

Full Length Research Paper

Bacteria and parasites infestation of cockroaches in a developing community, South Eastern, Nigeria

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A study to ascertain the role of American cockroach (*Periplaneta americana*) as reservoir and disseminator of pathogenic organism was conducted between January and May, 2013. This was accomplished by isolating and identifying micro-organisms from the external body surfaces of cockroaches trapped from different houses with open toilets and those with broken sewage systems. A total of 352 cockroaches were caught from these sites and 331 (94.0%) were positive for bacteria and parasites. These parasites include *Ballantidium coli* trophozoites, *Entamoeba histolytica* (cysts), *Ascaris lumbricoides* (ova), *Trichuris trichura* (ova), *Enterobius vermicularis* (larvae), *Ancylostoma duodenale* (larvae) and *Strongyloides stercoralis* (larvae). There was no significant difference (χ^2 - test, $P>0.05$) in the parasitic and bacterial infection rate of cockroaches irrespective of the sampling site. The bacterial species identified were *Klebsiella pneumoniae*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *Salmonella species*, *Shigella sonnei*, *Vibrio cholerae*, and *Citrobacter freundii*. This findings confirmed that cockroaches are not only nuisance in our houses but reservoirs and disseminators of pathogenic microorganisms to humans in our homes.

Key words: Bacteria, parasites, reservoir, disseminators, developing community, South- Eastern Nigeria.

INTRODUCTION

Cockroaches are predominantly found in residential houses, restaurants, hospitals and market stores. Two species of cockroaches widely known and distributed are the American cockroaches (*Periplaneta americana*) and German cockroach (*Blattella germanica*) as shown in some studies (Ajero, et al., 2011, Etim, et al., 2012). The most abundantly distributed cockroach species is *Blattella germanica*, followed by *Periplaneta americana* (Al-Mayali and Al-yaqoobi, 2010; Tilahun et al., 2012). According to Nagham et al. (2011) and Kassiri and Kazemi (2012) cockroaches frequently feed on human faeces, cabbage and sewage which has provided copious opportunity for them to disseminate pathogenic agents.

Several authors have incriminated cockroaches as reservoir and transmitters of disease-causing micro-organism like *Enterobacter species*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and *Salmonella species* (Graczyk et al., 2005; Ukay et al., 2009;

Tatfeng et al., 2005; Tilahun et al., 2012). The presence of fungal genera such as *Candida*, *Rhizopus*, *Mucor*, *Alternaria* and *Aspergillus* species have been reported on the external body surfaces of cockroaches in hospitals and residential houses (Nagham et al., 2011). Similarly, parasites have been found on the external and internal surfaces of cockroaches (Al-Mayali and Al-yaqoobi, 2010; Chamavit, et al, 2011; El-sherbini and El-Sherbini, 2011).

Various infective rates such as 98%, 100%, 98%, 83.33% and 54% of cockroaches have been reported by Salehzadeh, et al. (2007) in Iran, Kassiri and Kazemi (2012) in Iran, El-Sherbini and El-Sherbini (2011) in Egypt, Al-Mayali and Al-Yaqoobi in Irag, (Chamavit et al., 2011) in Thailand respectively.

Cockroaches are the most embarrassing pests that must be dealt with by occupants of residential houses, hospitals and commercial establishments due to their repulsive and annoying characteristic as well as the persistent and objectionable odour left on contaminated articles (Thyseen et al, 2004). Many reports revealed that cockroaches are responsible for serious health problems, provoke allergic reactions and even vector human enteric parasites (Thyseen et al., 2004; Tatfeng et al., 2005; Getachew et al., 2007; Fakoorziba et al., 2007).

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The close contact of these roaches with people and the attendant public health consequences in this unsanitary community necessitated the microbiological and parasitological studies of this insect, to enhance initiation of control measures of disease caused by this insect.

