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DERMATOLOGIC AND FAECAL HELMINTHIC EGG INVESTIGATION IN DROMEDARY CAMELS AT A LIVESTOCK MARKET IN DOHA, QATAR

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ABSTRACT

This study was aimed to assess cutaneous conditions and gastrointestinal (GI) parasitism of camels kept in a livestock market in Doha, Qatar. Fifteen animals showing skin lesions were examined through macroscopic inspection, adhesive tape impression cytology (ATIC) and superficial skin scraping cytology (SSSC). Fresh faeces from nine camels were tested using Mini-FLOTAC. Alopecia with or without hyperpigmentation and crusting was recorded in 13 animals, nodules/macules in one and mixed lesions in one. The skin lesions were mainly found on the neck, shoulders, abdomen and hump. On ATIC, larval (seed) ticks were detected in two animals; hyperkeratosis in eight; and exudative dermatitis with inflammatory cells in three. On SSSC, hair shaft arthroconidia consistent with dermatophytosis were observed in five camels, accompanied by hair shaft thickening, cuticular lifting or loss, trichoptilosis and altered melanin granules; yeast-like bodies were found in four cases. Background scale/scab material was common; lesion severity was mild in four cases and severe in 11. No inflammatory cells were detected on SSSC. Mini-FLOTAC identified non-sporulated oocysts of *Eimeria cameli* and *dromedari* in three faecal samples; no nematode or cestode eggs were detected. These findings highlight heterogeneous but predominantly superficial dermatologic processes and protozoal GI parasitism in market camels. These preliminary data prove that skin disorders are a welfare concern and are useful to suggest recommendations to improve the health and welfare of camels kept on markets. Further and larger studies are needed to confirm our findings.

Key words: Dermatologic examination, dermatophytosis, dromedary camels, faecal egg examination, qatar, skin diseases, skin scraping, tape impression

Skin disorders due or not to infectious agents are considered common among dromedary camels kept in intensive farming (Menchetti *et al,* 2021) and have been included as an animal-based welfare indicator in welfare protocols for this species (Menchetti *et al,* 2021; Padalino and Menchetti, 2021). Additionally, other most common skin diseases reported in camels include ringworm, contagious skin necrosis (*Dermatophilus congolensis*), and sarcoptic mange (*Sarcoptes scabiei var. cameli*), (Almuzaini *et al,* 2016; Kinne and Wernery, 2003; Khelifi-Ouchene *et al,* 2020; Jain *et al,* 2005).

A recent systematic review has shown that epidemiological data on dromedary camel skin infections and parasitic diseases are limited, with publications largely from Egypt, Tunisia, Morocco, Algeria, the United Arab Emirates (UAE) and Saudi Arabia (El-Alfy *et al,* 2024). Some of the skin infections surveys are the following; Kamili *et al* (2019) reported in Morocco an incidence of 52% and 30% mite and dermatophyte infections, respectively; Almuzaini *et al* (2016) reported 11.5% dermatophytosis in Saudi Arabia; Khelifi-Ouchene *et al* (2020) reported 57.1%, 28% and 16.5% of ticks, scabies and ringworms infested camels, respectively, in Algeria; Ahmed *et al* (2020) in Egypt reported 47.6% sarcoptic mange in dromedary camels from markets and slaughterhouses. GIT helminth infections such as haemonchosis, onchocerciasis, dipetalonemiasis, fasciolosis and hydatidosis have also been commonly reported (Toaleb *et al,* 2025). Parasitic helminths are responsible for various conditions in camels such as weight loss, poor body condition, poor growth, diarrhoea, low productivity, reduced immunity level and higher exposure to other infections. Different

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studies reported gastrointestinal parasites. For instance, in Algeria, 17% and 23.7% protozoan and helminth infections were reported, respectively, with Eimeria spp. reported as the most predominant protozoan species (Bouragba *et al,* 2020). In Iran, Radfar *et al* (2013) reported a high prevalence of GIT parasites in free range manged dromedary camels, in particular the authors quantify the incidence of *Nematodirus* spp. (52%), *Trichostrongyle* type eggs (49%), *Haemonchus* spp. (38 %), *Trichuris* spp. (14%) *Marshallagia* spp. (10%) and *Eimeria cameli* (24%).

