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Noboru Yamamoto · Yoshifumi Miyazaki
Keisuke Sakuda

Sensory evaluation of carpet cleaner containing essential oil and the effect on mites

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Abstract We prepared carpet cleaners containing three wood oils extracted from *Thujopsis dolabrata* Sieb. et Zucc. var. *hondai* Makino, *Chamaecyparis obtusa* Endl., and *Chamaecyparis taiwanensis* Masamune et Suzuki and studied their effects on mites and perfumerists' impressions. The oil concentrations were set at 0.1%, 0.2%, 0.4%, 0.8%, and 1.6%. The effects on *Dermatophagoides pteronyssinus* Trouessart were investigated. The sensory evaluations were conducted by seven male perfumerists using the SD method and they were asked to describe freely their impressions of the scents. These results showed that: (1) all three types of wood oil had a significant effect on making *D. pteronyssinus* inactive at 0.1% concentration; and (2) the wood oil of *T. dolabrata* evoked refreshing, natural, rich, and intellectual feelings; *C. obtusa* oil evoked vivacious, rich, and intellectual feelings; and *C. taiwanensis* evoked refreshing, natural, rich, rough, masculine feelings. According to the test subjects, *T. dolabrata* evoked "woody" and "earthy" impressions; *C. obtusa* evoked "woody," "citrus," and "pine-resin" impressions; and *C. taiwanensis* evoked "woody," "citrus," and "medical" impressions. Many issues remain to be investigated, but the inclusion of wood oil in carpet cleaners offered both good mite control and a pleasant aroma to humans. This study suggests a new potential for using these wood oils.

Key words Sensory evaluation · Essential oil · House dust mite · Carpet cleaner

N. Yamamoto (✉)
Kobayashi Pharmaceutical Co., Osaka 532-0035, Japan
Tel. +81-6-309-1493; Fax +81-6-309-3909
e-mail: n.yamanoto@kobayashi.co.jp

Y. Miyazaki
Laboratory of Biological Activities, Forestry and Forest Products Research Institute, Tsukuba, 305-8687, Japan
Tel. +81-298-73-3211; Fax +81-298-73-3795

K. Sakuda
Ogawa & Co., Tokyo
103-0023, Japan
Tel. +81-3-3270-1547; Fax +81-3-3270-1541

Introduction

Allergic diseases caused by an apparent increase in house dust mites such as *Dermatophagoides pteronyssinus* Trouessart are becoming a major problem.[1] This outbreak of the mite population is attributed to the high humidity in rooms due to changing lifestyles and methods of house construction. At the same time, with the recent increasing concern for health, essential oils of plants are attracting attention as possible natural mite-killing agents,[2,3] replacing chemical ones. It is generally known that the number of mites in a carpet is greater than in any other place in a house.

Carpet cleaners that prevent a static electric charge are reported[4] to be effective for removing mites. We therefore prepared carpet cleaners by mixing the wood oils of *Thujopsis dolabrata* Sieb. et Zucc. var. *hondai* Makino (common name: hiba), *Chamaecyparis obtusa* Endl. (common name: hinoki), and *Chamaecyparis taiwanensis* Masamune et Suzuki (common name: Formosan cypress, Taiwan hinoki) with a static electric charge-preventive carpet cleaner. The effect on comfort and health of humans must be taken into account, as humans and mites usually occupy the same living space. We have investigated the effects of wood oil on both humans and mites.

Materials and methods

Effect on mites

The *D. pteronyssius* was line-bred under a relative humidity (RH) of 84% (adjusted in saturated KCl solution) at 25°C at the Forestry and Forest Products Research Institute of the Ministry of Agriculture, Forestry, and Fisheries. The experiments were conducted at 25°C and 84% RH using a 1:1 mixture of rat feed and dried yeast for the culture medium. The test samples were a mixture of 75 g of the carpet cleaner containing each essential oil and 25 g of the culture medium with mites in it. The ingredients of the

carpet cleaner are shown in Table 1. The essential wood oils used were extracted from the sawdust of *Chamaecyparis obtusa*, *Chamaecyparis taiwanensis*, and *Thujopsis dolabrata* using traps standardized by the Association of Official Agricultural Chemists. They were adjusted to final concentrations of 0% (control), 0.1%, 0.2%, 0.4%, and 0.8%. The sawdust was extracted with a Soxhlet extractor using methanol for 8 h. The residual sawdust was used as the sawdust control for comparison. One gram of each test sample was put in a glass bottle (22 cm^3), with the initial number of mites about 2000/g. The mites were observed at 3, 6, 12, and 24 h and then at 2, 3, 5, 7, 14, 20, 25, and 30 days; the number of moving mites was counted. The experiments were repeated four times.

The observation method was as follows: A plate of acrylic resin (7.6 × 2.6 cm, thickness 3 mm) with a hole 1 cm in diameter was placed in the center of two glass plates (7.6 × 2.6 cm, thickness 1 mm); 2–3 mg of the sample was put in the hole. The mobilized mites (number of mites/mg) were counted with a video microscope (Scalar). The measured number was judged as significant at $P < 0.01\%$ employing Student's *t*-test.

