

**EFFICACY OF TUMERIC  
ON STRAY CATS WITH NOTOEDRIC MANGE**

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## CERTIFICATION

This is to certify that we have read this research paper entitled “**Efficacy of Turmeric on Stray Cats with Notoedric Mange**”, by P’ng Jia Qian, and in our opinion, it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirement for the course DVT 5436 – Research Project.



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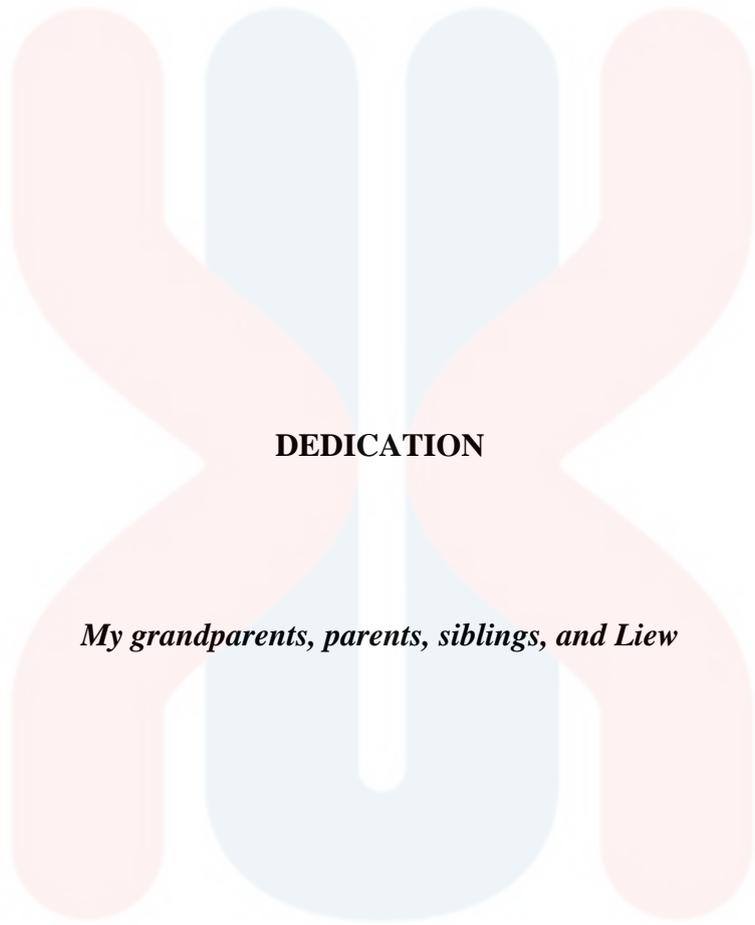
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**DEDICATION**

*My grandparents, parents, siblings, and Liew*

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## ABSTRACT

An abstract of the research paper was presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement on the course DVT 5436 – Research Project.

In this study, the efficacy of turmeric against *Notoedres cati* infestation in cats, was investigated. 6 stray cats which were apparently healthy otherwise than confirmed notoedric mange were randomly allocated into 2 groups, with 3 cats in each group. Cats in Group 1 were treated with topical application of 2ml of turmeric solution on each lesion associated with notoedric mange twice a day for 14 days. Cats in Group 2 were not treated with any treatment. Group 1 showed skin lesion improvement ( $p < 0.05$ ) and a reduced number of mites and eggs ( $p < 0.05$ ) following treatment. In conclusion, turmeric is an antiparasitic agent, has remarkable antioxidative and anti-inflammatory as well as potential anti-pruritic properties, and is safe to treat notoedric mange in cats.

**Keywords:** *Notoedric mange, Notoedres cati, Turmeric, Skin lesion, Number of mites and eggs, Antiparasitic*

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## ABSTRAK

Abstrak kertas penyelidikan yang dikemukakan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan untuk memenuhi sebahagian daripada keperluan kursus DVT 5436 – Projek Penyelidikan.

Keberkesanan kunyit terhadap kucing menjangkiti kurap notoedrik telah dikaji dalam kajian ini. 6 ekor kucing berkeliaran yang rupa-rupanya sihat selain daripada disahkan menjangkiti kurap notoedrik telah diperuntukkan secara rawak kepada 2 kumpulan, iaitu 3 ekor kucing dalam setiap kumpulan. Kucing dalam Kumpulan 1 dirawat dengan sapuan larutan kunyit secara topikal pada setiap lesi yang berkaitan dengan kurap notoedrik dua kali sehari selama 14 hari. Kucing dalam Kumpulan 2 tidak dirawat dengan sebarang rawatan. Kumpulan 1 menunjukkan penyembuhan lesi kulit ( $p < 0.05$ ) dan pengurangan bilangan hama dan telur ( $p < 0.05$ ) selepas rawatan. Kesimpulannya, kunyit adalah ejen antiparasit, dan mempunyai antioksidan dan antiradang yang luar biasa serta sifat anti-pruritik yang berpotensi dan selamat untuk merawat kurap notoedrik dalam kucing.

**Kata kunci:** *Kurap notoedrik, Notoedres cati, Kunyit, Lesi kulit, Bilangan hama dan telur, Antiparasit*

## 1.0 INTRODUCTION

Mange is a generic term for skin diseases caused by infestation with parasitic mites. Mites are very small arthropods, usually less than 1mm in length (Weeks *et al.*, 2019). Mites are classified into two types which are burrowing and non-burrowing mites. Female burrowing mites burrow into the stratum corneum of the epidermis of the host to lay eggs. Non-burrowing mites live on the epidermis or invade into hair follicles and glands of the host. Mange is a noteworthy skin disease in domestic animals due to it being highly contagious and is a zoonosis.

Notoedric mange is caused by infestation with parasitic burrowing mites known as *Notoedres cati*. This mite occurs on domestic cats (*Felis catus*), wild cats (*Felis silvestris*), rats, squirrels, rabbits, and bats (Weeks *et al.*, 2019). Kittens are more prone to the disease compared to adult cats (Noli *et al.*, 2020). Notoedric mange is characterized as intensely pruritic, dry, crusted lesions that usually appear on the medial edges of ear pinna and later spread over the ears, face, head, and neck. Lesions may subsequently spread to feet and perineum owing to the curled sleeping position adopted by cats (Curtis *et al.*, 2015). Infested skin becomes thickened, lichenified, alopecic, crusted, or excoriated (Hnilica *et al.*, 2017).

Notoedric mange is diagnosed by direct microscopic identification of *Notoedres cati* and/ or its oval-shaped eggs and/ or its round-shaped and brown feces, obtained by multiple superficial skin scrapings (Noli *et al.*, 2020). There are few, if any, medications currently labeled for treatment of notoedric mange in cats such as topical application of Advocate® which contains the active ingredient of 100g/L imidacloprid and 10g/L moxidectin. However, it is contraindicated for kittens under 9 weeks of age. Besides, it is toxic to non-target organisms such as cats who inadvertently ingest the solution. According to Euromonitor International, Malaysia reported having a cat population of approximately 795,000 cats in 2018, with the

number of cats steadily growing each year. The necessity of an effective, reliable, and easily applied treatment for cats should be emphasized.

