









No	Ret Time	Compound	LRI	Freeze Drying		Cabinet Drying		Sun Drying	
				Area ( 10 <sup>4</sup> )	% Area	Area ( 10 <sup>4</sup> )	% Area	Area ( 10 <sup>4</sup> )	% Area
7	10.356	Methyl petroselinate	2210	Nd	nd	46	0.66%	nd	nd
8	10.399	10-Octadecenoic acid, methyl ester	2216	Nd	nd	117	1.69%	nd	nd
9	10.54	Methyl stearate	2244	8,286	1.39%	240	3.46%	4,622	0.70%
10	11.94	Glycidyl palmitate	3296	1,144	0.19%	nd	nd	253	0.04%
11	13.415	1,2,3-propanetriyl tris[(E)-9-octadecenoate	2805	1,086	0.18%	nd	nd	1,112	0.17%
12	13.419	Ethylene glycol monooleate	2774	258	0.04%	nd	nd	nd	nd
13	13.635	Eicosyl 2-ethylbutanoate	2602	4,194	0.70%	72	1.04%	4,489	0.68%
14	13.81	2-Monopalmitin	2644	5,589	0.94%	nd	nd	9,172	1.39%
15	15.148	Heptadecyl hexanoate	2902	1,881	0.32%	nd	nd	4,357	0.66%
16	15.365	1-Monostearin	2948	2,596	0.44%	nd	nd	4,262	0.65%
<b>Total Area</b>				<b>113,571</b>	<b>19.06%</b>	<b>1,159</b>	<b>16.72%</b>	<b>136,305</b>	<b>20.68%</b>
<b>Acids</b>									
17	7.055	Myristic acid	1952	663	0.11%	nd	nd	228	0.03%
18	9.01	Palmitic acid	2174	19,099	3.21%	nd	nd	nd	nd
19	10.652	Linoleic acid	2273	Nd	nd	nd	nd	56,961	8.64%
20	10.675	Oleic Acid	2281	26,365	4.43%	867	12.51%	nd	nd
21	10.85	Stearic acid	2383	10,262	1.72%	169	2.44%	19,140	2.90%
22	20.41	3 $\beta$ -Hydroxy-5-cholen-24-oic acid	6203	9,963	1.67%	nd	nd	13,439	2.04%
<b>Total Area</b>				<b>66,352</b>	<b>11.14%</b>	<b>1,036</b>	<b>14.95%</b>	<b>89,768</b>	<b>13.62%</b>
<b>Lactones, Ketones</b>									
23	2.505	2,3-dihydro-3,5-dihydroxy-6-methyl-4H-Pyran-4-one	1607	1,743	0.29%	nd	nd	5,233	0.79%
24	8.465	1-(3-Methoxy-2-pyrazinyl)-2-methyl-1-propanone	2006	77,744	13.05%	nd	nd	70,882	10.76%
25	8.627	Cyclohexanone, 3-(1,2,4-triazol-1-yl)methyl-	2030	13,698	2.30%	nd	nd	nd	nd
26	8.82	7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione	2077	11,582	1.94%	nd	nd	11,475	1.74%
27	10.785	Tetrahydro-6-nonyl-2H-Pyran-2-one 9 (delta lactone)	2337	895	0.15%	nd	nd	1,100	0.17%
28	10.785	Tetrahydro-6-octyl-2H-Pyran-2-one (delta tridecalactone)	2334	802	0.13%	nd	nd	nd	nd
