Effects of Different Drying Treatments on Preservation of Organic Compounds in *Dalbergia bariensis* Wood

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Rosewood furniture and handicrafts are appreciated by Chinese people on account of their rich aroma and pleasing feel. The unique characteristics of rosewood are attributed to the presence of certain organic compounds in its gum canal and parenchyma cells. However, modern wood drying is different from traditional technology with respect to protecting those valuable organic compounds in wood. In this study, to investigate the valuable organic compounds in *Dalbergia bariensis*, and the effect of drying treatments on their preservation rates, wood extracts, untreated and treated with conventional drying (CD), vacuum drying (VD), and vacuum freeze drying (VFD), were analyzed by gas chromatography-mass spectrometry (GC-MS). The results indicated that there were some compounds with obvious pharmaceutical functions in *Dalbergia bariensis,* which can be used to improve the furniture function in health care. Also, the preservation of these compounds was affected by drying treatment; VFD drying preserved the maximum amount of organic compounds in wood.

Keywords: Dalbergia bariensis; Organic compounds; Extract; Effect of drying; Aroma of wood

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INTRODUCTION

Dalbergia is a large genus in the pea family, Fabaceae, subfamily Faboideae. The genus has a wide distribution, native to the tropical regions of central South America, Africa, Madagascar, and southern Asia. Many species of *Dalbergia* are important timber trees, valued for their decorative and often fragrant wood, which is rich in aromatic oils. The most famous of these species are used for rosewood furniture. Previous reports have shown that some crude extracts and pure compounds from the heartwood of the genus have various bioactivities (Ito *et al.* 1994; Chuankhayan *et al.* 2007; Umehara *et al.* 2009; Innocent *et al.* 2010).

Dalbergia odorifera T. Chen is the most representative type of fragrant rosewood tree that grows in Asia. The dried heartwood is an important traditional medicine in Asia, named "Jiangxiang" in Chinese. Dissipating blood stasis, regulating the flow of qi, and relieving pain are its main actions in traditional Chinese medicines (Liu *et al.* 2005). Modern pharmacological studies have shown that Jiangxiang possesses various biological activities, such as anti-inflammatory (Lee *et al.* 2009), antiplatelet (Tao and Wang 2009), anticoagulant, antitumor, anti-hyperlipidemic, and vasodilative effects (Zhao *et al.* 2000), as well as stimulating the activity of tyrosinase (Wu and Wang 2003). In addition to the medical functions of *Dalbergia* species, recent studies (Edmone 2006; Khyasudeen and Abu Bakar 2006; Wang 2006) have focused on enhancing the added value of rosewood

furniture. However, *Dalbergia odorifera* T. Chen is rarely used for rosewood furniture because of the fear of exhaustion of resources (Xu 2013). *Dalbergia bariensis*, a valuable reddish hardwood with good thermal diffusivity and permeability, is used widely in the rosewood furniture industry.

People like *Dalbergia bariensis* not only because of its color, density, watermark, and wood grain, but also because of the scent released from the wood, which has a refreshing function, and the pleasing feel. Consumers are increasingly interested in the comfortable feeling coming from aromatic smells and the sense of touch in daily life. All the healthy characteristics of *Dalbergia bariensis* are related to the extracts from its gum canal and parenchyma cells. In general, wood extracts contains various types of organic compounds, and the most common compounds include polyphenols, terpenes, lipids, flavonoids, lignans, and water-soluble carbohydrates (Zhao *et al.* 2002). However, there have not been any related studies on extracts from *Dalbergia bariensis* in China. In addition, the valuable organic compounds existing in wood may be destroyed because of the high dying temperature and the long drying process of modern conventional kiln (CK) drying (Esteves *et al.* 2011), resulting in decreased healthy functions of rosewood.

Therefore, to investigate the constituents and to identify the medically valuable organic compounds in *Dalbergia bariensis,* the wood was extracted with various solvents and the extracts were analyzed with gas chromatography-mass spectrometry (GC-MS) in this study. The effects of drying on organic compounds extracted by conventional drying (CD), vacuum drying (VD), and vacuum freeze drying (VFD) of the untreated and treated samples with the above three drying methods were also investigated.

