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Interspecific and Local Variations of Magnolol, Honokiol, and β-eudesmol Contents and Correlation between those Contents and Morphological Characters of Magnolia Barks

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To clarify the interspecific and local variations of magnolol, honokiol, and β-eudesmol contents in the magnolia barks, their contents and morphological characteristics of *Magnolia obovata*, *M. officinalis*, and *M. officinalis* var. *biloba* were studied. The results were as follows. *Magnolia officinalis* examined had the significantly higher magnolol and honokiol contents than *M. obovata* and *M. officinalis* var. *biloba*. *Magnolia obovata* had a significantly higher β-eudesmol content than *M. officinalis* and *M. officinalis* var. *biloba*. Additionally, in *M. officinalis*, a comparatively close correlation was recognized between the magnolol content and the honokiol content, and between the magnolol content and the thickness of bark. Therefore, we propose the ways to choose the Chinese magnolia barks similar to the Japanese magnolia barks in the magnolol content based on the thickness of bark.

Keywords: *Magnolia obovata*; *Magnolia officinalis*; *Magnolia officinalis* var. *biloba*; magnolol; honokiol; β-eudesmol

The magnolia bark is one of the important botanical medicines used for the digestive or sedative actions. The magnolia barks include the Japanese magnolia bark and the Chinese magnolia bark. The Japanese magnolia barks are trunk barks of *Magnolia obovata* growing in Japan, whereas the Chinese magnolia barks are those of *M. officinalis* or *M. officinalis* var. *biloba* growing in China. The amounts of major constituents, such as magnolol, honokiol, β-eudesmol, etc., in these magnolia barks on the market have been assayed and compared.[1-6] However, it is hard to make a critical comparison of the major constituent contents between the two because the magnolia barks on the market have different thickness and are the products from various districts, and sometimes derived from other species. Furthermore, it was reported that the amounts of major constituents in magnolia barks differ depending upon the parts of a tree and are affected by the preparation processes.[1,5,7,8]

To compare the major constituent contents between the Japanese and Chinese magnolia barks more strictly, the trees of *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba* were collected in Japan and China. Firstly, the variations of the constituent contents in each tree were examined. On the basis of their content variations in a tree, the interspecific and local variations of the constituent contents in the magnolia barks were estimated by the analyses of the variance. Additionally, the correlation between the each major constituent content and morphological character was investigated.

MATERIALS AND METHODS

Materials In June - Septembere, *Magnolia* trees whose trunk had a long diameter of about 20 cm at a height of human chest were selected and cut, when the bark is easy to tear off from the wood. Nine trees of *M. obovata* were collected in Iwate, Shizuoka, and Kochi prefectures in Japan. Thirteen trees of *M. officinalis* and four trees of *M. officinalis* var. *biloba* were collected in Sichuan and Yunnan provinces in China (Table I). Sichuan is one of the main producing districts of the Chinese magnolia barks. From each tree, trunk disks of height 10 cm were cut out at every 1 m height of the tree (as shown in Fig. 1). Then, the barks were torn off from the trunk disks and dried in an air oven at 37℃.

Quantitative analysis of magnolol and honokiol

Sample preparation: Dried barks were powdered and each powdered material (0.5 g) was accurately weighed, extracted 3 times with MeOH (15 ml × 3) under supersonication for 30 min, and then centrifuged (3000 rpm, 5 min). The supernatant was combined, to which MeOH was added to make 50 ml, and the solution was passed through a membrane filter (0.45 μm). This solution (10 μl) was subjected to HPLC analysis.

TABLE I. Collection Data and Vouchers

Magnolia obovata			
iwate96	Iwate-cho, Iwate pref. Japan.	1996.9.10	TM15134
iwate97	Iwate-cho, Iwate pref. Japan.	1997.7.31	TM15988
iwate98	Iwate-cho, Iwate pref. Japan.	1996.7.17	TM16587
shizuoka96	Oohito-cho, Shizuoka pref. Japan.	1996.8.8	TM15132
shizuoka97	Oohito-cho, Shizuoka pref. Japan.	1997.8.6	TM15990
shizuoka98	Oohito-cho, Shizuoka pref. Japan.	1998.7.27	TM16585
kochi96	Ochi-cho, Kochi pref. Japan.	1996.9.3	TC15133
kochi97	Ochi-cho, Kochi pref. Japan.	1997.8.4	TC15989
kochi98	Ochi-cho, Kochi pref. Japan.	1998.7.20	TC16586
Magnolia officinalis			
sichuan97-1	Dujiang Yan, Sichuan prov. China.	1997.6.12	TM15903
sichuan97-2	Guan Xian, Sichuan prov. China.	1997.6.26	TM16516
sichuan97-3	Guan Xian, Sichuan prov. China.	1997.6.26	TM16516
sichuan97-4	Guan Xian, Sichuan prov. China.	1997.9.8	TM16264
sichuan97-5	Guan Xian, Sichuan prov. China.	1997.9.19	TM16588
sichuan98-1	Dujiang Yan, Sichuan prov. China.	1998.6.2	TM16588
yunnan97-1	Ludian, Yunnan prov. China.	1997.7.23	TM16076
yunnan98-1	Ludian, Yunnan prov. China.	1998.6.23	TM16659
yunnan98-2	Ludian, Yunnan prov. China.	1998.6.11	TM16660
yunnan98-3	Yangshan, Yunnan prov. China.	1998.6.12	TM16661
yunnan98-4	Yangshan, Yunnan prov. China.	1998.6.13	TM16662
yunnan98-5	Yangshan, Yunnan prov. China.	1998.6.14	TM16663
yunnan98-6	Xuanwei, Yunnan prov. China.	1998.6.17	TM16664
Magnolia officinalis* var. *biloba			
sichuan97-1b	Dujiang Yan, Sichuan prov. China.	1997.6.12	TM15902
sichuan97-2b	Guan Xian, Sichuan prov. China.	1997.6.26	TM16515
sichuan97-3b	Guan Xian, Sichuan prov. China.	1997.9.8	TM16265
sichuan98-1b	Dujiang Yan, Sichuan prov. China.	1998.7.2	TM16589

Abbrevation TM indicates the medicinal specimen in Tsumura & Co.

Authentic sample: Magnolol and honokiol were isolated from this material.

HPLC condition: HPLC apparatus: Shimadzu LC-10 system; column: TSK gel ODS-80TM (250mm × 4.6mm i.d., TOSO); mobile phase: H_2O-CH_3CN-AcOH (40:50:1); flow rate: 1.0 ml/min; UV detection: 254 nm; column temperature: 40℃.

Quantitative analysis of β -eudesmol

Sample preparation: Each powdered material (0.2 g) was accurately weighed, extracted with hexane (5 ml) under supersonication for 15 min, and then centrifuged (3000 rpm, 1 min). The residue was further extracted with hexane (3 ml, 2 ml) for 5 min and centrifuged. The supernatant was combined, to which hexane was added to make 10 ml. This solution (2 μl) was subjected to GC analysis.

Authentic sample: The β -eudesmol used was prepared by NACALAI TESQUE,INC.

GC condition: GC apparatus: Hewlett-Packard HP5890A gas chromatograph; column: DB-WAX (30m × 0.25mm i.d., film thickness 0.25 μm, J&W); column temperature: 120℃(1 min) to 240℃(5 min) at 5℃/min; carrier gas: He (30 psi); injection: Split-less method (injection temperature; 240℃); detector: FID (detection temperature: 250℃).

