بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Prevalence and Risk Factors Associated with Mange, Ringworm and Dermatophilus Infection in the One-humped Camel (*Camelus dromedarius*) in Al-Butana area, El-Gazira State

نسبة الإصابة وعوامل الخطر المرتبطة بإصابة الإبل وحيدة السنام بالجرب والقوباء الحلقية والجقليس في منطقة البطانة – ولاية الجزيرة

A Thesis Submitted to the College of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Master of Preventive Medicine and Veterinary Public Health (MPVM)

By

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January / 2019

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قال تعالى:

﴿أَفَلَا يَنظُرُونَ إِلَى الْإِبِلِ كَيْفَ خُلِقَتْ﴾

الغاشية (17).

In The Name of Allah, the Most Gracious, the Most Merciful,

﴿Do they not look at the camels,

how they are created﴾

Al-Ghashiyah (17).

Dedication

I dedicate this work to my mother Noha Mohamdeen, father, brothers, sisters, my friends and Sudanese Revolution with deep love and sincerity.

Acknowledgements

I thank Allah who gave me the aptitude and patience to conduct and finish this work.

I am grateful to Professor/Mukhtar Taha Abu-Samra for his continuous support, supervision of this work and fatherly compassion.

My deep thanks and respect to all academic and technical staff of the College of Veterinary Medicine, Sudan University of Science and Technology.

I warmly thank and express my gratitude to the staff of Lining University-College of Veterinary Medicine.

Finally am indebted and very grateful to my parents for their love and support over the years.

Abstract

A cross-sectional study was carried out to determine the prevalence and risk factors associated with mange, ringworm and dermatophilus infection in One-humped camel (*Camelus dromedarius*) in Al-Butana area, El-Gazira State. Five hundred camels selected randomly were examined and skin infection was detected in 72 animals (14.4%) by examining skin scrapings in 20% KOH for detection mange and ringworm and stained smears of homogenized scab with Giemsa and Gram's stain for detection dermatophilus under the microscope. Among these; 18 camels (3.6%) were infected with mange, 50 camels (10%) were infected with ringworm and 4 camels (0.8%) were infected with dermatophilosis. There was significant difference in the prevalence of ringworm infection between male and female camels ($P \leq 0.05$), but no significant difference was observed in mange and dermatophillosis infection ($P \leq 0.05$). Also there was significant difference ($P \leq 0.05$) between the prevalence of mange and ringworm infection related to age groups of camels, and no significant difference ($P \leq 0.05$) was observed in dermatophillosis infection. Also there was significant difference ($P \leq 0.05$) in the prevalence of skin infection related to appetite, body condition, land topography, rearing system, drug use and type of lesion ($P \leq 0.05$).

The results obtained were indicative that camel skin diseases pose a problem in Al-Butana area, El-Gazira State, hence, further studies and strategic control measures are warranted to reduce the prevalence and the deleterious effects of skin diseases on camel health, reproduction, production and animal welfare.

ملخص البحث

لقد أُجريت دراسة مقطعية لتحديد نسبة الإصابة وعوامل الخطر المرتبطة بإصابة الإبل وحيدة السنام بالجرب والقوباء الحلقية والجقليس في منطقة البطانة - ولاية الجزيرة. ووفقاً لذلك ، فقد تم إجراء مسح إكلينيكي لعدد خمسمائة رأس من الإبل أختيرت عشوائيا، وتم فحص جلد هذه الإبل للوقوف على الأمراض الجلدية التي تصيبها. حيث تبين أن عدد 72 (14.4 ٪) من الإبل مصابة بأمراض جلدية مختلفة عن طريق فحص كشط الجلد في 20% هايدروكسيد البوتاسيوم للكشف عن الجرب والقوباء واستخدام الصبغ بصبغة جمسا وصبغة جرام للكشف عن الجقليس . ومن خلال الفحوصات المخبرية التي أُجريت تبين أن عدد 18 (3.6 ٪) من هذه الإبل مصاب بالجرب ، و عدد 50 منها (10 ٪) مصاب بالقوباء الحلقية، وعدد 4 (0.8 ٪) مصاب بمرض الجقليس. ومن خلال الدراسة تبن أن هناك فرق معنوي ($p \leq 0.05$) في إنتشار عدوى القوباء الحلقية بين الإبل الذكور والإناث ولكن لم يلاحظ أي فرق معنوي في الإصابة بمرض الجرب و الجقليس ($p \leq 0.05$). كما لُوحظ إختلاف معنوي ($p \leq 0.05$) في إنتشار الإصابة بالجرب والقوباء الحلقية بين الفئات العمرية للإبل. ولم يلاحظ أي فرق معنوي ($p \leq 0.05$) في العدوى بمرض الجقليس. كما لوحظ أيضاً إختلاف معنوي ($p \leq 0.05$) في إنتشار العدوى الجلدية في الإبل بين الشهية، وحالة الجسم، والنظام الإيكولوجي، والتربية، وتواتر الأدوية، ونوع الآفة.

ومن خلال البحث والنتائج المُتحصل عليها فقد تبين أن الأمراض الجلدية في منطقة البطانة بولاية الجزيرة تشكل مشكلة حقيقية، لذا يُوصى بإجراء دراسات مكثفة ووضع إستراتيجية شاملة لمكافحة هذه الأمراض والحد منها لتفادي التأثير السلبي الذي تسببه هذه الأمراض على صحة الإبل، توالدها، وإنتاجها ورفاهها.

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Chapter one

Introduction

The one-humped camel (*Camelus dromedarius*) or Arabian camel, commonly called the dromedary, is an important species uniquely adapted to hot and arid environments. The Genus *Camelus* was probably among the last of the major domestic species to be put to regular use by man. Since its domestication 3000-4000 years ago, the one-humped camel (*Camelus dromedarius*) accompanied humans and provided many facilities in arid and semi-arid areas. It is an indispensable species of domestic animal. It had been exploited by man in Asia and Africa in arid and semi-arid areas- often being the only supplier of food and transport for people. It is a multipurpose animal (Ishag and Ahmed, 2011; Palanivelrajana *et al*., 2015) that can be used for milk, meat, wool, hide, transport, races, tourism, agricultural work and beauty contests. No other domestic animal is able to provide as many variable services to humans. The dromedary- one-humped camel – *Camelus dromedarius* served the needs of people for thousands of years ago. They secured trade and communication through wide arid and semi-arid expanses. The majority of camels are kept by pastoralists in subsistence production systems (Ishag and Ahmed, 2011).

Camels belong to the family *Camelidae* in the ruminant suborder *Tylopoda* of the order *Artiodactyla* (even-toed ungulates). There are two species in the genus *Camelus*: the dromedary, or Arabian camel, (*Camelus dromedarius*) which gets its name from the Greek word δορooς meaning running, and *C. bacterianus*, the Bactrian camel named after the area of Bactriana in Central Asia where it has been domesticated (Al-Ani *et al*., 1998).

The ten first countries in the world according to their camel population are Somalia, Sudan, Ethiopia, Niger, Mauritania, Chad, Kenya, Mali, Pakistan and India (Faye *et al*., 2011).

The world camel population is increasing regularly with a yearly growth of 3.4%. Since 1961 (First FAO statistics), the world camel population has more than doubled (Faye, 2013).

According to FAO statistics (2009, 2013), the Sudan with a camel population of 4.5 million heads, is the second country in the world after Somalia. More than 80 % of the world camel population live in Africa (Bornstein, 1990), with 60 % in the horn of Africa (Faye, 2013).

Camels in the Sudan are normally found in the northern parts of the country about the 13°N parallel. They are concentrated mainly in the north-western parts of Kordofan and Darfur regions and in the Eastern Region. As a consequence of recent drought and desertification, camels have moved as far south as the 10°N parallel. Their movement further south is hindered by political instability and tribal disputes in the Southern parts of the country, and the unsuitability of the muddy soil, high rate of humidity and presence of fatal diseases like trypanosomiasis (Shommein and Osman, 1987). The total population of camels in the Sudan is 4.83 million (Faye, *et al.* 2011), and about 1,266,063 camels are in El-Gazira State (MAR, 2016).

