Research Articles

Influence of lavender essential oil inhalation on aggressive behavior of weaned pigs

Kochakorn Direksin[1*] Suttisak Nopwinyoowong[2] Suvaluk Seesupa[3]

[1]Department of Veterinary Medicine, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen, Thailand
[2]Department of Pathobiology, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen, Thailand
[3]Department of Surgery and Theriogenology, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen, Thailand

[*]Corresponding author, E-mail address: kochakrn@kku.ac.th

Abstract

The aim of this study was to investigate how lavender essential oil influence on aggressive behavior and different genders of weaned pigs. The pigs were raised on a farrow-to-finish 1,200 sow farm in a closed evaporative cooling building. Total of 160 recently weaned pigs (18-21 days old) were used in this experiment. The pigs were divided into 2 groups and put in 4 separated pens; control/non-exposed (male = 40, female = 40 pigs) and lavender groups (male = 40, female = 40 pigs). Shortly after had been transported by a car, pigs the lavender group was allowed to smell lavender oil *(Lavandula angustifolia)* for 4 hours. Number of fight and duration of each fighting were recorded by the same observers in each group, immediately after mixing the pigs, counted every 30 minutes, and followed for up to 4 hours. The emission of lavender oil was warranted by smelling sense of the observers and continued adding of the oil till the session ended. The frequencies of fighting in the lavender group of both sexes were significantly higher ($p<0.05$) than those of control pigs. Regardless of the groups, it was interesting that female pigs fought more often and took longer duration on each fight (average) than male pigs. In this study, lavender aroma possibly mitigated motion sickness and rendered the pigs adapting to a new environment and hence exhibited natural behavior faster than the control group. Smelling of lavender oil did not prevent aggressive behavior in weaned pigs, but rather stimulated the hierarchy to settle sooner.

Keywords: Essential oil, lavender, weaned pig

ผลของการดมกลิ่นน้ำมันหอมระเหยลาเวนเดอร์ต่อพฤติกรรมก้าวร้าวของสุกรหย่านม

กชกร ดิเรกศิลป์[1*] สุทธิศักดิ์ นพวิญญูวงศ์[2] สุวลักษณ์ ศรีสุภา[3]

[1]ภาควิชาอายุรศาสตร์ คณะสัตวแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น 40002 ประเทศไทย
[2]ภาควิชาพยาธิชีววิทยา คณะสัตวแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น 40002 ประเทศไทย
[3]ภาควิชาศัลยศาสตร์และวิทยาการสืบพันธุ์ คณะสัตวแพทยศาสตร์ มหาวิทยาลัยขอนแก่น จังหวัดขอนแก่น 40002 ประเทศไทย

[*]ผู้รับผิดชอบบทความ E-mail address: kochakrn@kku.ac.th

บทคัดย่อ

วัตถุประสงค์เพื่อทดสอบผลของการสูดดมกลิ่นน้ำมันหอมระเหยลาเวนเดอร์ ต่อพฤติกรรมก้าวร้าวและความแตกต่างของการตอบสนองระหว่างเพศของสุกรหย่านม ทำการทดสอบภายในโรงเรือนปิด ซึ่งเป็นระบบอีแวป ในฟาร์มขนาด 1,200 แม่ ใช้สุกรหย่านมอายุ 18-21 วัน รวมทั้งหมด 160 ตัว แบ่งออกเป็น 2 กลุ่ม แยกเป็น 4 คอก กลุ่มควบคุม 2 คอก (เพศเมีย = 40 เพศผู้ = 40 ตัว) กลุ่มลาเวนเดอร์ 2 คอก (เพศเมีย = 40 เพศผู้ = 40 ตัว) การศึกษาเริ่มในทันทีที่สุกรถูกขนย้ายลงจากรถและบรรจุเข้าในโรงเรือน โดยกลุ่มทดลองจะได้รับกลิ่นลาเวนเดอร์เป็นระยะเวลาติดต่อกันนาน 4 ชั่วโมง ผู้สังเกตจะทำการบันทึกจำนวนครั้งของการต่อสู้กันในแต่ละคอก และรวมจำนวนสะสมทุกๆ 30 นาทีไปจนครบระยะเวลา ระดับและการคงตัวของกลิ่นจะใช้การรับรู้จากจมูกของผู้สังเกต โดยหยดน้ำมันหอมระเหย 3-4 หยด บนตะเกียงเซอรามิคทุกๆ 15 นาที

