



## Assessment of Parasitic Contamination Carried by American Cockroaches (*Periplaneta americana*) in Dhuluiya, Salah al-Din Province, Iraq

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### ABSTRACT

American cockroaches are among the most important vectors of parasitic infections. Limited and unclear data are available on parasitic contamination caused by this cockroach in Iraq, particularly in Salah al-Din Province. This study aimed to evaluate the parasitic contamination carried by American cockroaches in some areas of Salah al-Din Province. A total of 150 American cockroach specimens were collected from 4 locations (homes, schools, hospitals, and restaurants), and parasitic contamination on both internal and external surfaces was examined microscopically using Lugol's iodine. The results show that 100 cockroaches were contaminated with various parasites, with internal surfaces showing higher contamination (78%) than external surfaces. 20 different species of parasites were recorded in the present study: *Nectotherus ovalis*, *Giardia lamblia*, *Strongyloides stercoralis*, *Trichomonas hominis*, and *Enterobius vermicularis* had the highest prevalence in all samples, while *Trichuris trichiura*, *Hymenolepis* eggs, *Diphyllobothrium latum*, *Taenia* sp., and *Balantidium coli* (trophozoite) were less prevalent. Homes and Schools in Dhuluiya/Salah al-Din Province, Iraq, recorded the highest levels of contamination in this study. In conclusion, this study indicates potential public health risks in the selected areas, which may serve as sources of transmission for medically important parasites, and that homes and restaurants need improved hygiene.

**Keywords:** American cockroaches, parasite contamination, Dhuluiya, Salah al-Din, Iraq.

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## تقييم التلوث الطفيلي المحمول على الصراصير الأمريكية (*Periplaneta americana*) في مدينة الضلوعية، محافظة صلاح الدين، العراق.

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### الملخص

الصراصير الأمريكية هي واحدة من أهم نواقل الميكروبات الطبية المهمة مثل الطفيليات. إن البيانات المتعلقة بالتلوث الطفيلي الذي تحمله هذه الصراصير في العراق قليلة وغير واضحة، خاصة في محافظة صلاح الدين. لذلك، هدفت هذه الدراسة إلى تقييم التلوث الطفيلي الذي تحمله الصراصير الأمريكية في بعض مناطق محافظة صلاح الدين.

تم جمع 150 صرصاراً أمريكياً من أربعة مواقع (المنازل، المدارس، المستشفيات، والمطاعم)، وتم فحص التلوث الطفيلي على كل من السطحين الداخلي والخارجي مجهرياً باستخدام صبغة اليود لوغول. أظهرت النتائج أن 100 صرصاراً كانت ملوثة بأنواع مختلفة من الطفيليات، وكان التلوث على السطح الداخلي أكثر (78%) مقارنة بالسطح الخارجي.

تم تسجيل 20 مرحلة مختلفة من الطفيليات في هذه الدراسة، وكان كل من *Strongyloides*، *Giardia lamblia*، *Nectotherous ovalis*، *Trichomonas hominis*، *stercoralis*، *Trichuris* الأكثر انتشاراً في جميع العينات، بينما كانت *Trichiura*، بيض *Hymenolepis*، *Diphyllobothrium latum*، *Taenia sp*، *Balantidium coli* (الطور المتحرك) أقل انتشاراً. كانت المنازل والمدارس في قضاء الضلوعية/محافظة صلاح الدين/العراق أكثر الأماكن التي وجدت فيها الصراصير الأمريكية ملوثة بطفيليات طبية مهمة.

في الختام، قد تكون المنطقة المختارة في محافظة صلاح الدين مصدراً لنقل الطفيليات الطبية المهمة، وتحتاج المنازل والمطاعم إلى تعزيز شروط النظافة.

### INTRODUCTION

Cockroaches are insects belonging to the Insecta class and the Blattodea order, with an ancient history; fossil evidence suggests their lineage can be traced back to the Upper Carboniferous period. (1) Modern species retain a high degree of phenotypic and physiological similarity to their ancestors, and these insects can adapt to a wide range of conditions. This trait has enabled them to survive in many different environments and under varying conditions. (2, 3). The majority of these insects live in the tropics and subtropics worldwide. (4, 5), and nearly 4600 species have been diagnosed, of which 99% are classified as being non-human (6) Among the species that are close to humans, the two species are the German cockroach, *Blatella germanica*. (6)

and the American cockroach, *Periplaneta americana* (7) One of the most popular types of cockroaches that are close to humans due to their abundance and large global distribution (7, 8).

