Essential Oils in Mood Disorders

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Essential oils (EOs) are extracted from plants and contain active components with therapeutic effects.

inhalation therapy | essential oil | anti-depression | anxiolytic

1. Introduction

Essential oil (EO), as the main component used in inhalation therapy, has been widely investigated for its therapeutic effects. Evidence indicates that EOs can successfully reduce anxiety and relieve pain when combined with conventional treatment [1][2]. EOs can be administered through oral consumption, direct skin contact, or inhalation [3]. Among all different administration routes, inhalation is the most commonly adopted method. In fact, EOs from different plant extracts have been studied to demonstrate different effects, with lavender and bergamot EOs being the most widely used ones for relaxation in either single use or mixed use with reported pharmacodynamic interactions [4]. It has been shown that the different positive effects were linked to specific constituents in EOs [5][6]. Therefore, the combined use of EOs consisting of different molecular compounds, is able to maximise the therapeutic effect [7][8].

2. Therapeutic Effects of EOs

Table 1 summarises the effect of EOs in human studies. For instance, the inhalation of lavender and chamomile EOs was found to decrease levels of depression, anxiety, and stress in older adults. It was suggested that the anxiolytic and antidepressant effects could be associated with the suppression of the activity of the sympathetic nervous system [9].

Table 1. Summary of clinical effects of EO inhalation on depression/anxiety disorders in human studies.

EO(s) Scientific Name (Common Name)	Author (Year)	Results	
Lavandula			
Lavandula angustifolia (Lavender)	Burnett et al. (2004)	Anxiolytic effect	[8]
	Lehrner et al. (2005)	Reduced anxiety; positive effect on mood; higher level of calmness	[10]

EO(s) Scientific Name (Common Name)	Author (Year)	Results	
	Fayazi et al. (2011)	Anxiolytic effect	[11]
	Senturk et al. (2018)	Anxiolytic effect	[12]
	Karan et al. (2019)	Blood pressure control; anxiolytic effect; respiratory relaxation	[13]
	Ebrahimi et al. (2021)	Antidepressant effect; anxiolytic effect; reduced stress	[14]
Citrus			
Citrus sinensis (Sweet orange)	Lehrner et al. (2005)	Anxiolytic effect; positive effect on mood	[10]
	Goes et al. (2012)	Anxiolytic effect	[15]
Citrus junos (Yuzu)	Matsumoto et al. (2014)	Anxiolytic effect; antidepressant effect	[16]
Citrus bergamia (Bergamot)	Watanabe et al. (2015)	Reduced salivary cortisol level	[17]
Matricaria			
Matricaria chamomilla (Chamomile)	McKay et al. (2006)	Antidepressant effect; anxiolytic effect	[18]
	Ebrahimi et al. (2021)	Antidepressant effect; anxiolytic effect; reduced stress	[14]
Salvia			
Salvia rosmarinus (Rosemary)	Burnett et al. (2004)	Anxiolytic effect	[8]
Salvia officinalis (Sage)	Muss et al. (2010	Positive effect on mood	[19]
Salvia lavandulaefolia (Spanish sage)	Muss et al. (2010)	Positive effect on mood	[19]
Mixture			
Lavandula angustifolia (Lavender) + Rosa damascena (Damascus Rose)	Conrad et al. (2012)	Anxiolytic effect; antidepressant effect	[20]

EO(s) Scientific Name (Common Name)	Author (Year)	Results	
Lavandula angustifolia (Lavender) Cananga odorata (Ylang-ylang) + Citrus aurantium (Neroli)	Song et al. (2017)	Anxiolytic effect	[21]

Moreover, EOs have the potential to relieve depression and secondary depressive symptoms arising from different types of chronic conditions, like anxiety disorders and dementia [22][23][24][25]. Fayazi and co-workers have shown that patients inhaling lavender EO before undergoing heart and abdominal surgeries reported less anxiety, suggesting the potential anxiolytic effect of the EO [11]. The therapeutic effects of EOs have also been proven in animal studies (Table 2).

