Saudi Journal of Biological Sciences 29 (2022) 595–600

Contents lists available at ScienceDirect

Saudi Journal of Biological Sciences

journal homepage: www.sciencedirect.com

Original article

Survey of mange mite infesting sheep in Riyadh region, Saudi Arabia

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ARTICLE INFO

Article history:
Received 13 March 2021
Revised 5 September 2021
Accepted 9 September 2021
Available online 16 September 2021

Keywords:
Sarcoptes scabiei
Sheep
Infectious
Morphologically
Epidemiology

ABSTRACT

The study was performed to survey the *Sarcoptic* mange in sheep and the effect of infection on the local strains during a specific period in different regions of Riyadh, Saudi Arabia. A total of 1745 sheep were examined clinically and were selected from the suspected cases for laboratory investigation of skin scrapings for disease diagnosis. The examined animals included (509) Naimi, (396) Najdi, (518) Hurri, and (322) Rufidi native sheep.

The results showed that the infestation rate was (12.77%) in all sheep. The highest strain was recorded (17.2%, 14.3%, 9.6%, and 8.6%), respectively. The infestation was highest in sheep over two years of age (15.2%) while it was lowest in sheep under two years of age (11.2 %). In addition, the infection rate in females was higher than in males. The prevalence of mange mites in females was (14%) compared to (11.2%) in males. The highest percentage of infestation was recorded in the head region at 67.2%, followed by that in the neck (4.4%), back (16.5%), tail (11.6%), and legs (0%).

The presence of mange mites was discovered by microscopic examination of deep skin scrapings of infected animals that were identified morphologically. The infection was assured by histological investigations. This study revealed that mange mite is one of the most significant sheep health constraints in Riyadh. Therefore, proper prevention measures must be implemented to take into consideration other non-host-related risk factors.

1. Introduction

Mange scabies mites is a skin disease caused by a parasitic mite called *Sarcoptes scabiei*, that affects a wide range of animals, such as cattle, goats, sheep, horses, pigs, rabbits, and dogs, including humans. Approximately 300 million humans worldwide are affected (Kuhn et al., 2008). It is producing a number of topical and generalized disease cases, and diseased animals are becoming more procumbent to other bacterial and viral infections (Radostits et al., 1983).

Mange can occur in sheep of any age, especially those held under poor management. Mange mites spread between sheep or from ewe to lamb, while sucking, via direct contact (Schmidt 1994). Infection is more common in sheep throughout the year, but mostly occurs in winter (Neog et al., 1992). Infections are a major welfare concern as they can be debilitating and are associated with high morbidity. Further, fatalities can occur via loss of condition, malnutrition, secondary infections, and hypothermia (Nieuwhof and Bishop, 2005; Nixon et al., 2017). It is one of the extreme diseases that is highly infectious in sheep and can cause significant economic losses in many countries because of a decline in growth and feed conversion rates (Yasine, 2015). It is also responsible for reduced reproductive efficiency and a decline in milk and meat production (Fthenakis et al., 2000; Fthenakis et al., 2001).

Mange mites are mainly of four types: sarcoptic, chorioptic, psoroptic, and demodectic in sheep. *Sarcoptes spp.* is an important cause of mange that leads to intense pruritus and dermatitis, which leads to animals losing much of their grazing time and hence losing general body condition. Consequently, vesicles and papules manifest, the skin becomes thickened, covered with pale scabs, and a thick layer of white scab (Radostits et al., 1983) covers the area.

The parasite is present in two forms, male and female, and the life cycle of the mite *Scabiei sarcoptes* begins by laying eggs in shallow tunnels or burrows that the females make by scaling and hosting portions of the stratum corneum (Solusby, 1968; Noble and Noble, 1971).

