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Systematic Review of Oestrosis in Small Livestock: Understanding the Impact and Management Strategies

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Abstract

Oestrosis is a mandatory cavitarymyiasis of sheep and goats, resulting from the larvae of Oestrusovis, referred as sheep nose bot. Although oestrusovis is a common parasite is known about the prevalence of oestrosis is globally and over large geographic areas. Despite the prevalence of oestrusovis as a common parasite worldwide, this study investigates various facets of oestrosis in small cattle. The examination covers pathogenic, clinical, epidemiological, and diagnostic aspects of this condition. When evaluating diminutive creatures like sheep and goats, it becomes crucial to consider the prevalence of oestrosis, a parasitic ailment transmitted by the bot fly Oestrusovis. Analyzing the spread of oestrosis underscores the significance of environmental variables but also enables the development of tailored treatment strategies. Delving into the pathogenic mechanisms, encompassing immunological reactions, histological alterations, and larval infiltration, enriches our comprehension of the intricate interplay between host and parasite. The range of symptoms that characterize clinical presentations in tiny cattle emphasizes the need of individualized treatment plans and complex diagnosis. To guarantee precise identification, a comprehensive framework of diagnostic methods is used, including imaging, clinical assessment, and molecular testing. To lessen the negative impacts of Oestrusovis infestation on animal health and production, a wide variety of management techniques are used, such as anthelmintics, environmental approaches, genetic resistance, and integrated processes. This study underscores the significance of considering season-specific factors in the management of oestrus infestations. It delves into the documented variations in larval characteristics during summer, spring, winter, and fall. By acknowledging these seasonal fluctuations, experts can formulate targeted and efficient strategies to combat oestrosis in small cattle. This approach supports the creation of specialized and adaptable methods, enhancing overall effectiveness while minimizing detrimental effects on animal health.

Keywords: Oestrosis; Small cattle; Epidemiology; Pathogenic mechanisms; Diagnostic methods; Management strategies

INTRODUCTION

Examining an extensive amount of research focused on understanding and managing the parasite disease becomes essential for the systematic evaluation of oestrosis in tiny cattle. The danger presented by Oestrosis and Oestrusovis to the health and production of small ruminants, notably sheep and goats, highlights the significance of a comprehensive examination. This study looks at several elements of oestrosis, such as its epidemiology, etiology, and clinical symptoms, as well as diagnostic procedures and possible control options (1). The major goal of the systematic review is to provide a complete evaluation of several researches that have contributed to understanding the parasitic disease's prevalence and geographical dispersion. The research aims to reveal trends, identify risk factors, and determine differences in the prevalence of oestrosis among small cattle populations by analyzing epidemiological data from diverse geographic locations. This in-depth examination of the epidemiological landscape allows for a nuanced understanding of the influence of environmental, climatic, and husbandry variables on the dynamics of oestrosis. The insights gained are critical for creating tailored preventative and control actions (2). To create successful treatment plans, it is essential to understand the pathophysiology of oestrosis. This analysis examines the intricate processes by which Oestrus ovis larvae enter small ruminant nasal canals and sinuses, and cause a variety of physiological effects. The review provides an

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understanding of the complex relationships between the parasite and its host by including the findings from immunological investigations, histopathological analyses, and genetic analyses. The identification of possible targets for therapeutic treatments is made easier by this information, which also improves our understanding of the disease's course (3). Oestrosis affects more than the disease itself; it affects the financial hardships faced by those who look after livestock and the health of the animals that are affected. This analysis examines a wide range of clinical research, illuminating the symptoms associated with oestrosis. These symptoms might be anything from minor respiratory irritation to serious conditions including sneezing, nasal discharge, and secondary bacterial infections. This study serves a crucial role in improving diagnostic criteria and promoting early diagnosis by clarifying the range of clinical symptoms. This leads to better results for animals and their caretakers by enabling prompt and focused veterinarian treatments (4). Implementing precise and effective diagnostic techniques is essential for the quick and accurate identification of instances with oestrosis. Comprehensive analyses of clinical evaluations, imaging modalities, molecular testing and other diagnostic methods that have been included in a number of researches are essential. In order to enable practitioners to choose the most practical and successful methods for identifying oestrosis in small cattle, thorough examination is essential (5). Prevention and management strategies are key to managing oestrosis in small cow herds. This systematic review explores the effectiveness of various control strategies, including genetic resistance, environmental management, and anthelmintic treatment, by conducting thorough an analysis of research. Through the integration of recent study results about the advantages and disadvantages of various treatment modalities, the review seeks to provide significant insights. Moreover, it aims to incorporate this information into long-term management plans that are customized for various agro-ecological contexts (6). A detailed examination of oestrosis in small animals is a laborious attempt to gather, evaluate, and integrate the wealth of information on this parasitic disease. This complete review of oestrosis will be achieved by an analysis of the disease's etiology, clinical symptoms, diagnosis techniques, and treatment approaches. Since small ruminant management is developing, the data from this systematic review will have a significant influence on future research projects, improve disease control protocols, and eventually raise the productivity and welfare of small livestock globally (7). Small livestock, which includes animals like sheep and goats, is an important part of the worldwide agricultural system and a major source of income for both rural communities and the national economy. In order to ensure the well-being and continued output of tiny animals, it is essential to understand the wide range of variables affecting small livestock and to implement effective management techniques. Because small cattle are the primary source of income and nutrition for many people, particularly in developing countries, their impact extends beyond economic considerations (8). Oestrus ovis, the sheep nasal bot fly, goes through a life cycle. As an immature third-instar larva, it emerges from the sheep's nostrils, develops, and eventually drops to the ground to pupate. As depicted in figure 1, the adult fly emerges and commences counterclockwise flight, devoid of any impending egg-laying in a sheep host.

