



## **Parasites in Cockroaches Recovered from Residential Houses around Awotan Dumpsite in Ido Local Government Area of Oyo State, Nigeria**

**O. A. Morenikeji<sup>1\*</sup>, A. Adebisi<sup>1</sup> and O. A. Oluwayiose<sup>1</sup>**

<sup>1</sup>*Department of Zoology, University of Ibadan, Nigeria.*

### **Authors' contributions**

*This work was carried out with the collaboration of all authors. Author OAM designed the study, wrote the protocol and supervised it. Author AA carried out the field study and gathered the initial data. Author OAO did the preliminary data analysis and the interpretation. Authors OAM and OAO managed the literature searches and produced the initial draft. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Residences clustering around dumpsites have increased tremendously due to recent population expansion, consequent insufficient land, high level of ignorance and poor economic status in Nigeria. One of the reasons open dumpsites pose health problems is because of their attraction of cockroaches which are known vectors of appreciable numbers of pathogen. This study was therefore carried out to determine the prevalence of parasites in cockroaches recovered from residential houses around Awotan dumpsite in Ido Local Government Area of Oyo state. Cockroaches were trapped using the sticky trap method and were washed using 2 mL normal saline solution. This solution was centrifuged at 2000 rpm for 5 mins and the sediment was stained with Lugol's iodine and viewed under the microscope. Out of the seventy cockroaches (*Periplaneta americana*) that got trapped and examined within the study period, a total of 61(87.1%) were infected with helminth and/or protozoan parasites. Parasites recovered and identified included *Strongyloides stercoralis* (80.6%), *Nyctotherus ovalis* (7.9%),

\*Corresponding author: E-mail: [jumokemorenikeji@yahoo.co.uk](mailto:jumokemorenikeji@yahoo.co.uk);

*Hammersmiditiella diesingi* (2.9%), *Toxascaris leonina* (1.4%), *Enterobius vermicularis* (0.7%) and a fluke (4.3%). More parasites (83.5%) were recovered from the gut than the external body part (16.5%) of the infected cockroaches.

Residents around the dumpsites are prone to parasitic infestation through mechanical transmission of parasites by cockroaches. There is therefore the need for government to ensure a relocation of the dumpsite to a distant place and also enlighten people on the immense dangers involved in residing close to dumpsites.

**Keywords:** Cockroaches; dumpsites; helminthes; protozoans; Oyo State.

## 1. INTRODUCTION

The increase in urban solid waste produced by society is becoming a huge problem all over the world, leading to high levels of pollution and dissipation of natural resources [1]. The generation of urban solid wastes in Nigeria is on the increase owing largely to accelerated rural-urban migration, industrialization, poverty, decreasing standard of living, poor governance, population growth and low level of environmental awareness [2,3]. The sources of solid waste are commercial, industrial, household, agricultural and educational establishments [4]. The consequences resulting from improperly managed wastes include its serving as reservoir of pathogens, habitat for pests such as rats, flies, mosquitoes and cockroaches, reduction of usable land area of the society, obstruction of motorable roads and general nuisance and societal problems in residential areas [5].

Cockroaches feed indiscriminately on garbage and sewage and so have copious opportunity to disseminate human pathogens [6,7]. Also their nocturnal and filthy habits make them ideal carriers of various pathogenic microorganisms [8]. Cockroaches are the most abundant and obnoxious non-biting insect pests in residential buildings, hospitals, hostels, hotels, restaurants [9] and waste dumpsites. They are among the notorious pests of premises, which not only contaminate food by leaving droppings and bacteria that can cause food poisoning but also transmit bacteria, fungi and other pathogenic microorganisms in infected areas [10,11]. Parasites are living organisms that are capable of causing harm to another organism referred to as the host which can be minute (microparasite), for example protozoans viruses and bacteria; or can be large enough to be seen with the naked eye (macroparasite) such as helminths [12,13].

The prevalence and morbidity of human helminth infections in Nigeria, especially, in rural areas are continuously high [14]. Some habits and communal associations of humans are believed

to encourage the spread and sustenance of helminth infections. Helminth infections are acquired either by ingestion of the eggs (*Ascaris lumbricoides*, *Enterobius vermicularis* and *Trichuris trichura*) or by larval penetration of skin (*Strongyloides stercoralis* and *Ancylostoma spp.*), and transmission is closely related to environmental hygiene [15-17].