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.sjbs.2021.09.019
1319-562X/

The estimated number of eggs laid by a single female is 40–50, with 3–5 eggs being laid every day. After 4–5 d of maturity, through intermittent periods between 2 and 3 d for a period of 2 months (Richard and Shearer, 2001, Roberts and Janovy, 2005). Health surveillance of mammals at risk of scabies infestation is of central importance for their effective treatment and maintenance (Seid et al., 2016). The usual way of diagnosing has been the optical and microscopic observation of S. *scabiei* in the scraping of the skin, which makes it impractical to examine many samples. Enzyme-linked immunosorbent assays (ELISA) are used to detect serum antibodies to verify that they are an effective diagnostic tool that facilitates epidemiological studies (Rodríguez-Cadenas et al., 2010).

Histologically, orthokeratosis and parakeratosis, epidermal hyperplasia and crust formation were observed. Vasodilation with perivascular and interstitial inflammatory infiltrates, containing lymphocytes, macrophages, eosinophils, plasma cells, neutrophils, and mast cells, has been detected, suggesting a delayed hypersensitivity response (Lavin et al., 1998, Rode et al., 2000). An immunohistochemistry study on formalin-fixed skin specimens of normal and sarcoptic mange-infected chamois explained the progressive poorness of epidermis cytokeratins and follicular epithelium in orthokeratosis and parakeratotic forms (Lavin et al., 1998).

This study demonstrates the high prevalence of mange mites in sheep in the study area. The study revealed that *Sarcoptes* is the predominant mite in sheep. Veterinarians and animal owners should provide mite protection for small ruminants as part of routine ectoparasite control. In addition, the animal pen should be cleaned to prevent parasitic infections and avoid the development of infected foci that serve as a vector for the spread of infection to new animals and humans.

2. Material and method

An examination of 1745 sheep of different ages and sexes was performed in several areas of the slaughterhouses and sale markets in Riyadh. They were examined daily for 4 months during the period from 1/9/2020 to 1/2/2021. The following 4 strains of native sheep were studied: 509 Naimi, 396 Najdi, 518 Hurri, and 322 Rufidi. We relied on the clinical signs in addition to the laboratory examination to diagnose *S. scabies* in the skin scrapings from the affected areas (head, neck, back, tail, and legs), and all the clinical episodes were recorded. Information related to the clinical and laboratory examinations was recorded on a special form.

2.1. Sample collection

In the present study, the skin scrapings were collected from the edge of the skin lesion by scraping with a sterile surgical scalpel and deep until blood was aspirated. The skin scrapings were gathered in a smooth manner with a scalpel blade that was dipped in mineral oil. Then, the skin scrapings were placed in glass bottles with a tight cover and appropriate amounts of ethyl alcohol (70%) were added to them for preservation till the time of examination in the parasitology laboratory at the Department of Zoology-College of Science-King Saud University.

2.2. Laboratory examination of the samples

Skin skimmers were treated in the laboratory as described by Coles (1986), where the preservation fluid was disposed by centrifugation at a speed of 1500 rpm for 5 min. For each 1 g of the sample, 10 mL of KOH solution was added at a concentration of 10%; the sample was then heated gently without reaching the boiling point, until the wool clipped fibers out. This solution digests tissues and wool while not affecting the mite's outer layer. Then, the sample left to cool to room temperature, and they were placed in a centrifuge at a speed of 1500 rpm for 5 min.

2.3. Morphological examination

The supernatant was disposed of with a glass pipette, and then a drop of the precipitate was placed on a slide glass and examined under 40x, 20x magnification with an optical microscope to search for a dream of sarcoptic scabies and all its phases. The samples were examined under a stereomicroscope to evaluate the mobility and morphology of the mites (Lekimme et al., 2006).

2.4. Histological examination

Skin from the lesions was collected and fixed in 70% neutral buffered formalin for routine histopathology. Skin biopsies and the rest of the fixed non-dermal tissues were briefly washed with 10% phosphate buffered saline (PBS) solution and embedded in paraffin wax, stained with Hematoxylin and Eosin (Luna, 1968; Espinosa et al., 2017).