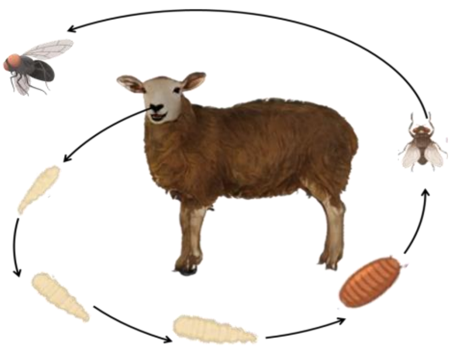

Figure (1). Life Cycle of Oestrus ovis: Larva to Fly (Source: Author)

The interconnection between the sustainability of small-scale livestock management and the condition of the environment, resource availability, and climate unpredictability is profound. Significantly contributing to this equation is the fact that climate change endangers water resources, animal health in general, and the quantity and quality of forage. In order to enhance the robustness of minor livestock systems, it is critical to recognize and confront these environmental obstacles. In the realm of small cattle husbandry, disease control assumes

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critical importance due to the significant detrimental effects that parasitic diseases, including gastrointestinal worms in the pharynx and oestrosis, have on the well-being and productivity of these organisms (9). To mitigate the spread of diseases within small livestock communities, it is critical for veterinarians to implement efficient disease surveillance systems, perform routine deworming, and administer immunizations in a timely manner. Furthermore, the development of region-specific treatment strategies is facilitated by the acquisition of knowledge regarding the epidemiology of prevalent diseases. The nutritional intake and output of miniature cattle are profoundly impacted by their dietary regimen. The fundamental components of effective livestock management include guaranteeing readily available, high-quality forage, and implementing sound feeding practices, and ensuring that animals have access to a balanced diet (10). The research presented which is crucial in formulating strategies to improve the resilience, productivity, and overall welfare of small livestock in the face of oestrosis challenges, as it underscores the critical nature of sustainable agriculture and the prioritization of animal welfare.

RELATED WORKS

The research (11) investigated the possible therapeutic impact of Epimedium brevicornu Maxim on osteoporosis Potential applications of Ext-epi in the treatment of osteoporosis have been illuminated by the discovery of biomarkers and important pathways, including glycerophospholipid metabolism and arachidonic acid metabolism. In order to comprehend illness etiology and natural product therapies, metabolomics is a useful technique. The research (12) emphasized how age-related bone loss and musculoskeletal problems are a global concern. Sirtuins, in particular SIRT1–SIRT7, become important modulators of bone homeostasis that affect illness and skeletal development. Transgenic models and sirtuin knockdown studies demonstrate their ability to prevent osteoporosis. An analysis of sirtuin agonists' functions and therapeutic potential was warranted by preclinical data that points them to effective treatments for age-related bone diseases. The study (13) explored Anabolic (parathyroid hormone) and anti-resorptive (calcitonin, estrogen, bisphosphonates) drugs are used to treat osteoporosis, a major issue in aging populations. This assessment of the literature looks at both established and novel therapies, giving doctors guidance on the best course of action while taking probable side effects, clinical data, and molecular pathways into account. The study (14) evaluated the effects of bone marrow stem cell transplantation (BMSCT), which may enhance mechanical qualities, decrease bone loss, and maybe metabolic markers, on osteoporosis resulting from ovariectomy. These results lay the groundwork for further research into bone marrow mesenchymal stem cell transplantation (BMSCT) as a treatment for osteoporosis treated with BMSCT, which promotes bone tissue repair. The research (15) emphasized the possible disturbances during grazing and larval development, underscoring Oestrusovis's considerable influence on small ruminants. The flexible life cycle of the parasite, which is impacted by environmental factors and weather, emphasizes how crucial it is to comprehend its epidemiology.

