

## Effects of Juniper Essential Oil on the Activity of Autonomic Nervous System

Jong-Seong Park<sup>†</sup>

Department of Physiology, Chonnam National University Medical School, Gwangju 61469, Korea

This study was designed to clarify the effect of juniper essential oil on the autonomic nervous system. Blood pressure and heart rate variability (HRV) reflecting autonomic nervous system activity were measured. The systolic and diastolic blood pressure were decreased by inhalation of juniper essential oil. High frequency (HF) power level, an indicator of parasympathetic nervous system activity was increased in the stimulation of juniper essential oil. High frequency/low frequency (HF/LF) ratio, an indicator of sympathetic nervous system activity was decreased by the juniper essential oil. These results suggest that juniper essential oil has a modulatory effect on the autonomic nervous system activity.

**Key Words:** Juniper, Autonomic nervous system, Blood pressure

It is well known that olfactory stimulus has various effects on the emotion, behaviors and physiological functions (Liu et al., 2014). Olfactory stimulations are sensed by olfactory chemoreceptors in the nasal mucosa, which is connected to the primary olfactory regions in the central nervous system (CNS). Olfactory information in part are transmitted to the limbic system which controls the emotion and autonomic nervous system (McCabe and Rolls, 2007). A number of essential oils such as rose, lavender, bergamot, lemon, and sandalwood are currently in use as aromatherapy agents to relieve stress, anxiety, and depression (Mannucci et al., 2017). Inhaling the scent of lavender is reported to prevent stress, anxiety, and depression after childbirth, and inhalation of bergamot essential oil decreases behavior related depressive disorder (Kianpour et al., 2016; Saiyudthong and Mekseepalard, 2015).

Juniper is an evergreen coniferous shrub occurring in Northeastern Asia. It is reported to have various biologic

effects (Rombolà et al., 2017). The berries of *J. rigida* have been used in Korean traditional medicine for the treatment of rheumatoid arthritis and the branches and leaves of *J. rigida* have been used for the treatment of nephritis and rheumatic arthritis (Zhao et al., 2016). Juniper essential oil is a safe and widely used material for aromatherapy (Barclay et al., 2006). The effect of juniper essential oil on the autonomic nervous system has not been reported. The change of autonomic nervous system activity after inhalation of essential oil can be detected by frequency domain analysis of heart rate variability (HRV) (TFESC, 1996). The aim of this study is to investigate the effects of juniper essential oil on the autonomic nervous function in terms of HRV.

Eighteen persons ranging from 22 to 29 years old (mean  $\pm$  S.D.:  $25 \pm 2.0$  years old), volunteered to participate in the study. Persons with nasal and breathing disorder were excluded. All participants received explanations of the aims, procedures of the study and safety of the juniper essential oil.

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<sup>†</sup>Corresponding author: Jong-Seong Park. Department of Physiology, Chonnam National University Medical School, 42 Jebong-ro, Dong-gu, Gwangju 61469, Korea.

Tel: +82-62-220-4264, Fax: +82-62-232-1242, e-mail: parkjs@jnu.ac.kr

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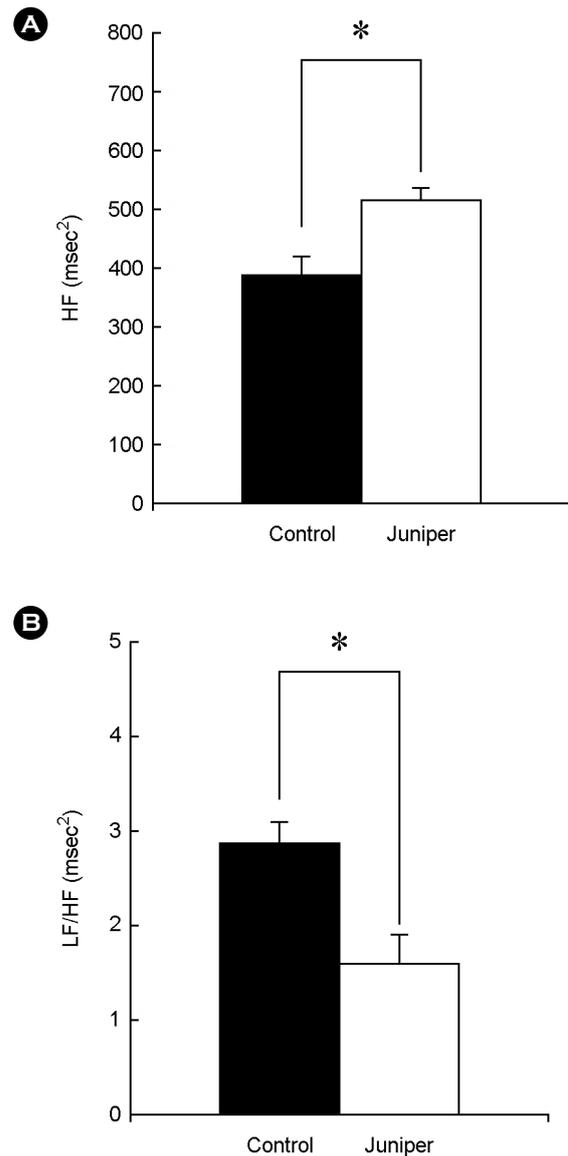
**Table 1.** Effects of juniper essential oil on the blood pressure ( $n = 18$ )

