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Post harvest processing and marketing of large cardamom in India

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ABSTRACT

Large cardamom is an important spice crop in India. Seeds of large cardamom possess medicinal properties like carminative, stomachic, diuretic, cardiac stimulant, and anthelmintic. In India, harvesting and processing of large cardamom capsules are carried out in traditional ways in spite of having many advanced processing methods. Besides, lack of good marketing channel has also restricted the growers to get better price for their produce. This article reviews the postharvest processing methods (curing, calyx cutting, packaging, and storage), quality issues and their impacts on the value chain and trade patterns. It also focuses on the marketing aspects and suggest approaches for future research and development that could make this crop more popular and sustainable.

Keywords : Large cardamom, marketing, post harvest, processing

Large cardamom (*Amomum subulatum* Roxb.) belonging to Zingiberaceae family is one of the important spice crops of India. The seeds of large cardamom contain about 3 per cent essential oil, rich in cineole which has a pleasant aromatic odour and is used for flavoring vegetables and many food preparations. India is now the second largest producer contributing about 37 per cent of the world's production, while Nepal is the world's largest producer with a share of more than 53 per cent (Subedi *et al.*, 2014). India has 26387 hectares of land under this crop with an annual production of 4850 tonnes during 2015-16. India is the largest exporter and exported 665 tonnes worth Rs. 8403.90 lakhs in the year 2015-16. Pakistan is the major importer of Indian large cardamom. In India, it is mostly grown in Sikkim (4075 tonnes) and Darjeeling district of West Bengal (775 tonnes). Over the last few decades, the cultivation of this crop has spread to other northeastern Indian states like Nagaland, Arunachal, Mizoram, Meghalaya, Manipur and to the central Indian Himalayan state of Uttrakhand (Srinivasa, 2006). Cultivation, harvesting, and processing of large cardamom are carried out in traditional ways (Sharma *et al.*, 2009) which produces poor quality capsules and do not meet the market standard, thus lowering its value. The capsules are manually removed (Rao, *et al.*, 2001), the farmers are reluctant in adopting advanced drying system due to some technical problems (Sharma *et al.*, 2000). Scissors are used to remove capsule tail which is laborious. The capsules are graded according to size and still no mechanical graders are available. Lack of proper marketing channel has also created a hindrance for the farmers to get better price for their produce.

Harvesting

Fully matured capsules are harvested during September to November. The top most capsule in a spike ripens first and then in the bottom, so harvesting is assessed by opening the topmost capsule on a spike. However brown color of seeds indicates full maturity. When the topmost capsule is fully matured, the spike-bearing shoots are cut at 45 cm height and left for another 10-15 days to ensure maturity of all the capsules. The spikes are harvested using a special knife known as an elaichi chhuri. The harvested spikes are stored for 2–3 days after harvesting, which makes it easier to separate the capsules (Spices Board, 2001). Separation is done by hand, and no device is available for this operation so far. The separated capsules are manually cleaned from other plant materials before curing. The fully grown cardamom plantations require 150-200 man days ha^{-1} for various farm operations such as intercultural operations and harvesting.

Curing

This operation will determine the quality of dried capsule so it is the most important step for large cardamom processing. Freshly harvested capsule contains 80-85 per cent moisture. Curing is done to lower the moisture content to 10-12 per cent which is safe for storage. The weight ratio from fresh to cured capsule is 4:1 to 5:1 (Madhusoodanan and Rao, 2001). Rout *et al.* (2003) observed that certain evaporable substances which are the part of essential oil are lost during curing. Curing at too high temperature causes charring of capsules and loss of volatile oil, while too less temperature leads to mould growth. The ideal curing temperature must be 45-55°C. Many advanced curing system have been developed, still traditional bhatti is popular for curing (Deka *et al.*, 2003). Various curing systems and its principles are mentioned below.

