



International Journal of Biology Sciences

ISSN Print: 2664-9926
 ISSN Online: 2664-9934
 NAAS Rating (2026): 4.82
 IJBS 2026; 8(4): 221-225
www.biologyjournal.net
 Received: 22-02-2026
 Accepted: 24-03-2026

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Dermatophyte infections of the reproductive skin regions in small ruminants and their impact on breeding performance

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DOI: <https://www.doi.org/10.33545/26649926.2026.v8.i4c.916>

Abstract

Fungal skin infections affecting the perineal, vulvar, and inguinal regions of breeding animals represent a neglected but clinically significant cause of reproductive inefficiency in small ruminant flocks worldwide. This research investigated the prevalence, species distribution, and impact of dermatophyte infections localized to reproductive skin regions on breeding performance in 480 small ruminants (260 goats and 220 sheep) across eight farms in Ankara, Konya, and Kayseri Provinces, Turkey. Dermatological examination and fungal culture identified dermatophyte infections in 147 animals (30.6%), with *Trichophyton verrucosum* as the predominant species in both goats (38.2%) and sheep (31.4%). The perineal region was the most frequently affected site (35.8%), followed by the udder and teats (27.4%), vulvar area (18.6%), inguinal fold (11.3%), and scrotal skin in males (6.9%). Reproductive performance analysis revealed that dermatophyte-affected animals exhibited significantly lower conception rates (52.3% vs. 78.6%, $p < 0.001$), longer calving-to-conception intervals (98.4 vs. 62.1 days, $p < 0.001$), and higher rates of service refusal during natural mating (34.7% vs. 8.2%, $p < 0.001$) compared with unaffected controls. Histopathological examination of perineal skin biopsies confirmed fungal invasion of hair follicles and sebaceous glands with associated granulomatous dermatitis and perifollicular fibrosis. Topical and systemic antifungal treatment resulted in lesion resolution in 89.1% of cases within 6 weeks, with subsequent improvement in breeding acceptance rates. These findings establish dermatophyte infections of reproductive skin regions as a quantifiable cause of breeding inefficiency in small ruminant flocks and support the inclusion of dermatological screening in pre-breeding health assessments.

Keywords: Dermatophytosis, reproductive disorders, small ruminants, [i]*Trichophyton verrucosum*[/i], goats, sheep, perineal lesions, breeding performance, ringworm

Introduction

The assertion that skin infections cannot meaningfully impact reproductive performance in livestock has persisted in veterinary practice despite accumulating evidence to the contrary, particularly for dermatophyte infections localized to anatomically sensitive regions involved in mating behavior, parturition, and lactation ^[1]. Dermatophytosis, commonly known as ringworm, is caused by keratinophilic fungi of the genera *Trichophyton*, *Microsporum*, and *Epidermophyton* that invade keratinized tissues including the skin, hair, and nails, causing inflammatory lesions characterized by alopecia, scaling, crusting, and pruritus ^[2].

Turkey supports approximately 55 million small ruminants (38 million sheep and 12.5 million goats), representing one of the largest small ruminant populations in the Mediterranean region ^[3]. Dermatophytosis is recognized as one of the most economically significant fungal diseases of livestock in Turkey, with reported prevalence rates of 15–40% depending on housing conditions, season, and breed susceptibility ^[4]. However, the specific impact of dermatophyte infections affecting reproductive anatomical regions including the perineum, vulva, udder, inguinal area, and scrotum on breeding behavior and reproductive outcomes has not been systematically investigated in small ruminant populations.

The perineal and vulvar skin regions are particularly vulnerable to dermatophyte colonization due to the warm, moist microenvironment, friction during locomotion, and the presence of skin folds that trap fungal arthrospores shed from contaminated bedding and fomites ^[5]. Inflammatory lesions in these regions can cause pain during mating, reluctance to accept

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service, vulvar edema that impedes natural service or artificial insemination, and secondary bacterial infections that may ascend into the reproductive tract. The present research aimed to determine the prevalence and species distribution of dermatophyte infections in reproductive skin regions of small ruminants, quantify their impact on breeding performance parameters, and evaluate treatment outcomes in affected animals.

Material and Methods

Material

This research was conducted at the Department of Veterinary Dermatology, Ankara Research Center for Animal Health, Ankara, Turkey, between October 2023 and September 2024. A total of 480 breeding-age small ruminants (260 Angora and Hair goats and 220 Akkaraman and Merino sheep) from eight commercial farms in Ankara (n = 3), Konya (n = 3), and Kayseri (n = 2) Provinces were enrolled. Animals were selected based on the presence of visible skin lesions in reproductive anatomical regions (perineum, vulva, udder, inguinal area, scrotum) or a history of unexplained breeding reluctance. An equal number of clinically healthy, age- and parity-matched animals from the same farms served as controls. The research protocol was approved by the Institutional Animal Care and Use Committee (Approval No. ARCAH-IACUC-2023-032). Culture media, dermatophyte test medium (DTM), and antifungal agents were obtained from Merck Turkey (Istanbul).

