Milena RUSIN, Janina GOSPODAREK
University of Agriculture in Krakow, Faculty of Agriculture and Economics
Department of Agricultural Environment Protection
Al. Mickiewicza 21, 31-120 Krakow, Poland
e-mail: milena_rusin@wp.pl

Received: 2018-06-14 ; Accepted: 2018-07-23

THE EFFECT OF WATER EXTRACTS FROM *Origanum vulgare* L. ON FEEDING OF *Leptinotarsa decemlineata* Say

Summary

The aim of this study was to determine the effect of water extracts from fresh and dry matter of Origanum vulgare L. *on feeding both females and males of Leptinotarsa decemlineata* Say. *Dried extracts were prepared at concentrations of 2%, 5% and 10%, while the fresh plant at concentrations of 10%, 20% to 30%. Beetles feeding intensity assessment was carried out by dipping leaves of potato in respective solutions of the extracts, and then determining the weight of food eaten by beetles twice daily. In addition, absolute deterrence index and palatability index were calculated. The results of the experiment showed that the extracts prepared from dry and fresh matter at the highest concentrations (10 and 30% respectively) contributed to the greatest reduction of the females and males feeding. Similar results were also observed after application of lower concentrations of extracts, however, only in the case of females. The highest concentrations of the extracts analysed hindered feeding of Colorado potato beetle adults mostly, what is demonstrated by the highest values of absolute deterrence index and the lowest values of palatability index in these objects.*
Key words*: water extract, Origanum vulgare* L.*, Leptinotarsa decemlineata* Say

WPŁYW WYCIĄGÓW WODNYCH Z LEBIODKI POSPOLITEJ (*Origanum vulgare* L.) NA STONKĘ ZIEMNIACZANĄ

Streszczenie

Celem badań było określenie oddziaływania wodnych wyciągów ze świeżej i suchej masy lebiodki pospolitej (Origanum vulgare L.*) na żerowanie zarówno samic, jak i samców stonki ziemniaczanej (Leptinotarsa decemlineata* Say.*). Wyciągi przygotowano w stężeniach 2, 5 i 10% dla suchej masy oraz 10, 20 i 30% dla świeżej masy. Ocena intensywności żerowania chrząszczy została przeprowadzona przez moczenie liści ziemniaków w roztworach odpowiednich wyciągów, a następnie określenie masy pokarmu zjedzonego przez chrząszcze z częstotliwością dwa razy na dobę. Dodatkowo obliczono wartość bezwzględnego wskaźnika deterentności oraz wskaźnika smakowitości. Na podstawie przeprowadzonych badań stwierdzono, że wyciągi z suchej i świeżej masy w najwyższych stężeniach (odpowiednio 10 i 30%) najbardziej ograniczały żerowanie zarówno samic, jak i samców stonki ziemniaczanej. Podobne prawidłowości zaobserwowano także po zastosowaniu niższych stężeń wyciągów jednak tylko w przypadku samic badanego szkodnika. Najwyższe stężenia wyciągów najbardziej hamowały żerowanie osobników dorosłych stonki ziemniaczanej, o czym świadczą najwyższe uzyskane wartości bezwzględnego wskaźnika deterentności oraz najniższe wartości wskaźnika smakowitości w tych obiektach.*
Słowa kluczowe*: wyciągi wodne, lebiodka pospolita, stonka ziemniaczana*

1. Introduction

Plant protection chemicals, for many years, have dominated domesticated plant pests control, primarily due to their rapid action. Nevertheless, it resulted in numerous problems related to pests immunisation to active substances contained in such compounds, the elimination of their natural enemies as well as the residues of toxic substances in food, water, air and soil [1]. It caused the disturbance of an ecological balance and could have an adverse impact on human health. All these alarming aspects led to searching for new, alternative methods of domesticated plant pests control which would be safe for natural environment [2, 6]. One of promising methods consists in using essential oils and herbal extracts which may limit pests activity [5, 18]. They have a series of bioactive compounds characteristic for insecticidal, repellent, ovicidal, antifeedant and antioviposition properties [7, 10].