Turmeric (*Curcuma longa*) is a perennial, rhizomatous, herbaceous plant belonging to the ginger family, Zingiberaceae. Turmeric contains an active compound known as curcumin which is well-known for its anti-inflammatory and anti-neoplastic activity. To explain the anti-inflammatory and anti-neoplastic activity, it is most likely mediated through its ability to suppress cyclooxygenase-2 (COX-2). Malaysia is one of the countries where turmeric is extensively cultivated. Nevertheless, up to now, there is no scientific research on the anti-parasitic activity of turmeric. The objective of this research was to investigate the efficacy of turmeric against *Notoedres cati* infestation in the cat.

## **2.0 PROBLEM STATEMENT**

Notoedric mange is highly contagious yet often considered a neglected disease in the cat. If not treated, the cat may become lethargic and dehydrated and may die in rare cases (Noli *et al.*, 2020). Turmeric is non-toxic, accessible, and cheap. It is worthy to prove it as an effective, reliable, and easily applied treatment for a cat with notoedric mange.

## **3.0 RESEARCH QUESTIONS**

- 3.1** Does the topical application of turmeric solution on cats with notoedric mange is an antiparasitic agent?
- 3.2** Does mite count decrease in responding to topical application of turmeric solution on cats with notoedric mange?

## **4.0 RESEARCH HYPOTHESIS**

- 4.1** Topical application of turmeric solution on cats with notoedric mange is an antiparasitic agent.
- 4.2** Decrease in mite count is evidence of responding to topical application of turmeric solution to cats with notoedric mange.

## **5.0 RESEARCH OBJECTIVES**

- 5.1** To investigate the efficacy of turmeric against *Notoedres cati* infestation in the cat.

## 6.0 LITERATURE REVIEW

### 6.1 NOTOEDRIC MANGE IN CATS

Notoedric mange is also known as feline scabies. It is a skin disease caused by infestation with parasitic burrowing mites known as *Notoedres cati*, sarcoptic mites that burrow superficially in the skin (Hnilica *et al.*, 2017). *Notoedres* mite belongs to the class of Arachnida and the family of Sarcoptidae. It is primarily an obligate ectoparasite of felids. This ectoparasite has not yet been classified into host-specific varieties, but they most likely do exist (Pence *et al.*, 1982). *Notoedric* mange is extremely contagious thence in multiple-cat households and catteries, usually, more than one cat is affected (Hnilica *et al.*, 2017).

### 6.2 MORPHOLOGY OF NOTOEDRES CATI

*Notoedres* closely resembled *Sarcoptes* but are smaller than *Sarcoptes*. It has an oval to round body which is dorsally convex and ventrally flattened. Adult females are approximately 225µm in length. Adult males are approximately 150µm in length (Taylor *et al.*, 2007). The head consists of a short and squared rostrum. It possesses four pairs of short limbs, two pairs anteriorly and two pairs posteriorly. Adult females have long, unsegmented pedicles with suckers on pairs 1 and 2. Adult males have long, unsegmented pedicles with suckers on pairs 1, 2, and 4 (Zajac *et al.*, 2012). The hindlimbs are rudimental and do not extend beyond the body margin with the presence of long setae. The dorsal cuticle shows a characteristic of concentric ‘thumb print’ striations without spines. The anal opening is dorsally located.

### 6.3 LIFE CYCLE OF NOTOEDRES CATI

The life cycle of *Notoedres cati* is similar to *Sarcoptes*. *Notoedres cati* exhibits permanent parasitism and has a direct life cycle that takes place entirely on the host. After mating on the skin surface, males remain on the skin surface, while fertilized females burrow tunnels

within the stratum corneum within 30 minutes at a speed of 2 – 3mm/day (Noli *et al.*, 2020). Two to three eggs are laid a day in the tunnels for 2 – 4 weeks. Eggs hatch into six-legged larvae in 3 – 4 days. These larvae crawl onto the skin surface, in turn, burrow into the superficial layers of the skin to create small ‘molting pockets’ (Taylor *et al.*, 2007). After two molts as protonymph and tritonymph, it becomes an adult mite. The life cycle spans 14 – 21 days, under favorable environmental conditions (Noli *et al.*, 2002). Adult males then emerge and seek adult females either on the skin surface or in molting pockets (Taylor *et al.*, 2007). After fertilization, fertilized females either burrow new tunnels or extend the molting pockets (Taylor *et al.*, 2007). The mites feed on epidermal debris and interstitial fluid (Noli *et al.*, 2020).

#### **6.4 TRANSMISSION OF NOTOEDRIC MANGE**

Transmission of notoedric mange is by contact, presumably from transferral of larvae, which are present more superficially than in other stages (Taylor *et al.*, 2007). Skin disease is extremely contagious. If notoedric mange is found in one cat in a cat population, it should be assumed that this skin disease is present in all cats in the population. *Notoedres cati* can survive a few days off the host. Hence, the transmission of notoedric mange can also occur through contact with fomites such as bedding and clothing. Skin entry may occur within less than 30 minutes after transmission to a new host (McCarthy *et al.*, 2004).

Notoedric mange is zoonosis. Human is the dead-end host for *Notoedres cati* and can be occasionally transiently infested after prolonged exposure to infested cats. Cases in humans are known as human notoedric mange. In a study, 63% of people coming into contact with an infested cat showed clinical signs of notoedric mange (Noli *et al.*, 2020). Although human notoedric mange is of limited relevance to human health, it is significant to animal handlers who may be in regular contact with infested cats.

## 6.5 CLINICAL SIGN OF NOTOEDRIC MANGE

Clinical signs of notoedric mange are represented by papules, which, with disease progression, evolve into grey-yellow thick crusts, extremely adherent to the skin surface (Noli *et al.*, 2020). Lesions usually first appear on the medial edges of the ear pinnae and then spread rapidly over the ears, face, head, and neck. Lesions may become generalized to the feet and perineum (Hnilica *et al.*, 2017). Pruritus is usually severe and then self-mutilation dermatitis is common, causing alopecia, erosions, and ulcers. These predispose to secondary bacterial or yeast infections. Marked hyperkeratosis with abundant epidermal flakes is also a clinical sign of notoedric mange which is frequently found (Bowman *et al.*, 2014). Peripheral lymphadenomegaly is common (Hnilica *et al.*, 2017). Severe chronic cases can lead to systemic debilitation and death (Mullen *et al.*, 2002).

Following prolonged exposure to infested cats, people may become sensitized to the mites and their products such as saliva and feces. The clinical signs typically present with intense pruritus within a few hours of initial contact with the infested cat. The most common sites of skin lesions are on the hands and legs, reflecting the areas most likely to come into contact with infested cats. *Notoedres cati* does not burrow into human skin (Chakrabarti *et al.*, 1986).

## 6.6 DIAGNOSIS OF NOTOEDRIC MANGE

### 6.6.1 SUPERFICIAL SKIN SCRAPING

Superficial skin scraping is the most commonly used laboratory diagnostic method for notoedric mange, owing to its effectiveness, low cost, and the location of *Notoedres cati* in the stratum corneum of the epidermis. Skin-scraping spatulas should be used instead of dulled scalpel blades in obtaining samples in cats. If clipping is necessary, scissors should be used instead of clippers and leave a few millimeters of hair, to avoid removal of sample materials containing the mites such as crusts.

