**Comprehensive review on cinnamon**

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ABSTRACT

The spice plant Cinnamomum verum is well- known for its pharmacological and therapeutic properties. This tree’s old botanical synonym, Cinnamomum zeylanicum, comes from Ceylon which was previous name of Sri Lanka . Cinnamomum verum belongs to the Lauraceae family and is also known by the synonym Cinnamomum zeylanicum Blume.Cinnamomum stands out of all spices in its “ warmth” and ranks as second to pepper. In folk medicine, cinnamon spices have been used as medicine for respiratory and digestive disorder. cinnamon considered one of finest sweet spices. Cinnamon bark powder, which contains antioxidant, flavonoids, cartenoids , vitamins, minerals, fiber, and trace quantity of essential oil, has been the subject of much research. Concentrated and separated cinnamon essential oil might also differ significant therapeutic benefits, especially in treatment of diabetes. In clinical reports it was found very safe and useful in allergic condition also. The majoi chemical constituents of cinnamon bark are cinnamaldehyde (65-80%) , and eugenol (5-10%) , due to their high concentration in cinnamon essential oil , these constituents are hypothesized to have most significant physiological activity.

Key words :- cinnamon , Antioxidant , flavonoids , cinnamaldehyde, Eugenol , Antidiabetic , condiment , spices .

1. Introduction:

For thousands of years , human beings have been conscious of the use of plant- based medicines for the treatment of multiple ailments. Cinnamon has a long tradition both as a seasoning and a drug . Cinnamon ( rougui ) is derived from the inner bark of tropical cinnamon trees , originating from a Greek term meaning sweet wood [1].

The word “amomon” in Hebrew and Arabic is root of common name for cin, Signifies a fragrant spice plant. Cinnamon is mostly employed in the aroma and fragrance industry because of its aroma, incorporated into variety in of foods, fragrance and medications. [2].

Cinnamaldehyde and trans- cinnamaldehyde (cin,) which are found in essential oil, are two most significant components of cinnamon [3].

Many spices of the Lauraceae family which includes the genus Cinnamomum ( cinnamon) , are used as spice. [4]. These plants have their composition compounds with many biological properties, like antimicrobial and antioxidant properties, for the food industry .

The two major varities of cinnamon are Ceylon or true cinnamon ( cinnamon zeylanicum Blume), which cultivated in Sri Lanka and South India , and Cassia (Cinnamon aromaticum Nessi) , which is cultivated in china , Indonesia and Vietnam [5]. According to Malaysian researchers and from United states department of agriculture cinnamon is one of the important spice used everyday by people around globe. It comprises about 38 % of your daily manganese needs and 10% of your iron and dietary fibre requirements[7]. Cinnamon has also been used to treat inflammation and urinary infection as health promoting agent [8]- [9].

1. Botanical Description of cinnamon

Cinnamon is mostly cultivated in Sri Lanka, Malagasy, Republic. In India it is grown in one or two parts of Kerala. Cinnamon zeylanicum tree grows around 10 m ( 30 ft. ). It’s branches are strong and bark is smooth and yellow in colour. Its leathery leaves have pointy points and measure 11 to 16 cm ( 4.5 to 6.25 in) in length. The leaves are dark green on top and light green at bottom. This inconspicuous yellow flowers with disagreeable odour , which are tubular with 6 lobes , grow in panicles (clusters) that are long as leaves. The fruit is tiny , meaty berry that is 1 to 1.5 cm (0.2 to 0.5 in) long , partly encased in cup shaped perianth that grew from flowers other portions and ripens black. Cinnamomum is adapted to wide range of climatic conditions. Cinnamon needs a warm , humid climate with average temperature of 27°c and well distributed annual rainfall of 2000- 2500 mm [10] [11].

The inner bark of tree is scraped off and dried before being ground into a powder to make the spice cinnamon Cultivated trees may also be copied( cut back to encourage shoot development) , so that the coppiced shoots can be harvested. The leaves and twigs are steam distilled to produce cinnamon oil. The quality of bark is significantly impacted by ecological and soil condition. The soil is well drained and high in humus.Sandy loan soil liberally incorporated with organic manures are best. Red dark brown soil free from rockj gravel or quartz are also good for cinnamon cultivation.[10],[11].