Oregano (*Origanum vulgare* L.) is a perennial plant from Lamiaceae family, with a series of medicinal properties [8, 17]. Furthermore, essential oils from this plant, owing to their allelopathic properties, are used for domesticated plant pests control [11, 19]. However, no research has been done so far on the impact of water extracts of oregano on domesticated plant pests.

The aim of this study was to determine the effect of water extracts from fresh and dry matter of *Origanum vulgare* L. on feeding both females and males of *Leptinotarsa decemlineata* Say.

2. Material and methods

The experiment was conducted in the laboratory, in six replicates. Fresh leaves of potato and *Leptinotarsa decemlineata* Say. adults ((males and females) used for the analysis at the beginning of July 2016 were collected. Extracts from dry matter (DM) of *Origanum vulgare* L. were prepared at concentration of 2%, 5% and 10% (dried plants + cold double-distilled water in proportions of 2:100, 5:100 and 10:100) and at concentration of 10%, 20% and 30% for

fresh matter (FM) (fresh above-ground parts of plants + cold double-distilled water in proportions of 10:100, 20:100 and 30:100). Extracts were stored in the dark at room temperature over a period of 24 hours, filtered through filters paper and immediately used to perform the experiments. Potato leaves were dipped for 3 seconds in an adequate plant extracts and in distilled water which was a control object, and then dried at room temperature. The test was carried out in Petri dishes, and as a substrate wet filter paper was used. In each dish a single leafs of potato, suitable for a specific object were placed and then one imago of *L. decemlineata* was introduced (males and females separately). In determining the effect of extracts *O. vulgare* on pest feeding the leaf mass consumed by adult twice daily was established.

In addition, values of palatability index as the ratio of the percentage mass of leaves consumed in individual objects to the percentage mass of leaves consumed in the control were calculated. Furthermore absolute deterrence index which takes into account the relationship between the mass of leaves consumed in the individual objects and the mass of leaves consumed in the control was established:

$$B_{wd} = [(K–T) : (K+T)] \cdot 100$$

where:

B_{wd} - absolute deterrence index,

K – mass of leaves consumed in control [mg],

T – mass of leaves consumed in individual objects [mg] [9].

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

After 24 hours from starting the experiment, nearly all oregano extracts (except fresh matter extracts of 10% concentration) caused the significant reduction of food eaten by Colorado potato beetle females (Table 1). After the experiment completion (after 60h) this dependence was determined only in objects with dry and fresh matter extracts in the highest concentrations (10% for dry matter and 30% for fresh matter), where the weight of food eaten by a female was approximately 60 mg lower than in the controlled sample.

The males of the pest under analysis turned out to be more resistant to the extracts; however, their feeding activity was generally less intense than that of females. Only the highest concentrations of fresh and dry matter extracts led to the considerable reduction in the weight of the food eaten after 36 and 48 hours. After 60 hours, the weight of food eaten by males in these objects was over 30% lower than in the control object.

No research has been done so far on the impact of water extracts of oregano on the feeding activity of plant pests. Pavela [12] demonstrated that alcohol extracts of this plant are characteristic for a repellent activity towards Colorado potato beetle adults reaching even 74%. Our earlier research also indicates that water extracts of other herbs may limit effectively the feeding activity of the analysed pest. Water extracts of absinthe (*Artemisia absinthium* L.) in 30% concentration from fresh matter and 10% concentration from dry matter cause the reduction in the weight of food eaten by Colorado potato beetle imago by over 135 mg after 68 hours from starting the experiment [15]. In this experiment, the impact of the highest concentrations of oregano extracts was slightly weaker; yet also statistically significant (approx. 60 mg for females and 35 mg for males after 60 hours). Extracts of 10% concentration from breckland thyme (*Thymus serpyllum* L.) dry matter after 12 hours only from starting the experiment caused the significant reduction in the weight of food eaten by Colorado potato beetle adults (by approx. 20 mg) [16]. Similar outcomes were observed after the use of tarragon (*Artemisia dracunculus* L.) extracts, where after 12 hours the weight of the food eaten by Colorado potato beetle imago was more than 60 mg lower than in the control sample [14]. Furthermore, an adverse impact on Colorado potato beetle larvae was demonstrated after the use of perforate St John's-wort (*Hypericum perforatum* L.) [3], absinthe [13] and sage (*Salvia officinalis* L.) [4].

