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REVIEW ARTICLE

ORIGIN, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETIC DIVERSITY, BREEDING AND CULTIVATION OF CINNAMON

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ABSTRACT

Cinnamomum verum belongs to the family Lauraceae, genus **Cinnamomum,** and species *Cinnamomum zeylanicum* or *Cinnamomum verum.* Local Common Names are Cannalavangapattai, dalchini, elavagnum, karuva, karuwa, tamalapatra, twak, vayana. Common Name(s) are Ceylon cinnamon, Ceylon cinnamon tree, Cinnamon, Cinnamon bark tree, Kayu Manis, True cinnamon. Indian Name of Spices are in Hindi : Dalchini, Darchini, Bengali : Dalchini, Gujarati : Dalchini, Kannada : Lavangapattai, Malayalam : Karuvapatta, Marathi : Dalchini, Oriya : Dalchini, Punjabi : Dalchini, Sanskrit : Darushila, Tamil : Karuvapattai, Sannalavangapattai, Urdu : Dalchini. Cinnomon has long been valued as a spice which was used by the ancient Egyptians in embalming mummies (mummification), witchery and the manufacture of perfumes and malabathrum oil. Chinese also use cinnabar in preserving the body of the dead. In Sri Lanka, cinnamon has originated in the central hills where several species of related taxa occur, especially in places such as Kandy, Matale, Belihull Oya, Haputale and the Sinharaja forest range (Ranatunga *et al*., 2003). Currently, cinnamon cultivation is concentrated along the coastal belt stretching from Negom to Matara. The bulk of the cinnamon plantation is about 70-80 years old, most of which belongs to small holders. Only about 10% of the plantations exceed 8-10 ha. Sri Lanka commands about 60% of the world export market and exports about 7,000 t of quills and chips per year, apart from cinnamon leaf oil and bark oil. Cinnamon is a valuable spice that is obtained from the bark of an evergreen tree (*Cinnamomum zeylanicum*) that belongs to the Laurel family. Cinnamon is native to Sri Lanka, Myanmar (Burma) and the southern coastal strip of India. The crop now grows in South America and the West Indies, the Seychelles and Reunion. The best quality cinnamon is produced in Sri Lanka. Cinnamon gets its distinctive smell and aroma from a volatile oil that is in the bark. The oil can be distilled from off-grade bark, leaves and roots. Cinnamon must be dried before it is stored and sold for market. This brief outlines the important steps that should be taken pre-harvest and post-harvest to ensure that the dried cinnamon is of top quality for the market. *Cinnamomum verum* (Lauraceae) is grown in several Asian countries, particularly in Sri Lanka and Southern India. Cinnamon is a traditional folk herb that can be found in Korea, China, and Russia. Cinnamon has been used by various cultures all over the world for ages. Cinnamon comes in two varieties: *Cinnamomum zeylanicum* and *Cinnamon cassia*, both of which are obtained from the inner bark of the tropical evergreen plant *Cinnamomum zeylanicum.* Cinnamon was one of the first known spices. In ancient Egyptian times, much of the world's cinnamon came from China. The Romans believed cinnamon's fragrance sacred and burned it at funerals, but it was not popular as a cooking spice. In medieval Europe, cinnamon became a favorite flavor in many banquet foods. It was also regarded as an appetite stimulant, a digestive, an aphrodisiac, and a treatment for coughs and sore throats. In this review article on Origin, Taxonomy, Botanical Description, Genetics and Cytogenetics, Genetic Diversity, Breeding and Cultivation are discussed.

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INTRODUCTION

Cinnamomum belongs to the family Lauraceae, genus *Cinnamomum***,** and species *Cinnamomum zeylanicum* or *Cinnamomum verum* (Rawat *et al*., 2020; Ashwani *et al.,* 2021; Pathak and Sharma, 2021; Bakewell-Stone, 2023; Bionity, 2024; Nisarga, 2024; Petruzzello, 2025). Local Common Names are Cannalavangapattai, dalchini, elavagnum, karuva, karuwa, tamalapatra, twak, vayana (Bakewell-Stone, 2023). Common Name(s) are Ceylon cinnamon, Ceylon cinnamon tree, Cinnamon, Cinnamon bark tree, Kayu Manis, True cinnamon (Rawat *et al*., 2020; NCSU, 2024). Indian Name of Spices are in Hindi : Dalchini, Darchini, Bengali: Dalchini, Gujarati: Dalchini, Kannada: Lavangapattai, Malayalam : Karuvapatta, Marathi : Dalchini, Oriya : Dalchini,

Punjabi : Dalchini, Sanskrit : Darushila, Tamil : Karuvapattai, Sannalavangapattai, Urdu : Dalchini **(**Pathak and Sharma, 2021; Indianspices, 2024**).** Cinnomon has long been valued as a spice which was used by the ancient Egyptians in embalming mummies (mummification), witchery and the manufacture of perfumes[1] and malabathrum oil. Chinese also use cinnabar in preserving the body of the dead (Dasanayaka, 2019). Common names are in English: cinnamon, Ceylon cinnamon, cinnamon tree; Arab: dâr sînî; Cambodia: che'k tum phka loëng; Dutch: kaneelboom; Finnish: aitokaneli, ceyloninkaneli, kaneli; French: cannelier de Ceylan; German: Ceylonzimt, Ceylonzimtbaum, echter Ceylonzimt, Zimtbaum; Hindi: dalchini; India: cannalavangapattai, ilayangam, kurundu; Indonesia: kayu manis; Italian: cannella del Ceylano; Java: kaju manis, manis djangan; Malaysia: kayu manis; Papua New Guinea: skin diwai; Philippines: cinnamon, kanela; Portuguese: caneleiro, canelleira da India; Portuguese (Brazil): canela-da-Índia; Spanish: canela, canelero de Ceilán; Sri Lanka: curruva-pattai; Swedish: äkta kanel; Vietnam: qu[ees] h[oof]i, qu[ees] r[af]nh, qu[ees] Srilanca; Transcribed Chinese: xi lan rou gui (Ceylon, 2024).

The etymology of cinnamon is derived from the Greek word kinnamómon (meaning spice). The Greeks borrowed the word from the Phoenicians, indicating trade with the East from early times. Cinnamon is recorded in Sanskrit, the Old Testament, and in Greek medicinal works and was employed by the Egyptians for embalming purposes as early as 1485 BC. A species synonym, *'zeylanicum'*, refers to the place of origin, the island of Ceylon (Sri Lanka). The word cinnamon can legally be applied to both true cinnamon and cassia in the U.S., while in the U.K. and other countries cassia must be labeled "cassia" and cannot be labeled simply as "cinnamon" (Ceylon, 2024). The English word "cinnamon", attested in English since the 15th century, deriving from the Ancient Greek κιννάμωμον (*kinnámōmon*, later κίνναμον : *kínnamon*), via Latin and medieval French intermediate forms. The Greek was borrowed from a Phoenician word, which was similar to the related Hebrew word *qinnāmōn*. The name "cassia", first recorded in late Old English from Latin, ultimately derives from the Hebrew word *qetsīʿāh*, a form of the verb *qātsaʿ*, "to strip off bark". Early Modern English also used the names *canel* and *canella*, similar to the current names of cinnamon in several other European languages, which are derived from the Latin word *cannella*, a diminutive of *canna*, "tube", from the way the bark curls up as it dries (Wikipedia, 2024). Cinnamon is the dried inner bark of various evergreen trees belonging to the genus *Cinnamomum*. The botanical name, *Cinnamomum*, derives from the Hebraic and Arabic term "amomon", meaning "fragrant spice plant". Some types of cinnamon are also referred to as "cassia". Cinnamon goes by many names in different languages such as ròuguì (Chinese), dalchini (Hindi), canela (Spanish), cannelle (French), qarfa (Arabic), and zimt (German) (Resources, 2024).

In Sri Lanka, cinnamon has originated in the central hills where several species of related taxa occur, especially in places such as Kandy, Matale, Belihull Oya, Haputale and the Sinharaja forest range (Ranatunga *et al.*, 2003). Currently, cinnamon cultivation is concentrated along the coastal belt stretching from Negom to Matara. Of late, cultivation has spread to the inland areas of Kalutara, Ambalangoda, Matara and Ratnapura . The area under cinnamon cultivation in Sri Lanka is around 15,500 ha (Ranatunga *et al.,* 2003). The bulk of the cinnamon plantation is about 70-80 years old, most of which belongs to small holders. Only about 10% of the plantations exceed 8-10 ha. Sri Lanka commands about 60% of the world export market and exports about 7,000 t of quills and chips per year, apart from cinnamon leaf oil and bark oil (Ranatunga *et al.,* 2003). Though only cinnamon (*C. verum*) and cassias (Chinese, Indonesian and Indian) are of commercial importance, there are other species that yield aromatic oils and are of local importance, both as spice and as an ingredient of local medicine (Shylaja *et al.,* 2003). *Cinnamomum* is a large genus and consists of around 450 species, and many of them may have some localised use. Little is known about these species, although some have been studied in more detail (Shylaja *et al*., 2003).

Cinnamon (*Cinnamomum verum*) (Family: Lauraceae) is one of the earliest known spice mainly cultivated for the dried inner bark of the tree. Cinnamon is a native of Sri Lanka and is cultivated in lower elevations of Western Ghats in Kerala and Tamil Nadu (Anandaraj *et al*., 2005). Cinnamon is a valuable spice that is obtained from the bark of an evergreen tree (*Cinnamomum zeylanicum*) that belongs to the Laurel family (Ali, 2008). Cinnamon is native to Sri Lanka, Myanmar (Burma) and the southern coastal strip of India. The crop now grows in South America and the West Indies, the Seychelles and Reunion (Ali, 2008). The best quality cinnamon is produced in Sri Lanka (Ali, 2008). Cinnamon gets its distinctive smell and aroma from a volatile oil that is in the bark. The oil can be distilled from off-grade bark, leaves and roots (Ali, 2008). Cinnamon must be dried before it is stored and sold for market. This brief outlines the important steps that should be taken pre-harvest and post-harvest to ensure that the dried cinnamon is of top quality for the market (Ali, 2008).

Cinnamon is one of the most popular spices in the world and has been used by mankind through time. Cinnamon occupied a pre-eminent position in the ancient world as well as it does nowadays. The Western powers, which were temped most by the famed spice, explored the unknown seas in search of spices in the lands of the East. Especially The Netherlands have a history of conquering countries for spices (Jansen, 2015). Imperialism and colonialism ruled the world and in this period the world powers fought bitter wars for naval supremacy and for monopoly in the spice trade. As for this, Cinnamon was like the Holy Grail for the foreign invaders, which was mainly addressed to Portugal, Holland, France and Britain. Cinnamon and its relative Cassia are often qualified as the „Spice of Life" and are amongst the most popular spices (Jansen, 2015). The inner bark of the tree *Cinnamon vernum* (= syn. *C. Zeylanicum*), belongs to the family Lauraceae. Its native roots derive from Sri Lanka, where it is grown on large scale, and exported. In trade it is known by the name of Cylon cinnamon or Sri Lankan cinnamon (Jansen, 2015). The term Cinnamon is derived from the Greek word *Kinnamon* or *Kinnamomon* (sweet wood). It probably has its Semitic origin from the Hebrew word *Quinamom*. *Kayu Manis* also means sweet wood and is a name from The Malayan and Indonesian. The ancient version of this word might have contributed to the Hebrew and Greek terminology. In Latin it is called *Canella*, meaning small tube or pipe, which refers to the form of the Cinnamon quills. The Dutch *Kaneel*, French *Canelle*, Italian *Cannella*, and Spanisch *Canela,* all are derived from the Latin (Jansen, 2015). *Dalchini* is the Hindi name, meaning Chinese wood, refers originally to the Chinese cinnamon. In northern India it was popular before the Cylon cinnamon became known

(Jansen, 2015). Cinnamon is mainly grown in Sri Lanka, but also in countries like the Seychelles, Madagascar and India (Jansen, 2015). The species *Cinnamomum zeylanicum* (sin. *C. verum*), known as Ceylon cinnamon, the true commercial cinnamon, belongs to the family Lauraceae and it is native of Sri Lanka (former Ceylon), main exporter and producer, followed by Seychelles, Madagascar and India **(**Smiderle and Souza, 2016**).** The tree of *C. zeylanicum* reaches of 8-17 m height and its barks and leaves are generally used in perfume-making, beverage and culinary manufacture due to their aromatic and seasoning properties **(**Smiderle and Souza, 2016**).** The essential oil of this plant is one of the most important on the world market and presents a great diversity in its composition **(**Smiderle and Souza, 2016**).** *C. zeylanicum* is much used in folk medicine for presenting medicinal properties, such as antispasmodic, carminative, stimulating, tonic, digestive, astringent, aphrodisiacal, antiseptic, antioxidant, aperient, aromatic, hypertensive, sedative and vasodilator **(**Smiderle and Souza, 2016**).** Brazil imports regularly significant amounts both of barks and essential from different countries, given the absence of commercial cultivation of that spice in the country. *C. zeylanicum* develops well on Brazilian soil, where it was cultivated in the past, having been introduced by the Jesuits **(**Smiderle and Souza, 2016**).** Studies that provide silvicultural information about the species, inclusive as far as the production of seedlings is concerned is of fundamental importance. The characterization of the quality of seedlings is one of the greatest concerns found in the plant nurseries due to the high production cost of seedlings. That is due, in part, to the development time of plants and hence, the greater expense on inputs (defensives and fertilizers), labor and equipment **(**Smiderle and Souza, 2016**).**

The genus *Cinnamomum* belongs to the family Lauraceae and consists of about 110 species of evergreen trees and shrubs (Azad *et al*., 2016). Out of nine *Cinnamomum* species, *Cinnamomum verum* is one of the most important species in Sri Lanka which contributes to 70% of the world true cinnamon bark production (Azad *et al.*, 2016). The export volume of cinnamon and earning for 2012 was 14,435 metric tons and16,654.7 million rupees respectively (Azad *et al*., 2016). Cinnamon is endemic to Sri Lanka and it had been found in central hilly areas of Sri Lanka and also in Sinharaja and Knuckles forest reserves. The ideal environmental condition for cinnamon is available in wet zone of Sri Lanka (Azad *et al*., 2016). Cinnamon bark is mainly used as a spice for flavoring food product and leaf oil is used as flavor ingredients and also in cosmetics and pharmaceutical industries (Azad *et al.,* 2016). Different biological activities including anti-diabetic, anti-inflammatory, astringent and diuretic effects have been popularized cinnamon in folk medicine (Azad *et al*., 2016). In modern medicine, cinnamon is combined with other ingredients to treat diarrhea, internal hemorrhage, impotency, typhoid, halitosis, checking nausea and vomiting and for restoring normal skin color on the face (Azad *et al.,* 2016). Cinnamon flower exhibits protogynous dichogamy and it is cross pollinated (Azad *et al.,* 2016). Thus, vegetative propagation is necessary for producing uniformly high yielding populations and for propagating elite lines (Azad *et al*., 2016). A core collection is a representative subset of a large number of populations which intends to improve management (Azad *et al*., 2016). The genus *Cinnamomum* has 250 species distributed from South, East and South East Asia to Australia. There are eight species of cinnamon grown in Sri Lanka, of which, *Cinnamomum verum* (syn. *C. zeylanicum* Blume) which is widely cultivated in the country. In addition, seven other species of wild cinnamon are also grown which are endemic to Sri Lanka which are considered wild cinnamon (Liyanage *et al*., 2017). Much work has been carried out with *Cinnamomum verum*, however, work on wild cinnamon varieties is scanty (Liyanage *et al.*, 2017). Study was carried out to identify and quantify the major chemical constituents of volatile oils obtained from bark and leaves of wild and true cinnamon species cultivated or grown in Sri Lanka. It was revealed that leaf oil of *Cinnamomum verum* contains significantly ($p<0.05$) higher percentage of volatile oil (3.23%) (Liyanage *et al.,* 2017). The highest cinnamaldehyde content (67.57%) was observed in Cinnamomum verum (Liyanage *et al*., 2017). The genus Cinnamomum consists of nearly 250 species distributed in the South, East and South East Asia and Australia. *Cinnamomum verum* (syn. *Cinnamomum zeylanicum* Blume) also known as true Cinnamon is one of the important spice crops cultivated in Sri Lanka (Liyanage *et al*., 2017). In addition to *Cinnamomum verum*, genus *Cinnamomum* includes seven other important wild species of Cinnamon namely *Cinnamomum dubium* Nees, *Cinnamomum ovalifolium* Wight, *Cinnamomum litseafolium* Thwaites, *Cinnamomum citriodorum, Cinnamomum rivulorum* Kostermans, *Cinnamomum sinharajense* Kostermans, *Cinnamomum capparu-corende* Blume which are present in Sri Lanka (Liyanage *et al.,* 2017). *Cinnamomum verum* is an evergreen tree of 10-15 m tall¸ native to Sri Lanka. It is the main commercially cultivated cinnamon species while the other species of *Cinnamomum* are reported to have medicinal and ethno-botanical values (Liyanage *et al.,* 2017). In many instances, very little distinction has been made between the bark oil of true cinnamon (*Cinnamomum verum* syn. *C. zeylanicum*) obtained from different locations of Sri Lanka (Liyanage *et al.,* 2017). Sri Lanka has the comparative advantage with regard to the cinnamon market due to its intrinsic quality. Sri Lanka exports cinnamon to many countries in the world. *viz* Mexico, India, USA, and Europe being the major buyers. The total value of exports of cinnamon was amounted to be Rs. 19099 US$ million in 2015 (Liyanage *et al*., 2017).

