Kodoth Prabhakaran Nair

The Geography of Cardamom (*Elettaria cardamomum M.*)

The "Queen" of Spices
Volume 2

Springer

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I dedicate this book to my wife, Dr Pankajam Nair, a nematologist trained in Europe, who gave up her profession to take up the task of a home maker, our son Dr. Kannan, our daughter Engineer Sreedevi, our son-in-law Engineer Arvind, and our grand children, Heera, Maya and Prahlad, who constantly encouraged me in this assignment. I also dedicate it to the memory of Black and Charlie, our canine fleet, who while alive, were a tremendous source of joy to me.

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Preface

Cardamom, popularly known as the "Queen" of spices, has an interesting history dating back to the Vedic period (ca. B.C. 3000) and is among the ingredients poured into the sacrificial fire during a Hindu marriage ceremony. Today, cardamom commands a leading position among spices of immense commercial importance and is finding its way into the dietary habits of millions around the world—even in Europe and North America as well as Japan, hitherto unaccustomed to its use. Cardamom use ranges from a simple dietary constituent to that of immense pharmacological benefits. Although beset with many problems, both agronomic and economic, it is certain that next to black pepper, cardamom will emerge as an important commercial spice in world trade. India was the world leader in cardamom production, but, starting in 1970, the country began to slide in both production and productivity. Guatemala took over as the leading cardamom producer, like what Vietnam could achieve in growing pepper. However, Guatemalan cardamom is of inferior quality, the same being the case with Vietnam pepper.

Among the primary constraints of production, it is the absence of an ideal ideotype, as in the case of black pepper, that is the biggest constraint in enhancing productivity. An ideal ideotype must combine superior productivity traits with strong resistance capacity to the dreaded Katte disease, widespread in the South Indian state of Karnataka. Fertility management of cardamom is still rooted in textbook knowledge, but this book contains an exclusive chapter on the "nutrient buffer power concept" based on the author's research, with specific reference to potassium as a major a source of nutrition for cardamom, as well as other plants in general, which is required in abundance for optimum cardamom production. The chapter details the author's research with reference to cardamom production in the two most important cardamom-growing states of Southern India: Kerala and Karnataka.

Malaparamba, Kozhikode, Kerala, India Kodoth Prabhakaran Nair

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Chapter 1
Introduction

Abstract The chapter discusses, at length, the historical background of cardamom, a global outlook of cardamom production. In the ancient Indian language Sanskrit, cardamom is referred to as "Ela." The role of cardamom is discussed with reference to ancient Indian Vedic literature. Cardamom dates back to B.C. 3000.

Keywords "Queen" of spices · Ela · Vedic literature · Global cardamom production

Cardamom, popularly known as the "Queen of Spices" is the second most important spice crop in the world, next to black pepper (*Piper nigrum*), which is known as the "King of Spices." The description "Queen of Spices" is apt, because cardamom has a pleasant aroma and taste and has been a highly valued spice since time immemorial. Cardamom belongs to the genus *Elettaria* and species *cardamomum* (Maton). The term *Elettaria*, which is the generic name, has its origin in the word *Elettari* (in Tamil, one of the popular South Indian languages), referring to the cardamom seeds. In the original description, it means a "particle/seed of the leaf." *Elettaria* is a large-sized perennial herbaceous rhizomatous monocot that belongs to the Zingiberaceae family. The plant is extensively grown in the hilly tracts of southern India at elevations ranging from 800 m to 1500 m. It grows best as an under crop, beneath forest trees, in shade, and a cool climate at high elevations. The plant is grown in Sri Lanka, in Papua New Guinea (PNG), and in Tanzania, Africa. In Latin America, Guatemala is the biggest grower of cardamom. Indeed, Guatemalan cardamom is the biggest competitor to Indian cardamom in the world market.

