

The Use of Bergamot Essential Oil for PTSD Symptomology: A Qualitative Study

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ABSTRACT

Posttraumatic stress disorder (PTSD) is a multi-faceted, symptomatic mental health diagnosis often accompanied with various physical and psychological comorbidities. The complexity of this diagnosis makes treatment difficult, thereby suggesting that all options, including alternative approaches to care, should be explored. Aromatherapy from plant essential oils is an increasingly utilized integrative health modality. Essential oils are lipophilic, volatile aromatic metabolites in plants consisting of various natural chemical constituents that permeate the blood stream and influence neurobiological responses. This qualitative phenomenological study sought to understand the impact of aromatherapy from Bergamot essential oil on managing PTSD symptomology. A two-week pilot study was conducted consisting of 12 first responder, medical, firefighter and military men and women presenting with symptoms of PTSD in San Diego, California. Data collected from the interviews identified that the bergamot essential oil produced a calming effect, improved sleep, reduced anxiety, increased positive mood, enhanced concentration and reduced avoidance behavior. Participants in the research study reported that aromatherapy of bergamot essential oil helped mitigate certain symptoms of PTSD from the symptom clusters of arousal, negative mood, and avoidance behavior. This modality could help practitioners and treatment clinics facilitate an adaptive recovery, by providing a calm and safe atmosphere to engage with clients to execute trauma focused therapy more effectively. Aromatherapy provides a non-invasive and promising modality that would best serve the mental health field for practitioners and their overseeing organizations to further research, educate and implement this therapy in facilitating an adaptive recovery and management of PTSD symptoms.

KEYWORDS: PTSD, mental health, aromatherapy, essential oils, complementary alternative medicine.

Posttraumatic stress disorder (PTSD) is defined by the development of a cluster of symptoms following exposure to a traumatic event (e.g., life-threatening experience, a major injury, sexual violation.) (American Psychiatric Association [APA], 2013). PTSD occurs in about 7-8% of the population; in fact, it is estimated that 8 million adults have PTSD annually (National Center for Posttraumatic Stress Disorder [NCPTSD], 2018). PTSD is a unique disorder because of

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the non-deactivation of the body's physiological reaction to stress causing it to maladaptively cycle and disrupt a cascade of other neurobiological processes (Bryant, 2017). Various neurobiological systems are involved within PTSD encompassing the neuroendocrine, neurotransmitter and neurocircuitry systems and have crossover or dual effects on the body playing a role in the manifestation of symptoms (Antunes-Alves & Comeau, 2014). Long-term exposure to excessive stress results in alterations of various pathways, specifically in the hippocampus, amygdala, and medial prefrontal cortex as well as changes to the brains' neural circuitry and neurochemistry (Antunes-Alves & Comeau, 2014). Several neurochemical pathways influence the maladaptive stress response in PTSD affecting the function of the prefrontal cortex, amygdala, and hippocampus which are key brain regions associated with its symptomology (Antunes-Alves & Comeau, 2014). These alterations contribute to the manifestation of the four key clusters of symptoms in PTSD defined in the DSM-V as intrusion symptoms, avoidance, negative mood, and arousal (APA 2013).

PTSD is unique as a disorder, not because of the body's physiological reaction to stress, but because of the non-deactivation of that reaction causing it to maladaptively cycle (Bryant, 2017). The endocrine system is primarily implicated in PTSD with its role in regulating cortisol and thyroid hormones (Fragkaki et al., 2016; Sherin & Nemeroff, 2011). The hippocampus is the primary inhibitor of the HPA axis during the stress response and one cardinal feature of those with PTSD is reduced volume of the hippocampus, therefore also causing dysregulation of the HPA axis in the stress cycle and contributing to the abnormal processing of fear (Antunes-Alves & Comeau, 2014; Nash et al., 2014; Sherin & Nemeroff, 2011).

Dysregulation of serotonin, catecholamines such as dopamine and norepinephrine, amino acids, peptides such as oxytocin and neuropeptide Y, opioid neurotransmitters, and the endocannabinoid system is evident in PTSD, all of which play a role with the responses to fear, stress, and emotional regulation (Kelemendi et al., 2016; Marinova & Maercker, 2015; Sakellariou & Stefanatou, 2017). For example, serotonin levels have been found to impact both the risk of PTSD development and symptom severity (Nash et al., 2014; Rasmusson & Shalev, 2014). Abnormal regulation of dopamine and norepinephrine contribute to the physiological effects of increased blood pressure, heart rate, respiration rate, startle reactivity, and hyperarousal in response to stress (Bryant, 2017; Marinova & Maercker, 2015; Sakellariou & Stefanatou, 2017). The amino acids of γ -aminobutyric acid (GABA) and glutamate (Glu) have profound effects on the body's ability to mitigate arousal and anxiety (Sakellariou & Stefanatou, 2017; Sherin & Nemeroff, 2011). GABA is the primary neurotransmitter inhibitor in the brain and plays an intrinsic role in emotional and fear memory coding (Kelemendi et al., 2016). Moreover, chronic fear and stress consequently diminish GABA activity in the amygdala (Nash et al., 2014). Several studies on PTSD patients show a decrease in GABA activity in correlation with behavioral reactions of stress and anxiety (Kelemendi et al., 2016; Sakellariou & Stefanatou, 2017). With long term dysregulation of endogenous chemicals, damage to brain circuitry and anatomy can be seen, disrupting various physiological and neurological processes (Shields et al., 2017).

There are three major brain regions that are found implicated in PTSD studies—the amygdala, hippocampus and multiple areas within the prefrontal cortex (Shields et al., 2017). Each of these regions have specific and synergistic roles in processing stress, emotions, fear, memory and arousal, plus influence many other areas in the brain and body. Stress pathways are core contributors to the breakdown of the several neural circuit systems that impact the brain resulting in the symptomology of PTSD, including impacting memory function through these three key regions of the hippocampus, amygdala, and the prefrontal cortex (Marinova & Maercker, 2015; Shields et al., 2017).

Moreover, avoidance behavior, a prime barrier to successful treatment, is motivated when the fear structure maladaptively cycles and reinforces trauma memories resulting in a lack of motivation to receive recovery treatment from PTSD (Rauch & Foa 2006).

Due to the complexity of the neurobiology of PTSD and the hallmark feature of avoidance behavior towards recovery, a multi-faceted approach to treatment could be beneficial. One viable complementary intervention that could help ease various symptoms of PTSD is aromatherapy. The World Health Organization (WHO) estimates that between 65% and 80% of the global population use medicinal plant remedies (Palhares et al., 2015). This therapeutic treatment originating from plant oils is gaining popularity as an integrative health modality, thereby reaffirming the need to gain educational and scientific data in order to respond accurately to ongoing demands (Boesl & Saarinen, 2016).

Plant remedies have had a historical presence worldwide and have been studied, though not as widely and thoroughly as a specific treatment modality (e.g., bergamot for PTSD). Essential oils are lipophilic volatile aromatic metabolites in plants consisting of various natural chemical constituents from flowers, seeds, bark, stems, roots, leaves, peel, and fruits (Rios, 2016). Aromatic inhalation of essential oils influences the brain as the molecules travel through the neural olfactory pathways, directly permeating the limbic system (Wu et al., 2012). Through this olfactory limbic permeation, the aromatic compounds are coupled with sensory receptors and decoded into an electronic signal influencing neurotransmitter alteration and modulation, nerve excitability and sedation, neuron stimulation and apoptosis, and neurogenesis and neuroplasticity (Lv et al., 2013). Certain aromatic compounds have been studied to surpass the blood brain barrier due to high lipophilic and unique chemical structures, which can directly permeate and influence the brain's higher cortex, processing conscious thought, the hippocampus, hypothalamus and the limbic system, all of which influence emotions, memory, mood and the management of stress responses (Lv et al., 2013).

Aromatherapy could be used as an accessible, cost-effective supplement to treatment for various PTSD symptoms. Essential oils are dynamic because one plant oil is often composed of multiple chemical compounds that produce a variety of therapeutic actions in the body (Rios, 2016). Research on certain essential oils (e.g. bergamot, jasmine, rose, lavender, geranium, lemon, the compounds linalool, pinene, and limonene, etc.) have been found to contribute to a calming effect throughout the central nervous system, including that of the stress cycle involving the HPA-axis, and have a positive effect on mood (Han et al., 2017; Lv et al., 2013) all of which are key components implicated in PTSD (Sakellariou & Stefanatou, 2017). Therefore, the focus of this study was to consider through participant experiences if aromatherapy could help in easing any of the symptoms of PTSD. Specifically, our study was interested in examining the proficiency in reducing the physiological reactivity contributing to the motivation towards avoidance behavior from trauma.