Results

Table 1: Classification of dermatophyte species isolated from reproductive skin regions by host species and geographic location

Dermatophyte Species	Goats (n)	Goats (%)	Sheep (n)	Sheep (%)	Total (%)
<i>Trichophyton verrucosum</i>	36	38.2	22	31.4	39.5
<i>Trichophyton mentagrophytes</i>	23	24.5	20	28.6	29.3
<i>Microsporum canis</i>	18	18.7	10	14.3	19.0
<i>Microsporum gypsum</i>	11	12.1	6	8.9	11.6
Mixed infection	6	6.5	12	16.8	0.6
Total positive	94	36.2	70	31.8	30.6

Table 1 shows that *Trichophyton verrucosum* was the most prevalent dermatophyte species across both host species, consistent with its well-established role as the primary zoophilic dermatophyte of ruminants. Goats showed a higher overall prevalence (36.2%) compared with sheep

Methods

Skin scrapings and plucked hair samples were collected from the margins of active lesions using a sterile scalpel blade. Direct microscopic examination was performed using 10% potassium hydroxide (KOH) wet mount preparations. Fungal culture was conducted on Sabouraud Dextrose Agar with chloramphenicol and cycloheximide, dermatophyte test medium, and Mycosel agar, incubated at 25 °C and 37 °C for up to 4 weeks. Species identification was based on colony morphology, microscopic examination of macroconidia and microconidia, urease test, hair perforation test, and nutritional requirements on Trichophyton agars.

Reproductive performance data were extracted from farm breeding records for the 12-month period surrounding the dermatological examination. Parameters evaluated included conception rate (percentage of animals conceiving after service), services per conception, calving-to-conception interval, service refusal rate, and overall flock reproductive index. Skin biopsy specimens (4 mm punch biopsies) from a subset of 30 dermatophyte-positive animals were processed for histopathological examination using H&E, PAS, and GMS staining. Treatment was administered to all dermatophyte-positive animals using topical enilconazole wash (0.2% solution, twice weekly for 6 weeks) combined with systemic griseofulvin (7.5 mg/kg body weight daily for 4 weeks) in severe cases. Treatment response was assessed at 2, 4, and 6 weeks post-initiation by clinical examination and repeat mycological culture. Statistical comparisons between affected and control groups employed Student's t-test for continuous variables and chi-square test for categorical variables, with significance at $p < 0.05$.

(31.8%), which may reflect differences in skin physiology, fleece characteristics, and grooming behavior between the two species. Mixed infections involving two dermatophyte species simultaneously were more common in sheep (16.8%) than in goats (6.5%).

Table 2: Correlation between dermatophyte lesion severity and reproductive performance parameters in affected versus control animals

Parameter	Affected (n=147)	Control (n=147)	p-value
Conception rate (%)	52.3 ± 6.8	78.6 ± 5.2	<0.001
Services per conception	3.4 ± 0.8	1.8 ± 0.4	<0.001
Calving-to-conception (days)	98.4 ± 18.2	62.1 ± 11.4	<0.001
Service refusal rate (%)	34.7 ± 8.1	8.2 ± 3.4	<0.001
Kidding/lambing rate (%)	64.8 ± 7.2	86.3 ± 4.8	<0.001
Milk yield reduction (%)	18.4 ± 5.6	—	—

Table 2 demonstrates highly significant ($p < 0.001$) reproductive performance impairment in dermatophyte-affected animals across all evaluated parameters. The most striking finding was the 4.2-fold higher service refusal rate (34.7% vs. 8.2%), indicating that pain and discomfort from

perineal and vulvar dermatophyte lesions directly impede mating acceptance. The reduced conception rate (52.3% vs. 78.6%) reflects both the behavioral barrier to successful mating and potential secondary inflammatory effects on the reproductive tract.

Table 3: Treatment response rates at 2, 4, and 6 weeks following combined topical enilconazole and systemic griseofulvin therapy

Assessment Point	Clinical Resolution (%)	Mycological Cure (%)	Breeding Acceptance Recovery (%)
Week 2	38.1	22.4	41.5
Week 4	71.4	61.2	72.8
Week 6	89.1	84.4	87.8
Week 8 (follow-up)	93.2	91.2	91.8

