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Clinical Features, Prevalence, and Bacterial Etiology of Abscess Disease in Sheep and Goats in Sana'a Province, Yemen

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Abstract

Abscess disease (caseous lymphadenitis and Morel's disease) is a chronic bacterial infection affecting sheep and goats, causing significant economic losses in small ruminant production worldwide. This study investigated the prevalence, clinical features, and bacterial etiology of abscess disease in sheep and goats in Sana'a Province. A total of 6,119 sheep and 2,974 goats were examined from March 2023 to February 2024. Clinical examinations were performed, and data on species, sex, age, and abscess location were recorded. Additionally, 86 pus samples (55 from sheep and 31 from goats) were collected for bacteriological analysis. Data were analyzed using SPSS version 25, and associations were evaluated using chi-squared (χ^2) test at $P<0.05$. The overall prevalence was 7.51%, with higher rates in sheep (7.82%) than goats (6.86%). Males showed significantly higher infection rates than females ($P<0.05$). Younger animals (<1 year) had the highest prevalence, followed by those aged 1–2 years, while animals older than four years had the lowest rates ($P<0.05$). Clinically, animals exhibited superficial lymph node abscesses of varying sizes, sometimes associated with wool or hair loss, while vital signs remained normal. The most commonly affected lymph nodes were parotid and prescapular in sheep, and prescapular, precrural, and parotid in goats. Bacterial growth was detected in 82.55% of samples. *Staphylococcus aureus subsp. anaerobius* was predominant isolate (40.84%), followed by *Corynebacterium pseudotuberculosis* (14.08%). Other pyogenic bacteria were identified, including *S.aureus*, *Streptococci*, *P.aeruginosa, A.pyogenes* and *Proteus*. These findings provide important epidemiological and clinical insights to support effective control strategies for abscess disease in Yemen.

Article Info

Keywords:
Caseous lymphadenitis, Morel's disease, Staphylococcus aureus subsp. anaerobius, Corynebacterium pseudotuberculosis, Sheep, Goats, Yemen.

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1. INTRODUCTION

Sheep and goat breeding hold significant economic and social value in Yemen. These species rank first in terms of both population and importance, with estimated numbers of approximately 9,866,017 sheep and 9,582,881 goats, according to the Annual Agricultural Statistics Book [1]. They play a vital role in satisfying local meat demand, particularly during religious occasions and holidays. Moreover, they are the primary source of livelihood for many rural Yemeni families.

Sheep and goats in Yemen are raised under traditional systems, where natural grazing is the main source of nutrition. These animals may face the risk of many diseases, particularly in the presence of adverse environmental conditions, which lead to significant economic

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losses for owners [2]. Abscess disease is one of the most serious health problems in sheep and goats in several provinces of Yemen, where its local and common name is referred to as "SANAFIR." This disease warrants attention due to its contagious nature, global distribution, and lack of efficient control strategies. Once introduced into a flock, it becomes extremely difficult to control because of its weak treatment response, capacity to survive in the environment, and limitations in diagnosing subclinically infected animals [3].

Abscess disease, also known as Morel's disease and caseous lymphadenitis, is characterized by abscess formation in the superficial lymph nodes of small ruminants [4, 5]. Morel's disease is caused by Staphylococcus aureus subsp. anaerobius [6, 7] and often affects lambs aged 4–10 months [8]. Caseous lymphadenitis (CLA) is caused by Corynebacterium pseudotuberculosis, which is most commonly identified in older sheep and goats [9, 10].

Abscess infection is prevalent in several African and Asian nations, including Kenya, Somalia, Sudan, Saudi Arabia, and Tunisia; as well as outbreaks have been documented in Europe, including Spain, Poland, Italy, and Croatia [6, 11–13].

Abscesses in farm animals are harmful because they cause enormous economic losses in terms of animal, meat, skin, and wool production [14]. Sheep and goat industries worldwide suffer large economic losses because infected animals must be removed from breeding herds due to poor physical condition or lower fertility, and carcasses are condemned entirely or partially at abattoirs [15].

