Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Spl Issue [1] January 2023: 567-573.

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Anti-Inflammatory Action of Essential Oils and Their Usage in respiratory Tract Infection

Md. Rageeb Md. Usman*, Bharat V. Jain[1], Suvarnalata S. Mahajan[1], Prerna N. Jadhav[1]
**Department of Pharmacognosy, Smt. Sharadchandrika Suresh Patil College of Pharmacy, Chopda, Maharashtra, India*
[1]Department of Pharmaceutics, Smt. Sharadchandrika Suresh Patil College of Pharmacy, Chopda, Maharashtra, India

ABSTRACT

This research is on fourteen essential oils and their main gaseous components were tested for their antibacterial activity towards "Haemophilusinfluenzae, Streptococcus pneumoniae, Streptococcus pyogenes, and Staphylococcus aureus". S. aureus was the most resistant to the essential oils tested, following by S. pneumoniae and S. pyogenes. Similar levels of susceptibility were seen across S. pneumoniae strains that were previously shown to be sensitive to penicillin and those that had developed resistance. The control organism, Escherichia coli, was the least susceptible. To quantify the potency of the vapour, the concept of a minimum inhibitory dose (MID) was used. Essential oils with significant concentrations of terpene ketone, ether, and, in particular, hydrocarbon, exhibited very high MIDs. Short-term vapour exposure was just as potent as overnight exposure, and fast evaporate was much more efficient than slow evaporation of plant oils. After 1 or 2 hours of fast evaporation, the vapour concentration of the essential oils peaked, and the oils were absorbed to the greatest extent possible by the agar. These findings suggest that essential oils' antibacterial impact is maximised when exposed to a high vapor intensity for a brief period of time.

KEYWORDS:*Constituents, Gaseous, Essential, Susceptible Resistant, Susceptibility.*

Received 02 .01.2023 Revised 22.01.2023 Accepted 25.02.2023

INTRODUCTION

The volatile, aromatic, and complex chemical components that make up essential oils include things like liquors, aldehydes, ester, ethers, ketones, quinones, and terpenes. Aromatherapists often use essential oils, which are extracted from various plant components via distillation [1]. Essential oils' potential benefits for respiratory disorders have been the subject of substantial research in the scientific literature. Essential oils have been the subject of much research for their antibacterial properties and their use in inhalation in traditional medicine and general health maintenance. Yet, most of the published research in the area of essential oil research focuses on finding the potential of a particular essential oil, despite the fact that there has been a spike in interest in supported directions in the field. Aromatherapy, on the other hand, is predicated on the principle of blending different essential oils in order to increase the therapeutic impact of the final product. It has been estimated that $25 billion is invested yearly by persons actively pursuing CAM treatments, such as aromatherapy, in wealthy nations to prevent or cure persistent infections. The rising popularity of complementary and alternative medicine (CAM) therapies calls for an increase in studies aimed at determining their reliability, safety, and effectiveness [2].

The World Health Organization (WHO) reports that 5% (3.1 million) of global fatalities are attributable to lower infections of the respiratory tract (LRTI) in both sexes.

The percentage was 6% among women and 5% among men. In 2012, 13% of deaths in children aged 1–59 months were caused by pneumonia. According to World Health Organization (WHO) statistics, LRTIs and COPD have been the two leading causes of death worldwide over the previous decade [3]. While the World Health Organization has a well-organized global vaccination action plan to combat most viruses and bacteria that cause RTIs, many individuals still fall prey to influenza, pneumonia, and TB, all of which may be fatal if left untreated. In the case of RTIs, EOs may be used as a preventative measure. As EOs are volatile, they may be inhaled to reach the area of the body where they are needed to effect a treatment.

AIMS AND OBJECTIVES

To list the plants' essential oils which have long been used to treat respiratory infections, and now they're being employed as a morally sound alternative treatment for the common cold.

MATERIAL AND METHODS

Listing of essential oils used in respiratory tract infections and conducting an analysis of their anti-inflammatory action.

