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Research Article

Identification of Cockroaches as Mechanical Vector for Parasitic Infections and Infestations in Kuantan, Malaysia

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Abstract

Background and Objective: Cockroaches are considered as obnoxious household pest due to its nature that can feed on almost everything. It is believed that cockroaches are the mechanical vectors for many kinds of parasites. As this nocturnal insect moves indiscriminately from places to places, the ability to crawl into every nook and crevices can cause it to pick up various pathogen and parasites that can be transmitted to human. The present study aimed to identify the parasites carried by cockroaches from two food stalls and two restaurants in Indera Mahkota, Kuantan. **Materials and Methods:** The cockroaches caught from the species of *Periplaneta americana*. The cockroach samples were collected using plastic traps and sticky traps. The samples were processed by using normal saline solution to obtain parasites. Normal saline solution with the freshly killed cockroaches were shaken vigorously and observed under light microscope to identify the presence of parasites. **Results:** The identification of cockroaches showed that the most parasites found were mites. Other parasites found including *Strongyloides* eggs, *Strongyloides* larvae and *Ascaris* eggs. There was no protozoan cyst found in all cockroach samples in the present study. The numbers of parasites carried from the cockroaches caught from the stalls were higher compared to the number of parasite from cockroaches caught from the restaurant. Low hygienic level at the stalls facilitates the cockroach infestation at the stall compared than the restaurant. **Conclusion:** Hence, cockroaches serve as carrier for endoparasites and ectoparasites. The findings from the present study suggested that appropriate preventive measures such as maintaining cleanliness of the stalls and restaurants can prevent the infestation of the cockroaches.

Key words: Cockroaches, mites, *Ascaris* eggs, *Strongyloides* eggs, protozoan cyst, mechanical vectors

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

INTRODUCTION

Cockroaches are insects that are commonly found in most manmade building¹. A warm and humid environment especially in the kitchen, toilet, drainage system and even the sewer are the most favorable habitats for cockroaches. The conditions of the cockroach habitats are also very suitable environment for pathogens such as bacteria and parasites. It is believed that the organic matter and fluid that being discharged into such place attracted the cockroaches². As the cockroaches crawl all over the places actively at night, the cockroaches might pick up various pathogens from dirty habitats and be transmitted to another places³. The most feared situation is when the cockroaches carried the pathogens into food-serving premises such as restaurants and stalls. Food premises that do not have good hygiene practices are usually have high number of cockroach infestation. The pathogens will be picked up while the cockroach crawl all over the places such as from dirty habitats can be transmitted and contaminate the food source and also contaminate the utensils used in preparing the food⁴.

The most common cockroaches found in human dwellings are American cockroaches (*Periplaneta americana*) and German cockroaches (*Blatta germanica*)¹. These species of cockroaches are typically found in tropical and sub-tropical region⁵. The cockroaches inhabit buildings such as houses, factories, food premises and sewers. These species of domiciliary pests prefer humid and warm environment with abundant food sources⁶. American cockroach (*Periplaneta americana*) is the largest species of common cockroach⁷. Commonly, cockroaches feed on almost everything especially starchy products, decaying matter, organic substances and even human faeces⁶. As the cockroaches feed on human faeces, enteric pathogens from the faeces will be harbored into cockroaches' body and these pathogens can be transmitted to human. A study had been done show that various species of enteric pathogens can be isolated from cockroaches⁵. The bacteria isolated are *Escherichia coli*, *Staphylococcus* spp., *Salmonella* spp. and *Shigella* spp.⁵

Among the important parasites carried by the cockroaches are helminths eggs. The medically important helminths include the soil-transmitted helminths. The species of the helminths isolated from cockroaches are *Ascaris lumbricoides*, *Strongyloides stercoralis* and *Trichuris trichiura*^{8,9}. Those helminths are responsible for parasitic burden called helminthiasis and can cause severe illnesses in human¹⁰. Besides helminths ova, cockroach also acts as a vector for protozoan cysts transmission¹¹.