EXPERIMENTAL

Materials

The raw material was *Dalbergia bariensis* heartwood, identified and provided by Zhongshan Dongcheng Furniture Co., Ltd (China). The initial moisture content of the material was approximately 40%.

Methods

Wood drying

The *Dalbergia bariensis* heartwood was sawed into three end-matched samples with dimensions of 30 mm (T) × 30 mm (R) × 100 mm (L). These samples were dried to an absolutely dry state by CD, VD, and VFD (Table 1). The absolutely dry state means the mass difference was within 0.02 g between the last two weight measurement intervals in 2 h (Cai *et al.* 2005).

Table 1. Conditions for the Various Drying Methods

No.	Drying method	Drying conditions	Drying instrument	
			Type and name	Manufacturer
1	CD	60 °C	JC101 Electrothermal blowing dryer	Shanghai Chengshun Instrument Co., Ltd.
2	VD	40 °C/130 Pa	DZF-6050 Vacuum dryer	Shanghai Yiheng Scientific Instrument Co., Ltd.
3	VFD	-50 °C/20 to 30 Pa	FD-1C-50 Vacuum freeze dryer	Shanghai Binlon Instrument Co. Ltd

Extraction

The untreated *Dalbergia bariensis* heartwood and the three absolutely dry samples were riven, ground, and sieved (40-mesh) as quickly as possible. Then, 2 g of each sample was wrapped in quantitative filter paper and placed in a Soxhlet extractor with 90 mL of benzene-ethanol (1:2, v/v) solvent. The benzene and ethanol were both analytical reagents. The benzene-ethanol solvent has a wide range of polarity, so almost all kinds of component in wood tissue can be dissolved, and it is not easy to volatilize (Zhao *et al.* 2002; Enma *et al.* 2014). The extraction step was performed for 6 h, and each extraction cycle took approximately 10 min with adjustable temperature. After obtaining the extract, the three wood residues of absolutely dry samples were baked to constant weight to calculate their extract yields,

$$C = \frac{M_1 - M_2}{M_1} \times 100\% \quad (1)$$

where C is the extract yield; M_1 is the mass of absolutely dry sample before extraction; and M_2 is the mass of wood residues after extraction.

GC-MS analysis

An Agilent (USA) 6890N+5795C GC-MS and Agilent DB-5MS capillary quartz column (30 m × 0.25 mm × 0.25 μm) were used to analyze the extracts in this study. Each extract was concentrated to approximately 1mL using a rotary evaporator (Shanghai YaRong Biochemical Instrument Co., Ltd) and then transferred to a 5 mL volumetric flask, diluted with benzene-ethanol solvent to the volume mark, and filtered with a microporous membrane of 0.45 μm. Then, 1 μL of the final extracted sample was injected into the GC-MS using a split ratio of 20:1 and inlet temperature of 290 °C. Helium was used as a carrier gas at a constant flow rate of 1.4 mL/min. The oven temperature program was initially set to 80 °C for the first 5 min, rose to 120 °C at a rate of 20 °C/min, then rose to 250 °C at a rate of 10 °C/min, and finally to 300 °C at a rate of 5 °C/min, where it was held for 5 min. The ionization mode of MS was electron ionization (EI), electron energy was 70eV, ion source temperature was 200 °C, quadropole temperature was 150 °C, and mass scan range was 30 to 500 amu. Identification of compounds was based on comparison of their spectra and relative abundance with NIST08 libraries (http://www.nist.gov/srd/). Those compounds with more than 80% matching degree same as previous reports (Zhao *et al*. 2014) were qualitative in this study.

RESULTS AND DISCUSSION

Compounds Extracted from *Dalbergia bariensis*

The GC-MS successfully separated most compounds in the extract of raw *Dalbergia bariensis* heartwood, as shown by the presence of 95 peaks and their relative quantitative contents in the total ion chromatograms (Fig. 1).

