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Effect of stage of harvest on the quality of cardamom (*Elettaria cardamomum* Maton)

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Small cardamom (*Elettaria cardamomum* Maton) is one among the major spice crops of India. Its cultivation is confined to the evergreen rain forest area of Western Ghats of South India mainly in the states of Kerala (41,242 ha), Karnataka (25,210 ha), and Tamil Nadu (4,560 ha) under varied agro-ecological conditions. The annual production in India during 2010-11 was 10,380 MT with a national average of 146 kg per hectare (Spices Board, 2012). Indian cardamom is well known for its flavour and aroma. Value added products fetch higher prices in the world market.

Cardamom oil is mainly derived from the seeds and it is used for flavouring beverages. It contains 2 to 10 per cent of volatile oil which is colourless with an agreeable camphoraceous flavour and a pungent aromatic taste (Mohammed Sayed *et al.,* 1979; Arjunan, 1980; Jothikumar and Nanjan, 1982). Earlier, attempts have been made to study the influence of stage of harvest on recovery percentage (Korikanthimath and Naidu, 1986) and oil quality (Govindarajan *et al.,* 1982; Sankarikutty *et al.,* 1984; Sumathikutty *et al*.,1985; Leela e*t al*., 2008). However, there is no report on the influence of different stages of maturity on characters like bulk density, fresh and dry weight, recovery percentage and oil quality in prostrate panicle types of cardamom in Karnataka. Hence, studies were undertaken to assess the physical characters of the capsules and the quantity of the oil obtained at different stages of harvest which will help the grower to judge the correct stage of harvest.

The study was undertaken for two years at Indian Cardamom Research Institute, Sakaleshpur, Karnataka during 2004-05 and 2005-06. Five thousand flowers of ICRI 3 variety were labeled during the month of July in each year and the fruits were harvested at three different stages of maturity such as (i) pre-mature stage (capsules harvested 70 days after flowering), (ii) physiologically mature stage (capsules harvested 90 days after flowering) and (iii) ripe stage (capsules harvested 110 days after flowering). The length and girth of cardamom capsules was recorded at weekly intervals from the day of flower opening till harvesting. After the harvest, fresh weight of the capsules were recorded. The capsules were dried in hot air oven and the physical characters *viz*, recovery percentage, bulk density of the capsules, seed:husk ratio, average weight of capsules and seeds were determined. Oil was extracted from the dry capsules and oil percentage was calculated using Clevenger Apparatus. (Mohammed Sayed *et al*., 1979; Jothikumar and Nanjan, 1982). Average of three observations was taken for interpretation. Oil analysis using gas liquid chromatography was carried out to study the quality aspects.

The data collected during 2 years were pooled together and analysed. At the time of flower opening, the length and the girth of the inferior ovary was 3.96 mm and 10.0 mm respectively. After the pollination the capsule showed growth up to 6th week (42 days). No increase in the length and girth of capsules were observed beyond 6 weeks.

Growth of the capsule was 1.04 mm long (11.0%) within one week after flower opening. Subsequent weeks the growth observed were 2.1 mm (22.2%), 2.5 mm (26.4%), 1.0 mm (14.8%) and 0.3 mm (3.1%) indicating maximum growth period to be 2nd, 3rd and 4th weeks after pollination. The growth

in capsule length attained its maximum (9.44 mm) in about 42 days after flower opening (Table 1).

Growth in the girth of a bean also showed a similar trend. The first week showed 4.5 mm (16.3%) growth in the girth followed by 5.6 mm (20.2%), 4.6 mm (16.6%), 6.5 mm (23.5%), 5.7 mm (20.6%) and 0.7 mm (2.5%) in the subsequent weeks. The maximum girth attained by a capsule was 27.6 mm (Table 1). After pollination, the fruits took 90-120 days for harvesting. On an average each fresh capsule weighed 0.7 g.

Table 1. Growth and development of cardamom fruits after flower opening

Days after flower opening	Fruit length (mm)		Growth rate week^{-1} (mm)	Fruit girth (mm)		Growth rate week^{-1} (mm)
	Mean	Range		Mean	Range	
0	4.0	3.5-4.5	0.0	10.0	10-10.5	0.0
7	5.0	4.5-5.5 (11.0)	1.0	14.5	13-15.5 (16.3)	4.5
14	7.1	7-8 (22.2)	2.1	20.1	18-21 (20.2)	5.6
21	9.2	9-10 (22.2)	2.1	24.7	23-26 (16.6)	4.6
28	11.7	10-13 (26.4)	2.5	31.2	29-33 (23.5)	6.5
35	13.1	11-14 (14.8)	1.0	36.9	31-41 (20.6)	5.7
42	13.4	11-15 (03.1)	0.3	37.6	34-41 (02.5)	0.7
49	13.4	11-15	0.0	37.6	34-41	0.0

The figures within parenthesis shows percentage growth rate week^{-1}

The bulk density, recovery percentage, seed:husk ratio and the oil yield showed increasing trend with maturation (Table 2). The individual capsule weight increased with maturity. Seeds in immature capsules did not develop well resulting in lower weight. Recovery percentage was maximum in ripe capsules with 26.7 per cent followed by 22.2 per cent in mature capsules and only 11.8 per cent in immature capsules. Similar trend had been noticed by Korikanthimath *et al.* (1986). Seed to husk ratio was more in ripe capsules (71:29) followed by mature capsules (67:33) and least in immature capsules (58:42). The oil content was maximum at mature stage (6.5%). There was a slight reduction in oil yield in the ripe stage (6.1%) and immature capsules gave only 5.5 per cent oil. Sumathykutty *et al. (*1985) reported 74.5 per cent seeds in fruit and 7.6 per cent oil. According to Leela *et al.* (2008) to obtain high oil yields capsules should be harvested at the physiologically mature stage.