Morphological characters The height above the ground, the number of annual rings in xylem, the length of long

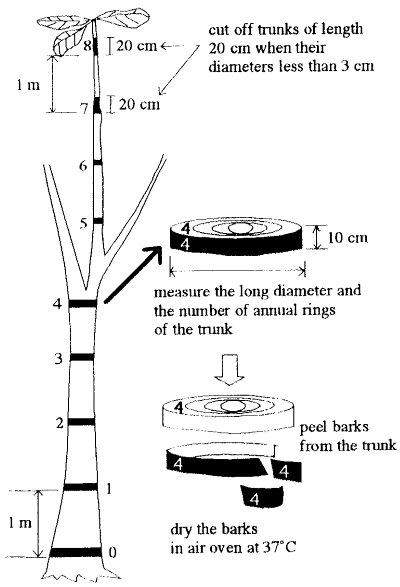

Fig. 1. Collecting Methods of Samples

diameter of trunk, and the thickness of bark were examined. To observe the anatomical features, cross sections of about 15 μm thickness were cut off from the barks and stained with the methylene blue solution after bleached with the Eau de Javell solution. In each cross section, the number of layers of phloem fiber bundles were counted microscopically. The number of layers of phloem fiber bundles was reported as 'the annual ring like structure' that indicates the growth years of the barks as the annual rings in xylem by Shimomura *et al.*[9] The area ratio of oil cells in each cross section was measured, because β-eudesmol is known to be in oil drops in *Atractylodes lancea*.[10] To measure the area ratio of oil cells, a video picture of the cross section about 1.2 mm in width was taken for each sample. On the video pictures, the total area and the total oil cell area were read on a Macintosh computer using the public domain NIH Image 1.60 program (developed at the U.S. National Institutes of Health and available on the Internet at http://rsb.info.nih.gov/nih-image/). The area ratio of oil cell equals the total oil cell area divided by the total area on the video picture.

Statistics The interspecific variation and regional differences of the constituent contents were evaluated by the analyses of variance. The analyses of variance and the correlation between each character were performed by using 'Excel statistics for the Macintosh'.[11]

RESULTS

The mean values and standard deviations of the major constituent contents and the morphological characteristics are shown in Table II. The magnolol, honokiol, and β-eudesmol contents in each sample tree are illustrated in Figs. 2 – 4, respectively.

Magnolol contents As shown Table II and Fig. 2, the mean magnolol content in *M. officinalis* was significantly higher than that in *M. obovata*, whereas there was no significant difference between the mean magnolol contents in *M. obovata* and *M. officinalis* var. *biloba*. However, the magnolol content had a larger standard deviation in *M. officinalis* (1.29 %) than in *M. obovata* (0.71 %) or *M. officinalis* var. *biloba* (0.91 %).

In *M. obovata*, there was no significant difference among the mean magnolol contents of the trees from Iwate (1.91 %), Shizuoka (1.48 %), and Kochi (1.88 %), though iwate96 (2.26 %) and iwate97 (2.54 %) from Iwate had somewhat higher magnolol contents (Fig. 2).

In *M. officinalis*, the mean magnolol content of the trees from Sichuan (3.53 %) was significantly higher than that from Yunnan (2.42 %).

Honokiol contents As shown in Table II and Fig. 3, the mean honokiol contents in *M. officinalis* was significantly higher than that in *M. obovata*, whereas there was no significant difference between the mean honokiol

TABLE II. Constitutent Contents and Morphological Characteristics in *Magnolia* species

Species or Producing district	number of tree	Magnolol content (%)	honokiol content (%)	β-eudesmol content (%)	height of tree (m)	long diameter of trunk at height of 1 m (cm)	the largest number of annual rings	number of layers of fiber bundles	thickness of bark (mm)	area ratio of oil cell (%)
M. obovata	9	1.78±0.71	0.75±0.65	0.23±0.10	11.6±2.4	21.0±2.5	39.2±16.0	22.4±5.7	2.82±0.99	3.73±1.30
Iwate	3	1.91±0.91	0.27±0.15	0.16±0.05	11.7±2.4	21.7±1.3	50.7±5.8	27.7±2.5	3.19±0.91	2.77±1.05
Shizuoka	3	1.48±0.67	0.32±0.20	0.32±0.10##	9.7±1.5	21.5±3.2	19.3±4.6##	16.7±0.6#	2.45±0.88##	4.28±1.15##
Kouchi	3	1.88±0.43	1.50±0.41##	0.24±0.08##	13.3±1.2	19.9±3.3	47.7±8.1	23.0±5.6	2.76±1.02	4.19±1.13##
M. officinalis	13	2.90±1.29 **	2.13±1.07 **	0.07±0.10**	10.1±2.8	16.2±6.6 *	22.1±9.2 **	20.9±5.7	2.42±1.06 **	4.16±1.59 *
Sichuan	6	3.53±1.24	2.28±1.27	0.13±0.12	9.3±2.2	21.3±5.7	23.3±10.1	18.8±5.1	2.64±1.12	4.13±1.48
Yunnan	7	2.42±1.12△△	2.01±0.88	0.03±0.02△△	10.7±3.2	13.3±5.5△	21.4±9.4	22.7±6.0	2.26±0.99△	4.17±1.67
M. officinalis* var. *biloba (Sichuan)	4	2.04±0.91	0.84±0.54	0.08±0.05**	9.0±1.2	14.5±2.0	15.7±2.1 **	13.5±1.0 **	1.88±0.51 **	3.14±1.54 *

All values are expressed as the mean ± standard deviation.
Least significant difference of the mean from *M. obovata*, $*p < 0.05$, $**p < 0.01$.
Least significant difference of the mean from Iwate, $\#p < 0.05$, $\#\#p < 0.01$.
Least significant difference of the mean from Sichuan, $\triangle p < 0.05$, $\triangle\triangle p < 0.01$.

content in *M. obovata* and that in *M. officinalis* var. *biloba*, though *M. officinalis* had a higher standard deviation (1.07 %) than *M. obovata* (0.65 %) and *M. officinalis* var. *biloba* (0.54 %).

In *M. obovata*, the mean honokiol content of the trees from Kochi (1.50 %) was obviously higher than those from Iwate (0.27 %) and Shizuoka (0.32 %) with significances (Fig.3).

In *M. officinalis*, there was no significant difference in the mean honokiol contents between the trees from Sichuan and Yunnan, though the mean honokiol contents of the trees from Sichuan (2.28 %) were slightly higher than those from Yunnan (2.01 %). Most trees of *M. officinalis* from Sichuan had comparatively high honokiol contents of about 3 %, but sichuan97-1 had an extremely low mean honokiol content (0.21 %). The honokiol contents of the samples collected in Yunnan were various, ranging from about 1 % to 3 % (Fig. 3).

β -eudesmol contents As shown in Table II and Fig. 4, the mean β -eudesmol content in *M. obovata* was significantly higher than those of *M. officinalis* and *M. officinalis* var. *biloba*, and there was no significant difference between the mean β -eudesmol content in *M. officinalis* and that in *M. officinalis* var. *biloba*. *Magnolia obovata*, and *M. officinalis* had a similar standard deviation (0.10 %), whereas *Magnolia officinalis* var. *biloba* had a lower standard deviation (0.05 %). However, the standard deviation in each tree of *M. obovata* (0.06 %) was obviously higher than those of *M. officinalis* (0.01 %) and of *M. officinalis* var. *biloba* (0.02%) (Fig. 4).