Past and present experiences proved that the dromedary camel is a very hardy animal and has very special anatomical characteristics, and many varied physiological mechanisms, which enable the animal to live, reproduce and produce milk and meat, and to work under extreme conditions of heat and aridness - even during periods of drought when cattle, sheep and goats barely survive. Nevertheless, they suffer from various endo and ecto-parasitic diseases which are major constraints in the improvement of camel

health. These diseases cause substantial economic losses in terms of decrease in working capacity, growth and productivity (Parsani, *et al*., 2008).

Problem Statement and Justification:

1) Camel skin diseases in the Sudan are widespread and some skin diseases are zoonotic such as mange, dermatophilosis and ringworm.
2) Skin infection leads to loss of the protective barrier against infection with micro-organisms.
3) Establishment of base-data for skin diseases of camel is warranted.
4) Skin diseases of camels cause serious economic losses resulting from death of the animal, damage and down-grading of hides and decrease in working capacity, growth and productivity.
5) The diagnosis, epidemiological investigation, and analysis of the associated risk factors of skin diseases, is an important approach for their control.
6) The zoonotic skin diseases of camels are, of public health significance that require treatment, control and prevention.

Objectives of the Study:

Overall Objectives:

1) To determine the prevalence of mange, ringworm and dermatophlius infection in the one-humped camel (*Camelus dromedarius*) in Al-Butana, El-Gazira State.

Specific objectives:

The present study was conducted to achieve the following goals:

1) To assess the prevalence rate of mange, ringworm and dermatophlius infection in the one-humped camel in Al-Butana area.
2) To diagnose the most important parasitic, bacterial and fungal infections affecting the skin of the one-humped camel in Al-Butana area, El-Gazira State.
3) To assess the risk factors associated with the spread of skin diseases in camels.

Chapter Two

Literature Review

The skin is the largest organ of the body and, depending on the species and age, it may represent 12-24% of an animal's body weight. The skin has many functions, including serving as an enclosing barrier and providing environmental protection, regulating temperature, producing pigment and vitamin D, sensory perception, etc. Anatomically, the skin consists of the following structures: epidermis, basement membrane, dermis, appendageal system, and subcutaneous muscles and fat. (Ministry of Industry Report, 2008).

2.1. Mange:

Mange is a serious skin disease of camelids. Camels may suffer from sarcoptic mange, and on rare occasions from psoroptic, and chorioptic mange. Sarcoptic mange is more common in camels and is of zoonotic importance (Palanivelrajana *et al*., 2015).

Sarcoptes scabiei is a cosmopolitan sarcoptid mite, which parasitizes domestic and wild animals as well as man. Sarcoptic mange (Nayel and Abu-Samra, 1986) and trypanosomiasis (Mahmoud and Gray, 1980) are the most prevalent diseases in camels, and recently dermatophilosis (Giato, Agab and Khalafalla, 1998); became prevalent among camels due to movement of camels herds to the Southern border of the camel belt (Abu-Samra, 2018).

Sarcoptic mange is the commonest of the more significant diseases of camels (Ono and Ikeda, 1941), and is the only form of scabies that affects them (Draz, 1947; Higgins, 1984).

Camel mange is frequently sudden in onset and often starts on the medial aspects of the thighs or inguinal region, the neck or the flanks. Occurrence is often associated with poor management or malnutrition and stray camels will often form a focus for infecting a clean herd when mingling at a watering place (Higgins, 1985).

Camel mange has been mentioned in the Annual reports of the Sudan Veterinary Services since 1922 (Nayel and Abu-Samra 1986).

In the Sudan the disease known locally as "jereb" is dreaded by camel owners because it spreads rapidly causing loss of condition, decreased work tolerance and in extreme cases, death (Nayel and Abu-Samra, 1986).

Sarcoptic mange in camels is a highly contagious disease and affects all ages. Transmission of the disease occurs by direct contact with infected camels or via indirect contacts with contaminated fomites, such as blankets and baggage (Salama and Osman, 2017). The lesions gradually progress from pruritic nodules which lead to scratching and eventually render the skin hairless, crusty and wrinkled especially on the thighs, hocks and axillae (Abu-Samra and Imbabi, 1981). Sarcoptic mange is considered to be one of the most serious and economically important zoonotic and epizootic disease.

There are many reports and studies regarding the prevalence of sarcoptic mange, in camels from different parts of the world, most of these studies revealed that the prevalence of mange in the camel population of different countries ranges from 3.5% to 83% (Zahid *et al*., 2015).

In the Sudan 33,000 camels were surveyed for sarcoptic mange (Nayel and Abu-Samra, 1986): 30,000 in moving herds at water points in Kassala, the Red Sea, Nile and Northern Provinces, the remaining 3,000 animals at sesame pressing plants or *Assara* in Gedaref town. Among the total surveyed the overall incidence of the disease was 55.12 %, while its

incidence among working camels "*Assara*" was 80 %, and its incidence among moving herds was 52.63 %. A detailed description of the disease in camels was provided by Nayel and Abu-Samra, (1986).

Sarcoptes scabiei is the causative agent of sarcoptic mange. It is a minute circular parasite. The female mite is 330 to 600 x 250 to 400 µm, and the male is 200 to 240 x 150 to 200 µm. The disease is widely recognized and owners regularly seek veterinary therapy when the disease occurs (Higgins, 1985).

The life cycle of the mite lasts for 4-5 weeks. Fertilized females dig burrows into the epidermis, causing inflammation and intense pruritus (Nayel and Abu-Samra, 1986; Richard, 1987). Under suitable conditions the mites multiply so rapidly that a single ovigerous female could theoretically give rise to over a million descendants within three months. The female digs tunnels in the keratinous layers of the skin. These tunnels are used for depositing eggs which are laid one or two at a time and three to five each day. Forty to 50 eggs may be laid in the tunnels and the resultant six-legged larvae emerge within two to four days. These larvae molt after two to three days to eight-legged nymphs, and after a further three to four days, another molt produces either a male mite or a pubescent female. After mating, the ovigerous female will start laying eggs. Larvae and nymphs may develop within tunnels or may themselves burrow deeper into the skin. They may also emerge onto the skin surface, either by their own efforts or mechanically as the skin layers are shed, hastened by nibbling or scratching. This is of some significance; since larvae, nymphs and adult mites are all capable of infecting other animals (Higgins, 1985).

The clinical picture of sarcoptic mange includes intense pruritus, exudative dermatitis, parakeratotic scaly crust formation, alopecia and dark

thickened skin. Fissures develop in the crust and underlying epidermis resulting in hemorrhages. Emaciation, debilitation, anemia and subcutaneous edema are common signs of mange in camels. During development of mange, itchiness distracts the animals from eating so that they often become emaciated (Sherif *et al*., 2012).

Psorotic mange mites spend their entire life on the skin, feeding superficially. *Psoroptic* mange was reported in camelids, but is of less significance than *S. scabiei* (Sherif *et al*., 2012). The mite attacks the epidermis of various domestic animals, causing a local reaction characterized by exudation and subsequent crust formation (Abu-Samra and Imbabi, 1981).

Chorioptic mites are surface-dwelling usually found below the knees or around the root of the tail in cattle. *C. bovis* resembles the psoroptic mange mite but has blunter mouth parts and legs with unsegmented pedicels. Chorioptic mange in camels is a relatively mild disease characterized by mild irritation and rubbing. Control measures used for sarcoptic mange were reported to be effective for chorioptic mange (Higgins, 1985).

Mange is diagnosed by examining skin scrapings in 10-20 % KOH for demonstration of the adult mite or any stage of its lifecycle. However, (Bornstein *et al*., 1997), developed a technique for the early diagnosis of the disease in camels by the demonstration of serum antibody to *Sarcoptes scabiei* in naturally infected camels.

Ivermectin at 0.4 mg/kg body weight reduced mite counts to zero in skin scrapings of animals infected with sarcoptic mange on day 45 of administration, whereas camels showing heavy lesions of sarcoptic mange and treated with the respective doses of ivermectin showed zero counts of live mites in scrapings after 60 days of treatment (Zahid *et al*., 2016).

