Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

State of the art on traditional medicine interventions for airborne respiratory system-related zoonotic diseases

Nodirjon N. Gadaev[1], Barnokhon K. Badridinova[2], Gayrat N. Raimov[3], Makhsuma K. q. Tashpulatova[4], Sadriddin Urunboev[5], Jurabek Begaliev[6], Abdugani Suyunov[7], Dilfuza M. Akhmedova[8]*, Shakhboskhan M. Akhmedov[9], Muattarxon P. d. Yuldashova[10], Saida A. Mirzaeva[11]

1. Associate Professor of the Department of Use of Hydromelioration Systems, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, National Research University, Tashkent, Uzbekistan & Western Caspian University, Scientific researcher, Baku, Azerbaijan
2. Head of the Department of Endocrinology of the Bukhara State Medical Institute Named After Abu Ali Ibn Sino of Uzbekistan
3. Department of Faculty and Hospital Surgery, Fergana Institute of Public Health and Medicine, Fergana, Uzbekistan
4. PhD, Candidate of Medical Sciences, Senior Researcher, Tashkent State Dental Institute, 140005 Tashkent, Uzbekistan
5. Deputy Director of INNO Innovative Educational Production Technopark under the Ministry of Higher Education, Science and Innovation, Tashkent, Uzbekistan
6. Kimyo International University in Tashkent Branch Samarkand, Samarkand, Uzbekistan
7. Head of the Department of Hydraulic Installations and Pumping Stations, Karshi Institute of Irrigation and Agrotechnology at the National Research University "TIIAME"
8. Candidate of Biological Sciences, Associate Professor, Department of Botany, Biotechnology and Ecology, Fergana State University, Fergana, Uzbekistan
9. PhD, Dotsent of the Department of Internal Diseases and Pulmonology, Tashkent Medical Academy, Tashkent, Uzbekistan
10. PhD, Associate Professor of the Department of Botany, Biotechnology and Ecology, Faculty of Natural Sciences,Fergana State University, Fergana, Uzbekistan
11. PhD, Associate Professor of the Department of Quarantine and Plant Protection, Faculty of Plant Protection, Agrochemistry and Soil Science, Andijan Institute of Agriculture and Agrotechnology, Andijan, Uzbekistan

** Corresponding author's E-mail: Ahmedova1965t@gmail.com*

ABSTRACT

Airborne diseases in horses encompass both non-infectious inflammatory conditions and infectious diseases caused by airborne pathogens. Understanding these diseases is vital for maintaining equine health and performance. Common non-infectious conditions include Inflammatory Airway Disease (IAD) and Recurrent Airway Obstruction (RAO), which are linked to exposure to airborne irritants in stables. These diseases arise from contact with organic dust and noxious gases, leading to airway inflammation and respiratory distress. Symptoms such as coughing, nasal discharge, and exercise intolerance significantly impact performance across various equine disciplines. *Rhodococcus equi* is a notable pathogen responsible for pneumonia in foals, primarily transmitted through inhalation of contaminated dust. Studies have shown that airborne concentrations of virulent *R. equi* are higher in stables compared to paddocks, correlating with increased disease prevalence. Other critical airborne diseases include Equine Influenza and *Streptococcus equi*, characterized by acute respiratory symptoms and high contagion rates. While airborne diseases pose significant risks to equine health, effective management strategies can mitigate these threats. These strategies include improving air quality, utilizing safe drugs, and implementing vaccination programs. However, challenges remain in ensuring consistent monitoring and control measures across various environments. The integration of traditional medicine interventions may offer additional avenues for addressing these diseases, highlighting the importance of exploring both conventional and alternative treatment options. Overall, a comprehensive understanding of airborne respiratory diseases in horses is essential

for developing effective prevention and treatment strategies, ultimately enhancing equine health and performance in diverse settings.

Keywords: Traditional medicine, Respiratory infections, Airborne, Pathogen, Horse.
Article type: Review Article.

INTRODUCTION

The utilization of natural products for medicinal purposes undoubtedly posed significant challenges for early humans. It is highly likely that in their quest for sustenance, early humans inadvertently ingested toxic plants, resulting in adverse effects such as vomiting, diarrhea, coma, or even fatal outcomes. Nevertheless, through these experiences, early humans gradually learned which materials were safe for consumption and which could serve as natural remedies. Following this period, humans harnessed fire, discovered the fermentation process for alcohol, established religious practices, achieved technological advancements, and began the systematic development of new pharmaceuticals (Yuan *et al*. 2016). Traditional medicines (TMs), which rely on natural products, hold considerable significance in various cultures. Systems such as traditional Chinese medicine (TCM), Iran, Ayurveda, Kampo, traditional Korean medicine (TKM), and Unani have utilized natural resources for centuries, evolving into well-structured and regulated medical practices. While these systems may exhibit certain limitations, they remain an invaluable repository of accumulated human knowledge (Dong 2013). The absence of viable alternatives for combating airborne pathogens in horses necessitates the urgent exploration of new antimicrobial agents for managing and treating infections. Plants can synthesize a diverse array of secondary metabolites, including alkaloids, glycosides, terpenoids, saponins, steroids, flavonoids, tannins, quinones, and coumarins. So, in the present review article, we tried to evaluate traditional herbal against common airborne diseases in the horse.