Sensory evaluation

The impressions of seven male perfumerists (two each in their twenties, thirties, and forties and one in his fifties) were surveyed regarding the carpet cleaner. The test samples were 1 g of the carpet cleaner mixed, respectively, with one of the three types of wood oil adjusted to final oil concentrations of 0% (control), 0.1%, 0.2%, 0.4%, 0.8%, and 1.6%, respectively. The control sample was the same carpet cleaner without wood oil.

The test room was air-conditioned at approximately 23°C with a humidity of about 60%. Each test sample (1 g) was put in a transparent glass bottle (22 cm^3). The perfumerists were asked to make their sensory evaluations of three groups of samples divided by oil type, each of which consisted of six samples, including the control. No information was given to the perfumerists other than that the samples were carpet cleaner.

The ranking of the aromatic intensity was as follows: no smell, slight smell, weak smell, moderate smell, strong smell, and unbearably strong smell. Each rank was further divided into three subranks, and the perfumerists were asked to evaluate those items.

The following 22 pairs of adjectives for smell were prepared for the SD method[5]: plain/rich, characteristic/banal, refreshing/not refreshing, active/mild, refined/rough, archaic/modern, relaxing/irritating, hard/soft, dark/bright, romantic/not romantic, exciting/unexciting, light/heavy, urban/rural, pleasant/unpleasant, feminine/masculine, stimulative/not stimulative, vivacious/gloomy, woody/not woody, delicate/rough, passionate/intellectual, natural/artificial, likable/dislikable. Scores of 1 to 7 were assigned by each perfumerist to the respective samples, from which basic factors were extracted by factor analysis.

The criterion for factor extraction was set at an eigen value of 1.0 of more. To evaluate the scores for each factor, Wilcoxon's method with contrasting two sides was employed and judged significant at $P < 0.05$. This SD method was used for the control and the 0.1% and 1.6% concentrations.

The perfumerists were asked to describe their impressions of the scents freely.

Device analysis of *Chamaecyparis obtusa* wood oil

We conducted the *C. obtusa* analysis by confining and sealing in each of five vials containing 1 g of carpet cleaner

Table 1. Ingredients of carpet cleaner[a]

Ingredient	%
Calcium carbonate	94.2
Aluminum oxide	5.0
sec.-Alcohol (C13) ethoxylated (9 mol)	0.5
Silicon dioxide	0.2
Cyclic polysiloxane	0.1

[a] Brand name is Furifuri Carpet, with no perfume. It is manufactured by Kobayashi Pharmaceutical Co. (Osaka, Japan).

Table 2. Percentage variation of mobilized *D. pteronyssinus* during 72 hours' exposure to carpet cleaners containing *C. obtusa*, *C. taiwanensis*, and *T. dolabrata* var. *hondai* wood oils

Carpet cleaner contents	% Variation of mobilized *Dermatophagoides pteronyssinus*, by hours of exposure						
	0	3	6	12	24	48	72
Sawdust (control)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Chamaecyparis obtusa							
Wood oil 0.4%	100.0	60.0	15.0*	8.0*	0*	0*	0*
Wood oil 0.8%	100.0	12.0	0*	0*	0*	0*	0*
Chamaecyparis taiwanensis							
Wood oil 0.4%	100.0	35.4*	31.7	3.8*	0*	0*	0*
Wood oil 0.8%	100.0	13.8*	15.0*	0*	0*	0*	0*
Thujopsis dolabrata							
Wood oil 0.4%	100.0	–	43.6*	10.0*	0*	0*	0*
Wood oil 0.8%	100.0	60.0	29.1*	0*	0*	0*	0*

* Significant difference from the control (sawdust). $P < 0.01$ (Student's *t*-test).

Table 3. Percentage variation of mobilized *D. pteronyssinus* during 30 days' exposure to carpet cleaners containing *C. obtusa*, *C. taiwanensis*, and *T. dolabrata* var. *hondai* wood oils

Carpet cleaner contents	% Variation of mobilized *D. pteronyssinus*, by days of exposure									
	0	1	2	3	5	7	14	20	25	30
Sawdust	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
C. obtusa										
Wood oil 0.1%	100.0	20.0	40.0	61.8	54.5	54.5	4.4*	1.8*	1.8*	0*
Wood oil 0.2%	100.0	2.2	3.6	14.5	10.9	3.6	0*	0*	0*	0*
C. taiwanensis										
Wood oil 0.1%	100.0	37.0*	67.3	37.5	39.2	14.0*	0.5*	0.4*	0*	0*
Wood oil 0.2%	100.0	5.9*	5.5*	8.8	11.8*	0.7*	0*	0*	0*	0*
T. dolabrata										
Wood oil 0.1%	100.0	27.5	–	45.2*	11.2	3.2*	1.5*	0*	0*	0*
Wood oil 0.2%	100.0	12.5*	–	0*	0*	0*	0*	0*	0*	0*

