Original Article

Isolation and Diagnosis of Medically Significant Parasites from the American Cockroach (*Periplaneta americana*) in Shendi City, Sudan

***Yassir A. Sulieman[1,2], Randa Eltayeb[2], Theerakamol Pengsakul[3]**

[1]Department of Biology, College of Science, United Arab Emirates University, Al Ain, UAE
[2]Department of Zoology, Faculty of Science and Technology, Shendi University, Shendi, Sudan
[3]Health and Environmental Research Center, Faculty of Environmental Management, Prince of Songkla University, Hat Yai, Songkhla, Thailand

***Corresponding author:** Dr Yassir A. Sulieman, E-mail: suliemany@uaeu.ac.ae, noury39@gmail.com

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Abstract

Background: Cockroaches are ubiquitous in residential environments and can act as vectors for pathogens relevant to public health. This investigation aimed to determine the diversity, prevalence, and intensity of parasites carried by the American cockroach, *Periplaneta americana*, in Shendi City, Sudan.

Methods: A total of 117 *P. americana* specimens were collected during the summer of 2021 from residential kitchens, bathrooms and sewers using jar traps baited with bread. Following euthanasia by freezing each cockroach was examined for external and internal parasite stages (cysts and ova) via standard parasitological techniques.

Results: The overall parasite prevalence was 31.6%, with a mean intensity of 6.7 parasites per infected insect. Eight species were detected: three protozoans (*Entamoeba histolytica/dispar*, *Entamoeba coli*, *Giardia lamblia*) and five helminths (*Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma* sp., *Taenia* sp., *Enterobius vermicularis*). *Entamoeba coli* was the most prevalent (10.3%), followed by *E. histolytica/dispar* (7.7%), *T. trichiura* and *Ancylostoma* sp. (0.9% each). *Taenia* sp. showed the highest infection intensity (8.6) compared to the lowest (4.0), *E. vermicularis* and *T. trichiura*. Statistically, the parasite prevalence and intensity were significantly greater on the cockroaches' body surfaces compared to their digestive tracts ($P < 0.001$). Adult cockroaches also demonstrated significantly higher infection rates and intensities than nymphs.

Conclusion: The findings confirm that the cockroach, *P. americana*, can serve as a mechanical vector for protozoan and helminth parasites. Implementing preventive strategies, including improved sanitation and comprehensive pest management, is crucial to reducing the associated public health threat.

Keywords: Blattodea; Infection; Parasite prevalence; Intensity; Sudan

Introduction

Parasitic diseases represent a significant global health burden, with a high prevalence in tropical and subtropical regions. Transmission occurs through multiple pathways, most commonly the ingestion of contaminated food or water containing infective eggs, cysts, or larvae (1). Additionally, arthropod vectors such as insects play a critical role in transmitting parasitic pathogens to both humans and animals (1, 2).

Cockroaches (Insecta: Blattodea) are synanthropic insects that have long been associated with human habitats. Of the over 4,400 known species, only a few, including the American cockroach (*Periplaneta americana*), the German cockroach (*Blattella germanica*) and the Oriental cockroach (*Blatta orientalis*), are significant pests of public health concern (3). These species thrive in temperate climates and are commonly found in environments with high moisture availability, such as kitchens, sewers and drainage systems (4, 5). Their nocturnal activity, coupled with a highly generalist diet that includes decaying organic matter, garbage and human foodstuffs, brings them into frequent contact with pathogens (3). Consequently, their feeding and breeding habits on unsanitary substrates establish them as mechanical vectors or reservoirs for a diverse range of infectious agents that usually infect the digestive canals of humans and animals (4, 6).

