



Research Article

POST HARVEST TECHNOLOGY AND CROP CALENDAR FOR LARGE CARDAMOM (*AMOMUM SUBULATUM* ROXB.)

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Abstract: Large cardamom was harvested when the seeds of top most capsules turn brown. As soon as the said colour appears and to enhance maturity bearing tillers were cut at a height of 30 – 40 cm from ground and left for another 10-15 days for full maturity. The spikes were harvested by using special knives known as “Cardamom-knife” (*Elaichi chhur*). Harvesting begins early in the lower altitudes, during August-September and was as late as November-December at higher altitudes. The average yield was 400 kg/ha under organic cultivation. The quality of large cardamom was governed by its external appearance, which was influenced by colour, uniformity of size, shape, consistency and texture and flavour, which ascertains taste and odour and was affected by composition of aromatic compounds. Appearance provides a visual perception of co-uniformity in size, shape, consistency. Cardamom was cured (*i.e.*, dehydration of the fruits over low sustained heat) in a curing furnace, the heat invariably coming from burning of wood fuel. Traditionally, locally made furnace, the “Bhatti”, crude and primitive in operation, was a stone-mud structure, cheap to erect and moderately efficient where capsules are dried by direct heating. Considerable loss of quality characteristics is seen with the bhatties, yet, they are common in the entire cardamom belt. The colour of the capsules turned to black due to direct heating and smoke. Improved curing techniques were available in which cardamom is processed to give quality and appearance. One such method was ICRI Bhatti curing system developed by Indian Cardamom Research Institute, Regional Research Station, Tadong where cardamom was dried through indirect heating. The system was available in 200 and 400 kg (fresh capsules capacities, cost was estimated as Rs. 48,000/- and 70,000/-, respectively. This Bhatti had been popularized by the Spices Board Regional Office at Gangtok and Zonal Offices in Sikkim and Kalimpong in West Bengal through subsidized development scheme. In this cardamom was dried by indirect heating at 50-55°C. Curing was done till moisture content of the produce was brought down to 10-12 percent and gives metallic sound while shuffling. Farmers were not used to do any grading but in practice there were two grades used to mention chota dana and bada dana. Grading was mainly done by the trader for their marketing purpose. Trader use different sieves to grade their produce which was not having any uniformity. Indian Cardamom Research Institute, Regional Station, Tadong, Spices Board developed four sieve standardizing the grades for large cardamom. Accordingly, five grades of large cardamom based on sieves size were standardized. The properly dried capsules should be allowed to cool and then packed in polythene lined jute bags. The bags may be stored on wooden platform away from sidewall to avoid absorption of moisture and thereby to avoid fungal growth on the stored produce. The marketing of large cardamom was controlled by traders. Around 10 % of the large cardamom was exported. Major importing countries include Pakistan and several countries of Middle East Asia. A crop calendar was also worked out under Good Agricultural Practices (GAP). Harvesting, curing, grading, packaging and marketing aspect of large cardamom is presented in this paper.

Keywords: Capsules, Curing, Grading, Harvest, Maturity, Natural Colour, Sustainable Agriculture, Traditional Bhatti

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Introduction

Large cardamom, a shade loving plant (sciophyte) grows well in the altitudes of 600-2000 m MSL receiving annual rainfall of 2000-3500 mm apportioned over 200 days. The crop has its natural habitat in the humid subtropical semi-evergreen forests of mountainous sub-Himalayan region. Cloudy conditions prevail for most of the monsoon period. The flowering season begins early in the lower altitudes with peak flowering during March-April, while it is late in the higher altitudes with a peak period during June-July [1]. The fruit is a trilobular, many seeded capsule. The capsule wall is echinate having reddish-brown to dark-pinkish to maroon colour. The seeds are di-angular, whitish when immature and become dark-greyish towards maturity. Usually the capsules which are formed at the basal portion of the spike are bigger and bolder than others. Apart from Sikkim and Darjeeling, large cardamom is also cultivated in some other North Eastern Hill states like Arunachal Pradesh, Nagaland and parts of Uttarakhand. Nepal, Bhutan and Myanmar are the other Himalayan countries where large cardamom is cultivated [2]. Sikkim is the largest producer of large cardamom and constitutes the major share of Indian and world market followed by Arunachal Pradesh,

Nagaland and Darjeeling District of West Bengal. The demand for natural products of flavour and fragrance has been on the rise in food industry, perfumeries, medicines etc., where large cardamom has tremendous potential [1-4].

