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Effect of pretreatments and curing methods on the flavor profile of essential oil of processed small cardamom (*Elettaria cardamomum* (L.) Maton)

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Abstract

Flavour profile of essential oil in small cardamom (Elettaria cardamomum (L.) Maton) capsules pre treated with one per cent concentration of sodium carbonate, potassium carbonate, magnesium sulphate, sodium hydroxide, sodium bicarbonate, copper acetate, 0.1 percent of ascorbic acid, citric acid, polyethylene glycol and 500 ppm of naphthalene acetic acid and cured under conventional and modern curing methods were analysed using Gas Chromatography Mass Spectrometry technique. Ninety different chemical compounds had been identified in the essential oil of which, the nine main constituents like 1, 8-cineole, α- terpinyl acetate, limonene, linalool, sabinene, trans nerolidol, α-terpineol, linalyl acetate, myrcene were statistically analyzed to find the influence of pre treatments , and curing methods. The higher percentage of the essential oil as well as α- terpinyl acetate, 1, 8-cineole, linalool, α-terpineol and linalyl acetate were noted in the essential oil obtained from small cardamom capsules pre treated with 1 per cent sodium hydroxide and 1per cent sodium carbonate followed by conventional curing. Pretreatment of small cardamom capsules with either 1 percent sodium hydroxide or with 1per cent sodium carbonate for two minutes followed by conventional curing can thus be a better treatment for retaining good flavor profile of essential oil.

Key words: Small cardamom, Elettaria cardamomum, pre treatment, curing methods , flavor profile, Essential Oil

1. INTRODUCTION

Cardamom is an important spice commodity of international commerce ever since the ancient Greek and Roman period. Indian cardamom occupies an enviable position in the global spice market due to its unique flavour and aroma. The important quality parameters of cardamom in the export market are colour, flavour, aroma, size of capsule, weight per specified volume and freedom from microbial, insect and filth contaminations [1]

The present study to identify the best pretreatment and curing method for small cardamom for retaining a good flavor profile was conducted in the Department of Processing Technology, College of Agriculture, Vellayani, and at Cardamom Research Station, Pampadumpara of Kerala Agricultural University during the period of 2012. The matured capsules of small cardamom (*Elettaria cardamomum* (L.) Maton variety Njallani cultivated at the Cardamom Research Station, Pampadumpara, Idukki was used for the study. The pre treatments and curing were carried out at Cardamom Research Station, Pampadumpara and flavor analysis of essential oil was carried out at Cashew Export Promotion Council Laboratory, Kollam.

11. MATERIALS AND METHODS

The freshly harvested cardamom capsules of Njallani variety were washed to remove soil and filth, then drained and subjected to different pretreatments consisting of one per cent concentration of sodium carbonate, potassium carbonate, magnesium sulphate, sodium hydroxide, sodium bicarbonate, copper acetate and 0.1 percent of ascorbic acid, citric acid, polyethylene glycol and 500 ppm of naphthalene acetic acid for two minutes and cured under conventional and modern curing methods. Experiments were laid out in completely randomized design (CRD). The pre treated, cured hot capsules were polished. The essential oil was extracted by hydro distillation method using modified Clevenger apparatus [2] on dry whole capsule weight basis. The steam distillate was removed, dried over anhydrous sodium sulphate and stored at low temperature. The oil collected was computed as percentage oil (volume/dry weight in 100 g).The flavour profile of essential oil was carried out using Gas Chromatography-Mass Spectrometry (GC-MS) technique.

The essential oils were directly analysed by gas chromatography coupled to mass spectrometry (GC-MS- computerized system comprising a 3800 gas chromatograph coupled to a Saturn 2200 mass spectrometer) using a fused –silica –capillary column with a polar stationary phase and Varian factor four capillary column VF-5ms (30 M x 0.25 MM) I.D,DF=0.25. Gas Chromatography-Mass Spectrometry were obtained using the following conditions: carrier gas- He; flow rate 1.0mL/min; split 1:20; injection volume 1microL; injection temperature 220^0C; oven temperature progress from 60 to 246^0C at 3^0/min, from 246 - 300^0C at 20^0C/min and holding at 300^0C for 30 min; the ionization mode used was electronic impact at 70Ev. Identification of the components was achieved from their relative retention indices (RRI) on VF-5ms column, determined with reference to an homologous series of C_8 – C_{28} *n*-alkanes and by a comparison of their mass spectral fragmentation patterns with those stored in the data bank (NIST library) and the literature.

