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*Review*

# Research and application of biological acaricides

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**This essay briefly introduces why acaricides are in great need and the classification of them. A screening for acaricidal activity of extracts with some known medicinal organisms attributes could lead to the discovery of new agents for pest control. So we put forward 3 kinds of biological acaricides, namely: botanical acaricides, microbiological acaricides and animal-based acaricides and compare their advantages and disadvantages with each other. We discuss their applications and research progress, and introduced present situation and future trends of biological acaricides finally.**

**Key words:** Biological acaricides, research progress, prospects.

## INTRODUCTION

Mites belong to the division of Arthropoda, Arachnida Class, Acari Subclass. There are around 500,000 species of mites in the world, being the most diverse specie in Arthropoda Arachnida. Mites can be classified into phytophagous ones and predaceous ones, parasitical and haematophagous ones or saprophagous, coprophagy, fungivorous ones (Wumar et al., 2009). Mites have diverse shapes, propensities and habitats. Their traces can be found nearly everywhere in the world (He et al., 2010), even on pulmonarius and oyster mushrooms and peoples' faces. That's why miticides are in great demand. Acaricides are pesticides for the control of mite pests, which can only or mainly control mites (Martin et al., 2010). Mite is an important agricultural pest with a global distribution. Its phytophagous nature, high reproductive potential and short life circle facilitate rapid resistance development to many acaricides often after a few applications (Fernandez et al., 1997; Devine et al., 2001; Stumpf and Nauen, 2001). They are especially major pests of cash crops, such as cotton, tea, jujube and are acknowledged as one of the most important pests in the world. We are now using chemical acaricides and biological acaricides, while the former one have many disadvantages, such as simplex modes of action, low efficacy, high residue, resistance, resurgence and are responsible for the reduction or suppression of beneficial species, such as natural predators (Arias-Estévez et al., 2008; Lagziri and Amrani, 2009).

Nowadays people come to understand that pesticides are not used to kill pests totally, but to control the population under economic injury level instead. So we put forward integrated pest management programme and biological pesticides (Bisignanesi and Borgas, 2007). Most biological pesticides appear to be a good fit for pest management because of its strong efficacy, the diversity of action modes, the persistence of control and its limited negative impact on important natural enemies. Therefore the future of acaricides lies in biological acaricides.

### Biological acaricides

Biological acaricides consist of botanical acaricides, microbiological acaricides and animal-based acarides. They have great potentials, especially microbiological acaricides and animal-based acaricides, since there are few researches in the field. Now let's take a closer look at research progress at home and abroad so far.

### Botanical acaricades

There are diverse vegetations in the world and more than 2,400 species can be used to control harmful creatures. Reportedly, among them there are around 1,000 species that can be used to control pests and 100 species to control mites (Yang et al., 2007). Some famous acaricidal plants are *Azadirachta india* A. Juss, *Melia azedarach* Linn, *Meliatoosendan* Sieb.et Zucc, *Tateges erecta*,

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*Stellera chamaejasme* L, *Nicotiana tobacum*, *Sophora flavescens*, *Leonurus heterophyllus* Sweet, *Foeniculum vulgare, Curcuma longa* (Zhang et al., 2004a). Zhang et al. (2004b) had done a systematic study of insecticidal and acaricidal properties of clove, a Chinese traditional medical plant. The hexane, benzene, ether absolute, methyl alcohol and water sequenced extracts of the plant were obtained and their bioactivities against *Tetranychus cinnabarinus* and *Sitophilus zeamais* were measured. The results showed that the acaricidal activity of hexane extract was the best, with a median lethal concentration ($LC_{50}$) of 1.5333 and 0.5796 g/L for 24 and 72 h against *T. cinnabarinus*. He also found that *Artemisia annua* L. had high acaricidal activity against *T. cinnabarinus* and *Panonychus citri* (Zhang et al., 2008, 2009) and different growth period *A. annua* extracts had different acaricidal bioactivity against *T. cinnabarinus*, which increased with the plant growth of *A. annua* (Zhang et al., 2007).