29	10.8	Tetrahydro-6-tridecyl-2H-Pyran-2-one	2344	Nd	nd	nd	nd	1,154	0.18%
<b>Total Area</b>				<b>106,464</b>	<b>17.87%</b>	<b>nd</b>	<b>nd</b>	<b>89,844</b>	<b>13.63%</b>
<b>Alcohols</b>									
30	4.16	2-(hydroxymethyl)-2-nitro-1,3-Propanediol (nitroisobutyl glycerol)	1581	25,895	4.35%	134	1.93%	15,395	2.34%
31	16.6	Octacosanol	3143	720	0.12%	nd	nd	nd	nd
32	16.61	1-Hexacosanol	3148	Nd	nd	nd	nd	346	0.05%
<b>Total Area</b>				<b>26,615</b>	<b>4.47%</b>	<b>134</b>	<b>1.93%</b>	<b>15,741</b>	<b>2.39%</b>
<b>Aldehydes</b>									
33	2.888	5-Hydroxymethylfurfural	1431	45,479	7.63%	134	1.93%	41,534	6.30%
34	3.089	2,3,4,5-Tetrahydroxypentanal	3219	Nd	nd	nd	nd	20,592	3.12%
<b>Total Area</b>				<b>45,479</b>	<b>7.63%</b>	<b>134</b>	<b>1.93%</b>	<b>62,126</b>	<b>9.43%</b>
<b>Alkenas</b>									
35	7.86	Neophytadiene	1975	224	0.04%	nd	nd	nd	nd
36	9.54	p-Mentha-1,5,8-triene	2125	593	0.10%	nd	nd	639	0.10%
37	12.775	alpha-springene	3562	254	0.04%	nd	nd	nd	nd
<b>Total Area</b>				<b>1,071</b>	<b>0.18%</b>	<b>nd</b>	<b>nd</b>	<b>639</b>	<b>0.10%</b>
<b>Alkanes</b>									
38	11.155	Eicosane	12888	378	0.06%	nd	nd	919	0.14%
39	11.16	Heneicosane	8033	3,273	0.55%	nd	nd	493	0.07%
40	12.831	1-iodo-Triacontane	11411	196	0.03%	nd	nd	nd	nd
41	12.836	Pentacosane	22800	Nd	nd	nd	nd	838	0.13%
42	13.891	Pentatriacontane	2681	Nd	nd	nd	nd	1,725	0.26%
43	14.19	Tetracosane	4840	Nd	nd	nd	nd	409	0.06%
44	14.075	Tetrapentacontane	2918	Nd	nd	nd	nd	1,384	0.21%
45	14.385	Dotriacontane	8600	845	0.14%	nd	nd	1,392	0.21%
<b>Total Area</b>				<b>4,692</b>	<b>0.79%</b>	<b>nd</b>	<b>nd</b>	<b>7,160</b>	<b>1.09%</b>
<b>Sterols and its derivatived</b>									
46	16.745	Cholest-5-en-3-ol (3 $\beta$ )-, carbonochloridate	3807	41,337	6.94%	537	7.75%	30,161	4.58%
47	17.54	22,23-Dibromostigmasterol acetate	4020	4,696	0.79%	145	2.09%	3,753	0.57%
48	18.215	Cholesta-2,4-diene	4250	3,305	0.55%	nd	nd	2,285	0.35%
49	18.27	Stigmasta-5,22-dien-3-ol, acetate, (3 $\beta$ )-	4221	10,461	1.76%	nd	nd	8,748	1.33%