พบว่ากลุ่มที่ดมกลิ่นลาเวนเดอร์มีความถี่ในการต่อสู้กัน ทั้งในเพศเมียและเพศผู้ สูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญ ($p<0.05$) และพบว่าหากไม่คำนึงถึงกลุ่มควบคุมและกลุ่มทดสอบ เพศเมียมีค่าเฉลี่ยของจำนวนครั้งของการต่อสู้กันมากกว่าเพศผู้ ข้อสรุปจากการศึกษานี้คือการดมกลิ่นลาเวนเดอร์ทำให้สุกรหย่านมมีความก้าวร้าวมากกว่ากลุ่มควบคุม และจัดลำดับทางสังคมได้เร็วกว่ากลุ่มควบคุม ทั้งนี้อาจเป็นเพราะกลิ่นลาเวนเดอร์ทำให้สุกรหายจากการเมารถและมีความแข็งแรงกว่ากลุ่มควบคุม

คำสำคัญ : น้ำมันหอมระเหย ลาเวนเดอร์ สุกรหย่านม

Introduction

Fighting during the first time of mixing is considered natural behavior of domestic pigs, Sus domesticus (Stukenborg, et al., 2011). Since pigs are herding or grouping animals, social ranking is necessary (Turner and Edwards, 2004). This agonistic behavior is often result in infected wounds (Ursinus, et al., 2014), growth retardation (Bohnenkamp, et al., 2013), immune suppression (Rudine, et al., 2007), and in a worse case, carcass condemnation (van Staaveren, et al., 2015). Finding methods to reduce aggression is therefore essential for better performances in pig production. Beside natural behavior, stressful conditions such as being separated from sows, early weaning, hunger, stocking density, meeting strange pigs, and uncomfortable atmosphere, can also enhance pig fighting behavior (Stukenborg, et al., 2011). Nevertheless, good husbandry can minimize these kinds of stress in nursery pigs.

Although hierarchy is unavoidable, there must be some methods that can minimize the severity of fighting and hence improve performance and welfare of the pigs as well. Therefore, we are interested in a natural way that works best for human and animals. Beside that it must have no toxic residues in animal meat and the environment. Aromatherapy has been known since ancient times and is now gaining popularity for alternative and complementary therapies, especially in human medicine. Inhalation of volatile or essential oils, extracted from different parts of plants, in order to improve mood, behavior, and perceived well-being, reducing anxiety and stress, is known as aromatherapy (Ali, et al., 2015). Essential oils are acceptable holistic therapy that can increase comfort and decrease stress in chronic or terminal states of illness (Blust, et al., 2014).

In humans, odor pleasure may be influenced by personal preferences and cultural experiences (Yoo, 2006). A good experimental design such as double blinded, randomized, and / or placebo control is necessary for clinical trials (Kirk-Smith, 2004). In addition, scientific evidences are essential to reinstate on the benefit of aromas. Otherwise, use of animal models is an alternative way to exclude such bias. Since animals cannot tell what they are thinking, measuring their pleasure is conferred by their behavior.

Lavender essential oil obtained from the aerial part of *Lavandula angustfolia* Mill is one of the most popular of essential oils (Gul, et al., 2015). Lavender essential oil has various physiological effects after inhalation, include stress reduction (Chioca, et al., 2013), euphoric emotional states (Sayorwan, et al., 2012), altered motor activity (Kim, et al., 2009), and improving sleep quality (Lillehei, et al., 2015).

Smelling of lavender essential oil could reduce oxidation and cortisol hormone in human (Atsumi Tonosaki, 2007). Lavender aroma could significantly reduce excitement in dogs during ñmini-truck transportation as measured by duration and frequency of rest, sit, bark, and movement (Wells, 2006). Similarly, motion sickness of finishing pigs decreased markedly when transported on a truck with lavender sprayed bedding (Bradshaw, et al., 1998). Heart rates of horses decreased after 7 consecutive days of lavender aromatherapy (Ferguson, et al., 2013). From these mention examples, lavender essential oil has tremendous benefits on bodies and minds of human and animals. It is interesting to know whether lavender oil can alleviate aggressive behavior of recently weaned pigs.