Study Area

This study was conducted in Yakurr community of Cross River State, Nigeria. Yakurr community is located between latitude 5° 40' and 6° 10' North and longitude 8° 50' East. The Yakurr people live in neighbouring compact towns north-west of Calabar, with no toilet facilities. Majority use man-hole toilets while others defecate on road sides, open yards and refuse dumps. Most households process goat and pig intestines around premises for evening delicacies. These anthropogenic activities provide favourable conditions for the proliferation of cockroaches in the area, and thus the choice for this study.

Sample Collection

Study samples were collected from households with open toilet and broken sewage systems. A total of 352 cockroaches were caught using sterile hand gloves from different houses in the study area. One hundred and eighty (180) cockroaches were obtained from houses with open toilets and one hundred and seventy-two (172) from houses with broken sewage systems. One hundred and seventy-six (176) cockroaches (90 from houses with open toilets and 86 from houses with broken sewage systems) used for parasitological studies were stored in sterile perforated rubber vials overnight. Another set of 176 cockroaches under similar storage facility were used for bacteriological studies. These rubber vials were transported to the laboratory in Cross River University of Technology for parasitological and bacteriological assay and identification (Piper and Antonelli, 2012).

Parasitological Studies

For parasitological studies, the method described by El-Sherbini and El-Sherbini, (2011) and Nagham et al (2011) was used. Isolation of developing stages of parasites was carried out by using 1ml of the external washing result of cockroaches which was centrifuged at 3000rpm for 5 minutes. The deposit was then examined after staining with 1% lugols iodine under light microscope. The parasite were identified and counted using standard keys (WHO, 2004). The mean heterotrophic parasitic load was determined as the average of these parasites and expressed as parasites per millilitre (parasites/ml). Parasites recovered were expressed as percentage abundance of the isolates.

Bacteriological studies

Two sets of 5cc body surface washing of cockroaches representing those collected from houses with open toilets and broken sewage systems, were put into two separate 100ml capacity flasks. The 5cc specimens were soaked in 50ml of an enriched medium of normal saline (0.85% w/v) and peptone water for 1 hour. The flasks were agitated by shaking every 20 minutes to dislodge the pathogens into the growth medium. The heterotrophic bacterial quality was determined by the pour plate method on tryptone soy agar (TSA) and nutrient agar in triplicate (Kassiri and Kazemi, 2012 and Tilahun et al, 2012). To determine the heterotrophic count of bacteria, a ten-fold dilution according to Cheesbrough (2005) was prepared. Then 0.1ml of 10⁸- diluent was spread-plated on nutrient agar in triplicate. The plates were incubated for 18 hours. The colonies that developed were counted and expressed as colony forming units (cfu ml⁻¹) per millilitre. Colonies counted were expressed as percentage abundance of the isolates. Discrete colonies developed were picked and purified by repeated subculturing. Characterization and identification were determined based on their cultural, morphological, biochemical reactions and growth pattern on presumptive and confirmed growth media (Winstanley et al, 1993; Peller and Weinstein, 2001; Yeng et al, 2010).

RESULTS

A total of 352 cockroaches (180 from open toilets and 172 from broken sewage systems) were trapped from different houses in the study area. In this study 94.0% of cockroaches collected from both locations were found to be infected. Of the 180 cockroaches collected from both sites and used for parasitological studies, 94.4% harboured similar parasites of medical importance. These were *Balantidium coli* trophozoites 14.7% and 13.0%, *Entamoeba histolytica* (cyst) 32.5% and 23.0%, *Ascaris lumbricoides* (ova) 17.6% and 19.2%, *Trichuris trichura* (ova) 12.9% and 11.8%, *Enterobius vermicularis* larvae 5.9% and 7.5%, *Ancylostoma duodenale* (larvae) 9.4% and 10.3% and *Strongyloides stercoralis* (larvae), 15.9 and 14.9 respectively (Table 1). There was no significant difference (χ^2 -test, $P > 0.05$) in the infective rate of cockroaches, irrespective of their sampling sites. The most predominant parasite encountered in this study from both sites was *Entamoeba histolytica* (cysts) 23.53% and 23.0% respectively, and the least was *Enterobius vermicularis* (larvae) 5.88% and 7.5% respectively (Table 1).

