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Entomotoxic potential of *Morinda lucida (benth.)* Leaf powder as contact and fumigant biopesticides in the management of *Plodia interpunctella* (Hübner) [Lepidoptera: Pyralidae].

Adeyera OJ*, Akinneye JO, Odeyemi OO

Federal University of Technology, Akure, Nigeria

Abstract

The toxic effects of leaf powder of *Morinda lucida* against the developmental stages of *Plodia interpunctella* was investigated in this study. Air-dried leaf of *Morinda lucida* was pulverized into fine powders and administered at 0.5, 1.0, 1.5, 2.0 and 2.5 g dosages to maize grains containing egg, larval and adult stages of *P. interpunctella* separately, for contact and fumigant treatments. The insecticidal activities of the leaf powder was monitored at 24, 48, 72 and 96 h post-treatment periods. The leaf powder achieved 100% larval mortality at 1.5 g dosage after 72 h and 96 h post-treatment period as contact insecticide. Also, 1.5 g, 2.0, and 2.5 g dosages of the leaf powder deterred egg hatchability, thus no adult emergence was recorded in these treatments. The leaf powder as a contact insecticide also achieved 100%adult mortality at 1.5 g, 2.0 g and 2.5 g dosage after 72 h and 96 h post-treatment period. As a fumigant insecticide, no deterrent to egg hatchability was recorded, 100% larvae mortality was recorded in 2.0 g and 2.5 g treatments after 96 h post treatment, while 100% adult mortality was recorded in 2.5 g treatment after 72 h post treatment. The results obtained from this study shows that the leaf powder of *M. lucida* has some insecticidal properties that could be considered in the integrated management of *P.interpunctella* infesting stored foods.

Keywords: Toxicity, *Plodia interpunctella,* Hatchability, Powder, Fumigant and contact.

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Introduction

Post-harvest preservation of the quality and quantity farm of produce had been one of the most serious constrains of the global agricultural aim of guaranteeing adequate food security for the growing populace [1]. Pest management all over the world had been relying so heavily on the use of synthetic pesticides, which of course have played a major role in grain storage and protection and have tremendously benefited mankind over years. But irrespective of these great contributions, their continuous use had resulted in a number of ecological and health-related challenges [2]. Included among such demerits are the development of resistant pests, resurgence and outbreak of new pests, toxicity to non-target organisms and hazardous effects on the environment [3]. It has been reported that over 2.5 million types of such pesticides are used in the agricultural crop protection annually across the globe and that over $100 billion is being spent annually to either combat or manage the side effects of these pesticides on man and environments [4]. As a result of this, the search for eco-friendly and bio-degradable pesticides for crop protection and management had been greatly encouraged over the last five decades [5]. It is expected that the ideal insecticide should control the target pest adequately, rapidly degradable and non-toxic to human and livestock. The use of herbal pesticides to make up for various short falls identified with synthetic pesticides had been promising over years. There had been reviews on the use of plants' secondary metabolites or photochemical to control the menace of pests' infestation on stored grains by several authors [6,7]. This study is therefore designed to assess the bioactivity of herbal powders from *M. lucida*, against the egg, larval and adult stages of the Indian meal moth, *Plodia interpunctella* (Hübner); a pyralid lepidopteran moth of sub-family phycitinae, is a pest of stored products and processed commodities.

Materials and Methods

Sourcing of plant materials

The plant *M. lucida* was sourced and harvested in the forest region along Akure-Ondo, Akure, Ondo State, Nigeria (located at latitude 7.2571ºN and longitude 5.2058ºE).

Preparation of plant materials

The plant parts (leaves) were harvest and brought to the storage laboratory of Biology Department, FUTA. They were carefully washed with water and air-dried in the laboratory for 30 days. The air-dried leaf was pulverized into fine powder using Binatone electric blender (Model 373). The powdery samples were further sieved to pass through 1mm^2 perforations to obtain labeled samples of fine powders which were kept in separate airtight plastic containers and stored at ambient temperature of 28 ± 2°C and 75 ± 5% Rh.