Materials and Methods

Experimental pigs and the farm

We measured effect of lavender aroma in weaned pigs raised on a commercial farm. The farm is a farrow-to-finish production type with approximately 1,200 sows. Male piglets were castrated at 7-10 days old. The pigs were weaned at 18-21 days, and moved to an evaporative cooling building by car transportation. Wind speed and temperature of the pig building was controlled by an automatic system. The farm practices high biosecurity, all-in/all-out pig flow, and separating pens of male and female pigs.

Experimental method

Total of 160 cross-bred recently weaned pigs were randomly selected. The dam and sir lines of the pigs are CP21 and CP73 respectively. Pigs were 18-21 days old and had average body weight of 7.2 kilograms. The pigs were divided into 2 groups and put in 4 separated pens; control (male = 40, female = 40 pigs) and lavender (male = 40, female = 40 pigs) groups. Four observers were pre-trained for an agreement on the judgment of aggressive behavior. In order to record data by the same observers, we did the studies of control and lavender groups once at a time. However, the investigation of non-exposed and lavender exposed groups was done in the same building.

Shortly after being transported by a car, the lavender group was allowed to smell lavender oil for 4 hours. Lavender is 100% pure essential oil extracted from *Lavandula angustifolia* (Botanics®). The Lavender aroma was dissipated by a ceramic candle lighting bowl. The emission of lavender oil was ensure by smelling sense of the observers and continued adding of the oil 3-4 drops in every 15 minutes till the session ended. The smell covered area about 8 meters radius per ceramic bowl. Number of fight and duration of each fighting were recorded by the same observers in each group, immediately after mixing the pigs.

Data collection

Number of fight and length of time spent on each fighting were recorded immediately after the pigs were moved into the pens. One fight was defined as 2 or more pigs use their mouth-to-neck attack to each other and push upward or sideward until separation. Frequency of fight in each pen was counted and summarized every 30 minutes and continued for up to 4 hours of pig mixing. Environmental factors of the building include temperature, wine speed, and relative humidity were controlled and monitored every hour by using the anemometer-hygrometer-thermometer (Krestel™ 3000 Weather Meter, USA).

Statistical analysis

The SPSS computerized program version 17.0 was used to compare average time spent on each fight between groups and sexes by the Independent sample T-test method. Number of fight between groups was compared by Chi-Square Test (χ^2).

Results

Environmental factors of the building

In this study, we observed nursery pig's behavior in a well-controlled atmosphere building. Average temperature, wind speed, and relative humidity inside building of the lavender group were 32.15 °C, 0.14 meters per second, and 74.17%, respectively (Table 1).

Similarly, average temperature, wind speed, and relative humidity inside building of the control group were 33.78 °C, 0.46 meters per second, and 76.00%, respectively (Table 2).

Table 1. Environmental factors inside the building of the lavender group

Factors/Time (Hours)	0	1	2	3	4	Mean	Min.	Max.
Air speed (m/sec)	0.40	0.40	0.30	0.30	0.40	0.36	0.30	0.40
Temperature (°C)	31.3	31.5	32.5	31	33.1	31.9	31.0	33.1
Relative Humidity (%)	77	76	76	76	70	75	70	77

Table 2. Environmental factors inside the building of the control group

Factors/Time (Hours)	0	1	2	3	4	Mean	Min.	Max.
Air speed (m/sec)	0.50	0.50	0.50	0.40	0.40	0.46	0.40	0.50
Temperature (°C)	34.5	35.0	34.5	29.4	35.5	33.8	29.4	35.5
Relative Humidity (%)	66	62	61	76	57	64	57	76

Fighting behavior of female pigs

Females in control and lavender groups started fighting at the first 10 minutes after mixing with new pigs in the pens. The busiest of attacking each other was during the first 120 minutes of meeting, and subsided after this. Similarly, the peak number of fight in both groups was at the first 60 minutes. Later on, frequency of fighting declined by the times (Figure 1). During the first 120 minutes of mixing, females in the lavender group exhibited higher numbers of fight than the control. During the 150-240 minutes, control females seemed to fight more often than the lavender group, although had fewer number of attacks during the first 120 minutes (Figure 1). Total accumulated number of fight for 4 hours in the lavender group was 64 whereas in the control group was only 52 times ($p<0.05$) (data not shown in the Figure). In addition, lavender exposed females took longer duration on each fight than the control pigs did, 94 seconds versus 79 seconds ($p<0.05$) (data not shown in the Figure).