In Yemen, sheep and goats face a high risk of various diseases. Although research is still sparse, a few studies have focused on issues such as gastrointestinal helminth infestations [16] and mineral deficiencies [17]. However, abscesses are a health problem affecting sheep and goats, and their incidence appears to be increasing, as evidenced by veterinary clinic records and information from animal owners, field veterinarians, and slaughterhouse workers. Despite ongoing efforts to control the disease through treatment and culling, its prevalence remains high in some regions. To the best of our knowledge, limited information is available on the prevalence and epidemiology of abscesses in small ruminants. Therefore, this study aimed to investigate the clinical features, prevalence, and bacterial causes of abscess disease in sheep and goats in Sana'a Province, Yemen.

2. MATERIALS AND METHODS

2.1. STUDY AREA AND PERIOD

This study was conducted from March 2023 to February 2024 in Sana'a Province, located in the north-central region of Yemen. The province lies at an altitude of approximately 2,300 m above sea level, between latitudes $14°45'$–$16°5'$ N and longitudes $43°30'$–$45°5'$ E. The region experiences average monthly temperatures ranging from $15°$C to $25°$C, with relative humidity levels of approximately 35% in June and 52% in April. Annual rainfall varies between 117.6 mm in the northern areas and 281.8 mm in the southern region [18]. Sana'a Province comprises 16 administrative districts and has a total livestock population of approximately 505,026 sheep and 309,314 goats. These figures represent 5.11% and 3.22% of the total national populations of sheep and goats, respectively [1].

2.2. FIELD SURVEY AND ANIMAL EXAMINATION

A total of 6,119 sheep and 2,974 goats from four districts (Hamdan, Jihanah, Sanhan, and Arhab) in Sana'a Province were included in this study. During the field survey, all animals were subjected to careful clinical examination, as described by Jackson et al.. [19]. The examination included visual inspection and palpation of the superficial lymph nodes and skin surface to identify any external abscesses. The district, name of the owner, total number of animals and herds, and species and sex of the examined animals were documented. Additionally, the location of the abscess and age of each animal were recorded. The age of the animal was determined based on dental examination and history provided by the owners, where available.

2.3. SAMPLING STRATEGY AND PUS COLLECTION

This study used a multistage sampling method. In the first stage of the study, four districts in Sana'a province, including Hamdan, Jihanah, Sanhan, and Arhab, were selected based on the relatively high animal density and ease of access. In the second stage, four to six rural localities from each district were randomly chosen, and all accessible herds and animals (sheep and goats) present on the day of the visit were inspected. This provided us with the opportunity to conduct a study and collect pus samples for bacteriological analysis.

Eighty-six pus samples (55 sheep and 31 goats) were collected from external intact abscesses of clinically ill sheep and goats. The outer surface of the affected lymph node was wiped with 70% alcohol to prevent external contamination. The pus was aspirated using a sterile 20 ml syringe fitted with a wide-gauge needle and placed in sterile plastic bags. Samples were labelled and transported in an ice box to the Microbiology Laboratory at the College of Veterinary Medicine, Sana'a University for bacterial cultivation and identification.

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2.4. CULTIVATION AND IDENTIFICATION OF BACTERIAL ISOLATES

All samples were cultured using standard microbiological procedures, as described by Coles [20] and Quinn et al. [21]. Using a sterile bacteriological swab, each pus sample was streaked onto two plates containing sheep blood agar and one plate containing MacConkey agar (Oxoid, UK). Each plate was properly labelled. One blood agar plate and one MacConkey agar plate were incubated aerobically, whereas the other blood agar plate was incubated anaerobically (using the candle jar technique) for the isolation of S. aureus subsp. anaerobius. The inoculated plates were incubated at 37℃ and checked for 48–72 h for bacteriological growth. Plates that exhibited no bacterial growth after the initial incubation were kept for an additional 48 h.