* Significant difference from the control (sawdust). $P < 0.01$ (Student's *t*-test).

containing the *C. obtusa* wood oil adjusted to the final concentrations of 0.1%, 0.2%, 0.4%, 0.8%, and 1.6%, respectively; the same volume of carpet cleaner without oil was the control. These samples were exposed to room temperature (about 23°C) for 30 min, after which 1 ml of the head space was retrieved from each bottle with a gas-tight syringe. α-Pinene, which is the main component of *C. obtusa* wood oil, was measured by gas chromatography (GC-17A Shimadzu Co. Manufacturing, Kyoto, Japan). The calibration curve was set in the units for α-pinene (Wako Pure Chemicals Manufacturing, Osaka, Japan).

Results and discussion

Effect on mites

The number of mites in the sawdust control sample increased eightfold in 30 days, whereas that in the sample with carpet cleaner decreased to 33.6% of that in the sawdust control sample in 14 days. The difference was significant ($P < 0.01$), and the same was observed even thereafter ($P < 0.01$). This result shows that the carpet cleaner significantly suppressed the breeding of *D. pteronyssinus* compared with the sawdust control. It is known that mites cannot ingest moisture from their mouths but absorb moisture contained in the atmosphere; hence their existence is strongly dependent on the environmental humidity. Oribe et al.[6] and Miyamoto et al.[7] reported that, in the relation between *D. pteronysinus* and humidity, the breeding of mites was suppressed under 60% RH or lower. Oribe et al.[6] reported that no moving mites were observed after 35 days, whereas 10.0 times and 8.4 times as many as the initial number were observed under 80% RH and 75% RH, respectively. In this experiment we found that the water content was 13.7% with sawdust and 0.2% with carpet cleaner, which was 1/70 that of the control (sawdust). Thus the suppressed breeding can possibly be attributed to the fact that the carpet cleaner contained almost no water.

Table 2 shows the percentage of mobilized *D. pteronyssinus* in the carpet cleaners containing three wood oils adjusted to 0.4% and 0.8%, respectively. With the 0.4% *C. obtusa* group a significant decrease of 85.0% ($P < 0.01$) was observed after 6 h, and no mobilized mites were seen after 24 h. With the 0.8% group there were no mobilized mites after 6 h. The 0.4% *C. taiwanensis* group showed a significant decrease of 65% ($P < 0.01$) after 3 h, and no mobilized mites were observed after 24 h. The 0.8% group showed a significant decrease of 86% ($P < 0.01$) after 3 h, and no moving mites were seen after 12 h. The percentage of mobilized mites for the 0.8% *T. dolabrata* wood oil was 29% after 6 h, a significant decrease ($P < 0.01$), and no moving *D. pteronyssinus* were observed after 12 h. The 0.4% group showed a meaningful decrease of 56% ($P < 0.01$) after 6 h and 0 after 24 h.

Table 3 shows the percentage of mobilized *D. pteronyssinus* in the carpet cleaners containing three kinds of wood oil adjusted to 0.1% and 0.2%, respectively. The 0.1% *C. obtusa* group showed a decrease of 96% ($P < 0.01$) after 14 days and 100% after 30 days. No mobilized mites were observed in the 0.2% group after 14 days. The 0.1% *C. taiwanensis* group showed a significant decrease of 63% ($P < 0.01$) the next day, with no moving mites found after 25 days. The 0.2% group showed a significant decrease of 94% ($P < 0.01$) the next day. With the 0.1% *T. dolabrata* group a significant difference ($P < 0.01$) was shown with a decrease to 3% after 7 days, reaching 0% after 20 days. The 0.2% group showed a decrease to 13% the next day giving a significant difference ($P < 0.01$); no moving mites were found after 2 days.

It was confirmed that the effects of all three types of wood oil were more significant at higher concentrations. At the same time the differences in the effect of controlling the mobility of *D. pteronyssinus* among the three wood oils showed that *T. dolabrata* was the strongest among the 0.1% and 0.2% groups followed by *C. taiwanensis* and *C. obtusa*. However, even with the 0.1% *C. obtusa* oil, a significant decrease was observed after 14 days, showing its ability to suppress *D. pteronyssinus* in even trace amounts.

Miyazaki[3] reported on the effect of *T. dolabrata* wood oil on *D. pteronyssinus*. According to his report, the percentage of active *D. pteronyssinus* in the group of 0.5% *T.*

dolabrata wood oil was 0% after 24h. This finding can be explained by Miyazaki's use of culture medium, whereas our experiment used a carpet cleaner. Empirical evidence shows that the breeding power of *D. pteronyssinus* was more strongly suppressed as a result of adding *T. dolabrata* wood oil to the carpet cleaner. The same result is likely with less wood oil if the carpet cleaner is combined with a wood oil that acts more effectively on *D. pteronyssinus*.

