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DETERRENT ACTIVITY OF PLANT POWDERS ON GRAIN WEEVIL (*SITOPHILUS GRANARIUS* L.) AND RED FLOUR BEETLE (*TRIBOLIUM CASTANEUM* HERBST.)

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Key words: storage pest, plant powders, deterent.

Abstract

The purpose of this study was to determine the deterrent properties of powders produced from the following species of plants: *Crataegus oxyacantha*, *Sambucus nigra*, *Hypericum perforatum*, *Chelidonium majus*, *Arthemisia absinthium*, *Centaurea cyanus*, *Achillea millefolium*, *Tussilago farfara*, *Matricaria chamomilla*.

The trials were performed on two species of storage pests: *Sitophilus granarius* L. and *Tribolium costaneum* Herbst. The deterrent effect of plant powders was tested by adding the powders to wheat grain. The following doses of the plant powders were tested: 5%, 2%, 1% and 0.5%. The deterrent properties of the plant powders varied, depending on plant species. It was found that higher concentrations of powders in wheat grain increase their deterrent properties. It seems that the substances present in *Crataegus oxyacantha*, *Arthemisia absinthium* and *Achillea millefolium* can be most useful in protecting stored products from *Sitophilus granaris* L. and *Tribolium castaneum* Herbst.

ODSTRASZAJĄCE DZIAŁANIE PROSZKÓW ROŚLINNYCH NA WOŁKA ZBOŻOWEGO (*SITOPHILUS GRANARIUS* L.) I TROJSZYKA GRYZĄCEGO (*TRIBOLIUM CASTANEUM* HERBST.)

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Słowa kluczowe: szkodniki magazynowe, proszki roślinne, deterentność.

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Abstrakt

Celem pracy było określenie właściwości deterentnych proszków otrzymanych z następujących gatunków roślin: *Crataegus oxyacantha, Sambucus nigra, Hypericum perforatum, Chelidonium majus, Arthemisia absinthium, Centaurea cyanus, Achillea millefolium, Tussilago farfara, Matricaria chamomilla.*

Eksperyment prowadzono na dwóch gatunkach szkodników magazynowych: *Sitophilus granarius* L. i *Tribolium castaneum* Herbst. Działanie deterentne proszków roślinnych badano dodając je do ziarna pszenicy w ilości 5%, 2%, 1% i 0,5%. Właściwości odstraszające proszków roślinnych były zróżnicowane w zależności od gatunku rośliny. Stwierdzono, że wraz ze wzrostem dawki proszku w ziarnie pszenicy rosną jego właściwości deterentne. Największe zastosowanie w ochronie produktów przechowywanych przed *Sitophilus granarius* L. i *Tribolium castaneum* Herbst. mogą mieć związki zawarte w *Sambucus nigra, Arthemisia absinthium* oraz *Achillea millefolium.*

Introduction

Plant products, while being stored, can be infested by a number of noxious organisms, which are responsible for large economic losses. Grain weevils (*Sitophilus granarius* L.) and red flour beetles (*Tribolium castaneum* Herbst.) are common representatives of such pests. They are most often found in stored cereal products (IGNATOWICZ 1998, SAHAYRAJ, PAULRAJ 2000, WARCHALEWSKI et al. 2000). Apart from eating products they attack, adults as well as larvae of these species infest them with their excrements, exuviae, dead insects and products of metabolism. Besides, they make the products moister and hotter, thus creating favourable conditions for the growth and development of fungi. Furthermore, pests feeding on stored products evoke some serious biochemical changes, which depress the quality of products. Grain which has been damaged by weevils contains less starch and is characterised by a disturbed ratio of fatty acids. Flour which has been infested by red flour beetles becomes light purple in colour while the gluten it contains is broken down. Irritated and living in overcrowded populations, beetles excrete volatile odorous compounds, benzoquinones, which alter the smell of products into an unpleasant odour. Moreover, inferior technological quality of grains (due to weevils) and flour (caused by red flour beetles) creates certain technological difficulties in the processing of cereals (NAWROT, WINIECKI 2000).

It is difficult to control these pests mainly because of the place where they feed, which is most often food products. Food products should certainly be protected from chemicals, therefore the problem ought to be solved using natural preparations.

Concluding, the aim of our research was to assess the effect of some plant powders on the feeding behaviour of *Sitophilus granarius* L. and *Tribolium castaneum* Herbst.

Material and Methods

The material

The material for our study consisted of plant powders produced from 9 plant species (Table 1).

Table 1

Composition of tested plants

Species	Family, species
1	2
Common hawthorn *Crataegus oxyacantha* L. (flower)	Rosaceae
European elder	Caprifoliaceae *Sambucus nigra* L. (flower, fruit)
St John's wort	Hypericaceae *Hypericum perforatum* L. (herb)
Celandine	Papaveraceae *Chelidonium majus* L. (herb)
Wormwood absinthium Cornflower Common milfoil Common colsfoot Common camomile	Asteraceae *Arthemisia absinthium* L. (herb) *Centaurea cyanus* L. (flower) *Achillea millefolium* L. (herb) *Tussilago farfara* L. (flower) *Matricaria chamomilla* L. (flower)

The plants were obtained from the Herbal Processing Plant in Warsaw.

