Efficacy of essential oil from *Artemisia scoparia* Waldst. & Kit. against *Tribolium castaneum* (Herbst) (Coleoptera:Tenebrionidae)

M. Negahban[1], S. Moharramipour[2], M. Yousefelahi[3]

1, 2- Department of Entomology, College of Agriculture and 3- Department of Chemistry, College of Basic Sciences, Tarbiat Modarres University, P.O.Box: 14115-336, Tehran, Iran ,1- Phone: +98 21 419 6522, Email: m_negahban@modares.ac.ir, 2- Phone: +98 21 419 6522, Email:moharami@modares.ac.ir, 3- Phone: +98 21 801 1001, Email: yousefelahi@modares.ac.ir

Abstract:
Artemisia scoparia (Compositae) is a widespread plant growing wild in many regions of Iran. Extracts from this plant are commonly used as flavoring agent in the food industry, and are recognized as an antihelmintic, stomachic and tonic-bitter. However, its insecticide activity is not reported yet. Most of this substance has lower mammalian toxicity and low persistence in the environment. The essential oil obtained from dry ground leave of *A. scoparia*, was subjected to hydrodistillation using a modified Clevenger-type apparatus, and was tested against one to seven days old adults of *Tribolium castaneum* at different concentrations ranging from 3.7 x 10^{-4} to 0.9 µl/cm^3. The experiment was conducted with five replications in growth chamber at 25±1 °C and 65±5% RH in dark condition. The mortality was recorded at several time intervals (3-48h). Fumigant toxicity of the essential oil for all tested treatments was found to increase as its concentration and time were increased. LC_{50} value after 12h was found 0.2µl/cm^3 and LT_{50} value at the concentration of 0.3µl/cm^3 was 8.46h. At the concentration of 0.9µl/cm^3 the mortality was attained 100% after 12 h. It was observed that the essential oil of *A. scoparia* contains sources of biological active vapors that are potential efficient insecticide. Consequently, the possibility of employing this natural fumigant to control stored product insects may be worthy of further investigation.

Keywords: *Artemisia scoparia*, Essential oils, *Tribolium castaneum*, Fumigant, Bioactivity

Introduction

The invasion of various food commodities by fungi and insects causes considerable losses in tropical and subtropical countries. Recently, There has been a growing interest in research conceiving the possible use of plant extracts as alternatives to synthetic insecticides. Essential oils are among the best-known substances tested against insects. (Risha *et al*., 1990; Rice and Coats, 1994; Regnault – Roger and Hamraoui, 1994; Shaaya *et al*. 1991). These compounds may act as fumigants, contact insecticides, repellents, antifeedants and may affect some biological parameters such as growth rate, life span and reproduction of various insect pests (Gunderson *et al*., 1985; Stamopoulos, 1991; Saxena *et al*., 1992; Reganult–Roger and Hamraoui, 1994). Most of these substances were tested against insects attacking stored products in order to establish new control practices with lower mammalian toxicity and low persistence in the environment. Oils of natural origin can play an important role in the stored products protection and reduce the risk associated with the use of highly toxic fumigants. At present, only two fumigants are in common use: Methyl bromide and phosphine. Methyl bromide has been identified as a major contributor to ozone depletion, which casts doubts on its future use in insect control (Anonymous, 1995). There have been indications that certain insects have developed resistance to phosphine, so its use is now suspected (Bell and Wilson, 1995: Narakita and Winks, 1981). During recent years, some pesticidal plants have been receiving global attention and their secondary metabolites have been formulated as botanical pesticides in plant protection and biological control. Since they do not leave toxic residues to the environment due to their natural origin (Duke, 1985).

The essential oil of *Artemisia* species has been found to possess strong insecticidal activity against the stored insect pests. In present work, the efficacy of A. s*coparia* oil has been tested as fumigants of higher plant origin in the management of *Tribolium castaneum*.

Materials and Methods:

1- Plant material:

Aerial parts of *Artemisia scoparia* (Compositae) were collected from Tehran province Iran, at full flowering stage. The collected plant was dried naturally on laboratory benches at room temperature (23-24 °C) for 5 days until it was crisp dry. The dried material was stored at –30 °C until needed and then hydrodistilled for recovery of its essential oil.

