South Asian Journal of Research in Microbiology

1(4): 1-14, 2018; Article no.SAJRM.43340

An Over View of Feline Dermatophytosis

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/SAJRM/2018/v1i4820
Editor(s):
(1) Dr. Ana Claudia Coelho, Assistant Professor, Department of Veterinary Sciences, University of Tras-os-Montes and Alto Douro, Portugal.
Reviewers:
(1) Nélida Virginia Gómez, University of Buenos Aires, Argentina.
(2) Aleruchi Chuku, Federal University Lafia, Nigeria.
(3) Abdul Razzaq, Pakistan.
(4) Daisy Machado, University of Campinas, Brazil.
Complete Peer review History: http://www.sciencedomain.org/review-history/26177

Review Article

Received 1st June 2018
Accepted 9th August 2018
Published 10th September 2018

ABSTRACT

Dermatophytosis is a superficial fungal infection of hair and keratinized layers of the epidermis and is caused by keratinophilic and keratinolytic genera such as *Microsporum*, *Trichophyton* and *Epidermophyton*. It is an endemic infection in many countries throughout the world affecting companion animals (dogs, cats), domestic animals (calves), and laboratory animals (rabbits) as well as humans. In cats *M. canis* is responsible for approximately 98% of the observed dermatophyte infections in indoor cats, whereas cats carrying *T. mentagrophytes* are usually hunters, indicating that the natural source of this species is either the soil or rodent prey.

Keywords: Dermatophytosis; feline.

1. INTRODUCTION

Dermatophytosis is one of the most common contagious disease infected cats [1]. It is highly contagious in shelters affected kittens because they are more susceptible and may have a rule as public health concern [2-4].

Feline dermatophytosis is a superficial fungal skin disease. *Microsporum canis* is the most commonly isolated pathogen [3-6] *Microsporum persicolor, Microsporum gypseum* and *Trichophyton* species were also isolated, outbreaks of dermatophytosis in multi-

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cat situations mostly caused by *M. canis* but rarely other species was reported.

2. EPIDEMIOLOGY

Feline dermatophytosis is worldwide the most common and important infectious skin disease in this species. It can be transmitted to other animal species human may also be infected. The disease poses risk to the person in contact with an infected cat, whether cats are symptomatic or assymptomatic, 50% developed lesions and at least one person in 70% of all households with an infected cat can show skin lesions.

It is important to note that clinically canine and feline ringworm infections are different. Infected dogs generally produce lesions, whereas clinical signs in cats may not be evident, because dermatophytes can be isolated from clinically healthy cats in this case they are carriers of the pathogen but are not themselves infected [7,8]. The prevalence of the disease is reported to be based on samples taken from animals that show ringworm lesions, [3,6] different results are shown in studies used random population, samples are also taken not only from an animal with skin lesions but also from animals with no lesions [9-11]. *M. canis* is a typical zoophilic dermatophyte. Subclinical infections is mostly reported in longhaired cats over 2 years of age. Therefore, isolation of *M. canis* from a healthy animal should not be considered part of the normal fungal flora of cats and its isolation indicates either subclinical infection or fomite carriage [12]. Arthrospores of *M. canis* are transmitted through contact with clinically or subclinically infected animals, especially cats, but also dogs or other animal species. The infected hair shafts containing arthrospores are fragile and hair fragments lead to spread of infection. In addition, hair with arthrospores from uninfected cats can passively transport the disease and act as a source of infection. Risk factors include: direct contact with new infected animals introduced into a cattery, cat shows, shelters, during mating, etc. The disease can also be transmitted by indirect contact with contaminated collars, brushes, toys, environments, etc. Due to the easy spread of arthrospores on dust particles, even to rooms infection can be occur even without contact with cats. Cats were reported to be the main source of dermatophytes infection in human [13] who analyzed 111 cases of human dermatophytosis due to *M. canis* according to the origin of infection; he found that in 15 cases (13.5%), 91 cases (82%) and five cases (4.5%) the origin of infection was by humans, cats and dogs respectively. Katoh T et al. [14] reported 93.8% cases of dermatophytosis in a human who kept cats in their home compared to only 25% of homes without cats.