The research (16) demonstrated that yak bone collagen peptides (YBP) therapy inhibited ovariectomy-induced bone degradation and had a beneficial effect on serum bone turnover indicators. With regard to the YBP group, non-targeted metabolomics found significant alterations in 41 biomarkers, 21 which had decreased expression and 20 of elevated expression. The potential of YBP as a natural therapeutic option for osteoporosis was highlighted by the systematic network analysis that demonstrated its protective impact on osteoporosis through regulation of amino acid and lipid metabolism. The study (17) highlighted an osteoporosis as a growing concern as the world's population ages. Enhancing bone formation is a problem, despite the fact that current pharmacological interventions concentrate on blocking bone resorption and encouraging mineralization. This article explores the possibilities of stem cell treatment, including its implications for understanding the processes behind osteoporosis, its discussion of animal models used in experiments. The study (18) suggested a substantial relationship between host health, sickness, and microbiome. One of the numerous illnesses connected to disruptions in the gut flora is osteoporosis. The mechanisms governing the interaction between bacteria and bone have been clarified by recent advances in molecular biotechnology. To develop targeted osteoporosis prevention and treatment strategies, it is imperative to understand the role of microbiome, particularly in relation to microRNAs. The study (19) described to express concern about osteoporosis due to the rising incidence of Primary Biliary Cholangitis (PBC). Despite expert-guided monitoring protocols, insufficient information is known about the management of osteoporosis in PBC. Excerpted from the literature on postmenopausal osteoporosis, many pathophysiological factors provide challenges for existing therapeutic approaches. The lack

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of effective treatments is a significant barrier to raising the quality of life for PBC sufferers. The study (20) demonstrated a substantial concern over the prevalence of osteoporosis in PBC. Despite PBC becoming more common, there was a limited information on addressing osteoporosis in this context. National recommendations state that the ideal time to test for PBC is at diagnosis, while the optimal course of treatment for debate. Despite the fact that there is an evidence connecting postmenopausal osteoporosis and PBC-related osteoporosis, there are treatment options available.

EPIDEMIOLOGICAL RESEARCH

Prevalence measures are crucial in determining the frequency of oestrosis in small cattle, as they indicate the proportion of animals in a population affected by the parasitic ailment in a specific period. These measures help in assessing the extent of oestrosis and its effects on small livestock herds, enabling efficient resource allocation and mitigation of its effects. Distribution research investigates the acquisition or retention of oestrosis in different subgroups of small cattle, identifying changes in susceptibility due to environmental factors like location, climate, or management practices (21). This information is essential for developing location-specific management strategies, such as customized medications to address specific challenges faced by small animals in specific regions. These epidemiological measures are necessary for a comprehensive analysis of oestrosis in small cattle, providing a numerical summary of the infection's impacts and guiding the assessment of its overall burden. Together, these resources enable researchers, policymakers, and veterinarians to implement targeted management approaches to enhance the well-being and health of small livestock populations affected by oestrosis.

The Hazard component

Numerous risk factors exist for the emergence and transmission of oestrosis in small cattle

The neighboring situation

Environmental factors, such as temperature and humidity, significantly impact the life cycle of Oestrus ovis, a bot fly (22), affecting its larvae's survival and development, thereby increasing the likelihood of infection in small animals.

A Precise Location

Geographical location significantly increases the risk of developing oestrosis, as favorable bot fly habitats and climate variability contribute to its prevalence. Small ruminant populations are more likely to experience oestrosis when the entire life cycle of the bot fly is supported.

The Husbandry Practices

Oestrosis susceptibility can be influenced by husbandry techniques, including overcrowded lodging, inadequate sanitation, and ineffective pasture management. Additionally, behaviors like sharing water and food sources can increase the likelihood of Oestrus ovis larvae flourishing and disseminating widely.

The Host Factors

Oestrosis susceptibility in small animals depends on their health and age, with adolescents and those with compromised immune systems being more susceptible. Variations in strain resistance could contribute to the disease's differential prevalence rates among different populations. Understanding these risk factors is crucial for developing effective management strategies. Prevention and management of oestrosis require environmental risk reduction, site-specific control measures, and effective husbandry practices to safeguard animal health and productivity.

