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Prevalence of dermatophilosis, ringworm and mange in camels (*Camelus dromedarius)* at Qassim region, central of Saudi Arabia

Salama A. Osman[1, 2]

[1]Department of Veterinary Medicine, College of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia. P.O Box 51452, **Saudi Arabia.**
[2]Department of Animal Medicine, Faculty of Veterinary Medicine, Kafrelsheikh University, Kafrelsheikh 33516, **Egypt**

***Correspondence:** salama2068@yahoo.com **Received 05-02-2020, Revised: 25-04-2020, Accepted: 01-05-2020 e-Published: 10-05-2020**

This study was executed to determine the prevalence of dermatophilosis, ringworm and mange in dromedary camels at Qassim region, central of Saudi Arabia. One thousand dromedary camels were used in this study. The prevalence of dermatophilosis, ringworm, mange and concurrent infection by ringworm and mange among examined camels was 1.40%, 13.90%, 16.10% and 3.70% respectively. The prevalence of ringworm ($p = 0.0001$) and concurrent infection by ringworm and mange ($p = 0.0005$) was significantly higher in camels under three years than camels older than three years. Differences were not significant among different age groups in case of dermatophilosis ($p = 0.9$) and mange ($p = 0.3$). The prevalence of concurrent infection by ringworm and mange was significantly (*0.006*) higher in male (8.66%) camels than female (2.98%) ones. The prevalence was not significantly differs between male and female camels in cases of dermatophilosis ($p = 0.6$), ringworm ($p = 0.9$) and mange ($p = 0.2$). Clinically, camels infected with dermatophilosis showed exudative dermatitis and thick greasy scabs. Ringworm infected camels showed non-pruritic skin lesions in the form of circular dry crusty hairless areas with powdery scales not associated with itching. Mange infected camels showed cutaneous erythema and terminated by crust formation and hair loss in addition to thickening and wrinkling of the skin. It can concluded that skin diseases in dromedary camels are common and great attention should applied to decrease such infections.

Keywords: Dromedary camels; Prevalence; Dermatophilosis; Ringworm; Mange

INTRODUCTION

Dromedary camel (*Camelus dromedarius*) is one of the highly valuable domestic animals in Saudi Arabia where is considered as a good source for milk and wool production. In addition to the previous traditional uses as means of transportation to support the survival of millions of citizens in barren areas of the world, modern applications in the dairy industry have led to the development of camel dairy farms that are capable of producing camel milk on commercial level. Recently, booming of camel racing in the Gulph countries made camel as highly attractive commodity (Breulmann et al. 2007).

Dermatophilosis is an infectious worldwide skin disease affecting animals and man and caused by Dermatophilus congolensis (Zaria 1993; Gebreyohannes and Gebresselassie 2013).

Ringworm is a mycotic disease affecting the outer layer of the skin caused by different types of dermatophytes affecting all domestic animals, including livestock and pets, as well as humans (Cafarchia et al. 2013)

Sarcoptic mange is a highly contagious

zoonotic skin disease, caused by *Sarcoptes scabiei var cameli* and affecting camels and man (Higgins 1983; Singh and Veer 2005).

Transmission of dermatophilosis, ringworm and mange occurs mainly by direct contact with infected camels or via indirect contacts with contaminated inanimate objects, such as blankets and baggage (Kumar et al**.** 1992; Radostits et al**.** 2007).

Diagnosis of dermatophilosis, ringworm and mange mainly based on clinical examinations and observation of skin lesions whereas direct microscopic examination and culture of skin scraping and hairs from the periphery of lesions are necessary to differtentiate between different skin affections (Markus *et al.* 2001; Parsani et al**.,** 2008; Gebreyohannes and Gebresselassie 2013).

The economic losses due to skin diseases is attributed to poor quality of the hides, low meat and milk production (Dalis et al. 2007) in addition to decrease in lactation due to lesion on the udder and teats which ultimately affects the growth of suckling calves (Edwards, 1985). Moreover, human infection by skin diseases from animal origin is common (Burd et al. 2007; Dalis et al. 2010).

Camel skin diseases are common in Saudi Arabia. So, this work was directed to determine the prevalence of dermatophilosis, ringworm and mange in camels at Qassim region, central of Saudi Arabia.

MATERIALS AND METHODS

Animals

At Qassim region, central of Saudi Arabia, one-thousand dromedary camels of different ages and sex were used in this study.

Samples

Scabs, skin scrapings and hairs were collected in clean sterile petri-dishes for bacteriological, mycological and parasitological examinations.

Clinical examination

All camels under study were examined clinically according to Higgins and Kock (1984).

Epidemiological investigation

Epidemiological data including prevalence, age and sex predisposition were estimated according to Martin et al. (1987).