Inhalation treatment of oils has been utilised to treat acute sinusitis and bronchitis. Essential oil vapour inhalation increased mucus production, kept the sinuses ventilated and drained, calmed inflammation in the windpipe (trachea), and alleviated asthma symptoms. Much of the research into the antibacterial properties of essential oils has been conducted in liquid. In 1959, Maruzzella et al. and Kienholz published the first systematic study of vapour activity using the upturned Petri dish method.

Essential oils, unlike medicines, are very volatile even when kept at room temperature. Research into the use of essential oils for inhalation therapy led to the determination of the oils' antibacterial activity against five pathogens "Haemophilusinfluenzae, penicillin-susceptible and -resistant Streptococcus pneumoniae, Streptococcus pyogenes, and Staphylococcus aureus—via gaseous contact in an airtight box. The standard was set using Escherichia coli."

Specific Essential Oils Activity

Among the 14 essential oils tested, "only the oils of cinnamon bark, lemongrass, and thyme (wild and red) showed significant effect, blocking six strains at 12.5 mg/L air." Nevertheless, the oil of lemongrass showed very poor effectiveness against E. coli (MID, 100 mg/L air). Oils from plants including "perilla and thyme (geraniol), peppermint, green tea, coriander, and lavender (spike and true) exhibited modest efficacy against all isolates except E. coli. Tea tree and coriander oils", however, demonstrated effectiveness against E. coli that was on par with that shown against other types of bacteria [5]. The oils with the least amount of action were eucalyptus (radiata) and citron.

Essential oil's evaporation rate clearly affected MID's efficacy against *Staphylococcus aureus* and *Enterococcus faecium*. The MID values were lower when the liquid was evaporated quickly using filter paper rather than slowly in a glass container. Hence, "cinnamon bark oil showed 6.25-12.5 mg/L in air by quick evaporation, while at 100 mg/L in air by slow evaporation, no inhibition was seen. In the case of tea tree oil, quick evaporation resulted in a MID that was 16 times smaller than slow evaporation. The effectiveness of two important oils over H. influenzae was tested", and the influence of exposure duration on MID was analysed.

One of the most significant discoveries was that the MID values varied according to the rate of vaporisation of oils; for example, MID values were 1/16 when essential oils were evaporated quickly through inseminated filter paper compared to when they were evaporated slowly from a glass vessel. Maximum vapour and agar absorption for four key components occurred within 2 hours under fast evaporation conditions and then dropped either gradually or quickly afterwards. Additionally, a 2-hour vapour exposure resulted in a MID that was equal to or higher than that obtained during overnight culture. "Our investigation on the antifungal action of essential oils did not identify the time course of vapour and agar concentrations during slow evaporation, but we did measure them at 27 degrees Celsius (S. Inouye, K. Uchida and H. Yamaguchi, unpublished results)." These findings suggest that throughout incubation, volatiles remained at a constant vapour pressure while accumulating in the agar layer increased unidirectionally with incubation duration [5]. These findings could be explained if we assumed that the maximum concentration of vapour and agar at the beginning of the incubation period primarily determined the antibacterial activity by vapour contact, and that maintaining vapour concentration might not be too essential for the antimicrobial property.

Comparing MID values led researchers to conclude that camphor was a significant contribution to rosemary oil's bioactivity, even though it was just one of several components present in the oil. Although 1,8-cineole made up a large portion of eucalyptus oil, -terpineol was thought to be more responsible for the oil's bioactivity since it was eight times as effective as 1,8-cineole against S. aureus. There is no evidence that 1,8-cineole is an active component in other eucalyptus oils, according to the literature. 15 Similarly, the primary components of both thyme (geraniol) oils and lavender oil, geranyl acetate and customers can buy acetate, respectively, were not the oils' active principles, but rather, geraniol and luteolin, which coexisted in the parent oils, were the active contributors. Thyme (red) oil's antibacterial properties may not be considerably helped by limonene, another key component.