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Traditional curing (Bhatti)

This curing system is constructed using mud and bricks. Raw cardamom capsules are spread over the drying platforms. Hot smokes from firewood are passed through the capsules. The process takes 35-40 hrs for complete drying. The bhatti operates with very poor operating thermal efficiency of the order of 5-15 per cent resulting in wastage of huge quantities of fuel wood. The specific fuel consumption is in the range of 1-2.5 kg fuel wood per kg fresh cardamom. The drying is non-uniform and produced poor quality, charred and smoky capsules. Constant attention is needed during drying for managing fire, maintaining low flame preventing fire hazards, and turning over the beds of capsules (Mande *et al.*, 1999). There is also loss in the volatile oil content of the capsules by this method.

Modified bhatti (Flue pipe curing house)

This system is developed by Indian Cardamom Research Institute, Gangtok. This is an indirect system of drying and smoke does not come in contact with the produce at any stage. Flue pipe is connected to a fire place with an exit provided outside the building. The capsules are spread over the floor/shelves. When the firewood is burnt, hot air passes through flue pipes and capsules gets dried by the heat generated. Proper ventilation is provided to control temperature inside the room. Since smoke does not come in contact with capsules, its original maroon colour is retained fetching better price in the market. The capacity of this system varies from 200 to 400 kg of fresh capsules. Drying time is reported as 17-24 hours, volatile oil content of 2-2.4 per cent. Costs of one unit is US$ 102 (Deka *et al.*, 2003). Few farmers in Arunachal Pradesh are using this system. Spices Board of India introduced it in Sikkim, but farmers are hesitating to utilize it due to high installment cost (Anonymous, 2007).

Natural convection dryer

The dryer designed by Central Food Technology Research Institute (CFTRI) is similar to Flue pipe curing system. This dryer with a thermal efficiency of about 5.6 is better than the conventional flue curing kilns. It can dry 300 kg large cardamom capsules at a time and for drying to a level of 10 per cent moisture the time required is 24 h.

Gasifier curing system

This system is developed by Tata Energy Research Institute (TERI). The solid fuel *i.e.*, firewood through biomass gasification and thermo chemical reaction is converted into gaseous fuel by partial combustion. A mixture of producer gas consisting of carbon monoxide, hydrogen, methane, carbon dioxide and nitrogen is obtained, which is combustible and is used to burn. Through updraft type of biomass gasifier, air enters the gasifier from bottom and producer gas is taken out from top for curing cardamom. This type of curing system has better conversion efficiency (above 70%), better control on burning (handling gaseous fuel), production of clean flue gases (as gas is burnt), fuelwood saving of up to 65 per cent (Rao *et al.*, 2001). The quality of dried capsules is better in color and volatile oil content than traditional system. This system is not being utilized by the farmers due to high installment cost and chipping of fuelwoods. The processing of large cardamom using gasifier-based system would save over 12,000 tones of fuel annually in Sikkim. However at present TERI is developing an advanced gasifier-based dryer system for curing of large cardamom in Sikkim under a project sponsored by Indo-Swiss Project Sikkim (ISPS).

Mechanical-trolley system

The Indian Council of Agricultural Research has developed this indirect heating curing system of 600 kg capacity, which operates by diesel or electricity. Apart from being very efficient it also produced quality capsules. It takes 12 hrs for complete curing. This curing system consists of a blower, a heating unit, and a multi tray curing chamber similar to a mechanical cabinet tray dryer. Because of high cost of installation and difficulty in transporting in hilly terrains it is not popular among farmers.

Portable curing chamber

This is a prototype of 'Copra dryer' developed at ICAR - Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala. Unit is made of a furnace curing chamber and an air heating system. All the four sides of the air-heating chamber are enclosed by asbestos sheets leaving the top for drying. Freshly harvested capsules are placed in wire mess platform of 3-5 mm to a thickness of about 15-20 cm. Air around the furnace gets heated by burning firewood inside the furnace cylinder. The heated air moves upwards passing through the capsules and drying it. Temperature inside heating chamber can be adjusted by regulating chimney valves and adjusting rate of burning firewood. 50 kg of raw capsules will get cured in 20 hours.