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1.1 Historical Background of Cardamom

Cardamom has an interesting history dating back to Vedic times, about B.C. 3000. In the ancient Indian language Sanskrit, it is referred to as "Ela." In ancient Hindu culture, sacrificial fire was a common ritual, and in ancient texts (Mahindru 1982), cardamom was an ingredient, along with several other materials, in the sacrificial fire, solemnizing a Hindu marriage. Both the *Charaka Samhita* and the *Susrutha Samhita*, the ancient Indian Ayurvedic texts, written in the post-Vedic period (B.C. 1400–B.C. 1600) mention cardamom. However, it is not known precisely whether cardamom, referred to as Ela in these texts, is the Indian variety or the large Nepalese variety. The Assyrians and Babylonians were familiar with medicinal plants, and cardamom was among the 200 or so plants that the former dealt with (Parry 1969). It was mentioned that Merodach-Baladan II (reigned B.C. 721–B.C. 702), the ancient king of Babylon, grew cardamom among other herbs in his garden. Surprisingly, there was no mention of cardamom in the ancient Egyptian texts, unlike their treatment of pepper. Possibly, cardamom was just beginning to reach Assyria and Babylonia through the land routes. Interestingly, cardamom is cited in some of the ancient Greek and Roman texts. Spices were the symbols of royalty and luxury, and cardamom was used in the manufacture of perfumes during Greek and Roman times. In addition, cardamom was used as an aphrodisiac (Parry 1969). Significantly, Dioscorides (40–90 A.D.), the Greek physician and author of the legendary *Materia Medica*, mentions cardamom in his work. Cardamom was widely used to aid digestion, and that was the most important reason both the Greeks and Romans imported the spice in large quantities from India. Thus, it became one of the most popular oriental spices in Greek and Roman cuisine. This achievement led to cardamom being listed as a dutiable item in Alexandria in 176 A.D.

In his *Journal of Indian Travels* (1596), Linschoten describes two types of cardamom in use in southern India: the "greater" (large) and "lesser" (small) types. This would suggest that the large cardamom found extensively in Nepal must have been finding its way to southern India through land routes, brought by travelers dating back to nearly 4000 years from today. Referring to the introduction of cardamom to Europe, Dymock writes, "When they were first introduced into Europe is doubtful, as their identity with the *Amomum* and *Cardamomum* of the Greeks and Romans cannot be proved." Linschoten writes about lesser cardamom that "it mostly is grown in Calicut and Cannanore, places on the coast of Malabar." Paludanus, a contemporary of Linschoten, wrote that, according to Avicenna, there are two kinds of cardamoms, "greater" and "lesser," and goes on to add that cardamom was unknown to Greeks personages such as Galen and Dioscorides. In his Seventh Book of *Simples*, Galen wrote, "cardamom is not so hot as Nasturtium or water cresses," "but pleasanter of savor and smell with some small bitterness." These properties were dissimilar to those of the Indian cardamom. In his First Book, Dioscorides, commenting on the cardamom brought from Armenia and Bosphorus, wrote, "we must choose that which is full, and tough in breaking, sharp and bitter of taste, and smell thereof, which cause heaviness in a man's head" (Watt 1872). Obviously,

Dioscorides was writing not about Indian cardamom, but about a different plant. Such references led Paludanus (Watt 1872) to infer that the *Amomum* and *Cardamomum* of the ancient Greeks were not the spices of India. On the whole, references to cardamom in ancient and early centuries of the Christian era and even in the middle ages are but scanty compared with references to black pepper. Even Auboyar, in his classic work on day-to-day living in ancient India (B.C. 200 to 700 A.D.), makes only a fleeting mention of cardamom (Mahindru 1982).

