Janina GOSPODAREK, Natalia KWIECIEŃ
University of Agriculture in Krakow, Faculty of Agriculture and Economics,
Department of Agricultural Environment Protection
Al. Mickiewicza 21, 31-120 Krakow, Poland
e-mail: rrjgospo@-cyf-kr.edu.pl

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EFFECT OF AQUEOUS EXTRACTS OF TARRAGON ON LADYBIRDS (COL. COCCINELIDAE)

Summary

The aim of the studies was to determine the effect of aqueous extracts from fresh and dry matter of tarragon (Artemisia dracunculus L.*) on the voracity of Asian lady beetle (Harmonia axyridis Pallas) larvae and adults. Extracts of tarragon were prepared in concentrations assumed conventionally as 2, 5 and 10% for dry matter and 10, 20 and 30% for fresh matter. Redistilled water was used as the control. The study investigated the gastric effect of the extracts on the voracity of the Asian lady beetle at two developmental stages: imago and L3 larvae. Aqueous tarragon extracts reduced the prey consumption in Asian lady beetle larvae in the L3 stage, but had no significant impact on the voracity in imago. The deterrence of prey consumption in lady beetle larvae was proportional to the increase in concentrations of the extracts used, and was stronger for extracts prepared from fresh tarragon matter. The findings provide evidence in favour of using tarragon extracts, especially in the initial period of aphid presence, before the appearance of lady beetle larvae.*
Key words*: aqueous extracts, tarragon, Harmonia axyridis Pallas*

WPŁYW WYCIĄGÓW WODNYCH Z BYLICY ESTRAGONU NA BIEDRONKOWATE (COL. COCCINELLIDAE)

Streszczenie

Celem badań było określenie oddziaływania wodnych wyciągów z suchej i świeżej masy bylicy estragonu (Artemisia dracunculus L.) na żarłoczność larw i postaci dorosłych biedronki azjatyckiej (Harmonia axyridis Pallas). Wyciągi przygotowano w stężeniach: 2, 5 i 10% dla suchej masy oraz 10, 20 i 30% dla świeżej masy. Obiekt kontrolny stanowiła woda redestylowana. Badano oddziaływanie żołądkowe wyciągu na żarłoczność biedronki azjatyckiej w dwóch stadiach rozwojowych – imago oraz larwy L3. Wyciągi wodne z bylicy estragonu ograniczały żerowanie larw biedronki azjatyckiej w stadium L3, natomiast nie wpłynęły w istotny sposób na żarłoczność imago. Hamowanie żerowania larw biedronek było proporcjonalne do wzrostu stężeń zastosowanych ekstraktów i silniejsze w przypadku wyciągów sporządzonych na bazie świeżej masy estragonu. Uzyskane rezultaty przemawiają za stosowaniem wyciągów z bylicy estragonu, przede wszystkim w początkowym okresie występowania mszyc, zanim pojawią się postacie larwalne biedronek.
Słowa kluczowe*: wyciągi wodne, bylica estragon, Harmonia axyridis Pallas*

1. Introduction

Tarragon (*Artemisia dracunculus* L.) is a plant species of the Asteraceae family, rich in numerous nutrients. It is cultivated primarily for seasoning purposes, but it is also used in medical care and medicine [7, 19]. Extracts and essential oils from that plant are used to control certain crop pests. The studies conducted to date using aqueous tarragon extracts have proved the effectiveness of those extracts in combating the pea aphid (*Acyrthosiphon pisum* Harris) and reducing the feeding activity of adult potato beetles (*Leptinotarsa decemlineata* Say.) and cereal leaf beetles (*Oulema melanopa* L.) [16]. Moreover, the extracts increased the mortality rate of potato beetle larvae by up to 50% [15]. Essential oils proved to be effective in the fight against stored products pests, such as the grain weevil (*Sitophilus granarius* L.) [8], the cowpea weevil (*Callosobrochus maculatus* F.) [14], as well as the cotton aphid (*Aphis gossypii* Glover) and the tobacco thrips (*Thrips tabaci* L.) [12]. Prior to the commercialisation of a biocide (even one that is based on natural products), it is necessary to assess its potential impact on other organisms which accompany pests and play a significant role in regulating their population. Among the most important of these are the coccinellidae (Colepotera, Coccinellidae). Very few studies have so far been devoted to the effect of plant extracts used for pest control on non-target organisms, and the results of those studies are varied [1, 3, 18]. Barczak [1] noted a decrease in the population and number of species of parasitoids hatching from aphids (*Aphis fabae* Scop) after spraying the aphids with infusions of the polygonum: the bistort, the wild buckwheat, and the spotted lady's thumb. El-Sharabasy [4] demonstrated, that alcoholic extracts of *Artemisia judaica* L. which exhibit toxic and repellent effect toward red spider mite (*Tetranychus urticae* Koch), may also have a negative effect on *Phytoseiulus persimilis* Athias-Henriot, which is the natural enemy of the pest. Plant extracts were also deemed to have a negative effect on the beetles of the family coccinellidae [9, 10].

