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# Essential oil from *Artemisia annua* aerial parts: composition and repellent activity against two storage pests

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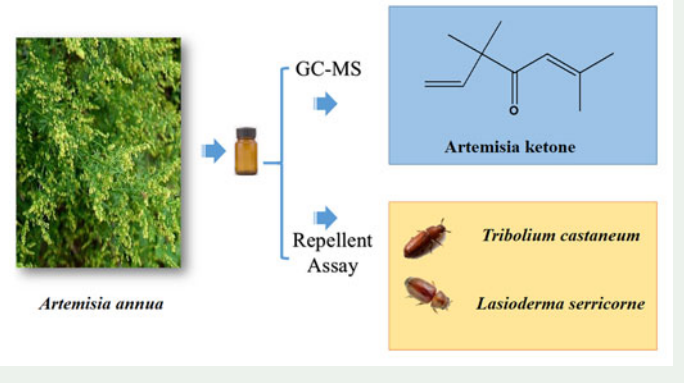
**ABSTRACT**

As a medicinal plant, *Artemisia annua* is widely distributed in China. The purpose of this work was to analyze the chemical composition of essential oil from *A. annua* aerial portions, as well as to assess its repellent activity against *Lasioderma serricorne* and *Tribolium castaneum* adults. GC-FID and GC-MS analyses enabled the identification of 15 components representing 90.1% of the essential oil. The main components included artemisia ketone (70.6%), α-caryophyllene (5.1%) and germacrene D (3.8%). The essential oil was found to possess considerable ability to repel the two storage pests. This paper provided some evidence for the exploitation and utilization of *A. annua* resources as a natural repellent.

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## 1. Introduction

The cigarette beetle (*Lasioderma serricorne* Fabricius) and the red flour beetle (*Tribolium castaneum* Herbst) were the major pests of stored products (Liu and Ho, 1999; Babarinde et al. 2008; Ebadollahi et al. 2010). As part of our screening program

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to find control agents from Chinese medicinal herbs, the essential oil of *Artemisia annua* L. (Flora of China, 1991) aerial portions was screened for bioactivities against the two beetles. *A. annua* is a perennial herb in the Compositae family. It is distributed throughout China. It is a medicinal plant locally known as "Qinghao" and famous for containing artemisinin which has antimalarial activities (Woerdenbag et al. 1992; Reale et al. 2008; Ivanescu et al. 2011; Abolaji et al. 2014). Major constituents of *Artemisia annua* essential oil has been reported in previous studies. For example, 2,5-dihydro-3-methyl-furan (68.5%) and $\beta$-myrcene (10.1%) were the major compounds of the oil sample from Xinjiang of China (Zhang et al. 2004). Artemisia ketone has been previously identified as a main component of *A. annua* by many researchers all over the world (Charles et al. 1991; Ahmad and Misra 1994; Chalchat et al. 1994; Héthelyi et al. 1995; Li et al. 2011). Up to now, this compound is found most abundant (75%) in *A. annua* from Hungary (Héthelyi et al. 1995). Literatures on essential oils from the *A. annua* also reported various bioactivities against storage pests (Tripathi et al. 2000; Goel et al. 2007; Haghighian et al. 2008; Brisibe et al. 2011). However, there is little research on the bioactivity against the two beetles. Thus, in this work, we investigated the chemical composition of the essential oil and its repellent activity against the two storage pests, *Lasioderma serricorne* and *Tribolium castaneum*.

## 2. Results and discussion

### 2.1. Chemical composition of the essential oil

The essential oil of *A. annua* had light yellow colour with the yield of 0.11% (v/w). Fifteen components were identified, and the results are shown in Table S1. The major compounds were artemisia ketone (Figure S1, 70.6%), $\alpha$-caryophyllene (5.1%), germacrene D (3.8%) and $\beta$-selinene (3.5%). Artemisia ketone can be useful for perfumery and fragrance (Haider et al. 2012), and it has antimicrobial activity (Bilia et al. 2014). However, many factors such as plant organs, geographical environment and harvest time might impact the amounts of artemisia ketone in this essential oil (Charles et al. 1991; Habibi et al. 2013).

### 2.2. Repellent activity

The essential oil exhibited repellent activity against *L. serricorne* and *T. castaneum* adults on different levels. The results are presented in Figure S2. *A. annua* oil showed either the same or higher level repellency against the two beetles than the positive control, DEET at all of the testing procedures. At the highest concentration of 78.63 nL/cm$^2$, the essential oil showed strong repellency $>$90% against the cigarette beetles (Figure S2A and S2B). The essential oil was also found to possess obvious repellent activity against the *T. castaneum* adults. Even at the concentration of 0.63 and 0.13 nL/cm$^2$, the essential oil showed significantly stronger repellency than DEET ($p \leq 0.001$) at 2 h after exposure (Figure S2C). At 4 h after treatment (Figure S2D), only at the last two concentrations (0.63 and 0.13 nL/cm$^2$), the essential oil showed $<$ 80% repellent activity (Class IV). According to previous studies, some compounds ($\alpha$-caryophyllene and $\alpha$-pinene) identified in this essential oil also displayed repellent activities (You et al. 2015). Further research need to focus on the isolation and bioactivity of the artemisia ketone.

## 3. Conclusions

The investigation of the chemical composition showed that artemisia ketone (70.6%) was the main compounds in the essential oil from *A. annua*. The essential oil of *A. annua* possessed strong repellency against the two storage pests. It was revealed that the essential oil has potential for development as natural protectants for stored products.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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