International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 25-10-2024, Accepted: 24-11-2024, Published: 09-12-2024
Volume 9, Issue 12, 2024, Page No. 116-119

The role of insects in Medicine: Unlocking novel treatments and bioactive compounds

Pritam N Dube[1*], Yogita B Thombare[2], Sainath B Aher[3], Sujit A Jadhav[4]
[1] Department of Pharmaceutical Chemistry, Sandip Foundation's Sandip Institute of Pharmaceutical Sciences, Mahiravani, Nashik, Maharashtra, India
[2] Department of Pharmaceutical Chemistry, Mahatma Gandhi Vidyamandir Pharmacy College, Panchavati, Nashik, Maharashtra, India
[3] Department of Pharmaceutical Chemistry, K. K. Wagh College of Pharmacy, Panchavati, Nashik, Maharashtra, India
[4] Department of Pharmaceutics, KCT's R. G. Sapkal College of Pharmacy, Anjaneri, Nashik, Maharashtra, India

Abstract
Insects have been utilized in traditional medicine for centuries, offering a diverse range of bioactive substances with therapeutic potential. Recent scientific advancements have highlighted the importance of insect-derived products, such as honey, propolis, bee venom, silk, and various insect proteins, in modern healthcare. These substances have demonstrated efficacy in treating a variety of conditions, including chronic wounds, inflammation, cancer, neurological disorders, and immune system support. The growing interest in entomotherapy underscores the promising role of insects in regenerative medicine, drug delivery systems, and sustainable nutrition. However, challenges remain in standardizing insect-derived therapies and conducting extensive clinical trials to establish their safety and efficacy. Future research should focus on optimizing production methods, exploring cross-disciplinary collaborations, and addressing ethical and environmental concerns. This review provides an overview of current insect-based treatments, their potential applications, and the future directions of insect-derived therapies in the medical field.

Keywords: Insects, apitherapy, insect venom, traditional medicine, regenerative medicine

Introduction

Insects have been an integral part of traditional medicine for centuries and are increasingly being studied for their potential therapeutic applications in modern medical science. The medical use of insects spans a wide range of practices, from apitherapy and entomotherapy to the application of insect-derived compounds in pharmacology and nutrition. The diversity of therapeutic benefits offered by insects is a reflection of their unique biochemistry and ecological roles, including antimicrobial, anti-inflammatory, analgesic, and wound-healing properties. This review explores the major insect species utilized in medicine, their active compounds, and the growing scientific interest in insect-based therapies [1].

One of the most well-known branches of insect-based therapy is apitherapy, which involves the use of products derived from honeybees (Apis mellifera), such as honey, propolis, royal jelly, and bee venom [2]. Honey has been used for thousands of years for its antimicrobial properties, especially in wound healing and the treatment of burns, ulcers, and sore throats. The application of honey to wounds promotes healing by maintaining a moist environment and preventing bacterial growth. Propolis, a resinous substance collected by bees from tree buds, has shown promise in treating infections, inflammation, and even in cancer therapy, due to its potent antimicrobial and antioxidant effects. Royal jelly, a secretion used to nourish the queen bee, is believed to have anti-aging, immune-boosting, and neuroprotective effects, while bee venom is used in apitherapy to alleviate symptoms of rheumatoid arthritis, multiple sclerosis, and other inflammatory conditions. Bee venom contains compounds such as melittin, which have been shown to possess anti-inflammatory and analgesic properties, thus supporting its use in pain management and autoimmune diseases [1, 2, 3].

In addition to honeybees, other insects have also gained attention for their medicinal value. For instance, silkworms (Bombyx mori) have long been used for their silk production, but they also provide valuable biological materials for medical applications. Silk proteins, such as fibroin and sericin, are used in wound healing and tissue regeneration due to their biocompatibility and bioactive properties. Silk is also being explored for its potential in drug delivery systems and regenerative medicine [4, 5]. Maggot therapy, which involves the use of sterile fly larvae (usually from the green bottle fly, Lucilia sericata) to clean chronic wounds, has become an established treatment for non-healing wounds. The larvae secrete enzymes that digest necrotic tissue, promoting faster healing while simultaneously preventing infection [6].

Moreover, termite-derived substances have shown potential in traditional medicine for their ability to treat wounds and infections. In some cultures, termite mound clay has been applied topically to wounds, where it is believed to have antimicrobial and healing effects [7]. Similarly, extracts from cicadas (Cryptotympana atrata) have been used in traditional Chinese medicine for centuries to treat fevers, coughs, and sore throats, due to their anti-inflammatory and antipyretic properties. Ant venom from fire ants has also been employed in folk medicine for its ability to reduce pain and inflammation, and recent studies have suggested that it could have potential applications in cancer therapy due to its ability to target cancer cells without harming healthy tissue [8, 9].