In *M. obovata*, the mean β -eudesmol content of barks from Iwate (0.16 %) was significantly lower than those from Shizuoka (0.32 %) and Kochi (0.24 %).

In *M. officinalis*, the mean β -eudesmol contents of barks from Sichuan (0.13 %) was significantly higher than that from Yunnan (0.03 %): sichuan97-1 had an extremely high mean β -eudesmol content (0.33 %), though the other trees of *M. officinalis* had comparatively low mean of β -eudesmol content of less than about 0.1 % (Fig. 4).

Morphological characteristics There was no significant differences in the long diameters of trunk at a height of 1 m, and in the area ratio of oil cells among *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba*. The largest number of annual rings in the tree and the thickness of bark were significantly lower in *M. officinalis* and *M. officinalis* var. *biloba* than in *M. obovata*. The number of layers of fiber bundles of *M. officinalis* var. *biloba* was significantly lower than those of *M. obovata* and *M. officinalis* (Table II).

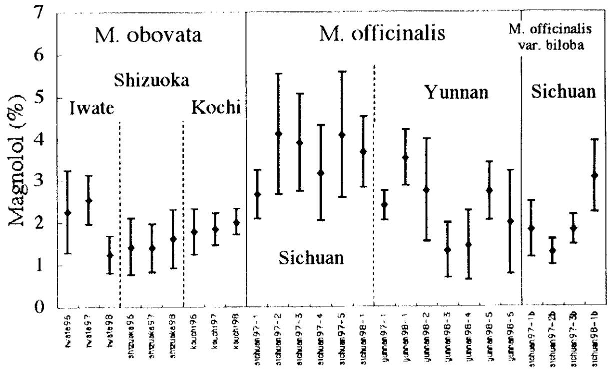

Fig. 2. Magnolol Content of Each Tree
Each bar represents the mean ± standard deviations of magnolol contents in each tree.

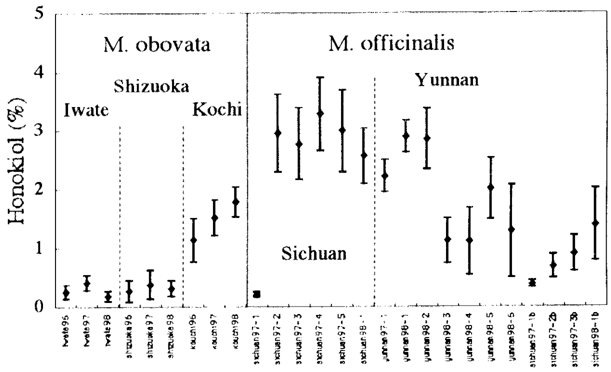

Fig. 3. Honokiol Content of Each Tree
Each bar represents the mean ± standard deviations of honokiol contents in each tree.

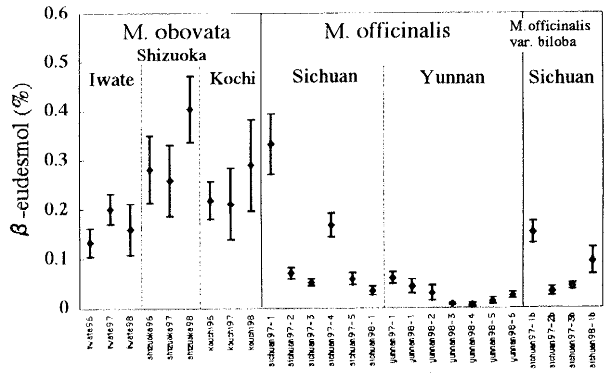

Fig. 4. β -eudesmol Content of Each Tree
Each bar represents the mean ± standard deviations of β -eudesmol contents in each tree.

Correlation of each character The simple correlation coefficients between each character in *M. obovata*, *M. officinalis,* and *M. officinalis* var. *biloba* are shown in Table III.

In *M. obovata*, a comparatively close correlation with a simple correlation coefficient above 0.500 was observed between the 'magnolol content' and the 'height above ground', 'long diameter of trunk', 'number of annual rings' and 'thickness of bark'; and between the 'β-eudesmol content' and the 'number of annual rings' and 'area ratio of oil cells', whereas, no correlation was observed between the morphological characters and the 'honokiol content'. However, the correlation with a simple correlation coefficient (0.793) was noted between the magnolol content and honokiol content in *M. obovata* in the trees from Iwate and Shizuoka, but not in those from Kochi (Fig. 5). Among the trees collected in Kochi, no correlation was noted between the magnolol content and the honokiol content probably because the honokiol contents of Kochi samples were much higher than those of Iwate and Shizuoka samples though the magnolol contents of Kochi, Iwate and Shizuoka samples were almost the same.

In *M. officinalis*, there was a comparatively close correlation between the 'magnolol content' and the 'honokiol content', 'long diameter of trunk', 'number of annual rings' and 'thickness of bark', and between the 'honokiol content' and the 'magnolol content' and 'thickness of bark', whereas, no clear correlation was noted between the morphological characters and the 'β-eudesmol content'.

In *M. officinalis* var. *biloba*, there was a comparatively close correlation between the 'magnolol content' and the 'honokiol content', 'number of annual rings' and 'area ratio of oil cells', between the 'honokiol content' and the 'magnolol content', and between the 'β-eudesmol content' and the 'area ratio of oil cells'.

Regressions of various characters Simple linear regressions for the magnolol and honokiol contents in *M. obovata* from Iwate and Shizuoka, in *M. officinalis*, and in *M. officinalis* var. *biloba* were $y = 0.16x + 0.01$, $y = 0.60x + 0.37$, and $y = 0.50x - 0.03$, respectively (Figs. 5, 6). The ratios between the honokiol content and the magnolol content in *M. officinalis* and *M. officinalis* var. *biloba* were about three or four times that of *M. obovata* samples collected in Iwate and Shizuoka.

Such morphological characters as the 'height above the ground', 'long diameter of trunk', 'number of annual rings', 'number of fiber bundle', and 'thickness of the bark',

TABLE III. Simple Correlation Coefficients of Individual Characters in Each Species

	magnolol content	honokiol content	β-eudesmol content	height above the ground	long diameter of the trunk	number of annual rings	number of fiberbundles	thickness of the bark
M. obovata (n = 113)								
Honokiol contents	0.276**							
β-eudesmol contents	-0.035	0.196*						
Height above the ground	-0.506**	0.169	0.181					
Long diameter of the trunk	0.614**	-0.104	-0.211*	-0.907**				
Number of annual rings	0.530**	0.046	-0.539**	-0.610**	0.784**			
Number of fiber bundles	0.478**	-0.081	-0.410**	-0.452**	0.655**	0.830**		
Thickness of the bark	0.531**	-0.132	-0.233*	-0.706**	0.845**	0.782**	0.829**	
Area ratio of oil cell	0.037	0.399**	0.500**	0.158	-0.247**	-0.360**	-0.460**	-0.358**
M. officinalis (n = 144)								
Honokiol contents	0.729**							
β-eudesmol contents	0.078	-0.344**						
Height above the ground	-0.454**	-0.203*	0.075					
Long diameter of the trunk	0.644**	0.234*	0.132	-0.804**				
Number of annual rings	0.531**	0.316**	-0.030	-0.662**	0.809**			
Number of fiber bundles	0.504**	0.357**	0.034	-0.745**	0.818**	0.873**		
Thickness of the bark	0.608**	0.510**	0.125	-0.651**	0.826**	0.887**	0.822**	
Area ratio of oil cell	0.330**	0.135	0.358**	0.037	0.126	0.258	0.077	0.274
M. officinalis var. *biloba* (n = 40)								
Honokiol contents	0.815**							
β-eudesmol contents	0.331*	-0.132						
Height above the ground	-0.346*	-0.372*	0.120					
Long diameter of the trunk	0.423*	0.196	0.220	-0.949**				
Number of annual rings	0.578**	0.377	0.047	-0.983**	0.963**			
Number of fiber bundles	0.375*	0.492**	-0.366*	-0.674**	0.461*	0.530**		
Thickness of the bark	0.051	0.171	-0.314*	-0.787**	0.865**	0.805**	0.569**	
Area ratio of oil cell	0.663**	0.261	0.653**	-0.090	0.490*	0.593**	-0.094	-0.169

