

## CHEMICAL COMPOSITION OF THE ESSENTIAL OIL AND ETHER EXTRACT FROM *Rhytidium rugosum*

Ling-he Li,<sup>1,2</sup> Jin-zhong Wu,<sup>1,2,3</sup>  
Ting-Han,<sup>1</sup> and Lu-ping Qin<sup>1\*</sup>

UDC 547.913

The genus *Rhytidium*, which belongs to the family Rhytidiaceae, consists of only 1 species – *Rhytidium rugosum* (Hedw.) Kindb. It grows from below the shrub forest, which is widely distributed in China, Korea, Japan, Russia (the Far East and Siberia), Europe, and North America [1].

Bryophyte has been used as herb medicine to treat trauma, empyrosis, infestation, pulmonary phthisis, eclampsia, pneumonia, and so on [2]. Recently, several chemical compounds from bryophyte were isolated, such as sesquiterpenoids, diterpenoids, biflavoids, bibenzyls, bis-benzyls, and fatty acids, which had shown many biological activities such as antibacterial, antiseptic, antitumor, anticoagulant, and nerve protection [3–5]. However, *R. rugosum*, a bryophyte that can treat coronary heart disease, high blood pressure, nervous prostration, etc. [6], has not been studied as far as we know. In the present work, the essential oil from *R. rugosum* was investigated for further development and application.

The chemical and class composition of the oils are presented in Table 1. Thirty-one compounds (representing of 99.9%) in the essential oil and 58 compounds (representing of 98.8%) in the diethyl ether extract were identified by GC-MS. The identified components and their percentages are given in Table 1.

The essential oil consisted mainly of sesquiterpenes (87.4%). The major compounds were *n*-hexadecanoic acid (27.94%), linolenic acid (11.87%), *cis*-9,*cis*-12-octadecadienoic acid (9.56%), hexahydrofarnesyl acetone (8.65%), pentadecanoic acid (7.86%), *Z*-11-hexadecenoic acid (4.54%), tetradecanoic acid (3.57%), and tetradecanal (3.42%).

The main constituents in the diethyl ether extract were diterpenes (34.2%) and sesquiterpenes (34.5%). Ethyl oleate (8.67%) and  $\tau$ -sitosterol (6.50%) were the most abundant components in the diterpenes and sesquiterpenes, respectively.

These experiments showed for the first time the chemical compositions of the essential oil from *R. rugosum*. The results showed that the main constituents were *n*-hexadecanoic acid (27.94%), linolenic acid (11.87%), and *cis*-9, *cis*-12-octadecadienoic acid (9.56%). Biological studies have reported that *n*-hexadecanoic acid is anti-thrombus and can prevent cardiovascular disease [7]. Linolenic acid has antibacterial, anti-HIV, anti-tumor, anti-inflammatory, anti-scleratheroma activities and can also be used to treat high blood pressure, premenarche syndrome, and diabetes [8, 9]. *cis*-9, *cis*-12-octadecadienoic acid can decrease the content of cholesterol and reverse arteriosclerosis [10]. This study on the essential oil establishes a reliable basis for further investigations on *R. rugosum*. Other studies on the chemical compositions and biological activities of *R. rugosum* are underway.

---

1) Department of Pharmacognosy, School of Pharmacy, Second Military Medical University, 325 Guohe Road, Shanghai 200433, P. R. China, fax: +86 21 25070394, e-mail: qinsmmu@126.com; 2) College of Chemistry&Chemical Engineering, Fuzhou University, 523 Gongye Road, Fuzhou 350002, P. R. China; 3) Department of Pharmacy, Fujian College of Traditional Chinese Medicine, 282 Wusi Road, Fuzhou 350003, P.R.China. Published in Khimiya Prirodnykh Soedinenii, No. 6, pp. 642-643, November-December, 2008. Original article submitted May 11, 2007.

TABLE 1. Chemical Constitutions in the Essential Oil and the Diethyl Ether Extract from *R. rugosum* (Hedw) Kindb