These species live in a variety of environments that provide optimal conditions for their survival, including residential buildings, commercial buildings, healthcare facilities, educational institutions and eating places (9). These insects are diverse in their nutritional preferences, preferring foods rich in starch and sugar. The World Health Organization (WHO) has classified cockroaches as a major public health risk due to their role as mechanical vectors that can carry pathogens on their

outer and inner surfaces, including bacteria, fungi, protozoa, helminths, and viruses<sup>(10,11)</sup>.

Parasites are one of the most prevalent pathogens around the world, especially in developing countries, as they cause many diseases in humans and animals.<sup>(12)</sup> Parasites can be transmitted through many vectors, and the method depends on the type of parasite, as some parasitic types can be transmitted through the mouth through the consumption of foods and liquids contaminated with different phases of the parasite, including the cystic stage, its eggs, or larvae, which are the infectious phases of parasites.<sup>(13)</sup>, and can also be transmitted through arthropods, which are among the largest animal phyla on Earth and the most successful among veterinary insects in terrestrial environments, and many of their species play important roles in the transmission of pathogens<sup>(14)</sup>. Many global studies have emerged that illustrate the role of cockroaches in the transmission of pathogens dangerous to human health, including those from diverse local environments, as in Maji and Ahmed's study.<sup>(15)</sup> In Nigeria, the importance of the American cockroach in the home environment for the transfer of pathogenic parasites on the outer and inner surfaces was noted. It was shown that 79 out of 150 American cockroaches were contaminated with medical parasites, including *Entamoeba histolytica* and various types of nematodes, and this is what other studies have shown in different environments, such as the university environment<sup>(16)</sup> and in shops<sup>(17)</sup> as well as in hospital settings<sup>(18)</sup> This indicates that these environments can pose a medical hazard by sheltering cockroaches contaminated with medical parasites. However, the assessment of parasitic contamination in local environments in Iraq remains unclear and requires further local studies.

In Iraq, recent studies evaluating bacterial contamination in the American cockroach found that these insects play a significant role in transmitting dangerous pathogens, as American cockroaches in the houses of the Diwaniyah Governorate were contaminated with numerous

antibiotic-resistant bacterial species.<sup>(19)</sup> And this is what the study<sup>(20)</sup> found for the same conclusion, but in the hospital environment in the capital, Baghdad, which leads to the hypothesis of the possibility of contamination of these cockroaches with other microscopic organisms such as parasites and in other local environments such as the environment of Salah al-Din province, and this hypothesis is based on the presence of local studies in many Iraqi provinces, all of which showed the presence of parasitic contamination carried on the American cockroach, including in the environment of schools and homes in the city of Mosul<sup>(21)</sup>, which showed that the American cockroach in these environments carries many parasitic species, including *Ancylostoma duodenale*, *Nyctotherus ovalis*, and many other parasitic species and in the environment of the houses of the city of Baquba, the American cockroaches from toilets, kitchens and rooms were contaminated with different types of medicinal parasites, including *Enterobius vermicularis* and *Giardia species*<sup>(22)</sup>.

Despite the large number of studies conducted globally, the researchers felt that more in-depth studies should be conducted locally, given the scarcity of research on them. To our knowledge, no previous studies have examined the role of American cockroaches as potential vectors of human intestinal parasites in Salah al-Din Governorate. The current study aimed to isolate American cockroaches from various regions and environments in Salah al-Din Governorate and to determine the percentage of contaminated American cockroaches with medical parasites.

## MATERIALS AND METHODS

### Sample collection

One hundred and fifty American cockroach samples were collected from the beginning of October to the end of December 2024, and 4 sites in the Dhuluiya area were tested, namely the sewers of houses, schools, hospitals, and restaurants. All cockroaches collected were identified by the Iraqi Natural History Center Research and Museum on 17 Dec 2024.

### Isolation and Identification of External Parasites

All collected American cockroaches were placed in sterile bottles and euthanized at  $-4^{\circ}\text{C}$  in a refrigerator according to (23), followed by the addition of 10 ml of sterile normal saline to each tube and vigorous shaking to displace eggs and larvae of external parasites; then the samples were transferred to 70% ethanol to prevent contamination for further identification of internal parasites. The solution phase of the pre-vigorous tubes was centrifuged at 3000 rpm for 5 min, and the pellets were examined microscopically using a drop of Lugol's iodine solution.(24).

