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Handi Suyono

Faculty of medicine, Widya mandala catholic university Surabaya, Campus Pakuwon City, 6th floor, west tower, Jalan Kalisari Selatan no. 1, Pakuwon City, Surabaya, East Java, Indonesia

FX Himawan Jong

Faculty of medicine, Widya mandala catholic university Surabaya, Campus Pakuwon City, 6th floor, west tower, Jalan Kalisari Selatan no. 1, Pakuwon City, Surabaya, East Java, Indonesia.

Sumi Wijaya

Faculty of Pharmacy, Widya mandala catholic university Surabaya, Campus Pakuwon City, 6th floor, east tower, Jalan Kalisari Selatan no. 1, Pakuwon City, Surabaya, East Java, Indonesia.

Corresponding Author:

Handi Suyono

Faculty of medicine, Widya mandala catholic university Surabaya, Campus Pakuwon City, 6th floor, west tower, Jalan Kalisari Selatan no. 1, Pakuwon City, Surabaya, East Java, Indonesia

Lavender, cedarwood, and vetiver balms work as an anti-stress treatment by reducing plasma cortisol levels

Handi Suyono, FX Himawan Jong and Sumi Wijaya

Abstract

Prolonged stress has a negative impact on health. Stress stimulates hypothalamic-pituitary-adrenal axis leading to increased cortisol hormone level. Excessive cortisol causes immunity suppression, sleep disturbance, and metabolic imbalance. Essential oils have been often used to stimulate relaxation. Lavender, cedarwood, and vetiver have a relaxation effect and they are useful for anxiety and depression. Common applications are aromatherapy inhalation and topical/massage. The aim of this study was to find the effect of lavender, cedarwood, and vetiver balms of reducing plasma cortisol levels. The study design was experimental with post-test-only control group that used 4 control (negative, positive, diazepam 2 mg/kg BW, balm vehicle) and 9 treatment (lavender 10%, 20%, 30%; cedarwood 10%, 20%, 30%; vetiver 10%, 20%, 30%) groups with 9 male Wistar rats in each group. Swim test was applied daily as a stress stimulus and the balms were applied daily on the shaved back for 30 days. Data were shown as mean \pm SD and analyzed using Kruskal Wallis and Spearman correlation test with a significant value of $p < 0.05$. We found a significant difference in plasma cortisol levels between control and treatment groups ($p = 0.001$). The concentration of each essential oil has a significant moderate negative correlation with plasma cortisol level. The three essential oil balms reduced plasma cortisol level of prolonged swim-induced stress rats. The greater essential oils concentration has a greater effect to reduce cortisol level. The 30% concentration of each essential oil has a similar effect to diazepam. The three essential oil balms have a similar effect of reducing cortisol levels. Lavender, cedarwood, and vetiver balms have a beneficial effect as an anti-stress treatment by reducing cortisol hormone level.

Keywords: Cedarwood, cortisol, lavender, stress, vetiver

1. Introduction

Stress is a reaction or response to stimuli (external or internal) which changes physical and psychological functions. Stress can occur immediate (acute) or prolonged (chronic). Stress stimulates fight or flight mechanisms in the body. Hypothalamic-Pituitary-Adrenal (HPA) axis is a defense mechanism to cope with stress. Stress stimuli can be mechanical, chemical, biological, or psychological factors. Stress enhances and activates the neuroendocrine mechanism which starts from hypothalamus by producing Corticotropin Releasing Hormone (CRH). The pituitary gland is stimulated by CRH to produce Adrenocorticotrophic Hormone (ACTH). The adrenal cortex is stimulated by ACTH to produce glucocorticoid hormones [1]. Cortisol is one of glucocorticoid hormones which work as a stress hormone. A prolonged stress exposure enhances the cortisol production. Excessive cortisol production causes immune suppression, sleep disturbance, and metabolic imbalance. Cortisol also enhances catabolic process which accelerates degradation and degeneration [1].

Essential oil aromatherapy has been widely used to treat stress by stimulating relaxation. Previous studies found some essential oils, e.g., lavender, cedarwood, vetiver, have a relaxing effect. These essential oils reduce anxiety and depressive symptoms. Common applications of essential oils are inhalation and topical/massage [2]. The aim of this study was to find the effect of lavender, cedarwood, and vetiver balm of reducing plasma cortisol hormone levels.

2. Materials and Methods

The study design was experimental with post-test-only control group. The study was approved by Ethical Committee, Faculty of Medicine, Widya Mandala Catholic University Surabaya.