Optimal samples are obtained by applying a few drops of mineral oil to the skin and gently scraping with short sweeping movements on the skin. Mites are more superficial in a cat's skin than in a dog's skin and then unless there is a thickening of the skin, it is rarely necessary to scrap until capillary bleeding is apparent (Little *et al.*, 2012). It is more fruitful to scrape more frequently and over larger areas. After obtaining the samples, it is transferred to a clean microscope slide and coverslipped. The slide is examined using 10x magnification. It is often helpful to move the condenser down to increase the contrast and scan first for the movement.

Notoedric mange is diagnosed by direct microscopic identification of *Notoedres cati* including its larvae and nymphs and/or its oval-shaped eggs and/or its round-shaped and brown feces (Noli *et al.*, 2020).

### **6.6.2 ACETATE TAPE IMPRESSION**

Acetate tape impression is recently reported as another laboratory diagnostic method for notoedric mange. This diagnostic technique is as sensitive as superficial skin scraping, even in cats presenting with a low infestation (Sampaio *et al.*, 2016).

Samples are obtained by applying a 4cm piece of transparent tape to the skin and gently squeezing the skin. After obtaining the samples, the tape strip is removed and placed directly on a clean microscope slide. The slide is examined using 10x magnification.

### **6.6.3 SKIN BIOPSY**

Skin biopsy for dermatohistopathology is the least commonly used diagnostic technique for notoedric mange. Microscopic lesions include epidermal hyperplasia, spongiosis, and perivascular eosinophilic or interstitial dermatitis with varying numbers of eosinophils (Zachary *et al.*, 2017). Mite segments may be found in the superficial epidermis (Hnilica *et al.*, 2017).

## 6.7 TREATMENT OF NOTOEDRIC MANGE

### 6.7.1 WHOLE-BODY TREATMENT

Whole-body treatments include lime sulfur rinses, fipronil sprays, and pyrethrin sprays (Little *et al.*, 2012). Previously lime sulfur was standard treatment as it was the only licensed product for the treatment of notoedric mange in cats (Campbell *et al.*, 2004). With lime sulfur, the infested cat is bathed to loosen the crusts, followed by a total body application of 2% – 3% of lime sulfur solution every 7 days for at least 6 weeks (Hnilica *et al.*, 2017). The most common adverse effects presumed to be associated with the application of lime sulfur include drying of footpads and hair coats as well as loss of hair on the ears (Newsbury *et al.*, 2007).

Nowadays registered products include spot-on formulations containing imidacloprid and moxidectin and spot-on containing fipronil, (S)-methoprene, eprinomectin, and praziquantel, which can be applied once or twice at a 1-month interval (Hellmann *et al.*, 2013; Knaus *et al.*, 2014).

### 6.7.2 SYSTEMIC ANTIPARASITIC DRUG

Systemic antiparasitic drugs for the treatment of notoedric mange in cats include extra-label use of ivermectin (0.2 – 0.4mg/kg PO or SC q 2 weeks for 3 doses), doramectin (0.2 – 0.3mg/kg SC q 1 – 2 weeks for 2 – 3 treatment), and selamectin (6 – 12mg/kg topically q 2 weeks for 3 – 4 doses) (Coyner *et al.*, 2020). However, toxicity may arise if the infested cat is administered with an avermectin antiparasitic agent simultaneously with ketoconazole or itraconazole (Plumbs *et al.*, 2008).

## 6.8 HISTORY OF TURMERIC

Turmeric (*Curcuma longa*) is a perennial, rhizomatous, herbaceous plant belonging to the ginger family, Zingiberaceae. This herb has a long history in both Ayurvedic and Chinese medicine. Turmeric contains an active compound known as curcumin, an excellent anti-

inflammatory and anti-neoplastic agent. To date, the rhizome of turmeric has been used as a spice for culinary purposes. Curcumin is insoluble in water, resulting in its poor bioavailability, and thence it is safe to consume at a low dose. Acute oral LD<sub>50</sub> of turmeric powder is greater than 5000 mg/kg (Susan *et al.*, 2007).

## **6.9 ROLE OF TURMERIC IN MODERN MEDICINE**

Turmeric has been shown to possess anti-inflammatory and anti-neoplastic activity, most likely through down-regulation of COX-2 and other inflammatory cytokines. A cohort study on broiler chicken indicated that 0.5% of turmeric as a feed additive in diet can enhance the overall performance of chicken (Al-Sultan *et al.*, 2003).

Ethnoveterinary medicine has used turmeric as a topical medication for castration wounds, abscesses, ulcers, and fungal diseases. Numerous reports suggest that curcumin accelerates wound healing. Other than that, turmeric is also used as a treatment for cough, diarrhea, and mastitis in ruminants (Punniamurthy *et al.*, 2021).

## 7.0 MATERIALS AND METHOD

This study was conducted after receiving approval from Final Year Project Research Committee and Animal Ethics Committee 2021 of the Faculty of Veterinary Medicine, University Malaysia Kelantan: UMK/FPV/ACUE/FYP/007/2022. The approval form was attached under Appendix A.

### 7.1 STUDY ANIMALS

The study was conducted in Kelantan and involved 6 stray domestic short-haired (DSH) cats aged between 6 to 36 months old who were caught in the vicinity of Kota Bharu, Kelantan. The cats included both sexes, with 4 tomcats and 2 queens. The age and sex of cats were tabulated in Table 1. These cats were apparently healthy otherwise than confirmed notoedric mange, based on clinical signs and positive results for direct microscopic identification of *Notoedres cati* and/or its oval-shaped eggs and/or its round-shaped and brown feces on superficial skin scrapings.

The cats were housed individually in a 47cm X 42cm X 40cm stainless steel cage to avoid cross-contamination, in a room with a room temperature of  $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . Each cage was equipped with a plastic food bowl, a plastic water bowl, a litter box, and a rubber mat. All cats were fed with 30g of commercial dry food and ad libitum water twice a day. They were acclimatized for at least a week before the study.

### 7.2 STUDY DESIGN

The 6 cats were randomly allocated to form a study population which consisted of 3 cats in the turmeric-treated group (Group 1) and 3 cats in the negative control group (Group 2). Cats in different groups were separated from each other at 2m apart. Cats in Group 1 were treated with topical application of 2ml of turmeric solution on each lesion associated with notoedric mange twice a day. This was accomplished by using a 1ml syringe to withdraw the turmeric solution and applied twice to each lesion. On the other hand, cats in Group 2

were not treated with any treatment. Treatment for Group 1 ended on Day 15. All cats were observed hourly for 4 hours throughout the study for adverse events.

*Table 1 – Age and Sex in Group 1 and Group 2*

Group	Cat	Age	Sex
1	1	12 months	Female
	2	36 months	Male
	3	12 months	Male
2	4	6 months	Female
	5	12 months	Male
	6	36 months	Male

### 7.3 USAGE OF TURMERIC SOLUTION

The study was conducted using turmeric powder, purchased from Pantai Timur Hypermarket, Pengkalan Chepa, Kelantan. This ready-made local product is certified halal by the Department of Islamic Development Malaysia (JAKIM). It is 70% turmeric and 30% rice flour.