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 **(**Kumar and Kumari, 2019**).** 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 **(**Kumar and Kumari, 2019**).** *Cinnamomum* are said to be among the oldest spices *Cinnamomum* has fragrant, sweet and warm taste **(**Kumar and Kumari, 2019**).** Commercial essential oil production industry used several aromatic plant species for extracting high quality essential oil **(**Kumar and Kumari, 2019**).** 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 **(**Kumar and Kumari, 2019**).** *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 **(**Kumar and Kumari, 2019**).** 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 Australia2 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*., reported noticeable improvement in digestion, as well as appetite stimulating properties in recent research **(**Kumar and Kumari, 2019**).** 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, as well as a potent medicine for the control and treatment of type 2 diabetes mellitus **(**Kumar and Kumari, 2019**).** *Cinnamomum* species are commercially valuable source of camphor, cinnamaldehyde and safrol oil in the world **(**Kumar and Kumari, 2019**).** *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 **(**Kumar and Kumari, 2019**).** 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 **(**Kumar and Kumari, 2019**).** 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 **(**Kumar and Kumari, 2019**).** Cinnamon possess immunomodulatory, antioxidant, antiviral, lowering blood cholesterol, antimicrobial, lipid-lowering, antihypertension, anti-inflammatory, antitumor, gastroprotective, antidiabetic, neuroprotective and blood purifying properties **(**Kumar and Kumari, 2019**).** Future conservation and sustainable management programmes for the *Cinnamomum* species are an urgent priority **(**Kumar and Kumari, 2019**).** Cinnamon has been used by humans for thousands of years- as early as 3,000 B.C. Despite of its exotic, distant origin, cinnamon was known and widely used in the ancient world. The Arabs were the first to introduce it to the west and dominated the trade for centuries via their network of trading routes that went as far as China (Dasanayaka, 2019). Their account of where and how cinnamon was obtained proves that exaggerated marketing techniques were not invented in the past. In spite of its widespread use, the origins of cinnamon was the Arab merchants' best-kept secret until the early 10th century (Dasanayaka, 2019). To maintain their monopoly on cinnamon trade and justify its exorbitant price, Arab traders' interlaced colorful stories for their buyers about where and how they obtained the luxurious spice (Dasanayaka, 2019).

Cinnamomum zeylanicum Blume is a commercially important species cultivated in Sri Lanka and traded as Ceylon cinnamon or true cinnamon (Bandusekara *et al*., 2020). In addition, seven endemic wild species of the genus Cinnamomum have been reported in Sri Lanka. The literature on wild relatives of *C. dubium, C. capparucoronde, C. citriodorum, C. litseaefolium, C. ovalifolium, C. rivulorum* and *C.sinharajaense* is limited (Bandusekara *et al*., 2020). Since the cinnamon is a cross-pollinated species, intra-species diversity is also a possibility (Bandusekara *et al.,* 2020). Work focused on inter- and intra-species diversity of Cinnamomum leaf morphology to develop a "Leaf Morphological Index" for field-level identification of reported species (Bandusekara *et al*., 2020). Forty accessions, representing a minimum of two from each species, collected from natural and cultivated habitats, were assessed with 12 morphological characters. The highest within-species variation was observed in *C. zeylanicum*, followed by *C.dubium* (Bandusekara *et al.,* 2020). Of the morphological characters, five-leaf traits, leaf shape, apex, base, venation, and size significantly contributed to the main principle components . Therefore, those traits were used for developing a leaf morphological index. The morphological index could distinguish all the species at the field level (Bandusekara *et al.,* 2020). The genus *Cinnamomum* Schaeff, belongs to the family *Lauraceae,* and consists of about 250 species distributed in Asia, Australia, and the Pacific Islands. Of them, *Cinnamomum zeylanicum* Blume (syn. *Cinnamomum verum* J. Presl), *C. cassia* Blume and *C. camphora* Seib are commercially cultivated around the world (Bandusekara *et al.*, 2020). The genus *Cinnamomum* Schaeffer consists of evergreen trees and shrubs, growing in natural and cultivated habitats from the Asiatic mainland to Formosa, the Pacific Island, Australia, and the tropical America (Bandaranayake and Pushpakumara, 2020). Of about 250 species in the genus, few are cultivated in several countries while many are endemic to certain geographical areas (Bandaranayake and Pushpakumara, 2020). Many species in the genus are economically valuable, traded in the local and world markets as spices, medicinal and aromatic compounds, food and industrial ingredients, and timber (Bandaranayake and Pushpakumara, 2020). While several species are brought into cultivation, many are harvested from the wild or natural habitats, making them endangered and requiring conservation effort (Bandaranayake and Pushpakumara, 2020). Since the *Cinnamomum* flower is naturally adapted for cross pollination, substantial intra-species diversity is also expected (Bandaranayake and Pushpakumara, 2020).

There are eight endemic *Cinnamomum* species in Sri Lanka, including *Cinnamomum zeylanicum* Blume (syn. *C. verum*), which is known commercially as Ceylon, true, or Sri Lankan cinnamon. Except for *C. dubium*, all other wild endemic *Cinnamomum* species are threatened (Abeysinghe *et al*., 2020). Some of these species such as *C. sinharajaense*, *C. capparu coronde,* and *C. liseaefolium* have high concentrations of eugenol and cinnamaldehyde in their bark and/or leaf oils, the two major commercially valuable components in cultivated cinnamon (Abeysinghe *et al*., 2020). Linalool (in *C. capparu coronde*) and citronellol (in *C. citriodorum*) are other valuable components. Several endemic species are used in indigenous medicine (Abeysinghe *et al*., 2020). In addition to *in situ* conservation efforts, cultivation of these species even in a small scale would help in their conservation (Abeysinghe *et al*., 2020). Although the traditional classification of plants, including *Cinnamomum* spp., is largely based on morphological and floral characteristics, there is considerable variation in morphology within *Cinnamomum* species due to obligate cross-pollination as a result of protogynous dichogamy (Abeysinghe *et al*., 2020). The Cinnamon popularly known as Dalchini (*Cinnamomum zeylanicum*), belongs to the Family Lauracae **(**Rawat *et al*., 2020**).** The main

part of its tree which is used for the spice purpose is its bark **(**Rawat *et al.,* 2020**).** Cinnamon is found widely in Sri Lanka but also grows in Malabar, Cochin-China, Sumatra and in Eastern Islands too. Besides India, it is also cultivated in Brazil, Mauritius, India, Jamaica and in other countries also **(**Rawat *et al.,* 2020**).**

Cinnamomum zeylanicum Blume is a commercially important species cultivated in Sri Lanka and traded as Ceylon cinnamon or true cinnamon. In addition, seven endemic wild species of the genus *Cinnamomum* have been reported in Sri Lanka. The literature on wild relatives of *C. dubium*, *C. capparucoronde*, *C. citriodorum*, *C. litseaefolium*, *C. ovalifolium*, *C. rivulorum* and *C.sinharajaense* is limited (Bandusekara *et al*., 2020). Therefore, proper field level identification and differentiation of both wild and cultivated species are critical for the conservation and utilization of such species (Bandusekara *et al.,* 2020). Since the cinnamon is a crosspollinated species, intra-species diversity is also a possibility. Our work focused on inter- and intra-species diversity of *Cinnamomum* leaf morphology to develop a "Leaf Morphological Index" for field-level identification of reported species (Bandusekara *et al*., 2020). Forty accessions, representing a minimum of two from each species, collected from natural and cultivated habitats, were assessed with 12 morphological characters. The highest within-species variation was observed in *C. zeylanicum*, followed by *C. dubium*. Of the morphological characters, five-leaf traits, leaf shape, apex, base, venation, and size significantly contributed to the main principle components (Bandusekara *et al.,* 2020). The genus *Cinnamomum* Schaeff, belongs to the family Lauraceae, and consists of about 250 species distributed in Asia, Australia, and the Pacific Islands. Of them, *Cinnamomum zeylanicum* Blume (syn. *Cinnamomum verum* J. Presl), *C. cassia* Blume and *C. camphora* Seib are commercially cultivated around the world. Other than *C. zeylanicum,* seven endemic wild species of the genus *Cinnamomum* have been reported in Sri Lanka (Bandusekara *et al*., 2020). *C. dubium* Nees. Is a widely distributed species whereas *C.capparu-coronde* Blume., *C. citriodorum* Thw., *C. litseaefolium* Thw., *C. ovalifolium* Wight., *C.rivulorum* Kosterm. and *C. sinharajaense* Kosterm. are found in limited habitats. *C.ovalifolium* and *C. sinharajaense* are only naturally grown in isolated habitats and do not exist in cultivation or other parts of the country (Bandusekara *et al.,* 2020). *C. litseaefolium* and *C. rivulorum* are categorized as endangered species in Sri Lanka while all other wild species are categorized as vulnerable species (Bandusekara *et al*., 2020). The demand for true cinnamon has an increasing trend worldwide as a high price spice crop due to ethnobotanical uses and recent scientific evidence on its medicinal and pharmacological properties. Several *in vitro* and *in vivo* evidences suggest that *C.zeylanicum* has anti-microbial, anti-parasitic, anti-oxidant and free radical scavenging properties and ability to lower blood glucose, serum cholesterol and blood pressure, suggesting beneficial cardiovascular effects (Bandusekara *et al.,* 2020). The *Cinnamomum* flower has naturally evolved for cross-pollination, having "protogyneous-dichorgamy" breeding system, which may result in intraspecies genetic diversity (Bandusekara *et al*., 2020). A key has been developed using the persistent nature of the perianth segment in the fruit cup, panicle length, leaf characters, and smell of various plant parts, although the use of this key is not pragmatic as panicle and flowers are not available throughout the year under field conditions (Bandusekara *et al.,* 2020). The Cinnamon popularly known as Dalchini (*Cinnamomum zeylanicum)*, belongs to the Family Lauracae. The main part of its tree which is used for the spice purpose is its bark. Cinnamon is found widely in Sri Lanka but also grows in Malabar, Cochin-China, Sumatra and in Eastern Islands too. Besides India, it is also cultivated in Brazil, Mauritius, India, Jamaica and in other countries also (Rawat *et al*., 2020).

Cinnamon is the common name for the spice obtained from the dried inner bark of several species of the genus *Cinnamomum* in the Lauraceae family (Pathirana and Senaratne, 2021). 'True' or 'Ceylon' cinnamon produced from *Cinnamomum zeylanicum* Blume (*C. verum* J. Presl), with the much easier to process, giving a more delicate, sweeter flavor with nuances of clove, but more importantly with only traces (often below detection thresholds) of coumarin, compared with 5–7 g/kg in other species (Pathirana and Senaratne, 2021). Cinnamon has been a popular and expensive spice in many civilizations, including ancient Egypt, Rome and in 14th and 15th century Europe, where it was used primarily to preserve meat for its antibacterial properties, fine aroma and flavour (Pathirana and Senaratne, 2021). Ancient Egyptians used cinnamon in mummification process due to its antibacterial properties and fragrance. The quest for cinnamon brought many explorers to Ceylon, whose ancient history is intertwined with the cinnamon trade. Ancient Egyptians and Romans used cinnamon as a valued spice and as an incense (Pathirana and Senaratne, 2021). In recent years, much research has been conducted in crop improvement, processing and value addition in cinnamon. In addition to direct use as a condiment/spice, cinnamon has found a multitude of uses in the food and beverage, traditional medicine, pharmacology, nutraceutical and cosmetics industries (Pathirana and Senaratne, 2021). Ceylon cinnamon is unique in that oils distilled from the bark (major constituents are cinnamaldehyde and oleoresins), leaf (eugenol is the major constituent used in dentistry, perfumes, flavorings and as an antioxidant) and roots (camphor) have different industrial uses (Pathirana and Senaratne, 2021). Cinnamaldehyde is now a proven natural bactericide widely used in food and beverage industry, effective against *Salmonella* spp. and Escherichia coli. Thus, it has become an important natural component of organic fruit and vegetable juices to enhance microbial safety of these nutritious beverages (Pathirana and Senaratne, 2021). Because of its manifold uses, cinnamon is an important crop. There have been many recent publications on its ethnobotany, genetics, crop improvement, agronomy, processing, biotechnology, chemistry, food and medicinal uses, and industrial applications (Pathirana and Senaratne, 2021). Cinnamon is a spice obtained from the inner bark of several tree species from the genus Cinnamomum. Cinnamon is used mainly as an aromatic condiment and flavouring additive in a wide variety of cuisines, sweet and savoury dishes, breakfast cereals, snack foods, tea and traditional foods (Ashwani *et al*., 2021). Ceylon cinnamon, also known as true cinnamon, is frequently used in other countries. Cinnamon usually causes no side effects. But heavy use could irritate your mouth and lips, causing sore (Ashwani *et al*., 2021). Some people are allergic to it. It might cause redness and irritation if you put it on your skin. Thus cinnamon offers an array of different oils with diverse characteristics, each of which determines its' value to the different industries. For example the root which has camphor as the Main constitute, has minimal commercial value unlike the Leaf and bark (Ashwani *et al.,* 2021). Generally in India, *Cinnamomum zeylanicum* is cultivated in south India. But it originates from the island of Sri Lanka, south east of India (Ashwani *et al.,*

2021). The aroma and flavour of cinnamon derive from its essential oil and principal component, cinnamaldehyde, as well as numerous other constituents including eugenol. Only a few *Cinnamomum* species are grown commercially for spice. *Cinnamomum verum* is sometimes considered to be "true cinnamon", but most cinnamon in international commerce is derived from the related species *Cinnamomum cassia*, also referred to as "cassia" (Ashwani *et al*., 2021). In 2018, Indonesia and China produced 70% of the world's supply of cinnamon, Indonesia producing nearly 40% and China 30% (Ashwani *et al.,* 2021).

Cinnamon and its products have gained worldwide attention than ever due to recent scientific evidence on its medicinal benefits and pharmacological applications (Liyanage *et al*., 2021). Several species belong to the genus *Cinnamomum* are traded as cinnamon in the local and international markets in different parts of the world. Of them, Ceylon cinnamon, also known as true cinnamon is considered superior to other species due to its unique biochemical properties (Liyanage *et al*., 2021). Both bark and leaf and oils extracted from collected materials are used in different domestic and industrial applications, *viz.,* food and beverage, traditional medicine, pharmacology, nutraceutical and cosmetics industries (Liyanage *et al.,* 2021). Ceylon cinnamon is scientifically known as *Cinnamomum zeylanicum* Blume (syn *Cinnamomum verum* J. Presl), belongs to the family Lauraceae. It is considered to be endemic to Sri Lanka and the wild collections are still found in some forest patches in the upcountry regions of Sri Lanka and the historical evidence suggests a monopoly of cinnamon trade in the *Kandy* region (Liyanage *et al.,* 2021). It was first brought into cultivation in the 1500s during the Dutch ruling period and expanded to the Sothern part of the country. Later, it has introduced to south India, Camaros, and Ghana, where it is commercially cultivated currently (Liyanage *et al*., 2021). The spice, consisting of the dried inner bark, is brown in colour and has a delicately fragrant aroma and a warm sweet flavour (Ashwani *et al.,* 2021). The gifts of Hellenistic rulers to temples sometimes included cassia and cinnamon. During the 1500s, Ferdinand Magellan was searching for spices on behalf of Spain, and in the Philippines found *Cinnamomum mindanaense*, which was closely related to *C. zeylanicum*, the cinnamon found in Sri Lanka (Ashwani *et al.,* 2021). Cinnamon has been known from remote antiquity. It was imported to Egypt as early as 2000 BC, but those who reported that it had come from China had confused it with cinnamon cassia, a related species (Ashwani *et al*., 2021). In Ancient Egypt, cinnamon was used to embalm mummies. From the Ptolemaic Kingdom onward, Ancient Egyptian recipes for kyphi, an aromatic used for burning, included cinnamon and cassia (Ashwani *et al*., 2021).

