Volume 16 • Number 4 • December 2025 • em00850 ISSN: 1309-6621 (Online)

JOURNAL OF CLINICAL AND EXPERIMENTAL INVESTIGATIONS

REVIEW ARTICLE

Pest to potential: Cockroaches offer hope for human health

Manoj Kumar [1,2*], *Vidhi Sai Nath* [3], *Dileep Kumar Arisham* [2], *Dheeresh Kumar* [2], *Pooja Naudiyal* [4]

[1] Department of Pulmonary Medicine, Vallabhbhai Patel Chest Institute, University of Delhi, Delhi, INDIA

[2] National Centre of Respiratory Allergy, Asthma & Immunology (NCRAAI), Vallabhbhai Patel Chest Institute, University of Delhi, Delhi, INDIA

[3] Department of Botany and Life Sciences, Sri Aurobindo College, University of Delhi, New Delhi, INDIA

[4] Department of MLT & Medical Microbiology, School of Allied Health Sciences, Sardar Bhagwan Singh University, Dehradun, Uttrakhand, INDIA

ABSTRACT

Background: Cockroaches considered pests, are a valuable biological resource and people avoid cockroaches due to their appearance or movement that cause psychological disgust. Nonetheless, it's noteworthy that cockroaches are among the hardy insects that have endured on earth for several million years and possess remarkable abilities to cure illnesses. Throughout the world, especially in East Asia, cockroaches have been used for the benefit of human health due to their biologically active molecule(s), which can be applied to a range of medical conditions.

Aim & objective: This review study explores the potential role of cockroaches in the medical field by reviewing various research studies. Different studies show that the immune system of cockroaches serve as a model for possible advancements in antibiotic research. Cockroach extract, gut microbiome, hemolymph, anti-microbial, anti-cancer and cosmetic properties which could be used as treatment of diseases/therapy. It's interesting to note that cockroach allergens are utilized in allergen-specific immunotherapy (ASIT), and that cockroach body parts, saliva, and waste can cause asthma and allergies. Effective in treating allergic rhinitis/conjunctivitis, allergic asthma, and stinging insect hypersensitivity, ASIT has the potential to modify the course of the disease. Research will aid in the creation of innovative cockroach allergy treatment and diagnosis, which may eventually result in the avoidance and management of allergic asthma.

Methodology: We reviewed many literature articles from online electronic databases that were PubMed, EMBASE, Google Scholar databases and many more national and international relevant articles were studied in-detail.

Results & Conclusion: Cockroaches are often viewed as pests but they possess several positive aspects that are frequently overlooked and their ability in medical research, disease control and ecological roles highlight their importance beyond mere nuisance. These positive aspects may highlight the importance of re-evaluating our perception of these remarkable insects. Precision diagnosis and management may become future developments in cockroach immunotherapy, allowing for accurate identification of the problematic allergen.

Keywords: cockroaches, cockroach hemolymph, cockroach extracts, medicinal benefits, allergen-specific immunotherapy, allergy and asthma

Correspondence:

Manoj Kumar, Dr.

Address: Department of Pulmonary Medicine, Vallabhbhai Patel Chest Institute, University of Delhi, Delhi, INDIA

Email: manojphysiology@gmail.com

Received: 09.05.2025,
Accepted: 11.10.2025
https://doi.org/10.29333/jcei/17399

INTRODUCTION

"Tilchaṭṭā", commonly referred to as a cockroach in Hindi, is a term used in India, derived from two words "oil" and "licker", as they lick up oil and other greasy substances. Cockroaches are living medical species on earth. It has history dating back about 360 million years and a great diversity of around 4700 species [1]. Cockroaches belong to class Insecta and order Blattodea. They can degrade food and cause allergic reactions, resulting in psychological discomfort [2]. However, it is important to use pests such as cockroaches, one of the most resilient insects as an excellent source for obtaining special bioactive substances that may be used as antibiotic, antibacterial or anticancer medications. Cockroaches thrive in unhygienic environments and can survive without food, air and even submerged in water for a long duration and also including digestion of plastic and release of nutrients from recycling dead plants and dead animals [3]. Cockroaches with one or two missing.

