***Review Article***

# An Over View of Dermatophytosis in Camels

**Abstract:**

Dermatophytosis is a fungal infection of the skin caused by dermatophytes-filamentous fungi which have ability to invade the epidermis and keratinized tissues such as hair, skin or nails. *Trichophyton verrucosum* is the most common dermatophytes species isolated from camel. The disease is characterized by circumscribed crusty hairless lesion, (1-2 cm) distributed over the head, neck, shoulder, limbs and flanks. Dermatophytosis can be diagnosed by direct examination, fungal culture, skin biopsy and molecular diagnosis methods. This overview forecast more light of the different aspects of this disease.

**Key words:**

**Dermatophytosis,Camel,Clinical feature, Diagnosis.Treatment**

## Introduction:

Camels in their natural habitat are exposed to severe stress conditions which make them susceptible to many diseases [1, 2]. In last decades camels were reported to be resistant to many disease causing agents [3, 4], now it has been realized that they are susceptible like other livestock or even more, to the common disease causing pathogens [5-7].

Dermatophytes are among the most frequent causes of superficial skin infections in man and animals, known as Dermatophytosis (ringworm). It is caused by fungi in the genera *Microsporum, Trichophyton and Epidermophyton*. Ecologically, dermatophytes are classified to three groups anthropophilic (mostly associated with humans), zoophilic (associated with animals) and geophilic (found in the soil). Dermatophytosis in camels is the most frequent mycosis worldwide it has public health and economic importance. There are two forms of the disease sporadic as well as epidemic form [8-10].

.Ringworm occurs in camels less than 3 year age and is characterized by circumscribed

crusty hairless lesion, 1-2 cm in diameter distributed over the head, neck, shoulder, limbs and flanks [1]. *T. verrucosum* is the most common cause of dermatophytosis in camels [11].

**Epidemiology:**

Dermatophytosis was reported to be a common disease of camels worldwide [10,12]. Different prevalence rate of the disease of 48 % [13] and 43.5% [14] were reported in camels, while [15] reported lower prevalence of 8.58% in camels suffering from dermatophytosis. Camels less than 3 year age were more susceptible to the disease than older animals.

**Predisposing factors:**

1- Age
2- Breed
3- Production system
4- Close confinement
5- Immunosuppression (including immunosuppressive treatment)[16,17]

**Transmission**

The transmission of dermatophytosis is usually occurs by direct contact with infected host (animals or humans) or asymptomatic carriers indirect contact with contaminated fomites besides contact with soil [18,19].

**Clinical features**:

Ringworm in camels is characterized by circumscribed crusty hairless lesion, 1-2 cm in diameter [1] on the head, the neck and shoulders with a possible extension to the flanks and legs, leading sometimes to emaciation [20] (fig.1-8).

