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Effects of Ylang-Ylang aroma on blood pressure and heart rate in healthy men

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Although the Ylang-Ylang aroma (YYA) has used as a general method for enhancing sedative effect, there was a little report on the efficacy of YYA on heart function using the electrocardiogram (EKG). Therefore, identifying of the effects of YYA on blood pressure (BP) and heart rate (HR) is important in order to demonstrate the effectiveness of YYA. The aim of this study was to investigate the effects of YYA on BP and HR in healthy men. Twenty-nine men took part in this study. The subjects were randomly divided into 2 groups: Ylang-Ylang group (YYG, n = 15) and control group (CG, n = 14). Physiological parameters recorded were BP by using a sphygmomanometer and HR by using an EKG. The present results demonstrated that inhalation of YYA significantly decreased the systolic and diastolic blood pressure. Inhalation of YYA also significantly decreased the HRs in 10 leads, except in lead I and aVR. This indicates that the HRs recorded in lead I and aVR were less sensitive or obtuse compared to those in the 10 other leads. Therefore, such a result reveals that it is necessary to be aware of the terms regarding the position. In the present results, YYA caused a reduction of HR and BP, and a relief of the arousal level in healthy men. The present results show a sedative effect of YYA, and this study provides some evidences for the usage of YYA in medicinal agent.

Keywords: Ylang-Ylang, Heart rate, Systolic blood pressure, Diastolic blood pressure, Electrocardiogram

INTRODUCTION

Regardless of the lack of sufficient scientific evidence to elucidate the effects of aromas' and their corresponding mechanisms, some extracted aromas are widely adopted into modern society and have reportedly generated specific effects (Lahlou, 2004; Su et al., 2007). As in the European Patent, the odorants, i.e. nutmeg oil, neroli oil, valerian oil, mace extract, myristicin, elemicin and isoelemcin, were investigated (Hongratanaworakit, 2004). When these odorants were used in a perfume compound at appropriate levels, a significant decrease of systolic blood pressure (SBP) was found. Warren et al. (1987) also reported that a nutmeg-based aroma reduced stress in humans as measured by the reduction in blood pressure (BP) and self-ratings. According to their study, subjects were stressed by mental arithmetic and sentence completion tasks under an aroma with and without nutmeg oil. Their study revealed that nutmeg oil reduced SBP, anxiety, anger and embarrassment whereas it increased calmness and happiness. Meanwhile, Yamaguchi (1990) reported that the changes in heart rate (HR) for the measurement regarding the effects of lemon and rose aromas. According to his research, lemon aroma led to an increase of HR whereas rose aroma led to a decrease of it. This finding may indicate that lemon aroma possesses a stimulating effect; in contrast rose aroma has a sedative effect. Kikuchi et al. (1991) also reported that lemon aroma enhanced the deceleration of HR; on the other hand, rose aroma suppressed it. Nagai et al. (1991) showed that sweet fennel oil suppressed the deceleration of HR as well. Furthermore, Hongratanaworakit et al. (2003a) investigated the effects of sweet orange aroma on human behavior and detected changes of HR in response to olfactory stimulation. They revealed

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that sweet orange aroma caused significant increases of HR and subjective alertness after inhalation.

Recently, an interest in the usage of Ylang-Ylang oil (*Cananga odorata, Annonaceae*) as a therapeutically active agent has grown considerably with regards to medicine (2006). The Ylang-Ylang oil has been used as an antidepressant in cases of depression and nervousness as well as used for reducing BP in the case of hypertension. According to Hongratanaworakit et al. (2002), inhalation of the Ylang-Ylang oil led to a decrease of BP and an increase of subjective attention.

The effects of essential oils are exerted through the skin (Hongratanaworakit et al., 2006) or through the olfactory system (Kutlu et al., 2008). The former acts directly on the physical organism, the latter acts through the sense of smell and may thereby elicit physiological effects (Hongratanaworakit, 2004). Physiological effects of aromas can be divided into two types: those which act via the stimulation of the nervous system and those which act directly on an organ or tissue through an effector-receptor-mechanism (Tisserand, 1977). In fact, we can know both the psychological and physiological effects or changes on aromas or other materials through HR and BP. For example, if we become stressed, our HR and BP will become elevated, however, if we get depressed, the opposite occurs.

