

Cockroaches as Vectors of Parasites of Medical Importance; Reports from Six states in Nigeria

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Abstract

Background: Cockroaches are not associated with diseases as noted with mosquitoes and fleas (by direct transmission); however, they harbour pathogens (typically those causing gastroenteritis) which are indiscriminately deposited on foods and equipment as the cockroaches comes in contact with them.

Methods: This report reveals an association of cockroaches with 13 bacteria species, 7 fungal species and 18 soil transmitted helminths all of which are medically important and have been implicated in many gastrointestinal disorders. *Entamoeba* species, *Balantidium coli*, hookworm and *Ascaris lumbricoides* have been reported to cause chronic diarrhea, liver complications and stunted growth in the affected people. Pathogen were independently isolated from the alimentary canal and body surface of cockroaches collected from toilets, residential houses, hostels, kitchens, living rooms, wardrobes and health facilities at six different states in Nigeria.

Results: This affirms that cockroaches constitute a serious public health threat in Nigeria. This study emphasizes the need to raise awareness on safeguarding food sources from being contaminated by cockroaches, as it may lead to the mechanical transmission of parasite-related morbidities.

Conclusion: Proper personal hygiene and environmental sanitation is strongly recommended since cockroaches only thrive in filthy environments. Periodic fumigation of hospitals and hostels is also imperative to reduce risks of nosocomial infections.

Key words: Cockroaches, Parasites, *E. coli*, *Ascaris lumbricoides*, parasites

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Introduction

Cockroaches are the most abundant and obnoxious non-biting insect pests in residential buildings, hospitals, hostels, hotels, and restaurants. They feed indiscriminately on human food and sewage (1). The significance of certain arthropods as vectors of diseases and the need to find solutions to their continued spread of disease between man, animals and the environment cannot be over emphasised.

Cockroaches are not associated with diseases as noted with mosquitoes and fleas (by direct transmission) (2), however they harbour several pathogens which are infective to man. These parasites are indiscriminately deposited on our foods and equipment as the cockroaches come in contact with them (2-6). Also human contact with food and house dust contaminated with the faeces of cockroaches causes allergic reaction especially those with asthma (6).

Most parasitic infections isolated from cockroaches are also spread directly from person to person without the aid of intermediary insects; therefore, it is usually difficult to prove that cockroaches are responsible for any disease outbreak. Nevertheless, because of their unsanitary habits they have been suspected as aiding in the transmission of various pathogens. More than 40 pathogenic and nonpathogenic bacterial species have been isolated from cockroaches, including *E. histolytica*, *Escherichia coli*, *Klebsiella pneumoniae*, *Mycobacterium leprae*, *Shigella dysenteriae*, and *Salmonella* species, including *S. typhi* and *S. typhimurium*, *Serratia* species, and *Staphylococcus aureus*. Eggs of the nematode *Enterobius vermicularis*, which is an extremely common worm in humans, can also be carried by cockroaches. There is little doubt that cockroaches contribute to the spread of several infections, mainly intestinal ones.

There is an unprecedented increase in cockroach population in public places all over the world particularly in Nigeria where the risk to human health arising from cockroach infestations have been reported (7). Cockroaches are abundant in most homes and hostels in Nigeria, where they are actually called "landlords" in homes (8) due to inadequate hostel accommodation for students and the lack of adequate maintenance of existing facilities, a disproportionately high incidence of pest infestation occurs, arising from poor hygiene and improper storage and disposal of

waste (9-11). Open dumpsites pose health problems because of their attraction of cockroaches (12), which are in turn known to be carriers of medically important parasites (13,14), as they harbor appreciable quantity of pathogens from animal and human faecal materials in the garbage (15).

The distribution of bacteria, fungi, and parasites in cockroaches could differ from one location to the other based on both environmental and sanitary conditions which could be used to assess the likely infectious diseases that pose great risk. Hence, this review reports pathogenic organisms present in cockroaches sampled at six different states in Nigeria. This will give a general picture of the severity of the situation in Nigerian. It will also provide information that will boost efforts in the control of vector born parasites. Published reports from six states (Edo, Sokoto, Plateau, Oyo, Delta and Abia) in Nigeria were assembled and their results were extracted and studied.