The Mediterranean merchants were clearly cheated by the Arabs on the sea route through which the latter brought home spices from India. Like pepper, cardamom was no exception. Pliny thought that cardamom was grown in Arabia. This belief persisted until the discovery of the sea route to India and the landing of the Portuguese on the west coast of India. The latter event coincided with the ending of the Arab monopoly on the spice trade, and the Portuguese started shipping out pepper, cardamom, and ginger to Europe. Since the European colonizers were more interested in procuring pepper and ginger, both crops took hold in India—the former in particular along the Malabar Coast. Cardamom was relegated to the back seat, a situation that lasted from the sixteenth to the eighteenth centuries. Cardamom was considered a minor forest produce. It was only at the beginning of the nineteenth century that cardamom plantations were established, but the spice was interplanted with coffee. Still, cardamom cultivation spread rapidly in the Western Ghats, and the region south of Palakkad (the midsouthern district of Kerala) came to be known as Cardamom Hills.

The earliest written evidence that cardamom was being grown in India was in the records of the officers working for the British East India Company. The most important among these written pieces was that of Ludlow, an assistant conservator of forests. Others were the *Pharmacographia*, *Madras Manual*, and *Rice Manual*. A brief description of cardamom cultivation in South India was also given by Watt (1872). The system of cardamom collection from naturally growing plants continued until 1803, but demand escalated in later years, and this naturally led to the establishment of large-scale plantations in India and Sri Lanka, then known as Ceylon (Ridley 1912). Within the entire state of Kerala, in the two erstwhile states of Travancore and Cochin, which had their own kings, cardamom was a monopoly of the respective governments. The Raja (King) of Travancore mandated that all the cardamom produced be sold to his official representative and sent to a central depot in the central Kerala town of Alleppey, which was then a state port. Here, the produce was sold by auction. The principal buyers were Muslims, and the best lot, known as "Alleppey Green," was reserved for export. In the forestland, in the state of Kerala, owned by the then British government, cardamom was considered a "miscellaneous produce," while in the neighboring Coorg district in the state of Karnataka, forestlands were leased out to private cultivators of cardamom. In Leghorn, the conservator of forests in the Madras Presidency (an early nomenclature that included four southern states, namely, Kerala, Karnataka, Madras, and Andhra, which have all become independent since then), noted that the spread of coffee eclipsed that of cardamom in many areas of "Malabar Mountains"—a reference to the Western Ghats (Watt 1872). Cardamom cultivation is mentioned in the

Madras Manual, which states, "In the hills of Travancore cardamom grows spontaneously in the deep shades of the forests: it resembles somewhat turmeric and ginger plants but grows to a height of 6–10 ft and throws out the long shoots which bear the cardamom pods." The following passage describes cardamom management: "The owners of the gardens, early in the season come up from the low country east of the Ghats, cut the brushwood and burn the creepers and otherwise clear the soil for the growth of the plants as soon as the rains fall. They come back to gather the cardamom when they ripen, about October or November" (Watt 1872). One can surmise from the writings of the British officials that a process of bleaching used to be carried out in Karnataka, and this was done by transporting cardamom to Havre, a place in the Dharma district of Karnataka, and the bleaching process used the water from a specific well, thereby enhancing the flavor of the dried product (Watt 1872). Mollison (1900) elaborately described a bleaching method in which soap nut water was used.

1.2 Cardamom Production and Productivity: A Worldview

Currently, cardamom production is concentrated primarily in India and Guatemala. Cardamom was introduced to Guatemala in 1920, most likely from India or Sri Lanka, by a New York broker and was planted in the vicinity of Cobán in the department of Alta Verapaz (Lawrence 1978). After World War II, cardamom production in Guatemala increased substantially on account of a shortage in production and high prices, and Guatemala soon became the top cardamom producer in the world. Native Guatemalans do not relish the taste of cardamom, and the entire quantity produced is exported. Today, Guatemala produces about 13,000–14,000 t of cardamom annually. Table 1.1 presents a worldview of cardamom production and productivity.

