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Short communication

Essential oil composition of selected cardamom genotypes at different maturity levels

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Cardamom (*Elettaria cardamomum* Maton.) is a herbaceous perennial belonging to the family *Zingiberaceae*. Its dried fruit is one of the highly priced spices in the world. The dried fruit is used either whole or in ground form as a flavouring agent and also in the medicinal preparations for ingestion for flatulence. The most functionally important constituent of cardamom is its volatile oil. The oil is used in perfumes and as a stimulant. The capsules are generally harvested three months after flowering at just near ripeness (Pruthi, 9). The chemical composition of cardamom oil has been studied by several workers (Baruah *et al*., 2; Noleau and Toulemonde 7; Menon, 6; Marongiu *et al*., 5; Thomas *et al.,* 11; Zachariah, 12). According to Korikanthimath (4), the capsules harvested at immature and physiologically mature stages had 20-30% higher oil recovery and better retention of colour compared to fully ripe ones. There is only one report on the effect of maturity on the essential oil of cardamom, where the analysis was conducted at very early stage of capsule development (Sarathkumara *et al.,* 10). Hence, the present study was carried out to understand the influence of maturity on the oil composition among seven cardamom genotypes.

The field experiment was laid out at Indian Institute of Spices Research, Cardamom Research Centre at Appangala, Karnataka with seven cardamom genotypes of belonging to Malabar (IC 349589, IC 547136, IC 349591), Vazhukka (IC 547185, IC 349646, IC 349650) and Mysore (IC 349396) types in RBD with three replications. The cardamom capsules were harvested at three maturity stages *viz.,* immature (95 to 109 days after flowering), physiologically mature (110 to 124 days after flowering) and fully ripe (125 to 140 days after flowering) stages and dried in an electrical drier by maintaining the temperature between 45°C and 50°C. Dried cardamom capsules (20 g per genotype per replication) were crushed and the seeds were separated and weighed. The decorticated seeds were subjected to hydro-distillation in a Clevenger-type apparatus for 3 h and the volatile oil yield was recorded. The oil was dried over anhydrous sodium sulphate and kept in refrigerator until the analysis was carried out. GC analysis was performed on a Shimadzu GC-2010 gas chromatograph fitted with FID detector and RTX – 5 column (30 m x 0.25 mm, film thickness 0.25 µm) with nitrogen as carrier gas at 1.67 ml/min. The injection port was maintained at 260°C, the detector temperature was 250°C. The oven was programmed as follows: at 60°C for 5 min. and then increased to 110°C @ 5°C/min, then up to 200°C @ 3°C/min, again up to 220°C @ 5°C/min at which the column was

Table 1. Effect of maturity on seed content and oil yield in cardamom genotypes.

Genotype	Seed content in capsule (%)			Oil yield in capsule (%)		
	IM	PM	FR	IM	PM	FR
IC 349589	67.87	69.80	72.80	6.00	5.63	4.00
IC 547136	70.60	70.53	72.33	6.92	7.07	5.00
IC 349591	68.03	68.67	72.77	6.80	6.30	5.37
IC 547185	65.87	71.60	74.30	8.70	7.67	5.70
IC 349646	66.37	69.50	73.30	7.27	7.10	6.23
IC 349650	72.53	72.47	73.13	7.00	7.00	6.20
IC 349396	59.03	66.47	70.53	6.57	6.20	5.1
	SED	CD (0.05)	CD (0.01)	SED	CD (0.05)	CD (0.01)
g	0.67	1.36	1.82	0.30	0.60	0.80
h	0.44	0.89	1.19	0.19	0.39	0.52
g x h	1.16	2.35	3.15	0.51	NS	NS

IM: 95-109 DAF; PM: 110-124 DAF; FR: 125-140 DAF.

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Table 2. Essential oil composition of cardamom genotypes at three harvest stages.

Compound	RI	Composition (%)																				
		IC 349589			IC 547136			IC 349591			IC 547185			IC 349646			IC 349650			IC 349396		
		IM	PM	FR	IM	PM	FR	IM	PM	FR	IM	PM	FR	IM	PM	FR	IM	PM	FR	IM	PM	FR
α-Pinene	935	1.26	1.17	-	1.21	1.15	1.15	1.06	1.08	0.86	1.34	1.28	1.16	1.20	1.47	1.20	1.30	1.26	1.17	0.88	0.77	0.72
Sabinene	976	3.68	3.56	2.96	3.63	3.62	3.52	3.84	3.80	3.20	4.26	4.14	3.88	3.80	4.39	3.80	3.98	3.89	3.74	2.95	2.85	2.61
α-Myrcene	993	2.16	1.83	1.42	2.35	2.29	1.87	1.97	1.92	1.57	2.50	2.33	2.09	1.98	2.31	1.95	1.97	2.13	1.75	2.03	2.18	2.06
1,8-Cineole	1038	21.66	22.84	23.78	24.50	24.33	23.86	22.63	23.61	22.32	23.21	23.59	21.65	24.90	27.22	26.87	27.34	26.42	25.32	16.08	15.88	17.59
Linalool	1108	4.03	3.89	3.51	5.21	5.27	5.33	1.45	1.45	1.50	4.16	4.04	4.02	-	-	-	-	-	-	8.98	9.38	8.66
4-Terpineol	1182	2.68	2.45	2.40	2.30	2.40	2.19	2.38	2.48	2.55	2.70	2.47	2.53	2.37	2.28	2.25	2.37	2.43	2.26	2.71	2.68	2.53
α-Terpineol	1198	6.52	6.46	6.34	5.02	5.11	5.06	7.16	7.32	7.37	6.84	5.56	5.91	2.58	2.25	3.21	2.95	2.46	3.08	5.25	5.97	5.40
Nerol	1259	4.40	3.92	3.27	4.99	5.06	5.24	2.63	2.61	2.32	2.72	2.97	-	2.67	2.58	1.99	2.24	2.48	2.13	6.81	6.66	6.19
α-Terpiny-lacetate	1366	39.28	40.90	45.16	41.61	41.73	40.54	45.53	44.63	43.82	42.62	44.52	45.27	46.51	45.49	47.24	45.61	47.92	46.43	39.79	40.44	40.20
Geranyl acetate	1388	3.16	2.57	1.20	3.35	3.43	2.13	2.79	2.23	0.92	3.32	2.98	1.49	2.49	1.99	1.51	1.84	1.49	0.84	2.72	2.05	1.62
Nerolidol	1567	2.70	2.30	2.44	1.00	0.92	1.07	1.72	1.72	1.89	0.31	0.76	0.89	1.26	1.22	1.30	1.21	1.32	1.40	3.03	2.82	3.03