In contrast, despite a national herd exceeding 116,000 head in Qatar in 2021 (Sanaullah, 2022) and a country with an extremely lofty proportion of camel livestock kept in several markets around the country (Faye, 2020), we found no published epidemiological studies conducted in this country (El-Alfy *et al,* 2024). To generate initial, practice-oriented data on disease patterns in Qatar, we performed a cross-sectional assessment of common cutaneous diseases and gastrointestinal (GI) parasitism among dromedary camels kept at a livestock market in Doha.

Materials and Methods

Study area and animals

This market-based survey was conducted over one day at a camel market in Doha, Qatar, in September 2019. Sampling was performed in the morning, from 8.00 to 11.00 am, with an average temperature of 42.3°C and 32.2% humidity, respectively. The camels were kept in different-sized pens in the market for different purposes, namely for meat, milk, breeding, racing; they were kept there permanently or temporarily until they were sold for slaughter or traded live. The camels originated from different countries (i.e., Qatar, Sudan, Oman, Saudi Arabia, United Arab Emirates, Kuwait, Pakistan and Somalia). A convenience sample of 15 dromedary camels with visible skin lesions was subjected to dermatologic examination (Table 1). Fresh, spontaneously voided faecal samples were obtained from nine animals for GI parasite testing (Table 1).

Data collection and analysis

Each pen was visited in the market and then several pictures of the skin disorders were taken for their macroscopic description. Most of the animals kept at the market were non-handled, so it was not easy to approach and restrain them without causing evident distress, fear and pain. Consequently, to comply with ethical procedures in animal research, only non-invasive sampling methods were performed on the camels, which were coping well with the procedures. The animals were approached calmly and gently to take a non-invasive skin sample. If the animal defecated, a fresh faecal sample was also collected, as rectal sampling was not approved.

Macroscopic observation

Lesions were recorded based on anatomic distribution, primary and secondary morphology (e.g., alopecia, nodules, macules, crusts and hyperpigmentation) and extent. The underlying cause of the presence of lesions could not be determined solely from external inspection.

Microscopic examinations

Two non-invasive cytologic techniques were used:

Adhesive tape impression cytology (ATIC): The adhesive surface of transparent tape was pressed repeatedly onto skin lesions. Tapes were stained with Diff-Quik and applied sticky-side down to a glass slide for light microscopy examination.

Superficial skin scraping cytology (SSSC): Superficial keratin, hairs and crusts from the lesion were collected using a sharp curette or blunt scalpel blade. Smears were prepared on glass slides, stained with periodic acid–Schiff and examined microscopically for keratin changes, fungal spores (arthroconidia) and yeast-like organisms.

Organism identification was limited to morphology on superficial preparations. Fungal culture and molecular assays were not performed. Accordingly, organisms could not be assigned to genus or species and findings are reported as patterns compatible with superficial dermatophytosis and Ixodidae infestation rather than species-level diagnoses.

All microscopic pictures were taken using an ocular (an eyepiece), using Carl Zeiss AX190 digital microscope with camera system (Carl Zeiss, Jena, Germany).

Faecal examination for GI parasites

Fresh faeces from nine camels were refrigerated at 4°C and analysed using the Mini-FLOTAC flotation method (KRUUSE Faecal Ova 3 Step, Cat. No. 291011, Langeskov, Denmark) with saturated magnesium sulfate solution, specific gravity 1.20 and pH 5.5 (KRUUSE Fasol, 1 L, Car. No. 291015, Langeskov, Denmark), following the manufacturer's instructions. The protocol was chosen for its

Table 1. Cases examined in the present study.