Table 2. Effect of capsule maturity on capsules characters and oil content

Characteristics	Stage of harvest		
	Immature	Mature	Ripen
Fresh capsule weight (g)	0.75	0.09	0.85
Dry capsule weight (g)	0.09	0.20	0.23
Recovery (%)	11.8	22.2	26.7
No. of dry capsules kg^{-1}	11,391	5,000	4,423
Bulk density of capsules (g l^{-1})	309	470	520
No. of capsules	3,520	2,350	2,300
Seed:husk ratio (%)	58:42	67:33	71:29
Dry seed weight (mg)	8.0	9.6	11.6
Oil (%)	5.5	6.5	6.1

Chemical composition of oil samples are presented in Table 3. The 1,8-cineole which contribute fresh, cool and camphoraceous flavour to the oil showed an increasing trend with maturity. The nerolidol, which is responsible for the woody floral and slightly green colour also showed an increasing trend till maturity and there was a slight decline in ripe capsules. The alcohol, linalool contributes to the floral flavor with citrusy note shows a decreasing trend from immature to ripe stage. The ester, α-terpinyl acetate responsible for the sweet spicy floral and fruity flavor of the spice was showing downward trend from immature capsules to mature capsules and then again showing upward trend in ripe capsules. α-pinene accounts for the woody pine like flavor was showing upward trend from immature to mature capsules but then slightly decreased in ripe capsules (Table 3).

Table 3. GC analysis of cardamom oils at different maturity stages (%)

Components	Immature stage	Mature stage	Ripe stage
α - pinene	0.62	1.46	1.30
1, 8-cineole	46.69	54.95	55.36
Linalool	1.35	0.61	0.70
α-terpinyl acetate	29.85	22.51	26.36
Nerolidol	4.04	5.89	5.37

Sumathikutty *et al*. (1985) analysed the quality aspects in Mysore types of cardamom at different stages of maturity and they found an increasing trend in 1,8-cineole content upto

three months and then a drop at ripened stage. However, in our studies we found the 1,8-cineole content to increase with maturity and ripening. The trend in α-terpenyl acetate content is similar to earlier studies. Sarath Kumara *et al*. (1985) reported that the maturity of cardamom capsules had a definite effect upon the chemical composition of oil.

From the present study, it is clear that though characteristic flavour like sweet spicy fruity flavour and floral flavour with citrusy note are more in immature capsules, their recovery percentage is very less (11.8%) with less oil percentage (5.5%). The oil percentage is more in mature capsules followed by ripe capsules with high percentage of α - pinene, nerolidol and 1,8-cineole. In cardamom the flowering period is staggered for six months and thus harvesting is also staggered. Generally, the harvesting is completed in six to seven rounds at 15-20 days intervals and hence cost of harvesting is high. Since there is no significant difference between the ripe and mature stage in terms of recovery percentage, oil content and quality, harvesting of these two stages could be made together to optimize harvesting cost.

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References

Arjunan, G. 1980. Cardamom-Chemical composition and medicinal values. *Cardamom* **12**(1): 33-34.

Govindarajan, V.S., Shanti Narasimhan, Raghuveer, K.G. and Lewis, Y.S. 1982. Cardamom production, technology, chemistry and quality. *Food Science and Nutrition* **16**(3): 326.

Jothikumar, P. and Nanjan, K. 1982. Oil extraction from cardamom parts. *Cardamom* **14**(9): 5-7.

Korikanthimath, V.S. and Naidu, R. 1986. Influence of stage of harvest on the recovery percentage of cardamom. *Cardamom* **19**(11): 5-8.

Leela, N.K., Prasath, D. and Venugopal, M.N. 2008. Essential oil composition of selected cardamom (Elettaria cardamomum Maton) genotypes at different maturity levels. *Indian Journal of Horticulture* **65**(3): 366-369.

Mohammed Sayed, A.A., Korikanthimath, V.S. and Mathew, A.G. 1979. Evaluation of oil percentage in different verities/types of cardamom. *Cardamom* **11**(1): 33-34.

Sankarikutty, B., Sumathykutty, M.A., Omanakutty, M., Padmakumari,K.P. and Narayanan, C.S. 1984. Analysis of quality aspects of different commercial grades of green cardamom. *Cardamom* **17**(10): 9-13.

Sarath Kumara, J.S., Packiyasothy, E.V. and Jansz. 1985. Some studies on the effect of maturity and storage on the chlorophyll content and essential oils of cardamom fruit (*Elettaria cardamomum*). *Journal of the Science of Food and Agriculture* **36**: 491-498.

Spices Board, 2012. *Annual Report* 20011-12, Spices Board, Cochin, Kerala.

Sumathikutty, M.A., Sankarikutty, B., Omanakutty, M., Nirmala Menon, A., Thomas, P.P., Bhat, A.V., Padmakumari, K.P. and Narayanan, C.B. 1985. Analysis of quality aspects of cardamom at different stages of maturity. *Cardamom* **18**(11): 3-7.

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