Cinnamomum verum (Lauraceae) is grown in several Asian countries, particularly in Sri Lanka and Southern India **(**Pathak and Sharma, 2021**).** Cinnamon is a traditional folk herb that can be found in Korea, China, and Russia. Cinnamon has been used by various cultures all over the world for ages **(**Pathak and Sharma, 2021**).** Cinnamon comes in two varieties: *Cinnamomum zeylanicum* and *Cinnamon cassia*, both of which are obtained from the inner bark of the tropical evergreen plant *Cinnamomum zeylanicum* **(**Pathak and Sharma, 2021**).** *Cinnamomum verum* shoots of their outer cork beneath parenchyma are used to make the medication.The surface is longitudinally striated and the fracture is short and splintery **(**Pathak and Sharma, 2021**).** It contains a minimum of 12 millilitres per kilogramme of essential oil obtained through steam distillation. It has a distinct odour that is both aromatic and pleasant **(**Pathak and Sharma, 2021**).** It has a pungently spicy, slightly sweet, mucilaginous flavour with only a tiny harshness **(**Pathak and Sharma, 2021**).** In the traditional Chinese system, cinnamon is regarded as a potent neuroprotective agent as well as a medicine for the treatment of type 2 diabetes mellitus **(**Pathak and Sharma, 2021**).** Cinnamon has been utilized in a variety of culinary applications for thousands of years **(**Pathak and Sharma, 2021**).** It has been employed as an antiemetic, antidiarrheal, ant flatulent, and stimulant in Ayurvedic medicine due to its high healing importance **(**Pathak and Sharma, 2021**).** It was employed for mummification by the Egyptians **(**Pathak and Sharma, 2021**).** During the 16th and 17th centuries, Portuguese traders brought the spice (*C. zeylanicum*) from Sri Lanka to Europe. Cinnamon cultivation began in Java under the Dutch occupation in the 17th century, and it was brought to Europe by the East India Company **(**Pathak and Sharma, 2021**).** A spice is a dried seed, fruit, root, bark or flower of a plant or a herb used in small quantities for flavor, color or as a preservative. The spices and Herbs used for flavor, aroma and medicinal properties derive a special valuefrom the said factors. Spices and herbs have been in use for centuries both for culinary and medicinal purposes (Muthalib *et al*., 2021). Spices not only enhance the flavor, aroma, and color of food and beverages, but they can also protect from acute and chronic diseases. Long before modern medicine, spices were valued for their ability to help individuals in disease prevention and health promotion (Muthalib *et al.,* 2021). Cinnamon is a spice obtained from the inner bark of trees belonging to the family 'Lauraceae' and genus 'Cinnamomum' (Muthalib *et al*., 2021). Cinnamon is found widely in Sri Lanka but also distributed in South and South-East Asia. There are over 250 plant species in the cinnamon genus. But only 4 types or varieties of Cinnamon are used for commercial purposes. Such as, Ceylon cinnamon (*Cinnamon zeylanicum Blume.*), Cassia cinnamon (*Cinnamomum aromaticum*), *Korintje cinnamon* (*Cinnamomum burmanni*) and *Saigon cinnamon* (*Cinnamomum loureiroi*). Ceylon cinnamon (*Cinnamomum zeylanicum* Blume), a variety native to Sri Lanka, sometimes referred to "true" cinnamon" globally, is one of the oldest and most important spice crops used for culinary purposes in Sri Lanka for centuries (Muthalib *et al*., 2021).

Cinnamon is a versatile spice that has been used in culinary applications for centuries. It is a staple in many cuisines around the world and is commonly used in sweet and savory dishes alike (Karthik, 2023). In baking, cinnamon is often used in cakes, cookies, and pastries to add a warm, comforting flavor and aroma (Karthik, 2023). It is also a popular spice in Indian cuisine mainly used in Indian Biriyani. In savory cooking, cinnamon is used in dishes like Moroccan tagines and Indian curries to add depth and complexity to the flavor profile. It can also be used to flavor hot beverages like coffee and tea, as well as alcoholic drinks like mulled wine (Karthik, 2023). Overall, cinnamon's versatility and unique flavor profile make it a beloved spice that can be used in a wide variety of culinary applications (Karthik, 2023). Cinnamon is native to India and Sri Lanka, though it is also considered to be native to the Tenasserim Hills of Myanmar. Cinnamon (*C. verum*) and cassia (*C. cassia*) were among the first spices sought after by most early European explorers in the 1400s and 1500s. The Portuguese, occupying Sri Lanka in 1536, and the Dutch, taking over in 1656, established virtual monopolies on

the trade. From a product collected from wild stands, it became a cultivated crop in Sri Lanka around 1770. It is likely to be present in many more tropical countries than stated in the distribution table, especially in the Caribbean, Central and South America, and Africa (Bakewell-Stone, 2023).

Cinnamon was one of the first known spices. In ancient Egyptian times, much of the world's cinnamon came from China (Resources, 2024). The Romans believed cinnamon's fragrance sacred and burned it at funerals, but it was not popular as a cooking spice (Resources, 2024). In medieval Europe, cinnamon became a favorite flavor in many banquet foods. It was also regarded as an appetite stimulant, a digestive, an aphrodisiac, and a treatment for coughs and sore throats (Resources, 2024). Because cinnamon was one of the first spices sought in 15th century European explorations, some say it indirectly led to the discovery of America (Resources, 2024). Between the 16th and 18th centuries, the Dutch and Portuguese brutally fought to control the cinnamon plantations of Ceylon (now called Sri Lanka) (Resources, 2024). *Cinnamomum verum* (*Cinnamomum zeylanicum,* also called true cinnamon tree or Ceylon cinnamon tree) is a small evergreen tree belonging to the family Lauraceae, native to Sri Lanka (Wikipedia, 2024a). The inner bark of the tree is historically regarded as the spice cinnamon, though this term was later generalized to include *C. cassia* as well (Wikipedia, 2024a).

Cinnamomum zeylanicum Blume. also known as true cinnamon, ceylon cinnamon or dalchini belongs to the family Lauraceae and includes about 300 genera and 2500 species (Niharika and Hanumantha, 2024). It is native to Sri Lanka and Malabar coast of India (Niharika and Hanumantha, 2024). It has received increased attention in recent years due to the vast amount of scientific evidence supporting its possible therapeutic and medical benefits (Niharika and Hanumantha, 2024). Approximately 65-70 per cent of the world's production of Ceylon cinnamon is produced in Sri Lanka (Niharika and Hanumantha, 2024). In addition to flourishing in Naga hills and coastal hills of Assam and Karnataka respectively, the genus *Cinnamomum* demonstrates a strong center of diversity particularly within Western Ghats and the surrounding areas of South India (Niharika and Hanumantha, 2024). The cinnamon flower is naturally pollinated through cross-pollination, which the botanists refer as protogynous dichogamy. Flower opens at twice, first it opens as female flower with a stigma and immature male components that enable it to pollinate with another male bloom. The female flower then shuts in approximately four hours. The identical flower blooms the following day as an active male flower that distributes pollen (Niharika and Hanumantha, 2024). Considerable genetic variation in the offspring produced by this pollination activity is represented in the chemical characteristics, yield and yield related morphological features (Niharika and Hanumantha, 2024). Before creating any selection procedure to find superior trees and use them to increase the yield, it is crucial to understand the scope of variation. One of the selection strategies used in tree development programs is progeny evalation, in which superior trees are chosen based on their respective progeny performances at a young age by giving progenies of selected genotypes identical environmental (growing) conditions. It is commonly known that those picked through this process have superior genetic traits (Niharika and Hanumantha, 2024). Due to diverse agro-ecological conditions present in Western Ghats, coastal areas and plains, finding suitable genotypes over Karnataka is of highest importance (Niharika and Hanumantha, 2024). Cinnamon leaf morphometric traits are important markers that can be adopted for measuring the magnitude of the genetic diversity (Niharika and Hanumantha, 2024). By understanding and evaluating morphometric parameters of leaf could help in the taxonomical classification and differentiation of closely related species and verities of Cinnamon and also helpful in indirect selection of high yielding plant. The big leaves and large round leaves had high bark yield (Niharika and Hanumantha, 2024). Bark oil quality (higher per cent of Cinnamaldehyde) is higher in the tree of inwardly curved leaves and high-quality leaf oil is obtained from the small round leaves (Niharika and Hanumantha, 2024).

Ceylon cinnamon is a world-famous cinnamon product produced mainly by Sri Lanka. In Indonesia, the distribution of Ceylon cinnamon is very limited (Rostiana *et al*., 2025). The yield components and essential oils quality of Ceylon cinnamon cultivated at a medium altitude were influenced by age of plant (Rostiana *et al.,* 2025). It is recommended that best harvesting would be 6 years after planting, and 4 years later on after the first pruning (Rostiana *et al*., 2025). Certain accession had optimum yield of bark and leaves, cinnamaldehyde content >60%, eugenol content >85%, and meets the international standard (Rostiana *et al*., 2025). Types of cinnamon that are widely cultivated are cassia vera or Padang cinnamon (*Cinnamomum burmanii*), Ceylon cinnamon or true cinnamon (*C. verum, syn. C. zeylanicum*) and Chinese cinnamon (*C. cassia*) (Rostiana *et al.,* 2025). Cinnamon is one of the most popular spice products in the world, especially countries in America and Europe (Rostiana *et al*., 2025). Cinnamon products traded on the world market are bark, as well as bark and leaves essential oils (Rostiana *et al*., 2025). The world's cinnamon producing countries are Sri Lanka, Seychelles, Madagascar, India, Indonesia, China, and Vietnam (Rostiana *et al*., 2025). There are four types of cinnamon products traded in the world, namely 1) Ceylon cinnamon, *Cinnamomum verum*; 2) cassia cinnamon, *Cinnamomum cassia*; 3) Saigon cinnamon, *Cinnamomum loureiroi*; and 4) Korintje cinnamon or cassiavera or Padang cassia, *Cinnamomum burmanii* (Rostiana *et al*., 2025). Ceylon Cinnamon are monopoly product of Sri Lanka. Indonesia is the main producer of cassia cinnamon known in the trading world as Korintje (*Cinnamomum burmanii* Bl.) or Padang cassia (Rostiana *et al.,* 2025). Cinnamon is traded as a spice, but it is also useful and can be used as medicine. One of the main functions of cinnamon powder as a medicine is for the treatment of diabetes with no evidence indicative of toxicity of *C. zeylanicum* (Rostiana *et al*., 2025). High coumarin content in cassia cinnamon will damage liver tissue and even cause liver cancer. *C. burmanii* (Korintje) generally has a coumarin content of 0.4-0.8%, while Ceylon cinnamon <0.02% (Rostiana *et al.,* 2025). *C. zeylanicum* also has anti-microbial, antiparasitic, anti-oxidant, free radical scavenging and wound healing properties. In addition, *C. zeylanicum* may lower blood glucose, serum cholesterol. and blood pressure, suggesting beneficial cardiovascular and metabolic effects (Rostiana *et al.,* 2025). The potential of the Indonesian Ceylon cinnamon market has the opportunity to fill the international market, because in addition to the low coumarin content, it also has an essential oil yield of > 1%, cinnamaldehyde content > 6% and leaf eugenol > 85% (Rostiana *et al*., 2025). Further, the production of Ceylon Cinnamon in main producing country, Sri Lanka, has remained constant with the average annual

productivity of 'Ceylon Cinnamon' at about 500 kg/ha, throughout the past thirteen years, and cultivated area has only shown a slight expansion over the past two decades. This would become an opportunity for Indonesia to expand production not only for Cassia Cinnamon, but also Ceylon Cinnamon (Rostiana *et al*., 2025). Ceylon cinnamon or known as true Cinnamon (*Cinnamomum zeylanicum* Blume) originates from Southwest India, Eastern Sri Lanka, and the Tennasserim Hills of Myanmar (Rostiana *et al*., 2025). Ceylon cinnamon in Indonesia was probably brought by the Portuguese in 1770. This plant was first developed in West Java, then spread to West Sumatra in areas with elevations below 500 m above sea level (Rostiana *et al.,* 2025). Ceylon cinnamon in Indonesian Spice and Medicinal Crops Research Institute was first planted in a forestry garden in Cikampek in 1908. In 1932, cinnamon from Cikampek was distributed to the Bogor Botanical Gardens and Cultuurtuin (the forerunner to the Research Institute for Spices and Medicinal Plants) in Cimanggu (Rostiana *et al.,* 2025). Ceylon cinnamon collection at Cimanggu Research Station, then propagated and replanted as a base collection of germplasm in the Cimanggu and Laing-Solok Research Station in 1984-1989 (Rostiana *et al*., 2025). This plant is usually harvested at 4-5 years old, and can grow and develop after pruning. In the first pruning of 6-year-old plants, bark yields ranged between 1,800 - 4,350 kg / tree with cinnamaldehyde content of bark ranging from 42.23% - 61.24% (Rostiana *et al*., 2025). It is not yet known the characteristics of the production and the quality of the oil yield after pruning, as well as the optimum harvest age which can produce oil quality according to trade standards, after the first pruning (Rostiana *et al*., 2025).

Cinnamon has been cultivated worldwide for centuries, and its popularity as a spice continues to grow. The evergreen species of this tree, scientifically known as *Cinnamomum verum*, is native to India, Sri Lanka, and Burma **(**Nosir, 2025**).** Its flavorful and aromatic bark makes cinnamon a much sought-after ingredient in the culinary world. As the demand for cinnamon continues to increase, there have been efforts to improve its production with modern technologies **(**Nosir, 2025**).** These range from sustainable growing practices to high-tech mechanical harvesting, harvesting aids, and postharvest handling **(**Nosir, 2025**).** When it comes to growing cinnamon, many cultivars vary in taste and aroma, each with unique qualities. Cultivars of the *Cinnamomum verum* species cultivated worldwide include Korarima, Saigon, Cinnamon Glabra, Zeylanicum, Nees, and Cleopatra **(**Nosir, 2025**).** Some of the most advanced technology employed in cinnamon cultivation involves developing irrigation systems that maximize production and maintain good yields, particularly during dry weather. In India and Sri Lanka, drip irrigation is a common practice to deliver nutrients and water directly to the plant's root zone **(**Nosir, 2025**).** There have also been advancements in machinery for mechanical harvesting, such as machines to collect Cinnamon from tall trees and deliver it directly to the factory. Other technologies have been used to reduce postharvest handling losses by implementing sophisticated equipment, including heat treating and dehydration machines, to reduce the time taken to process Cinnamon **(**Nosir, 2025**).** Infrared technology has been employed to improve the safety and hygiene of Cinnamon and to control disease and pests **(**Nosir, 2025**).** In addition, technology has been used to track and record the production process. This ensures a high level of traceability and reduces wastage, resulting in higher profits for producers and benefiting consumers **(**Nosir, 2025**).** Genetic technologies are becoming increasingly commonplace. Cross-breeding programs are used to select favorable traits, such as increased oil yield, disease resistance, and desired flavor notes **(**Nosir, 2025**).** New methods such as tissue culture and genetic engineering may allow for more precise improvements in production. Technology is now being employed to maximize the production of high-quality Cinnamon, increase profitability and create sustainable production processes. Adopting modern technologies in cinnamon cultivation is bringing positive changes to the global cinnamon industry, allowing it to remain a major agricultural commodity **(**Nosir, 2025**).**

In this review article on Origin, Taxonomy, Botanical Description, Genetics and Cytogenetics, Genetic Diversity, Breeding and Cultivation of Cinnamon are discussed.