Open dumpsites pose health problems because of their attraction of cockroaches [18], which are in turn known to be carriers of medically important parasites [19,20] as they harbour appreciable quantity of pathogens from animal and human faecal materials in the garbage. These pathogens including bacteria, viruses, protozoa and intestinal worm stages cause diseases such as infantile diarrhoea, hepatitis, skin diseases, typhoid and various forms of helminthiasis [21,22].

Due to recent population expansion and consequent insufficient land; high level of ignorance and poor economic status in this part of the world, residences clustering around dumpsites have increased tremendously. They drill boreholes and wells and utilise surface waters for different purposes with little or no concern about the potential negative influence of the closely located dumpsite on their health. Hence, this study was carried out to investigate the prevalence of parasites in cockroaches found in residential houses around Awotan dumpsite in Ido Local Government Area of Oyo state, Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Study Site

The study was carried out in Awotan community (Fig. 1) on latitude 7°:27', longitude 3°:50', 247 m above sea level; a sub-urban community situated in Ido Local Government Area (LGA), Oyo state. Awotan is a community where sanitary conditions are below standard, residential areas are underdeveloped with no pipe-borne water supply

with residents relying on wells and commercial bore holes for their water needs. Some households lack good water cistern toilet, relying on pit latrines or dumping their faecal matter in the nearby dumpsite. This study area was selected due to the presence of this refuse dumpsite in the community which attracted flies and cockroaches.

## 2.2 Sample Collection

A purposive sampling of seventy (70) adult cockroaches (*Periplaneta americana*) that got held up by sticky traps within the study period of four weeks in houses around Awotan dump site was carried out. They were examined for external and gastro-intestinal parasites. Selected houses around Awotan dumpsite were stratified into eight (8) cardinal points (North, East, West, South, North East, South East, North West, and South West). Adult cockroaches were collected from three (3) randomly selected houses from each cardinal point but there were no houses found at the NE, NW and SW areas of the dumpsite.

Sticky traps used in trapping the cockroaches were constructed by using cardboard paper and adhesive. The cardboard papers were cut in

small squares and the adhesive was evenly spread on them. The prepared trap was then pinned to flat wooden surfaces found in kitchens, toilets, bathrooms, bedrooms and living rooms. The traps were set at 7:00 pm and inspected at 7:00 am daily for four weeks [23]. Cockroaches were collected in universal containers and then transported to the Laboratory for further examination. The cockroaches were put to sleep by using chloroform soaked cotton wool and examined under the dissecting microscope for identification using standard taxonomical keys by [24].

## 2.3 Isolation of Parasites from the External Body Part and Gut of Cockroaches

Each cockroach was put into a universal bottle and then 2 mL of normal saline was added and shaken for 2 min to detach the parasites on the surface of the cockroach. 1 mL of the washing fluid was then transferred to a centrifuge tube and centrifuged at 2000 rpm for 5 min. The supernatant was discarded and the deposits stained with 1% Lugol's iodine and examined using light microscope x40 objective lens as described by [8]. Parasites were identified using taxonomical keys by [25] and [26].