PATHOGENIC PROCESSES

Oestrosis is a pathological condition affecting small cattle caused by the bot fly Oestrus ovis. It begins with infection and progresses through several stages (23). Mature female Oestrus ovis flies deposit larvae near susceptible animals' nostrils during milder seasons, causing them to invade the host's sinuses, nasal passages, and respiratory system. As the larvae molt, they cause irritation and inflammation, leading to symptoms like

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head tremors, discharge from the nose, and respiratory distress. Secondary bacterial infections from the larvae in the nasal passages can worsen the condition.

Method of larva infestation

Oestrus ovis larvae, deposited by adult bot flies near small animals' nasal regions, are used to manage oestrosis-induced infestations. These larvae cause irritation and inflammation in the sinuses, respiratory tract, and nasal cavity, leading to clinical symptoms. The larvae leave the host when they mature, indicating the end of their life cycle. The immune system's reaction to the infestation can cause damage to the nasal mucosa and other tissues. Understanding these mechanisms is crucial for developing targeted therapies for oestrosis prevention in small cattle (24).

Histopathological and Immunological Insights

The study of oestrosis on small cattle requires thorough examination of immunological and histopathological aspects. Histopathological examination reveals structural changes, inflammatory reactions, and adverse effects in the sinuses and nasal passages due to oestrus ovis larvae infestation (25). Immunological analysis examines the host's immune responses, including innate and adaptive mechanisms, to counteract the presence of oestrus ovis larvae. This understanding enhances the complex relationship between the host and parasite, enabling the development of effective preventive and therapeutic strategies to mitigate the health risks of small animals.

CLINICAL MANIFESTATIONS

Oestrosis in small cattle is a clinical condition characterized by observable symptoms. Veterinary professionals use examination, imaging, and molecular testing to diagnose the condition, ensuring early treatment for susceptible animals and a precise diagnosis of parasite infections through targeted treatment.

Spectrum of Symptoms in Small Livestock

Oestrosis is a condition affecting small cattle, causing symptoms like distended pupils, rhinorrhea, and respiratory distress. Symptoms can range from mild to severe, with respiratory distress accompanied by behavioral changes (26). The presence of Oestrusovis larvae can cause further complications, potentially leading to secondary bacterial infections and an expansion of the clinical spectrum. Due to the complexity of oestrosis, its identification and treatment must be approached cautiously, considering the wide range of symptom manifestations.

Variability and Severity

Oestrosis clinical manifestations are diverse due to various factors, including the number of larvae, host immune response, and variations among animals. A comprehensive examination is crucial for diagnosis, as the severity of symptoms depends on the extent of larval tissue damage. Severe cases can lead to respiratory complications or harm to the animals (27). The wide range of reactions emphasizes the need for customized therapeutic approaches, as oestrosis can cause discomfort ranging from moderate irritation to severe distress. Accurate diagnosis, intervention, and effective strategies to alleviate oestrosis's negative impacts on small cattle communities depend on understanding these variations.

DIAGNOSTIC METHODS

Diagnostic techniques are employed to identify and confirm the presence of Oestrus ovis larvae in small cattle afflicted with oestrosis.

Clinical Examination and Imaging

Clinical assessment is a crucial diagnostic method for tiny cattle, involving observing outward behaviors and symptoms. Symptoms include head shaking, nasal discharge, and respiratory discomfort (28). Visibility inside the sinuses and nose is crucial for imaging procedures like radiography and endoscopy. These procedures determine the presence, location, and degree of Oestrus ovis larvae infection. Imaging improves diagnosis accuracy by providing a visual assessment of larvae's impact on the respiratory system, aiding in successful intervention plans.

Molecular Tests for Detection

Molecular diagnostic techniques, such as polymerase chain reaction (PCR), have become advanced tools for oestrosis diagnosis due to their increased sensitivity and specificity. These methods can identify even trace amounts of larvae, improving diagnostic accuracy and minimizing health problems in small calves. Integrating molecular assays into diagnostic protocols facilitates preventative interventions, promoting effective disease management and enhancing the health and productivity of small cattle herds (29). Veterinary professionals use clinical examination, imaging, and molecular testing to create a comprehensive diagnostic framework for oestrosis in small cattle, ensuring the complete and precise diagnosis of parasite infections.

PERFORMANCE ANALYSIS

Seasonal dynamics are important to consider while examining and treating oestrosis in goats indicate significant differences in larval features according to the season. The varying characteristics of larvae in the autumn, spring, summer, and winter highlighted the seasonal variations affect the spread and intensity of oestrosis infections (30).

The Spring time

The study of third-instar larvae in spring revealed diverse sizes and maturity stages, with an average measurement of 1.18. The larvae's length and breadth were recorded at 1.54 and 0.63 were shown in table (1) and Figure (2), respectively, providing valuable insights into the dynamics of habitats where oestrosis is prevalent.

