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Repellent and fumigant activity of essential oil from *Artemisia vulgaris* to *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae)

J. Wang[a,b], F. Zhu[a], X.M. Zhou[a], C.Y. Niu[a], C.L. Lei[a,*]

[a]*Institute of Insect Resources, Huazhong Agricultural University, Wuhan, Hubei 430070, China*
[b]*Panyu Entry-Exit Inspection and Quarantine, Guangzhou, Guangdong 511400, China*

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Abstract

Repellent and fumigant activity of the essential oil of mugwort, *Artemisia vulgaris*, against the stored-product insect pest, *Tribolium castaneum* was investigated. *Artemisia vulgaris* oil had a very strong repellent activity to adults and was significantly repellent at a 0.6 μL/mL (v/v) and higher in a filter-paper arena test. The oil had high fumigant activity against adults and larvae with adults much more susceptible than larvae. At 8.0 μL/mL, mortality of adults reached 100%, but with 12-, 14- and 16-day larvae, mortalities were 49%, 53% and 52%, respectively. The oil also had high-fumigant activity against eggs and toxicity progressively increased with increased exposure time and concentration. At dosages of 10, 15 and 20 μL/L air and a 96 h exposure period, mortality reached 100%. Regression analysis of data on individuals fumigated in the larval stage confirmed that the percentage of larvae reaching the pupal stage and the percentage of pupae that reached the adult stage, decreased significantly with increase in dosage concentration. No larvae, pupae and adults were observed following a 60 μL/L dosage.

Keywords: *Artemisia vulgaris*; Essential oil; Repellent; Fumigant; *Tribolium castaneum*

*Corresponding author. Tel.: +86 27 87287207.
E-mail address: ioir@mail.hzau.edu.cn (C.L. Lei).

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1. Introduction

In ancient China, extracts of *Artemisia vulgaris* (L.) were used to control stored-product insect pests (Ding et al., 2000). This practice was progressively abandoned, however, with the advent of synthetic insecticides during the twentieth century. With the high cost of synthetic products and the current lack of effective pesticides for stored-product protection, evaluation of local plants as sources of protectants is very desirable to help farmers use locally available and environmentally friendly products to limit post-harvest losses of their produce (Bouda et al., 2001). Most *Artemisia* species are found growing wild and abundantly throughout the temperate and cold-temperate zones of the world. Mugwort, *A. vulgaris*, plants seem to have originated in eastern Asia (Cui, 1989) and are a very common weed in China. The crude extract has been used as an antimalarial agent for thousands of years, and Sun et al. (1992) found that artemisinin extracted from *A. vulgaris* had antitumour activity. It can also repel mosquitoes and other insects.

Insect repellent activity has been found in many plant species (Tripathi et al., 2000; Sighamony et al., 1984; Scheare, 1984). Essential oils are potential alternatives to current stored-grain fumigants because of their low toxicity to warm-blooded mammals and their high volatility (Shaaya et al., 1991, 1997; Li and Zou, 2001). Previous studies have assessed fumigant activity of essential oils on adults and larvae and recently authors have described the contact and fumigant toxicity of essential oils or their major components against eggs of stored-product insects (Shaaya et al., 1993; Ho et al., 1997; Huang et al., 1997, 2000; Tunc et al., 2000). When essential oils are used as fumigants to disinfest commodities, they should kill all stages of insects. In the present study, eggs are of particular concern because they may exhibit a higher tolerance to chemical agents, e.g. phosphine, than active stages (Bell, 1978).

In this paper, we evaluated the potential repellent and fumigant effects of essential oils extracted from the leaves of *A. vulgaris* on the red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae).

2. Materials and methods

2.1. Insects and bioassays

All stages of *T. castaneum* were obtained from laboratory cultures maintained in the dark in incubators at 28–30 °C and 70–80% r.h. at the Institute of Insect Resources of Huazhong Agricultural University. They were reared on wheat flour mixed with yeast (10:1, w/w). Larvae of *T. castaneum* used in the experiments were 12, 14 and 16 days old and adults were 5–7 days post-eclosion. Eggs were collected on pleated black filter papers placed in bowls half filled with milled rice for 0–24 h (Ho et al., 1996). All bioassays were carried out in the dark incubators at 28–30 °C and 70–80% relative humidity (r.h.).

2.2. Extraction of the essential oil

Extraction of *A. vulgaris* oil followed the method of Huang et al. (2000). Leaves and stems of *A. vulgaris* were collected from the experimental farm in Wuhan, central China, from June to