The bacteriological profile revealed 100% contamination of the external body surface of cockroaches with shared bacterial species such as *Klebsiella pneumoniae*, *Enterobacter cloacae* from both sites. All the 172 cockroaches were found to have 2 or

Table 1. Percentage abundance of parasitic infection of cockroaches from houses with open toilets and broken sewage systems.

Parasites	Houses with open toilets		Houses with broken sewage systems	
	No. of parasites (n = 170)	(%)	No of parasites (n=161)	(%)
<i>Ballantidium coli</i> trophozoites	25	14.71	21	13.0
<i>Entamoeba histolytica</i> (cysts)	40	23.53	37	23.0
<i>Ascaris lumbricoides</i> (ova)	30	17.65	31	19.2
<i>Trichuris trichura</i> (ova)	22	12.94	19	11.8
<i>Enterobius vermicularis</i> (larvae)	10	5.88	12	7.5
<i>Ancylostoma duodenale</i> (larvae)	16	9.41	17	10.6
<i>Strongyloides stercoralis</i> (larvae)	27	15.98	24	14.9

Table 2. Percentage abundance of bacterial contamination of cockroaches from houses with open toilets and broken sewage systems.

Bacterial	Houses with open toilets		Houses with broken sewage systems	
	No. of parasites (n = 347)	(%)	No of parasites (n= 244)	(%)
<i>Klebsiella pneumonia</i>	52	15.0	38	15.6
<i>Enterobius aerogenes</i>	49	14.1	45	18.4
<i>Salmonella</i> species	37	10.6	35	14.3
<i>Shigella sonnei</i>	54	15.6	37	15.2
<i>Vibrio cholera</i>	47	13.5	32	13.1
<i>Citrobacter freundii</i>	53	15.3	27	11.1
<i>Enterobacter cloacae</i>	55	15.9	30	12.3

Table 3. Mean heterotrophic bacterial and parasitic load of cockroaches.

Source	Mean bacterial load	Mean parasitic load
Houses with open toilets	49.7x10 ⁸ cfu ml ⁻¹	24 parasites/ml
Houses with broken sewage systems	4.9x10 ⁸ cfu ml ⁻¹	32 parasites/ml

more pathogenic species on their external surface. The highest infective rates of 15.9% and 18.4% were recorded by *Enterobacter cloacae* and *Enterobius aerogenes* in cockroaches collected from houses with open toilets and broken sewage systems respectively (Table 2). *Salmonella* species and *Citrobacter freundii* showed the least infective rates of 10.6% and 11.1% in cockroaches obtained from houses with open toilets and broken sewage systems respectively.

However, there was no significant difference (χ^2 - test, $P>0.05$) in the bacterial load of cockroaches irrespective of the site of collection.

Cockroaches collected from houses with open toilets recorded a mean heterotrophic bacterial and parasitic load 49.7x10⁸ cfu ml⁻¹ and 24 parasites/ml respectively. Those trapped in houses with broken sewage systems had a mean heterotrophic bacterial and parasitic load of

34.9x10⁸ cfu ml⁻¹ and 23 parasites/ml respectively (Table 3).

The results from this study substantiate the fact that cockroaches are not only nuisance in our houses but reservoirs and disseminators of pathogenic microorganisms, and therefore potential health hazards in endemic areas as well as the study area in particular.

DISCUSSION

Cockroaches have always been suspected as carriers of pathogens, but their role in the direct dissemination of infection has seldom been established (Tatfeng et al., 2005; Etim et al., 2012). The result from this study confirmed that the American cockroaches are reservoir and mechanical transmitters of pathogenic microorganisms

which was in agreement with previous studies (Naghham et al., 2011) in Irag; (Bala and Sule, 2012) in Sokoto; (Kassiri and Kazemi, 2012) in Iran, (Etim et al., 2012) in Calabar, Nigeria.

