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The Fumigation Bioactivities of Three Kinds of Plant Extracts on Four Species of Important Stored-grain Insects

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Abstract: Plant extracts were extracted by Soxhlet extractions with anhydrous diethyl ether from *Citrus suavissima* Tanaka, *Ailanthus altissima* L. and *Capsicum frutescensp* L., and their fumigation bioactivities on *Sitophilus oryzae*, *Oryzaephilus surinamensis*, *Tribolium castaneum* adults and *Liposcelis paeta* nymphae at a specific concentration of 1∶15 of plant extract : acetone by volume were detailedly investigated in the paper. The results showed that all of the plant extracts have significant fumigant activities on *O. surinamensis* adults and weak fumigant activities on *Sitophilus oryzae*, *Tribolium castaneum* adults and *Liposcelis paeta* nymphae. The highest corrected mortality of *O. surinamensis* adults reached more than 99%.

Key words: plant extracts, stored – grain insects, fumigation bioactivities

Introduction

The widespread and intensive use of synthetic insecticides for the control of stored-grain insects has led to serious problems including insecticide resistance, poisoning of workers, rising cost of production, and reduction of natural enemies in stored grain ecosystems. Development and implementation of alternative control strategies and integrated pest management systems have recently been considered to be the only solution to combat this increasing insecticide-resistant insect pests[1-3]. In this regard, plant-based insecticides may provide potential alternatives to currently used insect-control agents because they constitute a rich natural source of bioactive chemicals with complicated action mechanism, to which the insect pests are difficult to produce resistance, are readily biodegradable, often of low mammalian toxicity, and pose no or low danger to the environment if used in small amounts[4-6]. Many Chinese plants are potential sources of pesticides and have been shown to contain potent fumigation to many major stored-grain insects[6,7]. Base on the above background, the extracts from *Citrus suavissima* Tanaka, *Ailanthus altissima* L. and *Capsicum frutescensp* L. were tested for their potential fumigant activities against four major stored grain insects, *Sitophilus oryzae*, *Oryzaephilus surinamensis*, *Tribolium castaneum* adults and *Liposcelis paeta* nymphae.

Materials and Methods

1.1 Insects

All of the test insects were obtained from laboratory cultures maintained in the dark in incubators without exposure to any insecticide at 27 ±2℃ and 75% ±5% r. h. at the institute of stored product insects of Henan University of Technology. The food media used were washed, sterilized wheat with about 13.5% equilibrium moisture contentfor *S. oryzae*, wheat flour, rolled oats and yeast (6∶3∶1, w/w/w) for *O. surinamensis*, wheat flour and rolled oats (6∶1, w/w) for *T. confusum*, and wheat flour, degrease milk powder and yeast (1∶1∶1, w/w/w) for *L. paeta*. Healthy and consistant developmental insects were randomly chosen for tests.

1.2 Preparation of Plant Extracts

The *A. altissima* bark was collected in Henan, central China, October 2006, dried at room temperature, ground to powder, and screened by 60-eye sieve. 50 g of powder was extracted by Soxhlet extractions with 250 mL anhydrous diethyl ether until the distilled liquid was colorless. The solvent was evaporated under vacuum in a rotary evaporator. The essential oil was stored in airtight fuscous glassware in a refrigerator at 4 ℃, and evenly diluted with actone (analytical purity) at the proportion of 1∶15 (v/v) for the following tests.

The *Citrus suavissima* Tanaka bark and *Capsicum frutescensp* L. fruit were bought in market, and their extracts preparation were the

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same as the *A. altissima* bark extract.

1.3 Fumigant Activity

Fumigant activities to *S. oryzae*, *O. surinamensis*, *T. castaneum*, *L. paeta* were respectively carried out with 30 insects exposed in a 250mL flask sealed with a rubber stopper, holding 10g wheat. 1mL diluted plant extract was evenly applied to a Whatman No. 1 filter paper strip (7 cm × 9 cm), which was dried in air for 10 min and then fixed on the stopper by a staple at one end, and the equal amount of actone was applied alone as control. The stopper was tightly stuffed to make the filter paper suspending in the top, avoiding the filter paper contacting the flask wall. The flask was placed in the incubators at 27 ± 2 ℃ and 75% ± 5% r. h.. Five replicates were conducted. The number of dead insects was recorded after 4 d.

2 Results

The plant extracts from *C. suavissima*, *A. altissima* L. and *C. frutescensp* showed strong fumigant activities against *S. oryzae* and *O. surinamensis* adults, particularly the *A. altissima* L. bark extracts showed the most potent fumigant activities against *S. oryzae* and *O. surinamensis* adults, and the corrected percentage insect mortality reached 81.9% and 99.3% respectively. But all of the three plant extracts from *C. suavissima*, *A. altissima* L. and *C. frutescensp* showed slighty weak fumigant activities against *T. castaneum* adults and *L. paeta* nymphae (Table 1).

Table 1. The fumigant activities of the plant extracts against four species of important stored - grain insects (the corrected percentage insect mortality %)

plant extracts	*S. oryzae*	*O. surinamensis*	*T. castaneum*	*L. paeta*
A. altissima bark	81.9	99.3	5.3	44.2
C. frutescensp fruit	60.6	98.0	1.4	57.4
C. suavissima bark	56.4	96.0	2.6	19.7

3 Discussion

Many plant extracts and their constituents have been studied to possess potential as alternative compounds to currently used insect-control agents[6-8]. The plant extracts from *C. suavissima*, *A. altissima* L. and *C. frutescensp* also showed strong fumigant activity against *O. surinamensis* and *S. oryzae* adults. Further research on how to use the plant extracts as fumigants effectively for the control of insects in stored products is necessary. The activities of plant extracts and their pure constituent level along with structure-activity relationships against different developing stages, especially the eggs and pupae, of the major stored grain insects, are urgently required.

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