legs can still feed, move and reproduce even after their legs are removed [4]. Several cockroach species exist worldwide, but some prominent household species are German cockroach (GC) (*Blattella germanica*), American cockroach (AC) (*Periplaneta americana*) and oriental cockroach (OC) (*Blatta orientalis*) [5, 6]. Given that cockroaches are hardly enough to survive in harsh environments, it is plausible that the gut microbiota of these insects, or its metabolites play major role. This finding should be leveraged to find biologically active compounds that will improve human health. A number of major and minor cockroach allergens, including Bla g 1, Bla g 2, Bla g 4, and Bla g 5, have been identified and characterized from the GC. Major allergens from the AC include Per a 1, Per a 2, and Per a 2, which are used in ASIT to treat people who are allergic to cockroach proteins and may alter the course of asthma and offer long-term benefits. Concurrently, a pharmaceutical business has developed a syrup that claims to treat pulmonary tuberculosis, duodenal ulcers and gastroenteritis. Cockroaches may be used as a remedy for ear pain, treat skin, mucosal injuries, inflammation and even chronic heart failure [7]. In addition to its multidrug resistance and breast cancer rebellion proteins, AC has anti-tumor properties that counteract the effects of resistance to drugs on cells and raise the likelihood of effective cancer treatments. Because lectin and other antimicrobials are present in their cavities, cockroaches are able to withstand superbugs and other pathogens. This suggests that further research into the antibacterial properties of cockroaches is necessary in the hopes of discovering new bioactive molecules that may prove beneficial to humankind. The study of review literature for this article was done by electronic databases PubMed, Google Scholar, Science direct and many more National and International relevant articles were studied in-detail.

BIOLOGICAL CLASSIFICATION

Blattodea's phylogenetic tree is separated into two groups: Ectobius, Blaberidae, and Corydioidea, among which Nocticolidae and Corydiidae are members. The Blattoidea family of termites and cockroaches includes Blattidae, Tryonicidae, Lamproblattidae, Anaplectidae, Cryptocercidae, and Isoptera. In their life cycle, roaches go through three distinct developmental stages: the egg, nymph, and adult. They are mostly oviparous and lay their eggs outside of their mother's body. The prevalent bacteria in the eggs are especially advantageous because Blattabacterium is important for nitrogen cycling, absorption and the synthesis of vital nutrients, while Lactobacillus serves as a probiotic and protects the eggs from pathogens. Bacteroides, Dysgonomonas, Porphyromonadaceae and Alistipes are the most common bacteria in the nymphal and adult stages of cockroaches, followed by Desulfovibrio and Parabacteroides [8]. Cockroaches go through an incomplete metamorphosis, with nymphs having wings and genitalia similar to adults. Some cockroach species have even shown to survive for up to four years in lab settings [9, 10]. Based on results from DNA sequencing of mitochondrial rRNA genes, cockroaches are categorized as monophyletic despite their diversity of taxa. All cockroach species are related by a common evolutionary ancestry, according to genetic evidence [11, 12]. Nonetheless, minor variations exist among many species. When fully developed, a female cockroach can lay one egg capsule every nine days, each of which has about fourteen embryos. Juvenile cockroaches usually attain sexual maturity 6-12 months after they finish their molting stages. They have a one-and-a-half-year lifespan after they reach maturity [13]. GC are the most prevalent types of indoor cockroaches with two long whiskers and wings, 15 mm long, dark brown color, seen in areas like kitchens where food is plentiful. GC mostly favor hiding in the shadows. One of the largest subspecies, AC are found all over the world. They are reddish-brown in color and can grow to a length of 40 mm. Aside from the rare occasion that they fly, AC are extremely fast runners with strong survival instincts. Since moisture is essential to their life, they are primarily found in damp, humid environments. OC are up to 30 mm long, black in color, and have partially formed wings that allow them to fly and are found in cold, damp environments, they can endure much below body temperature (**Table 1**).

