

Original Article

Histopathological Investigation of *Sarcoptes scabiei* Infestation in Sheep Population in Diyala Province, Iraq



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ABSTRACT

Background: Mange, primarily caused by the parasitic mite *Sarcoptes scabiei*, poses a serious health threat to many mammalian species, including domesticated and wild animals.

Objectives: This study investigates the major effects of *S. scabiei*, the causative agent of scabies, focusing on the sheep population in Diyala Province, Iraq. The disease results in severe clinical symptoms, such as intense itching, hair loss, and secondary infections, and may negatively impact the productivity and wool quality of affected sheep. Despite its importance, the histopathological alterations induced by *S. scabiei* in sheep have remained poorly documented.

Methods: To explore these alterations, skin samples were collected from sheep diagnosed with scabies in Diyala Province. The tissue samples were stained using hematoxylin and eosin (H&E) and examined under a light microscope to identify and document pathological changes caused by the mite.

Results: Histopathological analysis revealed significant abnormalities, including hyperkeratosis, acanthosis, neutrophilic infiltration, and hemorrhage. *S. scabiei* in the stratum corneum, accompanied by follicular hyperkeratosis and acute cellular swelling, highlights the intense inflammation and tissue damage resulting from the infestation.

Conclusion: This study confirms distinct histopathological changes in sheep's skin affected by sarcoptic mange.

Keywords: Acanthosis, Sarcoptic mange, Hyperkeratosis, Scabies

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Introduction

Mange, predominantly caused by the parasitic mite *Sarcoptes scabiei*, poses a serious health threat to many mammalian species, including domesticated and wild animals (Moroni et al., 2022).

In regions like Diyala, Iraq, the impact of this parasite on livestock, particularly sheep, extends beyond basic health concerns, affecting both economic stability and animal welfare. This pruritic condition is severe, and animals become less productive, experience weight loss, and have poor wool quality. Secondary infections often follow skin eruptions after general deterioration of physical condition (Gebeyehu & Derso, 2015). Furthermore, it is important to note that this condition can lead to significant economic consequences, primarily reduced production levels and increased animal mortality rate (Deferes & Geresu, 2016; Akbari et al., 2024).

This study was conducted in Diyala Province, where, despite the critical importance of the sheep sector in agricultural economics, sarcoptic mange infestations have caused substantial damage. However, the histopathological implications of mange infestations have remained poorly understood. This research aims to carefully document the histopathological changes induced in mange-infested sheep, providing a detailed analysis of disease progression and impact (Murshed et al., 2022). Subcutaneous mites burrow channels beneath the skin, releasing powerful digestive enzymes in their saliva that dissolve skin cells and nourish them. It is important to note that these mites do not feed on blood. Mature females lay their eggs in these subdermal tunnels, where they incubate for 3–5 days before hatching. Full development, including several larval and nymphal stages, is typically completed in less than 14 days (Linn et al., 2024; Rahimi et al., 2024).

In affected farm animals, pruritic nodules cause intense itching, leading to wool loss, crust formation, and skin wrinkling. The effects are most pronounced on the thighs, hocks, and axillas (Reddy & Sivajothi, 2016). *S. scabiei* infestation causes severe itching, exudative inflammation, scaly crusts with parakeratosis, hair loss, and skin darkening and thickening (Zewdie et al., 2018; Abdolmohammadi et al., 2024). Beneath the crust and within the skin, fissures may lead to bleeding. Additional signs of scabies include anemia, emaciation, weakness, and subcutaneous fluid accumulation (Saleh et al., 2011).

This study is important for developing and implementing effective management and control strategies for sarcoptic mange. It aims to enhance our understanding of the tissue-level effects of *S. scabiei* on the host, which will contribute to improved diagnostic methods, treatment protocols, and prevention strategies. Ultimately, this will promote better animal health and support the economic sustainability of sheep farming in affected regions. Furthermore, this research will contribute to veterinary pathology and agricultural sustainability by highlighting the importance of combating animal diseases to ensure livestock health and productivity.