Camel ID	Age	Sex	Skin colour	Body condition score (BCS)	Faecal sample
1	Adult	Female	Beige	2	Not collected
2	Adult	Female	White	5	Collected
3	Adult	Female	White	3	Not collected
4	Yearling	Male	Black	2	collected
5	Yearling	Male	Beige	2	Not collected
6	Yearling	Male	White	2	collected
7	Calf	Female	White	1	Not collected
8	Adult	Female	Beige	2	collected
9	Calf	Male	Beige	1	collected
10	Adult	Female	Beige	2	Not collected
11	Yearling	Male	Beige	2	collected
12	Yearling	Male	White	1	collected
13	Adult	Female	Beige	2	Not collected
14	Old Age	Female	White	1	collected
15	Yearling	Male	Beige	2	collected

reported analytical sensitivity in detecting protozoal oocysts and helminth eggs (Mohammedsalih *et al,* 2025). Outcomes were recorded quantitatively as quantitative counts of oocysts or helminth eggs. Eimeria species were identified according to their morphological features (Al-Shaebi *et al,* 2024; Metwally *et al,* 2020).

Results

Skin lesions

Macroscopic findings

Lesions varied in size and shape and were broadly classified as alopecia or nodular/macular lesions. Among 15 animals, alopecia was present in 13 (Camel ID: 1-6, 8-10, 12-15); nodules/macules in one (Camel ID: 7); and mixed lesions in one (Camel ID: 11) (Table 2, Fig 1-4). Hyperpigmentation or crusting is frequently accompanied by alopecia (Fig 1, 3). Lesions were unevenly distributed, primarily affecting the neck, shoulders, abdomen and hump (Fig 1-4).

Microscopic findings

ATIC: Larval (seed) ticks were found in two animals (Camel ID: 9, 11), with morphology characterised by 3 pairs of legs, lack of a scutum and smaller than adult hard ticks (family Ixodidae) (Table 2, Fig 5). Hyperkeratosis, characterised by numerous anuclear keratinocytes and keratin debris, was observed in eight animals (Camel ID: 3-6, 8-10, 12) (Fig 6); exudative dermatitis with inflammatory cell infiltration in three (Camel ID: 2, 11, 13). No cytologic abnormalities were observed in four animals (Camel ID: 1, 7, 14 and 15). Among hyperkeratotic cases, severity was graded as mild in one case (Camel ID: 10) and moderate in seven cases (Camel ID: 3-6, 8, 9, 12) (Table 2).

Table 2. Macro- and microscopic findings of skin lesions.

Camel ID	Macroscopy	ATIC				SSSC		
		LT	HK	ED	DP	Tick	SK and ED	Yeast
1	AL	N	N	N	N	N	Mild	N
2	AL	N	N	+	+	N	Moderate	N
3	AL	N	+	N	N	N	Moderate	N
4	AL	N	+	N	N	N	Moderate	N
5	AL	N	N	N	N	N	Moderate	+
6	AL	N	+	N	+	N	Moderate	N
7	A, NM	N	N	N	N	N	Moderate	+
8	AL	N	+	N	+	N	Mild	N
9	AL	+	+	N	+	+	Moderate	N
10	AL	N	+	N	N	N	Moderate	+
11	AL, NM	+	N	+	+	+	Moderate	N
12	AL	N	+	N	N	N	Moderate	N
13	AL	N	N	+	N	N	Moderate	N
14	AL	N	N	N	N	N	Moderate	+
15	AL	N	N	N	N	N	Mild	N

Remarks LT: Larval tick, AL: Alopecia, NM: nodular or macular lesions, N: not found, HK: hyperkeratosis, ED: exudative dermatitis, DP: dermatophytosis, SK&ED: seborrhoeic keratosis and exudative dermatitis, Yeast: Yeast-like bodies, +: found.

SSSC: Hair shaft arthroconidia consistent with dermatophytosis were identified in five animals (Camel ID: 2, 6, 8, 9, 11) (Table 2). Round spores were present both within the hair shaft (endothrix) (Fig 7, 8) and on the hair surface (ectothrix) (Fig 9, 10). Spores occurred singly or in short chains and were sometimes embedded within keratin. The fungal species of dermatophytes could not be determined by their microscopic morphology. Spore-positive hairs showed localised shaft thickening with cuticular lifting, partial or complete cuticle loss, shaft fractures with split ends (trichoptilosis) and altered melanin granules (Fig 8-10). Spores were confined to hair shafts, with no root/follicular involvement, consistent

with superficial dermatophytosis. Yeast-like, light pink-to-red spherical bodies were observed in four animals (Camel ID: 5, 7, 10, 14) (Fig 11). Hyphae or pseudohyphae were not observed in spore- or yeast-positive cases.