ROLE OF COCKROACH GUT MICROBIOME

An old ancestry that originated more than 300 million years ago is represented by cockroaches. Because of their gregarious lifestyle, omnivorous food and rich hindgut microbial population, cockroaches are an ideal organism for researching the formation of gut microbial communities. Most animal's health and fitness depend on their gut microbiome, which also helps with nutrition absorption, energy control and the breakdown of food substrates. It also serves as a barrier against infections [15]. The gut microbiota has the ability to digest some poisons, such as pesticides [16]. The synthesis of pheromones by the hindgut microbiome facilitates social behavior promotion and aids in the digestion of items that pass through the midgut and foregut. Bacteroidota and Firmicutes bacterial lineages make up the majority of the extremely complex gut microbiome of cockroaches [17]. According to the study, bacterial communities in nymphs and adults had considerably more diversity and richness than those in AC ootheca The most prevalent core genera are known to be involved in nitrogen fixation, defense against pathogens, digesting of proteins and polysaccharides and Desulfovibrio (Proteobacteria), Fusobacterium (Fusobacteria), and Clostridium (Firmicutes) [18]. From the AC's intestines, a strain of Streptomyces that produces antibiotics was identified which was capable of creating bioactive compounds that might be developed into medications or plant protection goods [19]. Genetic elements implicated in DNA mobilization are

Table 1. Demographic details of cockroaches with human concern [14]

Scientific name	Common name	Distribution	Size (mm)	Description	Life span	Ecology
Blaberus atropos	Atropos roach	Neotropics	55-70	Dark brown to black	1-2 years	Terrestrial
Blaberus craniifer	Death's head cockroach	American tropics	50-60	Yellowish-orange Markings	425-475 days	
Blabers discoidal	Discoidal cockroach	American tropics	35-45		73+ weeks	
Biattella orientals	Oriental cockroach	Temperate zones	20-27	Reddish brown to Black	35-180 days	Cooler temperate environment
Biattella germanica	German cockroach	Universal	10-15	Light yellowish- Brown (males), Slightly darker (females)	100+ days	Warm and humid environment
Eurycotis floridan	Florida cockroach	Southern USA	30-40	Dark brown to black	1 year	
Leucophaea moderate	Maderia roach	Circumtropical	40-50	Forewings are speckled, tawny-olive color	1 year	Outdoors
Nauphoeta cinere	Cinereous or lobster cockroach	Tropical and subtropical	25-29	Ashy color	1 year	Outdoors
Neostylopyga rhombifoli	Harlequin cockroach	Circumtropical	20-25	Shining blackish brown with patches of yellow	156 days	Outdoors
Periplaneta americana	American cockroach	Universal	35-40	Shining red to chocolate brown color	1 year	Warm and humid environment
Periplaneta autralasia	Australian cockroach	Tropical and subtropical	27-33	Lateral pale yellow stripe on each forewing	4-6 months	Warm and humid environments
Periplaneta brunne	Large brown cockroach	Tropical and subtropical	31-37	Pronotum markings, pale but indistinct, similar to *P. Americana*	7-8 months	Warm and humid environments
Periptaneta futiginos	Smoky brown cockroach	Subtropical	31-35	Uniformly dark brown	215 days	Outdoors
Polyphaga saussure	Sand roach	Central and South Asia	32-44	Uniformly dark with lighter forewings (females are wingless)	3+ years	Adapted to life in loamy or clay rolls
Pycnoscelu surinamensi	Surinam roach	Universal	18-24	Dark brown to black	307 days	Outdoors
Supella longipalpa	Brown banded roach	Tropical and subtropical	10-14	Germanica without strips on pronotum	90 days	Warm and humid environment

present, suggesting that they can be shared by partners in the microbiota. First, 16S rRNA gene analysis was used to identify the makeup of the GC's gut bacterial community in cockroaches that were collected in the field and raised in a lab [20, 21]. Cockroaches are therefore potential vectors of transmission as well as reservoirs of antibiotic resistance genes [22]. Initial studies reviewing the antibacterial and anticancer properties of the molecules and bacterial metabolites found in the cockroach gut.