Table 2. Summary of pre-clinical examinations of EO inhalation on depression and anxiety-like symptoms in animal models.

EO(s) Scientific Name (Common Name)	Author (Year)	Animal	Behaviour Outcome (a)	Secondary Outcome (b)	Results	
Lavandula						
Lavandula angustifolia (Lavender)	Chioca et al. (2013)	Mice	MBT, OFT		(a) Increase in locomotor activity (b) -	[26]
	Chioca et al. (2013)	Mice	EPM	5-HT	(a) Increase in open arm timing (b) Increase of 5-HT level	[27]
	Coelho et al. (2014)	Rats	CFT	c-Fos	(a) Decrease in freezing response (b) Increase in c-Fos expression	[28]
	Sanchez-Vidana et al. (2019)	Rats	OFT, FST	DCX, BDNF	(a) Increase in locomotor activity; decrease in immobility timing (b) Increase in DCX expression and BDNF level	[29]
Citrus						
Citrus limon (Lemon)	Komiya et al. (2006)	Mice	EPM, OFT FST	DA, 5-HT	(a) Increase in open arm timing and locomotor activity; decrease in immobility timing	[30]

EO(s) Scientific Name (Common Name)	Author (Year)	Animal	Behaviour Outcome (a)	Secondary Outcome (b)	Results	
					(b) Increase of 5-HT and DA levels	
Citrus sinensis (Sweet orange)	Hocayen et al. (2019)	Mice	MBT, OFT, Light/dark test	NADPH-d	(a) Increase in locomotor activity and spending time in bright area (b) Decrease of NADPH cells	[31]
Other						
Acorus gramineus (Japanese sweet flag)	Koo et al. (2003)	Mice		NADPH-d	(a) - (b) Decrease of NADPH cells	[32]
Perilla frutescens (Perilla)	Ji et al. (2014)	Mice	OFT, FST, TST	5-HT, 5-HIAA	(a) Decrease in immobility timing (b) Increase of 5-HT and 5-HIAA levels	[33]
Coriandrum sativum (Coriander)	Cioanca et al. (2014)	Rats	EPM, FST	GSH	(a) Increase in open arm timing; decrease in immobility timing (b) Increase of GSH	[34]
Asarum caudatum (Asarum)	Park et al. (2015)	Mice	FST, TST	CRF, 5-HT	(a) Decrease in immobility timing (b) Decrease of CRF; increase of 5-HT level	[35]
Rosa disambiguation (Rose)	Villareal et al. (2017)	Rats	EPM		(a) Increase in open arm timing (b) -	[36]
Rosmarinus officinalis (Rosemary)	Villareal et al. (2017)	Mice	TST	DA, Cort	(a) Decrease in immobility timing (b) Decrease of serum Cort level and increase of brain DA levels	[37]
Cananga odorata (Ylang ylang)	Zhang et al. (2018)	Mice	EPM	5-HT	(a) Increase in open arm timing and locomotor activity (b) Increase of 5-HT level	[38]

Abbrev. FST = Forced swimming test; OFT = Open field test; TST = Tail suspension test; EPM = Elevated plus maze test; MBT = Marble burying test; CFT = Contextual fear-conditioning test; GSH = Glutathione; NADPH-d =

Nicotinamide adenine dinucleotide phosphate diaphorase; CRF = Corticotropin-releasing factor; 5–HT = Serotonin; 5-HIAA = 5-Hydroxyindoleacetic acid; DA = Dopamine; BDNF = Brain-derived neurotrophic factor; DCX = Doublecortin; c-Fos = Cellular oncogene fos; Cort = corticosterone.

3. Absorption of EO Molecules through Inhalation (Mechanisms behind the Effect of EOs on Brain)

EOs are composed of a variety of volatile chemical constituents. To facilitate the absorption of EOs, a novel administrative method utilising nanotechnology has been developed. By encapsulating EOs into nanoparticles, the uptake and effect of them can be enhanced. The inhaled EO molecules will be delivered to the brain region via different pathways according to their molecular sizes. The possible inhalation delivery pathway involves both the olfactory and respiratory systems (Figure 1).

