NPC Natural Product Communications

2010
Vol. 5
No. 1
157 - 162

Stimulating Effect of Aromatherapy Massage with Jasmine Oil

Tapanee Hongratanaworakit

Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Srinakharinwirot University, Rangsit-Ongkharak Road, Nakhonnayok 26120, Thailand

tapanee@swu.ac.th

Received: May 19th, 2009; Accepted: October 26th, 2009

The aim of this study was to investigate the effect of aromatherapy massage with jasmine oil (*Jasminum sambac* L., Oleaceae) on humans. Human autonomic parameters, i.e. blood pressure, pulse rate, blood oxygen saturation, breathing rate, and skin temperature, were recorded as indicators of the arousal level of the autonomic nervous system. In addition, subjects had to rate their emotional condition in terms of relaxation, vigor, calmness, attentiveness, mood, and alertness in order to assess subjective behavioral arousal. Forty healthy volunteers participated in the experiments. Jasmine oil was applied topically to the skin of the abdomen of each subject. Compared with placebo, jasmine oil caused significant increases of breathing rate, blood oxygen saturation, and systolic and diastolic blood pressure, which indicated an increase of autonomic arousal. At the emotional level, subjects in the jasmine oil group rated themselves as more alert, more vigorous and less relaxed than subjects in the control group. This finding suggests an increase of subjective behavioral arousal. In conclusion, our results demonstrated the stimulating/activating effect of jasmine oil and provide evidence for its use in aromatherapy for the relief of depression and uplifting mood in humans.

Keywords: *Jasminum sambac*, Massage aromatherapy, Autonomic arousal, Behavioral arousal, Stimulating effect.

Aromatherapy is now increasingly being treated more as a complementary rather than alternative medicine, but many claims of the effects of aromatherapy are made in aromatherapy books regarding essential oils and the metaphysical, which have no scientific collaborative evidence. Aroma-therapeutic essential oils cause physiological and psychological changes in humans, such as sleep and mood changes. It is assumed that the effects of essential oils are evoked by both pharmacological and psychological mechanisms. The pharmacological mechanism acts directly on the physical organism, whereas the psychological mechanism acts via the sense of smell and may thereby elicit physiological effects. The physiological and psychological effects are quite distinct, although they often occur simultaneously [1]. In order to evaluate the physiological and psychological effects of essential oils, researchers have taken a great variety of approaches including measuring changes in the patterns of brain wave activities, for example contingent negative variation, electroencephalograms, changes in physiological parameters, for example heart rate, skin conductance, blood pressure, muscle tension, skin temperature, and skin conductance, changes in emotion, mood and memory [2].

Jasmine essential oil (*Jasminum sambac* L., Oleaceae) is increasingly used as a fragrance in food, perfumes and cosmetic industries. In medicine, interest in the use of jasmine oil as a therapeutically active agent has grown considerably, especially in aromatherapy. Jasmine oil is used in aromatherapy as a holistic treatment for apathy, fear, hysteria, depression, balancing, uplifting mood and inspiring confidence [3a,3b]. Human attention experiments indicated that lavender essential oil was sedative and the stimulant one was jasmine oil [3c]. Many essential oils have been shown to depress contingent negative variation (CNV) brain wave in human volunteers and these essential oils are considered to be sedative. Others increase CNV and are considered stimulants. Torii and colleagues [3d] showed that jasmine had a stimulating effect, since CNV amplitude increased when subjects were exposed to jasmine. In a similar investigation, Kubota *et al.* [3e] demonstrated a stimulating effect of jasmine oil on brain wave activity. A study at the University of Occupational and Environmental Health, Kitakyushu, Japan [3f,3g] used changes in the electroencephalogram as indices for the measurement of the effects of essential oils. Their results indicated a stimulating effect of jasmine odor, namely, that there was a significant

Table 1: Mean and SEM of autonomic parameters of the control group and the experimental group.