The data of major nine chemical compounds of essential oil of small cardamom pre treated with different chemicals and cured under conventional and modern curing method were analyzed using analysis of variance technique [3] and are presented.

111. RESULTS AND DISCUSSION

The essential oil of small cardamom variety Njallani analysed using gas chromatography coupled with mass spectrometry revealed upto ninety compounds which is presented in Table 1.

Flavour profile of essential oil of small cardamom

The gas chromatograms showed upto 150-200 peaks and upto 90 compounds were identified. Among the identified compounds of essential oil of pretreated and cured small cardamom the major nine compounds were statistically analysed and presented. The identified 90 compounds are listed in Table 1.

The capillary column and gas chromatography has shown over 150 compounds in cardamom oil [4]. While many of the identified compounds – alcohols, esters and aldehydes are commonly found in many spice oils, the dominance of ether 1,8 –cineole and the esters α – terpinyl and linalyl acetate in the composition, make the cardamom volatile oil a unique one [5,6,4,7] .

Table 1. Chemical compounds present in essential oil of small cardamom

Common name	Chemical name
α- pinene	Bicyclo [3.1.1]hept-2-ene,2,6,6-trimethyl
β – pinene	Bicyclo [3.1.1] heptanes 6,6-dimethyl-2- methylene
Sabinene	Bicyclo [3,1,0] hexane, 4 –methylene -1-[1-methyl ethyl]-
Myrcene	1,6-octadiene,7-methyl-3-methylene
α- phellandrene	2-methyl-5-(1-methylethyl)
Limonene	1-methyl-4-(1-methylethyl)-cyclohexene
1,8-cineole	1,3,3-trimethyl-2-oxabicyclo(2.2.2)octane
γ - terpene	1-methyl-4-(1-methylethyl)-1,4-cyclohexadiene
p- cymene	1-methyl-4-isopropylbenzene
Terpinolene	4-Isopropylidene-1-methyl-cyclohexane
Linalool	2,6-Dimethyl-2,7-octadien-6-ol
Linalyl acetate	1,6-Octadien-3-ol,3,7-dimethyl-,acetate
Terpinen -4-ol	3-cyclohexane -1-ol,4-methyl-1-(1-methylethyl)
α- terpineol	3-cyclohexene -1-methanol, α, α,4-trimethyl-,(S)-
α- terpinyl acetate	p-menth-1-en-8-yl acetate
Citronellol	6-octane- 1-ol,3,7-dimethyl
Nerol	2-cis-3,7-Dimethyl-2,6-octadien-1-ol
Geraniol	Trans-3,7-Dimethyl-2,6-octadien-1-ol
Methyl eugenol	1-(3,4-Dimethoxyphenyl)-2-propene
Trans –nerolidol	trans-3,7,11-Trimethyl-dedeca-1,6,10-trien-3-ol
α- thujene	2-methyl-5-(1-methylethyl)bicycle[3.1.0]hex-2-ene
Camphene	Bicyclo[2,2,1], heptanes, 2,2- dimethyl -3-methylene –
α- terpinene	1-Isopropyl-4-methyl-1,3-cyclohexadiene
Cis-ocimene	cis-3,7-Dimethyl-1,3,6-Octatriene
Trans –ocimene	trans-3,7-Dimethyl-1,3,6-Octatriene
Toluene	Monomethyl benzene
p-dimethyl styrene	1-Methyl-4-(1-methylethenyl)-benzene
Cyclosativene	1,2α,4-Methenoindan,3aβ,4β,5,6,7.7a-hexahydro-5α-isopropyl-1β,7aβ-dimethyl
α - copane	Tricyclo[4.4.0.02,7]dec-3-ene,1,3-dimethyl-8-(1-methylethyl)-,
α - ylangene	Tricyclo[4.4.0.02,7]dec-3-ene,8-isopropyl-1,3-dimethyl-,(1S,2R,6R,7R,8S)-(+)-
γ - cadiene	Naphthalene
Acetic acid	Acetic acid 1-methyl-1-(4-methyl-5-oxo-cyclohex-3-enyl)-ethylester
Propionic acid	1-methyl-1-(4-methyl-3-cyclohexen-1-yl) ethyl 2-methylpropanoate
Butyric acid	1-Propanecarboxylic acid
2-methyl butyric acid	2-methyl-iso valeric acid
3-methyl butyric acid	3-methylbutanoic acid ethyl ester
3-methyl butanol	Isopentan-1-ol
p-meth-3-en-1-ol	4-(1-Methylethyl)-1-methyl-2-cyclohexenol
Cuminyl alcohol	4-(1-methylethyl)benzenemethanol
p-cresol	1-Hydroxy-4-methylbenzene
Carvacerol	2-methyl-5-isopropylphenol
Thymol	1-Hydroxy-5-methyl-2-isopropylbenzene
Carbonyls	carbon oxide sulphide
3-methyl butanal	3-Methylbutyric aldehyde
2-methyl butanal	2-Methylbutyric aldehyde
Pentanal	n-Valeric aldehyde
Furfural	2-furancarboxyaldehyde
8-acetoxycarvotanacetone	10H-phenothiazin-2-ol, 8-chloroo-10-[3-dimethyl amino], propyl-acetate[ester]
Cuminaldehyde	4-isopropylbenzaldehyde
Carvone	2-Cyclohexen-1-one,2-methyl-5-(1-methylethenyl)-
Pinole	Cis-pinonic acid