2- Extraction of essential oil:

The essential oil tested was extracted by water steam distillation using a cleavage apparatus type from the leaves and whole flowering plant of *Artemisia scoparia*. After extraction, the essential oil was dried over anhydrous sodium sulphate and stored in a refrigerator at 5 °C.

3- Insects preparations:

Tribolium castaneum was obtained from laboratory cultures maintained in the dark in incubator at 25 ± 1 °C and 65 ± 5% RH. *T. castaneum* was reared on wheat flour mixed with yeast (10:1, w.w). Adults with 1-7 days old were used for fumigant toxicity test.

4- Fumigant toxicity:

In order to determine the LC_{50} and LT_{50} of the essential oil, using the method of Huang *et al*. (1997, 2000) a filter paper (diameter 2.2cm) was impregnated with an appropriate concentration of the oil. Then, the filter paper was attached to the undersurface of the screw cap of a glass vial (volume 27ml). The cap was screwed tightly onto the vial containing 10 insects. Each treatment and control was replicated five times. The insects were exposed to the essential oil vapor and after 3, 6, 9, 12, 24 and 48 h the dead insects were counted.

5- Statistical analysis:

Probit analysis (Finney 1971), using a SAS software (V. 6.12) was employed in analyzing the dose-mortality response. Abbott's formula (Abbott, 1925) was used to correct for control mortality.

Results and discussion:

The essential oil of *A. scoparia* demonstrated fumigant toxicity to *T. castaneum.* The control mortality of *T. castaneum* adults were zero during the experiment. The analysis of fumigation toxicity data is given in table 1. The essential oil tested, *Artemisia scoparia* was shown strong toxic action against *T. castaneum*. The LC_{50} value after 12 h was 0.2 µl/cm^3 and the LT_{50} at the concentration of 0.3 µl/cm^3 was 8.43 h. After 12 h at the concentration of 0.45 µl/cm^3 the mortality was attained considerably high, however, a concentration of 0.9 µl/cm^3 was enough to obtain 100% kill within 24 h in space tests (Fig. 1). In all cases, a significant increase in susceptibility of insects to essential oil vapor was observed with increasing concentration. From the graph in Fig.1, it can be concluded that higher doses for a relatively short period are much more effective than lower doses for a longer period.

Apart this observed insecticidal activity, it is known that the essential oils has adverse effects on the adults of *T. custaneam* (Stamopoulos, 1991). The fumigant activity of some essential oils from *Artemisia* species has been evaluated against a number of stored product insects. Tripathi *et al.* (2000 and 2001) studied contact and fumigant toxicity of *Artemisia annua* against *Tribolium castaneum*, and found it as a toxic isolation for the insect. Dunkel and Sears (1998) studied the fumigant properties of the essential oil from *Artemisia tridentata* against some stored grain insects, and showed its potential as a good alternative to methyl bromide for protection of stored grain, commodity, and space fumigations. Under an identical procedure conducted by Shakarami *et al.* (2004a, b, c) *A. scoparia* proved to be toxic against *T. castaneum* like *Artemisia aucheri*. Chiasson *et al.* (2001) reported the acaricidal properties of the essential oil from *Artemisia absinthium*. *Artemisia verlotorum* was evaluated for its repellent effect. The extract reduced the total number and the percentage of *T. custaneam* in treated food (Novo *et al.,* 1997).

To the best of our knowledge, no study has been reported previously concerning the activity of *A. scoparia* as fumigants on insect pests. The observed fumigant activity shows that essential oils are source of biological active vapors that are potential efficient insecticides, the possibility of employing these natural fumigants to control insects in stored products may be worthy of further investigations.

Reference:

Abbott WW (1925) A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology* 18: 205-207.

Anonymous (1995) Scientific assessment of ozone depletion: *World Meteorological Organization Global Ozone Research and Monitoring Project, Report no. 37, WMO,* Geneva, Switzerland.

Bell CH, Wilson SM (1995) Phosphine tolerance and resistance in *Trogoderma granarium* Everts (Coleopteran: Dermestidae). *Journal of Stored Products Research* 31: 199-205.