Traditional medicine and its effect on inflammatory and hypersensitivity conditions

Natural products exhibit a remarkable diversity in their multi-dimensional chemical structures, and their role as modifiers of biological functions has garnered significant interest. Consequently, these compounds have been instrumental in the identification of new pharmaceuticals and have had a profound influence on the field of chemicobiology. Over the past era, the diverse structural characteristics of natural products have been recognized through the framework of physical chemistry. Their therapeutic efficacy is intricately associated with the complex arrangement of their three-dimensional chemical and steric properties, which confer significant advantages regarding the efficiency and specificity of interactions with molecular targets. In the past fifty years, a vast array of new pharmaceuticals has been created utilizing high-throughput screening methods and combinatorial chemistry. However, natural products and their derivatives continue to be essential components of pharmacological resources. Of the estimated 250,000 to 500,000 plant species, only a limited number have been subjected to scientific scrutiny for their bioactive properties. This presents a considerable opportunity for future research into plants and other natural products, which may uncover valuable insights into novel chemical structures and innovative mechanisms of act relevant to drug expansion (Mohammadi *et al*. 2023, 2024; Che *et al*. 2024). Traditional medicine (TM) holds significant importance in the research and development of contemporary pharmaceuticals. Despite its complex and often obscure nature, TM offers extensive applications within non-Western medical practices. A single herb or formulation in TM may encompass a variety of phytochemical constituents, including alkaloids, terpenoids, and flavonoids. These compounds can operate independently or synergistically to achieve the intended pharmacological outcomes. It is noteworthy that numerous plant-derived medications currently utilized in clinical settings have their origins in TM. Furthermore, it has been established that many valuable pharmaceuticals sourced from plants were initially identified through their use in traditional medicine (Taib *et al.* 2020). Nearly two decades ago, a comprehensive analysis of the pharmacopeias from both developed and developing countries, along with relevant global scientific literature, was undertaken as part of the World Health Organization's TM Program. This investigation aimed to ascertain whether TM had indeed influenced modern drug discovery and to explore any potential correlations between the contemporary utilization of various compounds and their historical applications in TM. The research concentrated on a range of compounds utilized in plant-derived medications across different nations, ultimately confirming that TM has played a crucial role in the development of effective new drugs (Jabin 2011; Lone *et al*. 2012). Five significant categories, namely triterpenoids, glycosides, flavonoids, alkaloids, and polyphenols, including various combinations such as triptolide, have been extensively investigated for their remarkable effects on pro-inflammatory cytokine expression in bronchial asthma (BA). Flavonoids, recognized as potent antioxidants, inhibit the chemical mediators that initiate Th2-type cytokine production and also suppress various processes involving basophils and mast cells. Specifically, flavonoids obstruct IL-4-induced signaling transduction and influence T-cell differentiation through the aryl hydrocarbon receptor (Rahman *et al*. 2022). Inflammation serves as a fundamental mechanism for tissue repair subsequent damage or stress induced by pathogens. Any disruption at any stage of this process can hinder the resolution of inflammation, potentially resulting in chronic inflammation. When inflammation becomes chronic, it may give rise to autoimmune disorders such as rheumatoid arthritis, allergies, and asthma. The downstream effects of NF-kB include the activation of the arachidonic acid pathway, which can be stimulated by proinflammatory cytokines, including tumor necrosis factor-alpha (TNF-α) and interleukin 6 (IL-6). Given its critical role in inflammatory processes, NF-kB has emerged as a significant target for therapeutic intervention (Bae *et al*. 2010). Eicosanoids, lipid mediators derived from cell membrane lipids, include prostaglandins, thromboxanes, and leukotrienes, and are implicated in inflammatory diseases such as rheumatoid arthritis, allergic conditions, and asthma. Activated cells release inflammatory mediators into the joint cavity, leading to damage in adjacent bone and ligaments. Conversely, allergic responses and asthma are primarily associated with Th2 dominance. Nitric oxide, produced via inducible nitric oxide synthase (I-NOS), along with reactive oxygen species (ROS), contributes to the activation of NF-kB, in addition to the previously mentioned cytokines TNF-alpha and IL-6. NF-kB serves as a pivotal regulator of inflammation, highlighting its potential as a therapeutic target for a range of diseases, particularly those related to the immune system (Rahman *et al*. 2022).

