Effect of Methods of Separation on Ginger Oil

Method of extractions affects how many components of a sample is successfully extracted from the sample. Figure one shows the chromatogram obtained for ginger oil using three separation methods. The GC/EIMS chromatogram of the cold macerations method shows thirty peaks (30), hot extraction, fifty four (54 peaks) and the liquid-liquid method, thirty peaks (30) respectively. The hot extraction method, the soxhlet method, extracted the oil the most out of the three separation methods of this sample, ginger oil. Table 1 shows components extracted by each method. The components comprises of different classes of compounds as indicated in table 2.

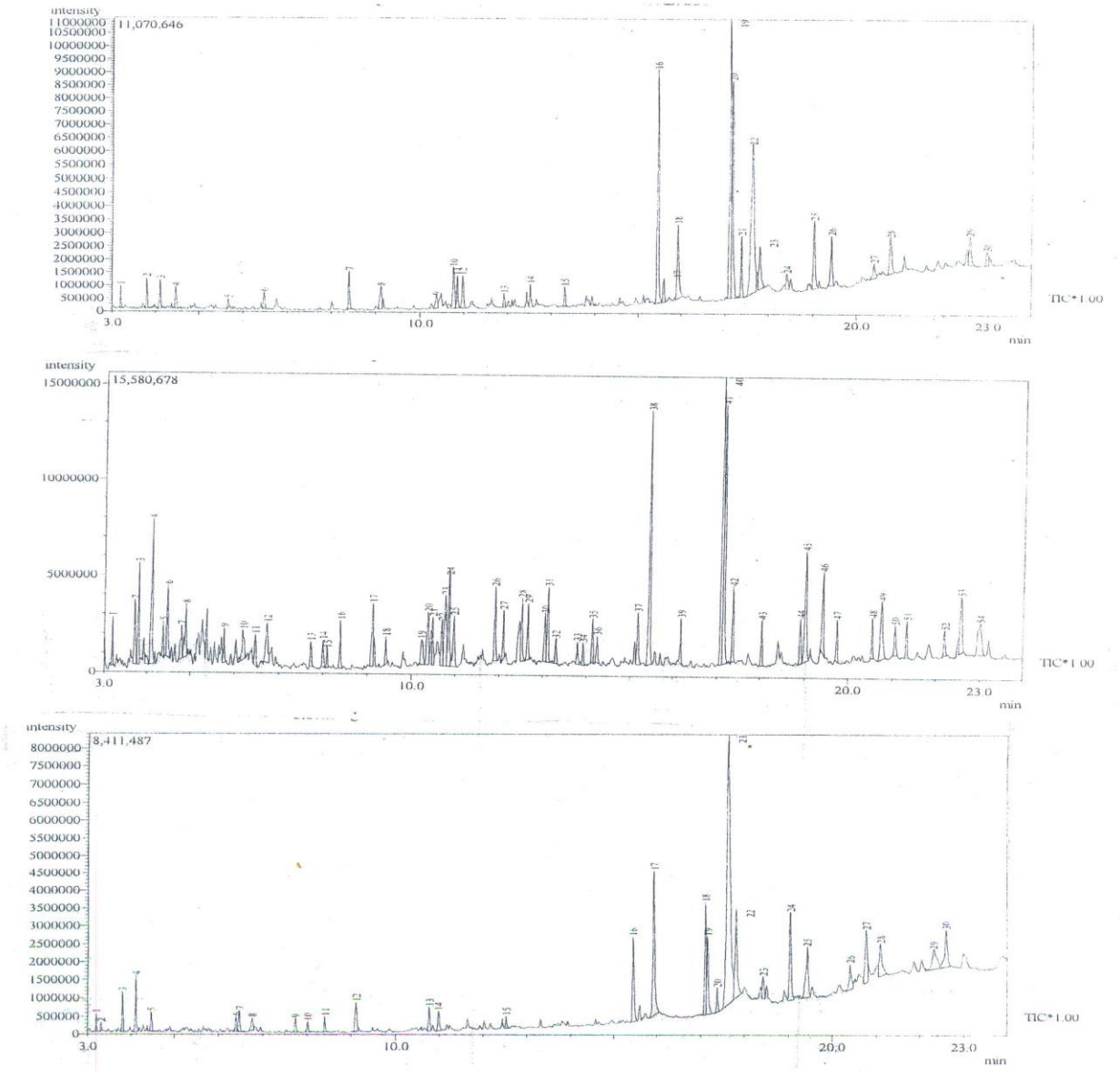

Figure 1 Separation of Ginger oil by (a) Cold Maceration (b) Hot Extraction (c) Liquid-Liquid Extraction -