Insect culture

The maize grains were bought at Isikan market, Akure Nigeria were winnowed and handpicked to remove contaminants and damaged grains. The sorted grains were disinfected in the oven at 60°C for 4 h and allowed to cool on open laboratory bench for 5-6 hours at 28 ± 2°C temperature and 75 ± 5% Rh. About 500 g of the grains was weighed into two kilner jars (1 L each). Ten newly emerged adults (5 male and 5 female) species of *P. interpunctella* were introduced into each of the jars. The jars were kept in the culturing chamber till the F1 generation emerged. The newly emerged moths were used for the experiment.

Insect bioassay

Contact toxicity of leaf powder on eggs, larval and adult stages of *P. interpunctella:* Twenty freshly laid eggs (0-24 h old) were placed on 20 g of maize grains treated with 0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 g of leaf powder separately inside plastic container (8 cm diameter and 4 cm depth). Each treatment and control was replicated trice. Daily observations were made with dissecting microscope to determine the number of egg that hatch from the total number of eggs seeded. The experiments were arranged in a randomized design inside a breeding wire mesh cage measuring75 X 50 X 60 cm. After the hatchability period (0-7days) the culturing containers were covered with muslin cloth and held in place with rubber bands. After 40 days the number of adult emerged was determined and percentage calculated. The leaf powder was again separately admixed with the grains at the rate of 0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 g dosage/20 g of the grains in plastic container (8 cm diameter and 4 cm depth). The container covers were punched with hot iron rod and lined with muslin on the inside to prevent larva from escaping and allow aeration. Twenty third instar larvae were introduced into the treated and untreated grains and were replicated three times. The number of dead larvae was counted after 24, 48, 72 and 96 h post treatment and percentage mortality was determined. The same procedure was repeated for the adult mortality.

Fumigant toxicity of leaf powder on egg, larval and adult stages of *P. interpunctella:* The following dosages; 0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 g leaf powder of the plant parts were separately weighed and sealed in muslin cloth (5 cm x 5 cm) and hanged on the lid of each of the plastic containers at a distance of 4cm from the bottom of the container (8 cm depth 4 cm diameter). Twenty freshly laid eggs (0-24 h old) were introduced into each of the plastic containers containing 20 g of maize grains and covered with lid. The plant powder was hanged between the lid and the bottom and was made air tight at equal distance. The treated and the control (untreated) were replicated three times. Daily observations were made using dissecting microscope to determine the number of eggs hatched from the total numbers of eggs incubated and the experiment was left inside the insect breeding wire mesh cage pending adult emergence. At the end of 40 days post-treatment period the total number of adults emerged was determined and percentage mean was calculated. For larval mortality test, twenty third instar larvae were introduced into the treated and untreated grains and the samples were replicated three times. Daily observations for larval mortality were made; those that did not show body movement after being pinched with office pin were regarded as dead. The dead larvae were counted and percentage mortality calculated after 24, 48, 72 and 96 h post treatment. The same procedure was repeated for the adult experiments.

Results

Contact toxicity of leaf powder of M. lucida on the developmental stages of Plodia interpunctella

Table 1 reveals the contact insecticidal potential of *M. lucida* leaf powder against egg hatchability, with respect to the length of days for adult emergence and the percentage adult emergence of the pest. A progressive reduction in egg hatchability and adult emergence was observed as the dosage of the leaf powder increased at 0.5 intervals from 0.5 to 2.5 g at 1.5 g dosage, the powder achieved 100% egg mortality and 0% adult emergence.

Table 2 describes the potency level of the leaf powder when used as contact larvicide against *P. interpunctella.* An increasing trend of effectiveness was observed along the dosage gradient. A dose of 1.5 g achieved 100% larval mortality after 72 h exposure. A similar pattern was observed when the powder was used as contact insecticide to control the dynamics of the adults. Table 3 shows that the powder was able to achieve 100% adult mortality at 1.5 g dosage after 72 h exposure.