Across all cases, exfoliated keratinocytes and keratin debris (scales) and scab material (coagulated exudate mixed with sebaceous debris) adhered to hairs or were present in the background. Overall, cytologic changes were interpreted as seborrhoeic keratosis and exudative dermatitis. Four cases were classified as mild (Camel ID: 1, 6, 8, 15) and 11 were classified as severe (Camel ID: 2-5, 7, 9-14). No inflammatory cell infiltration was detected on SSSC.

Faecal examination

Two species of Eimeria (*Eimeria dromedarii* and *Eimeria cameli*) were observed in 3/9 faecal samples (Camel ID: 4, 9 and 15). No nematode or cestode eggs were observed (Table 3).

Table 3. Results of faecal egg counts from the nine dromedary camels.

Camel ID	Faecal egg counts
2	No helminthic eggs detected
4	550 oocysts per gram (OpG) *Eimeria cameli*
6	No helminthic eggs detected
8	No helminthic eggs detected
9	300 oocysts per gram (OpG) *Eimeria cameli*
11	No helminthic eggs detected
12	No helminthic eggs detected
14	No helminthic eggs detected
15	250 oocysts per gram (OpG) *Eimeria dromedarii*

Discussion

This market-based survey documented heterogeneous cutaneous lesions and GI protozoal parasitism among dromedary camels in Doha, Qatar. While wide range of skin lesions were reported in literatures such as alopecia, macules, papules, nodules, plaques, masses, vesicles, pustules, scales, crusts (Abdel-Saeed, 2020; Ngeiywa, 1992; Osman, 2014), our investigation identified lesions of varying size and shape that were mainly classified as alopecia or nodular/macular lesions.

Hyperpigmentation or crusting was frequently accompanied by alopecia. Lesions were unevenly distributed, primarily affecting the neck, shoulders, abdomen and hump. This lesion pattern could be suggestive of mixed infections. Similar non-pruritic, dry, crusted alopecic lesions have been reported in dromedaries with dermatophytosis in Saudi Arabia (Almuzaini *et al,* 2016). In our study, most alopecic lesions showed cytological features of seborrhoeic or exudative dermatitis, while some were consistent with dermatomycosis and hair shaft fragility. Accumulation of sebaceous debris and crusts may have created a favourable environment for fungal or yeast proliferation, potentially worsening dermatitis and alopecia (Miller *et al,* 2012; Rodrigues Hoffmann *et al,* 2023). Yeast-like elements reminiscent of Malassezia were occasionally observed; given that Malassezia can be part of normal skin microbiota in many mammals, their clinical significance requires cautious interpretation in the absence of culture or molecular analyses (Miller *et al,* 2012; Rodrigues Hoffmann *et al,* 2023). In a mixed infection of dermatomycosis and mange, Al-Salihi *et al* (2013) described dermatitis characterised by acanthosis, parakeratosis, hyperkeratosis, crust formation, sebaceous gland hyperplasia, granulomatous hidradenitis and infiltration of eosinophils, lymphocytes, macrophages and neutrophils. The authors also revealed numerous fungal arthrospores and hyphae using histological sections stained with periodic acid-Schiff (PAS) and Gomori's Methenamine silver (GMS). Although our investigation did not detect hyphae or immune cell infiltration, similar skin lesions were observed in the examined samples.