Chen et al. (2006) did a research on 54 kinds of methyl extracts from 46 kinds of vegetations, which come from the northeast part of China, about acaricidal activity. The results showed that extracts from 10 kinds of vegetations including gingkgo had strong bioactivities. The corrected mortality treatment after 24 h against *P. citri* McGregor was 95.48%. Extracts from 15 kinds of vegetations including *Epigeal Srephaia* Root, Mahonia fortune had secondary bioactivities, with the corrected mortality after 24 h falling in between 60 and 90%. *S. flavescens* ethanol extract have great antifeedant activity to *Tetranychus urticae* Koch and *P. citri*, especially to *P. citri*, and the bioactivity became stronger as time went on (Liu, 2004). Jiang et al. (1998) found *Sophora alopecuroids* L. have great contact effects to *T. cinnabarinus* and

*Tetranychus viennensis* Zacher. *Eupatorium adenophorum* and *Mikania micrantha* are both the invasive plants, and significantly control *T. urticae* Koch eggs and adults and *P. citri* adults (Luo et al., 2006). The acaricidal activities of essential oils obtained from medicinal plants such as oregano (*Origanum onites* L.), thyme (*Thymbra spicata* L. subsp. *spicata*), lavender (*Lavandula stoechas* L. subsp. *stoechas*) and mint (*Mentha spicata* L.) were evaluated against the adults of *T. cinnabarinus* under laboratory conditions. Laboratory bioassay results indicated that all essential oils caused complete mortality of spider mites at different concentrations that are not phytotoxic to the host plant. Although all essential oils show acaricidal activities in a dose-dependent manner, essential oils of thyme and oregano have a marked acaricidal activity against carmine mite adults (at 5.0 and 7.5 µg/mL air concentrations, respectively).

The mean lethal concentrations ($LC_{50}$) of the essential oils of thyme, oregano, mint and lavender were 0.53, 0.69, 1.83 and 2.92 g/mL air, respectively. The results of the present study concluded that plant essential oils could be useful in promoting research aiming at the development of new agent for pest control from the plants with medicinal values (Sertkaya et al., 2010).

## Microbiological acaricides

Microbiological acaricides mainly mean antibiotics. Tetranactin, avermectins, hygromycin B, destomycin B and milbemycin are antibiotics, which have been industrialized to control generalized insects and mites. Take avermectins for example. Abamectin 1 was introduced as an acaricide and insecticide by Merck Sharp and Dohme Agvet (now Syngenta Crop Protection AG) in 1985 under the trade names Vertimec and Agrimec. It can effectively control a wide range of Lepidoptera, Coleoptera, Homoptera, Diptera insects on cotton, soybean, corn, vegetables, fruit trees, tea, potato, tobacco, etc, especially for antibiotic-resistant pests, for example *Liriomyza bryoniae*, *Plutella xylostella*, cotton bollworm, carmine spider mite, leaf miner, cabbage caterpillar, phylloxera, eelworm. Avermectins have contact and stomach effects, but don’t have ovicidal action against *P. xylostella* L.

Its mechanism is to interfere neural physiological activity of pests, stimulate them to produce γ-aminobutyrate, thus blocking neural information transfer process of sports, making pests’ central nervous system unaccepted by motor neurons, leading to rapid paralysis and apstia in several hours, namely dead in several days (Zhang, 1998).

## Animal-based acaricides

Currently there are no pertinent literatures for single animal-based acaricides, but insectical and acaricidal pestsides have been industrialized. Take nerextoxion for example. Nerextoxion is separated from clamworms, based from which insecticides like Cartap are commercialized (Pan, 2006). It is a modern synthetic insecticide on the base of natural products, which has neural paralysis. But because of the limitations of the lead compound, the species having commercialized are less than organophosphorus compounds and carbamates. Nerextoxion has all these tractors: 1). Having contact insecticidal, stomach insecticidal activitity and systemic action, which can be widely used to protect crops, vegetables and fruit trees from pests; 2) being low toxicity to humans and mammals, but high toxic to bees and silkworms; 3) special action mechanism, cross resistance with other insecticides have never been found; 4) easy to deteriorate in internal creatures and environment, being safe to the environment (Tan, 2006).