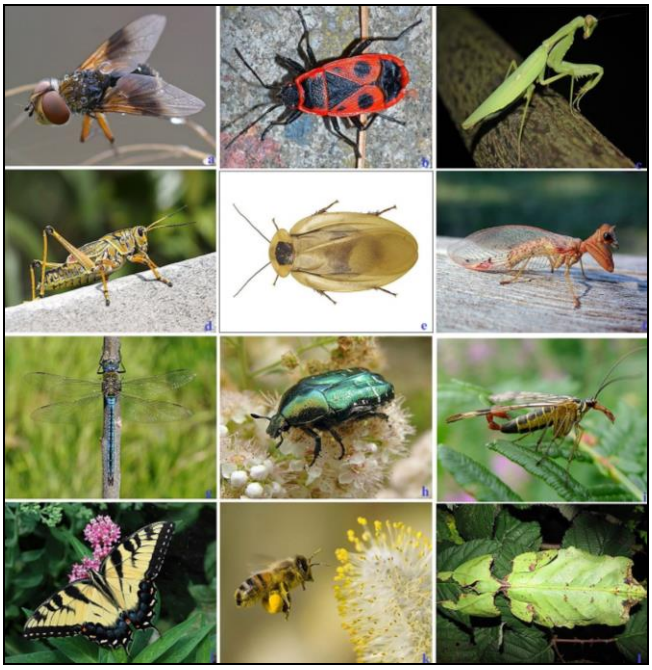

Fig 1: Some insects used in medicine production

Insects also provide valuable nutritional supplements. Cricket protein, derived from crickets, has gained significant interest as a sustainable and high-protein alternative to traditional animal-based proteins. Research has shown that cricket protein not only serves as a nutritious food source but also possesses anti-inflammatory and antioxidant properties, making it beneficial for overall health. Additionally, earthworms have been utilized in traditional Chinese medicine to treat conditions like stroke, blood clots, and inflammation. The biological activity of earthworm extracts, particularly their ability to modulate the immune response, has drawn attention in contemporary research as a potential therapeutic avenue [10, 11].

The growing field of entomotherapy—the medical use of insects—has led to the discovery of various insect-derived compounds with significant pharmacological potential. Research into the venom of spiders, particularly from species like the Brazilian wandering spider (Phoneutria nigriventer), has revealed peptides with powerful analgesic effects. These peptides may offer an alternative to opioid painkillers, providing pain relief without the addictive properties of traditional pharmaceuticals. Insect-derived toxins are being explored for their potential to treat a variety of medical conditions, ranging from chronic pain and inflammation to neurological disorders and even cancer [12, 13].

In addition to their direct medicinal uses, insects are also gaining attention as part of sustainable and eco-friendly pharmaceuticals. Insect farming for the production of therapeutic compounds offers a less resource-intensive alternative to traditional drug manufacturing processes, making insect-based therapies a promising avenue for addressing global health challenges, particularly in resource-limited settings. As insect-based products are increasingly recognized for their therapeutic value, it is likely that new insect species and their bioactive compounds will continue to emerge as valuable resources for modern medicine.

Overall, the use of insects in medicine represents a rapidly evolving field that blends traditional knowledge with cutting-edge scientific research. While much remains to be explored, the potential of insect-derived products in the treatment of various diseases and their role in promoting overall health is undeniable. As research in entomotherapy and related fields progresses, insects may play an even more prominent role in the development of novel therapeutic agents.

Table 1: Uses of insects derived bioactive compounds

Insect Species	Substance	Uses	References
1. Bees (Apis mellifera)	Honey	Used for its antibacterial and wound-healing properties; treats sore throats, burns, and ulcers.	[14]
	Propolis	A resin-like substance with antimicrobial, antifungal, and anti-inflammatory properties.	[15]
	Bee Venom	Used in apitherapy for arthritis, multiple sclerosis, chronic pain; reduces inflammation and stimulates healing.	[16]
	Royal Jelly	Rich in proteins and vitamins; used to boost immune health and improve skin conditions.	[17]
2. Silkworms (Bombyx mori)	Silk	Used in sutures and wound healing; shows potential in drug delivery and tissue regeneration.	[18]
	Silk Proteins (Sericin & Fibroin)	Used in cosmetics and medicine for moisturizing and anti-aging properties.	[19]
3. Termites (Isoptera)	Termite Mound Clay	Used as a poultice in traditional African and Asian medicines for treating wounds and infections; has healing properties.	[20]
	Termite Enzyme Extracts	Potential antimicrobial agent as suggested by studies.	[21]
4. Cicadas (Cicadidae)	Cicada Shells (Cryptotympana atrata)	Ground into powder in Traditional Chinese Medicine (TCM) for treating fevers, headaches, and sore throats.	[22]
5. Ants (Formicidae)	Ant Venom	Used for pain relief and inflammation reduction; potential use in cancer treatment and antimicrobial agents.	[23]
	Formic Acid	Extracted from ants; used for antiseptic and anti-inflammatory properties.	[24]
6. Ladybugs (Coccinellidae)	Ladybug Extracts	Compounds with antimicrobial properties; potential as natural insecticides in agriculture.	[25]
7. Mosquitoes (Culicidae)	Mosquito Larvae	Used in traditional medicine for healing properties, wound healing, and as a nutrient source.	[26]
	Mosquito Saliva	Contains proteins under research for treating allergic reactions and inflammation.	[27]
8. Maggots (Blowflies -	Maggot Therapy	Live maggots used for cleaning chronic wounds through larval debridement therapy.	[28]