In India, the cardamom area has come down during the last two decades, from 1,05,000 ha in 1987–1988 to 69,820 ha in 1997–1998, a decrease of 33.5%. Still, production increased 190%, from 3200 t during 1987–1988 to 9290 t in 1999–2000. During the same period, productivity has risen from 47 to 173 kg ha^{-1}, an increase of 268%. Cardamom cultivation is confined primarily to three South Indian states: Kerala, Karnataka, and Tamil Nadu. Kerala has 59% of the total area cultivated and contributes 70% of the total production. Karnataka has 34% of the total area cultivated and contributes 23% to total production, while Tamil Nadu has 7% of the area and contributes the same percentage to total production. Most of the cardamom-growing areas in Kerala are located in the districts of Idukki, Palakkad, and Wayanad. In Karnataka, the crop is grown in the districts of Coorg, Chikmagalur, and Hassan, and, to some extent, in North Kanara district. In Tamil Nadu, cardamom cultivation is located in certain places of Pulney and Kodai Hills. On the whole, in India, cardamom is a small-landholder's crop, and there are 40,000 holdings covering an area of 80,000 ha (George and John 1998). The cardamom-growing regions of South India lie within 8° and 30° latitude and 75° and 78° longitude. The

Table 1.1 Cardamom production in the world

Time span	Percentage share of total			World production (mt)[b]
	India	Guatemala	Others[a]	
1970/1971–1974/1975	65.4	21.5	13.1	4678
1975/1976–1979/1980	53.7	34.5	11.8	6628
1980–1981	42.9	48.8	8.3	10,250
1984–1985	31.9	60.3	7.8	12,220
1985/1986–1989/1990	26.5	67.5	6.0	14,392
1990/1991–1994/1995	28.4	65.6	6.0	19,470
1995/1996–1997/1998	29.8	64.2	6.0	24,953

Source: *Cardamom Statistics, 1984–1985*, Cardamom Board, Government of India, Cochin, Kerala State. Spices Statistics, 1997, Spices Board, Government of India, Cochin, Kerala State. All India Final Estimate of Cardamom, 1997/1998, Government of India, Ministry of Agriculture
Important note: In three decades, the percentage contribution of India to total production plummeted by 54%, while Guatemala's increased by 199%. Other countries in the same period had a similar decline of 54%, like that of India; thus, Guatemala takes the leading position in cardamom production in the world
[a]Estimates, actual figures unavailable
[b]Metric tons

crop grows at elevations from 800 m to 1500 m above mean sea level (amsl), and these areas lie on both the windward and leeward sides of the Western Ghats, which act as a barrier of the monsoon trade winds, thereby determining the spatial distribution of rainfall. The rainfall pattern differs among the cardamom-growing regions located in Kerala, Karnataka, and Tamil Nadu (Nair et al. 1991). The most important factors that have contributed to the increase in cardamom productivity are the cultivation of high-yielding varieties and improved crop management. However, cardamom export from India has plummeted during the same period. In 1985–1986, cardamom export was 3272 t; in 1989–1990, it hit rock bottom at 173 t—a steep decrease to 5.3% of the 1989–1990 level. In one decade, from 1985–1986 to 1994–1995, export earnings came down from Indian rupees (Rs) 53.46 crores to just Rs 7.6 crores—that is, from US$11.9 million to US$1.8 million—a dramatic decrease of 85%.

1.2.1 Cardamom Cultivation in Other Parts of the World

The cultivation of cardamom is getting to be popular in certain parts of PNG. Cardamom grows there in virgin forestlands, and its cultivation is exclusively with private estate owners. The productivity of these estates is very high, with yield levels of 2000–2500 kg ha^{-1} (Krishna 1997). Total production was about 313 million tons in 1985; by 1993, it had declined to about 54 million tons. Today, PNG production hovers around 68–70 million tons. In Tanzania, the crop was introduced in the beginning of the twentieth century by German immigrants and is being grown in certain parts of the country, such as Amani and East Usambaras (Lawrence 1978).

Production was as high as 760 million tons in 1973–1974 but declined to about 127 million tons in 1984–1985, a level that continues to today. Sri Lanka is another small producer of the crop, contributing about 75 million tons to world production annually.