Solar drier

This system was designed at College of Agricultural Engineering and Post Harvest Technology, Central Agricultural University, Ranipool, Sikkim. On an average 55.7 per cent of higher temperature was obtained in the solar dryer over the ambient temperature. It takes 24 hours (3 sunny days) for curing of capsules than open sun drying which takes 48 hours to obtain the same level of moisture contents resulting in a net saving of about

50 per cent of drying time for the solar dryer in comparison to the open sun drying (Gatea, 2011). This solar drier would definitely help to prevent the deforestation by saving the precious forest wood for drying of large cardamom in comparison to the traditional drying of large cardamom in the "traditional furnace" in India (Seveda and Jhajaria, 2012).

Alternate systems

Some other curing systems have been developed by G.B. Pant Institute of Himalayan Environment and the Development and Central Food Technological Research Institute, Mysore (Madhusoodanan and Rao, 2001; Deka *et al.,* 2003). Nepal has developed a curing system called rocket stove dryer (Stoep, 2010). This is an indirect-heating system producing quality capsules. All these systems are still not being adopted by farmers due to lack of niche market where they will get premium price for their quality products (Stoep, 2010). Researches have to be carried out for such reasons in order to develop new cutting systems. Nevertheless, additional modification of the new systems is still recommended to bring down the costs of construction (Chhetri *et al,* 2008).

Calyx cutting

Calyx or tail is either removed by rubbing against wire mesh just after curing or removed manually with scissors. So far no devise is developed for this purpose. Capsules with the tail removed are graded as kainchi-cut and those with the tail intact as non-kainchi-cut. This operation is labor-intensive because extra labor is hired with extra cost. The use of cardamom polisher for cutting tails is being evaluated by College of Agricultural Engineering and Post Harvest Technology in Ranipool, Sikkim, and the Indian Cardamom Research Institute (Spices Board) in Tadong, Sikkim (Yurembam, 2010).

Packaging and storage

Polythene-lines jute bag (40-100 kg capacity) is used for packaging for dried large cardamom. Capsules packed in polypropylene (PP) and ethylene terepthalate/ polyethyiene (PET/PE) was observed to have small changes in moisture and volatile oil content and retention of flavor component 1, 8 cineol was also very high (Sulochanamma *et al.,* 2008). In order to avoid moisture absorption by dry capsules, they are cooled after curing and placed in bag which are sealed and stored in wooden platforms. Dried capsule with optimum moisture content of 11 per cent capsule is ideal for storage (Naik *et al.,* 2000). Moisture content of capsule more than 13-15 per cent can lead to insect infestation. Central Food Technological Research Institute in Mysore has recommended use of fumigants like methyl bromide (0.016 kg m^{-3}), phosphine (0.0015 kg m^{-3}) and ethyl formate (0.30 kg m^{-3}) to control insect infestation during storage without affecting quality (Naik *et al.,* 2005).

Recommendations relating to storage and transport conditions

- The packages of large cardamom, as capsules or seeds, should be stored in covered premises, well protected from the sun, rain and excessive heat.
- The store should be dry, free from objectionable odours and proofed against the entry of insects and vermin. The ventilation should be controlled as so to ensure good ventilation during dry weather and to be fully closed during wet weather. Suitable arrangements should be made to allow fumigation of the store.
- The packages should be handled and transported in such a way that they are protected from rain, from the sun or other sources of excessive heat, from objectionable odours and from any other contamination, especially in the holds of ships.

Grading and quality standards for dried capsules

There are four commercial grades of dried capsules *viz.,* badadana (big capsule), chotadana (small capsule), kainchi-cut (capsule tail removed) and non-kainchi-cut (capsule tail intact) (Sharma *et al.,* 2009). Manually operated sieves for grading are reported, but so far no mechanical grading machines have been developed. For this purpose laborers are hired by local dealers and wholesalers. Quality standard for large cardamom capsule has been made by Bureau of Indian Standards (BIS, 2009) based on the Prevention of Food Adulteration Act of 1954 (Table 1). Cardamom importing countries imports only those capsules that are fulfilling these norms. Still there is lack of awareness among growers and traders.