Table 1 Components of Giger oil Extracted by Three Different Methods

Cold Maceration Method			Hot Extraction Method			Liquid –Liquid Method		
Peak #	**Ret Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**
1	3.20	Hexanoic acid methyl ester ($C_7H_{14}O_2$)	1	3.19	Hexanoic acid methyl ester ($C_7H_{14}O_2$)	1	3.20	Hexanoic acid methyl ester ($C_7H_{14}O_2$)
2	3.80	Unknown ($C_7H_{15}O$)	2	3.70	1,2,3-Trimethyl Benzene (C_9H_{12})	2	3.31	2—Ethyl-2-pentanal ($C_7H_{20}O$)
3*	4.108	(S)-1-piperideine-6-carboxylate ($C_6H_8NO_2$)	3	3.792	1,2,4-Trimethyl Benzene (C_9H_{12})	3	3.8	Unknown ($C_7H_{23}O$)
4	4.467	isopropyltoulene ($C_{10}H_{14}$)	4	4.1	1-ethyl-2-methyl Benzene (C_9H_{12})	4*	4.1	(S)-1-piperideine-6-carboxylate ($C_6H_8NO_2$)
5	5.658	Unknown ($C_8H_{15}O$)	5	4.37	1,3,7-Octatriene ($C_{10}H_{16}$)	5	4.47	Isopropyl toluene ($C_{10}H_{14}$)
6	6.467	Unknown (C_9H_{13})	6	4.47	1,4-diethyl-Benzene ($C_{10}H_{14}$)	6	6.4	Unknown ($C_9H_{19}O$)
7	8.40	Decanoic acid, methyl ester ($C_{11}H_{22}O_2$)	7	4.79	1-Methyl-3-propyl Benzene ($C_{10}H_{14}$)	7	6.48	Borrneol ($C_{10}H_{18}O$)
8	9.12	2-Butyl-2-octenal ($C_{12}H_{22}O$)	8	4.89	3-Carene-2-ol ($C_{10}H_{16}O$)	8	6.76	Octenol ($C_8H_{16}O$)
9	10.37	β-cubebene ($C_{15}H_{24}$)	9	5.76	2-Ethyl-1,3-dimethyl Benzene ($C_{10}H_{14}$)	9	7.73	1-Isobutyl-2,5-dimethyl benzene ($C_{12}H_{18}$)
10	10.77	α-copaene ($C_{15}H_{24}$)	10	6.18	(1-Methyl-1-propenyl)-Benzene ($C_{10}H_{12}$)	10	8.01	Unknown (C_8H_{15})
11	10.85	δ-elemene (Cubebene, $C_{15}H_{24}$)	11	6.46	Borneol ($C_{10}H_{18}O$)	11	8.4	Caprylate ($C_8H_{15}O_2^-$)