There are three potential basic mechanisms enabling EOs to influence brain functioning. The first mechanism involves the activation of nasal olfactory chemoreceptors and the subsequent effect of olfactory signals on the brain. The olfactory system is unique among the sensory systems for having direct anatomical and functional links with the limbic system. Thus, olfactory stimuli can have a strong effect on mood. The second putative mechanism of action is direct penetration of EO molecules via the olfactory nerve into connected brain areas and the induction of cellular and molecular events. The third potential pathway is the alveolar absorption of EO molecules into the blood circulation, crossing the blood–brain barrier (BBB) to interact with specific brain regions.

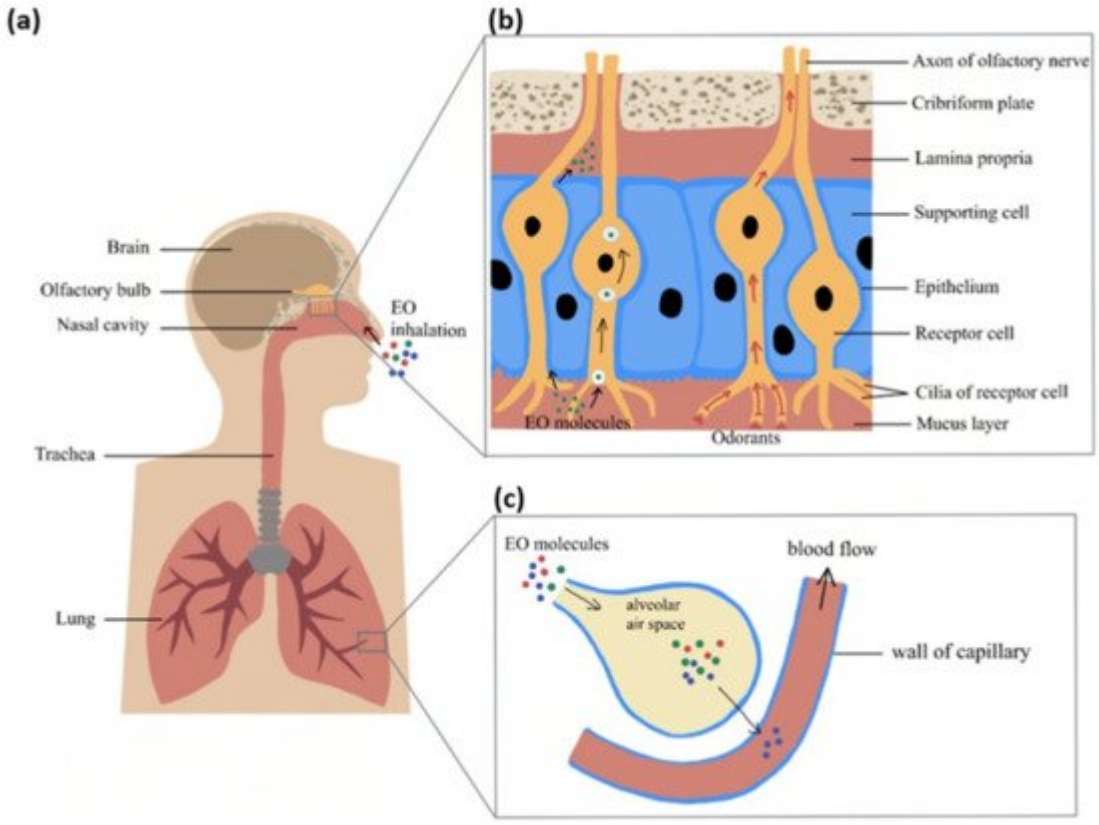

Figure 1. Inhaled EO response delivery to brain through the respiratory and olfactory systems: (**a**) Inhaled EO passes through the nasal cavity and reaches the olfactory system or respiratory system (**b**) Overview of EO molecules' delivery pathway in the olfactory system (**c**) Overview of EO molecules crossing the air–blood barrier to reach the circulatory system.