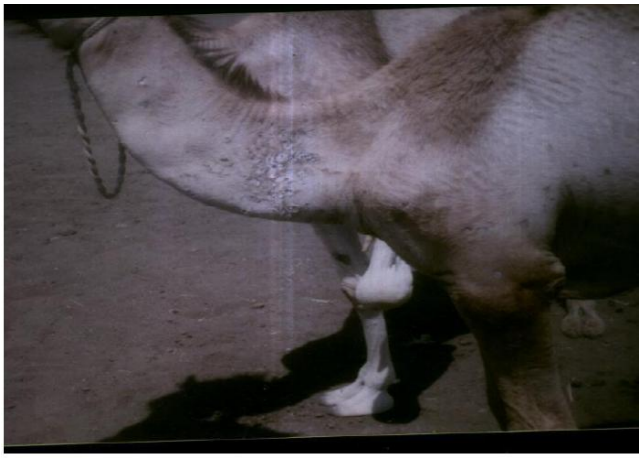

**Fig.1: Localized lesions of ringworm on camel neck [11]**

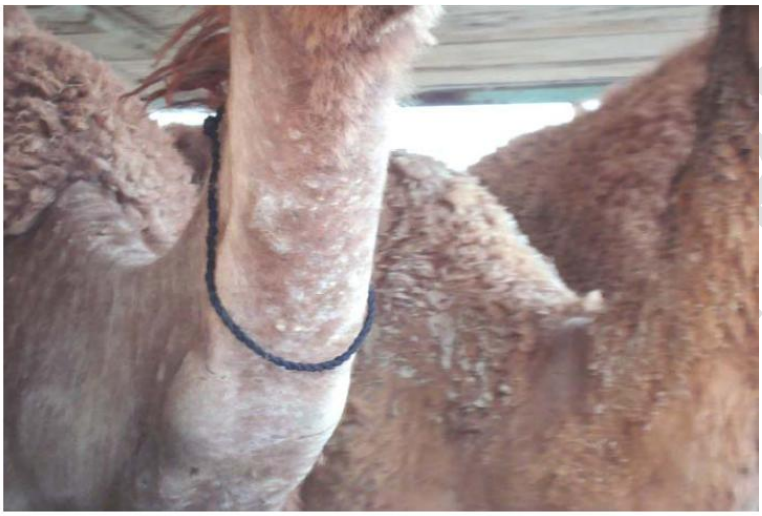

**Fig.2:** Circular lesions on the neck of camel[56]

**Fig.3: Alopecic ringworm lesions [57]**

**Fig.4: A young camel calf has Crusty and hairless lesions on the shoulder.[44]**

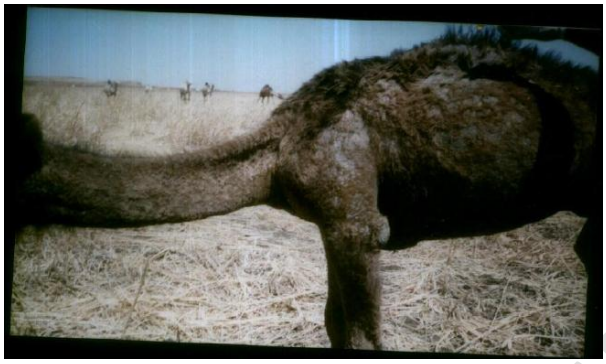

**Fig.5: Acamel from Elobied areas showing generalized lesions of ringworm giving moth-eaten appearance of wool.[11]**

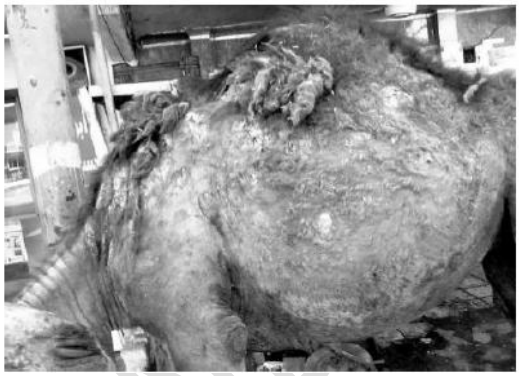

**Fig.6: Affected camel showed white hairless patches on different parts of the body. The lesions typically consisted of an area of alopecia.[44]**

**Fig.7: Epidermophyton fast spreading lesions with circular patches[29]**

**Fig.8: Epidermophyton lesions giving just burning appearance [29]**

**Mixed infection of dermatophytosis and other skin diseases:**

Mixed infection of dermatophytosis and *Sarcoptic scabiei* has been reported by [21, 22]. Mixed infection of dermatophytosis caused by *M.gpyseum* and *Dermatophilus congolensis* in dairy farm camel was recorded by [15] fig. 9.

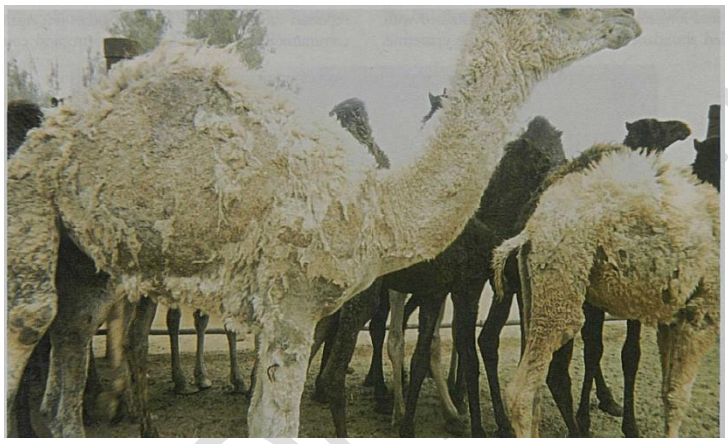

**Fig.9: Hair matting and crusty, hairless lésions on the flanks of a camel calf**

## Etiology:

The disease in camel is mainly caused by *Trichophyton verrucosum* [12, 14, 23, 24, 25]. *T. mentagrophytes* has been isolated by [11]. [26-28] were able to isolate *T. schoenleinii. T. dankaliense* was isolated by [4]. [29] has been isolated *T. equinum T. concentricum , T. tonsurans , T. violaceum , T. soudanense , T. rubrum , M. canis , M. nanum* and *M. ferrugineum. M.gpseum* has been isolated by [15, 30, 31] *Epidermophyton floccosum* has been reported by [32]

**Diagnosis:**

Dermatophytosis diagnosis is based on the clinical signs however in order to confirm the diagnosis culturing and direct microscopic examination of skin scrapings from the periphery of the lesions should be indicated [33].