Harvesting of large cardamom

The indication of time of harvest is when the seeds of top most capsules turn brown [Fig-3] & [Fig-4]. As soon as the said colour appears and to enhance maturity bearing tillers are cut at a height of 30 – 40 cm from ground and left for another 10 – 15 days for full maturity [Fig-1]. The spikes are harvested by using special knives known as “Cardamom-knife” (*Elaichi chhur*) [Fig-2]. A crop calendar for large cardamom (*Amomum subulatum* Roxb.) was worked out and practiced under sustainable cardamom production in the North-East region [Table-2].

Harvesting begins early in the lower altitudes, during August-September and is as late as November-December at higher altitudes. The average yields range from 200 to 800 kg/ha under sustainable agriculture.

Table-1 Grade specifications for large cardamom

S	Grade Name	Specifications	Grade Name	Specifications ICRI,RS Tadong
1	Badadana	>1.5cm	Extra Bold Hand pick	>1.5cm
2	Medium Badadana or Goldana	1.3-1.5cm	Medium Bold tailcut	>1.4 but<1.5cm
3	Chhotadana	1.2-1.3cm	Medium tail cut	>1.3 but<1.4cm
4	Pan grade or Pan variety	<1.2cm	Chotta tailcut	>1.2 but<1.3cm
5	-	-	Pan variety or Pan dana tail cut	<1.2cm



Fig-1 Cutting of bearing tillers



Fig-2 Elaichi chhuri



Fig-3 Mature spikes



Fig-4 Mature capsules

Cultivar	Harvesting time (in general)
Ramsey	October
Ramla	October
Sawney	September – October (November in high altitude)
Varlangey	October - November
Seremna	October
Dzongu Golsey	September – October

Curing of large cardamom

The quality of large cardamom is governed by its external appearance, which is influenced by colour, uniformity of size, shape, consistency and texture and flavour, which ascertains taste and odour and is affected by composition of aromatic compounds. Appearance provides a visual perception of co-uniformity in size, shape, consistency. The essential oil contains the volatile principles such as 1:8 cineole (75-85%), α -bisabolene (3-6%), r -terpinene (4-8%), α -terpineol + α -terpinyl acetate (3-6%) also the B-myrcene, nerolidol, pinene, thujene etc., are known in traces. Cineole contributes to the pungency while α -terpinyl acetate towards pleasant aroma. The fresh capsules are fleshy with almost 85 percent moisture. Their keeping quality is poor and is highly perishable. They are cured or dried to about 10-12 percent moisture on dry weight basis to prolong its shelf life. Cardamom is cured (*i.e.*, dehydration of the fruits over low sustained heat) in a curing furnace, the heat invariably coming from burning of wood fuel. Traditionally, locally made furnace, the "Bhatti", crude and primitive in operation, is a stone-mud structure, cheap to erect and moderately efficient where capsules are dried by direct heating [Fig-5]. Considerable loss of quality characteristics is seen with the bhatties, yet, they are common in the entire cardamom belt. The colour of the capsules turned to black due to direct heating and smoke [Fig-6].

For good market value, the retention of natural colour and flavor constituents is very important. The highly volatile flavor constituents are easily lost because of direct heat and/or high temperature. This necessitates adoption of an appropriate curing method/ system involving indirect heating with an optimum temperature range of 50-55°C, rapid air circulation within an exhaustion of moist air from the

drying unit. The unit must be easily maintained and convenient in operation near or in the vicinity of the remote plantations. Spices Board, Ministry of Commerce, Government of India has attempted for quite some time with improved and scientific "curing unit" based on hot-air flue indirect heating system but the traditional Bhatti still used to some extent.



Fig-5 Local bhatti



Fig-6 Local bhatti cured cardamom

ICRI improved bhatti

One such method is ICRI Bhatti curing system developed by Indian Cardamom Research Institute, Regional Research Station, Tadong where cardamom is dried through indirect heating [Fig-7 & Fig-8]. The system is available in 200 and 400 kg (fresh capsules capacities, cost is estimated as Rs. 48,000/- and 70,000/-, respectively. This Bhatti has been popularized by the Spices Board Regional Office at Gangtok and Zonal Offices in Sikkim and Kalimpong in West Bengal through subsidized development scheme. In this cardamom is dried by indirect heating at 50-55°C [Fig-9]. Curing is done till moisture content of the produce is brought down to 10-12 percent and gives metallic sound while shuffling [Fig-10].