Table 1 Cont'd

Cold Maceration Method			Hot Extraction Method			Liquid –Liquid Method		
Peak #	**Ret Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**
12	10.98	Dodecanoic acid Methyl ester ($C_{13}H_{26}O_2$)	12	6.73	4-(N-Benzoyl-aminomethyI)-2,3-dihydro-2-methyllH-Isoindole ($C_{10}H_{12}N$)	12	9.1	Decanoate ($C_{10}H_{19}O_2$)
13	11.92	Farnesyl group ($C_{15}H_{25}$)	13	7.73	5-Phenyl-4-pentenyl-1-alcohol ($C_{11}H_{14}O$)	13	10.77	δ-Elemene (Cubebene, $C_{15}H_{24}$)
14	12.53	Bisabolol oxide ($C_{15}H_{26}O_2$)	14	8.00	Unknown ($C_{10}H_{11}$)	14	10.98	Unknown ($C_9H_{19}O$)
15	13.32	Pentadecanoic acid ($C_{15}H_{30}O_2$)	15	8.1	Unknown ($C_{10}H_7$)	15	12.53	Bisabolol oxide ($C_{15}H_{26}O_2$)
16	14.44	Hexadecanoic acid-methyl ester ($C_{17}H_{34}O_2$)	16	8.39	Unknown ($C_{10}H_{19}O$)	16	15.44	Hexadecanoic acid, methyl ester ($C_{17}H_{34}O_2$)
17	15.59	1,2-Hexadodecanediol ($C_{16}H_{34}O_2$)	17	9.12	2-Octenal, 2-butyl ($C_{12}H_{22}O$)	17	15.92	Hexadecanoic acid, ($C_{16}H_{32}O_2$)
18	15.91	Palmitic acid ($C_{16}H_{32}O_2$)	18	9.42	Unknown (C_9H_{18})	18	17.1	9,12Octadecadienoic acid, methyl ester ($C_{19}H_{34}O_2$)
19	17.10	9,12-Octadecadienoic acid, methyl ester ($C_{19}H_{34}O_2$)	19	10.23	Elemene ($C_{15}H_{24}$)	19	17.15	Methyl Oleate ($C_{19}H_{36}O_2$)
20	17.16	Methyl Oleate ($C_{19}H_{36}O_2$)	20	10.37	Farnesene ($C_{15}H_{24}$)	20	17.35	Octadecanoic acid – methyl ester ($C_{19}H_{38}O_2$)
21	17.38	Octadecanoic acid ,methyl ester ($C_{19}H_{38}O_2$)	21	10.48	Germacrene ($C_{15}H_{24}$)	21	17.63	Oleic acid ($C_{18}H_{34}O_2$)
22	17.62	Linoleic acid ($C_{18}H_{32}O_2$)	22	10.68	Farnesol ($C_{15}H_{26}O$)	22	17.81	Octadecanoic acid ($C_{18}H_{36}O_2$)
23	17.8	Octadecanoic acid ($C_{18}H_{36}O_2$)	23	10.76	γ- Muurolene ($C_{15}H_{24}$)	23	18.42	Stearidonic acid ($C_{18}H_{28}O_2$)

Table 1 Cont'd

Cold Maceration Method			Hot Extraction Method			Liquid –Liquid Method		
Peak #	**Ret Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**
24	18.42	Stearidonic acid ($C_{18}H_{28}O_2$)	24	10.85	α- Muurolene ($C_{15}H_{24}$)	24	19.03	Stearidonic acid ($C_{18}H_{28}O_2$)
25	19.03	Oleic acid anion ($C_{18}H_{33}O_2^-$)	25	10.97	Methyl laurate ($C_{13}H_{26}O_2$)	25	19.42	Eicosadienoic acid ($C_{20}H_{36}O_2$)
26	19.43	Eicosadienoic acid ($C_{20}H_{36}O_2$)	26	11.9	Methyl -9-tetradecenoate ($C_{15}H_{28}O_2$)	26	20.39	Unknown ($C_{18}H_{33}O$)
27	20.39	Oleic acid anion ($C_{18}H_{33}O_2^-$)	27	12.09	7-(2-Hydroxy-2-propanyl)-1,4a-dimethyl decahydro-1-naphthalenol ($C_{15}H_{28}O_2$)	27	20.76	13,16-Docosadienoic acid methyl ester ($C_{23}H_{42}O_2$)
28	20.77	13,16-Docosadienoic acid methyl ester ($C_{23}H_{42}O_2$)	28	12.52	α-Bisabolol Oxide ($C_{15}H_{26}O2$)	28	21.08	13Z, 16Z - Docosadienoic acid ($C_{22}H_{40}O_2$)
29	22.58	Unknown ($C_{23}H_{40}O$)	29	12.66	Pentadecanoic acid ($C_{15}H_{30}O_2$)	29	22.3	Unknown (Oleic acid fragment) ($C_{18}H_{34}O_2$)
30	22.98	Unknown ($C_{23}H_{37}$)	30	13.05	(1S,4aS,7R,8S) -7-(2-Hydroxy-2-propanyl)-1,4a-dimethyl decahydro-1-naphthalenol ($C_{15}H_{28}O_2$)	30	22.58	Adrenic acid/ 7Z,10Z,13Z,16Z - Docosatetraenoic acid ($C_{22}H_{36}O_2$)
			31	13.12	Unknown ($C_{12}H_{25}O_2$)			
			32	13.3	Methyl Tetra decanoate ($C_{15}H_{30}O_2$)			
			33	13.8	β-Bisabolol Oxide ($C_{15}H_{26}O_2$)			