Experimentation with Herbal Concoctions

Vapor absorption by microbes and the media that the vapour was absorbed into both contribute to the antibacterial action of volatile substances, as has been shown. It has been observed that E. coli contributes significantly to the volatile chemicals via agar absorption. Consequently, it was necessary to quantify the

agar concentration in order to calculate the precise value of the vapour effect. The capacity of a volatile chemical to be absorbed into aqueous medium was shown to be dependent on the substance's hydrophobicity, volatility, and stability. Therefore, unlike the volatile and labile citral, the more stable and less volatile carvacrol and thymol collected in the agar layer.

It has been shown that the antibacterial activity of terpene components is strongly connected to their aqueous solubility, hence the agar concentration may be beneficial for judging the antimicrobial activity of these compounds. As well, "terpene hydrocarbons and esters, which have a negligible agar concentration. The spontaneous deterioration of unstable components by air was a process that was pronounced in the gaseous state but not so noticeable in the solution phase. Therefore, octanal, nonanal, citral, perillaldehyde, d-limonene, and -pinene all showed evidence of oxidation or oxido-reduction of aldehyde groups and unsaturated bonds, as well as linkage rearrangement." Essential oils have an antibacterial effect when subjected to gaseous contact at a high vapour concentration for a short period of time. This study's findings indicated that a vapour concentration in the air between 0.1 and 0.9 mg/L has the potential to inhibit the development of respiratory infection-causing bacteria. Important variables, such as the lowest exposure duration for effectiveness and the bactericidal vapour concentration, must be identified, in addition to a safety evaluation, before the vapour treatment of essential oils may be utilised in clinical practise.

The highest antibacterial activity was shown by essential oils whose primary components were phenol or aldehydes, followed by essential oils whose primary components were terpene alcohols. There was little to no activity detected in essential oils that included terpene hydrocarbons, while oils containing terpene ketones were very weak in action. Oils of "cinnamon bark, thyme (Red, geranial, and with wild forms), perilla, lemongrass, and peppermint were chosen for quantification and their effects on pulmonary infection. The antioxidant and anti-inflammatory qualities of essential oil plants", in addition to their physiochemical features, suggest that this substance may one day prove to be a significant medicine for the treatment of a variety of respiratory disorders.

DISCUSSION

Respiratory Disorder and Essential Oils Usage

Chronic obstructive pulmonary disease (COPD), asthma, acute respiratory infections, TB, and lung tumours all rank among the world's leading killers. According to the World Health Organization's annual report, acute respiratory tract infections account for about an of all deaths worldwide, but they disproportionately impact women. It's important to remember that these illnesses are not limited to adults; they may also affect kids. In alternative medicine, essential oils are often utilised to treat a wide variety of infectious disorders. These essential oils for colds are traditional medications used for many years to treat respiratory tract illnesses due to their antibacterial characteristics. Essential oils are utilised in inhalation therapy and acute sinusitis in the medical treatment of chronic and acute bronchitis. Asthma, the common cold, cough, bronchitis, whooping cough, and pneumonia are just a few of the many significant respiratory disorders caused by upper and lower respiratory infections. Natural compounds from the plant have a wide range, which may be used to represent livestock and, in particular, the untapped potential of herbivores for the medicine. Medicinal herbs are utilised all around the globe to reduce inflammation, modify the immune system, and prevent the spread of communicable illnesses like cancer and the flu (Solórzano Santos and Miranda Novales, 2012)[12].

Symptoms of respiratory diseases may be alleviated using the classic and cheap method of vapour inhalation over a bowl of warm water with a modest amount of eucalyptus oil (EUO). By wrapping oneself in a towel, you may inhale the concentrated fragrance components. Peppermint oil has an unique odour and flavour, and its hue ranges from light yellow to a greenish yellow. Essential oils found in peppermint include: "acetate menthyl, limonene, cineole 1-8%, menthol-furan, acetate menthyliso-menthone, menthone, menthol, carvone, pulegone, and cineole", all in concentrations of 1-3%. The pharmacological and therapeutic applications of peppermint include its effectiveness in treating gastrointestinal issues and respiratory illnesses like coughs and colds. Even just a few sprays of peppermint oil may have a significant impact. When used for respiratory or stomach issues, menthol is quite beneficial. Tea tree oil is quite good in treating respiratory infections like the common cold, influenza, and bronchitis. In most cases, it combines the properties of a liquid and a semi-solid. Even though, pregnant women shouldn't use tea tree oil. Miller Foeniculumvulgare is distilled to produce fennel bitter fruit oil.