M. gypseum, a geophilic fungus living in soil is a source of infection to outdoor cats, especially in rural areas. Cats may be infected with *T mentagrophytes* or *T quinckeanum* through contact with small rodents, and with *T verrucosum* through contact with cattle.

Animals younger than one-year-old are more susceptible to dermatophytoses [15-18], while many authors argue that there is no relationship between the sexes of the animals and predisposition to dermatophytosis [19-23]. Besides age, risk factors include poor nutrition, high density of animals, poor management, and lack an adequate quarantine period for infected pets [24]. Discussing the breed as risk factor Persian cats were found to be infected only by *M. canis* where as European and halfbreeds can also infect with geophilic dermatophyte species [25].

3. TRANSMISSION

Transmission of dermatophytosis is dependent on many factors like the amount of infective material, the frequency of exposure, the health status of the cat, and physiological stress [26].

Direct contact from infected cat-to healthy one cat is the most common and important route of transmission and represents the highest risk factor. Exposure to infection via contaminated blankets, bedding, toys, brushes, lab coats, leather gloves or even external parasites is also reported [26].

4. CLINICAL FEATURES

In cats, lesions may consist of any combination of scaling and crusting with or without alopecia; focal, multifocal or generalized alopecia; erythema; miliary dermatitis and onychomyhcosis [27,28]. Dermatophytosis is one of the few skin diseases of cats in which hyperpigmentation may be seen [27,29] Focal pruritic lesions mimicking areas of eosinophilic plaques may be seen. Longhaired cats may present with breakage and the complaint of ‘excessive shedding’. Ingestion of larger than normal amounts of hair may result in owner complaints of constipation, weight loss, anorexia and vomiting; these are more common

in longhaired cats. Cats may also develop granulomatous lesions (kerions, mycetomas, pseudomycetomas) of the skin and subcutaneous tissues. This is a rare clinical presentation with a poor prognosis for cure.

Fig. 1. Focal lesion of dermatophytosis below the ear of cat

Fig. 2. Shows generalized dermatophytosis in a kitten

Fig. 3. Shows dermatophytosis of an 8 weeks old kitten. Note the hair loss and erythema above the eye

5. ETIOLOGY

The most common cause of dermatophytoses in cats is *M. canis* [30,31]. Copetti MV et al. [32] beside *M. canis* isolated *M canis var distortum.* Copetti MV et al. [32], Nardoni S et al. [33] reported *M. gypseum*. [34,35] isolated *Tricophyton mentagrophytes*, [36] isolated *Trichophyton terrestre. M. nanum* was isolated by Ilhana Z et al. [37] while [38] isolated *Chrysosporium* as a case report from two cats.

6. DIAGNOSIS

Diagnosis is based of combination of history, physical examination (incorporating examination in white light), Wood's lamp examination, direct examination of fluorescing hairs, and fungal culture [2,39,40].

7. HISTORY

It is the first step in diagnosis of the disease especially in mutli-cat situation (eg.home, breeding establishment, cattery or shelter) it will be a benefit to know if the disease is previously reported. History can make veterinarians expect the spread time of the disease. Any information taken from owner helps the diagnosis.

7.1 Physical Examination

Physical examination is done by palpation the skin of suspected infected cat. Skin lesions might not otherwise be found, the examination is done either in room light using a strong beam flashlight. The last is particularly helpful for revealing lesions that are 'washed out' by room light. Lesions are most commonly found in: muzzle, lips, periocular area, in and around the ear and ear margins, digits, medial aspects of the limb, axillary area and tail. Inflammation in cat even caused by ear mites or fleas can be a predisposing factor to multi skin lesion [41].

7.2 Wood's Lamp Examination

Hair shafts of *M. canis*-infected hairs when examined with Wood's lamp will be fluoresce, however, only about 50% of *M. canis* strains fluoresce and other dermatophytes do not fluoresce at all. This examination is a screening tool and it help to use the fluorescent hair shaft in direct examination and culture [42].