No	Ret Time	Compound	LRI	Freeze Drying		Cabinet Drying		Sun Drying	
				Area (10 <sup>4</sup> )	% Area	Area (10 <sup>4</sup> )	% Area	Area (10 <sup>4</sup> )	% Area
50	19.13	Cholesterol	5016	80,364	13.49%	948	13.68%	84,707	12.85%
51	19.31	9,19-Cyclocholestene-3,7-diol, 4,14-dimethyl-, 3-acetate	4936	1,352	0.23%	nd	nd	nd	nd
52	19.585	Desmosterol	5119	1,181	0.20%	nd	nd	850	0.13%
53	19.745	Lathosterol	5144	514	0.09%	nd	nd	633	0.10%
54	20.825	Stigmasterol	5404	36,686	6.16%	618	8.92%	45,993	6.98%
55	21.91	Cholest-5-en-3-ol, 24-propylidene-, (3 $\beta$ )-	5600	1,859	0.31%	nd	nd	2,873	0.44%
56	23.985	Cholest-4-en-3-one	6120	1,456	0.24%	nd	nd	3,269	0.50%
<b>Total Area</b>				<b>183,211</b>	<b>30.75%</b>	<b>2,248</b>	<b>32.43%</b>	<b>183,272</b>	<b>27.81%</b>
<b>Phenols and methylated phenols</b>									
57	4.81	2,4-Di-tert-butylphenol	1628	4,115	0.69%	nd	nd	2,942	0.45%
58	15.856	5-Octadecenal	3003	Nd	nd	nd	nd	389	0.06%
59	17.178	$\delta$ -Tocopherol	3950	Nd	nd	nd	nd	696	0.11%
60	18.572	$\gamma$ -Tocopherol	4454	10,034	1.68%	nd	nd	1,257	0.19%
61	18.975	dl- $\alpha$ -Tocopherol	4750	Nd	nd	nd	nd	1,268	0.19%
<b>Total Area</b>				<b>14,149</b>	<b>2.37%</b>	<b>nd</b>	<b>nd</b>	<b>6,552</b>	<b>0.99%</b>
<b>Sugars</b>									
62	4.157	Sucrose	1580	Nd	nd	nd	nd	16,540	2.51%
63	7.951	Trehalose	2013	263	0.04%	nd	nd	819	0.12%
<b>Total Area</b>				<b>263</b>	<b>0.04%</b>	<b>nd</b>	<b>nd</b>	<b>17,359</b>	<b>2.63%</b>
<b>Amide</b>									
64	15.848	cis-11-Eicosenamide	3001	Nd	nd	nd	nd	1,090	0.17%
<b>Total Area</b>				<b>Nd</b>	<b>nd</b>	<b>nd</b>	<b>nd</b>	<b>1,090</b>	<b>0.17%</b>
<b>Others</b>									
65	4.74	1,6-Anhydro- $\beta$ -D-Glucopyranose (Levogluconan)	1618	15,730	2.64%	127	1.83%	9,099	1.38%
66	5.55	1,6-Anhydro- $\beta$ -D-Glucufuranose	1702	9,168	1.54%	125	1.80%	3,627	0.55%
67	6.595	Trimethylsilyl 3-methyl-4-[(trimethylsilyloxy)benzoate	1815	5,123	0.86%	nd	nd	3,731	0.57%
68	8.252	Caffeine	2411	Nd	nd	920	13.27%	25,033	3.80%
69	8.476	Theobromine	2008	Nd	nd	1,049	15.13%	nd	nd
70	13.422	1,54-dibromo-tetrapentacontane	2780	Nd	nd	nd	nd	635	0.10%
71	13.638	d-Ribose, 2-deoxy-bis(thioheptyl)-dithioacetal	2601	2,852	0.48%	nd	nd	nd	nd
72	16.152	Squalene	3091	Nd	nd	nd	nd	148	0.02%
73	18.136	(R)-2,7,8-Trimethyl-2-((3E,7E)-4,8,12-trimethyltrideca-3,7,11-trien-1-yl) chroman-6-ol ( $\gamma$ -Tocotrienol)	5606	Nd	nd	nd	nd	16,287	2.47%
74	22.915	9,19-Cyclolanostan-3-ol, 24-methylene-, (3 $\beta$ )-	5740	1,066	0.18%	nd	nd	3,315	0.50%
<b>Total Area</b>				<b>33,939</b>	<b>5.70%</b>	<b>2,221</b>	<b>32.04%</b>	<b>49,149</b>	<b>7.46%</b>
<b>Overall Total Area</b>				<b>595,806</b>	<b>100.00%</b>	<b>6,932</b>	<b>100.00%</b>	<b>659,005</b>	<b>100.00%</b>

Remarks: Ret Time = Retention Time; LRI = Linear Retention Index; nd = not detected

Freeze drying also maintains the content of antioxidant compounds in cacao beans. In this research, volatile compounds indicated as an antioxidant on cocoa beans treated freeze drying were  $\gamma$ -Tocopherol [22], 2,4-Di-tert-butylphenol [23], 5-Hydroxymethylfurfural [24], and palmitic acid. Palmitic acid exhibits anti-inflammatory and metabolic regulatory effects and antitumor activities in several tumors [25]. Freeze drying also maintains other bioactive compounds which was biological activity, such as Neophytadiene and ethyl linoleate as anti-inflammatory [26], [27], Myristic acid as an anti-diabetic [28] and anti-inflammatory [29], Octacosanol as anti-fatigue, anti-hypoxia, antioxidant, anti-inflammatory, antitumor [30], Stigmasta-5,22-dien-3-ol, acetate, (3 $\beta$ )- as inflammatory, antipyretic, anti-ulcer, antiarthritic [31].

#### IV. CONCLUSION

Variation drying methods on cocoa beans affected the total phenol, flavonoid, and antioxidant content. Cocoa beans

treated freeze drying showed the highest phenol, flavonoid antioxidant content, and volatile bioactive compound identified.

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