The properties of each ground dried plant was examined in four concentrations: 5%, 2%, 1% and 0.5%, adding 0.5 g, 0.2 g, 0.1 g and 0.05 g of the plant powder to 10 g undamaged wheat grain.

Entomological tests

The observations concerned the behaviour of two species of beetles: *Sitophilus granarius* L. and *Tribolium castaneum* Herbst. reacting to the applied powders. The experiment was conducted in an olfactormeter according to the methods elaborated by NAWROT (1973). Two hundred beetles were placed in the olfactometer, which was kept in a laboratory incubator CL 135 for 24 hours, in the conditions optimal for the pests.

The deterrent properties of the plant powders were assessed from the formula:

$$D = No - Np/No \cdot 100\%,$$

where:
D – % of deterrence,
No – number of tested beetles,
Np – number of beetles in flasks with the plant powder.

The results were subject to analysis of variance in a completely random design. T-Tukey's test was used to evaluate and compare the means. In order to evaluate the correlation between the concentration of a preparation and its deterrence, simple regression method was applied.

Results and Discussion

The powders produced from several plant species had diverse deterrent properties (Table 1). *Sitophilus granarius* reacted strongly to the applied plant powders. The strongest deterrent effect was observed in the case of the samples containing 5% concentrations of the powders. It was somehow weaker when the powders were applied in lower concentrations, such as 2 and 1%. Powders used in the concentration of 0.5% either failed to produce any influence at all or had a very weak effect on the pests.

Sitophilus granarius was most effectively deterred by the powders obtained from *Arthemisia absinthium*, *Achillea millefolium* and *Sambucus nigra* (fruit). These plants at the highest doses of the powders can deter 90% of weevil beetles. Powders produced from the above-said plants retain their deterrent properties even at lower concentrations, with about 80% of the pests being deterred. Differences between the doses turned out to be statistically significant (Table 2). Of all the plants examined, *Arthemisia absinthium* proved to have special deterrent properties. This plant was investigated as a repellent of other noxious insects (*Sitophilus oryzae* and *Rhyzopertha dominica*) by BOUCHER et al. (2001).

Considerable deterrence was also observed in the case of powders made from *Matricaria chamomilla* and *Hypericum perforatum*. At the highest doses of powders, these plants could deter over 80% of the pests. No statistical differences were observed between 2% and 1% addition of the camomile powder to wheat grain. As regards the experiments on *Hypericum perforatum*, effects produced by 2% and 0.5% powder doses did not differ statistically (Table 2).

The weakest deterrent properties towards *Sitophilus granarius* were produced by the powders produced from *Centaurea cyanus*. When applied in the doses of 2%, 1% and 0.5%, cornflower powders acted as attractants (Table 2). Application of cornflower powders in small doses has no practical sense. The

Table 2

Deterrent activity of plant powders on grain weevil *Sitophilus granarius* L. and red flour beetle *Tribolium castaneum* Herbst.