From the six reports, a total of 1,626 cockroaches were screened across the states. It was noted that different pathogens (bacteria, fungi and intestinal parasites) were isolated from both the external body surface and alimentary canals of the cockroaches sampled. From Edo, a total of 246 cockroaches were examined, and it was demonstrated that more microbes and parasites were collected in the alimentary canal than the body surface of cockroaches. Ten (10) species of bacteria, 7 species of fungi and intestinal parasites were isolated (Table 1). 6 parasites were recovered from Sokoto, with *E. histolytica* (24.40%) having the highest prevalence (Table 2). From Plateau state, 12 different parasites and 7 bacterial species and were isolated from the cockroaches studied (Table 3). From Oyo state, out of the 70 cockroaches examined, a total of 61(87.1%) were infected with helminth and/or protozoan parasites. More parasites (83.5%) were recovered from the gut than the external body part (16.5%) of the infected cockroaches. (Table 4). The report from Delta state revealed that all the cockroaches irrespective of the species were carriers of human parasites. Seven (7) different parasites were isolated (table 5). The report from Abia showed that all the cockroaches' collected from toilets, residential/hostels and health facilities harbored parasites (Table 6).

Table 1. Comparative Analysis of Pathogenic Organisms in Cockroaches from Different Community Settings in Edo State, Nigeria. (N=246)

BACTERIA		FUNGUS		PARASITE (EGGS)	
Body surface	Alimentary canal	Body surface	Alimentary canal	Body surface	Alimentary canal
	<i>Bacillus sp.</i>				
	<i>E. coli.</i>				
<i>Bacillus sp.</i>	<i>P. mirabilis</i>		<i>A. niger.</i>		<i>A. lumbricoides.</i>
<i>Escherichia coli.</i>	<i>Psuedomonas aeruginosa.</i>		<i>Candida sp.</i>		<i>T. trichiura.</i>
<i>Proteus mirabilis.</i>	<i>Proteus vulgaris.</i>	<i>A. niger</i>	<i>Mucor sp.</i>	<i>A. lumbricoides.</i>	<i>E. vermicularis.</i>
<i>Staphylococcus aureus.</i>	<i>Staphylococcus aureus.</i>	<i>Mucor sp.</i>	<i>Rhizopus.</i>	<i>T. trichiura.</i>	<i>S. haematobium.</i>
<i>Citrobacter freundii.</i>	<i>Staphylococcus epidermis.</i>	<i>Saccharomyces cerevisiae</i>	<i>S. cerevisiae.</i>	<i>Coccidia.</i>	<i>Balantidium coli.</i>
	<i>Enterococcus faecalis.</i>		<i>Fusarium sp.</i>	<i>E. histolytica.</i>	<i>E. histolytica.</i>
	<i>Salmonella sp.</i>		<i>Penicillium sp.</i>		

(Clement *et al.*, 2014).**Table 2.** Vectorial Potential of Cockroaches in Transmitting Parasites of Medical Importance in Arkilla, Sokoto, Nigeria. (N=218).

Parasites recovered	Prevalence (%)
<i>A. lumbricoides</i>	24.4
<i>E. histolytica</i>	40.8
<i>E. vemicularis</i>	16.0
<i>S. haematobium</i>	3.0
<i>S. mansoni</i>	9.5
<i>T. trichuria</i>	2.4

(Sampling site: Bedroom, Kithcen, Parlour, Refuse Dump and Toilet)
(Bala and Sule, 2012).**Table 3.** Cockroach Biota from Student's Hostels at the University of Jos, North Central Nigeria. (N=151)

Pathogen recovered	Intestinal parts Frequency (%)	Outer parts Frequency (%)
	Parasites	
<i>E. histolytica</i> (cyst)	45 (29.8)	34 (22.5)
<i>E. coli</i> (cyst)	17(11.3)	17(11.3)
<i>E. nana</i> (cyst)	20 (13.2)	13 (8.6)
<i>Isospora belli</i> (oocyst)	10 (6.6)	2 (1.3)
<i>Giardia lamblia</i>	36 (23.8)	29 (19.2)
<i>Taenia spp</i> (egg)	4 (2.6)	6 (4.0)
<i>Hymenolepis nana</i> (egg)	5 (2.3)	10 (6.6)
<i>A. lumbricoides</i> (egg)	14 (9.3)	9 (6.0)
<i>T. trichiura</i> (egg)	4 (2.6)	0(0.0)
<i>E. vermicularis</i>	7 (4.6)	2 (1.3)
Hookworm ova	22 (14.6)	12(7.9)
<i>S. stercoralis</i> (larvae)	15 (9.9)	1(0.7)
	Bacterial species	
<i>Staphylococcus species</i>	12(11.4)	
<i>Streptococcus species</i>	11(10.5)	
<i>Escherichia coli</i>	36(34.3)	
<i>Salmonella species</i>	6(5.7)	
<i>Shigella species</i>	10(9.5)	
<i>Klebsiella species</i>	18(17.5)	
<i>Bacillus species</i>	8(7.4)	

(Mawak *et al.*, 2005).

