Saudi Journal of Biological Sciences (2012) 19, 503–509

King Saud University

Saudi Journal of Biological Sciences

www.ksu.edu.sa
www.sciencedirect.com

ORIGINAL ARTICLE

Mosquito larvicidal activity of *Aloe vera* (Family: Liliaceae) leaf extract and *Bacillus sphaericus*, against Chikungunya vector, *Aedes aegypti*

Jayapal Subramaniam [a], Kalimuthu Kovendan [a,*], Palanisamy Mahesh Kumar [a], Kadarkarai Murugan [a], William Walton [b]

[a] *Division of Entomology, Department of Zoology, School of Life Sciences, Bharathiar University, Coimbatore 641 046, Tamil Nadu, India*
[b] *Department of Entomology, University of California, Riverside, CA 92521, USA*

Received 12 May 2012; revised 13 July 2012; accepted 14 July 2012
Available online 22 July 2012

KEYWORDS

Aloe vera;
Bacillus sphaericus;
Aedes aegypti;
Dengue vector;
Larvicidal activity

Abstract The bio-efficacy of *Aloe vera* leaf extract and bacterial insecticide, *Bacillus sphaericus* larvicidal activity was assessed against the first to fourth instars larvae of *Aedes aegypti*, under the laboratory conditions. The plant material was shade dried at room temperature and powdered coarsely. *A. vera* and *B. sphaericus* show varied degrees of larvicidal activity against various instars larvae of *A. aegypti*. The LC_{50} of *A. vera* against the first to fourth instars larvae were 162.74, 201.43, 253.30 and 300.05 ppm and the LC_{90} 442.98, 518.86, 563.18 and 612.96 ppm, respectively. *B. sphaericus* against the first to fourth instars larvae the LC_{50} values were 68.21, 79.13, 93.48, and 107.05 ppm and the LC_{90} values 149.15, 164.67, 183.84, and 201.09 ppm, respectively. However, the combined treatment of *A. vera* + *B. sphaericus* (1:2) material shows highest larvicidal activity of the LC_{50} values 54.80, 63.11, 74.66 and 95.10 ppm; The LC_{90} values of 145.29, 160.14, 179.74 and 209.98 ppm, against *A. aegypti* in all the tested concentrations than the individuals and clearly established that there is a substantial amount of synergist act. The present investigation clearly exhibits that both *A. vera* and *B. sphaericus* materials could serve as a potential larvicidal agent. Since, *A. aegypti* is a container breeder vector mosquito this user and eco-friendly and low-cost vector control strategy could be a viable solution to the existing dengue disease burden. Therefore, this study provides first report on the mosquito larvicidal activity the combined effect of *A. vera* leaf extract and *B. sphaericus* against as target species of *A. aegypti*.

* Corresponding author. Tel.: +91 9962447932; fax: +91 422 2422387.
E-mail address: gokulloyo@yahoo.co.in (K. Kovendan).
Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

1. Introduction

A recent estimate shows that more than 50 million people are at risk of dengue virus exposure worldwide. Annually, there are 2 million infections, 500,000 cases of dengue hemorrhagic fever, and 12,000 deaths (Guha-Sapir and Schimme, 2005).

1319-562X © 2012 King Saud University. Production and hosting by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.sjbs.2012.07.003

Aedes aegypti is generally known as a vector for an arbo-virus responsible for dengue fever, which is endemic to Southeast Asia, the Pacific island area, Africa, and the Americas. This mosquito also acts as a vector of yellow fever in Central and South America and West Africa. However, Dengue fever has become an important public health problem as the number of reported cases continues to increase, especially with more severe forms of the disease, dengue hemorrhagic fever, and dengue shock syndrome, or with unusual manifestations such as central nervous system involvement (Pancharoen et al., 2002).

A. aegypti is a cosmotropical species that proliferates in water containers in and around houses. Secondary vectors include *Aedes albopictus*, an important vector in Southeast Asia and that has spread to the Americas, western Africa and the Mediterranean rim, *Aedes mediovittatus* in the Caribbean, and *Aedes polynesiensis* and *Aedes scutellaris* in the western Pacific region. *A. aegypti* breeds in many types of household containers, such as water storage jars, drums, tanks, and plant or flower containers (Muir and Kay, 1998; Honorio et al., 2003; Harrington et al., 2005; Murugan et al., 2011).

Mosquito control, in view of their medical importance, assumes global importance. In the context of ever increasing trend to use more powerful synthetic insecticides to achieve immediate results in the control of mosquitoes, an alarming increase of physiological resistance in the vectors, its increased toxicity to non-target organism and high costs are noteworthy (WHO, 1975). Most of synthetic chemicals are expensive and destructive to the environment and also toxic to humans, animals and other non-target organisms. Besides, they are non-selective and harmful to other beneficial organisms. Some of the insecticides act as carcinogenic agents and are even carried through food chain which in turn affects the non-target organism. Therefore alternative vector control strategies, especially effective and low cost are extremely imperative (Piyarat et al., 1974; Kalyanasundaram and Das, 1985).