RESPIRATORY ALLERGIES DIAGNOSIS AND MANAGEMENT

For more than 50 years, cockroach allergy has been recognized as a significant contributing factor to asthma. Asthma and other respiratory allergies are widely believed to be significantly influenced by breathed allergens [23]. Following inhalation of cockroach extract by cockroach allergic asthmatic patients, bronchoconstriction was demonstrated in experiments, establishing a connection between cockroach allergy and asthma [24]. There was no significant link found between the severity of the illness and stress, obesity, or vitamin D, but there was a large correlation between the severity of the asthma and allergen sensitization, allergic inflammation, pulmonary physiology, exposure to ambient tobacco smoke, and severity of rhinitis [25]. One of the biggest risk factors for the onset of asthma in low-income urban populations globally is sensitization to cockroach allergens. According to skin prick testing, 60-80% of kids who have asthma are cockroach-sensitive [26]. Atopy, rhinitis severity, pulmonary physiology measurements and bronchodilator responsiveness were all linked to the need for high-dose asthma controller medication [27]. Specifically, the total number of allergen sensitizations at baseline, mild sensitization and serum IgE levels at baseline differentiated individuals with difficult-to-control asthma from those with easy-to-control illness. Various asthma endotypes have been identified including eosinophilic/atopic asthma,

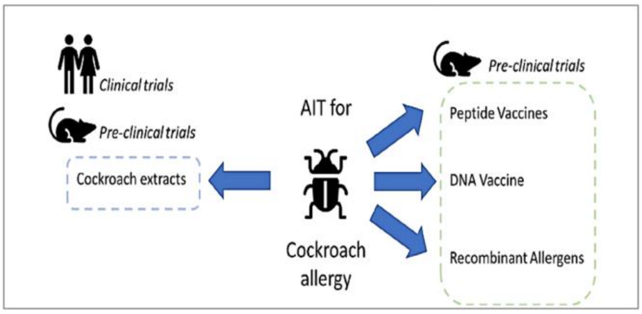

Figure 1. Different approaches to cockroach AIT which has been tested in both human clinical trials and animal pre-clinical trials [29]

neutrophilic/non-atopic asthma, mixed granulocytic asthma, paucigranulocytic asthma, type 2-high/low asthma and Th2/Th17-predominant/neutrophilicTh2/Th17-low asthma. Currently, the only therapeutic procedure that can result in the long-term treatment or elimination of allergic disorders is allergen-specific immunotherapy (ASIT). ASIT is a potentially disease-modifying therapy that is effective for the treatment of allergic rhinitis/conjunctivitis, allergic asthma and stinging insect hypersensitivity. It lowers medicine use and the chance of developing a new allergy sensitization that can result in the long-term reduction of allergic illnesses. A component resolved allergen vaccine was formulated with the B. malayi immunosuppressive protein, TGH, to treat allergies resulting from the AC. The primary allergen of P. americana, recombinant Per a 9, was combined with recombinant B. malayi TGH to create the vaccine, which was then encapsulated in cationic liposomes. In the mouse model of AC allergy, the therapeutic efficacy and molecular mechanisms of the admixed vaccine (liposome-entrapped TGH + Per a 9) were examined in relation to liposome-entrapped Per a 9 alone, liposome-entrapped TGH alone, and placebo (liposome-entrapped buffer) [28]. Only cockroach extract-based immunotherapy has been studied in human clinical trials, according to a search of the current literature. In contrast, other strategies utilizing defined and purified molecules, like recombinant allergens, peptides and DNA vaccines, are still in the preclinical proof-of-concept phase of animal model studies (**Figure 1**) [29].

AEC estimate, serum total IgE (tIgE) and skin prick testing are readily accessible instruments and markers for the assessment of allergy sufferers. One of the main allergen sources for the emergence of asthma and allergic rhinitis has been shown to be cockroaches. It is one of the major global contributors to indoor allergens [30]. Since AC is one of the cockroach species that is most commonly found in India, we employed its antigens for the skin prick test. Cockroach sensitivity has been shown to be a major cause of asthma and plays a significant part in the pathophysiology of bronchial allergies and the presence of specific IgE in the serum is the primary indicator of allergic asthma [31, 32]. When they are propelled up into the air, their saliva, faeces, and lost body parts behave like dust mites and exacerbate symptoms. It is possible to notice cockroach sensitivity even in the absence of cockroach infestation signs. However, genetic variables, specifically those related to TLRs, CLRs, and CD14, may also be significant in determining an individual's sensitivity to cockroach sensitization. Asthma-related symptoms and cockroach sensitization have been linked to several genes. The most frequent aeroallergens that caused problems were discovered to be insects (cockroach, housefly, mosquito, rice weevil and moth) in our investigation. In that order, mosquitoes (21.11%), moths (19.94%), female cockroaches (17.59%), male cockroaches (9.97%), and rice weevils (9.38%) were the next most common insect allergens [33]. Research will aid in the creation of innovative cockroach allergy treatments and diagnostics, which may eventually result in the avoidance and management of allergic asthma.

