CINNAMON (CINNAMOMUM VERUM PRESL) - THE SWEET BARK SPICE FOR FLAVOUR AND FRAGRANCE- A REVIEW

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ABSTRACT

Cinnamon is a very useful tree spice, and every part of the tree is used for different purposes like culinary, pharmaceutical and perfumery. It is native to Sri Lanka and in India it is cultivated in lower elevations of Western Ghats in Kerala, Tamil Nadu and Karnataka. The area, production and productivity in our country is very low and it is mainly due to the non adoption of improved crop management and post harvest handling technologies, decline in area under cultivation and incidence of pest and diseases. Hence, the positive developments made in various aspects of crop improvements, production, protection and post harvest handling techniques are reviewed here.

Key words: Cinnamon, Bark spice, Flavour, Frangance.

Cinnamon, Cinnamomum verum Presl. (Family: Lauraceae) is one of the earliest known and most important tree spices of India. Cinnamon is mainly cultivated for the dried inner bark of the tree which is the spice of commerce. The bark has a delicate fragrance and a warm sweet agreeable taste and used as a spice in culinary preparations. It is precious not only as a flavoring agent for food, but as a medicine and perfume (Yousef and Tawil, 1980; Namba et al. 1987; Matsuda et al. 1987; Pande, 1987; Pruthi, 2001). India produces about 1659 tonnes of cinnamon spice in an area of 774 ha and as such it is not adequate to meet the internal demand. The quantity imported from other countries ranges from 120-250 MT per annum (KAU, 2008; Singh and Singh, 2008). There is a vast scope to enhance the production through adoption of improved production technologies and expansion of the cultivable area.

Genetic Resources

The true cinnamon comes from Cinnamomum verum Presl. (Syn. C. zeylanicum Bluma) belonging to the family Lauraceae. The genus Cinnamomum consists of about 250 species (Willis, 1973) comprising evergreen trees and shrubs, occurring in the Asiatic mainland to the Pacific Islands and Australia. Hooker (1886) reported 25 species from the Indian subcontinent, mainly from the Western Ghats and North Eastern India. Ridley (1924) reported 10 species in Indo Malaya, China, Australia and Polynesia. Gamble (1925) described 11 species of Cinnamomum, mainly from the Western Ghats forests. Kostermans (1983) described 13 species from South India, most of them from the Western Ghats. The variability of South Indian species were studied in detail by Shylaja (1984) and the North Eastern species were studied by Baruah et al. (2000); Baruah and Nath, (2004).
Cinnamon, though considered indigenous to Sri Lanka, occurs in the Western Ghats and this region is considered as the secondary centre of origin of the species (Sasikumar et al., 1999). The conservation of available variability of cinnamon in India and from exotic sources is carried out at the Indian Institute of Spices Research, Kozhikode, Regional Research Laboratory, Bhubaneswar, Kerala Agricultural University and Tamil Nadu Agricultural University. The IISR Germplasm include 166 cultivated types, 35 related/wild types and 14 exotic accessions. The Tamil Nadu Agricultural University germplasm consists of 18 cultivated types while Kerala Agricultural University contains 234 types. (Krishnamoorthy and Rema, 1994; Ravindran, 1999; Ravindran et al., 2005; Nybe et al., 2006).

In addition to the true cinnamon (Cinnamomum verum) the other economically important species are Chinese cassia (C. cassia Bercht. & Presl), (Syn. C. aromaticum Nees). Indonesian cassia (C. burmannii), Saigon cassia (C. loureiri) and Indian cassia (C. tamala Nees). Among the economically useful related taxa. C. camphora L. Bercht. and Presl. is important as a source of camphor. The wild species of cinnamon (C. malabatrum, C. macrocarpum, C. riparium, C. heynianum, C. travancorium and C. micolsonianum) are in danger of extinction because of indiscriminate bark extraction from them (Sasikumar et al., 1999; Nybe et al., 2006).

Cytology

The earliest cytological studies of Cinnamomum were done by Tackholm and Solderbrg (1917) and reported a somatic number of \(2n = 24\) in C. Sieboldii. Later studies confirmed \(2n = 24\) as the somatic number for C. verum and the basic number as \(n = 12\) (Okada and Tanaka; 1975, Okada, 1977; Singh and Singh, 2008).