The use of different parts of locally available plants and their various products in the control of mosquitoes has been well established globally by numerous researchers. The larvicidal properties of indigenous plants have also been documented in many parts of India along with the repellent and anti-juvenile hormones activities (Singh and Bansal, 2003). Almost all tropical regions of the world are experiencing the resurgence and reoccurrence of one of the world's most deadly diseases, i.e., malaria, filariasis, dengue, and Chikungunya in world and India is no exception. Traditionally, plants and their derivatives were used to kill mosquitoes and other household and agricultural pests. In all probability, these plants used to control insects contained insecticidal phytochemicals that were predominantly secondary compounds produced by plants to protect themselves against herbivorous insects (Shaalan et al., 2005; Preeti Sharma et al., 2009).

Aloe vera is a perennial plant belonging to the family of Liliaceae, of which there are about 360 species (Klein and Penneys, 1988). Taxonomists now refer to *Aloe barbadensis* as *A. vera* (Coats and Ahola, 1979). Aloe is one of the few medicinal plants that maintain its popularity for a long period of time. The plant has stiff, graygreen lance-shaped leaves containing clear gel in a central mucilaginous pulp. *A. vera* gel has hypoglycemic (Rajasekaran et al., 2004), wound healing (Pandarinathan et al., 1998) and anti-inflammatory effects (Davis et al., 1991). The *A. vera* (L.) Burm. f., plant (synonym = *Aloe barbadensis* Miller) is commonly referred to as *A. vera* and belongs to the lily family (family: Liliaceae, tribe Aloinae). This species is one of the approximately 420 species of aloe (Burdock, 1997).

Since, 1986 *A. vera* has been used as a traditional medicine and as an ingredient in many cosmetic products; it has gained high importance for its diverse therapeutic properties. The plant, being succulent, contains 99.5% water and the remaining solid material contains over 75 different ingredients including vitamins, minerals, enzymes, sugars, anthraquinones or phenolic compounds, lignin, tannic acids, polysaccharide, glycoproteins, saponins, sterols, amino acids, and salicylic (Reynolds and Dweck, 1999). *A. vera* provides nutrition, shows anti-inflammatory action and has a wide range of antimicrobial activity (Reynolds and Dweck, 1999).

Bacillus sphaericus is a naturally occurring soil bacterium that can effectively kill mosquito larvae present in water. *B. sphaericus* has the unique property of being able to control mosquito larvae in water that is rich in organic matter. *B. sphaericus* is effective against *Culex* spp. but is less effective against some other mosquito species. Commercially available formulations of *B. sphaericus* are sold under the trade name Vectolex. When community mosquito control is needed to reduce mosquito-borne disease, the Department of Health favors the use of larvicide applications targeted to the breeding source of mosquitoes (Meisch, 1990).

Bacterial larvicides have been used for the control of nuisance and vector mosquitoes for more than two decades. The discovery of bacterium like *B. sphaericus*, which is highly toxic to dipteran larvae, has opened the possibility of its use as a potential biolarvicide in mosquito eradication program worldwide (Kalfon et al., 1984). The mosquitocidal activity of the highly active strain of *B. sphaericus* resulted in their development as commercial larvicides. This is now used in many countries in various parts of the world to control vector and nuisance mosquito species (Wirth et al., 2001).

Indeed, source reduction is one of the key components in the malaria vector control program since the target is exceptionally specific unlike adult control. Innovative vector control strategy like use of phytochemicals as alternative sources of insecticidal/larvicidal agents in the fight against the vector-borne diseases has become inevitable. Above and beyond, in recent epoch, around the globe phytochemicals have gained massive attention by various researchers because of their bio-degradable and eco-friendly values (Karunamoorthi and Ilango, 2010). In this context, the purpose of the present investigation is to explore the larvicidal properties of *A. vera* leaf extract and bacterial insecticide, *B. sphaericus* against Chikungunya vector, *A. aegypti*, under the laboratory conditions. Therefore, this study provides first report on the mosquito larvicidal activity combined effect of *A. vera* leaf extract and *B. sphaericus* against *A. aegypti* as target species.

2. Materials and methods

2.1. Collection of eggs and maintenance of larvae

The eggs of *A. aegypti* were collected from National Centre for Disease Control field station of Mettupalayam, Tamil Nadu, India, using an "O"-type brush. These eggs were brought to the laboratory and transferred to $18 \times 13 \times 4$-cm enamel trays