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Phytochemicals derived from *Piper longum* in insect and mite pests management: A review

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Abstract
The need for the development of alternative types of selective control methods for crop protection with reduced use of chemical pesticides was the main objective of this present review article. This review is based on earlier works performed by many investigators on insecticidal and acaricidal property of bioactive components derived from *Piper longum*. The summarization of all recent works on application of phytochemicals associated with *P. longum* in insect pests control may be an alternative to currently used chemical pesticides for development of target specific, biodegradable into nontoxic products, safer and potentially suitable to use in integrated pests management programmes.

Keywords: Crop loss, Insect pests control, *Piper longum*, Phytochemicals, Plant extract

INTRODUCTION

Insect pests and mite are some of the major causes of crop loss not only in India but also a worldwide problem. Feeding damage and the transmission of plant diseases by insect and mite pests not only quantity but reduces the quality value also. The Indian agriculture is currently suffering an annual loss of about Rs. 8, 63, 884 million due to insect pests (Dhaliwal *et al*., 2010). The estimated global as well as India crop losses due to insect pests are 10.8 % and 17.5 % respectively and in terms of monetary value, Indian agriculture suffers an annual loss of about US$ 42.66 millions due to insect pests (Singh *et al*., 2014). A large section of farmers are mainly dependent on chemical control measure along with misuse and overuse of insecticides which cause resistance and increase the survival rate of insect pests leading to consistent increase in crop loss (Dhaliwal and Koul, 2010). This also causes harmful effect on non target living organism (Cork *et al*., 2003).
The potential source of new pesticides is naturalproducts produced by plants. Not only might certain natural products be source of new pesticides, butbotanical derivatives may be more environmentally benign than synthetic chemicals. Plant secondary metabolites are highly diverse; more than 30,000 'natural products' or 'secondary metabolites' have been reported from plants so far (Su and Horvat, 1981; Park *et al*., 2000).
Researches on plant-derived pesticides in agriculture are currently intensified as it becomes evident that plant-derived pesticides still have enormous potential to inspire and influence modern agrochemical research. Although defining the ecological effects of most synthetic pesticides is difficult, there is a good reason to suppose that the secondary metabolism of plants has evolved to protect them from insects and microbial pathogens (Benner, 1993; Harbone, 1993).
Therefore, efforts have been focused on secondary plant metabolites for potentially useful products as commercial pesticides or as lead compounds (Balandrin *et al*., 1985; Benner, 1993; Hedin *et al*., 1997).Bioactive natural products play an important role as lead compounds in the development of new pesticides, and in understanding the natural phenomenon throughout their biosynthesis, metabolism, and mode of action. Plants in the Piperaceae are members of traditional pharmacopeia in many Asian and African cultures and have also been used for pest control. Plant extracts and phytochemicals may be an alternative to currently used pesticides for controlling insect pests, because they constitute a rich source of bioactive chemicals (Swain, 1977; Van, 1989). They are specific target species, biodegradable into nontoxic products, and potentially suitable for use in integrated management programs, thus leading to the

development of new classes of insect control agents.The fruits of Piperaceae plants have been studied for their biologically active principles including unsaturated amides, which have potent insecticidal activities (Park *et al*., 2003).The genus Piper, belonging to the piperaceae family, has been receiving considerable attention in recent years due to its biological properties. Various Piper species, widely distributed in varied regions of India, have been used as spices as well as folk medicines as *P. longum*also called Indian long pepper, is a slender aromatic climber easily available in different parts of India. Different common names were given in different language in India i.e. Pippali (Marathi) ; Tippili (Tamil) ; Tippali (Malayalam) ; Pippallu (Tellugu) ; Kandan Lippili (Kannada) ;Pipli (Konkani) ; Pipul (Urdu) ; Pipari (Gujrathi) ;Pippali, Magadhi (Sanskrit), Pipal (Assamese).The country like India has got variety of climatic conditions and seasons favorable for growth of many species of plants. *Piper longum*L. popularly known as Pippali belonging to the family Pipperaceae, an important medicinal plant is used in traditional medicine in Asia and Pacific islands especially in Indian medicine.The plant is a native of Indo-Malaya region. It was very early introduced to Europe and was highly regarded as a flavour ingredient by the Romans. The Greek name “Peperi", the Latin "Piper" and the English "Pepper" were derived from the Sanskrit name "Pippali". It grows wild in the tropical rain forests of India, Nepal, Indonesia, Malaysia, Srilanka and Rhio (Islam and Aktar, 2013).

