

# EVOLUTION OF CROP PLANTS

SECOND EDITION



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## Herb spices

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### Introduction

Spices are plant parts or plant products used for imparting flavour and taste to food. Various plant parts of a large number of plants are used as spices, condiments and herbs. Spices can be grouped as herb spices and tree spices. For general accounts of spices see Rosengarten (1969), Purseglove *et al.* (1981), Pruthi (1980) and Spices Board (1991).

In Asia, where most spices are grown, they are essentially smallholders' crops and are often grown as an intercrop or mixed crop, seldom in pure stands. This makes production statistics difficult to obtain and the figures given here on production and yield are estimates. The present trade in spices is about 400,000 t valued at about US\$1.4 billion, according to International Trade Centre estimates. In 1985, the comparative figures were 350,000 t valued at US\$1 billion.

The principal herb spices are pepper (see Ch. 80), cardamom (*Elettaria cardamomum* the true small cardamom; *Amomum subulatum*: large cardamom; fruit capsules), and ginger (*Zingiber officinale*: underground rhizomes).

### Ginger

*Zingiber officinale* (Zingiberaceae). Ginger is a rhizomatous herbaceous perennial of about 1 m in height. Its underground rhizomes, in both fresh and dried states, constitute the ginger of commerce. The name *Zingiber* perhaps originated from the

Sanskrit word *singabera*, meaning 'shaped like a horn', probably because of the resemblance of the rhizome to a deer's horns.

Ginger is widely used in cooking, especially in oriental cuisine, it is also extensively used in preparing beverages (ginger ale, ginger beer, etc.), confectionery (ginger biscuits and candy) and pickles. Ginger oil obtained from its rhizomes is used in medical and toiletry preparations. It is also widely used in native medicine, especially as a carminative.

World production is estimated at 386,000 t annually. India, Thailand, Japan, Bangladesh, South Korea and Indonesia are the world's leading producers of ginger. For a general treatment of the crop, see Purseglove *et al.* (1981) and CPCRI (1980); cytogenetic studies have been reviewed by Ratnambal (1979).

The family Zingiberaceae, to which ginger belongs, is Indo-Malayan in distribution. Ginger was first described by van Rheede (1692) in *Hortus Indicus Malabaricus*. Roscoe (1806) described *Z. officinale* from a plant grown in the Botanical Garden, Liverpool, and referred to it as *Amomum Zingiber* (Sp. Pl. 1:6) Linnaeus (1753). *Amomum Zingiber* is a nomenclatural synonym of the conserved generic name *Zingiber*.

*Zingiber* was included in the tribe Hedychiae by Holtum in 1950, but Mabberley (1989) includes it as the only tribe in the Zingiberaceae. It consists of 85 species which are distributed in southern, Southeast and eastern Asia and tropical Australia.

Cytological studies carried out so far are restricted to chromosome number reports only. Most authors have reported the somatic chromosome number of all the *Zingiber* species as  $2n = 22$ , except *Z. mioga* which is  $2n = 55$ . Since chromosome pairing is normal in the diploid ( $2n = 2x = 22$ ) species, *Z. mioga*, which occurs in Japan would appear to be a pentaploid species. In the genus *Zingiber* there are also two reports of  $2n = 24$  and  $2n = 22 + 2f$  chromosomes, but these have not been confirmed. Thus, the basic number of the genus appears to be  $x = 11$ . It has also been reported that the karyotype of *Z. officinale* is the least specialized (Ratnambal, 1979). However, as the size of the chromosomes is small, and as they do not stain well, some of these conclusions should be regarded as tentative.

Dried ginger has been among the earliest spices to be exported from India. However, its exact antiquity is yet to be determined. Ginger has been widely used

in eastern and southern Asia since very ancient times in native systems of medicine and cooking.

There is no unanimity of opinion regarding the centre of origin of ginger. Various authors have suggested India, China, Malaysia and Pacific Ocean islands. In the absence of substantial evidence for any specific centre, these proposals must be regarded as speculative. Ginger was probably introduced into Europe in the ninth century AD, and from there it spread to other areas.

Wild forms of ginger *Z. officinale* have not been found in nature. Ginger shows maximum variability in India, particularly in the north-east. These have prompted some authors to suggest that India is the centre of origin of ginger. No information is available on the species ancestral to the cultivated ginger, nor on the time of origin of the species.

