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Conceptual

A Suggested Method for Evaluation of Sandalwood Essential oil Quality

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Assume that we have Sandalwood essential oil extracted by hydrodistillation technique or by a modified hydrodistillation, for example Microwave HydroDistillation (MHD) or Microwave Air-Hydro Distillation (MAHD) [1]. After making GC-MS analysis on this Sandalwood essential oil we have a data set of volatile and semi-volatile compounds . From these compounds we should pay attention to the following entities:

Let s be the total content of all sesquiterpenes ($C_{15}H_{24}$) and their derivatives

Let s_o be the total content of all oxygenated sesquiterpenes and their derivatives

Let m be the total content of all monoterpenes ($C_{10}H_{14}$, $C_{10}H_{16}$) and their derivatives

Let m_o be the total content of all oxygenated monoterpenes and their derivatives

Let e be the total content of all fatty acids and their derivatives

Let f be the total content of all allergens

Let g be the total content of all toxins

Let S be the total content of all compouds listed in the GC-MS Test Report

Similar to our previous finding [2], we first derive from experiences and sensory comments.

Practical experiences and intuitional consideration

The higher s_o (in comparison with s) the better aromatic scent and therapeutic effects of sandalwood essential oil [3]. The smaller m (in comparison with s) the better quality of sandalwood essential oil. For a normal sandalwood essential oil, we obviously require: e is small, s + s_o is big, f=g=0 and S ≥ 75%.

We hereby propose a suggested method for evaluation of sandalwood essential oil quality (in chemical composition):

Let $\alpha = \frac{s_o + m_o}{s + m}$ then the bigger the α, the higher the quality of sandalwood essential oil on condition that β = s+so ≥ 65% (this constrain of β is also mentioned in [2]. This criteria can applicable to agarwood essential oil (not only to sandalwood essential oil).

We try to apply α to evaluate the quality of essential oils mentioned in the following article: H.S. Kusuma and M. Mahfud [1] extracted sandalwood (santalum album) essential oils from different techniques: Microwave hydrodistillation (MHD), see figure 1, and Microwave air-hydrodistillation (MAHD), see figure 2. After making GC-MS analysis they obtained two sets of data, each set consists of 59 compound names together with their corresponding content (%). Sum of 59 contents S=100%. From these two sets of data we extracted a list of monoterpenes and oxygenated monoterpenes, see table 1, and a list of sesquiterpenes and oxygenated sesquiterpenes, see table 2.

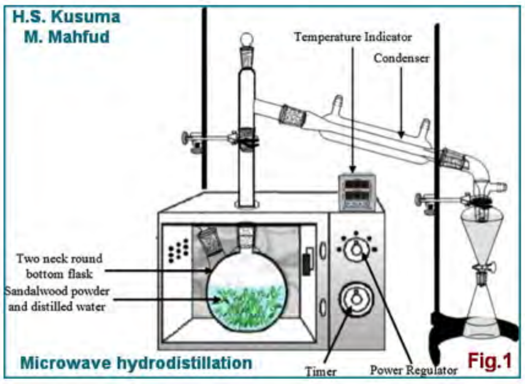

Figure 1

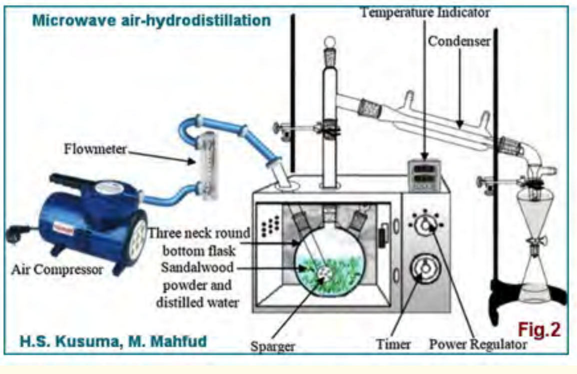

Figure 2

No	Compound name	Molecular Formula	Classification	Content (%)	
				MHD	MAHD
1	Camphene	$C_{10}H_{16}$	monoterpene	0.95	0.82
2	Alpha-Pinene	$C_{10}H_{16}$	monoterpene	0.06	nd
3	Santolina triene	$C_{10}H_{16}$	monoterpene	0.07	nd
4	Beta-ocimene	$C_{10}H_{16}$	monoterpene	0.58	nd
5	cis-ocimene	$C_{10}H_{16}$	monoterpene	1.87	0.09
6	(Z)-alloocimene	$C_{10}H_{16}$	monoterpene	0.06	nd
7	Alpha-terpinene	$C_{10}H_{16}$	monoterpene	1.04	1.11
8	1-cyclohexylidene-2-methylpropene	$C_{10}H_{16}$	monoterpene	nd	1.19
9	Isoterpinolene	$C_{10}H_{16}$	monoterpene	0.31	nd
	Sum		**m**	**4.94**	**3.21**
1	8-methylene-2-exo-noradamantanol	$C_{10}H_{14}O$	Oxygenated monoterpene	nd	0.04
2	3a,6-methano-3aH-inden-7(4H)-one, hexahydro-7a-d-, (3aa,6a,7ab)-	$C_{10}H_{14}O$	Oxygenated monoterpene	0.72	nd
3	Teresantalol	$C_{10}H_{16}O$	Oxygenated monoterpene	4.58	1.45
4	Sabinene hydrate	$C_{10}H_{18}O$	Oxygenated monoterpene	0.10	nd
	Sum		**m_o**	**5.4**	**1.49**

