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Research Article

Cockroaches as Potential Mechanical Vectors for Mites Infestation The First Report in Kuantan

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Abstract

Background and Objective: Cockroaches have been long hated by people due to their creepiness and considered as pests. Since mites share the same environment as cockroaches, there are a number of possibilities for mites to be found on the cockroaches. Hence, the study aimed to identify the occurrence of mites carried by cockroaches from two food stalls and two restaurants in Indera Mahkota, Kuantan, Pahang, Malaysia. **Materials and Methods:** A total of 179 cockroaches from the species of *Periplaneta americana* were caught and processed for identification of mites. The mites were observed under light microscope. **Results:** Microscopic evidence showed that 102 cockroaches carried mites. The percentage of mites' occurrence was higher in the food stalls as compared to the restaurants. **Conclusion:** Overall, the study found that cockroaches potentially serve as mechanical vectors for mites. By reducing the cockroach infestation in food premises, the risk of transmission of dangerous mites via cockroaches also can be reduced.

Key words: *Periplaneta americana*, cockroach infestation, food premises, dangerous mites, food stalls and two restaurants

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

American cockroach (*Periplaneta americana*) is the most common cockroach found worldwide. It can survive in buildings and human residential area. Although *Periplaneta americana* or American cockroach can fly quite well, it prefers to run on its legs. American cockroaches also prefer dark and moist surroundings. During daytime, they prefer to hide in dark and humid area such as under the sink, in the toilet and even in the sewer before becoming active at night¹. The nature of the places chosen by the cockroach is the perfect micro habitats for pathogens. It is suspected that cockroach will pick the pathogens up while it was crawling from such places.

Most of the studies that have been done on the relationship between cockroaches with parasitic pathogens were only reported the occurrence of bacteria, helminths ova and protozoan cysts²⁻⁴. However apart from helminths ova and protozoan cysts, microscopic ectoparasites such as mites are important pathogens that can be potentially carried by cockroaches. Very few studies have been done to find out the relationship between cockroaches and mites transmission⁵.

Most of recent studies were reported the allergen exposure towards mites and cockroaches^{6,7}. For instance, a recent study done by Panzner *et al.*⁶ reported that mostly patients of Central Europe allergic towards allergens content in mites and cockroaches. The study suggested a future study on allergen content in mites is needed⁶.

Mites are ectoparasites that can cause serious health problems to human such as scabies and scrub typhus⁸. Mites also can cause respiratory diseases such as asthma, dermatitis and rhinitis and allergic reactions⁹. The optimal condition for dust mites to survive and growth is between 20-30°C with the humidity more¹⁰ than 65%. Overall, mites prefer high humidity environment (65-70%) to survive and breed⁸. Since mites share the same environment as cockroaches, there are a number of possibilities for mites to be found on the cockroach.

In Malaysia, several studies were reported on the occurrence of mites. A recent study by Ernieenor *et al.*¹¹ found the mite species from house dust samples collected in Pahang known as *S. medanensis* was belonging to *S. medanensis* from Korea and the United Kingdom clade. Another recent study reported on the association of house dust mites' allergens among 2,192 office workers in Malaysia via self-administered questionnaires. The study revealed that house dust mites was one of the allergens that independently related with asthma and rhinitis. A study conducted by

Dilipkumar *et al.*¹² reported that Malaysian red palm weevil or snout beetle serves as vector to carry mites. The authors documented that the mites significantly higher on the surface body of male red palm weevil than female red palm weevil. The study suggested that detail study on the relationship of mites and Malaysia red palm weevil in terms of physically and biologically is needed in future. Another study done by Ahamad *et al.*¹³ described the morphology and morphometry of medically important mite known as *Suidasia pontifica* that obtained from dust in details. The characteristic of *S. pontifica* was viewed under scanning electron microscope.

Despite, several recent studies reported the occurrence of mites in Malaysia, none of the previous studies were done on the occurrence of mites in cockroaches. So far, in Malaysia, only few studies had been done pertaining to cockroaches¹⁴⁻¹⁸. For instance, a study of the infestation level of cockroaches conducted in 1997 at Kuala Lumpur revealed that *Periplaneta* spp. were the predominant species found and may be able to cause food contamination¹⁵. Later, another study of the infestation level of cockroaches was conducted in 2000 at Pulau Pinang reported that the dominant species of cockroaches found in human residential area was the American cockroach (*Periplaneta americana*) due to poor sanitation level of the area¹¹. A finding by Wahab *et al.*¹⁷ revealed that bacteria pathogens, *Salmonella* spp., *Shigella* spp. and *Escheria coli* (medically important bacteria) were isolated from the body of cockroaches caught from food premises¹⁷. A latest study in 2017, a study was done by Yahaya *et al.*¹⁸ emphasized on the morphology and characteristic of the parasite, *Gregarina blattarum* that infected 115 guts of American cockroaches in Pulau Pinang via compound microscope.