Table (1). Oestrus ovis Larval Characteristics in spring

[“**Source**: https://www.mdpi.com/2076-2615/11/3/689”]

Larvel Characterstics	Spring
L2 Instar	0.02
L3 Instar	1.18
L3 Length	1.54
L3 Width	0.63
L3 Infestation	0.88

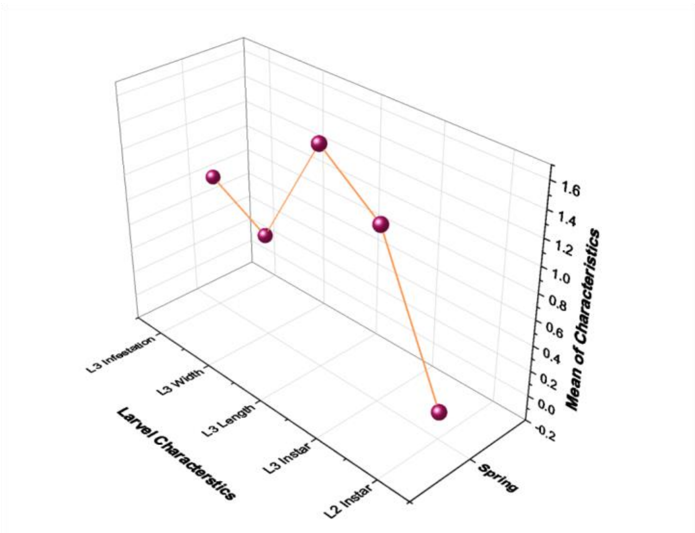

Figure (2). Oestrus ovis spring Larval Characteristics

[“**Source**: https://www.mdpi.com/2076-2615/11/3/689”]

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Quantitative measures were used to describe larvae's exterior aspects in spring, with a recorded infection rate of 0.88 indicating a high incidence of oestrosis in the study community. Understanding seasonal fluctuations is crucial for effective management strategies, ultimately increasing cattle health and well-being.

The Winter time

An extensive study of third-instars (L3) larvae carried out in the winter produced distinctive characteristics that provided important information on the dynamics of oestrosis infestations in lower temperatures. The average measurement for the L3 instars was 1.05, indicating that the study had found a unique size and maturity stage that was only present during the winter. In addition, the L3 larvae had precise measurements: they were 1.57 inches long and 0.54 inches wide.

Table (2). Wintertime characteristics of the ovis larva

[“**Source**: https://www.mdpi.com/2076-2615/11/3/689”]

Larvel Characterstics	Winter
L2 Instar	0
L3 Instar	1.05
L3 Length	1.57
L3 Width	0.54
L3 Infestation	0.45

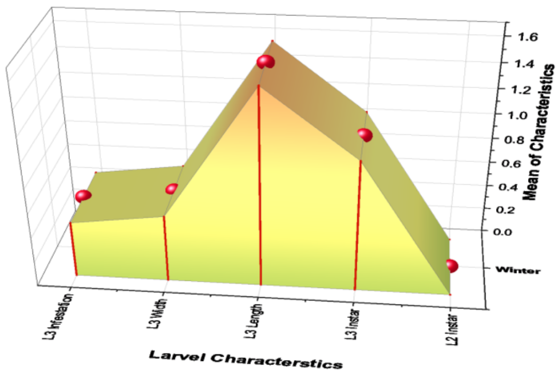

Figure (3). Examination of Oestrus ovis Winter Larval Features

[“**Source**: https://www.mdpi.com/2076-2615/11/3/689”]

The study evaluates winter-associated physical traits in larvae, providing insights into adaptation mechanisms to temperature fluctuations. The seasonally adjusted infection rate of 0.22 suggests a decreased incidence of oestrosis in the population. More information about the seasonal variations in larval features can be found in Tables (2) and Figure (3). These findings, unique to winter, can help create tailored management strategies to protect animals and provide valuable insights into winter adaptation mechanisms.

The Autumn time

A detailed examination of third-instar (L3) larvae in the fall produced unique characteristics that provided insight into the dynamics of oestrosis infestations during this transitional phase. The L3 instars’ average measurement f 1.17 revealed an extraordinary size and maturation stage unique to the fall season. The L3 larvae also showed measurements of 0.51 widths and 1.49 lengths.