Pest	Plant	Concentration of plant powder				Means
		5%	2%	1%	0.50%	
		plant x pest x concentration				pest x plant
Sitophilus granarius L.	1. *Sambucus nigra* L. (flower)	76.3 *a**	59.1 *b*	58.0 *b*	54.4 *c*	64.7 *e*
	2. *Sambucus nigra* L. (fruit)	90.3 *a*	86.3 *a*	78.9 *b*	73.7 *c*	85.3 *a*
	3. *Arthemisia absinthium* L.	94.2 *a*	89.4 *b*	85.6 *c*	81.4 *d*	85.8 *a*
	4. *Centaurea cyanus* L.	50.8 *a*	47.1 *b*	39.2 *c*	46.4 *b*	45.4 *i*
	5. *Hypericum perforatum* L.	83.8 *a*	66.4 *b*	63.4 *c*	66.5 *b*	73.7 *d*
	6. *Chelidonium majus* L.	63.7 *a*	64.9 *a*	62.0 *b*	39.0 *c*	53.2 *h*
	7. *Crataegus oxyacantha* L.	64.0 *a*	62.9 *a*	58.5 *b*	51.1 *b*	62.1 *f*
	8. *Achillea millefolium* L.	91.5 *a*	81.9 *b*	80.0 *b*	77.5 *bc*	83.1 *b*
	9. *Tussilago farfara* L.	69.1 *a*	65.9 *b*	63.2 *c*	54.5 *d*	55.3 *g*
	10. *Matricaria chamomilla* L.	85.7 *a*	68.7 *b*	69.9 *b*	64.2 *c*	76.8 *c*
Tribolium castaneum Herbst.	1. *Sambucus nigra* L. (flower)	75.8 *a*	63.4 *b*	61.2 *b*	58.3 *c*	62.0 *f*
	2. *Sambucus nigra* L.(fruit)	89.9 *a*	90.2 *a*	87.8 *a*	73.2 *b*	82.9 *b*
	3. *Arthemisia absinthium* L.	93.2 *a*	91.2 *a*	83.4 *b*	75.3 *c*	87.7 *a*
	4. *Centaurea cyanus* L.	51.2 *a*	49.2 *a*	48.1 *b*	33.2 *c*	45.9 *i*
	5. *Hypericum perforatum* L.	79.3 *a*	81.3 *a*	72.1 *b*	62.3 *c*	70.0 *d*
	6. *Chelidonium majus* L.	58.1 *a*	53.7 *b*	50.7 *c*	50.1 *c*	57.4 *h*
	7. *Crataegus oxyacantha* L.	65.8 *b*	70.3 *a*	63.2 *b*	48.9 *c*	59.1 *g*
	8. *Achillea millefolium* L.	89.4 *a*	86.4 *b*	79.2 *c*	77.3 *c*	82.7 *b*
	9. *Tussilago farfara* L.	59.8 *a*	58.7 *a*	51.2 *b*	51.4 *b*	63.2 *e*
	10. *Matricaria chamomilla* L.	78.9 *b*	80.4 *a*	76.3 *b*	71.5 *c*	72.1 *c*
		pest x concentration				Pest
Sitophilus granarius L.		76.9 *a*	69.5 *b*	65.9 *c*	60.9 *d*	68.3 *a*
Tribolium castaneum Herbst.		74.1 *a*	72.5 *b*	67.3 *c*	60.2 *d*	68.5 *a*
		pest x plant				plant
	1. *Sambucus nigra* L. (flower)	76.1 *a*	61.3 *b*	59.6 *c*	56.4 *d*	63.3 *f*
	2. *Sambucus nigra* L. (fruit)	90.1 *a*	89.3 *a*	83.4 *b*	73.5 *c*	84.0 *b*
	3. *Arthemisia absinthium* L.	93.7 *a*	90.3 *b*	84.5 *c*	78.4 *d*	86.7 *a*
	4. *Centaurea cyanus* L.	51.0 *a*	48.2 *b*	43.7 *c*	39.8 *d*	45.7 *d*
	5. *Hypericum perforatum* L.	81.5 *a*	73.9 *b*	67.8 *c*	64.4 *d*	71.9 *e*
	6. *Chelidonium majus* L.	60.9 *a*	59.3 *b*	56.35 *c*	44.6 *d*	55.3 *i*
	7. *Crataegus oxyacantha* L.	64.9 *b*	66.6 *a*	60.9 *c*	50.0 *d*	60.6 *g*
	8. *Achillea millefolium* L.	90.5 *a*	84.2 *b*	79.6 *c*	77.4 *d*	82.9 *c*
	9. *Tussilago farfara* L.	64.5 *a*	62.3 *b*	57.2 *c*	52.93 *d*	59.2 *h*
	10. *Matricaria chamomilla* L.	82.3 *a*	74.55 *b*	73.1 *c*	67.85 *d*	74.5 *d*
		concentration				
		75.54 *a*	71.0 *b*	66.6 *c*	60.5 *d*	
	$LSD_{0.01}$	0.32				

* values each column, followed by the same letter, are not significanthy different

plants tested in the trials on *Sitophilus granarius* were significantly different in their deterrent properties. *Tribolium castaneum* was similar to *Sitophilus granarius* in its response to the application of the plant powders, although the effect of the strongest deterrents on this pest was slightly weaker. The strongest deterrent proved to be the powder made from *Arthemisia absinthium*. The statistical analysis showed no significant differences between the 5% and 2% addition of the wormwood powder to wheat grain. In their report, TRIPATHI et al. (2000) also concluded that this plant species had the strongest deterrent properties.

In the present trials, the powders produced from *Chelidonium majus*, *Centaurea cyanus* and *Tussilago farfara* had small deterrent influence on *Tribolium castaneum*. In fact, it was found that 3% addition of *Crataegus oxyacantha* powder attracted red flour beetles. There were significant differences in deterrence between all the plant powders used in the trails on *Tribolium castaneum*, except the effects produced by 5% and 2% concentrations of *Sambucus nigra* (fruit) powder.

Similar responses of the two species of beetles to the deterrents applied are probably a consequence of the fact that both species are typical storage pests, similar in their bionomics, long adapted to feeding on stored grains (IGNATOWICZ 1999).

Conclusions

1. Deterrence of *Arthemisia absinthium, Achillea millefolium and Sambucus nigra towards Sitophilus granarius L. and Tribolium castaneum* Herbst. is high and quite uniform.

2. The weakest deterrent effects on the two species of beetles were produced by *Crataegus oxyacantha*, which has some characteristics of an attractant.

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