2.5. Statistical analysis

The least significant difference between pairs of mean values (LSD) test was utilized in a one-way ANOVA. The statistical analysis was carried out using the SPSS program (version 17).

3. Results

3.1. Clinical signs and diagnosis

The main clinical signs recorded in sheep infested by mange mite were pruritus, the animal attempting to rub the infested region with its legs or walls, fences, and some sheep biting the infested area with their teeth, in addition to loss of hair, crusts, pityriasis, and pustules.

The lesions were characterized by the presence of small red papules and general erythema which started near the mouth (lips, nostrils) and spread to other parts of the face and then to the head and ears. Later, the animals showed much scratching and biting of the skin. Also seen were thick brown scabies formation and thickening accompanied by wrinkling of the surrounding skin (Fig. 1).

Microscopic examination of deep skin scrapings revealed the presence of Sarcoptes mites, which could be differentiated based on morphological characters due to the presence of short legs, unsegmented pedicels, and terminal anus. Microscopic examination of deep skin scrapings under 10x, 20x, and 40x to evaluate the mobility and morphology of the mites, which invade superficial and burrowing keratinized structures such as skin and hair. As shown in (Fig. 2).

3.2. Lesion prevalence

Of the total 1745 sheep that were examined, *Sarcoptic scabies* were diagnosed in 223, with an infection rate of 12.77%. The highest rate of infection was recorded in Nuaimi and Najdi, where it was 17.2% and 14.3%, respectively, while the lowest incidence was in Harry and Rafidi, at 9.6% and 8.6%, respectively (Tables 1, 2).

The distribution of disease lesions in different areas of the body was studied and identified that the highest rate of infection was recorded in the head area (67.2%), followed by the back (16.5%), tail (11.6%), neck (4.4%) and legs (0%), (Table 3).

Fig. 1. Distribution of disease lesions to areas of the body in the strains examined: (A) Najdi (B) Rufidi (C) Naimi (D) Hurri.

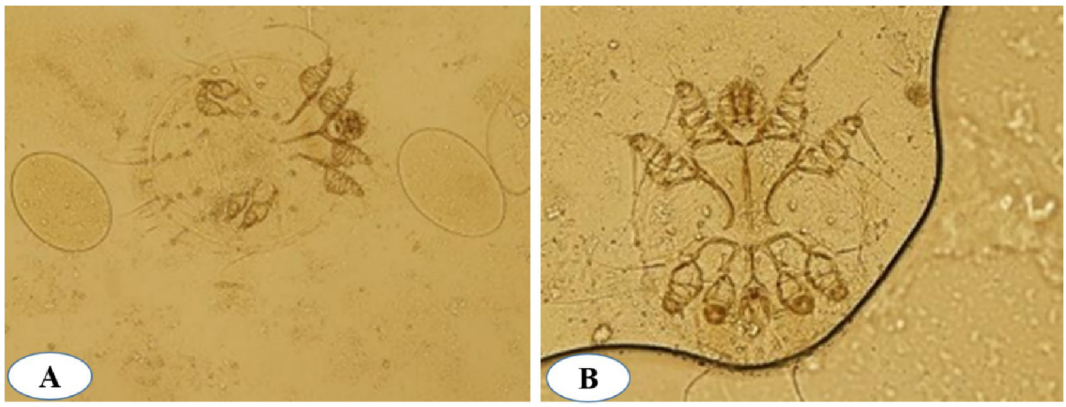

Fig. 2. Different stages of *S. scabiei*, (A) Adult female with eggs (B) Adult male.

Table 1
Distribution of pathological lesions over areas of the body.

Month	Total examined	Uninfected	Infected	Infection (%)
1	373	324	49	26
2	420	369	51	24.2
3	480	417	63	26
4	472	412	60	25.3
Total	1745	1522	223	12.77

Table 2
Distribution of the infection rate in all strains.

Strain	Total examined	Infected Sheep	Infection (%)
Nuaimi	509	88	17.2
Najdi	396	57	14.3
Hurri	518	50	9.6
Rafidi	322	28	8.6

Table 3
Distribution of the disease lesions in the different body area.

