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Efficacy Evaluation of Pulmoboost in Managing Respiratory Distress of Small Ruminants (Sheep/Goat)

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Abstract: *This study aimed to evaluate the efficacy of Pulmoboost in the treatment of mild, moderate, and severe symptoms of respiratory distress in small ruminants (sheep/goat). A total of 16 sheep and 26 goats with a history of respiratory distress were divided into two groups: group 1 (G1) comprised of ruminants with mild-to-moderate respiratory distress (7 sheep + 21 goats), and group 2 (G2) comprised of ruminants with moderate-to-severe respiratory distress (9 sheep + 5 goats). The animals in G1 were administered 10 mL of Pulmoboost twice daily for 3–5 days, whereas those in G2 were administered the same dose of Pulmoboost (10 mL twice daily for 3–5 days) along with antibiotics. Results revealed that complete alleviation of the symptoms of respiratory distress was observed on 4 and 5 days of treatment with Pulmoboost in G1 and G2, respectively. The responses to the treatment score in G1 and G2 were 4.00 ± 0.00 and 3.00 ± 0.00, respectively. In conclusion, Pulmoboost at the recommended dose could be used for the treatment of mild, moderate, and severe symptoms of respiratory distress in sheep/goat.*

Key Words: *Pulmoboost, Respiratory distress, Cough relieving, Ease of breathing, Antibacterial, Anti-inflammatory, Immunomodulatory*

1. Introduction

Small ruminants,especially sheep and goats,significantly contribute to the economy of farmers in the Mediterranean as well as in African and Southeast Asian countries. These small ruminants are valuable assets owing to their significant contribution to the production of meat, milk, and wool as well astheir potential to replicate and rapidly grow. The great Indian leader and freedom fighter M. K. Gandhi, who was known as the "father of the nation," referred to goats as the "poor man's cow," emphasizing the importance of small ruminants in poor countries. In India, sheep and goats play a pivotal role in the economy of the poor, deprived, backward classes, and landless laborers. The respiratory diseases of small ruminants are multifactorial, with multipleculprit pathogens [1]. Among them, bacterial diseases have gained attention due to theirvarying clinical manifestations, disease severity, and reemergence of strains resistant to a number of chemotherapeutic agents [2].

Respiratory diseases account for 5.6% of all other infectious diseases in small ruminants [3]. Small ruminants are particularly sensitive to pathogens that cause respiratory infections, namely, viruses, bacteria, and fungi, mostly as a result of deficient management practices that make these animals more susceptible to infectious agents. The tendency of these animals to huddle and their exposure to group-rearing practices further predispose them to infectious and contagious diseases [4,5]. In both sheep and goat flocks, respiratory diseases that affect individuals or groups may be encountered, which result in poor live weight gain and high mortalityrates [6]. This causes considerable financial losses to shepherds and goat keepers in the form of decreased meat, milk, and wool production, along with a reduction in the number of offspring. Adverse weather conditions leading to stress often contribute to the onset and progression of such diseases. The condition becomes adverse when bacterial and viral infections are combined,especially under adverse weather conditions [1]. Moreover, under stress, immunocompromised, pregnant, lactating, and older animals are more susceptible to respiratory pathogens, such as*Streptococcus pneumoniae*,*Mannheimiahaemolytica*, *Bordetella parapertussis*, *Mycoplasma species*, *Arcanobacterium pyogenes*, and *Pasteurella* species [2,5,7-10].Such infections pose a major obstacle to the intensive rearing of sheep and goats and diseases likepeste des petits ruminants, bluetongue, and ovine pulmonary adenomatosis (Jaagsiekte), all of which adversely affect international trade, ultimately hampering the economy [2, 5,10,11].

Pneumonia refers to the inflammation of the pulmonary parenchyma, which is usually accompanied by inflammation of the bronchioles. Pneumonia occurs when infectious and non-infectious agents affect the lungs of sheep and goats, which become inflamed. The most frequently encountered causes of respiratory infection and death are *Pasteurella multocida*and *Mannheimiahaemolytica*. These two pathogens are responsible for the outbreaks of acute pneumonia in sheep and goats of all ages. Respiratory infections caused by these pathogens are associated with poor management practices and occur as secondary infections or as a consequence of severe stress.