The oil in question is bright yellow in hue and transparent. Anethole trans and fenchone are essential components of this plant. It helps with breathing issues and can be a cure. Effective dosing for adults is a single 200-microliter injection. Several respiratory disorders may be effectively treated with only four or five drops with thyme oil. Pharmaceutical and therapeutic applications successfully treat RD (respiratory disease), bronchial catarrh, and supportive pertussis therapy. Pregnancy, thyroid disease, epilepsy, and

patients younger than five are all situations in which rosemary oil is not an appropriate therapy. Death and disease in people with cystic fibrosis (CF) are connected to pulmonary problems, such as a vicious loop of pollution and chronic airways inflammation. In reaction to the bronchial infection, the body launches a massive inflammatory response, with neutrophils, leukocytes, eosinophils, lymphocytes, and monocytes all playing key roles (Blonder et al. (2014)[13].

When used together, the essential oils showed enhanced antibacterial activity, less toxicity, and enhanced anti-inflammatory benefits. The best results were seen when combining Melaleuca alternifolia (tea tree) with one of five other plants: "Cupressus sempervirens (cypress), Hyssopus officinalis (hyssop), Origanummarjorana (marjoram), Myrtuscommunis (myrtle), and Origanum vulgare (oregano)."

One of the most pressing problems facing international public health is antimicrobial resistance, which has been steadily documented over the world as a result of excessive antibiotic usage. Resistance to medicines like penicillin has spread among strains of "Streptococcus pneumoniae", a common respiratory tract disease. Resistance to penicillin typically correlates with resistance to other antibiotics like macrolides and tetracyclines. Complementary and alternative medicine (CAM) has been found to have antimicrobial properties and treat illnesses from every angle, making it a viable option in the fight against antibiotic resistance. Studies have shown the potential of these compounds against multidrug-resistant infections, making the development of novel antibacterial drugs based on organic ingredients a priority in the area of scientific study.

Heightened Usage of Essential Oils in Recent Times

Many scientific studies have shown that essential oils may reduce inflammation. Symptoms like wheezing, congestion, and trouble breathing caused by respiratory infections may be alleviated by using essential oils having anti-inflammatory properties. Despite this, aromatherapists often combine essential oils for enhanced anti-inflammatory benefits, despite a dearth of research on the topic. In order to understand the ability for essential oils in combination to impact the inflammatory process, which is central to respiratory tract infections, is crucial.[4]

There is evidence that essential oils are more harmful than average, even among natural substances. The American Food and Drug Administration (US, FDA) has included essential oils on its list of "generally recognised as safe" (GRAS) products, but only when used alone and not in combination. Combinations of essential oils may either amplify or dampen the harmful effects of the individual oils. Inhaling even a very little amount of certain essential oils may have hazardous consequences. Regardless of these results, essential oils continue to be the most often utilised kind of supplementary medicine, sometimes used in synergy with other methods of administration such as cutaneous or inhalation application. "Further research is needed to confirm the therapeutic potential for use of essential oils via the respiratory tract because of the insufficient evidence to substantiate the use of oils in combination for antibacterial and anti-inflammatory effects, in addition to the enhanced risk of toxicity associated with essential use when combined."[6]

The most common types of respiratory tract illnesses are discussed, and the antibacterial action of EOs in vapour phase is shown in this review.