An extensive literature review was completed on various essential oils and individual plant constituents to determine the best essential oil to select for this study according to the neurobiology in PTSD (see Table 1, 2, and 3 for a summary of this literature review). From this literature review, Bergamot essential oil was chosen for this research study.

Bergamot is a citrus fruit whose essential oil coming from the rind, is high in linalyl acetate and linalool, known for their calming effects via its ability to alleviate the symptoms of physical and psychological stress (Liu et al., 2013). Bergamot also contains a chemical constituent called limonene, which is the primary compound in citrus essential oils, showing its high potential at mitigating the effects of stress within various pathways (Han et al., 2017). One study induced hyperactivity via methamphetamine injection and found that the compound limonene was able to reverse the elevated dopamine levels in the nucleus accumbens of rats and inhibited

hyperlocomotion and hyperactivity (Yun, 2014). Several other studies have been done confirming the neuroprotective effects of limonene against corticosteroids. One such study on d-limonene found that it reversed the neurotoxic effects of corticosterone thereby inhibiting reactive oxygen species and pro-inflammatory factors that contribute to neuronal death and depression (Tang et al., 2019). In a chronic unpredictable stress induced test on mice, inhaled limonene restored mood and regulated the hyperactivity of the HPA axis, causing an improvement in BDNF receptor expression in the hippocampus and monoamine neurotransmitters (Zhang et al., 2019). Other limonene studies confirm its ability to reduce anxiety-like reactions via the central nervous system and antioxidant effects (Avram et al., 2018; De Alameida et al., 2012; Cardoso de Alameida et al., 2014; Vieira et al., 2018). In fact, one study used the preclinical pharmacological marble burying test used with anxiolytic drugs to test active-avoidance behavior and found that the group administered limonene resulted in an anti-avoidant like response suggesting it produced an anxiolytic action (Cardoso de Alameida et al., 2014).

Studies on bergamot report its ability to reduce stress, anxiety, depression, blood pressure and heart rate (Han et al., 2017). One study showed that bergamot essential oil attenuated HPA axis activity by reducing the corticosterone response to stress and exhibited anxiolytic-like behaviors (Saiyudthong & Marsden, 2011). Beta-pinene is a compound also found in bergamot. A study on beta-pinene found that after injection with a depressive animal model test, it interacted with the dopaminergic system most prominently in the limbic areas of the brain, a key area involved in emotional and memory regulation (Guzman-Gutierrez et al., 2015). Studies on bergamot therefore have multiple therapeutic benefits in relation to PTSD via modulation of the various neurotransmitters involved as well as exerting calming actions on the HPA axis and neuroendocrinological system restoring homeostasis in stressful environments.

Table 1
Summary of Neuroscientific findings of Aromatherapy

Plant/Compound	Neurosystems Tested	Reported Effects	Source Citation
Cardamom	PTSD CNS	Anxiolytic Neuroprotective Anti-stress ↑Cognition ↑GABA ↑CRF ↓Oxidative stress ↓Neuroinflammation ↑ Learning ↑ Memory	(Auti & Kulkarni, 2019), (Masoumi-Ardakani et al., 2017).
Turmeric	PTSD Memory	↑5HT in hippocampus & prefrontal cortex ↓Fear ↑↓Neurotransmitters ↓Neuroinflammation ↓Neuronal damage ↓ Cognitive decline Antioxidant ↑Cerebral blood flow ↑Neurons in hippocampus & prefrontal cortex Neuroprotective Reversed memory damage	(Chen et al., 2018), (Lee & Lee, 2018).
Lavender	PTSD w/ Silexan Fear Anxiety Depression	Sedative Anxiolytic ↓Fear ↓ Agitated Bx ↓ANS: HR & BP ↑5-HT ↑NMDA Neuroprotective ↑↓ Neurochemicals involved in anxiety & depression ↓NE ↑↓GABA	(Ayaz et al., 2017), (Chioca et al., 2013), (Coelho et al., 2018), (Hosseini et al., 2016), (Kiecolt-Glaser et al., 2008), (Lopez et al., 2017), (Mesri et al., 2017), (Sayorwan et al., 2012), (Uehleke et al., 2012).

Agarwood	Stress	Anti-inflammatory Antioxidant Sedative Hypnotic ↑↓ GABA ↓CRH ↓HPA axis hyperactivity ↑↓Cortisol Neuroprotective ↓ACTH	(Wang et al., 2018), (Wang et al., 2017).
Neroli	Stress Alzheimer Memory Test	Anxiolytic antidepressant ↑↓ 5-HT Sedative Vasorelaxant ↓BP Soothing Calming Uplifting to mood Motor relaxant ↑Learning ↑Memory	(Akhlaghi et al., 2011), (Choi et al., 2014), (Cho et al., 2013), (Dosoky & Setzer, 2018), (Mannucci et al., 2018), (Moslemi et al., 2019), (Namazi et al., 2014).
Limonene	Stress Trauma Anxiety	↑Glu ↑ GABA ↓Corticosterone Anti-stress Anxiolytic ↓HPA-axis hyperactivity Anti-inflammatory Antioxidant ↑BDNF Anti-depressant Anti-avoidant ↓Dopamine in hyperactive state ↓Hyperlocomotion from drug withdrawals ↑NE	(Avram et al., 2018), (Cardoso De Alameida et al., 2014), (Ceccarelli et al., 2004), (De Alameida et al., 2012), (Jafarzadeh et al., 2013), (Kiecolt-Glaser et al., 2008), (Tang et al., 2019), (Vieira et al., 2018), (Yun, 2014), (Zhang et al., 2019), (Zhou et al., 2009).
Bergamot	Stress	↓HPA-axis hyperactivity ↓Corticosterone Anxiolytic ↑Positivity ↓Stress	(Chang & Shen, 2011), (Han et al., 2017), (Guzman-Guitierrez et al., 2015), (Hsieh et al., 2018), (Hwang, 2006), (Kim et al., 2017), (Kwon et al., 2018). (Liu et al., 2013), (Saiyudthong & Marsden, 2011).
Linalool	Stress Anxiety	↑↓ Adrenergic ↑↓ Serotonergic Antidepressant ↓Aggression Sedative ↑↓Glutamatergic Relaxing Anxiolytic	(Guzman-Guitierrez et al., 2015), (Linck et al., 2010), (Lv et al., 2013).
Cinnamon	Stress Anxiety	↑NPY ↓NE frontal cortex & hippocampus ↓DA frontal cortex & hippocampus Anxiolytic ↓Neuroinflammation	(Cheng et al., 2015), (Ogawa & Ito, 2016), (Sousa et al., 2017).
Sweet Basil	Stress Depression	↓Corticosterone ↓Hippocampal nerve atrophy ↑Neurogenesis ↑BDNF antidepressant anti-stress	(Ayuob et al., 2017), (Chang & Shen, 2011), (Liu et al., 2013),
Hinoki	Stress Anxiety	Anxiolytic ↑BDNF Anti-stress ↓ANS: HR & BP Relaxing	(Chen et al., 2015), (Ikel et al., 2015), (Kasuya et al., 2013).
Shiso, mint	Stress	↑BDNF ↑5-HT in hippocampus Anti-inflammatory ↑NE in prefrontal cortex	(Sousa et al., 2017).
Clove	Stress	↑BDNF Anti-stress ↑↓HPA-axis hyperactivity ↑↓Monoamines ↑Learning ↑Memory ↑Neuroplasticity ↓Negative Mood	(Liu et al., 2015), (Sousa et al., 2017).
Beta-Caryophyllene	Alzheimer model Inflammatory	Antioxidant Anti-inflammatory Neuroprotective Antidepressant Antispasmodic Antiaddictive Anxiolytic	(Ames-Sibin et al., 2018), (Bahi et al., 2014), (Cheng et al., 2014), (Guimaraes-Santos

	Anxiety Depression	Surpass BBB ↑Cognition ↓Dependence ↓Compulsion ↑BDNF ↑Memory ↑↓Monoamines	et al., 2012), (Javed et al., 2016), (Kobayashi et al., 2011), (Sousa et al., 2017).
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Note. ↑ Increase | ↓ Decrease | ↑↓ Modulation