Among the pathogens carried or disseminated by cockroaches are protozoan parasite cysts or oocysts, such as those of *Amoeba* spp., *Giardia* spp., *Toxoplasma* spp. and *Sarcocystis* spp. (7, 8); various helminth ova or larvae, including *Ascaris* spp., *Trichuris* spp., *hookworms*, *Taenia* spp. and *Echinococcus* spp. (9, 10); bacteria like *Enterobacter* spp., *Shigella* spp., *Enterococcus* sp., *Pseudomonas* spp., *Klebsiella* spp., *Haemophilus* spp. and *Escherichia coli* (4, 11, 12); viruses such as Rotavirus and Enterovirus (11, 13); fungi such as *Candida* spp., *Penicillium* spp., *Aspergillus* spp., *Rhizopus* spp. and *Acremonium* spp. (14, 15). Furthermore, it has been documented that exposure to cockroach antigens may contribute to asthma-related health issues (16). Moreover, to reduce health risks and enhance urban quality of life, a comprehensive approach to cockroach control is essential, integrating public education, stringent sanitation and strategic urban planning (17).

The presence of cockroaches in areas with poor sanitation, including both urban and rural settings as well as food-handling establishments, significantly amplifies the risk of pathogen transmission to humans and animals (18, 19). This poses a direct threat to public health through the contamination of food and water. Therefore, epidemiological data on the prevalence and parasitic load of cockroaches are essential for informing public health interventions.

Currently, there is a lack of published data on the parasites carried by cockroaches in Sudan. This study was conducted to address this knowledge gap by investigating the diversity, prevalence and intensity of parasites carried by the American cockroach, *P. americana*, in Shendi City, Sudan.

Materials and Methods

Samples collection

A total of 117 samples of *P. americana* cockroaches were collected alive from kitchens, bathrooms and sewers across 45 randomly selected residential sites in Shendi City (16°41’N, 33°26’E, Fig. 1) during the summer of 2021, using jars baited with a piece of bread, the inner top of which was coated with a thin film of petroleum jelly to keep the insects from escaping (20). Traps were set at night (19:00 hr) and collected the following morning (7:00 hr). The collected insects were individually placed in sterile plastic containers and brought to the Zoology Laboratory at Shendi University for parasitological examination. The insects were individually killed by freezing at 0 °C for 10 minutes and identified using a morphological key (21).

Cuticle (body surface) examination

The cockroaches were individually placed in sterile test tubes containing 5 mL of 0.9% normal saline solution and shaken for 5 min to detach any parasite stages from the body surface (cuticle) (22). The insects were then removed, washed with 70% alcohol, and individually placed in separate Petri dishes for subsequent use. The saline wash solutions were centrifuged at 2,000 rpm for 5 min using a Medifuge centrifuge (Heraeus Sepatech GmbH, Germany) and both the sediment and supernatant droplets were placed on two slides to obtain three smears each. The preparations were stained with 1% Lugol's iodine solution, covered and examined under a light microscope to detect the parasite stages such as ova, cysts, oocysts and/or larvae (23).

Digestive tract examination

The dried insects that were washed with alcohol were dissected and their entire guts were removed, opened and placed in separate Petri dishes containing normal saline solution. Subsequently, the contents were examined under a dissecting microscope. Six smears were prepared from the material, stained with 1% Lugol's iodine and examined under a light microscope. Parasite stages were identified at the genus or species level using available literature and systematic keys (23, 24).

Data analysis

The prevalence and mean intensity of infection were calculated as prevalence (P= n/Z× 100) and mean intensity (MI= N/n), respectively, where n= number of insects parasitized, N= total number of parasites and Z= total number of insects examined (25).

A chi-square test was used to determine the level of significance of the observed variations in prevalence rates, and paired-sample t-tests were used to detect any significant differences in the mean infection intensity. SPSS 29.0 (Armonk, NY, IBM Corp. USA) for Windows was used for data analysis and values were considered significant at P< 0.05.

Results

Out of the 117 cockroaches (*P. americana*, 77 adults and 40 nymphs) collected, 31.6% (37/117) were found infected with protozoan and helminth parasite species, with an overall mean intensity of 6.7 parasites per infected cockroach (Table 1). Cysts and ova from eight distinct parasite species were identified, comprising three protozoans (*Entamoeba histolytica/dispar*, *E. coli*, *Giardia lamblia*) and five helminths (*Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma* sp., *Taenia* sp., *Enterobius vermicularis*) (Fig. 2).