Chiasson H, Belanger A, Bostanian N, Vincent C, Poliquin A (2001) Acaricidal properties of *Artemisia absinthium* and *Tanacetum vulgare* (Asteraceae) essential oils obtained by three methods of extraction. *Journal of Economic Entomology* 94(1): 167-71.

Duke JA, (1985) Handbook of Medicinal Herb, CRC press, Boca Raton, FL. PP. 114-115.

Dunkel FV, Sears LJ (1998) Fumigant properties of physical preparations from mountain big Sagebrush, *Artemisia tridentata* Nutt. ssp. vaseyana (Rydb.) for stored grain insects. *Journal of Stored Products Research* 34: 307-321.

Finney DJ (1971) Probit Analysis. Cambridge University Press, London. 333 pp.

Gunderson AC, Samuelian HJ, Evans KC, Brattsten BI (1985) Effects of the mint monoterpene Pulegoneon *Spodoptera eridania* (Lepidoptera: Noctuidae). *Environmental Entomology* 14: 859-863.

Huang Y, Lam SL, Ho SH (2000) Bioactivities of essential oil from *Elleteria cardamomum* (L.) Maton. to *Sitophilus zeamais* Motschulsky and *Tribolium castaneum* (Herbst). *Journal of Stored Products Research* 36: 107-117.

Huang Y, Tan JWML, Kini RM, Ho HS (1997) Toxic and antifeedant action of nutmeg oil against *Tribolium castaneam* (Herbst) and *Sitophilus zeamais* Motsch. *Journal of Stored Products Research* 33: 289-298.

Narakita H, Winks RG, (1981) Phosphine resistance in immature stages of a laboratory selected strain of *Tribolium castaneum* (Herbst). *Journal of stored products Research* 17: 43-52.

Novo RJ, Viglianco A, Nassetta M (1997) Repellent activity of different plant extracts on *Tribolium castaneum* (Herbst). *AgriScientia* 14: 31-36.

Regnault-Roger C, Hamraoui A (1994) Inhibition of reproduction of *Acanthoselides obrectus* Say (Coleoptera). A kidney been (*Phaseolus vulgaris*) bruchid by aromatic essential oils, *Crop Protection* 13: 624-628.

Rice P J, Coats JR (1994) Insecticidal properties of several monoterpenoids to the house fly (Diptera: Muscidae), red flour beetle (Coleoptera; Tenebrionidae), and southern corn rootworm (Coleoptera: Chrysomelidae). *Journal of Economic Entomology* 87: 1172-1179.

Risha ME, E1-Nahal MKA, Schmidt HG (1990) Toxicity of vapour of *Acorus calamus* L. oil to the immature stages of some stored – product coleopteran. *Journal of Stored Products Research* 26: 133-134.

Saxena RC, Dixit OP, Harshan V (1992) Insecticidal action of *Lantana camara* against *Callosobruchus chinensis* (Coleoptera: Bruchidae). *Journal of Stored Products Research* 28: 279-281.

Shaaya E, Ravid V, Paster N, Juven B, Zisman U, Pissarew V (1991) Fumigant toxicity of essential oils against four major stored product insects. *Journal of Chemical Ecology* 17: 499-504.

Shakarami J, Kamali K, Moharramipour S (2004a) Application of *Artemisia aucheri* Boiss as a botanical insecticide. *1st Iranian National Seminar on Development of Agrochemical Industries* P. 31.

Shakarami J, Kamali K, Moharramipour S (2004b) Effects of Essential oil of *Artemisia aucheri* Boiss on Stored – Product pest control. *3rd National Conference on the Development in the Application of Biological Products and Optimum Utilization of Chemical Fertilizers and Pesticides in Agriculture* P. 479

Shakarami J, Kamali K, Moharramipour S, Lachinani P (2004c) Insecticidal and deterrency effects of essential oils of *Artemisia aucheri* Boiss, *Salvia bracteata* L. and *Nepeta cataria* L. on *Callosobruchus maculatus* F., *3rd National Conference on the Development in the Application of Biological Products and Optimum Utilization of Chemical Fertilizers and Pesticides in Agriculture* P. 490.