The high infective rate of 94.0% recorded in cockroaches trapped from both locations might be an indication of their filthy feeding habit which makes them efficient carriers of parasitic worms, cysts or eggs as earlier reported by Nagham et al., 2011). The infective rate reported in this study is higher than 54.1%, 83.33%, 67.0%, and 77.5% observed by Chamavit, et al (2011) in Thailand, Al-mayali and Al-yaqoobi (2011) in Irag; Ajero, et al (2011) in Owerri, Nigeria and Bala and Sule (2012) in Sokoto, Nigeria, respectively. However, the infective rate was lower than 98% and 100% reported by El-Sherbini and El-Sherbini, 2011) in Egypt and Kassiri and Kazemi (2012) in Iran respectively.

That there was lack of significant difference in the infective rates of cockroaches irrespective of source of collection suggest that cockroaches from both sites have equal chances of harbouring and transmitting pathogens to humans. This finding correlates with the observation of many investigators (Chamavit et al., 2011; El-Sherbini and El-Sherbini, 2011; Ajero et al., 2011) who established that parasites are common, especially in areas where personal hygiene and socio-economic status are low.

The high prevalence of *Entamoeba histolytica* in both sites might be due to the resistance conferred on the parasite by the cyst wall. This eventually prolonged its life span on the environment and subsequently transmitted by cockroaches to humans. This observation supports the findings of Bala and Sule (2012) in Sokoto.

Worthy of mention in this study is the isolation and identification of *Ballantidium coli* trophozoite from the external body surface of cockroaches. The presence of this parasite is not unconnected with the persistent customary processing of goats and pigs intestine by local butchers around premises, before being used for evening delicacies as earlier reported by Chamavit et al. (2011).

Most of these organisms produce disease in human (Tachbele, et al, 2006) and therefore a threat to public health. The recovery of these protozoans from the external surface of cockroaches suggest their role as agents of amoebic dysentery which is surpassed only by malaria in its capacity to cause high morbidity and mortality in humans.

Also, the discovery of *Trichuris trichura* and *Ascaris lumbricoides* ova in the external washings of cockroaches agrees with the preposition that cockroaches are seriously involved in the epidemiology of soil transmitted helminthes (STH) as earlier reported by Etim, et al (2012). These researchers explained that cockroaches are able to spread pathogens to other places due to their ability to travel up to 4.8 kilometers an hour to and from unsanitary sites. In addition, the presence of *Enterobius vermicularis* signifies the obvious contact of cockroaches with infected patients in houses or clothings which

confirm their ability to transmit pathogens (Chan et al., 2004).

The bacteriological studies revealed that cockroaches from both locations also shared the same bacteria and are a store of micro-organisms. This finding correlates with the report of Taffeng et al., 2005; Salehzadeh et al., 2007; Kassiri and Kazemi, 2012 and Tilahun et al., 2012). Some of the bacterial isolates in this study were *Klebsiella pneumoniae*, *Enterobacter aerogenes*, *Salmonella species*, *Shigella sonnei*, *Vibrio cholera*, *Citrobacter freundii* and *Enterobacter cloacae*. This discovery is in consonance with the finding of Tilahun et al (2012) and Nagham, et al (2011) who emphasized that these species can cause urinary tract infection, sepsis, gastroenteritis, biliary and peritoneal infection, pneumonia or wound infection. *salmonella species* and *Shigella sonnei* have been incriminated as the causative agents of gastroenteritis and the outbreak of dysentery in Northern Ireland respectively (Talihun et al., 2012).

Cockroaches collected from houses with open toilets recorded a mean heterotrophic bacterial and parasitic load of 49.7×10^8 cfu ml⁻¹ and 24 parasites/ml respectively. Those trapped in houses with broken sewage systems had a mean heterotrophic bacterial and parasitic load of 34.9×10^8 cfu ml⁻¹ and 23 parasites/ml respectively.

In conclusion, this study revealed that cockroaches in the study area are important reservoir for infectious pathogens and appropriate control measures should be instituted to mitigate morbidity caused by cockroach infection.

Authors Contributions

Iboh CI was the leader of this study and determined the association between parasitic infection and site of collection of specimen by chi-square. Ajang RO and Iboh CI were responsible for the collection of specimen. The parasitological profile was carried out by Iboh CI, The bacteriological profile was carried out by Etim LB. The final vetting and approval of the manuscript was done by all the authors.

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