Objectives

The study focuses on the major effects of *S. scabiei*, the mite responsible for causing scabies, particularly in Diyala, Iraq. The disease results in severe symptoms such as intense itching, hair loss, and secondary infections, and it can negatively impact sheep's productivity and wool quality. Despite its significance, the histopathological alterations caused by *S. scabiei* in sheep remain inadequately documented.

Materials and Methods

Parasitological examination

The lesion was deeply scraped using a sterile scalpel to collect skin scales. The scrape samples were obtained from the periphery or outer edge of the lesion, then placed into a sterile Petri dish and transported to the laboratory using aseptic techniques (Sargison et al., 2007).

The collected skin cell samples were carefully placed onto a microscopic slide and mixed with 10%–30% potassium hydroxide (KOH) solution to dissolve any remaining tissue. The slide was gently warmed and left to rest briefly. Subsequently, a cover slip was applied and gently pressed down, and the slide was examined under low and high magnification using reduced lighting conditions (AL-Khardi & Khudhair, 2013).

Histopathological examination

Biopsy samples were taken from the edges of the affected regions. Tissue specimens approximately 1 cm in size were preserved for 72 hours and fixed directly in a 10% buffered formalin solution. Following fixation, the tissues were washed in tap water and processed routinely. They were then immersed in a series of increasing alcohol concentrations ranging from 70% to 100% for 2 hours.

The process involved a two-stage infiltration using liquid paraffin wax at 58 °C to embed the specimens. Blocks were formed using paraffin wax, and the embedded tissues were sectioned using a rotary microtome at a thickness of 5 µm. This step was performed after the tissues had been dehydrated. To identify histopathological alterations, the sections were mounted on slides and stained with hematoxylin and eosin (H&E) (Wolfe, 2018).

A total of 25 samples were collected from sheep—some exhibiting signs of wool loss and itching and others without symptoms. The sheep varied in age and included both sexes, as illustrated in the Figure 1.

Results

According to the histological examination, many sections revealed alterations in the skin layers during scabies infection. Histopathological examinations of the skin sections showed severe abnormalities, including hyperkeratosis (Figure 2A). Furthermore, in another section, acanthosis, hyperkeratosis, accumulation of neutrophils, and separated branching were observed in the stratum corneum (Figure 2B). *S. scabiei* and hyperkeratosis are depicted in Figure 2C, which illustrates a segment of the skin. Hemorrhage, an eosinophilic layer of keratin, macrophages, congested blood vessels, and hyperacanthosis were also observed in Figures 2D, 2E, and 2F. Inflammatory cells in the sublayer, along with *S. scabiei*, collagen fibers, and additional inflammatory cells, are shown in Figures 2G and 2H.

Demographic characteristics and symptom distribution

The demographic analysis and symptom distribution among the participants are illustrated in Figure 3. The age histogram reveals that most samples were 8 to 10 years old. Regarding gender, the distribution was fairly balanced between males and females, indicating no significant gender disparity among the sampled population. Additionally, several sheep experienced hair loss, while fewer did not present this symptom. A similar trend was observed for itching, with a notable portion of the animals showing its presence, whereas others did not show any itching. These findings provide a general overview of the population structure and the prevalence of key clinical signs associated with sarcoptic mange.

Age-based distribution of health parameters

The heatmaps provide detailed insights into how various health indicators related to sarcoptic mange in sheep are distributed across different age groups and genders. The age versus gender heatmap shows a relatively balanced distribution between male and female participants. Most females were concentrated around ages 9 and 10, while most males were between 8 and 10 years old.

Regarding hair loss, the corresponding heatmap highlights that this symptom was more commonly reported in specific age groups, particularly between 9 and 10 years old. Out of the total cases, 17 animals experienced hair loss, whereas only 7 showed no such symptom.

Similarly, the age-related heatmap for itching reveals that the condition was more frequently reported among sheep between 9 and 11 years. These visual analyses offer a clearer understanding of the demographic patterns associated with sarcoptic mange, emphasizing the age and gender tendencies in symptom manifestation (Figure 1).