India was the leader in world cardamom production until the early 1980s, when Guatemala came into the picture. From thereon, India's production plummeted while that of Guatemala escalated. By the turn of the last century, whereas India's production came down by as much as 54% since the beginning of 1970s, that of Guatemala increased by as much as 199%. Guatemala is the major rival to India in cardamom production. A lot of Guatemalan cardamom is smuggled into India through the Nepalese border; this has resulted in a crash in Indian cardamom prices. As of now, nearly 90% of the global cardamom trade is controlled by Guatemala (Table 1.2).

Among the many factors that adversely affected India's cardamom production are the following:

1. Continuous drought, which lasts nearly half the year, combined with indiscriminate deforestation; together, these two factors have led to dramatic changes in the ecology of the cardamom habitat. Deforestation is the major cause of the dwindling of cardamom plantations.
2. Disease and infestation by insect pests.
3. Poor crop management. For example, cardamom nutrition in India is still rooted in "text- book knowledge." Cardamom is a heavy feeder on potassium, and Indian agronomists and soil scientists have not kept abreast of advancements in crop nutrition. (The relevance of "The Nutrient Buffer Power Concept," especially with regard to potassium nutrition of cardamom, will be discussed in later sections of this chapter.)

Table 1.2 Cardamom scenario in Guatemala

Year	Area (ha)	Production (mt)	Productivity (kg ha^{-1})	Export (mt)
1985	32,336	7348.32	90.89	6173.50
1986	38,333	8845.20	92.33	7978.82
1987	41,418	10,591.56	102.29	11,489.69
1988	42,656	10,432.80	97.83	11,303.71
1989	43,000	11,340.00	105.49	11,076.91
1990	43,000	11,340.00	105.49	11,113.20
1991	43,000	12,201.84	113.51	13,163.47
1992	43,000	12,474.00	116.04	13,240.58
1993	47,472	12,927.60	114.57	14,442.62
1994	45,133	14,969.80	126.13	13,213.37
1995	47,472	15,603.84	131.48	13,920.98
1996	47,472	16,329.60	137.59	21,255.70
1997	119,540	16,692.48	139.64	14,020.78
Total	11,576.70			12,491.79

4. Despite the aforesaid limiting factors, cardamom production in India has increased through enhanced productivity arising from the evolution of high-yielding clones, somewhat better crop management, and increased awareness of the importance of phytosanitary measures, especially control of diseases and pests. Between 1988–1989 and 1989–1990, cardamom export from India was 787 and 180 million tons, respectively. Exports crossed the 500 million ton mark in 1991–1992 (544 million tons precisely) and touched the 550 million ton mark in 1999–2000. The unit price of cardamom increased from about Rs 125 (US$3 kg^{-1}) in 1987–1988 to about Rs 395 (US$9) in 1992–1993. In 1996–1997, the unit price was about Rs 384 (US$8.9). The current unit price hovers around Rs 450 kg^{-1}, which is equivalent to about US$10.5. The edge that Guatemala has over India is a lower cost of production. This is the reason Guatemala edges out India in world cardamom trade. India has an extensive domestic market for cardamom. Annual consumption is around 7000 million tons, and a survey indicates that it could be as high as 7300 million tons. The total value of this market is close to Rs 2200 million, which is more than US$50 million. This is, indeed, a large internal market. In addition, apart from individual and household consumption, cardamom in India has an extensive industrial consumptive base. Cardamom-flavored biscuits, tea, and milk are some end uses for cardamom in the culinary sector, and the spice is used in medicines of herbal origin, in food mixes, and in the ubiquitous "pan masala" (the pervasive Indian "chewing gum," which leaves a pleasant flavor in the mouth). The industrial consumption of cardamom in India currently is estimated to be about 2050–2010 million tons annually. The demand in the hotel, bakery, and fast-food sector is about 1250 million tons. In the current century, total demand of cardamom in India will escalate to about 9500 million tons annually (George and John 1998).