There were a total of 42 compounds out of the 95 candidate compounds that had been identified and assigned chemical names (Table 2). These identified compounds primarily included aromatic compounds, aldehydes, ketones, and esters, and their peak areas occupied 75.571% of the total peak area. The main components were 6H-benzofuro[3,2-c][1]benzopyran-3-ol, 6a, 11a-dihydro-9-methoxy-, (6aR-cis)- (20.762%); 6a, 12a-dihydro-6H-(1,3)dioxolo(5,6)benzofuro(3,2-c)chromen-3-ol (15.052%); estroxide

(10.314%); 4H-1-benzopyran-4-one, 7-hydroxy-3-(4-methoxyphenyl)-(9.642%); pseudobaptigenin (6.437%); methyl3-(1-formyl-3,4-methylenedioxy)benzoate (3.413%); Liquiritigenin (2.911%); benzofuran, 2,3-dihydro-(2.084%), and pyrimido[1,2-a]indole, 4-isopropyl-5-methyl-2-phenyl-(1.48%).

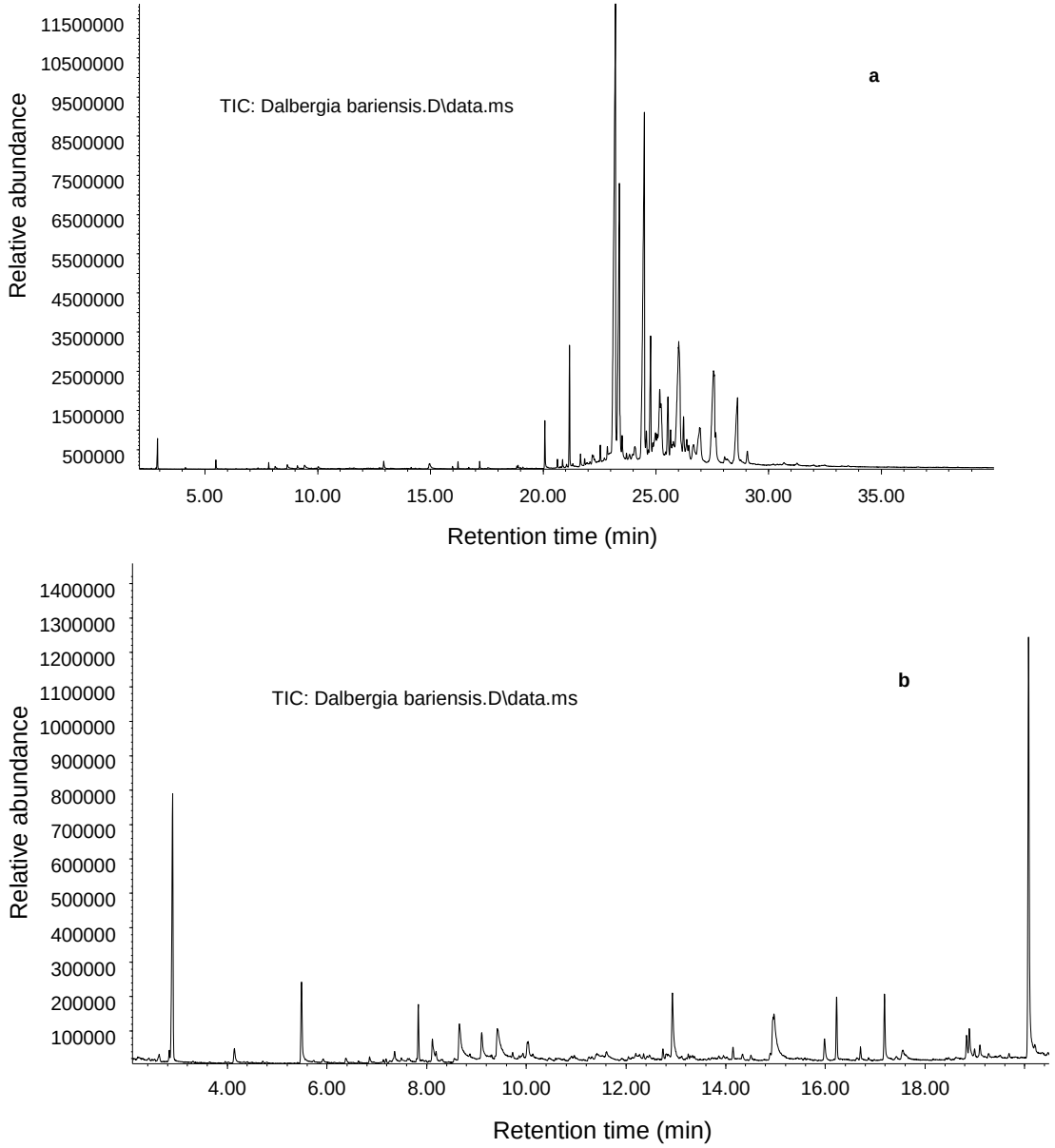

Fig. 1. Total ion chromatograms of the extracts of *Dalbergia bariensis*

Among these compounds, phenol and 4-methyl-(*p*-cresol) are used as disinfectants, resorcinol can sterilize, so it is often added in cosmetics, drug paste, and ointment for treating skin disease. Benzene and 1,2,3-trimethoxy-5-(2-propenyl)(Elemicin) have hypnotic and antiseptic effects. β-Endesmol is one of the main effective components of traditional Chinese medicine. *Rhizoma atractylodis* has a certain effect on protecting liver cells, treatment of diabetes, and gastrointestinal disorders, and is also a drug in treatment of nervous system diseases (Yoshinobu *et al.* 1983; Nakai *et al.* 2003; Jeon *et al.* 2007; Yang *et al.* 2011).

Table 2. Identified Compounds in*Dalbergia bariensis*

No.	Retention time (min)	Compound	Formula	Detected molecular weight	CAS number	Relative content (%)
1	5.487	1-Hexanol,2-ethyl-	$C_8H_{18}O$	130.14	104-76-7	0.146
2	6.372	Phenol, 4-methyl-	C_7H_8O	108.06	106-44-5	0.011
3	7.353	Pentanedioic acid, dimethyl ester	$C_7H_{12}O_4$	160.07	1119-40-0	0.026
4	7.831	2-Butenedioic acid(Z)-,diethyl ester	$C_8H_{12}O_4$	172.07	141-05-9	0.077
5	8.112	Ethanol, 2-(2-butoxyethoxy)-	$C_8H_{18}O_3$	162.13	112-34-5	0.053