Shommein and Osman (1987) reported that sarcoptic mange is treated by spraying the infected camels with a freshly- prepared solution of Gamatox (lindane) or diazinon. It may be necessary to repeat the applications several times to effect a cure. However, Abu-Samra (1999) conducted a detailed comparative study for the efficacy of sebacil E.C. 50 %, gamatox and ivomec in the treatment of sarcoptic mange in camels and found that sebacil E.C. 50 % gave excellent results.

2.2. <u>Ringworm infection</u>:

Dermatophytosis (syn. ringworm) is a zoonotic skin infection of the keratinized tissues caused by a specialized group of fungi named dermatophytes. The disease can affect man, and all domestic animals, including camels (Almuzainia *et al*., 2016). Dermatophytosis is caused by pathogenic, keratin-digesting fungi in the genera *Microsporum*, *Trichophyton* and *Epidermophyton*. Members of *Microsporum* and *Trichophyton* cause the disease in both humans and animals.

Ringworm occurs in camels less than 3 years of age, and is characterized by circumscribed crusty hairless lesions of 1-2 cm in diameter distributed over the head, neck, shoulder, limbs and flanks (Agab, 1993). *Trichophyton verrucosum* was isolated almost exclusively from young camels and *T. mentagrophytes* from old ones although *T. verrucosum* was isolated from a five- year old male camel. In the Sudan *T. verrucosum* was first isolated and confirmed as the causative agent of ringworm in camels by (Agab, 1993; Wisal, and Salim, 2010). The incidence of *T. verrucosum* was 43.5% among camel calves while the overall incidence was 11.2%. The disease was more prevalent during the rainy and cold seasons.

The clinical picture of dermatophytosis vary, depending on the infecting organism, affected tissues (skin, hair or nails) and area of the body. In the unhaired (glabrous) skin, the lesions are usually characterized by inflammation that is most severe at the edges, with erythema, scaling and occasionally blister formation. The central area may clear, resulting in the formation of a classic "ringworm" lesion. In haired areas, the hairs become brittle and areas of alopecia may appear. Dermatophytes acquired from animals or the soil generally produce more inflammatory lesions than anthropophilic dermatophytes, but with few exceptions, and the lesions are also less likely to become chronic than those caused by anthropophilic organisms (Center for Food Security and Public Health, 2013).

Direct microscopic examination by using 20 % potassium hydroxide solution reveal arthrospores and hyphae under a light microscope using low and high powers (Bornstein, 1990). Culture of dermatophytes was conducted on Sabouraud Dextrose Agar (SDA) media to which chloramphenicol and cyclohexidine were added. The inoculated media were incubated at 27 °C under aerobic conditions for four weeks. Identification of the dermatophyte was made based on the colony characteristics and microscopic features of the fungal isolates (Almuzainia *et al.*, 2016).

Dermatophyte infections are treated with a variety of topical and oral antifungal drugs. Topical agents may also be used to treat asymptomatic carriers or prevent re-infection (Center for Food Security and Public Health, 2013).

2.3. ***Dermatophilus congolensis* infection:**

Dermatophilosis is cosmopolitan in distribution. The disease is caused by Gram positive, non-acid fast, aerobic bacterium *Dermatophilus*

congolensis of the family *Dermatophilaceae* of the order *Actinomycetales* (Abu-Samra, 1978 a; Yared *et al*., 2015). The disease is reported in domestic animals, man and several species of wild animals as well as reptiles (Abu-Samra, 1978 a; Yasser and Falah, 2016). Dermatophilosis, is a zoonotic acute or chronic exudative epidermatitis caused by the pleomorphic Gram-positive, aerobic bacterium (*Dermatophilus congolensis*), producing multistrata scab (Abu-Samra, 1978 a).

Dermatophilus congolensis has two characteristic morphologic forms: filamentous hyphae and motile zoospores (Abu-Samra, 1978 b). The hyphae are characterized by branching filaments of 1.2-2.4 µm in diameter and varying length with the most common range of 4.8-20 µm that ultimately fragment by both transverse and longitudinal septation into 2-4 parallel rows of coccoid cells of 0.6 µm (Abu-Samra, 1978 b). The coccoid cells mature into flagellated ovoid zoospores of 0.6-1µm in diameter (Abu Samra, 1978 b; Yared *et al*., 2015).

Dermatophilosis is an epizootic disease in tropical and subtropical areas of the world (Dalis *et al*., 2010). The disease was first reported by Van-Saceghem in 1915 in cattle in the Belgian Congo (Abu Samra, 1978 b; Yared, *et al*., 2015). It is commonly called cutaneous streptothricosis in cattle, goats, and horses. In sheep, it is termed lumpy wool. The disease in camels was reported by Agab (1993) and Giato, *et al*., (1998). Infection in camel herds has been related to drought and poverty and movements of camel herds outside the southern border of the camel belt (Adedeji and Adene, 2017; Abu-Samra, 2018).

Transmission of dermatophilosis follows the disruption of the natural skin barriers by skin abrasions from thorns, grain awns, ticks, and flies. Prolonged wetting of skin during or after the rainy season may predispose

camels to more severe infection because of the emulsification of the wax barrier and disruption of the stratum corneum.

The lesions commence as a circumscribed moist patch, often with raised or matted hairs, giving a characteristic “Paint brush” appearance. Discrete lesions occur in the initial stages, which coalesce to form large areas of hyperkeratotic scab and crust. The distribution of the gross lesions usually correlates with the predisposing factors that reduce or permeate the natural barrier of the integument. Typical lesions consists of circular, dome shaped scab 2-9 cm in diameter. Multistrata scab may be of variable thickness and on removal show a concave underside leaving a raw, bleeding epidermis (Abu-Samra, 1978 a; Yared *et al.*, 2015). Human infection, in the form of pustules, furuncles, or desquamated eczema of the hands or forearms or superficial erosions of the esophagus, can be acquired through contact with diseased animals (Yasser and Falah, 2016).

Samples of scabs and fibers were taken from camels with active cutaneous lesions on different parts of their body and investigated for the presence of *D. congolensis.* The scab with adherent fibers were homogenized in a pestle and mortar and stained with Giemsa and Gram’s stain and examined under the microscope. The smears revealed Gram positive multiseptate filaments 1.2-2.4 µm in diameter, giving parallel chains of cocci 0.6-0.8 µm in diameter that were characteristic to *Dermatophilus congolensis* (Abu-Samra, 1978 a; Yasser and Falah, 2016).

The isolation of *Dermatophilus congolensis* was conducted by seeding the homogenized scab and fibers in blood agar and brain heart infusion agar to which polymixin B sulphate was added (1000 iu/ml). The seeded plates were incubated at 37 °C for 48 hours under aerobic conditions and in 10 %

carbon dioxide. Typical colonies of the organism were obtained under both aerobic conditions and increased carbon dioxide tension. The colonies were 1-1.5 mm in diameter, β-haemolytic, hard fimbiriated and embedded in the medium. Mycelia 1.2-2.4 µm in diameter, septated transversely or both transversely and longitudinally forming 2-4 parallel rows of cocci 0.6-0.8 µm in diameter, were seen in films (Abu-Samra and Walton, 1977).

The *in vitro* sensitivity of *Dermatophilus congolensis* to various antibiotics ranged from complete inhibition of growth to no effect as judged by the width and clarity of inhibition zones on solid media (Abu-Samra *et al*., 1976). However, affected animals treated with long acting terramycin at the dose rate of (20mg/kg), resulted in disappearance of the lesions and the animals became healthy, only to reappear the following rainy season, and even when the dosage of the drug was increased and given for five days; treatment was also not effective (Adedeji and Adene, 2017). In field cases dermatophilosis caused by *Dermatophilus congolensis* seems to be a self-limiting disease (Abu-Samra, 2018), that disappears in summer, but the infected animals remain as carriers of the organism, and the disease flares up in the rainy season when the conditions are conducive for the propagation of the organism (rain, humidity, ticks and flies).

Chapter Three

Materials and Methods

3.1. Study area:

The study area was located between, Blue Nile and River Atbara with the Khartoum, El Gadaref and Kassala railways as the southern boundary. It covered approximately 120,000 km^2, lying between latitude13° 50’ and 17º 50’ N and longitude 32º 40' and 36º 00' E (Edris *et al*., 2013).

Figure 1: Map showing the area covered during the current investigation. Source: Google.