The study of mites carried by cockroach in Malaysia needs to be conducted as it will help to increase the awareness on the occurrence of mites through cockroaches. Hence this is considered the first study conducted to determine the mites' occurrence through cockroaches which can act as mechanical vectors for the transmission of mites in Kuantan, Pahang, Malaysia. Besides, mites are considered as medically important parasite to cause allergic diseases to human.

MATERIALS AND METHODS

Sampling area: The study was conducted at Indera Mahkota, Kuantan, Pahang, Malaysia. In this study, 179 cockroaches including adults and nymphs were collected from two food stalls (FS1 at the latitude of 3°49'20.874"N and longitude of

103°18'15.772" E and FS2 at the latitude of 3°49'22.339" N and longitude of 103°18'16.236" E) and two restaurants (R1 at the latitude of 3°49'25.499"N and longitude of 103°17'59.627" E; and R2 at the latitude of 3°49'25.499" N and longitude of 103°18'44.600" E). For FS1 and FS2, a number of 49 cockroaches were collected from each stall. Meanwhile for R1 and R2, it had been estimated 38 and 40 cockroaches were collected respectively. These food stalls and restaurants shared some similarities in terms of hygiene and environment condition.

Sample collection: The cockroach samples were collected by using plastic trap and sticky trap that had been set for 8-12 h per day. The duration of the traps was left for 3 weeks. Each cockroach was collected individually or separately depending on the location in order to avoid cross contamination.

Sample processing: The cockroach was kept in air tight container individually in order to kill it. The die cockroach samples were processed instantly based on a method by previous studies^{2,3}. All samples processing were done at the laboratory of Central Research and Animal Facility (CREAM), Kulliyah of Science, International Islamic University of Malaysia (IIUM), Kuantan.

Identification of mites: Mites were identified under a light microscope. The identification of house dust mites for its species through morphology and characteristic based on the literature references by Service⁸. The study could only determine the genus but not the species of mites unless molecular work by PCR or phylogenetic analysis have been carried out.

Microscopic detection of mites: A drop of sediment from the collected sediment was placed on a clean glass slide. Gram's iodine was added onto the glass slide for better morphology identification of parasite. All slides were identified under 100X and 400X magnification (Leica DM2500 LED Optical Microscope). The positive samples with mites were calculated and documented.

RESULTS

Mites found on the external body of cockroaches: Out of 179 cockroaches, 102 cockroaches carried mites with the percentage of 57.95 (Table 1). The highest percentage of cockroaches carried mites was 40.20% at FS1, followed by 35.29% at FS2, 8.82% at R1 and finally, 15.69% at R2. Most of the slides that were positive with mites were from the cockroaches caught from the food stalls. Microscopy is an effective way to observe microscopic organisms. The process took short time to produce the results. In this study, the morphology of mites could be observed clearly by using the right staining method. However, the species of mites cannot be identified through microscopy alone. Further study by using molecular method was needed in order to identify the species of mites accurately.

The mites stained with Lugol's iodine appeared as dark yellow to brown in color under the light microscope (Fig. 1-3). Figure 1 showed that the mite's body was covered in short bristles called setae. The mite's body can be divided into two parts which are anterior gnathosoma and posterior idiosoma. The important characteristic of a house dust mite is the presence of a long pair of setae on the anterior part of idiosoma. Gnathosoma is the head part which carries a pair of sensory organ called palps. The head part of house dust mites (Pyroglyphidae) is distinguishable from its body which differs it from scabies mites (Sarcoptidae). The eyes are absent so the mites will rely on its palps positioned at the gnathosoma as its sensory organ.

The characteristic of house dust mite can be distinguished by its body shape. House dust mite has slightly rounded or oval body in shape with no segmentation. The body is covered with short setae and a pair of long setae at its posterior end (Fig. 2). Figure 3 showed that the mite had eight legs thus it was not classified as insects. The number of its legs was the reason why it was considered as Arachnidae. The legs of house dust mite have visible segmentation when viewed at 400X magnification. The appearance of short setae on each of its legs was also visible from the microscopic view.

Table 1: Percentage of cockroaches carried mites in samples collected from food stalls (FS1 and FS2) and restaurants (R1 and R2), Indera Mahkota, Kuantan

Cockroach collection site	No. of cockroaches collected	No. of cockroaches positive with mites	Cockroaches positive with mites according to collection site (%) (n = 179)	Cockroaches positive with mites (%) (n = 102)
Food stall 1 (FS1)	49	41	83.67	40.20
Food stall 2 (FS2)	49	36	73.47	35.29
Restaurant 1 (R1)	38	9	23.68	8.82
Restaurant 2 (R2)	40	16	40.00	15.69
Total	176	102	57.95	100

A total number of cockroaches and number of cockroaches harboring the mites on their body surface is presented

DISCUSSION



Fig. 1: House dust mite under a total magnification of 400X. The body can be divided into two parts which are known as gnathosoma and idiosoma