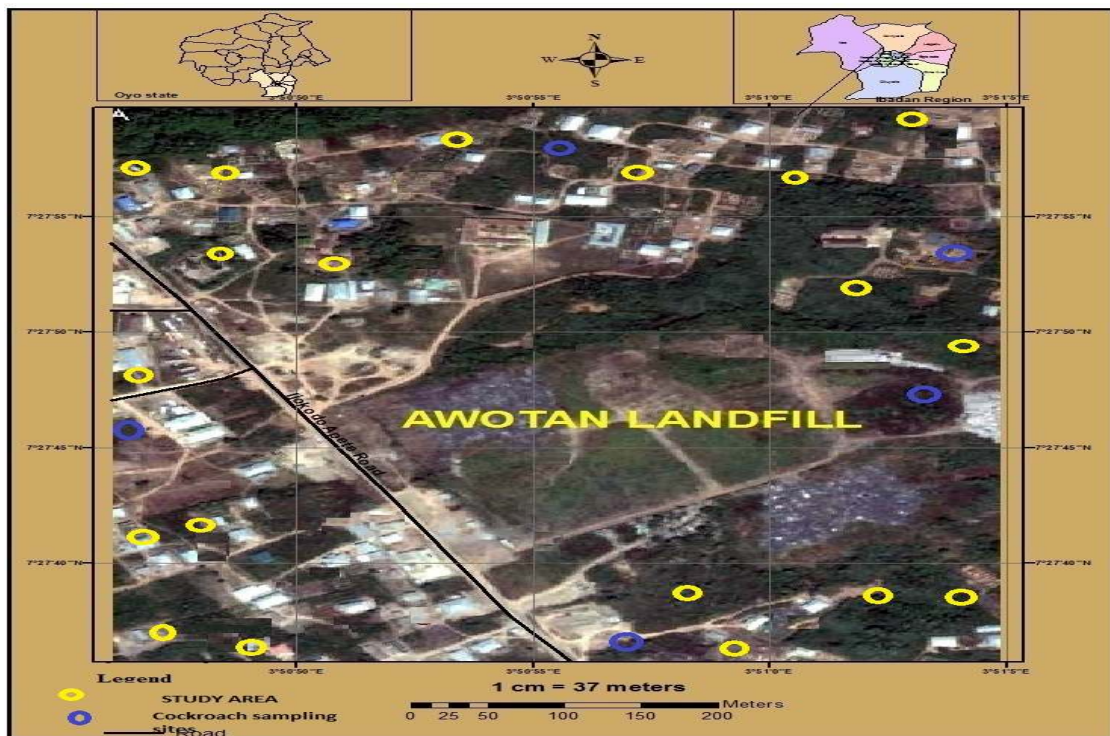


Fig. 1. Map of Awotan showing study areas and cockroach sampling sites

After the external examination, cockroaches were washed in sterile saline to remove the alcohol and allowed to dry at room temperature. Each cockroach was fixed on a dissecting Petri-dish; the head severed first, followed by the legs, then the abdomen was opened using fine pointed forceps the gut and other abdominal organs were removed using fine needles and the intestine examined over a black background for detection of possible macroscopic parasites. This was followed by the addition of 2 mL normal saline and the maceration of the intestine. 1 mL of the macerate was centrifuged at 2000 rpm for 5 min and the deposits stained with 1% Lugol's iodine before examination. Ova and cysts of parasites present were also identified using taxonomical keys by [25] and [26] counted using x40 objective lens of the light microscope.

### 2.4 Statistical Analysis

Data obtained were analysed with Statistical Package for Social Sciences (SPSS) version 20 and Chi square test statistics was used to

establish the relationship between qualitative variables obtained.

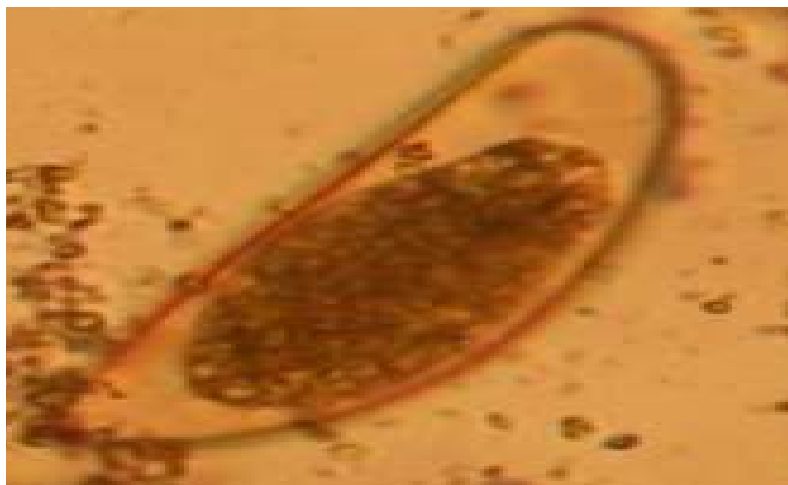
### 3. RESULTS

Seventy (70) adult *Periplaneta americana* from North, South, East, West, and Southeast directions of the dumpsite were examined. A total of 61(87.1%) cockroaches were infected. The highest [30(49.2%)] and the lowest [4(6.5%)] prevalence was recorded in the houses found around the Southern and Western directions of the dumpsite respectively (Table 1).