### Isolation and Identification of Internal Parasites

The isolation of internal parasites protocol was done according to (21) In brief, all isolated cockroaches were anatomized, and the digestive tracts from all samples were separated, rinsed with distilled water, mixed with 10 ml of normal saline, and filtered through a sterile filter.(7) The pellets were centrifuged for 5 min at 2000 rpm, and the pellets were examined microscopically for identification of internal parasites using Lugol's iodine dye.

### Identification of Parasites

Identification of all isolated external and internal parasites was performed according to the most recent key. (25) According to the size, shape and number of cysts and oocysts.

### Statistical analysis

Significant differences in the prevalence of infected cockroaches and in the percentages of each parasite between selected areas were determined using the Chi-square test in SPSS (v.23).

## RESULTS

Table 1 shows the results of collecting samples from American cockroaches and the number of infected samples by month. The results indicated that 150 American cockroach samples were collected. December had the highest number of samples (89, 82.02%), while October had the least (19, 47.37%). The same table shows that 66.67% of the 100 American cockroaches collected in Al-Dhuluiya, Salah al-Din, were infected.

**Table 1: Distribution of collected cockroaches and infected samples.**

Month	Number of collected cockroaches	Number of infected cockroaches	Percentages (%)
October	19	9	47.37
November	42	18	42.86
December	89	73	82.02
Total	150	100	66.67

Samples collected in the present study were from 4 different locations in higher Al-Dhuluiya (homes, schools, hospitals, and restaurants). Table 2) shows a significant difference ( $P < 0.05$ ) in the percentages of parasitic contamination among cockroaches collected from the 4 locations; restaurants had the highest contamination rates, with 27 out of 34 (79.41%) of the collected samples testing positive

for different types of parasites, while homes had the second highest rate at 77.97%. Also, the present study shows that both schools and hospitals were less likely to harbor cockroaches contaminated with medical parasites, as Table 2 shows that the percentage of infected samples from hospitals was 64.41%, and from schools, 50%.

**Table 2: Percentages of parasitic cockroach contamination in the locations.**

Sites	Number of collected sample	Number of infected samples	Percentage (%)
Homes	59	46	77.97
Schools	32	16	50
Hospitals	25	11	64.41
Restaurants	34	27	79.41
<b>Totals</b>	<b>150</b>	<b>100</b>	<b>66.67</b>
<b>P-value</b>	<b>0.000</b>		

Table 3 shows that the rate of internal parasitic infection was higher than that of external parasitic infection, with 46 of 100 cockroaches contaminated

with internal parasites. In comparison, the highest percentage was 78 infected cockroaches out of 100.

**Table 3: Contamination percentages of external and internal cockroaches with parasites.**

Cite	Number of contaminated cockroaches	Percentages (%)
External	46	46
Internal	78	78

The present study reports the isolation of 20 parasite species at different life stages. Table 4 shows that *Nectothyrus ovalis* has a high prevalence of cockroach contamination among restaurant samples (11 samples). In comparison, *Giardia lamblia* has a high prevalence rate of isolation from cockroaches collected in homes (14 samples). Additionally, cockroaches collected from schools were more contaminated by both *Nectothyrus ovalis* and *Strongyloides stercoralis*. Cockroaches collected from hospitals frequently contained the last

parasites. Restaurants had more cockroaches contaminated with both *Nectothyrus ovalis* and *Giardia lamblia* (trophozoite) (13 each). Other parasites were also recorded in the present study; *Trichomonas hominis* was more prevalent in cockroaches collected from homes, as were *Entamoeba coli* cysts. However, the statistical analysis of the present study shows no significant difference ( $P < 0.05$ ) in the prevalence of all parasites isolated from cockroaches from all sites.

Table 4: Frequency of contaminated parasites from cockroaches' surfaces.