Significance of corellation coefficient, * $p < 0.05$, ** $p < 0.01$.
Correlation coefficients beyond 0.500 are shown in bold - face type.

which increase with the growth of the trees, were closely correlated with each other in *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba*. Especially, the thickness of the bark which directly concerned with the quality of the magnolia bark had a close correlation with the 'long diameter of trunk' and the 'number of annual rings' in each species. The simple linear regression between the 'thickness of bark' and the 'long diameter of trunk' for all the samples of *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba* are illustrated in Fig. 7. The simple linear regression was $y = 0.12x + 1.13$ and its simple correlation coefficient was 0.774. The involutional regression between the 'thickness of bark' and the 'number of annual rings' for samples of *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba* are

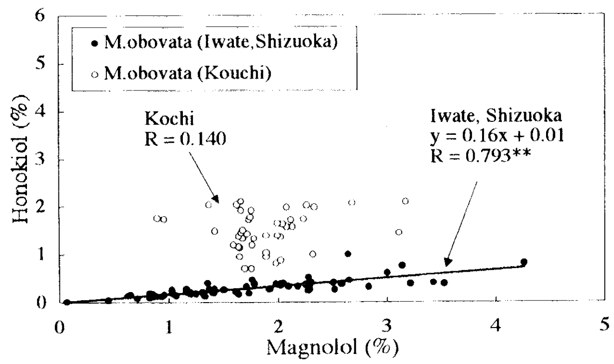

Fig. 5. Correlation between Magnolol and Honokiol Contents of *M. obovata*
Line represents the simple linear regression of *M. obovata* produced in Iwate and Shizuoka. R is the simple correlation coefficient. Significance of the simple correlation coefficient, $**p < 0.01$.

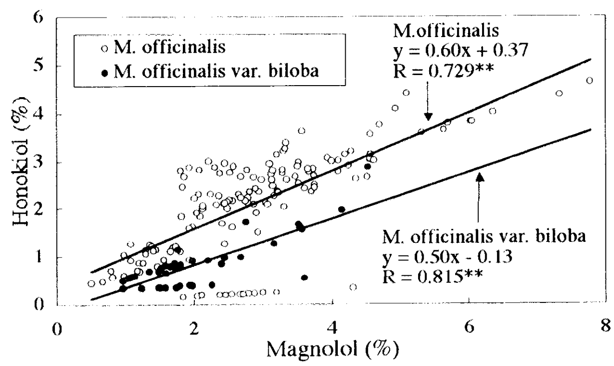

Fig. 6. Correlation between Magnolol and Honokiol Contents of *M. officinalis* and *M. officinalis* var. *biloba* Lines represent the simple linear regressions of *M. officinalis* and *M. officinalis* var. *biloba*. R is the simple correlation coefficient. Significance of the simple correlation coefficient, $**p < 0.01$.

illustrated in Fig. 8. The involutional regression was $y = 0.71x^{0.44}$ and its multiple correlation coefficient was 0.879.

DISCUSSIONS

Interspecific and local variations of magnolol, honokiol, and β -eudesmol contents *Magnolia obovata* had a significantly higher β -eudesmol content than *M. officinalis* and *M. officinalis* var. *biloba* but lower magnolol and honokiol contents than *M. officinalis*. The honokiol content of *M. obovata* from Kochi was unusually high for the Japanese magnolia barks, and was about five times than from Iwate or Shizuoka. The mean honokiol content of the barks from Kochi (1.50 %) was obviously higher than the

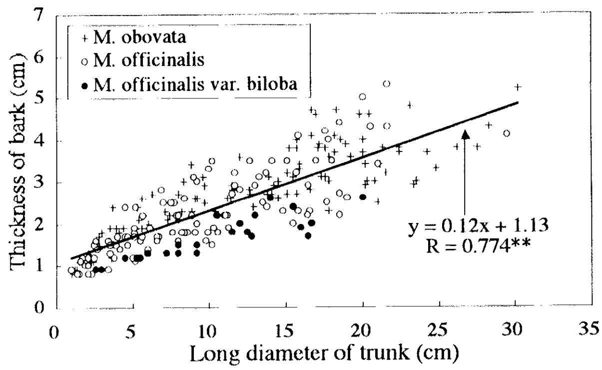

Fig. 7. Correlation between Long Diameter of Trunk and Thickness of Bark
Line represents the simple linear regression for all samples including *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba*. R is the simple correlation coefficient. Significance of the simple correlation coefficient, $**p < 0.01$.

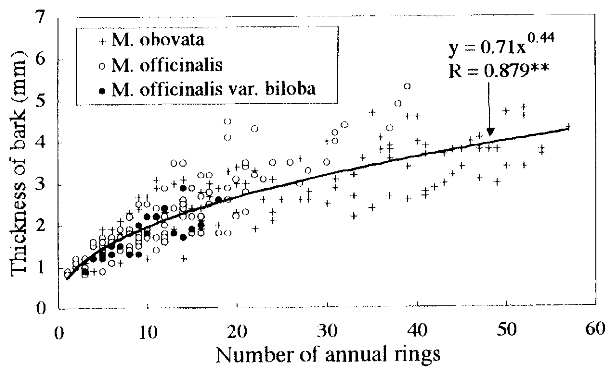

Fig. 8. Correlation between Number of Annual Rings and Thickness of Bark
Line represents the involutional regression for all samples including *M. obovata*, *M. officinalis*, and *M. officinalis* var. *biloba*. R is the multiple correlation coefficient. Significance of the multiple correlation coefficient, $**p < 0.01$.

value reported by Arimoto *et al.* for the Japanese magnolia bark (0.59 %) or that by Katsura *et al.* for *M. obovata* (0.43 %).[5,7] The β-eudesmol content of *M. obovata* from Iwate was significantly lower than those from Shizuoka and Kochi.

Magnolia officinalis had significantly higher magnolol and honokiol contents than *M. obovata* and *M. officinalis* var. *biloba* but a lower β-eudesmol content than *M. obovata*. The magnolol and β-eudesmol contents of *M. officinalis* from Sichuan were significantly higher than those from Yunnan, though the β-eudesmol contents among Sichuan samples were extremely various as shown in Fig. 4. *Magnolia officinalis* had higher standard deviations of the magnolol and honokiol contents than *M. obovata*. Therefore, when we use the barks of *M. officinalis* as the magnolia bark, we have to consider that their constituent contents tend to be various.

The magnolol and honokiol contents of *M. officinalis* var. *biloba* were almost the same as those of *M. obovata*, but less than those of *M. officinalis*. The β-eudesmol content in *M. officinalis* var. *biloba* was significantly less than in *M. obovata*. There was no significant difference in the β-eudesmol content between *M. officinalis* and *M. officinalis* var. *biloba*.