ANTI MICROBIAL ACTIVITY

The gut-inhabiting bacteria of cockroaches produce antimicrobial agents that form a potential source of novel antimicrobial compounds [34]. Cockroach hemolymph contains a variety of strong antitoxins, and it has been found that as microorganisms pass from the cuticle to the hemocoel, they come into contact with lipids, proteins, and hydrocarbons, diphenols, carbohydrates, chitin, and melanin, among other antimicrobial substances. These antimicrobials can offer information on how to combat microbial diseases like dengue fever, malaria, trypanosomiasis, and leishmaniasis. They also prevent the growth and penetration of those agents into the hemocoel insects [22, 35]. It was found that the presence of triazoles in the OC hemolymph gave a broad spectrum of antibacterial activity. Stimulation of the AC immune system resulted in the creation of antibacterial proteins and peptides that had an inhibitory effect on the bacteria and it is probably useful for developing natural antibacterial chemicals to combat harmful microorganisms [36]. AC was developed as a prescription drug for wound healing and tissue repair. Current study is examining the idea that leg regeneration in the AC is connected to a "growth factor" that may be found in the ethanol extract of the AC which is used to treat wounds and repair tissue in humans. Lectins help cockroaches identify pathogenic bacteria and subsequently suppress their harmful activities in the hemolymph [37]. These molecules, found in the hemolymph of invertebrates, are generally involved in immune responses that include wound healing, phagocytosis, hemolymph coagulation, encapsulation, parasite and bacterium removal [38, 39]. Streptomyces griseus was observed to enhance lectin activity and cause S. griseus agglutination when added to the hemolymph of AC [40]. Hemolymph produced by bacteria was reported to have antibacterial properties against 13 types of human pathogenic bacteria via inducing the AC immune system. The current study also discovered that injecting E. coli to stimulate the cockroach's immune system resulted in the release of antibacterial compounds and that the induced hemolymph inhibited the growth of two susceptible bacterial strains, namely S. aureus (Gram-positive) and E. coli (Gram-negative). It was found that non-induced hemolymph lacked antibacterial efficacy against both susceptible and resistant strains of bacteria [41, 42]. This is likely because the susceptible bacteria developed resistance to the hemolymph's lipopolysaccharide content. Additionally, it was shown that certain substances in cockroach brains have antibacterial properties against hazardous strains of E. coli and methicillin-resistant S. aureus (MRSA) The results of the study indicate that Kocuria rosea and Bacillus licheniformis have excellent antibacterial action, but Bacillus subtilis has none. Kocuria rosea is effective against MRSA and Streptococcus mutants, while Bacillus licheniformis is particularly powerful against Candida albicans. There is no action against Salmonella enterica exhibited by any of the gut-isolated bacteria. According to these findings, it may be possible to combat the issue of multidrug-resistant human infections by using the metabolites of these bacteria in place of currently prescribed antibiotics [43]. The development of novel antibacterial medications will be made possible by more research on this hemolymph of the bioactive component [44]. From the digestive tract of the AC, important medicinal fungi were isolated and identified. Aspergillus species (67.4%), Penicillium species (11.6%), Mucorales species (11%), Candida species (10.5%), and Rhodotorula species (8.4%) were the primary fungus that were isolated [45]. Cockroaches have developed complex coping mechanisms to cope with their unclean surroundings. In response to bacterial and fungal infections, the cells secrete antimicrobial peptides into the hemolymph and have built-in detoxifying systems. Concurrently, a pharmaceutical business has developed a syrup that may claims to treat pulmonary tuberculosis, duodenal ulcers, and gastroenteritis [46]. The potential discovery of novel antimicrobial drugs from insects, like cockroaches, has prompted us to examine the antibacterial properties of their different tissues in AC.

