Romblon State University Research Journal
ISSN: 2619-7529 (Online) | ISSN: 2350-8183 (Print)
Volume 4 (2), 6-9, 2022

Insecticidal and Antifeedant Activity of *Andrographis paniculata* as Rice Grain Protectant against Red Flour Beetle (*Tribolium castaneum* Herbst)

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ABSTRACT

The red flour beetle (*Tribolium castaneum* Herbst) is the most common stored-product insect pest infesting rice, which acts as vector for several fungal post-harvest diseases. To eradicate such pest, fumigation with chemicals is often used. As a natural alternative, this study explored the potential of *Andrographis paniculata,* an indigenous herb in the Philippines, as an antifeedant agent against *T. castaneum*. Three treatment groups were prepared, consisting of 2kg infected rice with 50 starved unsexed adult red flour beetles. Two grams of *A. paniculata* crushed leaves were placed inside a teabag (5.5 cm x 7 cm). Different amounts of *A. paniculata* tea bags (2 g, 4 g, and 6 g) were used for each treatment to determine its toxicity and antifeedant effect. Gathered data were further analyzed by analysis of variance (ANOVA) to compare the significant differences among treatments. Results of the study showed that among the treatments, three teabags (6g) of *A. paniculata* crushed leaves exhibited the highest percent insect mortality (50%) and lowest percent weight loss (1.87%) of rice. Therefore, this study suggests that three teabags of *A. paniculata* powder may be used for the efficient management of *T. castaneum* infestation and reduce the weight loss of rice in storage.

Keywords: *Tribolium castaneum, stored grain, teabag, antifeedant activity, toxicity effect*

INTRODUCTION

The continuous expansion of human population and the rising demand for food grains and other agricultural-based products put pressure on managing losses due to the infestation of stored insect-pest. One of the major secondary pests that has been a big problem mostly in stored products are the red flour beetles (*Tribolium castaneum* Herbst) since both grub and adults reduce the quality and quantity of grain (Satshi & Patrigi, 2017). To minimize infestation, most farmers typically depend on the use of synthetic products as a method of grain protection against stored-product pests (Azad et al., 2013). Repeated application of this chemical to control stored-product pests leads to several adverse effects on humans, to the environment, and thorough misuse leads to the development of pest resistance (Belmain et al., 2013). Thus, the demand for safeguarding food security by finding a new source of natural and sustainable approaches are needed to be prioritized, hence the use of synthetic chemicals must be prohibited (Ayvaz et al., 2008). As a natural alernative, scientists are exploring various plants to discover potential natural products that can address the problem with *T. castaneum* infestation in rice. One such plant that is being studied is *Andrographis paniculata,* an indigenous herb commonly known in the Philippines as "serpentina" or "king of bitters" due to its extremely bitter taste in every part of the plant body. The aerial parts of this plant are proven to contain the different active phytochemical compounds such as diterpenoid lactone, which contains 2.39% andrographolide (Shahid, 2011). These plants are widely used in traditional medicine for prevention and treatments of malaria, dysentery, and digestive ailments but relatively limited studies were undertaken on its biological activities as bio-pesticides (Kanokwan & Nobuo, 2008).

Exploiting plant products with bioactive components that have similar efficacy as synthetic pesticides are safer and may impart different modes of action in their pesticidal activities (Dubey, 1999). The *A. paniculata* leaves were found to possess andrographolide, a bioactive compound that has insecticidal and antifeedant activity against *Helicoverpa armigera, Sitophilus oryzae*, *Spodoptera litura, Aedes aegypti* (Govindarajan et al., 2011), and *Nephotettix cincticeps* (Widiarta et al., 1997).

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Received 11 April 2022; Revised 28 September 2022; Accepted 21 October 2022

Relatively limited studies made use of plant products as biopesticides in the Philippines, particularly in the province of Romblon where this control method using *A. paniculata* is still unpopular to farmers despite being abundantly available in the province. Thus, the present study aimed to determine the insecticidal and antifeedant activity of *A. paniculata* for the management of *T. castaneum* in stored rice grains under laboratory conditions.

METHODOLOGY

Collection and preparation of plant powders

Two-kilogram fresh leaves of *A. paniculata* were collected around the municipality of Odiongan, Romblon. The collected plant materials were authenticated by a plant expert from the University of Rizal System (URS). Following collection, the leaves were washed separately, shade-dried for 7 days to obtain constant weight. The dried leaves were blended using an electric blender and thereafter sieved into 25 mesh net to obtain a fine powder.

Collection and rearing of test insect

Adult red flour beetles were collected from the different rice storage facilities in Odiongan, Romblon. The collected insects were authenticated by an insect expert from the Cavite State University (CvSU). These insects were maintained at temperature range of 30-35°C in the College of Agriculture, Fisheries and Forestry, Laboratory for mass culture production. These were reared for 35 days in plastic containers with rice grains as a food source, covered with fine mesh cloth and secured with a rubber band for ventilation.