Table 1. The effect of extracts from *Origanum vulgare* L. on the food weight eaten by males and females of *Leptinotarsa decemlineata* Say. [mg]

Tab. 1. Wpływ wyciągów z lebiodki pospolitej na masę pokarmu zjedzonego przez samce i samice stonki ziemniaczanej [mg]

Object	12 h	24 h	36 h	48 h	60 h
Females					
C	28.8^{a*}	56.5^{c}	95.8^{c}	123.3^{c}	163.8^{b}
DM 2%	21.8^{a}	41.3^{ab}	63.8^{a}	98.5^{b}	133.5^{ab}
DM 5%	26.8^{a}	48.5^{b}	74.3^{b}	90.5^{b}	112.8^{ab}
DM 10%	22.3^{a}	39.3^{a}	66.5^{a}	88.0^{b}	104.3^{a}
FM 10%	35.3^{a}	61.8^{c}	92.5^{c}	124.0^{c}	170.8^{b}
FM 20%	13.8^{a}	32.0^{a}	65.3^{a}	90.0^{b}	122.0^{ab}
FM 30%	46.0^{a}	52.3^{b}	61.8^{a}	69.8^{a}	101.8^{a}
Males					
C	20.0^{a}	46.8^{b}	65.8^{bc}	94.5^{c}	117.8^{b}
DM 2%	22.0^{a}	45.0^{ab}	70.3^{c}	95.0^{c}	117.5^{b}
DM 5%	15.8^{a}	35.0^{a}	61.8^{b}	93.8^{c}	121.8^{b}
DM 10%	19.8^{a}	39.3^{a}	56.5^{ab}	70.3^{b}	85.5^{a}
FM 10%	24.3^{a}	44.3^{ab}	64.8^{b}	95.5^{c}	131.3^{b}
FM 20%	18.0^{a}	50.0^{b}	68.8^{b}	89.8^{bc}	109.3^{ab}
FM 30%	18.3^{a}	32.5^{a}	46.3^{a}	58.3^{a}	75.0^{a}

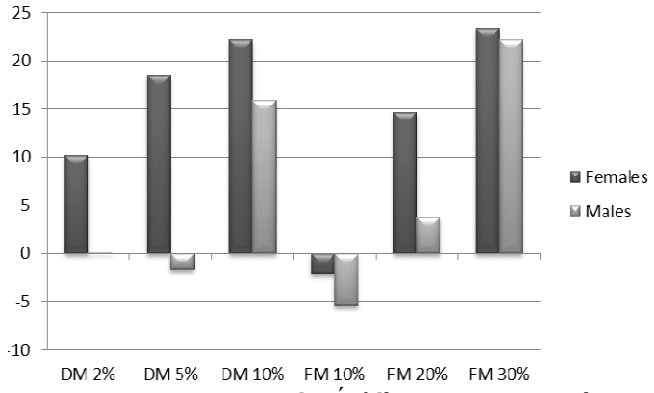
C – control, DM – dry matter, FM – fresh matter. *Values for individual terms of observations marked by different letters are statistically different ($\alpha = 0.05$).

Source: own work / Źródło: opracowanie własnae

An absolute deterrence index in general was above 0 what demonstrates that the extracts used hindered feeding of Colorado potato beetle females and males (Fig. 1). However, 10% concentration fresh matter extract and 5% concentration dry matter extract (for males only) had a stimulating effect on feeding of the pests under analysis. An absolute deterrence index had the highest values (for both males and females) after the use of the highest concentration of fresh matter extract (30%) – which was approx. 23. As the dry and fresh matter extracts concentration grew, usually their deterrent activity towards the pests analysed increased.

Rusin et al. [15] indicated that 10% concentration absinthe dry matter extracts and 30% concentration fresh matter extracts are characteristic for the strongest hindering activity for feeding of Colorado potato beetle adults (absolute deterrence index values at the level of

approx. 45). As part of this experiment, also the highest concentrations of oregano extracts hindered the feeding of the pest analysed to the greatest extent (both males and females); nevertheless, the values of the index under discussion were more than twice as high. Similar results were also observed among Colorado potato beetle larvae after the use of St John's wort extract in the research done by Biniaś et al. [3]. In the experiment carried out by Rusin at al. [16], the value of the absolute deterrence index after the use of 10% breckland thyme dry matter extract was the highest for Colorado potato beetle imago (over 16); yet, there was no similar dependence for fresh matter extract.