Among the identified parasites, *E. coli* was the most prevalent (10.3%), followed by *E. histolytica/dispar* (7.7%). In contrast, *T. trichiura* and *Ancylostoma* sp. were the least prevalent (0.9% each). *Taenia* sp. exhibited the highest mean infection intensity (8.6), while *E. vermicularis* and *T. trichiura* had the lowest (4.0 each).

Of the cockroaches examined, 23.1% (27/117) had a single parasite species and 8.5% (10/117) had mixed infections. A significantly greater parasite prevalence and intensity was found on the cuticle compared to the digestive tract (P< 0.001). Infection status also varied significantly with life stage; adults harbored a higher prevalence (P< 0.001) and mean intensity (P= 0.02) of parasites than nymphs. Statistical tests were only applied where sample sizes were sufficient (Tables 2 and 3).

Fig. 1. Map showing the geographical location of the study area, Shendi City, Sudan, 2021

Table 1. Parasitic infection parameters and infection sites in the cockroach *Periplaneta americana* (n= 117), collected in Shendi City, Sudan, during the summer of 2021

Parasite species	Prevalence %	Mean intensity (range)	Infection site
Protozoans (cyst)			
Entamoeba histolytica/dispar	7.7	5.6 (3–10)	Cuticle + digestive tract
Entamoeba coli	10.3	7.8 (3–14)	Cuticle + digestive tract
Giardia lamblia	4.3	6.0 (3–13)	Cuticle + digestive tract
Helminths (ova)			Cuticle + digestive tract
Ascaris lumbricoides	1.7	6.0 (5–7)	Cuticle + digestive tract
***Ancylostoma* sp.**	0.9	7.0 (7.0)	Cuticle
Enterobius vermicularis	1.7	4.0 (3–5)	Cuticle
Trichuris trichiura	0.9	4.0 (4.0)	Cuticle
***Taenia* sp.**	4.3	8.6 (7–11)	Cuticle + digestive tract
Overall	31.6	6.7 (2–14)	

Table 2. Prevalence of parasite infection and comparative analysis, according to infection site and life stage of the cockroach *Periplaneta americana* (n= 117), collected in Shendi City, Sudan, during the summer of 2021

Parasite species	Prevalence %							
	Cuticle (n=117)	**Digestive tract (n=117)**	χ^2	***P* value**	**Adult (n=77)**	**Nymph (n=40)**	χ^2	***P* value**
Protozoans (cyst)								
Entamoeba histolytica/dispar	5.1	2.6	56.96	0.001	7.8	7.5	18.37	0.002
Entamoeba coli	9.4	4.3	82.07	0.001	9.1	12.5	26.93	0.001
Giardia lamblia	3.4	1.7	28.49	0.034	5.2	2.5	9.23	0.002
Helminths (ova)								
Ascaris lumbricoides	1.7	0.9	57.99	0.017	2.3	00	ND	ND
***Ancylostoma* sp.**	0.9	00	ND	ND	1.3	00	ND	ND
Enterobius vermicularis	1.7	00	ND	ND	2.3	00	ND	ND
Trichuris trichiura	0.9	00	ND	ND	1.3	00	ND	ND
***Taenia* sp.**	4.3	1.7	77.32	0.001	2.3	7.5	25.96	0.004
Overall	27.4	11.1	38.84	0.001	32.5	30.0	10.28	0.001

ND= no data

Table 3. Mean intensity of parasite infection and comparative analysis, according to infection site and life stage of the cockroach *Periplaneta americana* (n= 117), collected in Shendi City, Sudan, during the summer of 2021