Horse-common airborne diseases

Airborne infectious diseases in horses are a significant concern due to their potential impact on equine health and the equine industry. These diseases can be caused by various pathogens, including bacteria and viruses, which are transmitted through aerosols in environments such as stables and riding arenas. Understanding the epidemiology and transmission mechanisms of these diseases is crucial for effective management and prevention strategies. The following sections explore key aspects of airborne infectious diseases in horses.

Bacterial infections

Rhodococcus equi is a foremost reason of pneumonia in foals, transmitted through inhalation of dust contaminated with virulent *R. equi*. Studies have shown higher concentrations of this bacterium in stables compared to paddocks, correlating with the prevalence of pneumonia on farms. *Rhodococcus equi* is a gram-positive, pleomorphic rod-shaped bacterium that is predominantly found in soil environments. This organism is recognized as a significant respiratory pathogen in young foals, as noted by Giguère *et al*. (2012). Infections caused by *R. equi* can lead to subacute or chronic forms of abscessation bronchopneumonia, which may be accompanied by ulcerative typhlocolitis. Furthermore, the infection can manifest in various other conditions, including mesenteric lymphadenitis, osteomyelitis, purulent arthritis, reactive arthritis, and ulcerative lymphangitis (Kumar *et al*. 2023). *Streptococcus* spp. predominantly found in indoor riding arenas. These bacteria increase in concentration during riding activities, suggesting that the arena ground is a primary source. The health impact of this bacterial burden on horses remains to be fully understood (Cillóniz *et al*. 2018).

Viral infections

Equine Influenza and Herpesvirus are among the most significant monocausal respiratory infections in horses, transmitted through aerosols. Vaccination and chemotherapy are primary control measures. The family Orthomyxoviridae is prominently represented by four genera of influenza viruses, namely A, B, C, and D, which are responsible for causing influenza in various vertebrate species, including birds, humans, and other mammals. Research has identified 30 plant species that demonstrate antiviral activity against multiple strains of influenza viruses, particularly those associated with avian influenza and swine flu (Giguère *et al.* 2012; Cock & Van Vuuren 2020; Zitterl-Eglseer & Marschik 2020).

Environmental and management factors

Air quality acting a vital role in the prevalence of respiratory diseases among horses, which has led to significant interest in the impact of various floor materials in training arenas and bedding types in stables where horses rest. The equine environment is rife with allergens that can trigger severe equine asthma (sEA) or RAO, a condition that restricts the utility of affected horses. Several factors contribute to air quality, including the nutritional quality of feed, the choice of bedding, the flooring materials in riding facilities, the frequency of their replacement, and the overall cleanliness of stables and paddocks. Poor air quality, characterized by high levels of organic dust and noxious gases, contributes to inflammatory airway diseases like IAD and RAO, which, while non-infectious, can exacerbate the impact of infectious agents. Effective air sampling techniques are crucial for detecting airborne pathogens. Various samplers have different efficiencies, impacting the detection limits and reliability of airborne disease surveillance (Riihimäki *et al*. 2008). While the focus is often on the direct transmission of pathogens, the role of environmental factors and management practices in facilitating airborne transmission should not be underestimated. Improving air quality and implementing effective biosecurity measures can significantly reduce the risk of airborne infectious diseases in horses. Additionally, the potential for undetected transmission highlights the need for comprehensive surveillance and research to better understand and mitigate these risks. The management of allergen exposure involves distinct immune cellular mechanisms. In instances where these reactions occur at a subclinical or non-pathological level, the equine immune system typically responds appropriately to environmental agents. However, when this immune response is exaggerated, it is classified as hypersensitivity, which has historically been divided into four types: Type I through Type IV reactions (Pearson *et al*. 2007). In equines, the predominant form of allergic reactions is classified as Type I hypersensitivity. These reactions are most commonly observed in conditions such as atopy and asthma, and they arise from an elevated production of immunoglobulin E (IgE) in response to specific allergens. Additionally, these hypersensitive responses are characterized by dysregulation of T-cells, heightened reactivity of multiple organ systems primarily the respiratory and integumentary systems—and alterations in the secretion of various mediators involved in cell-to-cell communication. Horses that develop the asthma-like condition known as recurrent airway obstruction (RAO) typically exhibit a response to antigen exposure, such as dusty hay or straw, which leads to bronchoconstriction, an increase in pulmonary neutrophils, and excessive mucus production. The condition is primarily characterized by Type I hypersensitivity, mediated by immunoglobulin E (IgE), which triggers the activation of inflammatory cells and the modulation of transcription factors that regulate cytokine production, notably nuclear factor kappa B (NF-kB). Furthermore, some researchers propose that Type III hypersensitivity reactions may also contribute to airway inflammation, as evidenced by the presence of neutrophilic bronchitis linked to the formation of antigen-antibody complexes and the subsequent activation of the complement cascade. A significant pathological feature in horses affected by RAO is bronchiolitis, which is marked by the accumulation of lymphocytes around the bronchioles and the presence of neutrophils within the lumen. The neutrophilic inflammation observed in these horses can be partially explained by Type III hypersensitivity (Davis & Rush 2002; Fig. 1).