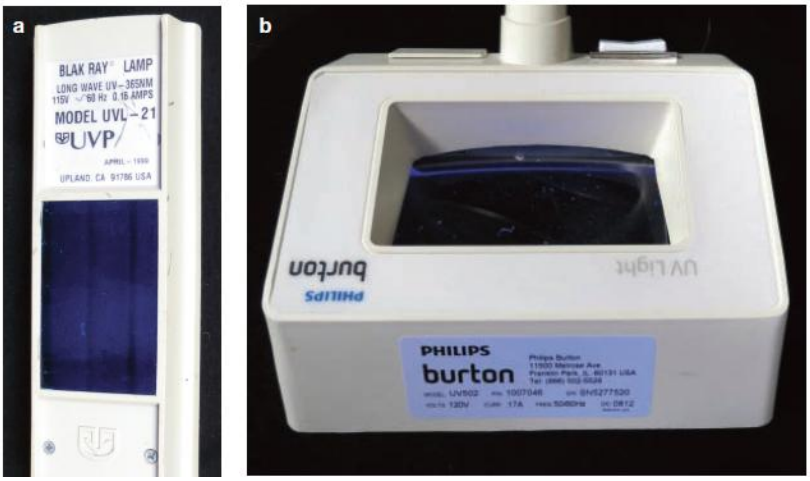

Fig. 4. Wood's lamps. (a) Small compact model and (b) model with built-in magnification

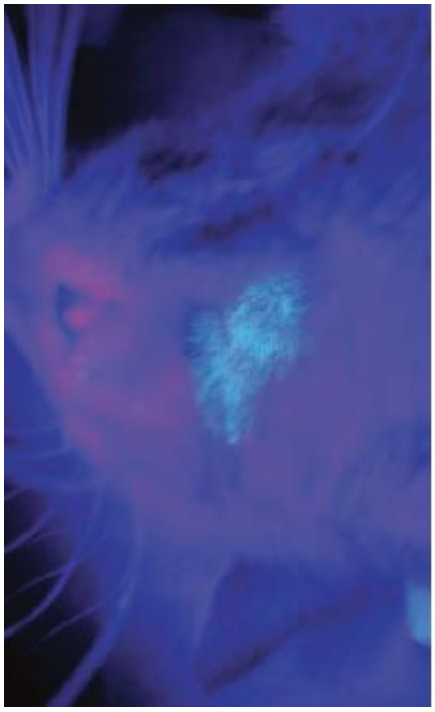

Fig. 5. Wood's lamp positive lesion

7.3 Direct Examination

Each Sample from infected cat was 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 [43-45]. 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). Positive result of KOH direct test can to positive cultures, which are considered as the gold standard. Direct microscopic examination may give false-positive results due to presence of fungal spores of saprophytic fungi. The sensitivity of this technique is59% it seems to be poor compare with other techniques [19]. The sensitivity of the test increased to (76%) by using fluorescence microscopy with calcofluor white – a special fluorescent stain which have an affinity to bind the structures contain cellulose and chitin [46].