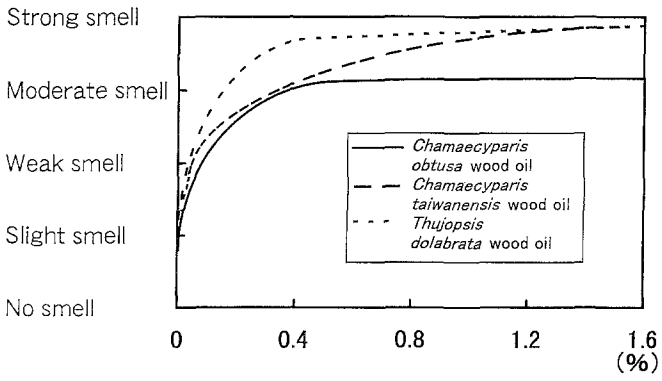

Fig. 1. Variation in the intensity of smell perceived by the perfumerists from carpet cleaners containing *Chamaecyparis obtusa*, *Chamaecyparis taiwanensis*, and *Thujopsis dolabrata* var. *hondai* wood oils by concentration

Sensory evaluation

The sensory intensity of the carpet cleaner without wood oil (wood oil content 0%) was closer to "slight smell" than to "no smell" (Fig. 1). It was apparently due to a slight odor inherent in the carpet cleaner itself. It was between "moderate smell" and "strong smell" at the highest concentration (wood oil 1.6%). The curves showing the degree perceived by the perfumerists and the concentration of smell source showed similar trends among the three types of wood oil. This result shows consistency with Weber-Fechner's law, which concerns the concentration of the source of an odor and the olfactory sense of humans. It can be seen from what we have so far reported[6] that the wood oils of *T. dolabrata*, *C. taiwanensis*, and *C. obtusa* gave people a stronger natural feeling than the control sample.

The data obtained by the SD method from the seven subject perfumerists were used for the evaluation. The loads on the respective factors obtained from factor analysis are shown in Table 4. Six factors were selected for an eigen value of 1. For the first factor, the definition pairs such as relaxing/irritating, archaic/modern, likable/dislikable, pleasant/unpleasant, and natural/artificial had large factor loads and were generalized as a refreshing/natural feeling. For the second factor, cheerful/gloomy, bright/dark, and light/rich had the major loads and were generalized as a cheerful/light feeling. For the third factor, active/mild and

Table 4. Magnitude of factor loads obtained by factor analysis

Parameter	Magnitude, by factors I–VI						
	I	II	III	IV	V	VI	Interpretation
Relaxing/irritating	0.8733	0.1752	−0.1416	0.0960	−0.0996	0.0227	
Archaic/modern	0.7219	−0.2572	0.2464	−0.1130	0.0978	0.0636	
Likable/dislikable	0.7076	0.4898	−0.0686	0.0833	0.1319	−0.0748	
Pleasant/unpleasant	0.7024	0.4518	−0.0627	−0.0200	0.0481	0.1287	Refreshing, Natural feeling
Refined/rough	0.6814	−0.0038	0.1416	0.5061	0.0257	−0.0130	
Natural/artificial	0.6271	0.1192	0.3684	0.0272	−0.3306	0.0294	
Woody/not woody	0.6115	−0.2840	0.3692	−0.0083	0.0306	0.3103	
Urban/rural	0.5973	−0.4234	0.1390	−0.2871	−0.1273	0.3495	
Vivacious/gloomy	0.0658	0.8445	0.1986	0.1159	0.0196	−0.0274	
Dark/bright	0.0092	0.8388	0.1229	0.1061	0.0889	−0.0086	Cheerful, Light feeling
Light/heavy	0.0388	0.8253	−0.1485	0.0400	−0.0848	0.0905	
Refreshing/not refreshing	0.2307	0.6982	−0.1951	0.2534	−0.0970	0.1305	
Hard/soft	−0.2696	0.6011	−0.3237	0.1623	−0.0279	0.0071	
Active/mild	0.0940	0.2953	0.7624	−0.0380	0.0736	−0.0291	
Plain/rich	−0.0621	−0.4592	0.6766	−0.0358	0.1091	0.0833	Vivacious, Rich feeling
Characteristic/banal	0.4243	−0.0771	0.6752	0.0606	0.0441	−0.2627	
Stimulative/not stimulative	−0.1480	−0.2958	0.5325	−0.0878	0.4653	0.2730	
Delicate/rough	0.0168	0.3253	0.0178	0.7692	0.0125	−0.1418	
Feminine/masculine	−0.4563	0.2259	−0.0870	0.7052	−0.3223	0.1168	Delicate, Feminine feeling
Romantic/not romantic	0.4326	0.0267	−0.0849	0.6165	0.2144	−0.0613	
Refined/rough	0.6814	−0.0038	0.1416	0.5061	0.0257	−0.0130	
Exciting/unexciting	0.0182	0.0663	0.1497	0.0382	0.9303	−0.0075	Exciting feeling
Passionate/intellectual	0.1542	0.1584	−0.0541	−0.0769	0.0298	0.8914	Passionate feeling
Eigen/value	4.6322	4.3404	2.4391	1.9761	1.4441	1.2558	
Contribution (%)	21.1	19.7	11.1	9.0	6.6	5.7	