## Collection of samples:

Skin scraping samples from the cattle that were suspected to be infected with dermatophytes will be collected on the basis of gross lesion on their body after cleaning with ethyl alcohol 70%. Hair and scrapings samples should be collected with forceps or scalpel just behind the extending margin in the infected area. Samples can be kept in polyethylene bags [25].

**Direct examination:**

Each Sample from infected camel should be divided into two portions, one portion for direct microscopic examination and the other for culture. Fungal hyphae and/or ectothrix spores are determined to be seen in the direct examination when they appear to make hairs or hair fragments thicker and rough with irregular surface.

Potassium Hydroxide (KOH) 10 or 20% is used as a clearing agent because it has keratinolytic activity [34-36]. Infected hairs appear pale, wide and filamentous compared with normal hairs when examined at x4 or x10 magnification, appearing. Arthrospores can be visible on high magnification (x40).(fig.10)

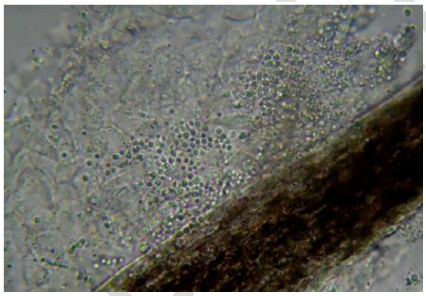

**Fig.10: KOH preparation showing hair surrounded with chain of large ectothrix spores X400[58]**

**Fungal culture:**

Fungal culture is considered the ‘gold standard’ for diagnosis [37]. Sabouraud’s dextrose agar (SDA) containing cycloheximide, penicillin and streptomycin were used in most diagnostic

laboratories. Plates should be incubated at 25ºC for 5 weeks. Dermatophytes test media (DTM) is recommended as the best media for isolation of dermatophytes because the presence of the red color indicated positive result, this can help in early identification of highly suspected cultures [38]. The isolates should be examined macroscopically and microscopically after staining with lactophenol cotton blue using wet mount technique [39].(fig.11-20)

In addition to technique steps mentioned above, pigment production on corn meal agar, urease activity on urea agar base, growth at 37◦C on SDA.(fig.21)

**Fig.11:** Colony of ***T. verrucosum*** on the modified SDA. [55]

**Fig.12:** Colony ***T. mentagrophytes*****: surface of colony show powder-like shape, white, loose irregular mycelium on the edge. [58]**