2.1 Taxonomy of cinnamon

 Table 1 : Taxonomy [10]

|  |  |
| --- | --- |
| Kingdom  | Plantae |
| Subkingdom  | Viridiplantae |
| Infrakingdom | Streptophyta |
| Super division  | Embryophyta |
| Division  | Tracheophyta |
| Subhash division  | Spermatophytina |
| Class  | Magnoliopsida |
| Order | Laurales |
| Family | Lauraceae  |
| Genus | Cinnamomum schaeff |
| Species  | Cinnamomum verum |

* 1. vernacular names of cinnamon [12]

Table no. 2

|  |  |
| --- | --- |
| India  | Dalchini  |
| English  | Cinnamon  |
| Spanish  | Canela |
| French  | Cammelle  |
| Gujarati  | Taja |
| Punjabi | Dalchini, Darchini  |
| Telugu  | Lavanga, Patta |
| Oriya  | Dalechini, Guda twa |
| Malayalam  | Karuvapatta |
| Bengali  | Daruchini |

### Different species of cinnamon

The genus Cinnamomum contains more than 250 recognised aromatic spices , most of which are found in Asia and Australia. Many of these species are employed as flavouring agents because they are fragrant (Thomas & Duethi, 2001). Among these species Ceylon cinnamon , or Cinnamomum zeylanicum Blume (also known as Cinnamomum verum J. Presl.) and Cinnamomum cassia J. Presl. The most economically significant species are cassia cinnamon.(Barceloux, 2008; Muhammed & Dewettinck, 2017).

In Indonesia , Cinnamomum brumanni Blume grows and Vietnam’s Cinnamomum loureiroi Nees. (Chen et al., 2014), and in India and Nepal Cinnamomum tamala and Cinnamomum brumanni Blume are has economic significance.(Anonymous, 2015; Barceloux, 2008). Cinnamomum zeylanicum, widely known as the “true cinnamon,” is naturally found in Sri Lanka, while C. Cassia, C. Burmannii, and C. Loureirii are known as Cassia cinnamon (Ghodki & Goswami, 2016).



1. Nutritional properties of cinnamon

 The pharmacological and nutritional perspective of cinnamon are established in the review. There are a lot of time saving processed foods on the market nowadays, but they also have lot of negative health implications, because of its phytochemica components, which include volatile and phenolic compounds, cinnamon offers several health Benefits for people, especially as an anti-inflammatory, antitumour, anticancer, Antidiabetic and antihypertriglyceridemia agent. So, people are more aware of the usage of the natural herbal product in the diet. As a result , more individual are aware of benifits of including natural herbal products in their diets. The most popular spice in world is cinnamon ( Cinnamomum verum) . The bioactive ingredient in cinnamon is called cinnamonaldehyde . Cinnamon contains healthy number of nutrients. Energy , carbohydrates, vitamins A and C, calcium, iron magnesium are examples of micronutrients. Cinnamon also well known for its antibacterial, anticancer, immunomodulatory, and metabolic syndrome health effects. So cinnamon is very helpful in fight against illness. It is detemined that cinnamon is incredibly helpful for the maintenance of health and it is helpful in the prevention of diseases. [26]

Table no. 1 Micronutrients ( per 100 gm) Bharti Goel and sunidhi Mishra (2020) [26].

|  |  |
| --- | --- |
|  Constituents  |  Value |
| Energy  | 247 kcal / 1035 KJ |
| Protein  | 3.99 g |
| Total fat | 1.24 g |
| Ash | 3.6 g |
| Carbohydrates  | 80.59 g |

Table no 2: Nutritive value of minerals [26]

|  |  |
| --- | --- |
| Constituents  | Value |
| Calcium | 1002 mg |
| Iron  | 8.32 mg |
| Magnesium  | 60 mg |
| Phosphorous  | 60 mg |
| Potassium  | 431 mg |
| Zinc | 1.83mg |
| Copper | 0.339 mg |
| Manganese  | 17.466 m |

Table no. 3: Nutritive value of vitamins [26]

|  |  |
| --- | --- |
| Constituents | Values |
| Vitamin C | 3.8 mg |
| Vitamin A | 295IU |
| Thaimine | 0.002 mg |
| Riboflavin  | 0.041 mg |
| Niacin | 1.332 mg |
| Pantothenic acid  | 0.558 mg |

1. Phytochemical study of cinnamon

Cinnamon is member of family Lauraceae and as known as Ceylon cinnamon , Cinnamomum zeylanicum Nees , and true cinnamon. Bark , leaf essential oil, bark essential oil and oleo resins of cinnamon are used as spice. ( Nabavi et al 2015).