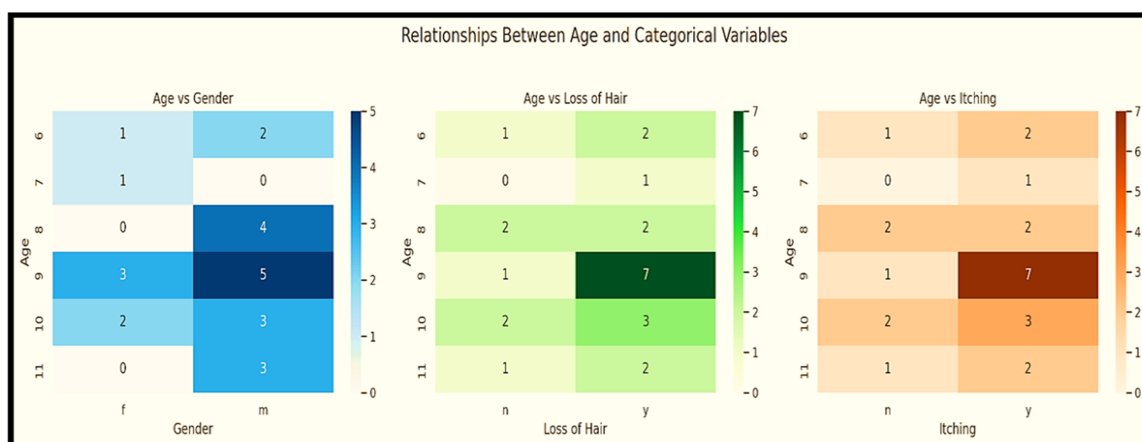


Figure 1. The relationships between age and various health parameters in sheep infected with *S. scabiei*