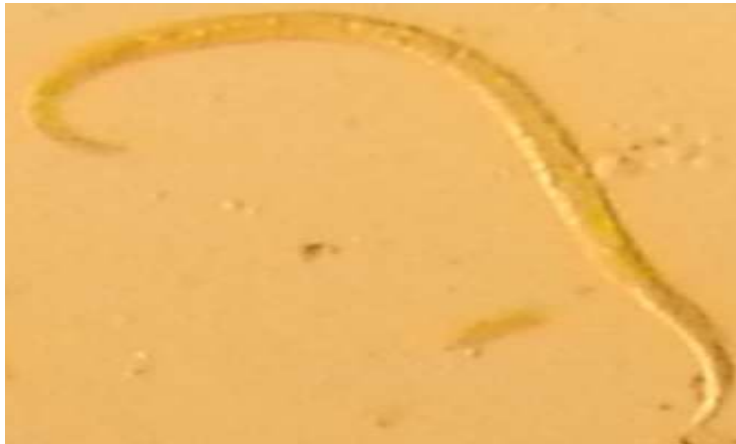
The overall (external and gut) prevalence of the identified species was: *Strongyloides stercoralis* (80.6%), *Nyctotherus ovalis* (7.9%), *Hammerschmidtella diesingi* (2.9%), *Toxascaris leonina* (1.4%), *Enterobius vermicularis* egg (0.7%). Mixed infections of *Strongyloides stercoralis* and fluke [1(0.7%)]; *Nyctotherus ovalis* and fluke [1(0.7%)] and *Strongyloides stercoralis* and *Enterobius vermicularis* [1(0.7%)] were found only in the guts of infected cockroaches while external body parts were not observed to carry mixed infections (Table 2) (Plates 1-4).

**Table 1. Percentage infection of cockroaches in study sites around Awotan dumpsite**

Location	Number of cockroaches examined	Number of cockroaches infected	Percentage infection (%)
North	12	10 (16.4%)	83.3
South	33	30 (49.2%)	90.9
East	13	11 (18.0%)	84.6
West	6	4 (6.5%)	66.7
Southeast	6	6 (9.8%)	100
Total	70	61 (87.1%)	85.9



**Plate 1. Egg of *Hammerschmidtella diesingi***



**Plate 2. *Strongyloides stercoralis* larva**



**Plate 3. Egg of *Enterobius vermicularis***

The gut had higher [116(83.5%)] prevalence of parasites than the external body part [23(16.5%)] ( $p < 0.05$ ).

Table 3 shows the association between the types of parasite recovered from infected cockroaches and the source of the cockroaches around the dumpsite. *Strongyloides stercoralis*, *Toxascaris leonina*, *Nyctotherus ovalis*, *Enterobius vermicularis*, *Hammerschmidtella diesingi* and flukes had their highest prevalences in Southeast [34 (30.4%)], East [2 (100%)], South [11 (100%)], Southeast [1 (100%)] and West [4 (100%)] respectively. There was a significant relationship between the types of parasites recovered and the

sources of the cockroaches ( $\chi^2_{(32)} = 105.033$   $p < 0.05$ ).

Table 4 shows the association between the type of parasites and their classifications. Of the total 139 parasites recovered, there were more helminths [125 (89.9%)] than the protozoans [13 (9.4%)] and only 1 (0.7%) co-infection of the two groups was found. Within the helminth group, *Strongyloides stercoralis* had the highest prevalence [112(80.6%)] followed by fluke [6 (4.3%)] and the lowest [1 (0.7%)] was *Enterobius vermicularis* while among the protozoan group, prevalence of *Nyctotherus ovalis* found [11 (7.9%)] was higher than *Toxascaris leonina* [2 (1.4%)]. This association was significant ( $\chi^2_{(16)} = 278$ ,  $p < 0.05$ ).

**Table 2. Prevalence of parasites recovered from body parts (external and gut) of cockroaches**

			Types of parasite									Total	
			I	II	III	IV	V	VI	VII	VIII	IX		
Body parts	External	Count	20	2	0	0	1	0	0	0	0	23	
		% within Body parts	87.0	8.7	.0	.0	4.3	.0	.0	.0	.0	.0	100.0
		% of Total	14.4	1.4	.0	.0	.7	.0	.0	.0	.0	.0	16.5
	Guts	Count	92	4	11	2	0	4	1	1	1	116	
		% within Body parts	79.3	3.4	9.5	1.7	.0	3.4	.9	.9	.9	100.0	
		% of Total	66.2	2.9	7.9	1.4	.0	2.9	.7	.7	.7	.7	83.5
Total		Count	112	6	11	2	1	4	1	1	1	139	
		% within Body parts	80.6	4.3	7.9	1.4	.7	2.9	.7	.7	.7	100.0	
		% of Total	80.6	4.3	7.9	1.4	.7	2.9	.7	.7	.7	100.0	