3.2. Study type:

The study is a cross-sectional study to establish the prevalence and risk factors of mange, ringworm and dermatophilus infection in One-humped Camel.

3.3. Camels examined:

The study was conducted in 500 camels selected by the simple random sampling method.

3.4. Study design:

A cross sectional study which provides snapshot information on the occurrence of the disease (Martin, *et al*., 1987) was conducted.

3.5. Sample size:

The sample size was determined based on the formula recommended by Thrusfield (1995), and is as follows: $n = \frac{1.96^2 * \text{Pexp} * \text{q}}{\text{d}^2}$

Where:

N = sample size required.

Pexp = expected prevalence.

q = 1- pexp.

d = desired absolute precision

In this formula expected prevalence of 50 % and absolute precision of 95% were considered. Accordingly, a total 384 camels were required for this study, but the sample size was increased to 500 to increase precision.

3.6. Individual risk factors:

Data on potential risk factors were collected through a questionnaire addressing camel owners (Appendix 1) and were as follows: age, sex, body condition, appetite, and distribution and type of lesions, housing,

management, related communities, acaricides used, and response to treatment.

3.7. Survey, collection and examination of skin scrapings:

3.7.1. Survey:

Camels were examined by visual inspection, and suspected animals with skin lesions were carefully examined by skin the scraping technique and photographed. A questionnaire regarding the potential risk factors associated with mange, ringworm and Dermatophilus infection (age, sex, body condition, appetite, and distribution and type of lesions, housing, management, related communities, acaricides used, and response to treatment) was completed (Appendix 1).

3.7.2. Collection and examination of skin scrapings:

Deep skin scrapings were collected from camels with skin lesions. The skin scrapings were conducted until hyperemia without bleeding occurred. The skin scrapings were examined in 20 % KOH for demonstrating mange mites or arthrospores for ringworm and scab with adherent fibers were homogenized in distilled water using a pestle and mortar then smears were prepared from the homogenized scab, stained with Giemsa and Gram's stains, and examined for *Dermatophilus*.

All data obtained were recorded.

3.8. Statistical analysis:

The data obtained were statistically analyzed using Statistical Package of Social Science (SPSS). Descriptive statistical analysis was first displayed in frequency distribution and cross-tabulation tables. Then Univariate analysis using the chi-square for qualitative data was performed. A *P*-value ≤ 0.05 was considered as a significant association, and the risk factors were

then selected to enter the Multivariate analysis. Multivariate analysis forward stepwise logistic regression was used to analyze the data and to investigate the association. A *P*-value ≤ 0.05 indicates significant association between camel skin disease and the risk factor.

Chapter Four

Results

4.1. Microscopic examination of skin scrapings and scab:

4.1.1. Sarcoptic mange in camels:

Skin scrapings examined in 20 % potassium hydroxide (KOH) revealed *Sarcoptes scabiei* mites and their different developmental stages (Fig. 2 a) in 18 samples of skin scrapings.

Sarcoptes scabiei mites have round body with short legs, the caudal two pair of legs do not extend beyond the margins of the body, with bell-shaped caruncles on the long non-segmented pedicels in the leg of the male and only the anterior two pair of females. The male has no copulatory disc and the head is broad. The female mites measure about 0.5 mm, and the male about 0.3 mm.

Figure 2a: *Sarcoptes scabiei* mite in skin scrapings from an infected camel.

Figure 2b: A camel with advanced lesions of sarcoptic mange, showing complete alopecia, thick crust formation.

Camels infected with sarcoptic mange were restless showing intense pruritus manifested by rubbing or biting and gnawing the affected areas on the skin. Severe erythema with many papules and nodules (0.5 – 1cm) were seen on the head, neck, flanks, abdomen and thighs (Fig. 2b). The papules and nodules oozed serous exudate, and the scratching and rubbing of the affected

areas resulted in alopecia (1 -1.5 cm). The hair is initially moist. New papules and nodules appear in many areas, and the coat became rough, naked and had moth eaten appearance. There is crust formation, secondary excoriation. The skin had an offensive odor and became thickened.

4.1.2. Distribution of mange lesions on the camels' body:

The distribution of lesions in the 18 camels infected with mange is shown in (Table 4.1). Mange affected different parts of the camels' body. Ten camels (55.5%) had lesions on the head, nine camels (50 %), had lesions on the neck, three camels (16.6%) had lesions on the abdomen, three camels (16.6%) had lesions on the back, and four camels (22.2%) had lesions on the thighs.

Table 4.1: Distribution of mange lesions on the camel's body.

Head	Neck	Abdomen	Back	Thighs
10 (55.5%)	9 (50%)	3 (16.6%)	3 (16.6%)	4 (22.2%)

4.1.3. Dermatophytoses (ringworm) in camels:

Skin scrapings examined in 20 % potassium hydroxide (KOH) showed arthrospores characteristic to the dermatophytes (Fig.3 a) in 50 samples.

The lesions of ringworm appeared on the head especially round the eyelids and muzzle, neck, shoulders, abdomen (Fig. 3 b), legs and tail. The lesions varied in size and characterized by their circular or semi-circular shape. The affected areas became inflamed with serous exudation, which became dry through time forming scales and crusts covering the lesions, and the skin of the affected areas became thickened. The lesions caused severe pruritus and scratching of the affected areas. As the result of pruritus and scratching the lesions became enlarged and spread covering extensive areas of the skin, and in many occasions the lesions became infected with secondary bacteria.

Figure 3a: 20% KOH preparation of skin scrapings showing large arthrospores of dermatophytes.

Figure 3b: A camel infected with ringworm showing papules, vesicles and circular moth-eaten appearance of wool involving the whole body.

4.1.4.Distribution of ringworm lesions on the camels' body:

The distribution of lesions in the 50 camels infected with ringworm is shown in (Table 4.2)

Head	Neck	Abdomen	Back	Thighs
33 (66%)	39 (78%)	28 (56%)	23 (46%)	20 (40%)

Table 4.2: Distribution of ringworm lesions on the camel's body.

4.1.5. Dermatophilosis in camels:

Smears prepared from the homogenized scab, stained with Giemsa and Gram's stains showed parallel chains of cocci. *Dermatophilus congolensis* was distinguished by branching hyphae subdivided by transverse and longitudinal septae forming parallel rows of cocci (Fig. 4 a) in four samples.

Camel calves showed higher skin involvement than adult ones, while adults had a higher incidence of hair matting. In camel calves less than one year of age the disease was more severe affecting most of the skin especially

the head, neck, chest, flank, and upper fore and hind limbs. Infected camel calves developed alopecia, and yellowish brown crusts on the affected areas (Fig. 4b).

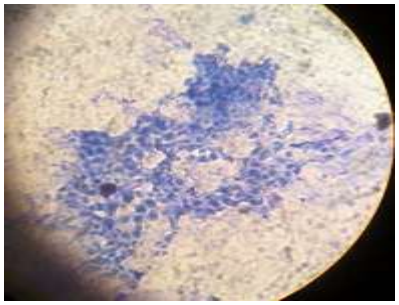

Figure 3 a: *Dermatophilus congolensis* in smears made from the scab of infected camels. Giemsa stain.

Figure 3 b: A young camel showing scab covered generalized lesions of dermatophilosis.

The infected calves showed enlarged regional lymph nodes, anorexia and their general health condition deteriorated resulting in emaciation terminating in death in advanced cases.

4.1.6. Distribution of dermatophilosis lesions on the camels' body:

Dermatophilosis lesions were also distributed on the different parts of the camels' body (Table 4. 3).

Head	Neck	Abdomen	Back	Thighs
2 (50%)	3 (75%)	3 (75%)	1 (25%)	1 (25%)

Table 4.3: Distribution of dermatophilosis lesions on the camel's body.

4.2. Prevalence of dermal infection in examined camels (mange, ringworm and dermatophilosis):

Five-hundred camels were surveyed of these 72 (14.4 %) had skin diseases. Among those infected the prevalence of mange infection was 3.6%, and within skin diseases infection; the prevalence rate was 25% (Table 4.5). The prevalence of ringworm infection was 10 %, and within skin infections the prevalence rate was 69.4% (Table 4.5.). The prevalence of dermatopihlosis was 0.8%, and within dermal infections the prevalence rate was 5.6% (Table 4.5.).