ORIGIN AND DISTRIBUTION

Native to Ceylon (Sri Lanka), true cinnamon, *Cinnamomum zeylanicum*, dates back in Chinese writings to 2800 B.C. and is still known as kwai in the Cantonese language today. Its botanical name derives from the Hebraic and Arabic term amomon, meaning fragrant spice plant. Ancient Egyptians used cinnamon in their embalming process. From their word for cannon, Italians called it canella, meaning "little tube," which aptly describes cinnamon sticks. In the first century A.D., Pliny the Elder wrote off 350 grams of cinnamon as being equal in value to over five kilograms of silver, about fifteen times the value of silver per weight (Filippone, 2019). Cinnamon is mostly cultivated in Sri Lanka, Malagasy Republic and Seychelles. It has its origin in the central hills of Sri Lanka. In India, it is grown in one or two locations in Kerala. Cinnamon is a hardy plant and is cultivated in Sri Lanka under varying conditions ranging from semi dried to wet zone conditions. The optimum temperature for growing cinnamon is between 20-30 degree C and rainfall between 1250 to 2500 mm. It thrives well as a forest tree at 300-350 meter above MSL **(**Rawat *et al*., 2020**).** Cinnamon is native to Sri Lanka (formerly Ceylon), the neighbouring Malabar Coast of India, and Myanmar (Burma) and is also cultivated in South America and the West Indies (Ashwani *et al.,* 2021). Cinnamomum verum is mostly cultivated in Sri Lanka, Malagasy Republic and Seychelles. It has originated in the central hills of Sri Lanka. In India, it is grown in one or two locations in Kerala. Cinnamon is a hardy plant and is cultivated in Sri Lanka under varying conditions ranging from semi dried to wet zone conditions. The ideal temperature for growing cinnamon is between 20-30 degree C and rainfall between 1250 to 2500 mm. It thrives well as a forest tree at 300-350 meter above MsL **(**Indianspices, 2024**).**

C. verum has been known in southern Europe for well over a thousand years, but it became more widely known in other parts of Europe during the Middle Ages when the Islamic world extended its influence to the Orient and east to Iberia starting in the 8th century AD. Cinnamon and other aromatic plants were used to produce comfit boxes in Europe during the 15th century. Comfit was a home remedy kit composed of about a dozen different pastilles made from sugar, honey, saffron and spices. While Arabs dominated the trade in cinnamon and many other spices in the Middle Ages, several kingdoms in Europe aspired to wrest control of the lucrative trade in spices. Sri Lanka was a coveted prize because of its extensive wild stands of premium cinnamon, and the

Portuguese took control of cinnamon production on the island by 1536. The Portuguese held onto it for a century until they were dislodged by the Dutch, who were in turn ousted by the British in 1796. In 1770, while Sri Lanka was under Dutch control, cinnamon was 1st intensively cultivated on the island. They also started plantations on Java in 1825; cinnamon has thus been truly domesticated only since the 18th century. [4] True cinnamon, *Cinnamomum verum* which originates from Sri Lanka and Southern India has been introduced to many other areas, notably Madagascar and the Seychelles (Ceylon, 2024).

TAXONOMY

Cinnamomum verum belongs to the family Lauraceae, genus *Cinnamomum***,** and species *Cinnamomum zeylanicum* or *Cinnamomum verum* (Rawat *et al*., 2020; Ashwani *et al.*, 2021; Pathak and Sharma, 2021; Bakewell-Stone, 2023; Bionity, 2024; Nisarga, 2024; Petruzzello, 2025).

There are 4 types of Cinnamon (Ashwani *et al*., 2021)

- Indonesian Cinnamon
- Saigon Cinnamon
- Chinese Cinnamon
- Ceylon Cinnamon

A number of species are normally sold as cinnamon (Rawat *et al*., 2020; Wikipedia, 2024)

- *Cinnamomum cassia* (Chinese cinnamon or commercial cinnamon)
- *C. burmannii* (Padang cassia or Indonesian cinnamon)
- *C. loureiroi* (Saigon cinnamon, Vietnamese cassia or Vietnamese cinnamon)
- *C. verum* (Srilanka cinnamon/ ceylone cinnamon)
- *C. citrodorum* (Malabar cinnamon)
- *C. Tamale* (Indian cinnamon).

Synonyms (Wikipedia, 2024a)

Camphorina cinnamomum (L.) Farw.
Cinnamomum alexei Kosterm.
Cinnamomum aromaticum J.Graham
Cinnamomum barthii Lukman.
Cinnamomum bengalense Lukman.
Cinnamomum biafranum Lukman.
Cinnamomum bonplandii Lukman.
Cinnamomum boutonii Lukman.
Cinnamomum capense Lukman.
Cinnamomum cayennense Lukman.
Cinnamomum cinnamomum (L.) H.Karst. nom. inval.
Cinnamomum commersonii Lukman.
Cinnamomum cordifolium Lukman.
Cinnamomum decandollei Lukman.
Cinnamomum delessertii Lukman.
Cinnamomum ellipticum Lukman.
Cinnamomum erectum Lukman.
Cinnamomum humboldtii Lukman.
Cinnamomum iners Wight nom. illeg.
Cinnamomum karrouwa Lukman.
Cinnamomum leptopus A.C.Sm.
Cinnamomum leschenaultii Lukman.
Cinnamomum madrassicum Lukman.
Cinnamomum maheanum Lukman.
Cinnamomum mauritianum Lukman.
Cinnamomum meissneri Lukman.
Cinnamomum ovatum Lukman.
Cinnamomum pallasii Lukman.
Cinnamomum pleei Lukman.
Cinnamomum pourretii Lukman.
Cinnamomum regelii Lukman.
Cinnamomum roxburghii Lukman.
Cinnamomum sieberi Lukman.
Cinnamomum sonneratii Lukman.
Cinnamomum vaillantii Lukman.
Cinnamomum variabile Lukman.
Cinnamomum wolkensteinii Lukman.
Cinnamomum zeylanicum Blume
Cinnamomum zollingeri Lukman.
Laurus cinnamomum L.
Synonyms (Ceylon, 2024)
Camphorina cinnamomum (L.) Farw.,
C cinnamomum (L.) H.Karst.,
C. zeylanicum Blume,
Laurus cinnamifera Stokes,
Persea cinnamomum Spreng

BOTANICAL DESCRIPTION

The *C. verum* tree is evergreen, grows to around 10 m. Its branches are strong and bark is smooth and yellowish in colour. It has leathery leaves, 11 to 16 cm long, with pointed tips. The leaves are dark green on top and light green at the bottom. The inconspicuous yellow flowers with a disagreeable odour, which are tubular with 6 lobes, grow in panicles (clusters) that are as long as the leaves. The fruit is a small, fleshy berry, 1 to 1.5 cm long, that ripens to black, partly surrounded by a cup-like perianth (developed from the outer parts of the flower). The spice form of cinnamon is obtained by removing the outer bark of the tree, and scraping the inner bark, which is dried and ground into powder. Cultivated trees may also be coppiced (cut back to encourage shoot development), so that the coppiced shoots can be harvested. Cinnamon oil is steam distilled from the leaves and twigs **(**Rawat *et al*., 2020**).** *Cinnamomum zeylanicum* (Dalchini) is an evergreen tropical shrub with thick, smooth, reddish-brown bark that grows to a height of around 6-8 metres. The opposite or sub-opposite leaves are glabrous, ovate and lanceolate, hard and coriaceous, and opposite or sub-opposite leaves are glabrous, ovate and lanceolate, hard and coriaceous. The leaves are brightly coloured above and pale beneath, with 3-5 major nerves. Petiole flattened to ½ inch in length. Axillary or sub-terminal cymes or panicles produce flowers. The fruit is ovate or oblong in shape, about 1.5-2 cm long, minutely apiculate, dry or somewhat fleshy and dark purple in colour **(**Pathak and Sharma, 2021**).**

An evergreen tree up to 18 m tall (in cultivation, it is usually a dense bushy plant about 2-3 m high); bole low-branching, up to 60 cm in diameter; buttresses 60 cm tall, 70 cm deep, thin, light pinkish-brown; bark about 10 mm thick, strongly aromatic; the bark on young shoots is smooth and pale brown, on mature branches and stems rough, dark brown or brownish-grey; oil cells are located in the phloem, and are oval or round in cross-section; wood of mature trees varies from light brownish-grey to grey or yellowish-brown, without markings, more or less lustrous and faintly scented. Leaves stiff, extipulate, opposite, somewhat variable in form and size, strongly aromatic; petiole 1-2 cm long, grooved on upper surface. Lamina ovate to elliptical or lanceolate 5-25 cm x 3-10 cm, conspicuously 3-veined, or 5-veined, base rounded, apex acuminate, glabrous, coriaceous, with age shiny dark green above with pale glaucous beneath. Leaves bright red when young. Inflorescence consisting of lax axillary or terminal panicles on the end of twigs up to 10 cm long or longer; peduncle creamy white, softly hairy, 5-7 cm long; flowers small, 3 mm in diameter, with foetid smell, pale yellow, subtended by small ovate hairy bract; perianth 8 mm

long, silky hairy, with short campanulate tube and six persistent tepals about 3 mm long; fertile stamens 9, in three whorls, with two small glands at the base of the stamens of the 3rd whorl; a fourth innermost whorl consists of three staminodes; filaments hairy, stout; anthers 4- or 2-celled; ovary superior, 1-celled, with a single ovule, style short. Fruit a 1-seeded berry, ellipsoidal to ovoid, 1-2 cm long, black when ripe, surrounded by the enlarged perianth at the base (Bakewell-Stone, 2023). *Cinnamomum verum* trees are 10–15 m tall. The leaves are ovate-oblong in shape and 7–18 cm long. The flowers, which are arranged in panicles, have a greenish color and a distinct odor. The fruit is a purple 1 cm drupe containing a single seed (Wikipedia, 2024a). Cinnamon is produced by selectively pruning young *Cinnamomum* sp. evergreen tree branches after about 2-3 years of growth. After cutting, new branches will regenerate and a typical tree can be harvested for about 40-50 years. At harvest, the outer bark is first scraped off and then the inner bark is stripped and laid in the sun, where it curls into cylindrical "quills" (Resources, 2024). Cinnamomum comes from the Greek word Kinnamomon, which translates to spice, while verum means true. Thus the common name of True Cinnamon. Cinnamon is a small evergreen tropical tree native to Sri Lanka that is not likely to grow well in North Carolina due to colder winter temperatures. Optimum conditions for growing include warm and wet climate. Young trees will perform at their best when shade from the afternoon sun is provided. As the tree matures, it can withstand more sunlight. Typically a tree grown in the tropics, it can thrive in a cooler location when overwintered in a protected environment, such as indoors as a houseplant. After overwintering indoors, allow the tree to acclimate to the outdoors by placing outdoors for short periods of time, and slowly increasing its outdoor time each day. Failure to provide the necessary time to acclimate can cause the leaves to scorch. Oils from the foliage and bark are both fragrant, and are used in the production of food and beverages as well as soaps and candles. After drying the bark, it can be used as a spice for baking, or a seasoning for meats, sauces, pickles, and confectionery treats. True cinnamon is pollinated by insects, especially flies **(**NCSU, 2024). The "True Cinnamon" or Sri Lankan Cinnamon is the dried inner stem bark of Cinnamomum Verum. Cinnamon plants are grown as bushes. When the plants are of two years age, they typically measure at about 2 meter in high and 8-12 cm at the base. It is at this stage they are ready for harvesting **(**Indianspices, 2024**).**

Cinnamomum verum was previously known as *C. zeylanicum*, meaning from Ceylon. Like many of its huge clan, this species is a most handsome tree, with a widely spreading dense crown and sturdy erect trunk that has smooth, papery, spicily pungent bark. In traditional cultivation, *C. verum* was grown as a bush, with seeds sown directly in a circle of about 1.3 m in diameter. As the saplings developed (up to two years), they were cut close to the ground after the rainy season, when the young bark was easily detached from stems. Saplings resprouted and cultivation continues. Currently, trees are planted in plantations and coppiced every 2 years. After 10 years, rootstocks are removed, split up and replanted. The processed product of cinnamon, that is, quills, which are individually hand-made after peeling off the bark of the stems, is unique to Sri Lanka. The production of quills requires a substantial amount of skills and time, making the process quite expensive. The process also makes mechanization very difficult (Ceylon, 2024). Aromatic, leathery and highly lacquered, the dark green leaves have the distinctive 3-5 longitudinal veins of the genus; they are brilliant red on emerging but soon deepen to rich, dark green. Leaves of cinnamon also yield oil, main constituent of which is eugenol. The oil possesses strong odour and is used for blending with camphor. Expanded panicles of tiny, yellowish white flowers attract bees. The flowers have an unpleasant aroma. The fleshy, green fruits will mature to dark purple. They form as drupes and will contain one seed. Although they have a cinnamon aroma, they are not used for the production of cinnamon. Fruit is 1.5-2 cm long when ripe, with the enlarged calyx at the base. Fruits mature in 6 months (Ceylon, 2024).

Cinnamon leaves and flower clusters of a cinnamon tree (*Cinnamomum verum*). The cinnamon tree grows in moist well-drained soils and rarely reaches more than 15 meters in height. The thick simple leaves have smooth margins and are usually oval; the veins are roughly parallel to one another. Young leaves are red and mature to a deep green. The small, bisexual flowers are greenish to yellow and are borne in clusters. The fruit is a dark drupe. Cinnamon contains 0.5 to 1 percent essential oil, the principal component of which is cinnamic aldehyde (Petruzzello, 2025).

GENETICS AND CYTOGENETICS

Chromosome number of all 4 species viz *C. camphora, C. zeylanicum, C. tamala* and *C. iners* is 2n = 24 (Sharma and Bhattacharyya, 1959). The cinnamon tree, *Cinnamomum zeylanicum*, has 24 chromosomes in each cell. The karyotype of *C. zeylanicum* is 8m + 16sm. *Cinnamomum zeylanicum*, also known as Ceylon cinnamon, is a member of the Lauraceae family. All species of Cinnamomum that have been tested so far have 24 chromosomes. The karyotype of *C. zeylanicum* is different from other species of *Cinnamomum*, such as *C. camphora* and *C. tamala*. The karyotype of *C. zeylanicum* is more heterogeneous than the karyotypes of *C. camphora* and *C. tamala*. The karyotype of *C. zeylanicum* is reflected in the symmetry classes of Stebbins' classification. The CMA- and DAPI-banding patterns of *C. zeylanicum* are different from other species of *Cinnamomum*. *Cinnamomum zeylanicum* is a tree native to Sri Lanka, India, Madagascar, Brazil, and the Caribbean. It is also cultivated commercially in Seychelles and Madagascar (Google, 2024).

GENETIC DIVERSITY

Cinnamomum zeylanicum Blume. is an important taxa cultivated in coastal plains for its stem bark, leaf, fruits and roots as spice and for its medicinal properties. *Cinnamomum* is an indicator plant of semi evergreen forest. In this study, RAPD-PCR analysis involving 11 decamer random primers was used to assess the genetic variation within **C.** *zeylanicum* in Western Ghats of southern India. Some primers showed appreciable intra-species variation or molecular polymorphism at amplicon levels. Despite morphological similarity, a great deal of genetic polymorphism was observed among the accessions. In this study, unweighed pair group method with arithmetic averages (UPGMA) analysis showed up to 89% genetic variation among these accessions, which is further supported by principle co-ordinate analysis (PCA) (Sandigawad and Patil, 2011) Botanical description is given in Fig. 1. A comprehensive study was conducted on morphological characters of cinnamon during the eco-geographic survey of the 269 accessions. There was a variation in both quantitative and qualitative characters.