Essential oils (EOs) are a complex combination of hundreds of different chemical components, including volatile chemicals like mono- and sesquiterpenoids, phenylpropanoids, and others that may have biological action. Distillation (watersteam or hydro distilling), pressing, enfleurage, solvents, or supercritical fluid extraction are all used to get these substances after they have been released by specialised cells, ducts, cavities, or glandular hairs. 1 The chemical makeup of EOs is often determined by gas chromatography-mass spectrometry (CGMS). It is well knowledge that the composition of EOs, which in turn determines their biological activity, is affected by a wide variety of variables, including but not limited to the following: "environmental conditions, rich soil, plant part, chemotype of species of plants, isolation technique, and so on."[7]

Essential Oils in the Treatment of Respiratory Tract Infections

Table 1: Essential oils in the treatment of respiratory tract infections

S. No.	Essential Oil	Derived From	Usage	Prohibited for:
1	Anise oil	Dried, mature fruits of Pimpinellaanisum L.	To alleviate the symptoms of a cold-related cough	Should be avoided during pregnancy and lactation
2	Bitter fennel fruit oil	Mature fruits of Foeniculumvulgare	To treat cough	Prohibited in children and adolescents
3	Eucalyptus oil	Fresh leaves and fresh	Alleviation of upper	Young children

		terminal branches of eucalyptus	respirator tract symptoms like cough, cold, bronchitis or catarrh	should not apply it to their face
4	Peppermint oil	Mentha piperita L.	To relieve symptoms of cold and cough	Danger of laryngeal and bronchial spasms on applying directly to nasal region and chest. Prohibited for new borns and young children
5	Tea tree oil	From foliage of Melaleuca alternifolia		
6	Thyme oil	Fresh flowering aerial parts of Thymus vulgaris		

A detailed discussion on the same is presented below:

(i) Anise oil: Anise oil (Anisiaetheroleum) is derived from the dried, mature fruits of Pimpinellaanisum L., whereas star anise oil (Illicium verum Hook) is distilled from the seeds of the Illicium verum plant. Oils extracted from anise seeds are either colourless or very light yellow in hue. As a result of their high trans anethole concentration, they will jellify between 14 and 16 degrees Celsius. The essential oil content of the fruits ranges from 2% to 6%. Anise oil is mostly composed of trans large number of distributed (80-95%) and anisaldehyde, whereas star anise oil consists of trans anethole and methyl cavicol. Oil from the anise plant is effective in relieving respiratory issues, especially when used to alleviate the symptoms of a cold-related cough. Anise oil should be taken between 50 and 200 L three times day for no more than two weeks. Because of the absence of data and the presence of estragole, its usage is prohibited in children and adolescents under the age of 18. Anise and anise oil should be avoided by anyone who have shown sensitivity to anethole. Due to evidence of modest oestrogenic action and the anti - fertility effects of anethole in rats, integrating various the EO or alcoholic extracts should be avoided during pregnancy and lactation. There is uncertainty about the incidence of cutaneous and respiratory allergic responses [8].

(ii) Bitter fennel fruit oil: "The mature fruits of *Foeniculum vulgare* Miller, ssp. vulgare var. vulgare are steam distilled to extract the bitter fennel fruit oil (*Foeniculiam arifructusaetheroleum*). Essential oil (EO) is a transparent, colourless to light yellow liquid with a distinct aroma. Fenchone (at 12.0–25.0%) and transanethole (55.0–75.0%) are the primary components of the oil." Traditional herbal medicines containing oil extracted from bitter fennel fruit are used to treat coughs caused by the common cold by acting as an expectorant. Adults and the elderly may take 200 mL of EO once daily or in many split doses, but only for a maximum of two weeks. Because of the absence of data and the presence of estragole, its usage is prohibited in children and adolescents under the age of 18. There is a risk of developing an allergy to the active ingredient (trans-anethole, for example). Intense amounts of fennel oil may interfere with the effectiveness of the hormone treatment, "oral contraceptive pill, and hormone replacement therapy due to the oestrogenic action of trans-anethole. It is unknown how often people have allergic responses to fennel oil affecting their respiratory system."