Table 4.4: Prevalence of skin infections in the surveyed camels.

Animals surveyed	No	%
Infected	72	14.4
Not infected	428	85.6
Total	500	100

X^2 = 500 P-value = 0.000

Table 4.5: Prevalence of mange, ringworm and Dermatophilus infection in camels at Al-Butana area, El-Gezira state.

Microscopic examination	No.	% within the total number of animals	% within skin diseases
Mange infection	18	3.6	25
Ring worm infection	50	10	69.4
Dermatophlosis	4	0.8	5.6
Not infected	428	85.6	0
Total	500	100	100

X^2 = 500 P-value = 0.000

4.3. Descriptive statistical analysis frequency, cross tabulation and association between skin diseases (mange, ringworm and dermatophlosis), and potential risk Factors:

4.3.1. Mange infection:

4.3.1.1. Sex of the animals:

Among the total number of camels surveyed (500 camels); 86 were males and 414 were females. Among male animals, 6 (7 %) were found infected, while among female camels, 12 (2.9 %) were found infected. No significant association (P-value = 0.065, x^2 = 3.14) was observed between the sex of animal and mange infection (Table 4.6).

4.3.1.2. Age of animals:

Among the total number of camels surveyed (500 camels), 121were young animals (1 to 5 years), 203 were adult animals (6 to 10 years) and 176 were old animals (more than 10 years). Among young animals 11(9 %) were found infected, and among adult animals only two animals (0.98%) were found infected, while among old animals 5 (2.8%) were infected. A significant association (P-value = 0.001, x^2 =14.80) was observed between the age of animals and mange infection (Table 4.6).

4.3.1.3. Appetite of animals:

Among the total number of camels surveyed (500 camels), 62 animals showed inappetance and the remaining 438 animals had normal appetite. Among the animals that showed inappetence 17 (27.4%) were found infected, while one animal (0.22%) with normal appetite was found infected. A significant association (P-value =0.000, x^2 =115.7) was observed between the appetite of the animals and mange infection (Table 4.6).

4.3.1.4 Body condition of animals:

Among the total number of camels surveyed (500 camels), 36 animals were found with poor body condition, 36 animals with fair body condition and 428 with good body condition. Among the animals with poor body condition 16 (44.4%) were found infected, and two animals (5.5%) with fair body condition were found infected. A significant association (P-value = 0.000, x^2 =189.4) was observed between the body condition of the animals and mange infection (Table 4.6).

4.3.1.5 Land ecology:

Among the total number of camels surveyed (500 camels), 17 animals live in muddy land, 454 animals live in rocky land and 29 animals live in sandy land. Among the animals that live in muddy land 6 (35.2%) were found infected, while among those that live in rocky land 11(2.4%) were infected, and only one animal (3.4%) among animals that live in sandy land was found infected. A significant association (P-value = 0.000, x^2 = 51.02) was observed between the land ecology and mange infection (table 4.6).

4.3.1.6 Rearing system:

Among the total number of camels surveyed (500 camels), 44 animals were in mixed rearing and 546 animals were reared separately. Among the animal in the mixed rearing system 4 (9 %) were found infected, while among the animals that were in the separate rearing system 14 (3%) were found infected. No significant association (P value = 0.064, x^2 = 4.19) was observed between type of rearing and mange infection (table 4.6).

4.3.1.7 Drug use:

Among the total number of camels surveyed (500 camels), 61 animals did not receive drugs, 27 animals received drugs on irregular basis and 412 animals received drugs on regular basis. Among animals that did not receive

drugs 18 (29.5%) were found infected, and no infection was observed among the groups of camels that received drugs. A significant association (P-value = 0.000, x^2 =134.4) was observed between drug use and mange infection (table 4.6).

4.3.1.8 <u>Type of lesion</u>:

Among the total number of camels surveyed (500 camels), 61 animals showed scab covered lesions, 2 animals showed moist oozing lesions and 437 animals were healthy. Among the animals that showed scab covered lesions 16 (26.2%) were found infected with mange, while only two animals infected with mange had moist oozing lesions (100%). A significant association (P-value = 0.000, x^2 =159.9) was observed between the type of lesion and mange infection (table 4.6).

Table 4.6: Univar ate analysis of association of potential risk factor with ma Mange infection in Al- Butana area, El-Gezira state

Factor	No. of Camels Examined	No of + Ve (%)	Df	X^2	P. Value
Sex of animal					
Male	86	6 (7)	1	3.14	0.065
Female	414	12 (2.9)			
Age of animal					
From1to5 years	121	11 (9)	2	14.80	0.001
From 6 to 10 years	203	2 (.98)			
More than 10 years	176	5 (2.8)			
Appetite					
Inappetence	62	17 (27.4)	1	115.7	0.000
Normal	438	1 (0.22)			
Body condition					
Poor	36	16 (44.4)	2	189.4	0.000
Fair	36	2 (5.5)			
Good	428				
Land ecology					
Muddy land	17	6 (35.2)	2	51.02	0.000
Rocky land	454	11 (2.4)			
Sand land	29	1 (3.4)			
Rearing system					
Mixed rearing	44	4 (9)	1	4.19	0.064
Separate rearing	456	14 (3)			
Drug use					
Not use	61	18 (29.5)	2	134.4	0.000
Irregular use	27				
Regular use	412				
Type of lesion					
Scab	61	16 (26.2)	2		0.000
Moist	2	2 (100)		159.9	
Healthy	437				

4.3.2 Ringworm infection:

4.3.2.1 Sex of the animal:

Among the total number of camels surveyed (500 camels); 86 were males and 414 were females. Among male camels 15 (17.4%) were found infected, while among female camels 35 (8.4%) were infected. A significant association (P-value = 0.011, $x^2 = 6.39$) was observed between the sex of animals and ringworm infection (Table 4.7).

4.3.2.2 Age of the animals:

Among the total number of camels surveyed (500 camels), 121camels were young (1 to 5 years), 203 were adult animals (6 to 10 years) and 176 old animals (more than 10 years). Among young animals 28 (23.1%) were found infected and among adult animals 11(5.4%) animals were found infected, while in old animals 11 (6.2%) were infected. A significant association (P-value = 0.000, $x^2 = 30.69$) was observed between the age of animals and ringworm infection (Table 4.7).

4.3.2.3 Appetite of the animals:

Among the total number of camels surveyed (500 camels), 62 animals showed inappetance and 438 animals had normal appetite. Among the camels that showed inappetence 47 (75.8%) were found infected, while only 3(0.68%) animals with normal appetite were found infected. A significant association (P-value = 0.000, $x^2 = 340.6$) was observed between appetite of animals and ringworm infection (Table 4.7).

4.3.2.4 Body condition:

Among the total number of camels surveyed (500 camels), 36 animals were found with poor body condition, Another 36 animals were in fair body condition, and 428 with good body condition. Among the camels showing poor body condition 27(75%) animals were found infected, 20 (55.5%)

animals with fair condition were found infected, while among animals showing good body condition only three (0.7%) were found infected. A significant association (P-value = 0.000, x^2 = 293.1) was observed between the body condition of animals and ringworm infection (table 4.7).

4.3.2.5 Land ecology:

Among the total number of camels surveyed (500 camels), 17 animals live on muddy land, 454 animals live on rocky land and 29 animals live on sandy land. Among camels living on muddy land 12 (70.5%) animals were found infected, while those living on rocky land 32 (7%) animals were infected, and only 6 (20.6%) animals living on sandy land were found infected. A significant association (P-value = 0.000, x^2 =77.41) was observed between land ecology on which the camels live and ring worm infection (table 4.7).

4.3.2.6 Rearing system:

Among the total number of camels surveyed (500 camels), 44 animals were kept under mixed rearing conditions, and 546 animals were kept under separate rearing system. Among camels kept under mixed rearing 28 (63.6%) were found infected with ringworm; while those kept under separate rearing 22 (4.8%) were found infected. A significant association (P-value = 0.000, x^2 =154.2) was observed between rearing and ringworm infection (Table 4.7).