Value addition of large cardamom

Value added products of large cardamom, such as essential oil and oleoresin, have high market values and export potentials. However, no equipment for extracting such products is available in India. The major markets for oleoresin are the USA, the UK, Germany, France, Canada, Japan and South Korea. After removing the oleoresin from the dry cardamom spices, the residues also has good marketing scope as ingredient of animal-feed. The capsule on an average comprises 70% seeds and 30% skin. Moisture- 8.49%, volatile oil- 2.8% v/w, protein- 6.0%, total ether extract- 5.31%, non-volatile ether extract- 2.31%, volatile ether extract- 3.0%, crude fibre- 22.0%, starch- 43.21%; alcohol extract- 7.02%. Total ash in large cardamom and seeds varied from 5.49 to 6.56% and 3.45 to 4.57 and volatile oil 0.5 to 1.5% and 0.9 to 2.0% (Pruthi, 1991).

Table 1: Quality standard of large cardamom capsule in India

Quality parameters	Requirements
1. Odor and taste	Free from foreign odor and taste, including rancidity and mustiness
2. Insects, molds and other infestations	Not more than 10% on visual observation
3. Extraneous matter: Calyx and Stalks	Not more than 5% (by weight *i.e.*, m/m)
Other extraneous matter	Not more than 1% (m/m)
4. Empty and malformed capsules	Not more than 2% (by count)
5. Immature and shriveled capsules	Not more than 2% (by weight *i.e.*, m/m)
6. Light seeds	Not more than 3% (by weight *i.e.*, m/m)
7. Insect damaged matter	Not more than 1% (by mass)
8. Moisture	Not more than 12% (by weight)
9. Volatile oil	Not less than 1% (mL/100 g) on dry basis

Source: BIS (2009).

Essential oil

Essential oil is obtained by steam distillation of crushed seeds which yield 2.5 per cent of dark-brown coloured mobile oil. The volatile oil of large cardamom seed contains 1, 8 cineole, á-terpineol, á-pinene, â-pinene, and alloaromadendrene (Gurudutt *et al.*, 1996). The essential oil of large cardamom is reported to have antimicrobial properties (Agnihotri and Wakode, 2010).

Oleoresin

Large cardamom oleoresin may be extracted by solvent extraction method. But to get the true flavor of the oleoresin, the solvent extraction is not the ideal choice because during the removal of the oleoresin of the dry cardamom spices, several aroma components are lost along with the solvent. Supercritical Fluid Extraction offers another choice whereby the true fresh flavour is retained in the extract solution. Supercritical Fluid Extraction is also known as CO_2 extraction process. It is a high technology process for extracting oleoresins from the dry large cardamom without the use of hazardous organic solvents, such as acetone, hexane and methylene chloride. SCFE is the two-step process which uses a dense gas as a solvent *e.g.*, carbon dioxide for extraction, above its critical temperature (31°C) and critical pressure (74 bar). The feed (dried capsules) is charged into the extractor. Supercritical CO_2 is fed to the extractor through a high-pressure pump (100 - 500 bar). The extract laden CO_2 is sent to a separator (60 - 120 bar) *via* a pressure reduction valve. At reduced temperature and pressure conditions, the extract precipitates out in the separator. The extract free CO_2 stream, leaving the separator is then recycled to the extractor.

Marketing

Marketing of large cardamom in India is unorganized particularly its assembling aspect, due to smallness of holdings, extremely poor economic conditions of growers, preponderance of moneylenders-cum-traders, unsatisfactory means of transportation and communication in the producing and assembling centers, lack of growers' organization and minor commercial importance of the crop. There is, however, a great scope for improving existing conditions.