Bacterial colonies were identified on the bases of colonial, morphological and characteristics as well as biochemical activities according to Coles [20]; Quinn et al. [21]; Møller et al. [22]; Luis et al. [23] and De la Fuente et al. [6]. *Corynebacterium psudotuberculosis* isolates were identified using standard biochemical tests, including the catalase test, urea hydrolysis (using Christensen's urea broth base; Oxoid, UK), and carbohydrate fermentation tests with glucose, maltose, sucrose, mannitol, and xylose. Carbohydrate fermentation was assessed using heart infusion broth (Oxoid, UK) containing 1% of the respective sugar and phenol red as a pH indicator. *Pseudomonas aeruginosa* was identified by their production of greenish exopigments and the detection of the oxidase enzyme using a newly prepared 1% α-naphthol solution in 95% ethanol, along with a 1% aqueous solution of p-aminodimethylaniline oxalate. *Actinomyces pyogenes* was recognized by its beta hemolytic glistening colonies after 48 hours on blood agar. *Actinomyces pyogenes* tested positive for gelatinase but negative for catalase and nitrate reduction analyses. *Streptococci* identified through culturing on blood agar and biochemical tests like the catalase test.

Staphylococcus aureus isolates were subcultured onto mannitol salt agar and identified based on colony morphology, catalase positivity, mannitol fermentation, and coagulase positivity. The identification of *S. aureus subsp. anaerobius* was based on anaerobic growth on blood agar, negative mannitol fermentation, and positive maltose fermentation with acid production.

2.5. STATISTICAL ANALYSIS

The data collected during the survey were inputted into Excel sheets and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. The prevalence was determined by dividing the number of infected animals by the total number of animals examined. The chi-squared (χ^2) test was performed to compare the prevalence of animal species, sex, age, and study areas using statistical methods. Differences were considered significant at $P < 0.05$ level of probability.

3. RESULTS

3.1. PREVALENCE OF ABSCESS DISEASE

The results indicated that the overall prevalence rate of abscess disease in both sheep and goats was 7.51% (7.82% and 6.86%, respectively) (Table 1). According to the studied districts, the prevalence rate of disease was higher in Hamdan (8.70% in sheep and 8.54% in goats), while it was lower in Jihanah (6.21% and 2.33%, respectively) compared to other districts. There was a significant difference (P<0.001) in the prevalence rate between goat species compared to sheep, where the prevalence rates were approximately similar. In contrast, there was no significant difference in the prevalence rates of the disease between sheep and goats in any of the districts. However, in Jihanah, sheep had a significantly higher prevalence rate than that of goats (Table 2).

Table 1. Prevalence rate of abscess disease in sheep and goats examined of Sana'a Province

Animal species	No. Examined	No. Infected	Prevalence (%)
Sheep	6119	479	7.82
Goats	2974	204	6.86
Overall	**9093**	**683**	**7.51**

Table 2. Prevalence rate of abscess disease in sheep and goats according to districts

	Sheep		Goats	
Districts	**Examined**	**Infected (%)**	**Examined**	**Infected (%)**
Hamdan	1217	106 (8.70%)	644	55 (8.54%) *
Jihanah	1739	108 (6.21%) **	471	11 (2.33%)
Sanhan	2062	171 (8.29%)	1397	110 (7.87%)
Arhab	1101	94 (8.53%)	462	28 (6.06%)

* Significant differences in the same species among districts.
** Significant differences between sheep and goats in the district.

Concerning the sex of the animals, the prevalence rates of disease in both sheep and goats were relatively higher in males (12.77% and 11.21%, respectively) than in females (7.20% and 6.34%, respectively). There was a significant difference (P<0.05) in the prevalence of disease between males and females in both sheep and goats (Table 3).

Regarding age, the results indicated that the highest prevalence rates in both sheep and goats were observed in the age class of less than 1 year (12.94% and 11.99%, respectively). This cohort was followed by the age class of 1-2 years, which had prevalence rates of 7.52% for

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Table 3. Prevalence of abscess disease in sheep and goats according to sex

Animal species	Sex	Examined	Infected (%)	P-Value
Sheep	Male	681	87 (12.77%)	0.001
	Female	5438	392 (7.20%)	
Goats	Male	312	35 (11.21%)	0.003
	Female	2662	169 (6.34%)	

sheep and 6.86% for goats. In contrast, the lowest prevalence rates were found in animals older than 4 years, with figures of 5.65% for sheep and 5.27% for goats. There was a significant difference (P<0.05) in the prevalence rates of disease between age classes in both sheep and goats (Figure 1).