Floral biology

Flowers are small; numerous in terminal and axillary panicles on current seasons growth. The peduncles are creamy white and 5 to 7 cm long. Individual flowers are 3 cm in diameter with foetid smell. Each flower is subtended by a hairy tract. Perianth six in two whorls of three each and pubescent. Stamens nine plus three or in four whorls of three each. Outer two whorls are introrse and glandless, third whorl extrose and flanked by two prominent glands, fourth whorl is represented by sagitate, stalked staminodes. Fertile stamens show valvuler opening filaments hairy. Anthers are four celled; dehisce by four small valvular lids. Staminodes three ovary superior, one celled with solitary anatropus ovule. Fruit is a berry surrounded by enlarged perianth (Sastri, 1965; Joseph, 1981; Mohankumar et al., 1984).

Flowering is from November to March. On an average, 13.83 days are required for the flower bud development from the stage of its visible initiation. The peak anthesis is from 11 am to 12 noon. Stigma receptivity is highest on the day of anthesis (Sastri, 1963; Shylaja, 1984; Ravindran et al., 2004; Nybe et al., 2006). Ponnuswamy et al. (1982) have reported the variability in this crop, which is indicative of cross-pollination. Insects are the pollinating agents. Mohankumar et al. (1984) reported 13 insects which aid pollination on cinnamon, but nothing is known about their relative efficiency.

Joseph (1981) reported that every flower opens twice in two stages. In stage one on the first day, when a flower opens, its stigma is receptive, and there is no dehiscence of anthers, and the stamens of the first whorl and those of the third whorl appear fused. The flower closes in the afternoon. In stage two, the next day, the anthers dehisce 30-60 minutes after the flower opening. After about five hours
the flower closes and will not open again. This type of dichogamy is termed as synchronized dichogamy or as protogynous dichogamy, where the male and female phases are separated temporally thereby ensuring outcrossing (Shylaja, 1984).

**Crop Improvement Variability**

The variability studies with 101 open pollinated accessions indicated a wide range of variability for number of peeler shoots per plant, plant height, plant girth and spread (Ponnswamy *et al.*, 1982). Balasubramanayan *et al.* (2002) observed variability among 10 accessions of cinnamon for regeneration capacity of bark and oil yield. Joy *et al.*, (1996) found considerable variation among 234 accessions of cinnamon for growth parameters, leaf oil yield and quality. From these accessions 163 morphologically better types were selected for further improvement. Krishnamoorthy *et al.* (1988) studied the relation between colour of young flushes and oil yield parameters. Plants with purple coloured flushes had 29 per cent more bark oil as compared to yellow flush plants. The bark oleoresin and leaf oil content did not show any difference among such young flush colours. Variability studies conducted at Horticultural Research Station, Yercaud among 10 accessions of cinnamon revealed the existence of variability for biometric characters and bark yield (Kennedy and Balakrishnamoorthy, 2000). Significant variation was observed among 300 cinnamon genotypes for most of the characters related to growth and yield. From these genotypes four promising types were identified. The bark yield varied from 33.35 to 84.5g whereas the leaf yield (fresh) ranged from 1.47 to 3.69 kg. The percentage of oil in the bark varied between 1.88 and 3.2, cinnamaldehyde content of oil from 66.77 to 70.23% and eugenol content from 5.71 to 8.61% (Haldankar *et al*.1994).

Krishnamoorthy and Rema (1994) identified elite cinnamon lines based on the variability in yield and quality.

**Varietal evaluation**

Paul and Sahoo (1993) isolated a promising selection RRL (B) C-6 from seedling progenies. It had stable high oil content and quality with 94 percent eugenol in leaf oil and 83 per cent cinnamaldehyde in bark oil. Two high yielding and high quality selections namely “Navashree” and “Nithyashree” have been developed at IISR which are selections from germplasm, the former from the collections in India and the latter from the introductions from Sri Lanka (Krishnamoorthy *et al.*, 1996).