For the preparation of turmeric solution, 1 part (200g) of turmeric powder was added to 4 parts (800ml) of drinking water at room temperature of  $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . The solution was stirred and filtered through a strainer into a container. Filtration was repeated 2 times. The filtrate was kept at a refrigerator temperature of  $4^{\circ}\text{C}$ .

### 7.4 STUDY PROCEDURE

#### 7.4.1 GENERAL HEALTH ASSESSMENT

General health assessment was performed on each cat daily which begins from baseline, Day 0 until Day 15. General observation including assessment of appetite, defecation, and urination, followed by physical examination including body weighing, measurement of heart rate, respiratory rate, dehydration status, and mucous membrane color as well as capillary refill time were performed. All information was systematically recorded to

monitor the safety of topical application of turmeric solution on lesions associated with notoedric mange in cats. The general health assessment form was attached under Appendix B.

#### 7.4.2 NOTOEDRIC LESION ASSESSMENT

Notoedric lesion assessment was performed on each cat daily, beginning from baseline, Day 0 until Day 15. A *Notoedres*-induced skin lesion score (NISLS) scoring system was adopted from a study conducted by Hellmann *et al.* (2013) with slight modification to evaluate the severity and extent of lesions associated with notoedric mange in cats.

Table 2 shows the scores for the severity of the notoedric lesions. Table 3 shows the scores for the extent of the notoedric lesion.

**Table 2 – Scores for the severity of the notoedric lesions.**

Score	Skin lesion	Alopecia	Scratching
0	Absent	Absent	Absent
1	Erythematous papular rash with easily detached crust	Mild alopecia (Localized region of partial alopecia)	Occasionally scratching
2	Erythematous papular rash with crust	Moderate alopecia (Multifocal region of partial alopecia)	Occasionally scratching with the presence of scratch wounds
3	Lichenification of skin with a thick crust	Extensive alopecia (Generalized complete alopecia)	Constantly aggressive scratching with the presence of scratch wounds

**Table 3 – Scores for the extent of the notoedric lesions.**

Score	Location of skin lesion
0	Absent
1	Ear region
2	Ear and head region
3	Ear, head, and face region

Both scores of the severity and extent of notoedric lesions were added up and expressed as NISLS with the sum values ranging between 0 and 6. A final notoedric lesion assessment for each cat was performed on Day 15. The clinical cure is defined when the NISLS is 0 on Day 15. Clinical improvement is defined when the NISLS is < 50% of Day 0 on Day 15. Clinical failure is defined when the NISLS is >50% of Day 0 on Day 15.

#### **7.4.3 SUPERFICIAL SKIN SCRAPING AND MITE COUNT**

A superficial skin scraping was conducted from all cats on Day 0, Day 7, and Day 15 at three different sites that have a notoedric lesion or, if lesions regressed, from the area where lesions have been present at study commencement. The sites taken for sampling were the same for all cats which were at bilateral ear pinnae. Using scalpel blade size 10, skin scraping of approximately 1cm X 1cm was performed. After obtaining the samples, it was transferred to a microscope slide with a drop of 10% potassium hydroxide (KOH) added to the samples and left to fix for 15 minutes. The slide was examined using 4x, 10x, and 40x magnifications. Mites were counted using 10x magnification.

#### **7.4.4 COMPLETE BLOOD COUNT**

Complete blood count (CBC) was conducted on all cats on Day 0, Day 7, and Day 15. The site of venipuncture was at the cephalic vein. Using a sterile 25G needle attached to a 1ml syringe, 0.5ml of blood was withdrawn. After withdrawing the blood, it was transferred into EDTA microtubes for CBC.

#### **7.5 STATISTICAL ANALYSIS**

Data were statistically examined using IBM® SPSS® Statistics® (version: 28.0.1.1 (15)). All data were expressed as mean  $\pm$  SD and the value expressed represents the 3 cats in each group. Notoedric lesion assessments based on NISLS were analyzed using Pearson's chi-square. The

number of mites on Day 0, Day 7, and Day 15 were analyzed using the Wilcoxon-Mann Whitney test for both Group 1 and Group 2. Results from CBC were analyzed using a one-way analysis of variance (ANOVA). The result is considered statistically significant when  $p \leq 0.05$  (Statistics, 2015).



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## 8.0 RESULTS

### 8.1 GENERAL HEALTH ANALYSIS

General health of cats in Group 1 and Group 2 were monitored throughout the study. Group 1 was observed hourly for 4 hours following topical application of turmeric solution on lesion associated with notoedric mange for evidence of the adverse event. No local reaction at the application site was reported, besides temporary yellow-stained fur.

Generally, 2 cats were bright, alert, and responsive following treatment. Only 1 cat in Group 1 showed persistent inactive throughout the study. They exhibited a short period of scratching on their lesions most likely due to the presence of residual turmeric solution on the lesions which caused temporary discomfort. All cats in Group 1 and 2 cats in Group 2 managed to consume 30g of commercial dry food and approximately 150ml of water daily. 1 cat in Group 2, on the other hand, constantly showed poor appetite throughout the study, meanwhile, an adult *Toxocara cati* was found in its loose feces. All cats showed positive defecation and urination throughout the study.

### 8.2 NOTOEDRIC LESION ANALYSIS

Group 1 showed NISLS of <50% of Day 0 on Day 15, indicating clinical improvement. Meanwhile, in Group 2, 2 cats showed consistent NISLS while 1 cat showed increasing NISLS throughout the study, indicating no anti-parasitic response. Based on Pearson's chi-square,  $p = 0.014 (< 0.05)$  and thence there is statistically significant skin lesion improvement in Group 1 as compared to Group 2. The detailed data for NISLS of Group 1 and Group 2 were tabulated in Table 4. Progression of the notoedric lesion in Group 1 was attached under Appendix C.

For cat 1, on day 0, it showed greyish crusted lesions on the ear pinnae bilaterally with a long linear scratch wound on the left ear pinna. Generalized complete alopecia was

observed on the head. After 4 days of treatment, the crusted lesions on the ear pinnae started to detach. Other than that, hair growth was observed on the head. On day 8, increasing detachment of the crusted lesions on the ear pinnae was noticed as they were loosely attached to the skin. On day 15, its skin lesion has resolved completely with considerable hair growth on the previously alopecic region of the ear pinnae and head.

For cat 2, on day 0, it showed the presence of greyish crusted lesions on the edges of ear pinnae bilaterally. These lesions were extended to the cranial half of the right ear pinna with generalized complete alopecia. On top of that, its head showed multifocal partial alopecia. On day 2, the crusted lesions on the medial edges of the right ear pinna and head started to detach, leaving hyperaemic lesions. The remaining crusted lesions showed black discoloration. On day 4, the hyperaemic lesions on the head were resolved. Pieces of crusted lesions were found to be loosely attached to the skin. On day 8, increasing detachment of crusted lesions on the ear pinnae were noticed with considerable hair growth on the ear pinnae and head. On day 15, its skin lesion has resolved completely with considerable hair growth on the previously alopecic region of the head.