The ways to choose of the Chinese magnolia barks similar to the Japanese magnolia barks in the constituent contents

As regards the constituent contents of the magnolia barks on the market, Arimoto *et al.* reported that the magnolol content was lower in the Chinese magnolia barks than in the Japanese magnolia barks and that the honokiol content was higher in the Chinese magnolia barks than in the Japanese magnolia barks.[5] In contrast, our results showed that the magnolol and honokiol contents in the Chinese magnolia barks (= *M. officinalis* and *M. officinalis* var. *biloba*) were almost the same or higher than those in the Japanese magnolia barks (= *M. obovata*) and that there was a comparatively close correlation between the magnolol content and the honokiol content except in the *M. obovata* samples collected in Kochi. This contradiction may reveal the fact that there are various magnolia barks on the market with large variations in the magnolol, honokiol, and β-eudesmol contents than expected. Then, we propose two ways to choose the Chinese magnolia barks similar to the Japanese magnolia barks in the constituent contents.

One is to use the barks of *M. officinalis* var. *biloba* because *M. officinalis* var. *biloba* had almost the same magnolol and honokiol contents as *M. obovata* though it had the less β-eudesmol contents than *M. obovata*.

The other way is to choose and use comparatively thin barks of *M. officinalis*. The magnolol and honokiol contents in *M. officinalis* are closely correlated with the thickness of barks (Table III). If we chose thin barks of *M. officinalis*, the magnolol and honokiol contents should be low. The magnolol and honokiol contents in *M. officinalis* barks of different thickness were compared with the corresponding values of *M. obovata* (Figs. 9, 10). In *M.*

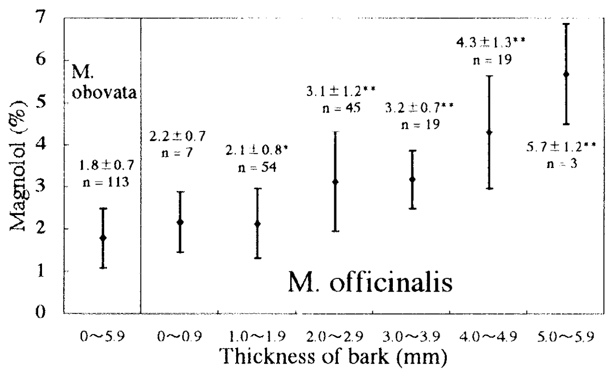

Fig. 9. Magnolol Contents in *M. officinalis* Barks of Different Thickness

Each bar represents the mean ± standard deviations of magnolol contents. The least significant difference of the mean from the mean of *M. obovata*, $^{*}p < 0.05$, $^{**}p < 0.01$.

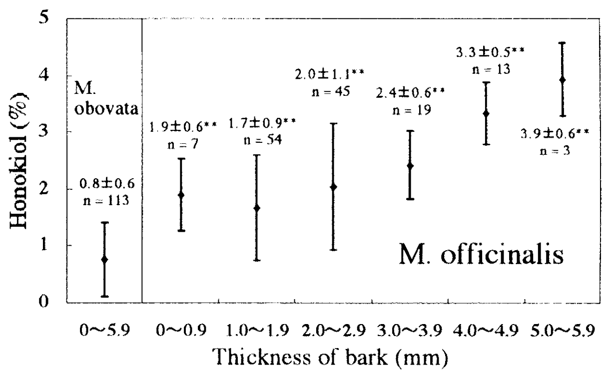

Fig. 10. Honokiol Contents in *M. officinalis* Barks of Different Thickness

Each bar represents the mean ± standard deviations of honokiol contents. The least significant difference of the mean from the mean of *M. obovata*, $^{*}p < 0.05$, $^{**}p < 0.01$.

officinalis, the barks thicker than 2 mm had significantly higher magnolol content than that in *M. obovata* ($p < 0.01$) but the barks thinner than 1.9 mm had about the same mean of magnolol content as *M. obovata* (Fig. 9). The honokiol contents in *M. officinalis* increased with the increase of thickness of barks and even very thin barks had obviously higher honokiol contents than the barks of *M. obovata* ($p < 0.01$) (Fig. 10). Therefore, comparatively thin barks of *M. officinalis* are similar to the Japanese magnolia barks in the magnolol content.

On the contrary, if we want magnolia barks of high magnolol and honokiol contents, we should choose the magnolia barks consisting of the thick barks of *M. officinalis*.

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Appendix: List of characters examined.