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Table (3). Autumn time characteristics of the ovis larva

["**Source**: https://www.mdpi.com/2076-2615/11/3/689"]

Larvel Characterstics	Autumn
L2 Instar	0
L3 Instar	1.17
L3 Length	1.49
L3 Width	0.51
L3 Infestation	0.23

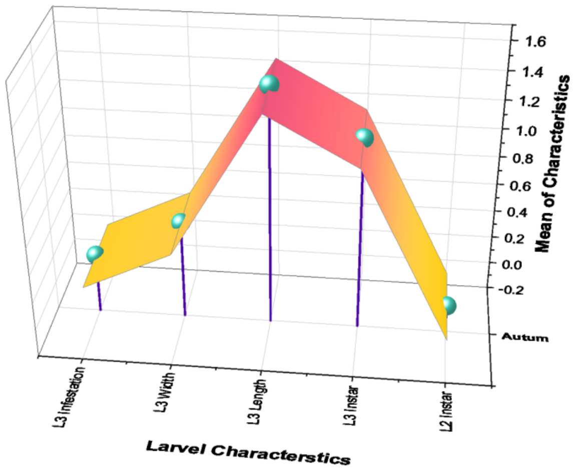

Figure (4). Characteristics of Oestrus ovis autumn larvae

["**Source**: https://www.mdpi.com/2076-2615/11/3/689"]

The study provides a detailed analysis of fall larvae's physical characteristics, revealing a moderate prevalence of oestrosis in the community. Table (3) and Figure (4) further demonstrate the moderate prevalence of oestrosis in the community under study. The infestation rate is 0.23, and analyzing these differences can help develop tailored management strategies for cattle health and wellbeing, thereby enhancing the overall environment.

The Summer time

The study found significant seasonal variations in goat larval features, affecting the frequency of the third instar (L3) and total larvae. These changes were explained by the visual representations in Table (4) and Figure (5).The summer saw higher mean values, with the third instars having a higher mean of 1.91 ± 0.12.

Table (4). Oestrus ovis Larval Characteristics in summer

["**Source**: https://www.mdpi.com/2076-2615/11/3/689"]

Larvel Characterstics	Summer
L2 Instar	0.03
L3 Instar	1.91
L3 Length	1.47
L3 Width	0.58
L3 Infestation	0.45

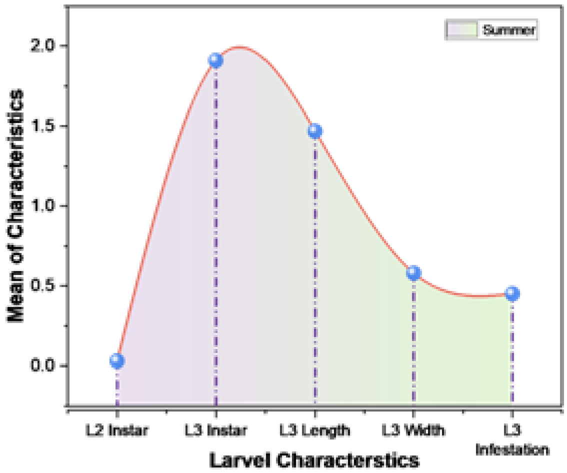

Figure (5). Oestrus ovis Summer Larval Characteristics

[“**Source**: https://www.mdpi.com/2076-2615/11/3/689”]

The study reveals that goats are more susceptible to larvae infestations in summer, with a significant spike in L3 instar. This underscores the need for season-specific management measures and the complexity of oestrosis dynamics, emphasizing the need for customized.

CONCLUSION

The study explores the complex dynamics of oestrosis, emphasizing the need for a multimodal approach to effectively treat it. It emphasizes the importance of considering seasonal fluctuations in intervention tactics, as distinct larval traits manifest over different periods. To improve the health and welfare of small cattle herds, targeted management plans are crucial, considering pathogenic processes, risk factors, and epidemiological trends. Diagnostic tools are used to ensure accurate identification and timely intervention. The paper reviewed a comprehensive approach, regional differences and various small livestock production techniques. This includes environmental control and genetic resistance management strategies. The study underscores the importance of using season are autumn, winter, summer and spring specific factors for controlling oestrosis infestations. It contributes
to our understanding of oestrosis dynamics and provides a framework for precise management plans to mitigate its negative impacts on goat cattle.