Until now, although the functional role of aromatherapy including Ylang-Ylang oil has been dramatically revealed in cardiovascular organs, the effectiveness on normal cardiovascular systems is of great opinion and the evidence on the cardiovascular systems via Ylang-Ylang oil is somewhat lacking. Moreover, there was no report on the efficacy of inhalation for Ylang-Ylang aroma (YYA) in changing ones heart condition following an electrocardiogram (EKG). Therefore, identifying HR on a 12-lead EKG and BP in the normal condition is very important in order to demonstrate the effectiveness of Ylang-Ylang oil. That being said, in the present study we investigated the effects of YYA oil on BP and HR using a 12-lead EKG in the healthy men.

MATERIALS AND METHODS

Subjects

All of the subjects who took part in the study were volunteer males. Before the experiment, the subjects were randomly divided into 2 groups. The subjects were composed of 29 males, 15 of whom constituted the experimental group or Ylang-Ylang group (YYG) and 14 were the control group (CG). The ages (mean±SEM) of YYG and CG were 21.07±0.43, 22.00±0.58 years, their heights (mean±SEM) were 171.87±1.80, 173.79±1.33 cm, and their body weights (mean±SEM) were 64.40±2.51, 67.86±1.57 kg, respectively. All of the subjects underwent physical examination including medical history and olfactory function. They read and signed an informed consent form approved by the Ethical Committee of Hanseo University Institute and the Korean Academy of Medical Sciences (KAMS) for Health, prior to participation. Subjects were excluded if they reported any of the following: (1) discomfort concerning the odor, (2) nose injury within 3 months prior to participation, or (3) history of nasal disorders.

Experimental design

First, all of the subjects arrived at research center to sign an informed consent form and to complete a self-report questionnaire about nasal function included in physical examination. After this procedure, each subject underwent the experiment conducted by an expert. Neither the YYG nor the CG was given information about the effects of the procedure and that the YYA was being used as an intervention. The YYG was placed in a room in which doors and windows were closed 20 minutes prior to the experiment and wherein the environment was fragranced by incenses of Ylang-Ylang oil. The experiment was performed in the atmosphere of the YYA, and the doors and windows of the room were not opened until the end of the test. The CG was placed in another room where there was no fragrance by incenses of Ylang-Ylang oil. The duration of the test was 60 min. The rooms where the YYG and CG were placed had the same characteristics with respect to size (16.53 m^2), temperature (25-26°C), and humidity (50-60%).

YYA administration

YYA was selected for olfactory stimulation in this study. Ylang-Ylang, *Cananga odorata*, is a tree valued for its perfume. The essential oil derived from the flowers is used in aromatherapy. The fragrance of Ylang-Ylang is rich and deep with notes of rubber and custard. The essential oil of its flower is obtained through steam distillation of the flowers and separated into different grades according to when the distillates are obtained (Harley and Craig, 2006). We used the Ylang-Ylang oil containing linalool (13.6%), geranyl acetate (5.3%), caryophyllene (1.7%), p-cresyl ether (16.5%), methyl benzoate (8.7%), benzyl acetate (25.1%), benzyl benzoate (2.2%), and other sesquiterpenes (7.4%). In this study, we put 3 drops (0.15 cc) of Ylang-Ylang oil by using a pipette into a warm water (90°C) lamp and created incense. All of the subjects in YYG smelt a fragrance emerging from the lamp for 20 min.

Blood pressure and heart rate measurement

The SBP and diastolic BP (DBP) were measured using a sphygmomanometer (Aneroid Mo 500, Kenzmedico Co., Ltd., Japan) and heart rates using a 12-lead EKG (FX-2111, Fukudadensh Co. Ltd., Japan) after Ylang-Ylang exposure for 20 min. The subjects in YYG and CG were on the bed during the measurement. First of all, electrodes were attached to the upper body on 10 suitable positions. Then, the HRs from a 12-lead EKG were measured for 5 min. The SBP and DBP were measured at the end of the HRs' test. This procedure was repeated in the second trial. At the end of each trial, the subjects were asked if they had smelled any odor during the experiment. All subjects of YYG stated that they smelt odor during the experiment whereas all subjects of CG stated that they did not smell any odor during the experiment. We recorded two trials from EKG for HR and used a sphygmomanometer for BP. Afterwards we selected the mean values from each result.