		
Tree	**Tree with flowers and fruits**	**Fruits**
		
Seeds	**Rooted Cutting**	**Air Layer**
		
Young leaves	**Leaves**	**Leaves**
		
Leaves	**Flower**	**Flower buds**
		
Flower buds and Foliage	**Flower Buds**	**Flowers and leaves**

Continue …

Dry Flowers

Removing the bark

Bark being removed

Bark removed

Drying of quills

Rolls

Rolls

Powder

Powder

Oil

Olioresin

Mulled Wine

Fig. 1: Botanical Description

Leaves showed a higher variation in the collection: Leaf length (LL), Leaf width (LW), Leaf length-width ratio (LLWr), Petiole length(PL) varied from 7.43 to 20.26 cm, 3.4 to 10.08 cm, 1.58 to 3.19 and 0.9 to 2.7 cm respectively. The shape of the lamina (LS) was elliptic to ovate, oval, lanceolate to ovate-lanceolate (Fig 2) (Azad *et al.,* 2019). The apex of the leaf (LAP) was acute, acuminate to long acuminate and acuminate with broad acumen and the base of the leaf (LB) was acute or cuneate or obtuse. The leaves were 3-veined, or 5-veined with very slender additional basal veins. The upper surface of mature leaf was dark green mostly, while the lower surface was pale green with paler veins. The leaf petiole (PL) was 9-27 mm and was slightly curved upward. Axillary and terminal panicles were observed, which formed both from axil and apex of branchlets. Peduncles were highly branched and consisted of long sub-branches. Flowers were pale yellowish green and 8-12 mm long. The number of tepals was 6 in 2 whorls and the shape of the tepal was oblong-lanceolate or ovate. The fruit of cinnamon ranged from 1.5-2 cm in length and dark purple in colour. The fruit was a fleshy berry, one seeded, ellipsoid or ovoid in shape and with an enlarged calyx (Fig 3) (Azad *et al.,* 2019). Considerable variation was noted in leaf characteristics among the selected progenies of *Cinnamomumzeylanicum*, with four distinct morphotypes related to leaf shapes (elliptic,

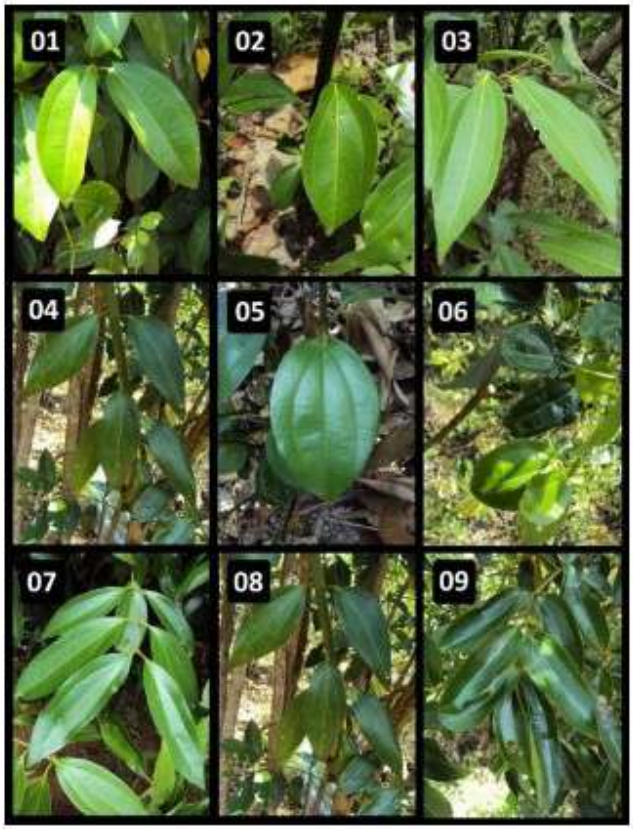

Fig. 2. Variation of leaf shape among 269 accessions; 01. Elliptic, 02. Broadly elliptic, 03. Narrowly elliptic, 04. Ovate, 05. Broadly ovate, 06. Oval, 07. Lanceolate, 08. Ovate-lanceolate, 09. Oblong-lanceolate

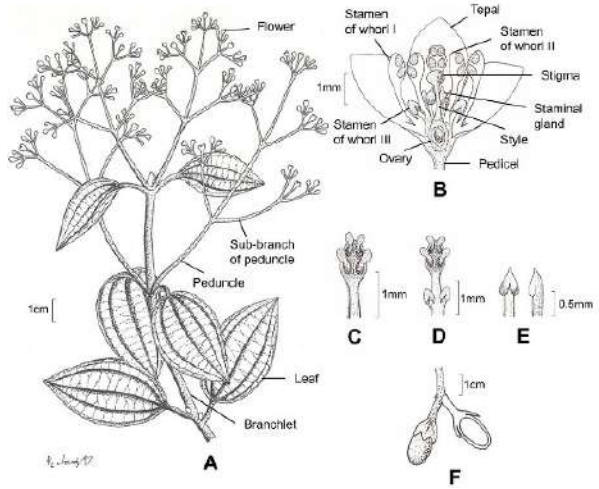

Fig 3. *Cinnamomum verum.* A. Flowering shoot; B. Longitudinal section of flower; C. Stamen of whorl I; D. Stamen of whorl II with stamen of whorl III at the base, E. Staminal gland, F. Longitudinal section of mature fruit

ovate, ovate elliptic and ovate lanceolate) and four types of leaf tip shapes (acuminate, acute, and sub-acute), with acuminate tip shape being the most prevalent. Among the progenies, only two (G2 from Gejjehalli and K18 from Kankodlu sources) exhibited purple and light purple petiole coloration, while the rest displayed green petioles. Progenies of M21 showed superiority in all the quantitative leaf parameters; hence further work on these families helps in improvement of thespecies. The color of the leaf flush is regarded as an indicator of greater essential oil content and can be effectively utilized as a marker for indirectly selecting trees with superior oil production (Niharika and Hanumantha, 2024).

BREEDING

Germplasm: Forty seven representative cinnamon accessions were collected from Matara District of Sri Lanka to analyze the morphological variation of *Cinnamomum verum* germplasm. Morphological characters *viz*. Leaf length, Leaf width, Leaf length-width ratio, Petiole length, Leaf arrangement, Leaf shape, Leaf apex, Leaf base, Leaf texture, Upper surface leaf color, Flush color, Bark color, Bark surface, and Bark fragrant were recorded. Principal component analysis (PCA) using four quantitative morphological characteristics, indicated that the first two principal components (PCs) with Eigen values of more than one and accounted for 88.88% of the total variance. Cluster analysis classified 47 accessions into nine groups. The present study demonstrates a considerable diversity of morphological characters among the accessions that can be useful in germplasm management and future crop improvement programs (Azad *et al*., 2016).

Two hundred and sixty nine cinnamon accessions were collected. The average shoot regeneration frequency of 269 accessions was 47.76% after one month of vegetative propagation. The collection was established at Faculty of Agriculture, University of Ruhuna for further studies. The collection was characterized for 15 quantitative and qualitative characters of leaf, stem and inflorescence among which, a wide variation was detected for leaf characters mainly. Leaf length positively correlated with Leaf width (+0.643) and Petiole length (+0.483). Principal component analysis (PCA) revealed that there were 3 dimensions of PCA explaining 88.85% of total variance. In Hierarchical cluster analysis based on above characters, 269 accessions were grouped into five clusters at rescaled distance of 0.1. A representation of 10% accessions was randomly selected from each cluster to develop a core collection with 33 accessions. The core collection of 33 accessions was clustered into five groups according to the same method at rescaled distance of 0.075. The core collection is a representation of the total collection as clusters of the two dendograms could be overlapped. Morphological characterization and core collection development during this study will be useful for germplasm management, conservation and varietal improvement through breeding programmes (Azad *et al.,* 2019).

The largest true cinnamon germplasm is in Sri Lanka. It has been established by the Cinnamon Research Institution (CRI), Sri Lanka in the 1980s by doing an Island-wide collection of superior genotypes in terms of quality and quantity of yield, resistance to pest and diseases and other agronomic traits. It has been enriched since then with new additions of superior accessions collected from farmer fields and currently, it consists of 602 accessions. While 342 of them were originally established from the seeds collected from the superior mother plants, 260 of were originated from cuttings. Nevertheless, the germplasm is not fully characterized for its morphological, yield and biochemical traits so far. It is the primary step in any cinnamon breeding efforts enabling them to start breeding programs targeting niche markets around the world (Liyanage *et al.,* 2021). The Department of Export Agriculture (DEA), Sri Lanka, on the other hand, holds the largest *C. zeylanicum* germplasm in the world, which consists of over 600 superior accessions collected island wide (Suriyagoda *et al.*, 2021).

Both morphological and biochemical traits contribute to the quality and quantity of yield. In cinnamon, both bark and leaf are economically important produce and having separate industrial applications. Therefore, the leaf and stem traits were evaluated separately. The leaf quantitative measurements included leaf petiole length, leaf length and leaf width whereas leaf shape, leaf apex, leaf base, and leaf arrangement were evaluated qualitatively. While some accessions had long leaves, the others had very short leaves with an average value of 12.3 ± 2.3 and the highest and lowest values of 22.8 cm and 3.0 cm respectively. The qualitatively measured traits such as the leaf arrangement, leaf apex shape, leaf shape, and leaf base also varied among accessions considerably. The presence of opposite to sub-opposite leaf arrangements in the same branch in the same plant was more prominent than others. Further, the majority of the accessions had narrowly elliptic shape leaves with, acuminate shape apex and obtuse base (Fig.4) (Liyanage *et al*., 2021).

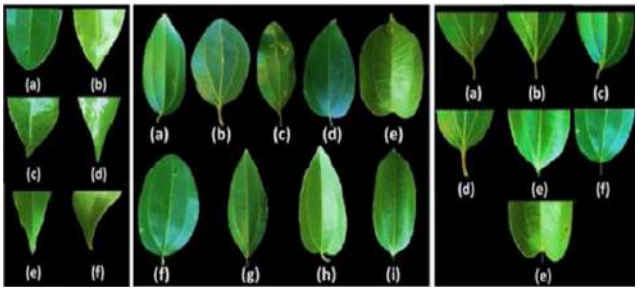

Fig. 4. Evaluation of *Cinnamomum zeylanicum* germplasm using qualitative morphological traits

Breeding: A significant amount of genetic diversity is generated among *C. zeylanicum* progeny that results from a single cross-pollination event and this is also reflected in morphological and biochemical diversity. However, only limited published literature is available on genetic diversity assessment of *C. zeylanicum*. Interestingly, the chloroplast regions alone could not completely resolve the phylogenetic relationships among *C. zeylanicum, Cinnamomum citriodorum, Cinnamomum capparu-coronde, Cinnamomum dubium, Cinnamomum litseifolium, Cinnamomum rivulorum, Cinnamomum sinharajaense*, and *Cinnamomum ovalifolium*. The sequences of the ITS region turned out to be more useful for the identification of the above species. Later, a small number of *C. zeylanicum* accessions were studied using RAPD, sequence-related amplified polymorphism. Work comprising all the *Cinnamomum* species present in Sri Lanka has assessed both intraspecies and interspecies diversity using universal barcoding regions and a widely used identifier. The assessed regions had identical nucleotide sequences in all three *C. zeylanicum* accessions, while considerable intraspecies diversity was observed in wild species (Suriyagoda *et al*., 2021). Nevertheless, *C. zeylanicum* breeding and crop improvement efforts in Sri Lanka are limited. The recently assembled draft of the *C. zeylanicum* (variety *Sri Gemunu*) genome and identification of gene-specific markers would facilitate future crop improvement efforts, including pest and disease resistance. Furthermore, the recent transcriptomics and metabolomics work on the effect of plant growth environment and maturity stage on the quality of *C. zeylanicum* leaf and bark yield would assist the decision-making process of the government and commercial growers on the establishment of new plantations for diversified products and markets (Suriyagoda *et al*., 2021). In Sri Lanka, several wild and semi-wild types and local cultivars are recognized, with distinctive local names, mainly based on aroma and therefore are location-specific. Little improvement work has been done considering its economic value. It is possible that it could hybridize with some other species in the genus. Since *Cinnamomum* is open-pollinated, selection, together with vegetative propagation of clonal material would be advantageous. Some selection for superior strains is carried out in Sri Lanka and the Seychelles (Bakewell-Stone, 2023).

Varieties: Two high yielding, high quality cinnamon varieties released from IISR are suitable for cultivation in various regions of India. The varieties Navashree and Nithyashree have an yield potential of 56 and 54 kg dry quills/hectare per year respectively, in the initial years, when one seedling or cutting is planted in a hill. Navashree yields 2.7% bark oil, 73% cinnamaldehyde in bark, 8% bark oleoresin, 2.8% leaf oil and 62% leaf eugenol. Nithyashree yields 2.7% bark oil, 58% cinnamaldehyde in bark, 10% bark oleoresin, 3% leaf oil and 78% leaf eugenol (Anandaraj *et al*., 2005).

The study was also extended to identify the within-species diversity of *C. zeylanicum* with special emphasis on recently released *Sri Gemunu* and *Sri Wijaya* varieties by the Department of Export Agriculture (DEA), Sri Lanka (Bandusekara *et al*., 2020). Two varieties, *Sri Wijaya* and *Sri Gemunu* released based on selections from the DEA germplasm (Suriyagoda *et al*., 2021). The Department of Export Agriculture (DEA), Sri Lanka released two superior varieties *Sri wijaya* and *Sri gamunu,* based on selections from CRI germplasm collection (Liyanage *et al.,* 2021).

Two high yielding, high quality cinnamon varieties released from IISR are suitable for cultivation in various regions of India. The varieties Navashree and Nithyashree have an yield potential of about 200 kg dry quills/hectare. Navashree yields 2.7% bark oil, 73% cinnamaldehyde in bark, 8% bark oleoresin, 2.8% leaf oil and 62% leaf eugenol. Nithyashree yields 2.7% bark oil, 58% cinnamaldehyde in bark, 10% bark oleoresin, 3% leaf oil and 78% leaf eugenol (IISR, 2024). There are several different cultivars of *Cinnamomum verum* based on the taste of bark (Wikipedia, 2024a).

Uses: Its wood is used to make decorations, furniture, cabinets, and plywood. True cinnamon is made from the bark of the *Cinnamomum verum* tree and is one of the most often used spices. 28 C. politum bark is added to hot beverages to help strengthen muscles and reduce discomfort. Cinnamon has antifungal, antibacterial, antitermitic, larvicidal, nematicidal, and insecticidal effects, among others. This plant balances the Vata and Pitta energies in the body. It helps to relieve menstruation pain. According to a study, drinking a cup of warm cinnamon water every day can assist women have less pain during menstruation for a brief period of time **(**Pathak and Sharma, 2021**).**

Some Major Ayurvedic Medicinal Uses of *Cinnamomum Zeylanicum* are (Pathak and Sharma, 2021):

- It relieves sore throats, influenza, the common cold, and headaches.
- It also has antitubercular properties and is used as an expectorant.
- In the case of rheumatoid arthritis, it is a natural treatment.

- It's also good for lowering cholesterol and strengthening the cardiac muscles.
- It provides relief in menstrual pain. A study says women should drink a cup of warm cinnamon water every day it helps in experiencing less pain during menstruation for a short duration.

Cinnamon has a long history of use in traditional medicine, and modern research has proved that it has a range of potential health benefits. Cinnamon contains compounds that have antioxidant, anti-inflammatory, and antimicrobial properties, making it potentially beneficial for a variety of health conditions. Studies have shown that cinnamon may help improve blood sugar control in people with type 2 diabetes, and may also have potential benefits for heart health by reducing inflammation and improving cholesterol levels. Additionally, cinnamon has been shown to have antimicrobial properties and may help fight off bacterial and fungal infections. It may also have potential benefits for brain function and may help protect against age-related cognitive decline. However, it is important to note that while cinnamon is generally considered safe when consumed in small amounts as a spice, high doses or long-term use of cinnamon supplements may be harmful. It is always best to consult with a healthcare professional before using cinnamon for medicinal purposes (Karthik, 2023).

Ground cinnamon is used in baked dishes, with fruits, and in confections. Cinnamon is predominant in the spice blends of the East and Southeast Asia. It is a component of Chinese five spice powder (along with star anise, cloves, pepper, and fennel). It is also used in savory dishes such as moles, garam masala, and berbere. Vietnamese cinnamon is often sold as a premium product in the United States whereas Ceylon cinnamon is prized more so in Europe and Mexico (Resources, 2024). The commercial products of cinnamon are quills, quillings, featherings, chips, cinnamon bark oil and cinnamon leaf oil. 'Quills' are scraped peel of the inner bark of the mature cinnamon shoots, joined together with overlapping tubes, the hollow of which has been filled with smaller pieces of cinnamon peels which is dried first in the sun and thereafter in the shade. 'Quillings' are broken pieces and splits of all grades of cinnamon quills. 'Featherings' are feather like pieces of inner bark consisting of shavings and small pieces of bark left over. Cinnamon 'chips' are rough unpeelable barks scraped off from the thicker stems. Cinnamon leaf and bark oil are obtained by distilling the leaf and bark separately. Cinnamon bark is a popular spice with a delicate fragrance and a warm agreeable taste. It is used in the form of small pieces or powder. It is widely used in flavouring confectionary, liquors, pharmaceuticals and cosmetics. It is found to help diabetics in digestion of sugar. It has astringent; stimulant and carminative properties and can check nausea and vomiting. The cinnamon bark oil has anti-fungal properties and cinnamon leaf oil is widely used in perfumery and cosmetics **(**Indianspices, 2024**).**

Food Uses: The major uses of cinnamon, both in whole and ground form, are for domestic culinary purposes and for flavouring processed foods (bakery products, sauces, pickles, puddings, beverages, confectionery). Cinnamon bark oil is used in meat and fast-food seasoning, sauces and pickles, baked goods, confectionery and cola-type drinks. The leaf oil is also used as a flavouring agent for seasonings and savoury snacks. In Mexico, the bark is used to enhance the flavour of coffee (Ceylon, 2024).

