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Susceptibility of some dried medicinal plants to attack of *Oryzaephilus surinamensis* (L.) (Coleoptera Silvanidae)

Abstract - The susceptibility of 24 dried medicinal plants commonly used in the food industry to attack of *Oryzaephilus surinamensis* (L.) was evaluated.
The development of the beetle was observed on roots of *Angelica archangelica*, *Rheum officinale* and *Valeriana officinalis*, flowers of *Citrus aurantium*, flower heads of *Crataegus oxyacantha*, whole and sieved flower heads of *Matricaria chamomilla*, whole fruits of *Foeniculum vulgare*, whole berries of *Juniperus communis*, pressed fruits of *Silybum marianum* and leaves of *Vitis vinifera*.
The highest mean number of adults, the shortest mean period of development and the highest mean index of susceptibility were observed on *S. marianum*. The lowest mean number of adults, the longest mean period of development and the lowest mean index of susceptibility were observed on *M. chamomilla*.
O. surinamensis did not develop on 14 medicinal plants tested in the present study.
The factors, that affected insect development on dried medicinal plants were various: quality and quantity of nutrition, presence of repellent, antifeedant, or with insecticidal action substances or the physical shape, dimension and state of the substrates.

Riassunto - *Suscettibilità di alcune piante officinali essiccate all'attacco di* Oryzaephilus surinamensis *(L.) (Coleoptera Silvanidae).*
È stata valutata la suscettibilità di 24 piante officinali essiccate, comunemente utilizzate nell'industria alimentare, all'attacco di *Oryzaephilus surinamensis* (L.).
Lo sviluppo del coleottero è stato osservato su radici di *Angelica archangelica*, *Rheum officinale* e *Valeriana officinalis*, fiori di *Citrus aurantium*, capolini di *Crataegus oxyacantha*, fiori interi e setacciati di *Matricaria chamomilla,* frutti interi di *Foeniculum vulgare*, bacche di *Juniperus communis*, acheni spremuti di *Silybum marianum* e foglie di *Vitis vinifera*.
Il numero medio di adulti più elevato, il periodo medio di sviluppo più breve e l'indice medio di suscettibilità più alto sono stati osservati su *M. chamomilla*. Vari fattori hanno influenzato il mancato sviluppo dell'insetto su 14 piante officinali: qualità e quantità dei nutrienti, presenza di principi attivi repellenti, fagoinibitori o ad azione insetticida, oltre che per la struttura dei substrati (forma, dimensione e consistenza).

Key words: *Oryzaephilus surinamensis*, dried medicinal plants, insect development.

INTRODUCTION

During storage, medicinal plants are prone to insect attack. Serious damages are caused by species belonging to Coleoptera families: Anobiidae, Silvanidae, Tenebrionidae and Dermestidae (Curtis & Clark, 1974; Wohlgemuth, 1975; El-Halfawy, 1977a, 1977b; Levinson & Levinson, 1978; Buchelos, 1980; Buchanan *et al.*, 1984; Basak, 1991; Chungae, 1998; Riudavets *et al.*, 2002). Other pests of dried medicinal plants are also the Lepidoptera Pyralidae *Plodia interpunctella* (Hübner), *Cadra cautella* (Walker) (Heykal *et al.*, 1978; Arbogast *et al.*, 2002; Locatelli & Stampini, 2003), *Ephestia elutella* (Hübner) (Kalinovic & Rozman, 2000) and the Lepidoptera Geometridae *Idaea bonifata* (Hulst) (Martinez & Coutin, 1985).

Oryzaephilus surinamensis (L.) was found on some spices used to flavour foodstuffs and on several medicinal plants. The present paper describes a study on the susceptibility of 24 medicinal plants to attack of *O. surinamensis*.

MATERIALS AND METHODS

Groups of 25 *Oryzaephilus surinamensis* adults were placed in polyethylene containers (Ø: 12 cm; h: 6 cm) with 3 g of soft-wheat flour. The containers were placed in a rearing room at 26±1°C and with 70±5% r.h.. Eggs were separated from the substrate using a 60 mesh sieve.

Groups of 50 eggs were placed into glass Petri dishes (Ø: 6 cm), on the substrate to be tested (20 g). Samples of 24 dried medicinal plants shown in Table 1 were used for testing insect development. Culture media made of a mixture of flours (soft-wheat flour, maize meal, bran and oat flakes) served as control. Daily checks were made to observe adult emergence. Newly emerged insects were counted and removed. Each dried medicinal plant and the control were tested in four replicates. The mean period of development (T) was calculated as the time in days spent from the oviposition to the time at which 50% of the adults emerged. In order to define the potential rate of development of the insects on different substrates (Howel & Games, 1974; Zar, 1984) a susceptibility index (S.I.) [(1)] was calculated based on the total number of emerged adults (N) and the mean development period (T). Results were subjected to analysis of variance (ANOVA) and to the Duncan multiple range test (SPSS 11.5 for Windows).