YCD-1 is a cinnamon selection from Horticultural Research Station, Yercaud, TNAU. It comes to harvest from third year onwards and can be maintained economically for 20 years. It gives a bark yield of 359.75 kg quills and 3800 kg of dried leaves/ha with high bark recovery of 35.3 per cent. (Kennedy and Balakrishnamoorthy, 2000).The evaluation studies at Aromatic and Medicinal plants Research Station, Odakkali, KAU for growth yield and quality of cinnamon genotypes paved way for the release of a variety ‘Sugandhini’ in the year 2000 (KAU, 2001). It is recommended for cultivation in the midlands and high lands of Kerala both in open and as intercrop in coconut gardens for the production of cinnamon leaf oil. Average leaf yield is 18 kg/tree/year and average bark yield is 1.2 kg/tree/year.

Konkan Tej was developed by clonal selection at KKV, Dapoli which has got high bark oil (3.2%), cinnamaldehyde (70.23%) and eugenol (6.93%), yield 789.75g fresh bark and 3.56 kg leaf per plant. Characterization of cinnamon germplasm at Pechiparai led to the identification of one high yielding Pechiparai(C)1 cinnamon with a bark yield of
440g/tree and leaf yield of 12 kg/tree. The oil recovery from the bark and leaf is 2.9 and 3.3 per cent respectively. It is highly suited for lower elevations (Thangaselvabai et al., 2006).

**Crop ecology**

Cinnamon is a hardy plant, which tolerates a wide range of climatic conditions. The crop performs well from 300 to 350 m above MSL and thrives up to 1000 m above MSL (Nair, 1970). It flourishes in places with an annual rainfall of 150-250 cm with an average temperature of 27°C. A hot and moist climate is highly suited for cultivation of cinnamon and prolonged spells of dry weather are not conducive for its growth. (Radhakrishnan, 1992). In fact the finest quality cinnamon from Sri Lanka is grown in the sandy soils of the coastal area in the Island.

Cinnamon flourishes well in a wide range of soils including marginal soils with poor nutrient status. The quality of the bark is greatly influenced by the soil. Sandy loam soil rich in organic matter is the best for cinnamon (Purse glove et al., 1981). In Sri lanka cinnamon bark of the first quality is obtained in white sandy soil. In the west cost of India cinnamon is cultivated in lateritic and sandy soils which are poor in nutrient status (Radhakrishnan, 1992). Water logged and marshy areas may be avoided as they yield an undesirable produce (Krishnamoorthy and Rema, 1988).

**Propagation**

Cinnamon is commonly propagated through seeds. (Joseph, 1981). Seeds are extracted from ripe fruits from selected mother trees with desirable characters. The seeds are sown immediately after collection, otherwise viability gets reduced. Seeds are sown in nursery beds or in pots filled with a mixture of sand, cattle manure and soil in the ratio 2:2:1 (Nair, 1970). Kannan and Balakrishnan (1967) obtained the highest germination of 94 per cent by sowing seeds on the third day after harvesting. After 40 days, there was complete loss of viability. Under normal conditions, seeds germinate within 20 days (Krishnamoorthy and Rema, 1988). Seeds may be sown in rows of 12 cm apart in nursery beds and covered with thin layer of soil. Radhakrishnan (1992) observed July-August as the best time for sowing. Beds may be watered and shade should be provided during early stages. From beds, seedlings are transplanted to polythene bags when they attain a height of 15 cm. Polythene bags of 30 cm x 15 cm size filled with soil, farm yard manure and sand (3:3:1) are used (Krishnamoorthy and Rema, 1988).