(iii) Eucalyptus oil: "Steam distillation and rectification of fresh leaves or fresh terminal branchlets from several Eucalyptus species rich in 1,8-cineole yields eucalyptus oil (*Eucalypti aetheroleum*). The three most common types of Eucalyptus are *Eucalyptus globulus* Labill., Eucalyptus polybractea R.T. Baker, and Eucalyptus smithii R.T. Baker. This oil has a camphoraceous scent and a camphoraceous flavour, and it is a colourless or light yellow liquid. The essential oil concentration of the plants ranges from 0.55% to 3.5%, with 1,8-cineole constituting at least 70% of the total and other components include -pinene (2%-8%) and camphor (less than 0.1%). Oil produced from first steam distillation is rectified by alkaline treatment and fractional distillation to attain these characteristics and decrease less desired components like aldehydes. Eucalyptus oil is most often used for the alleviation of upper respiratory tract symptoms such as a cough, a cold, bronchitis, or catarrh." A 1.5% V/V solution made from 1 tablespoon (15 ml) per litre of warm water may be inhaled up to three times daily. Alternatively, 12 drops can be added to 150 ml of boiling water for inhalation. Adults and children older than 12 may use eucalyptus oil ointments with 1.3% V/m oil

as a thick coating up to three times daily. Baby and young children should not have eucalyptus oil or any of its derivatives applied to their faces, particularly the noses. Without enough human data, eucalyptus should not be utilised by pregnant or breastfeeding women [8-10].

(iv) Peppermint oil: Peppermint oil, or Mentha piperita L., is derived from the fresh aerial portions of the blooming plant and is produced by steam distillation. EO is a clear, light yellow, or greenish yellow liquid. Smelling and tasting it is immediately followed by a chilling feeling that is distinctive. "Peppermint essential oil (EO) includes menthol (30–55%), menthon (14–32%), isomenthone (1.5–10%), menthyl acetate (2.8–10%), menthofuran (1–9%), 1,8-cineole (3.5–14%), limonene (1.5–5%), pulegone (3%), and carvone (1%), with a larger ratio of cineole to limonene." Peppermint oil's medicinal uses range from relieving the symptoms of a cold or cough to alleviating digestive issues including flatulence and irritable bowel syndrome. Inhalation of 3–4 drops of oil in hot water is recommended. Since menthol might trigger reflex apnea and laryngospasm, peppermint oil shouldn't be used on children less than 2 years old. There is a danger of laryngeal and bronchial spasms by applying peppermint oil formulations directly to the nasal region or chest of newborns and young children. Menthol has the potential to produce apnea and laryngo-constriction if inhaled. Jaundice is a side effect of menthol that may affect newborns (due to glucose-phosphate dehydrogenase deficiency). Because of the lack of proof, peppermint oil should not be taken by pregnant women unless otherwise directed by a doctor [11, 12].

(v) Tea tree oil: "Tea tree EO (*Melaleucaeaetheroleum*) is obtained by steam distillation from the foliage and terminal branchlets of *Melaleuca alternifolia* (Maiden and Betch) Cheel, *M. linariifolia* Smith, *M. dissitiflora*F. Mueller and/or other species of *Melaleuca*. It is a clear, colourless to pale yellow liquid with a characteristic odour."[13]

(vi) Thyme oil: "Thyme oil (*Thymia etheroleum*) is obtained by steam distillation from the fresh flowering aerial parts of *Thymus vulgaris*L., *T. zygis* Loefl. ex L. or a mixture of both species. It is a clear, yellow or very dark reddish-brown liquid with a characteristic, aromatic, spicy odour, reminiscent of thymol. The dried herbal substance contains up to 2.5% EO. The thyme oil contains phenols, mainly thymol and/or carvacrol, and terpenoids." [14, 15]

CONCLUSIONS

This research elucidates a potentially life-saving method of using essential oils in combination, namely in the respiratory system. "This is the first research to report on the efficacy of most of these essential oil combinations against respiratory tract infections and their anti-inflammatory and cytotoxic effects on lung cell lines." Findings from this research indicate that five different essential oil combinations have the most potential for usage in the respiratory system due to their "antibacterial, cytotoxic, and anti-inflammatory properties. C. sempervirens and M. alternifolia, H. officinalis and R. officinalis, O. marjorana and M. alternifolia, M. communis and M. alternifolia, and O. vulgare and M. alternifolia are just a few of the possible pairings." Research on the optimal ratios at which various essential oil combinations should be blended to generate a holistic blend that would be non-toxic and elicit the most positive antibacterial and anti-inflammatory activity is ongoing and will inform future research.