RESULTS AND DISCUSSION

Oryzaephilus surinamensis did not develop on *Achillea millefolium*, *Artemisia vulgaris*, *Camellia sinensis* (green tea), *Cynara scolymus*, *Eucalyptus globulus*, *Illicium verum*, *Malva sylvestris*, *Myrtus communis*, *Thymus vulgaris*, *Vaccinium*

[(1)] I.S. = [(log N)/T] x 100

Table 1 - Tested dried medicinal plants.

Medicinal plant	Family	Plant part tested
Achillea millefolium L.	Asteraceae	Flower heads
Angelica archangelica L.	Apiaceae	Roots
Artemisia vulgaris L.	Asteraceae	Flower heads
Camellia sinensis (L.)	Theaceae	Leaves
Citrus aurantium L.	Rutaceae	Flowers
Crataegus oxyacantha L.	Rosaceae	Flower heads
Cynara scolymus L.	Asteraceae	Leaves
Eucalyptus globulus Labill.	Myrtaceae	Leaves
Foeniculum vulgare Mill.	Apiaceae	Whole fruits
Glycyrrhiza glabra L.	Fabaceae	Roots
Illicium verum Hook. F.	Illiciaceae	Whole fruits
Juniperus communis L.	Cupressaceae	Whole berries
Malva sylvestris L.	Malvaceae	Leaves
Matricaria chamomilla L.	Asteraceae	Whole and sieved flower heads
Myrtus communis L.	Myrtaceae	Leaves
Passiflora incarnata L.	Passifloraceae	Whole and powdered leaves
Rheum officinale H. Baillon	Polygonaceae	Roots
Silybum marianum Gaertner.	Asteraceae	Pressed fruits
Thymus vulgaris L.	Lamiaceae	Leaves
Vaccinium myrtillus L.	Ericaceae	Leaves
Valeriana officinalis L.	Valerianaceae	Roots
Vanilla planifolia Andr.	Orchidaceae	Whole capsules
Vitis vinifera L.	Vitaceae	Leaves and grapes
Zingiber officinale Roscoe	Zingiberaceae	Rhizomes

myrtillus, *Vanilla planifolia* and *Zingiber officinale.* In these plants an essential oil, rich in alcohols and terpenes toxic for the insects, such as trans-anethol, cineole, terpineol, carvacrol, thymol, linalol, limonene, pinene, myrcene, cariophyllene, is present (Rudnew & Smeljanez, 1969; Karr & Coats, 1988; Calderone *et al.*, 1991; Shaaya *et al.*, 1991; Phillips *et al.*, 1994; Ngoh *et al.*, 1998; Hummelbrunner & Isman, 2001; Lee *et al.*, 2001). *O. surinamensis* did not develop either on *Passiflora incarnata.* Pristos *et al.* (1988) observed that quercetin, a flavonoid contained in *P. incarnata*, prevents the activity of catalase and of glutathion reductase in *Papilio polyxenes* (F.) (Lepidoptera Papilionidae) larvae. The insect also did not develop on *Glycyrrhiza glabra.* This medicinal plant contains high concentrations of saponin (60.000-140.000 ppm). Jain & Tripathi (1991) showed that a saponin, diosgenin-3-0-β-D-glucopyranoside, at 0.02% concentration, acts as an antifeedant for *Spilosoma obliqua* larvae

(Walker) (Lepidoptera Noctuidae). The toxicity of some extracts of *G. glabra* on IV instar larvae of *Spodoptera littoralis* (Boisd.) (Lepidoptera Noctuidae) was shown by Erian & Mahrous (1982). Adel *et al.* (2000) observed that adding saponin to the diet of this noctuid moth, resulted in an extension of the time necessary to reach the adult stage and larval mortality increased.