Medicinal Uses: Cinnamon bark oil is employed in dental and pharmaceutical preparations. Historically, cinnamon drops were regarded as a tonic, a sedative in childbirth, and a remedy for many common disorders. Cinnamon served as a breath sweetener in the past. In medieval times, cinnamon was distilled to produce cordials, ostensibly to aid in digestion. In the Orient, cinnamon and its near relatives are still widely used for local remedies, particularly for gastrointestinal and respiratory disorders and as an aphrodisiac. In the Philippines and the Pacific, it is taken to relieve headache. In Colombia, cinnamon sticks are chewed to speed parturition. In Ghana, bark of young shoots are used as a carminative and to treat catarrh (coryza), and the bark extract is an intestinal astringent. In Haiti, the essence is used as a poultice for rheumatism and is taken orally for spasms and for stomach and intestinal gas. In European phytomedicine, cinnamon bark oil (0.05-0.2 g daily intake) is used in teas and other galenicals for its antibacterial, carminative, and fungistatic properties, and also for loss of appetite and dyspeptic disturbances. The maximum permitted level in food products is 0.06% (Ceylon, 2024).

Other Uses: Cinnamon leaf oil is used in flavouring and perfumery, and as a source of its major constituent eugenol. Eugenol is used for the synthesis of vanillin, and for conversion into iso-eugenol, used for flavouring confectionary products. Cinnamon leaf oil is extensively used as a fragrance component in soaps, detergents, cosmetic and alcoholic perfumery, with a maximum permitted level of 0.8% in the perfume. The seeds contain about 30% fixed oil, used in India for candle making. The oil is obtained by boiling crushed ripe fruits. Cinnamon bark oil possesses the delicate aroma of the spice and a sweet pungent taste. Its major constituent is cinnamaldehyde but other, minor components impart the characteristic odour and flavour. It is employed mainly in the food flavouring industry but is also used in tobacco flavours and for incense. It has limited use in some perfumes. In Sri Lanka, cinnamon bark oil is produced by distillation of chips and variable amounts of featherings (pieces of inner bark from twigs and twisted shoots) and quillings (broken fragments of quills). In many cases, the older form of hydro-distillation is used, in which chips and water are placed together in the distillation vessel, which is heated by direct fire. Modern methods involve steam distillation. Sapwood is light brown, slightly soft; heartwood is brownish-yellow with green cast, or olive to light olive brown to blackish-brown, medium to coarse texture, satiny or silky lustre, straight and often rosy grain, spicy odour. Excellent working qualities (Ceylon, 2024).

Beauty and Wellness Uses: In addition to its culinary and medicinal uses, cinnamon is also a popular ingredient in beauty and wellness products. Its warm, comforting fragrance makes it a common ingredient in candles, room sprays, and other aromatherapy products. Cinnamon has also been used in skincare products due to its potential benefits for the skin. It has been shown to have antimicrobial properties that may help fight acne-causing bacteria, as well as anti-inflammatory effects that may help soothe irritation and redness. Cinnamon may also have potential benefits for hair health, as it has been shown to promote hair growth and may help improve scalp health. Additionally, cinnamon essential oil is often used in massage and spa therapies due to its relaxing and warming properties. Overall, cinnamon's amazing scent and potential health benefits make it a valuable ingredient in a wide variety of beauty and wellness products (Karthik, 2023).

Cooking Tips: Both ground and stick cinnamons are readily available. Ground cinnamon can be sprinkled as a flavor enhancing garnish on desserts and beverages. Cinnamon sticks can be used to infuse subtle cinnamon flavor into beverages and stews and can be removed before serving. Stick cinnamon can be ground with a fine grater to make ground cinnamon (Resources, 2024). Did you know that not all Cinnamon is created equal for baking cinnamon rolls? The "gooey" component of the cinnamon filling comes from soluble "mucilaginous" fibers naturally found in cinnamon bark. Indonesian (Korintje) cinnamon, sometimes referred to as baker's cinnamon, typically contains higher amounts of mucilaginous fibers and thus produces a "gooey-er" filling (Resources, 2024).

Nutritional Properties: As far as nutritional properties are concerned, cinnamon is known to be a very good source of iron, calcium and dietary fiber as well as manganese. There are various nutrients present in cinnamon such as sodium, carbohydrates, sugar, fatty acids, amino acids and so on **(**Rawat *et al*., 2020**).** Cinnamon bark contains up to 4% essential oil, most of which is cinnamaldehyde (60-75%), cinnamyl acetate (1-5%), eugenol (1-10%), -caryophyllene (1-4%), linalool (1-3%), and 1.8-cineole (1-2 percent), ligopolymeric procyanidins, cinnamic acid, phenolic acids, pentacyclic diterpenes cinnzeylanol and its acetyl derivative cinnzeylanine, sugars mannitol,5 L-arabino-Dxylanose, L-arabino-Dxylose, D-xylose, D-glucane, and mucilage polys Cinnamon's pharmacological characteristics, such as anti-inflammatory, anti-microbial, blood glucose, cardiovascular, cognitive function, and anticarcinogenic, have been proven in several research **(**Pathak and Sharma, 2021**).**

Ground cinnamon is composed of around 11% water, 81% carbohydrates (including 53% dietary fiber), 4% protein, and 1% fat. In a 100 gram reference amount, ground cinnamon is a rich source of calcium (100% of the Daily Value (DV)), iron (64% DV), and vitamin K (30% DV). Cinnamon consists of a variety of resinous compounds, including cinnamaldehyde, cinnamate, cinnamic acid, and numerous essential oils. Cinnamon leaf oil contains high concentrations of eugenol (Ceylon type 80-88%; Seychelles type 87-96%); it also contains many of the major constituents present in cinnamon bark oil (*e.g.,* cinnamaldehyde, cinnamyl acetate, eugenol acetate, and benzaldehyde) as well as other minor compounds, including humulene (Ashwani *et al.,* 2021).

Cinnamon bark contains about 0.5-1.0% of volataile oil, 1.2% of tannins (Phlobatannin), mucilage, calcium oxalate, starch and a sweet substance known as mannitol [2]. The volatile oil is active constituent of drug. It is light yellow in colour and changes to red on storage. Bark yields 14-16% of 90% International Journal of Herbal Medicine alcohol soluble extractive. Cinnamon oil contains 60-70% cinnamaldehyde, 5-10% eugenol, benzaldehyde, cuminaldehyde and other terpenes like phelandrene, pinene, cymene, α-humulene, δ-cadinene, caryophyllene, and limonene (Azmi *et al.,* 2024).

The different varieties and types of cinnamon can slightly vary in nutritional composition. The two main types of the spice, Ceylon, or real cinnamon (*Cinnamomum verum*) and cassia, or Chinese cinnamon (*Cinnamomum cassia*), have varying levels of some nutrients possibly because of their different origins. Cinnamon contributes to human health with small amounts of some essential nutrients, such as proteins, carbohydrates, and fatty acids (Ceylon, 2024).

Side Effects & Rick

1. Body heat. 2. Antiobiotic Conflict. 3. Increased Heart Rate. 4. Skin Irritation. 5. Allergies. 6. Blood Thinner. 7. Reduce blood sugar level. 8. Problem for Pregnant women. 9. Liver damage and 10. Mouth sores (Ashwani *et al.,* 2021). Cinnamon is POSSIBLY UNSAFE when taken in larger amounts or when used long-term. Taking cinnamon oil by mouth is also POSSIBLY UNSAFE. The oil can be irritating to the skin and mucous membranes, including the stomach, intestine, and urinary tract. It can cause side effects such as diarrhea, vomiting, dizziness, drowsiness, and others (Nisarga, 2024).

Toxicity

A systematic review of adverse events as a result of cinnamon use reported gastrointestinal disorders and allergic reactions as the most frequently reported side effects. In 2008, the European Food Safety Authority considered the toxicity of coumarin, a component of cinnamon, and confirmed a maximum recommended tolerable daily intake (TDI) of 0.1 mg of coumarin per kg of body weight. Coumarin is known to cause liver and kidney damage in high concentrations and metabolic effect in humans with CYP2A6 polymorphism. Based on this assessment, the European Union set a guideline for maximum coumarin content in foodstuffs of 50 mg per kg of dough in seasonal foods, and 15 mg per kg in everyday baked foods (Wikipedia, 2024).

Health Benefits

Cinnamon powder and uses (Rawat *et al*., 2020):

Influenza: Boil the mix of 2½ g. cinnamon, 500 mg cloves, and 1 gm ginger root in 1/2 liter water till water is reduced to 200 ml. Strain the solution. Give 40 ml of this solution thrice a day. It cures influenza fever.

Cold and cough: Mix pinch of cinnamon powder with 1 spoon of honey and take it 3 times a day to relive cough.Cinnamon *(Cinnamomum zeylanicum)* 167

Diarrhoea, loose motion: For diarrhoea treatment, cinnamon or dalchini is taken with equal amount of sonth, cumin seeds and honey. Make a thick paste by adding honey. Take 1 teaspoon of it three times a day.

Loss of taste: Make a paste of honey and dalchini. Rub this paste on tongue and keep for few minutes.

Tooth ache: Mix cinnamon powder and honey in 1:5 ratio and apply at area of tooth ache.

Hair fall: Mixture of cinnamon powder and honey with warm olive oil should be applied on scalp and wash the hair after 15 min.

Bad breathe: Cinnamon powder boiled in water can be used as mouth wash.

Acne and black heads: Mix cinnamon with lemon juice and apply on acne and black heads.

Memory improvement: Mix 1 gm cinnamon powder and honey and this mixture should be taken every night.

Insomnia or sleepleeness: Boil 2 gm of cinnamon powder in one cup water for 5 min. Add honey and drink before going to bed.

Arthritis pain: Make the paste of cinnamon powder with water and honey and apply it at the painful area.

Impaired or weak digestion: It is a good remedy for treating digestive problems.

The essential oil of cinnamon is obtained by distilling the leaves/ inner bark of this plant. The leaf oil should be administered under medical supervision. For its external use, it should be diluted and should be used with caution to avoid irritation. A piece of cotton if soaked in cinnamon oil and then applied on the aching tooth, may cure the tooth ache. Cinnamon leaves can be used to brush the teeth. It cleans the teeth and the teeth become brighter and whiter (Rawat *et al*., 2020). Cinnamon bark is used for gastrointestinal (GI) upset, diarrhea, and gas. It is also used for stimulating appetite; for infections caused by bacteria and parasitic worms; and for menstrual cramps, 168 Medicinal Plants in India: Importance and Cultivation the common cold, and the flu (influenza). The oil present in cinnamon bark reduces spasms, gas and stimulates the appetite. It also increases blood flow and lowers blood sugar levels (Rawat *et al*., 2020). Medicinal Properties of Cinnamon oil and uses (Rawat *et al*., 2020):

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Impaired or weak digestion: It is a good remedy for treating digestive problems.

Medicinal Properties of Cinnamon bark **(**Rawat *et al.,* 2020**):** It is used for gastrointestinal (GI) upset, diarrhea, and gas. It is also used for stimulating appetite; for infections caused by bacteria and parasitic worms; and for menstrual cramps, 168 Medicinal Plants in India: Importance and Cultivation the common cold, and the flu (influenza). The oil present in cinnamon bark reduces spasms, gas and stimulates the appetite. It also increases blood flow and lowers blood sugar levels. *Cinnamomum zeylanicum* Blume, commonly known as Ceylon cinnamon or true cinnamon has gained worldwide attention than ever due to recent scientific pieces of evidence on its health benefits and medicinal applications. Ceylon cinnamon consists of a higher concentration of beneficial chemical compounds, superior flavor and taste while having a minimum amount of harmful coumarin. Of the 515 accessions characterized separately for bark and leaf chemical composition using methanol extracts, the majority had aboveaverage values of bark cinnamaldehyde and leaf eugenol. Interestingly, more than 70 % of bark and more than 90 % of leaf samples did not have a detectable amount of coumarin. The overall average coumarin content in methanol extracts of bark and leaf was 0.010 mg/g and 0.004 mg/g respectively. The large-scale chemical fingerprinting work confirmed the superiority of Ceylon cinnamon. After a comprehensive analysis considering 25 different traits, 16 superior genotype accessions were identified as parental materials for immediate breeding attempts and or to release to the farmers after mass propagation (Liyanage *et al.,* 2021).

Health Benefits (Ashwani *et al*., 2021):

- It has anti-viral, anti-bacterial and anti-fungal properties
- Contains antioxidants with anti-inflammatory effects
- Its prebiotic properties may improve gut health
- Reduces blood pressure
- Lowers blood sugar and risk of type 2 diabetes
- Relieves digestive discomfort
- Cinnamon Is Loaded With Antioxidants.

Cinnamon has a long history of use in traditional medicine as a digestive aid. However, contemporary studies are unable to find evidence of any significant medicinal or therapeutic effect. Reviews of clinical trials reported lowering of fasting plasma glucose and inconsistent effects on hemoglobin A1C (HbA1c, an indicator of chronically elevated plasma glucose). Four of the reviews reported a decrease in fasting plasma glucose, only two reported lower HbA1c, and one reported no change to either measure. The Cochrane review noted that trial

durations were limited to 4 to 16 weeks, and that no trials reported on changes to quality of life, morbidity or mortality rate. The Cochrane authors' conclusion was: "There is insufficient evidence to support the use of cinnamon for type 1 or type 2 diabetes mellitus." Citing the Cochrane review, the U.S. National Center for Complementary and Integrative Health stated: "Studies done in people don't support using cinnamon for any health condition." However, the results of the studies are difficult to interpret because it is often unclear what type of cinnamon and what part of the plant were used.

A meta-analysis of cinnamon supplementation trials with lipid measurements reported lower total cholesterol and triglycerides, but no significant changes in LDL-cholesterol or HDL-cholesterol. Another reported no change to body weight or insulin resistance (Wikipedia, 2024). Cinnamon has a long history of use in traditional medicine as a digestive aid. Preliminary studies show that cinnamon could slow symptoms of Alzheimer's disease through the reduction of the oligomerization of beta-amyloid (Wikipedia, 2024a). Cinnamon has a long history of use in traditional and herbal medicine. It has been found to be a coagulant and may enhance blood circulation in the uterus, promoting tissue regeneration. Additionally, the essential oils and other constituents of cinnamon have been reported to have antimicrobial, antifungal, antioxidant, and antidiabetic properties. Beyond these properties, traditional usage suggests that cinnamon may have anti-inflammatory, insecticidal, and anticancer attributes. Coumarin—a fragrant organic compound found in trace amounts in true cinnamon but in significantly higher amounts in cassia cinnamon—may adversely affect the liver, and prolonged use is generally discouraged, especially for individuals with preexisting liver conditions (Petruzzello, 2025).

CULTIVATION

Propagation: Semi hardwood cuttings of about 10 cm length with 2 leaves are taken and dipped in IBA 2000 ppm or in a rooting hormone (Keradix-B) and planted either in polythene bags filled with sand or a mixture of sand and coir dust (1:1) or in sand beds raised in a shaded place. The cuttings in polythene bags must also be kept in a shaded place or in a nursery. The cuttings are to be watered regularly 2-3 times a day. The cuttings root in 45-60 days and the well rooted cuttings can be transplanted to polythene bags filled with potting mixture and maintained in a shaded place and watered regularly (Anandaraj *et al*., 2005). Air layering of cinnamon is done on semi hardwood shoots. A ring of bark is removed from the semi hardwood portion of the shoot and a rooting hormone (IBA 2000 ppm or IAA 2000 ppm) is applied on the portion where the bark has been removed. Moist coir dust or coir husk is placed around the region where the hormone has been applied and is secured in position by wrapping with a polythene sheet of 20 cm length. This would also avoid moisture loss. Rooting takes place in 40-60 days. The well rooted air layers are separated from the mother plant and bagged in polythene bags filled with potting mixture and kept in a shaded place or nursery by watering the plants twice daily. The rooted cuttings and layers can be planted in the main field with the onset of rains (Anandaraj *et al*., 2005). Cinnamon can also be propagated through seeds. However, in such cases wide variability is observed among the seedlings. Under West Coast conditions, cinnamon flowers in January and the fruits ripen during June-August. The fully ripened fruits are either picked Plant protection (Anandaraj *et al.,* 2005).