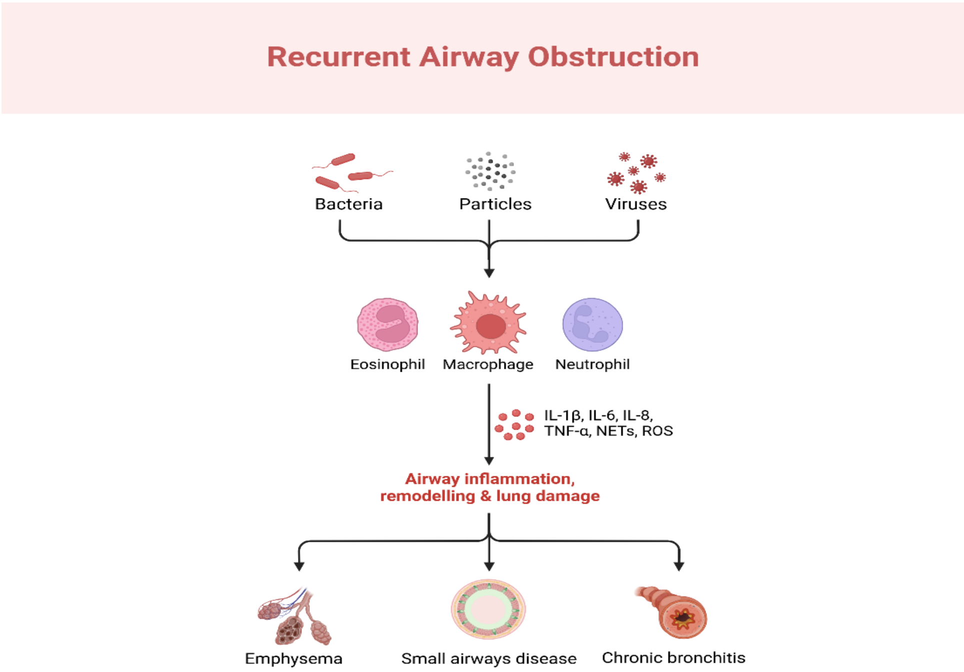

Fig. 1. The pathogenesis of RAO in horses including airway inflammation, remodeling of tissue, and tissue damage (https://app.biorender.com/illustrations/6762b28cdef1b5461011a971).