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Chapter 2
Cardamom Botany

Abstract The chapter discusses, at length, the taxonomy of cardamom, types, varieties, etc. It further discusses growth, flowering, and fruit set. Additionally, it discusses palynology and pollination biology, including physiology of cardamom and effect of growth regulators.

Keywords Variety · Type · Genetic variability · Hybridization · Biotechnology of cardamom

Cardamom belongs to the genus *Elettaria* and species *cardamomum* (Maton). The name is derived from the root *Elettari*, which, in the popular South Indian language Tamil, means "granules of leaf." The genus consists of about seven species (Mabberley 1987). Only *Elettaria cardamomum* (Maton) grows in India—a fact that is of economic importance. Closely related to *E. cardamomum* (Maton) is *E. ensal* (Gaertn) Abeywick. *E. major* (Thaiw.), a much larger and sturdier plant, is a native of Sri Lanka, where it is known as the Sri Lankan "wild" cardamom; its flavor and taste are inferior to those of the Indian variety. *E. longituba* (Ridl.) Holtt., a large perennial herb whose flowering panicles often grow as tall as 3 m or more, is the Malaysian variety (Holttum 1950), whereas the native Indian variety is a low-grown one. The flowers of *E. longituba* (Ridl.) Holtt. appear singly, and the fruit is large and is not used. Seven species have been identified from Borneo (Indonesia) and have been listed by Sakai and Nagamasu (2000). The related genera are *Elettariopsis* and *Cypbostigma*, both of which occur in the Malaysia–Indonesia region.

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2.1 Taxonomy

Cardamom belongs to the monocot family Zingiberaceae (ginger family) of the natural order Scitamineae. Genus *Elettaria* consists of seven species, distributed over India, Sri Lanka, Malaysia, and Indonesia. Among these species, only *E. cardamomum* is economically important (Holttum 1950; Mabberley 1987; Willis 1967).

2.1.1 Type Species: *Elettaria cardamomum* (Linn.), Maton

2.1.1.1 Etymology

The generic epithet *Elettaria* is derived from Rheed's *Elettari*. Elanthari (the modern transcription of Rheed's name) is still used for the seeds of *E. cardamomum*. (*Thar*i means "granules" in the local language.) Following is the description of *Elettaria* provided by Holttum (1950):

> Stout or fairly stout rhizome, short intervals between leaf-shoots. Leaf shoots are tall with many blade-bearing leaves, while petioles are short and inflorescences arise from rhizome close to the base of a leaf-shoot. They are long, slender, prostrate, either just at the surface of the ground or just below it (not bearing roots), protected by alternate fairly large-scale leaves, in the axils of which cicinni arise, their attachment being sometimes supra-axillary. Cincinni short, bearing a close succession of tubular bracts, each of which encloses entirely the next flower and also the next bract; the flowers in two close rows on one side of the composite axis of the shoot, all pointing in the same direction, curved and opening in succession. Calyx tubular, split about one-fourth of its length down one side, shortly three-toothed; in some species joined at the base to the corolla-tube about as long as calyx; lobes not very broad, subequal, the upper one with a concave apex. Labellum as in Amomum, with yellow median band and red stripes, sometimes so curved that it stands as a hood over the top of the flower. Staminodes none, or short and narrow.
>
> Filament of anther very short, broad. Anther longer than filament, stigma small, in close contact with the distal end of the pollen sac. Fruit globose or ellipsoid, thin- walled, smooth, or with longitudinal ridges when ripe.
>
> Following is the description provided by Burtt and Smith (1983) for E. cardamomum: Leafy shoot nearly 4 m high, petioles 2.5 cm, lamina about 1 m × 15 cm, lanceo-late, acuminate, lightly pubescent or glabrous below; ligule about 1 cm long, entire.
>
> Inflorescence normally borne separately on a prostrate, erect or semierect stalk up to 40 cm long, or more in certain cases. Bracts two to three, 0.8–1.0 cm long, lanceolate, acute glabrous, rather persistent which becomes fimbriate with age. Cincinni many flowered. Bractioles about 2.5 cm long, tubular, mucronate, glabrous. Calyx about 2 cm long, 2- or obscurely 3-lobed, lobes mucronate. Corolla tube as long as calyx. Lobes 1–1.5 cm long, rounded at the apex, the dorsal tube widens. Labellum white, streaked violet, 1.5–2.1 cm at the widest part, ovate, obscurely 3-lobed, narrowed at the base. Lateral staminodes inconspicuous, subulate. Anther sessile, about 1 cm long, parallel, connective prolonged into a short, entire crest. Ovary 2–3 mm long, glabrous. Fruit is a capsule, oblong or more or less globose. The genus has only few species—the most important being E. cardamomum and E. major (E. ensal) from South India and Sri Lanka, respectively.