	Control	Juniper	<i>P</i> value
SBP (mmHg)	118±2	107±3	$P < 0.05$
DBP (mmHg)	75±1	68±2	$P < 0.05$
HR (beats/min)	74±2	72±2	Nonspecific

Abbreviations: SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate

The study was performed in accordance with the Declaration of Helsinki of the World Medical Association and Regulations of the Ethics Committee of Chonnam National University. All measurements were performed in a temperature-controlled (25 °C), quiet, comfortable room. Before measurements were taken, the participants relaxed comfortably for about 10 min in a seated position. Blood pressure measurements were done with electronic blood pressure detector (Omron HEM-7220, Omron Healthcare Co., Kyoto, Japan) Electrocardiogram (ECG) recording in the augmented unipolar limb leads was performed for the analysis of the HRV. HRV was analyzed by means of frequency domain analysis (SA-3000P, Medcore, Seoul, Korea). To apply juniper essential oil, a diffuser for aromatherapy was used (Aroma breeze NOVA T, ALTA Corporation, Nagoya, Japan). According to previous studies with essential oil, 10 µL of juniper essential oil was pipetted onto a small cotton pad for a diffuse (Dunn et al., 1995). The speed of airflow was 1.2 m/min. The diffuser was placed near the participant's nostrils with 30-cm long circular cylinder. The participants inhaled the essential oil diffused from the diffuser for 5 min. HRV measurements were performed before and during the application of juniper oil. Blood pressure were performed before and just after the stimulation of juniper oil.

All data were expressed as mean ± standard deviation. Student's *t*-test was used to compare the responses to the juniper essential oil. Values of  $P < 0.05$  were considered statistically significant. The systolic pressure was decreased by juniper essential oil from 118±2 mmHg to 1107±3 ( $P < 0.05$ ). The diastolic pressure was also decreased from 75 ±1 mmHg to 68±2 mmHg ( $P < 0.05$ ) by juniper essential oil. The heart rate also decreased from 74±2/min to 72±



**Fig. 1.** Effects of juniper essential oil on high-frequency (HF) and low-frequency (LF)/HF power level ratios of heart rate variability. Data are expressed as  $n=18$ . \* $P < 0.05$  by Student's *t*-test.

2/min without statistical significance (Table 1).

High frequency (HF) component was significantly higher (509±19 msec<sup>2</sup>) with juniper application than that in the control condition (385±30 msec<sup>2</sup>) ( $P < 0.05$ ). In contrast, changes in LF/HF were significantly lower (1.5±0.3) with juniper application in comparison to the control (2.8±0.2) ( $P < 0.05$ ). Low frequency (LF) component was significantly lower (405±15 msec<sup>2</sup>) with juniper application than that in

the control condition ( $535 \pm 25 \text{ msec}^2$ ) ( $P < 0.05$ ) (Fig. 1).

The heart is innervated by autonomic nervous system. Sympathetic nervous system accelerates the cardiac function, whereas parasympathetic nervous system decelerates the cardiac function. To evaluate the autonomic nervous system activity quantitatively, analyzing HRV in the frequency domain is known to be a valuable method (TFESC, 1996). By frequency domain analysis of oscillation in R-R intervals, HF (0.15~0.40 Hz) reflects the activity of parasympathetic nervous system, and LF component (0.04~0.15 Hz) reflects both sympathetic and parasympathetic nervous activities (Peter et al., 2015). LF/HF is used as a relative marker of sympathetic nervous activity (Landolt et al., 2017).

There are a few reports on the effects of essential oils on the autonomic nervous system by measuring the HRV. Lavender inhalation elicits a significant increase in HF component and reduction in LF/HF ratios, suggesting of increased parasympathetic nervous activity and reduced sympathetic activities (Saeki, 2000). Inhalation of petitgrain essential oil showed LF decrease and HF increase (Nagai et al., 2000).

It is well known that juniper essential oil has antimicrobial and antioxidant activity (Khoury et al., 2014). Juniper essential oil is reported to have ulceroprotective effects in rats and anti-acetylcholinesterase activities on amyloid Beta (1-42)-Induced oxidative stress in the rat hippocampus (Ben Ali et al., 2015). However, despite many studies on the biologic effects of juniper essential oil, its modulatory effects on the autonomic nervous system has not reported. In the present study, juniper increased HF with simultaneous reductions in the LF/HF ratios, which implies that juniper increases parasympathetic activities and decreases sympathetic activities. By gas chromatography-mass spectrometry, many components were identified from the juniper essential oil, including  $\alpha$ -pinene, camphene,  $\beta$ -pinene, sabinene, myrcene,  $\alpha$ -phellandrene,  $\alpha$ -terpinene,  $\gamma$ -terpinene caryophyllene,  $\alpha$ -caryophyllene, caryophyllene oxide, trans-nerolidol and germacrene (Ben Ali et al., 2015). It is not clear which component is related to the modulatory effects of juniper essential oil. But it could be postulated that elements of juniper essential oil absorbed by olfactory system into the CNS modulate the neuronal excitability, or control the

neurotransmitter releasing process. (Vatanparast et al., 2017). Future studies are needed to investigate the precise mechanism of action of juniper essential oil.

## CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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