# Bark anatomy of four species of Cinnamomum (Lauraceae) from Kerala

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## ABSTRACT

Bark anatomy of four species of *Cinnamomum* - three cultivated (*C. verum, C. cassia, C. camphora*) and the most common wild cinnamon (*C. malabatrum*) are reported here. They differ with regard to many characters such as the nature of the sclerenchymatous groups in the pericyclic region, nature of the phloem rays, distribution of phloem fibres and in the presence of crystalline inclusions. The differences in the bark structure are useful in distinguishing the genuineness of the true cinnamon (*C. verum)* bark and also in the taxonomy of the genus.

Key words: bark anatomy, *Cinnamomum,* Lauraceae

Genus *Cinnamomum* Schaeffer (Lauraceae) consists of about 250 species (Wiley 1973) comprising of ever green trees and shrubs occurring in the Asiatic mainland to Formosa, the Pacific Islands and Australia. Hooker (1986) reported 25 species from the Indian subcontinent, where it is distributed mainly in the Western Ghats, and adjoining areas and in the North Eastern regions. Gamble (1925) reported 12 species of *Cinnamomum* form the Western Ghats and adjoining areas, while Kostermans (1982) listed 13 species from different parts of South India.

The bark of *C. verum* Presl is the cinnamon of commerce. *C. cassia* Presl gives the Chinese Cassia. The other economically important species are *C. camphora* (L) Presl. (Camphor tree); *C. tamala* (Ham.) Th. Nees & Eberum. (Tejpat or Indian Cassia); *C. burmanii* C.G & Th. Nees (Indonesian Cassia) and *C. loureirii* Nees (Saigon Cassia).

Though cinnamon bark is of great economic importance, very little work has been done on their structure and development. The earlier studies on these aspects were by Birnsteil (1922), Santos

(1930) and more recently by Bamber and Summerville (1979). All of them had shown the prevalence of differences of bark structure in this genus. The present study was undertaken to investigate the bark anatomical features of the most important species of *Cinnamomum* occurring in south India namely *C. verum*, *C. cassia*, *C. camphora* and *C. malabatrum* Bercht & Presl. The first three are cultivated while the last one is the wild *Cinnamomum*, most widely distributed in Kerala the bark of which is frequently used for adulterating the true cinnamon and also used as a base material in Agarbathi manufacture. Voucher specimens of the species are deposited at Calicut University Herbarium.

Bark was peeled off from shoots of two year old twigs of identical thickness (finger-thick shoots) and fixed in 70% FAA. Two year old shoots were used because they are the ones used commercially for extracting the bark. Both the mature bark (dark grey in colour) from the lower portion of shoots and the young bark (green) from the top region are used in this study. The fixed bark was processed for microtomy in the conventional way. Sections were cut at 12 μ and stained in safranine. Both free hand and microtomy sections were used for the study.

The bark is thicker in *C. verum* and *C. cassia.*, comparatively thinner in *C. malabatrum* and thinnest in *C. camphor.* In all the four species the barks are characterised by secretion cells containing mucilage or essential oil droplets. The bark is also characterised by islands of sclerenchyma in the pericyclic region in *C. cassia*, *C. verum* and *C. malabatrum* while such a band is absent in *C. camphora*. This is the demarcating zone between the extra pericyclic region comprising of phellum and phelloderm and the secondary phloem. The salient features of the bark tissues of the four species are given in Table 1.

**Table 1. Bark characteristics of Cinnamomum spp.**

| Species | B.t. (mm) 1 | E.p.t. (mm) 2 | P.t. (mm) 3 | P.r.f. (mm) 4 | P.r.w. (mm) 5 | D.s.l. (mm) 6 | p.f. (mm) 7 | P.o. (mm) 8 | R. (mm) 8 | O.cr.i. (mm) 10 | T. (mm) 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C.verum | 0.95 | 0.64 | 0.30 | 0.92 | 0.03 | 0.29 | + | +++ | + | ++ | ++ |
| C.cassia | 0.97 | 0.60 | 0.36 | 0.65 | 0.03 | 0.30 | + | +++ | + | ++ | ++ |
| C.camphora | 0.59 | 0.38 | 0.28 | 0.92 | 0.03 | 0.62 | ++ | + | – | + | – |
| C.malabatrum | 0.73 | 0.38 | 0.36 | 0.46 | 0.06 | 0.12 | +++ | – | +++ | + | + |