6	8.184	Naphthalene	$C_{10}H_8$	128.06	91-20-3	0.016
7	8.55	Benzofuran, 2,3-dihydro-	C_8H_8O	120.06	496-16-2	2.084
8	8.655	Phenol,3-methoxy-	$C_7H_8O_2$	124.05	150-19-6	0.126
9	9.1	1,2-Benzenediol,3-methoxy-	$C_7H_8O_3$	140.05	934-00-9	0.080
10	9.416	Resorcinol	$C_6H_6O_4$	110.04	108-46-3	0.144
11	9.722	Naphthalene, 1-methyl-	$C_{11}H_{10}$	142.08	90-12-0	0.009
12	9.851	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	150.07	7786-61-0	0.208
13	10.033	Phenol,3,4-dimethoxy-	$C_8H_{10}O_3$	154.06	2033-89-8	0.047
14	11.412	4-Methoxybenzene-1,2-diol	$C_7H_8O_3$	140.05	3934-97-2	0.009
15	12.35	1,3-Benzenedicarboxylic acid, dimethyl ester	$C_{10}H_{10}O_4$	194.06	1459-93-4	0.006
16	12.737	Benzene, 1,2,3-trimethoxy-5-(2-propenyl)-	$C_{12}H_{16}O_3$	208.11	487-11-6	0.017
17	12.93	4-Methyl-2,5-dimethoxybenzaldehyde	$C_{10}H_{12}O_3$	180.08	4925-88-6	0.159
18	14.144	β-Eudesmol	$C_{15}H_{26}O$	222.20	473-15-4	0.019
19	14.89	2-Propenal,3-(4-hydroxy-3-methoxyphenyl)-	$C_{10}H_{10}O_3$	178.06	458-36-6	0.013
20	14.968	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol	$C_{10}H_{12}O_3$	180.08	/	0.258
21	16.224	Diisobutyl phthalate	$C_{16}H_{22}O_4$	278.15	84-69-5	0.088
22	17.186	Dibutyl phthalate	$C_{16}H_{22}O_4$	278.15	84-74-2	0.123
23	18.831	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280.24	60-33-3	0.037
24	18.885	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	$C_{18}H_{30}O_2$	278.23	463-40-1	0.066
25	19.098	Octadecanoic acid	$C_{18}H_{32}O_2$	284.27	57-11-4	0.026
26	21.036	7,8-Diethylbenz[a]anthracene	$C_{22}H_{20}$	284.16	38678-95-4	0.052
27	22.181	Pinocembrin	$C_{15}H_{12}O_4$	256.07	480-39-7	0.187
28	22.226	1-Methyl-4-azafluorenone, 2-methylphenylimine	$C_{20}H_{16}N_2$	284.13	/	0.189
29	22.533	1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester	$C_{16}H_{22}O_4$	278.15	4376-20-9	0.291
30	23.211	6H-Benzofuro[3,2-c][1]benzopyran-3-ol, 6a,11a-dihydro-9-methoxy-, (6aR-cis)-	$C_{16}H_{14}O_4$	270.09	32383-76-9	20.762