Autonomic parameters	Control (Mean±SEM)		Jasmine (Mean±SEM)	
	Trial 1	Trial 2	Trial 1	Trial 2
SBP	117.7±3.1	115.9±2.3	117.5±3.4	121.7±3.6
DBP	69.2±1.4	69.0±1.1	69.0±1.9	72.1±1.6
ST	33.8±0.2	33.2 ±0.2	33.5±0.3	32.8±0.3
BR	17.0±0.8	16.5±0.8	17.0±0.9	18.4±1.1
PR	66.8±2.6	63.9±2.5	67.9±1.9	65.6±1.6
BOS	97.3±0.2	97.2±0.2	97.2±0.8	98.2±0.1

SBP: systolic blood pressure ; DBP: diastolic blood pressure; ST: skin temperature; BR: breathing rate; PR: pulse rate; BOS: blood oxygen saturation; SEM: standard error mean

increase of beta brain wave activity upon presentation of jasmine odor.

Although *J. sambac* L. essential oil is quoted extensively in the literature as being used as a stimulant, there have been relatively few published controlled studies of its efficacy in stimulating nervous system and emotional responses. Up to now, no experiments on the effects of jasmine oil on human autonomic parameters and on emotional responses after transdermal administration have been carried out. Therefore, the main objective of the present study was to investigate the effects of this fragrance on autonomic parameters, as well as on emotional responses in healthy humans following transdermal absorption.

In the present investigation jasmine oil was administered transdermally to healthy subjects. Autonomic parameters, i.e. systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR), blood oxygen saturation (BOS), breathing rate (BR), and skin temperature (ST), were recorded as indicators of the arousal level of the autonomic nervous system. In addition, subjects had to rate their mental and emotional condition in terms of relaxation, vigor, calmness, attentiveness, mood, and alertness in order to assess subjective behavioral arousal.

Autonomic parameters: The mean and SEM of autonomic parameters of the control group and the experimental group are presented in Table 1. SBP of subjects in the control group decreased at the end of the second trial compared with the end of the first. In contrast, SBP of subjects in the jasmine oil group increased at the end of the second trial compared with the end of the first. The difference scores of SBP between the second and first trials for the control group and the jasmine oil group are shown in Figure 1. Comparison of these difference scores revealed a significantly larger increase of SBP in the jasmine oil group than in the control group (P=0.041).

DBP of subjects in the control group only marginally changed in the second trial compared with the first one. In contrast, DBP of subjects in the jasmine oil group increased in the second trial compared with the first.

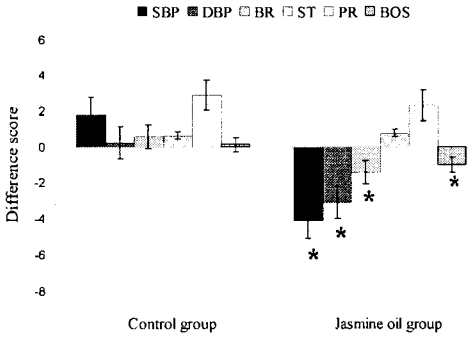

Figure 1: The difference scores of systolic blood pressure (SBP), diastolic blood pressure (DBP), breathing rate (BR), skin temperature (ST), pulse rate (PR) and blood oxygen saturation (BOS) for the control group and the jasmine oil group. * on the top of the bars indicates significant differences (P<0.05)

The different scores of DBP between the second and first trials for the control group and the jasmine oil group are shown in Figure 1. Comparison of these scores revealed a significantly larger increase of DBP in the jasmine oil group than in the control group (P=0.017). The jasmine oil group showed significant increases of systolic and diastolic blood pressure. Since blood pressure is determined by the activity of the sympathetic branch of the ANS, an increase in blood pressure shows an increase in sympathetic tone, i.e., an increase of autonomic arousal [4].

BR of subjects in the control group decreased at the end of the second trial compared with the end of the first one. In contrast, BR of subjects in the jasmine oil group increased at the end of the second trial compared with the end of the first. The difference scores of BR between the second trial and the first for the control group and the jasmine oil group are shown in Figure 1. Comparison of these scores revealed a significantly larger increase of BR in the jasmine oil group than in the control group (P=0.027).

BOS of subjects in the control group only marginally changed in the second trial compared with the first. In contrast, BOS of subjects in the jasmine oil group increased in the second trial compared with the first. The difference scores of BOS between the second and

Table 2: Mean and SEM of emotional parameters of the control group and the experimental group.