At present, ginger is widely cultivated in tropical and subtropical countries of Asia, West Africa and the West Indies. India is the largest producer with about 153,000 t annually. The other major producing countries are Thailand (89,000 t), Japan (67,000 t), Bangladesh (39,000 t), South Korea (20,000 t), Indonesia (11,000 t), Fiji (4000 t), Ghana (1000 t), Malaysia (1000 t), Mauritius (1000 t) and Jamaica (1000 t) (Spices Board, 1991). Statistics about the area and production are inadequate and it is difficult to study production trends. At the same time ginger is a popular spice, and its consumption can safely be expected to increase steadily over the years. Of late increasing quantities of ginger are being produced and marketed in the form of oleoresin which is obtained by solvent extraction of ginger.

However, the absence of seed setting restricts breeding work. Two main constraints in its production are the major diseases of rhizome rot caused by *Pythium* spp. and bacterial wilt caused by *Pseudomonas solanacearum*. Unless remedial measures are developed for their control and management, especially rhizome rot, production is unlikely to show any significant advances.

### Turmeric

*Curcuma longa* (Zingiberaceae). The turmeric of commerce is the dried rhizome of *Curcuma longa*. It is used widely throughout the world in cooking and in southern Asia, also in native systems of medicine

and in rituals. A striking feature of turmeric is the bright yellow colour of the rhizome due to the presence of curcumin. No production statistics are available, but global production is estimated at over 400,000 t. India is by far the largest producer (340,000 t) (DCAS, 1989).

The genus *Curcuma*, belonging to the family Zingiberaceae, includes about 70 species and consists of herbaceous rhizomatous perennials. Though mainly Indo-Malayan in distribution, these occur also in tropical Madagascar, Sri Lanka, Indo-China and north Australia (Purseglove *et al.*, 1981). In addition to *C. longa*, which is used in food, medicine and as a dye, a number of other species are also used, of which a number are listed below:

- C. amada*, or mango ginger, is cultivated to a limited extent for its rhizomes, which have the flavour and odour of raw mangoes. The rhizomes are used in pickles and curries.
- C. mangga* is similar in taste and flavour to *C. amada*, but differs from it in having a characteristic sulphur yellow colour of the rhizomes. It is cultivated in Indonesia.
- C. angustifolia*, the Indian arrowroot occurs wild in many parts of India. Its rhizomes are used for starch extraction.
- C. caesia*, called black deodary is a native of eastern and north-eastern regions of India. It is used in toiletry and in native medicine.
- C. xanthorrhiza* is a native of India and is cultivated to a limited extent for starch.
- C. zeodaria* is native of north-eastern India and is cultivated in Malaysia for the starch contained in the rhizomes. It is used in toiletry and in native medicine.

Cytogenetic studies have been limited to chromosome counts. Even in these there is much confusion and disagreement. Suganara in 1936 reported the chromosome number of *C. longa* as  $2n = 64$ . But subsequently there have been reports of  $2n = 32$ , 34, 62, 63, 64. For the other species, the reports are *C. amada*, *C. angustifolia*,  $2n = 42$ ; *C. aromatica*,  $2n = 42$ , 86; *C. petiolata*,  $2n = 64$ ; *C. zeodaria*,  $2n = 63$ , 64. These counts do not give any useful indications of their interrelationships or origins.

There have been very few studies on the origin of turmeric. Ramachandran (1961, 1969) reported

$2n = 63$  for *C. longa*, and found trivalent associations during meiosis. He concluded that cultivated turmeric is a triploid and was the result of natural crossing between diploid and tetraploid forms. From India, turmeric is believed to have spread to the Far East and the Polynesian islands by the pre-Aryans of India (Sopher, 1964). Ramachandran (1961, 1969) further suggested a high basic number of  $x = 21$  for *Curcuma*, and proposed that the genus arose either by amphidiploidy or by secondary polyploidy.

Turmeric is known and used most widely in south Asia, where it is used for a variety of purposes. It is now used all over the world as a flavouring agent in cooking. It is in India that turmeric is most extensively used, not only in cooking but also in several religious and social rites, as a dye and in toiletry preparations. India is by far the largest producer; maximum varietal diversity also occurs in India.

Turmeric has not been observed in the wild state anywhere. No work has been carried out to identify the species ancestral to turmeric. Though more varietal diversity in turmeric occurs in north-east India as compared to peninsular India, a greater number of wild and weedy relatives of *C. longa* are present in south-western India than in any comparable area, with more than 10 species out of a total of 70 species. For these reasons, it is widely believed that India is the home of turmeric.