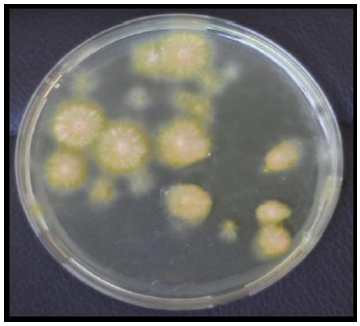

**Fig.13: Colony surface of *M.canis*. [59]**

**Fig.14: Colony of *Microsporum gypseum.* [60]**

**Fig.15: Colony surface of *E.flocosum*[59]**

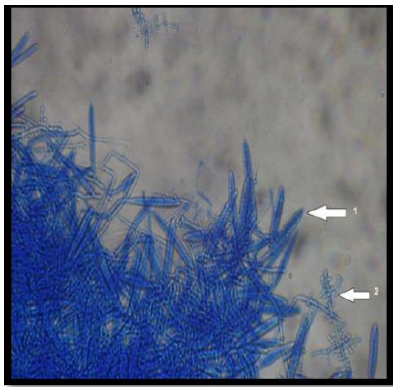

**Fig.16: 1)Macroconidia . 2) Microconidia in *T.mentagrophytes* . [59]**

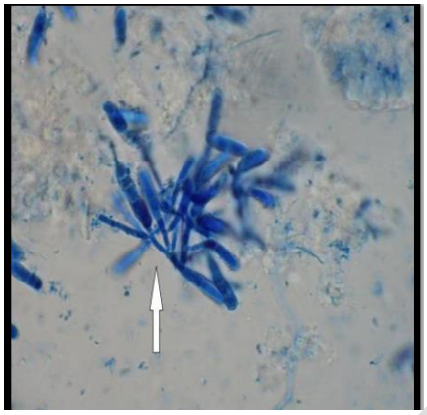

**Fig.17: Macroconidia in *E.flocosum*. [59]**

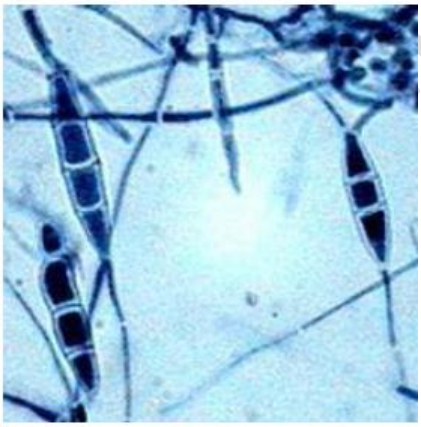

**Fig.18*: Microsporum canis* microscopic observation in lactophenol cotton blue [61]**

**Fig.19: *Microsporum gypseum* microscopic observation in lactophenol cotton blue [60]**

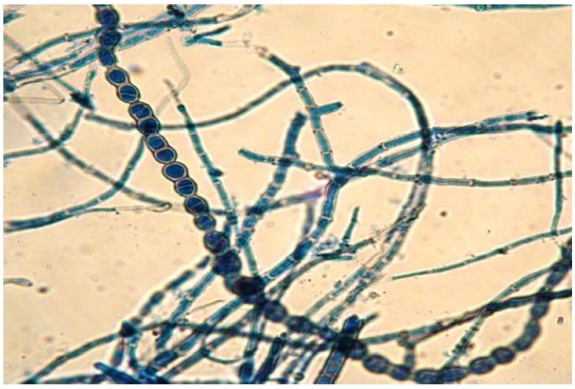

**Fig.20: Microscopic appearance of *T. verrucosum*.[52]**

**Fig.21: Growth of *T.mentogrophytes* on urea agar after 4 days showing hydrolysis of the urea.[62]**

**Molecular diagnosis:**

Diagnosis with conventional methods is time-consuming because it might take up to 4 weeks or longer to give the final results [40]. Furthermore, morphological identification may be confusing due to polymorphism of dermatophytes [41]. During the last decade, a wide variety of molecular techniques has become available as possible alternatives for routine identification of fungi in clinical microbiology laboratories [42, 43].

Molecular identification for *Trichophyton* species isolated from camel skin lesions was done using ( GACA) 4 all the strains were amplified simply resulting PCR bands ranged from 2-5. Three profiles of *Trichophyton mentagrophytes* have been detected so *T.mentagrophytes* is known to be a species complex [44].(fig.22)

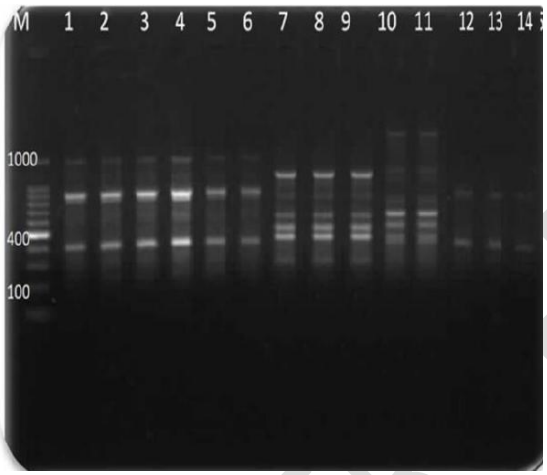


**Fig.22: Agarose gel electrophoresis for PCR using (GACA)4. M, molecular weight marker. Lanes (1-6) first profile of *T.mentagrophytes*Lanes (7-9) second profile of *T.mentagrophytes*. Lanes (10&11) third profile of *T. mentagrophytes*Lanes (12-14) *T.verrucosum*. [44]**

*Trichophyton* species isolated from camel and human were identified using restriction fragment length polymorphism (RFLP), *Mva*1 was used as `restriction` enzyme. Five different patterns of two to four bands were obtained. None of these different species gave the same profile pattern [45]. (fig.23)