Terpinyl-4-ylacetate	p-menth-1-en-8-yl acetate
α -terpinene propionate	p-menth-1-en-8-yl propionate
Dihydro – α – terpinyl acetate	p-8-menthanyl acetate
Styrene	Isopropenyl toluene
α - terpinyl propionate	p-menth-1-en-8-yl propionate
3-boranol	Bicyclo[2,2,1]heptan-2-ol
Bornyl acetate	1,7,7-Trimethylbicyclo(2.2.1)heptan-2-ol acetate
Methyl nerolate	cis-2,6-Octadienoic acid, 3,7-dimethyl-methyl ester
Gurjunene	7-isopropenyl-1,4-dimethyl-1,2,3,3a,4,5,6,7-octahydroazulene
Cadinene	1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-(1-methylethyl)-
Guajene	1,2,3,4,5,6,7,8-octahydro-1,4-dimethyl-7-(1-methylethyl)-

Cymene	p-Isopropylmethybenzene
Retinal	2,4,6,8-Nonatetraenal,3,7-dimethyl-9-(2,6,6-trimethyl-1-cyclohexen-1-yl)
Thujene	1-isopropyl-4-methylenebicyclo [3,1,0]hexene
Caryophyllene	Bicyclo [7,2,0]undec-4-ene,4,11,11-trimethyl-8-methylene-,(E)-(1R,9S)-(-)
Isogeraniol	3,6-octadien-1-ol, 3,7-dimethyl-(Z)-
Cumene	2-Phenylpropane
Safranal	2,6,6-Trimetyl-1,3-cyclohexadiene -1-carboxaldehyde
Deoxy l*ycorenine	Lycorenan, 9,10 –dimethoxy -1-mehyl-
Cis-5-octane-1-ol	5-octaen-1-ol,(Z)-
Pinene oxide	2,7,7-trimethyl-3-oxatricyclo[4.1.1.02,4]octane
α - thujene	2-methyl-5-(1-methylethyl)-bicyclo[3,1,0]hex-2-ene
Octane	Octatriene
Geranyl toluate	3,7-Dimethyl-2,6-octadienyl phenylacetate
Cinnamic acid	Trans-3-Phenyl-2-propenoic acid
L-tyrosine	A-Amino-β-(4-hydroxyphenyl)propionic acid)
Linolenin	9,12,15-octadecatrienoic acid
Camphosulfonyl chloride	Bicyclo [2,2,1]heptane-1-methanesulfonyl chloride,7,7-dimethyl-2-oxo-
Isolimone	3-isopropenyl-6-metyl-1-cyclohexene-,(3R-trans)-
Muurolene	[1α,4aα,8aα]-Naphthalene,1,2,3,4,4a,5,6,8a-octahydro-7-methyl-4-methylene-1-[1-methylethyl]-
Phthalic acid	1,2-benzenedicarboxylic anhydride
Masonine	1-Methyl-9,10-[methylenebis(oxy)lycorenan-7-one
2-carene	Bicyclo [4,1,0]hept-2-ene,3,7,7,-trimethyl-
Anthranilic acid	1,6-octadien-3-oll, 3,7-dimethyl-, 2-aminobenzoate1,6-octadien-3-oll, 3,7-dimethyl-, 2-aminobenzoate
Deoxy lycorenin	Lycorenan 9,10-dimethoxy-1-methyl
2-propenoic acid	1,3-butylene glycol dimethacrylate
1-verbenone	Bicyclo[3,1,1]hept-3-en-2-one, 4,6,6 –trimethyl-
Octatriene	trans-3,7-Dimethyl-1,3,6-Octatriene
Cyclohexanol	1-methyl -4-[1-methylethylidene]-