Parasite species	Mean intensity							
	Cuticle (n=117)	**Digestive tract (n=117)**	**t**	***P* value**	**Adult (n=77)**	**Nymph (n=40)**	**t**	***P* value**
Protozoans (cyst)								
Entamoeba histolytica/dispar	6.7	3.3	2.20	0.15	5.8	5.0	-1.73	0.22
Entamoeba coli	5.5	3.4	7.30	0.002	9.3	5.8	1.47	0.21
Giardia lamblia	5.0	4.0	ND	ND	7.0	2.0	ND	ND
Helminths (ova)								
Ascaris lumbricoides	5.0	2.0	ND	ND	6.0	00	ND	ND
***Ancylostoma* sp.**	7.0	00	ND	ND	7.0	00	ND	ND
Enterobius vermicularis	4.0	00	ND	ND	4.0	00	ND	ND
Trichuris trichiura	4.0	00	ND	ND	4.0	00	ND	ND
***Taenia* sp.**	7.0	4.0	2.33	0.25	9.5	8.0	0.33	0.79
Overall	5.8	3.5	4.94	0.001	7.1	5.8	2.52	0.02

ND= no data

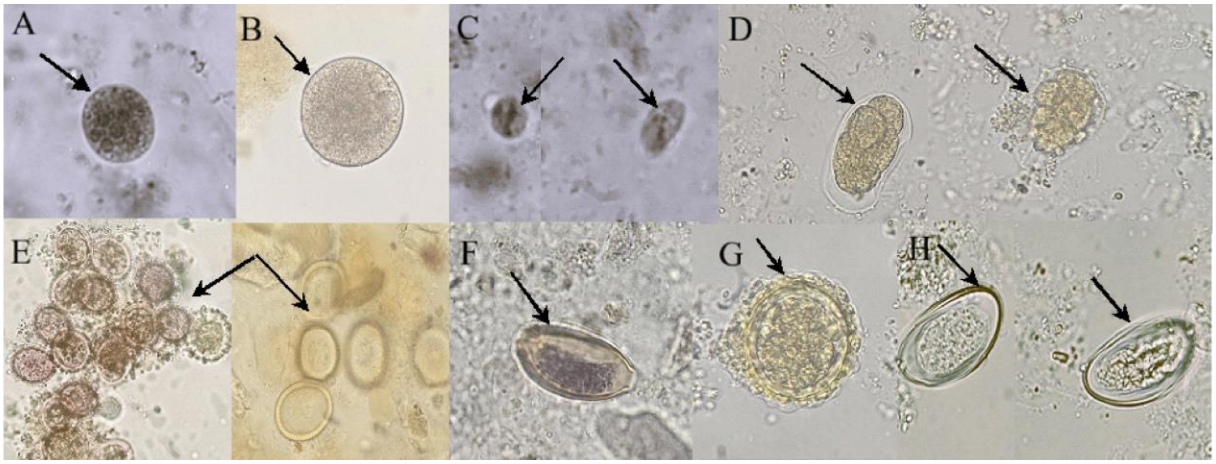

Fig. 2. Light micrographs of parasite stages recovered from *Periplaneta americana* collected in Shendi City, Sudan, 2021. A– *Entamoeba coli* cyst (2000×); B – *Entamoeba histolytica/dispar* cyst (2000×); C– *Giardia lamblia* cysts (2000×); D– *Ancylostoma* sp. ova (800×); E– *Taenia* sp. ova (800×); F– *T. trichiura* ovum (800×); G– *Ascaria lumbricoides* ovum (800×); H– *Enterobius vermicularis* ova (800×)

Discussion

The synanthropic nature of cockroaches, coupled with their propensity for unsanitary environments, solidifies their role as mechanical vectors for human pathogens, representing a persistent public health challenge (8, 11). This study confirms that *P. americana* in residential areas of Shendi City carries stages of eight medically important protozoan and helminth parasites. The overall prevalence of 31.6% and a mean intensity of 6.7 parasites per infected cockroach, however, are markedly lower than the rates reported in several other regions, such as Egypt, 98% (26), Iraq, 96.4% (27), China, 96.9% (8) and Nigeria, 95.7% (28). This pronounced discrepancy may be attributable to local environmental conditions, such as the high temperatures and low humidity of the Shendi region, which could impair parasite survival outside a host. Alternatively, it may reflect comparatively better community sanitation standards, limiting the cockroaches' exposure to contaminated materials.