Table 4. Parasites in Cockroaches Recovered from Residential Houses around Awotan Dumpsite in Ido Local Government Area of Oyo State, Nigeria. (N=70)

Parasites recovered	Body part		Total (%)
	External (%)	Within body (%)	
<i>S. stercoralis</i>	20(17.9)	92(80.1)	112(80.6)
Fluke	2(33.3)	4(66.7)	6(4.3)
<i>Nyctotherus ovalis</i>	0(0.0)	11(100.0)	11(7.9)
<i>Toxascaris leonine</i>	0(0.0)	2(100.0)	2(1.4)
<i>E. vermicularis</i>	1(100.0)	0(0.0)	1(0.7)
<i>Hammerschmidtiella diesingi</i>	0(0.0)	4(100.0)	4(2.9)
<i>S. stercoralis</i> and fluke,	0(0.0)	1(100.0)	1(0.7)
<i>N. ovalis</i> and fluke	0(0.0)	1(100.0)	1(0.7)
<i>S. stercoralis</i> and <i>E. vermicularis</i>	0(0.0)	1(100.0)	1(0.7)
Grand Total	23(16.5)	116(83.5)	139

(Morenikeji et al., 2016)

Table 5: Potentials of Cockroach Vectors in Transmitting Parasites of Medical Importance in Abraka, Delta State Nigeria (N=841)

Parasite	Location in selected apartments (%)				Total (%)
	Toilet	Kitchen	Living room	Wardrobe	
<i>A. lumbricoides</i>	103 (34.4)	58 (40.0)	8 (29.6)	7 (13.5)	176 (33.6)
<i>S. stercoralis</i>	75 (25.1)	33 (22.8)	0 (0.0)	9 (17.3)	117 (22.4)
<i>E. vermicularis</i>	0 (0.0)	0 (0.0)	13 (48.1)	19 (36.5)	32 (6.1)
<i>E. coli</i>	60 (20.1)	14 (9.7)	6 (22.2)	11(21.2)	91 (17.4)
Hookworm	10 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	10 (1.9)
<i>E. histolytica</i>	25 (8.4)	13 (9.0)	0 (0.0)	0 (0.0)	38 (7.3)
<i>Nyctothermus ovalis</i>	26 (12.0)	27 (18.2)	0 (0.0)	6 (11.5)	59 (11.3)
Total					523

(Ojianwuna, 2014)

Table 6. Isolation and Identification of Some Microbial Pathogens Associated with the External Body Surface of *Periplaneta americana* in Umuahia, Abia State. (N=100)

Microbial Pathogens isolated	LOCATION		
	Toilet area No. (%)	Residential/hostel No. (%)	Health facilities No. (%)
Fungi isolates (N=196)			
<i>Aspergillus spp</i>	30 (32.6)	21 (30.4)	14 (40.0)
<i>Mucor spp.</i>	17 (18.5)	14 (20.3)	4 (11.4)
<i>Pencilum spp.</i>	13 (14.1)	10 (14.5)	7(20.0)
<i>Rhizopus spp.</i>	8 (8.7)	5 (7.3)	0(0.0)
<i>Candida spp.</i>	24(26.1)	19(27.5)	10(28.6)
Total	92	69	35
Bacteria isolates (N=245)			
<i>Bacillus spp.</i>	15 (12.2)	10(13.2)	8 (17.4)
<i>Escherichia coli</i>	26 (21.1)	17 (22.4)	6(13.0)
<i>Klebsiella spp.</i>	22 (17.9)	12 (15.8)	8(17.4)
<i>P. aeruginosa</i>	9(7.3)	7(9.2)	4(8.7)
<i>Proteus vulgaris</i>	7(5.7)	5(6.6)	1(2.2)
<i>Proteus mirabilis</i>	5(4.1)	3(4.0)	1(2.2)
<i>Shigella spp.</i>	5(4.1)	3(4.0)	0(0.0)
<i>Staphylococcus aureus</i>	14(11.4)	9(11.8)	10(21.7)
<i>Streptococcus spp.</i>	6(4.9)	3(4.0)	2(4.4)
<i>Staphylococcus epidermidis</i>	8(6.5)	4(5.3)	4(8.7)
<i>Salmonella spp.</i>	6(4.9)	3(4.0)	2(4.4)
Total	123	76	46
Parasites (N=167)			
<i>Endolimax nana</i>	15(16.7)	10(16.4)	3(18.8)
<i>Giardia lamblia</i>	26(28.9)	18(29.5)	4(25.0)
<i>A. lumbricoides</i>	27(30.0)	20(32.8)	8(50.0)
<i>E. histolytica</i>	22(24.4)	13(21.3)	1(6.3)
Total	90	61	16
GRAND TOTAL	305	206	97

(Nwankwo et al., 2016)

DISCUSSION

The review reports the association of cockroaches with thirteen (13) bacterial species, seven (7) fungal species and eighteen (18) parasitic organisms from 1,626 cockroaches screened at different parts of Nigeria. This affirms the claim that cockroaches constitute a serious public health threat in Nigeria as all the parasites recovered from their body are of medical importance and have been implicated in many gastro-intestinal disorders. *Entamoeba species*, *B. coli*, Hookworm and *A. lumbricoides* have been reported to cause chronic diarrhea, liver complications and stunted growth in the affected people (16-21).