Cryptosporidium spp., *Giardia* spp., *Entamoeba histolytica* and *Entamoeba coli* are found on the cockroaches' body as well as in the gut¹¹. Intestinal protozoan can cause illnesses such as diarrhea, malnutrition and bowel discomfort¹¹. The prevalence of human intestinal parasites such as protozoan cysts carried by cockroach is very high due to the improper management of sanitation¹².

In Malaysia, there are very few studies done pertaining to cockroach. One of the previous studies was conducted in Selangor to identify medically important bacteria carried by cockroaches. The study reported the positive result for bacteria such as *Salmonella* spp., *Shigella* spp. and *Escherichia coli* isolated from the body of cockroaches⁵. Another study done regarding the level of cockroach infestations in human residential areas. A study conducted in 1997 at Kuala Lumpur revealed that *Periplaneta* spp. were found in large number compared to other cockroach species in human habitats¹². Meanwhile a study done at residential areas in Pulau Pinang revealed that the American cockroach (*Periplaneta americana*) was reported as the dominant species caught in the human residential area¹³. The number of cockroaches caught depends on the sanitation level of the sampling site¹³. However, none of the studies were done to determine the occurrence of parasitic infections in cockroaches.

To the best of author's knowledge, there is no other study done in Malaysia regarding the mechanical transmission of parasites by cockroaches. Hence, this was the first study to identify the parasites carried by cockroaches from two food stalls restaurants and two in Indera Mahkota, Kuantan. The finding of the research can be used to plan a strategic effort to control the population of cockroaches in Malaysia thus increasing the awareness about the potential of cockroaches as vectors for harmful parasites.

MATERIALS AND METHODS

Cockroaches sampling: A total of 176 cockroaches (adults and nymphs) were caught from two food stalls FS1 (3°49'20.874"N 103°18'15.772"E), FS2 (3°49'22.339"N 103°18'16.236"E) and two restaurants R1 (3°49'25.499"N 103°17'59.627"E), R2 (3°49'25.499"N 103°18'44.600"E) in Indera Mahkota, Kuantan. From the food stalls, 49 cockroaches caught at FS1 and 49 cockroaches caught at FS2. Meanwhile, the numbers of cockroaches caught at the restaurant were 38 cockroaches from R1 and another 40 cockroaches from R2. The sampling areas in the present study were chosen based on the hygienic level of the surrounding area. The cockroaches were caught by using plastic trap and also sticky traps. The traps were baited

and set for 8-12 h every day for 4 months starting from November, 2017 until February, 2018. Traps were set from the evening at 6 pm until the morning at 8 am at various locations at the chosen premises. The locations for setting the traps were in the dark and humid place inside the premises especially at the kitchen and under the sink. The cockroaches were separated according to the site of collection where the cockroaches were caught to prevent any cross-contamination that might tamper with the result.

Species identification of cockroaches: The cockroach caught was identified for its species by its physical and distinctive characteristics. The identification was done by observing the appearance based on the literature references. The most common cockroach in Malaysia is from the species *Periplaneta americana*⁵. Adult *Periplaneta americana* has reddish brown body with yellowish brown band at the edge of the pronotum. The size of the adult *Periplaneta americana* is about 3-4 cm and the wings are longer than its body. Meanwhile, the nymph of the *Periplaneta americana* has reddish brown coloured body but without wings¹⁴. Another species of cockroach that is commonly found in Malaysia is known as German cockroach or *Blatella germanica*⁵. The size of German cockroach is between 1.1-1.6 cm that makes it is much smaller than American cockroach. The color of the body is light to dark brown and has two dark, roughly parallel streaks on the pronotum until to the base of the wings^{1,15}. In this study, the cockroaches caught were from the *Periplaneta americana* species. There was no *Blatella germanica* identified from the sampling.