Cinnamon contains 9.5-10.5% moisture , 3.89-4.65% protein , 59.55-80.59% carbohydrates, 53.1% dietary fibre, 3.55% Ash and vitamins .( Charles 2013; Parthasarathy 2008; Peter 2001).

Cinnamon contains wide range of phytochemicals including cinnamaldehyde, cinnamyl acetate , cinnamyl alcohol, eugenol , linalool, benzaldehyde, hydrocarbon ( jayprakash et al. 2002; kaefer and Milner 2008; Peter 2001; Vangalapati 2012;; Yashin et al. 2017). The major constituents of cinnamon bark are essential oil ( upto 2.8%) with cinnamaldehyde (60-90% ) as major component (Maromgiu et al.2007). In addition the major components of root bark , flowers , and fruit oils are camphor, trans – cinnamyl acetate, and linalool ( Parthasarathy et al. 2008). Vanillic acid , caffeic acid , and ferulic acid are main phenolics found in cinnamon, and their increased polyphenol concentration is linked to its biological qualities.( Muchuweti et al. 2007). Abesekera et al. (2013) repoted that the ethanolic extracts of cinnamon leaf and bark had high phenolics and flavonoids contents which are more than those of dichloremethane/ methanol extracts. Besides phytochemicals such as glycosides, steroids , alkaloids , saponins , anthraquinones , tannins , terpenoids , and coumarin has also identified in cinnamon extracts ( De soya et al. 2016; Harsha et al. 2013; Sibi et al. 2013; Shreya et al. 2015; Tacouri et al. 2013). [40].

1. Pharmacology of cinnamon

5.1. Antioxidant Activity

DPPH, phosphomolybdate, and ferric reducing antioxidant power assays were used to determine the antioxidant activity of hexane, chloroform, and methanol extracts of cinnamon, black pepper, ginger, and turmeric. Of all the extracts, cinnamon methanol extract has the strongest antioxidant activity [20]. Cinnamon essential oil was found to have the highest antioxidant activity when compared to lemon oil in another study [21]. Cinnamon powder has antioxidant action in alloxan-induced diabetic rats. Cinnamon powder contains antioxidant enzymes such as glutathione, peroxidase, catalase, and superoxide dismutase, which dramatically boosted and reduced blood glucose levels in rats [22].

5.2. Anti-ulcer

Overall, we have shown that using cinnamon extract to stop H. Pylori’s growth and urease activity in vitro works better than using thyme extract. According to (Tabak et al.) the effectiveness of cinnamon extract in liquid media and it’s tolerance to pH levels may increase its impact in environments like human stomach. [33]

5.3 Antimicrobial Activity

 Because of its strong hydrophobic character, Cinnamomum zeylanicum is a well-documented antibacterial agent, according to many researches [15-16]. The antimicrobial activity of essential oils of C. Zeylanicum and three more herbs such as cuminum cuminum , Amomum subulatum, and Syzgium aromaticum were examined for their ability to inhibit salmonella typhi, salmonella para-typhoid , Escherichia coli, staphylococcus aurens, Bacillus lichneniforms , and psedimonas fluorescence using the broth C. Zeylanicum was found to have more powerful antibacterial action against all bacteria than the other three plants [17] The results revealed that ethyl acetate exhibited substantial antibacterial action against Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa, while petroleum ether extract had the highest sensitivity against Bacillus subtilis[ 18]. Another study shows how 15 different plant essential oil extracts affected various bacterial strains. Cinnamon essential oil has a higher antimicrobial action than other essential oils [19].

5.4 Anti-diabetic Activity

Cinnamon methanol extract and 50 green teas have anti-diabetic action in 50 diabetic rats caused by streptozotocin (STZ). The treatment lasted six weeks. After medication, the rats blood glucose levels were significantly reduced. The extracts have been found to have a synergistic impact in the treatment of diabetes[ 24] Streptozocin was used to stimulate the mice. Cinnamon was given to mice for a period of 14 days. A gluco Oxidase (GOD) assay and a radioimmunoassay (RIA). Cinnamon maintains blood glucose and insulin levels in rats, according to the findings. [25].