E. longituba Holttum (Syn. *E. longituba*) is one of the largest species of the genus grown in Malaysia. Its flowers appear singly at long intervals, and each cincinnus contains only a few flowers. It appears that the cincinnus stops flowering as soon as fruit is formed. The fruits are large, but have no commercial value (Holttum 1950). In their studies on Bornean Zingiberaceae, Sakai and Nagamasu (2000) described five species of *Elettaria*: *E. kapitensis*, *E. surculosa*, *E. linearicrista*, *E. longipilosa*, and *E. brachycalyx*.

2.1.2 Varieties

Based on the nature of their panicles, three varieties of cardamom are recognized (Sastri 1952; Table 2.1). The variety Malabar is characterized by a prostrate panicle, and the variety Mysore possesses an erect panicle. The third variety, Vazhukka, is considered a natural hybrid between the two, and its panicle is semi-erect or flexuous.

2.1.2.1 Variety Malabar

Plants are medium sized and attain a height of 2–3 m on maturity. The dorsal side of leaves may be pubescent or glabrous. Panicles are prostrate, and the fruits are globose (oblong shaped). This variety grows best at elevations of 600–1200 m amsl. It is less susceptible to an infestation of *Thrips*, a common cardamom pest. Malabar can thrive under conditions of low rainfall.

Table 2.1 Varietal description

Features	Malabar	Mysore	Vazhukka
Adaptability	Low elevation (600–1000 m amsl)	High elevation (900–1200 m amsl)	High elevation (900–1200 m amsl)
Tolerance to drought	Withstands long dry spell (4–6 months)	Needs well-distributed rainfall	Needs well-distributed rainfall
Plant stature	Dwarf (2–3 m)	Tall (3–5 m)	Tall (3–5 m)
Leaf	Short petiol	Long petiole	Long petiole
Panicle	Prostrate	Erect	Semi-erect
Bearing nature	Early, short span of flowering	Late, long span of flowering	Late, long span of flowering
Capsule color	Pale, golden yellow	Green	Green

Source: Sudarsan et al. (1991)
Note: amsl, above mean sea level

2.1.2.2 Variety Mysore

Plants are robust and grow up to 3–4 m in height. Leaves are lanceolate or oblong–lanceolate, glabrous on both sides. Panicles are erect and the capsules are ovoid, bold, and dark green in color. The capsules variety is better adapted to altitudes ranging from 900 to 1200 m amsl and thrives well under an assured, well-distributed rainfall pattern.

2.1.2.3 Variety Vazhukka

This is a natural hybrid between variety Malabar and variety Mysore and exhibits characteristics that are intermediate between both of these varieties. Plants are robust, like those of variety Mysore. Leaves are deep green, oblong–lanceolate or ovate; panicles are semi-erect (flexous) in nature; and capsules are bold, globose, or ovoid in shape.

Two more varieties—variety Mysorensis and variety Laxiflora—have recognizable morphological characteristics.

2.1.2.4 Variety Mysorensis

A robust, tall plant that possesses either glabrous or pubescent leaves. This variety has flexous panicles. The flowers are produced in short racemes. The capsules are bold and distinctly three angled.