Parasites	Homes	Schools	Hospitals	Restaurants	Total
<i>Nectothyrus ovalis</i>	11	4	2	13	30
<i>Giardia lamblia</i> (trophozoite)	14	1	1	13	29
<i>Strongyloides stercoralis</i>	9	4	4	4	21
<i>Trichomonas hominis</i>	6	0	3	2	11
<i>Enterobius vermicularis</i>	3	3	0	4	10
<i>Entamoeba coli</i> (cyst)	5	1	1	1	8
<i>Hymenolepis</i> sp.	2	1	3	2	8
<i>Entamoeba histolytica</i> (cyst)	3	2	0	1	6
<i>Ancylostoma daudenal</i>	3	2	1	0	6
<i>Dipylidium</i>	1	2	1	2	6
<i>Enterobius vermicularis</i> (eggs)	2	0	0	2	4
<i>Fasciola hepatica</i>	0	2	0	1	3
<i>Schistosoma mansoni</i>	2	0	0	0	2
<i>Toxocara canis</i>	0	1	0	1	2
<i>Ascaris lumbricoides</i>	0	1	1	0	2
<i>Balantidium coli</i> (trophozoite)	1	0	0	0	1
<i>Taenia</i> sp.	1	0	0	0	1
<i>Diphyllobothrium latum</i>	0	1	0	0	1
<i>Hymenolepis</i> eggs	0	1	0	0	1
<i>Trichuris trichiura</i> eggs	0	0	0	1	1
P-value	0.154				