	Control (Mean±SEM)		Jasmine (Mean±SEM)	
	Trial 1	Trial 2	Trial 1	Trial 2
AT	14.8±2.6	10.1±2.3	18.7±2.6	13.9±2.8
AL	29.8±3.1	26.6±3.7	30.3±3.3	17.6±3.4
C	14.3±2.9	11.5±3.2	15.8±2.7	13.2±2.6
R	25.4±4.2	11.8±3.0	24.6±3.5	18.4±2.8
M	19.9±3.1	16.2±3.3	24.2±3.8	18.7±3.5
V	29.4±4.4	27.9±5.2	30.7±3.9	17.6±3.5

AT: attentiveness; AL: alertness; C: calmness; R: relaxation; M: mood; V: vigor; SEM: standard error mean

first trials for the control group and the jasmine oil group are shown in Figure 1. Comparison of these difference scores revealed a significantly larger increase of BOS in the jasmine oil group than in the control group (P=0.015). Transdermal absorption of jasmine oil led to significant increases of breathing rate and blood oxygen saturation. In general, the cardiovascular system has a relationship with the respiratory system. Muscle sympathetic nerve activity is associated with respiratory function, namely, an increase in respiratory rate leads to an increase of muscle sympathetic activity [5a]. Furthermore, an increase in breathing rate may cause a decrease of baroreceptor sensitivity and an increase of blood oxygen saturation [5b].

No significant effects of the jasmine oil on ST and on PR were found (P>0.05 for all).

Emotional parameters: The mean and SEM of emotional parameters of the control group and the experimental group are presented in Table 2. Subjects in the control and the jasmine oil groups felt more alert at the end of the second trial compared with the end of the first. The difference scores of subjective alertness between the second and first trials for the control group and the jasmine oil group are shown in Figure 2.

Comparison of these difference scores revealed a significant increase of subjective alertness in the jasmine oil group compared with the control group (P=0.046). Subjects in the jasmine oil group rated themselves more alert than subjects in the control group. This finding points towards an increase of arousal in terms of self-evaluation [4].

In addition, subjects in the control and jasmine oil groups felt more vigorous at the end of the second trial compared with the end of the first one. The difference scores of subjective vigor between the second and first trials for the control group and the jasmine oil group are shown in Figure 2. Comparison of these difference scores revealed a significant increase of subjective vigor in the jasmine oil group compared with the control group (P=0.037). Subjects in the jasmine oil group

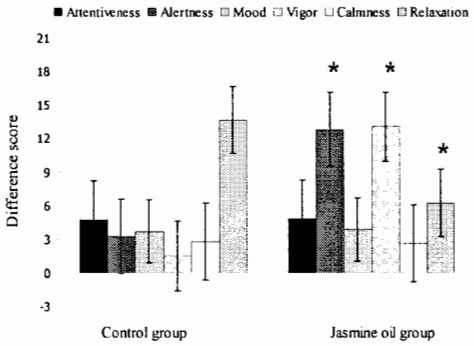

Figure 2: The difference scores of subjective attentiveness, alertness, mood, vigor, calmness, and relaxation for the control group and the jasmine oil group. * on the top of the bars indicates significant differences (P<0.05)

rated themselves more vigorous than subjects in the control group. This finding points towards an increase of arousal in terms of self-evaluation [4].

Furthermore, subjects in the control and jasmine oil groups felt more relaxed at the end of the second trial compared with the end of the first trial. The difference scores of subjective relaxation between the second and first trials for the control and jasmine oil groups are shown in Figure 2. Comparison of these difference scores revealed a significant decrease of subjective relaxation in the jasmine oil group compared with the control (P=0.022). Subjects in the jasmine oil group rated themselves less relaxed than subjects in the control group. This finding points towards an increase of arousal in terms of self-evaluation [4].

No significant effects of the jasmine oil on subjective attentiveness, mood and calmness were found (P>0.05 for all).