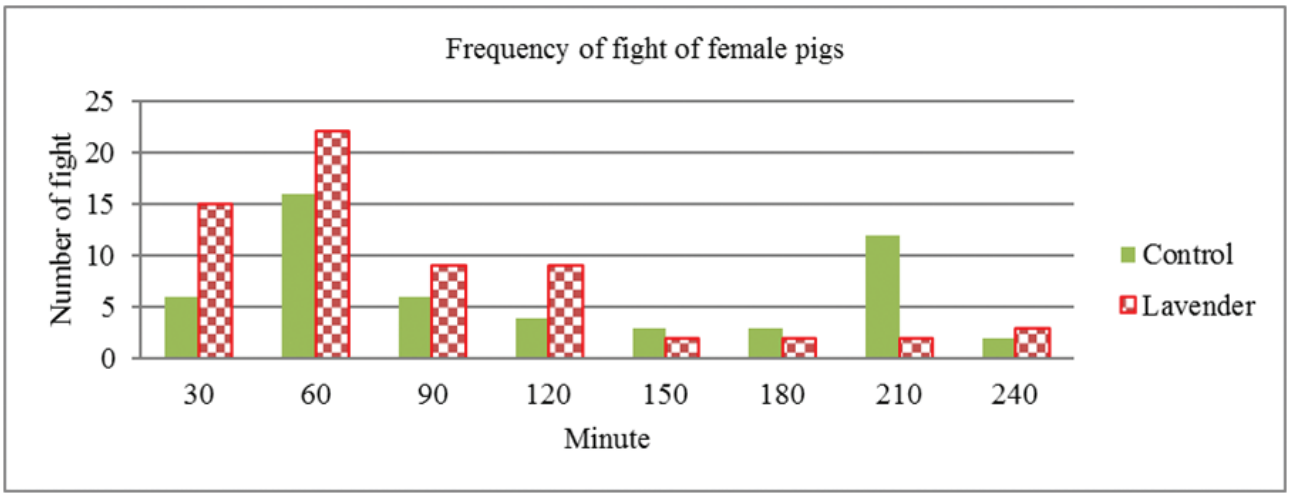

Figure 1. Number of fight between the lavender and control groups of female pigs, counted every 30 minutes, during the first 240 minutes of mixing pigs

Fighting behavior of male pigs

Similar to the females, aggression of the male pigs began at the first 10 minutes and maximum number of fight seen at 60 minutes after mixing. Males in the lavender group attacked each other more often than the control males. During the first 150 minutes, lavender group exhibited markedly more aggression than the control did (Figure 2). Overall 4 hours of the observation period, males in the lavender group fought 32 times whereas males in the control group did only 18 times ($p<0.05$) (data not shown in the Figure). Average duration of time spent on each fight of the lavender and control male pigs were similar, 59 and 50 seconds, respectively ($p>0.05$). Interestingly, control males fought only 4 times during the first 120 minutes. During the 210-240 minutes, males in the control group fought 13 times whereas lavender males did only 6 times ($p<0.05$) (data not shown in the Figure).