**Fig.23: RFLP profiles of *Trichophyton* spp isolates. WM 07.322, WM 07.323, WM 07.327, WM 07.339 were *T.mentagrophytes var mentagrophytes*, WM06.837, WM 06.871, WM 06.884, WM 06.861 were *T.mentagrophytes var interdigitale*, WM 07.420, WM07.421, WM 06.838, WM 06.873 were *T.tonsurans*, WM 07.133 *T.mentagrophytes* var *erinacei* and WM 06.839 was *T.rubrum*.[45]**

**Skin biopsy:**

Specimens from infected skin should be taken and fixed in 10%formaline solution then dehydrated, cleared and embedded in paraffin wax, sectioned at 4 μm thickness should be stained by haematoxylin and eosin for microscopical examination [46]. haematoxylin and eosin staining (H&E) may or may not identify dermatophytes and special stains such as periodic acid Schiff (PAS) and Grocott methenamine silver (GMS) are needed.

Microscopically, the hair follicles and sweat glands exhibited cystic dilatation (fig. 24) and were lined by atrophied epithelium.

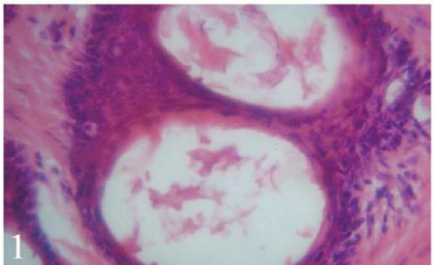


**Fig.24: Ring worm in camels, noticed destructed hair shaft, perifollculitis and cystic dilatation of the hair follicles (H&E X650). [46]**

Occasionally, perivascular dermatitis, and intra-epidermal pustules characterized by focal aggregation of neutrophils mixed with eosinophil and karyrrhectic debris were reported (fig. 25).

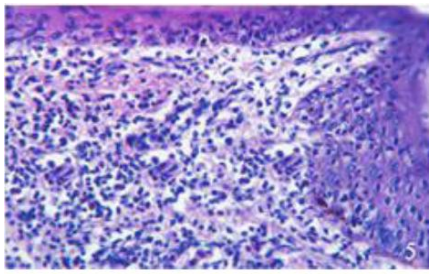

**Fig.25: Ring worm in camels, noticed intra epidermal pustules and acanthosis (H&E X400). [46]**

The branched fungal hyphae were seen when sections stained with PAS (fig.26)

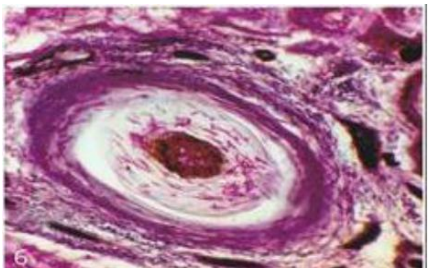

**Fig.26: Ring worm in camels, noticed tricophyton hyphae positive for PAS-reaction (H&E X400). [46]**

The surface as well as intrafollicular hairs was colonised by large numbers of refractile or slightly basophilic arthrospores and hyphae. These were coloured bright magenta with periodic acid-Schiff stain and black with Gomori's methenamine silver stain. The Keratin-filled follicles ruptured leading to prominent furunculosis [22]. (fig.27,28)

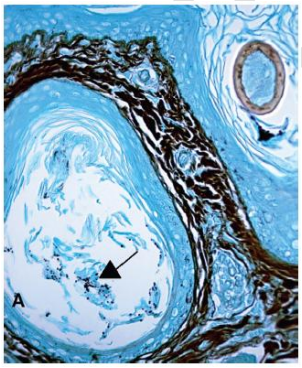


**Fig.27: Refractile arthrospores and hyphae appear: bright magenta with Periodic Acid-Schiff stain [22].**

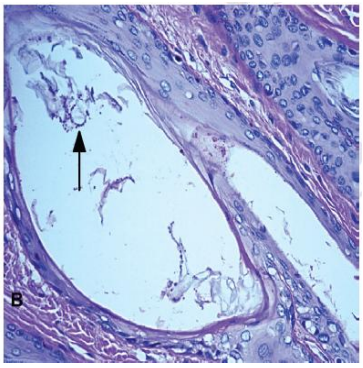

**Fig.28: Refractile arthrospores and hyphae appear black with Gomori's Methenamine Silver stain [22].**

**Treatment:**

Optimal therapy of dermatophytosis requires a combination of topical antifungal therapy, concurrent systemic antifungal therapy and environmental decontamination. The treatment should be continued until two consecutive negative cultures (at weekly or bi-weekly intervals) are obtained [47]. Topical treatments speed resolution of clinical lesions and may help prevent zoonotic contagion. Systemic therapies that have prolonged residual activity in the skin and hair provide the most effective treatments.