4.3.2.7 Drug use:

Among the total number of camels surveyed (500 camels), 61 animals received did not receive drugs, 27 animals received drugs on irregular basis, and 412 animals received drugs on regular basis. Among the animals that did not receive drugs 41(67.2%) were found infected, while among animals that received drugs on irregular basis only 9 (33.3%) animals were found

infected. A significant association (P-value = 0.000, x^2 =284) was observed between drug frequency and mange infection (Table 4.7).

4.3.2.8 Type of lesion:

Among the total number of camels surveyed (500 camels), 61 animals showed scab covered lesions, 2 animals had oozing lesions and 437 animals were healthy. The animals that had scab covered lesions were 48 (78.2%) were found infected, while animals showing moist lesions were all (100%) infected. A significant association (P-value = 0.000, x^2 = 386.3) was observed between the type of lesions and ringworm infection (Table 4.7).

Table 4.7: Univariate analysis of association of potential risk factors with ringworm infection in Al-Butana area, El-Gezira state.

Factor	No. of Camels Examined	No of + Ve (%)	df	x^2	P.Value
Sex of animal					
Male	86	15 (17.4)	1	6.39	0.011
Female	414	35 (8.4)			
Age of animal					
From1to5 years	121	28 (23,1)			
From 6 to 10 years	203	11 (5.4)	2	30.69	0.000
More than 10 years	176	11 (6.2)			
Appetite					
In appetence	62	47 (75.8)	1	340.6	0.000
Normal	438	3 (.68)			
Body condition					
Poor	36	27 (75)			
Fair	36	20 (55.5)	2	293.1	0.000
Good	428	3 (0.7)			
Land ecology					
Muddy land	17	12 (70.5)			
Rocky land	454	32 (7)	2	77.41	0.000
Sand land	29	6 (20.6)			
Rearing system					
Mixed rearing	44	28 (63.6)	1	154.2	0.000
Separated rearing	456	22 (4.8)			
Drug use					
Not use	61	41 (67.2)			
Irregular use	27	9 (33.3)	2	284	0.000
Regular use	412				
Type of lesion					
Scab	61	48 (78.6)	2	386.3	0.000
Moist	2	2 (100)			
Healthy	437				

4.3.3. Dermatophilus infection:

4.3.3.1. Sex of animals:

Among the total number of camels surveyed (500 camels); 86 were male camels and 414 were females. Among male camels only one animal (1.16%) was found infected, while among female camels three (0.7%) were found infected. No significant association (P-value = 0.0678, x^2 = 0.172) was observed between the sex of animals and dermatophilosis (Table 4.8).

4.3.3.2. Age of animals:

Among the total number of camels surveyed (500 camels), 121 were young animals (1to5 years), 203 were adult animals (6 to 10 years) and 176 were old animals (more than 10 years). Among young animals; two (1.65%) were found infected and among adult ones only one animal (0.49%) was found infected, while among old animals also one animal (0.56%) was infected. No significant association (P-value = 0.480, x^2 =1.47) was observed between the age of the animals and dermatophilosis (Table 4.8).

4.3.3.3 Appetite of animals:

Among the total number of camels surveyed (500 camels), 62 animals showed inappetance and 438 animals had normal appetite. Among camels that showed inappetence 4 (6.4%) were found infected. A significant association (P-value = 0.000, x^2 = 28.48) was observed between the appetite of animals and dermatophilosis (Table 4.8).

4.3.3.4 Body condition:

Among the total number of camels surveyed (500 camels), 36 animals were in poor body condition, 36 animals had fair body condition, and 428 were in good body condition. Among those in poor condition one animal (2.7%) was found infected and three (8.3%) animals that had fair body

condition were found infected. A significant association (P-value = 0.000, x^2 = 30.97) was observed between the body condition of the animals and dermatophilosis (Table 4.8).

4.3.3.5 Land ecology:

Among the total number of camels surveyed (500 camels), 17 animals live on muddy land, 454 animals live on rocky land and 29 animals live on sandy land. Among those living on rocky land three (0.66%) were infected and only one camel living on sandy land (3.44%) was found infected. No significant association (P-value = 0.245, x^2 = 2.81) was observed between land ecology and dermatophilosis (Table 4.8).

4.3.3.6 Rearing system:

Among the total number of camels surveyed (500 camels), 44 animals were kept under mixed rearing and 546 animals were kept under separate rearing. Among those kept under mixed rearing two (4.5%) were found infected, and also two (0.43%) animals kept under separate rearing conditions were found infected. A significant association (P-value = 0.003, x^2 = 8.52) was observed between the rearing system and dermatophilosis (Table 4.8).

4.3.3.7 Drug use:

Among the total number of camels surveyed (500 camels), 61 animals did not receive drugs, 27 animals received drugs on irregular basis, and 412 animals received drugs on regular basis. Among animals that did not receive drugs 4 (6.5 %) were found infected. A significant association (P-value = 0.000, x^2 = 29.01) was observed between drug frequency and dermatophilosis (Table 4.8).

4.3.3.8 Type of lesion:

Among the total number of camels surveyed (500 camels), 61 animals had scab covered lesions, 2 animals had oozing lesions, and 437 animals were healthy. Among animals that had scab covered lesions 4 (6.5%) animals were found infected. A significant association (P-value = 0.000, x^2 = 29.01) was observed between the type of lesion and dermatophilosis (Table 4.8).

Table 4.8: Univariate analysis of association of potential risk factor with dermatophilosis infection in Al-Butana area, El-Gezira state.

Factor	No. of Camels Examined	No of +Ve (%)	df	x^2	P.Value
Sex of animal					
Male	86	1 (1.16)	1	0.172	0.678
Female	414	3 (0.7)			
Age of animal					
From1to5 years	121	2 (1.65)			
From 6 to 10 years	203	1 (0.49)	2	1.47	0.480
More than 10 years	176	1 (0.56)			
Appetite					
In appetence	62	4 (6.4)	1	28.48	0.000
Normal	438				
Body condition					
Poor	36	1 (2.7)			
Fair	36	3 (8.3)	2	30.97	0.000
Good	428				
Land ecology					
Muddy land	17				
Rocky land	454	3 (0.66)	2	2.81	0.245
Sand land	29	1(3.44)			
Rearing system					
Mixed rearing	44	2 (4.5)	1	8.52	0.003
Separate rearing	456	2 (0.43)			
Drug use					
Not use	61	4 (6.5)	2	29.01	0.000
Irregular use	27				
Regular use	412				
Type of lesion					
Scab	61	4 (6.5)	2	29.01	0.000
Moist	2				
Healthy	437				

4.4 Multivariate Analysis:

Table 4.9: Multivariate analysis of mange infection and potential risk factors in 500 camels examined at Al-Butana area, El-Gezira state; using logistic regression.

Factor	No. of Camels Examined	No. of positive (%)	Exp. (B)	P-value	95% C.I for Exp.(B) Lower -Upper
Age of animal				.001	
From1to5 years	121	11 (9)	2.038		0.241 – 17.253
From 6 to 10 years	203	2 (0.9)	Ref		
More than 10 years	176	5 (2.8)	0.514		0.071 – 43.843
Appetite	62			000	0.014 7.776
Inappetence	438	17 (27.4)	0.333		
Normal		1 (0.22)	Ref		
Body condition	36			000	0.000
Poor	36	16 (44.4)	0.000		.000
Fair	428	2 (61)	0.000		
Good		0 (0)	Ref		
Land ecology	17	6 (35.2)	0.100	000	0.003—3.097
Muddy land	454	11 (2.4)	Ref		0.000
Rocky land	29	1 (3.4)	7.707E6		
Sand land					
Drug use				000	0.0000.000
Not use	61	18 (29)	0.000		
Irregular use	27	0	1.195E12		
Regular use	412	0	Ref		
Type of lesion	61	16 (26)	0.000	000	0.000

Scab	2	2 (100)	0.000		0.000
Moist	437	0	Ref		
Healthy					

Factor	**No. of Camels Examined**	**No. of positive (%)**	**Exp. (B)**	**P-value**	**95% C.I for Exp. (B) Lower -Upper**