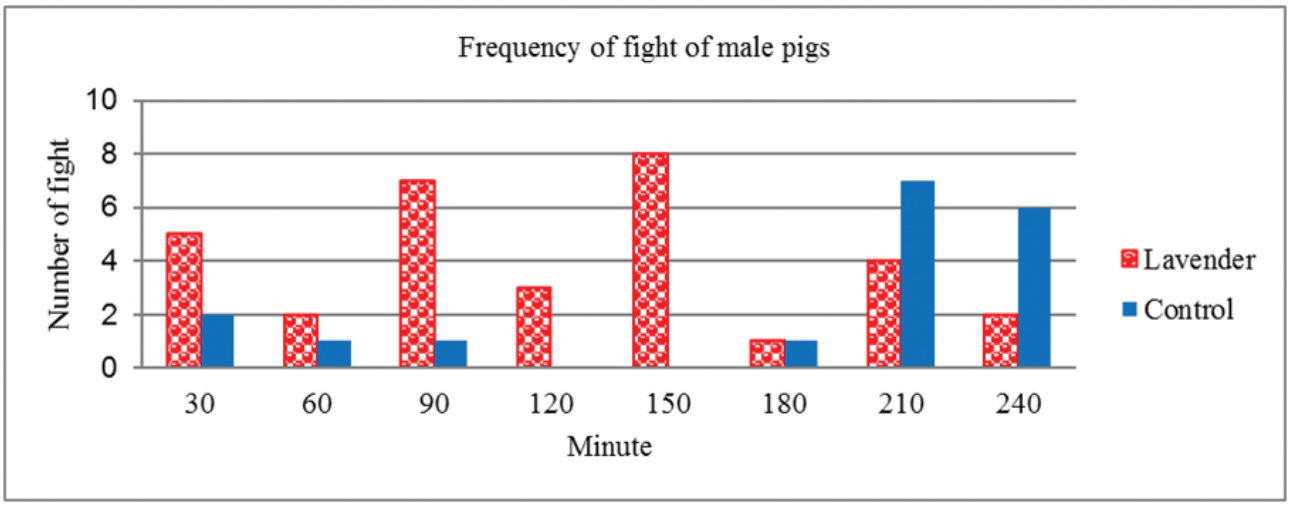

Figure 2. Number of fight between the lavender and control groups of male pigs counted every 30 minutes, counted every 30 minutes, during the first 240 minutes of mixing pigs

Fighting behavior between control and lavender groups

Regardless of the groups when comparing between genders, male fought only 48 times whereas female did 116 times ($p<0.01$) (Table 3). The average time spent on each fight of the male was 55 seconds as compared to 87 seconds of the female ($p<0.01$). During the first 4 hours of meeting with new pigs, lavender exposed pigs fought 96 times and control pigs did 70 times in total of the observation period ($p<0.05$). Average duration on each fight of the lavender group was 83 seconds and that of the control group was 71 seconds ($p>0.05$) (Table 3).

Table 3. Average duration of each fight between male and female pigs, exposed and non-exposed to lavender essential oil groups

Factors	Groups	Number of fight	P-value	Mean duration of each fight (second)	P-value
Sex	Male	48	0.000	55	0.005
	Female	116		87	
Lavender	Exposed	96	0.044	83	0.304
	Non-Exposed	70		71	

Discussion

As the observers must be the same person when recoding the fight of control and the lavender groups. So we did the trails of lavender and control groups at a different time. However, the closed buildings were well controlled and had similar environmental factors in both groups. Hence, temperature, wind speed and moisture would not affect the pig behavior.

In this present study, females in the experiment were surprisingly more aggressive than male pigs. This result was in contrast to previous reports which found that growing and finishing male pigs were more aggressive than females (Clark and D'Eath, 2013). The differences may be due to ages of the pigs or recent castration may cause some pain in the castrated male pigs. Previous studies indicated that castrated pigs were less active than the intact ones (Tallet, et al., 2013). Much aggression may occur in some pens when dominant pigs were inadvertently put together. Previous studies pointed out that high rank pigs maintained their dominance after being moved to another place (Desire, et al., 2015). However, in our experiment, agonistic behavior tended to decrease by the time and seemed to have no any obvious dominant pig. Aggressive behavior of pigs can also stem from environmental stress such as stocking density, temperature, hunger, early weaning, and genetics (Stukenborg, et al., 2011) which is unlikely to occur in our experiment since we conducted the trials in a well-controlled building which had optimal atmosphere.

Regardless of genders, it was not expecting that the lavender exposed pigs were more vigorously active than the control pigs, and they also tended to take longer time on each fight than the control group. We assumed that lavender aroma may have physiological benefits to the nursery pigs. It has been proved that pigs do suffer from road transportation (Roldan-Santiago, et al., 2015).

The lavender exposed pigs probably recovered from motion sickness quicker than the control pigs and then establishing ranking order much quicker. Previous studies have demonstrated that lavender oil mitigated nausea in finishing pigs during mini-truck transportation (Bradshaw, et al., 1998). In human, aromatherapy had been employed to alleviate post-operative or chemotherapy-induced nausea and vomiting (Blust, et al., 2014). We can possibly assume that positive effects of lavenders oils in those varieties of studies may help explain why the pigs in our experiment were much active than the control group.

