BIOACTIVITY OF CINNAMON ESSENTIAL OIL

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ABSTRACT
The interest in using antifungal instead of chemical preservatives in fruits and food products has been increasing in recent years. Regarding essential oils natural and liquid secondary plant metabolites are gaining importance of their use in the protection of foods. Since, they are safe and healthy. Cinnamon bark and leaf oils are selected essential oil. The antifungal activity of essential oil are mostly depend on its chemical constituents present in it which does not allowed the fungal hyphae and mycelium to grow in certain time of period. These oils are mainly used in pharmaceutical in order to preserve certain living entities. The phytochemicals present in this plant are mostly used for antifungal, antibacterial, antihistaminic, antipyretic etc. A review provides an overview of the current literature on cinnamon essential oils mainly antifungal activity, antibacterial activity, antioxidant activity, anti-mycotoxigenic activity.

Keywords: Chemical preservative, secondary metabolites and cinnamon essential oil

INTRODUCTION
Essential oils have secondary metabolites; it has volatile, natural, and complex characteristics (Bakkali F, et al., 2008). The advantages of essential oils have bioactivity in the vapour phase, their characteristics that make them attractive as possible fumigants for stored product protection (Paster et al., 1991; Hammer et al., 1999; Tripathi et al., 2008). Essential oils are playing role in plant protect and defence mechanisms against phytopathogenic micro-organisms (MIHALIAK et al. 1991). According to antifungal activity, several studies have investigated for the antifungal properties of essential oils against postharvest pathogen (Giamperi et al. 2002).

Cinnamon tree is evergreen, it grows around 10m. The plant is popularly known as Dalchini, belongs to Lauraceae family, it contains about 250 species. These are shrubs and small to medium sized plant tree. Mostly, found in tropical rains forests where they grow at various altitudes from highland slopes to lowland forests and they occur in both marshy places and on well-drained soils, widely cultivated in Sri Lanka and India (Jantan. I.B. et al., 2008). Bark is smooth and yellowish colour. Leaves are leathery, 11 to 16 cm long with pointed tips. Yellow flowers are inconspicuous with a particular odour. Fruit of this plant is a small, fleshy and berry. However, in latitudes with seasonal climatic condition and atmospheric changes, they become exceedingly rarely occurrences (Lawrence, 1967).

Cinnamon oil is spicy, sweet, and prized for its lush fragrances (Rao and Gan 2014). Cinnamon oil has bioactivities such as antibacterial, antifungal, antioxidant, anti-mycotoxigenic (Jatan. I. B., et al., 2008; Yousef Naserzadeh et al., 2019; Siripornvisal et al., 2009; Mutullingok, A., et al., 2020). Cinnamon essential oils are thought to play role in plant defence mechanism against phytopathogenic micro-organisms like fungus and bacteria (Mihaliak et al., 1991). Cinnamon oil is both natural preservative and flavouring substances that are not harmful when it consumed as food products (Sukatta, U., et al., 2008). Antifungal activity of cinnamon oil has been reported to inhibit the growth of moulds, yeasts and bacteria (Matan et al., 2006). Cinnamon oil derived from cinnamon bark and cinnamon leaves (Siripornvisal et al., 2009). Oil from cinnamon bark it commercially know as cinnamon oil, it’s used as flavouring ingredient and agent in foods and drinks, as perfumery material, and in many pharmaceutical preparations and its practises for its carminative and astringent properties. Leaf oil distilled from C. zeylanicum used as a source of eugenol (Reynolds, 1993). The essentials of cinnamon species have also recorded subject of some studies. For example, linalool (Fujita & Fujita, 1972), camphor (Yuangzheng et al., 1986), cinnamaldehyde (Fang et
al., 1989), 1, 8-cineole, eugenol (Wijesekera & Jayewardene, 1974), terpine-4-ol, and safrole (Biyao et al., 1986) have been found and reported as major components of leaf, twig, bark, wood, and root oils of various species.

2. PHYTOCHEMICALS

The main compounds isolated and identified from C. zeylanicum, it belongs two chemically classes as phenols: polyphenols and volatile phenols. Among regards polyphenols, C. zeylanicum contain chemical components mainly vanillic, caffeic, gallic, protocatechuic, p-coumaric, and ferulic acids (Muchuweti. M., et al., 2007) (table-1). Regard to volatile components, cinnamon oil having chemical components depend on the part of the plant which they are extracted. In cinnamon bark essential oil, cinnamaldehyde is most represented substances, with a content ranging from 90% to 62% - 73%, it depend on the type of extraction, it being higher for steam distillation than soxhlet extraction (Wong Y. C. et al., 2014) (table-2), and the other minor volatile components are hydrocarbons and oxygenated compounds like β-caryophyllene, benzyl benzoate, linalool, eugenol acetate, and Cinnamyl acetate (configuration-2) (Wong Y. C. et al., 2014). Cinnamon leaf oil has main component is eugenol, it has 80% concentration. Cinnamyl acetate and caryophyllene are the major components in the essential oil it obtained from cinnamon fruits and flowers (table-2) (Jayaprakasha G.K., et al., 1997; Jayaprakasha G.K. et al., 2000; Filoche S.K. et al., 2005).