Figure 1. Prevalence of abscess disease in sheep and goats according to age

3.2. CLINICAL PRESENTATION

Affected sheep and goats exhibit enlarged superficial lymph nodes of various sizes and locations. 92.88 Of the identified lesions, 92.88% were closed. However, 7.12% of the lesions were opened and discharged pus, which was associated with ulceration of the surrounding skin. The pus was whitish, creamy, or greenish in color and had a milky, thick-cheesy, dry, and firm consistency. Some cases involved the loss of hair or wool around the lesion. The results of the physical examination revealed that the vital signs were within normal limits, and there was no systemic response. Some afflicted animals showed gradual emaciation and weight loss. The clinical symptoms of abscess disease in sheep and goats are shown in Figures 2 and 3.

Regarding the distribution of subcutaneous abscesses in infected sheep and goats, the results showed one or more lesions were identified in various superficial lymph nodes. The parotid lymph nodes were the most affected nodes in sheep, accounting for 28.39% (136 cases), followed by the prescapular lymph nodes (27.34%, 131 cases) and the precrural lymph nodes



Figure 2. Clinical symptoms of abscess disease in in infected sheep



Figure 3. Clinical symptoms of abscess disease in in infected goats

(17.32%, 83 cases). In goats, the prescapular region exhibited the highest percentage of abscesses, accounting for 32.84% (67 cases), followed by the precrural region at 22.06% (45 cases) and the parotid region at 21.08% (43 cases). Abscesses in the submandibular lymph nodes were recorded in 14.20% sheep and 11.76% goats. Tail lymph nodes had the lowest percentage of abscesses in

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Table 4. Bacteria isolated from subcutaneous abscesses in sheep and goats

Isolated Bacteria	Sheep	Goats	Total Isolates n=71 (%)
Pure cultures			
S. aureus subsp. Anaerobius	18	11	29 (40.84)
S. aureus	5	2	7 (9.86)
C. pseudotuberculosis	7	3	10 (14.08)
Streptococcus species	4	2	6 (8.45)
Pseudomonas aeruginosa	4	1	5 (7.04)
Actinomyces pyogenes	2	1	3 (4.22)
Proteus spp.	2	1	3 (4.22)
Mixed cultures			
S. aureus subsp. anaerobius + S. aureus	1	2	3 (4.22)
C. pseudotuberculosis + Streptococcus species	1	1	2 (2.81)
Actinomyces pyogenes + Streptococcus species	1	1	2 (2.81)
S. aureus + Proteus spp	1	0	1 (1.40)

both sheep and goats (0.83% and 0.49%, respectively) (Figure 4).

3.3. BACTERIOLOGICAL FINDINGS

Bacterial isolates were recovered from 71 of the 86 pus samples (82.55%). The remaining samples were found to be sterile. Table 4 shows the frequency of bacterial isolates from sheep and goat abscesses. Pure cultures of *S. aureus subsp anaerobius* were obtained from 29 samples (40.84%), whereas *S. aureus* was isolated from 7 samples (9.86%). Pure cultures of *C. pseudotuberculosis* were recovered from 10 (14.08%) samples. *Streptococci* were isolated from six samples (8.45%), and *Pseudomonas aeruginosa* was isolated from five samples (7.04%). Three cultures were identified as Actinomyces pyogenes (4.22%), and three cultures were identified as *Proteus*. Eight samples yielded mixed culture results. These mixed cultures included duplicates of *S. aureus subsp. anaerobius* + *S. aureus* (4.22%), *C. pseudotuberculosis* + *Streptococcus spp.* (2.81%), *Actinomyces pyogenes* + *Streptococcus spp.* (2.81%), and *S. aureus* + *Proteus spp.* (1.40).