Effect of pretreatments and curing methods on the major constituents of essential oil of small cardamom

The pretreated capsules showed significant variation in essential oil content (Table 2). The different curing methods were not influential in making any significant difference in the essential oil content. The cardamom capsules treated with 1% sodium hydroxide, 1% sodium carbonate and 1% magnesium sulphate had shown higher essential oil content (5.83%, 5.58% and 5.42% respectively) and was on par. All other pre treatments were on par with respect to essential oil content. The predrying treatment of small cardamom capsules with 2 percent sodium carbonate and drying temperature of 45 ^{0}C showed minimum loss in total oil, while maximum terpenoids were retained at 45^{0}C in the untreated cardamom[8].

Table 2. Effect of pre treatments and curing methods on the essential oil content (%) of small cardamom

Pre treatments	Curing methods		Mean
	Conventional curing	Modern curing	
Sodium carbonate (1%)	6.1	5.07	5.58
Potassium carbonate (1%)	4.87	3.83	4.35
Magnesium sulphate (1%)	5.83	5	5.42
Sodium hydroxide (1%)	6.3	5.37	5.83
Sodium bicarbonate (1%)	4.2	3.87	4.03

Ascorbic acid (0.1%)	4.1	4.07	4.08
Citric acid (0.1%)	4.97	3.87	4.42
Polyethylene Glycol (0.1%)	3.8	4.97	4.38
Naphthalene Acetic Acid (500ppm)	4.63	4.7	4.67
Potassium carbonate (1%)	4.87	3.83	4.35
Magnesium sulphate (1%)	5.83	5	5.42
Sodium hydroxide (1%)	6.3	5.37	5.83
Sodium bicarbonate (1%)	4.2	3.87	4.03
Ascorbic acid (0.1%)	4.1	4.07	4.08
Citric acid (0.1%)	4.97	3.87	4.42
Polyethylene Glycol (0.1%)	3.8	4.97	4.38
Naphthalene Acetic Acid (500ppm)	4.63	4.7	4.67
Copper acetate (1%)	3.87	4.27	4.07
Control (no treatment)	4.4	4.6	4.5
Mean	4.82	4.50	
Treatment effects	**SE**	**CD**	
Pre treatments	0.36	1.04**	
Curing methods	0.16	NS	

Table 3. Effect of pre treatments and curing methods on flavor profile of small cardamom

Pre treatments	α- terpinyl acetate (%)			1, 8 - Cineole (%)			Limonene (%)		
	Curing methods		Mean	Curing methods		Mean	Curing methods		Mean
	Conventional curing	Modern curing		Conventional curing	Modern curing		Conventional curing	Modern curing	
Sodium carbonate (1%)	37.2	36.87	37.03	37	35.8	36.4	2.9	3.57	3.23
Potassium carbonate (1%)	36.67	36.13	36.4	37.6	37	37.3	4	3.37	3.68
Magnesium sulphate (1%)	37.33	36	36.67	40.37	38.3	39.3	2.5	4.5	3.5
Sodium hydroxide (1%)	39.37	38	38.68	37.4	37.3	37.35	3	3.53	3.27
Sodium bicarbonate (1%)	37.57	36.4	36.98	36.3	36.4	36.35	3.23	3.77	3.5
Ascorbic acid (0.1%)	34.3	34	34.15	40.6	39.2	39.9	4.33	4.03	4.18
Citric acid (0.1%)	34.5	34	34.25	36	35.5	35.75	4.23	4.03	4.13
Polyethylene Glycol (0.1%)	35.47	35	35.23	38.6	38	38.3	3.23	3.27	3.25
Naphthalene Acetic Acid (500ppm)	34.48	34	34.24	40.1	38.5	39.3	3.09	3.01	3.05
Copper acetate (1%)	33	32	32.5	39.27	39	39.13	3.05	2.9	2.97
Control (no treatment)	34.5	34	34.25	38.2	37.8	38	3.33	3	3.17
Mean	35.85	35.13	-	38.31	37.53	-	3.36	3.54	-
Treatment effects	**SE**	**CD**		**SE**	**CD**		**SE**	**CD**	
Pre treatments	0.22	0.64**		0.15	0.44**		0.12	0.34**	
Curing methods	0.09	NS		0.06	0.19**		0.05	0.14**	