In this prelimary investigation, even though different macroscopic skin lesions, which may be suggestive of mixed infection was observed, we had only identified the larval stage of ticks. This could be due to the sampling and diagnostic methods limitations we had in the investigation. Seed ticks morphologically consistent with the family Ixodidae were found on two camels, in line with the literature (Mathison and Pritt, 2014). Even if ticks can be identified only using morphology, future studies should include deeper investigation of ticks and screening for tick-borne pathogens (TBPs) similar to a recent study (Getange *et al,* 2021). Regional surveys indicate that Hyalomma is the predominant tick genus infesting dromedary camels across East and North Africa, including Kenya, Ethiopia, Algeria and Somalia (Hamza *et al,* 2019; Khelifi-Ouchene *et al,* 2020; Getange *et al,* 2021; Desta, 2025). A study in the United Arab Emirates (UAE), discovered *Hyalomma dromedarii* as the predominant tick species (Camp *et al,* 2020). Collectively, these findings suggest that the infestations observed in our study may represent more than simple bite-related dermatitis and justify the need for a larger study including

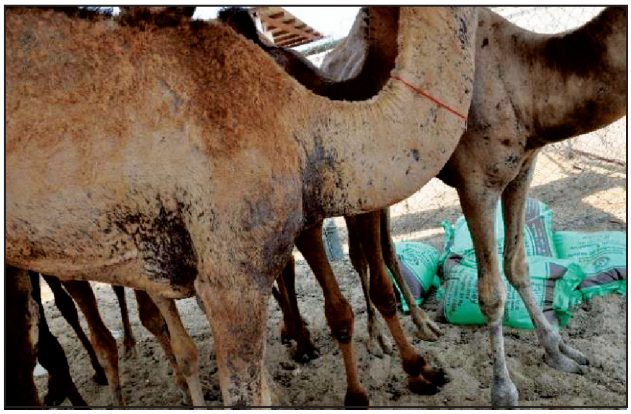

Fig 1. Alopecia on the chest and shoulders and the skin was dark (hyperpigmentation) (Camel ID: 5).

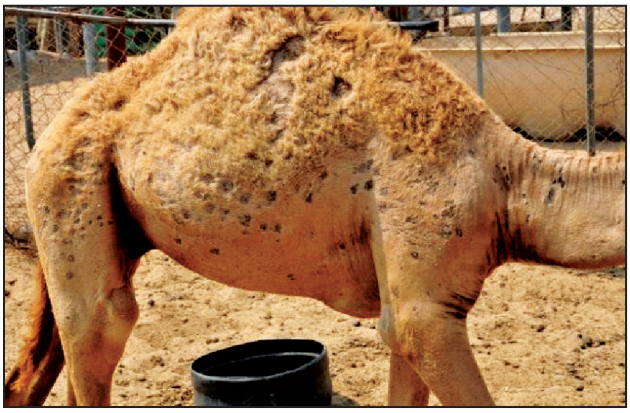

Fig 2. Numerous alopecic lesions, with crusty skin all over the body (Camel ID: 9).

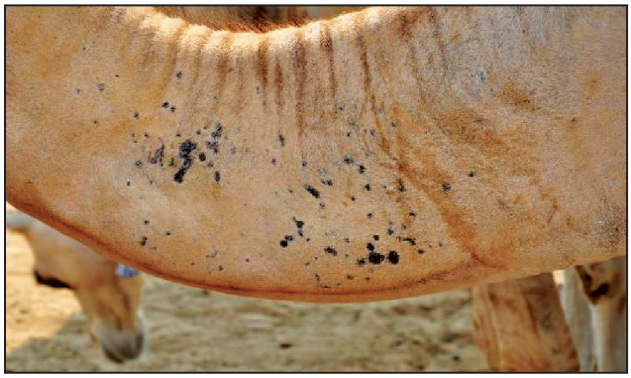

Fig 3. Numerous small, round alopecic lesions on the neck, which appear dark (Camel ID: 8).

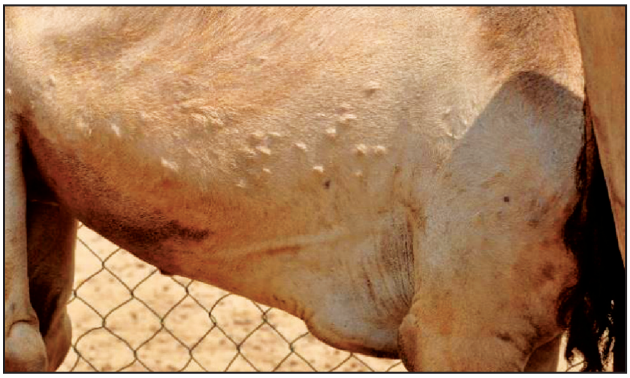

Fig 4. Nodular/macular lesions on the abdominal and respiratory regions.