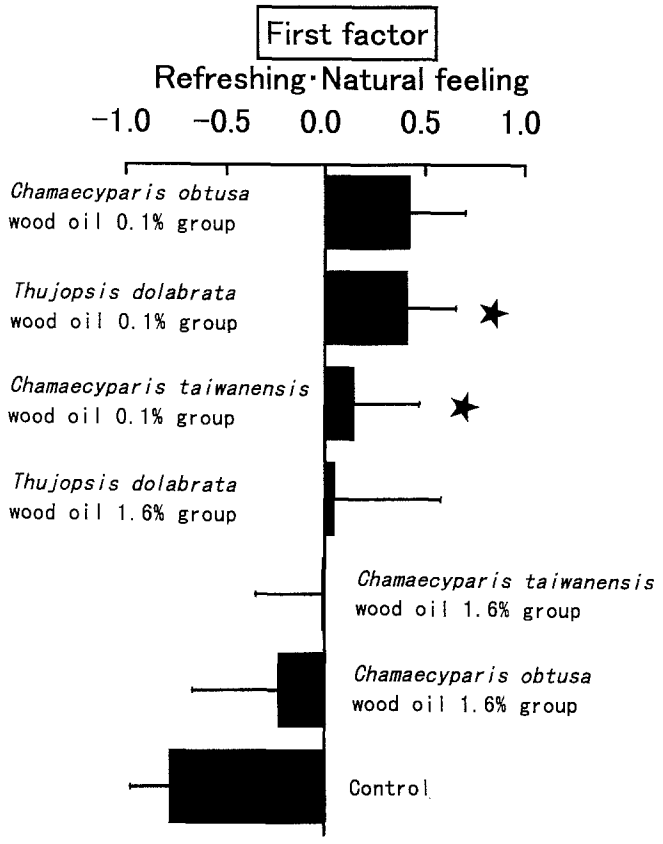

Fig. 2. Construction of the first factor (refreshing/natural feeling). *Lines* extending from the *bars* show the standard error. Those with a significant difference are marked with a *star*. $P < 0.01$ (by Wilcoxon's dual side test)

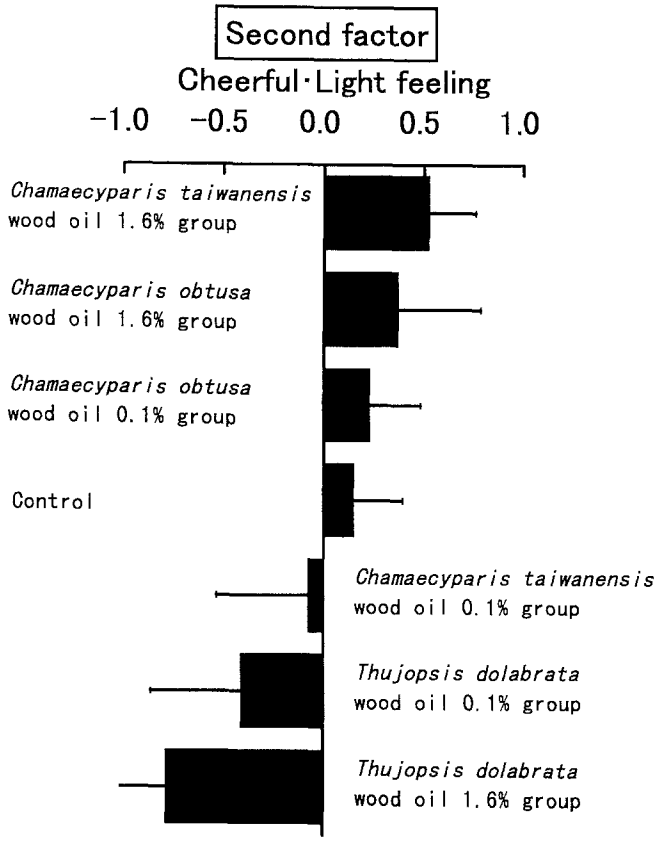

Fig. 3. Construction of the second factor (cheerful/light feeling). *Lines* extending from the *bars* show the standard error

rich/plain were the major factors and were generalized as a vivacious/rich feeling. Accordingly, delicate/rough and feminine/masculine were generalized as a delicate/feminine feeling for the fourth factor, exciting/not exciting as an exciting feeling for the fifth factor, and passionate/intellectual as a passionate feeling for the sixth factor.

