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Extended Abstract

Enhancement of Diatomaceous Earth Grain Protectant Activity by Essential Oils †

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† Presented at the 16th International Symposium "Priorities of Chemistry for a Sustainable Development" PRIOCHEM, Bucharest, Romania, 28–30 October 2020.

Published: 14 November 2020

Keywords: diatomaceous earth; essential oils; biorationals; grain protectants; *Tribolium confusum*

Diatomaceous earth (*kieselguhr*), composed mainly of amorphous silica, SiO_2xnH_2O, is largely used as a feed additive [1]. Its safety for grain treatment has been recently reviewed [2]. Diatomaceous earth (DE) acts as desiccant, reducing the water availability in the stored grain environment [3]. It has been proven that powder of horsetail (*Equisetum arvense*) has a similar efficacy with diatomaceous earth [4]. The effect was considered to be mainly due to the high accumulation of silica in the horsetail. Our intention on this work was to investigate the effect of the horsetail essential oils against insects damaging stored grains. The addition of other biorationals products, such as essential oils, is a method intended to reduce the risk of developing desiccant resistance and enhancing the DE activity [5].

Two products were tested for their activity against *Tribolium confusum*, on wheat grains. DE from Adamclisi (Constantza, Romania), marine DE with an average dimension of 8 μ, was the main ingredient of both powders. One experimental treatment consisted entirely of Adamclisi DE, the other powder was 95% Adamclisi DE with 5% horsetail essential oil (DE–the). The field horsetail (*E. arvense*) essential oil was supplied by Chemspeed (Bucharest, Romania), being obtained by microwave hydro-distillation. The powders were tested at three temperatures (15, 22.5, and 30 °C), two relative humidity (RH) levels (55 and 75%), and three level of concentrations (200, 400, and 800 mg/kg). *T. confusum* were grown in wheat grains (*Triticum aestivum*, cv. Izvor), with an average humidity of 10%. The mortality of adults was measured after the 7th and 15th days of exposure.

The DE efficacy against *T. confusum* is significantly enhanced by the field horsetail essential oil. Mortality on DE–HTE reached 100% after the seventh day of exposure at 30 °C and 55% RH. The main components of *E. arvense* essential oil are hexahidrofarnesyl acetone, *cis*-geranyl acetone, and thymol. Other essential oils with high thymol content were demonstrated to be efficient against *T. confusum* [6]. Hexahidrofarnesyl acetone and *cis*-geranyl acetone were proven to have a repellent effect on *T. confusum* [7]. Most probably, the effect of the horsetail powder is related also to the essential oils, not only to the desiccant and abrasive effect of the amorphous phytosilica.

Acknowledgments: The work on this paper was supported by the Romanian Ministry of Agriculture and Rural Development, project "Research on the biological activity of some nanomaterial-based products on major pest and pathogens of fruit trees and assessment of the ecotoxicological impact of these on useful entomofauna–ADER 7.3.9".

References

1. Bennett, D.; Yee, A.; Rhee, Y.-J.; Cheng, K. Effect of diatomaceous earth on parasite load, egg production, and egg quality of free-range organic laying hens. *Poult. Sci.* **2011**, *90*, 1416–1426.
2. Anastassiadou, M.; Arena, M.; Auteri, D.; Brancato, A.; Bura, L.; Carrasco Cabrera, L.; Chaideftou, E.; Chiusolo, A.; Marques, D.C. Peer review of the pesticide risk assessment of the active substance kieselgur (diatomaceous earth). *EFSA J.* **2020**, *18*, e06054.
3. Korunic, Z. Diatomaceous earths, a group of natural insecticides. *J. Stored Prod. Res.* **1998**, *34*, 87–97, doi:10.1016/s0022-474x(97)00039-8.
4. Bohinc, T.; Vayias, B.; Bartol, T.; Trdan, S. Assessment of Insecticidal Efficacy of Diatomaceous Earth and Powders of Common Lavender and Field Horsetail against Bean Weevil Adults. *Neotrop. Entomol.* **2013**, *42*, 642–648, doi:10.1007/s13744-013-0168-7.
5. Korunić, Z.; Liška, A.; Lucić, P.; Hamel, D.; Rozman, V. Evaluation of diatomaceous earth formulations enhanced with natural products against stored product insects. *J. Stored Prod. Res.* **2020**, *86*, 101565, doi:10.1016/j.jspr.2019.101565.
6. Saroukolai, A.T.; Moharramipour, S.; Meshkatalsadat, M.H. Insecticidal properties of Thymus persicus essential oil against Tribolium castaneum and Sitophilus oryzae. *J. Pest Sci.* **2010**, *83*, 3–8.
7. Licciardello, F.; Muratore, G.; Suma, P.; Russo, A.; Nerín, C. Effectiveness of a novel insect-repellent food packaging incorporating essential oils against the red flour beetle (Tribolium castaneum). *Innov. Food Sci. Emerg. Technol.* **2013**, *19*, 173–180, doi:10.1016/j.ifset.2013.05.002.

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