Infected region	Infected Sheep	Infection (%)
Head	150	67.2
Back	10	16.5
Tail	37	11.6
Neck	26	4.4
Legs	0	0

3.3. Age and sex effect on mange mite infestation

The results of this study showed that the percentages of the infestation were high in sheep that were more than two years old, 15.2%, and low in sheep that were less than two years old, 11.4%. On the other hand, the high rates of mange mite infestation in male sheep were 11.2% compared with females at 14% (Table 4).

3.4. Histological finding

Severe histopathological changes were observed in skin sections, comprising mainly thick crust formation, with a mite on the surface of the keratin layer, and severe degenerative and necrotic changes evident within the epidermal layers. Crusting with marked parakeratosis is progressively severe. The crusts are associated with serum lakes and extravasated erythrocytes. Inflammatory infiltrates diffuse into the dermis.

The mite with its exoskeleton and remnants were detected in the tunnel of the stratum corneum of the epidermis and appeared in the upper as a cleft epidermis, epidermis acanthosis and spongiosis associated with dense eosinophilic dermal infiltrate. Diffuse infiltrate of superficial perivascular lymphocytes and histiocytes, accompanied by neutrophils and eosinophils, were obvious in the dermis. There was psoriasiform hyperplasia characterized by epidermal projections into the dermis interdigitating with dermal papillae (Fig. 3).

Table 4
Relationship between age and sex of animals and percentages of sheep mite infestation.

Animal age	Uninfected Sheep	Infested Sheep	%	
<2 years	624	95	15.2	
>2 years	1121	128	11.4	
Sex	Male	753	84	11.2
	Female	992	139	14