Statistical analyses

The sample sizes in this study were not adequate since we achieved a statistical power greater than 90% for the standardized differences between time greater than 5% at a probability of Type-I error <0.05. All data are reported as mean (standard error mean: SEM). The Kolmogorov–Smirnov test was used to determine the normality of distribution for the examined variables. In order to examine the differences of the variables between YYG and CG, the non-parametric test (two-independent samples tests - Mann-Whitney U Test) was completed. Also, to investigate the changes of the variables between pre-test and post-test, non-parametric test (two-related samples tests - Wilcoxon Signed Ranks Test) was performed. The significance level for all analyses was set a priori at $P<0.05$. The SPSS program (version 15.0; SPSS Inc., Chicago, IL, USA) was used to calculate statistics for this study.

Table 1. Changes of systolic and diastolic blood pressure in times and groups

	Pre	Post	Wilcoxon test[a] Z (P)
Systolic blood pressure			
Ylang-Ylang group	115.40±2.96	97.87±2.12	-3.436 (0.001)
Control group	113.79±2.82	111.14±3.24	-1.444 (0.149)
Mann-Whitney U tes[b] Z (P)		-0.515 (0.606)	-2.799 (0.005)
Diastolic blood pressure			
Ylang-Ylang group	66.00±2.48	59.20±1.65	-2.375 (0.018)
Control group	66.57±2.42	64.07±2.89	-1.382 (0.167)
Mann-Whitney U test[b] Z (P)		-0.111 (0.911)	-0.790 (0.429)

All data represents mean±standard error mean (SEM). [a]Represents the statistical analysis method between pre and post. [b]Means the statistical analysis method between Ylang-Ylang group and control group.

RESULTS

Effect of YYA on blood pressures

The data from SBP and DBP of the both groups were analyzed for differences in the pre- and post-test results after the experiment (Table 1). In the post-test, the SBP and DBP of the CG were decreased compared to those of the pre-test, but were not statistically significant. However, the SBP and DBP of the YYG in the post-test were more significantly ($Z=-3.436$, $P=0.001$ and $Z=2.375$, $P=0.018$, respectively) decreased than those of the pre-test. Moreover, the SBP between both groups in the post-test were shown to be significantly ($Z=-2.799$, $P=0.005$) different. The present results demonstrated that the inhalation of Ylang-Ylang oil significantly decreased the SBP and DBP levels.

Table 2. Changes of heart rates of six limb leads in times and groups

	Pre	Post	Wilcoxon test[a] Z (P)
Lead I			
Ylang-Ylang group	61.67±2.16	60.20±2.38	-0.998 (0.318)
Control group	64.36±2.42	63.71±2.95	-0.251 (0.802)
Mann-Whitney U test[b] Z (P)	-0.111 (0.911)	-0.790 (0.429)	
Lead II			
Ylang-Ylang group	65.27±2.29	59.60±2.15	-2.477 (0.013)
Control group	63.21±2.64	65.86±3.10	-1.190 (0.234)
Mann-Whitney U test[b] Z (P)	-0.525 (0.599)	-1.530 (0.126)	
Lead III			
Ylang-Ylang group	66.87±2.80	60.27±1.97	-2.365 (0.018)
Control group	63.29±2.74	65.07±2.56	-0.723 (0.469)
Mann-Whitney U test[b] Z (P)	-0.700 (0.484)	-1.467 (0.142)	
aVR			
Ylang-Ylang group	64.20±2.56	60.53±2.37	-1.912 (0.055)
Control group	63.07±2.93	64.14±2.85	-0.503 (0.615)
Mann-Whitney U test[b] Z (P)	-0.175 (0.861)	-0.919 (0.358)	
aVL			
Ylang-Ylang group	64.00±2.75	59.67±2.14	-2.561 (0.010)
Control group	61.71±2.55	65.71±3.10	-1.926 (0.054)
Mann-Whitney U test[b] Z (P)	-0.612 (0.540)	-1.663 (0.096)	
aVF			
Ylang-Ylang group	63.80±2.35	58.73±2.08	-2.818 (0.005)
Control group	61.36±2.48	65.43±2.71	-1.959 (0.051)
Mann-Whitney U test[b] Z (P)	-0.350 (0.726)	-1.923 (0.054)	

All data represents mean±standard error mean (SEM). [a]Represents the statistical analysis method between pre and post. [b]Means the statistical analysis method between Ylang-Ylang group and control group. aVR, aVL, aVF mean lead augmented vector right, lead augmented vector left and lead augmented vector foot, respectively.