1. Bark thickness 2. Thickness from epidermis to pericycle 3. Phloem thickness 4. Phloem ray frequency 5. Phloem ray width 6. Distance between sclerenchyma islands 7. Presence of phloem fibres 8. Presence of oil globules 9. Presence of raphides 10. Presence of other crystalline inclusions 11. Presence of tannin in phloem rays.
\+ Very sparse ++ Frequent +++ Very frequent – Absent

The phloem ray frequency per unit length (1 mm) is highest in *C.camphora*, followed by *C.verum* and lowest in *C. malabatrum*. The rays are broader in *C. malabatrum* and are biseriate. The rays are prominently dilating at the top in the case of *C. camphora* and *C. malabatrum*. The ray cells of both old

and young barks are filled with dark, golden or brown substance in *C. verum* and *C. cassia* while such contents were rarely seen in *C. camphora* bark. In *C. malabatrum* such deposits are absent in young bark, while present in the older barks.

Islands of sclerenchyma in the pericyclic region are characteristic feature of the barks. The distance between such groups are more in *C.camphora* (mean distance 0.621 mm) while they are closest in *C. malabatrum* (mean distance 0.137 mm). In the latter case each group consists of very few cells, while in the other three species the cells are more.

The distribution of bast fibres is another characteristic feature of the barks. In *C. cassia* and *C. verum* these fibres are rare and very sparsely distributed. In *C. camphora* they are more frequent, while in *C. malabatrum* they are very frequent in distribution.

The cortical region of the young bark and the phellum and phelloderm region of the older bark contain large numbers of cells with brown tannic or mucilage deposits. Such cells are frequent in *C. cassia* and *C. verum*, less frequent in *C. camphora* and *C. malabatrum*. Oil globules are abundant in the outer bark tissues of *C. cassia* and *C. verum;* very few in *C. camphora* and almost absent in *C. malabatrum*.

Crystalline inclusions, mostly in the form of raphides or prismatic crystals occur in the bark of all the species except in *C. camphora*. Raphides are distributed sparsely in *C. cassia* and in *C. verum*. They are abundant in *C. malabatrum*, and absent in *C. camphora*. These raphides are needle shaped or spindle shaped, occurring alone or in groups in the phloem tissues. Granular inclusions were present in the phelloderm of all the species.

The observations indicate species variation in the bark anatomical features. Santos (1930) in a study on the bark anatomy of six Philippine species of *Cinnamomum* reported the resemblances among the species with regard to the general features, but difference were noted in certain details. Birnstiel (1922) investigated 20 species which he divided into two groups based on anatomical features. In the first the stone cells occurred as islands, in the second a great part of the secondary cortex was composed of sclerosed cells. In the present study it is noted that the thick walled stone cells form a continuous ring connecting the sclerenchymatous groups in three species (*C. verum, C. cassia, C. malabatrum*) while in *C. camphora* the stone cells are present as isolated islands. Occurrence of phloem fibres (bast fibres) was reported by Santos (1930) and Metcalfe and Chalk (1950). Santos (1930) reported their presence in all the species studied by him except in *C. mindanensis*. Bast fibres are observed in all the four species in the present study also, though their numbers were very sparse in *C. verum* and *C. cassia*. Bamber and Summerville (1979) demonstrated the taxonomic significance of sclerified tissues in phloem of Lauracean genera. According to them such tissues occur in two general forms - (1) tissues formed directly from the cambium which consisted either of rectangular fibres or of polygonal fibres in association with sclereids (fibres/sclereid aggregate) and (2) those formed in the outer phloem. Rectangular fibres occurred in all the species studied here, in *C. camphora* these fibres occurred in narrow tangential bands. In *C. verum* they are distinctly flattened. Fibre/sclereid aggregation and sclerified pa-

renchyma were not found in the species studied here.

The bark characters seem to be useful in the identification of the genuineness of the commercial bark of samples of *C. verum* which is often known to be adulterated with the barks of the wild forms. This may also be useful in taxonomical studies in *Cinnamomum* especially in the context of the highly uniform floral characters in this genus.

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