Lanka, which still produces the largest quantity and best quality, mainly in the form of quills. This genus contains evergreen trees or shrubs belongs to Lauracaceae family contain around 250 species in tropical and subtropical regions, mostly in Asia and some in South and Central America, and Australia[2] however, in Himalayan region only eight species i.e. *Cinnamomum bejolghota* (Buch.-Ham.) Sweet, *Cinnamomum camphora* (L.) J. Presl, *Cinnamomum glanduliferum* (Wall.) Meisn, *Cinnamomum glaucescens* (Nees) Hand.-Mazz., *Cinnamomum impressinervium* Meisn., *Cinnamomum* parthenoxylon (Jack) Meisn., *Cinnamomum* tamala (Buch.-Ham.) Nees and Eberm., and *Cinnamomum zeylanicum* Breyn is found Imani et al.,[3] reported noticeable improvement in digestion, as well as appetite stimulating properties in recent research. In another report, Vangalapati et al.[4] reported that in ancient Egypt cinnamon was used for beverage flavouring, as well as to treat illnesses. Moreover, it has been frequently used in savoury cuisines, Persian sweets soups and pickles. In conventional Chinese medicine, cinnamon has been used as a potential neuroprotective agent,[5] as well as a potent medicine for the control and treatment of type 2 diabetes mellitus.[6] *Cinnamomum* species are commercially valuable source of camphor, cinnamaldehyde and safrol oil in the world. This review presents a summary of *Cinnamomum* species from the Indian Himalaya, Nepal, and Bhutan, focusing on their ethnobotanical uses with the volatile compounds.

Methodology

The current review was conducted using a complete and organized search of the available literature on the medicinal plant cinnamon by using the keywords: essential oil, Himalaya, India, Nepal, Assam, Karnataka, and Indian Himalaya. The searches were performed using various databases, including PubMed (http://www.ncbi.nlm.nih.gov/pubmed), Science Direct (http://www.sciencedirect.com/), Scopus (http://www.scopus.com/), Scirus (http://www.scirus.com/), and Google Scholar (http://www.scholar.google.com/).

Distribution

Sri Lanka is the major Cinnamon growing country along with Seychelles, Madagascar and India.[7] Best quality of cinnamon bark, mainly as quills is produced by Sri Lanka. Sri Lanka and Seychelles have approx 24,000 ha and 3400 ha area under cultivation producing around 12,000 t and 600 t cinnamon respectively.[8] Cinnamon leaf oil is mostly produced in these countries, though the bark oil is distilled mostly in the importing countries. Sri Lankan export is to the tune of around 120 t of leaf oil and 4–5 t of bark oil.[9]

Cultivation of cinnamon

Around 27,000-35,000 annual tons cinnamon is globally produced.[10] It is mostly raised in China, Seychelles, Madagascar and Sri Lanka; additionally, it's cultivated on a little scale in Vietnam and India. It's a hardy plant in terms of its suitableness for its cultivation in various weather conditions. The optimal temperature for the cultivation of cinnamon ranges between 20 to 30°C, with a yearly rainfall ranging between 1250 to 2500 mm. Cinnamon is usually propagated by dried seed and vegetative propagation (Table 1).[11]

Table 1 Ethnopharmacological uses, essential oil compositions, and any biological activities of the essential oils of *Cinnamomum* species