At present, India is the largest producer of turmeric in the world with over 340,000 t annually and the largest exporter of this commodity. Other major producers of turmeric are Bangladesh (29,000 t) and Pakistan (24,000 t). Smaller quantities are produced in other south and Southeast Asian countries (DCAS, 1989).

There may be some increase in demand for turmeric in future, but no dramatic increase can be expected unless concerted publicity and promotional drives succeed in popularizing its use in toiletry and other preparations. Breeding work is limited by lack of concerted efforts, but some selection work is under way in India for identifying types with high curcumin and oleoresin content and better yields.

## Cardamom

*Elettaria cardamomum* (Zingiberaceae). Cardamom, always known as the 'queen of spices', is the dried fruit

of several rhizomatous herbaceous perennial species belonging to the Zingiberaceae. Among these, by far the most widely known and the subject of virtually the entire international trade is *E. cardamomum*. It is sometimes referred to as small or true cardamom.

The other cardamom species are as follows:

*E. major* Thwaites, Ceylon cardamom, a native of Sri Lanka which inhabits moist forests.

*Amomum subulatum*, Nepal cardamom or large cardamom, grown in Nepal, Bhutan, and north Bengal and Sikkim of India; used widely throughout north India, Nepal and Bhutan as a less expensive substitute for small cardamom. The fruits are larger than small cardamom and blackish in colour.

The fruits of the following species are used as cheap substitutes for cardamom: *A. aromaticum* (Bengal cardamom); *A. kepulga* (Javan cardamom); *A. dealbatum* (from Java); *A. krevanh* (Cambodian cardamom); *Aframomum forarima* (Ethiopian cardamom). Here, all further discussions will concern only the small cardamom, *E. cardamomum*.

India and Guatemala are the main producers of cardamom. Other countries that grow cardamom to a small extent are Sri Lanka, Tanzania and Papua New Guinea (Spices Board, 1991). Cardamom seeds have a very pleasant flavour and aroma. They are used extensively as a flavouring agent in a wide variety of confectionery and bakery products. Medicinally it has carminative, aromatic and stimulant properties. The essential oil is also widely used in perfumery, confectionery and liqueurs (Pruthi, 1980).

Cardamom *E. cardamomum* belongs to the tribe Alpineae, family Zingiberaceae. The genus includes about eight species, which are Indo-Malaysian in distribution, *E. cardamomum* being the only species that occurs in India. However, *E. major* occurs in Sri Lanka.

Cardamom is a shade-loving plant and is grown in the lower canopy of forests, underneath larger trees. Wild forms of cardamom are also widely found in tropical moist forests of the Western Ghats, in western peninsular India. There are no essential differences between the wild and cultivated forms of cardamom. Until comparatively recently cardamom was forest produce. Now the population of wild cardamom is being rapidly eroded. Peninsular India is generally taken as the centre of origin of *E. cardamomum*.

Most authors have reported a chromosome number of  $2n = 48$ , but there is one report of  $2n = 52$ .

The basic number appears to be  $x = 12$ . The karyotype consists of four pairs of long chromosomes having median centromeres, two pairs having subterminal constrictions, fourteen pairs of median chromosomes having submedian centromeres and four pairs of short chromosomes having subterminal or terminal constrictions (Sato, 1960).

The spice trade is known to have flourished from the Roman period (third century BC) (Thapar, 1966). Cardamom along with black pepper and dried ginger are the spices for which India has been best known from very early times. No archaeological remains of cardamom have been recovered to date.

The cultivated cardamom is essentially the same as that found in moist evergreen forests of the southern Western Ghats in peninsular India. The crop is monospecific in India. There is thus no need to look for an ancestral species of the cultivated cardamom, the time of origin nor the mode of speciation.

Until recently, India had a virtual monopoly of cardamom production in the world with an annual crop of about 4000 t. Guatemala now ranks as the largest producer of cardamom in the world with annual production of 5000 t. Excluding India, other countries together produce about 1000 t.

Cardamom will continue to reign as the 'queen of spices'; the only constraint limiting its further popularity appears to be its availability. Manuring reduces the quality of the produce and cardamom does not respond as readily to fertilizers as most other crops. Yields can be increased to some extent by better cultural practices such as irrigation during the dry months. Breeders have been slow to select high-yielding varieties, though of late some improved selections have been released. Cardamom is affected by various pests and diseases, but none appear to be very serious.