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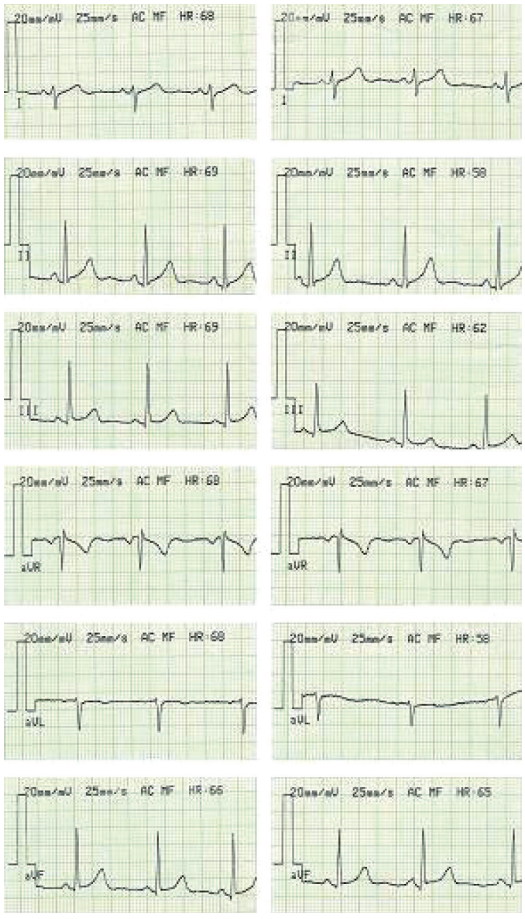

Fig. 1. Changes of heart rates in six limb leads in the Ylang-Ylang group. Left lines: Sample figures of six limb leads (from lead I to aVF) in the pre-test. Right lines: Sample figures of the same leads in the post-test. The heart rate is represented in the upper right end.

Effect of YYA on heart rates in six limb leads

The data from HR for both groups in six limb leads were analyzed for differences in the pre- and post-test results after the experiment (Table 2). In the post-test, the HRs of the CG changed little compared to those of the pre-test. However, in the post-test, the HRs of the YYG except for those of lead I and aVR (lead augmented vector right) were significantly decreased compared to those of the pre-test. The present results revealed that the inhalation of Ylang-Ylang oil significantly decreased the HRs' levels for the majority of limb leads (Fig. 1).

Effect of YYA on heart rates in six chest leads

The data from HRs for both groups in six chest leads were analyzed for differences in the pre- and post-test results after the experiment (Table 3). In the post-test, the HRs of the CG changed little or increased compared to those of the pre-test. However, in the post-test, the HRs of the YYG from V1 to V6 were significantly decreased compared to those of the pre-test. Moreover, the HR of V5 between both groups in the post-test were shown to be significantly ($Z = -2.229$, $P = 0.026$) different. The present results represented that the inhalation of Ylang-Ylang oil significantly decreased the HR levels for all of the chest leads (Fig. 2).