Transdermal absorption of jasmine oil increased the level of arousal of the autonomic nervous system (ANS), i.e. increases of systolic and diastolic blood pressure, breathing rate, and blood oxygen saturation. Moreover, massage of jasmine oil led to activation at the behavioral level, i.e. subjects feel more vigorous, more alert and less relaxed than before the administration of the oil. This finding points towards an increase of arousal in terms of self-evaluation. Thus, the effects of jasmine oil by massage may be characterized by the concept of stimulating/activating effects, which has also been described for kaffir lime oil [6a], rosemary oil [6b], sandalwood oil [6c], and sweet orange oil [6d]. Our findings clearly support previous studies indicating the stimulating effect of jasmine oil [3c-3g]. Although our findings agree with other reports, it is important to assess further biochemical measures (e.g., noradrenaline), as these would further confirm the presence of a stimulating/activating effect.

In contrast, previous reports [7a,7b] have suggested that the odor of jasmine tea had lavender-like sedative effects on autonomic nerve activity and mood states at a very low intensity. In addtion, their results showed that (*R*)-(-)-linalool, the main component of jasmine tea, had a sedative effect, whereas (*S*)-(+)-linalool showed the opposite effect. Moreover, Hoeferl and colleagues [7c] showed that (*S*)-(+)-linalool had activating effects on blood pressure, heart rate and skin conductance. On the contary, (*R*)-(-)-linalool only exerted a sedative effect on heart rate. Furthermore, our previous study [7d] suggested that inhalation of (+)-limonene and (-)-carvone caused increases in autonomic and behavioral parameters, while inhalation of (-)-limonene and (+)-carvone only affected autonomic parameters. Kubota *et al.* [3e] demonstrated that the different chiral isomers caused a significant difference of changes of CNV. From these findings, it is interesting to note that differential effects of odor molecules or essential oils may be influenced by their chirality and depend on route of administration.

Correlation analysis between the ANS and behavior parameters showed that the increases of systolic and diastolic blood pressure, breathing rate, and blood oxygen saturation were not correlated with changes in behavioral responses (data not shown). These findings suggest the effectiveness of pharmacological mechanisms, for example direct interactions between fragrance molecules and receptor sites which are involved in the regulation of ANS arousal. Due to their high lipophilicity, fragrance molecules easily penetrate the blood brain barrier and enter the brain following inhalation or massage [8a,8b]. Therefore, one possibility that explains the stimulating effect of jasmine oil could be that the oil possibly stimulates the locus ceruleus in the brain into releasing noradrenaline, a neurotransmitter that creates a stimulating/ activating effect. The locus ceruleus is also involved in arousal and activation [4,8c]. Another possibility that explains its effect could be that jasmine oil exerts its effects by an interaction with central (e.g. hypothalamic, limbic, thalamus) structures which control the level of autonomic and/or behavioral arousal.

In conclusion, our investigation demonstrates the stimulating/activating effects of jasmine oil and provides evidence for its use in medicines for the relief of depression and uplifting mood in humans.

Experimental

Subjects and essential oil: Forty healthy volunteers aged between 18 and 21 years (mean age 19.48 ±0.79 years) took part in the experiments. Demographic data for the control group and the experimental group are presented in Table 3. Subjects were tested in individual sessions and randomly assigned to either the control group or the jasmine oil group according to random numbers. They were fully briefed, given written informed consent to all aspects of the study (Srinakharinwirot University Ethics Committees) and were free to withdraw at any time. Forty-eight hours prior to testing subjects were asked to abstain from food, beverages and toiletries containing the essential oil, as well as from any stimulants (for example, caffeine and nicotine).

Table 3: Demographic data for the control group and the experimental group.

Parameter		Control group	Jasmine oil group
Number of volunteers		20	20
Sex (M:F)		10:10	9:11
Height (cm) (mean±SD)	Male	172.90±7.20	176.33±5.43
	Female	158.70±3.92	161.73±8.22
Weight (kg) (mean±SD)	Male	65.60±14.83	73.33±7.25
	Female	55.70±4.60	55.45±9.07

Jasmine oil was obtained by enfleurage of fresh petals of *J. sambac* (available from Thai-China Flavours and Fragrances Industry Co., Ltd., Thailand). The oil was analyzed by GC/FID and GC/MS. The oil contained hexenyl benzoate (20.6%), benzyl acetate (16.7%), β-linalool (15.4%) and methyl anthranilate (13.5%). The minor components were benzyl alcohol (9.6%) and farnesene (8.63%).