No.	Retention time (min)	Compound	Formula	Detected molecular weight	CAS number	Relative content (%)
31	23.389	estroxide	$C_{18}H_{22}O_2$	270.16	472-56-0	10.314
32	23.509	Phenol,2-[5-(2-furyl)pyrazol-3-yl]-4-methoxy-	$C_{14}H_{12}N_2O_3$	256.08	309923-40-8	0.849
33	24.495	6a,12a-Dihydro-6H-(1,3)dioxolo(5,6)benzofuro(3,2-c)chromen-3-ol	$C_{16}H_{12}O_5$	284.07	22091-18-5	15.052
34	24.773	Methyl 3-(1-formyl-3,4-methylenedioxy)benzoate	$C_{16}H_{12}O_5$	284.07	/	3.413
35	24.869	6-Hydroxy-3-(3,5-dimethoxyphenyl)benzo(b)furan	$C_{16}H_{14}O_4$	270.09	/	0.497
36	25.658	6-Iodo-2-methylquinazolin-4(3H)-one	$C_9H_7IN_2O$	285.96	90347-75-4	0.983
37	26.018	4H-1-Benzopyran-4-one, 7-hydroxy-3-(4-methoxyphenyl)-	$C_{16}H_{12}O_4$	268.07	485-72-3	9.642
38	26.234	Pyrimido[1,2-a]indole, 4-isopropyl-5-methyl-2-phenyl-	$C_{21}H_{20}N_2$	300.16	163158-91-6	1.480
39	26.464	4'-Methoxy-5,7-dihydroxy isoflavone	$C_{16}H_{12}O_5$	284.07	491-80-5	0.547
40	26.945	Liquiritigenin	$C_{15}H_{12}O_4$	256.07	578-86-9	2.911
41	27.562	Pseudobaptigenin	$C_{16}H_{10}O_5$	282.05	90-29-9	6.437
42	29.059	7-Acetyl-4,6-dihydroxy-2',5-dimethyl-3-methylenespiro(benzofuran-2(3H),1'-(2)cyclopenten)-4'-one	$C_{17}H_{16}O_5$	300.10	/	0.398
43	/	Others	/	/	/	24.429

2-Propenal, 3-(4-hydroxy-3-methoxyphenyl)-(Conifer aldehyde) are used as antifungal and anti-swelling agents and as the biosynthesis inhibitor for prostaglandin, 9, 12-Octadecadienoic acid (Z,Z)- which has the effects of decreasing the blood lipid level and blood pressure and softening the human blood vessels. It also facilitates microcirculation, which can prevent or reduce the incidence of cardiovascular disease and is especially useful for the prevention of high blood pressure, high cholesterol, angina, coronary heart disease (CHD), and atherosclerosis. Meanwhile, 9,12-octadecadienoic acid (Z,Z)(linoleic acid) is also regarded as a scavenger receptor and helps prevent cardiovascular disease and atherosclerosis (Rodrigues 2010). 9,12,15-octadecatrienoic acid, (Z,Z,Z)-(linolenic acid) has the effect of reducing blood fat and blood pressure (Lorente *et al.* 2012). Pinocembrin can resist *Staphylococcus aureus* infection and inflammation (Fu *et al.* 2013; Duan *et al.* 2006). 6H-Benzofuro[3,2-c] (Ito *et al.* 2003) benzopyran-3-ol, 6a,11a-dihydro-9-methoxy-, (6aR-cis)-(medicarpin), flavonoids with high biological activity (Li *et al.* 2001; Martinez *et al.* 2011) have been detected in licorice and other herbal products. 4H-1-benzopyran-4-one and 7-hydroxy-3-(4-methoxyphenyl), which have anti-cancer effects, are beneficial for prevention of colon, breast, and prostate cancers and improvement of menopausal symptoms and hot flashes, cyclic breast pain or tenderness (mastalgia).