RI: Relative linear indices; IM: 95-109 DAF; PM: 110-124 DAF; FR: 125-140 DAF.

maintained for 5 minutes. GC-MS analysis was carried out using a Shimadzu GC-2010 gas chromatograph equipped with QP 2010 mass spectrometer. RTX–5 column (30 m x 0.25 mm, film thickness 0.25 µm) coated with polyethylene glycol was used. Helium was used as the carrier gas at a flow rate of 1.67 ml/minute. The injection port was maintained at 220°C, the detector temperature was 250°C. Oven temperature was programmed as stated above. The split ratio was 1:40 and ionization voltage maintained at 70 eV. 0.1 µl sample was injected. The compounds were identified by a combination of retention indices, co-injection of the authentic standards purchased from Fluka Chemicals and also by matching the mass spectrum of individual compounds with that of NIST and Wiley library and published literatures (Adams, 1). The concentration of each compound was determined by area normalization.

The seed content in capsules and essential oil yield in the seven genotypes of cardamom at three maturity levels are indicated in table 1. The results revealed that mean seed content increased with maturity and the highest mean seed content (72.72%) was recorded at fully ripe stage in all genotypes. Among the seven genotypes, the highest seed weight content of 74.3% was recorded in the genotype IC 547185. In IC-547136 and IC-349591, the seed content in capsules harvested at immature stage were at par with that of physiologically mature stage, whereas in IC-349650 during the three stages of harvest, the seed content did not vary significantly. The increase in seed weight with maturity is due to the accumulation of starch during the later stage (Pruthi, 9). The interaction between genotypes and harvest stages showed significant differences. The highest mean oil yield was obtained at immature stage, which was at par with that of physiologically mature stage. In all genotypes, the lowest oil yield was recorded at fully ripe stage. The difference between immature and physiologically mature stages was non-significant except for IC 547185 and IC 349591. Among the genotypes, IC 547185 recorded the highest oil yield at the immature stage. In IC 349646, IC 349650, IC 349396, IC 349589 and IC 547136, the oil yield at immature and physiologically stage was not significantly different. Sarathkumara *et al*. (10) reported that volatile oil content increased with maturity because the capsules were harvested at an early stage (during 26-46 days after flowering).

By GC and GC-MS analysis of cardamom oil, 32 compounds contributing to 93-95% of oil were identified, of which the composition of 11 major compounds namely, 1,8-cineole, α-terpinyl acetate, α-pinene, sabinene, α-myrcene, linalool, 4-terpineol, α-terpineol, nerol, geranyl acetate and nerolidol were compared (Table 2). 1,8-cineole and α-terpinyl acetate are the major components in the cardamom volatile oil and the basic cardamom aroma is produced by combination of these two. The major chemical constituents that impart sweet flavour to the oil are α-terpinyl acetate, geranyl acetate, nerol and α-terpineol; while 1,8-cineole imparts harsh camphory note (Zachariah, 12). In the present study, all the seven genotypes had higher level of α-terpinyl acetate compared to 1,8-cineole, indicating their superior quality (Pillai *et al*., 8). Highest α-terpinyl acetate content was recorded in IC-349646 and IC-349650. IC-349396 had the lowest 1,8-cineole content and higher contents of linalool and nerol compared to others genotypes. This is because all these monoterpenes are biosynthesized from a common precursor, namely , geranyl pyrophosphate (Franz, 3). In the essential oil of IC 349646 and IC 349650, linalool could not be detected. In all the genotypes studied, the geranyl acetate content decreased with maturity. The study indicated that the oil composition did not vary much over a period of 95-140 DAF. This might be because the biosynthesis of the secondary metabolites would have been completed by 95 DAF in cardamom capsules. The study also revealed the close chemical similarity between Malabar and *Vazhukka* types.

The present study shows that it is desirable to harvest capsules at physiologically mature stage (110 to 124 days after flowering) as it results in high oil yield. Besides this, green colour retention of the capsules and dry recovery were also reported to be better at physiologically mature stage (Zachariah and Korikanthimath, 13).

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