Few individuals emerged on *Crataegus oxyacantha*, *Foeniculum vulgare*, *Matricaria chamomilla* and *Rheum officinale* (Table 2). These plants contain carbohydrates, fatty acids, mineral salts (Ca, Fe, P) and vitamins, in particular vitamin B_1 and B_2 (thiamin and riboflavin), essential elements for insect development, but also substances potentially toxic such as α and β-pinene, *d*-limonene, myrcene and flavonoid substances (Karr & Coats, 1988; Santos *et al.*, 1997; Prates *et al.*, 1998; Maga *et al.*, 2000; Tripathi *et al.*, 2000; Neetu *et al.*, 2001). The lowest mean number of adults (2.5±0.58) and the longest mean period of development (84.5±1.29 days) were recorded on *M. chamomilla*.

A high mean number of individuals emerged from *Angelica archangelica*, *Citrus aurantium*, *Juniperus communis*, *Silybum marianum*, *Valeriana officinalis* and *Vitis vinifera*. The roots of *A. archangelica* and *V. officinalis*, the flowers of *C. aurantium* and the berries of *J. communis* are tender and rough. As observed by some authors, plants part with rough surface, facilitate insect attack (Le Cato, 1976; Locatelli & Finoli, 1986; Mbata, 1987; Ja Hyun & Mun, 2000). Moreover, these plants, when dried, produce a high percentage of fragments. The development of insect infestation is favoured by substrates which are rich in powders or easily crumbled (Ibrahim *et*

Table 2 - Mean number of adults of Oryzaephilus surinamensis *(L.), mean period of development and mean index of susceptibility observed on aromatic plants.*

Dried medicinal plant	Mean number of adults (±S.D.)	Mean period of development (days)	Mean index of susceptibility (±S.D.)
Angelica archangelica	19.8±2.75c	65.8±1.26b	2.0±0.08e
Citrus aurantium	21.0±3.16cd	42.5±1.73f	3.1±0.25c
Crataegus oxyacantha *	5.5±1.73e	63.0±2.94c	1.2±0.24f
Foeniculum vulgare	2.8±0.96e	52.0±0.82d	0.8±0.29g
Juniperus communis	18.5±2.08d	66.0±2.16b	1.9±0.14e
Matricaria chamomilla	2.5±0.58e	84.5±1.29a	0.5±0.12h
Rheum officinale	3.8±0.96e	46.3±2.22e	1.2±0.24f
Silybum marianum	42.0±2.16a	35.0±0.00g	4.6±0.06b
Valeriana officinalis	23.5±2.08c	50.5±2.08d	2.7±0.11d
Vitis vinifera	30.3±4.11b	49.8±0.50d	3.0±0.12c
Control	40.5±1.29a	32.5±0.58h	5.0±0.09a

* Whole flower heads.
The values followed by a different character are significantly different for an interval of confidence of 95%.

al., 1970; Srivastava, 1970; Verner, 1971; Yoshida, 1975). Besides dried leaves there are many grapes, such as in *V. vinifera*, that are rich in glucose and fructose; a number of cases of *O. surinamensis* infestation on these dried fruits has been recorded (Buchanan *et al.*, 1984; Riudavets *et al.*, 2002).

The highest mean number of adults (42.0±2.16), the shortest mean period of development (35.0±0.00 days) and the highest mean index of susceptibility (4.6±0.06) were observed on the achenes of *S. marianum*. This substrate is rich in lipids, in particular in oleic, linoleic and linolenic acids besides proteins, water-soluble and fat-soluble vitamins (in particular vitamins C, E and K), carbohydrates and mineral salts. These nutrients provide a balanced diet necessary for insect development.

REFERENCES

ADEL M.M., SEHNAL F., JURYZYSTA M., 2000 - Effects of alfaalfa saponins on the moth *Spodoptera littoralis*. - J. Chem. Ecol., 26 (4): 1065-1078.

ARBOGAST R.T., KENDRA P.E., MANKIN R.W., MCDONALD R.C., 2002 - Insect infestation of a botanicals warehouse in north-central Florida. - J. Stored Prod. Res., 38: 349-363.

BASAK P.K., 1991 - New records and seasonality of beetles infesting stored herbal drugs. - Geobios New Reports, 10 (1): 38-41.

BUCHANAN G.A., MC DONALD G., EVANS P.W.C., 1984 - Control of *Drosophila* spp., *Carpophilus* spp. and *Ephestia figulilella* (Gregson) in sultana grapes grown for dried fruit. - Austr. J. Exp. Agr. Anim. Husban., 24 (126): 440-446.

BUCHELOS C.T., 1980 - The populations of some Coleoptera species found in storage warehouses of currants and sultanas. - Ann. Inst. Phyt. Benaki, 12 (2): 155-168.

CALDERONE N.W., BRUCE W.A., ALLEN-WARDELL G., SHIMANUKI H., 1991 - Evaluation of botanical compounds for control of the honey-bee tracheal mite, *Acarapis woodi*. - Am. Bee J., 131 (9): 589-591.