The aim of the studies was to determine the effect of aqueous extracts from fresh and dry tarragon matter on the voracity of Asian lady beetle (*Harmonia axyridis* Pallas) larvae and adults.

2. Material and methods

The experiment was conducted in May 2015 under laboratory conditions in six replications. Extracts of tarragon were prepared in concentrations assumed conventionally as 2, 5 and 10% for dry matter (DM) (dried

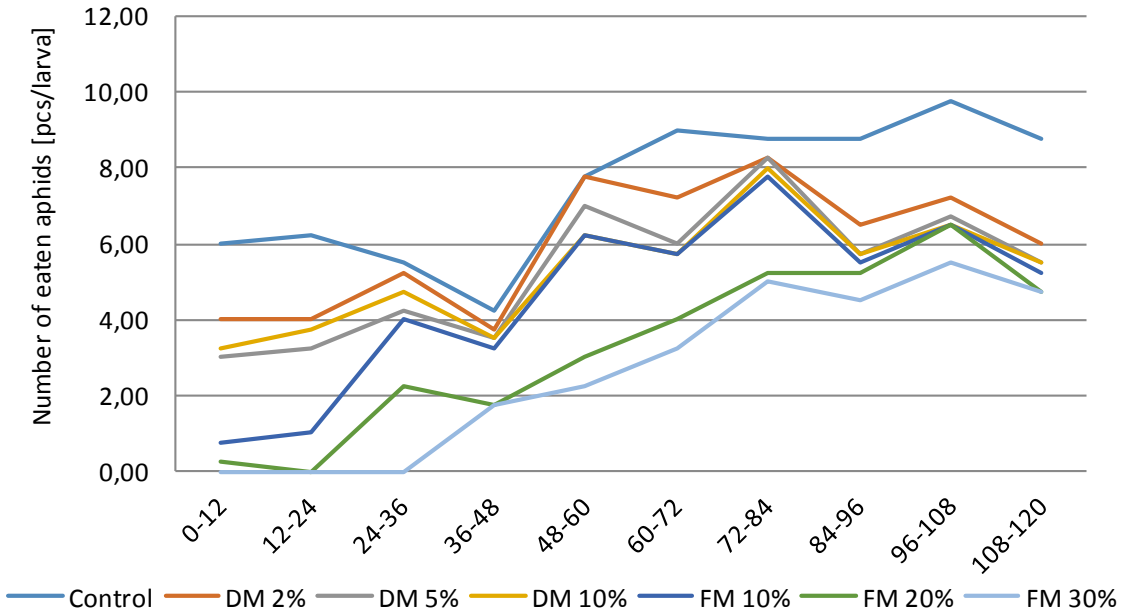
plant + cold redistilled water in proportions 2 : 100, 5 : 100 and 10 : 100) and 10, 20 and 30% for fresh matter (FM) (fresh above-ground parts of plants + cold redistilled water in proportions 10 : 100, 20 : 100 and 30 : 100). For the period of 24 hours the extracts were stored in the dark, and then filtered through filter papers and immediately used in experiment. The experiment was conducted at room temperature (24°C) in daylight. Redistilled water was used as the control. The study investigated the gastric effect of the extract on the voracity of the Asian lady beetle at two developmental stages: imago and L3 larvae. In Petri dishes with a diameter of 9 cm, lined with damp filter paper, a mock-orange leaf was placed along with one larva or adult of the Asian lady beetle and 15 black bean aphid larvae (*Aphis fabae* Scop.) of identical size (7-day-old), which constituted the feeding base. The experiment lasted five days during which the predators were fed with aphids every 12 hours. Each time, the number of aphids eaten by lady birds was counted and replenished to 15 in the dish. Prior to being placed in the dish, the aphids intended for feeding were sprayed with a given extract or redistilled water. A glass laboratory sprayer was used for this purpose. The distance between the sprayer and the sprayed object, i.e. the aphids, was 50 cm. Two milliliters of liquid were used at a time.