Propagation of cinnamon is by rooted cuttings, air layerings and seedlings. Cinnamon from the tree or the fallen ones are collected from the ground. The seeds are removed from the fruits, washed free of pulp, and sown without much delay as the seeds have a low viability. The seeds are sown in sand beds or polythene bags containing a mixture of sand, soil and well rotten cattle manure (3:3:1). The seeds start to germinate within 15-20 days. Frequent irrigation has to be provided for maintaining adequate moisture. The seedlings require artificial shading till they are about 6 months old (Anandaraj *et al.,* 2005). 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 **(**Kumar and Kumari, 2019**).** Cinnamon is generally propagated by seed. Other means of propagation are planting cutting and layering. Cinnamon fruits ripe in July-August and fall down when they are fully ripened. The fleshy berries are kept in heaps in shade to soften and rot. The mass is then trampled. The seeds without pulp are washed and dried in shade. They have to be sown without much delay because they have a short period of viability. The nursery is raised in a suitable spot in soil, rich in organic matter. The place is dug well twice or thrice. The soil is broken to powder and made loose, making it altogether free from stones, root bits. The seed beds are made 1 metre wide and of suitable length with adequate provision for drainage. The seeds are sown in lines 12 cm apart and are covered with a layer of soil to a thickness of about 2.5 cm. Germination of seed occurs in about 20 days. The beds have to be provided with artificial shade and watered regularly. The shade should continue until the plants are about 12 cm in height and then removed gradually. Frequent irrigations are required for maintaining adequate moisture level **(**Rawat *et al*., 2020**).**

Propagation is by seed or by vegetative means. Fruits are much liked by birds and the seed is easily spread, so the fruits have to be bagged for collection. Fruit pulp is allowed to rot before seeds are removed, washed and dried. Seeds quickly lose their viability. Fresh seeds germinate in 20-25 days. They are sown in nurseries or directly in the field. Vegetative propagation is by cuttings, layering or division of old rootstocks. Young cuttings with 2-3 nodes are planted in polybags and placed under polythene cover; they are ready for field planting after 12-18 months. Old rootstocks can be divided. For this, old plants are cut down to within 15 cm of the ground, and suitable parts of the rootstock planted out with adhering soil. Harvesting can start 1-1.5 years after planting out in the field compared with 3 years for seedlings (Ceylon, 2024).

Cultivation

C. zeylanicum can be propagated from either seeds or stem cuttings. Vegetative propagation is achieved using single-leaved semi-hardwood pieces of stem approximately 2.5 cm long. Seeds or stems are raised in nurseries for 4–6 months before field planting. These are field planted in commercial plantations with a spacing of 120 cm × 90 cm, and 60 × 120 cm in slopes. Soil conservation, weed control, manuring, pest and disease management, and training of the plant are important aftercare operations (Suriyagoda *et al.,*

2021). The commercial production of *C. zeylanicum* begins about 3–4 years after field planting and the plants have an economic lifespan of around 35–40 years. Initial plant training is important in order to produce a long-lasting and spreading plant base which produces continuous, vigorous, and straight shoots (Suriyagoda *et al*., 2021). The actual yield (average 445 kg/ha) is known to be much lower than the potential yield (1,000 kg/ha). This is known to be related to aging and poor maintenance of the crop and the incidence of pests and diseases. The wood-boring moth (*Ichneumoniptera cinnamomumi*) can be considered as the major pest and rough bark disease (*Phomopsis* spp.) as the disease of significance, causing major yield losses (Suriyagoda *et al.,* 2021).

Cinnamon is an evergreen tree characterized by oval-shaped leaves, thick bark and a berry fruit. When harvesting the spice, the bark and leaves are the primary parts of the plant used. However, in Japan, the more pungent roots are harvested in order to produce *nikki* which is a product distinct from cinammon . Cinnamon is cultivated by growing the tree for two years, then coppicing it, *i.e*., cutting the stems at ground level. The following year, about a dozen new shoots form from the roots, replacing those that were cut. A number of pests such as Colletotrichum gloeosporioides, Diplodia species and Phytophthora cinnamomi (stripe canker) can affect the growing plants. The stems must be processed immediately after harvesting while the inner bark is still wet. The cut stems are processed by scraping off the outer bark, then beating the branch evenly with a hammer to loosen the inner bark, which is then pried off in long rolls. Only 0.5 mm of the inner bark is used; the outer, woody portion is discarded, leaving metre-long cinnamon strips that curl into rolls ("quills") on drying. The processed bark dries completely in four to six hours, provided it is in a well-ventilated and relatively warm environment. Once dry, the bark is cut into 5 to 10 cm lengths for sale. A less than ideal drying environment encourages the proliferation of pests in the bark, which may then require treatment by fumigation with sulphur dioxide. In 2011, the European Union approved the use of sulphur dioxide at a concentration of up to 150 mg/kg for the treatment of *C. verum* bark harvested in Sri Lanka (Wikipedia, 2024). The old botanical synonym for the tree, *Cinnamomum zeylanicum*, is derived from Sri Lanka's former name, Ceylon. Sri Lanka still produces 80–90% of the world's supply of *C. verum*, which is also cultivated on a commercial scale in the Seychelles, Madagascar and Tanzania. On Borneo, *Cinnamomum verum* is cultivated at low elevations in Sarawak (Kuching District), Sabah (Keningau and Sandakan districts), and Kalimantan (Wikipedia, 2024a).
In India, pits of 50 cm are dug at a spacing of 3x3 m. They are filled with compost and topsoil before planting. One-year-seedlings are planted. In each pit, 5 seedlings can be planted. In some cases, the seeds are directly dibbled in pits that are filled with compost and soil. Partial shade in the initial years is advantageous for healthy and rapid growth of plants (Ceylon, 2024).

Harvesting: The cinnamon tree may attain a height of 10-15 m, but it is generally coppiced or cut back periodically. When the plants are 2 years old, they are coppiced during June-July to a height of about 12 cm from the ground. The stump is then covered by earthing up. This operation encourages the development of side shoots from the stump. This is repeated for every side shoot developing from the main stem during the succeeding season, so that the plant will assume the shape of a low bush of about 2 m height and shoots suitable for peeling would develop in a period of about 4 years. The first coppicing can be done from the fourth or fifth year of planting. The shoots are harvested from September to November, under Kerala conditions. Coppicing is done in alternate years and shoots having 1.5-2.0 cm thickness and uniform brown colour are ideal for bark extraction. A 'test cut' can be made on the stem with a sharp knife to judge its suitability for peeling. If the bark separates readily, coppicing can be commenced immediately. The stems are cut close to the ground when they are about 2 years old. Such shoots are bundled after removing the leaves and terminal shoots. The harvested shoots are cut into straight pieces of 1.00 -1.25m length. Cutting is followed by scraping and peeling operations. Peeling is a specialized operation, requiring skill and experience. It is done by using a specially made knife, which has a small round end with a projection on one side to facilitate ripping of the bark. The rough outer bark is first scraped off. Then the scrapped portion is polished with a brass or an aluminium rod to facilitate easy peeling.

A longitudinal slit is made from one end to the other. The bark can be easily removed by working the knife between the bark and the wood. The shoots cut in the morning are peeled on the same day. The peels are gathered and kept overnight under shade. They are dried first in shade for a day and then in sunlight for four days. During drying, the bark contracts and assumes the shape of a quill. The smaller quills are inserted into larger ones to form compound quills (Anandaraj *et al*., 2005). Cinnamon bark is harvested twice a year immediately after each of the rainy seasons when the humidity makes the bark peel more easily. The trees are first harvested when they are three years old, one year after pruning. The side stems that are about three years old are removed and the bark is stripped off. Cinnamon bark is only obtained from stems that are between 1.2 cm and 5cm in diameter **(**Rawat *et al.,* 2020**).** The stems are ready for the first harvest in about 2.5–3 years, when the bark turns a brown color. The subsequent shoots are ready to be harvested in about 1.5 years. Traditionally, harvesting takes place when the new leaves turn a light green color because, at this stage, the bark is easier to peel. Peeling is difficult at times when plants bear red-colored immature leaves, flowers or fruits, and during dry periods. Peelability and its basis are still inadequately researched, but are suggested to be related to water relations of the plant. When harvesting, the stems are coppiced, leaving one to two immature stems per bush to grow, at a 45° angle toward the middle of the base, which promotes spreading of the base (Suriyagoda *et al.,* 2021).

First harvest of cinnamon can be taken after three years of planting and two harvests can be taken per year. Harvesting is done when the bark color of the stem turn in to brown and stick diameter is about 3-5 cm diameter. Branches and leaves are removed from harvested sticks before peeling and harvested stems should be peeled on the same day. Ceylon cinnamon has to be harvested during the wet season because then the cambium is active and the cortex can be easily separated from the wood. The shoots are harvested when they are 2-3 m tall and 1.2-5.0 cm in diameter. Shoots in the centre of the clump are cut low down, while those on the outside are cut higher up to ensure that new buds sprout mainly on the outside of the clump. In Sri Lanka harvest peaks are in May-June and October-November. The first harvest is of inferior quality (thick bark), but this improves in later harvests. Best quality cinnamon is obtained from thin bark from the middle

part of shoots in the centre of the stool. After harvesting, all unwanted shoots and stumps are cut off the stool, which is then covered with earth, and new shoots are allowed to grow. The number of shoots per stool normally increases to a maximum at 8 years and declines after 10-12 years. A cinnamon plantation can remain profitable for 15-45 years, mainly depending on the standard of management (Ceylon, 2024).

Yield: There are two regular cutting seasons in South India, which more or less synchronize with two monsoons. The appropriate time for cutting the shoots for peeling is determined with reference to the circulation of sap between the wood and the corky layer. The yield varies with type of variety and age. 3-4 year and onwards 62 to 125 kg quills/ha. 10-11 year and onwards - 225 to 300 kg quills/ha. Further, about 75 kg of quillings and featherings are additionally obtained. One ton of leaves yielding 1 to 1.25 kg of oil are obtained per year **(**Rawat *et al.,* 2020**).**

Diseasesm (Anandaraj *et al.*, 2005).

Leaf spot and die back: Leaf spot and die back disease is caused by *Colletotrichum gloeosporioides*. Small deep brown specks appear on the leaf lamina, which later coalesce to form irregular patches. In some cases the affected portions are shed leaving shot holes on the leaves. Later the entire lamina is affected and the infection spreads to the stem causing die back. Pruning the affected branches and spraying Bordeaux mixture 1% are recommended to control the disease.

Seedling blight: Seedling blight caused by *Diplodia* sp. occurs on seedlings in the nursery. The fungus causes light brown patches which girdle the stem resulting in mortality . The disease can be controlled by spraying Bordeaux mixture 1%.

Grey blight: Grey blight is caused by *Pestalotia palmarum* and is characterized by small brown spots which later turn grey with a brown border. The disease can be controlled by spraying Bordeaux mixture 1%

Insect pests (Anandaraj *et al.,* 2005).

Cinnamon butterfly: The cinnamon butterfly (*Chilasa clytia*) is the most serious pest especially in younger plantations and nursery and is generally seen during the post monsoon period. The larvae feed on tender and slightly mature leaves; in severe cases of infestation, the entire plant is defoliated and only midribs of leaves with portions of veins are left behind. The adults are large sized butterflies and occur in two forms. One has blackish brown wings with white spots on outer margins; the other has black wings with bluish white markings. Fully grown larvae are pale yellow with dark stripes on the sides and measure about 2.5 cm in length. The pest can be controlled by spraying quinalphos 0.05% on tender and partly mature leaves.

Leaf miner: Infestation by the leaf miner (*Conopomorpha civica*) is more common during the monsoon period and generally nursery seedlings are seriously affected. The adult is a minute silvery grey moth. The larvae are pale grey initially and become pink later measuring about 10 mm in length. They feed on the tissues between the upper and lower epidermis of tender leaves resulting in linear mines that end in 'blister' like patches. The infested leaves become crinkled and the mined areas dry up leaving large holes on the leaves. Spraying quinalphos 0.05% during emergence of new flushes is effective in preventing the pest infestation. Many other leaf feeding caterpillars and beetles also occur sporadically on cinnamon feeding on tender flushes. Application of quinalphos 0.05% would keep them under check.

Processing: The quills are graded from 00000, being the finest quality, to 0 the coarsest quality. The small pieces of the bark, left after preparing the quills are graded as 'quillings'. The very thin inner pieces of bark are dried as 'featherings'. From the coarser canes, the bark is scraped off, instead of peeling, and this grade is known as 'scraped chips'. The bark is also scraped off without removing the outer bark and is known as 'unscraped chips'. The different grades of bark are powdered to get 'cinnamon powder'. Leaf and bark oils of cinnamon could be obtained by distilling dried cinnamon leaves and bark, respectively. The dried cinnamon leaves are steam distilled in special distiller. About 4 kg of bark oil could be obtained from a hectare of cinnamon plantation. Leaf oil and bark oil are used in the manufacture of perfumes, soaps, tooth pastes, hair oils and face creams and also as an agent for flavouring liquor and in dentifrices (Anandaraj *et al.,* 2005).

During processing (making of "quills"), the tops of the branches are lopped-off for leaf oil distillation. The corky tissues of sticks are scraped off and then the sticks are rubbed using a brass rod to loosen the bark from the hardwood. Two longitudinal slits are drawn from an end of stick to the end on the two opposite sides, and the knife is worked between the bark and stem to detach the bark into two halves. These barks are connected one inside the other until 106.7-cm long, cigar-shaped quills are made by joining the overlaps, and the hollow is filled with smaller pieces of the same peel and the edges were trimmed as necessary. The quills are then dried on coir rope strands indoors for 4–7 days (Suriyagoda *et al.,* 2021). Quills are graded based on the diameter, thickness of the quill, uniformity, and color, and "foxing." Foxing is a defect that appears as reddish-brown patches on the surface of the quills. These patches may turn dark brown in color with time. Quill making is a traditional, highly skilled, and time-consuming task, which is unique to the cinnamon produced in Sri Lanka and is associated with the lives of its people culturally, socially, and economically. A skilled worker can produce 4–5 kg of dried, processed cinnamon per day, for which they are required to peel about 50 sticks, taking approximately 10–15 hr. The method of quill making is known to be low in efficiency and high in cost due to the labor charges, which can account up to 50% of the income (Suriyagoda *et al*., 2021). Bark to be distilled for oil should not be allowed to become damp, as this encourages mould or fermentation, which affects oil composition. Bark oil is obtained by steam or hydro-distillation with cohobation, or solvent extraction of the distillate. Solvent extraction of the distillate gives the finest quality oil. Leaves stripped from shoots, together with small leafy twigs and stems are left in the field for 3-4 days and then transported to the distillery. Root bark oil is only produced when a plantation is uprooted for replanting. Roots are cleaned, trimmed and peeled prior to distilling (Bakewell-Stone, 2023).

The trees grow as leafy bushes, usually reaching a maximum of 3 m in height. They are first harvested at 3 years old and continue producing well for 40–50 years. Small side branches, 1.5–5 cm in diameter, are removed from the trees. The outer bark is removed and processed into mulch. Twigs, leaves and berries (seeds) are crushed to make cinnamon oil, a less

valuable byproduct. The inner bark of the branches is loosened by being rubbed with a brass rod. The bark is then split with a brass or stainless-steel knife and peeled off as intact as possible. Long, full 'quills' of cinnamon are more valuable than broken pieces. These quills are then dried over several days in the shade, then in darkness. All this work is done by hand by experienced workers; this is the most expensive part of producing cinnamon spice. Finally, the dried bark is cut into sticks or ground into powder for sale to consumers (Wikipedia, 2024a).

The grower harvests the main crop in the wet season, cutting the shoots close to the ground. In processing, the shoots are first scraped with a semicircular blade and then rubbed with a brass rod to loosen the bark, which is split with a knife and peeled. The peels are telescoped one into another, forming a quill about 107 cm (42 inches) long and filled with trimmings of the same quality bark to maintain a cylindrical shape. After four or five days of drying, the quills are rolled on a board to tighten the filling and then placed in subdued sunlight for further drying. Finally, they are bleached with sulfur dioxide and sorted into grades (Petruzzello, 2025). Processing accounts for about 60% of the cost of production of cinnamon as removal of bark from the stem is very labour intensive and is usually done by hand and by skilled labourers. 174 Medicinal Plants in India:

The quality of cinnamon depends on how well the bark is removed from the stems. The larger pieces of bark known as quills are sold at higher rate than the smaller broken pieces. Drying is also one of the important stages of cinnamon processing as it adds to the quality of the final product **(**Rawat *et al*., 2020**).**

Peeling and extraction of bark: Branches, 1 to 2 cm in thickness and which have attained brown colour are cut. The branches should be 1 to 2 years old. Cutting of shoots for extraction of bark is done in May and November. The cut shoots are collected, bundled arid tied to shed for peeling. Peeling is done with a small knife having a round edge at the end **(**Rawat *et al*., 2020**).** Peeling consists of stripping the bark for the preparation of quills from the inner bark. The outer bark is first removed and the stem then rubbed with a brass rod to loosen the inner bark. Two horizontal cuts are made 30 cm apart and two longitudinal slits on opposite sides of the shoot. The inner bark is then separated from the wood. Alternatively, the outer and inner bark are separated from the wood together. The strips are packed together, wrapped and left overnight for slight fermentation, facilitating the subsequent scraping off of the outer bark (epidermis, cork and green cortex). The curled pieces are assembled into compound quills of 1 m length by joining the best and longest quills on the outside and smaller pieces inside the longer ones. They are dried in the shade until they are yellowish-brown (Ceylon, 2024).