Table 1 Cont'd

Cold Maceration Method			Hot Extraction Method			Liquid –Liquid Method		
Peak #	**Ret Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**
			34	13.93	Geranyl isopentanoate ($C_{15}H_{26}O_2$)			
			35	14.13	Palmitoleic acid ($C_{16}H_{30}O_2$)			
			36	14.25	Unknown ($C_{10}H_{21}$)			
			37	15.18	1,2-Hexa decanediol ($C_{16}H_{34}O_2$)			
			38	15.43	Palmitic acid, methyl ester ($C_{17}H_{34}O_2$)			
			39	16.18	Oleic acid ($C_{18}H_{34}O_2$)			
			40	17.1	Methyl Linoleate ($C_{19}H_{34}O_2$)			
			41	17.15	Methyl Linolenate ($C_{19}H_{32}O_2$)			
			42	17.37	Methyl Stearate ($C_{19}H_{38}O_2$)			
			43	18.03	Unknown ($C_{16}H_{33}$)			
			44	18.9	Oleic acid anion ($C_{18}H_{33}O_2^-$)			
			45	19.01	Stearidonic acid ($C_{18}H_{28}O_2$)			
			46	19.41	EICOSADIE NOIC ACID ($C_{20}H_{36}O_2$)			

Table 1 Cont'd

Cold Maceration Method			Hot Extraction Method			Liquid –Liquid Method		
Peak #	**Ret Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**	**Peak #**	**Ret. Time (min)**	**Component**
			47	19.73	Unknown ($C_{15}H_{27}O_2$)			
			48	20.54	Unknown ($C_{18}H_{38}$)			
			49	20.74	Unknown ($C_{23}H_{41}O_2$)			
			50	21.06	13,16-Docosadienoic acid ($C_{22}H_{40}O_2$)			
			51	21.33	Unknown ($C_{18}H_{33}O_2^-$)			
			52	22.2	Unknown ($C_{18}H_{33}O_2^-$)			
			53	22.57	Adrenic acid ($C_{22}H_{36}O_2$)			
			54	23.01	Unknown ($C_{24}H_{28}O_2$)			

Unknown = fragments of high mass components * needs further clarification

Table 2 Classes of Compounds in Ginger Oil

Class of Compound	Cold Maceration Extraction Method	Hot Extraction Method	Liquid – Liquid Extraction Method
Fatty acids	C_7-C_{20}	C_7- C_{22}	C_7-C_{22}
Oxygenated Hydrocarbons	C_7- C_{23}	C_{10} - C_{24}	C_8- C18
Hydrocarbons	C_{10}, C_{15}	C_9, C_{15}	C_{15}
Heterocycles	C_6	C_{10}	C_6
Unsaturated Hydrocarbons	C_{12}	C_{10}	C_7
Aromatic Hydrocarbons	None	C_9,C_{10}	C_{10},C_{12}
Isomers	C_{15}	C_{15}, C_{18}, C_{19}	

Table 2 shows compounds of higher molecular weight compounds than reported in an earlier paper for ginger oil (Indu Sasidharan et al, 2010). We can conclude that the hot extraction method is the best method that extracted the most components and all classes of compounds but

one may need to use more than one extraction method to completely extract the components of a sample. Table 2 also shows that the cold maceration method did not extract aromatic hydrocarbons. The hot method did not extract lower molecular weight oxygenated hydrocarbons or may be the lower molecular oxygenated hydrocarbons are very volatile and has evaporated when the oil is cooled down before analysis. Most of the oxygenated hydrocarbons, hydrocarbons, heterocycles and unsaturated hydrocarbons are terpene or sesquiterpene compounds.

Reference

1. Indu Sasidharan, A. Niramala Menon, (2010) Comparative Chemical Composition And Anti microbial Activity Fresh & Dry Ginger Oils (*ZINGIBER OFFICINALE ROSCOE*)**.** International Journal of CURRENT PHARMACEUTICAL RESEARCH Vol 2, Issue 4, 40-43