Pesticidal treatments

Different amounts of crushed *A. paniculata* (2 g = 1 teabag, 4 g = 2 teabag and 6 g = 3 teabag) were used as treatment in 2 kg rice. These were placed inside a teabag measuring 5.5 cm x 7 cm. Each tea bag contained 2 g powder.

Bioassay test

The teabags per treatments were placed inside a plastic container with 2 kg rice and were infested with 50 starved unsexed adult red flour beetles to determine their toxicity and antifeedant effect. Adults used in the experiment were aged 2 weeks, unsexed and starved for 24 h before testing. Toxicity effect were observed after 7, 14, 21, and 28 days after the treatments were employed. Percentage of insect mortality was calculated using Abbott's formula (1925), and weight loss (%) of rice after 28 days of observation using the formula by Parkin (1956).

$$\text{Pr} = \frac{Po - Pc}{100 - Pc}\ x\ 100$$

where, Pr= *Corrected % mortality*, Po = *Number of mortality*, Pc = *Total number of insects*

$$\%\ \text{WL} = \frac{WI - W}{WI}\ x\ 100$$

where, W_I = *wt. of rice grains before the experiment*, W = *wt. of rice grains after the experiment*

Data analysis

Data were analyszd and subjected to Analysis of Variance using a Statistical Package for the Social Sciences (SPSS) software with a completely randomized design. Means were compared using Tukey's Multiple Comparison Test at 0.05 probability level to check the significant differences among treatments.

RESULTS AND DISCUSSION

Toxicity

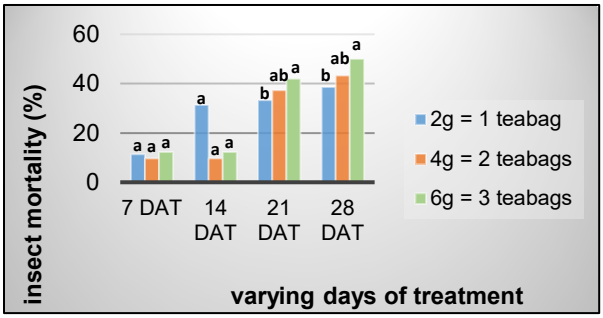

Figure 1. Percent mortality of *T. castaneum* as affected by *A. paniculata* powder at varying days after treatment. *Means followed by the same letters above bars indicate no significant difference (*$p < 0.05$*) in a Tukey's test.*

Earlier utilization of plant powders as stored grain protectant has been reported by Ogban et al., (2015). The effect of different plant products may depend on several factors which include its chemical composition and susceptibility of an insect pest (Isman & Akhtar, 2004). Based on the results, *A. paniculata* powders placed in teabags show significant toxic effect against *T. castaneum* adults. At 28 days after treatment (DAT) application, the highest mean percent mortality (50.00%) was observed using three teabags (6 g) of *A. paniculata* powders (6 g = 3 teabags) followed by 4 g = 2 teabags (43.33%) and 2 g = 1 teabag (38.67%).

At 7 DAT, 6 g = 3 teabags gave a highest mean percent mortality (12.33%) followed by 2 g = 1 teabags (11.33%) and 4 g = 2 teabags (9.67%). Still, at this time, 1 teabag performed better against *T. castaneum* than 2 teabags = 4 g with an average increase of 1.66%. At 14 DAT, still, 6 g = 3 teabags obtained the highest mean

percent mortality (37.33%) which is much higher than the untreated grains.

In addition, as the days of storage period prolonged a significant increase in mean percent mortality increases ranged from zero to an average of 50 percent among other treatments. This can be linked to the volatile compounds present in *A. paniculata,* which is responsible for its strong odor that once inhaled or taken in by the insect, could block its tracheal system that is used for respiration, leading to its death (Pugazhvendan et al., 2012). Most insects breathe through the trachea which usually leads to the opening of the spiracles. This simply implies that the effectiveness of the *A. paniculata* powder was dose and days dependent as its mortality increases with the increase in dose and days of exposure to *A. paniculata* powders.

Antifeedant

Insects inflict damage on stored products mainly by direct feeding. The *T. castaneum* mainly feeds on the nutritive tissues of rice grains causing weight loss and quality, while other species feed on the germ, resulting in poor seed development and seed viability. Thus, due to damage done by these insects, rice grains valued for selling, consumption, and for planting were lost. Figure 2 shows the percent mean values for weight loss of rice grains caused by *T. castaneum* observed after 28 DAT.

Figure 2. Percent weight loss of rice grains at 28 days after treatments (DAT). *Means followed by the same letters to the right of the bars indicate no significant difference ($p < 0.05$) in a Tukey's test.*

Results revealed that after 28-days of storage, all treatments were effective in limiting the percentage weight loss caused by *T. castaneum*. The treated rice grains had shown lower weight loss than untreated grains. The lowest percent weight loss was observed in grains treated with 6 g = 3 teabags of *A. paniculata* powder with 1.87 percent indicating its ability to act as an antifeedant. However, the mean weight loss of rice grains treated with 4 g = 2 teabags of *A. paniculata* powder (3.56 %) were lower compared to rice grains treated with 2 g = 1 teabags (5.73%).