5.5 Anticancer Activity

 A cell proliferation assay was used to test the anticancer efficacy of the water-soluble polysaccharide and other cinnamon extracts against macrophage cell lines in an in-vitro investigation. When compared to other cinnamon extracts, the polysaccharide component of cinnamon was found to have greater immunostimulatory properties [41] . The resuls showed that cinnamon aqueous extract significantly reduced the development of oral cancer.[42]

6.Traditional Uses

Cinnamon has been called one of maximum common spice and food flavouring additive due to the fact ancient instances[13]. Because of its delicate and fresh effects that forms in mouth , it has been employed as taste in chocolates and chewing gum. It also used to treat thoathaches , oral infections , and foul breath. Cinnamon has additionally been used to deal with pimples and melisma [14].

• Some Major Ayurvedic Medicinal Uses of Cinnamomum Zeylanicum are: [12]

-It cures headaches , the common cold , influenza, and sore throats.

-It also used as expectorant and has antitubercular qualities

-In is a natural treatment for rheumatoid arthritis.

-It’s also good for lowering cholesterol and strengthening the cardiac muscles.

-It provides relief in menstrual pain. According to study , women can temporarily reduce their menstrual pain by drinking a cup of warm cinnamon water each day.

7.Conclusion

Cinnamon oil demonstrates a wide range of beneficial properties, including antioxidant, antidiabetic, neuroprotective, antifungal, antimicrobial, and insecticidal effects. It also shows promise in food preservation and as a component in nanoemulsions for enhanced stability and efficacy. These findings highlight the potential of cinnamon oil as a natural alternative in various medical, industrial, and agricultural applications. The findings of this study have implications for the development of novel therapeutic strategies, particularly in the prevention and management of infectious diseases, inflammatory disorders, and diabetes.

8. References

1] Hamidpour, R., Hamidpour, M Hamidpour , S., and Shahlari , M.(2015) . Cinnamon from the selection of traditional applications to its novel effects on the inhibition of angiogenesis in cancer cells and prevention of Alzheimer’s disease, and a series of functions such as antioxidant, anticholesterol , Antidiabetic, antibacterial activities Journal of traditional and complementary medicine, 5(2), 66-70.

2] Rao P. V., & Gan , S.H. (2014) . Cinnamon a multifaceted medicinal plant. Evidence Based complementary and Alternative Medicine, 2014.

3] Yeh Hf , Lio CY , Lin CY , Cheng SS , Hsu YR , Chang ST. Methods for thermal stability enhancement of leaf essential oils and their main constituents from indigenous cinnamon ( Cinnamomum osmophloeum). Journal of agriculture and food chemistry. 2013 Jul 3;61 (26): 6293-8.

4] Shan B, Cai YZ , Brooks DJ , Cork H. Antibacterial properties and major bioactive component of cinnamon stick ( Cinnamomum burmanii): activity against food has pathogenic bacteria. J Agric Food Chem. 2007; 55: 5484e5490.

5] Vinitha M, Ballal M. In vitro anticandidal activity of Cinnamomum verum. K Medisci.

2008;8:425e428.

6] Ravindran PN, Shylaja. , Nirmal Babu K, Krishnamoorthy B. Botany and crop improvement of cinnamon and Cassia . (Boca Raton:CRC) 2004: 14-79.

7] Ulbricht C. Seamon E. Windsor RC. Armbrester N. Bryan JK. Costa D. Giese N. Gruenwald J. Jovin R. Issac R. Grimes Serrano JM. An evidence based systematic review of cinnamon by Natural standard Research collaboration. Journal of dietary supplements 2011. Oct 28:8(4): 378-454.

8]Chen J, Jiang QD,Wu YM, Liu p, Yao JH, Lu Q, Zhang H, Duan JA. Potential of essential oils as penetration enhancers for transdermal administration of ibuprofen to treat dysmenorrhoea. Molecules.2015 Oct ; 20 (10): 18219-36.

9] Brierley SM, Kelber O. Use of natural products in gastrointestinal therapies. Current opinions in pharmacology. 2011 Dec 1;1(6): 604-11.

10] Idu Rawat, Nisha Sharma, Kushagra Joshi. Cinnamon ( Cinnamomum zeylanicum). In book: Medicinal Plants in India: importance and cultivation . January 2020, 164-177.

11] Subasinghe, S., Hettiatachchi, C.S. and Iddagoda, N. 2016. In vitro propagation of cinnamon. (Cinnamomum verum Presl) using embryos and in vitro axillary bud . Journal of Advance Agriculture Technology, 3(3):164-169.