Skin scraping

Deep skin scrapings were collected from the peripheral of the active lesions of the affected areas of skin with the help of a sharp scalpel in a Petri dish (Fowler 2010).

Bacteriological examination and mycological examination

Direct microscopic examination

For dermatophilosis, small pieces were collected from the layers of skin beneath the scabs and softened in few drops of sterilized normal saline on a clean slide, then air-dried, fixed by heating and stained by Gram and Giemsa stains (Quinn et al. 1994).

Culturing

Samples and swabs were inoculated onto 5% sheep blood, MacConkey agar plates, Sabouraud Dextrose Agar Media, Edward's medium and on Manitol salt agar. Incubation aerobically at 37°C for 24-48 hrs was done. Colonial morphology were recorded after 24 - 48 hours. Culture on Sabouraud Dextrose Agar Media (SDA) with chloramphenicol and cyclohexidine. The media kept at 27^{o}C for 3 weeks. Differentiation between the different bacteria was done based on its colonial and biochemical characters (Cruickshank et al. 1975). For culturing of *D. congolenses,* incubation at 37^{o}C in 20% CO_2 tension for 24 to 48 hours in indicated (Cruickshank et al. 1975).

Parasitological examination

Examination of the skin scraping was done (Fthenakis et al. 2000).) and types of mites were identified (Bowman (1995)..

Statistical analysis

The obtained data were analyzed by Chi-Square using the SPSS for Windows (Version 15.0, USA) statistical software program and probability (*P*-values) of less than 0.05 were considered significant.

RESULTS

Out of the examined 1000 camels, the prevalence of dermatophilosis, ringworm, mange and concurrent infection by ringworm and mange among examined camels was 1.40%, 13.90%, 16.10% and 3.70% respectively (Table 1).

The prevalence of skin diseases among the examined 396 camels under 3 years and 604 camels older than three years was 1.26% and 1.49% for dermatophilosis, 25.76% and 6.12% for

ringworm, 18.18% and 14.74% for mange 6.57% and 1.82 for concurrent infection with ringworm and mange respectively (Table 2).

The prevalence of skin diseases among the examined 873 female and 127 male camels was 1.26% and 2.36% for dermatophilosis, 13.97% and 13.38% for ringworm, 16.84% and 11.02% for mange 2.98% and 8.66 for concurrent infection with ringworm and mange respectively (Table 3).

Dermatophilosis infected camels (Figure 1) showed exudative dermatitis, thick greasy scabs and the long hairs over the affected skin were gattered to each other forming a shape of paint brush. Removing the hairs from recent lesions reveals severe pain and leaving bleed area beneath it but later in old lesion, the hairs were easily removed without pain. The lesion may be localized or generalized according to the stage of the disease, but back of the animal is mostly affected. Temperature and appetite of the animals was not affected.

Ringworm infected camels (Figure 2) showed skin lesions in the form of circular dry crusty hairless areas with powdery scales not associated with itching. The lesions may be localized or generalized to involve more areas of the body. Neck, shoulder, limbs and flanks were the most commonly affected areas. Young camels showed severe lesions.

Mange infected camels (Figure 3) showed skin lesions in the form of cutaneous erythema and terminated by crust formation and hair loss in addition to thickening and wrinkling of the skin of the affected area. These signs were associated with severe itching and loss grazing time. Biting of the affected area was common. The lesions may be localized but later involve large areas of the animal body. Brisket region, neck region, head and inner aspects of the thighs were the most commonly affected.

Culturing on sheep blood agar incubated at 37^{o} C with 10-20% CO_2 atmosphere yielded a characteristic colonies of *D. congolensis* which appeared within 24–48 hours as small, grey-yellow colour adhered to the surface of the agar. These colonies become more wrinkled and the yellow pigmentation more intense after incubation for 3-4 days. A beta-hemolytic zone was observed around the colonies. Microscopically, *D. congolensis* seen as septate, branching filamentous hyphae become longitudinally, as well as transversely divided to form spherical or ovoid cocci in multiple rows.

Trichophyton verrucosum was isolated and identified from all of the specimens collected from clinically diseased camels. On SDA media, colonies were small, button or disk shaped, heaped and folded white to cream colored colony with no reverse pigment, with a velvety surface, a raised centre, and flat periphery. Microscopically, broad, irregular hyphae with many terminal and intercalary chlamydospores were present. Chlamydospores were numerous, symmetrical typically present in chains.

Sarcoptes scabiei mite was the only detected mite in the skin scrapping of the infected camels.