Table 2
Summary of Neurochemical and Aromatherapy Findings

Neurochemicals	Essential Oils	Source Citation
Acetylcholine	Limonene ↑	(Zhou et al., 2009).
Adrenocorticotrophic Hormone (ACTH)	Agarwood ↓	(Wang et al., 2018), (Wang et al., 2017).
Brain Derived Neurotrophic Factor (BDNF)	Cardamom ↑ Limonene ↑ Basil ↑ Hinoki ↑ Shiso, mint ↑ Clove ↑↓ BCP ↑ Indian Mahogany ↑	(Auti & Kulkarni, 2019), (Cheng et al., 2014), (Kasuya et al., 2013), (Liu et al., 2015), (Sousa et al., 2017), (Zhang et al., 2019).
Corticotrophin Releasing Hormone (CRH)	Cardamom ↑↓ Agarwood ↓	(Masoumi-Ardakani et al., 2017). (Wang et al., 2018), (Zhou et al., 2009).
Cortisol or Cortiscosterone	Clary Sage ↓ Lavender ↓ Ylang ylang ↓ Marjoram ↓ Neroli ↓ Rose ↓ Rosemary ↓ Limonene ↑↓ Bergamot ↓ Basil ↓	(Atsumi & Tonosaki, 2007), (Ceccarelli et al., 2004), (Choi et al., 2014), (Cho et al., 2013), (Field et al., 2008), (Fukada et al., 2012), (Kim et al., 2012), (Lee et al., 2014), (Shiina et al., 2008), (Tang et al., 2019).
Dopamine	Limonene ↑↓ Beta-pinene ↑↓ Cinnamon ↓ Eucalyptus ↓ Indian Mahogany ↑↓ Bergamot ↑↓	(Cheng et al., 2015), (Yun, 2014).
Epinephrine	Linalool ↑↓	(Guzman-Gutierrez et al., 2015).
GABA	Cardamom ↑↓ Agarwood ↑ Limonene ↑ Eucalyptus ↑ Carvacrol ↑↓ Pinene ↑↓	(Lv et al., 2013), (Masoumi-Ardakani et al., 2017), (Wang et al., 2018), (Zhou et al., 2009).
Glutamate	Limonene ↓ Linalool ↑↓ Croton conduplicatus Kunth ↑↓	(Linck et al., 2010), (Zhou et al., 2009).
Neuropeptide-y (NPY)	Cinnamon ↑	(Ogawa & Ito, 2016).
N-methyl D-aspartate (NMDA)	Lavender ↑↓	(Lopez et al., 2017).
Norepinephrine	Lavender ↓ Limonene ↑ Linalool ↑↓ Cinnamon ↓ Shiso, mint ↑↓	(Cheng et al., 2015), (Kiecolt-Glaser et al., 2008).
Opioids	Croton conduplicatus Kunth ↑↓	(Oliveira et al., 2018).
Serotonin	Turmeric ↑ Lavender ↑ Neroli ↑↓ Linalool ↑ Shiso, mint ↑↓ Indian Mahogany ↑↓ Clary Sage ↑ Perennial Flower oil ↑↓ Lemon ↑↓	(Cheng et al., 2015), (Coelho et al., 2018), (Choi et al., 2014), (Cho et al., 2013), (Lee & Lee, 2018), (Lopez et al., 2017), (Lv et al., 2013), (Sousa et al., 2017), (Xue et al., 2015).

	Black Cumin ↑↓ Patchouli ↑↓ L-Menthone ↑↓ Ylang ylang ↑	
Thyroid Stimulating Hormone (TSH)	Clary Sage ↓	(Lee et al., 2014).

Note. ↑ Increase or upregulated | ↓ Decrease or reduce | ↑↓ Modulate or Mediate or recovered abnormalities

Table 3*Summary of Behavioral and Aromatherapy Findings*

Behavior	Essential Oils	Source Citation
Addiction ↓	Limonene BCP	(Javed et al., 2016), (Yun, 2014).
Agitation Aggression ↓	Lavender Linalool	(Ayaz et al., 2017), (Linck et al., 2010)
Anhedonia ↓	Cinnamon Shiso, mint L-Menthone	(Sousa et al., 2017).
Anxiety ↓	Cardamom Turmeric Lavender Neroli Limonene Bergamot Linalool Cinnamon Hinoki BCP Croton conduplicatus Kunth	(Auti & Kulkarni, 2019), (Cardoso de Alameida et al., 2014), (Chioca et al., 2013), (Coelho et al., 2018), (Choi et al., 2014), (Cho et al., 2013), (Dosoky & Setzer, 2018), (Han et al., 2017), (Hosseini et al., 2016), (Jafarzadeh et al., 2013), (Javed et al., 2016), (Lee & Lee, 2018), (Lopez et al., 2017), (Mannucci et al., 2018), (Masoumi-Ardakani et al., 2017), (Mesri et al., 2017), (Wang et al., 2018), (Namazi et al., 2014),
Arousal Hyperactivity ↓	Neroli Limonene Linalool Eucalyptus	(Choi et al., 2014), (Cho et al., 2013).
Attention Alertness ↑	Ylang ylang	(Cheng et al., 2015), (Lopez et al., 2017).
Calming Sedative	Lavender Agarwood Neroli Linalool Basil Hinoki BCP Croton conduplicatus Kunth Rose	(Choi et al., 2014), (Cho et al., 2013), (Wang et al., 2017).
Cognition ↑	Cardamom BCP	(Masoumi-Ardakani et al., 2017).
Compulsion ↓	BCP	(Javed et al., 2016).
Fear ↓	Turmeric Lavender Limonene	(Coelho et al., 2018),
Depressed Mood ↓	Lavender Agarwood Neroli Limonene Bergamot Cinnamon Basil Hinoki Clove BCP Indian Mahogany Clary Sage L-Menthone	(Choi et al., 2014), (Cho et al., 2013), (Dosoky & Setzer, 2018), (Han et al., 2017), (Javed et al., 2016), (Lopez et al., 2017), (Tang et al., 2019), (Uehleke et al., 2012), (Wang et al., 2018), (Xue et al., 2015), (Zhang et al., 2019).
Memory Learning ↑	Cardamom Turmeric Neroli Beta-pinene Clove BCP	(Choi et al., 2014), (Auti & Kulkarni, 2019), (Lee & Lee, 2018), (Liu et al., 2015).

Sleep ↑	Lavender Agarwood Neroli	(Cho et al., 2013), (Sayorwan et al., 2012), (Uehleke et al., 2012).
Stress ↓	Cardamom Lavender Agarwood Neroli Limonene Bergamot Cinnamon Basil Hinoki Shiso, mint Clove Carvacrol	(Cho et al., 2013), (Dosoky & Setzer, 2018), (Kiecolt-Glaser et al., 2008), (Liu et al., 2015), (Wang et al., 2018), (Zhou et al., 2009).

Note. ↑ Increase or Improve | ↓ Decrease or reduce |

Method

Study Design

A phenomenological qualitative study was used to understand the subjective psychological experiences of people suffering from PTSD symptoms while using aromatherapy. A qualitative approach seeks to understand the experience of the research subject and was chosen to establish a baseline of integrating aromatherapy for PTSD (Williams & Moser 2019). Charmez & Thornberg (2020) state that by focusing on the individual's experience through an interactive process, it can allow the most significant issues or phenomena to arise. Because symptomology of PTSD is not only wide-ranged amongst the four clusters, but it also varies on the spectrum of severity experienced, it was important to qualify this integrative approach in order to establish a basis for further investigation. This study focused specifically on the conscious awareness of participants, how they experience and identify their PTSD symptoms, and how aromatherapy could be used daily to alleviate those symptoms.

Because of the unique complexities of PTSD, open-ended questions were used to better understand the differences, which included personal symptomatic expressions, experiences, individual awareness and language. More specifically, interviews were employed before and after two weeks of essential oil application to determine its qualitative effectiveness in managing PTSD symptoms, with a focus on avoidance behavior (See Appendix B for Pre and Post interview questions). Interviews were conducted by a Doctor of Clinical Psychology candidate who was also a licensed clinical social worker trained in mental health treatment and diagnostic criteria. The phenomenon under investigation of this research was if participants would experience symptomatic relief through essential oil use and most specifically reduced avoidance behavior.

Participants

Participants were recruited from Healing Our Heroes Inc., a 501c3 non-profit organization established in 2016 in the state of California, United States of America. Healing Our Heroes Inc. serves active and former military, first responders such as medical, firefighters and law enforcement individuals. This center offers alternative treatments for PTSD therefore previous clients were called and interviewed to verify eligibility to participate in this study. The participation criteria consisted of those with a history of PTSD and who were still presenting with symptoms of PTSD (See Appendix C for full list of criteria and instructions). Symptom verification was completed from participants responses to the PCL-5 PTSD checklist developed by the National Center for Post-Traumatic Stress Disorder (NCPTSD), which corresponds with the DSM-5 criteria for the diagnosis of PTSD (See Appendix D for PCL-5 Questionnaire). This study excluded anyone who was currently receiving another PTSD treatment modality, as to not affect intervention results.

Participants were required to be at least 18 years of age and be able to read and write in the English language.

There were 12 people who completed participation in this study, consisting of both adult men and women, ranging between the ages of 27 to 64. Creswell suggests 6 participants to reach saturation for qualitative research (Creswell et al., 2017). Of these 12 participants, 7 were men and 5 were women, all were fluent in the English language and lived in San Diego County. Participants primarily had a military background, either in the navy, marines and/or special forces with 9 having trauma exposure during active-duty service; there were also two firefighters, and one participant was a medical first responder. PTSD trauma occurred from combat exposure, sexual assault, witnessing traumatic accident and/or an accumulation that included childhood, family, or other exposures.