Cinnamon is also propagated by cuttings and layering. Vadivel et al. (1981) reported 45 per cent rooting in hard wood cuttings treated with IBA 2500 ppm. Nageswari et al., (2000) obtained 50 per cent rooting when hard and semi-hard wood cuttings were treated with IAA 100 ppm, while Ananthan and Chezhiyan (2002a) reported 82.6% rooting of hard wood cuttings with NAA – 2500 ppm. Banerjee et al., (1982) and Hedge et al., (1990) reported success of air layering. Ranaware et al., (1995) reported that the most favourable season for air layering in cinnamon is July, followed by June and August. Haldankar et al., (1996) reported 95 per cent success in air layering during September. The maximum period required for complete rooting was 270 days. Air layers treated with IBA 250 ppm registered 90 per cent rooting in the month of August (KAU, 2001). As rooting medium sphagnum moss was found better than sand and saw dust in equal proportions. According to Ananthan and Chezhiyan (2002b) IBA 4000 ppm registered maximum percentage of rooting and survival of cinnamon layers Propagation by tissue culture is also successful. Multiple shoot formation was induced directly from seeds and also from seedlings explants on MS medium supplemented with auxin and cytokinins. The
multiplication rate had been reported up to twenty (Rai and Chandra, 1987; KAU, 2001).

**Planting and after care**


Systematic manuring is rarely practiced in India for this crop. Shanmugavelu and Madhava Rao (1977) recommended application of ammonium sulphate @ 1.5-2 kg per plant after cutting the branches to achieve better growth. A fertilizer mixture of urea, rock phosphate and muriate of potash in 2:1:1 ratio is suggested (Bavappa and Rethinem, 1981). For a productive tree, a fertilizer dose of 150 g nitrogen, 90 g phosphorus and 100 g potassium along with 10 kg of organic manure may be applied (Krishnamoorthy, 1988). Kuriakose et al. (1989) recommended mussoriephos for higher yield and better quality of leaf oil. For a yielding plant NPK in 100:80:100 g per year is recommended (Rao, 1991). The Kerala Agricultural University (KAU, 2001) has recommended a fertilizer schedule of 20:20:25 g of NPK along with 20 kg of compost per year during the first year of planting which is to be gradually increased to 200:180:200 g NPK and 50 kg of compost per year from 15th year onwards. A fertilizer dose of 250 g nitrogen, 130 g phosphorus and 250 g potassium along with 10 kg of farmyard manure and 30 g VAM per tree is recommended by Tamil Nadu Agricultural University (TNAU, 2007). Fertilizers may be applied in two splits during May-June and September-October (Nair, 1970; Radakrishnan, 1992; Singh and Singh, 2008).

Sefanaia et al. (1982) reported that cinnamon can be intercropped with coconut. A combination of coconut + pepper + cacao/cinnamon + pineapple cropping was found profitable (Nelliat et al., 1974; Thangaselvabai et al., 2007).

**Pests and Diseases**

The important pests affecting cinnamon trees include, cinnamon butterfly (*Chilasa clytia*), leaf miner (*Gonophomorpha civica*), *Phyllocnistis chrysophthalma*, leaf and shoot webber (*Sorolopha archmedias*), pink hopper (*Bothrogonia sp*), the tussock caterpillar (*Dasychira mendoasa*), leaf psyllid (*Pauropsylla depressa* ) (Singh et al., 1978, Butani, 1983; Pruthi, 2001).

The leaf miner and its larvae mine the leaves. It can be controlled by spraying of monocrotophos (0.05%). The light infestation of *Chilasa clytia* may be controlled by removing infested branches, by manual removal of eggs, larvae and pupae. Heavy severe infestation may be controlled by spraying quinalphos at 0.04 percent concentration. The tussock caterpillar feed on the leaves. The leaf psyllid sucks the sap of leaves and tender shoots. To control either the pests’ application of dimethoate (0.03%) or dimecron (0.04%) is recommended (KAU, 2001). Krishnamoorthy and Rema (1988) suggested that leaf feeding caterpillars on the older seedlings can be controlled by spraying of quinalphos or monocrotophos at 0.05% concentration.

**Diseases**

Cinnamon suffers comparatively from a few diseases. The diseases reported include die back caused by *Colletotrichum gloeosporioides* (Karanakaran et al., 1993) red leaf spot caused by *Colletotrichum capsici* (Prakashan, 1991) and blight caused by *Glomerella cingulata* (Kumar, 1983) and *Pestalotiopsis palmarum* (Karanakaran et al., 1993) Stripe canker (*Phytophthora cinnamomi*) is found on the trunk and branches, particularly, on young trees of
various Cinnamomum species under poor drainage conditions. Various rots are reported on cinnamon viz, root rot (Rosellinia spp.) brown rot (Phellinus lamaensis) and white rot (Leptoporus lignosus). Pink disease caused by Corticium salmonicolor has been found in cinnamon and causes pink encrusted areas on the stem with death of the smaller shoots (Singh and Singh, 2008).