Traditional Medicine for alleviated respiratory disease in horse

Furthermore, it is crucial to recognize that there are still effective pharmacological options available to slow the progression of the disease or effectively control inflammation in the narrow airways and lung parenchyma. Various protein families are known to inactivate serine, cysteine, and matrix metalloproteinases through both catalytic pathways and mechanisms that inhibit specific active sites. Research conducted by Sartor *et al.* has highlighted the inhibitory effects of flavonoid epigallocatechin gallate on leukocyte elastase, revealing its significant role in animal models of lung injury (Sartor *et al.* 2002). Lee *et al.* investigated the therapeutic potential of *Callicarpa japonica*, a traditional remedy in Eastern medicine for inflammatory conditions. Their findings indicated that extracts from *C. japonica* influence eosinophil infiltration and the production of cytokines such as IL-6 and TNF-alpha in models exposed to dust. The involved pathways were analyzed and compared, revealing a reduction in ERK phosphorylation (Lee *et al*. 2024). The natural metabolites jaboticabin and 3,3'-dimethyellagic acid-4-O-sulfate, derived from *Myrciaria cauliflora*, commonly known as jaboticaba, have garnered significant attention for their potential therapeutic effects on chronic lung diseases, particularly in Brazil. Research conducted by Da-Ke *et al.* has demonstrated that extracts from jaboticaba possess important medicinal properties, particularly in their anti-inflammatory effects and their role in managing chronic obstructive pulmonary disease (COPD). Additionally, celastrol, a well-researched anti-inflammatory compound sourced from the traditional Chinese medicinal plant *Tripterygium wilfordii*, exhibits triterpenoid metabolites capable of inhibiting the NF-kappa B signaling pathway. This inhibition is crucial, as celastrol has been shown to markedly reduce lung injury associated with various pulmonary conditions through the modulation of EDNRB gene expression, thereby influencing cellular apoptosis. Furthermore, celastrol effectively diminishes the expression of EDNRB/Kng1 in both cellular and animal models, contributing to the alleviation of COPD via its inhibitory action on the signaling pathway. The efficacy and cost-effectiveness of numerous plants and herbal extracts position them as valuable alternatives in the treatment of respiratory diseases globally (Zhao *et al*. 2019). Chloroquine, derived from the bark of the Cinchona tree, serves as a quinine analog, while hydroxychloroquine is a synthesized derivative of chloroquine. Numerous *in vitro* investigations have indicated that chloroquine exhibits potential antiviral activity against SARS-CoV. This effect is attributed to its ability to elevate endosomal pH and disrupt the glycosylation of cellular receptors associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), thereby demonstrating anti-SARS-CoV-2 properties similar to those observed against SARS-CoV. Notably, research has shown that a 48-hour treatment with hydroxychloroquine proved to be more efficacious than chloroquine in Vero cells infected with SARS-CoV-2. Furthermore, administering a daily dose of 600 mg hydroxychloroquine sulfate to COVID-19 patients resulted in a significant reduction of viral load within three to six days compared to a control group (Singh & Vijayan 2020). Griffithsin, a lectin composed of 121 amino acids from the *Griffithsia* genus, emerges as a compelling candidate in the fight against coronaviruses due to its ability to interfere with the spike (S) proteins of these viruses. Its highly glycosylated nature enhances its effectiveness in inhibiting the functional activities of S proteins. Additionally, Griffithsin exhibits low systemic toxicity, positioning it as a promising therapeutic option against MERS-CoV. Research has also indicated that emodin can inhibit the binding of the S protein to ACE2, thereby disrupting the infectivity of S protein pseudo-typed retroviruses in Vero E6 cells. Moreover, emodin has been shown to block the 3a ion channel of both SARS-CoV and HCoV-OC43, as well as impede the release of HCoV-OC43, with an approximate aK1/2 value of twenty μM. Extracts from various medicinal plants, including *Mollugo cerviana*, *Dioscorea batatas*, *Polygonum multiflorum* Thunb., *Glycyrrhiza radix*, *Psoralea corylifolia*, *Salvia miltiorrhiza*, *Rheum officinale* Baill., and *Trichosanthes cucumerina* L., have demonstrated antiviral activity against coronaviruses. Additionally, diammonium glycyrrhizinate, a compound derived from licorice root, has been reported to alleviate severe symptoms associated with COVID-19 (Jabbari *et al*. 2019; Adhikari *et al*. 2021; Bains *et al*. 2023). In an experimental study, phytochemical analysis revealed that the water-soluble fraction (WSF) of the sequential extract with water and ethanol (SEWE) from *Eucalyptus globulus* leaves exhibited positive results for catechol tannins, phenolic compounds, saponins, and carbohydrates. In contrast, the ethanol-soluble fraction (ESF) of SEWE from *Tamarindus indica* leaves contained catechol tannins, phenolic compounds, flavones, and carbohydrates. Compared to conventional antibiotics such as azithromycin and rifampicin, the concentrations of these plant extracts required for effective *in vivo* application were significantly higher. The most potent herbal fractions, specifically the WSF from *Eucalyptus globulus* and the ESF from *T. indica*, demonstrated minimum inhibitory concentrations (MIC) of 3.19 mg mL^{-1} and 4.81 mg mL^{-1}, respectively. Given the widespread availability of *T. indica* and *E. globulus* in India, along with their demonstrated antibacterial properties against *R. equi*, these plants present a promising potential for use as disinfectants targeting this pathogen (Kumar *et al.* 2022). Research indicated that the leaves of *T. indica* and *E. globulus* exhibit significant *in vitro* antibacterial properties against *R. equi*. Given the widespread availability of these plants, their leaves were evaluated for disinfectant efficacy against *R. equi* found in agricultural soil. It was observed that boiled water from the leaves at concentrations of 10% and higher effectively inhibited *R. equi* in the soil. The active principle identified in *T. indica* was consistent with previous studies, while the active principle from *E. globulus* could not be correlated with earlier findings; nonetheless, it was determined to be a highly polar compound (Kumar *et al*. 2022). The primary and most widely utilized treatment for *R. equi* infections in foals involves a combination of macrolides, specifically erythromycin or azithromycin, alongside rifampicin. However, the emergence of resistant strains of *R. equi* has been documented. In the study, commercially available azithromycin and rifampicin were administered at a concentration of 10 mg L^{-1} , both demonstrating significant zones of inhibition. Notably, the herbal fraction SEWE derived from the leaves of *Hibiscus rosa-sinensis* L. exhibited considerable antibacterial activity at a concentration of 89.77 mg mL^{-1} against *R.equi*. This indicates that the conventional antibiotics currently in use possess greater antimicrobial efficacy compared to the most potent SEWE fraction from *H. rosa-sinensis* L. leaves. Should the SEWE fraction be deemed non-toxic and not adversely affected by digestive and metabolic processes, it could potentially be employed in the treatment of foals. This underscores the necessity for further investigation into more purified compounds from the most active SEWE fraction of *H. rosa-sinensis* L. leaves to explore their viability for *in vivo* applications. Additionally, there is potential for utilizing boiled water from *H. rosa-sinensis* L. leaves as a farm disinfectant against *R. equi* (Kumar *et al*. 2020). In the study (Yaghoobpour *et al.* 2023) carried out in Iran, following the isolation and identification of *S. equi* strains, the antibiotic resistance of these isolates was assessed. The antibacterial properties of lavender essential oil were examined through a broth microdilution assay. Resistance was most pronounced against amoxicillin, whereas ceftriaxone demonstrated the highest sensitivity. Lavender essential oil effectively inhibited 90% of the isolates at concentrations of 2048 μL mL^{-1} or greater. The results of their study suggest that lavender essential oil possesses the ability to inhibit the growth of *S. equi* isolates in a manner that is dependent on the concentration used. Specifically, it was observed that concentrations of 2048 and 4096 μL mL^{-1} were effective in eliminating over 90% of the isolates. The results of the antibiogram analysis in an experimental study revealed that *S. equi* strains isolated from animals exhibiting clinical symptoms demonstrated resistance to several commonly used antibiotics, including Trimethoprim-sulfamethoxazole, Cefotaxime, Penicillin, and Azithromycin. This resistance is likely attributable to the widespread application of antimicrobials in veterinary medicine, which significantly contributes to the emergence of bacterial resistance and may facilitate the development of resistance to the antibiotics mentioned above. In light of the antimicrobial resistance (AMR) observed in horses treated with standard antibiotic regimens, our research suggests that the incorporation of medicinal plants and their bioactive compounds could serve as viable alternatives to synthetic antibiotics (Yaghoobpour *et al.* 2023). The efficacy of an herbal composite comprising garlic, white horehound, boneset, aniseed, fennel, licorice, thyme, and hyssop in alleviating the clinical manifestations of recurrent airway obstruction (RAO) was evaluated. The study involved administering the herbal composite to six horses diagnosed with symptomatic RAO over 21 days in a crossover design. The results indicated that treatment with the herbal composite did not yield statistically significant alterations in the measured parameters. However, a trend suggesting a reduction in respiratory rate and an increase in macrophage proportion was noted in the horses treated with the herbal formulation compared to the placebo group. These findings imply that the herbal composite may have the potential to safely lower the elevated respiratory rate in horses suffering from RAO, warranting further investigation with a larger cohort to elucidate the product's effects more comprehensively (Pearson *et al*. 2007).