**Topical Therapy:**

1- 2% solution of tincture iodine [23].
2- 10% iodine ointment daily for three weeks [48].
3- Enilconazole Wash or spray with diluted emulsion (2000 ppm) four times at 3–4-day intervals [49].

**Systemic Therapy:**

1- Griseofulvin10 mg/kg body weight for 7 days in mild infections; in severe cases 2–3 weeks [49].

**Environmental decontamination:**

Dermatophytes can remain viable in infected soil for many years [50-52], so 10% hypochlorite solution can be used as disinfectant [53].

**Vaccination:**

Live attenuated vaccine is used for prophylaxis and therapy for dermatophytosis caused by *T.verrucosum* and *T.mentagrophytes* every five years [54].

**Conclusion:**

Dermatophytoses are the most common fungal infections in camels. Many studies were done considering different aspects of the disease (eg. epidemiology, clinical presentation and diagnosis, treatment, prevention, and control).Infected camel with dermatphytes can be a source of infection to human this can lead to public health problem.

**References:**


1- Agab H. Epidemiology of camel diseases in eastern Sudan with emphasis on brucellosis, 1993;M.V.Sc Thesis University of Khartoum. Khartoum, Sudan.

2- Abbas B, Saint-Martin G, Planchenauct D. Constraints to camel production in eastern Sudan: a survey of pastoralists conception. Sudan J of Vet Sci and Anim Husb. 1993;32 (1):31–41.

3- Zaki R. Brucella infection among ewes, camels and pigs in Egypt. J of Comparative Pathol; 1984 58:145–51.

4- Dalling T, Robertson A, Boddie G, Spruell J. Diseases of camels. In: The International Encyclopedia of Veterinary Medicine. Edinburgh, U.K.; W. Green and Son. 1988; 585**.**

5- Wilson RT. The Camel. Longman, New York, ISBN 0-582-77512-4.1984

6- Abbas B, Tilley P. Pastoral management for protecting ecological balance in Halaib District, Red Sea Province, Sudan. Nomadic Peoples.1990; 29: 77–86.

7- Abbas B, Agab H. A review of camel brucellosis. Preventive Vet Med; 2002;55:47–56

8- Rajpal PS, Gill GS, Mohan MH, Thami TG. Tinea capitis due to *Trichophyton verrucosum*. Indian J. Dermatol.2005; 50: 42-43.

9- Ming PX, Ti YL, Bulmer GS. Outbreak of *Trichophyton verrucosum* in China transmitted from cows to humans. Mycopathol. 2006; 161: 225-28.

10- Wernery U, Kaaden, O R. Infectious Diseases of Camelids. Blackwell Science, Berlin,2002

11- Wisal AG, Salim MO. Isolation and identification of Dermatophytes from infected Camels. Sudan J Vet Res.2010; 25:49–53.
12- Kuttin ES, Alhanaty E, Feldman M, Chaimovits M, Müller J. Dermatophytosis of camels. J Med Vet Mycol. 1986; 24:341–44.
13- Mahmoud AL. Dermatophytes and other associated fungi isolated from ringworm lesions of camels. Folia Microbiol(Praha). 1993;38:505–08.
14- Fadlelmula A, Agab H, Le Horgne JM, Abbas B, Abdalla AE. First isolation of *Trichophyton verrucosum* as the aetiology of ringworm in the Sudanese camels (*Camelus dromedarius*). Revue d,Elevage Et De Medicine Veterinaire Des Pays Tropicaux. 1994; 47:184–87.
15- Gitao CG, Agab H, Khalifalla AG. An outbreak of a mixed infection of *Dermatophilus congolensis* and *Microsporum gypseum* in camels (*Camelus dromedarius*) in Saudi Arabia Revue Scientifique Et Technique De L`Office International Des Epizooties. 1998; 17:749–55.
16- Al-Rubiay KK. Dermatoepidemiology: A household survey among two urban areas in Basra city, Iraq. Int J Dermatol. 2006; 4:1-4
17- Tuteja F C, Dahiya SS, Narnaware SD. Prevalence of bacterial and fungal diseases in dromedary camels in the Rajsthan state of India. Vet Practitioner. 2015; 16 (1):28-32.
18- Smith BP. Large animal internal medicine. Diseases of horse, cattle, sheep and goats. 4th ed. St. Louis (MO): Mosby-Elsevier. 2002.
19- Cafarchia C, Figueredo LA, Otranto D. Fungal diseases of horses. Vet Microbiol. 2013; 167:215–34.
20- Chermette R, Ferreiro L. Guillot J. Dermatophytoses in Animals. Mycopathol. 2008; 166:385-405.
21- Abdurahman SH O, Bornstain S. Diseases of camel (Camelus dromedaries) in Somalia and prospects for better health. Nomadic people. 1991;29:104-12
22- Al-Salihi KA, AbdHatem A, Ekman E**.** Pathological studies of mixed dermatomycosis and mange infection in camels accompanied with chronic granulomatous hidradenitis. J of Camel Pract and Res. 2014*;* 20 (2):1-7.
23- Pal M, Lee CW. *Trichophyton verrucosum* infection in a camel and its handler. Korean J of Vet Clinical Med. 2000; 17: 293-294.