Liquiritigenin has the effects of anti-cancer, anti-ulcer, anti-bacteria, and anti-virus (Maggiolini *et al.* 2002; Kanno *et al.* 2005; Renugadevi 2010; Fu *et al.* 2013). At the same time, 4'-methoxy-5,7-dihydroxy isoflavone; 2-butenedioic acid (Z)-, diethyl ester; 4-methyl-2,5-dimethoxybenzaldehyde, and other components are often used as pharmaceutical intermediates. From these compounds we can see *Dalbergia bariensis* has high medical value and health care potential to human.

Extract Yields of Absolutely Dry Samples

Modern conventional kiln (CK) processing is used for wood drying in China and throughout the world. There have been many studies on drying technology, drying schedules, and drying properties of rosewood (Li *et al.* 2001; Cai and Sun 2013; Torelli *et al.*1995a,b); however, few studies have been carried out on the effect of wood extracts of drying methods. In this study, wood extracts were studied and analyzed. The extract yields of the absolutely dry samples were calculated using Eq. 1 and compared among the three drying methods, as shown in Table 3. The extract yield from the absolutely dry sample by the VFD method was the maximum (24.471%). This result demonstrates that the VFD method outperformed the CD and VD methods with respect to preserving the organic compounds existing in *Dalbergia bariensis.* In the VFD process, the sample was frozen quickly at -18 to 30 °Cat first, so the internal moisture was fixed in its original position and became uniform with tiny ice formation, which was sublimated directly into water vapor under vacuum conditions. Eventually, moisture was removed, and the sample became dry. The drying process occurred at low temperature and vacuum conditions so that thermal reaction and oxidation can be avoided (Maggiolini *et al.* 2002; Sadoth *et al.* 2012).

Table 3. Extract Yields of the Absolutely Dry Samples Dried by Various Methods

No.	Drying method	M1 (g)	M2 (g)	C (%)
1	CD	2.0002	1.5472	22.648
2	VD	2.0002	1.5826	20.878
3	VFD	2.0003	1.5108	24.471

Comparison of the Three Extracts from Absolutely Dry Samples

To further verify the above experimental results concerning the extract yields of absolutely dry samples, the three extracts were analyzed by GC-MS. Although 25 compounds out of 50 peaks had been identified in the extract sample treated by VFD, only 25 and 50 compounds out of 25 and 61 peaks had been identified in extract samples treated by CD and VD, respectively.

The identified components in the three types of absolutely dry samples were all fewer than that in the raw material, which has 25 unique components. Specifically, only 10 kinds of compounds with obvious health care effects were detected after drying compared with un-dried materials, in which 13 kinds were detected. Benzene, 1,2,3-trimethoxy-5-(2-propenyl)-; 2-propenal,3-(4-hydroxy-3-methoxyphenyl)-; 9,12-octadeca-dienoic acid (Z,Z)-; and 9,12,15-octadecatrienoic acid, (Z,Z,Z)- were not be detected in heartwood material after drying. Those peaks area corresponding to the compounds were compared and are shown in Table 4.