Table 3. Changes of heart rates of six chest leads in times and groups

		Pre	Post	Wilcoxon test[a] Z (P)
V1				
Ylang-Ylang group		64.13 ± 2.27	60.20 ± 2.09	-2.532 (0.011)
Control group		63.36 ± 2.87	65.71 ± 3.10	-0.974 (0.330)
Mann-Whitney U test[b]	Z (P)	-0.219 (0.827)	-1.268 (0.205)	
V2				
Ylang-Ylang group		63.73 ± 2.06	59.33 ± 2.23	-2.861 (0.004)
Control group		63.43 ± 2.46	64.21 ± 2.70	-0.094 (0.925)
Mann-Whitney U test[b]	Z (P)	-0.044 (0.965)	-1.246 (0.213)	
V3				
Ylang-Ylang group		63.80 ± 2.29	59.33 ± 2.35	-2.423 (0.015)
Control group		61.14 ± 2.44	64.50 ± 2.69	-1.508 (0.131)
Mann-Whitney U test[b]	Z (P)	-0.656 (0.512)	-1.399 (0.162)	
V4				
Ylang-Ylang group		66.13 ± 2.17	60.07 ± 2.25	-2.340 (0.019)
Control group		62.71 ± 2.72	64.43 ± 2.60	-0.597 (0.551)
Mann-Whitney U test[b]	Z (P)	-0.963 (0.336)	-1.225 (0.220)	
V5				
Ylang-Ylang group		66.40 ± 2.44	58.40 ± 2.31	-3.185 (0.001)
Control group		62.93 ± 3.13	65.50 ± 2.44	-0.865 (0.387)
Mann-Whitney U test[b]	Z (P)	-0.831 (0.406)	-2.229 (0.026)	
V6				
Ylang-Ylang group		65.73 ± 2.96	58.40 ± 2.12	-2.986 (0.003)
Control group		64.07 ± 2.78	64.50 ± 2.77	-0.175 (0.861)
Mann-Whitney U test[b]	Z (P)	-0.066 (0.948)	-1.531 (0.126)	

All data represents mean ± standard error mean (SEM). [a]Represents the statistical analysis method between pre and post. [b]Means the statistical analysis method between Ylang-Ylang group and control group.

DISCUSSION

In this study, the demographic features between both groups were not significantly different (age $P = 0.400$; height $P = 0.354$; body weight $P = 0.377$, respectively). This is of importance with regard to the fact that both groups were homogeneous from the pre-test. The present investigation administered YYA to healthy men. The BP and HR, which were considered physiological parameters, were recorded as indicators of the arousal level in regards to the autonomic nervous system referred to Kutlu et al. (2008)

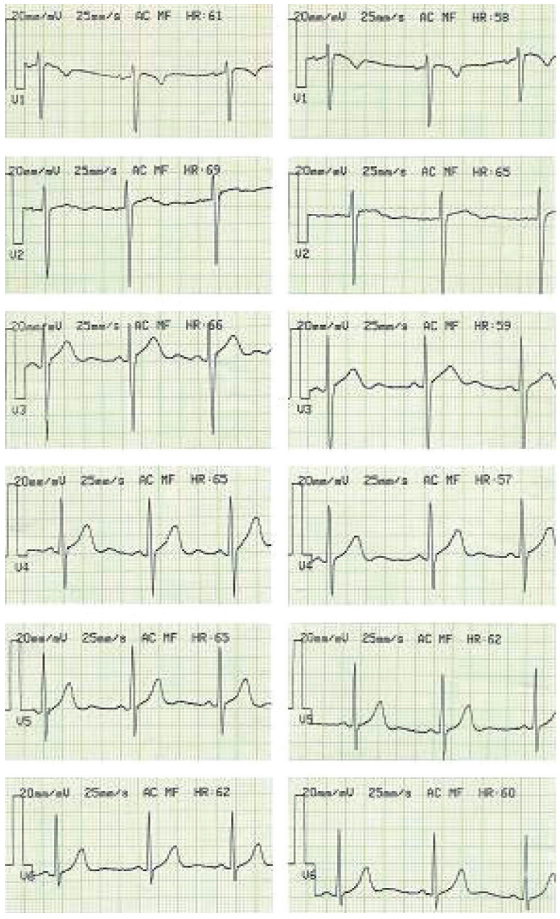

Fig. 2. Changes of heart rates in six chest leads in the Ylang-Ylang group. Left lines: Sample figures of six chest leads (from V1 to V6) in the pre-test. Right lines: Sample figures of the same leads in the post-test. The heart rate is represented in the upper right end.