CURTIS C.E, CLARK J.D., 1974 - Comparative biologies of *Oryzaephilus surinamensis* and *O. mercator* (Coleoptera: Cucujidae) on dried fruits and nuts. - Tech. Bull. Agr. Res. Ser., United States Depart. Agr. N°1488: 1-42.

EL-HALFAWY M.A., 1977a - Entomofauna of dried medical and aromatical plants with a short note on their occurrence and populations. - Agr. Res. Rev., 55 (1): 103-160.

EL-HALFAWY M.A., 1977b - Biology of *Lasioderma serricorne* F. on certain medical and aromatical dried plants (Coleoptera: Anobiidae). - Agr. Res. Rew., 55 (1): 107-110.

ERIAN N.S., MAHROUS T.S., 1982 - Biochemical studies on the licore roots (*Glycyrrhiza glabra*). - Res. Bull., Faculty of Agriculture, Ain Shams University, 13: 16.

HEYKAL A., EL - HALFWAY M.A., ABD EL WAHAB A.E., ASRAN A.M., 1978 - Biological study on *Plodia interpunctella* Hbn. (Lepidoptera: Phycitidae) on certain medical and aromatical dried plants. - Agr. Res. Rev., 56: 147-149.

HOWELL J.F., GAMES P.A., 1974 - The effect of variance heterogeneity multiple. Comparison procedures with equal sample size. - Brit. J. Math. Statist. Psychol., 27: 72-81.

HUMMELBRUNNER L.A., ISMAN M.B., 2001 - Acute, sublethal, antifeedant and synergistic effects of monoterpenoid essential oil compounds on the tobacco cutworm, *Spodoptera litura* (Lepidoptera: Noctuidae). - J. Agric. Food Chem., 49 (2): 715-720.

JA HYUN N., MUN I.R., 2000 - The influence of temperature on development of *Plodia interpunctella* (Lepidoptera: Pyralidae) on dried vegetable commodities. - J. Stored Prod. Res., 36 : 125-129.

JAIN D.C., TRIPATHI A.K., 1991 - Insect feeding-deterrent activity of some saponin glycosides. - Phytother. Res., 5 (3): 139-141.

KALINOVIC I., ROZMAN V., 2000 - Infestation of stored medicinal plants and herbal tea by insects and mites. - Plant Prot. Sci., 36 (1): 21-22.

KARR L.L., COATS J.R., 1988 - Insecticidal properties of *d*-limonene. - J. Pest Sci., 13 (2): 287-290.

IBRAHIM M.M., KOURA A., EL-HALFAWY M.A., 1970 - Ecological and biological studies in some insects infesting dried onions, in U.A.R.. - Agr. Res. Rev., 48 (1): 59-63.

LE CATO G.L., 1976 - Yield development, and weight of *Cadra cautella* (Walker) and *Plodia interpunctella* (Hübner) on twenty-one diets derived from natural products. - J. Stored Prod. Res., 12 : 43-47.

LEE S., LEE B., CHOI W., PARK B., KIM J., CAMPBELL B.C., 2001 - Fumigant toxicity of volatile natural products from Korean spices and medicinal plants towards the rice weevil, *Sitophilus oryzae* (L.). - Pest Manag. Sci., 57 (6): 548-553.

LEVINSON H.Z., LEVINSON A.R., 1978 - Dried seeds, plant and animal tissues as food favoured by storage insect species. - Ent. exp. Appl., 24: 505-517.

LOCATELLI D.P., FINOLI C., 1986 - Osservazioni sullo sviluppo postembrionale di *Plodia interpunctella* Hbn. (Lepidoptera: Phycitidae) infestante mandorle e armelline. - Tecnologie alimentari, Panis, 9 (4): 17-21.

LOCATELLI D.P., STAMPINI M., 2003 - Suscettibilità di alcune piante officinali all'attacco di *Corcyra cephalonica* (Stainton), *Plodia interpunctella* (Hbn.), *Lasioderma serricorne* (F.) e *Tribolium confusum* (J. du Val). - Atti VII Simposio "La difesa antiparassitaria nelle industrie alimentari e la protezione degli alimenti", Piacenza, 2002: 149-156.

MAGA R., BROUSSALIS A., CLEMENTE S., MAREGGIANI G., FERRARO G., 2000 - 1,8- cineole: responsible for the insecticide activity of *Lavandula spica* Mill (lavender). - Revta lat.-am. Quimica, 28 (3): 146-149.