Table 1: Prevalence of different skin diseases among examined camels

Status Disease	Total camels examined	Infected camels	Prevalence (%)
Dermatophilosis	1000	14	**1.40**
Ringworm		139	**13.90**
Mange		161	**16.10**
Concurrent infection (Ringworm + mange)		37	**3.70**

Table 2: Prevalence of different skin diseases in relation to age

Age Disease	Camels under 3 years (n = 396)		camels over 3 years (n = 604)		P value
	Infected	%	Infected	%	
Dermatophilosis	**5**	**1.26**	**9**	**1.49**	**0.9**
Ringworm	**102**	**25.76**	**37**	**6.12**	**0.0001**
Mange	**72**	**18.18**	**89**	**14.74**	**0.3**
Concurrent (Ringworm+mange)	**26**	**6.57**	**11**	**1.82**	**0.0005**

Table 3; Prevalence of different skin diseases in relation to sex

Age Disease	Females (N = 873)		Males (N = 127)		P value
	Infected	%	Infected	%	
Dermatophilosis	**11**	**1.26**	**3**	2.36	**0.6**
Ringworm	**122**	**13.97**	**17**	13.38	0.9
Mange	**147**	**16.84**	**14**	11.02	0.2
Concurrent (Ringworm+mange)	**26**	**2.98**	**11**	8.66	0.006

Figure 1: Dermatophilosis infected camel

Figure 2: Ringworm infected camel

Figure 3: Mange infected camel

DISCUSSION

It has been shown that camels are vulnerable at the same degree or even higher to the prevalent disease causing agents compared with other livestock (Abbas and Tilley 1990; Abbas and Agab 2002 and Pathak and Chhabra 2010) despite the old notion that they are resistant (Dalling et al. 1988).

Adverse and difficult environmental conditions in the areas where camels are raised especially in dry seasons lead to decrease the availability of food for these animals and subsequently resulted in lower their resistance and make them easily vulnerable to diseases (Abbas and Tilley 1990; Agab 1993; Abbas and Agab 2002; Pathak and Chhabra 2010).

Dermatophilosis is a zoonotic skin disease affects primarily cattle, small ruminants, equidae and certain non-domesticated species such as the zebra and red deer. The disease transmitted from infected animals to men by direct contact (Dickson et al. 2010). In tropical and subtropical areas of Africa, great losses to the livestock and leather industries are attributed to dermatophilosis (Zaria 1993).

The prevalence of dermatophilosis among examined camels was 1.40%. Higher prevalence rates recorded previously by Gitao et al. (1998) who reported an outbreak of mixed infection of both *Dermatophilus congolensis* and *Microsporum gypseum* infections in Saudi Arabia and recorded a prevalence rate of 23.4% and Agab (2006) who reported dermatophilosis as one of the most common diseases affecting camels (*Camelus dromedarius*) and recorded a prevalence of 18.7%.

Concerning age and sex predisposition, the prevalence of dermatophilosis was not significantly differs ($p = 0.9$) among different age groups. Similar results recorded previously by Hyslop (1980) and Haward (1996) who reported that the resistance to dermatophilosis not related to animal age or sex.

Dermatophilosis infected camels showed exudative dermatitis, thick greasy scabs and the long hairs over the affected skin were gattered to each other forming a shape of paintbrush. Similar lesions observed in previous studies by Radostits et al. (2007); Awad et al. (2008); Osman (2014) and Abd (2018). The exudative inflammation that developed resulted from attacking the hair sheath by the hyphae that developed from the spores of the microorganism in the epidermis and lead to bulging of the slow growing epidermis away from the corium, thereby allowing growth of a new layer of epidermal cells (Seifert 1992). Dryness of the serous exudates resulted in crust formation.

Nowadays, increasing in the incidence of fungal infection was observed in both natural and controlled systems (Fisher et al. 2012).

The prevalence of ringworm among examined camels was 13.90% as single infection and 17.6% in all cases (single and concurrent infection with mange). Lower prevalence were reported previously by Gitao et al. (1998) who reported prevalence of 8.58% and Almuzaini et al. (2016) who reported prevalence rate of 11.5%. Higher prevalence of 48% (Mahmoud 1993) and 43.5% (Fadlelmula et al. 1994) was reported. The differences in the disease prevalence among different studies attributed to the hygienic measures and management systems applied in each farm. In addition to immunity of camels in

each study (Kuttin et al. 1986; Mahmoud 1993).

Concerning sex predisposition, the prevalence of ringworm was not significantly differs (*p = 0.9*) between male and female camels where, it was 13.97% in females and 13.38% in males. Similar finding were observed previously by Abdalla and Salim (2010) and FadlelMula,et al. (1994) who observed no significant difference in the susceptibility of male and female camels to ringworm infection. On contrary, Khamiev (1982) recorded a higher prevalence of ringworm infection in female camels (77%) than the male ones (23%).