In this study, although the SBP between both groups was not significantly different in the results of the pre-test, it was significantly different between groups in the results of the post-test. Moreover, the SBP in the YYG significantly decreased whereas it was not changed in the CG after the experiment. In the DBP case, it was similar to the SBP in pre-result; it was not significantly different between groups in the results of the post-test. However, the DBP in the YYG significantly decreased compared to that of the CG. Such results showed that the inhalation of YYA significantly decreased both the SBP and DBP levels. In this context, Hongratanaworakit et al. (2002, 2003b) demonstrated that the inhalation of the YYA led to a decrease of BP and an increase of subjective attention. They also reported that their findings pointed towards a decrease of autonomic arousal. Distinct from this study, many researchers revealed that beneficial effects of essential oils were exerted by absorption of fragrance molecules via the skin. According to Hongratanaworakit and Buchbauer (2006), the Ylang-Ylang oil caused a significant decrease of BP and a significant increase of skin temperature following transdermal absorption. They also reported that the subjects in the Ylang-Ylang oil group rated themselves calmer and more relaxed in the behavioral level compared to the subjects in the control group. This finding points towards a decrease of arousal in terms of self-evaluation. Transdermal absorption of Ylang-Ylang oil reduced the level of arousal for the autonomic nervous system and led to deactivation at the behavioral level, i.e. subjects felt calmer and more relaxed than before the administration of the oil. Thus, the effects of YYA by means of percutaneous administration may be characterized by the concept of relaxation, which has also been described for the sandalwood essential oil (Hongratanaworakit et al., 2004). Their findings were likely to show a relaxing effect of the Ylang-Ylang oil and to provide some evidence for the usage of the Ylang-Ylang oil in causing relief for depression and stress. Our findings indicate that the inhalation of the YYA is similar to the transdermal usage of it in terms of decreasing both the SBP and DBP levels. In other words, the beneficial effects of Ylang-Ylang oil are not only exerted by inhalation of the vapor but also by absorption of the fragrance molecules through the skin.

Meanwhile, although many researchers attempted to prove the scientific effects of aromatherapy, most of the aromatherapy studies were not controlled and their results were possibly biased and not scientific (Hongratanaworakit et al., 2006). Especially, in the HR case, the HR observed in aromatherapy studies were only investigated through a simple method, i.e. pulse rate checked in the carotid, temporal or radial arteries. Thus, we believe that the present study is very important to expiscate the changes in HR levels via diversified observation, which is a 12-lead EKG.

The results of HR, which appeared in this study, were quite similar to those of BP in the six chest leads (Table 3). However, the results of HR, which appeared in six limb leads, were dissimilar to those of the six chest leads (Table 2). In the post-test of this study, the HRs of lead I and aVR in the YYG displayed declining tendencies but were not significantly decreased compared to those of the pre-test. In other word, we believe that those of lead I and aVR were less sensitive or obtuse compared to the ten other leads. Therefore, such a result provides a hint that it is necessary to be aware of the terms regarding the position. In the YYG, however, most of the HRs' levels for a 12-lead EKG in the post-test significantly declined compared to those of the pre-test. On the other hand, in the CG, most of the HRs' levels for a 12-lead EKG in the post-test did not change or displayed inclining tendencies

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compared to those of the pre-test. In this context, Cha et al. (2010) investigated the effectiveness of aromatherapy on BP, HR variability and so on in essential hypertensive patients. The experimental group in their study was given a blend of oils pertaining to lemon, lavender, and ylang-ylang, which were prepared in the ratio of 2:2:1, respectively. The control group was given an artificial lemon fragrance of a mixture of limonene and citral. According to their results, there was a notable difference in sympathetic nervous system activity for HR variability. From other materials' standpoint, a few researchers reported that lemon aroma increased HR whereas rose aroma decreased it. This finding indicates that lemon aroma possesses a stimulating effect whereas rose aroma possesses a sedative effect (Kikuchi et al., 1991; Yamaguchi, 1990). Thus, we learn that the YYA is similar to the rose aroma, which has a sedative effectiveness.

In another dimension, the evaluation for the effects of aromas on the nervous system may be divided into two different forms of arousal, the cortical arousal such as brain wave activity and the autonomic arousal such as HR. Decreases of the cortical arousal or the autonomic arousal are interpreted in terms of a sedative/ relaxing effect of aromas. In contrast, increases of the cortical arousal or autonomic arousal are interpreted in terms of the stimulating effect of aromas (Stern et al., 2001). Overall, the YYA inhibited the sympathetic nervous system whereas it activated the parasympathetic nervous system. Finally, it results in decreased BP and HR.

In the present study, we confirmed that YYA showed the sedative effectiveness and provided some evidence for causing decreases of BP and HR or for the relief of the arousal level regarding the autonomic nervous system.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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