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**Introduction**

Spices are plants, plant parts or plant products that are used as flavouring agents in food. A number of them are trees, and in this chapter we shall deal with two of them, cinnamon and nutmeg.

**Cinnamon**

*Cinnamomum verum* (Lauraceae). Cinnamon is one of the oldest spices known to man. References to cinnamon are given in the Old Testament (Exodus 30: 23-5). Cinnamon is the dried inner bark of the shoots of the tree *Cinnamomum verum*, commonly known as Ceylon cinnamon (syn: *C. zeylanicum*). Cassia is often used as a cheaper substitute for cinnamon. Cassia cinnamon comes from various sources (Table 100.1).

The quality of cinnamon depends on the amount of various aromatic constituents present, the most important of which is cinnamaldehyde. Chinese cassia is equally important as a spice. It is grown on a large scale in south China and adjoining areas of Vietnam. It has a stronger aroma than cinnamon because of the higher content of cinnamaldehyde. The Indonesian cassia and Saigon cassia are important locally and have also some limited international market.

The major producers of cinnamon are Indonesia (19,000 t), Sri Lanka (16,000 t), Seychelles (1000 t), and Madagascar (1000 t). The world production is about 37,000 t, of which about 7000 t enter international trade. Production figures are not available for Chinese cassia, but about 31,000 t enter

international trade, almost the entire quantity coming from China (Spices Board, 1991).

*Cinnamomum* (Lauraceae) is a large genus of more than 250 species, having a distribution in south and Southeast Asia, China and Australia (Mabberley, 1989). The earliest description of cinnamon has been given in van Rheede's *Hortus Indicus Malabaricus* in 1678 and 1685. In this, two species are described, karua (*C. verum*) and Kattu (wild) karua (*C. malabathrum*) (Shylaja, 1984).

Cytological studies show a uniform chromosome number of  $2n = 24$  for all the members of the cinnamon species so far studied. Thus, polyploidy is not thought to have contributed to their evolution.

The Lauraceae is considered to be one of the most primitive families along with the Magnoliaceae and Proteaceae. The existing fossil evidence has shown the presence of the Lauraceae in the Cretaceous period (Shylaja, 1984). The genus *Cinnamomum* and the Lauraceae generally are considered to be among the most primitive dicotyledonous plants.

Cinnamon is one of the oldest spices used by man. Queen Hatshepsut of Egypt mounted an expedition around 1485 BC to secure precious commodities like myrrh (a bitter aromatic gum) and cinnamon (Rosengarten, 1973). The Emperor Nero (AD 66) is stated to have burnt one year's stock of cinnamon on his wife's funeral pyre. The cinnamon trade was carried out by Arabs from early times until it passed to the Europeans after the discovery of the sea route

**Table 100.1** Sources of cinnamon and cassia cinnamon (*Cinnamomum* spp.).

Botanical name	Common name	Origin
<i>C. verum</i>	Cinnamon	Sri Lanka and South India
<i>C. zeylanicum</i>	Ceylon cinnamon	China, Taiwan
syn: <i>C. aromaticum</i> , <i>C. cassia</i>	Chinese cassia	Vietnam
<i>C. burmanii</i>	Indonesian cassia	Indonesia
<i>C. loureirii</i>	Saigon cassia	Vietnam, Thailand
<i>C. tamale</i>	Indian cassia	North-east India
<i>C. malabathrum</i>	Folia Malabathri	South India
<i>C. macrocarpum</i>	Wild cinnamon	South India
<i>C. nicolsonianum</i>	Wild cinnamon	South India
<i>C. camphora</i>	Camphor	China, Japan

to the Orient by the Portuguese navigator Vasco da Gama in 1498 (Rosengarten, 1973).

*Cinnamomum verum* occurs in the forests of Sri Lanka and south-west India. Individual trees of natural stands show variation with regard to quality. This has been taken advantage of in Sri Lanka, a major producer of cinnamon in the world, where distinct varieties of cinnamon are available. These are the result of selection of élite trees and their further multiplication. Flowers are cross-pollinated, but because of the very large number of flowers produced on a tree, such pollinations are mostly limited to flowers on the same tree (Joseph, 1980). The major centres of diversity and the centre of origin are considered to be in Sri Lanka. It is, however, difficult to assign a centre of origin to this crop, because differences between the present-day varieties and wild populations of Sri Lanka and south-west India are similar in extent.