12] Rashmi pathak, Himanshu Sharma. A review on medicinal use of cinnamon verum ( cinnamon) . Journal of drug delivery and therapeutic 11(6-s):161-166.

13] Wijesekera RO. Chichester CO. The chemistry and technology of cinnamon. Critical Reviews in Food Science and Nutrition. 1978 sep 1;10 (1):1-30.

14] Vijayan, K.; Thampuran, R.A. Pharmacology and Toxicology of Cinnamon and Cassia. In Cinnamon and Cassia: The Genus Cinnamomum; Ravindran PN, Babu KN, Eds.; CRC Press: Boca Raton, FL, USA; 2004.

15] Shifali et al., Dalchini (cinnamomum zeylanicum) a versatile spice with significant therapeutic potential, International Journal of Pharmaceutics and Drug Analysis. 2021; 9(2):126-136.

16] NG Vasconvelos, J. Croda, S. Simionatto. Antibacterial mechanism of cinnamon and it’s constituents: A Review. Microbial Pathogenesis 120 , 198-203, 2018.

17] Wisal GA. Antibacterial and antifungal effect of cinnamon, Microbiology Research Journal International. 2018 May 10:1-8.

18] Naveed R, Hussain I, Tawab A, Tariq M, Rahman M, Hameed S, Mahmood MS, Siddique AB, Iqbal M. Antimicrobial activity of the bioactive components of essential oils from Pakistani spices against Salmonella and other multi-drug resistant bacteria, BMC complementary and alternative medicine. 2013 Dec; 13(1):1-0.

19] Abdalla RM, Abdelgadir AE. Antibacterial activity and phytochemical constituents of Cinnamomum verum and Matricaria chamomilla from Sudan, Bio Bulletin. 2016; 2(2):01-0.

20] Mith H, Dure R, Delcenserie V, Zhiri A, Daube G, Clinquart A. Antimicrobial activities of commercial essential oils and their components against food‐borne pathogens and food spoilage bacteria, Food science & nutrition. 2014 Jul; 2(4):403-16.

21] Saranya B, Sulfikarali T, Chindhu S, Muneeb AM, Leela NK, Zachariah TJ. Turmeric and cinnamon dominate in antioxidant potential among four major spices, Journal of Spices and Aromatic Crops. 2017 Jun 1; 26(1):27-32.

22] Elgendy EM, Ibrahim HS, Elmeherry HF, Sedki AG, Mekhemer FU. Chemical and biological comparative in vitro studies of cinnamon bark and lemon peel essential oils, Food and Nutrition Sciences. 2016 Dec 9; 8(1):110-25.

23] Vaibhavi Jakhetia, Rakesh Patel , Pankaj Khatri, Neeraj Pahuja, Sunil Garg, Anupriya Pandey, Sonu Sharma. Cinnamon: A Pharmacologica Review. Journal of Advanced Scientific Research. J.Adv.Sci.Res., 2010, 1(2): 19-23.

24]Ezzat SK, AbuElkhair MT, Mourad MI, Helal ME, Grawish ME. Effects of aqueous cinnamon extract on chemically-induced carcinoma of hamster cheek pouch mucosa, Biochemistry and biophysics reports. 2017 Dec 1; 12: 72-8.

25] Shokri G, Fathi H, Jafari Sabet M, Nasri Nasrabadi N, Ataee R. Evaluation of antidiabetic effects of hydroalcoholic extract of green tea and cinnamon on streptozotocininduced diabetic rats, Pharmaceutical and Biomedical Research. 2015 Jun 10; 1(2):20-9.

26] Bharti Goel , Sunidhi Mishra . Medicinal and Nutritional perspective of cinnamon: A Mini review , European Jouryof Medicinal plants Feb 2020.

27]Navabi , S.F. Di Lorenzo , M. Sobarzo – Sanchez, E., Danglia, M., and Navabi S.M. (2015) . Antibacterial effect of cinnamon: from farm to food , cosmetics and pharmaceuticals industries. Nutrients. 7(9):77729-7748.

28] Charles , D.J.(2013) . Antioxidant properties of spices, herbs and other sources. Frontier Natural product co-op , Norway. Doi: 10.1007/978-1-4614-4310-0.

29] kaefer , C.M. and Milner , J.A. (2008) . The role of herbs and spice in cancer prevention J. Nutr. Biochem 19(6):347-361.