In cell culture experiments, *Echinacea purpurea* effectively inactivated highly pathogenic avian influenza viruses of the H_5 and H_7 subtypes, as well as the H_1N_1 strain of swine-origin, across various concentrations. Investigations focusing on the H_5N_1 strain revealed that optimal inhibition of viral replication necessitated direct contact between EF and the virus before infection. Hemagglutination assays indicated that the extract hampers the virus's receptor binding activity, thereby obstructing its entry into host cells. Notably, during sequential passage studies, no EF-resistant variants were observed in cultures infected with the H_5N_1 virus, unlike the situation with Tamiflu, which led to the emergence of resistant strains (Ge *et al*. 2010). Additionally, a review by Arora *et al.* highlighted various medicinal plants utilized in Ayurveda and traditional Chinese medicine possessing antiviral properties against influenza, which may prove beneficial in managing H_1N_1 flu, a pandemic linked to swine flu. Glycyrrhizin, a triterpene saponin derived from licorice root (*Glycyrrhiza glabra* L.), has been extensively studied for its antiviral effects, demonstrating the ability to disrupt replication and mitigate cytopathogenic effects in several viruses, including those responsible for respiratory infections and influenza (Safdarpour *et al*. 2022; Arora *et al*. 2024). Michaelis *et al.* examined the effects of glycyrrhizin H_5N_1 influenza A viruses in lung epithelial cells, which are implicated in avian influenza and are considered potential precursors to an influenza pandemic. Their research revealed that glycyrrhizin concentrations between 25 and 50 µg mL^{-1} significantly decreased the levels of pro-inflammatory molecules that are induced by H_5N_1. However, to effectively suppress H_5N_1 replication and the apoptosis caused by the virus, concentrations of 100 µg mL^{-1} or higher were necessary. Therefore, glycyrrhizin may represent a promising addition to the array of potential therapeutic options for H_5N_1 infections. Furthermore, compounds like pterocarpans and flavanones derived from *Sophora flavescens* Aiton (Leguminosae) have also been recognized as inhibitors of neuraminidase, an enzyme crucial for influenza virus replication (Michaelis *et al.* 2010).