Fig 5. Larval (seed) tick (Camel ID: 9). under microscope 10 x objective lens.

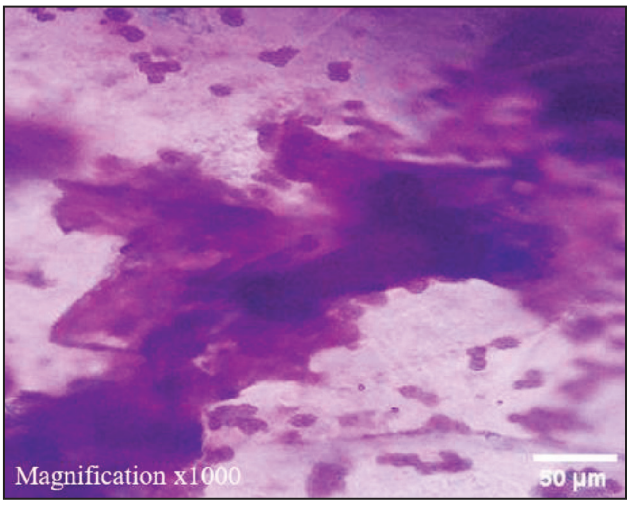

Fig 6. Yeasts and large numbers of the scales and scabs in the background under 100 x objective lens. Magnification= x 1000. (Camel ID: 10).

blood testing for TBPs due to potential animal health, zoonotic and public health risks, as previously done in other countries (El-Alfy *et al,* 2024). Mange is a most prevalent and debilitating cutaneous disease caused by mites (e.g., Sarcoptes, Demodex) in dromedary camels (Gharban, 2024). Although mange was not detected in all examined animals, negative superficial skin scrapings do not rule out infestation, as follicular mites reside deep within pilosebaceous units and require deep scrapings until capillary bleeding for detection (Miller *et al,* 2012). However, as this is an invasive procedure not permitted for our research purpose, this may remain

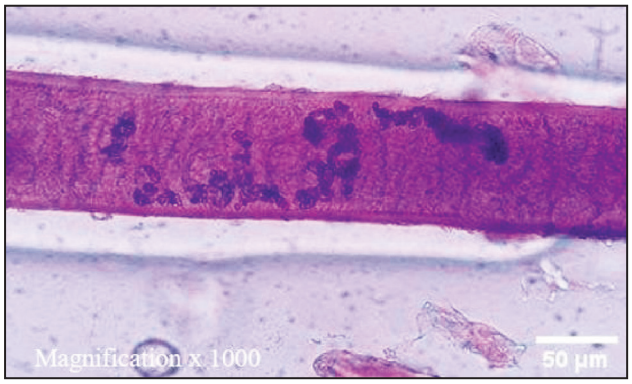

Fig 7. Endothrix in the core area of the hair shaft under the microscope with a 100 x objective lens. Magnification=x 1000 (Camel ID: 6).

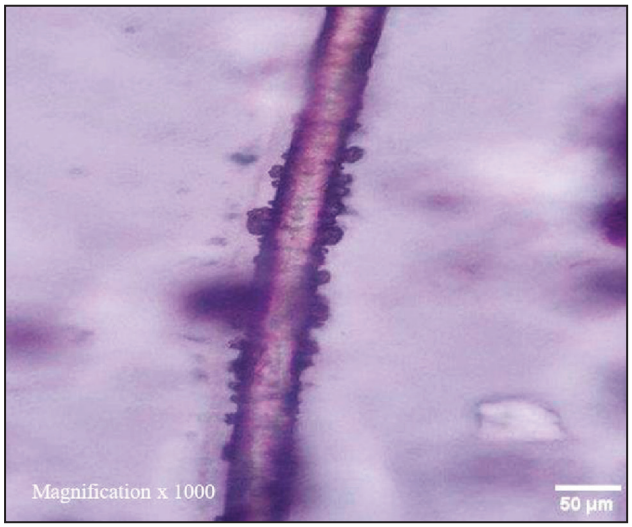

Fig 9. Ectothrix in the cuticle surface under a microscope with a 100x objective lens. Magnification= x 1000. (Camel ID: 9).