4. Effect of EO on Cellular/Molecular Events

4.1. Regulation of Monoamines

According to the 5-HT hypothesis of depression [39], the signs and symptoms of depression are the result of 5-HT deprivation. The 5-HT hypothesis is currently the accepted hypothesis with regard to the pathophysiology of depression. The effect of EOs on the 5-HTergic system has been demonstrated in various studies. In a study, which used compound anshen EO, the inhalation of the EO improved sleep quality and promoted 5-HT increase in experimental mice [40]. An increase of 5-HT-expressing neurons in the dorsal raphe nucleus was found in animals that inhaled EO from asarum heterotropoides for 3 h [35], suggesting that the positive effect of EO inhalation may occur in both acute and chronic conditions.

4.2. Neurogenesis and Neurotrophic Factors

Studies on EOs and neurotrophic factors have mainly focused on the expression levels of brain-derived neurotrophic factor (BDNF). In a clinical study, women whose children were diagnosed with attention deficit and hyperactivity disorder were recruited, assuming that this particular population suffered from considerable stress affecting their mental health [41]. After a 4-week treatment program with EOs, the level of anxiety and depression of the subjects decreased, while the plasma BDNF level (reflecting the brain tissue level of BDNF) significantly increased. In other animal models of depression assessing the effect of EOs, similar findings have been observed as well.

4.3. Regulation of the Neuroendocrine System

It is believed that regulation of hormonal levels is a potential underlying mechanism explaining the effect of EOs, for instance, in the treatment of premenstrual syndrome [42] and menopausal disorder [43][44]. Since stress is a risk factor in depression and anxiety disorders, stress hormone cortisol has been the focus of studies examining the antidepressant and anxiolytic effects of EOs [45]. In human studies, acute exposure to lavender EO has been shown to decrease salivary and serum cortisol levels [46][47]. Simultaneously, findings indicated increased relaxation in subjects, including improved coronary flow velocity [47]. The cortisol-suppressing effect was reported in adults [48], pregnant women [49], mothers of children with developmental dysfunction [41], young children [50], as well as patients undergoing chemotherapy [51]. Apart from lavender, other EOs were also shown to affect cortisol levels, including bergamot [17][52] and grapefruit seed [53].

4.4. Other Possible Mechanisms: Oxidative Stress and Inflammation

Based on the assumption that ROS and inflammatory signalling have a role to play in depression, EOs may be beneficial in depression due to their antioxidant and anti-inflammatory properties. For instance, exposure to lavender and rosemary EOs was found to reduce free radical scavenging activity (FRSA), which further prevents the detrimental effects of oxidative stress [46]. In addition, cinnamomum cassia presl (CC-EO), the active component of cinamaldehyde EO also possesses antioxidant properties [54]. Exposure to MJ was effective in preventing depression-like behaviour induced by lipopolysaccharide (LPS) and attenuated the increase of malondialdehyde (MDA), glutathione (GSH), and tumour necrosis factor-alpha (TNF-α) in mice [55].

5. Future Studies

To facilitate the use of EOs in clinical practice when treating depression and anxiety disorders, further large-scale clinical trials are required to confirm the effectiveness and efficacy of them. Although various studies have illustrated that certain EOs possess antidepressant and anxiolytic effects [24][56], the choice of EOs is not standardised. As the active ingredients may vary among EOs due to non-standardised manufacturing processes, clinical trials with large sample size and standardised EOs as treatment agents are required.