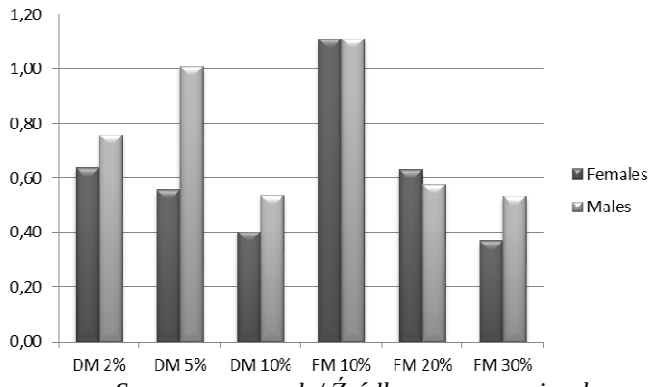


Source: own work / Źródło: opracowanie własnae

Fig.1. Absolute deterrence index. Symbols as in Table 1
Fig. 1. Bezwzględny wskaźnik deterentności. Oznaczenia jak w tab. 1

A palatability index, both for males and females, had the lowest values after the use of 30% concentration fresh matter extract (approximately 0.4-0.5). In the object with 10% concentration fresh matter extract, a palatability index was higher than 1.0 what demonstrates that a leaf blade depletion caused by imago feeding was higher in these objects than in the control one (Fig. 2).

In the experiment by Rusin et al. [14] the lowest values of a palatability index for the Colorado potato beetle imago were observed after the use of the highest concentrations of dry and fresh matter absinthe extracts (20% and 30% respectively) and they were at the level of approx. 0.4 what corresponds with the results of this experiment, especially among the females of the pest under analysis. Similar results were observed after the use of breckland thyme dry matter extract in 10% concentration in the research carried out by Rusin et al. [15].



Source: own work / Źródło: opracowanie własnae

Fig. 2. Palatability index. Symbols as in Table 1
Fig. 2. Wskaźnik smakowitości. Oznaczenia jak w tab. 1

4. Conclusions

1. The extracts of fresh and dry matter oregano in their highest concentrations (30 and 10% respectively) caused the significant reduction in the weight of food eaten by Colorado potato beetle imago. Similar results were observed also after the use of lower extract concentrations (2 and 5% for dry matter and 20% for fresh matter); nevertheless, only with the females of the pest analysed.
2. The highest concentrations of the extracts analysed hindered feeding of Colorado potato beetle adults mostly, what is demonstrated by the highest values of absolute deterrence index and the lowest values of palatability index in these objects.
3. The obtained results indicate a prospective usefulness of oregano extracts in Colorado potato beetle control what may be used in further laboratory and field studies.

5. References

[1] Arivoli A., Tennyson S.: Antifeedant activity, developmental indices and morphogenetic variations of plant extracts against *Spodoptera litura* (Fab) (Lepidoptera: Noctuidae). J. Entomol. Zool. Stud., 2013, Vol. 1(4), 87-96.

[2] Attia S, Grissa K.L., Lognay G., Bitume E., Hance T., Mailleux A.C.: A review of the major biological approaches to control the worldwide pest Tetranychus urticae (Acari: Tetranychidae) with special reference to natural pesticides. J. Pest Sci., 2013, Vol. 86, 361-386.

[3] Biniaś B., Gospodarek J., Rusin M.: Effect of aqueous extract of st. John's wort (*Hypericum perforatum* L.) on the Colorado potato beetle (*Leptinotarsa decemlineata* Say.) behaviour. J. Res. Appl. Agric. Engng, 2016, Vol. 61(3), 25-29.

[4] Biniaś B., Gospodarek J., Rusin M.: The effect of extracts from sage (*Salvia officinalis* L.) on black bean aphid (*Aphis fabae* Scop.) and Colorado potato beetle (*Leptinotarsa decemlineata* Say.) behaviour. Zesz. Probl. Post. Nauk Rol., 2016, Vol. 586, 135-145.