Plant Name	Ethnopharmacology	Antifungal and Antimicrobial	Essential oil
C. camphora (L.) J. Presl	Bronchitis, cold, congestion, diarrhea, dysentery, edema, influenza, flatulence, metabolic and heart problems, gynecological problems[15]	leaf oils: antifungal activity against *Choanephora cucurbitarum*[16] and antibacterial activity against *Pasturella multocida*[17] and *Aspergillus niger*;[18] leaf oil sample from Nepal had shown notable allelopathic activity, cytotoxic activity against MCF-7 human breast tumor cells, and insecticidal activity (*Chaoborus plumicornis, Pieris rapae*, *Drosophila melanogaster*, Solenopsis invicta x richteri);[18] camphor has shown antibacterial activity against the respiratory pathogen *Haemophilus influenza*[19]	Essential oil chemotypes: (1) camphor, (2) linalool, (3) 1,8-cineole, (4) nerolidol, and (5) borneol;[20] Leaf oil from Pantnagar, Uttarakhand: camphor (82.4%) (Agarwal et al., 2012) from Nukuchiatal, Uttarakhand: camphor (81.5%),[21] from Hetauda, Makwanpur, Nepal: camphor (36.5%), camphene (11.7%), limonene (9.0%), sabinene (6.3%), β -pinene (6.3%).[18]
C. glanduliferum (Wall.) Meisn.	Root: wounds and toothache;[22]Leaves: used as stimulant, carminative, and to treat coughs and colds,[23] analgesic, antiseptic, astringent, and carminative properties;[24] Seed: cold, cough, toothache and taenias, muscular swellings, seed oil in treating muscular spasm, joint pain and body aches;[9] Bark: kidney trouble.[25]	Leaf oil sample of northern India, rich in 1,8-cineole (41.4%), α-pinene (20.3%), and α-terpineol (9.4%), was found to have antibacterial activity against Gram-positive bacteria (*Micrococcus luteus*) and Gram-negative bacteria (*Escherichiacoli*, *Pseudomonas aeruginosa*, and *Aeromonas salmonicida*). The high concentration of 1,8-cineole likely contributes to its efficacy against coughs and colds. 1,8-Cineole has shown clinical efficacy as a mucolytic and spasmolytic as well as beneficial effects in inflammatory airway diseases such as asthma and chronic obstructive pulmonary disease (COPD).[26,27]	Leaf oil from northern India: 1,8-cineole (41.4%), α-pinene (20.3%), α-terpineol (9.4%), germacrene D-4-ol (6.1%) and α-thujene (5.10%).[28]
C. tamala (Buch.-Ham.) Nees and Eberm.	Leaves: gastic problems;[29] spice and flavoring agent.[30]	Root essential oil from Nepal, insecticidal (*Culex pipiens*, *Solenopsis invicta* richteri).[18] Leaf oil from Munsyari, Uttarakhand, antibacterial (*Salmonella enterica*, *Escherichia coli, Pasturella multocida*); leaf oil from Logaghat, antibacterial (*Pasturella multocida*).[17]	Root essential oil from Hetauda, Makwanpur, Nepal: camphor (35.0%), linalool (10.6%), p-cymene (8.5%), o-cymene (6.8%), and 1,8-cineole (6.1%).[18] Leaf oil from Jeolikote, Uttarakhand: (E)-cinnamaldehyde (79.4%), (E)-cinnamyl acetate (3.7%), linalool (5.4%).[21] Leaf oil from Munsyari, Uttarakhand: linalool (52.5%), (E)-innamaldehyde 26.4%), 1,8-cineol (4.2%).[17] Leaf oil from Lohaghat, Uttarakhand: linalool (29.8%), camphor (44.0%), (E)-cinnamaldehyde (14.3%).[17] Leaf oil from Champawat, Uttarakhand: linalool (24.7%), camphor (25.5%), (E)-cinnamaldehyde (30.4%) .[17] Leaf oil from Pannagar, Uttarakhand: eugenol (65.0%).[17] Leaf essential oil from Uttarakhand: (E)-cinnamaldehyde (35.8%–62.3%), (E)-cinnamyl acetate (4.7%–22.7%), linalool (5.7%–16.2%).[31]
C. glaucescens Hand.-Mazz.	In Manipur, India, the powdered bark is used to treat kidney trouble.[25]	Fruit oil from Hetauda, Makwanpur, Nepal, nematicidal (Caenorhabditis elegans, LC50 = 151 g/mL), insecticidal (*Culex pipiens*, Reticulitermes virginicus).[18] Fruit oil from Lucknow, India, insecticidal (Callosobruchus chinensis), antifungal (Aspergillus flavus).[25]	Fruit essential oil from Hetauda, Makwanpur, Nepal: methyl (E)-cinnamate (40.5%) 1,8-cineole (24.8%), -terpineol (7.4%).[17] Commercial fruit essential oil from Nepal: methyl (E)-cinnamate (14%) 1,8-cineole (13%), -terpineol (7%).[32] Leaf oil from northeast India: elemicin (92.9%).[33]
C. bejolghota (Buch.-Ham.) Sweet	Bark and its infusions used to treat cough, cold, toothache, liver complaints, diabetes, gall stones and as mouth fresher;[34] bone fracture and wonds[35]		Panicle oil from Jorhat area of Assam: Linalool (65.00%), α-phellandrene (8.90%), 1-8-cineole (3.96%), α-pinene (3.40%), β-phellandrene (3.00%), β-pinene (2.55%), β -caryophyllene (2.55%), (Z)-methyl isoeugenol (2.05%) and α-farnesene (1.93%). Stem bark oil from Jorhat area of Assam: α-terpineol (23.30%), linalool (14.40%), p-cymene (13.90%), α-pinene (5.30%), 1,8-cineole (6.85%) and (E)-methyl cinnamate (3.06%), β-pinene (1.40%), α-phellandrene (1.46%), terpinen-4-ol (1.70%), (E)-cinnamaldehyde (1.50%), eugenol (1.50%), β –caryophyllene (2.85%) and (Z)-methyl isoeugenol (1.05%).[36]