CONCLUSION

Traditional medicine offers potential interventions for managing airborne respiratory diseases in horses, particularly those caused by pathogens like *Rhodococcus equi* and viruses. Various medicinal plants, including *Eucalyptus globulus* and *Tamarindus indica*, have shown significant antibacterial properties against *R. equi*, suggesting their use as effective disinfectants in agricultural settings. The herbal composite evaluated in the study indicated a trend towards reducing respiratory rates in horses with Recurrent Airway Obstruction (RAO), highlighting the need for further research to confirm these findings. The study emphasizes the importance of understanding the pharmacological properties of traditional herbal remedies, as they may provide safer alternatives to conventional antibiotics, especially in light of rising antibiotic resistance. Overall, while traditional medicine shows promise, further investigation into the efficacy and safety of these herbal treatments is necessary to establish their role in veterinary medicine. Effective management strategies, including improved air quality and the use of traditional remedies, can help mitigate the risks associated with airborne diseases in equines.

REFERENCES

Adhikari, B, Marasini, BP, Rayamajhee, B, Bhattarai, BR, Lamichhane, G, Khadayat, K, Adhikari, A, Khanal, S & Parajuli, N 2021, Potential roles of medicinal plants for the treatment of viral diseases focusing on COVID-19: A review. *Phytotherapy Research*, 35: 1298-1312.

Arora, H, Choudhir, G, Sengupta, A, Sharma, A & Sharma, S 2024, Bioactive metabolites of licorice and thyme as potential inhibitors of Cox1 enzyme of phytopathogens of *Capsicum annuum* L.: In-silico approaches. *Journal of Biomolecular Structure and Dynamics*, 12:1-18.

Bae, H-B, Li, M, Kim, J-P, Kim, S-J, Jeong, C-W, Lee, H-G, Kim, W-M, Kim, H-S & Kwak, S-H 2010, The effect of epigallocatechin gallate on lipopolysaccharide-induced acute lung injury in a murine model. *Inflammation*, 33: 82-91.

Bains, A, Fischer, K, Guan, W & LiWang, PJ 2023, The antiviral activity of the lectin Griffithsin against SARS-CoV-2 is enhanced by the presence of structural proteins. *Viruses*, 15:2452.

Che, C-T, George, V, Ijinu, TP, Pushpangadan, P & Andrae-Marobela, K 2024, Traditional medicine. *Pharmacognosy*, 2: 11-28.

Cillóniz, C, Garcia-Vidal, C, Ceccato, A & Torres, A 2018, Antimicrobial Resistance Among Streptococcus pneumoniae. *Antimicrobial Resistance in the 21st Century*, 7:13-38.

Cock, IE & Van Vuuren, SF 2020, The traditional use of southern African medicinal plants in the treatment of viral respiratory diseases: A review of the ethnobotany and scientific evaluations. *Journal of Ethnopharmacology*, 262: 113194.

Davis, E & Rush, BR 2002, Equine recurrent airway obstruction: pathogenesis, diagnosis, and patient management. *Veterinary Clinics: Equine Practice*, 18: 453-467.

Dong, J 2013, The Relationship between Traditional Chinese Medicine and Modern Medicine. *Evidence-Based Complementary and Alternative Medicine*, 2013: 153148.

Ge, H, Wang, Y-F, Xu, J, Gu, Q, Liu, H-B, Xiao, P-G, Zhou, J, Liu, Y, Yang, Z & Su, H 2010, Anti-influenza agents from traditional Chinese medicine. *Natural Product Reports*, 27: 1758-1780.

Giguère, S, Lee, EA, Guldbech, KM & Berghaus, LJ 2012, In vitro synergy, pharmacodynamics, and postantibiotic effect of 11 antimicrobial agents against *Rhodococcus equi*. *Veterinary Microbiology*, 160: 207-213.

Jabbari, N, Gheibi, P & Eftekhari, Z 2019, The therapeutic effects of isolated Eugenol of *Syzygium aromaticum*. *Plant Biotechnology Persa*, 1: 42-44.

Jabin, F 2011, Guiding tool in Unani Tibb for maintenance and preservation of health: a review study. *African Journal of Traditional, Complementary and Alternative Medicines*, 8: 5S.

Kumar, L, Sankhala, L, Kant, L & Dedar, R 2022, *In vitro* antibacterial activity of leaves extract of *Eucalyptus globulus Labill.* and tamarindus indica L. against *Rhodococcus equi*. *Annals of Phytomedicine: An International Journal*, 11: 55.

Kumar, L, Sankhala, LN, Dedar, RK, Kant, L, Badsiwal, DK & Kumar, S 2020, Evaluation of *in vitro* antibacterial property of some plants of subtropical climate against *Rhodococcus equi*. *Journal of Entomology and Zoology Studies*, 8: 1590–1594.