References

1. Jaradat, N.A.; Al Zabadi, H.; Rahhal, B.; Hussein, A.M.; Mahmoud, J.S.; Mansour, B.; Khasati, A.I.; Issa, A. The effect of inhalation of Citrus sinensis flowers and Mentha spicata leave essential oils on lung function and exercise performance: A quasi-experimental uncontrolled before-and-after study. J. Int. Soc. Sports Nutr. 2016, 13, 36.
2. Lakhan, S.E.; Sheafer, H.; Tepper, D. The Effectiveness of Aromatherapy in Reducing Pain: A Systematic Review and Meta-Analysis. Pain Res. Treat. 2016, 2016, 8158693.
3. Cooke, B.; Ernst, E. Aromatherapy: A systematic review. Br. J. Gen. Pract. 2000, 50, 493–496.
4. Hay, I.C.; Jamieson, M.; Ormerod, A.D. Randomized trial of aromatherapy. Successful treatment for alopecia areata. Arch. Dermatol. 1998, 134, 1349–11352.
5. De Groot, A.C.; Schmidt, E. Essential Oils, Part III: Chemical Composition. Dermatitis 2016, 27, 161–169.
6. Koyama, S.; Heinbockel, T. The Effects of Essential Oils and Terpenes in Relation to Their Routes of Intake and Application. Int. J. Mol. Sci. 2020, 21, 1558.
7. Petrovic, J.; Stojkovic, D.; Sokovic, M. Terpene core in selected aromatic and edible plants: Natural health improving agents. Adv. Food Nutr. Res. 2019, 90, 423–451.
8. Burnett, K.M.; Solterbeck, L.A.; Strapp, C.M. Scent and mood state following an anxiety-provoking task. Psychol. Rep. 2004, 95, 707–722.

9. Penninx, B.W.; Beekman, A.T.; Honig, A.; Deeg, D.J.; Schoevers, R.A.; van Eijk, J.Z.; van Tilburg, W. Depression and cardiac mortality: Results from a community-based longitudinal study. Arch. Gen. Psychiatry 2001, 58, 221–227.
10. Lehrner, J.; Marwinski, G.; Lehr, S.; Johren, P.; Deecke, L. Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office. Physiol. Behav. 2005, 86, 92–95.
11. Fayazi, S.; Babashahi, M.; Rezaei, M. The effect of inhalation aromatherapy on anxiety level of the patients in preoperative period. Iran. J. Nurs. Midwifery Res. 2011, 16, 278–283.
12. Senturk, A.; Tekinsoy Kartin, P. The Effect of Lavender Oil Application via Inhalation Pathway on Hemodialysis Patients' Anxiety Level and Sleep Quality. Holist Nurs. Pract. 2018, 32, 324–335.
13. Karan, N.B. Influence of lavender oil inhalation on vital signs and anxiety: A randomized clinical trial. Physiol. Behav. 2019, 211, 112676.
14. Ebrahimi, H.; Mardani, A.; Basirinezhad, M.H.; Hamidzadeh, A.; Eskandari, F. The effects of Lavender and Chamomile essential oil inhalation aromatherapy on depression, anxiety and stress in older community-dwelling people: A randomized controlled trial. Explore (N. Y.) 2021.
15. Goes, T.C.; Antunes, F.D.; Alves, P.B.; Teixeira-Silva, F. Effect of sweet orange aroma on experimental anxiety in humans. J. Altern. Complement. Med. 2012, 18, 798–804.
16. Matsumoto, T.; Asakura, H.; Hayashi, T. Effects of olfactory stimulation from the fragrance of the Japanese citrus fruit yuzu (Citrus junos Sieb. ex Tanaka) on mood states and salivary chromogranin A as an endocrinologic stress marker. J. Altern. Complement. Med. 2014, 20, 500–506.
17. Watanabe, E.; Kuchta, K.; Kimura, M.; Rauwald, H.W.; Kamei, T.; Imanishi, J. Effects of bergamot (Citrus bergamia (Risso) Wright & Arn.) essential oil aromatherapy on mood states, parasympathetic nervous system activity, and salivary cortisol levels in 41 healthy females. Forsch. Komplementmed. 2015, 22, 43–49.
18. McKay, D.L.; Blumberg, J.B. A review of the bioactivity and potential health benefits of chamomile tea (Matricaria recutita L.). Phytother. Res. 2006, 20, 519–530.
19. Moss, L.; Rouse, M.; Wesnes, K.A.; Moss, M. Differential effects of the aromas of Salvia species on memory and mood. Hum. Psychopharmacol. 2010, 25, 388–396.
20. Conrad, P.; Adams, C. The effects of clinical aromatherapy for anxiety and depression in the high risk postpartum woman–A pilot study. Complement. Ther. Clin. Pract. 2012, 18, 164–168.
21. Song, E.J.; Lee, M.Y. Effects of Aromatherapy on Stress Responses, Autonomic Nervous System Activity and Blood Pressure in the Patients Undergoing Coronary Angiography: A Non-Randomized Controlled Trial. J. Korean Acad. Nurs. 2018, 48, 1–11.