The higher percentage of the cockroaches harbouring gastro-intestinal parasites encountered in hospital vicinity is not a departure from the expected results as similar observations have also been reported elsewhere (22). Hospitals host patients suffering from different ailments and these cockroaches would have been contaminated during their nocturnal movements from one ward to another and to other areas including toilets (22). This emphasizes the significant role of cockroaches in the transmission of diseases. The remarkable aspect of these of various studies from different parts of Nigeria is however, the recovery of the major gastro-intestinal parasites (*Entamoeba species* and *A. lumbricoides*) in cockroaches from residential areas. This observation arguably signifies the high burden of gastro-intestinal diseases and poor sanitary conditions of residential areas in Nigeria despite monthly environmental sanitation in the city where these reports were generated. Apart from the report from Oyo state, all the studies implicated cockroaches as carriers of *A. lumbricoides* ova. It has been reported that heavy ascariasis infestation in humans may cause nutritional deficiency; other complications, sometimes fatal, include obstruction of the bowel by a bolus of worms (observed particularly in children) and obstruction of the bile or pancreatic duct (23).

The marginal disparity in the number of the parasites encountered on the body surface could possibly be explained in two ways; it could be that the insects only have body contact with the parasites without ingesting them or the parasites were unable to survive in the intestines of the insects. Both reasons are valid when considering the fact that some of the ova cysts of the parasites encountered are sensitive to changes in environmental factors (24).

Reports from this review corroborates with other studies from other parts of the world (25-28), where parasites that are of public health significance were found on the external surface of cockroaches assessed. The variations on the parasite infestation on the cockroaches may be attributed to the differences in the environments where the cockroaches roamed, as different settings and conditions like the presence of human excreta and wastes in the areas where they wandered account for the variation in the parasite carriage rate of the cockroaches (26).

The isolation of *Salmonella* spp., *S. aureus*, *Shigella*, and *E. coli* from cockroach species indicated that domestic pests could pose health problem to

humans. Based on the study of Tachbele *et al.*, *E. coli* O157 was isolated from *Blattella germanica* for the first time, which may indicate the potential role of cockroaches to spread rare and emerging pathogens into the community. Considering the abundance of cockroaches in Nigeria and the very low infective dose of *E. coli* O157, its presence in *B. germanica* might enable high rates of transmission through foods, which might result in outbreaks.

Salmonella has been isolated from different species of cockroaches found in hospitals, restaurants, residents, schools, animal shelters etc. throughout the world (29-35). In the study by Tachbele *et al.*, in Ethiopia 10 of the 12 *Salmonella* isolates were from the gut suggesting that cockroach intestine served as a major reservoir of *Salmonella* (36). Moreover, 11 of the isolates were from hospital cockroaches and were found to be resistant to 3 or more drugs, suggesting the possible role of cockroaches as reservoir and vectors of drug resistant *Salmonella* in health facilities that may contribute to nosocomial infections. Isolation of drug resistant salmonellae and other pathogens from hospital cockroaches has been reported by various workers elsewhere (31-35).

Although food handlers are claimed to play the major role in the transmission of *Shigella*, different authors have reported the presence of *Shigella* spp. in cockroaches found in hospitals, restaurants and residences indicating their importance in the dissemination of the bacterium (29, 37, 38). The isolation of *S. aureus* from the cockroaches collected from hospital facilities in Abia state agrees with other findings elsewhere (34, 36-40).

Conclusion

This study has reported cockroaches are carriers of parasites of medical importance from cities in Nigeria, also that cockroaches pose public health risks in the country. Since cockroaches only thrive in filthy environment, a wholesome hygienic condition of living will keep them away. Periodic fumigation of hospitals and hostels is also imperative so as to reduce the incidence and risks of nosocomial infections through mechanical insect disseminators such as cockroaches. This study emphasis the need to raise people's awareness that they need to safeguard themselves and their food sources from being contaminated by cockroaches, as it may play an important role in the mechanical transmission of parasite-related morbidities. The national environmental sanitation laws should be promoted in all states of the country to reduce the possible transmission of pathogens by cockroaches.

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