I: *Strongyloides stercoralis*, II: *Fluke*, III: *Nyctotherus ovalis*, IV: *Toxascaris leonina*, V: *Enterobius vermicularis*, VI: *Hammerschmidtella diesingi*, VII: *Strongyloides stercoralis* and *fluke*, VIII: *Nyctotherus ovalis* and *fluke*, IX: *Strongyloides stercoralis* and *Enterobius vermicularis*

**Table 3. Association between the types of parasite recovered and the source of the cockroaches**

			Types of parasite (TOP)									Total
			I	II	III	IV	V	VI	VII	VIII	IX	
Location	North	Count	9	4	0	0	0	0	1	0	0	14
		% within location	64.3	28.6	.0	.0	.0	.0	7.1	.0	.0	100.0
		% within TOP	8.0	66.7	.0	.0	.0	.0	100.0	.0	.0	10.1
		% of total	6.5	2.9	.0	.0	.0	.0	.7	.0	.0	10.1
	South	Count	20	2	11	0	0	0	0	1	0	34
		% within location	58.8	5.9	32.4	.0	.0	.0	.0	2.9	.0	100.0
		% within TOP	17.9	33.3	100.0	.0	.0	.0	.0	100.0	.0	24.5
		% of total	14.4	1.4	7.9	.0	.0	.0	.0	.7	.0	24.5
	East	Count	29	0	0	2	0	0	0	0	0	31
		% within location	93.5	.0	.0	6.5	.0	.0	.0	.0	.0	100.0
		% within TOP	25.9	.0	.0	100.0	.0	.0	.0	.0	.0	22.3
		% of total	20.9	.0	.0	1.4	.0	.0	.0	.0	.0	22.3
	West	Count	20	0	0	0	0	4	0	0	0	24
		% within location	83.3	.0	.0	.0	.0	16.7	.0	.0	.0	100.0
		% within TOP	17.9	.0	.0	.0	.0	100.0	.0	.0	.0	17.3
		% of total	14.4	.0	.0	.0	.0	2.9	.0	.0	.0	17.3
	Southeast	Count	34	0	0	0	1	0	0	0	1	36

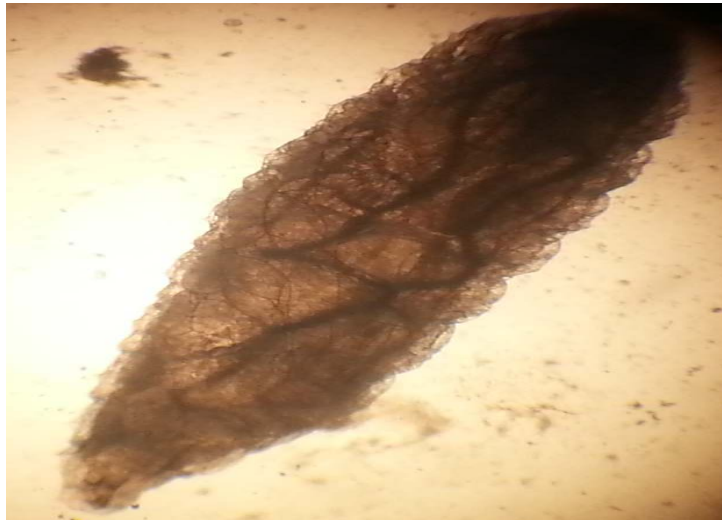
		Types of parasite (TOP)									Total
		I	II	III	IV	V	VI	VII	VIII	IX	
	% within location	94.4	.0	.0	.0	2.8	.0	.0	.0	2.8	100.0
	% within TOP	30.4	.0	.0	.0	100.0	.0	.0	.0	100.0	25.9
	% of Total	24.5	.0	.0	.0	.7	.0	.0	.0	.7	25.9
Total	Count	112	6	11	2	1	4	1	1	1	139
	% within location	80.6	4.3	7.9	1.4	.7	2.9	.7	.7	.7	100.0
	% within TOP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	% of total	80.6	4.3	7.9	1.4	.7	2.9	.7	.7	.7	100.0