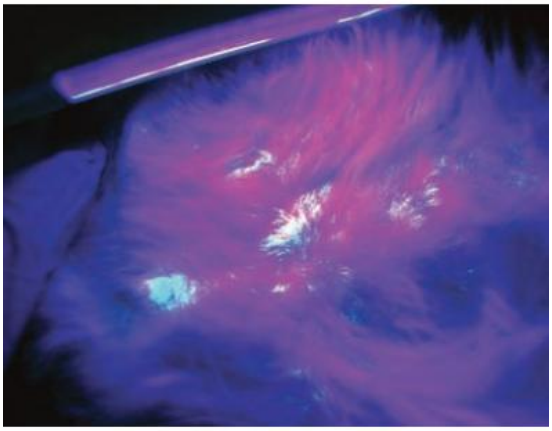

Fig. 6. Wood's lamp positive hairs

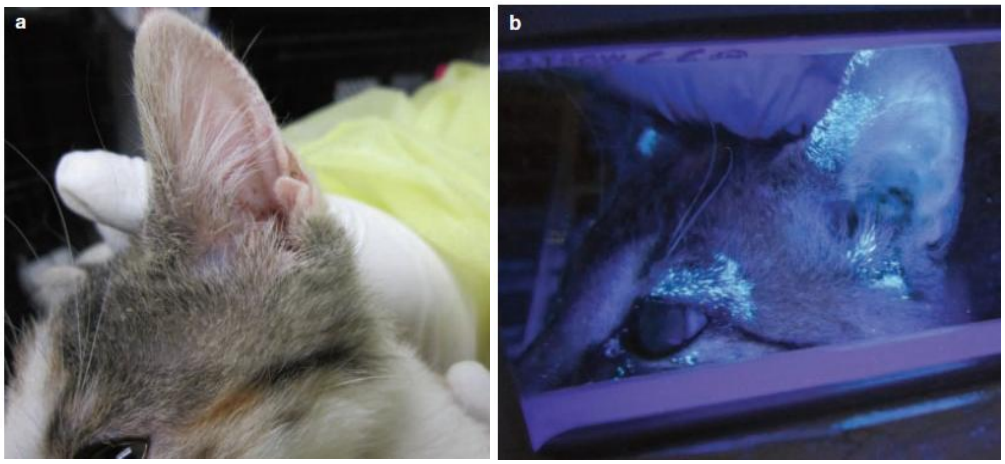

Fig. 7. Ear of a cat with dermatophytosis. Note the limited lesion extent observed in room light (a) versus how, under Wood's lamp examination (b), the extent of the lesions is highlighted

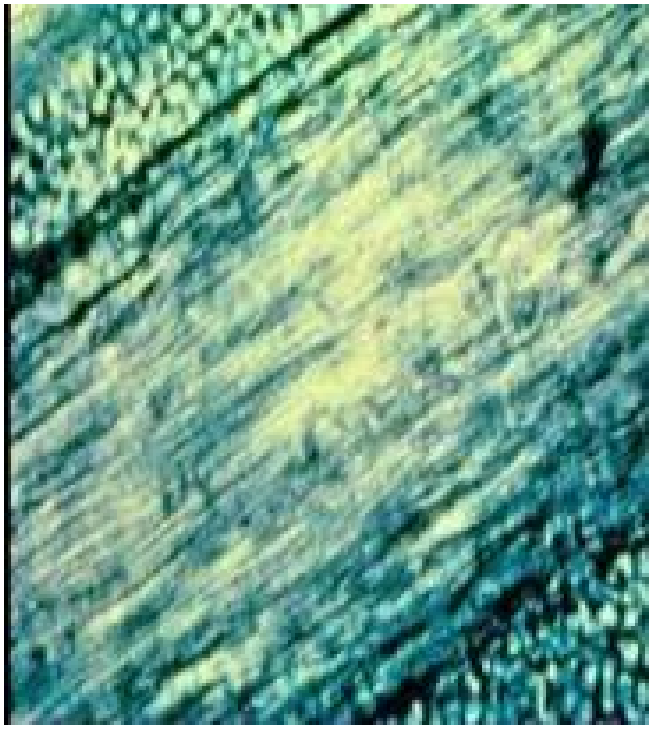

Fig. 8. Ectothrix spores of *M. canis*

8. FUNGAL CULTURE

Samples are usually collected by sterile toothbrush which is more preferred than hair plucking technique. The samples are a culture on Sabouraud dextroseagar supplemented with chloramphenicol (0.05 mg/mL) and cycloheximide is add as to reduce the growth of saprophytic fungi (0.5 mg/mL). Petridishes were incubated at 25°C for 5 weeks. The isolates examine macroscopically and microscopically after staining with lactophenol cotton blue for wet mount technique [37]. The slide culture was made simultaneously, for a better visualization of typical structures of each fungi species. Dermatophytes test media (DTM) is recommended as the best media for isolation of dermatophytes because the presence of the red

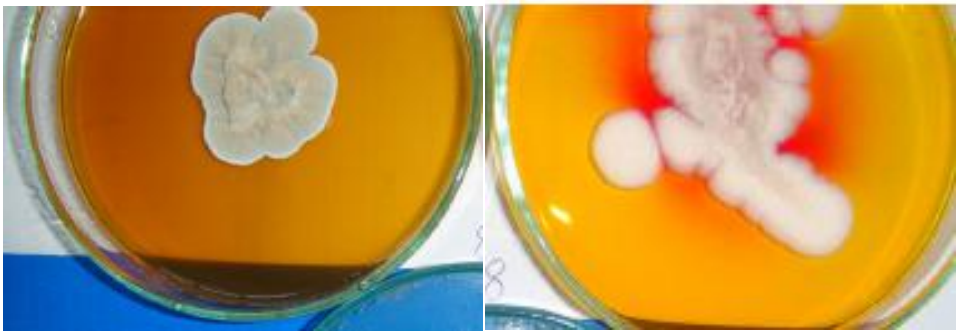

Fig. 9. *Trichophyton terrestre* on Sabouraud dextrose agar (left), dermatophyte test medium (right)