Among the identified parasites, the protozoan *E. coli* was the most prevalent (10.3%), followed by *E. histolytica/dispar* (7.7%), while helminths such as *T. trichiura* and *Ancylostoma* sp. were the least prevalent (0.9% each). The prevalence rates for both protozoan and helminth species in this study were consistently lower than those reported elsewhere. For instance, *E. coli* was found at 21.05% in Iraq (27) and *E. histolytica* at 19.3% in Nigeria (29). Similarly, helminth infections were substantially lower compared to high prevalence rates of *Ancylostoma* sp. (60.5%) in Iraq (27), *E. vermicularis* (43.1%), *Ancylostoma* spp. (34.8%) and *A. lumbricoides* (3.1%) reported in Nigeria (28, 30). While *E. coli* is generally a commensal and non-pathogenic (31), its presence serves as a robust indicator of fecal contamination. In contrast, the other detected protozoa, *E. histolytica* and *G. lamblia*, are significant global causes of intestinal disorders and diarrheal diseases, particularly in children (32). The dominance of these pathogens in cockroach populations likely mirrors their high prevalence in the local human community, facilitated by fecal-oral transmission and the environmental resilience of their cysts or ova (33).

A notable finding was the high infection intensity of *Taenia* sp. (8.6 ova per infected cockroach), which surpassed that of other helminths like *E. vermicularis* and *T. trichiura* (4 ova per infected cockroach). This suggests that while the likelihood of a cockroach encountering *Taenia* ova may be lower (reflected in its low prevalence), when exposure does occur, it involves a high density of infectious material. This is consistent with the biology of adult *Taenia* worms, which produce vast numbers of highly resistant ova capable of prolonged environmental survival.

The community structure of parasites in the studied cockroaches was characterized by a higher prevalence of mono-parasitic infections compared to polyparasitism. This pattern may serve as a valuable ecological indicator; high frequencies of mixed infections typically signal heavy environmental contamination with diverse pathogens. Consequently, the low level of polyparasitism observed here suggests a relatively favorable state of environmental hygiene in the study area, with less concentrated sources of contamination.

Our analysis also revealed that the cockroach cuticle was significantly more infested with parasites, in both prevalence and intensity, than the digestive tract. This finding aligns with some previous studies (34, 35) but contrasts with others that reported higher gastrointestinal loads (27, 28). These conflicting observations are likely context-dependent, influenced by factors such as the specific roaming habitats of the vectors, the size and adhesiveness of the parasite stages, local sanitation conditions and even the diagnostic methodologies employed.

Finally, a strong demographic pattern emerged, with adult cockroaches harboring significantly higher rates and intensities of infection than nymphs. This is logically explained by the cumulative nature of exposure; adults have had a longer lifespan for interaction with contaminated environments (36). Furthermore, their larger body surface area provides more space for the mechanical attachment and accumulation of parasites. The high infection loads in adults thus directly reflect their frequent and prolonged contact with contaminated materials, primarily human and animal feces.

As the first assessment of medically significant parasites in *P. americana* cockroaches in Sudan's Shendi area, this study offers crucial baseline data. Its focus on host age and infection site provides a solid starting point; however, future research should also consider host sex and conduct a more detailed assessment of seasonal variation. The results underscore the need for ongoing surveillance and targeted investigations into parasite dynamics and control

Conclusion

This investigation identifies *P. americana* in Shendi as a potential mechanical vector for enteric pathogens, including protozoan and helminth species. The relatively lower prevalence and limited polyparasitism, when viewed in a global context, suggest that local environmental conditions may modulate, but do not eliminate, the disease risk. These results underscore the critical need for integrated public health strategies, including sustained community sanitation programs, improved personal hygiene practices, and effective pest control measures, to mitigate the health threat posed by this ubiquitous insect.