Value chains

Post harvest value chain consists of growers, collectors, traders, and exporters. Processing of capsules for the market consists of curing, tail cutting and grading. Curing is done by farmers, but the remaining steps are carried out by wholesalers. Processing cost per kilogram at various stage are US$ 0.07 for curing (including fuelwood), US$ 0.04 for tail cutting, and US $0.02 for grading (cleaning and sorting); and the volume loss per kilogram in value chain is estimated to be US$ 0.25 (MoAC 2008). The main marketing channel in India is by three ways (SFAC 2012).

1. Farmers- Aggregators- Wholesalers-Retailers-Consumers
2. Farmers-Contractors-Wholesalers-Retailers-Consumers
3. Farmers-Bidders-Wholesalers-Retailers-Consumers

The losses in the field vary from 5 to 10 per cent which may go up to 80 per cent in case of disease affected materials.

The prices for 1 kg at the farmer, aggregator, wholesaler, and retailer levels are US$ 12.16, US$ 13.38, US$ 16.26, and US$ 20.33, respectively. The margins enjoyed by aggregators, wholesalers, and retailers are reported as US$ 1.22, US$ 2.71, and US$ 4.07, respectively (SFAC, 2012).

Table 2: Price build-up of large cardamom from farm gate to market (per kg)

Particulars	Amount (Rs)	Markup (Rs. piece^{-1})	Contribution (%)
Farm gate price	600.00	600.00	60%
Aggregator margin @10%	60.0	660.00	6%
Transportation	2.00	662.00	0%
Wastage@1%	6.62	668.62	1%
Wholesaler (@20%)	133.72	802.34	13%
Retailer 25%	200.59	1002.93	20%

Source: Sharma et al., 2012

Marginal farmers used to take advances from local traders before the harvest season and repay the amount with interest through selling their products to them. Another system is the dahadani, the selling of crops in the field to local merchants, in which farmers display the harvested produce after drying (MoAC, 2008; Stoep, 2010).

As per the cardamom (Licensing & Marketing) Rules, 1987, all the producers of cardamom should sell their produce only through a licensed auctioneer/dealer and the auction system came into existence since then. Depending upon the marketing channel the average selling price of the farmers ranges from Rs.550 to Rs.900 rupees. NERAMAC an agricultural marketing agency have provided a platform for farmers and bidders time and again. It also has an auction centre and warehouse at northeast India and provides free warehouse service for the farmers. This platform provides opportunities for farmers and bidders interaction. If farmers are not willing to sell their produce to the highest bidder they can keep their produce in the warehouse for next auction. During the auction, good quality cardamom fetches Rs.800 to Rs.900 per kg.

Domestic and International trade of capsule

In India the majority of the produce is consumed in domestic market. Indian export volume is comparatively low for exporting to other countries like Pakistan, Canada, Australia, UAE, UK, USA and South Africa. Pakistan has the largest market for large cardamom and from there it is exported to other countries. Delhi, Guwahati and Kolkata are the major domestic market in India. The Spices Board of India controls and monitors the spice trade in India. Farmers sell their produce to local dealers and wholesalers who sell in bulk. This way the price is fixed between farmers and dealer which leads to farmers for getting lower prices than market. Major local markets in Sikkim (traditional growing region) are Singtam, Gangtok, Jorethang, Gyalshing, Naya Bazar, Rongli, and Mangan (Anon., 2006). The produce goes to Siliguri in North Bengal which is the main trade junction for Indian large cardamom and from there gets distributed to other collection center *viz.*, Guwahati, Kolkata, Delhi, and Amritsar (Stoep, 2010; SFAC 2012). Price protection for farmers will be an important aspect in large cardamom trade, as this plays a major role in the value chain.