REFERENCE

1. Burney P, Jarvis D, Perez Padilla R (2015) The global burden of chronic respiratory disease in adults. The International Journal of Tuberculosis and Lung Disease 19(1): 10-20.
2. Ben Arye E, Dudai N, Eini A, Torem M, Schiff E, et al. (2011) Treatment of upper respiratory tract infections in primary care: a randomized study using aromatic herbs. Evidence-based complementary and alternative medicine, pp. 1-10.
3. Van Bambeke F, Reinert RR, Appelbaum PC, Tulkens PM, Peetermans WE (2007) Multidrug-resistant Streptococcus pneumoniae infections. Drugs, 67(16): 2355-2382.
4. Inouye S, Takizawa T, Yamaguchi H (2001) Antibacterial activity of essential oils and their major constituents against respiratory tract pathogens by gaseous contact. Journal of antimicrobial chemotherapy 47(5): 565-573.
5. Khan AA, Arshad S, Mohsin M (2014) Population growth and its impact on urban expansion: A case study of Bahawalpur, Pakistan. Universal Journal of Geoscience 2(8): 229-241.
6. Williamson EM (2001) Synergy and other interactions in phytomedicines. Phytomedicine 8(5): 401-409.
7. Wagner H, Ulrich Merzenich G (2009) Synergy research: approaching a new generation of phytopharmaceuticals. Phytomedicine 16(2-3): 97- 110.
8. Reichling J, Saller R (2001) Herbal remedies in veterinary phytotherapy. SchweizerArchiv fur Tierheilkunde 143(8): 395-403.

9. Disler M, Ivemeyer S, Hamburger M, Vogl C, Tesic A, et al. (2014) Ethnoveterinary herbal remedies used by farmers in four north-eastern Swiss cantons (St. Gallen, Thurgau, AppenzellInnerrhoden and AppenzellAusserrhoden). Journal of Ethnobiology and Ethnomedicine 10(1): 1-23.
10. Mayer M, Vogl CR, Amorena M, Hamburger M, Walkenhorst M (2014) Treatment of organic livestock with medicinal plants: a systematic review of European ethnoveterinary research. Complementary Medicine Research 21(6): 375-386.
11. Schmid K, Ivemeyer S, Vogl C, Klarer F, Meier B, et al. (2012) Traditional use of herbal remedies in livestock by farmers in 3 Swiss cantons (Aargau, Zurich, Schaffhausen). Complementary Medicine Research 19(3): 125-136.
12. Solórzano Santos F, Miranda Novales MG (2012) Essential oils from aromatic herbs as antimicrobial agents. Current opinion in biotechnology 23(2): 136-141.
13. Blonder JP, Mutka SC, Sun X, Qiu J, Green LH, et al. (2014) Pharmacologic inhibition of S-nitrosoglutathionereductase protects against experimental asthma in BALB/c mice through attenuation of both bronchoconstriction and inflammation. BMC pulmonary medicine 14(1): 1-15.
14. Dongmo PM, Boyom FF, Sameza ML, Ndongson B, Kwazou NL, et al. (2008) Investigations of the essential oils of some aframomum species (Zingiberaceae from Cameroon) as potential antioxidant and anti-inflammatory agents. International journal of essential oil therapeutics 2(4): 149-155.
15. Oyemitan IA, Iwalewa EO, Akanmu MA, Olugbade TA (2008) Antinociceptive and anti-inflammatory effects of essential oil of Dennettiatripetala G. Baker (Annonaceae) in rodents. African Journal of Traditional, Complementary and Alternative Medicines 5(4): 355-362.

CITATION OF THIS ARTICLE

Md. Rageeb Md. Usman, Bharat V. Jain, Suvarnalata S. Mahajan, Prerna N. Jadhav: Anti-Inflammatory Action of Essential Oils and Their Usage in respiratory Tract Infection. Bull. Env. Pharmacol. Life Sci., Spl Issue [1]: 2023:567-573.