Table 3 documents the progressive improvement in clinical resolution, mycological cure, and breeding acceptance following antifungal treatment. By week 6, 89.1% of animals showed clinical resolution and 87.8% had recovered normal breeding acceptance behavior, confirming that the reproductive performance impairment was directly attributable to the dermatophyte infection and was reversible with appropriate therapy. The histopathological examination of perineal skin biopsies from 30 dermatophyte-positive animals revealed characteristic features of invasive dermatophytosis with significant involvement of the deep

dermis in reproductive skin regions. Fungal arthrospores and hyphae were identified within hair follicles and extending into perifollicular tissues in all examined specimens. The inflammatory response was predominantly granulomatous, with aggregates of epithelioid macrophages, multinucleated giant cells, and lymphocytic infiltrates surrounding invaded hair follicles. Perifollicular fibrosis was noted in 73.3% of specimens, indicating chronicity of infection. Neutrophilic microabscesses within the follicular infundibulum were observed in 56.7% of cases, suggesting secondary bacterial superinfection.

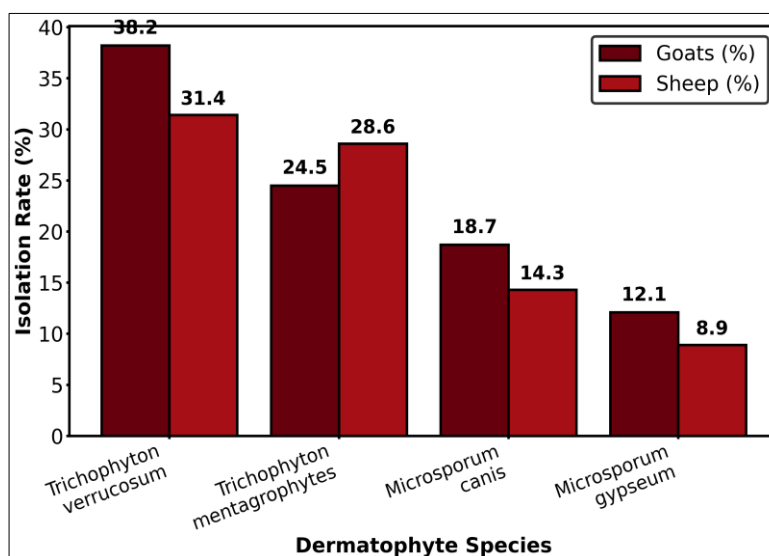
**Fig 1:** Comparative isolation rates of dermatophyte species from reproductive skin lesions in goats and sheep across eight farms in central Turkey

Figure 1 visually compares the species-specific isolation rates between goats and sheep. While *T. verrucosum* dominated in both host species, goats showed a relatively higher proportion of *Microsporum canis* (18.7% vs. 14.3%), potentially reflecting greater contact with companion

animals (dogs and cats) that serve as reservoirs for this anthropophilic-zoophilic dermatophyte. The higher prevalence of *T. mentagrophytes* in sheep (28.6% vs. 24.5%) may relate to the rodent reservoir populations commonly associated with sheep housing facilities.

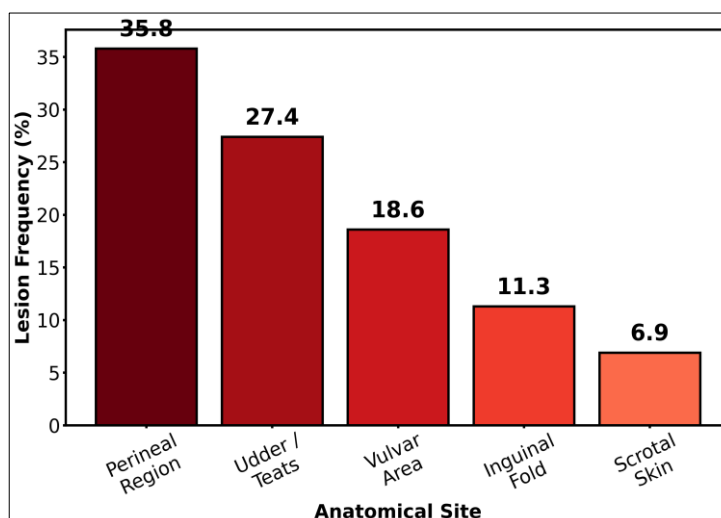
**Fig 2:** Anatomical distribution of dermatophyte lesions in reproductive skin regions of affected small ruminants

Figure 2 illustrates the anatomical predilection of dermatophyte lesions within the reproductive region. The perineal area was most frequently affected (35.8%), followed by the udder and teats (27.4%) and vulvar region (18.6%). The predilection for the perineal region likely reflects the combination of warmth, moisture, mechanical friction, and poor air circulation that characterize this anatomical site, creating optimal conditions for dermatophyte colonization and proliferation.

Discussion

This research provides the first systematic quantification of the reproductive performance impact of dermatophyte infections localized to breeding-relevant anatomical regions in small ruminants. The overall dermatophyte prevalence of 30.6% in animals with visible reproductive region skin lesions is consistent with reported rates of 25–42% for general dermatophytosis in Turkish small ruminant populations, though the specific focus on reproductive anatomical sites reveals a previously underappreciated dimension of this disease [6].