Rolling: Peeled barks are packed together and placed one above the other and pressed. Length of peeled barks is reduced to 20 cm and these are piled up in small enclosures covered with dried leaves or mats-to preserve moisture for next day's operation and also to aid slight fermentation **(**Rawat *et al.,* 2020**).**

Piping: Peeled and rolled slips are bundled and taken to piping yard. These slips are kept on a horizontal stick supported on a stand. The outer skin of the slip is scrapped-off with a curved knife. These scrapped slips are then graded according to thickness. The graded slips are rolled to form pipes by fitting them over the outer cover of pipes. After piping, slips are dried. Such piped slips are called quills'. The smaller quills are inserted into larger ones to form compound quill. The compound quills are placed on coir rope racks and dried in the shade to avoid warping. After drying for 4-5 days, the quills are rolled on a board to tighten the filling and then placed in subdued sunlight for further drying. After drying, they are packed in mats for marketing **(**Rawat *et al*., 2020**).**

Grading: The quills are graded from '00000' being the finest quality, to '0' the coarsest quality. The small pieces of the bark, left after preparing the quills are graded as 'quillings'. The very thin inner pieces of bark are dried as 'featherings'. From the coarser canes, the bark is scrapped-off, instead of peeling and this grade is known as 'scrapped chips'. The bark is also scrapped-off without removing the outer bark and is known as 'unscrapped chips'. The different grades of bark are powdered to get 'cinnamon powder'. The quality of the cinnamon is dependent upon the thickness of the bark, the appearance, aroma and flavor. The Sri Lankan grading system divides the cinnamon quills into four main groups according to diameter **(**Rawat *et al.,* 2020**).**Ceylon cinnamon sticks (quills) have many thin layers and can easily be made into powder using a coffee or spice grinder, whereas cassia sticks are much harder (Wikipedia, 2024; Wikipedia, 2024a). The grading of Ceylon cinnamon is rather elaborate compared with the grading of cinnamon from other sources. The various forms and qualities are known as unscraped bark, scraped bark, compound quills, simple quills, quillings (broken pieces of quills), featherings (bark of twigs and twisted shoots) and chips (trimmings, shavings). Quills are further graded according to the thickness of the bark. Grinding usually takes place in the consuming countries (Ceylon, 2024).

The Sri Lankan grading system divides the cinnamon quills into four groups (Wikipedia, 2024):

- Alba, less than 6 mm (0.24 in) in diameter
- Continental, less than 16 mm (0.63 in) in diameter
- Mexican, less than 19 mm (0.75 in) in diameter
- Hamburg, less than 32 mm (1.3 in) in diameter

These groups are further divided into specific grades. For example, Mexican is divided into M00000 special, M000000 and M0000, depending on quill diameter and number of quills per kilogram. Any pieces of bark less than 106 mm long are categorized as quillings. Featherings are the inner bark of twigs and twisted shoots. Chips are trimmings of quills, outer and inner bark that cannot be separated, or the bark of small twigs.

Grinding: Most consumers, from wholesalers to individual customers, prefer to buy whole spices. Cinnamon is sometimes ground to powder form prior to sale. The ground powder should be packaged in moisture proof packaging (polypropylene bags) to retain the flavour **(**Rawat *et al.,* 2020**).**

Packaging: Cinnamon quills are normally cut into pieces of 10 cm in length and packed into moisture-proof polypropylene bags for sale. The bags should be sealed to prevent moisture entering. The label on the bags should contain all relevant product and legal information – the name of the product, brand name, details of the manufacturer (name and address), date of manufacture, expiry date, weight of the contents, added ingredients **(**Rawat *et al.,* 2020**).**

Storage: Dried cinnamon quills must be stored in moisture-proof containers away from direct sunlight. If they have absorbed moisture, they should be re-dried to a moisture content of 10%. The storage room should be clean, dry, cool and free from pests. Mosquito netting should be fitted on the windows to prevent pests and insects from entering the room. Strong smelling foods, detergents and paints should not be stored in the same room as they will spoil the delicate aroma and flavour of the cinnamon **(**Rawat *et al.,* 2020**).**

Characteristics: Ceylon cinnamon may be crushed into small pieces by hand while Indonesian cinnamon requires a powerful blender (Wikipedia, 2024). The flavour of cinnamon is due to the aromatic essential oils that makes up 0.5 to 1% of its composition. Cinnamon bark can be macerated, then extracted in 80% ethanol, to a tincture. Cinnamon essential oil can be prepared by roughly pounding the bark, macerating it in sea water, and then quickly distilling the whole. It is of a golden-yellow colour, with the characteristic odour of cinnamon and a very hot aromatic taste. *Cinnamon oil nanoemulsion* can be made with polysorbate 80, cinnamon essential oil, and water, by ultrasonic emulsification. *Cinnamon oil macroemulsion* can be made with a dispersing emulsifying homogenizer. The pungent taste and scent come from cinnamaldehyde, about 90% of the essential oil from cinnamon bark. Cinnamaldehyde decomposes, in high humidity and high temperatures, to styrene, and, by reaction with oxygen as it ages, it darkens in colour and forms resinous compounds. Cinnamon constituents include some 80 aromatic compounds, including eugenol, found in the oil from leaves or bark of cinnamon trees (Wikipedia, 2024). Cinnamon is used as a flavoring in cinnamon liqueur, such as cinnamon-flavored whiskey in the United States, and rakomelo, a cinnamon brandy in Greece (Wikipedia, 2024). Cinnamon ranges in color from yellowish brown (Ceylon), reddish brown (Indonesian and Vietnamese) to darker brown (Chinese) (Resources, 2024). Dried bark is formed into cylindrical quills and cut into cinnamon sticks. Ceylon cinnamon sticks tend to be multilayered, thin, and fragile while Vietnamese and Indonesian sticks tend to be a single thick layer and less prone to breakage. Chinese cinnamon is often sold as chunks of bark rather than in quills (Resources, 2024). Cinnamaldehyde (spicy), woody, musty, sweet, astringent (drying), and bitter (Resources, 2024). Good quality cinnamon bark can contain up to around 4% essential oil. The main flavor of cinnamon comes from the aromatic compound “cinnamaldehyde” which is described as tasting like spicy “red hot” or “atomic fireball” candy. Of the four main culinary species of cinnamon, Vietnamese and Chinese typically have the highest cinnamaldehyde content and spicy flavor. Chinese cinnamon can sometimes taste bitter and astringent and is generally considered to be lower in quality than Vietnamese. Indonesian cinnamon is usually less spicy and is prized by bakers for its balanced warm and woodsy flavor. Ceylon cinnamon has a mild spiciness and exhibits unique flavors such as fruity, floral, and clove-like (Resources, 2024).

Production and Trade: Sri Lanka produces, mainly as quills, some of the best quality cinnamon bark (Ceylon cinnamon), which is reflected in its higher producer price (7570 US$/t in 2014) compared with that from other producers (e.g. 1008 US$/t for Vietnam). According to the FAO, world production of cinnamon has been increasing steadily, from 19,912 t in 1961, to 67,276 t in 1990 to 201,045 t in 2009, and has since levelled off at around 200,000 t. The period 1961-2013 saw an overall increase in world production of 5.3%, with increases of 6.24% recorded for Indonesia, but much lower increases for other traditional producers such as Sri Lanka (1.7%). The Seychelles, another traditional producer, saw a decline (-6.5%) In 2013, the principal producers were Indonesia (89,500 t), China (69,500 t), Vietnam (22,000 t), Sri Lanka (15,865 t) and Madagascar (2400 t). Highest yields per ha were obtained from Madagascar (1778 kg/ha) and China (1695 kg/ha). The best-quality cinnamon is still produced in Sri Lanka (Bakewell-Stone, 2023). Most cinnamon leaf oil also originates from these countries, whereas cinnamon bark oil and oleoresin are mainly prepared in the importing countries. From 1987 to 1992, Sri Lanka annually exported less than 3 t of bark oil, and about 115 t of leaf oil. The USA and western Europe are the main markets for these oils. Cinnamon bark oil is very expensive, reflecting the high raw material cost. Cinnamon leaf oil is much cheaper, but still more expensive than clove leaf oil, an alternative source of eugenol (Bakewell-Stone, 2023).

REFERNCES

Abeysinghe, P.D., Bandaranayake, P.C.G. and Pathirana, R. 2020. Botany of Endemic *Cinnamomum* Species of Sri Lanka. In: Senaratne, R., Pathirana, R. (eds) Cinnamon. Springer, Cham. https://doi.org/10.1007/978-3-030-54426-3_4

Ali, S.A. 2008. Cinnamon Processing. https://core.ac.uk/download/pdf/48027458.pdf

Anandaraj, M., Devasahayam, S., Krishnamoorthy, B., Mathew, P.A. and Rema, J. 2005. Cinnamon (*Cinnamomum verum*) (Family: Lauraceae). Editors: P. Rajeev and R. Dinesh. Publisher: V. A. Parthasarathy, Director, Indian Institute of Spices Research

Ashwani, Y., *et al*., 2021. A Review on Cinnamon species. International Journal of Creative Research Thoughts (IJCRT), 9(1): 2226-2232

Azad, R., *et al*., 2016. Morphological variation of cinnamon (*Cinnamomum verum* Persl) germplasm in Matara District of Sri Lanka. International Journal of Minor Fruits, Medicinal and Aromatic Plants 2 (1): 6 - 14

Azad, R., *et al*., 2019. Development of a core collection for Sri Lankan cinnamon germplasm based on morphological characterization using an eco-geographic survey. Australian Journal of Crop Science, 13(09):1473-1485

Azmi, A., *et al*., 2024. Medicinal properties of Darchini (Cinnamomum

zeylanicum): A review. International Journal of Herbal Medicine, 12(2): 05-09

Bakewell-Stone, P. 2023. Cinnamomum verum (cinnamon). Publication: CABI Compendium. https://doi.org/10.1079/cabicompendium.13573

Bandaranayake, P.C.G. and Pushpakumara, D.K.N.G. 2020. Genetics and Molecular Characterization of Genus *Cinnamomum*. In: Senaratne, R., Pathirana, R. (eds) Cinnamon. Springer, Cham. https://doi.org/10.1007/978-3-030-54426-3_5

Bandusekara, B.S., Pushpakumara, D.K.N.G., Bandaranayake, P.C.G., Wijesinghe, K.G.G. and Jayasinghe, G.G. 2020. Field Level Identification of Cinnamomum Species in Sri Lanka Using a Morphological Index. Tropical Agricultural Research, 31(4): 43-53

Bionity. 2024. Cinnamon. https://www.bionity.com/en/encyclopedia/ Cinnamon.html

Ceylon. 2024. Cinnamon, Ceylon - *Cinnamomum verum.* 2025. file:///C:/Users/KRMS/ Downloads/ Cinnamon, %20Ceylon,%20Cinnamomum%20verum.htm

Dasanayaka, R. 2019. Cinnamon: A Spice of an Indigenous Origin- Historical Study**. A**kayana- July-December 2019

Filippone, P.T. 2019. Origin and Historical Uses of Cinnamon. https://www.thespruceeats.com/history-of-cinnamon-1807584

Google. 2024. AI Overview**-**Chrosomes of *Cinnamomum zeylanicum* https://www.google.com/ search?q =chromosomes +in+cinnamomum+ zeylanicum &client=firefox-b-

IISR. 2024. Cinnamon. Vikaspedia. https://agriculture. vikaspedia.in/viewcontent/agriculture/crop-production/package-of-practices/spices/cinnamon?lgn=en

Indianspices. 2024. Cinnamon. https://www .indianspices.com/spice-catalog/cinnamon.html

Jansen, E.R.M. 2015. Cinnamon, the spice of life. https://www.academia.edu/15383537/Cinnamon_the_spice_of_life

Karthik. 2023. Cinnamon: A Spice Worth Savoring – Exploring the Types, Benefits, and Culinary Uses. https://www.pureleven.com/cinnamon-types-benefits-and-culinary-uses/?srsltid=AfmBOooy2JIz-uQhKpLQQM_5oq_V-

Kumar, S. and Kumari, R. 2019. *Cinnamomum*: review article of essential oil compounds, ethnobotany, antifungal and antibacterial effects. Open Access J Sci*.,* 3(1):13–16. DOI: 10.15406/oajs.2019.03.00121

Liyanage, T., Madhujith, T. and Wijesinghe, K.G.G. 2017. Comparative Study on Major Chemical Constituents in Volatile Oil of True Cinnamon (*Cinnamomum verum* Presl. syn. *C. zeylanicum* Blum.) and Five Wild *Cinnamon* Species Grown in Sri Lanka. Tropical Agricultural Research, 28 (3) : 270– 280

Liyanage, N.M.N., *et al*., 2021. Identification of superior *Cinnamomum zeylanicum* Blume germplasm for future true cinnamon breeding in the world. Journal of Food Composition and Analysis, 96: 103747

Muthalib, A.M., *et al*., 2021. A Literary Review On *Cinnamomum Zeylanicum* With Special Reference To Its Varieties. International Journal of Advance Research and Innovative Ideas in Education, 7(3): 2395-4396

NCSU. 2024. Cinnamomum verum**.** https:// plants.ces.ncsu.edu/plants/cinnamomum-verum/

Niharika, M. and Hanumantha, M. 2024. Progeny variation for leaf morphometric traits of *Cinnamomum zeylanicum* Blume. in Uttara Kannada district, Karnataka. J. Farm Sci., 37(2): (188-193) 2024

Nisarga. 2024. Cinnamomum zeylanicum. Taxonomical Classification. https://nisargabiotech.com/wp-content/uploads/2024/03/Cinnamonum-zeylanicum-1.pdf

Nosir, W. 2025. Cultivation and agricultural practices of Cinnamon. In: Cinnamon-Production, Processing, and Functional Properties. 2025, Pages 13-21. https://doi.org/10.1016/B978-0-443-21820-0.00004-0

Pathak, R. and Sharma, H. 2021. A Review on Medicinal Uses of Cinnamomum verum (Cinnamon). Journal of Drug. Delivery and Therapeutics. 2021; 11(6-S):161-166

Pathirana, R. and Senaratne, R. 2021. Cinnamon: Botany, Agronomy, Chemistry and Industrial Applications. Book. Pp 442. https://www.google.co.in/ books/edition/ Cinnamon/sioXEAAAQBAJ?hl=en&gbpv=0

Petruzzello, M. 2025. Cinnamon- plant and spice. The Editors of Encyclopaedia Britannica. https://www. britannica. com /plant/cinnamon

Ranatunga, J., Senanayake, U.M. and Wijesekera, R.O.B. 2003. Cultivation and Management of Cinnamon. In: BookCinnamon and Cassia

Rawat, I., Verma, N. and Joshi, K. 2020. Cinnamon (*Cinnamomum zeylanicum*). In: Medicinal Plants in India: Importance and Cultivation (pp.164-177).

Resources. 2024. Cinnamon. https://www. mccormickscienceinstitute. com/resources/culinary-spices/herbs-spices/cinnamon

Rostiana, O., Suryani, E., Purwiyanti, S., Heriyanto,. R. and Arlianti, T. 2025. Yield and essential oil quality of Indonesian ceylon cinnamon at different age of harvest. 1st International Conference on Sustainable Plantation (1st ICSP 2019). IOP Conf. Series: Earth and Environmental Science, 418:012025 IOP Publishing. doi:10.1088/1755-1315/418/1/012025

Sandigawad, A. M. and Patil, C. G. 2011**.** Genetic diversity in *Cinnamomum zeylanicum* Blume. (Lauraceae) using random amplified polymorphic DNA (RAPD) markers. Afr. J. Biotechnol., 10(19): 3682-3688 ,

Sharma, A.K. and Bhattacharyya, N.K. 1959. Chromosome studies on four different species of Cinnamomum. Japanese Journal of Botany, 17(1): 43-54

Shylaja, M., Ravindran, P.N. and Nirmal Babu, K. 2003. Other Useful Species of Cinnamomum. In: BookCinnamon and Cassia

Smiderle, O.J. and Souza, A.G. 2016. Production and quality of *Cinnamomum zeylanicum* Blume seedlings cultivated in nutrient solution. Brazilian Journal of Agricultural Sciences, 11(2):104-110

Suriyagoda, L., *et al*., 2021. "Ceylon cinnamon": Much more than just a spice**.** Plants, People, Planet, 3(4): 319-336

Wikipedia. 2024. Cinnamon. From Wikipedia, the free encyclopedia. https://en.wikipedia.org/wiki/Cinnamon

Wikipedia. 2024a. *Cinnamomum verum.* From Wikipedia, the free encyclopedia. *Cinnamomum verum***.** https://en.wikipedia.org/wiki/Cinnamomum_verum

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