Stamopoulos DC, (1991) Effect of four essential oil vapours on the oviposition and fecundity of *Acanthoscelides obtectus* Say (Coleoptera: Bruchidae). Laboratory evaluation. *Journal of Stored Products Research* 27: 199-203.

Tripathi AK, Prajapati V, Aggarwal KK, Khanuja SP, Kumar S (2000) Repellency and toxicity of oil from *Artemisia annua* to certain stored-product beetles. *Journal of Economic Entomology* 93(1): 43-47.

Tripathi AK, Prajapati V, Aggarwal KK, Kumar S (2001) Toxicity, feeding deterrence, and effect of activity of 1,8,-Cineole from *Artemisia annua* on progeny production of *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Journal of Economic Entomology* 94: 979-983.

Table 1- Fumigant toxicity of *Artemisia scoparia* essential oil vapor against *Tribolium castaneum*.

Entries	X^2	Intercept ± SE	Slope ± SE	LC_{50} / LT_{50}*	95% Confidence limit	
					lower	upper
LC 50 at 12h	6.05	1.86 ± 0.99	2.66 ± 0.30	0.200	0.160	0.232
LT 50 at 0.3 µL/cm^3	1.77	-2.77 ± 0.43	2.98 ± 0.48	8.460	7.310	10.110

* LC_{50} and LT_{50} values are expressed in µl/cm^3 and hour, respectively.

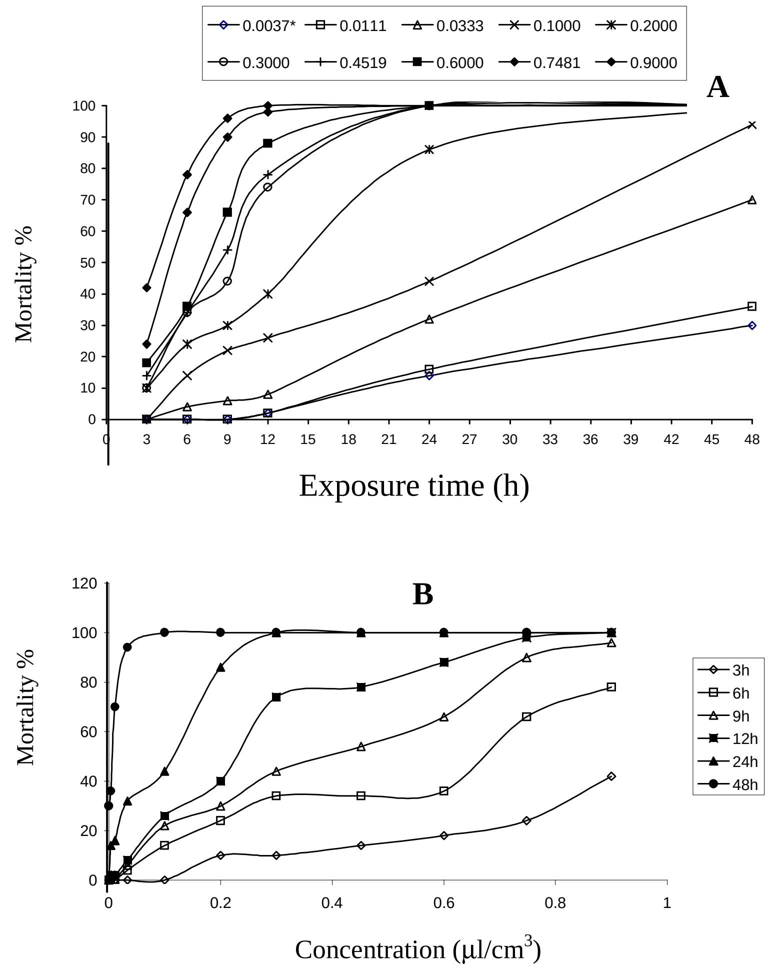

Fig. 1- Mortality of *Tribolium castaneum* exposed to the essential oil of *Artemisia scoparia* vapor for different exposure time (A) and concentrations (B).

* : Concentration (μl/cm^3)