PIPERACEAE PLANTS IN INSECT AND MITE PESTS’ MANAGEMENT

One of the most important and challenging aspects in the pesticidal research is the development of new and effective approaches for controlling various insect and mite pests, plant diseases and mosquito larvaes (Brown, 1978; Hayes and Laws, 1991). Furthermore, some Piperaceae plant fruits have been used as food-flavoring agents and arealso known to possess insecticidal activities (Miyakado et al., 1979; Su and Horvat, 1981;Tyagi, 1993). *Piper guineese* Schumacher &Thonn and *P. nigrum* L. are used as insecticides and molluskicides in several areas of Africa (Su and Horvat, 1981; Ivbijaro and Bolaji, 1990). Natural products isolated from the Indian species *P. longum* L., *P. betle* L. and *P. cubeba* L.have been shown to have insecticidal activity against mosquitoes and flies (Miyakado et al., 1989).*P. nigrum* hasbeen reported to be toxic to houseflies (*Musca domestica* L.),rice weevils *(Sitophilus oryzae* L.), and cowpea weevils(*Callosobruchus maculatus* F.) (Scott and McKibben, 1978; Su and Horvat, 1981).Piperine can be easilyisolated from the fruit of black pepper plants, although it isapparently inactive as a contact toxicant to houseflies (Su and Horvat, 1981).Several insecticidal amides, such as pipericide, (E,E)-N-(2-methylpropyl)-2,4,12-tridecadienamide, and (E,E,E)-11-(1,3-benzodioxol-5-yl)-N-(2-methylpropyl)-2,4,10-undecatrienamide,have been isolated from *P. nigrum* (Miyakado *et al*., 1979; Su and Horvat, 1981).

***P. longum* in Insect and mite management:** Various attempts have been madeto control insect pests using effective andsynthetic pesticides (Abbott, 1925; Ahn *et al*.,1998; Bartine and Tantaouri-Elaraki, 1997) but most of the insect pests has developed resistance including laboratory strains of fiveagricultural insect pests, brown planthopper (*Nilaparvatalugens*), diamondback moth (*Plutellaxylostella*), greenpeach aphid (*Myzuspersicae*), tobacco cutworm (*Spodopteralitura*), and two-spotted spider mite (*Tetranychusurticae*) against numbers of insecticides. The methanolextract of *P. longum* fruits possessed insecticidal activityagainst *M. persicae*, *S. litura*, and *T. urticae* with 100%control value at 1,000 ppm. Two active isolates fromthe hexane fraction showed potent insecticidal activities, andwas characterized by spectral analyses as pipernonaline andpiperoctadecalidine (Yang *et al.,* 2002).Both pipernonaline and piperoctadecalidine showedpotential insecticidal activities against *M. persicae* and *P.xylostella*, but little against *N. lugens* and *S. litura*.Both compounds resulted in 100% mortality at 1,000 ppmagainst *M. persicae* and *P.* xylostella ((Yang *et al.,* 2002)).This indicatedthat the insecticidal activities of both piperidine alkaloid compounds from *P. longum* fruits varied with the species tested. The toxicity of anethole has been demonstrated against a number of species, including various beetles, weevils, mosquitoes, and moths (Sarac and Tunc, 1995; SAS, 1995; Ho *et al*., 1997; Keem *et al*., 1997). These studies strongly support the possibility of piperoctadecalidine as a new acaricide. The essential oil of the *P. longum*fruits showed insecticidal and insect-repellant activity (Kokate *et al.*, 1980).