24- Ghoke S, Jadhav KM, Pal M. Dermatophytosis in Indian dromendary (*Camelus dromendarius*) caused by *Trichophyton verrucosum*. J of Camel Pract and Res. 2006; 13: 59-60.

25- Pal M. First mycological investigation of dermatophytosis in camels due to *Trichophyton verrucosum* in Ethiopia J. Mycopathol. Res. 2016; 54(1): 89-92.

26- Al-Rawashed OF,Al-Ani FK, Sharrif IA, Al-Qudah KM, Al-Hami Y, Frank N. A survey of camel (*Camelus dromedaries*) diseases in Jordon.J Zoo Wild Med. 2000;31(3):335-8.

27- Chatterjee A, Chakraborty P, Chattopadhyay D, Sengupta DW.Isolation of *Trichophyton schoenleinii* from a camel. Indian J Anim Hlth.1978; 17: 79–81.

28- Al-Ani FK.,Bassam LS, Al-Salhi KA. Epidemiological study of dermatophytosis due to *Trichophyton schoenleinii* in camels in Iraq Bull Anim Hlth Prod Afr. 1995;43: 87-92.

29- Tuteja Fa C , Patil NV, Narnaware S D,Dahiya SS. Camel dermal mycoses caused by dermatophytes. J of Camel Pract and Res. 2013; 20 (2):157-65.

30- Boever WJ, Rush DM. *Microsporum gypseum* infection in a dromedary camel. Vet Med Small Anim Clin. 1975; 70(10):1190-2.

31- Mancianti F, Papini R Cavicchio P Dermatophytosis by *Microsporum gypseum* in a camel (Camelus bactrianus)]. Annali della Facolta di Medicina Veterinaria di Pisa. 1988;42: 233-37.

32- Tuteja Fa C, Patil NV, Narnaware SD, Govindasamy N. Primarily human pathogenic fungi causing dermatophytosis in camel. J of Camel Pract and Res. 2013*;* 20( 2): 151-55

33- Markus R, Huzaira M, Anderson R, et al. A better potassium hydroxide preparation? In vivo diagnosis of tinea with confocal microscopy. Arch Dermatol. 2001;137(8): 1076-8.

34- Lacaz CS, Porto E, Martins JEC, Heins- Vaccari EM, Melo TN. Tratado de Micologia Médica, 9th ed. Prefácio: Bertrand Dupont. São Paulo: Sarvier. 2002;44(5):297-298

35- Sidirm J. Micologia médica à luz de autores contemporâneos. Rio de Janeiro: Guanabara Koogan; 2004.

36- Pérez J, Carrasco L. Diagnóstico histopatológico de micosisenpatología veterinária. Revista Iberoamericana de Micologia. 2000;17:18-22.

37- Moriello KA. Diagnostic techniques for dermatophytosis. ClinTechniques in Small Anim Pract. 2001;16:219–24

38- Moriello K. Feline dermatophytosis Aspects pertinent to disease management in single and multiple cat situations. J of Feline Medicine and Surgery. 2014;16: 419–31.

39- Ilhana Z, Karacab M, Ismail Hakki Ekina IH, Solmazc H, Akkanb AH, Tutuncud M. Detection of seasonal asymptomatic dermatophytes in Van cats. Brazilian J of Microbial. 2016;47:225–30.

40- Weitzman I, Summerbell RC. The dermatophytes. Clin Microbiol Rev. 1995;8:240-59.

41- Gupta AK, Ryder JE, Summerbell RC. Onychomycosis: Classification and diagnosis. J Drugs Dermatol. 2004;3:51–56.