Against leaf rot and twig blight, spraying of 1 percent Bordeaux mixture at an interval of 1 1/2 months has been suggested as preventive method (Pruthi, 2001). Benomyl a 500 ppm and captan at 100 ppm gave the best control of leaf blight (Khanna and Chandra, 1977).

Harvesting, Post harvest handling and Yield
Cutting

Coppicing is practiced from second or third year onwards (Nair, 1970 and Rao, 1991). Stems are cut during rains to facilitate peeling. Best time for peeling is when new flushes and leaves are hardened after a rainy season (Radhakrishnan, 1992). Essential oil content increased with increasing tree height and decreasing bark thickness (Uhlig, 1977). Plants are coppiced to a height of 12 cm from the ground level. The subsequent harvest is made between 12-18 months after. The side shoots are also cut so that the plant assumes the shape of a low bush and a bunch of canes suitable for peeling are available subsequently. The regular peeling operations are commenced from fourth or fifth year depending on extent of peeler shoots available (Purseglove et al., 1981; Rao, 1991). The best quality is obtained from the thin bark of shoots in the centre from the middle portion of shoots. Fully developed cinnamon shoots of 1.5-3.0 cm diameter harvested during rainy season gives good quality bark and high yield (Pruthi et al., 1978; Singh and Singh, 2008).

Preparation and curing of spice

The cut stems are collected, tied and bundled and carried to the peeling shed. The cut stems are subjected to scraping and peeling operations. After scraping the outer skin, the peeling of the bark is done carefully using specially made knife. Two longitudinal slits are given on opposite sides of the stem and by working the knife under, the bark is lifted; two halves of the bark obtained is then combined by keeping edge of one inside the other. The tube like barks thus obtained in lengths of 6 to 8 inches are placed one inside the other to form a tube of 36 inches called quills (Sahoo et al., 2000). These peels are piled up within enclosures of sticks and wrapped up in mats and kept overnight in that condition. A little softening of the bark does occur, with the result that the peels become more pliable for the subsequent piping operation (Pruthi, 1992). These are then dried on a mat in the sun for about three days and thereafter in shade for another three days (Nair, 1970). During the process of drying, the quills should be pressed by hand to prevent them from opening up. Barks, which cannot be taken out like tubes, are graded as quillings and featherings respectively (Nair, 1970). Yet another grade of bark is the cinnamon chips obtained by drying the broken pieces of bark from over-matured shoots. Besides quill extraction, the leaves could be used for distillation for obtaining aromatic oil (Pruthi, 2001; Singh and Singh, 2008).

Yield

Quills of 60-125 kg/ha can be obtained from the first crop of 3-4 years after planting whereas grown up plants with an age of 10-11 years, yield about 225-300 kg/ha quills. About 75 kg of quillings and featherings are obtained from one hectare of cinnamon. (Shanmugavelu and Madava Rao, 1977). According to Krishnamoorthy and Rema
(1988) the average productivity is around 350 kg per hectare. Smarawira (1964) observed in Srilanka conditions that the first crop yields 556-667 kg quills/ha after 3-4 years subsequently increasing to 168-220 kg of quills/ha. Productivity usually declines after 10 years. Yield of cinnamon leaf oil was 1.8-2.6 per cent in fresh leaves and 3.75 per cent in dried leaves. Recovery of oil from leaves after drying for 2-3 days in shade is recommended to avoid loss of oil (Pruthi et al., 1978).

CONCLUSION

The literature reviewed in this paper highlighted the improved cinnamon production technologies. Since, increasing productivity and extending area to non traditional regions are going to be the major thrust areas for the future; all these emerging positive developments provide strength to profitable cinnamon farming and to meet the challenges of global competition.

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