Table 1: List of monoterpenes and oxygenated monoterpenes.

nd: not detected

No	Compound name	Molecular Formula	Classification	Content (%)	
				MHD	MAHD
1	Alpha-farnesene	$C_{15}H_{24}$	Sesquiterpene	0.50	1.88
2	Beta-patchoulene	$C_{15}H_{24}$	Sesquiterpene	0.62	nd
3	Alpha-santalene	$C_{15}H_{24}$	Sesquiterpene	nd	0.03
4	Alpha-cedrene	$C_{15}H_{24}$	Sesquiterpene	nd	0.05
5	Gamma-curcumene	$C_{15}H_{24}$	Sesquiterpene	nd	0.17
6	Alpha-guaiene	$C_{15}H_{24}$	Sesquiterpene	0.66	0.11
7	Isosativene	$C_{15}H_{24}$	Sesquiterpene	0.18	nd
8	Beta-santalene	$C_{15}H_{24}$	Sesquiterpene	0.05	0.07
9	Seychellene	$C_{15}H_{24}$	Sesquiterpene	0.77	nd
10	Alpha-patchoulene	$C_{15}H_{24}$	Sesquiterpene	0.38	nd
11	Germacrene B	$C_{15}H_{24}$	Sesquiterpene	5.50	0.10
12	alpha-selinene	$C_{15}H_{24}$	Sesquiterpene	0.06	nd
13	Delta-guaiene	$C_{15}H_{24}$	Sesquiterpene	0.48	0.15
14	Gamma-elemene	$C_{15}H_{24}$	Sesquiterpene	nd	3.69
15	Alpha-bergamotene	$C_{15}H_{24}$	Sesquiterpene	nd	0.20
16	Bicyclogermacrene	$C_{15}H_{24}$	Sesquiterpene	0.64	0.45
17	2-methyl-6-(4-methylcyclohex-3-en-1-ylidene)hept-2-ene	$C_{15}H_{24}$	Sesquiterpene	nd	0.71
18	Acoradiene	$C_{15}H_{24}$	Sesquiterpene	1.39	0.59
19	Bicycloelemene	$C_{15}H_{24}$	Sesquiterpene	nd	1.36

20	Viridiflorene (ledene)	$C_{15}H_{24}$	Sesquiterpene	0.91	nd
	Sum		**s**	**12.14**	**9.56**
1	Beta-santalol	$C_{15}H_{24}O$	Oxygenated sesquiterpene	22.67	24.80
2	Alpha-santalol	$C_{15}H_{24}O$	Oxygenated sesquiterpene	27.81	28.73
3	Alpha-bergamotol	$C_{15}H_{24}O$	Oxygenated sesquiterpene	10.82	10.18
4	cis-alpha-copaene-8-ol	$C_{15}H_{24}O$	Oxygenated sesquiterpene	1.86	nd
5	cis-lanceol	$C_{15}H_{24}O$	Oxygenated sesquiterpene	3.42	2.74
6	Alpha-cedrol	$C_{15}H_{26}O$	Oxygenated sesquiterpene	nd	2.65
7	Caryophylla-3,8(15)-dien-5alpha-ol	$C_{15}H_{26}O$	Oxygenated sesquiterpene	0.47	0.52
8	Isolongifolol	$C_{15}H_{26}O$	Oxygenated sesquiterpene	0.21	0.59
	Sum		**s_o**	**67.26**	**70.21**

Table 2: List of sesquiterpenes and oxygenated sesquiterpenes.

nd: not detected

So, we have

	For MHD	For MAHD
$\beta = s + s_o$	67.26%+12.14% = 79.40%	70.21%+9.56%= 79.77%
$\alpha = \frac{s_o + m_o}{s + m}$	= 4.254	= 5.615

Conclusion

MAHD technique is (chemically) better than MHD technique.

Usually we want both α and β to be large, but in practice when β grows (for example when s>so), it makes the α smaller, then we need to choose an acceptable compromise of α and β. For a possible compromise between α and β we can choose two positive numbers x and y , (x+ y= 1), for forming the function ω = x*α + y*β. So, the bigger ω the better (chemically) quality of sandalwood essential oil.

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