For cat 3, on day 0, it showed the presence of greyish crusted lesions on medial edges of ear pinnae bilaterally. These lesions were extended to the caudal half of the right ear pinna with generalized complete alopecia and multiple scratch wounds. On day 4, the crusted lesions on the ear pinnae started to detach with the healing of scratch wounds on the right ear pinna. On day 8, increasing detachment of crusted lesions on ear pinnae bilaterally were observed. On day 15, nearly complete detachment of crusted lesions on ear pinnae bilaterally with hair growth.

**Table 4 – NISLS of Group 1 and Group 2**

Group	Cat	Day 0		
		Severity	Extent	NISLS
1	1	3	2	5
	2	3	2	5
	3	3	2	5
2	4	3	2	5
	5	3	2	5
	6	3	3	6
Group	Cat	Day 4		
		Severity	Extent	NISLS
1	1	2	2	4
	2	2	2	4
	3	2	2	4
2	4	3	3	6
	5	3	2	5
	6	3	3	6
Group	Cat	Day 8		
		Severity	Extent	NISLS
1	1	1	1	2
	2	1	1	2
	3	1	1	2
2	4	3	3	6
	5	3	2	5
	6	3	3	6
Group	Cat	Day 15		
		Severity	Extent	NISLS
1	1	0	0	0
	2	0	0	0
	3	1	1	2
2	4	3	3	6
	5	3	2	5
	6	3	3	6

**Note:** NISLS – *Notoedres*-induced skin lesion score

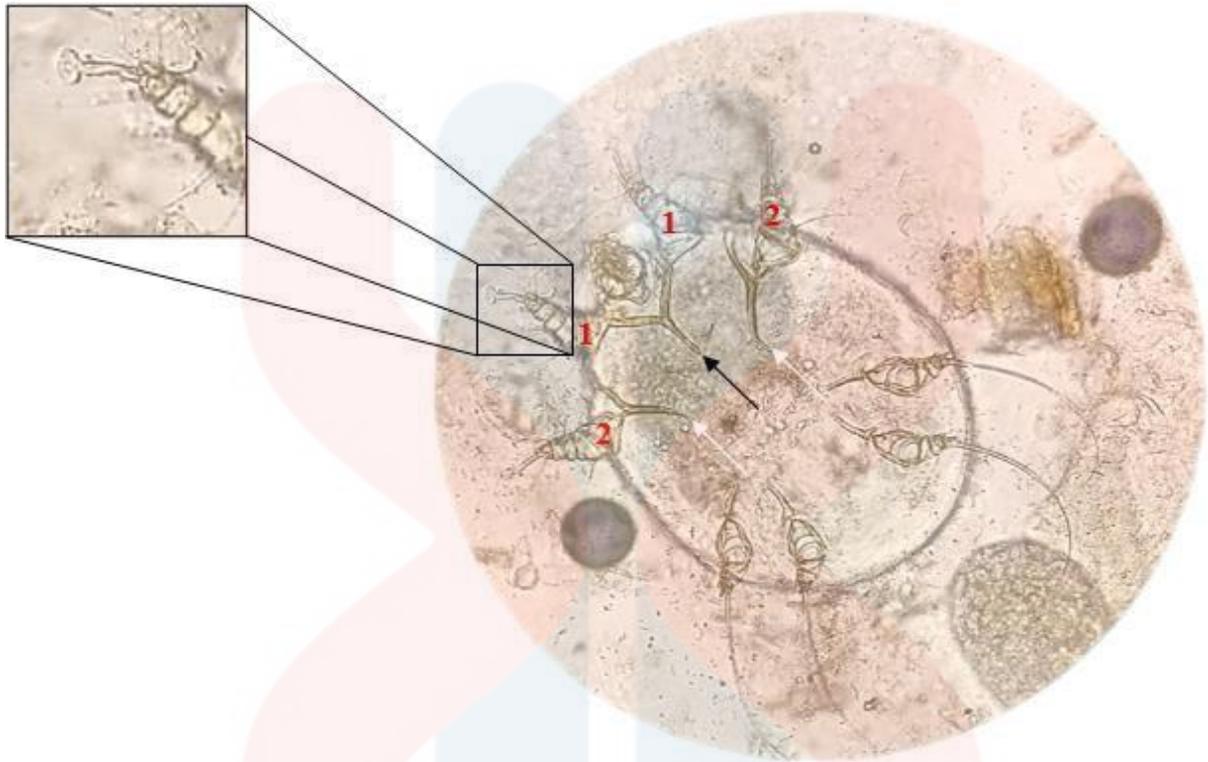
### 8.3 SUPERFICIAL SKIN SCRAPING AND MITE COUNT ANALYSIS

Numerous *Notoedres cati* and their oval-shaped eggs were identified by using a compound microscope through superficial skin scraping. The mite has an oval to the round body. A long, unsegmented pedicle with a sucker is observed on limb pairs 1 and 2. Apodemes of pair 1 (Figure 1, black arrow) are jointed to give a Y-shaped structure, and thus, a sternum. Apodemes of pair 2 (Figure 1, white arrow) are free and each is Y-shaped. The oval-shaped egg has a thin wall containing blastomeres (Figure 2). Based on the Wilcoxon-Mann Whitney test,  $p = 0 (< 0.05)$  for the number of mites and eggs for Group 1 and Group 2. Hence, there are statistically significant in the number of mites and eggs between Group 1 and Group 2. The detailed data for mite and egg count of Group 1 and Group 2 were tabulated in Table 5.

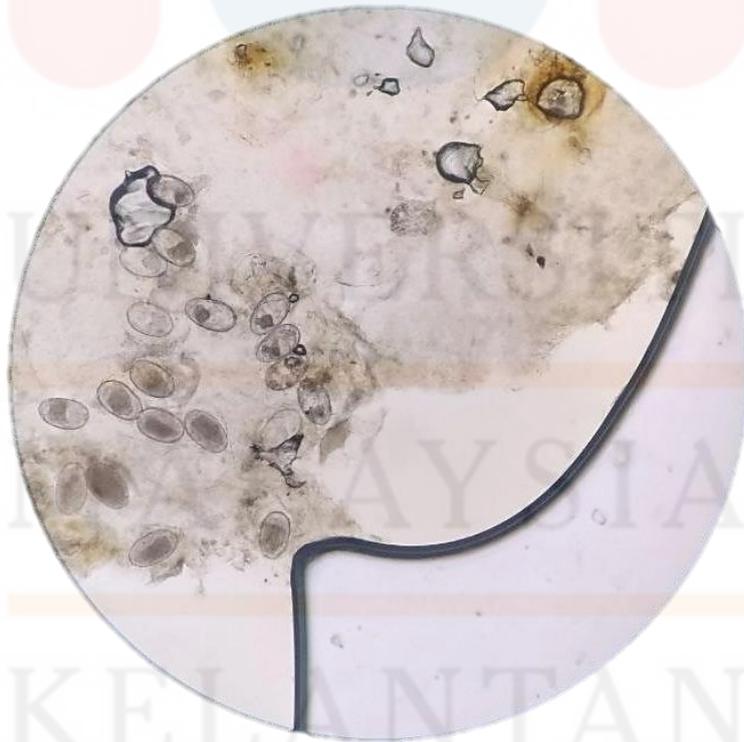
**Table 5 – Mite and Egg Count of Group 1 and Group 2.**