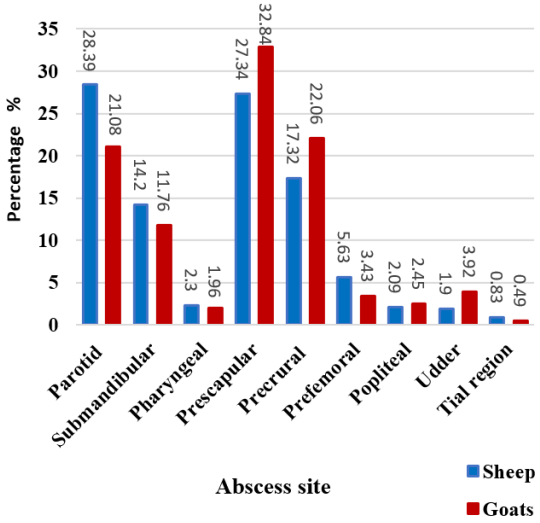


Figure 4. Distribution of subcutaneous abscesses in infected sheep and goats

4. DISCUSSION

Abscess disease (commonly known as Morel's disease and caseous lymphadenitis) is an important disease in small ruminants worldwide. Once introduced into a herd, it is very difficult to control because of its poor response to treatment, its ability to persist in the environment, and the limitations in detecting subclinically infected animals [3, 24]. Abscesses result in significant economic losses associated with reduced animal productivity and a decline in meat, skin, and wool quality and yield [25],[11, 12, 14].

In Yemen, little information is available on the prevalence and epidemiology of abscesses in small ruminants. Therefore, the current study included a large-scale survey of thousands of sheep and goats to investigate the clinical aspects, prevalence, and causative agents of abscess disease in these animals within Sana'a province, Yemen.

The survey findings revealed that abscesses were endemic in sheep and goats, with overall prevalence rates of 7.51% (7.82% in sheep and 6.86% in goats). Previous studies have reported that abscesses in sheep and goats are common worldwide, but their prevalence varies between countries. Lower findings were reported by Al Azazi [2] in Yemen, who found that the prevalence of abscesses in sheep and goats was 5.70% and 4.94%, respectively, and Khadeega et al. [26] reported prevalence rates of 4.1% in sheep and 2.3% in goats in Sudan. Oreiby et al. [27] in Egypt revealed that the prevalence of abscesses in sheep was 7.54%, compared to 3.98% in goats. However, Al-Gaabary et al. [4] found that the prevalence of abscesses was higher in Egypt, with 23.33% in sheep and 11.04% in goats. In addition, Al-Harbi [28] reported that the prevalence of abscesses in Saudi Arabia ranged from 5% to 44.1% in sheep farms and 2.2% to 6.5% in goat farms. The differences between these studies might be attributed to varied breeding and management practices, environmental circumstances, breed variances, diverse survey methodologies used, and samples collected by various researchers. In our study, no significant difference was observed in the

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prevalence rates of external abscesses among sheep and goats; this may be attributed to the mixed breeding of sheep and goats, which is the prevailing system in the study areas.

The current study found that male sheep and goats had higher rates of abscess infection than females, with a significant difference (P<0.05) between the sexes in both sheep and goats. These findings are consistent with previous studies [2, 28, 29], although Al-Gaabary et al. [4] found that disease prevalence was significantly higher in females (19.67%) than in males (12.42%). This high prevalence in males is related to their aggressive disposition and the consequences of fighting, which may result in injuries. Castration is also a risk factor for developing osteoporosis [30]. However, other studies have indicated that sex has no influence on abscess infection [31].

Our findings revealed that the majority of abscesses in sheep and goats occurred in the age group of less than one year (12.94% and 11.99%, respectively), with a significant difference (P<0.05) between age classes in both species. Other studies have found a low prevalence for this age group (under 1 year) at 3.07% [4]. The decreased incidence in animals under one year of age may be related to passive transfer of maternal immunity, with an increase in incidence in animals over one year of age reflecting the loss of this immunity. In contrast, the increased prevalence of abscesses in animals under one year of age might be attributed to the epidemiology of *S. aureus anaerobius,* the causative agent of abscess (Morel's) disease, which commonly affects young sheep and goats.

Clinically, the infected sheep and goats in this study developed superficial lymph node abscesses of varying sizes and locations. These abscesses can be either closed or open, discharging whitish, milky, or creamy caseated pus. Some cases involved hair or wool loss over the lesion. Some afflicted animals exhibited gradual weight loss. Similar symptoms were reported by Al-Gaabary et al. [4] and Al-Gaabary and El-Sheikh [32].