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Ethical consideration

It is not applicable.

Conflict of Interest Statement

The authors declare there is no conflict of interest.

References

1. Isaev V (2024) The global burden of parasitic diseases: Prevalence, mortality and economic costs. Bio Med. 16(12): No. 1000760.
2. Giovanni FD, Wilke AB, Beier JC, Pombi M, Mendoza-Roldan JA, Desneux N, Canale A, Lucchi A, Dantas-Torres F, Otranto D, Benelli G (2021) Parasitic strategies of arthropods of medical and veterinary importance. Entomol Gen. 41 (5): 511–522.
3. Cochran DG (1999) Cockroaches: Their Biology, Distribution and Control. World Health Organization, Geneva.
4. Donkor ES (2020) Cockroaches and food-borne pathogens. Environ Health Insights. 14: 1–6.
5. Hayati RZ, Susanna D (2020) The human pathogens carried by the cockroaches in the food-related environment potentially causing a food borne diseases: A systematic review. Malays J Public Health Med. 20(2): 159–170.
6. Patel A, Jenkins M, Rhoden K, Barnes AN (2022) A systematic review of zoonotic enteric parasites carried by flies, cockroaches and dung beetles. Pathogens. 11 (1): 90.
7. Ulewicz K, Wolanska M, Kruminis-Lozowska W (1981) Epidemiological role of *Blattella germanica* (L.) in amebiasis. Wiad Parazytol. 27(1): 43–47.
8. Pai H, Ko Y, Chen E (2003) Cockroaches (*Periplaneta americana* and *Blattella germanica*) as potential mechanical disseminators of *Entamoeba histolytica*. Acta Trop. 87(3): 355–359.
9. Cazorla Perfetti D, Morales P, Navas P (2015) Isolation of intestinal parasites from American cockroach (*Periplaneta americana*) in Coro, Falcon State, Venezuela. Boletín Malariol. Salud Ambient. 55(2): 184–193.
10. Abdullah AM, Merza AS, Meerkhan AA (2024) Cockroaches as carriers of human medically important parasites. Parasitol Res. 123(2): 119.
11. Liu J, Yuan Y, Feng L, Lin C, Ye C, Liu J, Li H, Hao L, Liu H (2024) Intestinal pathogens detected in cockroach species within different food-related environment in Pudong, China. Sci Rep. 14(1): 1947.
12. Akbari S, Oshaghi MA, Hashemi-Aghdam SS, Hajikhani S, Oshaghi G, Shirazi MH (2015) Aerobic bacterial community of American cockroach *Periplaneta americana*, a step toward finding suitable paratransgenesis candidates. J Arthropod-Borne Dis. 9(1): 35–48.
13. Tetteh-Quarcoo PB, Donkor ES, Attah SK, Duedu KO, Afutu E, Boamah I, Olu-Taiwo M, Anim-Baidoo I, Ayeh-Kumi PF (2013) Microbial carriage of cockroaches at a tertiary care hospital in Ghana. Environ Health Insights. 3(7): 59–66.
14. Salehzadeh A, Tavacol P, Mahjub H (2007) Bacterial, fungal and parasitic contamination of cockroaches in public hospitals of Hamadan, Iran. J Vector Borne Dis. 44(2): 105–110.
15. Nasirian H (2017) Contamination of cockroaches (Insecta: Blattaria) to medically fungi: A systematic review and meta-analysis. J Mycol Med. 27(4): 427–448.
16. Do DC, Zhao Y, Gao P (2016) Cockroach allergen exposure and risk of asthma. Allergy. 71(4): 463–474.
17. Li Q, Liu M, Liu T, Tong Y, Zhang Y (2023) An evolutionary game study of cockroach control strategies in residential households. Sci Rep. 13(1): 7342.
18. Kinfu A, Erko B (2008) Cockroaches as carriers of human intestinal parasites in two localities in Ethiopia. Trans R Soc Trop Med Hyg. 102(11): 1143–1147.