We are now doing a research on acaricidal bioactivities of the extracts from *Cnidocampa flavescens* Walker against *T. cinnabarinus* Bois (Acari:*Tetranychidae*). The ethyl acetate, benzene, petroleum ether, alcohol, chloroform and water parallel extracts of the *C.*

*flavescens* Walker were obtained and their bioactivities against *T. cinnabarinus* were measured. We found the most suitable solvent to be petroleum ether, the optimal material to be worm powder marinated by 95% alcohol. Treatment with petroleum ether extract from *C. flavescens* Walker for 48 h against *T. cinnabarinus* gave a median lethal concentration ($LC_{50}$) of 1.0069 g/L.

## Application

Chemical acaricides are harmful to the environment and have negative impact on important natural enemies at the same time. Since they are complex synthetic compounds that don't exist in the world originally, they are difficult to deteriorate. To sum up all the disadvantages, we can come to the conclusion that extractives from living creatures have great advantages over synthesized chemicals when considering the environment. And during the past thousands of years, living creatures have formed effectual defense systems against mite pests. Some paracites don't live on some special creatures, the precise reason is not known now. But it is likely to have something to do with the structure of its own and its secretion (Pang, 1998). If this happens, we can imitate the creature or extract the secretion to substitute acaricides existed or improve them.

In summary, biological acaricides have great potentials. Researches on botanical acaricides started early, and are more thorough than mirobiological acaricides and animal-based acaricides. Botanical pesticides have many advantages over agrichemicals, but are limited by intrinsic defects. These defects manifest in the following respects as thus explained.

### *The activity of active ingredient is not stable*

They are plant secondary metabolites, vulnerable to the change of external environment conditions (for example temperature, humidity, illumination, the pH value of the soil, nutrition of the soil and ambient living creature community, etc), therefore their stability is not high. What's more, the active ingredient content is low, the effect is slow, which bring difficulties to production.

### *Plant resource constraints*

These constraints include the protection of wild plant resources, the limit to protection of a few species of quality and the limit to the geography position, varieties of ecological location, the difference of different material, etc. Now through the cell and tissue culture, the hair of cultivation, using the endogenous bacteria and other biological technology, increasing breeding power and the insecticidal plant organs, cell mass culture, so as to solve the problem of pesticidal plants (Ma et al., 2008). Microbial sources are abundant, soil is their base camp, and microorganisms with agricultural activity are everywhere. Their individual is small and easy to cultivate, and can expand by fermentation. Microbial fermentation is not influenced by season, geographical constraints, but is difficult to purify. Nowadays, the researching hotspot on the acaricides is within the botanical acaricides. There are rare reports on the microbiological and animal-based acaricides, especially the animal-based acaricides. But there are many animal-based pesticides, for example animal toxin, hormone, pheromone, natural animals, etc.

Animal-based pesticides generally are high efficiency, low toxic and safer to use, some still have strong stomach toxicity, contact toxicity, certain fumigated activity and ovicidal activity. Research of some animal-based pesticides, especially the insect hormone, is relatively weak. We should strengthen the research and development. It should be clear that animal pesticides and biomimetic pesticides, together with synthesis of drugs, may be toxic to higher animals and the non-target organisms, and might cause environmental residue problems. This is because people, animals and insects exists similarity to a certain extent in the nervous system. In view of animal and bionic pesticides' special pesticide mechanism, they have greater development prospects (Pan, 2006). The animal resources are abundant in our country, they have great prospects to be exploited. Research and development of animal acaricides, to make full use of animal resources, control mite pests with pests, promote development of animal-based acaricides, is extremely urgent.

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