Aromatherapy

A two-week period was chosen after reviewing previous research on plant compounds and PTSD indicating that more significant results were achieved compared to shorter term studies (ie. a preclinical study applying a rat model of PTSD using cardamom for 7 days and a study of Turmeric used on a rat model of PTSD for 14 days) (Lee & Lee, 2018; Masoumi-Ardakani et al., 2017).

Participants were given daily instructions detailing the aromatic application of the essential oil four times a day starting between the hours of 0600 and 0800, by placing two drops in the palm of the hand and inhaling through the nasal passageway for 30 seconds or 5 deep breaths. Secondly, repeating these instructions between the hours of 1100 and 1300 hours, and third repeating these same instructions between the hours of 1600 and 1800 hours. The fourth aromatic application of the essential oil was to be applied at bedtime by putting 5 drops in an aromatic diffuser next to their bed on the six-hour setting during sleep (See Table 4). These four daily sessions of aromatic inhalation allowed for the essential oil to be regularly introduced throughout the day, at the hours of most convenience, first thing in the morning, during a lunch break, during an evening break and while sleeping.

Table 4
Daily Application & Tracking Instructions

Application Time	Application Method	Duration	Tracking
0600 - 0800	2 drops palm of hand	Inhale for 30 seconds or 5 deep breaths	Record any symptom changes in daily notebook
1100 - 1300	2 drops palm of hand	Inhale for 30 seconds or 5 deep breaths	Record any symptom changes in daily notebook
1600 - 1800	2 drops palm of hand	Inhale for 30 seconds or 5 deep breaths	Record any symptom changes in daily notebook
Bedtime	5 drops into aromatic diffuser	6-hour diffusion setting	Record any symptom changes in daily notebook

Bergamot essential oil was selected for the aromatherapy, as it encompassed the largest range of benefits to address the multi-symptomatic disorder from the neurobiology of PTSD. Bergamot and its primary constituents, limonene, linalyl acetate and linalool, have been seen in research to reduce stress, possess anxiolytic-like properties, produce an antidepressant like effect, improve positive mood scores, reduce cortisol levels, interact via the limbic region of the brain, calm the HPA-axis and the neuroendocrine system, modulate adrenergic activity, serotonin, GABA and glutamate, and calm the central nervous system (Guzman-Gutierrez et al., 2015; Han et al., 2017; Lv et al., 2013; Zhang et al., 2019). A key focus in this study was expounding upon previous essential oil research that supports the deactivation of the HPA-axis cycle (Zhang et al., 2019).

Studies on the compound limonene alone also confirm the deactivation of the HPA-axis, modulation of the neurotransmitters involved in stress, anxiety, protective against neuronal degeneration, various improvements in the neuroendocrine system and negative mood, including reporting anti-avoidance behavior like effects (Cardoso de Alameida et al., 2014; Zhang et al., 2019). Other conclusions from the literature review that influenced the instrumentation use of bergamot essential oil were studies on the compound's linalool and beta-pinene, such as sedative effects, antidepressant like effects, modulation of the serotonergic system and adrenergic responses (Guzman-Gutierrez et al., 2015). These associated behavioral outcomes in addition to the pleasant scent of Bergamot confirmed this oil to be the most desirable aromatherapy for this study.

Individual 15ml bottles of bergamot essential oil were purchased by the researcher from the company doTERRA®. The purity and chemical compounds of the bergamot essential oil bottles were tested through Aromatic Plant Research Center verifying that there were no contaminants or adulteration, signifying the oil was pure. The major compounds in this bergamot essential oil lot were reported as limonene at 43.58%, linalyl acetate 27.76%, gamma-Terpinene 7.74%, linalool 6.36%, and beta-pinene 5.15% (See appendix A for quality control and essential oil constituent composition). The diffuser used was an ultrasonic aromatherapy diffuser manufactured by InnoGear purchased on Amazon by the researcher.

Data Collection and Analysis

Data was collected from three sources of information; the 20 question PCL-5, pre and post research questions and daily field notebooks (see Appendix B & D). The 20 question PCL-5 checklist for PTSD symptoms was used to rate the presence and severity of symptoms, and to establish a baseline of symptom severity and frequency for this research study in order to evaluate patterns in responses at the pre and post study interviews (See Appendix D). Pre and Post study questions and PCL-5 were conducted by a licensed mental health clinician in a private setting at the Healing Our Heroes offices downtown San Diego. Research questions were also asked pre and post study during a face-to-face interview with participants before and after the study (See Appendix B). This involved gathering demographics, type of trauma onset, when the onset of symptoms began, previous experience with essential oils and the post questions explored the participants experience with aromatherapy during this study. Lastly, field notebooks were given to each participant who were then instructed to respond to open-ended questions in order to note any changes they noticed throughout the day and record those experiences daily.

Data was then compiled from these three sources of information and coded using the qualitative method to explore in more detail the participants' experience using aromatherapy including any trends in symptom fluctuations, avoidance behavior, barriers to using the essential oil, and any other effects or details they noticed during the two weeks study. Coding in qualitative phenomenological research entails collecting various forms of data in order to evaluate trends or phenomena that occurred during the study. Similar words and phrases were coded according to the

theme they expressed as directed for efficacy in qualitative research coding (Williams & Moser 2019). This data was hand-coded and manually organized according to the most common experiences found relevant throughout the study. These codes were chosen in relation to the PTSD diagnostic criteria, symptomatology and co-morbid symptoms experienced and barriers. They were then created into a codebook, which were reviewed for these themes (Levitt et al., 2018). These themes identified how individuals with symptoms of PTSD experienced the aromatherapy of Bergamot. The variety of codes created for this codebook, included categorizing the PTSD symptoms into their top four symptom clusters as “Arousal”, “Negative Mood”, “Avoidance”, and “Intrusive Memories”, then sorting them into the DSM-V symptoms from each of those 4 clusters. Common co-morbid mental health symptoms were coded (ie., anxiety) as well as barriers to aromatherapy use were also coded into a theme.

Table 5
Code Book Table

PTSD Symptom Clusters	Symptoms coded	Themes Associated
Arousal	Difficulty sleeping, irritability, anger, outburst, difficulty with concentration	Improved sleep, calmer, reduced reactivity, less anger, responded better, less irritable, improved concentration or focus, clear mindedness, more focused, focus sustained, increased alertness.
Negative Mood	Rumination, negative thoughts, negative attitude	Good mood, improved mood, reduced ruminations, positive mood, easier to cope, reduced/interrupted negative thoughts
Avoidance	Avoidant behavior of thoughts, conversation or activities that could relate or trigger the traumatic stress response	Feeling more comfortable talking about experiences, emotions, feelings. Calmer when discussing trauma. Handling triggers better, coping better
Intrusive Memories	Flashbacks, recalling distressing memories, dreams of trauma	Fewer visual images, shortened the time of intrusion of the memory
Other Symptoms/Barriers		
Anxiety	Anxiousness, panic attacks	Calmer, less anxious, less anxiety, reduced panic attacks, more relaxed
Barriers	Difficulty implementing aromatherapy protocols	Busy, forgot, change work uniforms and left it, leave bottles at home, travel, irregular schedule, rigorous work schedule (on emergency calls).

Results

Specific to each individual participant field notebook, responses most prominently indicated that they experienced improved symptoms by feeling “calm” from the bergamot essential oil both during the day and at night. Interviews also reaffirmed this, while other statements

indicated common themes including improved sleep, a decrease in anxiety symptoms, positive effect on mood and improved clarity of thought. Participants also reported a noticeable change regarding avoidance during the two-week study. The most noticeable experiences occurred generally after 7 days of consistent use and were reflected in the daily field notebook on day 7 or 8. Among the other commonalities found during the study was minimal changes in participants who were not consistent with the aromatherapy application. However, those with regular consistency in applying the aromatherapy and higher symptom severity of PTSD from the PCL-5 questionnaire, reported more noticeable improvement after use of the bergamot essential oil. The themes are reviewed in order of prevalence as emerged from the daily field book entries.

Theme 1: Calming

The most common statement made by participants in describing their experiences after use of the bergamot aromatherapy was the word “calm.” Other words used to describe these feelings while using the aromatherapy included “relaxed,” “soothing,” and “at ease.”

Participants reported that they felt calm throughout the day, had a sense of calm, their stress was calmed, or they experienced a state of calm or ease after inhaling the bergamot essential oil. Participants also stated that using the oil relaxed them and they were able to maintain feeling calm with longer term and consistent exposure of the essential oil versus with a single- time or sporadic use. On day 14, PA05 described these noticeable lasting change,

I woke up calm and relaxed again. Noticing the calming effect is lasting a little longer. Overall, today I noticed that the longer you do this process, the longer it helps, but mostly with calming and anxiety.