The obtained results were then subject to analysis by STATISTICA 10.0 software. The significance of differences between the means were tested by univariate analysis of variance, and the means were differentiated by Fisher's LSD test at $\alpha = 0.05$.

3. Results and discussion

The extracts under examination had a significant effect on the number of aphids eaten by Asian lady beetle larvae (Fig. 1, Table 1). Extracts made from fresh tarragon parts had a stronger effect than those prepared from dried tarragon. Feeding deterrence became stronger as the extract concentration increased - lady beetle larvae ate the smallest number of aphids sprayed with a 30% extract from fresh tarragon parts. During the entire period of observation, the larvae also ate a significantly smaller number of aphids sprayed with a 20% extract from fresh *A. dracunculus* matter. The extracts from dried plant matter reduced the voracity in *H. axyridis* larvae during the first twenty-four hours of breeding, and later - after three days of breeding. In general, the negative impact of the extracts on the amount of eaten food deepened as the larvae consumed further victims sprayed with the extracts.

A different situation was observed with respect to voracity in *H. axyridis* adults (Fig. 2, Table 2). Certain difference in relation to the control were noticed only during the first 12 hours of feeding the lady beetles with aphids sprayed with particular extracts. The beetles in the objects where the aphids were sprayed with all kinds of dried tarragon extracts and a 10% extract from fresh tarragon matter consumed less food. During the following days of breeding until the end of the experiment, no statistically significant differences were noted in the number of aphids eaten by *H. axyridis* imago.



Source: own work / Źródło: opracowanie własne

Fig. 1. Number of eaten aphids by larvae of *Harmonia axyridis* Pallas during 12 hours after application of the aqueous extract from dried (DM) and fresh (FM) matter of tarragon. 0-12, 12-24…. – time intervals from the start of the experiment [hour]

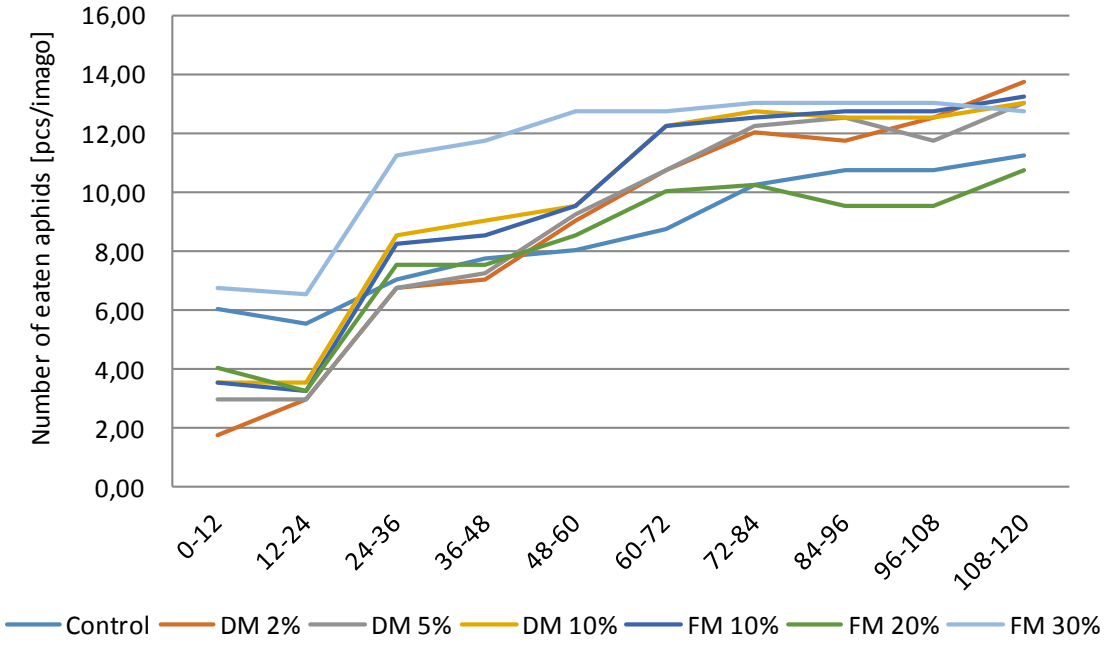
Rys. 1. Liczba mszyc zjedzonych przez larwy biedronki azjatyckiej Harmonia axyridis Pallas w ciągu 12 godzin po zastosowaniu wodnych ekstraktów z suchej (DM) i świeżej (FM) masy bylicy estragonu. 0-12, 12-24…. – przedziały czasowe od momentu rozpoczęcia eksperymentu [godzina]