Histograms of the scores for the first to the sixth factors are shown in Figs. 2–7, respectively. For the first factor (Fig. 2), a refreshing/natural feeling, all the groups containing wood oil were considered more refreshing and natural by the perfumerists than the control sample. The 0.1% wood oil evoked a more refreshing and natural feeling than the 1.6% wood oil regardless of the wood type. A significant difference ($P < 0.05$) from the controls was observed with the 0.1% group containing wood oil of *T. dolabrata* and *C. taiwanensis*.

For the second factor (Fig. 3), a cheerful/light feeling, the 0.1% and 1.6% wood oils of *T. dolabrata* evoked gloomy and dark feelings. The 1.6% wood oil of both *C. taiwanensis* and *C. obtusa* evoked more cheerful and light feelings than the control. For the third factor (Fig. 4), a vivacious/rich feeling, all wood oil samples evoked more vivacious and rich feelings than the control, and the 1.6% oil was thought to be stronger than the 0.1% oil. The 1.6% and 0.1% groups of *T. dolabrata* wood oil and the 1.6% *C. taiwanensis* wood oil and *C. obtusa* wood oil showed significant differences ($P < 0.05$).

Regarding the delicate/feminine feeling of the fourth factor (Fig. 5), all but the 0.1% *C. obtusa* wood oil were evaluated as evoking rough and masculine feelings. The 1.6% *C. taiwanensis* wood oil was also perceived as rough and masculine, but with a significant difference ($P < 0.05$). For the fifth factor (Fig. 6), an exciting feeling, all the wood oil types at 1.6% concentration were evaluated as giving an exciting feeling; an exciting but calm feeling was evoked by the 0.1% wood oil. As for the sixth factor (Fig. 7), a passionate feeling, it was found that all the groups with wood oil evoked a more intellectual feeling than the control. Significant differences ($P < 0.05$) were observed with 0.1% *T. dolabrata* and *C. obtusa* wood oils.

The freely described impressions are shown in Table 5. Because the subjects were perfumerists, little variation was seen in their words, though they had been asked to describe freely. For example, the words wood, tree, and natural were used for "woody," medical, drug, and chemical for "medical," and citrus and lime for "citrus." Generally, "woody" is an adjective expression the impression of wood oil from trees such as cedar and sandalwood, "citrus" for the oil extracted from the rinds of lemons and oranges, and "medical" for the essential oils of thyme, sage, and rosemary. *T.*

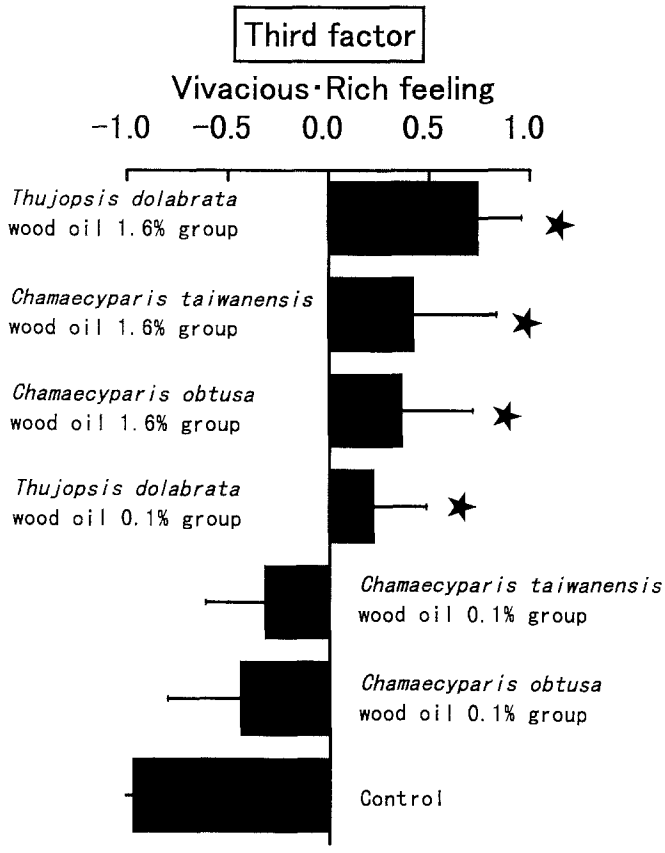

Fig. 4. Construction of the third factor (vivacious/rich feeling). *Lines* extending from the *bars* show the standard error. Those with a significant difference are marked with a *star*. $P < 0.01$ (by Wilcoxon's dual side test)