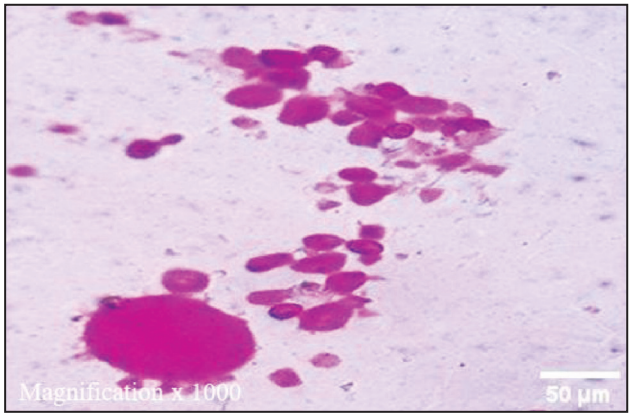

Fig 11. Many yeasts in the background under a microscope with a 100x objective lens. Magnification= x 1000. (Camel ID: 7).

a diagnostic tool advised under veterinary practice. Mange adversely affects camel welfare by causing pruritus, distress, reduced feed intake, weight loss, immune compromise and increased susceptibility to

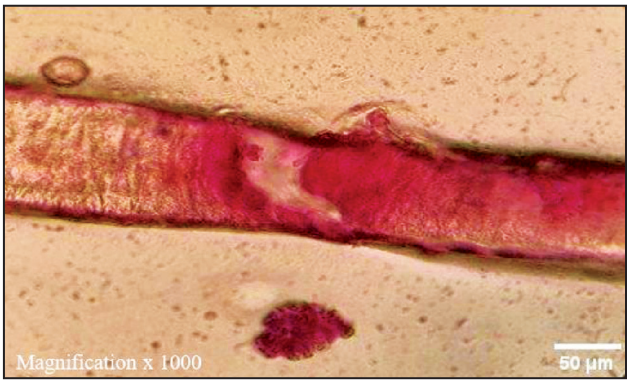

Fig 8. Fungal spore (endothrix) infection, frequent hair damage. Broken hair shaft at the site of endothrix under the microscope with a 100x objective lens. Magnification=x 1000. (Camel ID: 6).

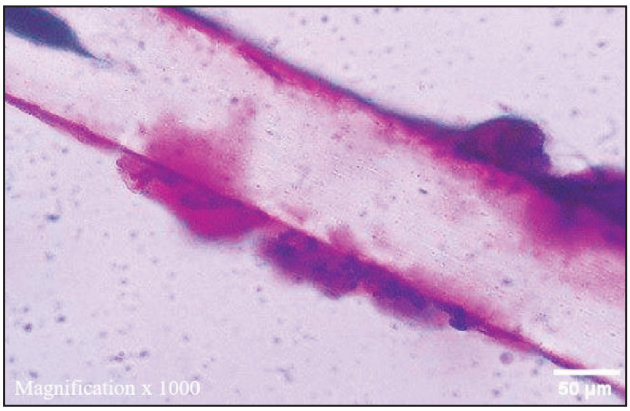

Fig 10. Fungal spore (ectothrix) infection with marked hair damage (loss of melanin granules) under a microscope with a 100x objective lens. Magnification= x 1000. (Camel ID: 2).

infections and is characterised clinically by alopecia, erythema, crusting and a rough coat (Chalchisa and Bersissa, 2023). Therefore, regular veterinary monitoring is recommended at markets as thorough diagnosis, timely treatment and effective prevention are essential to improve the health and welfare of dromedary camels.