This was also reflected by PA11 who stated, “I found myself staying in a calmer state longer, looking forward to the aromatherapy.”

In relation to stress, various participants referenced feeling calmer after use of the bergamot essential oil. PA11, summed up the experience stating, “I believe aromatherapy can be very useful when applied correctly and used to its potential. The aroma takes my mind to another place quickly making a day less stressful.” Overall, participants reported feeling less stress and that the bergamot essential oil produced a calming, soothing, and/or relaxing experience which seemed to be prolonged with daily and consistent use of the essential oil.

Theme 2: Reduced Symptoms from PTSD Category of Arousal

The specific identification of symptoms regarding arousal as defined in the DSM V (e.g., sleep, angry outbursts, irritability, and concentration) in participants affected by PTSD were coded with the most common theme that emerged being that of sleep.

Within the symptom category of arousal, difficulty sleeping is very common. During this study most participants consistently referenced experiencing improved sleep with use of bergamot essential oil, therefore decreasing this specific symptom of arousal. The benefit of sleep was most evidenced by day one or two. The overarching themes focused on sleeping better and waking up feeling revitalized. PA01 noted “I slept better, a deeper sleep and I woke up feeling refreshed.” PA02 also referenced being able to sleep consistently and well almost every night,

I mostly noticed a more solid sleep. I had a consistent 6 hours of sleep almost every night with the diffuser. Normally I wake up maybe two to three times a night, but with the diffuser and essential oil going all night, I slept solid through the night.

This feedback indicates that the bergamot essential oil may have helped this participant sleep through the night instead of experiencing their normal pattern of waking every few hours. PA03 also detailed the benefits from sleep in the post study questions on symptom reduction:

The [ability to] sleep was a shock. I have tossed and turned for as long as I can remember, and I didn't do that with the bergamot. I was able to hit REM sleep the first time I used the diffuser. The first time I used it at night it took me only 10 minutes to fall asleep, then the second and third and fourth time was instantaneous. I definitely recommend the diffuser while resting, it is a huge difference from when I try to sleep on my own. I am not going back; I will continue to use that tool. The quality of my sleep was higher too.

Participants responded positively to the diffuser at the bedside and stated they would continue to use it to sleep even after the study.

Irritability, Anger, Outbursts

The symptom cluster of arousal includes irritable behavior and angry outbursts. Some participants reported specifically that bergamot aromatherapy decreased irritability, anger, and outbursts. PA05 stated,

It reduced outbursts at first for about 10 minutes but with more use over time, calming the outburst seemed to last about 30 minutes. It seemed to calm me for short spurts and over time I was able to maintain the calm longer.

Participants also described situations that would induce normal irritability and stated how the bergamot aromatherapy contributed to feeling calm in a situation that often incited anger or other adverse emotions. PA06 shared; "I found that [breathing in the bergamot] helped me from instantly reacting, like I normally would do. I was able to slow down a little bit and respond better".

PA11 described how some negative symptoms, like irritability, felt diminished while using aromatherapy as well,

[I had] less stress, anxiety, anger, less irritability, less tiredness and better sleep. I noticed on day 2 that throughout the day I was less stressed and less irritable and that the oil would keep me calmed down. The aromatherapy really took my mind and put it somewhere else and helped me just feel okay and get over it instead of being irritable. It was easier to calm down than before.

Therefore, bergamot essential oil was reported to contribute to participants' experiencing a calming sensation of the arousal symptom from PTSD of outbursts, anger and irritability.

Concentration

The inability to concentrate also lies under the arousal symptom cluster of PTSD. Several words became apparent in the coding process, as participants mentioned focus, concentration, attentiveness, clear mindedness, attention, clearer thoughts, and alertness. Participants reported that mental focus was more sustained, having the ability to experience clearer thoughts and be more focused than normal during the two-week period using aromatherapy. PA04 reported,

I was able to stay focused after work. I even realized I didn't take my second dose of ADHD medication on some of the days but still felt a lot of energy, attentive and clear thoughts.

Another participant, PA11, shared their experience in using the bergamot aromatherapy alongside a meditation practice, "The aromatherapy helps my mind from being so distracted during the meditation."

PA13 described how this new clarity helped solve problems experienced in life, "I felt more alert, able to cope with challenges and clear my head. My focus seemed better."

Overall, participants experienced an improved ability to concentrate while using the bergamot essential oil.

Theme 3: Improved Mood

Participants who described having an improvement to negative mood symptoms used many words to describe it, including good mood, improved mood, felt good, felt better, less negative thinking, stop spiraling thoughts, reduced ruminations, and positive mood. These words were all coded to describe moods while using aromatherapy. PA13 mentioned,

I had more positive thoughts than negative for up to 30 minutes after inhaling the bergamot essential oil. Aromatherapy put thoughts into another place, made it easier to cope, felt like I was outdoors and would get rid of negative thoughts. It was hard to think negative thoughts when inhaling it.

Another participant, PA03, also described the experience that bergamot essential oil had on the symptom of negative mood, specifically on their ruminations, or a persistent cycle of negative thoughts:

[Using the oil] reduced my ruminations; I was able to focus and validate how I felt. I cried but I felt safe. I believe the oil facilitated that safe space to process. I felt comfort during my bouts of shame and sadness. It doesn't make it disappear, but it definitely brings your focus forward and breaks you from your cycle of negative thoughts.

Being able to stop negative moods or attitudes from occurring was a major highlight for participants. PA11 described how they were able to avoid becoming negative,

The biggest effect for me was being able to get my head out of a negative space easier than before. If I had a trigger that started negative thinking

and feeling stressed, using the oil helped me with processing the emotion so that I didn't spiral into more negativity. The key I noticed after using it for a week was that I was able to get out of my head easier and feel more relaxed. This was a big deal for me. It reduced the emotion even though the thought was still there, so it helped keep me from spiraling.

Therefore, the bergamot essential oil appeared to facilitate a positive mood, not only with the absence of a negative mood, but also in the ability to interrupt rumination patterns and other negative thoughts.

Theme 4: Decreased Avoidant Behavior

Avoidance behavior was identified in the pre and post PCL-5 questionnaire. Results were reaffirmed through participant interviews. During this time, there were several themes presented that contributed to understanding the experiences that bergamot aromatherapy had on avoidance behavior. Words to describe these feelings included: feeling more comfortable talking about the experience, feelings, and emotions, feeling calmer to be able to manage avoidance behavior, handling triggers well, and helping them use coping techniques better. These words represented a theme that was compared with participant answers in the post PCL-5, which confirmed an overall reduction in avoidance behavior during the two weeks. PA03 described this experience,

I felt way more comfortable talking about how I felt. The oils pulled my obsession with fear to focus on the scent and the scent brought calm and joyful memories. I didn't ignore or try to pretend. I sat down and did a thought record. I had the mental clarity to do so.

Feeling more comfortable to talk about their feelings is a positive step in the right direction of addressing unresolved trauma. PA04, shared a similar experience, also describing how it felt easier to discuss the trauma than before:

I was able to talk with a stranger about my childhood trauma. I found that it was easier to talk about all this stuff which I don't like to talk about because normally it brings anxiety, but I was able to pretty easily without feeling any anxiety.

These experiences could be attributed to the essential oil, which again, encouraged a calm mood in participants affected by PTSD. Being relaxed helped in being able to apply coping mechanisms for avoidance behavior. PA05 stated "It helped me feel a little calmer to apply coping techniques I had already learned to manage my avoidance behavior."

The essential oils were used at-home, work and on the go during this study, allowing the residual benefits to be experienced in various social settings. In fact, PA11 mentions how the oils were used to mitigate negative behavior while discussing historical trauma with a friend,

Today was eventful with a lot going on with different emotions, but I was able to come back down after using the aromatherapy throughout the day. Someone who was with me [during the time of the trauma] kept bringing up [our experiences overseas] and it was stressing me out because they wanted to talk about all the negative things we went through. I could feel

it was angering me to have him bring it up when it is always on my mind already. So, I used the aromatherapy and it just kind of calmed me down and I noticed it eased everything, it definitely helped.

This experience seemed to help calm the reaction that triggers negative symptoms of PTSD. Using bergamot essential oil also assisted with coping mechanisms when participants typically could have exhibited avoidance behavior. Participants reported reduced avoidance behavior while using bergamot aromatherapy.

Theme 5: Decreased Anxiety

Anxiety disorder is one of the top comorbidities of PTSD (APA, 2013); because of this prevalence, it was a concern and focus of the participants in this study. Participants confirmed experiencing anxiolytic benefits with the use of bergamot aromatherapy through consistently mentioning a calming concurrently with the word anxiety. When asked which symptoms decreased after inhaling the bergamot as directed for two weeks, PA01's primary answer was anxiety,

Anxiety. I felt calmer, felt like things were easier. I didn't get into my head like I normally do. Felt calm in a crowd and did not have a panic attack in the crowd. Normally I have 1-2 panic attacks a week that last 20-30 minutes each but during the two weeks of bergamot use, I only had one panic attack total and it only lasted maybe 10 minutes. During the two weeks I felt like certain things were just easier for me.