Generally, lavender aromatherapy affected emotion and behavior in human and animals by modification of the central nervous system through olfactory nervous system (Nagai, et al., 2014). In human, it is quite clear that lavender oil ameliorates generalized anxiety (Kianpour, et al., 2016) and positively affects emotion (Sayorwan, et al., 2012). Currently, many studies are focusing on brain functions in animal models in order to prove biologic action of lavender essential oil. Although there was no such detailed study in pigs, researches in rat (Hancianu, et al., 2013), mouse (Chioca, et al., 2013), sheep (Hawken, et al., 2012), and horse (Ferguson, et al., 2013) models may help explain how lavender essential oil affects brain functions. More specifically, linalool, a major component of lavender essential oil (Lafhal, et al., 2016), affected brain functions via the glutamatergic system (Hancianu, et al., 2013) and potentiated the action of GABA receptors (Chioca, et al., 2013). In addition, linalool could activate brain striatum slice to release dopamine and also increase plasma dopamine levels in rats and mice (Hao, et al., 2013). Dopamine involves in locomotor activity, mental states, appetite, and endocrine control (Haller, 2013). Therefore, lavender aroma exposed pigs were more alert than the control pigs.

The hierarchy in pigs, however, is unavoidable. The control pigs once recovered from a car sickness, they started to fight. Therefore, lavender aroma could not prevent fighting in the nursery pigs. The ranking order must continue until win or lose results. Once hierarchy is established, the conflicts are resolved by avoidance rather than fighting. Social status settle the sooner the better pig performance, in terms of stress, welfare, injuries and feed intake. More investigations are needed to verify whether lavender oil can reduce injury in weaned pigs.

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References

Ali B, Al-Wabel NA, Shams S, Ahamad A, Khan SA, Anwar F. Essential oils used in aromatherapy: A systemic review. Asian Pac J Trop Biomed. 2015; 5(8):601-611.

Atsumi T, Tonosaki K. Smelling lavender and rosemary increases free radical scavenging activity and decreases cortisol level in saliva. Psychiatry Res. 2007; 150(1):89-96.

Blust AM, Buchko B, Crouse M, Reed J, Reisinger J, Shank K. Evidence Based Practice: Aromatherapy Use for the Treatment of Post Operative Nausea and Vomiting (Ponv). J Perianesth Nurs. 2014; 29(5):e35.

Bohnenkamp AL, Traulsen I, Meyer C, Muller K, Krieter J. Comparison of growth performance and agonistic interaction in weaned piglets of different weight classes from farrowing systems with group or single housing. Animbio. 2013; 7(2):309-315.

Bradshaw RH, Marchant JN, Meredith MJ, Broom DM. Effects of lavender straw on stress and travel sickness in pigs. J Altern Complement Med (New York, N.Y.). 1998; 4(3):271-275.

Chioca LR, Ferro MM, Baretta IP, Oliveira SM, Silva CR, Ferreira J, Losso EM, Andreatini R. Anxiolytic-like effect of lavender essential oil inhalation in mice: Participation of serotonergic but not GABAA/benzodiazepine neurotransmission. J Ethanopharmacol. 2013; 147(2):412-418.

Clark CCA, D'Eath RB. Age over experience: Consistency of aggression and mounting behaviour in male and female pigs. Appl Anim Behav Sci. 2013; 147(1-2): 81-93.

Desire S, Turner SP, D'Eath RB, Doeschl-Wilson AB, Lewis CRG, Roehe R. Analysis of the phenotypic link between behavioural traits at mixing and increased long-term social stability in group-housed pigs. Appl Anim Behav Sci. 2015; 166:52-62.

Ferguson CE, Kleinman HF, Browning J. Effect of Lavender Aromatherapy on Acute-Stressed Horses. J Equine Vet Sci. 2013; 33(1):67-69.

Gul S, Nisa NT, Shah TA, Shah MUA, Wani AB. Research output on Lavender, 2008-2012. Eur J Integr Medi. 2015; 7(5):460-466.

Haller J. The neurobiology of abnormal manifestations of aggression--A review of hypothalamic mechanisms in cats, rodents, and humans. Brain Res Bull. 2013; 93:97-109.

Hancianu M, Cioanca O, Mihasan M, Hritcu L. Neuroprotective effects of inhaled lavender oil on scopolamine-induced dementia via anti-oxidative activities in rats. Phytomedicine. 2013; 20(5): 446-452.