42- Arabatzis M, Xylouri E, Frangiadaki I, Tzimogianni A, Milioni A, Arsenis G, Velegraki A. Rapid detection o*f Arthroderma vanbreuseghemii* in rabbit skin specimens by PCR-RFLP. Vet Dermatol. 2006;17:322–26.

43- Arabatzis M, Bruijnesteijn van Coppenraet LE, Kuijper EJ, de Hoog GS, Lavrijsen AP, Templeton K, van der Raaij-Helmer EM, Velegraki A, Graser Y, Summerbell RC. Diagnosis of common dermatophyte infections by a novel multiplex real-time polymerase chain reaction detection identification scheme. Br J Dermatol. 2007; 157:681–89.

44- Enany, M. E., khafagy, A. R., Madiha S. Ibrahim1, Marwa M. Azab and ²Dalia T. Hamad1 Identification of dermatophytes isolated from ringworm lesions of camels. SCVMJ, XVIII (1) 2013:1-12

45- Wisal GA, Meyer W, Salim MO. Molecular Identification of *Trichophyton* Spp. by PCR-RFLP. Sudan J Vet Res. 2017; 32: 31-33

46- Abo El Foutah E, Abd El Wahab G, Mekawyb S,Abdalla M S. Some pathological and mycological studies on ringworm in camels a locality in Sharkia governorate. Benha Vet Med J. 2012; 23( 1): 26-33

47- Chermette R, Ferreiro L, Guillot J. Dermatophytoses in animals. Mycopathol. 2008;166:385-405.

48- Almuzaini A M,. Osman SA, Saeed EMA. An outbreak of dermatophytosis in camels (*Camelus dromedarius*) at Qassim Region, Central of Saudi Arabia, J of Applied Anim Res.2016; 44( 1): 126–29

49- Rochette F, Engelen M, Bossche V. Antifungal agents of use in animal health - Practical applications J Vet Pharmacol. Therap. 2003; 26:31–53.

50- Haggag Y, Draz A, Samaha H. Soil as a reservoir of certain dermatophytes and other fungi to man and animals. Alexandria J Vet Sci. 1999; 15:1–9.

51- Nashwa KO. Zoonotic aspect of *Trichophyton mentagrophytes* in rabbit farms. Beni-Suef Vet Med J.2001; 11:49–56.

52- Efuntoye MO, Fashanu SO. Fungi isolated from skins and pens of healthy animals in Nigeria. Mycopathol. 2002; 153:21–23.

53- Rycroft AN, McLay C. Disinfection in the control of small animal ringworm due to *Microsporum canis*. Vet Rec. 1991;129: 239–241.

54- Ovchinnikov R, Manoyan M, Panin NA. Vaccines against dermatophytosis in animals. Russian expirience. 2014.1-33 DOI: 10.13140/2.1.3053.9205

55- Hussain MH. Survey on Dermatophytosis in Iraqi camels. Msc Al-Qadissiya Univ.

56- KISA J Z. Clinical and pathological investigations on camel skin diseases in some camel rich districts of Northern Kenyan. ENYAN. MSc in clinical studies university of Nairobi. 1992

57- El-Ged AM, Khalid AM, Abd El-Tawab AA, Abd El-Baset E. A rapid biological molecular method for identification and differentiation between *T. equinum* isolated from dermatophytic horses. Benha Vet Med J. 2011; I:70—75

58- Zeng X, Zheng Q, Chi X. A case of *Trichophyton mentagrophytes* infection in rabbits accompanied by farm staff infection in China. KafKas Univ Vet Fak Derg. 2017; 23(3):497-501.

59- Habeb KA, Maikhan HK,. Rachid SK. Molecular identification of dermatophytes among clinical isolates. Asian J of Natural and Applied Sci.2016; 5(2):108-18

60- Mattei AS, Beber MA, Madrid IM. Dermatophytosis in small animals. Microbiol Infect Dis. 2014; 2(3):1-6.

61- Sánchez TAC, Perla García PAE, Cristian Ismael López Zamora CIL, Martínez MA, Valencia VP, Orozco AL. Use of Propolis for topical treatment of dermatophytosis in Dog. Open J of Vet Med. 2014; 4: 239-245.

62- Issa NA, Zandana IK. Isolation of *Trichophyton mentogrophytes var mentogrophytes* from naturally infected laboratory albino rats: Experimental infection and treatment in rabbits. Iraqi J of Vet Sciences. 2009; 23:29-34.

420
421