Table 4. Effect of pre treatments and curing methods on flavor profile of small cardamom

Pre treatments	linalool (%)			sabinene(%)			trans nerolidol (%)		
	Curing methods		Mean	Curing methods		Mean	Curing methods		Mean
	Conventional curing	Modern curing		Conventional curing	Modern curing		Conventional curing	Modern curing	
Sodium carbonate (1%)	4.47	4	4.23	3.34	3.33	3.34	2	3.17	2.58
Potassium carbonate (1%)	4.27	4.13	4.2	1.83	2.12	1.98	1.96	3.33	2.65
Magnesium sulphate (1%)	4.27	4.03	4.15	2.7	2.67	2.68	2.04	1.93	1.99
Sodium hydroxide (1%)	4.67	4.17	4.42	2.93	2.5	2.72	2.10	2.09	2.09
Sodium bicarbonate (1%)	4.17	4	4.08	2.93	2.73	2.83	2.60	2.13	2.37
Ascorbic acid (0.1%)	3.77	3.57	3.67	1.74	3.10	2.42	2.02	2.02	2.02
Citric acid (0.1%)	3.6	3.43	3.52	3.43	3.13	3.28	1.97	2.43	2.20
Polyethylene Glycol (0.1%)	2.13	2.01	2.07	1.4	2.13	1.77	1.81	2.10	1.96
Naphthalene Acetic Acid (500ppm)	3.8	4.17	3.98	1.01	1.53	1.27	3.10	2.93	3.02
Copper acetate (1%)	3.23	3.33	3.28	4.57	4.93	4.75	2.50	2.47	2.48
Control (no treatment)	4.03	3.33	3.68	2.12	4	3.06	3.30	3.10	3.2
Mean	3.86	3.65	-	2.55	2.93	-	2.31	2.52	-
Treatment effects	**SE**	**CD**		**SE**	**CD**		**SE**	**CD**	
Pre treatments	0.22	0.64**		0.15	0.44**		0.12	0.34**	
Curing methods	0.09	NS		0.06	0.19**		0.05	0.14**	

Table 5. Effect of pre treatments and curing methods on flavor profile of small cardamom

Pre treatments	α- terpineol (%)			linalyl acetate (%)			myrcene (%)		
	Curing methods		Mean	Curing methods		Mean	Curing methods		Mean
	Conventional curing	Modern curing		Conventional curing	Modern curing		Conventional curing	Modern curing	
Sodium carbonate (1%)	3.33	3.12	3.23	4.37	4.21	4.29	1.93	2.08	2.01
Potassium carbonate (1%)	3.33	2	2.67	1.73	1.53	1.63	1.15	1.87	1.51
Magnesium sulphate (1%)	3.13	2.37	2.75	4.37	4.2	4.28	1.25	1.2	1.22
Sodium hydroxide (1%)	3.15	2.83	2.99	4.7	4	4.35	1.28	1.41	1.35
Sodium bicarbonate (1%)	2.93	2.7	2.82	2.03	1.53	1.78	2.57	2.5	2.53
Ascorbic acid (0.1%)	3.13	2.7	2.92	1.87	1.63	1.75	2.34	2.26	2.30
Citric acid (0.1%)	3.40	3.13	3.27	2.63	2.37	2.5	2.03	2.12	2.08
Polyethylene Glycol (0.1%)	3.17	2	2.58	3.7	3.5	3.6	2.77	2.83	2.8
Naphthalene Acetic Acid (500ppm)	3.18	3	3.09	4.2	3.7	3.97	1.02	2.01	1.52
Copper acetate (1%)	2.6	2.13	2.37	2.3	2.03	2.17	2.5	2	2.25
Control (no treatment)	2.83	2.67	2.75	2.43	2.13	2.28	2.13	1.97	2.05
Mean	3.11	2.61	-	3.12	2.80	-	1.91	2.02	-
Treatment effects	**SE**	**CD**		**SE**	**CD**		**SE**	**CD**	
Pre treatments	0.17	0.49*		0.12	0.33**		0.14	0.40**	
Curing methods	0.07	0.21**		0.04	0.14**		0.06	NS	