The lesions are commonly located in the parotid, prescapular, and precrural lymph nodes of sheep and goats. This may be related to the habits of sheep and goats, which scrape their ears and shoulders on hard items such as walls, fences, and metallic feeders. Similar findings were reported by Al-Azazi [2] and Khadeega et al. [26], who found that the parotid and prescapular lymph nodes were the most affected. In contrast, Al-Gaabary et al. [4] reported that the parotid lymph nodes were the most commonly injured nodes in sheep, whereas the superficial cervical lymph nodes were the most commonly affected nodes in goats. This variation in the distribution of afflicted nodes could be due to the different modes of transmission of the organism. Docking and shearing wounds are not important in Yemen because these operations are not typically performed.

The results of the bacteriological culture in this study indicated that *S. aureus subsp. anaerobius* was the most frequently isolated pathogen (40.84%), followed by *C. pseudotuberculosis* (14.08%). The high frequency of *S. aureus subsp. anaerobius* among the isolates confirms its critical role in subcutaneous abscess formation in small ruminants. This finding is consistent with previous studies that identified *S. aureus subsp. anaerobius* as the primary causative agent of abscess disease, also known as Morel disease [5, 11, 25, 26]. *C. pseudotuberculosis* was the second most frequently isolated organism, supporting its well-known role in caseous lymphadenitis (CLA) in sheep and in goats [33]. The presence of *C. pseudotuberculosis*, particularly in both pure and mixed infections, reflects its ability to persist in the environment and infect animals through skin injuries or abrasions. In contrast, other studies have reported that *C. pseudotuberculosis* is the predominant isolate, followed by Staph. aureus in sheep and goats [34–36].

The presence of mixed bacterial infections in our study indicates a potential synergistic interaction between the organisms involved in the formation and progression of abscesses. Co-infection with *Streptococcus spp.* and *Actinomyces pyogenes* may worsen tissue damage and make healing more difficult [37]. Opportunistic bacteria, such as *Pseudomonas aeruginosa* and *Proteus spp.* may also contribute to chronicity, particularly in animals under poor hygienic or stressful conditions.

Despite the important findings of this study, some methodological limitations should be considered when interpreting these results. A potential sample bias may have occurred because the animals included in the study were selected from flocks that were accessible during the study period rather than randomly sampling the entire sheep and goat population of Sana'a Province. Furthermore, several animals included in the study had clinically evident abscesses, which may have increased their likelihood of selection and resulted in an overestimation of disease prevalence.

5. CONCLUSION

In conclusion, the results of this study revealed that the overall prevalence rate of abscess disease in both sheep and goats was 7.51% (7.82% and 6.86%, respectively). Males of both sheep and goats had a higher prevalence rate than females. Both sheep and goats under one year of age exhibited the highest prevalence, followed by those aged 1–2 years, whereas animals older than four years showed the lowest rates. The parotid and prescapular lymph nodes were more frequently affected nodes in sheep, whereas the prescapular, precrural, and parotid were in goats. The bacterial isolates suggested that S. aureus subsp. anaerobius was the most dominant (40.84%), followed by C. pseudotuberculosis, which accounted for approximately 14.08%. These findings prove

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that this disease is present in small ruminants in the Sana'a province of Yemen. Therefore, Morel's disease and caseous lymphadenitis should be addressed as a one-entity problem and require real efforts to combat them through the implementation of appropriate biosecurity measures, effective diagnosis, and development of an effective vaccine. Due to the high degree of mixing between the two diseases and their co-existence in many areas, a bivalent vaccine has been proposed.

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CONTRIBUTION OF AUTHORS

AAA contributed to the study conception, design, written 1st draft and final version of the manuscript. Material preparation and data collection were performed by AAA, SAMAA, HAA, BSA, FAO, and SMA. Data analysis and visualization were performed by AAA and AA. All authors have read and approved the final version of the manuscript.

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CONFLICT OF INTEREST

The authors declared that they do not have any conflicts interest.

ETHICS STATEMENT

The study protocol was approved by the Faculty Board of the Faculty of Veterinary Medicine, Sana'a University.

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