22. Fung, J.K.; Tsang, H.W.; Chung, R.C. A systematic review of the use of aromatherapy in treatment of behavioral problems in dementia. Geriatr. Gerontol. Int. 2012, 12, 372–382.
23. Lee, Y.L.; Wu, Y.; Tsang, H.W.; Leung, A.Y.; Cheung, W.M. A systematic review on the anxiolytic effects of aromatherapy in people with anxiety symptoms. J. Altern. Complement. Med. 2011, 17, 101–108.
24. Sanchez-Vidana, D.I.; Ngai, S.P.; He, W.; Chow, J.K.; Lau, B.W.; Tsang, H.W. The Effectiveness of Aromatherapy for Depressive Symptoms: A Systematic Review. Evid. Based Complement Alternat. Med. 2017, 2017, 5869315.
25. Yim, V.W.; Ng, A.K.; Tsang, H.W.; Leung, A.Y. A review on the effects of aromatherapy for patients with depressive symptoms. J. Altern. Complement. Med. 2009, 15, 187–195.
26. Chioca, L.R.; Antunes, V.D.; Ferro, M.M.; Losso, E.M.; Andreatini, R. Anosmia does not impair the anxiolytic-like effect of lavender essential oil inhalation in mice. Life Sci. 2013, 92, 971–975.
27. Chioca, L.R.; Ferro, M.M.; Baretta, I.P.; Oliveira, S.M.; Silva, C.R.; Ferreira, J.; Losso, E.M.; Andreatini, R. Anxiolytic-like effect of lavender essential oil inhalation in mice: Participation of serotonergic but not GABAA/benzodiazepine neurotransmission. J. Ethnopharmacol. 2013, 147, 412–418.
28. Coelho, L.S.; Correa-Netto, N.F.; Masukawa, M.Y.; Lima, A.C.; Maluf, S.; Linardi, A.; Santos-Junior, J.G. Inhaled Lavandula angustifolia essential oil inhibits consolidation of contextual- but not tone-fear conditioning in rats. J. Ethnopharmacol. 2018, 215, 34–41.
29. Sanchez-Vidana, D.I.; Po, K.K.; Fung, T.K.; Chow, J.K.; Lau, W.K.; So, P.K.; Lau, B.W.; Tsang, H.W. Lavender essential oil ameliorates depression-like behavior and increases neurogenesis and dendritic complexity in rats. Neurosci. Lett. 2019, 701, 180–192.
30. Komiya, M.; Takeuchi, T.; Harada, E. Lemon oil vapor causes an anti-stress effect via modulating the 5-HT and DA activities in mice. Behav. Brain Res. 2006, 172, 240–249.
31. Hocayen, P.A.S.; Wendler, E.; Vecchia, D.D.; Kanazawa, L.K.S.; Issy, A.C.; Del Bel, E.; Andreatini, R. The nitrergic neurotransmission contributes to the anxiolytic-like effect of Citrus sinensis essential oil in animal models. Phytother. Res. 2019, 33, 901–909.
32. Koo, B.S.; Park, K.S.; Ha, J.H.; Park, J.H.; Lim, J.C.; Lee, D.U. Inhibitory effects of the fragrance inhalation of essential oil from Acorus gramineus on central nervous system. Biol. Pharm. Bull. 2003, 26, 978–982.
33. Ji, W.W.; Li, R.P.; Li, M.; Wang, S.Y.; Zhang, X.; Niu, X.X.; Li, W.; Yan, L.; Wang, Y.; Fu, Q.; et al. Antidepressant-like effect of essential oil of Perilla frutescens in a chronic, unpredictable, mild stress-induced depression model mice. Chin. J. Nat. Med. 2014, 12, 753–759.