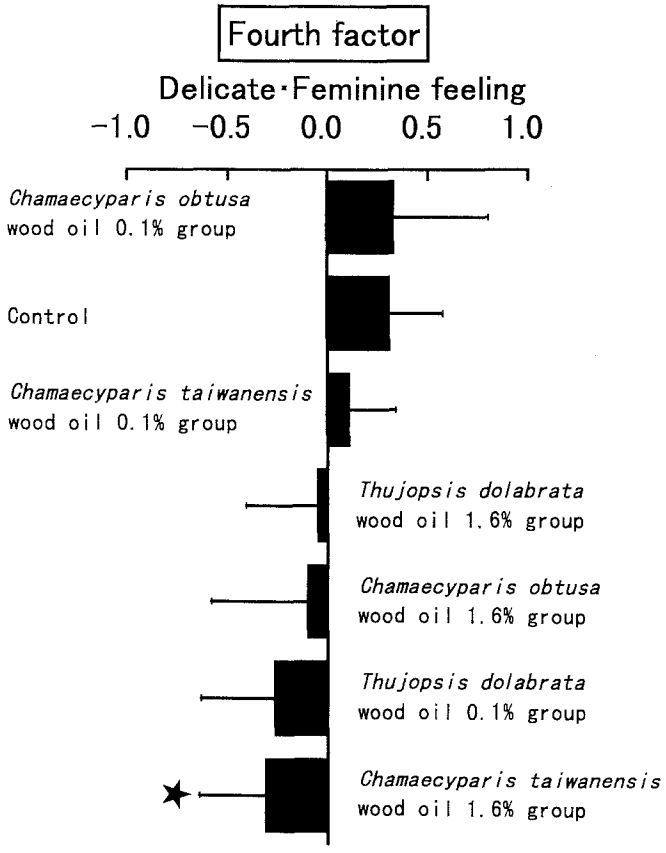

Fig. 5. Construction of the fourth factor (delicate/feminine feeling). *Lines* extending from the *bars* show the standard error. Those with a significant difference are marked with a *star*. $P < 0.01$ (by Wilcoxon's dual side test)

dolabrata was described overwhelmingly as "woody" (74%) and "earthy" (13%). *C. obtusa* was described less often as "woody" (44%) than *T. dolabrata* and included "pine resin" (19%), which was not assigned to *T. dolabrata*. *C. taiwanensis* was described as "woody" at the same rate (44%) as *C. obtusa*; but "citrus" had a larger percentage (38%) than the other two species, and "medical" comprised 12%.

In the free descriptions of impressions, all the 1.6% wood oils gave a strong "woody" impression. On the other hand, with the SD method all the essential oils caused a refreshing/natural feeling. These results indicate that the refreshing/natural feeling people have should be related to the "woody" impression. It was also seen in the free descriptions of impressions that the respective 1.6% *C. obtusa* wood oil samples; *C. taiwanensis* wood oil produced a "citrus" image, but 1.6% *T. dolabrata* wood oil did not. As the second factor of the SD method, the 1.6% *C. obtusa* and *C. taiwanensis* wood oils gave a cheerful/light feeling, whereas 1.6% *T. dolabrata* wood oil evoked a gloomy/dark feeling. This finding indicates that the citrus image contributes to the cheerful/light feeling.

A few reports have been concerned with the effect of essential oil and the components of wood on people's moods. For example, Terauchi et al.[8] studied the effect on humans of inhaling the essential oil of wood, using as an indicator the brain wave called contingent negative variation (CNV). They found that the aroma of *C. obtusa* lowered the awareness level of humans from the variation of CNV amplitude. Regarding *C. taiwanensis*, one report noted[9] that the wood oil that gives people a natural feeling brings down blood pressure and improves working efficiency. Furthermore, a survey by the profile of mood state (POMS) reported[9,10] that wood oil tends to decrease the tension/anxiety, fatigue, and depression/dejection scores.

Device analysis of *Chamaecyparis obtusa* wood oil

Figure 8 shows the results of α-pinene measurements at the respective wood oil concentrations of the test samples of carpet cleaner mixed with *C. obtusa* wood oil. The content of α-pinene at 1.6% was approximately 22 ppm and at 0.2% 1.6 ppm. The correlation coefficient obtained by z-analysis was 0.998, proving the existence of a relation. It was thus confirmed that the wood oil of *C. obtusa* was present in each sample at the specified percentage.

We conducted a basic experiment that confirmed the desirable effect of carpet cleaner containing *C. obtusa*, *T.*