The α-terpinyl acetate and 1, 8-cineole content in essential oil showed significant difference among pre treatments and curing methods. The higher content of α- terpinyl acetate were reported from capsules treated with 1% sodium hydroxide (38.68%) and 1% sodium carbonate (37.03%) compared to control. The capsules treated with conventional curing method showed a higher concentration of α- terpinyl acetate (35.85%) and 1, 8-cineole (38.31%) compared to modern curing. The 1, 8- cineole content in the essential oil of small cardamom pre treated with 1% sodium hydroxide, 1% potassium carbonate and control were on par. The ratio of 1, 8-cineole to α – terpinyl acetate is a fairly good index of the purity and authenticity of cardamom volatile oil [9]. The volatile oil from variety Malabar represented by Coorg greens are ‘‘more camphory’’ in aroma due to the relatively higher content of 1,8-cineole. It is known that the early fraction during distillation are dominant in low boiling monoterpenes and 1, 8-cineole. The α terpinyl acetate contributes to the mildly herbaceous sweet spicy flavor that is predominant in var. Mysore or the commercial grade commonly known as “Álleppey Green”. [1]. The GC- MS evaluation of the essential oil of the enzyme pretreated small cardamom showed an increase from 38.9 percent to 48.6 percent in α - terpinyl acetate[10] . As high as 41% of 1, 8 – cineole content in the oil of variety Malabar and as low as 26.5 percent in the oil from variety Mysore was reported [11]. 1,8 – cineole is a biosynthetic dead end in many systems thus allowing accumulation of large quantities of this compound in plants. The results of the present experiment also showed higher α –terpinyl acetate in the cardamom capsules treated with 1% sodium hydroxide and sodium carbonate indicating the superiority of the above chemicals in enhancing the flavour.

In the essential oil of small cardamom capsules, limonene, linalool and sabinene content in essential oil of small cardamom capsules showed significant difference among different pre treatments (Table 3, 4.). The content of limonene in the capsules treated with 0.1 % ascorbic acid (4.18%), 0.1 % citric acid (4.13%), 1% potassium carbonate (3.68%), 1% magnesium sulphate (3.5%) and 1% sodium bicarbonate (3.5%) were on par. The linalool content in essential oil of small cardamom capsules pre-treated with 1% sodium hydroxide (4.42%), 1% sodium carbonate (4.23%), 1% potassium carbonate (4.2%), 1% magnesium sulphate (4.15%), 1% sodium bicarbonate (4.08%) and 500 ppm naphthalene acetic acid were on par. The highest sabinene content was noticed with the capsules treated with 1% copper acetate (4.75%). The sabinene content in essential oil of small cardamom capsules treated with 1% sodium carbonate (3.34%), 0.1% citric acid (3.28%) and capsules treated as control (3.06%) were on par. Significant variation in sabinene content was noticed among conventional and modern curing methods. The cardamom oil from Sri Lanka gave a high range of values for α pinene plus sabinene, 4.5 to 8.7 percent and linalool 3.6-6 percent and a wider range for the principal components 1,8- cineole, 27-36.1 percent and α – terpinyl acetate, 38.5-47.9 percent[1] .It was observed that locations also do play a role in altering the concentration of linalool, limonene and α- terpineol [11].

Trans neorolidol and α- terpineol content in essential oil of small cardamom showed significant difference among pre treatments and curing methods. The highest concentration of trans nerolidol content was noticed in untreated cardamom capsules (3.2%) while the capsules treated with 0.1 % citric acid and 1 % sodium carbonate recorded the highest α- terpineol content. The modern curing method recorded a higher percentage of trans nerolidol content (2.51%) where as α- terpineol content (3.11%) was more in conventional method of curing.