Fig-7 ICRI improved bhatti



Fig-8 ICRI bhatti flue pipes



Fig-9 Drying



Fig-10 ICRI bhatti cured cardamom

Grading, packaging and marketing

Grading

Farmers are not used to do any grading but in practice there are two grades used to mention chota dana and bada dana. Grading is mainly done by the trader for their marketing purpose. Trader use different sieves to grade their produce which is not having any uniformity. Indian Cardamom Research Institute, Regional Station, Tadong, Spices Board developed four sieves standardizing the grades for large cardamom. Accordingly, five grades of large cardamom based on sieves size standardized [Fig-11 & Table-1].

Table-2 Crop calendar for large cardamom

Month	Activities
January-February	Nursery
	Regular watering may be done in secondary/sucker nursery based on available soil moisture in nursery.
	In primary nursery if 25% germination is observed, the mulch has to remove immediately and shade pandal has to erect.
	If any symptoms of disease/pest infestation noticed it may be controlled immediately.
	Need based weeding.
	Plantation
	After harvest of the crop, the dried leaves and shoot may be dumped in pit instead of using as mulching material.
	The base of the plants may be mulched with forest leaves.
	Viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting/burial at regular intervals.
	Leaf caterpillar/stem borer infested plant parts may be collected and destroyed mechanically.
March-April	Regular watering may be done based on available soil moisture in plantation.
	Nursery
	Regular watering may be done in secondary/sucker nursery based on available soil moisture in nursery.
	Decomposed or powdered cattle manure/organic manure may be applied in the nurseries for healthy growth of suckers.
	Disease/pest infested suckers may be removed and destroyed.
	One round of weeding followed by forking of soil at plant base.
	Plantation
	Irrigation may be done based on available soil moisture in plantation.
	<i>Colletotrichum</i> blight and viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting and burial at regular intervals.
	Prophylactic spray and drench of <i>Pseudomonas fluorescens</i> (3-5 lt. in 100 lt water) during April last week after removing blight infected plants (Phytosanitation).
	Regular inspections may be carried out to observe shoot fly/stem borer incidence if any, may be hand picked and destroyed mechanically.
	One round of weeding may be done for easy movement of bumble bee and honey bee for pollination.

Months	Activities
May - June	Nursery
	Disease & pest affected plant parts may be removed and destroyed.
	New site for secondary/sucker nursery has to prepare and planting may be completed.
	One year old sucker nursery seedlings ready for planting in main field.
	Plantation
	Decomposed cattle manure/organic manure may be applied in the plantation if not applied earlier for sustained production.
	<i>Colletotrichum</i> blight and viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting/burial at regular intervals.
	Prophylactic spray and drench of <i>Pseudomonas fluorescens</i> 3-5 lt. in 100 lt water – 1 st week of May after removing blight infected plants if not applied in earlier.
	Spray and drench the plants with copper oxychloride 50% WP @ 1 Kg in 300-400 l of water/acre.
	Regular inspections may be carried out to observe caterpillar/stem borer/shoot fly incidence if any, may be hand picked and destroyed mechanically.
	All the aged /diseased/ un productive cardamom plants may be uprooted and removed. Line marking, opening pits and filled with top soil/compost/cow dung so that timely replanting/gap filling operation can be taken soon after getting rains.
	Suitable native shade tree saplings may be used for planting where shade is less and where shade is more it may be regulated by lopping the excess shade.
	Bordeaux mixture 1% as prophylactic spray during onset of monsoon.
July - August	Nursery
	Nursery bed may be mulched properly with dried forest leaves.
	Disease/pest affected suckers may be removed and destroyed.
	Weeding may be carried out if necessary.
	Plantation
	Replanting/gap filling operation may be completed within 1 st fortnight of July if not done earlier.
	<i>Colletotrichum</i> blight and viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be uprooted and destroyed by burial at regular intervals.
	Spray and drench of <i>Pseudomonas fluorescens</i> 3-5 lt. in 100 lt water in August after removing the blight affected plants.
	Spray and drench the soil with copper oxychloride 50% WP @ 1 Kg in 300- 400 l of water/acre.
	Regular inspections may be carried out to observe caterpillar/stem borer/shoot fly incidence if any, may be hand picked and destroyed mechanically.
	Farmers who are not having bhatti for curing cardamom have to start constructing ICRI improve <i>bhatti</i> before starting of harvest.
	In lower elevation capsule start maturing and one round of weeding and threshing may be done.
	Harvesting may be carried out based on maturity in August last.



Fig-11 Grading sieves developed by ICRI, Tadong

Packaging and storage

The properly dried capsules should be allowed to cool and then packed in polythene lined jute bags [Fig-12 & Fig-13]. The bags may be stored on wooden platform away from sidewall to avoid absorption of moisture and thereby to avoid fungal growth on the stored produce.