Overall results range from 1.87% to 6.41%, indicating low to high percent weight loss. The rice grains treated with 2 g of *A. paniculata* demonstrated the highest weight loss while 6 g *A. paniculata* showed the lowest grain weight loss. This demonstrates a significant decrease in weight loss as dosages of *A. paniculata* powder increase and further indicates that as exposure and storage period prolonged the antifeedant activity of the botanical powder becomes more effective.

CONCLUSION AND RECOMMENDATION

This study demonstrates the bioefficacy of *A. paniculata* powder against *T. castaneum* adults. These findings suggest that there may be different constituents in the powder possessing different bioactivities but their identities are yet to be determined. The isolation and identification of the bioactive compounds in the plant powder are of utmost importance so that their potential application in controlling stored-product pests can be fully exploited. However, the present findings could be used to control insects in stored products to minimize pest infestation.

ACKNOWLEDGEMENT

The author wants to express her sincere thanks and appreciation to the following who provided support and contribution to make the study a success. To the Commission on Higher Education headed by Commissioner Dr. J. Prospero "Popoy" E. De Vera III, Chairman, for the CHED Kto12 Transition Program Scholarship Grant for the financial assistance and to the Romblon State University led by SUC President Dr. Merian C. Mani and to the former SUC President Dr. Arnulfo F. De Luna, for allowing the author to enjoy this huge privilege of taking and finishing her Master's degree. The author also wants to extend her heartfelt thanks to Dr. Evelyn O. Singson, her professor, adviser, English critic and to the panel members for sharing their time and knowledge for the improvement of this study. To her colleagues, most especially to Dr. Julio T. Chavez for sharing his knowledge and constant reminders to make this study successful.

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

Ayvaz, A., Albayrak, S., & Karaborklu, S. (2008). Gamma radiation sensitivity of the eggs, larvae, and pupae of Indian meal moth *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae). *Pest Management Science*, *64*(5), 505-512.

Azad, A. K., Sardar, A., Yesmin, N. Rahman, M. & Islam, S. (2013). Eco – Friendly Pest Control in Cucumber (*Cucumis sativa* L.) Field with Botanical Pesticides. *Scientific Research on Natural Resources*, *4*, 404-409.

Belmain, S.R., Haggar, J., Holt, J. & Stevenson, P.C. (2013). Managing legume pests in sub-Saharan Africa: Challenges and prospects for improving food security and nutrition through agro-ecological intensification. *Chatham Maritime (United Kingdom): Natural Resources Institute, University of Greenwich*. *34*.

Dubey N. K, Srivastav B. & Kumar A. (2008). Current Status of Plant Products as Botanical Pesticides in Storage Pest Management. *Journal of Biopesticides*, *1*(2), 182-186.

Isman M. B. & Akhtar Y. (2004). Comparative Growth Inhibitory and Antifeedant effects of Plant extracts and Pure Allelochemicals on Four Phytophagous Insect Species. *Journal of Applied Entomology*, *128*(1), 32-38.

Govindarajan M, Mathivanan T, Elumalai K, Krishnappa K. & Anandan A. (2011). Ovicidal and repellent activities of botanical extracts against *Culex quinquefasciatus, Aedes aegypti* and *Anopheles stephensi* (Diptera: Culicidae). Asian Pacific Journal of Tropical Biomedicine, *1*(1), 43-48.

Kanokwan, J. & Nobuo N. (2008). Pharmacological aspects of *Andrographis paniculata* on Health and Its major diterpenoid constitute andrographolide. *Journal of Health Science*, *54*(4), 370-381.

Ogban, E. I., Ukpong, I.G., Oku, E.E., Usua, E. J., Udo, S. E., Ogbeche, J. O., & Ajang, R. O. (2015). Potentials of two indigenous plant powder for the control of stored maize weevil (*Sitophilus zeamis)*. *American Journal of Experimental Agriculture*, *5*(1), 12-17.

Pugazhvendan S. R, Ross P.R, & Elumalai K. (2012). Insecticidal and repellent activities of four indigenous medicinal plants against stored grain pest, *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae). *Asian Pacific Journal of Tropical Disease*, *2*(Suppl 1), S16-20.

Satshi, K. & Patrigi, P. (2017). Laboratory evaluation of some indigenous plant extracts as grain protectant against red flour beetle (*Tribolium castaneum Herbst). International Journal of Entomology and Zoology Studies, 5*(4), 1600-1606.

Shahid, A. (2011). Andrographis paniculata: A review of pharmacological activities and clinical effects. *Alternative Medicine Review*, *16*, 66-77.

Widiarta, I.N, Hermawan, W., Oya, S., Nakajimas, S., & Nakasuji, F. (1997). Antifeedant activity of constituents of *Andrographis paniculata (*Acanthaceae) against the green rice leafhopper, *Nephotettix cinticeps* (Hemipte ra: Cicadellidae). *Applied Entomology and Zoology*, *32*(4), 561-566.