colour indicates positive result this help the early identification of highly suspect cultures [41]. In addition to the mention above, pigment production on corn meal agar, urease activity on urea agar base, growth at 37◦C on SDA *in vitro* and hair perforation tests are used for identification of dermatophytes [47-49]. Biochemically series Trichophyton agars from 1 to 7 enriched with ammonium nitrate, thiamine, histidine, nicotinic acid and inositol are used to differentiate *Trichophyton* species [50].

9. MOLECULAR IDENTIFICATION

Identification with *in vitro* culture as a diagnostic procedure is time-consuming [51]. It might take up to 4 weeks or longer to give the final results or are not succesfull. Furthermore, morphological identification may be confusing due to polymorphism of dermatophytes [52].

Polymerase chain reaction (PCR)-based techniques shorten the diagnostic procedure and generally have high sensitivity and specificity compared to conventional methods [53]. Many PCR-based techniques such as PCR fingerprinting [54,55], Random Amplification of Polymorphic DNA (RAPD) [56], Restriction Fragment Length Polymorphism (RFLP) [57] and real-time PCR [58]. Further, TRFLP (PCR-terminal restriction fragment length polymorphism) [59], nested PCR [60] or PCR-ELISA [61] have also found there use in identification of previously cultured dermatophytes however, [62] used PCR-based methodology for dermatophytes from hair samples of cats.

10. TREATMENT

Although in healthy individuals the infection may resolve spontaneously, treatment is necessary in all cases to speed up the resolution because of the risk of infection of humans and contact animals. 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 [63,64].

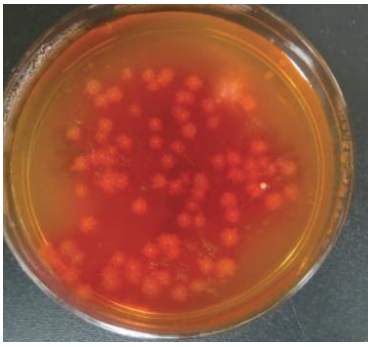

Fig. 10. Positive *M. canis* growth on DTM

10.1 Topical Therapy

This kind of treatment is recommended for cats with a limited number of lesions, firstly hairs should be clipped all around lesions. Clipping should be gentle to avoid making trauma which lead to spread of infection. Spot treatment of lesions may have limit effect in this cases whole body shampooing, dipping or rinsing is recommended. In generalised longhaired infected cats clipping the entire cat is useful for better medication [12]. Topical antifungal drugs are different in their efficacy. In case of a whole body treatment with a 0.2% enilconazole solution twice weekly is effective [65]. 2% miconazole with or without 2% chlorhexidine a twice weekly is very effective [12]. Lime-sulphur solution is commonly used in the USA.