Table 1. Results of the statistical analysis of number of eaten aphids by larvae of *Harmonia axyridis* Pallas during 12 hours after application the aqueous extract from dried (DM) and fresh (FM) matter of tarragon. See fig. 1 for explanation
Tab. 1. Wyniki analizy statystycznej odnośnie liczby mszyc zjedzonych przez larwy biedronki azjatyckiej Harmonia axyridis Pallas w ciągu 12 godzin po zastosowaniu wodnych ekstraktów z suchej (DM) i świeżej (FM) masy bylicy estragonu. Objaśnienia jak na rys. 1

Treatment	0-12	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120
Control	c*	c	c	a	b	d	c	b	b	b
DM 2%	b	b	c	a	b	cd	c	ab	a	a
DM 5%	b	b	bc	a	b	c	c	a	a	a
DM 10%	b	b	bc	a	b	bc	c	a	a	a
FM 10%	a	a	bc	a	b	bc	bc	a	a	a
FM 20%	a	a	ab	a	a	ab	ab	a	a	a
FM 30%	a	a	a	a	a	a	a	a	a	a

* Values marked with different letters differ significantly at α = 0.05

Source: own work / Źródło: opracowanie własne



Source: own work / Źródło: opracowanie własne

Fig. 2. Number of eaten aphids by adult of *Harmonia axyridis* Pallas during 12 hours after application of the aqueous extract from dried (DM) and fresh (FM) matter of tarragon. See fig. 1 for explanation
Rys. 2. Liczba mszyc zjedzonych przez osobniki dorosłe biedronki azjatyckiej Harmonia axyridis Pallas w ciągu 12 godzin po zastosowaniu wodnych ekstraktów z suchej (DM) i świeżej (FM) masy bylicy estragonu. Objaśnienia jak na rys. 1

Table 2. Results of the statistical analysis of number of eaten aphids by adult of *Harmonia axyridis* Pallas during 12 hours after application the aqueous extract from dried (DM) and fresh (FM) matter of tarragon. See fig. 1 for explanation
Tab. 2. Wyniki analizy statystycznej odnośnie liczby mszyc zjedzonych przez osobniki dorosłe biedronki azjatyckiej Harmonia axyridis Pallas w ciągu 12 godzin po zastosowaniu wodnych ekstraktów z suchej (DM) i świeżej (FM) masy bylicy estragonu. Objaśnienia jak na rys. 1

Treatment	0-12	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120
Control	bc*	a	a	a	a	a	a	a	a	a
DM 2%	a	a	a	a	a	a	a	a	a	a
DM 5%	a	a	a	a	a	a	a	a	a	a
DM 10%	a	a	a	a	a	a	a	a	a	a
FM 10%	a	a	a	a	a	a	a	a	a	a
FM 20%	ab	a	a	a	a	a	a	a	a	a
FM 30%	c	a	a	a	a	a	a	a	a	a