Ethnoveterinary research is defined as "the systematic investigation and application of folk veterinary knowledge, theory,and practice" [12].Most ethnoveterinary surveys on the preparation and utilization of herbal remedies have been conducted in Africa, Asia, and Latin America [13]. In these countries, access to conventional drugs is more difficult; hence, they are dependent on the use of homemade preparations [14]. Thus, there is an increasingconsumer demand for high-quality animal food products with limited or no pharmaceuticals produced on a chemical or biotechnological basis [13].

With this background and the growing acceptance of herbal medicinal therapy, the polyherbal formulation Pulmoboost, which was claimed to possess antibacterial properties, was developed by the Himalaya Wellness Company. Hence, the present study aimed to evaluate the efficacy of Pulmoboostin the treatment of mild, moderate, and severe symptoms of respiratory distressin sheep and goats.

2. Materials and Methods

2.1 PolyherbalFormulation:

Pulmoboostis a proprietary polyherbal formulation developed by the Himalaya Wellness Company, Bengaluru, India. It is mainlycomposed of aqueous (*aq.*) extracts of *Solanum xanthocarpum*, *Glycyrrhiza glabra*,*Ocimumbasilicum*, *Terminalia chebula*,*Adhatodavasica*, and *Piper nigrum*, and essential oils like *Eucalyptus globulus*.

2.2 Ethical Approval

The use of animals for this study was approved by the Institutional Animal Ethics Committee (IAEC), the Himalaya Wellness Company, Bangalore, Protocol No. 01/LA/COWS/16.

2.3 Study Subjects

A total of 16 sheep and 26 goats with a history of respiratory distress atveterinary dispensaries of Makali, Bangaloreand at the Challakere village of the Chitradurga district were selected. Thesheep and goatsthat did not have gag reflex and those that had severe disease conditions such as TB and prolapsewere excluded from the study.

2.4 Study Design and Experimental Details

The 16 sheep and 26 goats with a history of respiratory distress were divided into two groups: G1 comprised ofanimals with mild-to-moderate respiratory distress (7 sheep + 21 goats), whereas G2 comprised ofanimals with moderate-to-severe respiratory distress (9 sheep + 5 goats).

Study Design

S. No.	Groups	Total No. of Animals	Treatment
1	G1–Mild-to-moderate respiratory distress	7 sheep + 21 goats	Pulmoboost 10 mL twice daily for 3–5 days
2	G2–Moderate-to-severe respiratory distress	9 sheep + 5 goats	Antibiotics 3–5 days + Pulmoboost 10 mL twice daily for 3–5 days

Animals with mild-to-moderate respiratory distress (G1) were administered 10 mL of Pulmoboost twice daily for 3–5 days, whereas those with severe respiratory distress (G2) were administered a similar dose of Pulmoboost (10 mL twice daily for 3–5 days) along with antibiotics. Each animal was used as its own control; therefore, they were allocated to a control pre-treatment period (1–2 days), followed by a treatment period (3–5 days). When Pulmoboost was administered to the sheep and goats, concurrent treatment with other herb-based products was not followed.

2.5 Animal Husbandry

Animals were managed by the farmers and housed under standard conditions at farm sites. Regarding the regular feeding of the animals, concentrated feed (commercial concentrate feed) and roughages (maize, ragi, and paddy straw) were offered. Drinking water was made available *ad libitum.*

2.6 Evaluation of Study Parameters

The assessment parameters wereseverity of respiratory distress, cough relieving, ease of breathing, and response to treatment,as described in Table 1 [15].The number of days taken for the complete alleviation of symptoms of respiratory distress was recorded for each animal.The efficacy of Pulmoboost was assessed based on the overall improvement in the scores of the assessment parameters, namely,severity of respiratory distress, mucus expulsion, ease of breathing, and response to treatment.

Table1. *Assessment Parameter Grading System*

Parameter	Description	Score
A. Severity of Respiratory Distress Score	Normal	0
	Tachypnea	1
	Dyspnea	2
	High dyspnea	3
B. Cough Relieving Score	Excellent	0
	Good	1
	Fair	2
	Unsatisfactory	3
C. Ease of Breathing Score	No abnormal sound	0
	Moist rales on the anterior lung	1
	Moist rales on the whole lung	2
	Crepitation on the whole lung	3
D. Response to Treatment Score	Highly satisfied	4
	Moderately satisfied	3
	Neither satisfied nor dissatisfied	2
	Not satisfied (no relief)	1

3. Results and Discussion

3.1 Results

The mean scores of the assessment parametersin G1 and G2 are presented in Table 2. According to our findings,after the administration of Pulmoboost to animals in G1 and G2, the mean scores of the assessment parameters were viz. severity of respiratory distress and ease of breathing scores improved as early as day 1 compared with the pre-treatment scores. However, the complete alleviation of the symptoms of respiratory distress was observed on day 4 and day 5 of treatment with Pulmoboost in G1 and G2, respectively.