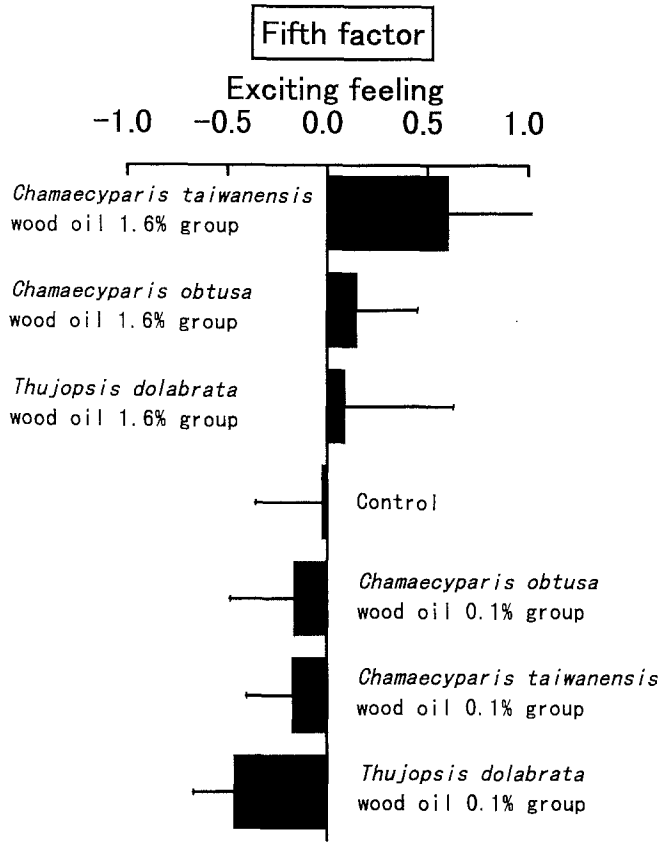

Fig. 6. Construction of the fifth factor (exciting feeling). *Lines* extending from the *bars* show the standard error

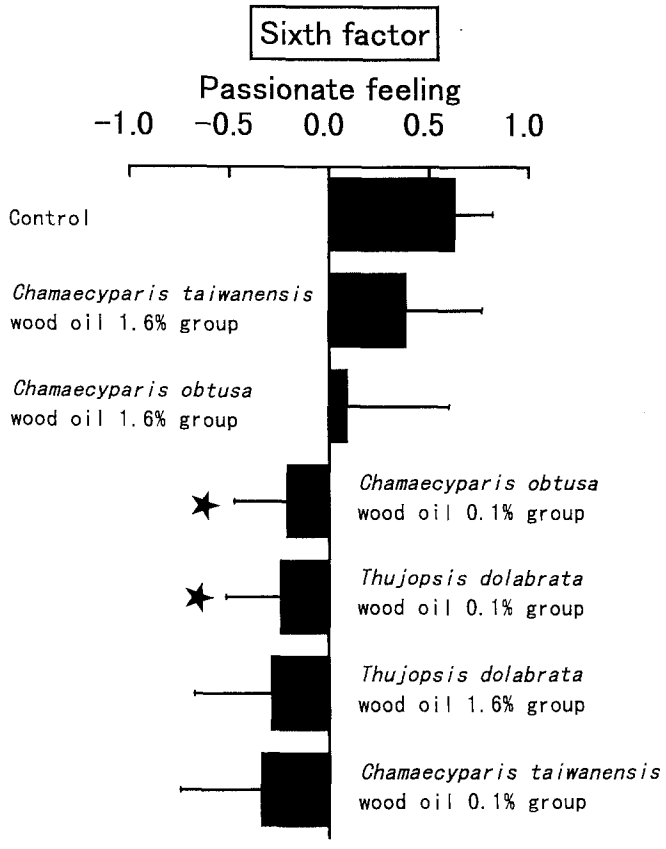

Fig. 7. Construction of the sixth factor (passionate feeling). *Lines* extending from the *bars* show the standard error. Those with a significant difference are marked with a *star*. $P < 0.01$ (by Wilcoxon's dual side test)

Table 5. Impressions of perfumerists from the carpet cleaner containing *C. obtusa*, *C. taiwanensis*, and *T. dolabrata* var. *hondai* wood oils at 1.6%

Impression	Percent		
	C. obtusa wood oil	*C. taiwanensis* wood oil	*T. dolabrata* wood oil
Woody	44	44	74
Citrus	19	38	0
Medical	0	12	0
Pine-resin	19	0	0
Resin	13	0	0
Earthy	0	0	13
Others	6	6	13

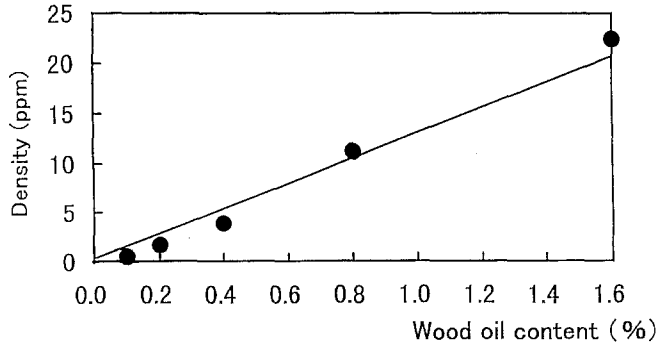

Fig. 8. Calibration curve for the density variation of α-pinene by gas chromatography corresponding to the concentration of wood oil contained in respective test samples of *C. obtusa*

dolabrata, and *C. taiwanensis* wood oils on mites and humans. Further experiments are needed to evaluate this effect from various other aspects by, for instance, spreading the carpet cleaner with wood oil over a carpet in a simulated living environment and measuring the ability to control the mobility and breeding of mites, impressions people receive by sensory experimentation, and the absolute amount of the scent source materials. Many issues remain to be investigated, as pointed out above. However, the inclusion of wood oil in carpet cleaners offers both good mite control and a pleasant odor to humans. This study suggests a new potential use for these wood oils.

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