In the year 2015-16 an estimate of 3410 tonnes of large cardamom worth 30795.48 lakhs was imported by India (Spice Board, 2016a) and in the same year India exported 600 tonnes of large cardamom worth 7,332.50 lakhs (Spice Board, 2016b). There is a constant fluctuation in the export volume of major large cardamom producing countries. From 2013-14 the export volume started decreasing and export value started increasing till date *i.e.*, 2015-16.

The market price of capsule is greatly influenced by the following major quality considerations:

- Size – the bigger the size of the capsules, the higher the price obtained. No grading is in vogue at present and mixing of all sizes and different cultivars is quite common.
- Color – more prices are offered to the capsules having a light pink color in international markets.
- Moisture contents – the products with high moisture fetch comparatively low price. The moist capsules are also subject to easy fungal infection.

Table 3: Exports of large cardamom from India, 2011-2015

Country	2011-2012		2012-2013		2013-2014		2014-2015(EST)	
	Quantity (MT)	Value (Rs. lakhs)	Quantity (MT)	Value (Rs. lakhs)	Quantity (MT)	Value (Rs. lakhs)	Quantity (MT)	Value (Rs. lakhs)
Pakistan	719.52	4859.99	905.11	4489.86	967.86	7471.32	471.14	5633.31
USA	30.84	286.93	69.51	425.51	9.54	133.91	6.73	105.51
Total (including others)	934.91	6829.99	1217.22	6254.63	1110.00	7961.15	665.00	8403.90

Source: Spices Board (2015).

Policies for improvement of processing and marketing of large cardamom

Many policies are being undertaken in India. Such policies focus mainly on replanting, rejuvenating and crop maintenance. In the field of post harvest processing and marketing steps are also being taken. Indian Cardamom Research Institute set up in Sikkim by Spices Board (2013) is providing funds to the farmers for installment of improved curing system under Export and Development Fund, administered by the Department of Commerce. A unit of processing and extraction of essential oil and oleoresin for large cardamom is also been approved by Ministry of Commerce (DoC, 2010). For introducing improved Bhatti in Sikkim, Indian

Cardamom Research Institute in collaboration with Indian Council of Agriculture Research is starting National Agricultural Innovation Project on Improvement of Large Cardamom (Bhattarai *et al.*, 2013). NERAMAC has started a platform for farmers to sell their produce in auction to fetch better price (NERAMAC, 2012).

Constraints

Declination in the production of large cardamom in the recent years has caused a negative impact on the trade in India (Sharma *et al.*, 2009). Improved curing methods needs to be popularized because of their better quality capsule however, the constraint lies in their high installment cost for the growers. Improper grading due to lack of grading machines has also caused famers to obtain lesser price in the market. Unorganized Marketing channel for selling quality capsules have also become a limitation (MoAC, 2008; Sharma *et al.*, 2009).

Supports

Many government and non-government organizations such as Spice Board of India, ICRI, Department of Horticulture and Cash Crop Development, Government of Sikkim, ICAR and North Eastern Regional Agricultural Marketing Corporation are developing policies and technologies to mitigate the problems of processing and marketing of large cardamom in India.

Large cardamom one of the important spice crops in India has started showing declining in production greatly due to viral diseases and to some extent by improper post harvesting processing technologies. By reducing post harvest loss and adding value to the produce can compensate for the decreased production. This can be achieved by adoption of advanced post harvesting methods. Despite of the fact that these advanced curing system yields better quality capsules than traditional bhatti, it is still not popular among growers owing to its high installation cost. So research should be emphasized on technology which is low cost and produces better quality capsules. Machines that carry out operations like separation of spike from capsule, tail cutting and grading are not developed which makes these operations labour intensive and costly. Focus should also be given towards value added products like oil and oleoresin as it fetches better price. There is a need to uplift this crop production so that the large cardamom growers of India will have good livelihood. Many post harvest technologies have been developed but still the traditional methods are being followed by majority if the growers due to many difficulties in the advanced postharvest management. Extension work should be better in order to create awareness among growers and dealers. Lastly, proving good marketing platform and proper pricing of the quality product will ensure better return for the growers.

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