Table 4. Comparison of Peak Area Corresponding to Each Compound

No.	Compound	Peak area		
		CD	VD	VFD
1	1-Hexanol,2-ethyl-	669842	594758	633024
2	Phenol, 4-methyl-	58449	42099	129446
3	Pentanedioic acid, dimethyl ester	ND	ND	ND
4	2-Butenedioic acid(Z)-,diethyl ester	209205	202211	226539
5	Ethanol, 2-(2-butoxyethoxy)-	ND	ND	ND
6	Naphthalene	ND	ND	ND
7	Benzofuran, 2,3-dihydro-	148851	167168	93229
8	Phenol,3-methoxy-	930359	942599	772597
9	1,2-Benzenediol,3-methoxy-	93811	148868	202226
10	Resorcinol	1753612	1600719	2014780
11	Naphthalene, 1-methyl-	ND	ND	ND
12	2-Methoxy-4-vinylphenol	115964	115886	122253
13	Phenol,3,4-dimethoxy-	218397	185331	254965
14	4-Methoxybenzene-1,2-diol	ND	ND	ND
15	1,3-Benzenedicarboxylic acid, dimethyl ester	ND	ND	ND
16	Benzene, 1,2,3-trimethoxy-5-(2-propenyl)-	ND	ND	ND
17	4-Methyl-2,5-dimethoxybenzaldehyde	1496187	1349630	1290414
18	β-Eudesmol	271427	126208	586727
19	2-Propenal,3-(4-hydroxy-3-methoxyphenyl)-	ND	ND	ND
20	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol	891818	916733	1080333
21	Diisobutyl phthalate	296717	299123	317606
22	Dibutyl phthalate	198959	185764	234241
23	9,12-Octadecadienoic acid (Z,Z)-	ND	ND	ND
24	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	ND	ND	ND
25	Octadecanoic acid	ND	ND	ND
26	7,8-Diethylbenz[a]anthracene	ND	ND	ND
27	Pinocembrin	1399100	1293181	1583853
28	1-Methyl-4-azafluorenone, 2-methylphenylimine	ND	ND	ND
29	1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester	1163013	964563	1104771
30	6H-Benzofuro[3,2-c][1]benzopyran-3-ol, 6a,11a-dihydro-9-methoxy-, (6aR-cis)-	74233128	77174874	96729840
31	estroxide	47733739	51560016	53365611
32	Phenol,2-[5-(2-furyl)pyrazol-3-yl]-4-methoxy-	1315987	483737	927189
33	6a,12a-Dihydro-6H-(1,3)dioxolo(5,6)benzofuro(3,2-c)chromen-3-ol	47990477	40708241	57426715
34	Methyl 3-(1-formyl-3,4-methylenedioxy)benzoate	ND	ND	ND
35	6-Hydroxy-3-(3,5-dimethoxyphenyl)benzo(b)furan	ND	ND	ND
36	6-Iodo-2-methylquinazolin-4(3H)-one	ND	ND	ND
37	4H-1-Benzopyran-4-one, 7-hydroxy-3-(4-methoxyphenyl)-	28131195	28272046	38181014
38	Pyrimido[1,2-a]indole, 4-isopropyl-5-methyl-2-phenyl-	ND	ND	ND
39	4'-Methoxy-5,7-dihydroxy isoflavone	349366	482427	781884

No.	Compound	Peak area		
		CD	VD	VFD
40	Liquiritigenin	8657142	6715645	9051114
41	Pseudobaptigenin	4237656	5030467	6983355
42	7-Acetyl-4,6-dihydroxy-2',5-dimethyl-3-methylenespiro(benzofuran-2(3H),1'-(2)cyclopenten)-4'-one	536961	625274	601588
43	Others	122803589	120855638	130936347
44	Total	345904951	341043206	405631661

ND: not detected

Under set operating conditions, the mass of analyzed components or their concentrations in carrier gas is proportional to the corresponding peak areas. Therefore, it is feasible to use peak area to represent the relative amount of components (Yoshinobu 1983; Xu *et al.* 2010). For the VFD sample, the total peak area was larger than those of either the CD sample or the VD sample. Except for 1-hexanol,2-ethyl-; benzofuran, 2,3-dihydro-; phenol,3-methoxy-; 4-methyl-2,5-dimethoxybenzaldehyde; 1,2-benzene-dicarboxylic acid, mono(2-ethylhexyl) ester, and 7-acetyl-4,6-dihydroxy-2',5-dimethyl-3-methylenespiro(benzofuran-2(3H),1'-(2)cyclopenten)-4'-one, every peak area in the VFD sample was also larger than the corresponding peak areas of the CD sample or VD sample.