19. Kramer RD, Brenner RJ (2009) Cockroaches (Blattaria). In: Mullen GR, Durden LA (Eds) Medical and Veterinary Entomology, 2nd Edition. Academic Press/ Elsevier Inc., New York, USA, pp. 41–55.
20. Adenusi AA, Akinyemi MI, Akinsanya D (2018) Domiciliary cockroaches as carriers of human intestinal parasites in Lagos Metropolis, Southwest Nigeria: Implications for public health. J Arthropod-Borne Dis. 12(2): 141–151.
21. Burgess NRH (1993) Cockroaches (Blattaria). In: Lane RP, Crosskey RW (Eds) Medical Insects and Arachnids. Chapman and Hall, London, pp. 473–482.
22. Bala A, Sule H (2012) Vectorial potential of cockroaches in transmitting the parasites of medical importance in Arkilla, Sokoto, Nigeria. Nigerian. J Basic Appl Sci. 20(2): 111–115.
23. Bench aids for the diagnosis of intestinal parasites, second edition (2019) Geneva: World Health Organization.
24. Bowman DD (2009) Georgis' parasitology for veterinarians. 9th edition. Saunders Elsevier.
25. Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. J Parasitol. 83(4): 575–583.
26. El-Sherbini GT, El-Sherbini ET (2011) The role of cockroaches and flies in mechanical transmission of medical important parasites. J Entomol Nematol. 3: 98–104.
27. Al-Badrani SAS, Al-Rubaye FSI, Abbass LY (2024) Isolation and diagnosis of parasites from domestic cockroach *Periplaneta americana* in Mosul City, Iraq. Journal of Life and Bio Sciences Research 5(2): 34–41.
28. Otu-Bassey IB, Mbah M, Udoh DI, Kayode JO (2019) Parasitological survey of domestic cockroaches in some residential houses in Calabar, Nigeria. Calabar J Health Sci. 3(2): 68–72.
29. Maji A, Ahmed UA (2023) Identification of parasites of public health important from the body of cockroach (*Periplaneta Americana*) in Kafin Hausa area of Jigawa State. African J Adv Sci Technol Res. 10(1): 97–102.
30. Akeju AV, Olusi TA, Obi RE (2024) Intestinal parasites associated with American cockroach (*Periplaneta americana*) in Akure, Ondo State, Nigeria. J Parasit Dis. 48(1): 67–73.
31. Feng M, Pandey K, Yanagi T, Wang T, Putaporntip C, Jongwutiwes S, Cheng X, Sherchand JB, Pandey BD, Tachibana H (2018) Prevalence and genotypic diversity of *Entamoeba* species in inhabitants in Kathmandu, Nepal. Parasitol Res. 117(8): 2467–2472.
32. Kantor M, Abrantes A, Estevez A, Schiller A, Torrent J, Gascon J, Hernandez R, Ochner C (2018) *Entamoeba histolytica*: Updates in clinical manifestation, pathogenesis and vaccine development. Can J Gastroenterol Hepatol. 2018: 4601420.
33. Ravdin J (1988) Amoebiasis: Human infection by *Entamoeba histolytica*. John Wiley and Sons, New York.
34. Etim SE, Okon OE, Akpan PA, Ukpong GI, Oku EE (2013) Prevalence of cockroaches (*Periplaneta americana*) in households in Calabar: Public health implications. J Public Health Epidemiol. 5(3): 149–152.
35. Atiokeng Tatang RJ, Tsila HG, Wabo Poné J (2017) Medically important parasites carried by cockroaches in Melong Subdivision, Littoral, Cameroon. J Parasitol Res. 2017: 7967325.
36. Carretero MA, Roca V, Martin JE, Llorente GA, Montori A, Antos XS, Mateos J (2006) Diet and helminth parasites in the Gran Canaria giant lizard *Gallotia stehlini*. Rev Esp Herp. 20: 105–117.