The percentage of linalyl acetate and myrcene content in essential oil showed significant difference among different pre treatments. The capsules treated with 1% sodium hydroxide (4.35%), 1% sodium carbonate (4.29%) and 1% magnesium sulphate (4.28%) were on par with respect to the linalyl acetate content in essential oil. Significant variation was noticed among the curing methods

with respect to linalyl acetate. Cardamom capsules treated with conventional curing method showed higher mean percentage of linalyl acetate (3.12%) compared to modern curing (2.80%). The combination of lower 1,8- cineole with harsh camphory note and higher linalyl acetate with its sweet, fruity floral odour result in the relatively pleasant mellow flavour in the variety Mysore [1].

The cardamom oil contained terpinene, sabinene, limonene, 1, 8 – cineole, α - terpinyl acetate, terpinen -4-yl formate and acetate and terpinen -4-ol [12]. All plants employ the general isoprenoid pathway in the synthesis of certain essential substances. The mono and sesqui terpenes are regarded as diverging at the C_{10} and C_{15} stages respectively in the biosynthetic pathways. This, now well known pathway, begins with the condensation of 3-acetyl CoA in two steps to form hydroxyl methyl –glutaryl -CoA which is reduced to mevalonic acid, the precursor of all isoprenoids. A series of phosphorylations and decarboxylation with the elimination of the C-3 oxygen function (as phosphate) yields isopentenyl pyrophosphate (IPP) [13]. This is isomerised to dimethylallyl pyrophosphate (DMAPP). This in turn leads to synthesis of geranyl pyrophosphate (GPP) and farnesyl pyrophosphate (FPP). The biosynthesis of monoterpenes, limonene and carvone, proceeds from geranyl diphosphate. The geranyl diphosphate is cyclised to (+) –limonene by mono terpene synthase. This intermediate is either stored in essential oil ducts without further metabolism or is converted by limonene-6-hydroxylase to (+) - trans carveol. This is oxidised by a dehydrogenase to (+) – carvone[14]. The biosynthesis of 1,8 – cineole from linalyl pyrophosphate [15]. 1, 8 cineole and α -terpinyl acetate together with terpene alcohols (linalool, terpinen-4 ol and α –terpinol) are important for the evaluation of aroma quality of cardamom[11]. The cardamom treated with 1 % sodium hydroxide and 1 % sodium carbonate retained more flavour which might be due to the presence of suitable combination of α - terpinyl acetate , 1,8 cineole, linalool , α – terpineol and linalyl acetate.