ANTI-CANCER ACTIVITY

Since cancer is one of the leading causes of death, much in-depth research is required. According to studies, AC has anti-tumor activities that mostly entail reversing drug resistance, suppressing angiogenesis, inducing cell cycle arrest and death, and inhibiting the development of tumor cells. Given that cockroaches are among the most productive and varied insects, and because of their widespread application in traditional Chinese medicine (TCM), their lysates and gut microbiota could be a valuable source of new, potentially medicinal bioactive compounds. Cockroach extracts may target breast cancer resistance proteins and multidrug resistance proteins, which counteract the effects of drug resistance on cells and increase the likelihood of effective cancer treatments and is cockroach extracts anti-cancer capabilities. Removing Staphylococcus xylosus from the gut microbiome of cockroaches showed anti-cancer effects by inhibiting the growth of the PC-3 human prostate cancer cell line [4]. In Lewis lung cancer cells, AC extracts caused apoptosis by up-regulating the expression of the genes for Fas, Fas receptor (FasR) and p53 and down-regulating the expression of Bcl-2. Furthermore, a study found that the mitochondrial pathway was the means by which AC extract caused human hepatocellular carcinoma SMMC-7721 cells to undergo apoptosis. It has been shown that AC extracts can stop progesterone receptor-negative endometrial cancer cells from growing by up-regulating p53 expression and down-regulating C-erbB-2 expression, which blocks the cell cycle. Human lung cancer cells H125 could have their cell cycle stopped in the S phase by AC extract [47]. Furthermore, the proliferation of three human and animal leukemia cell lines were inhibited by the AC extract and it has a positive clinical impact as a type of TCM, and research on its anti-tumor effects is getting better. P. americana fresh adults or dried worms are frequently utilized as TCM drugs. Its nature is frigid, and its taste is bitter and salty that help with digestion, aid in detoxification, remove blood stasis, increase blood circulation and cause diuresis to alleviate edema. Insect bites, tonsillitis, body phlegm, carbuncles and infantile malnutrition can all be treated with AC. According to current pharmacological research, AC can also function as an antioxidant, analgesic and anti-inflammatory in addition to boosting immunity, promoting tissue repair, regulating blood pressure, improving microcirculation and protecting the liver. China has created some clinical medications containing the active compounds identified from AC, has strong anti-bacterial and anti-tumor effects. In individuals with hepatitis B virus infection, it has been shown to lessen liver inflammation, encourage the restoration of liver function, and lessen the severity of liver fibrosis. P. americana possesses anti-inflammatory, analgesic, anti-tumor, anti-bacterial, antiviral, anti-radiation and detumescence properties. The removal of OH and 2,2-diphenylpicrylhydrazyl free radicals indicates that AC has a strong antioxidant ability as well. The therapies have the ability to stop tumor cells ability to metabolize energy and to synthesize proteins, RNA, and DNA. A growing body of research has demonstrated that AC has anti-tumor effects on a range of cancer cells [47].

FUTURE PERSPECTIVE OF COCKROACHES

In the future, the cockroach could be seen in a more positive light as advancements in science and technology and have its potential benefits as ecosystem cleaners and even medical research.

- **Ecosystem cleaners:** Cockroaches help break down organic materials in their surroundings, acting as nature's decomposers. They replenish the nutrients in the ecosystem by feeding on decomposing plant matter and other organic waste. Through their vital function, cockroaches help to preserve a stable and hygienic environment.