Data of the samples	height above ground (m)	long diamiter of trunk (cm)	number of annual rings	number of layers of fiber bundles	thick-ness of bark (mm)	area ratio of oil cell (%)	magnolol (%)	honokiol (%)	β-eudesmol (%)
iwate96	0	24.2	54	28	3.7	5.47	3.22	0.39	0.159
	1	20.2	52	26	3.4	4.00	3.43	0.4	0.127
M. obovata	2	20.2	50	25	3.4	3.63	3.53	0.39	0.126
Japan,	3	20.3	49	23	3	2.84	2.27	0.24	0.126
Iwate pref.	4	17.3	47	23	3.1	2.80	2.52	0.27	0.119
Iwate-cho.	5	15.9	45	27	3.4	2.95	2.83	0.32	0.165
1996.9.10	6	17.8	43	29	3	3.23	2.29	0.26	0.172
TM15134	7	8.8	39	23	3.4	5.06	1.64	0.17	0.158
	8	8.0	33	17	2.2	3.44	1.74	0.2	0.09
	9	5.7	16	18	2.2	5.22	1.33	0.13	0.125
	10	2.2	14	12	1.2	3.83	0.07	0.02	0.081
iwate97	0	27.5	44	30	3.8	4.68	4.26	0.81	0.193
	1	22.4	41	30	3.7	1.70	2.51	0.42	0.169
M. obovata	2	20.4	40	30	4.6	1.73	2.25	0.37	0.179
Japan,	3	19.2	37	25	3.6	1.49	2.02	0.35	0.157
Iwate pref.	4	18.2	36	29	4.1	2.13	2.09	0.33	0.167
Iwate-cho.	5	17.8	34	22	3.6	1.41	2.18	0.34	0.189
1997.7.31	6	15.7	30	23	4	2.42	2.65	0.46	0.199
TM15988	7	12.0	27	21	3.6	3.27	2.5	0.41	0.23
	8	8.3	21	22	3	2.70	2.59	0.38	0.212
	9	5.3	16	28	2.4	2.85	2.58	0.39	0.252
	10	3.7	9	11	2.4	2.29	2.29	0.36	0.25
iwate98	0	26.2	54	25	3.8	2.57	2.29	0.43	0.159
	1	22.4	49	27	3.8	1.93	1.25	0.2	0.092
M. obovata	2	21.3	47	26	3.8	1.63	1.31	0.21	0.106
Japan,	3	20.0	46	35	4	2.34	1.25	0.18	0.127
Iwate pref.	4	18.2	43	26	3.7	1.76	0.89	0.13	0.084
Iwate-cho.	5	17.2	41	33	3.9	1.83	0.85	0.12	0.106
1998.7.17	6	17.0	39	35	4.6	2.11	0.87	0.12	0.105
TM16587	7	15.2	36	30	3.8	1.67	1.41	0.2	0.197
	8	16.7	35	34	4.7	2.65	1.92	0.29	0.28
	9	9.7	31	29	2.9	2.57	1.61	0.22	0.211
	10	9.7	30	19	2.5	2.55	1.32	0.19	0.18
	11	7.1	24	20	2.3	2.62	1.42	0.21	0.202
	12	5.4	16	21	2.1	2.20	1.2	0.17	0.198
	13	4.4	13	19	1.9	1.84	0.84	0.11	0.15
	14	3.0	8	13	1.8	3.33	0.94	0.13	0.181
	15	1.3	3	5	0.9	2.40	0.45	0.06	0.163
shizuoka96	0	30.2	22	17	5.2	6.75	3.14	0.75	0.462
	1	23.5	20	16	3	4.26	2.28	0.53	0.332
M. obovata	2	21.1	20	14	3.4	4.24	1.78	0.38	0.284
Japan,	3	15.9	19	16	3.3	3.70	1.42	0.28	0.225
Shizuoka pref.	4	15.7	17	16	2.7	2.48	1.5	0.26	0.343
Oohito-cho.	5	12.6	16	17	2.8	3.03	1.37	0.26	0.307
1996.6.8	6	8.9	14	14	2.3	2.63	1.2	0.21	0.254
TM15132	7	7.4	11	12	2.2	3.33	0.96	0.16	0.227
	8	5.7	8	13	2.2	3.20	0.84	0.13	0.242
	9	3.9	6	11	1.9	3.43	0.83	0.11	0.236
	10	2.8	4	7	1.5	3.60	1.07	0.14	0.215
	11	1.8	3	5	1.2	6.04	0.71	0.09	0.235
shizuoka97	0	21.0	14	16	2.5	5.18	2.64	1.01	0.244
	1	17.8	12	10	2.3	2.43	1.36	0.41	0.171
M. obovata	2	15.5	11	10	3.1	3.18	1.77	0.47	0.308
Japan,	3	13.8	10	7	2.7	4.83	1.79	0.39	0.357
Shizuoka pref.	4	10.4	8	6	2.3	6.45	1.37	0.28	0.37
Oohito-cho.	5	9.0	7	7	2.1	4.31	1.03	0.26	0.247
1997.6.6	6	5.6	5	5	1.9	4.28	1.16	0.28	0.272
TM15990	7	3.6	4	5	1.2	5.44	0.83	0.19	0.201
	8	2.4	3	5	1.1	5.53	0.65	0.16	0.155
shizuoka98	0	24.8	22	17	3.3	3.54	3	0.62	0.403
	1	23.3	18	16	2.9	3.78	2.02	0.39	0.29
M. obovata	2	20.8	17	20	3	4.04	2.05	0.4	0.385
Japan,	3	17.6	14	18	3.1	4.50	1.98	0.38	0.359
Shizuoka pref.	4	14.5	13	18	3	4.13	2.3	0.42	0.477
Oohito-cho.	5	11.5	11	13	2.9	3.21	1.71	0.33	0.481
1998.7.27	6	8.0	10	16	2.7	4.88	1.16	0.23	0.353
TM16585	7	6.3	9	14	2.7	6.06	1.03	0.2	0.41
	8	4.1	7	11	1.8	5.49	0.86	0.18	0.322
	9	2.3	3	8	1.1	3.99	1.04	0.19	0.526
	10	1.3	3	3	0.9	4.98	0.63	0.14	0.431
kochi96	0	26.3	57	29	4.3	5.65	1.98	0.81	0.218
	1	23.1	52	26	4.8	3.99	1.76	0.7	0.198
M. obovata	2	19.8	52	26	4.6	3.63	1.7	0.7	0.188
Japan,	3	18.3	50	35	4.7	3.36	2.32	1.01	0.188
Kochi pref.	4	17.1	48	24	3.8	2.88	2.02	0.88	0.232
Ochi-cho.	5	16.7	47	26	4.1	2.82	3.11	1.46	0.225
1996.9.3	6	15.7	45	27	3.8	3.33	1.89	0.95	0.316
TM15133	7	13.9	31	18	3.1	4.49	1.89	1.03	0.218
	8	9.6	24	17	3.1	3.01	1.65	0.95	0.25
	9	5.6	18	20	2.6	3.03	1.68	1.33	0.185
	10	3.5	10	16	1.9	3.89	1.43	1.5	0.233
	11	1.5	7	7	1.1	5.59	0.9	1.76	0.214
	12	1.0	1	2	0.8	4.02	0.96	1.74	0.149
kochi97	0	20.2	42	18	2.9	5.04	3.17	2.1	0.214
	1	16.6	41	19	2.8	2.91	1.77	1.2	0.131
M. obovata	2	15.1	41	20	2.7	3.50	1.65	1.15	0.128
Japan,	3	14.5	39	15	2.6	3.02	1.64	1.17	0.135
Kochi pref.	4	14.1	37	14	2.7	1.87	1.6	1.19	0.129
Ochi-cho.	5	12.9	35	15	2.4	3.66	1.78	1.33	0.147
1997.8.4	6	12.7	33	17	2.7	3.09	2.08	1.59	0.173
TM15989	7	11.2	28	16	2.6	3.71	2.04	1.64	0.204
	8	11.4	25	20	2.6	3.96	1.64	1.39	0.204
	9	9.2	23	22	2.6	3.68	1.72	1.45	0.208
	10	8.2	20	17	2.3	4.38	1.67	1.46	0.228
	11	6.0	19	17	2	4.28	1.68	1.51	0.262