Participants also described how the aromatherapy decreased panic attacks, anxiety and stress. PA06 shared,

This decreased anxiety helped to avoid daily medication, I felt calmer overall and less anxiety. I usually take anti-anxiety medication and/or sleeping medication on a daily basis as needed and I only needed a sleeping pill one night.

Because PTSD symptoms are so wide-ranging and the symptoms can arise at any given moment, anxiety was felt by participants at different times. The participants reported that aromatherapy helped decrease anxiety felt in a crowded setting versus just at night while sleeping. PA13 said "The aroma helped me deal with the crowd, was able to ease my anxiety and relax more."

Therefore, a common theme of reduced anxiety was experienced by various participants indicating that bergamot had a multi-faceted approach to not only symptoms of PTSD but also the most common comorbidity. Aromatherapy of bergamot helped to calm and ease anxiety, thereby allowing participants the ability to find effective coping mechanisms and ultimately, manage symptoms.

Theme 6: Less Intrusion Symptoms

Intrusion involves recalling distressing memories, dreams and/or flashbacks of traumatic events. This theme was coded as it is one of the 4 cluster categories that define PTSD. Interviews confirmed that the bergamot essential oil was not experienced to be positive or negative on this

symptom. This symptom was not prevalently experienced in this study, however, there was notice of an improvement of traumatic visuals reported by PA10.

I had fewer visual images in my mind. It went down to one time a week whereas before I was having it at least every other day. There is one specific visual image that I have, and it almost seems like the image will still come to mind, but it gets cut off, like it stops. So, it is just not something that I think about, it doesn't stay around as long. It is like a shorter visual image now.

One participant noted that it helped specifically with managing flashbacks; however, the other common theme that participants experienced was a calming in the mind and this could contribute to experiencing fewer visual images therefore would need to be further investigated.

Theme 7: Barriers to Aromatherapy Use

The main barrier experienced by participants was the difficulty of using aromatherapy across various settings (e.g., work, travel, training). This was mostly due to being busy and forgetting, leaving the bottle at home, or irregular employment schedules. Participants expressed that it would be helpful to have two bottles of the aromatherapy—one for home and one for work. Work-related barriers primarily affected the mid-day application of the oil.

Work-related barriers seemed to be correlated with participants' employment. Active-duty military and firefighters reported the most difficulty carrying the bottle of oil with them, because of changing uniforms or attending emergency calls. Other factors contributing to lack of aromatherapy use was due to travel and leaving the bottle at home. PA07 shared:

The biggest barrier I had was having it on me at all times, so I could take it at the proper time, and then just not losing it when changing into and out of uniforms.

Participants also found themselves busy at work, wherein the mid-day application was forgotten or overlooked. However, most participants highlighted that there were very few or limited barriers to applying and using the essential oil. PA04 stated:

[There were] no barriers. In fact, I looked forward to doing it. I found that a couple of times during the two weeks when I got a little stressed, I wanted to drop the oil in my hands to feel better and handle it all.

PA11 shared how they were able to consistently use the oil because of workplace flexibility, “[there were] no barriers because my job allows me to take quick breaks.”

Participants' experiences confirm that job schedules and flexibility allowed for a more consistent oil application, which encouraged improved PTSD symptoms. Having extra bottles, or diffusers in the workplace or car could help minimize those barriers.

Discussion

Posttraumatic stress disorder (PTSD) is estimated to affect 8 million adults annually (NCPTSD, 2018). Traumatic experiences can be prevalent among children which contributes to

posttraumatic stress severity (NCPTSD, 2018). PTSD is also highly prevalent among male and female first responders, such as firefighters, paramedics, military and law enforcement (Pole et al., 2016). The disorder is a multi-faceted symptomatic mental health disorder that is frequently accompanied with physical and mental health comorbidities; these comorbidities are difficult to treat through pharmaceutical medications and therapeutic interventions, as treatment is often limited in addressing the complex needs of individuals. Moreover, avoidance behavior—the hallmark symptom of PTSD—contributes to poor treatment continuity, despite the effectiveness of some evidence-based therapies (Hundt et al., 2018).

The purpose of this study was to review a novel intervention to support in the management of PTSD symptoms outside of therapy; this treatment is also cost-effective, easy to use, and an accessible tool for all people affected by PTSD. The study sought to understand if aromatherapy could play this role. Essential oils are dynamic because one plant oil is often composed of multiple chemical compounds that produce a variety of therapeutic actions in the body (Rios, 2016). Research on certain essential oils have also found that various compounds cause a calming effect throughout the central nervous system, including that of the stress-cycle involving the HPA-axis, which is a key component implicated in the neurobiology of PTSD (Han et al., 2017; Lv et al., 2013; Sakellariou & Stefanatou, 2017). Therefore, the purpose of this study was to understand the experiences of bergamot aromatherapy through participants who presented with various symptoms of PTSD; the study also wanted to highlight if using the oils could reduce avoidance behavior.

The focus of the study involved viewing the four symptom clusters which comprise the diagnosis of PTSD alongside participant experiences in applying bergamot essential oil aromatically to manage those symptoms. The key target of this study was to address the root of the biological stress cycle and arousal, anxiousness, and mood symptoms, which are all major contributors to avoidance behavior. The primary theme that emerged from participants' experiences was feeling calm after use of the bergamot essential oil. Participants also reported experiencing reduced stress and anxiety. Participants noted that, in general, they felt calmer each day with use of the essential oil, and more specifically, after day 7 or 8 with continual use of the aromatherapy, noting that the calming sensation was lasting longer.

Bergamot can affect arousal symptoms. The aromatically inhaled bergamot was reported to reduce three of the six arousal symptoms in PTSD, including irritable behavior and angry outbursts, problems with concentration, and difficulty sleeping. Therefore, participants reported experiencing a decrease in these arousal symptoms of PTSD after the aromatic application of bergamot essential oil. Other isolated compounds, such as linalool, contained within bergamot, have also exhibited a calming effect, which could play a role in the effects on this symptom by calming the central nervous system and modulating adrenergic activity (Guzman-Guitierrez et al., 2015). Improved sleep patterns could be correlated with the sedative-like effects found in previous research studies (Guzman-Guitierrez et al., 2015; Lv et al., 2013). Participants reported being able to fall asleep quicker and remain asleep through the night, countering typical difficulty sleeping and disturbed sleep patterns. This study found that bergamot contributed to an overall calming experience, thereby reducing irritability and angry outburst behavior.

Participants reported improved situations that would typically invoke arousal symptoms, which happened after inhaling the bergamot; participants mentioned how they returned to a calm state, not only by reducing the physiological symptoms but also increasing their clarity of thought and focus, which could help them process and cope more effectively with adverse situations. Bergamot, therefore, was likely able to mitigate various arousal symptoms through its calming effect on the stress cycle, anger, irritability, and restless sleep patterns.

Bergamot was also reported to improve mood, which was reviewed in this study because negative mood is one of the four clusters of symptoms of PTSD. Interestingly, Han and colleagues

(2017) studied the effect of bergamot essential oil in a mental health clinic with patients in their waiting room and reported it had an increase in positive mood (Han et al., 2017). Other studies have isolated compounds in bergamot essential oil (e.g., limonene), which have shown positive effects on mood (Zhang et al. 2019). Limonene, specifically, mitigates the effects of stress by regulating the HPA-axis, which can restore mood by improving BDNF receptor expression through monoamine neurotransmitters and exerting an antidepressant-like effect (Zhang et al., 2019). Beta-pinene, another constituent found in therapeutic bergamot essential oil, also has positive effects on depressive mood through its interaction with the dopaminergic system, most predominantly in the limbic area of the brain, which is the key area involved in emotion regulation (Guzman-Guitierrez et al., 2015). This information directly correlates with participants' experiences in this study, as improved mood was felt consistently by the participants. Additionally, participants reported interrupted negative thoughts and even found it difficult to feel pessimistic when inhaling the scent. Many participants reported being in a “good mood” from use of the bergamot aromatherapy.

Inhalation of the bergamot essential oil was also reported to decrease anxiety symptoms among the participants, a common comorbidity of PTSD. Previous research on bergamot essential oil and the major compounds of limonene and linalool, have been found to exert anxiolytic-like effects in various studies, which can calm the central nervous system by modulating GABA and glutamic acid, all of which are primary neurotransmitters involved in anxiety (Cardoso de Almeida et al. 2014). This study experienced these results, as participants described reduced anxiety. Participants also reported feeling less anxious in situations where they would typically experience high anxiety, such as in crowds, unfamiliar places, or recalling traumatic events of the past. There appeared to be an overall reduction in other anxiety symptoms, such as panic attacks. The daily use of bergamot essential oil seemed to be instrumental in producing a calming experience to ease anxiety.