Lucilia sericata)	Maggot Secretions	Enzymes from maggots being researched for wound healing and tissue regeneration.	[29]
9. Crickets (Gryllidae)	Cricket Protein	High-quality protein source in supplements and food; investigated for anti-inflammatory and antioxidant properties.	[30]
10. Beetles (Coleoptera)	Beetle Extracts	Used in traditional medicine to treat digestive disorders and inflammation.	[31]
	Cantharidin (from Spanish Fly)	Toxin used in traditional treatments for skin conditions (toxic if misused).	[32]
11. Dragonflies (Odonata)	Dragonfly Wing Extracts	Used in Asian traditional medicine to treat fevers and as an anti-inflammatory agent.	[33]
12. Worms (Earthworms)	Earthworm Extracts (Eisenia fetida)	Used in traditional Chinese medicine to treat blood clots, stroke, inflammation; considered an immune system booster.	[34]
13. Spiders (Araneae)	Spider Venom	Contains peptides with potential applications in pain management, neurology, and developing new painkillers.	[35]

Insects have long been a source of medicinal substances, providing a wealth of bioactive compounds with diverse therapeutic potentials. From bee products like honey, propolis, and bee venom to the silk of silkworms and the enzymes from termites, the range of insect-derived substances with applications in medicine is vast and growing. These insect products have been utilized in traditional practices for centuries, but modern scientific research continues to uncover their potential in treating a wide variety of health conditions, including chronic wounds, inflammation, cancer, neurological disorders, and immune system boosting.

The growing interest in entomotherapy, or the use of insects and their derivatives for medical purposes, underscores the importance of understanding and harnessing the unique properties of these organisms. Advances in biotechnology and pharmacology have allowed for the identification and isolation of bioactive compounds from insect venoms, proteins, and other substances, leading to innovative treatments in pain management, wound healing, and even anti-aging therapies. The use of insects in regenerative medicine, drug delivery systems, and sustainable nutrition also holds significant promise.

However, despite the significant progress made in insect-based medicine, there are still several challenges that need to be addressed. The standardization and safety of insect-derived therapies remain key concerns, as does the need for more rigorous clinical trials to validate the efficacy of these treatments. Additionally, ethical considerations regarding the collection and use of insects in medicine must be carefully considered, particularly in terms of environmental sustainability and animal welfare.

Future scope

The future of insect-derived medicines looks promising, with several avenues for further research and development. Key areas of focus should include:

1. **Clinical trials and standardization:** More extensive clinical trials are necessary to validate the safety and efficacy of insect-based therapies in human populations. Standardizing the processes for extracting and processing insect-derived substances will help ensure consistent quality and therapeutic outcomes.

2. **Biotechnology advancements:** The development of more sophisticated biotechnological methods for producing insect-derived compounds, such as recombinant proteins and engineered insect venoms, could pave the way for more targeted and sustainable therapeutic applications.

3. **Cross-disciplinary approaches:** Collaborations between entomologists, pharmacologists, biochemists, and healthcare professionals will be crucial in unlocking the full potential of insect-based therapies. Integrating knowledge from various fields could lead to the development of more effective and versatile insect-derived treatments.

4. **Environmental and ethical considerations:** As the demand for insect-derived products increases, ensuring environmentally sustainable practices in insect harvesting and production will be vital. Moreover, ethical guidelines regarding the use of insects in medicine must be developed and adhered to.

5. **Insect-based nutrition:** In addition to therapeutic uses, insects offer a highly nutritious, sustainable alternative to traditional protein sources. The growing interest in edible insects for both human and animal consumption may provide a dual benefit, enhancing food security while contributing to health and wellness.

In conclusion, while insect-derived substances already play an important role in modern medicine, the full scope of their potential remains to be fully realized. Continued research and innovation are essential to overcome the challenges and explore the myriad possibilities that insects can offer in the medical field.

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