Sample processing: The samples were processed at the laboratory of Central Research and Animal Facility (CREAM), Kulliyyah of Science, International Islamic University of Malaysia (IIUM), Kuantan. The cockroaches were put into airtight container according to the site of collection. A cotton ball was soaked in chloroform and added into the airtight container to weaken and kill the cockroaches. After the cockroaches were killed, all of them were processed immediately to observe for any pathogens carried on the body surface areas. The method of sample processing for obtaining the pathogens from the external body of the cockroach was slightly modified^{8,9}. Each cockroach was put into a tube filled with 5 mL of normal saline solution and was shaken vigorously for 2 min. The tube was centrifuged under 2000 rpm for 5 min. The sediments deposited by centrifugation were collected by using pipette and transferred to glass slides for microscopic examination. This study focuses on the cockroach as the mechanical vector for parasites instead of biological vector.

Hence, the isolation of parasites from cockroaches was only done from the external surface of the cockroaches.

Staining techniques and microscopic examination: Two types of staining techniques were used for microscopic examination, namely by using 1% Lugol's iodine and acid-fast staining. Lugol's iodine was used to enhance the image of the helminths ova¹⁶. The sediments obtained from the sedimentation by centrifugation were collected using sterile Pasteur pipettes. A drop of the sediment was put on the microscope slide. Then a drop of Lugol's iodine was added on the slide. The sediments and Lugol's iodine were mixed thoroughly using another sterile Pasteur pipette before it was covered with cover slip. The slide was examined under light microscope under a total magnification of 100x and 400x. Acid fast staining or modified Ziehl-Neelsen staining was used in this experiment to observe coccidian parasites¹⁷. A drop of sediments was put on the slide for air-dried. Carbol fuchsin solution was flooded onto the slide and heated slightly. Carbol fuchsin was let to stain the slide for 5 min before it was rinsed with distilled water. The slide was decolorized by immersing it in 3% acid alcohol for 30 sec. Then the slide was rinsed using distilled water. Later the slide was counter stained by immerse it in malachite green for about 1 min. The slide was later rinsed with distilled water and let to dry. The slide was examined using a light microscope.

RESULTS

Prevalence of parasitic carrier cockroaches caught from two restaurants and two food stalls in Indera Mahkota, Kuantan: Table 1 showed a total number of cockroaches and number of cockroaches harboring the parasites on the body surface. The highest number of cockroaches harboring parasites on the body surface was from the cockroaches caught at FS1. The percentage of cockroaches harboring parasites is the highest at FS1 (83.67%) followed by FS2 (73.47%), R2 (40.00) and finally R1 (23.68%).

Table 1: Tabulation of total number of cockroaches and number of cockroaches that act as mechanical vectors for parasites caught from 2 restaurants (R1,R2) and 2 food stalls (FS1, FS2) in Indera Mahkota, Kuantan

Site of collection	Total number of captured cockroaches		Total number of identified parasitic carrier cockroaches	
	No.	No.	No.	%
R1	38	9	9	23.68
R2	40	16	16	40.00
FS1	49	41	41	83.67
FS2	49	36	36	73.47

R1: Restaurant 1, R2: Restaurant 2, FS1: Food stall 1, FS2: Food stall 2

Table 2: Types of parasites found on the body surface of cockroaches caught from two restaurants and two food stalls in Indera Mahkota, Kuantan

Site of sampling	Parasites on the body surface of cockroaches
R1	Mites <i>Strongyloides</i> spp. eggs
R2	Mites
FS1	Mites <i>Strongyloides</i> spp. eggs <i>Strongyloides</i> spp. larvae
FS2	Mites <i>Ascaris</i> spp. eggs

R1: Restaurant 1, R2: Restaurant 2, FS1: Food stall 1, FS2: Food stall 2

Prevalence of parasites found on the body surface of cockroaches: The data in Table 2 showed the type of parasites carried by the cockroaches caught at the site of sampling in Indera Mahkota, Kuantan. Each sampling site showed positive for mites. Various helminth eggs were identified from the body surface of cockroaches caught at R1, FS1 and FS2. *Strongyloides* spp. eggs were found on the cockroach samples from R1 and FS1. Meanwhile nematode larvae of *Strongyloides* spp. were found in cockroach samples collected at FS1. Meanwhile, *Ascaris* spp. eggs were found in the cockroach samples collected at FS2. Only cockroach samples from R2 carried mites and negative for helminths egg and larvae. There was no protozoan cyst found in all cockroach samples collected in Indera Mahkota, Kuantan.