Group	Cat	Day 0		Day 7 Count		Day 15	
		Mite	Egg	Mite	Egg	Mite	Egg
1 Treat- ment	1	30	5	12	2	0	0
	2	25	5	12	2	3	2
	3	23	7	14	3	7	3
	Mean ± SD	26.00 ± 3.61	5.67 ± 1.15	12.67 ± 1.15	2.33 ± 0.58	3.33 ± 3.51	1.67 ± 1.53
2 Con- trol	4	24	3	30	5	27	7
	5	24	3	26	5	29	6
	6	41	3	42	7	37	6
	Mean ± SD	29.67 ± 9.81	3.00 ± 0.00	32.37 ± 8.33	5.67 ± 1.15	31.00 ± 5.29	6.33 ± 0.58

*Figure 1 – Ventral view of Notoedres cati.*



*Figure 2 – Cluster of eggs of Notoedres cati*



#### 8.4 HAEMATOLOGY ANALYSIS

CBC of cats in Group 1 and Group 2 was performed. Initially, on day 0, both Group 1 and Group 2 showed the mean  $\pm$  SD of the white blood cells (WBC) of  $3.54 \pm 0.41 \times 10^3/\mu\text{l}$  and  $4.30 \pm 1.31 \times 10^3/\mu\text{l}$  respectively with a normal range of  $6.0 - 15.5 \times 10^3/\mu\text{l}$ , indicative of leukopenia. On day 7, Group 1 showed an increased value to  $11.37 \pm 1.22 \times 10^3/\mu\text{l}$ , which is within the normal range. On the other hand, Group 2 showed an increased value to  $16.23 \pm 0.61 \times 10^3/\mu\text{l}$ , which is above the normal range, indicative of mild leukocytosis. However, monocytes (MON) of Group 1 and Group 2 were  $2.93 \pm 0.92$  and  $4.40 \pm 0.98$  respectively with a normal range of  $0.1 - 1.0$ , indicative of monocytosis. On day 15, both Group 1 and Group 2 remained to show monocytosis, meanwhile, Group 2 also remained to show mild leukocytosis. Based on ANOVA, the  $p = 0.218 (> 0.05)$ . Hence, there is no statistically significant in the WBC between Group 1 and Group 2.

On day 0, both Group 1 and Group 2 showed the mean  $\pm$  SD of granulocytes (GRA) of  $0.74 \pm 0.46 \times 10^3/\mu\text{l}$  and  $1.29 \pm 0.46 \times 10^3/\mu\text{l}$  respectively with a normal range of  $2.0 - 8.0 \times 10^3/\mu\text{l}$ , indicative of granulocytopenia. On day 7, Group 1 showed an increased value to  $3.77 \pm 0.31 \times 10^3/\mu\text{l}$ , which is within the normal range. On the other hand, Group 2 showed an increased value to  $8.70 \pm 0.40 \times 10^3/\mu\text{l}$ , which is above the normal range, indicative of granulocytosis. On day 15, Group 2 persisted to show granulocytosis. Based on ANOVA, the  $p = 0.151 (> 0.05)$ . Hence, there are no statistically significant in the GRA between Group 1 and Group 2.

On day 0, both Group 1 and Group 2 showed normocytic normochromic anemia with hematocrit (HCT) of  $8.30 \pm 0.00\%$  and  $8.50 \pm 1.20\%$  respectively with a normal range of  $30.0 - 45.0\%$ . On day 7, Group 1 showed normal HCT of  $32.47 \pm 3.10\%$ , while Group 2 still showed normocytic normochromic anemia with HCT of  $26.13 \pm 1.76\%$  and  $25.87 \pm 2.0\%$  on day 15. . Based on ANOVA, the  $p = 0.02 (< 0.05)$ . Hence, they are statistically significant in the HCT between Group 1 and Group 2.

On day 0, both Group 1 and Group 2 showed the mean  $\pm$  SD of the platelets (PLT) of  $129.20 \pm 103.75 \times 10^3/\mu\text{l}$  and  $200.1 \pm 120.69 \times 10^3/\mu\text{l}$  respectively with a normal range of  $300 - 800 \times 10^3/\mu\text{l}$ , indicative of thrombocytopenia. On day 7, Group 1 showed an increased value to  $325.55 \pm 27.10 \times 10^3/\mu\text{l}$ , which is within the normal range. On the other hand, Group 2 still showed thrombocytopenia with a PLT of  $244.67 \pm 27.06 \times 10^3/\mu\text{l}$ . On day 15, Group 2 showed a slight increase in value to  $261.33 \pm 2$ , indicative of thrombocytopenia.

The detailed data for CBC of Group 1 and Group 2 were tabulated in Table 6.

**Table 6 – CBC of Group 1 and Group 2.**

Blood Parameters	Results (Mean ± SD)						Ranges
	Group 1			Group 2			
	Day 0	Day 7	Day 15	Day 0	Day 7	Day 15	
WBC 10 <sup>3</sup> /μl	3.64±0.41	11.37±1.22	12.03±1.45	4.30±1.31	16.23±0.61	16.10±0.80	6.0 – 15.5
LYM	2.34±0.21	4.67±0.31	4.67±0.31	2.20±0.78	3.13±0.98	3.20±0.10	1.0 – 5.0
MON	0.57±0.12	2.93±0.92	2.60±0.35	0.81±0.45	4.40±0.98	4.00±0.78	0.1 – 1.0
GRA 10 <sup>3</sup> /μl	0.74±0.46	3.77±0.31	4.77±0.31	1.29±0.46	8.70±0.40	9.27±1.34	2.0 – 8.0
RBC 10 <sup>6</sup> /μl	3.73±0.81	5.90±0.26	6.00±0.26	3.20±0.66	7.43±0.47	6.23±0.15	6.5 – 10.0
HGB g/dl	10.20±1.90	11.43±1.02	12.43±1.03	10.07±2.08	10.53±0.80	12.47±1.20	10.0 – 15.0
HCT %	8.30±0.00	32.47±3.10	33.47±2.90	8.50±1.20	26.13±1.76	25.87±2.02	30.0 – 45.0
MCV μm <sup>3</sup>	41.93±12.27	42.53±8.91	41.53±9.40	49.07±13.64	53.97±9.53	54.37±6.05	39.0 – 55.0
MCH pg	100.73±15.44	31.80±1.47	31.47±0.32	91.70±11.91	31.77±21.33	31.77±21.33	25.9 – 34.0
MCHC g/dl	36.90±9.35	35.63±9.77	34.70±9.71	42.37±9.38	51.67±10.02	49.60±10.00	30.0 – 35.9
RDW %	52.43±29.30	12.23±0.83	12.43±1.51	30.13±33.07	15.63±1.29	15.37±1.50	10.0 – 16.0
PLT 10 <sup>3</sup> /μl	129.20±103.75	325.33±27.10	340.33±11.59	200.1±120.69	244.67±27.06	261.33±23.07	300 – 800
MPV μm <sup>3</sup>	8.13±0.31	7.73±0.35	7.73±0.35	8.47±0.57	11.57±2.00	11.23±1.50	7.0 – 11.0

**Note:** WBC – White blood cell, LYM – Lymphocyte, MON – Monocyte, GRA – Granulocyte, RBC – Red blood cell, HGB – Haemoglobin, HCT – Haematocrit, MCV – Mean corpuscular volume, MCH – Mean corpuscular hemoglobin, MCHC – Mean corpuscular hemoglobin concentration, RDW – Red cell distribution width, PLT – Platelet, MPV – Mean platelet volume.