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Sex of animal				0.011	
Male	86	15 (17)	1.147		0.194-6.779
Female	414	35 (8.4)	Ref		
Age of animal				0.000	
From1to5 years	121	28 (45)	0.666		0.707-6.386
From 6 to 10 years	203	11 (5.4)	Ref		
More than 10 years	176	11 (6.2)	0.727		0.104-5.082
Appetite				0.000	
Inappetence	62	47 (75.8)	0.000		0.000
Normal	438	3 (0.7)	Ref		
Body condition				0.000	
Poor	36	27 (75)	0.833		0.155-4.476
Fair	36	20 (55.5)	0.000		.000
Good	428	3 (0.7)	Ref		
Land ecology				0.000	
Muddy land	17	12 (70.5)	0.861		0.095-7.791
Rocky land	454	32 (7)	Ref		
Sand land	29	6 (20.6)	11.916		0.491-289.438
Rearing system				0.000	
Mixed rearing	44	28 (63.6)	15.271		1.529-152.517
Separate rearing	456	22 (4.8)	Ref		
Drug use				0.000	
Not use	61	41 (67.2)	0.000		0.000
Irregular use	27	9 (33.3)	0.000		0.000
Regular use	412	0 (0)	Ref		
Type of lesion				0.000	
Scab	61	48 (78.7)	0.000		0.000
Moist	2	2 (100)	4.571		0.000
Healthy	437	0 (0)	E34 Ref		

Table 4.10: Multivariate analysis of ringworm and potential risk factors in 500 camels examined at Al-Butana area, El-Gezira State using logistic regression

Table 4.11: Multivariate analysis of dermatophilosis and potential risk factors in 500 camels examined at Al-Butana area, El-Gezira State using logistic regression.

Factor	No. of Camels Exami-ned	No. of positive (%)	Exp. (B)	P-value	95% C.I for Exp. (B) Lower-Upper
Appetite				0.000	
Inappetence	62	**4 (6**.4)	0.000		0.000
Normal	438	-	Ref		
Body condition				0.000	
Poor	36	1 (2.7)	0.000		0.000
Fair	36	3 (8.3)	0.000		0.000
Good	428	-	Ref		
Rearing system				0.003	
Mixed rearing	44	2 (4.5%)	1.228		0.090-16.700
Separated rearing	456	2 (.4%)	Ref		
Drug use				0.000	
Not use	61	4 (6.5%)	0.000		0.000
Irregular use	27	-	3.107		0.000
Regular use	412	0	Ref		
Type of lesion				0.000	
Scab	61	4 (6.5%	0.032		0.000
Moist	2	-	2.885		0.000
Healthy	437	-	E18		
			Ref		

Chapter Five

Discussion

A rigorous field and laboratory investigation was conducted to study the incidence and prevalence of mange, ringworm and dermatophilus infection and their epidemiology in Al-Butana area, Gezira State. The study included thorough clinical examination of the skin, a detailed questionnaire, investigation of the potential risk factors associated with the occurrence of the different skin diseases, and deep skin scrapings from skin lesions were subjected to laboratory examination.

Knowledge of risk factor associated with camel skin diseases is an important pre-requisite for the design and implementation of effective control strategies and management programs that curtail and probably eradicate these diseases. The eradication of camel skin diseases is among the priorities because the diseases investigated in the current study are zoonotic and of public health significance. This in addition to the deleterious effects produced by these diseases on camels' health, reproduction, production and animal welfare.

In this study the overall infection rate of camel skin infection was 14.4% (72/500).

5.1. Mange infection:

Sarcoptic mange is probably the most important ectoparasite infecting camels and is dreaded by camel owners. *Sarcoptes scabiei* is a burrowing mite causing a severe disease in all domestic animals especially camels, sheep and goats (Abu-Samra, et al, 1981; Ibrahim and Abu-Samra, 1985; Nayel and Abu-Samra, 1986).

In this study the overall infection rate was 3.6% (18/500) and within skin infections was 25% (18/72). The results obtained in the present study was lower than the prevalence rate reported by Agab and Abbas (1992) in Sudan who reported sero-prevalence of 31.6% (1170/3681) in camels. In Egypt Saber and Ahamed (2015) reported prevalence of 6.06% (40/660) in camels, and in Pakistan Zahid *et al.*, (2015) reported prevalence of 11.28% (168/1489) in camels. These differences in prevalence of mange could be related to the difference in the sample size (n), or the excessive use of anti-parasitic drugs.

In this study mange was more prevalent in male camels 7 % than in female camels 2.9 %. Statistical analysis showed that there was no significant correlation $X^2=3.14$ P = 0.065 (table 4.6) between mange infection and sex of the animal. This finding was not in agreement with Awol *et al*., (2014), but was in agreement with Megersa, *et al*., (2012) who reported no significant difference in mange infestation between male and female camels. The high prevalence in male could be explained by the fact that male camels are more aggressive and in more contact with inanimate objects and other camels in the herd.

In this study sarcoptic mange was more prevalent in young animals (9 %) followed by old ones (2.8%) and then adult animals (0.98). Statistical analysis showed that there was a significant correlation between mange

infection and age of animal. This finding agrees with the finding of Ashraf *et al*., (2014). However, Megersa *et al.* (2012) and Awol *et. al.* (2014) reported no significant correlation. This could probably be due to the weak immune mechanism in both young and old animals and young animals are in continuous and intimate contact with their dams.

The prevalence rate of mange in animals that showed inappetence was (27.4%) and camels with normal appetite was (0.22%). Statistical analysis showed that there was significant correlation between mange infection and appetite. This finding is in agreement with Saber and Ahamed (2015).

The prevalence rate of mange was higher in animals with poor body condition compared with animals with fair body condition. No infection was observed in animals with good body condition. Statistical analysis showed that there was a significant correlation between mange infection and body condition of the animal. This result is in agreement with Saber and Ahamed, (2015), and could be explained in terms of low immunity and high susceptibility of animals with poor body condition.

The prevalence rate of mange in camels living in muddy land was much higher than camels living in sandy or rocky areas. Statistical analysis showed a significant correlation between mange infection and land ecology. This result supports the findings of Angarano and Parish (1994) and Saber and Ahamed (2015). This could be attributed to the fact that muddy areas provide optimum conditions for mange mites survival and rocky areas may cause skin scratches and injuries facilitating entry and propagation of the mite. Sandy areas are very hot and not conducive for entry and multiplication of the mite in the skin.

The prevalence rate of mange in camels kept under mixed rearing system was higher than in those reared separately. Statistical analysis

showed no significant correlation between mange and the rearing system. This finding authenticated the finding of Qadoos *et al*., (1995) and El-Khodery *et al*., (2009). This could be explained in terms of lack of strict specificity of *Sarcoptes* mite, and transmission of infection to camels from other species of domestic animals (goat and sheep) grazing side by side with camels is most likely.

All infected camels did not receive any drug. Statistical analysis showed a significant correlation between mange infection and drug use. This result was in agreement with Saber and Ahamed (2015). The use of drugs such as acaricides and ivermectin curtails the spread of infection and treat mange lesions.

Animals showing scab lesions were infected and also the two camels with moist lesions. Statistical analysis showed a significant correlation between mange infections and type of lesion. This result is in agreement with Richard (1987), who reported that two weeks after the first sign, the affected regions of skin lose their hair, becoming reddened and moist, and the lesions may become generalized after 20-30 days.

According to distribution of camel mange lesions on the animal's body, mange infestation usually starts from head region and then extends to the neck and other areas of the body. The scabies may spread to the whole body within a period of one month (Mukassa–Mugerwa, 1981). Richard (1987) reported findings similar to the findings recorded in this study that camel mange infestation commences at areas of thin skin, the head, and base of the neck, udder, prepuce and flank. The head becomes affected rapidly in every case because the animal uses its teeth to scratch the affected areas.

5. 2. Ringworm infection:

Dermatophytosis (syn. ringworm) is a zoonotic skin infection of the keratinized tissues caused by a specialized group of fungi named dermatophytes. The disease can affect man, and all domestic animals, including camels (Almuzainia, *et al*., 2016).

In this study the overall infection rate was 10 % (50/500) and within skin diseases was 69.4 % (50/72) verified by microscopic examination. The prevalence of ringworm recorded in the present study was higher than the prevalence rate reported by Agab and Abbas (1992) in Sudan who reported sero prevalence of 5.8 % (217/3681) of ringworm in camels, and in Ethiopia by Megersa (2010) who reported prevalence of 8.3% (14/169) in camels.