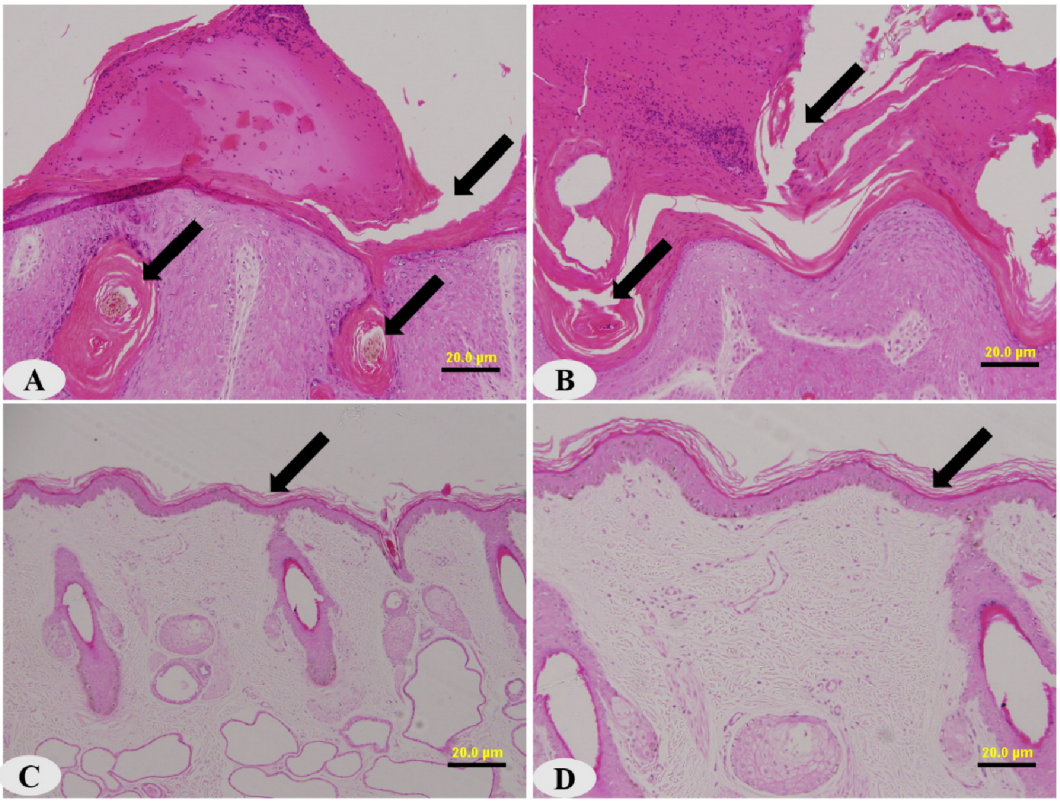

Fig. 3. Infested Sheep skins histopathology staining with Hematoxylin and Eosin. (A – B, 20X) Presence of mites, tunnel of stratum corneum of epidermis, parakeratotic hyperkeratosis, Parakeratotic hyperkeratosis characterized by upsurge in the thickness of the stratum corneum and excessive production of squames followed by infiltration into epidermis, suggested crust formation. There was infiltration of cells especially eosinophils into epidermis and dermal vascular area causing dermatitis. acanthosis, serocellular and eosinophilic crusts and keratinocytes with spongiotic oedema, acanthosis. (C – D, 20X) not show any damage on skin and regular corneal layer, no hyperkeratosis, acanthosis or rete ridges. (Scale bar: 20 µm).

4. Discussion

Sheep scabies is a highly communicable skin disease that is caused by a mite infestation. It causes major losses in the livestock sector in countries where it is endemic. Several other forms of infections include foot mange, itch mange, follicular mange, and head scabies. Symptoms of sheep scabies include scaly, crusty, yellowish sores, skin damage, and fur loss (Mitra et al., 1993).

The present study revealed an inclusive prevalence of 12.77%, accounting for 17.2%, 14.3%, 9.6%, and 8.6% in the Al-Nuaimi sheep, Najdi, Harri, and Rufidi, respectively. This finding was higher than that reported previously by studies conducted in other parts of the country, where an infection rate of 5.6% was reported for sheep in the Makah region (Asghar et al., 2011). This difference could be attributed to the management status or the use of acaricides and the related control practices (Zeryehun and Tadesse, 2012).

In this study, the lesions were characterized by pruritus, papules formation, scratching of the skin, alopecia, scab formation and thickening, and wrinkling of the skin. These results were in correspondence with those reported by Solusby, 1968 and Kettle, 1995. Also, clinical signs that appeared in infected sheep by a mange mite of pruritis and a loss of hair can be explained by the mites drilling tunnels beneath the skin. Their saliva has potent digestive enzymes that dissolve the skin tissues as well as the sarcoptes mite burrows in the deeper parts of the stratum corneum or the superficial layers of the skin. This corresponds with what was mentioned by Al-Shebani et al. (2012).

The study revealed identified mite isolated that sarcoptic scabiei examined the head, neck, back, tail, and legs of all infected animals. Which the infection rate reached 67.2%. The obtained results almost corresponded with findings reported in Iraq that mentioned the rate of infection in the head (58.15%).

As the study revealed, mites isolated from sarcoptic scabiei examined the heads, necks, backs, tails, and legs of all infected animals. In which the infection rate reached 67.2%, 4.4, 16.5 and 11.6, respectively. While there is no injury to the legs. These results obtained were almost identical to those reported in Iraq (Shamsa et al., 2008), which reported a head injury rate of 61. 58%. While Hassoun's results (2016) were disagreed at a higher rate than obtained, which amounted to 84.72%. The difference in the infection rate reported in the present study and that reported previously may be related to the difference in the strain of animals

and the atmospheric temperature difference between areas (Al-Ramahy, 2006, Shamsa et al., 2008). This indicates that the dream of sarcoptic scabies prefers to infect areas of the body with little wool (Al-Ramahy, 2006; Prates et al., 2013).