[5] Dankowska E., Bendowska J.: Further studies on the effect of plant infusions on the feeding of *Deroceras leave* (O.F. Müller, 1774). Folia Malacol., 2006, Vol. 14, 57-60.

[6] Elumalai K., Krishnappa K., Anandan A., Govindarajan M., Mathivanan T.: Antifeedant activity of medicinal plant essential oils against *Spodoptera litura* (Lepidoptera: Noctuidae). Int. J. Recent Sci. Res., 2010, Vol. 2, 62-68.

[7] Isman M.B., Wan A.J., Passreiter C.M.: Insectcidal activity of essential oils to tobacco cutworm, *Spodoptera litura*. Fitoterapia, 2001, Vol. 72, 65-68.

[8] Kaurinovic B., Popovic M., Vlaisavljevic S., Trivic S.: Antioxidant capacity of *Ocimum basilicum* L. and *Origanum vulgare* L. extracts. Molecules, 2011, Vol. 16, 7401-7414.

[9] Kiełczewski M., Drożdż B., Nawrot J.: Badania nad repelentami pokarmowymi trojszyka ulca (*Tribolium confusum* Duv.). Materiały 19 Sesji Nauk. Inst. Ochr. Roślin, 1979, Vol. 1, 367-376.

[10] Mehmet K., Hakki M.A: Insecticidal effect of essential oil from various plant against larvae of pine processionary moth (Thaumetopoea potyocampa Schiff) (Lepidoptera: Thaumerropoeidae). Pest Manage. Sci., 2003, Vol. 60, 173-177.

[11] Nasr M., Sendi J.J., Moharramipour S., Zibaee A.: Evaluation of *Origanum vulgare* L. essential oil as a source of toxicant and an inhibitor of physiological parameters in diamondback moth, *Plutella xylustella* L. (Lepidoptera: Pyralidae). J. Saudi Soc. Agric. Sci., 2017, Vol. 16(2), 184-190.

[12] Pavela R.: Repellent effect of ethanol extracts from plants of the family Lamiaceae on Colorado Potato Beetle adults (*Leptinotarsa decemlineata* Say). Natl. Acad. Sci. Lett., 2004, Vol. 27(5/6), 195-203.

[13] Rusin M., Gospodarek J., Biniaś B.: The effect of water extracts from *Artemisia absinthium* L. on feeding of *Leptino-*

tarsa decemlineata Say. larvae. J. Res. Appl. Agric. Engng, 2015, Vol. 60(4), 80-83.
[14] Rusin M., Gospodarek J., Biniaś B.: Effect of aqueous extracts from tarragon (*Artemisia dracunculus* L.) on feeding of selected crop pests. Res. Appl. Agric. Engng, 2016, Vol. 61(4), 143-146.
[15] Rusin M., Gospodarek J., Biniaś B.: Effect of water extracts from *Artemisia absinthium* L. on feeding of selected pests and their response to the odor of this plant. JCEA, 2016, Vol. 17(1), 188-206.
[16] Rusin M., Gospodarek J., Biniaś B.: The effect of water extract from wild thyme on Colorado potato beetle feeding. J. Ecol. Eng., 2016, Vol. 17(4), 197-202.
[17] Spiridon I., Colceru S., Anghel N., Teaca C.A., Bodirlau R., Armatu A.: Antioxidant capacity and total phenolic contents of oregano (*Origanum vulgare*), lavender (*Lavandula angustifolia*) and lemon balm (*Melissa officinalis*) from Romania. Nat. Prod. Res., 2011, Vol. 25(17), 1657-1661.
[18] Wawrzyniak M.: Effect of extracts from Geraniaceae plants on *Pieris brassicae* L. JCEA, 2009, Vol. 10(4), 361-365.
[19] Yazdani E., Sendi J.J., Hajizadeh J.: Effect of Thymus vulgaris L. and *Origanum vulgare* L. essential oils on toxicity, food consumption, and biochemical properties of lesser mulberry pyralid *Glyphodes pyloalis* Walker (Lepidoptera: Pyralidae). J. Plant Prot. Res., 2014, Vol. 54(1), 53-61.

Acknowledgements
This Research was financed by the Ministry of Science and Higher Education of the Republic of Poland.
Badania zostały sfinansowane z dotacji przyznanej przez MNiSW na działalność statutową.