Ringworm was more prevalent in male camels than female. Statistical analysis showed a significant correlation between ringworm infection and sex of animals. This finding was contrary to the findings of Fadlelmula *et al*., (1994), and Wisal and Salim (2010) who reported no significant difference between ringworm infection and gender.

The prevalence rate of ringworm in young animals was higher than old and adult animals. Statistical analysis showed a significant correlation between ringworm infection and age of animals. This finding was in agreement with Agab (1993) who reported that ringworm occurs in camels less than 3 years of age. This was probably due the weak immunity in young and old animals.

The prevalence rate of ringworm in animals showing inappetence was higher than animals with normal appetite. Statistical analysis showed a significant correlation between ringworm infection and loss of appetite. This result supported the findings of Saber and Ahamed (2015). The most

probable explanation to this finding is that animals showing inappetence become weak and are more susceptible to infection with ringworm.

The prevalence rate of ringworm in animals with poor and fair body condition was higher than animals with good body condition. Statistical analysis showed a significant correlation between ringworm infection and loss of body condition. This result was in agreement with Enany *et al*., (2013). This could probably be explained in terms of resistance to infection; animals with good body condition are more resistant to ringworm infection than animals with fair or poor body condition.

The prevalence rate of ringworm in animals living in muddy areas was higher than animals living on sandy and rocky areas. Statistical analysis showed a significant correlation between ringworm infection and land ecology. This is probably due to fact that environmental conditions in muddy areas on being humid was suitable for the survival of the causative agent. Similar findings were reported by Fadlel-Mula *et al*., (1994) who found that ringworm infection in camels is more prevalent in the rainy season.

The prevalence rate of ringworm in animals kept under mixed rearing was higher than animals kept under separate rearing system. Statistical analysis showed a significant correlation between ringworm infection and rearing systems. Similar results were obtained by the Center for Food Security and Public Health (2013), who reported that dermatophytes may be acquired from other species of animals grazing side by side with camels.

The prevalence rate of ringworm in animals that did not receive drugs was higher than animals that received drugs. Statistical analysis showed a significant correlation between ringworm infection and lack of treatment. Similar result was recorded by Manefield and Tinson (1997) who

found that *Trichophyton* infection in camels was effectively treated by chlorinated or iodine-based topical treatments.

Camels showing scab lesions (78.6%) were infected and (100%) of animals with moist lesions were infected. Statistical analysis showed a significant correlation between ringworm infection and type of lesion. This finding authenticated the finding of Shathele and Fadlelmula (2010) who reported that the lesions start with thickening of skin, alopecia and scaliness involving small circular areas or become confluent covering extensive areas.

The distribution of camel ringworm infection in the body is shown above. Lesions of ringworm initially involve the head, neck, abdomen and back with different ratios. Similarly, Chermette *et al*., (2008) reported that the lesions of ringworm initially involve the head, neck and shoulders, with a possible extension to the flanks and legs, leading sometimes to pyoderma and emaciation.

5.3. Dermatophilosis:

Dermatophilosis is a skin disease mainly of young camels, but adults are also infected. The disease is zoonotic and people can get infected if they come into contact with infected animals (Köhler-Rollefson *et al*., 2001).

The result obtained from microscopic examination in the present study showed that the overall infection rate was 0.8% (4/500) and within skin infection was 5.6% (4/72) verified by microscopic examination.

The prevalence rate of dermatophilosis in male camels was higher than female camels. Statistical analysis showed no significant correlation between dermatophilosis infection and sex of animals. This result was in agreement with Yaser and Falah (2016).

The prevalence rate of dermatophilosis in young animals was higher than old and adult ones. Statistical analysis showed no significance between dermatophilosis infection and age of animal. This result agrees with Yaser and Falah (2016), who reported that the prevalence of dermatophilosis was significantly higher in young camels (1–2 and 3–4 years of age) compared to the ≥ 5 years age group ($p < 0.05$).

The prevalence rate of dermatophilosis in animals showing inappetence was higher than animals with normal appetite. Statistical analysis showed a significant correlation between dermatophilus infection and loss of appetite. This finding was in agreement with Yaser and Falah (2016).

The prevalence rate of dermatophilosis in animals with poor body condition was lower than animals with fair body condition. Statistical analysis showed that there was significant correlation between dermatophilus infection and body condition of animals. This result is in agreement with Yared *et al*., (2015).

The prevalence rate of dermatophilosis in camels living in sandy areas was higher than animals living in rocky areas. Statistical analysis showed no significant correlation between dermatophilus infection and land ecology. This result disagrees with Yared *et al*., (2015), who reported that high relative humidity has a significant influence on the maturation and motility of the infective zoospores and it has been claimed to be a major predisposing factor in the spread and epidemiology of dermatophilosis.

The prevalence rate of dermatophilosis in animals kept under the mixed rearing system was higher than in animals kept under the separate rearing system. Statistical analysis showed a significant correlation between

dermatophilosis infection and rearing systems. This result was in agreement with Yared *et al.*, (2015). The only possible explanation is that animals kept under the mixed rearing system are more prone to infection from other species of domestic animals grazing side by side with camels.

The prevalence rate of dermatophilosis in animals that do not receive drugs was higher than animals that receive drugs. Statistical analysis showed a significant correlation between dermatophilosis and lack of treatment. This result was in agreement with Yared *et al.*, (2015). the use of drugs curtails and possibly control dermatophilosis.

We found that (6.5%) of animals with scab lesions were infected. Statistical analysis showed a significant correlation between dermatophilosis and type of lesion. This result was in agreement with Pal (1995), who reported that the lesions included vesicles, pustules, thick crusts (cream to brown in color) and dirty yellow-colored scabs. The crusts later dried up to form white scabs approximately 1-3 cm in diameter Giato et al., (1998). The pattern of disseminated lesions is more consistent with the natural disease where the whole flank of the animal is affected. Disease spread generally occurs through contact, which was probably the case in this study, as the animals were observed to rub themselves on the infected flanks (Gitao, 1992).

Conclusions

It is concluded from the results obtained in the current investigation that:

1. The overall prevalence of skin diseases in the Al-Butana area, El-Gezira state is high.
2. Both Single and concurrent skin infections are observed.
3. Ringworm was highly prevalent fallowed by mange and dermatophilosis, respectively.
4. High prevalence of skin infection was encountered in males than females and in young animals (1-5) years of age than old ones.
5. Skin diseases in camels cause loss of appetite and body condition.
6. Skin diseases were more prevalent in animals living in muddy areas than in animals living in rocky and sandy areas.
7. Skin diseases in camels were more prevalent in camels in contact with other species of domestic animals, and in animals that did not receive drugs.
8. Ringworm, mange and dermatophilosis are zoonotic diseases and are of public health significance.

Recommendations

Based in the light of the current study, the following recommendations should be considered when attempting diagnosis, treatment and control of skin diseases of camels:

1. The deleterious effects of tick and other ectoparasites in camels should receive thorough attention because they play a significant role in the transmission of most skin diseases, and their treatment and control in a national program is warranted.
2. Strategic application of antibacterial, antifungal, acaricides and insecticides, especially during rainy season and camel breeding season is highly recommended for the control of ringworm dermatophilosis and mange.

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Appendix 1

Questionnaire

- **Effect of sex and age** :
- **Sex of animal*:***

Male ☐ female ☐

- **Age of animal:** ……
- **Appetite and Body Score:**
- **Appetite:**

Normal appetite ☐ Inappetence ☐

- **Score of body condition :**

Good ☐ Fair ☐ Poor ☐

- **Effect of land ecology:**
- **Housing management :**

Muddy land ☐ Rocky land ☐ Sandy land ☐

- **Rearing system :**

Separate rearing ☐ mixed rearing ☐

- **Drug use:**

Regular use ☐ Irregular use ☐ No use of drugs ☐

- **Type of lesion :**

Scab ☐ Moist and oozing ☐

- **Distribution of lesions:**

Head ☐ Neck ☐ Abdomen ☐

Inner surface of thighs ☐ inguinal region ☐