2.1 Animals

Four-to-5-month-old male Wistar (*Rattus norvegicus*) rats with 100-200 g body weight, were acclimatized for 1 week, in the laboratory with room temperature ($28 \pm 1^\circ\text{C}$), and humidity of $35 \pm 3\%$. The rat was excluded if the body weight decreased $>10\%$. The rats were randomly

divided into 4 control and 9 treatment groups with 9 rats in each group. The control groups were 1) negative (no stress and treatment), 2) positive (stress and no treatment), 3) stress and a standard drug (diazepam 2 mg/kg BW), 4) stress and balm vehicle. The treatment groups were lavender balms with concentrations of 10%, 20% and 30%; cedarwood balms with concentrations of 10%, 20% and 30%; vetiver balms with concentrations of 10%, 20% and 30%.

2.2 Essential oils balm

We used lavender (linalyl acetate, linalol), cedarwood (α -himachalene, β -himachalene, γ -himachalene), and vetiver (khusimol, α -vetivone, β -vetivone) essential oils (Young Living™). The vehicles were beeswax (West Java) and virgin coconut oil (VCO) (Kalimantan) purchased from the local markets. The ratio of beeswax and VCO was 1:5. The equipment was sterilized using ultraviolet (UV) light for 30 minutes. The balms were stored in room temperature ($28 \pm 1^\circ\text{C}$) and humidity of $35 \pm 3\%$.

2.3 Stress Stimulus

Swim test was given 10 seconds daily in the afternoon. The rat was placed in a transparent water-filled cylinder with depth of 20 cm.

2.4 Plasma Cortisol Hormone Level

The intracardiac blood sample was collected for 1 mL and tested using ELISA method. We used ELISA rat cortisol

reagent kit (Elabscience®). Data were measured in ng/mL.

2.5 Experiment Protocol

After an adaptation period, the rats that matched the criteria were randomly divided into control and treatment groups. The back was shaved 2 cm x 2 cm. The swim test was given daily for 30 days. The balms were daily applied on the shaved back after the swim test. The 3 rats from each group were euthanized on 10th, 20th, and 30th day by ether inhalation. Data were shown in mean \pm SD. Kruskal Wallis and Spearman correlation tests were used with a significant value of $p < 0.05$ by SPSS 20.0.

3. Results and discussion

We found a significant difference of plasma cortisol levels between control and treatment groups by Kruskal Wallis test ($p = 0.001$). Concentrations of essential oils have a significant weak negative correlation with plasma cortisol level by Spearman test ($p = 0.003$, $r = -0.266$).

The three essential oils balms reduced plasma cortisol level of prolonged swim-induced stress rats. The greater essential oils concentration has a greater effect to reduce cortisol level. The 30% concentration of each essential oil has a similar effect to diazepam. However, the diazepam had greater effect than essential oil 30% balms. The three essential oils balms have a similar effect of reducing cortisol levels.