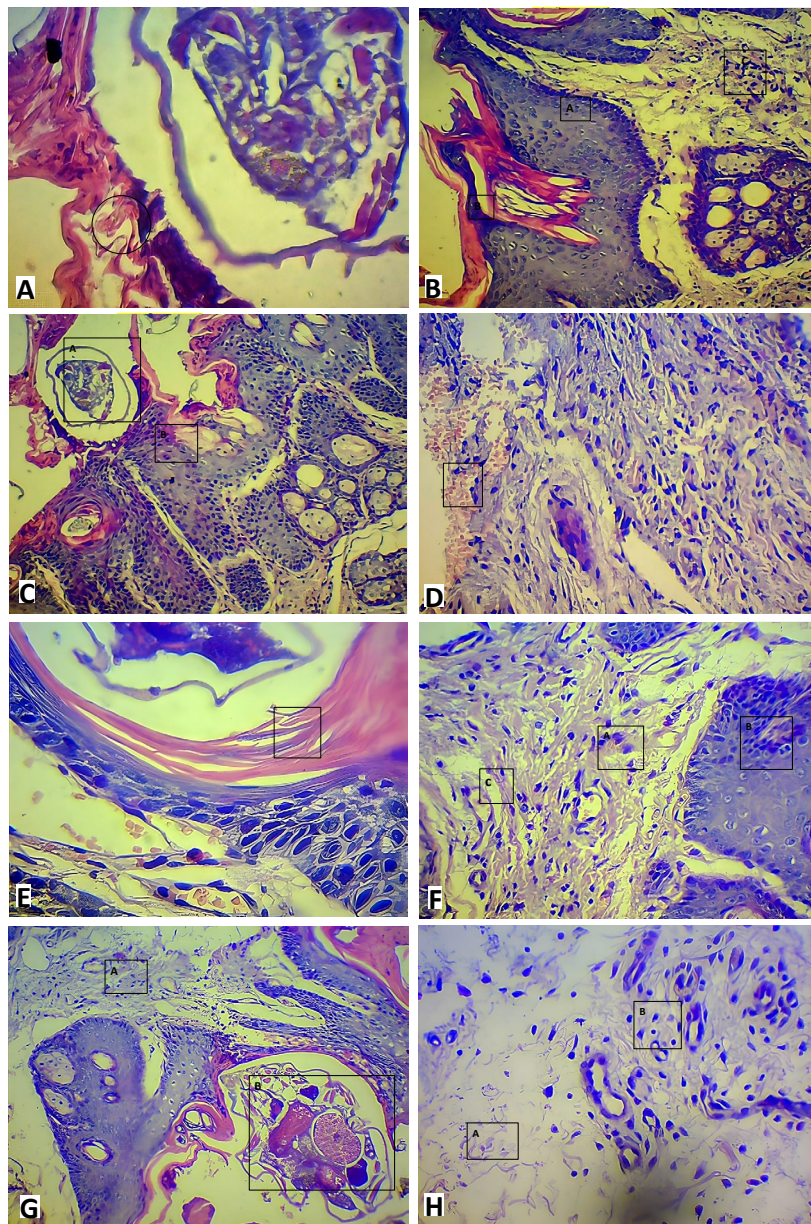


Figure 2. Histopathological features of skin lesions in sheep infected with *S. scabiei*

- A) Histopathological section of skin showing hyperkeratosis H&E, magnification $\times 20$)
- B) Histopathological section of skin showing (A) acanthosis, (B) hyperkeratosis, (C) collection of neutrophils and separated branching in strum corneum (H&E, magnification $\times 20$)
- C) The histopathological section in the skin showing (A) a section of *S. scabiei* and (B) Hyperkeratosis (H&E, magnification $\times 20$)
- D) The histopathological part of the skin showing hemorrhage (H&E, magnification $\times 20$)
- E) The histo-pathological part of the skin shows an eosinophilic layer of keratin by a line (H&E $\times 20$)
- F) Histopathological section of skin showing (A) macrophage (B) congestive (C) hyperacanthosis (H&E $\times 20$)
- G) Histopathological section in skin showing (A) inflammation cells in the sulayer (B) section of *S. scabiei* (H&E, magnification $\times 20$)
- H) Histopathological section in skin showing: (A) collagen fiber (B) Inflammatory Cell (H&E, magnification $\times 20$)

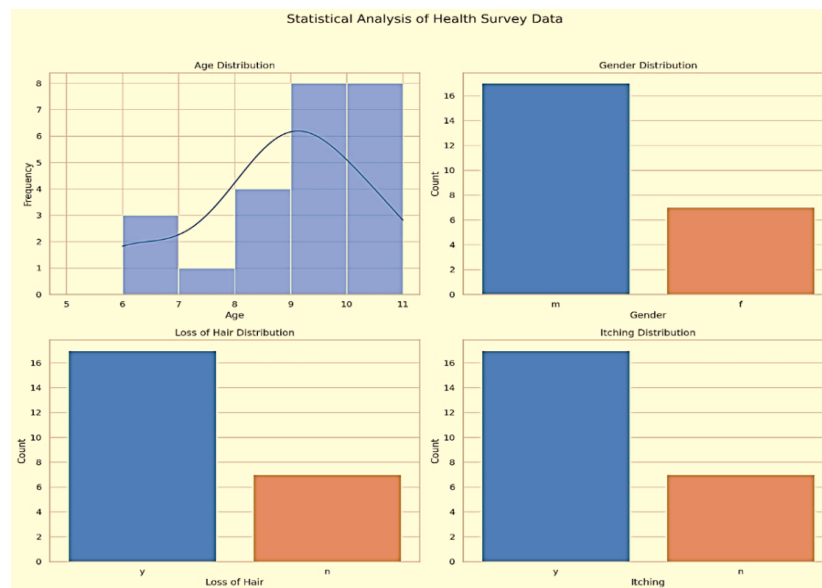


Figure 3. Statistical analysis of health survey data related to sarcoptic mange in sheep sarcoptic mange illustrates the distribution of age, gender, hair loss, and itching among the studied population

Discussion

Histopathological evaluation is a fundamental diagnostic procedure for analyzing tissue samples and identifying various localized infectious agents (Espinosa et al., 2017). Our research identified a correlation between mange infection in sheep and specific histological changes. These changes were categorized into three distinct levels of severity: Mild, moderate, and severe. The observed histopathological features included cutaneous hyperkeratosis (specifically orthokeratosis and parakeratosis), epidermal hyperplasia, skin perforations, crust development, and inflammation.