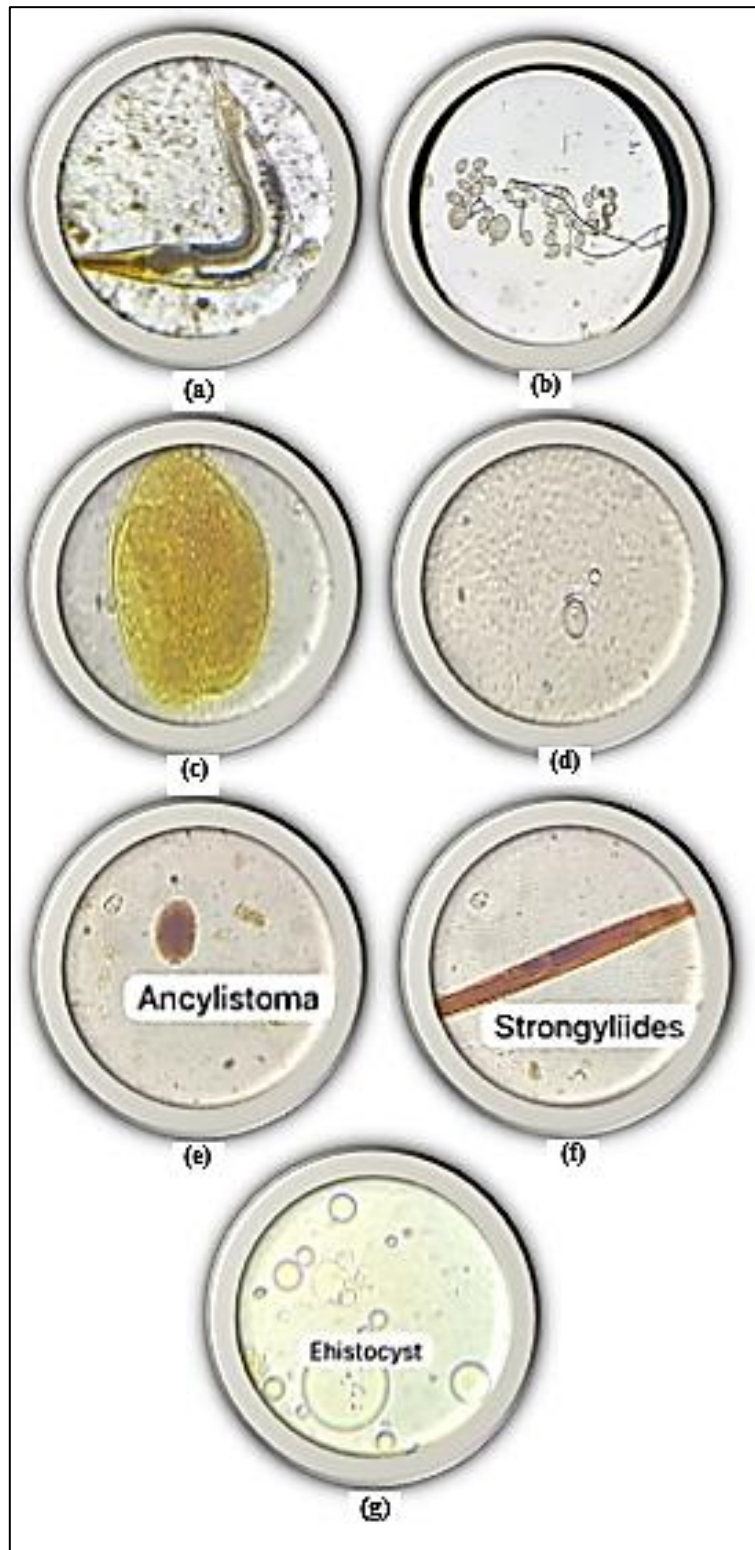


Figure 1: Microscopic examination of parasites isolated from American cockroaches. *Strongyloides stercoralis* (a). *Nectothyrus ovalis* (b). *Balantidium coli* (c). *Hymenolepis* eggs (d). *Ancylostoma daudenal* (e). *Strongyloides stercoralis* (f). *Entamoeba coli* (cyst) (g).

## DISCUSSION

Due to the lack of good data about the parasitic contamination of American cockroaches in Al-

Dhuluiya in the district of Salah Aldin, especially in eligible areas by population like homes, schools, hospitals, and restaurants, the present study aimed

to evaluate the medical parasitic contamination carried by American cockroaches from a crucial area in Al-Dhuluiya in the district of Salah Aldin.

The present study (as shown in Table 1) shows that the percentage of contaminated American cockroaches with medical parasites were 66.67%, and this result was brought into line with the results of <sup>(19)</sup> In the same area, the researchers found that the percentage of contaminated cockroaches exceeded 50%; however, the results differed from those of a recent study in Iraq. <sup>(21)</sup> which indicates that the medical parasitic contamination of American cockroaches reaches 96.4%, and the reasons for these differences may be differences in geographic area, as the study was conducted in Mosul city.

The present study also shows that the homes and restaurants in Al-Dhuluiya sheltered more American cockroaches contaminated with medical parasites; this finding is consistent with the results of a local study of <sup>(26)</sup> which aimed to evaluate the microbial contamination from American cockroaches and show that both locations were highly contaminated with medical bacteria associated with American cockroaches, as well as the results of other geographical areas show the same findings <sup>(8, 27)</sup>.

Cockroaches are among the most common hosts of medically important microbes that affect humans, such as viruses, bacteria, and parasites. In the present study (Table 4), 20 different parasites were isolated from contaminated cockroaches, and this was more than recorded by <sup>(28)</sup> In a study aimed to isolate the parasitic contamination from American cockroaches in Bulgaria, while this number was exactly as recorded in Iraq by <sup>(21)</sup> that record 20 different parasites from cockroaches, as well as the isolated parasite species, were much like what scientific studies have reported <sup>(8, 29)</sup>.

Most of the parasites isolated in the present study are responsible for various human diseases. *Nectotherus ovalis* is the most prevalent parasite isolated in the present study, and this finding is similar to the findings of <sup>(21)</sup> which reported a

61.84% isolation rate for *Nectotherus ovalis* in cockroaches collected from homes, and the most prevalent (82.85%) was found in cockroaches collected from schools. The statistical analysis of the present study shows no significant difference in the number of isolated parasites across locations, indicating that cockroach contamination is not related to location type.

The present study indicates that the internal contamination with parasites is more than external contamination (as shown in Table 3), and several previous studies, such as local studies confirm this <sup>(19, 21)</sup>, and several other studies in different geographical areas, such as Indonesia <sup>(30, 31)</sup>. The reason for this finding may be the nutritional habits of American cockroaches, which contribute to their high prevalence of internal parasitic contamination, as well as the loss of many eggs and other developmental stages of parasites from external sources during movement. <sup>(19, 30)</sup>.

## CONCLUSIONS

Most cockroaches in homes, schools, hospitals, and restaurants in Dhuluiya city/ Salah Al-Din/Iraq were medically important parasites. The number of parasites was not correlated with the type of area, and these areas may be sources of parasite-related disease, such as gastrointestinal infections or allergic reactions, affecting the health of individuals in those environments.