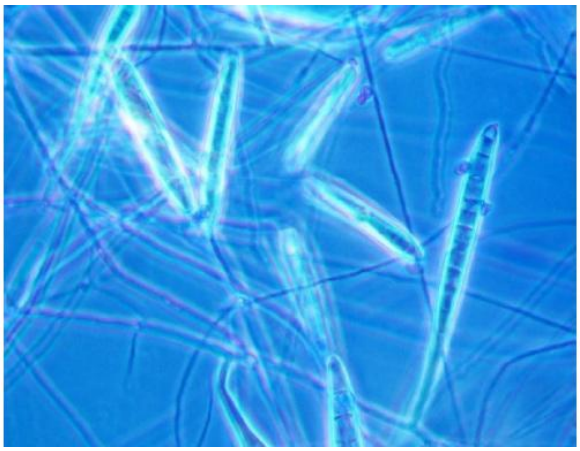

Fig. 11. Macroconidia of *M. canis* lactophenol cotton blue

Fig. 12. Macroconidia of *M. gypseum* lactophenol cotton blue

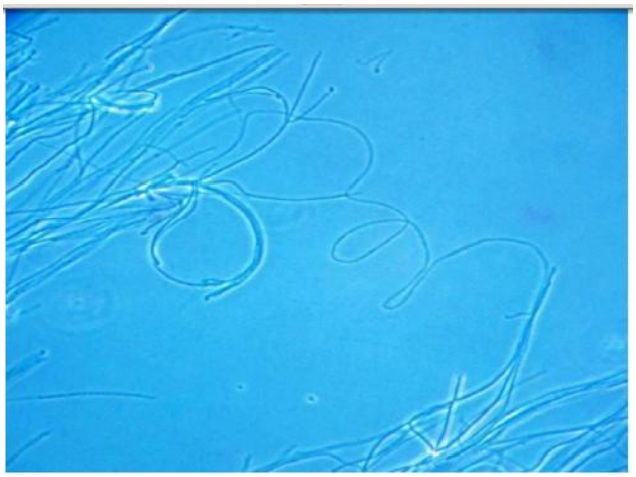

Fig. 13. Microcondia of *T. mentagrophytes* (lactophenol cotton blue)

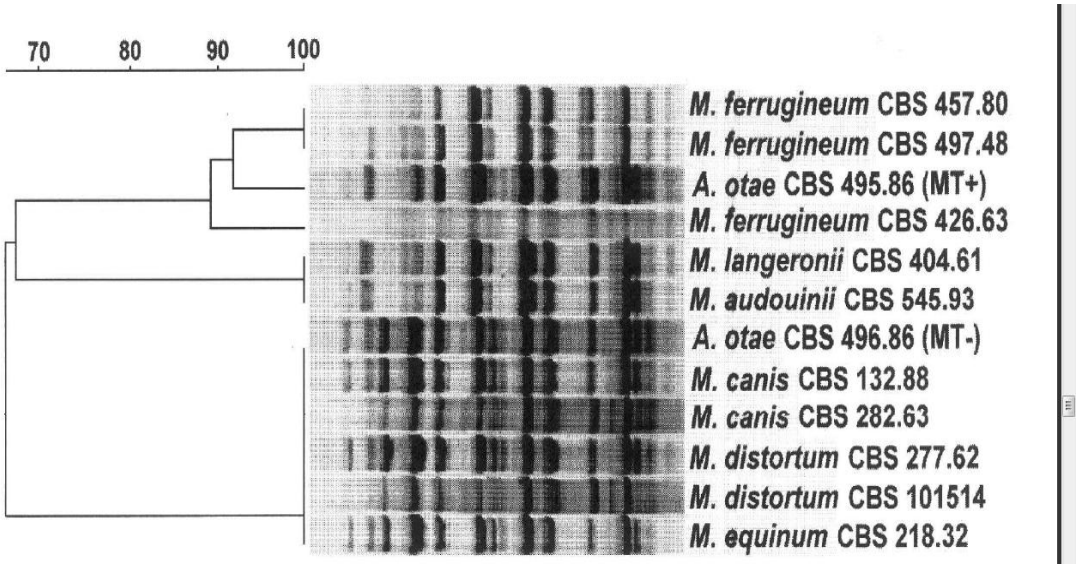

Fig. 14. Phenogram and PCR fingerprinting pattern of *M. canis* complex obtained using primer T3B. The scale shows the similarity (%). This figure was generated using the GelCompar software. MT (mating type); NT (neotype)