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Table Continued...

Plant Name	Ethnopharmacology	Antifungal and Antimicrobial	Essential oil
C. zeylanicum Breyn	Ground cinnamon is used in diarrhoea and dysentery; for cramps of the stomach, gastric irritation; for checking nausea and vomiting; used externally in toothache, neuralgia and rheumatism. The bark is included in medicinal preparations for indigestion, flatulence, flu, mothwashes, gargles, herbal teas.[37]	Bark from Lucknow, antibacterial S. aureus (Gram positive) and *E. coli* (Gram-negative), anticancer and apoptotic activityagainst human breast cancer cell line MDA-MB-231.[38]	Buds volatile oil: α-bergamotene (27.38 %), α-copaene (23.05%), α- humulene (6.19%), δ-cadinene (5.97%), tetradecanol (4.27%) and viridiflorene (3.29%).[39] Leaf oil: Linalool (85.7%), eugenol (3.1%), β –caryophyllene (2.4%), (E)-cinnamaldehyde (1.7%), α-terpineol (1.1%), (E)-cinnamyl acetate (0.9%).[40] Fruit stalks oil: (E)-cinnamyl acetate (36.59%), (E)-caryophyllene (22.36%), α-humulene (5.49), τ –cadinol (4.90%), δ-cadinene (4.70%), and α-copaene (3.02%).[41] Flower oil: (E)-cinnamyl acetate (41.98%), trans- α -bergamotene (7.97%); caryophyllene oxide (7.29%); α -cadinol (6.35%), tetradecanal (5.05%) and globulol (3.80%) .[42]

Discussion and Conclusion

IUCN red listed twenty-four *Cinnamomum* species.[12] *Cinnamomum* are facing great pressure and threat because of economic activities, especially manual picking of bark and fruits as spice and for their medicinal value. Due to the unregulated use and overexploitation, its number is steadily decreasing. If the necessary conservation measures are not adopted, the species could become extinct. Genetic diversity data are important for conservation and management of rare and endangered species. Maintenance of genetic diversity is essential to the long term survival of the tree species without which there may be a risk of its extinction because of lack of adaptive ability.[13] Cinnamon possess immunomodulatory, antioxidant, antiviral, lowering blood cholesterol, antimicrobial, lipid-lowering, antihypertension, anti-inflammatory, antitumor, gastroprotective, antidiabetic, neuroprotective and blood purifying properties.[14] Therefore, future conservation and sustainable management programmes for the *Cinnamomum* species are an urgent priority.

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None.

Conflicts of interest

The author declares that there is no conflict of interests concerning this paper.

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