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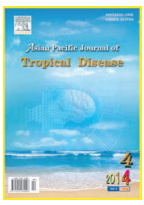

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Microbial secondary metabolites are an alternative approaches against insect vector to prevent zoonotic diseases

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PEER REVIEW

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Comments

This is a good study in which the author categorized the broad spectrum of microbial secondary metabolites as alternatives to insect vector to prevent zoonotic diseases. Broad range chemical insecticides disrupt ecosystems and affect natural balances in insect populations. Hence these data could be informative for future possibilities of recombinant DNA technology.

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ABSTRACT

Approximately 1500 naturally occurring microorganisms have been identified as potentially insecticidal agents. Metabolites from 942 microbial isolates were screened for insecticidal and properties. The isolates included 302 streptomycetes, 502 novel actinobacteria including representatives of 18 genera, 28 unidentified aerobic actinobacteria, 70 fungi and 40 bacteria other than actinobacteria showed the insecticidal activity. Most spore-forming bacteria pathogenic to insects belong to the family Bacillaceae. Only four *Bacillus* species namely *Bacillus thuringiensis*, *Bacillus popilliae*, *Bacillus lentimorbus*, *Bacillus sphaericus* have been closely examined as insect control agents. Fungi are applied directly in the form of spores, mycelia or blastospores or by their metabolites. Many viruses that belong to the family Baculoviridae are pathogenic in insects. The microbial insecticides are generally pest-specific, readily biodegradable and usually lack toxicity to higher animals. This review paper communicates the insect problem in the transmission of diseases in human, animals, plants and problem of chemical insecticides control of insects using microbial metabolites from actinobacteria, bacteria, fungi and viruses.

KEYWORDS

Bioinsecticidal agents, Chemical insecticides, Microbial metabolites, Plant insecticides, Vector control

1. Introduction

Despite significant advances in the techniques used for its control during recent decades, the mosquito continues to pose serious public health problem. In addition to the persistent irritation, they cause humans and animals simply by virtue of their bloodsucking behavior, the itching. This cause mosquitoes are also the principal vector of a variety of serious diseases[1]. Blood-feeding insects are of great medical and veterinary importance, due both to their nuisance value and as vectors of diseases[2]. Amongst insects that feed on humans, mosquitoes are of global importance[3].

Insect's transmitted disease remains a major source of illness and death worldwide. Such diseases are particularly important in the developing world. Mosquitoes are the most important single group of insects in terms of public health importance, which transmit a number of diseases such as malaria (*Anopheles*), filariasis (*Culex*), dengue (*Aedes*), *etc*., causing millions of deaths every year[4].

Culex quinquefasciatus (*Cx. quinquefasciatus*), a vector of lymphatic filariasis, is a widely distributed tropical disease

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with around 120 million people infected worldwide and 44 million people having common chronic manifestation[5]. Filariasis is a global public health problem. One hundred and twenty million people are currently infected and around 1.3 billion at risk of infection[6,7]. However, it has been estimated that the Japanese encephalitis is endemic in one hundred and thirty five districts of India. Saxena and Dhole reported the other species are *Culex vishnui* India, *Culex gelidus* and *Culex fuscocephala* India, Malaysia and Thailand[8].

The most important mosquito vector in Asia is *Culex tritaeniorhynchus* (*Cx. tritaeniorhynchus*) which breeds in stagnant waters like paddy fields or drainage ditches[9]. *Aedes aegypti* (*Ae. aegypti*), a vector of dengue that carries the arbovirus responsible for these diseases, is widely distributed in the tropical and sub-tropical zones. Recent reports of large-scale outbreaks of Chikungunya virus infection in several parts of Southern part of India[10,11].

India is endemic for six major vector-borne diseases namely Malaria, Dengue, Chikungunya, Filariasis, Japanese encephalitis and visceral leishmaniasis. Japanese encephalitis results in thousands of deaths annually. Vector borne diseases cause morbidity of millions of persons resulting in loss of man-days causing economic loss[12]. Japanese encephalitis virus is a member of the family *Flaviviridae* and the leading cause of viral encephalitis in Asia with 30 000-50 000 cases reported annually. The present review describes the insects' borne diseases in human, animals and plants and control strategies using insecticides from the microbial resources.

2. Insect-borne diseases

Insect-borne diseases cause about 1.5 million human deaths every year[13]. There are many different species of blood sucking fleas, lice, ticks and mites. Lice lives on humans or in their clothing while fleas are frequently found taking blood meals on people and domestic animals (Table 1)[14-17]. Bedbugs, which can be found in beds or furniture, feed on humans to obtain blood-meals. Some mites live in people's skin, *e.g.* the mites that cause scabies. Other mite species and ticks may take blood meals on humans[18].

In the Indian scenario, almost the entire country is endemic to the mosquito-borne diseases due to favorable ecological conditions. To prevent mosquito-borne diseases and improve public health, it is necessary to control them. In recent years, however, mosquito control programmes have failed because of the ever increasing insecticide resistance[19]. Most of the mosquito control programmes target the larval stage in their breeding sites with larvicides because the adulticides may only reduce the adult population temporarily[20]. Therefore, a more efficient way to reduce mosquito population is to target the larvae.

3. Chemical insecticides

Carbamates were developed in the 1950s and are still used today. These insecticides are rapidly detoxified and excreted in warm-blooded animals and in general, they are selective against targeted insect pests. Twelve insecticides from four classes (organochlorines, organophosphates, carbamates and pyrethroids) have been recommended for Internal Revenue Service but only pyrethroids have been approved for treating bed nets[21].

However the heavy use of chemical insecticides has not been without drawbacks. Let's mention contamination of water and food sources, poisoning of non-target fauna and flora, concentration in the food chain and selection of insect pest populations resistant to the chemical insecticides[22]. Increased public concern of the potential adverse environmental effects associated with the heavy use of chemical insecticides has prompted the examination of alternative methods for insect pest control. Since the mid-1950s, there have been numerous reports of reduced *Anopheles* susceptibility to malathion, fenitrotion, propoxur, bendiocarb and resistance to all four classes of insecticides has been found in *Anopheles* species in different parts of Africa. Synthetic chemical insecticides provide many benefits to food production and human health, but they also pose some hazards.

4. Plant insecticides

Mosquitoes in the larval stage are attractive targets for pesticides because mosquitoes breed in water, and thus, it is easy to deal with them in this habitat. Many researchers have reported on the effectiveness of plant extract against mosquito larvae (Table 2)[23-26].

Garlic (*Allium sativum* L.) is not only a food ingredient widely used in gastronomy; it has also been used for over 4 000 years as a medicinal plant for a variety of ailments including headaches, bites, intestinal worms and tumors. The medicinal use of garlic remains popular all over the world and its strong insecticidal activity has also been demonstrated by several studies. Extracts from many

Table 1
Insect borne diseases.

Disease	Vector	Endemic zone	Reference
Malaria	Plasmodium *Anopheles gambiae*	Global tropical and subtropical areas	[14]
Lyme disease	Ticks	Europe (Inc. UK), USA, Australia, China and Japan.	[15]
Bancroftian filariasis	*Cx. quinquefasciatus* black flies	Africa, West Asia, the Middle East and the United States.	[16]
Tick-borne encephalitis	*Ixodes ricinus and Ixodes persulcatus*	Europe (Inc. UK), USA, Australia and China	[15]
Chikungunya	*Ae. aegypti*	Swahili or Makonde (the effect of the incapacitating arthralgia)	[17]
West nile virus	Transmitted by mosquitoes (mainly of the genus *Culex*)	Greece	[18]

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