## REFERENCES

1. Crespo A, de Armas Y, Capó V, Iglesias E, Palomares-Marín J, Fonte L, et al. Pathogens of Medical Importance Identified in Hospital-Collected Cockroaches: A Systematic Review. *Microorganisms*. 2025;13(2):337. DOI: [10.3390/microorganisms13020337](https://doi.org/10.3390/microorganisms13020337)
2. Novia A, Windusari Y. THE RELATIONSHIP BETWEEN SANITARY HYGIENE AND PHYSICAL ENVIRONMENTAL CONDITIONS WITH COCKROACH DENSITY IN THE CANTEEN OF SRIWIJAYA UNIVERSITY INDRALAYA CAMPUS IN 2024. *HEARTY*. 2024;12(2):384-92. DOI: [10.32832/hearty.v12i2.11210](https://doi.org/10.32832/hearty.v12i2.11210)

3. Yun S, Choi JH, Oh S, Kim M, Yi MH, Kang D, et al. Microbiome of laboratory-reared and environmentally collected cockroaches. *Entomological Research*. 2024;54(4):e12727. DOI: [10.1111/1748-5967.12727](https://doi.org/10.1111/1748-5967.12727)
4. Abudin S, Martini M, Nurjazuli N. Factors that trigger cockroach density: A literature review. *Majalah Kesehatan Indonesia*. 2023;4(2):71-6. DOI: [10.47679/makein.2023157](https://doi.org/10.47679/makein.2023157)
5. Muhsin SN, Daoud IS. A comparison between microscopic and ELISA techniques in the diagnosis of *Giardia lamblia* infection, with an epidemiological and biochemical study among children under 10 years in Tikrit District. *Tikrit Journal of Pure Science*. 2015;20(3).
6. Guzman J, Vilcinskis A. Bacteria associated with cockroaches: health risk or biotechnological opportunity? *Applied microbiology and biotechnology*. 2020;104:10369-87. DOI: [10.1007/s00253-020-10931-1](https://doi.org/10.1007/s00253-020-10931-1)
7. Linnaeus, C.V. *Systema Naturae per regna tria naturae* (1758).
8. Atiokeng Tatang R, Tsila H, Wabo Poné J. Medically important parasites carried by cockroaches in Melong Subdivision, Littoral, Cameroon. *Journal of Parasitology Research*. 2017;2017(1):7967325. DOI: [10.1155/2017/7967325](https://doi.org/10.1155/2017/7967325)
9. Adenusi AA, Akinyemi MI, and Akinsanya D conducted a study on domiciliary cockroaches as carriers of human intestinal parasites in Lagos Metropolis, Southwest Nigeria, highlighting the implications for public health. *Journal of arthropod-borne diseases*. 2018;12(2):141
10. Akeju AV, Olusi TA, Obi R-TE. Intestinal Parasites Associated with American Cockroach (*Periplaneta americana*) in Akure, Ondo State, Nigeria. *Journal of Parasitic Diseases*. 2024;48(1):67-73. DOI: [10.1007/s12639-023-01633-z](https://doi.org/10.1007/s12639-023-01633-z)
11. Gutiérrez AC, Machado J, Hubner-Campos R, Pennisi M, Rodrigues J, López Lastra CC, et al. New insights into the infection of the American cockroach *Periplaneta americana* nymphs with *Metarhizium anisopliae* sl. *Journal of Applied Microbiology*. 2016;121(5):1373-83. DOI: [10.1111/jam.13271](https://doi.org/10.1111/jam.13271)
12. Parhomenko O., Ostapchuk V., Komlyk V., & Brygadyrenko V. Influence of medicinal plants on *Blaberus craniifer* cockroaches and their parasites, gregarines, and nematodes. *Biosystems Diversity*. 2024;32(3):398-405. DOI: [10.15421/012440](https://doi.org/10.15421/012440)
13. Hajare ST, Gobena RK, Chauhan NM, Eriso F. Prevalence of intestinal parasite infections and their associated factors among food handlers working in selected catering establishments from Bule Hora, Ethiopia. *BioMed Research International*. 2021;2021(1):666974. DOI: [10.1155/2021/666974](https://doi.org/10.1155/2021/666974)
14. Petersen LR, Cartter ML, Hadler JL. A food-borne outbreak of *Giardia lamblia*. *The Journal of Infectious Diseases*. 1988;157(4):846-8. DOI: [10.1093/infdis/157.4.846](https://doi.org/10.1093/infdis/157.4.846)
15. Di Giovanni F, Wilke AB, Beier JC, Pombi M, Mendoza-Roldan JA, Desneux N, and others discuss the parasitic strategies of arthropods that are important in medical and veterinary contexts. *Entomologia Generalis*. 2021;41(5). DOI: [10.1127/entomologia/2021/1301](https://doi.org/10.1127/entomologia/2021/1301)
16. Maji A, Ahmed U. Identification of parasites of public health importance from the body of the cockroach (*Periplaneta Americana*). *African Journal of Advances in Science and Technology Research*. 2023;10(1):97-102.
17. Hashim NA, Bakar AA. The isolation of human intestinal parasites from American cockroaches: A preliminary study. *Transactions on Science and Technology*. 2023;10(3):170-4.
18. AMBARNINGRUM TB, et al. The composition and abundance of cockroaches in the traditional markets of Purwokerto City, Indonesia. *Biodiversitas Journal of Biological Diversity*. 2024;25(6). DOI: [10.13057/biodiv/d250625](https://doi.org/10.13057/biodiv/d250625)
19. Cevahir F, Düzlü Ö, Atelge M, Yıldırım A. Phylogenetic characterization of cockroaches in Türkiye and determination of their vector potential. *Ankara Üniversitesi Veteriner Fakültesi Dergisi*. 2024;71(4):417-26. DOI: [10.33988/auvfd.1219500](https://doi.org/10.33988/auvfd.1219500)