Table2. *Impact of Pulmobooston the Assessment Parameters in Sheep/Goat*

Assessment Parameter	Pre-treatment	Day 1	Day 2	Day 3	Day 4	Day 5
G1–Mild-to-moderate respiratory distress (n=28)						

Severity of Respiratory Distress Score	3.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Cough Relieving Score	3.00 ± 0.00	3.00 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Ease of breathing Score	3.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
G2–Moderate-to-severe respiratory distress (n=14)						
Severity of Respiratory Distress Score	3.00 ± 0.00	3.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	0.00 ± 0.00
Cough Relieving Score	3.00 ± 0.00	3.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	0.00 ± 0.00
Ease of breathing Score	3.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	0.00 ± 0.00

Values are expressed as mean ± SEM

The response to treatment scores in G1 and G2 were 4.00 ± 0.00 and 3.00 ± 0.00, respectively (Table 3). These findings indicated that clients/veterinarians who used Pulmoboostwere highly satisfied with the treatment of mild-to-moderate respiratory distress symptoms. On the other hand, clients/veterinarians were only moderately satisfied with the efficacy of Pulmoboostin the treatment of moderate-to-severe respiratory distress in sheep and goats.

Table3. *Impact of Pulmoboost on the Response to Treatment Score in Sheep and Goats*

Groups	**Response to Treatment Score**
G1–Mild-to-moderate respiratory distress (n=28)	4.00 ± 0.00
G2–Moderate-to-severe respiratory distress (n=14)	3.00 ± 0.00

Values are expressed as mean ± SEM

3.2 Discussion

The alleviation of symptoms of respiratory distress following Pulmoboost supplementation in our study could be attributed to its individual herbal ingredients,mainly*S.xanthocarpum*, *G. O.basilicum*, *T.chebula*, *A.vasica*, and essential oils of *E. globulus*.

Studies have reported that *S.xanthocarpum* is useful in bronchial asthma and cough [16,17].A pilot study on the clinical efficacy of *S.xanthocarpum* in the treatment of bronchial asthma was conducted to prove the significant use of herbs in the treatment of asthma [18].Major literature data support the use of whole plants. Vadnereet al. evaluated the therapeutic effect of ethanolic extracts of *S.xanthocarpum,* i.e.,asthma-relieving or antihistaminic and anti-allergic property [19].Vadnereet al.studied the effects of the *S.xanthocarpum* extract on some of the parameters such as smooth muscle relaxation, antagonism of asthma mediators such as histamine and eosinophils, and protection against mast cell degranulation, a key process in the pathophysiology of asthma. In addition, they demonstrated that the ethanol extracts of *S.xanthocarpum*exhibited a significant antihistaminic activity in histamine-induced contraction in goat tracheal chain preparation. Thus, the significant inhibition of histamine-induced contractions produced by the ethanol extracts of the*S.xanthocarpum* flower in the isolated goat tracheal chain preparation indicates that the *S.xanthocarpum*flower has antihistaminic (H1 receptor antagonist) properties [19].

The active compounds present in *G. glabra*are the triterpene saponins, especially glycyrrhizic acid, whichalso has antiviral and bacteriostatic activities; moreover, several flavonoids present in the extracts of *G. glabra*have antimicrobial activity. Thealcoholic extracts of *G. glabra*, as well as the sodium salts ofglycyrrhizicacid, exhibit *invitro* antimicrobial action against a range of organisms, such as*Staphylococcus aureus*, *Mycobacterium tuberculosis*, *Escherichia coli*, *Entamoeba histolytica* protozoa, and Trichomonas [20].Many of the flavonoid constituents(hispaglabridin-A, hispaglabridin-B, glabridin, methylglabridin, glabrol, and 3-hydroxyglabrol) of the extract have been identified as active agents [21]. Furthermore, glycyrrhetic acid showed anantipyretic activity similar to that of sodium salicylate on the rectal temperatures of normal and pyretic rats. In a clinical trial of traumatic inflammation, it was revealed that *G. glabra* possesses a more potent antipyreticeffect thanoxyphenylbutazone [22].