Histological examination revealed hyperkeratosis with crust formation and thickening of the outer skin, acanthosis, vesiculation, and mites in the stratum corneum—the outermost layer of the skin. The pathological features included the proliferation of connective tissue in the dermis, fluid accumulation (edema) in the papillary layer, and pronounced degeneration and necrosis in the hair follicles. These findings are consistent with the classic description of sarcoptic mange in dogs (Kido et al., 2014; Teodoro et al., 2018) and sheep (Abo-Elhassan & Eman, 2020).

Additionally, the manifestation of pruritic ectoparasitism was characterized by hyperplasia and eosinophilic infiltration. The findings of this study align with earlier reports that associated epidermal thickening and keratosis with inflammatory cell infiltration (Salavastu et al., 2017).

The female mite stimulates the infiltration of mononuclear immune cells at the site of infection. These parasites burrow tunnels to lay eggs, causing tissue damage. The female secretes enzymes that facilitate penetration into the skin. Antigenic substances released at the site of infection recruit inflammatory cells, leading to heightened immune activity and inflammation in the affected areas (Welch et al., 2021). This finding is consistent with the findings of (Bhat et al., 2017), who observed the infiltration of various immune cells, including lymphocytes, eosinophils, and histiocytes, in the infected region.

It is crucial to emphasize that the histopathological changes observed in this study are primarily attributed to the burrowing behavior of scabies mites and the host's immune response (Arlan & Morgan, 2017). Sarcoptic mites, commonly known as burrowing mites, invade the host's skin, laying eggs and continuing their life cycle (Niedringhaus et al., 2019). Throughout this cycle, many antigenic materials accumulate in the skin, such as dead mites, shed skin from larvae and adults, and eggshells. This reaction triggers hypersensitivity reactions against the mites (Morgan et al., 2017).

Furthermore, the act of skin excavation by adult female mites stimulates epidermal thickening and crust formation (Teodoro et al., 2018). Many mast cells in the affected dermis align with sarcoptic mange's immunopathology, primarily driven by an exaggerated immune response (Doukas et al., 2021). These pathological features are consistent with those seen in domestic and wild animals infected with sarcoptic mange (Nimmervoll et al., 2013).

In this study, histological changes included thickened skin, pigmented vesicular areas, and the presence of mites in the stratum corneum. Excessive keratinocyte proliferation was also evident. Dermatological changes involved significant degeneration and necrosis of hair follicles, papillary dermis edema, and connective tissue intradermal proliferation. These findings matched classical descriptions of sarcoptic mange in dogs (Mauldin & Peters-Kennedy, 2016) and are consistent with our current observations.

It is worth noting that the histopathological findings in this study corresponded precisely with microscopic lesions. Upon examination of the skin in unaffected sheep, no visible damage was observed in the epidermal or corneal layers. There was also a marked absence of hyperkeratosis, acanthosis, or rete ridge formation. Differences in sheep breeds and environmental temperatures in the study area may explain discrepancies in infection rates between this and previous investigations.

Conclusion

This study revealed clear histopathological changes in skin samples collected from sheep infected with sarcoptic mange. The histopathological findings included hyperkeratosis, epidermal hyperplasia, and the presence of *S. scabiei* mites in the stratum corneum, all characteristic signs of mange infection. These changes are associated with the immune response triggered by the burrowing behavior of the mites and resulting tissue damage. The findings also highlight the significant negative impact of the disease on sheep health and productivity, emphasizing the importance of early diagnosis and effective management strategies for controlling the infection.

Ethical Considerations

Compliance with ethical guidelines

This study was conducted at the Veterinary Hospital in Diyala Governorate. Although no formal ethical code was issued, all procedures involving animals were performed within the hospital's laboratory setting and adhered to standard veterinary practices following local institutional norms.

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Authors' contributions

Conceptualization, study design and final approval: All authors; Statistical analysis, data interpretation and writing the original draft: Ahmed Talib Jassam;

Conflict of interest

The authors declared no conflict of interest.

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