34. Cioanca, O.; Hritcu, L.; Mihasan, M.; Trifan, A.; Hancianu, M. Inhalation of coriander volatile oil increased anxiolytic-antidepressant-like behaviors and decreased oxidative status in beta-amyloid (1-42) rat model of Alzheimer's disease. Physiol. Behav. 2014, 131, 68–74.
35. Park, H.J.; Lim, E.J.; Zhao, R.J.; Oh, S.R.; Jung, J.W.; Ahn, E.M.; Lee, E.S.; Koo, J.S.; Kim, H.Y.; Chang, S.; et al. Effect of the fragrance inhalation of essential oil from Asarum heterotropoides on depression-like behaviors in mice. BMC Complement. Altern. Med. 2015, 15, 43.
36. De Almeida, R.N.; Motta, S.C.; de Brito Faturi, C.; Catallani, B.; Leite, J.R. Anxiolytic-like effects of rose oil inhalation on the elevated plus-maze test in rats. Pharmacol. Biochem. Behav. 2004, 77, 361–364.
37. Villareal, M.O.; Ikeya, A.; Sasaki, K.; Arfa, A.B.; Neffati, M.; Isoda, H. Anti-stress and neuronal cell differentiation induction effects of Rosmarinus officinalis L. essential oil. BMC Complement. Altern. Med. 2017, 17, 549.
38. Zhang, N.; Zhang, L.; Feng, L.; Yao, L. Cananga odorata essential oil reverses the anxiety induced by 1-(3-chlorophenyl) piperazine through regulating the MAPK pathway and serotonin system in mice. J. Ethnopharmacol. 2018, 219, 23–30.
39. Albert, P.R.; Benkelfat, C.; Descarries, L. The neurobiology of depression--revisiting the serotonin hypothesis. I. Cellular and molecular mechanisms. Philos. Trans. R. Soc. Lond. B Biol. Sci. 2012, 367, 2378–2381.
40. Zhong, Y.; Zheng, Q.; Hu, P.; Huang, X.; Yang, M.; Ren, G.; Du, Q.; Luo, J.; Zhang, K.; Li, J.; et al. Sedative and hypnotic effects of compound Anshen essential oil inhalation for insomnia. BMC Complement. Altern. Med. 2019, 19, 306.
41. Wu, J.J.; Cui, Y.; Yang, Y.S.; Kang, M.S.; Jung, S.C.; Park, H.R.; Yeun, H.Y.; Jang, W.J.; Lee, S.; Kwak, Y.S.; et al. Modulatory effects of aromatherapy massage intervention on electroencephalogram, psychological assessments, salivary cortisol and plasma brain-derived neurotrophic factor. Complement. Ther. Med. 2014, 22, 456–462.
42. Heydari, N.; Abootalebi, M.; Jamalimoghadam, N.; Kasraeian, M.; Emamghoreishi, M.; Akbarzaded, M. Evaluation of aromatherapy with essential oils of Rosa damascena for the management of premenstrual syndrome. Int. J. Gynaecol. Obstet. 2018, 142, 156–161.
43. Berihanova, R.R.; Minenko, I.A. Possibilities of complex non-drug programs in the correction of psychoemotional disorders of menopause in patients with metabolic syndrome. Vopr. Kurortol. Fizioter. Lech. Fiz. Kult. 2019, 96, 50–59.
44. Berihanova, R.R.; Minenko, I.A. Hormonal profile of women with metabolic syndrome in the background of multimodal non-medicinal correction of climacteric disorders. Adv. Gerontol. 2020, 33, 721–728.