Compound	HD, %*	DE, %*	Compound	HD, %*	DE, %*
$\alpha$ -Caryophyllene	0.56	0.7	4,11,11-Trimethyl-8-methylenebicyclo[7.2.0]-	-	0.19
$\alpha$ -Amorphene	0.21	0.25	undec-4-ene	-	-
Eremophila-1(10),11-diene	0.19	-	Patchoulene	-	0.32
$\alpha$ -Selinene	0.2	0.11	$\beta$ -Resorcyraldehyde,6-methyl-	-	0.33
$\tau$ -Cadinene	0.2	0.35	Hexadecane	-	0.2
Cadina-1,3,5-triene	0.11	-	Limonen-6-ol pivalate	-	0.68
<i>n</i> -Dodecanoic acid	0.76	-	Eudesm-4(14)-en-11-ol	-	0.63
Caryophyllenyl alcohol	0.26	0.29	Diepicedrene-1-oxide	-	0.32
Caryophyllene oxide	2.89	0.9	<i>n</i> -Nonadecane	-	0.34
1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]-3,7-diene	1.29	-	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	-	1.27
<i>trans</i> -Longipinocarveol	3.04	-	4,4,8-Trimethyltricyclo[6.3.1.0(1,5)]-	-	0.42
<i>n</i> -Heptadecanol	1.03	-	dodecane-2,9-diol	-	-
<i>Z,E</i> -2,13-Octadecadien-1-ol	1.2	-	Palmitic acid	-	2.38
Tetradecanal	3.42	-	5-(7 $\alpha$ -Isopropenyl-4,5-dimethyl-octa-	-	0.52
Tetradecanoic acid	3.57	-	hydroinden-4yl)-3-methyl-pent-2-en-1-ol	-	-
Pentadecanoic acid	7.86	-	<i>n</i> -Heneicosane	-	3.05
Hexahydrofarnesyl acetone	8.65	0.31	7-Isopropyl-1,1,4 $\alpha$ -trimethyl-1,2,3,4,4 $\alpha$ ,	-	1.05
( <i>Z</i> )-7-Hexadecenal	0.97	-	9,10,10 $\alpha$ -octahydrophenanthrene	-	-
<i>Z</i> -11-Hexadecenoic acid	4.54	-	Ethyl oleate	-	8.67
1-Hexadecen-3-ol,3,5,11,15-tetramethyl-	1.09	-	Octadecanoic acid	-	1.19
9-Hexadecenoic acid	0.54	-	Osthole	-	3.9
<i>n</i> -Hexadecanoic acid	27.94	0.52	Eicosane	-	1.27
Arachidonic acid methyl ester	1.08	-	Eicosanoic acid	-	2.14
<i>Z</i> -(13,14-Epoxy)tetradec-11-en-1-ol acetate	0.73	-	Tetracosane	-	1.76
Phytol	3.11	0.53	Heptacosane	-	4.03
<i>cis</i> -9, <i>cis</i> -12-Octadecadienoic acid	9.56	-	1-Docosene	-	1.39
Linolenic acid	11.87	-	2-(3,7-Dimethyl-octa-2,6-dienyl)-	-	5.29
Labd-14-ene-8,13-diol,(13 <i>R</i> )-	0.58	-	4-methoxyphenol	-	-
3-Ethyl-5-(2'-ethylbutyl)octadecane	0.57	-	1-Eicosanol	-	4.13
<i>n</i> -Octacosane	0.86	1.75	Hentriacontane	-	6.04
<i>n</i> -Nonacosane	1.03	3.17	<i>E,E,Z</i> -1,3,12-Nonadecatriene-5,14-diol	-	1.55
<i>n</i> -Nonaldehyde	-	0.18	Nonadecyl alcohol	-	7.01
<i>n</i> -Nonanoic acid	-	0.16	Spirosta-5,7-dien-3-ol	-	1.23
Benzosulfonazole	-	0.13	Vitamin E	-	1.26
Acetic acid	-	0.11	Docosane	-	1.14
<i>n</i> -Decanoic acid	-	0.07	Dotriacontane	-	1.9
Copaene	-	0.05	Campesterol	-	5.08
2-Methyl-5-hydroxybenzofuran	-	0.11	Stigmasterol	-	1.76
Phen-1,4-diol,3,6,-dimethyl-	-	0.11	Baccharis oxide	-	1.31
<i>cis</i> -(-)-2,4 $\alpha$ ,5,6,9 $\alpha$ -Hexahydro-3,5,5,9-	-	0.3	$\tau$ -Sitosterol	-	7.02
tetramethyl(1H)benzocycloheptene	-	-	Retinoyl- $\beta$ -glucuronide 6',3'-lactone	-	1.33
Dihydropseudoionone	-	0.18	Diploptene	-	6.5

HD: hydrodistillation method; DE: Diethyl ether extraction method.

\*Relative content.

## REFERENCES

1. P. C. Wu and M. Z. Wang, *Bryoflora of Hengduan Mts (Southwest China)*. Institute of Botany, Academia Sinica, BeiJing, 2000, pp. 663.
2. X. Q. Li, J. C. Zhao, L. Li, and S. L. Huang, *J. Hebei Normal Univ. (Nat. Sci. Ed.)*, 11 (2004).

3. X. N. Wang and H. X. Lou, *J. Chin. Trad. Herb. Drugs*, 2 (2005).
4. Y. C. Gao, J. N. Wang, and H. T. Yang, *J. Shandong Sci.*, 9 (2004).
5. Q. Wang and X. Luo, *J. Guizhou Sci.*, 4, 19 (2001).
6. Y. J. Yi, *J. Chin. Trad. Herb. Drugs*, 8, 31 (2000).
7. Y. Wang, *J. Family Medicine*, 7 (2004).
8. X. Y. Zhao and Y. Ma, *J. China Food Additives*, 1 (2004).
9. R. X. Xu, *J. Med. J. Commun.*, 4, 20 (2006).
10. W. Jiang, *J. Chin. Cereals Oils Assoc.*, 3, 21 (2006).