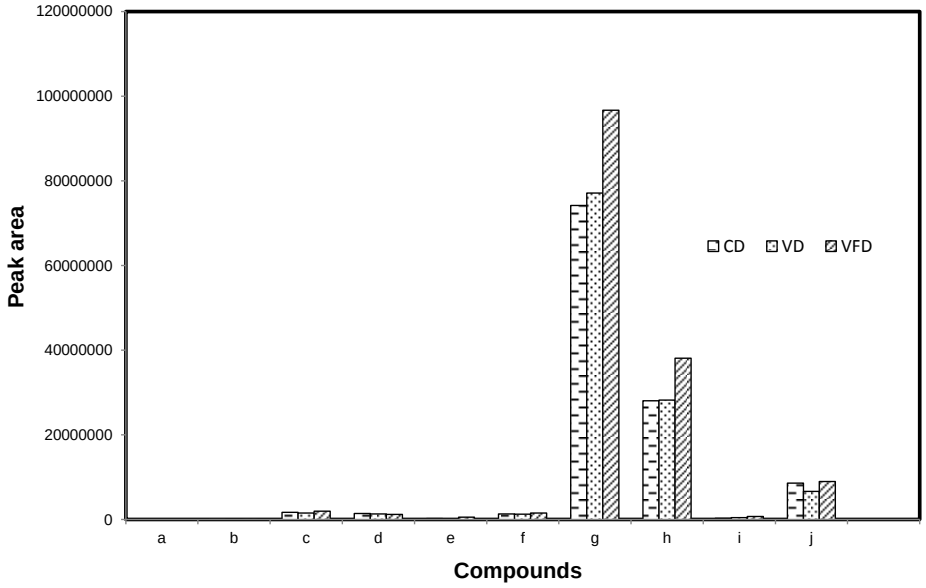

Fig. 2. Comparison of pharmaceutical ingredients peak area
a: Phenol, 4-methyl-; b: 2-Butenedioic acid(Z)-,diethyl ester; c: Resorcinol; d: 4-Methyl-2,5-dimethoxybenzaldehyde; e: β-Eudesmol; f: Pinocembrin; g: 6H-Benzofuro[3,2-c][1]benzopyran-3-ol, 6a,11a-dihydro-9-methoxy-, (6aR-cis)-; h: 4H-1-Benzopyran-4-one, 7-hydroxy-3-(4-methoxyphenyl)-; i: 4'-Methoxy-5,7-dihydroxy isoflavone; j: Liquiritigenin

The peak areas of 10 kinds of pharmaceutical ingredients from samples treated by the three drying methods were plotted and compared (Fig. 2). In general, the sample treated by VFD had a higher mass for each pharmaceutical ingredient than the other samples, excepting 4-methyl-2,5-dimethoxybenzaldehyde. Clearly, the sample treated by VFD had a larger mass of phenol, 4-methyl; β-eudesmol; 6H-benzofuro[3,2-c][1] benzopyran-3-ol, 6a,11a-dihydro-9-methoxy-, (6aR-cis)-;4H-1-benzopyran-4-one, 7-hydroxy-3-(4-methoxy-phenyl)-; and 4'-methoxy-5,7-dihydroxy isoflavone in comparison to the samples

treated by CD or VD. Thus, VFD can be regarded as the most favorable method for preserving the components and their mass in *Dalbergia bariensis*, compared with the other two drying methods.

For the VD sample, the total peak areas were the smallest. This result is consistent with the conclusion from calculating the extract yields.

CONCLUSIONS

1. The extracts of *Dalbergia bariensis* heartwood were analyzed by GC-MS. A total of 42 compounds were identified in the extracts.
2. Several compounds have obvious medical efficacy, *e.g.*, anti-bacteria, anti-inflammation, antioxidation, scavenging free radicals, reducing blood lipid, anti-cancer, and physiological benefits, such as phenol, 4-methyl-,2-butenedioic acid(Z)-,diethyl ester, and resorcinol *etc*. Therefore, *Dalbergia bariensis* also has high value and potential to be used for rosewood furniture products as a novel health care function.
3. VFD method has better performance over CD and VD methods with respect to preserving the physiologically valuable ingredients and total mass of organic compounds in *Dalbergia bariensis*.

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