Avoidance behavior was the third of the four categories of symptoms that was reported to improve with the use of inhaled bergamot essential oil. The compound of limonene in bergamot was found in a preclinical anxiolytic pharmacological test to create an anti-avoidant-like response (Cardoso de Almeida et al., 2014). Participants confirmed this, as they reported feeling more calm while discussing or revisiting trauma. Participants reported being more equipped to cope and remain calmer than normal while addressing trauma. Therefore, this information suggests that less avoidance behavior seemed to occur with use of the aromatherapy in this study.

The data gathered from participants in this study provided an understanding of the impact that bergamot essential oil could have on individuals who suffer from PTSD symptoms. This data also provided insight into the preferability of certain individuals experiencing these symptoms to implement complementary alternative medicine in conjunction to medical treatment. This research also aimed to understand the effects aromatherapy could have on the different clusters of PTSD symptoms, specifically that of avoidance behavior.

In this study, aromatherapy of Bergamot was shown to be effective and could complement symptom management throughout the day, both in a home and therapeutic setting. By minimizing symptoms, including that of avoidance, engagement in therapy could be enhanced and improved. Moreover, the ease, accessibility, and simple use of aromatherapy provides a tool that can be used on a regular basis. For example, in the event of an unexpected trigger, one could keep an essential oil in their pocket or purse and apply it via a rollerball or spray immediately to mitigate associated physiological and psychological responses, therefore facilitating an adaptive emotional processing of the triggered trauma. Instruction on implementation would be to use two drops, spray, or roll in the palm of the hand and inhale for 30 seconds or 5 deep breaths three times during the day; this could occur once in the morning, again at midday and finally, during late afternoon. This modality could empower individuals affected by PTSD by allowing them to maintain a certain level of

functioning within their occupation, society, and family life as they process through emotions and trauma experiences.

Interestingly, the experiences with the aromatherapy of bergamot essential oil were reported to help mitigate certain arousal, negative mood and avoidance symptoms of PTSD as recorded by participants in their field books. This could potentially help practitioners and treatment clinics to facilitate an adaptive recovery by providing a calm and safe atmosphere to engage with clients and execute trauma focused therapy more effectively. This could be accomplished by having a high-quality grade essential oil via aromatic diffusion be released during the trauma focused therapy.

Limitations of this study could be addressed in future research by including a larger group of participants. This study was also limited to mostly military exposed trauma with a wide range of PTSD symptoms and symptom severity in the one demographic area of San Diego, California. Future research could isolate symptom clusters within PTSD and study how those symptoms respond to Bergamot. With this baseline study finding that participants presenting with PTSD symptoms reported an improvement with the protocols of Bergamot essential oil, future research could specifically study groups of individuals in various locations with various symptom severity and/or trauma exposure. It is recommended from this study to also give more than one bottle of the Bergamot essential oil so as to increase participant application by having one available at work and one at home.

Thus, the simple and desirable complementary integrative medicine of aromatherapy would be an effective way to not only facilitate the therapeutic recovery process, but also the engagement into the therapeutic relationship. Because bergamot essential oil can potentially calm, boost mood, enhance concentration, improve sleep, and reduce anxiety, it could be highly beneficial in improving therapeutic treatment, recovery, and ultimately quality of life for an individual.

Conclusion

In this study, bergamot essential oil was used to see if there was some relief or alleviation of some symptoms of PTSD. A qualitative phenomenological perspective was used to understand these experiences. It was found that the aromatherapy of bergamot produced a calming sensation that helped participants sleep better, reduce anxiety, improve negative mood, and decrease avoidance. Few or no barriers were described while using the essential oil. Ultimately, this study determined that the aromatherapy of bergamot could provide a non-invasive and safe modality to help patients with PTSD manage symptoms before and during onset.

This study is the first of its kind and therefore established a starting point to conduct further aromatic research in the field of mental health, a field of study that could be termed Psychoaromacology. This research sets a baseline of information that can be expanded by targeting other solutions for mental health disorders by using aromatherapy, a treatment that could be termed Psychoaromatherapy. The ease of use of psychoaromatherapy could be utilized efficiently by mental health clinicians, treatment centers and hospitals, or even individuals themselves, which empowers and facilitates recovery. With more patients seeking complementary or integrative treatment to facilitate recovery, mental health practitioners need to be educated on this application to guide their clients and assist the therapeutic recovery process.

First and foremost, recommendations for future research would be to study Bergamot essential oil by isolating symptom clusters and symptom severity. Specifically, and most importantly would be to study in further detail just the symptom cluster of Avoidance behavior. If Bergamot can mitigate avoidance behavior, this could in turn increase patient participation in other healing modalities to address symptoms and support in an adaptive recovery of PTSD.

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Dr. Tara Rava Zolnikov earned a PhD in Developmental Science from North Dakota State University. She has published a hundred research papers extensively in some of the world's most renowned public health and global health journals, including *The Lancet Oncology*, *American Journal of Public Health*, *AIDS and Behavior*, *Science of the Total Environment*, and many more. In 2022, she was inducted into the Explorers Club as a fellow, regarded for her exploration through qualitative research. She is the editor for *Dialogues in Health*.

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Appendix A

Bergamot Analysis of quality control and constituent composition



Aromatic Plant Research Center

We provide uncompromising
quality control for your products.

Customer: doTERRA International

Lot Number: 1905910

Date Filled: 2/28/2019

Column: ZB5 (60 m length × 0.25 mm inner diameter × 0.25 µm film thickness)

Instrument: Shimadzu GCMS-QP2010 Ultra

Carrier gas: Helium 80 psi

Temperature ramp: 2 degrees celsius per minute up to 260-degrees celsius

Split ratio: 30:1

Sample preparation: 5%w/v solution with Dichloromethane.



Comments:

The analysis of this Bergamot lot revealed no contaminants or adulteration.

The sample meets the expected chemical profile for authentic essential oils of *Citrus bergamia*.



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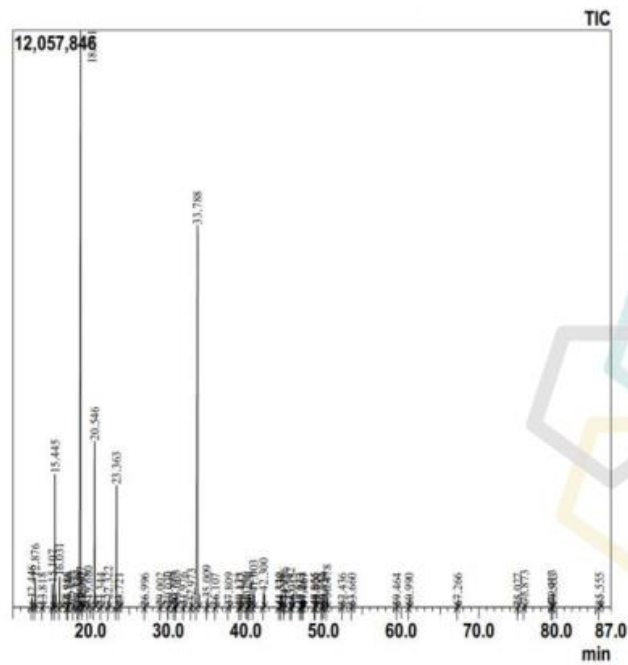
1 of 2