Kumar, L, Sankhala, LN, Kant, L, Badsiwal, DK, Kumar, S & Dedar, RK 2023, Screening for in vitro antibacterial activity of laves extracts of crtain selected plants against *Rhodococcus equi*. *International Journal of Bio-resource and Stress Management*, 14:101–109.

Lee, J-W, Lee, HJ, Yun, SH, Lee, J, Kim, H, Kang, HY, Ahn, K-S & Chun, W 2024, Medicinal herbal extracts: therapeutic potential in acute lung injury. *Future Pharmacology*, 4:700-715.

Lone, AH, Ahmad, T, Anwar, M, Sofi, GH, Imam, H & Habib, S 2012, Perception of health promotion in Unani herbal medicine. *Journal of Herbal Medicine*, 2: 1-5.

Michaelis, M, Geiler, J, Naczk, P, Sithisarn, P, Ogbomo, H, Altenbrandt, B, Leutz, A, Doerr, HW & Cinatl, JJ 2010, Glycyrrhizin inhibits highly pathogenic H5N1 influenza A virus-induced pro-inflammatory cytokine and chemokine expression in human macrophages. *Medical Microbiology and Immunology*, 199: 291-297.

Mohammadi, Z, Pishkar, L, Eftekhari, Z, Barzin, G & Babaeekhou, L 2024, Evaluation of the antimicrobial and cytotoxic activity of cultivated *Valeriana officinalis*. *Plant Science Today*, 11: 145-155.

Mohammadi, Z, Pishkar, L, Eftekhari, Z, Barzin, G & Babaeekhou, L 2023, The human host defense peptide LL-37 overexpressed in lung cell lines by methanolic extract of *Valeriana officinalis*. *Brazilian Journal of Pharmaceutical Sciences*, 59: e21025.

Pearson, W, Charch, A, Brewer, D & Clarke, AF 2007, Pilot study investigating the ability of an herbal composite to alleviate clinical signs of respiratory dysfunction in horses with recurrent airway obstruction.*Canadian Journal of Veterinary Research = Revue Canadienne de Recherche Veterinaire*, 71: 145–151.

Rahman, MM, Bibi, S, Rahaman, MS, Rahman, F, Islam, F, Khan, MS, Hasan, MM, Parvez, A, Hossain, MA, Maeesa, SK, Islam, MR, Najda, A, Al-malky, HS, Mohamed, HRH, AlGwaiz, HIM, Awaji, AA, Germoush, MO, Kensara, OA, Abdel-Daim, MM, Saeed, M & Kamal, MA 2022, Natural therapeutics and nutraceuticals for lung diseases: Traditional significance, phytochemistry, and pharmacology. *Biomedicine & Pharmacotherapy*, 150: 113041.

Riihimäki, M, Raine, A, Elfman, L & Pringle, J 2008, Markers of respiratory inflammation in horses in relation to seasonal changes in air quality in a conventional racing stable. *Canadian Journal of Veterinary Research*, 72: 432-439.

Safdarpour, S, Eftekhari, Z, Eidi, A & Doroud, D 2022, Encapsulated saponin by ferritin nanoparticles attenuates the murine pneumococcal pneumonia. *Microbial Pathogenesis*, 172:105731.

Sartor, L, Pezzato, E & Garbisa, S 2002, (−) Epigallocatechin-3-gallate inhibits leukocyte elastase: Potential of the phyto-factor in hindering inflammation, emphysema, and invasion. *Journal of Leukocyte Biology*, 71:73–79.

Singh, R & Vijayan, V 2020, Chloroquine: a potential drug in the COVID-19 scenario. *Transactions of the Indian National Academy of Engineering*, 5: 399-410.

Taib, M, Rezzak, Y, Bouyazza, L & Lyoussi, B 2020, Medicinal uses, phytochemistry, and pharmacological activities of *Quercus* species. *Evidence-Based Complementary and Alternative Medicine*, 2020: 1920683.

Yaghoobpour, M, Fozouni, L & Ghaemi, P 2023, A new solution for control of respiratory infection by Streptococcus equi isolated from horses in northern Iran. *Bulgarian Journal of Veterinary Medicine*, 2020: 144.

Yuan, H, Ma, Q, Ye, L & Piao, G 2016, The traditional and modern medicine from natural products. *Molecules*, 21: 559.

Zhao, D-K, Shi, Y-N, Petrova, V, Yue, GGL, Negrin, A, Wu, S-B, D'Armiento, JM, Lau, CBS & Kennelly, EJ 2019, Jaboticabin and related polyphenols from Jaboticaba (*Myrciaria cauliflora*) with anti-inflammatory activity for chronic obstructive pulmonary disease. *Journal of Agricultural and Food Chemistry*, 67: 1513–1520.

Zitterl-Eglseer, K & Marschik, T 2020, Antiviral medicinal plants of veterinary importance: A literature review. *Planta Medica*, 86: 1058-1072.