2.1.2.5 Variety Laxiflora

Comparatively less robust than, nor as tall as, variety Mysorensis. Leaves are glabrous with short petioles. This variety has flexuous, lax decumbent panicles. The flowers are produced in 4–40 short lax racemes. The capsules are variable, oblong–oblong fusiform.

In India, a number of other cultivars of cardamom are also recognized. In general, they can be considered as ecotypes of var. Mysore, var. Malabar, or var. Vazhukka. Most common among them are Bijapur, Kannielam, Makaraelam, Munjarabad, Nadan, and Thara.

2.1.2.6 The Sri Lankan Wild Cardamom (E. ensal Abheywickrama)

The botanical identity of both the Sri Lankan wild cardamom and the Indian varieties just described is shrouded in much confusion. Cardamom varieties have been named differently by various authors as follows:

E. cardamomum var. minus
E. cardamomum var. miniscula
E. cardamomum var. major
E. cardamomum var. majus
E. cardamomum var. minor

Ridley (1912), who set forth one of the earliest descriptions of cardamom, gives the following details: "There are two forms of varieties of the plant, viz., var. minus with narrower and less firm leaves and globose fruits from 0.5–0.1 in. long, grayish yellow or buff in color. This is confined to South India. Var. majus with shorter stems, broader leaves and oblong fruit, 1- to 2-in. long and rather narrower than the Malabar fruit, distinctly three sided, often arched and dark grayish brown when dry, the seeds larger and more numerous and less aromatic. This is the Ceylon cardamom and is peculiar to that country."

In his notes on cardamom cultivation in Ceylon, Owen (1901) mentions three varieties, which he calls the indigenous Ceylon, the Malabar, and the Mysore. The first two can easily be recognized by the color of the stem. The Malabar plant is green or whitish at the base of the leafy or aerial stem, while the base of the Ceylon plant has a pink tinge. Owen also mentions that the Mysore form is robust, that its panicles are borne perpendicularly from the bulbs, and that the fruits grow in clusters of five to seven. This form does well at high altitudes. *E. cardamomum* var. major was described earlier as *E. major* Sm. (Rees Cyclop., 39, 1819), but this name did not find favor with cardamom workers. Many subsequent authors used the terminology indiscriminately and even began mentioning var. Mysore as var. major. While studying the flora of Sri Lanka (Ceylon then), Abheywickrama (1959) coined the name *E. ensal* for the Ceylon wild cardamom (from *Zingiber ensal*, under which the plant was described by Gaertner (1791). But Burtt (1980) is of the opinion that the differences are not reasons enough to differentiate this variety into a new species. However, Bernhard et al. (1971) and Rajapakse (1979) provided chemical evidence substantiating the distinct nature of Sri Lankan wild cardamom (Photos 2.1 and 2.2).

2.1.3 Fruit and Seed

The cardamom fruit has great commercial value. The fruit is a capsule developed from an inferior ovary. It is more or less three sided with rounded edges. The shape and size vary. In var. Malabar, the fruits are short and broadly ovoid, and dried fruits are somewhat longitudinally wrinkled. In var. Mysore, the fruits are ovoid to narrowly ellipsoid or elongate, and the surface is more or less smooth. The wild Sri Lankan cardamom is much larger, elongate, angular, and distinctly three sided. The dry pericarp is about 0.5 to 1 mm thick, with a rough, woody texture. The capsule has three locules, the septa is membranous, and the placentation is axile. There are five to eight seeds in each locule, and they adhere together to form a mass. The

Photo 2.1 Popular cardamom variety "*Vijetha*"

Photo 2.2 Single bunch of cardamom variety "*Kodku Suvasini*"

transverse section of a pericarp shows an outer and an inner epidermis consisting of small polygonal cells and a mesocarp of thin-walled, closely packed, parenchymatous cells. Vascular bundles traverse the mesocarp; each bundle consists of a few xylem vessels, phloem, and a sclerenchymatous sheath partially surrounding the vascular elements. Many resin canal cells (oil cells) are found distributed in the