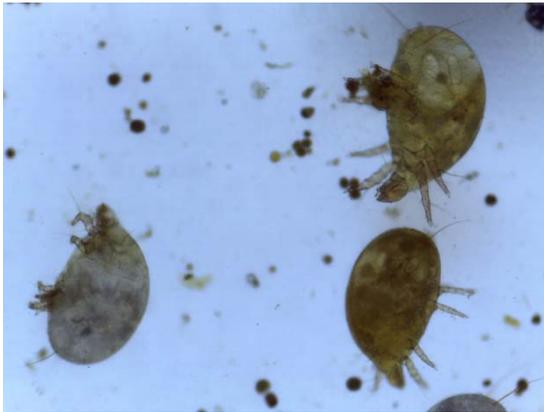


Fig. 2: Mites that have been stained with Gram's iodine appear dark yellowish to brown in color at 400X total magnification. Adult house dust mite has a slightly rounded or oval body with no segmentation



Fig. 3: Idiosoma is the body part that is attached to its four pairs of legs. The body of a house dust mite does not have segmentation (400X total magnification)

In this study, cockroaches were caught from the food stalls carries more mites than cockroaches were caught from the restaurants. This could be due to the surrounding environments of the food stalls were humid and dirty which serves as a good habitat for mites and cockroaches. The presence of mites on the external surface of cockroaches might be picked up when a cockroach was crawling all over the places. Dust mites can thrive in all households. Covered areas such as under household furniture that have lots of dust is a thriving habitat for mites¹⁹. Since the covered areas also can provide protection for the cockroaches, it is possible for mites to be picked up by cockroaches as the cockroaches were hiding in dark and humid places during the daytime.

House dust mites feed on epidermal debris either from human or animal¹⁹. House dust mites (Pyroglyphidae) do not bury into skin layer unlike Sarcoptidae²⁰. Two most common species of house dust mites are *Dermatophagoides* spp. and *Euroglyphus* spp.⁸. The numbers of cockroaches need to be controlled to prevent the spread of the house dust mites. This is because house dust mites can spread diseases to human such as atopic dermatitis, rhinitis and asthma¹⁹. In addition, respiratory inflammatory responses such as bronchial asthma and rhinitis are caused by the inhalation of the fecal matter/droppings of the house dust mites²¹. Apart from that, mites can cause severe allergy reaction in children compared to adults²². This is due to cross reaction process of allergen of dust mites and cockroaches²². It is supported by research done by Uzel *et al.*⁵ which reported an allergen in cockroach can cause cross reaction with allergen in dust mites.

A previous study found that dust mites not only on the pillows but also on the carpets of the restaurants which can cause mite allergens such as asthma. The study suggested that frequent cleaning and regular vacuuming are needed in order to control the mites' infestations²³. The house dust mites fondness for food containing protein and fat for example meat¹⁰. Besides, house dust mites also able to contaminate the cooking flour especially wheat flour. The mites were more likely to reproduce more progeny in that type of flour. Proper storage of contaminated flour with mites should be refrigerated for a maximum of 20 weeks before it can be used²⁴. Interesting study done by Tay *et al.*²⁵ reported a case of 30 year old female wheezing and cause food allergies after eating home bake scones in Singapore. It was found that a large number of live house dust mites were contaminated the self-raising flour that used for home bake scones observed under light microscope. The contamination of mites could be due to improper storage of self-raising flour.

Referring to these previous studies, it was possible that the same phenomenon can occur in food stalls and restaurants of this study area, if there is no proper action being done to control 'the infestation of cockroaches and mites. It is clearly showed that cockroaches serve as carrier of mites that could be possible contaminated carpets, foods and surrounding area of food stalls and restaurants. More detail studies are recommended to investigate the physical and biological relationship between cockroaches and mites by collecting more samples but not only limited to cockroaches but also other form of mites such as carpets, curtains and certain foods as well. All in all, proper prevention and control strategies on both cockroaches and mites are needed to be applied in order to reduce indirect transmission to human. However, this study can only report the occurrence of mites through the genus but not the species due to there was no molecular work done to confirm the species of mites. Hence, this study can also be served as a stepping stone for future studies to do the prevalence of cockroaches carried the mites by incorporating molecular analysis such as PCR and phylogenetic analysis to support the findings.

CONCLUSION

This is the first microscopy evidence shows that the cockroaches potentially serve as mechanical vectors for mites. If the number of cockroach is not being controlled it can pose the transmission of vector-borne diseases and health risks such as severe allergies and itchiness, especially to children when the cockroach snuck up to human residential areas such as houses or apartments as they carry a high number of mites. Hence, future study by collecting more cockroaches from different area to determine the occurrence of mites is recommended.

SIGNIFICANCE STATEMENT

In this study, it was discovered that cockroaches that carried mites and act as mechanical vectors might pose some threat to public community especially at food premises. Awareness among food premises workers need to be raised to encourage a proper hygiene practice including improve the sanitary of the markets place and disinfecting the kitchen area in order to control the cockroaches' infestations as well as mites' invasion.

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