45. Chan, J.N.; Lee, J.C.; Lee, S.S.; Hui, K.K.; Chan, A.H.; Fung, T.K.; Sanchez-Vidana, D.I.; Lau, B.W.; Ngai, S.P. Interaction Effect of Social Isolation and High. Dose Corticosteroid on Neurogenesis and Emotional Behavior. Front Behav. Neurosci. 2017, 11, 18.
46. Atsumi, T.; Tonosaki, K. Smelling lavender and rosemary increases free radical scavenging activity and decreases cortisol level in saliva. Psychiatry Res. 2007, 150, 89–96.
47. Shiina, Y.; Funabashi, N.; Lee, K.; Toyoda, T.; Sekine, T.; Honjo, S.; Hasegawa, R.; Kawata, T.; Wakatsuki, Y.; Hayashi, S.; et al. Relaxation effects of lavender aromatherapy improve coronary flow velocity reserve in healthy men evaluated by transthoracic Doppler echocardiography. Int. J. Cardiol. 2008, 129, 193–197.
48. Toda, M.; Morimoto, K. Effect of lavender aroma on salivary endocrinological stress markers. Arch. Oral. Biol. 2008, 53, 964–968.
49. Chen, P.J.; Chou, C.C.; Yang, L.; Tsai, Y.L.; Chang, Y.C.; Liaw, J.J. Effects of Aromatherapy Massage on Pregnant Women's Stress and Immune Function: A Longitudinal, Prospective, Randomized Controlled Trial. J. Altern. Complement. Med. 2017, 23, 778–786.
50. Field, T.; Field, T.; Cullen, C.; Largie, S.; Diego, M.; Schanberg, S.; Kuhn, C. Lavender bath oil reduces stress and crying and enhances sleep in very young infants. Early Hum. Dev. 2008, 84, 399–401.
51. Stringer, J.; Swindell, R.; Dennis, M. Massage in patients undergoing intensive chemotherapy reduces serum cortisol and prolactin. Psychooncology 2008, 17, 1024–1031.
52. Pasyar, N.; Rambod, M.; Araghi, F. The effect of bergamot orange essence on anxiety, salivary cortisol, and alpha amylase in patients prior to laparoscopic cholecystectomy: A controlled trial study. Complement Ther. Clin. Pract. 2020, 39, 101153.
53. Kawai, E.; Takeda, R.; Ota, A.; Morita, E.; Imai, D.; Suzuki, Y.; Yokoyama, H.; Ueda, S.Y.; Nakahara, H.; Miyamoto, T.; et al. Increase in diastolic blood pressure induced by fragrance inhalation of grapefruit essential oil is positively correlated with muscle sympathetic nerve activity. J. Physiol. Sci. 2020, 70, 2.
54. Chou, S.T.; Chang, W.L.; Chang, C.T.; Hsu, S.L.; Lin, Y.C.; Shih, Y. Cinnamomum cassia essential oil inhibits alpha-MSH-induced melanin production and oxidative stress in murine B16 melanoma cells. Int. J. Mol. Sci. 2013, 14, 19186–19201.
55. Adebesin, A.; Adeoluwa, O.A.; Eduviere, A.T.; Umukoro, S. Methyl jasmonate attenuated lipopolysaccharide-induced depressive-like behaviour in mice. J. Psychiatr. Res. 2017, 94, 29–35.
56. De Sousa, D.P.; de Almeida Soares Hocayen, P.; Andrade, L.N.; Andreatini, R. A Systematic Review of the Anxiolytic-Like Effects of Essential Oils in Animal Models. Molecules 2015, 20, 1860–1862.