DISCUSSION

In this study, the samples of cockroaches collected from several food premises in Indera Mahkota, Kuantan were positive for intestinal parasites including helminths (*Strongyloides stercoralis*, *Ascaris lumbricoides* and hookworm) and ectoparasite (mites). Meanwhile, the external body of cockroaches were negative with the protozoan parasites. This study strongly speculated that the occurrence of *Strongyloides stercoralis*, *Ascaris lumbricoides* and hookworm also might had been due to the thick egg wall surface thus conferring resistance and long survival on the surface body of cockroaches. Meanwhile, the negative occurrence of protozoa parasites could have been due to the wall thickness of protozoa cysts that might not be resistance enough to survive towards the environment in this study area. This also corroborated previous research regarding helminths to be the higher prevalent intestinal parasites compared to protozoa parasites survival in cockroaches because of the ova wall thickness of helminths¹⁸.

Besides, there was no enteric protozoan cyst found might be due to the different sanitation level in the surrounding study area. This finding corresponds to the study done in the

Niger Delta region of Nigeria, where the number of helminths isolated from cockroach was higher if it was caught from unhygienic place and contact with the soil contaminated with faeces¹⁹. The lower the hygiene level suggested that there was more possibility for cockroaches to come in contact with contaminated objects.

The findings also indicated that poor garbage disposal practice by the restaurants and stalls premises observed in this area may have contributed to helminths contamination of these external bodies of cockroaches. The findings are in agreement with a previous study done by Morenikeji *et al.*²⁰ in Oyo state, Nigeria. The study revealed that of total 23 cockroaches were carried helminths known as *Strongyloides stercoralis*, fluke and *Enterobius vermicularis* externally. None of the external cockroach bodies were positive for protozoa. The authors stated that higher helminths prevalence could be due to improper of waste disposal practice in their study area. Hence, these were possible ways in which cockroaches could contact the helminths intestinal parasites.

However, this study in contrast with several previous studies that able to identify both helminths and protozoa on the external cockroaches²¹⁻²³. For instance, a study done by the findings by El-Sherbini and El-Sherbini found *Entamoeba histolytica*, *Balantidium coli*, *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Enterobius vermicularis*, *Trichuris trichuria* and *Strongyloides stercoralis* from the external cockroaches in premises²². Despite this study was unable to revealed any protozoa parasites, the study corroborates with the authors conclusion that cockroaches can lead to the transmission of parasitic diseases.

Of note is the presence of mites on the external surface of cockroaches in the restaurants and stalls in this study. Cockroaches were caught from the food stalls carries more mites than cockroaches that were caught from the restaurants. This could be due to the surrounding environments of the food stalls were humid and dirty which serve 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 mites^{14,24}. 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.

Overall, the limitation of this study is the identification was solely based on staining and direct microscopy to identify the parasites on the external cockroaches. By incorporating

molecular analysis, the identification of the parasites is more precise and reliable. Hence, future study on genotypic characterisation of parasitic contamination on the external cockroaches is recommended.

CONCLUSION

The cockroaches act as mechanical vectors for various enteric parasites and ectoparasites especially mites. The enteric parasites such as helminths larvae and helminths eggs can be identified using microscopy technique. Therefore, the findings from this study hoped can spread awareness to the food premises' owners to combat the infestation of cockroaches by increasing the sanitation level of the surrounding area.

SIGNIFICANCE STATEMENT

This study displays the capability of cockroaches function as mechanical vectors for entero-and ectoparasites. From this study, it is important to take note on solving the problem of sanitation level especially at food premises in order to avoid of any foodborne diseases related to parasitic infection and infestation caused by the cockroaches.

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