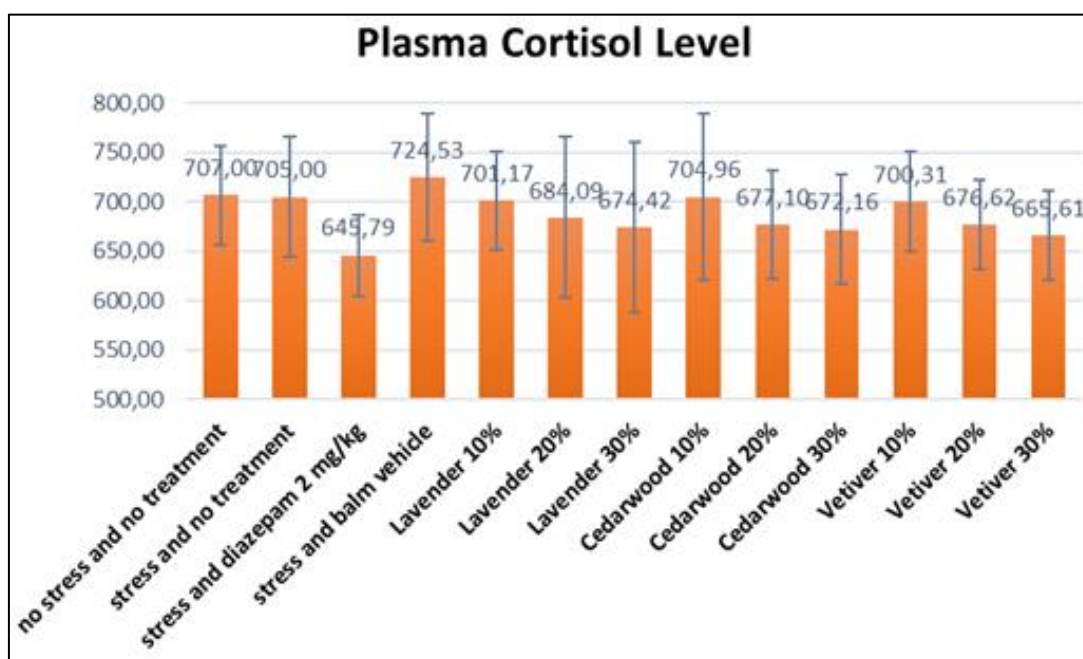


Fig 1: Plasma cortisol levels

We used 4-to-5-month-old rats because of this age analog with the human adolescent period of the age of 13-18. Prolonged stress in adolescence reduces prefrontal cortex, amygdala, and hippocampus volume. Morphologic changes associated with the deterioration of learning ability and cognitive function. The disruption of these structures leads to neuropsychiatric disorders in adulthood. The adolescent brain is more susceptible and responsive to glucocorticoid hormone (cortisol) than the adult [3, 4]. Chronic cortisol exposure reduces neuroplasticity (neurogenetic and synaptic connectivity), stimulates aggressively, inhibits social interaction/relationship, and stimulates anxiety in adulthood [3, 4]. Our study found the effect of essential oil balms to reduce plasma cortisol level. Previous several studies found the effect of essential oil aromatherapy to ameliorate stress disorders.

The research conducted by Cho *et al.*, 2013, found that the mixed essential oil inhalation (lavender, Roman chamomile, and neroli) attenuated anxiety level and improved the sleep quality of percutaneous coronary intervention patients in intensive care unit [5]. Chamine *et al.*, 2016 showed that the lavender essential oil use in subjects with acute stress improved their work performance in memory and speed-related tasks [6]. Another study of Takeda *et al.*, 2017 found that elderly people who were treated using 3 kinds of aromatherapy (pure lavender; lavender and sweet orange blend; pine, cypress, Virginian cedarwood, and Japanese cypress blend) on the night before sleep for 20 days would have better total sleep time and sleep maintenance. The treatment would also inhibit early morning awakening [7]. Metanalysis study conducted by Sánchez-Vidana *et al.*, 2017

reported the benefit of essential oils to ameliorate depressive symptoms. Topical application by massage predominantly improved depressive symptoms than inhalation. Lavender is the common usage in order to gain a relaxing effect^[8]. The possible mechanism of aromatherapy to reduce anxiety was studied by Wu *et al.*, 2012. Aromatherapy inhalation of lavender, clary sage, Indian sandalwood, sweet orange in rats for 10 days increased threitol, glucose-6-phosphate, glucose, glucuronolactone, N-acetylglutamine, mannose, glucose-5-phosphate. These compounds were discovered to have an anxiolytic effect. These essential oils increased histamine and decreased phenylalanine. This subsequently caused anxiety amelioration^[9]. Lavender has the anxiolytic effect similar to pregabalin. Lavender inhibits voltage-dependent calcium channel in primary hippocampus neuron synaptosome. Calcium influx inhibition reduces glutamate and norepinephrine releasing. Glutamate and norepinephrine have roles in anxiety pathogenesis^[10]. The study by López *et al.*, 2017, reported the mechanism of lavender oil (linalool and linalyl acetate) as anxiolytic and antidepressant through N-methyl-D-aspartate (NMDA) receptor antagonism and serotonin transporter (SERT) inhibition^[11]. In addition, the study by Atsumi and Tonosaki, 2007, found lavender oil reduced blood and saliva cortisol level in human subjects^[12]. The cedarwood essential oil has been used as antispasmodic, astringent, decongestant, insecticide, and sedative. Cedarwood contains a sesquiterpene (cedrol 12-22%) as the main active ingredient. Cedrol inhalation has a relaxing/sedative effect. The mechanism of action of cedrol was not only in the olfactory pathway but possibly also via the non-olfactory one^[13]. The vetiver essential oil has a relaxing/sedative effect. Vetiver increases total sleep time and has a similar sedative/hypnotic effect to diazepam^[14]. Vetiver also contains sesquiterpene hydrocarbons (khusimol, β -vetivenene and β -vetispirene). Our study found that lavender, cedarwood, and vetiver balm could reduce plasma cortisol level. Essential oil titration could have a greater effect to reduce cortisol level. We still need further investigations for the dose titration to understand toxicity, side effects, dependency and tolerance of the essential oils. We argue the essential oil balms have a systemic effect via the skin penetration. There is well-established evidence that cortisol works as a stress hormone. If we can modulate the plasma cortisol level, stress can be attenuated. Lavender, cedarwood, and vetiver oils can be proposed as anti-cortisol agents.

4. Conclusions

Lavender, cedarwood, and vetiver balms have a beneficial effect as an anti-stress treatment by reducing cortisol hormone level. The dose increase gives a greater effect on reducing plasma cortisol level. These balms can be used as an alternative medication to manage prolonged stress.

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