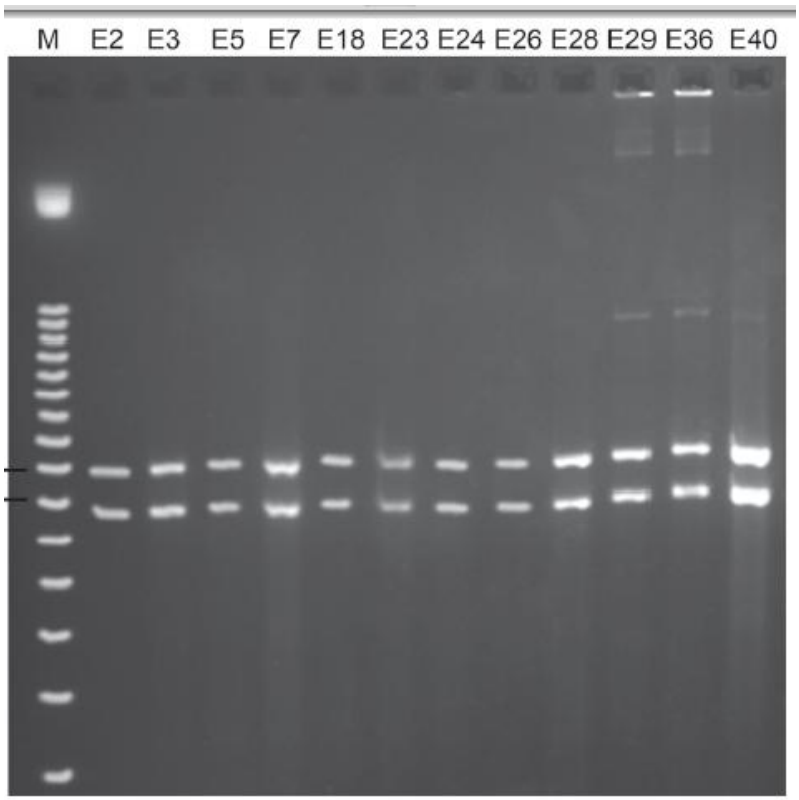

Fig. 15. Polyacrylamide-gel electrophoresis of PCR products of *M. canis* isolates digested with *EcoRI* restriction enzyme. Ribosomal DNA internal transcribed spacers (ITS) were amplified by using sets of primers ITS1-ITS4

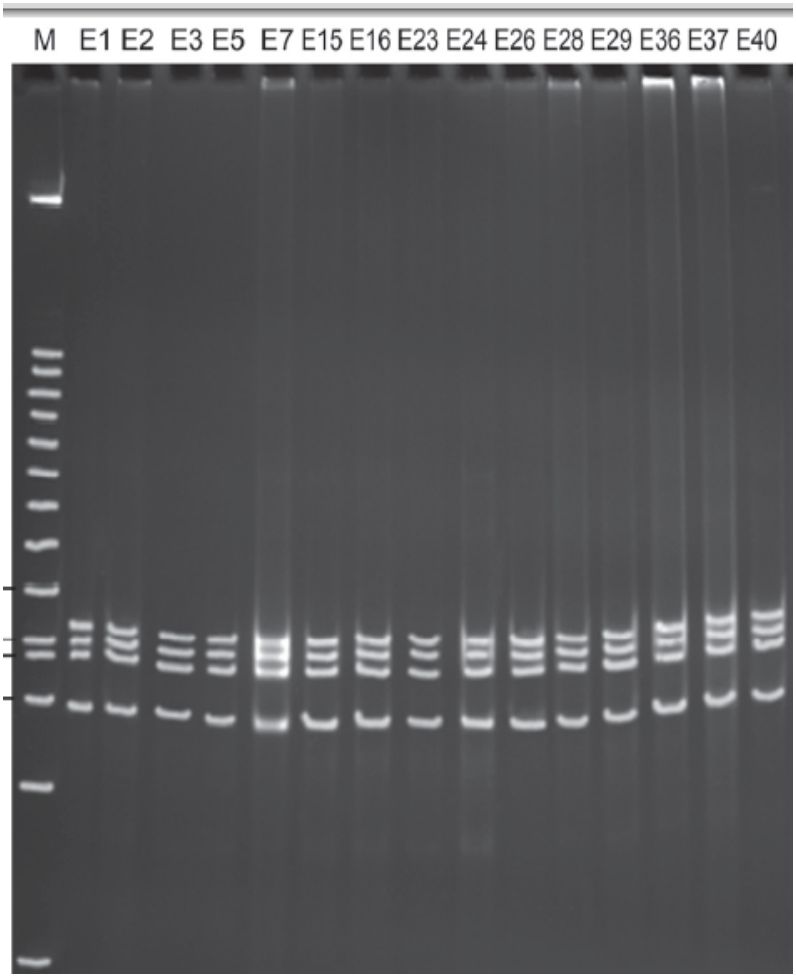

Fig. 16. Polyacrilamide-gel electrophoresis of PCR products of *M. canis* isolates digested with *HinfI* restriction enzyme. The ITS1-ITS4 sets of primers were used to amplify ribosomal DNA including internal transcribed spacers (ITS)