The demand for this spice is likely to remain steady; only moderate increases in demand are likely to be experienced even if prices fall.

## Nutmeg

*Myristica fragrans*, *Myristica argentea* (Myristicaceae). The nutmeg tree yields two spices, nutmeg and mace. Nutmeg is the dried shelled seed and mace the dried aril covering the seed in the fruit. World production is estimated at 10,000 t annually. Indonesia (6000 t) and Grenada (3000 t) account for 90 per cent of the production. Other countries that produce nutmeg in smaller quantities are Sri Lanka, Papua New Guinea, India and Brazil.

The spice is widely used in cooking and in native systems of medicine. Nutmeg has stimulative, astringent and carminative properties. The ripe pericarp is used for making jams. Nutmeg oil is used for flavouring liqueurs and in perfumery (Pruthi, 1980; Purseglove *et al.*, 1981).

The source of true nutmeg is *M. fragrans*. In addition, fruits of several other species are used as substitutes or adulterants of nutmeg. Its closest relative is *M. argentea* which occurs in both the wild and cultivated states in Papua New Guinea. This territory is thought to be its centre of diversity (Flach and Willink, 1989).

The Bombay nutmeg is obtained from *M. mala-*

*baricam* and *M. beddomii*. They occur wild in the Western Ghats forest of peninsular India and their nuts and aril are often used for adulterating true nutmeg. The Brazilian nutmeg is obtained from *Cryptocarya moschato* (Lauraceae) and is used locally as a spice. Madagascar nutmeg is obtained from *Ravensara aromatica* (Lauraceae) and is also used locally as a spice.

The Myristicaceae, to which nutmeg belongs, is a medium-sized family with 19 genera and about 440 species. They are native to lowland tropical forests. They are dioecious or monoecious trees with aromatic tissues. The genus *Myristica* contains about 80 species. They occur from south Asia to Australia and the Polynesian islands (Mabberley, 1989). New Guinea appears to be the centre of diversity of the species with some 40 species present, 34 of them endemic (Sinclair, 1958). Flach and Willink (1989) have, however, stated that *M. fragrans* shows maximum variability in Banda and nearby islands in eastern Indonesia. In this region the species does not occur in the wild state, but a number of related species are found in the region. The present areas of main cultivation of nutmeg are Indonesia, New Guinea and Grenada.

Nutmeg, like most members of the family Myristicaceae, is dioecious. It is insect pollinated; occasionally a few male flowers produce fruits. Efforts to identify male and female trees at the juvenile phase have not met with much success.

The somatic chromosome number of *M. fragrans* is  $2n = 44$  (Flach and Willink, 1989). No detailed studies of the chromosomes have been carried out, nor have any heteromorphic bivalents indicative of sexual differences in chromosomes been observed. The chromosome number of *M. argentea* is also  $2n = 44$  (Flach, 1966; cf. Flach and Willink, 1989).

The time when nutmeg came to be used by man is shrouded in mystery. It has been widely used in south and south-east India from time immemorial. Nutmeg was first introduced into Europe (Constantinople) in AD 540 (Flach and Willink, 1989). By the end of the twelfth century, nutmeg became popular in Europe, and thus began the association of this spice with Western colonial expansion. In 1512, the Portuguese discovered Banda and established a monopoly in the nutmeg trade. This later passed to the French who in 1772, took control of the islands and the monopoly. The British captured the islands in 1802, and during their occupation the nutmeg was introduced into

Grenada, where it naturalized. Today, Grenada is the second largest producer of nutmeg in the world (Flach and Willink, 1989).

Nothing is known about the origin of the species, though as already stated, it shows maximum diversity in Banda, and a high level also in New Guinea. Wild populations of *M. fragrans* no longer occur in Indonesia (Flach and Willink, 1989). Southeast Asia can be taken as the centre of diversity and origin of the species.

In view of its manifold uses in the food industry, confectionery and medicine, the outlook for this spice appears to be moderately good. However some sales promotional efforts would help promote its usage. As with other spices, its cultural requirements are also very specific.

Little improvement work has been carried out on the nutmeg. Some work has been done on sexing individuals of this species in the juvenile phase, but without much success. Work has also been carried out on vegetative propagation. However, more basic and applied studies are called for in this crop.

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