Piperoctadecalidine has a potentacaricidal activity against *T. urticae* because piperidine alkaloids showedsimilar insecticidal activities against the same insect species (Yang *et al.*, 2002).Using the bioassay method (Ahn *et al.*, 1996), found that AC303630, flucycloxuron, and other acaricides, when usedalone, were highly effective against egg, immature and adultstages of *T. urticae* at 50 ppm. Various essential oils have been documented to exhibitacute toxic effects against insects (Lee *et al.*, 1997;Lee *et al.*, 1997, 2001; Park *et al.*, 2002). demonstrated the toxicity of a number of essential oilconstituents against the western corn rootworm, *Diabroticavirgifera*, the two-spotted spider mite, *T. urticae*and thecommon house fly, *Musca domestica*as well as to manyother insects. The dried fruits of some Piperaceae are used as flavoring agents in food, but are known to haveinsecticidal properties (Miyakado *et al.*, 1979). Moreover, piperoctadecalidine also has acaricidal activity against *Tetranychusurticae* (Park *et al*., 2002). Insecticidal and acaricidal activity of pipernonaline and piperoctadecalidine derived from dried fruits of *Piper longum* (Park *et al.,* 2002). Insecticidal and acaricidal activities of constituents derived from *P. longum* fruits was also studied (Lee, 2005) against *Nilaparvatalugens*, *Myzuspersicae*, *Plutellaxylostella*, *Spodopteralitura* and *Tetranychusurticae*.

P. longum**plant product as larvicide:** The yellow fever mosquitoes, *Aedes aegypti* (L.), *Aedestogoi* (Theobald), and *Culexpipienspallens* (Coquillett) are widespread and serious primary medical insect pests.

Mosquitoes are insects belonging to the order lower Diptera. Over3,000 different species of mosquitoes exist worldwide (Park *et al*., 2002).Mosquitoes are hosts to a variety of pathogens and parasites,including virus, bacteria, fungi,protoctistans, and nematodes (Clements, 1992).Some of these organisms alternate a parasitic phase with afree-living phase; others are entirely parasitic, many of whichalternate between their mosquito hosts and other invertebrateor vertebrate host. The blood-sucking habit renders adultmosquitoes prone to acquiring pathogens and parasites fromone vertebrate host to pass them on to other hosts. Controlof these mosquito larvae can be achieved by repeatedapplications of organophosphates such as temephos andfenthion, and insect growth regulators such as diflubenzuronand methoprene. Although effective, their repeated use hasdisrupted natural biological control systems, leading tooutbreaks of insect species, sometimes resulted in the widespread development of resistance, had undesirable effectson nontarget organisms, and fostered environmental andhuman health concerns. These problems have highlighted theneed for the development of new strategies for selectivemosquito larval control (Wink, 1993; Lee, 2000; Park *et al*., 2002).

Against the larvae of *A. aegypti* and *C. pipienspallens*,methanolic extract of *P. longum* fruits possessed a strongmosquito larvicidal activity at 40 ppm (Lee, 2005).Further solventfractionation showed strong larvicidal activity in the hexanefraction, which showed 100% mortality at 40, 20, and10 ppm. Chloroform fraction showed 31 and 39%, and waterfraction exhibited 15 and 22% mortality against *A. aegypti*and *C. pipienspallens* at 40 ppm, respectively. The hexane extract of pipernonaline showed a potent larvicidal activity against *A. aegypti* and *C. pipienspallens*, giving LD_{50} values of 0.35 and 0.21 ppm, respectively. This LD_{50} value of pipernonaline against C. pipienspallens larvaewas 27-, 110-, and 245-fold higher than those of obacunone, nonmilin and limonin, respectively[43].Crude aqueous extracts from leaf, stem and root of *Piper longum*L. was used in larvicidal bioassays against the 2nd instar larvae of the housefly, *Musca domestica*L. for 72h exposure. LC_{50} concentrations of the extracts of the most effective was 8149.33ppmof *P. longum*. The results suggested that *P. longum* extract is effective in controlling of 2nd instar larvae of *Musca domestica*L (Jayaprankasha *et al*., 1997).

Conclusion

It was concluded that the findings of earlier workers on insecticidal properties of *Piper longum* may be utilised for development of target specific, biodegradable into nontoxic products, safer and potentially suitable to use in integrated pests management programmes. Moreover, the insecticidal significant constituents associated with *P. longum* may be of high commercial and economical importance in near future.

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