Fig-12 Packaging in polythene lined gunny bag



Fig-13 Storage in godown



Fig-14 Tail cutting



Fig-15 Cardamom polishing machine

Table-2 Crop calendar for large cardamom..[conti..]

Months	Activities
September - October	Nursery:
	Over head pandal may be raised for the nursery opened during May- June.
	Nursery bed may be mulched properly with dried forest leaves.
	Disease/pest infested suckers may be removed and destroyed.
	Necessary weeding may be carried out.
	Seed bed/primary nursery bed may be prepared for raising nursery and seed may be sown.
	Plantation
	<i>Colletotrichum</i> blight and viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting and burial at regular intervals.
	Spray/ drench of <i>Pseudomonas fluorescens</i> 3-5 lit. in 100 lit water in September if not applied in August after removing the blight affected plants/plant parts.
	Regular inspections may be carried out to observe caterpillar/stem borer/shoot fly incidence if any, may be hand picked and destroyed mechanically.
	Capsule start maturing in higher elevation and one round of weeding and threshing may be done if not carried out earlier.
	Farmers may repair their bhatti for curing cardamom.
	Harvesting may be done when capsules are fully matured and curing can be carried out immediately.
	Second round of application of dried or powdered cattle manure/organic manure may be carried out in the plantation to boost up the production.
November- December	Nursery
	Nursery bed may be mulched properly with dried forest leaves.
	Irrigate the nursery based on available soil moisture.
	Disease/pest infested suckers/plant parts may be removed and destroyed.
	Seed sowing and mulching has to complete immediately within 1 st week of November in the seed bed/primary nursery bed and regular watering may be done based on soil moisture.
	Plantation
	Harvesting has to be completed in higher elevation based on maturity and curing may be carried out immediately.
	After harvest of the crop, the dried leaves and shoot may be dumped in pit for composting instead of using as mulching material.
	The base of the plants may be mulched with forest leaves.
	Viral disease (<i>chirke</i> and <i>foorkey</i>) infected plants may be destroyed by uprooting and burial at regular intervals.
	Leaf caterpillar/stem borer infestation may be collected and destroyed mechanically.
	Regular watering may be done based on available soil moisture in plantation.

Tail cutting and polishing

At farmers' level no one is involved in tail cutting and polishing but to increase the market price traders are doing both tail cutting and polishing of cardamom capsules. Tail cutting is done manually and polishing by machineries [Fig-14&15].

Marketing of large cardamom

The marketing of large cardamom is controlled by traders and is exclusively in the unorganized sector. It involves a number of intermediaries right from the production centre at the village level to the final consumer the house hold sector, industry and export clients. In fact, there is an average of three to five intermediaries between the producer and the final consumer. In order to streamlining the large cardamom market Spices Board India made it mandatory to trader of large cardamom to obtain cardamom trader license from Spices Board and made it mandatory to submit trade details to the Board. Spices Board also initiated large cardamom auction centre at Singtam and Kalimpong by authorizing auctioneer for organized system of sales. At present, in Sikkim and Darjeeling 45 nos. of large cardamom dealers are available in different local market. Among them important market centre is Singtam, Gangtok, Rongli, Mangan, Jorethang, NayaBazar, Gyalshing, Rabangla, Sukhiapokhri, Bijanbari & Simana. But large cardamom market in Arunachal Pradesh and Nagaland is controlled from Siliguri which is the major trade centre of large cardamom not only for Indian produce but also for Nepal and Bhutan produce. Principal marketing centers for large cardamom are Delhi, Amritsar, Kanpur, Mumbai, Calcutta and Hyderabad. Amritsar, Mumbai and Siliguri besides catering to the local demand, are also the principal exporting centre for large cardamom. Around 10 % of the large cardamom is exported. Major importing countries include Pakistan and several countries of Middle East Asia.

Application of research: The quality of large cardamom was governed by its external appearance, which was influenced by colour, uniformity of size, shape, consistency and texture and flavour, which ascertains taste and odour and was affected by composition of aromatic compounds. Improved curing techniques were available in which cardamom was processed to give quality and appearance. One such method was ICRI Bhatti curing system developed by Indian Cardamom Research Institute, Regional Research Station, Tadong where cardamom was dried through indirect heating. Spices Board developed four sieves standardizing the grades for large cardamom. Accordingly, five grades of large cardamom based on sieves size were standardized.

Research Category: Spice research.

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Cultivar / Variety / Breed name: Cardamom (*Amomum subulatum* Roxb.)

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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