$\chi^2 (32) = 105.033, p < 0.05$ . I: *Strongyloides stercoralis*, II: Fluke, III: *Nyctotherus ovalis*, IV: *Toxascaris leonina*, V: *Enterobius vermicularis*, VI: *Hammerschmidtella diesingi*, VII: *Strongyloides stercoralis* and fluke, VIII: *Nyctotherus ovalis* and fluke, IX: *Strongyloides stercoralis* and *Enterobius vermicularis*

**Table 4. Association between the type and classification of parasites (COP - helminths and protozoans) in cockroaches around Awotan dumpsite**

			Types of parasite									Total
			I	II	III	IV	V	VI	VII	VIII	IX	
COP	Helminths	Count	112	6	0	0	1	4	1	0	1	125
		% within COP	89.6	4.8	.0	.0	.8	3.2	.8	.0	.8	100.0
		% of Total	80.6	4.3	.0	.0	.7	2.9	.7	.0	.7	89.9
	Protozoans	Count	0	0	11	2	0	0	0	0	0	13
		% within COP	.0	.0	84.6	15.4	.0	.0	.0	.0	.0	100.0
		% of Total	.0	.0	7.9	1.4	.0	.0	.0	.0	.0	9.4
	Co-infection	Count	0	0	0	0	0	0	0	1	0	1
		% within COP	.0	.0	.0	.0	.0	.0	.0	100.0	.0	100.0
		% of Total	.0	.0	.0	.0	.0	.0	.0	.7	.0	.7
Total	Count	112	6	11	2	1	4	1	1	1	139	
	% within COP	80.6	4.3	7.9	1.4	.7	2.9	.7	.7	.7	100.0	
	% of Total	80.6	4.3	7.9	1.4	.7	2.9	.7	.7	.7	100.0	

$\chi^2 (16) = 278.00, p < 0.05$ . I: *Strongyloides stercoralis*, II: Fluke, III: *Nyctotherus ovalis*, IV: *Toxascaris leonina*, V: *Enterobius vermicularis*, VI: *Hammerschmidtella diesingi*, VII: *Strongyloides stercoralis* and fluke, VIII: *Nyctotherus ovalis* and fluke, IX: *Strongyloides stercoralis* and *Enterobius vermicularis*



**Plate 4. Fluke**

#### **4. DISCUSSION**

The high rate (87.1%) of infected cockroaches observed in this study might be due to the influence of the Awotan dumpsite as most of the cockroaches recovered in households around the area might have the dumpsite as their origin. The result agrees with the findings of [27] who also recorded parasitic infection rate of cockroaches found around a dumpsite to be above average (55.5%).

The significant difference ( $p < 0.05$ ) in the prevalence of parasites in the gut and external body parts of cockroaches observed in this study shows that the body part of cockroaches play a role in transmission of parasitic infection with the gut having higher prevalence of parasite than the external body surface. This does not agree with the findings of [28] where the difference in the prevalence of parasites in the gut and the external body part of cockroaches was insignificant.

The highest (25.9%) parasite prevalence recorded from the Southeast direction of the dumpsite might be due to the fact that the area is located at the lower side of the elevated dumpsite area with a highest vulnerability to leachates, moisture and wind-blown waste materials from the dumpsite. However, the lowest (10.1%) parasite prevalence recorded in the West direction of the dumpsite could be attributed to its location uphill and an observed farther distance away from the dumpsite.

Higher helminth prevalence (89.9%) than protozoans (9.4%) observed in this study could be due to poor rural condition of the community and the habit of defecating in bushes around the home as a result of inadequate toilet facilities and improper disposal of waste. This is supported by the work of [14].

#### **5. CONCLUSION AND RECOMMENDATIONS**

This study reveals that cockroaches collected from around the dumpsite carry potentially harmful parasites which may contribute to high cases of parasitism among residents in the Awotan community.

Hence, adequate awareness should be created in sensitizing inhabitants of Awotan community on the dangers of residing around dumpsites and the vectoral ability of cockroaches in disease transmission of pathogenic organisms. There is a need for the Government to relocate the dumpsite to an area far away from residential buildings and put laws in place debarring people from building houses in areas earmarked for dumpsites. There is a need for proper waste management within the study area.

#### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.



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