	12	5.3	15	15	2.4	4.35	1.74	1.73	0.314
	13	3.5	12	11	1.6	4.51	1.76	1.92	0.361
	14	2.1	10	6	1.2	6.55	1.63	2.04	0.316
kochi98	0	21.5	44	22	3.2	3.76	2.02	1.37	0.125
	1	20.0	43	23	3.7	3.13	1.89	1.4	0.184
M. obovata	2	18.6	40	22	4	4.85	1.99	1.41	0.178
Japan,	3	17.6	37	23	3.8	3.58	2.13	1.58	0.201
Kochi pref.	4	16.9	37	31	3.9	4.25	2.68	2.07	0.309
Ochi-cho.	5	15.1	33	25	3.2	4.05	2.23	1.75	0.282
1998.7.20	6	14.2	31	23	2.9	3.83	1.99	1.65	0.241
TM16586	7	11.5	28	23	2.8	5.40	2.12	1.73	0.233
	8	9.1	27	20	2.6	6.14	2.33	1.99	0.284
	9	7.3	24	18	2.1	5.76	2.26	2.02	0.339
	10	6.1	22	14	1.9	5.59	2.08	1.99	0.33
	11	5.1	16	13	1.9	3.72	1.75	1.77	0.359
	12	2.8	10	11	1.7	4.58	1.67	1.91	0.39
	13	2.1	8	9	1.3	7.06	1.67	2.11	0.482
	14	1.2	4	5	0.9	6.08	1.37	2.04	0.395
sichuan97-1	0	21.0	21	18	3.4	8.32	4.31	0.34	0.306
	1	19.0	19	13	2.6	5.99	3	0.24	0.274
M. officinalis	2	17.7	17	17	2.5	5.17	3.18	0.25	0.258
China,	3	16.5	15	15	2.9	4.35	2.54	0.21	0.279
Sichuan,	4	14.8	14	14	2.3	5.09	2.79	0.22	0.343
Dujiang Yan.	5	13.8	13	14	2.4	5.08	2.67	0.21	0.335
1997.6.12	6	11.0	12	13	2.2	5.34	2.37	0.19	0.279
TM15903	7	10.5	11	13	2.2	5.39	2.88	0.23	0.42
	8	9.2	9	11	2	5.22	2.46	0.19	0.384
	9	6.1	7	11	1.9	6.29	2.71	0.21	0.374
	10	5.6	5	13	1.7	6.86	2.05	0.17	0.393
	11	3.9	4	8	1.5	5.57	2.46	0.19	0.438
	12	2.5	3	8	1.2	4.38	1.84	0.16	0.226
	13	1.9	2	6	1	5.93	2.11	0.19	0.343
sichuan97-2	0	-	-	23	5.8	7.82	7.33	4.36	0.076
	1	-	-	23	4.6	5.86	5.63	3.64	0.076
M. officinalis	2	-	-	18	3.5	4.27	4.09	2.78	0.069
China,	3	-	-	21	3.6	5.64	4.09	3.01	0.085
Sichuan,	4	-	-	20	3.2	5.52	3.72	2.84	0.067
Guan Xian.	5	-	-	21	3.4	3.80	3.46	2.68	0.083
1997.6.26	6	-	-	15	2.6	3.51	3.51	2.98	0.066
TM16514	7	-	-	11	1.8	2.62	2.48	2	0.047
	8	-	-	12	1.6	2.59	2.64	2.31	0.06
sichuan97-3	0	-	-	11	2.9	4.28	6.36	4.01	0.061
	1	-	-	15	2.6	4.70	5.31	3.59	0.064
M. officinalis	2	-	-	23	2.4	3.46	3.74	2.5	0.049
China,	3	-	-	21	2.4	3.74	4.24	2.91	0.052
Sichuan,	4	-	-	18	2.1	2.64	3.04	2.13	0.045
Guan Xian.	5	-	-	17	2	2.69	3.51	2.54	0.055
1997.6.26	6	-	-	16	1.9	2.33	2.78	2.13	0.041
TM16516	7	-	-	15	1.5	1.86	3.27	2.75	0.052
	8	-	-	15	1.9	1.88	2.8	2.36	0.05
sichuan97-4	0	-	19	22	4.5	4.74	4.92	4.08	0.061
	1	20.0	-	24	5	3.03	5.09	4.4	0.064
M. officinalis	2	-	-	26	4.2	4.28	3.28	3.2	0.049
China,	3	-	-	24	4.3	4.01	3.32	3.37	0.052
Sichuan,	4	-	-	26	4.2	5.00	3.55	3.62	0.045
Guan Xian.	5	-	-	21	4	2.61	2.06	2.3	0.055
1997.9.8	6	-	-	20	4.1	3.90	2.3	2.86	0.041
TM16264	7	-	-	19	2.8	5.16	2.21	3	0.052
	8	-	-	13	2.4	5.83	1.85	2.68	0.05
sichuan97-5	0	-	38	24	4.9	6.48	7.78	4.62	0.074
	1	29.5	-	23	4.1	3.24	4.54	3.03	0.055
M. officinalis	2	-	-	19	4	2.30	4.54	3.05	0.055
China,	3	-	-	21	3.1	2.98	3.15	2.27	0.045
Sichuan,	4	-	-	16	2.7	3.94	4.56	3.55	0.081
Guan Xian.	5	-	-	17	2.8	4.06	3.49	2.88	0.061
1997.9.19	6	-	-	14	2.1	3.42	2.97	2.6	0.056
TM16263	7	-	-	12	1.8	3.55	2.56	2.16	0.04
	8	-	-	12	1.7	2.69	3.11	2.73	0.058
sichuan98-1	0	18.5	15	15	2.2	4.31	6.03	3.81	0.02
	1	16.6	14	13	2.3	3.78	4.5	2.66	0.025
M. officinalis	2	16.4	12	15	2.2	2.89	3.69	2.35	0.032
China,	3	13.0	12	17	2.9	3.63	3.59	2.43	0.039
Sichuan,	4	11.5	12	14	1.8	1.90	3.06	2.1	0.037
Dujiang Yan.	5	11.3	10	14	1.9	3.72	3.3	2.04	0.036
1998.7.2	6	9.8	9	12	1.6	3.39	3.73	2.7	0.039
TM16588	7	7.9	8	13	2.2	1.90	2.87	2.1	0.036
	8	6.0	7	13	1.4	2.88	3.92	3.06	0.057
	9	5.2	6	11	1.1	3.00	3.33	2.61	0.034
	10	3.4	5	8	0.9	3.57	3.14	2.48	0.027
	11	2.3	3	5	0.8	1.98	2.94	2.36	0.032
yunnan97-1	0	18.0	26	18	3.5	4.67	3.2	2.39	0.077
	1	17.0	24	15	3.5	4.69	2.78	2.24	0.056
M. officinalis	2	15.7	22	21	3.2	3.16	2.74	2.17	0.055
China,	3	15.1	21	19	3.5	4.16	2.43	2.12	0.054
Yunnan,	4	13.3	20	19	3.1	2.67	2.32	2.07	0.048
Ludian.	5	11.7	19	16	2.9	3.41	2.09	1.85	0.048
1997.7.23	6	11.5	16	14	2.7	2.76	2.04	1.91	0.085
TM16076	7	8.4	14	15	2.6	4.51	2.12	2.01	0.064
	8	7.7	10	14	2.5	4.07	2.12	2.06	0.062
	9	7.0	9	11	2.5	3.95	2.76	2.82	0.071
	10	4.5	7	7	1.7	4.13	2.23	2.3	0.046
	11	3.4	4	5	1.6	4.21	2	2.22	0.049
	12	2.1	3	4	0.8	4.52	2.37	2.74	0.063
yunnan98-1	0	21.6	39	28	5.3	6.32	4.61	3.01	0.021
	1	21.6	37	27	4.3	6.26	4.55	3.13	0.04
M. officinalis	2	18.5	32	25	4.4	6.21	3.66	2.78	0.044
China,	3	17.6	31	25	4.2	5.60	3.99	2.99	0.034
Yunnan,	4	17.8	31	24	4	6.45	4.19	3.13	0.035
Ludian.	5	14.1	30	20	3.5	5.15	3.64	2.83	0.06
1998.6.11	6	10.0	28	19	3.3	6.56	3.14	2.48	0.039
TM16659	7	9.2	27	18	3	5.37	4.27	3.2	0.057
	8	9.0	23	17	3.1	5.42	3.12	2.6	0.061
	9	6.9	21	17	2.8	4.99	3.27	2.81	0.057