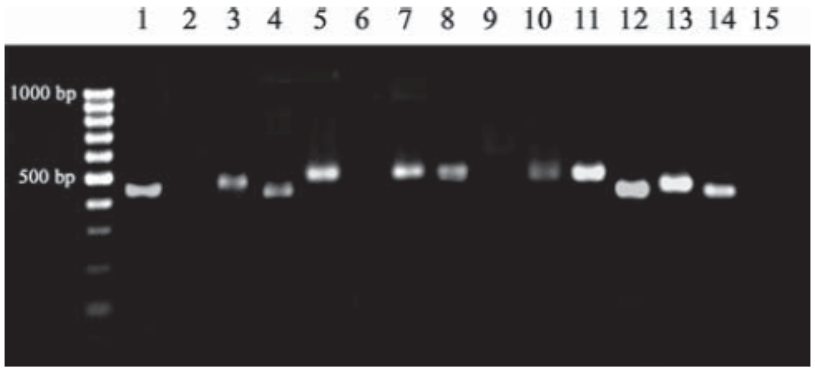

Fig. 17. Nested-PCR testing of genomic DNAs from hair samples isolated from dogs or cats (lanes 1 – 10), as well as from *M. canis* , *M. gypseum* , *T. interdigitale* (zoophilic) and *T. terrestre* and no-DNA control samples (lanes 11 – 15, respectively). Amplicons were sized by comparison with a 100 bp ladder (Gene Ruler, MBI Fermentas)

10.2 Systemic Therapy

All oral systematic antifungal drugs such as, griseofulvin, itraconazole and terbinafine are effective.

10.2.1 Itraconazole

- Itraconazole is currently the preferred drug in feline dermatophytosis systemic treatment.
- A dministration of 5 mg/kg/day for 1 week, repeated after 2 weeks for 6 weeks has been recommended.
- After three cycles of treatment consisting of 1 week with treatment (5 mg/kg) and 1 week without, recover is expected after 7 weeks.

10.2.2 Terbinafine

- Orally administered 30–40 mg/kg once daily.
- Terbinafine is suitable for pulse therapy.
- Its side effects are vomiting and intensive facial pruritus.

10.2.3 Ketoconazole

- Orally is 2.5–5 mg/kg twice daily.
- The side effects of this drug include liver toxicity, anorexia, vomiting, diarrhoea and suppression of steroid hormone synthesis.
- Ketoconazole is not suggested in pregnant animals.

10.2.4 Griseofulvin

- Orally administeration for at least 4–6 weeks at 25–50 mg/kg q12–24 h.
- Griseofulvin has poor solubility of n in water while absorption of the drug increased after fatty meals.
- Side effects include anorexia, vomiting, diarrhoea and bone marrow suppression, particularly in Siamese,
- The drug is not recommended in kittens younger than 6 weeks and in pregnant animals.

11. VACCINATION

Limited efficacy of anti-*M. canis* vaccines as prophylactic or therapeutic for cats has been reported, compared to success of anti-dermatophyte vaccines in cattle, horses, foxes, guinea pigs, cats and dogs [66-72]. There are several kinds therapeutic of dermatophytosis vaccine in cats, such as fungal cell wall vaccines [73,74], an inactivated broad-spectrum dermatophyte vaccine [75] or a live attenuated dermatophyte vaccine [76]. None of these vaccines showed sufficient protection in cats against challenge exposure [73,74,77,78]. In Germany two type of vaccine are used for prophylaxis of *M. canis* infection the first one is (Rivac Mikroderm, Riemser Arzneimittel AG, Germany) which use in cats and dogs the second is (Insol® Dermatophyton, Boehringer Ingelheim, Germany) is used in horses, cats and dogs in several European countries [79,80].

12. CONCLUSION

Dermatophytoses are the most common infectious skin diseases in cats. Many studies were done in different sides of the disease (eg. epidemiology, clinical presentation and diagnosis of ringworm are important for treatment, prevention, and control). Feline dermatophytosis is one of the public health problems because of direct contact with people, especially children.

ETHICAL APPROVAL

As per international standard or university standard ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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