O. basilicum has traditionally been used for the management of a number of ailments of the respiratory tract, including asthma, and bronchitis [23].Scientific investigations on the plant material of *O. basilicum* demonstrated anti-inflammatory activity [24], anti-platelet aggregation [25], and anti-parasitic activities [26,27]. Moreover, Janbazet al.reported the folkloric use of *O. basilicum* in constipation, vascular insufficiency, and respiratory distress through *invitro* rat model experiments [28]. In addition, ethanol, methanol, and hexane extracted from *O.basilicum*had antibacterial effects. The hexane extract showed a strong and broader spectrum of antibacterial activity, followed by the methanol and ethanol extracts. The minimal inhibition zones of the hexane, methanol, and ethanol extracts ranged from 125to 250 µL/mL [29].Furthermore, Harsh et al.investigated rosmarinic acid (RA), a multifunctional caffeic acid ester present in *O.basilicum*. They found that RA shows antimicrobial activity against a range of soil-borne microorganisms, with its most deleterious effects being against *Pseudomonas aeruginosa* [30]. Various studies in the literature reported immunomodulatory effects of *O. basilicum* in animal model studies [31,32].

T. chebula exhibited an antibacterial activity against a number of both gram-positive and gram-negative pathogenic bacteria [33-35].Aqueous extracts of dried fruits of *T. chebula* showed anti-inflammatory properties by inhibiting inducible nitric oxide synthesis [36]. Furthermore, Pratibha et al. reported that *T. chebula* in a polyherbal formulation (Aller-7) exhibited a dose-dependent anti-inflammatory effect against Freund's adjuvant-induced arthritis in rats [37]. Moreover, reports in the literature revealed the immunomodulatory properties of *T. Chebula*. The aqueous extracts of *T. chebula* produced an increase in humoral antibody titers and delayed-type hypersensitivity in mice [38].The crude extracts of *T. chebula* stimulated cell-mediated immune responses in experimental amoebic liver abscess in golden hamsters [39].

Alkaloids present in *A. vasica*,such as vasicine and vasicinone, are therapeutically employed as potent respiratory agents. The extracts of the leaf and root parts of *A. vasica*have potential actions against a multitude of pulmonary disorders, such as bronchiole disorders, bronchitis, cough, and cold. The decoction prepared from the leaves of *A. vasica*has a soothing effect that helps clear throat irritation; it can also act as an expectorant[40]. Various other researchershave studied the anti-asthmatic activity of *A. vasica*by extracting the powdered leaves using ethanol as well as its effects on guinea pigs with bronchospasm induced using acetylcholine and histamine. They also conducted *invitro* studies on isolated guineapig ileum. The extract has shown promising effects by inhibiting the bronchial construction dose-dependently[41]. Furthermore, there is evidence of the antibacterial effects of *A. vasica*in the literature [42].The chemical constituents of*A. vasica* vasicine were found to have anti-inflammatory effects. Among all the extracts of the plant, the methanolic ones'show promising anti-inflammatory activity [43].

Horvath and Acs revealed in a systematic review that essential oils have a complex mode of action owing to their multiple compositions. Respiratory tract diseases associated with bacterial infection and inflammation affect a large number of people of every age group worldwide. Due to their volatility, essential oils can easily reach the upper and lower parts of the respiratory tract through inhalation. Moreover, due to their antimicrobial and anti-inflammatory potencies, they offer an effective treatment for respiratory tract infections [44]. In another paper by Vail and Vail,the possible use of some essential oilsfor the treatment of severe acute respiratory syndrome was described [45].

4. Conclusion

In conclusion,after the administration of Pulmoboost, there was an alleviation of symptoms of respiratory distress in sheep and goats,as evidenced by the improvement in the mean scores of the assessment parameters (the severity of respiratory distress score and ease of breathing score). The alleviation of symptoms of respiratory distress following Pulmoboost supplementation could be attributed to the antimicrobial, anti-inflammatory, and immunomodulatory properties of the individual herbal ingredients, mainly *S.xanthocarpum*, *G. glabra*, *O.basilicum*, *T.chebula*, *A.vasica*, and the essential oils of *E. globulus*. Hence, Pulmoboost at a dose of 10 mL twice daily for 4 days is recommended for the treatment of small ruminants (sheep/goat) with symptoms of mild-to-moderate respiratory distress,whereas Pulmoboost at 10 mL twice daily for 5 days along with antibiotics is recommended for the treatment of small ruminants (sheep/goat) with severe respiratory distress symptoms.

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