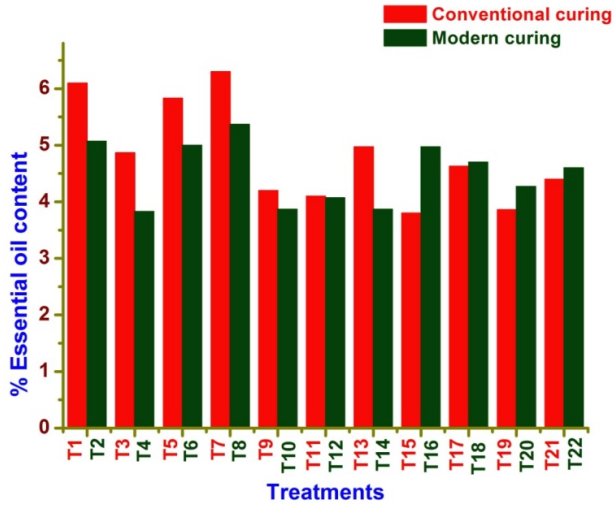

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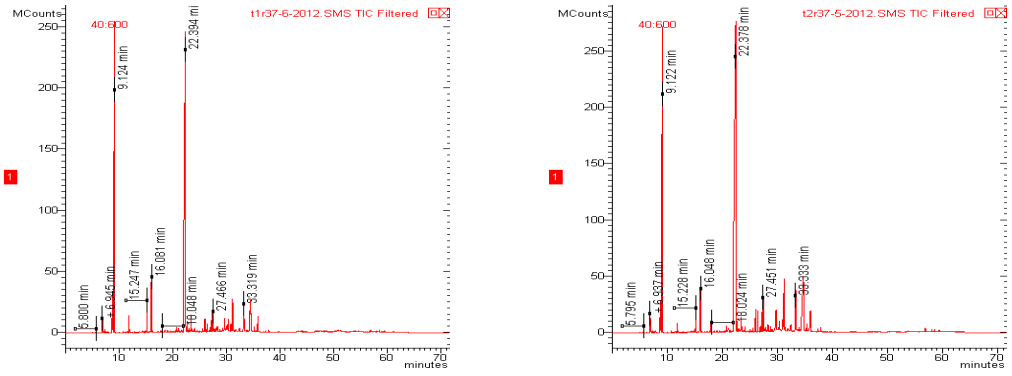
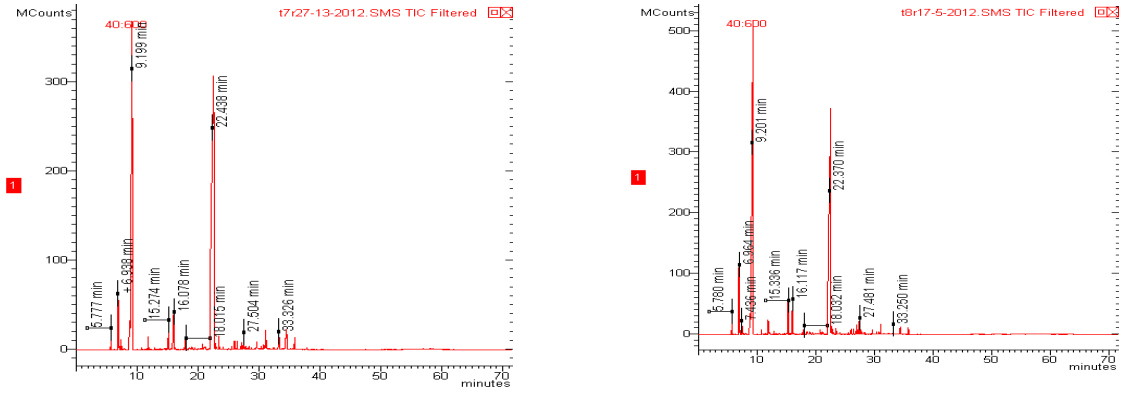
Fig.1.Effect of pretreatments and curing methods on the essential oil content (%) of small cardamom

Chromatogram of essential oil of small cardamom samples pre treated with different chemicals



a)Conventional curing *b) Modern curing*

Fig. 2. Chromatogram of essential oil of small cardamom samples pre treated with sodium carbonate (1%)



a) Conventional curing *b) Modern curing*

Fig. 3 Chromatogram of essential oil of small cardamom samples pre treated with sodium hydroxide (1%)

Chromatogram of essential oil of small cardamom samples pre treated and cured under conventional and modern method showed about 150 compounds of which nine have been analysed statiscally. Each particular compound corresponds to particular period of retention time in all the treatments. If a compound shows identical mass spectrum and retention time with a known compound then, they are considered identical. The major nine compounds identified in a range of retention time were listed below (Table 6).

Table. 6. Compounds present in chromatogram of treated small cardamom samples

Sl.No	Range of retention time	Name of compound
1	5.7 - 5.82	Limonene
2	6.93 - 6.97	Sabinene
3	7.42 - 7.46	Myrcene
4	9.05 - 9.29	α- terpinyl acetate
5	15.22 - 15.41	α –terpineol
6	16.03 -16.23	Linalool
7	22.26 - 22.51	1,8-cineole
8	27.45 - 27.54	trans nerolidol
9	33.17 – 33.40	linalyl acetate

Pretreating small cardamom with 1% sodium carbonate or sodium hydroxide for two minutes was found to be superior in retaining the major flavor constituents of essential oil. These treatments retained more of esters like α- terpinyl acetate, linyl acetate, the terpenoid oxide, 1,8- cineole, terpene alcohols like linalool and α- terpineol. The combination of higher α- terpinyl acetate, linalool , α- terpineol and linyl acetate and slightly lower 1,8 cineole have resulted in a mellow flavor in the essential oil of small cardamom pretreated with 1% sodium carbonate or sodium hydroxide for two minutes and cured in conventional method which is similar to higher flavor characteristics of oil from Mysore and Guatemalan varieties of small cardamom[16] suggesting that post harvest processing can alter the flavor characteristics.

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