Hao C-W, Lai W-S, Ho C-T, Sheen L-Y. Antidepressant-like effect of lemon essential oil is through a modulation in the levels of norepinephrine, dopamine, and serotonin in mice: Use of the tail suspension test. J Funct Foods. 2013; 5(1):370-9.

Hawken PAR, Fiol C, Blache D. Genetic differences in temperament determine whether lavender oil alleviates or exacerbates anxiety in sheep. Physiology & Behavior. 2012; 105(5):1117-1123.

Kianpour M, Mansouri A, Mehrabi T, Asghari G. Effect of lavender scent inhalation on prevention of stress, anxiety and depression in the postpartum period. Iranian journal of nursing and midwifery research. 2016; 21(2):197-201.

Kim Y, Kim M, Kim H, Kim K. Effect of lavender oil on motor function and dopamine receptor expression in the olfactory bulb of mice. J Ethanopharmacol. 2009; 125(1):31-35.

Kirk-Smith M. Clinical evaluation of aromatherapy. Int J Aromatherapy. 2004; 14(3):102-109.

Lafhal S, Vanloot P, Bombarda I, Kister J, Dupuy N. Chemometric analysis of French lavender and lavandin essential oils by near infrared spectroscopy. Ind Crops Prod. 2016; 80:156-164.

Lillehei AS, Halcon LL, Savik K, Reis R. Effect of Inhaled Lavender and Sleep Hygiene on Self-Reported Sleep Issues: A Randomized Controlled Trial. J Altern Complement Med(New York, N.Y.). 2015; 21(7):430-438.

Nagai K, Niijima A, Horii Y, Shen J, Tanida M. Olfactory stimulatory with grapefruit and lavender oils change autonomic nerve activity and physiological function. Autonomic Neuroscience. 2014; 185:29-35.

Roldan-Santiago P, Trujillo-Ortega M, Borderas-Tordesillas F, Martinez-Rodriguez R, Mora-Medina P, Flores-Peinado S, Sanchez-Hernandez M, Garcia-Herrera R, Gonzalez-Lozano M, Mota-Rojas D. Physiometabolic responses to road transport in weaned piglets for a short period and the effects of straw bedding. Anim Sci J Nihon chikusan Gakkaiho. 2015; 86(5):563-571.

Rudine AC, Sutherland MA, Hulbert L, Morrow JL, McGlone JJ. Diverse production system and s ocial status effects on pig immunity and behavior. Livestock Science. 2007; 111(1ñ2):86-95.

Sayorwan W, Siripornpanich V, Piriyapunyaporn T, Hongratanaworakit T, Kotchabhakdi N, Ruangrungsi N. The effects of lavender oil inhalation on emotional states, autonomic nervous system, and brain electrical activity. J Med Assoc Thai Chotmaihet thangphaet. 2012; 95(4):598-606.

Stukenborg A, Traulsen I, Puppe B, Presuhn U, Krieter J. Agonistic behaviour after mixing in pigs under commercial farm conditions. Appl Anim Behav Sci. 2011; 129(1):28-35.

Tallet C, Brilloüet A, Meunier-Salaün M-C, Paulmier V, Guérin C, Prunier A. Effects of neonatal castration on social behaviour, humanñanimal relationship and feeding activity in finishing pigs reared in a conventional or an enriched housing. Appl Anim Behav Sci. 2013; 145(3-4):70-83.

Turner SP, Edwards SA. Housing immature domestic pigs in large social groups: implications for social organisation in a hierarchical society. Appl Anim Behav Sci. 2004; 87(3-4):239-253.

Ursinus WW, Van Reenen CG, Kemp B, Bolhuis JE. Tail biting behaviour and tail damage in pigs and the relationship with general behaviour: Predicting the inevitable? Appl Anim Behav Sci. 2014; 156:22-36.

van Staaveren N, Teixeira DL, Hanlon A, Boyle LA. The effect of mixing entire male pigs prior to transport to slaughter on behaviour, welfare and carcass lesions. PloS one. 2015; 10(4):e0122841.

Wells DL. Aromatherapy for travel-induced excitement in dogs. J Am Vet Med Assoc. 2006; 229(6):964-967.

Yoo KM. Statistical analysis of aromatherapy preferences and complications for 3000 otolaryngology patients. Int J Aromatherapy. 2006; 16(3-4):181-185.