30] Jayprakasha , G.K., Rao, l. J. And Sakariah, K.K. (2002). Chemical composition of volatile oil from cinnam zeylanicum buds. Zeitschriftfur Naturforschung 57(11-12) : 990-993.

31] Morongiu, B., Piras, A., Porcedda, S., Tuveri, E., Sanjust, E., Meli, M., and Rescign , A. (2007) . Supercritical CO2 extract of Cinnamomum zeylanicum chemical characterization and antityrosinase activity. Food chem. 55(24): 10022-10027.

32] Abesekera , W.P.K.M., Premakumara, G.A.s., and Ratnasooriya, W.D.(2013). In vitro antioxidant properties of leaf and bark extract of Ceylon cinnamon ( Cinnamomum zeylanicum Blume) Trop. Agric. Res. 24(2):128-138.

33]De soya , E.J.S., Abeysinghe, D.C., and Dharmadasa, R.M. (2016) . Comparison of phytochemicals Antioxidant activity and essential oil with four selected spice crpp. Word J. Agric. Res. 4(6):251-255.

34] Harsha , N., Sridevi , V., Lakshmi, M.V.V.C. Rani K. , and Vani, N.D.S., (2013). Phytochemical analysis of some selected spices.Int. J. Innov. Res.Sci..Eng.Technol.2(11):6618-6621.

36] Shreya, A., Manisha, D., and Sonali, J., (2015). Phytochemical screening and antimicrobial activity of cinnamon spice against urinary tract infection and fungal pathogens.Int. J.Life sci. Pharma.Res. 5(4):30-38.

37] Vangalapati, M., Satya, S.N. , Prakash, S.D.V., and Avanigadda, S. (2012). A review on pharmacological activities and clinical effects of cinnamon spices. Res.J.Pharma. Biol.Chem.Sci. 3(1):653-663

38] Feyza Tosya and Sibel Bolel. (2021). Effects of cinnamon on Health and it’s potential as a functional food ingredient. Science of spices & culinary Herbs. Vol. 5,115-127.

39] Priyanga Ranasinghe , Shehani Pigera, GA Sirimal Premkumara, Priyadarshani Galappaththy, Godwin R. Constantine & Prasad Katulanda. (2013). Medicinal properties of “True cinnamon ( Cinnamomum zeylanicum) a systematic review. 22 oct 2013. Volume 13, article no. 275.

40] Abul Hossain, Fereidoon Shahidi , Bioactives in spice , and spice oleoresins: Phytochemicals and their beneficial effects in food preservation and health promotion. Food Bioact July 2018: 3., 8-75.

41] Qabaha K, Abu-Lafi S, Al-Rimawi F. Antiinflammatory Activities of Ethanolic Extracts of curcuma Longa (Turmeric) and cinnamon (Cinnamomum verum).

42] Goyal M, Kaur H, Bhandari M, Rizvanov AA, Khaiboullina SF, Baranwal M. Antioxidant and Immune Effects of Water-Soluble Polysaccharides Isolated from Cinnamomum verum Bark, BioNanoScience. 2018 Sep; 8(3):935-40.

43] Thomas, J., & Duethi, P. P. (2001). Cinnamon. In K. V. Peter (Ed.), Handbook of herbs and spices. Woodhead Publishing Limited.

44] Barceloux, D. G. (2008). Cinnamon (Cinnamomum Species). Medical toxicology of natural substances: Foods, fungi, medicinal herbs, toxic plants, and venomous animals (pp. 39–43). John Wiley & Sons.

45] Muhammed, D. R. A., & Dewettinck, K. (2017). Cinnamon and its derivatives as potential ingredient in functional food-A review. International Journal of Food Properties, 20(2), 2237–2263.

46] Chen, P., Sun, J., & Ford, P. (2014). Differentiation of the four major species of cinnamons (C. Burmannii, C. Verum, C. Cassia, and C. Loureiroi) using a flow injection mass spectrometric (FIMS) fingerprinting method. Journal of Agricultural and Food Chemistry, 62, 2516–2521.

47] Anonymous. (2015). Cinnamon cultivation and processing. Technical Bulletin 5 (Published in Sinhala language), Department of Export Agriculture of Sri Lanka, 41 pp.

48] Ghodki, B. M., & Goswami, T. K. (2016). Optimization of cryogenic grinding process for cassia (Cinnamomum loureiri Nees L.). Food Process Engineering, 39, 659–675.