## 9.0 DISCUSSION

*Notoedres cati*, the feline sarcoptic mite, can infest cats of any age leading to notoedric mange. Kittens are riskier compared to adult cats and may succumb to the disease. This disease possesses zoonotic potential, especially following prolonged exposure to infested cats. There are labeled and extra-labeled drugs used as a treatment for notoedric mange. However, most of these drugs are very likely toxic to cats and can contribute to drug resistance. Thereby, the necessity of an effective, reliable, and easily applied treatment for cats should be emphasized.

This study has conducted on 6 stray cats with inclusion criteria of notoedric mange limited to ears, head, and face. The turmeric powder used in this study is a registered product for human consumption. The result revealed that concern pertaining to the safety level of topical application of turmeric solution on lesions associated with notoedric mange in cats is well tolerated without adverse event was noticed.

In the underlying study, initially, all 6 cats appeared to have greyish crusty lesions on the ears, head, and face. On day 15, all cats in Group 1 showed improvement in skin lesions associated with notoedric mange ( $p < 0.05$ ). In Group 1, 1 cat showed the earliest detachment of crusty lesions on day 2, while 2 cats showed on day 4. It was believed that the turmeric solution acts as an exfoliant to soften, loosen, and thereby facilitate the detachment of crusty lesions.

Notoedric mange is generally accompanied by intense pruritus due to epidermal burrowing by the mites. Infested cats often attempt to scratch to alleviate the pruritus thence scratch wounds are normally seen. This study proved that turmeric accelerates wound healing. The speed of wound healing depended on factors such as the severity of the wound, age, and the presence of underlying disease in the cats. Cat 1 showed the most drastic improvement in skin lesions compared to cat 2 and cat 3 in Group 1. Healthy and younger cats have increased inflammatory responses. Hence, injured skin will be healed faster. Cat 2 who was the oldest among Group 1

also showed great improvement in skin lesions. As mentioned, notoedric mange is a very pruritic skin disease. Cat 2 showed the earliest reduction in scratching compared to cat 1 and cat 3. This finding suggested that turmeric might be a potential therapeutic option for the treatment of pruritus. However, further research is needed to confirm this finding. Cat 3 showed the slowest improvement in skin lesions compared to cat 1, nevertheless, both of them have a similar age. It was believed that cat 3 might have an underlying disease shown by inactivity persistently throughout the study which lowers the immune response and results in delayed wound healing.

Group 1 showed NISLS of <50% of Day 0 on Day 15, indicating clinical improvement. Meanwhile, in Group 2, 2 cats showed consistent NISLS while 1 cat showed increasing NISLS throughout the study, indicating no antiparasitic response. Thus, it demonstrated that turmeric possesses an antiparasitic effect against *Notoedres cati*. This finding was further validated by a great reduction in the number of mites and eggs for Group 1 compared to Group 2 ( $p < 0.05$ ). The mechanism of action of how turmeric acts as miticide is subjected to further research.

Turmeric contains curcumin, a well-known active compound with antioxidative and anti-inflammatory properties. Notoedric mange causes an increased rate of oxidative stress. The high levels of reactive oxygen species (ROS) reduce the cell's natural ability to reproduce, regenerate, and renew itself. All cats in Group 1 displayed progressive hair growth in previously alopecic regions. Hence, proved that turmeric accelerates hair growth by lowering oxidative damage. On top of that, mite infestation is often associated with a reduction in feed intake, which raises the need for protein mobilization from skeletal muscle. This explained the poor hair growth in infested cats. In this context, topical application of turmeric solution on lesions associated with notoedric mange aids in mite control, meanwhile reducing the clinical signs of notoedric mange.

Initially, all 6 cats showed leukopenia, granulocytopenia, normocytic normochromic anemia, and thrombocytopenia. On day 7, Group 1 showed remarkable improvement toward normalcy. On the other hand, Group 2 showed leukocytosis, granulocytosis, persistent normocytic normochromic anemia, and thrombocytopenia until day 15. Turmeric possesses an anti-inflammatory effect. Thereby, it was proven that Group 1 gradually increased WBC to the normal range since day 7. WBC in Group 2 were slightly above the normal range. These deviations were not significant ( $p > 0.05$ ). Conversely, HCT between Group 1 and Group 2 were significant ( $p < 0.05$ ). Group 1 showed a drastic increase in HCT from non-regenerative normocytic normochromic anemia to the normal range. This type of anemia is commonly associated with the disease which causes decreased production of red blood cells such as malnutrition. Turmeric which has proven to possess an antiparasitic effect able to exert a great control of the mite infestation. Mildly infested cats gradually improve in feed intake. Hence, anemia was resolved in Group 1. However, this study was conducted on stray cats with their health histories unrevealed, so other possibilities such as the presence of endoparasitism which can contribute to the same hematology must be taken into consideration.

## **10.0 CONCLUSION**

Topical application of 2ml of turmeric solution which consists of 0.25g of turmeric powder twice a day for 14 days consecutively on lesions associated with notoedric mange in cats is an antiparasitic agent. This is evidenced by skin lesion improvement and a decrease in the number of mites and eggs on day 15. This study can contribute to the development of novel local antiparasitic, antioxidative, anti-inflammatory, and potential antipruritic drugs by using turmeric which is readily accessible in Malaysia.

## 11.0 RECOMMENDATION

This study was conducted on 6 stray cats who were randomly allocated into 2 groups, with 3 cats in each group. Turmeric-treated group underwent a treatment period of 14 days and the experiment ended on day 15. It is recommended to continue the study by starting topical application of turmeric solution on lesions associated with notoedric mange in the negative control group on day 16 for a treatment period of 14 days. This is to provide more convincing evidence if the initial negative control group shows skin lesion improvement and a decrease in the number of mites and eggs following treatment. Otherwise, a longer treatment period is recommended. This is to allow a better skin lesion assessment from lichenification to complete skin healing. Hence, a higher level of validity can be provided compared to a short treatment period. On top of that, absolute eosinophil count should be evaluated before treatment, during treatment, and post-treatment. Notoedric mange is associated with eosinophilia and thence it should be evaluated to investigate the significance of eosinophil count to skin healing in cats with notoedric mange.

## APPENDICES

### Appendix A – Approval form from Final Year Project Research Committee and Animal Ethics Committee 2021 of Faculty of Veterinary Medicine, Universiti Malaysia Kelantan.