* Values marked with different letters differ significantly at α = 0.05

Source: own work / Źródło: opracowanie własne

The data concerning the effect of pest-controlling plant extracts on the natural enemies of those pests is scarce and varied. While some authors emphasise the lack of negative impact of those extracts on non-target organisms [3, 5, 18], others point to the possible existence of this kind of negative influence, which sometimes is even stronger than the effect on pests themselves [4, 10]. So far, no evidence has been found to confirm the adverse impact of the extract from plants systematically similar to the tested one, i.e. the wormwood (*Artemisia absinthium* L.), on the presence of larvae of two lady beetle species - *Coccinella septempunctata* L. and *Scymnus subvillosus* Goeze in the colonies of mealy plum aphids (*Hyalopterus pruni* Geoffroi) [18]. On the other hand, the extracts from certain plants, e.g. the thorn apple (*Datura stramonium* L.) turn out to be lethal for lady beetles. Interestingly, the LC90 value of that plant's extract was much lower for the lady beetle *Stethorus gilvifrons* (Muls.) than for its prey – the European red mite *Panonychus ulmi* (Koch) [10]. Moreover, the seven-spotted lady beetle and the two-spotted lady beetle turned out to be very sensitive to essential oil vapours tested against four aphid species, the black bean aphid *Aphis fabae*, the pea aphid *Acyrthosiphon pisum*, the chrysanthemum aphid *Macrosiphoniella san borni* and the green peach aphid *Myzus persicae*. The degree of toxicity depended on the species of the prey, the predator and the type of essential oil [9].

Although it is hard to compare the feeding activity of predatory and herbivorous lady beetle species, it is worth noting that an alcoholic extract from aerial parts of the *Artemisia annua* L. caused complete feeding rejection in the larvae of the herbivorous lady beetle *Epilachna paenulata* Germ at an extract concentration of 1.5 mg/cm^2 on pumpkin leaf tissue [11]. Lower concentrations (0.03 and 0.075 mg/cm^2 of the leaf) did not prevent the larvae from feeding, but had a negative effect on their survival rate and body mass. Mamoon-ur-Rashid et al. [13] analysed the influence of various concentrations of neem oil (from 0.5% to 3%) on prey consumption in the predatory lady beetle *Cryptolaemus montrouzeri* Mulsant and demonstrated that the parameter decreased by about 20% at the highest concentration of the oil. The concentrations below 1.5% did not affect the lady beetle's feeding. This, to a certain extent, is reflected by the results of our study - the inhibition of aphids consumption increased along with the increase in the concentration of the extract used for spraying the food. The observed negative effect of the tarragon extract on Asian lady beetle larvae might also be related to the chemical composition of the plant. Tarragon contains diverse substances (including tannins and flavonoids), which are characterized by toxic effect toward certain insects [19].

In our tests, the larvae of the Asian lady beetle turned out to be more sensitive to food sprayed with extracts than the adults. Larval forms are usually more sensitive to the quality of eaten food than imago, as shown by numerous studies concerning the use of different kinds of extracts for pest control. The principle applies to both insects of the order beetles [17] and aphids [2]. This has also been confirmed by the studies conducted by Hamd et al. [6]. The researchers tested, among other things, the toxicity of neem weed aqueous extract against aphids via soil. They demonstrated that the larvae of the lady beetle *Hippodamia variegata* feeding on contaminated aphids exhibited a mortality rate of 26.7%, as compared to adult forms where the mortality rate was only 10%. The absence of any effect on the adult feeding provides an argument for using tarragon extract in the initial period of development of aphid population, and avoiding its use when the pest population is already big enough to become an appropriate feeding base for lady beetles which then start laying their eggs.

4. Conclusions

1. Aqueous tarragon extracts reduced the prey consumption in Asian lady beetle larvae in the L3 stage, but had no significant impact on the voracity in imago.
2. The deterrence of prey consumption in lady beetle larvae was proportional to the increase in concentrations of the used extracts, and was stronger for extracts prepared from fresh tarragon matter.
3. The findings provide evidence in favour of using tarragon extracts, especially in the initial period of aphid presence, before the appearance of lady beetle larvae.

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