Concerning age predisposition, significant difference (*p = 0.0001*) in the prevalence of ringworm was observed among different age groups, whereas, the prevalence was significantly higher (25.76%) among camels younger than three years than those (6.12%) older than three years. Similar results observed previously by Agab (1993) and Almuzaini et al. (2016). The variation in the disease prevalence among different studies may attributed to the hygienic measures applied in each farm in addition to the immaturity of the immune system of young animals (Colditz et al. 1996). Shams-Ghahfarokhi et al. (2009) attributed the lower prevalence of ringworm in adults to the development of cell-mediated immune response elicited by the *T. verrucosum*, which results in resistance in adults. In addition, Abdalla and Salim (2010) attributed this to the suitable microclimate of the skin of young camels to ringworm.

In this study, *T. verrucosum* was the only dermatophyte isolated from young and old camels. Similar findings recorded previously by FadlelMula et al. (1994) and Almuzaini et al. (2016) who isolated *T. verrucosum* from all ages, although Kuttin et al. (1986) and Mahmoud (1993) detected *Trichophyton verrucosum* only from youngs and *T. mentagrophytes* only from adults. In addition, Abdalla and Salim (2010) isolated *T. verrucosum* from both young and old camels, *T. schoenlenii* and *Trichophyton tonsurans* from young camels and *T. mentagrophytes* only from old ones.

Clinically, ringworm infected camels showed non-pruritic skin lesions in the form of circular dry crusty hairless areas with powdery scales not associated with itching. Similar lesion observed previously by Abdalla and Salim (2010) and Almuzaini et al. (2016).

Sarcoptic mange considered as one of the most important and prevalent camel diseases that often ranked second in importance to all the disorders in dromedary camels after trypanosomosis (Mochabo et al. 2005; Palanivelrajan et al. 2015).

The prevalence of mange among examined camels as a single infection was 16.10% and was 19.8% in all cases (single and as mixed infection with ringworm). Nearly similar result recorded previously in Al-Qassim region, central of Saudi Arabia by Agab (2006) who reported a prevalence of 22.6%. Lower prevalence reported by Dinka et al., (2010) who reported prevalence of 10.68% prevalence rate and Kotb and Abdel-Rady (2015) who reported a prevalence of 6.06%. Higher prevalence reported by Abebe (2001); Parmar et al. (2005) and Jain et al. (2019) who reported 27.8%, 57.97% and 31% prevalence rates respectively.

Concerning age predisposition, the prevalence of mange was not significantly differs (*p = 0.3*) among different age groups. Similar results were observed by Dinka et al. (2010); Megersa et al. (2012); Ashraf et al. (2014); Awol et al. (2014); Kotb and Abdel-Rady (2015).

Concerning gender, the prevalence of mange was not significantly differs (*p = 0.2*) between male and female camels. Similar results were observed by Parmar et al. (2005); Dinka et al. (2010); Megersa et al. (2012); Kotb and Abdel-Rady (2015). On contrary, Awol et al. (2014) observed a significant correlation of the prevalence between male and female camels.

Parasitological examination of skin scrapings those collected from infected camels revealed that, *Sarcoptes scabiei* mites were the only detected mites. This observation was coincided with Dinka et al., (2010); Megersa et al**.** (2012); Awol et al**.** (2014); Feyera et al**.** (2015); Kotb and Abdel Rady (2015) and osman (2017) who identified only *Sarcoptes scabiei var. cameli* as the only mite species in all skin scrapings collected from mange infected camels. On contrary, Pegram and Higgins (1992) and Parsani et al**.** (2008) detected *Sarcoptic* and *chorioptic mites* from mange infected camels.

Clinically, mange infected camels showed skin lesions in the form of cutaneous erythema and terminated by crust formation and hair loss in addition to thickening and wrinkling of the skin of the affected area. These signs were associated with severe itching. Similar lesions observed previously by Premalatha et al. (2010); Hussain et al. (2012); Awol et al. (2014); Palanivelrajan et al. (2015) and osman (2017). Itching resulted from the histamine release from the destructed cells (Greaves and Wall 1996).inflammation which

developed from itching create an iedeal environment for opitimal growth of the parasite and help the mite to spread (Berriatua et al. 2001).

CONCLUSION

Dermatophilosis, ringworm and mange are common in dromedary camels at Qassim region, central of Saudi Arabia and great attention should applied to decrease prevalence of these diseases..

CONFLICT OF INTEREST

The author declared that present study was performed in absence of any conflict of interest.

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This work was performed at Veterinary Teaching Hospital, Department of Veterinary Medicine, Faculty of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia.

AUTHOR CONTRIBUTIONS

Salama Ahmed Osman is the sole author for this manuscript.

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