REFERENCES

1. Huang, Y. Y., Wang, Z. H., Deng, L. H., Wang, H., & Zheng, Q. (2020). Oral administration of quercetin or its derivatives inhibit bone loss in animal model of osteoporosis. Oxidative medicine and cellular longevity, 2020. https://doi.org/10.1155/2020/6080597
2. Estell, E. G., & Rosen, C. J. (2021). Emerging insights into the comparative effectiveness of anabolic therapies for osteoporosis. Nature Reviews Endocrinology, 17(1), 31-46.https://doi.org/10.1038/s41574-020-00426-5
3. Kobza, A. O., Herman, D., Papaioannou, A., Lau, A. N., & Adachi, J. D. (2021). Understanding and managing corticosteroid-induced osteoporosis. Open Access Rheumatology: Research and Reviews, 177-190. https://doi.org/10.2147/OARRR.S282606
4. Evenepoel, P., Cunningham, J., Ferrari, S., Haarhaus, M., Javaid, M. K., Lafage-Proust, M. H., ...&Cannata-Andia, J. (2021). European Consensus Statement on the diagnosis and management of osteoporosis in chronic kidney disease stages G4–G5D. Nephrology Dialysis Transplantation, 36(1), 42-59.https://doi.org/10.1093/ndt/gfaa192
5. Lei, C., Song, J. H., Li, S., Zhu, Y. N., Liu, M. Y., Wan, M. C., ...&Niu, L. N. (2023). Advances in materials-based therapeutic strategies against osteoporosis. Biomaterials, 122066.https://doi.org/10.1016/j.biomaterials.2023.122066

6. Ahaduzzaman, M. (2019). The global and regional prevalence of oestrosis in sheep and goats: a systematic review of articles and meta-analysis. Parasites & vectors, 12(1), 1-17.https://doi.org/10.1186/s13071-019-3597-2
7. Pagnotti, G. M., Styner, M., Uzer, G., Patel, V. S., Wright, L. E., Ness, K. K., ...& Rubin, C. T. (2019). Combating osteoporosis and obesity with exercise: leveraging cell mechanosensitivity. Nature Reviews Endocrinology, 15(6), 339-355.https://doi.org/10.1038/s41574-019-0170-1
8. Cai, X., Li, Z., Yao, Y., Zheng, Y., Zhang, M., & Ye, Y. (2023). Glycolithocholic acid increases the frequency of circulating Tregs through constitutive androstane receptor to alleviate postmenopausal osteoporosis. Biochemical Pharmacology, 115951.https://doi.org/10.1016/j.bcp.2023.115951
9. Salamanna, F., Maglio, M., Sartori, M., Tschon, M., &Fini, M. (2020). Platelet features and derivatives in osteoporosis: a rational and systematic review on the best evidence. International Journal of Molecular Sciences, 21(5), 1762.https://doi.org/10.3390/ijms21051762
10. Niedermair, T., Lukas, C., Li, S., Stöckl, S., Craiovan, B., Brochhausen, C., ...&Grässel, S. (2020). Influence of extracellular vesicles isolated from osteoblasts of patients with cox-arthrosis and/or osteoporosis on metabolism and osteogenic differentiation of BMSCs. Frontiers in Bioengineering and Biotechnology, 8, 615520.https://doi.org/10.3389/fbioe.2020.615520
11. Zhao, J. F., Xu, J. Y., Xu, Y. E., Chen, S. L., Guo, Y. X., Gao, Q. Y., & Sun, G. C. (2020). High-throughput metabolomics method for discovering metabolic biomarkers and pathways to reveal effects and molecular mechanism of ethanol extract from epimedium against osteoporosis. Frontiers in Pharmacology, 11, 1318.https://doi.org/10.3389/fphar.2020.01318
12. Li, Q., Cheng, J. C. Y., Jiang, Q., & Lee, W. Y. W. (2021). Role of sirtuins in bone biology: Potential implications for novel therapeutic strategies for osteoporosis. Aging cell, 20(2), e13301.https://doi.org/10.1111/acel.13301
13. Ukon, Y., Makino, T., Kodama, J., Tsukazaki, H., Tateiwa, D., Yoshikawa, H., &Kaito, T. (2019). Molecular-based treatment strategies for osteoporosis: a literature review. International journal of molecular sciences, 20(10), 2557.https://doi.org/10.3390/ijms20102557
14. Wang, W., Wang, Y., Hu, J., Duan, H., Wang, Z., Yin, L., & He, F. (2022). Untargeted metabolomics reveal the protective effect of bone marrow mesenchymal stem cell transplantation against ovariectomy-induced osteoporosis in mice. Cell Transplantation, 31, 09636897221079745.https://doi.org/10.1177/09636897221079745
15. Gracia, M. J., de Arcaute, M. R., Ferrer, L. M., Ramo, M., Jiménez, C., &Figueras, L. (2019). Oestrosis: parasitism by Oestrus ovis. Small Ruminant Research, 181, 91-98.https://doi.org/10.1016/j.smallrumres.2019.04.017
16. Ye, M., Zhang, C., Jia, W., Shen, Q., Qin, X., Zhang, H., & Zhu, L. (2020). Metabolomics strategy reveals the osteogenic mechanism of yak (Bosgrunniens) bone collagen peptides on ovariectomy-induced osteoporosis in rats. Food & function, 11(2), 1498-1512.https://doi.org/10.1039/C9FO01944H
17. Paspaliaris, V., &Kolios, G. (2019). Stem cells in osteoporosis: from biology to new therapeutic approaches. Stem Cells International, 2019.https://doi.org/10.1155/2019/1730978
18. De Martinis, M., Ginaldi, L., Allegra, A., Sirufo, M. M., Pioggia, G., Tonacci, A., &Gangemi, S. (2020). The osteoporosis/microbiota linkage: the role of miRNA. International Journal of Molecular Sciences, 21(23), 8887.https://doi.org/10.3390/ijms21238887
19. Trivedi, H. D., Danford, C. J., Goyes, D., & Bonder, A. (2020). Osteoporosis in primary biliary cholangitis: prevalence, impact and management challenges. Clinical and Experimental Gastroenterology, 17-24.https://doi.org/10.2147/CEG.S204638
20. Trivedi, H. D., Danford, C. J., Goyes, D., & Bonder, A. (2020). Osteoporosis in primary biliary cholangitis: prevalence, impact and management challenges. Clinical and Experimental Gastroenterology, 17-24. https://doi.org/10.2147/CEG.S204638
21. Aziziyeh, R., Amin, M., Habib, M., Perlaza, J. G., McTavish, R. K., Lüdke, A., ...& Cameron, C. (2019). A scorecard for osteoporosis in four Latin American countries: Brazil, Mexico, Colombia, and Argentina. Archives of osteoporosis, 14, 1-10.https://doi.org/10.1007/s11657-019-0622-1