	10	5.2	14	13	2.4	6.46	3.09	2.93	0.06
	11	4.5	11	13	2.4	4.47	2.36	2.27	0.032
	12	3.5	8	10	1.5	5.84	3.18	3.13	0.05
	13	2.5	5	7	1.5	6.67	3.31	3.25	0.023
	14	1.7	2	3	1.2	9.50	2.57	2.88	0.024
yunnan98-2	0	20.5	22	23	4.3	5.11	5.69	3.79	0.017
	1	15.8	19	20	4.1	4.66	4.69	3.75	0.028
M. officinalis	2	13.7	17	18	3.2	4.43	2.87	2.66	0.025
China,	3	11.7	16	16	3.2	4.28	1.81	1.85	0.023
Yunnan,	4	12.7	14	15	3.5	5.49	2.68	2.67	0.042
Ludian.	5	10.2	13	14	3.5	6.55	2.52	2.76	0.066
1998.6.11	6	7.0	10	13	2.5	4.72	2.44	2.96	0.045
TM16660	7	5.1	9	10	1.8	2.91	1.83	2.46	0.024
	8	4.0	7	8	1.7	4.98	2.08	2.82	0.018
	9	2.6	4	6	1.6	4.02	1.92	2.87	0.015
	10	1.6	2	5	1.1	3.19	1.8	2.8	0.013
yunnan98-3	0	7.5	9	13	2.5	4.40	2.56	1.61	0.0048
	1	5.1	8	11	1.9	1.99	0.67	0.47	0.0051
M. officinalis	2	5.1	7	9	1.7	2.95	1.36	1.25	0.0096
China,	3	2.7	5	8	1.4	1.91	0.98	1.04	0.0085
Yunnan,	4	1.5	1	2	0.8	5.76	1.08	1.27	0.009
Yangshan.									
1998.6.12									
TM16661									
yunnan98-4	0	12.0	17	23	2.8	1.45	3.74	2.45	0.0053
	1	8.9	16	20	2.2	1.98	0.98	0.6	0.0021
M. officinalis	2	8.6	15	19	1.8	2.29	1.2	0.86	0.0029
China,	3	8.0	14	21	2.2	1.33	1.45	1.15	0.0052
Yunnan,	4	8.4	13	16	1.8	2.23	1.08	0.92	0.0045
Yangshan.	5	6.7	12	16	1.7	1.32	0.82	0.57	0.0049
1998.6.13	6	6.6	11	14	1.7	1.32	0.79	0.71	0.0037
TM16662	7	6.0	11	11	1.4	1.56	0.51	0.44	0.0021
	8	5.7	10	10	2.2	2.52	1.3	1.14	0.0044
	9	4.7	9	9	1.5	2.15	1.3	1.05	0.0038
	10	4.0	6	9	1.7	2.68	1.38	1.22	0.0048
	11	2.1	3	4	1.2	1.37	2.51	2.18	0.0127
	12	1.0	1	1	0.9	3.42	1.75	1.17	0.0091
yunnan98-5	0	18.5	16	31	2.7	6.22	4.34	2.62	0.0056
	1	13.5	14	18	2.5	2.90	2.93	1.52	0.0055
M. officinalis	2	15.5	12	13	2	3.06	2.9	1.92	0.0073
China,	3	11.2	11	16	2.2	2.35	2.41	1.69	0.0088
Yunnan,	4	10.3	10	16	1.9	1.91	1.69	1.2	0.0072
Yangshan.	5	9.9	8	13	1.8	2.82	1.65	1.1	0.0075
1998.6.14	6	10.2	7	12	1.5	3.57	3.21	2.34	0.0194
TM16663	7	8.0	6	9	1.6	2.39	2.89	2.43	0.021
	8	5.5	5	9	1.6	3.71	2.48	2.15	0.0167
	9	5.0	4	5	1.2	3.26	2.68	2.23	0.019
	10	3.8	2	4	1.2	4.09	3.13	2.8	0.0202
	11	1.5	1	2	0.6	7.94	2.44	2.12	0.0164
yunnan98-6	0	15.8	21	23	2.3	5.24	6.05	3.82	0.0297
	1	11.1	20	20	2.2	5.66	2.45	1.27	0.0302
M. officinalis	2	10.6	19	16	1.8	5.75	1.92	0.93	0.0276
China,	3	9.1	18	17	1.8	4.65	1.47	0.8	0.0289
Yunnan,	4	8.2	16	16	1.8	5.52	1.55	0.94	0.0276
Xuanwei.	5	7.6	15	15	1.8	3.85	1.8	1.11	0.0372
1998.6.17	6	6.6	12	15	1.6	4.12	1.21	0.68	0.026
TM16664	7	5.6	10	12	1.7	3.78	1.26	0.87	0.0247
	8	4.7	9	10	1.7	4.69	1.17	0.71	0.0156
	9	4.2	8	10	1.4	3.06	1.73	1.21	0.0209
	10	3.5	6	7	1.3	4.53	1.98	1.61	0.0226
	11	2.1	3	5	1	5.54	1.92	1.6	0.0207
	12	1.4	1	2	0.8	6.26	1.41	1.12	0.0075
sichuan97-1b	0	20.0	18	12	2.6	6.96	3.59	0.55	0.162
	1	16.7	16	10	2	4.73	1.94	0.4	0.132
M. officinalis	2	16.5	14	10	1.7	6.05	1.98	0.39	0.138
var. biloba	3	15.5	12	13	2.4	4.94	2.26	0.4	0.176
China,	4	12.5	10	10	1.8	3.40	1.79	0.38	0.173
Sichuan,	5	12.0	9	9	2	3.44	1.58	0.36	0.154
Dujiang Yan.	6	9.2	7	11	1.5	2.83	1.51	0.36	0.146
1997.6.12	7	8.0	6	9	1.5	3.80	1.23	0.34	0.139
TM15902	8	6.0	5	9	1.3	2.27	1.74	0.36	0.194
	9	5.5	4	6	1.2	3.82	1.48	0.36	0.146
	10	2.6	3	5	0.9	3.26	0.96	0.33	0.109
sichuan97-2b	0	-	-	14	3	1.60	1.77	1.14	0.033
	1	-	-	16	2.4	0.58	1.04	0.55	0.024
M. officinalis	2	-	-	14	2.6	1.27	1.13	0.58	0.024
var. biloba	3	-	-	13	2.1	1.95	0.96	0.49	0.023
China,	4	-	-	12	2	2.01	1.07	0.57	0.027
Sichuan,	5	-	-	9	2	2.19	0.96	0.49	0.028
Guan Xian.	6	-	-	11	1.9	1.36	1.34	0.69	0.04
1997.6.26	7	-	-	10	1.8	1.87	1.58	0.81	0.05
TM16515	8	-	-	8	1.8	3.29	1.72	0.86	0.043
sichuan97-3b	0	-	14	14	2.9	3.73	2.75	1.73	0.043
	1	14.0	-	15	2.6	1.43	1.52	0.75	0.032
M. officinalis	2	-	-	14	2.5	1.27	1.97	0.92	0.042
var. biloba	3	-	-	13	2.2	1.70	1.75	0.81	0.037
China,	4	-	-	11	1.8	1.83	1.8	0.83	0.045
Sichuan,	5	-	-	13	1.9	1.04	1.66	0.79	0.041
Guan Xian.	6	-	-	12	1.8	1.83	1.71	0.8	0.047
1997.9.8	7	-	-	12	2	2.72	1.48	0.68	0.041
TM16265	8	-	-	10	2	1.89	1.71	0.78	0.054
sichuan98-1b	0	16.0	15	14	1.9	4.96	4.52	2.86	0.093
	1	12.8	14	13	1.7	4.00	3.5	1.67	0.103
M. officinalis	2	11.5	13	15	1.8	4.55	3.53	1.61	0.088
var. biloba	3	13.0	11	14	2.2	4.77	4.14	1.97	0.164
China,	4	10.5	10	15	2.2	5.96	3.56	1.57	0.091
Sichuan,	5	9.2	9	14	1.3	2.81	3.15	1.26	0.075
Dujiang Yan.	6	8.0	8	14	1.3	3.22	2.2	0.91	0.065
1998.7.2	7	7.2	6	15	1.3	5.06	2.45	0.97	0.077
TM16589	8	5.3	5	12	1.2	2.65	1.59	0.65	0.064
	9	4.5	4	10	1.2	3.96	2.68	0.99	0.103
	10	3.0	3	6	0.9	4.40	2.39	0.85	0.105