Bergamot Essential Oil



Customer: doTERRA International
Lot Number: 1905910
Date Filled: 2/28/2019

Chromatogram



Peak Report

Ret.Time	Compound Name	Area %	Ret.Time	Compound Name	Area %	Ret.Time	Compound Name	Area %
12.449	alpha-Thujene	0.20	30.03	alpha-Terpinol	0.09	47.264	alpha-Furculene	0.03
12.876	alpha-Pinene	1.02	30.779	n-Decanal	0.06	48.497	beta-Burbinene	0.01
13.818	Camphene	0.03	31.053	Caryl acetate	0.14	48.825	Geranone D	0.04
15.107	Sabinene	3.92	31.205	Neol	0.04	49.036	cis, cis-alpha-Farnesene	0.03
15.445	beta-Pinene	6.15	32.273	Isual	0.22	49.742	Bicyclogermacrene	0.01
16.051	Myrcene	1.86	33.789	Linyl acetate	21.76	50.035	cis-alpha-Bisabolene	0.03
16.206	n-Octanal	0.05	35.003	Geranyl	0.24	50.478	beta-Bisabolene	0.44
17.148	alpha-Phellandrene	0.03	36.127	Bornyl acetate	0.02	52.436	trans-alpha-Bisabolene	0.01
17.613	alpha-Terpinene	0.16	37.819	n-Nonenyl acetate	0.03	53.08	trans-Neodial	0.01
18.228	gamma-Caryophyllene	0.11	38.173	Linolyl propionate	0.03	53.464	gamma-Burbinene	0.01
18.741	Limonene	43.59	39.447	Bicyclogermacrene	0.01	60.99	alpha-Bisabolol	0.02
18.907	beta-Phellandrene	0.09	40.241	alpha-Terpinyl acetate	0.18	67.266	Nonastrene	0.01
18.992	gamma-beta-Oscimene	0.09	40.421	Citronellyl acetate	0.01	75.027	Palmitic acid	0.01
19.60	trans-beta-Oscimene	0.36	41.003	Neryl acetate	0.7	76.873	Chrysen	0.18
20.649	gamma-Terpinene	1.74	42.3	Geranyl acetate	0.76	78.413	ter-Bergapten	0.14
21.244	gamma-Sabinene hydrate	0.04	44.33	Deryl acetate	0.09	79.003	Diene/ind derivative	0.02
22.522	Terpinolene	0.32	44.838	cis-alpha-Bergamotene	0.02	86.993	Bergapten	0.09
23.263	Linolyl	6.26	44.946	beta-Caryophyllene	0.3			
23.781	n-Nonanal	0.02	45.762	trans-alpha-Bergamotene	0.29			
26.956	Citronellal	0.01	46.015	Acroscadenone	0.02			
28.002	Terpinen-4-ol	0.03	47.023	trans-beta-Farnesene	0.09			

Area Total: 100

Comments:
The analysis of this Bergamot lot revealed no contaminants or adulteration.
The sample meets the expected chemical profile for authentic essential oils of *Citrus bergamia*.

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Appendix B

Research Pre and Post Interview Questionnaire

Pre-Study Research Questions

Demographics:

- 1) What is your identified gender?
- 2) What is your current age?
- 3) What is your occupation?

Background:

- 4) Was the trauma occupation related?
- 5) How many years ago did the trauma symptoms begin?
- 6) What type of trauma occurred? For example:
 - a. Sexual assault
 - b. War/combat related
 - c. Scene of an accident related
 - d. Other:
- 7) Do you desire a natural alternative method to manage your symptoms?
- 8) Have you tried essential oils before to manage your trauma symptoms?

Post Research Questions:

- 9) Did you experience overall a decrease in symptoms associated with PTSD after inhaling the bergamot as directed for 2 weeks?
 - a. If yes, which symptoms?
- 10) Did you experience overall a decrease in avoidance behavior after inhaling the essential oil during the two weeks?
 - a. If yes, which avoidance behavior shifted for you? (Example: was able to talk more about the trauma with another; was able to visit a friend/place I had avoided because of the trauma etc.)
- 11) What barriers to using the aromatherapy treatment did you experience?
- 12) What other effects were experienced by using the aromatherapy treatment?
- 13) Did you enjoy using aromatherapy?
 - a. Yes
 - b. Neutral
 - c. No
- 14) Would you continue to use aromatherapy and/or recommend it to others dealing with PTSD symptoms?
 - a. Yes
 - b. Neutral
 - c. No

Appendix C

PTSD and Aromatherapy Research Study Flyer & Instructions

Criteria for participation:

- Presenting with symptoms of PTSD from experiencing a past trauma
- Not currently being treated with another PTSD targeted therapy or complimentary alternative medicine (CAM) intervention
- Desire to use CAM intervention.
- Both adult male and female adults will be included and invited to study
- Both active and non-active military and first responders are invited to participate in the study
- Do not have allergy to citruses, specifically bergamot fruit. Those with any citrus allergy will be excluded to limit any risk of allergy. However essential oils do not contain the allergens which are in the proteins of the plant. Their volatile liquid solution is clear of these proteins, nevertheless any citrus allergy will be excluded for extra precautions.
- Read and speak comfortably the English language

Study Instructions:

(This study does not entail discussing the trauma or emotions related to the trauma in anyway).

A. Participant will meet the research investigator at the Healing Our Heroes center downtown San Diego, or their own place of employment twice for two 60 minutes interviews each before and after the two-week study period.

B. The first interview will consist of:

- > Signing a consent form
- > Establish baseline by answering the PCL-5 PTSD checklist for DSM-5
- > Answer a total of 14 research interview questions
- > Be given a diffuser and instructions on how to use the diffuser
- > Be given a 15ml bottle of Bergamot (citrus peel) essential oil and instructed on its use and safety

- The 15ml essential oil of Bergamot was verified to be pure and free of synthetic markers and contaminants, containing only the essential oil from the bergamot citrus peel. Each oil purity is verified by its lot number tested by Aromatic Plant Research Center using the standardized testing method of Gas Chromatograph Mass Spectrometry (GCMS).

C. During a 2-week period, each participant will use the essential oil and diffuser as described below:

1) 06:00-08:00 hours – One time during this two-hour window, place 2 drops of the essential oil bergamot in the palm of the hand, then inhale it through the nasal passageway for 30 seconds or 5 deep breaths.

2) 11:00-13:00 hours – Repeat step 1.

3) 16:00-18:00 hours – Repeat step 1.

4) Each night before sleep:

i. Plug the diffuser next to the bed, add the max amount of water from the diffuser instructions.

ii. Place 5 drops of bergamot into the water.

iii. Power on the diffuser on the 6-hour night mode to run while sleeping

iv. dump the remaining water each time before repeating this step every night

D. Participant will be given a small notebook to record once a day a brief experience from using the aromatherapy by three prompted open-ended questions:

- i. How did you feel today using aromatherapy?
- ii. What was different if anything?
- iii. What did you notice after using aromatherapy?

E. The second interview will again be at the Healing Our Heroes center in person or place of employment and the participant will:

- > Answer the PCL-5 checklist for the DSM-5 for their symptoms after aromatherapy usage
- > Answer 6 further research questions experience using aromatherapy

F. Participants will keep the essential oil and the diffuser for future use if desired

Precautions:

Bergamot essential oil is considered to be phototoxic therefore should not be applied to outer skin that will be exposed to the sun or could cause the skin to darken and burn. Do not get essential oils in your eyes or on other sensitive areas of the body, could cause tissue discomfort, irritation and/or burning. or If any oil does get in the eyes, touch sensitive skin or starts to irritate the skin, use a carrier oil to dilute such as olive oil or coconut oil. DO NOT USE WATER as it will intensify the reaction.

Although essential oils do not contain plant compounds that cause allergies, if you feel any allergic reaction, stop application immediately and contact your doctor.

Appendix D
PCL-5 Questionnaire

Instructions: Below is a list of problems that people sometimes have in response to a very stressful experience. Please read each problem carefully and then circle one of the numbers to the right to indicate how much you have been bothered by that problem <u>in the past month</u> . In the past month, how much were you bothered by:	Not at all	A little bit	Moderately	Quite a bit	Extremely
1. Repeated, disturbing, and unwanted memories of the stressful experience?	0	1	2	3	4
2. Repeated, disturbing dreams of the stressful experience?	0	1	2	3	4
3. Suddenly feeling or acting as if the stressful experience were actually happening again (as if you were actually back there reliving it)?	0	1	2	3	4
4. Feeling very upset when something reminded you of the stressful experience?	0	1	2	3	4
5. Having strong physical reactions when something reminded you of the stressful experience (for example, heart pounding, trouble breathing, sweating)?	0	1	2	3	4
6. Avoiding memories, thoughts, or feelings related to the stressful experience?	0	1	2	3	4
7. Avoiding external reminders of the stressful experience (for example, people, places, conversations, activities, objects, or situations)?	0	1	2	3	4
8. Trouble remembering important parts of the stressful experience?	0	1	2	3	4
9. Having strong negative beliefs about yourself, other people, or the world (for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can be trusted, the world is completely dangerous)?	0	1	2	3	4
10. Blaming yourself or someone else for the stressful experience or what happened after it?	0	1	2	3	4
11. Having strong negative feelings such as fear, horror, anger, guilt, or shame?	0	1	2	3	4
12. Loss of interest in activities that you used to enjoy?	0	1	2	3	4
13. Feeling distant or cut off from other people?	0	1	2	3	4
14. Trouble experiencing positive feelings (for example, being unable to feel happiness or have loving feelings for people close to you)?	0	1	2	3	4
15. Irritable behavior, angry outbursts, or acting aggressively?	0	1	2	3	4
16. Taking too many risks or doing things that could cause you harm?	0	1	2	3	4
17. Being “superalert” or watchful or on guard?	0	1	2	3	4
18. Feeling jumpy or easily startled?	0	1	2	3	4
19. Having difficulty concentrating?	0	1	2	3	4
20. Trouble falling or staying asleep?	0	1	2	3	4