| Polyphenolic constituents | Structure |
|---------------------------|-----------|
| Vanillic acid             | ![Vanillic acid](image) |
| Caffeic acid              | ![Caffeic acid](image) |
| Gallic acid               | ![Gallic acid](image) |
| Protocatechuic            | ![Protocatechuic](image) |
| p-coumaric                | ![p-coumaric](image) |
| Ferulic acids             | ![Ferulic acids](image) |

Table-1: polyphenolic components (Nabavi, S.F., et al., 2015)
Table-2 major and minor components (Nabavi, S.F., et al., 2015)

2. MEDICINAL PROPERTIES

Outer bark of cinnamon used as spice and several medicinal properties. Inner bark of cinnamon used as medicinal properties and it have essential oil. All over the world, cinnamon bark and leaves are used as an important spice (Rao and Gan 2014). *Cinnamon* as aromatic plant, it is not only used for cooking but they have used as medicinal properties, it also used in traditional medicine (Rao and Gan 2014). Cinnamon has mainly used as bark and powder. It can be found on the spice markets (Ravindra et al., 2003). Cinnamon has high medicinal potential and wide range of possible positive effect for human body and sources (Katarina Jeramic et al., 2019).

| Medicinal uses | Cinnamon comes from a tree. People use the bark and leaves to make medicine. |
|----------------|--------------------------------------------------------------------------------|
|                | - Prevent diabetes                                                           |
|                | - Prevent against Diarrhoea                                                   |
|                | - Prevent infections                                                          |
|                | - Protect against worm infestations                                           |
|                | - Prevent against common cold                                                 |
|                | - Effective against Influenza                                                 |
|                | - Effective for upset stomach                                                 |
|                | - Prevent gastric problem                                                     |

(Subasinghe, S., et al., 2016)
3. BIOACTIVITY OF CINNAMON OIL

Cinnamon oil has bioactivity such as: antifungal, antibacterial, antioxidant, and anti-mycotoxigenic activity (MutulIngok, A., et al., 2020).

- **Antifungal activity of cinnamon oil**

  Fungal infection caused by eukaryotic organisms and fungal spore (Filomena Nazzaro, et al., 2017). Fungal cell wall may be considered as the prime target for selectively toxic antifungal agents because of cell wall have chitin structures, chitin absent in human cells. Chemical treatments are largely effective, but resistant strains and intrinsically resistance species can be developed. Cinnamon oil can represent one of the most promising natural products for fungal inhibition (Hu Y. et al., 2007; kalemba, D., et al., 2003). In fact, cinnamon oil many kinds of essential oils obtained from different plants, herbs and shrubs exhibited intense antifungal properties (Hu Y. et al., 2007; Bakkali, F., et al., 2008; Prakash, B., et al., 2012; Lang, G et al., 2012). Essential oils like the other phytochemicals it could attenuate the microbial growth and bio-film development through specific mechanisms (Hylgdaard, M et al., 2012). To check effectiveness of a group of essential oils in a study investigating and comparing, it including spearmint, peppermint, and mainly cinnamon oils, the most effective one was found to be cinnamon essential oil against Penicillium spp. Moreover, it tested on Penicillium species. It showed considerable antifungal sensitivity to essential oils obtained from the leaf and bark of cinnamon plant (Jeong, E.J. et al., 2014). *Cinnamon zeylanicum* most effective one was indicated to be cinnamon EO with the lowest MIC values against *Aspergillus flavus*, *Aspergillus ochraceus*, and *Aspergillus niger* (Hu, F., et al., 2019). Cinnamon (*Cinnamomum zeylanicum*) essential oil has most effective components due to their biological activities were indicated to be eugenol and cinnamaldehyde (Siddiqua S., et al., 2015). The antifungal activity of cinnamon oil has been determined against several species of fungus, it includes *Aspergillus flavus* (Cisarova, m., et al., 2016), *Aspergillus ochraceus* (Moghadam, Z.A., et al., 2015; Hu, F., et al., 2019), and *Aspergillus niger*, *Aspergillus oryzae* (Hu, F., et al., 2019), *Aspergillus parasiticus* (Cisarova, m., et al., 2016), and *Fusarium proliferatum* (Velluti, A., et al., 2003). Cinnamon essential oil’s inhibitory effects from *Cinnamomum cassia* (cinnamon, 78% e-cinnamaldehyde) was also proved against *Aspergillus carbonarius* (Lappa, I.K., et al., 2017). In addition to Aspergillus species, *Fusarium verticilloides* was also investigated in terms of its sensitivity against cinnamon oils, it includes different kind levels of cinnamaldehyde, the main component of cinnamon oil, as 85% and 99%. If cinnamon oil has higher inhibitory effect, cinnamaldehyde concentration was higher (Jeong, E.J. et al., 2014).