MARTINEZ M, COUTIN R., 1985 - A new occasional pest: the American dried-plant moth. - Phytoma, 368: 40-41.

MBATA G.N., 1987 - Studies on the susceptibility of groundnut varieties to infestation by *Plodia interpunctella* (Hübner) (Lepidoptera: Phycitidae). - J. Stored Prod. Res., 23: 57-63.

NEETU V., TRIPATHI A.K., VEENA PRAJAPATI, BAHAL J.R., BANSAL, R.P., KHANUJA S.P.S, SUSHIL KUMAR, 2001 - Toxicity of essential oil extracted from *Lippia alba* towards stored grain insects. - J. Medicinal & Aromatic Plant Sciences, 23: (4): 117-119.

NGOH S.P., CHOO L.E.W., PANG F.Y., KINI M.R., HO S.H., 1998 - Insecticidal and repellent properties of nine volatile constituents of essential oils against the American cockroach, *Periplaneta americana* (L.). - Pest. Sci., 54 (3): 261-268.

PHILLIPS T.W., PARAJULEE M.N., WEAVER D.K., 1994 - Toxicity of terpenes secreted by the predator *Xylocoris flavipes* (Reuter) to *Tribolium castaneum* (Herbst) and *Oryzaephilus surinamensis* (L.). - J. Stored Prod. Res., 31 (2): 131-138.

PRATES H.T., SANTOS J.P., WAQUIL J.M., FABRIS J.D., OLIVEIRA A.B., FOSTER J.E., 1998 - Insecticidal Activity of Monoterpenes Against *Rhyzopertha dominica* (F.) and *Tribolium castaneum* (Herbst). - J. Stored Prod. Res., 34 (4): 243-249.

PRISTOS C.A., AHMAD S., BOWEN S.M., ELLIOTT A.J., BLOMQUIST G.J., PARDIN R.S., 1988- Antioxidant enzymes of the black swallowtail butterfly, *Papilio polyxenes*, and their response to the prooxidant allochemical, quercetin. - Arc. Ins. Biochem. Physiol., 8 (2):101-112.

RIUDAVETS J., LUCAS E., PONS M.J., 2002 - Insects and mites of stored products in the northeast of Spain. - IOBC/WPRS Working Group Integrated Protection in Stored Products", Lisbon, 2001. Bull. OILB/SROP, 25 (3): 41-44.

RUDNEW D.F., SMELJANEZ W.P., 1969 - Origins of the mass-outbreak of some species of forest pests. - Anz. Schädlingsk. Pfanzen. Umweltsch., 42 (12): 177-184.

SANTOS J.P., PRATES H.T., WAQUIL J.M., OLIVERIA A.B., 1997 - Evaluation of plant-origin substances on the control of stored product pests. Pesquisa em Andamento - Centro Nacional de Pesquisa de Milho e Sorgo (CNPMS), Sete Lagoas, Brasil, 19: 8-20.

SHAAYA E., RAVID U., PASTER N., JUVEN B., ZISMAN U., PISSAREV V., 1991 - Fumigant toxicity of essential oils against four major stored product insects. - J. Chem. Ecol., 17 (3): 499-504.

SRIVASTAVA A.S., 1970 - Important insect pests of stored oilseeds in India.- Intern. Pest Control, 12: 3, 18-20.

TOH CHUNGAE, 1998 - Studies on pest insects of crude drugs. - Korean J. Pharm., 29 (4): 365-373.

TRIPATHI A.K., VEENA PRAJAPATI, AGGARWAL K.K., SUSHIL KUMAR, 2001 - Toxicity, Feeding Deterrence, and Effect of Activity of 1,8-Cineole from *Artemisia annua* on Progeny Production of *Tribolium castaneum* (Coleoptera: Tenebrionidae). - J. econ. Ent., 94 (4): 979-983.

VERNER P.H., 1971 - Food preferences of the two species of *Oryzaephilus* (Coleoptera, Cucujidae). - Acta Entom. Bohem., 68: 3, 145-149.

WOHLGEMUTH R., 1975 - *Trogoderma angustum* Sol., a new pest in pharmacies. - Anz. Sch. Pflanz. Umweltschuz, 48 (2): 18-21.

YOSHIDA T., 1975 - Milk powder preferences of insects infesting stored products. - J. Food Hygenic Soc. Japan, 16: 74-79.

ZAR J.H., 1984 - Biostatistical Analysis. Prentice-Hall Inc., Englewood Cliffs, New Jersey, U.S.A.: 1-718.

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