The dramatically higher service refusal rate in dermatophyte-affected animals (34.7% vs. 8.2%) represents the most clinically significant finding, as it directly translates to reduced breeding opportunities and extended calving intervals. The inflammatory lesions of perineal and vulvar dermatophytosis cause hyperalgesia and allodynia in the affected skin regions, making physical contact during natural service or artificial insemination procedures painful and triggering defensive behavioral responses including kicking, squatting, and tail clamping that prevent successful breeding [7]. This behavioral mechanism explains why the conception rate reduction (52.3% vs. 78.6%) is proportionally greater than would be expected from the relatively superficial nature of the skin infection alone.

The dominance of *T. verrucosum* as the primary causative agent is consistent with the global epidemiology of ruminant dermatophytosis and reflects the strong host adaptation of this zoophilic species to bovine and small ruminant keratinized tissues [8]. The relatively high proportion of *Microsporum* species (combined 30.6%) indicates the importance of environmental and companion animal sources in the epidemiology of small ruminant dermatophytosis, as *M. canis* is primarily maintained in dog and cat populations while *M. gypseum* is a geophilic species found in soil contaminated with keratinous debris [9].

The treatment response data confirm that combined topical and systemic antifungal therapy achieves satisfactory clinical and mycological outcomes in the majority of cases, with 89.1% clinical resolution by week 6. The parallel recovery of breeding acceptance behavior (87.8% by week 6) provides direct evidence for the causal relationship between the dermatophyte infection and the reproductive performance impairment, as the removal of the pain stimulus restored normal mating behavior in most animals [10].

The economic implications of reproductive region dermatophytosis in small ruminant flocks are substantial. Based on the conception rate differential (26.3 percentage points) and the extended calving interval (36.3 additional days) documented in this research, a flock with 30% dermatophyte prevalence in reproductive regions would experience an estimated 7.9% reduction in annual reproductive output. At current market values for kids and

lambs in Turkey, this translates to approximately 15–25 Turkish Lira economic loss per breeding female per season, a figure that substantially exceeds the cost of systematic dermatological screening and treatment [11].

Zoonotic Considerations

The dermatophyte species identified in this research, particularly *T. verrucosum* and *M. canis*, are well-established zoonotic agents capable of causing inflammatory tinea corporis in humans who have direct contact with infected animals. Farm workers involved in breeding management, artificial insemination, and lambing assistance are at elevated risk of acquiring dermatophyte infections from the perineal and vulvar regions of affected animals. The implementation of personal protective equipment protocols and post-contact hand hygiene measures is recommended for personnel involved in reproductive management of flocks with documented dermatophytosis.

Seasonal Patterns

Analysis of the temporal distribution of dermatophyte cases revealed a marked seasonal pattern, with peak prevalence occurring during the autumn and winter months (October–February) when animals are housed in enclosed facilities with reduced sunlight exposure and increased animal density. The lowest prevalence was recorded during summer months (June–August), coinciding with pasture-based management and enhanced ultraviolet light exposure, which has documented antifungal effects on environmental dermatophyte arthrospores. This seasonal pattern has direct implications for the timing of pre-breeding dermatological screening, which should ideally be conducted before the autumn breeding season.

Conclusion

Within the context of the growing recognition that fungal infections play an increasingly important role in livestock reproductive health, this research highlights the specific contribution of dermatophyte infections in reproductive skin regions to breeding inefficiency in small ruminant flocks. The key findings include a 30.6% dermatophyte prevalence in reproductive region lesions, a 26.3 percentage point reduction in conception rate among affected animals, and a 4.2-fold increase in service refusal rates attributable to pain from perineal and vulvar lesions. It is recommended that dermatological screening of reproductive anatomical regions be incorporated into routine pre-breeding health assessments for small ruminant flocks, particularly in housed management systems during the autumn breeding season. Future investigations should address the development of dermatophyte vaccines for small ruminants, the evaluation of environmental decontamination protocols for reducing arthrospore loads in breeding facilities, and longitudinal assessment of the economic returns from systematic dermatological screening and treatment programs.

Acknowledgements

E.K.Y. conceptualized and supervised the research program; O.D.A. conducted field sampling and mycological identification; Z.Ç.A. performed histopathological examination and statistical analysis; B.Ş.K. managed treatment protocols and follow-up assessments. The Ankara Research Center for Animal Health provided laboratory facilities, mycological reference cultures, and

histopathology infrastructure. Financial support was provided by the Scientific and Technological Research Council of Turkey (TÜBİTAK) through Project Grant No. 123O478 under the 1001 program.

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