**Table-3: Overview of antifungal properties of cinnamon essential oils (MutulIngok, A., et al., 2020).**

| Essential oil from | Fungal culture | Method | MIC¹/ inhibition | References |
|--------------------|----------------|--------|------------------|------------|
| Cinnamon (cinnamon) sp. | *Aspergillus ochraceus* | Macro dilution | 0.078 µL/ml | (Moghadam, Z.A., et al., 2015) |
| Cinnamon (cinnamon) sp. | *Fusarium verticilloides* | Semisolid agar antifungal susceptibility technique | 60 µL/L | (Xing, F., et al., 2014) |
| Cinnamon (cinnamon) sp. | Penicillium spp., Cladosporium spp. | Disc diffusion | 100% inhibition at 20 µL | (Jeong, E.J. et al., 2014) |
Cinnamomum camphora Aspergillus niger, Aspergillus oryzae, Aspergillus ochraceus Gradient plate 2mg/mL (Hu, F., et al., 2019)

Cinnamomum cassia Aspergillus flavus Broth micro dilution 62.5 µg/mL (Pekmezovic, M., et al., 2015)

Cinnamomum cassia Aspergillus carbonarius Poisoned food technique 100% inhibition at 50-100 µL/L (Lappa, I.K., et al., 2017)

Cinnamomum cassia Aspergillus flavus, Aspergillus carbonarius, Penicillium viridacatum Inhibitory zone method 1.67>5 µL/ml (Wang, H., et al., 2018)

Cinnamomum zeylanicum Aspergillus niger, Aspergillus oryzae, Aspergillus ochraceus Gradient plate 0.062-0.125 mg/mL (Hu, F., et al., 2019)

Cinnamomum zeylanicum Botrytis cinerea, Penicillium expansum Broth micro dilution 625-1250 mg/mL (Nikkhah, M., et al., 2017)

Cinnamomum zeylanicum Aspergillus flavus, Aspergillus parasiticus Micro atmosphere 100% inhibition at 500 µL/L (Cisarova, m., et al., 2016)

- Antibacterial activity of cinnamon oil

Table-4: Overview of antibacterial activities of cinnamon essential oil (MutulIngok, A., et al., 2020).

| Essential oil from | Bacterial culture | Method | MIC1 | References |
|--------------------|-------------------|--------|------|------------|
| Cinnamomum camphora | Bacillus subtilis, Escherichia coli, Staphylococcus aureus, Salmonella typhimurium | Micro dilution broth | 2-4 mg/mL | (Tu, X.F., et al., 2018) |
| Cinnamomum zeylanicum | Bacillus subtilis, Escherichia coli, Staphylococcus aureus, Salmonella typhimurium | Micro dilution broth | 0.12-0.025 µg/mL | (Tu, X.F., et al., 2018) |
| Cinnamomum zeylanicum | Bacillus cereus, Escherichia coli O157:H7, Pseudomonas aeruginosa, P. fluorescens, P. putida, Pectobacterium carotovorum, Salmonella enterica subsp. Enterica, , Staphylococcus aureus | Broth dilution | 100-400 µg/mL | (Clemente, L., et al., 2016) |
| Essential oil from                                      | Most abundant compounds                                                                 | Method          | Results                              | References                                 |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------|--------------------------------------|--------------------------------------------|
| Cinnamomum zeylanicum Blume (cinnamon)                 | Cinnamaldehyde (77.34%), trans-cinnamyl acetate (4.98%), 1,4-benzenedicarboxylic acid (3.55%), 1,8-cineole (3.19%), α-pinene (2.6%) | Phosphomolybdenum assay | 108.75 mg of EO/ equivalent to 1 mg of vitamin C in terms of antioxidant power 21.3% inhibition 55.2% inhibition | (Kallel, I., et al., 2019)                  |
| Cinnamomum zeylanicum Blume (cinnamon)                 | (E)- Cinnamaldehyde (81.39%), (E)- cinnamyl acetate (4.2%), (Z)- Cinnamaldehyde (3.42%), 1,8-cineole (1.9%), dihydrocinnamaldehyde (1.85%) | Phosphomolybdenum assay | 111.46 mg TEs/g sample -9.82 mg TEs/g sample 3.49% inhibition (0.30 mg TEs/g sample) 19.20% inhibition (1.03 mg TEs/g sample) | (Tepe, A.S., et al., 2020)                |
| Cinnamomum zeylanicum (cinnamon)                       | Cinnamaldehyde (66.2%), eugenol (9.57%), β-caryophyllene (7.21%), 1,2-benzenedicarboxylic acid, mono(2-ethylhexyl) ester (3.27%) | DPPH, β-carotene, linoleic acid bleaching assay | 4.62 - 57.56% inhibition lower inhibitory activity than clove oil and black pepper 2.13- | (Purkait, S., et al., 2018)               |

**Antioxidant activity**

Table 5: overview of antioxidant properties of cinnamon essential oil (MutulIngok, A., et al., 2018)
4. CONCLUSION
According to multipurpose source, cinnamon oil is the finest spice oil for phytochemicals screening, research, and pharmaceutical practices. Cinnamon plant’s both parts leaf and bark extract are considered as essential oil. It has strong activity against bacteria and fungus. Cinnamon oil has strong bioactivity such as antifungal, antimicrobial, antioxidant, anti-
mycotoxigenic activities then other essential oil. Hence it can be further explored for its medicinal properties.

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