- **Food source for wildlife:** In the wild, cockroaches are an important source of food for many predators, including birds, rodents, and amphibians. These insects help the animals develop and survive by giving them a high-protein diet. Certain predator populations may decline in the absence of cockroaches, leading to perturbations in the food chain.
- **Medical research:** Cockroaches have made a major contribution to key developments in medical research, against popular belief. Scientists have studied them to learn more about immune responses and the treatment of illnesses because of their hardiness and resistance to certain diseases. The immune systems of cockroaches have served as a model for possible advancements in antibiotic research. Scientists produced synthetic nerves that caused cockroach muscles to react. This could eventually lead to significant advancements in touch-sensitive robots or human prosthetic limbs [3].
- **Allergen:** Although they can cause allergies in certain people, cockroach allergens have been essential to the study of allergies. Beyond cockroach-related sensitivity, these allergens have helped scientists better understand and manage a variety of allergies by enabling them to research allergic reactions and create therapies. Precision diagnosis will be a future development in cockroach immunotherapy, allowing for accurate identification of the problematic allergen. Afterwards, standardized allergens that have been treated to preserve an immune response without causing allergic reactions will be used in precision immunotherapy. In order to modulate the immune response away from the allergic response, this strategy can be combined with contemporary adjuvants and delivery methods that support a Th1/Treg milieu [48]. There are several issues with allergen immunotherapy (AIT)'s current implementation that must be resolved. First, specified allergens, which are now readily manufactured in the laboratory, should be used in place of extracts that are prone to content and quality variations. This will yield medicinal compounds that are standardized, reproducible, and free of contaminants and poisons. Secondly, it is also common for the usage of entire allergens, as present in the extracts, to cause unwanted allergic reactions. Similar immunomodulatory effects could be obtained without the undesirable side effects by altering the allergen genetically, synthetically generating T- or B-cell epitopes, or deleting the IgE epitopes while keeping other immunological components of the allergen. It's also important to concentrate on immunotherapy based on allergen groups (such as tropomyosin, arginine kinase, etc.) rather than the particular allergen source, particularly for allergen sources without a dominant allergen, like cockroach allergens. Several results showing cross-reactivity among allergen groups support this strategy. Third, because of the time and financial strain involved, the length of the "standard" three-year immunotherapy has been a topic of discussion [49].
- **Environmental indicators:** Cockroaches are a good way to gauge the health of your surroundings. Their existence or absence in some ecosystems might reveal information about the state of the surrounding environment. Cockroach population fluctuations may indicate changes in humidity, temperature, or other elements that affect the insect's ability to survive.
- **Biodiversity and adaptability:** With a multimillion-year evolutionary history, cockroaches are one of the oldest insect groups. They can survive in a variety of settings, from urban areas to tropical jungles, because of their diversity and flexibility. Researchers can learn more about evolution and how animals can adapt to changing environments by examining their adaptability.
- **Garbage decomposers:** By eating food scraps and other organic materials, cockroaches aid in the breakdown of garbage in metropolitan environments. This can help create a more sustainable waste management system by lowering the quantity of waste that ends up in landfills.
- **Nutrition cycle:** By assisting in the decomposition of organic matter, cockroaches play a role in the cycle of nutrients. By replenishing the soil with essential nutrients, this procedure improves soil fertility and promotes plant development. Their function in recycling nutrients is essential to the upkeep of thriving ecosystems.
- **Source of protein:** Cockroaches are eaten as a source of protein in various cultures. Although this may not be a common practice, it illustrates how these insects may be used as a substitute source of protein in areas where conventional cattle production is not practical [3, 50].

CONCLUSION

For medical research, cockroaches offer distinctive biological characteristics. Their robust immune systems, capacity for regeneration and variety of microbial interactions provide prospective insights into the creation of new compounds, the investigation of wound healing mechanisms and the advancement of biotechnological applications. Although they are frequently considered pests, cockroaches have a number of advantages that go beyond their unfavorable reputation. They support scientific study, are vital to ecosystems, provide food for wildlife, and even shed light on allergies and immunological reactions. By shifting the perspective from pest to potential of cockroach, we can unlock new medical innovations in healthcare.

Author contributions: **MK:** supervision, conceptualization, methodology, writing - original draft; **VSN:** data curation, validation, writing - original draft; **DKA:** formal analysis, writing - review & editing; **DK:** administration, editing, acquisition; **PN:** investigation, resources, visualization, and proofreading; All authors have agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: The authors stated that the study does not require any ethical approval. This standard review article does not involve human or animal subjects directly and synthesized information from existing published studies.

AI statement: The authors stated that generative AI and other AI-based tools are powerful technologies that can be used to create new content and perform a variety of tasks.

Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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