Essential oil administration: In the experimental group, 1 mL of a 20% (w/w) solution of jasmine oil in sweet almond oil was applied to the skin of the lower abdomen of each subject and the subjects self-massaged the oil into the skin for 5 min. Afterwards, the massage area was covered with a plastic film in order to prevent evaporation of the oil. In the control group, 1 mL of the placebo oil, pure sweet almond oil, was used. In both groups, subjects were supplied with pure air through breathing masks in order to eliminate any olfactory stimulation by nose or mouth.

Experimental protocol: The experimental protocol has been previously described [6,7d,9]. Briefly, one session consisted of two trials of 20 min each. At the beginning and at the end of each trial, emotional responses were assessed by visual analogue scales. Autonomic parameters were recorded continuously during each trial. In the first trial, which served as a control for influences of the experimental setup, the placebo substance was administered to all subjects. In the second trial, the placebo was again administered to the control group, whereas in the experimental groups the appropriate fragrance was administered.

Acquisition of autonomic parameters: BOS, BR, PR and ST were recorded simultaneously and in real time on the non-dominant side of the body. All parameters were measured using MP100WSW hardware (Biopac Systems, Inc., Santa Barbara, California, USA), including sensors and Ag/AgCl surface electrodes and Acq*knowledge*® software (Biopac Systems, Inc., Santa Barbara, California, USA). BR was measured using a SKT100C amplifier and TSD102D surface temperature thermistor probe. BOS and PR were assessed using a Pulse Oximeter Module (OXY100C) and a photoelectric transducer (TSD123B). ST was measured with a SKT100C amplifier and a fast response thermistor (TSD102A). SBP and DBP were measured in the dominant arm by sphygmomanometry using an automated system (Digital Electronic Model DS-155E, Japan). Details of the recording system and procedure have been described elsewhere [6,7d,9].

Acquisition of visual analogue scales (VAS): VAS were used to assess subjective mental and emotional conditions. They consisted of 100 mm lines for 6 items: relaxation, vigor, calmness, attentiveness, mood and alertness. Each subject was asked to mark his or her feeling for each item between the two possible extremes: relaxed and tense for the item 'relaxation', vigorous and feeble for the item 'vigor', calm and restless for the item 'calmness', attentive and inattentive for the item 'attentiveness', cheerful and bad tempered for the item 'mood', alert and tired for the item 'alertness'.

Procedure: All experiments were conducted in a bright and quiet room. Ambient temperature was 24-26°C. Upon arrival, the volunteers were interviewed about their personal data, e.g. sex, age, height, weight. In addition, they were asked about the rating of emotional responses. After completion of the interview and the rating scales, SBP and DBP were measured. Subsequently, subjects were seated in a semi-reclined position, providing easy access to attach the ANS electrodes or probes. Electrodes were placed on suitable positions, as mentioned above. The breathing mask was fitted to the volunteer's face to cover the nose and mouth. Oxygen was then supplied directly. Either the oil or the placebo was administered, as described, together with recording of the autonomic parameters. After completion of the first trial, the subjects were asked to rate the VAS. SBP and DBP were measured at the end of each trial. At the end of each trial, the subjects were asked if they had perceived any odor during the experiment. All subjects stated that they had not.

Data and statistical analyses: The autonomic recordings of each subject were computed by trial using Acq*knowledge*® software (Biopac Systems, Inc., Santa Barbara, California, USA). For each subject and every parameter the mean value in the second trial was subtracted from the mean value in the first to give the individual inter-trial difference score. For emotional ratings, on each scale the distance of the mark from the left-hand side was measured in mm. Individual difference scores between ratings were calculated for each item. The SPSS version 11.5 was used for statistical analysis. Mann- Whitney-*U*-Test analysis of variances was used in this study. The effects of fragrances on autonomic parameters and ratings of emotional responses were determined by comparing the difference scores between the control group and the experimental groups. Correlational analyses between ratings of emotional responses and autonomic parameters were performed by means of Spearman rank-order correlation coefficient.