Oocysts of *Eimeria cameli* and *dromedarii* were present in one-third of the tested faecal samples; no helminth eggs were detected. These results align with reports demonstrating the presence of protozoal enteroparasites being predominant in dromedary camels. For example, in Southern Algeria, using similar flotation methods, *Eimeria* spp. and *Balantidium* spp. were detected commonly and with only few helminths reported (Bouasla *et al,* 2023). Similarly, in Iran (Radfar and Aminzadeh Gowhari, 2013) and Egypt (El-Khabaz *et al,* 2019), *Eimeria* spp. was also identified as a common gastrointestinal parasite in camels Overall, the literature suggests that protozoal infections, particularly *Eimeria*

spp., are more prevalent than helminth infections in dromedary camels, highlighting the need for appropriate treatment and preventive measures (Metwally *et al,* 2020). Eimeria infects intestinal mucosal epithelium and can impair digestion (Mohammed, 2023), future studies should therefore link oocyst counts to species identification, clinical signs and body condition scores to clarify clinical significance.

This preliminary survey highlights the occurrence of skin diseases and protozoal infestations in market-kept camels. Parasitic infections adversely affect camel welfare by causing pain, weight loss, immune compromise and increased susceptibility to secondary infections (Toaleb *et al,* 2025). Although deworming is commonly practised by camel handlers, it is often done without veterinary prescription, which may promote inappropriate drug use and parasite resistance (Padalino *et al,* 2021; Padalino *et al,* 2024). Therefore, targeted control strategies, including veterinary-guided treatment and routine faecal egg counts rather than indiscriminate deworming, should be implemented to improve camel health and welfare (Nielsen, 2012).

Our data need to be interpreted with caution, as this preliminary study has its own limitations. Firstly, the sample size was very limited and the sampling was conducted in a single market, so our preliminary findings cannot be generalised to all markets. Secondly, only a superficial skin scraping sample was collected and consequently, the presence of the deep borrowing mites could have been underestimated. In addition, fungal hyphae or pseudohyphae were not detected in our sample and further mycological tests should have been performed to confirm the diagnosis. Finally, as we did not use any invasive collection methods, we collected faecal samples only from 9/15 camels, reducing even further our sample size and the possibility to identify helminth eggs. Notwithstanding those limitations, our study has increased our knowledge of skin disorders and parasite infections of dromedaries kept in a market in Qatar, providing some useful suggestions, such as increasing veterinary monitoring to better protect the welfare of dromedary camels kept at markets

Conclusions

Despite the limitations of this preliminary investigation, the findings highlight heterogeneous but predominantly superficial dermatologic processes and protozoal GI parasitism in market camels. These conditions likely reflect suboptimal husbandry practices common in animal markets, including high stocking density, poor hygiene, mixing and regrouping of animals. Given the potential risk of tick-borne pathogens, further studies incorporating morphological tick species identification and pathogen screening are warranted, along with routine monitoring by official veterinarians. Overall, these preliminary data support the need for improved management practices to enhance the welfare of dromedary camels at markets.

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Disclosure

The authors declare no conflict of interest in relation to the research, authorship or publication of this article.

Ethical Statement

The study was conducted according to the guidelines of the Declaration of Helsinki. The research project was run with the permission of the Department for Agriculture Affairs and Fisheries of the Ministry of Municipality and Environment of the State of Qatar (Approval code 2404/2020). The study involved no invasive sampling methods and all data collection was performed without disturbing the animals. Oral owners' consents were received before the assessment.

Author contributions

Conceptualisation of the study was done by Masa-aki Oikawa, Barbara Padalino. Data collection was done by Masa-aki Oikawa, Barbara Padalino, Jessica P. Johnson and Midori G. Asakawa. Laboratory investigation was done by Masa-aki Oikawa, Jessica P. Johnson and Midori G. Asakawa. Data analysis and drafting of the manuscript were done by Naod Thomas Masebo, Masa-aki Oikawa and Barbara Padalino. Reviewing, writing and proofreading were done by Naod Thomas Masebo, Barbara Padalino, Jessica P. Johnson and Midori G. Asakawa. Masa-aki Oikawa and Barbara Padalino supervised the entire research work.

Data availability

The data generated during the study can be requested from the corresponding author.

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