The results showed the rate of mange infection in male and female sheep reached 11.2% and 14% respectively. This study has a higher rate than that obtained by (Khardi and Khudhair, 2013), who found the rate of mange mite infestation reached 7.17%. While they did not agree with the study who found the rate of infestation reached 3.65% for all sexes (Husain and Yaqoob, 2010; Al-Shebani, et al., 2012; Al-Ezzy et al., 2015). This can be attributed to the diversity of breeds imported from multiple countries.

The results have revealed the rate of mange infection according to the age of the infected animals, so the highest rate reached 15.2% in the age stage before two years. while it was 11.2% in the age stage after two years. This study disagrees with the Al-Shebani, et al. (2012) study who found the highest rate in sheep more than two years old (3.74%) and the lowest in sheep less than two years old (3.40%). While this study agrees with (Husain and Yaqoob, 2010) study who found the highest rate was 22.96% in age stage 2 to 4 years, the lowest was 15.91% in age stage 1 to 2 years. Another study done by Khardi and Khudhair (2013), refers to the prevalence of the infestation as highest in sheep older than two years (9.02%) and the lowest in sheep younger than two years (1.9%).

Histopathological examination, an important diagnostic tool for tissue biopsies, is for detection of different infectious factors on site (Shieh, 2018). Infection by sheep mange was associated with certain histopathological changes in the form of cutaneous hyperkeratosis (parakeratosis and orthokeratosis), hyperkeratosis of the epidermis, epidermal tunnels, crust formation and dermatitis, which is consistent with several previous reports (Al-Salihi et al., 2013). Furthermore, the reported histopathological lineaments in the current study correspond with previous studies regarding mange in different animal species (Pence and Ueckermann, 2002). Despite this consistency, discrepancies in severity and dispersal of the skin lesions were encountered with animals of the same species, possibly due to the variation of immune responses between different animals (Nimmervoll et al., 2013). It should be stressed that the histopathological changes triggered by mange mites in the examined sheep are largely due to the parasite's burrowing behavior as well as the defensive response of the affected hosts (Arlian et al., 2017).

Sarcoptic mange is commonly referred to as burrowing mites that create skin tunnels in the infested host where they lay eggs and continue their lifecycle (Jimenez et al., 2010, Niedringhaus et al., 2019). Along this course, an enormous aggregate of antigenic material is released into the skin, including dead mange, sloughed skin of the living adult and immature mange, and eggshells, leading to an increase in hypersensitivity to the mites (Niedringhaus et al., 2019, Morgan et al., 2016). Moreover, excavations on the skin, particularly those made by mature females, resulted in induction of thickening of the epidermis and crust formation (Teodoro et al., 2018), and these observations are identical with our present findings. It is noteworthy to mention that the histopathologic results in the present study were identical to the macroscopic lesions. While we observed in the skin of uninfected sheep, there was no damage to the skin or regular corneal layer, no hyperkeratosis, acanthosis or rete ridges.

The difference in the infection rates between the present and previous studies may be related to the difference in the strains of animals and the atmospheric temperature difference between the study areas. Easy transmission of the disease highlights its importance, particularly for random animal collection, as that occurs in the Kingdom in places where sheep are sold, slaughtered, and during pilgrimage seasons. The transmission ability of the disease explains the role of the infected animals in the contamination of the insulation pens used to house animals before slaughter, such as pens that can transmit the infection to new animals after this. This problem clarifies the value of this work for following up animal groups to establish the recommendation to apply the eradication plan after the end of each slaughtering in slaughterhouses or shopping places with cleaning and disinfection.

5. Conclusion

This study demonstrated that mange still constitutes a notable problem, with prevalence in all age groups, both sexes. Further epidemiological studies on the economic and zoonotic value of mites in various organisms, across various agroecological zones, breeding and management systems are warranted. Animal owners and veterinarians in Saudi Arabia should consider mite control in all animals and sheep as part of routine control of ectoparasites. Relevant extension projects should be launched to raise public awareness of their economic value.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This work was supported by Researcher supporting project (RSP- 2021/3). King Saud University.

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