Acknowledgments - This work was supported by grants (No. 022/2008) from Srinakharinwirot University. The author is grateful to Prof. Dr G. Buchbauer and Dr E. Heuberger for experimental design suggestion.

References

[1] (a) Tisserand R. (**1977**) *The art of aromatherapy*. C.W. Daniel, Essex; (b) Jellinek JS. (**1997**) Psychodynamic odor effects and their mechanisms. *Cosmetics & Toiletries*, ***112***, 61-71; (c) Setzer WN. (2009) Essential oils and anxiolytic aromatherapy. *Natural Product Communications*, ***4***, 1305-1316.

[2] (a) Moss M, Hewitt S, Moss L, Wesnes K. (**2008**) Modulation of cognitive performance and mood by aromas of peppermint and ylang-ylang. *International Journal of Neuroscience*, ***118***, 59-77; (b) Brauchli P, Ruegg PB, Etzweiler F, Zeier H. (**1995**) Electrocortical and autonomic alteration by administration of pleasant and unpleasant odor. *Chemical Senses*, ***20***, 505-515; (c) Bensafi M, Rouby C, Farget V, Bertrand B, Vigouroux M, Holley A. (**2000**) Autonomic nervous system responses to odors: the role of pleasantness and arousal. *Chemical Senses*, ***27***, 703-709; (d) Kanamura S, Kitoya S, Takashima Y, Kariisana T, Indo M, Loveren GV, Fukuda H, Torii S. (**1989**) Effects of odors on the contingent negative variation IV. *Chemical Senses*, ***14***, 303-304; (e) Lorig TS, Schwartz GE. (**1998**) Brain and odor: I. Alteration of human EEG by odor administration. *Psychobiology*, ***16***, 281-284; (f) Diego MA, Jones NA, Field T, Hernandez-Reif M, Schanberg S, Kuhn C, McAdam V, Galamaga R, Galamaga M. (**1998**) Aromatherapy positively affects mood, EEG patterns of alertness and math computations. *International Journal of Neuroscience*, ***96***, 217-224; (g) Degel J, Koester EP. (**1999**) Odors: Implicit memory and performance effects. *Chemical Senses*, ***24***, 317-325; (h) van Toller S, Kirk SM, Wood N, Lombard J, Dodd GH. (**1983**) Skin conductance and subjective assessments associated with the odor of 5α-androstan-3-one. *Biological Psychology*, ***16***, 85-107; (i) van Toller S, Behan J, Howells P, Kendal RM, Richardson A. (**1993**) An analysis of spontaneous human cortical EEG activity to odors. *Chemical Senses*, ***18***, 1-16.

[3] (a) Lis-Balchin M. (**2006**) *Aromatherapy science: a guide for healthcare professionals.* Pharmaceutical Press, London, 210-212; (b) Albert YL, Steven F. (**1996**) *Encyclopedia of common natural ingredients 2nd ed.* John Wiley & Sons, Inc., New York, 319-320; (c) Ilmberger J, Heuberger E, Mahrhofer C, Dessovic H, Kowarik D, Buchbauer G. (**2001**) The influence of essential oils on humans attention. I: Alertness. *Chemical Senses*, ***26***, 239-245; (d) Torii S, Fukuda H, Kanemoto H, Miyanchi R, Hamauzu Y, Kawasaki M. (**1988**) Contingent negative variation and the psychological effects of odor. in *Perfumery: the psychology and biology of fragrance* van Toller S, Dodd GH. (Eds). Chapman & Hall, New York, 107-120; (e) Kubota M, Ikemoto T, Komaki R, Inui M. (**1992**) Odor and emotion-effects of essential oils on contingent negative variation. *Proceedings of the 12th International Congress on Flavours, Fragrances and Essential Oils*, Vienna, Austria. October 4-8, 456-461; (f) Sugano H. (**1988**) *Psychophysiological studies of fragrances.* in *Perfumery: the psychology and biology of fragrance* van Toller S, Dodd GH. (Eds). Chapman & Hall, New York, 221-228; (g) Sugano H. (**1989**) Effects of odors on mental function. *Chemical Senses*, ***14***, 303.