22. Gizaw, A., Admasu, P., Nagasa, A., Shiferaw, S., Bayu, M. D., &Abdella, A. (2022). Prevalence and Associated Risk Factors of Ovine Oestrosis in Dendi District of Central Ethiopia. Veterinary Medicine: Research and Reports, 59-64.https://doi.org/10.2147/VMRR.S349995
23. Salem, H. M., &Attia, M. M. (2021). Accidental intestinal myiasis caused by Muscadomestica L.(Diptera: Muscidae) larvae in broiler chickens: a field study. International Journal of Tropical Insect Science, 41, 2549-2554.https://doi.org/10.1007/s42690-021-00492-w
24. Attia, M. M., Soliman, S. M., Mahmoud, M. A., & Salem, M. A. (2022). Oxidative stress markers, immune-regulating cytokines, and the pathological evaluation of sheep co-infected with Oestrusovis and Coenuruscerebralis. Microbial Pathogenesis, 169, 105613.https://doi.org/10.1016/j.micpath.2022.105613
25. Srivastava, R. K., &Sapra, L. (2022). The rising era of "Immunoporosis": role of immune system in the pathophysiology of osteoporosis. Journal of Inflammation Research, 1667-1698.https://doi.org/10.2147/JIR.S351918
26. Tejtel, S. K. S., Munoz, F. M., Al-Ammouri, I., Savorgnan, F., Guggilla, R. K., Khuri-Bulos, N., ...&Engler, R. J. (2022). Myocarditis and pericarditis: case definition and guidelines for data collection, analysis, and presentation of immunization safety data. Vaccine, 40(10), 1499-1511.https://doi.org/10.1016/j.vaccine.2021.11.074
27. Crosta, L. (2021). Respiratory Diseases of Parrots: Anatomy, Physiology, Diagnosis and Treatment. Veterinary Clinics: Exotic Animal Practice, 24(2), 397-418.https://doi.org/10.1016/j.cvex.2021.01.005
28. Bouzid, D., Zanella, M. C., Kerneis, S., Visseaux, B., May, L., Schrenzel, J., &Cattoir, V. (2021). Rapid diagnostic tests for infectious diseases in the emergency department. Clinical Microbiology and Infection, 27(2), 182-191.https://doi.org/10.3390/s19051100
29. Sepúlveda-Crespo, D., Reguera, R. M., Rojo-Vázquez, F., Balaña-Fouce, R., &Martínez-Valladares, M. (2020). Drug discovery technologies: Caenorhabditiselegans as a model for anthelmintic therapeutics. Medicinal research reviews, 40(5), 1715-1753.https://doi.org/10.1002/med.21668
30. Metwally, D. M., Albasyouni, S. A., Barakat, I. A., Al-Turaiki, I. M., Almuhanna, A. M., Bashir, M. A., ...&Alajmi, R. A. (2021). Prevalence rate and molecular characteristics of Oestrus ovis L.(Diptera, Oestridae) in sheep and goats from Riyadh, Saudi Arabia. Animals, 11(3), 689.https://doi.org/10.3390/ani11030689