UNIVERSITI  
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KELANTAN

Fakulti Perubatan Veterinar

RUI. KAMI (*Our Ref*) : UMK/FPV/ACUE/FYP/007/2022  
TARIKH (*Date*) : 20 FEBRUARY 2022

**PROF. DR. JASNI BIN SABRI**  
Main Supervisor  
Faculty of Veterinary Medicine  
Universiti Malaysia Kelantan

Dear Prof,

#### APPROVAL OF INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) TO CONDUCT RESEARCH INVOLVING ANIMALS

We are pleased to inform you that your application for approval to conduct research from Institutional Animal Care and Use Committee (IACUC), Faculty of Veterinary Medicine, Universiti Malaysia Kelantan has been approved. Please refer the table below for approval code:

APPROVAL CODE	UMK/FPV/ACUE/FYP/007/2022
TITLE	INVESTIGATION OF TURMERIC ON STRAY CATS WITH NOTOEDRIC MANGE

2. Please be noted for the Final Year Project, you are responsible to supervise your student to conduct all animal-related procedures as stated during ethic application. The co-supervisor(s) for the project are encouraged to help with the procedures as well.

3. You are advised to always follow "3R" (REDUCE, REFINE, & REPLACE) and all animal ethics and animal welfare principles to reduce suffering in animal.

Thank you.

"RAJA BERDAULAT, RAKYAT MUAFAKAT, NEGERI BERKAT"  
"WAWASAN KEMAKMURAN BERSAMA 2030"  
"BERKHIDMAT UNTUK NEGARA"

Yours sincerely,

**DR. NOR FADHILAH BINTI KAMARUZZAMAN**  
Chairman  
Institutional Animal Care and Use Committee  
Faculty of Veterinary Medicine  
Universiti Malaysia Kelantan

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FYP FPV

## Appendix B – General Health Assessment Form

Day	Day 0			Day 1			Day 2			Day 3			Day 4			Day 5		
Cat	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
A																		
B																		
U																		
Bright																		
Alert																		
Responsive																		
Wt (kg)																		
RR (bpm)																		
HR (bpm)																		
Dehydration status (%)																		
MM colour																		
CRT (sec)																		
Vomiting																		
Diarrhoea																		
Others																		

**Note:** A – Appetite, B – Bowel movement, U – Urination, Wt – Weight, kg – Kilogram, RR – Respiratory rate, HR – Heart rate, bpm – breath per minute/ beat per minute, MM – Mucous membrane, CRT – Capillary refill time, sec – Seconds

Day	Day 0			Day 1			Day 2			Day 3			Day 4			Day 5		
Cat	4	5	6	4	5	6	4	5	6	4	5	6	4	5	6	4	5	6
A																		
B																		
U																		
Bright																		
Alert																		
Responsive																		
Wt (kg)																		
RR (bpm)																		
HR (bpm)																		
Dehydration status (%)																		
MM colour																		
CRT (sec)																		
Vomiting																		
Diarrhoea																		
Others																		

**Note:** A – Appetite, B – Bowel movement, U – Urination, Wt – Weight, kg – Kilogram, RR – Respiratory rate, HR – Heart rate, bpm – breath per minute/ beat per minute, MM – Mucous membrane, CRT – Capillary refill time, sec – Seconds

### Appendix C – Progression of the notoedric lesion in Group 1.



Cat 1 on day 0. Greyish crusted lesions on ear pinnae bilaterally with a long linear scratch wound on left ear pinna (white arrow) as well as generalized complete alopecia on the head.



Cat 1 on day 4. Detachment of crusted lesions on ear pinnae bilaterally with hair growth on the head.



Cat 1 on day 8. Detachment of loosely attached crusted lesions on ear pinnae bilaterally with considerable hair growth on the head.



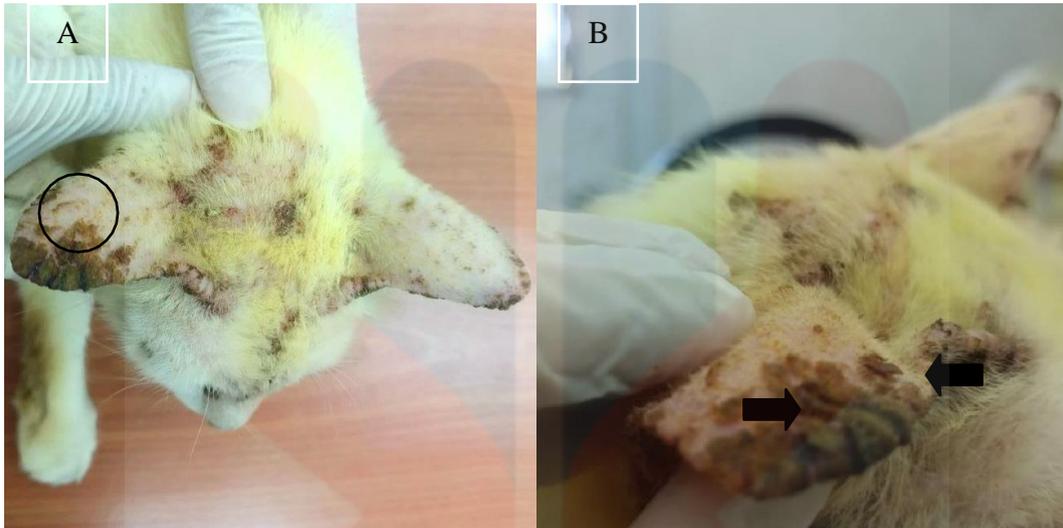
Cat 1 on day 15. Skin lesion completely resolved with considerable hair growth on ear pinnae and head.



Cat 2 on day 0. Greyish crusted lesions on edges of ear pinnae bilaterally, extended to cranial half of right ear pinna with generalized complete alopecia. Multifocal partial alopecia on the head can be observed.



Cat 2 on day 2. Detachment of crusted lesions on medial edges of right ear pinna and head, leaving hyperaemic lesions (black circle) while the remaining crusted lesions showed black discoloration.



Cat 2 on day 4. (A) Detachment of loosely attached crusted lesions on the right ear pinna (black circle) with hyperaemic lesions on the head were resolved. (B) Pieces of crusted lesions were loosely attached to the skin of the right ear pinna (black arrow).



Cat 2 on day 8. Detachment of crusted lesions on ear pinnae bilaterally with considerable hair growth on ear pinnae and head.



Cat 2 on day 15. Skin lesion completely resolved with considerable hair growth on ear pinnae and head.



Cat 3 on day 0. Greyish crusted lesions on ear pinnae bilaterally, extended to caudal half of right ear pinna with generalized complete alopecia and multiple scratch wounds (black arrow).



Cat 3 on day 4. Detachment of crusted lesions on ear pinnae bilaterally with the healing of scratch wounds on right ear pinna.



Cat 3 on day 8. Increasing detachment of crusted lesions on ear pinnae bilaterally.



Cat 3 on day 15. Nearly complete detachment of crusted lesions on ear pinnae bilaterally with hair growth.

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