[4] (a) Andreassi JL. (**2000**) *Psychophysiology: human behavior & physiological response.* Lawrence Erlbaum Associated, London, 301-329; (b) Hugdahl K. (**1995**) *Psychophysiology: the mind-body perspective.* University Press, England, 1-98.

[5] (a) Goso Y, Asanoi H, Ishise H, Kameyama T, Hirai T, Nozawa T. (**2001**) Respiratory modulation of muscle sympathetic nerve activity in patients with chronic heart failure. *Circulation*, ***104***, 418-423; (b) Bernadi L, Porta C, Spicuzza L, Bellwon J, Spadacini G, Frey AW. (**2002**) Slow breathing increases arterial baroreflex sensitivity inpatients with chronic heart failure. *Circulation*, ***105***, 143-145.

[6] (a) Hongratanaworakit T, Buchbauer G. (**2007**) Chemical composition and stimulating effect of *Citrus hystrix* oil on humans. *Flavour and Fragrance Journal*, ***22***, 443-449; (b) Hongratanaworakit T. (**2009**) Simultaneous aromatherapy massage with rosemary on humans. *Scientia Pharmaceutica*, ***77***, 375-387; (c) Heuberger E, Hongratanaworakit T, Buchbauer G. (**2006**) East Indian sandalwood oil and alpha-santalol odor increase physiological and self-rated arousal in humans. *Planta Medica*, ***72***, 792-800; (d) Hongratanaworakit T, Buchbauer G (**2005**) Human behavioral and physiological reactions to inhalation of sweet orange oil. *Acta Horticulturae*, ***679***, 75-81.

[7] (a) Inoue N, Kuroda K, Sugimoto A, Kakuda T, Fushiki T. (**2003**) Different autonomic nervous responses according to preference for the odor of jasmine tea. *Bioscience Biotechnology Biochemistry*, ***67***, 1206-1214; (b) Kuroda K, Inoue N, Ito Y, Kubota K, Sugimoto A, Kakuda T. (**2005**) Sedative effects of the jasmine tea odor and (*R*)-(-)-linalool, one of its major odor components, on autonomic nerve activity and mood states. *European Journal Applied Physiology*, ***95***, 107-114; (c) Hoeferl M, Krist S, Buchbauer G. (**2006**) Chirality influences the effects of linalool on physiological parameters of stress. *Planta Medica*, ***72***, 1188-1192; (d) Heuberger E, Hongratanaworakit T, Boehm C, Weber R, Buchbauer G. (**2000**) Effects of chiral fragrances on human autonomic nervous system parameters and self-evaluation. *Chemical Senses*, ***26***, 281-292.

[8] (a) Kovar KA, Gropper B, Friess D, Ammon HTP. (**1987**) Blood level of 1,8-cineole and locomotor activity of mice after inhalation and oral administration of rosemary oil. *Planta Medica*, ***53***, 315-319; (b) Buchbauer G, Jirovetz L, Jaeger W, Plank C, Dietrich H. (**1993**) Fragrance compounds and essential oils with sedative effects upon inhalation. *Journal of Pharmaceutical Sciences*, ***82***, 660-664; (c) Kalat JW. (**1995**) *Biological psychology.* Brooks/Cole Publishing Company, Washington.

[9] (a) Hongratanaworakit T. (**2009**) Relaxing effect of rose oil on humans. *Natural Product Communications*, ***4***, 291-296; (b) Hongratanaworakit T, Buchbauer G. (**2006**) Relaxing effect of ylang ylang oil on humans after transdermal absorption. *Phytotherapy Research*, ***20***, 758-763; (c) Hongratanaworakit T, Heuberger E, Buchbauer G. (**2004**) Evaluation of the effects of East Indian sandalwood oil and alpha-santalol on humans after transdermal absorption. *Planta Medica*, ***70***, 3-7; (d) Hongratanaworakit T, Buchbauer G. (**2004**) Evaluation of the harmonizing effect of ylang-ylang oil on humans after inhalation. *Planta Medica*, ***70,*** 632-636; (e) Hongratanaworakit T, Buchbauer G (**2007**) Autonomic and emotional responses after transdermal absorption of sweet orange oil in humans: placebo controlled trial. *International Journal of Essential Oil Therapeutics*, ***1***, 29-34.