20. Al-Fattly H, Al-Aridhi HS. Antibiotic-resistant bacteria associated with the cockroach *Periplaneta americana* in Al-Diwaniya city/Iraq. *Int J Adv Res.* 2014;2:709-14.
21. AL-Marjani MF, et al. Cockroaches: reservoirs of metallo  $\beta$ -lactamase and extended-spectrum  $\beta$ -lactamase-producing bacteria in the Medical City Hospital in Baghdad. *Pakistan Journal of Biotechnology.* 2017;14(3):317-21.
22. Al-Badrani S, Al-Rubaye F, Abbass L. Isolation and Diagnosis of Parasites from Domestic Cockroach *Periplaneta americana* in Mosul City, Iraq. *Journal of Life and Bioscience Research.* 2024;5(02):34-41. DOI: [10.38094/jlbrs52174](https://doi.org/10.38094/jlbrs52174)
23. Iraqi household cockroaches collected from Diyala Province serve as potential vectors of medically important parasites. 2023. DOI: [10.21931/RB/2023.08.02.100](https://doi.org/10.21931/RB/2023.08.02.100)
24. Chamavit P., Sahaisook P., and Niamnuy N.: The majority of cockroaches in Samut Prakan province, Thailand, are carriers of parasitic organisms. *EXCLI journal.* 2011;10:218.
25. World Health Organization (WHO). Bench aids for diagnosing intestinal parasites. 2019. ISBN: 9789241515344
26. Garcia L. Diagnostic medical parasitology. 2001. DOI: [10.1128/9781555816001](https://doi.org/10.1128/9781555816001)
27. Jalil AT, et al. Bacterial contamination of cockroaches in different wards of the hospital, restaurant, and home. *Heliyon.* 2023;9(11). DOI: [10.1016/j.heliyon.2023.e21626](https://doi.org/10.1016/j.heliyon.2023.e21626)
28. Salehzadeh A., Tavacol P., and Mahjub H. Bacterial, fungal, and parasitic contamination of cockroaches in public hospitals in Hamadan, Iran. *Journal of Vector-Borne Diseases.* 2007;44(2):105.
29. Nedelchev S, Pilarska D, Takov D, Golemansky V. Protozoan and nematode parasites of the American cockroach *Periplaneta americana* (L.) from Bulgaria. *Acta Zoologica Bulgarica.* 2013;65(3):403-8.
30. Alwan ASBaAH. The study discusses the role of rotavirus, pathogenic bacteria, and parasites in causing infant diarrhea in Tikrit, as published in the *Tikrit Journal of Pure Science.* 1994;1(1):19-29.
31. ZIANE M, et al. Biodiversity of intestinal parasites carried by the external body of cockroaches... *Genetics & Biodiversity Journal.* 2022;6(2):58-63. DOI: [10.46325/gabj.v6i2.235](https://doi.org/10.46325/gabj.v6i2.235)