Table 1. *Contact toxicity of leaf powder of M. Lucida to eggs of P. Interpunctella.*

Concentration	Egg Hatchability (%)	Length of days for Adult Emergence	Adult Emergence (%)
0.5	46.67 ± 4.41c	31.67 ± 0.88c	20.00 ± 2.89b
1	16..67 ± 1.67b	0.00 ± 0.00a	0.00 ± 0.00a
1.5	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a
2	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a
2.5	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a
Control	83.33 ± 3.33d	28.00 ± 0.58b	68.33 ± 1.67c

NOTE: Means followed by the same letter(s) within the column are not significantly different (P<0.05) using Tukey's Test.

Table 2. *Contact toxicity of leaf powder of M. lucida to larvae of P. interpunctella.*

Concentration	24 hrs	48 hrs	72 hrs	96 hrs
0.5	23.33 ± 3.33b	50.79 ± 4.66b	70.51 ± 4.22b	74.46 ± 2.09b
1	36.67 ± 3.33c	72.89 ± 4.35c	92.57 ± 3.73c	94.71 ± 2.90c
1.5	58.33 ± 1.67d	89.82 ± 2.89d	100.00 ± 0.00c	100.00 ± 0.00c
2	71.67 ± 1.67e	93.25 ± 1.62d	100.00 ± 0.00c	100.00 ± 0.00c
2.5	81.67 ± 1.67e	100.00 ± 0.00d	100.00 ± 0.00c	100.00 ± 0.00c
Control	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a

NOTE: Means followed by the same letter(s) within the column are not significantly different (P<0.05) using Tukey's Test.

Table 3. *Contact toxicity of leaf powder of M. lucida to adult of P. interpunctella.*

Concentration	Egg Hatchability (%)	Length of days for Adult Emergence	Adult Emergence (%)
0.5	66.67 ± 1.67c	31.67 ± 0.33c	45.00 ± 2.89c
1	36.67 ± 1.67b	34.67 ± 0.33d	21.67 ± 4.41b
1.5	26.67 ± 7.26b	37.00 ± 0.58e	3.33 ± 1.67a
2	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a
2.5	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a
Control	81.67 ± 3.33c	28.67 ± 0.33b	73.33 ± 4.41d

NOTE: Means followed by the same letter(s) within the column are not significantly different (P<0.05) using Tukey's Test.

Table 4. *Fumigant toxicity of leaf powder of M. lucida to eggs of P. interpunctella.*

Concentration	Egg Hatchability (%)	Length of days for Adult Emergence	Adult Emergence (%)
0.5	86.67 ± 1.67d	29.33 ± 0.33a	73.33 ± 1.67cd
1	76.67 ± 1.67cd	30.33 ± 0.33a	63.33 ± 1.67c
1.5	68.33 ± 3.33c	32.33 ± 0.67b	45.00 ± 2.89b
2	48.33 ± 3.33b	33.67 ± 0.33bc	20.00 ± 2.89a
2.5	26.67 ± 4.41a	34.67 ± 0.33c	13.33 ± 3.33a
Control	88.33 ± 1.67d	28.67 ± 0.33a	76.67 ± 1.67d

NOTE: Means followed by the same letter(s) within the column are not significantly different (P<0.05) using Tukey's Test.

Table 5. *Fumigant toxicity of leaf powder of M. lucida to larvae of P. interpunctella.*

Concentration	24 hrs	48 hrs	72 hrs	96 hrs
0.5	11.67 ± 1.67ab	27.02 ± 2.98b	35.53 ± 2.45b	37.04 ± 1.85b
1	13.33 ± 1.67ab	30.35 ± 4.65b	37.19 ± 4.03b	40.74 ± 1.85b
1.5	21.67 ± 1.67bc	50.70 ± 4.30c	71.05 ± 4.89c	83.33 ± 8.49c
2	30.00 ± 5.77cd	70.96 ± 6.69d	94.82 ± 3.04d	100.00 ± 0.00c
2.5	43.33 ± 3.33d	94.82 ± 3.04e	94.82 ± 3.04d	100.00 ± 0.00c
Control	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a

NOTE: Means followed by the same alphabets are not significantly different at P < 0.05 using Tukey's Post hoc test.

Table 6. *Fumigant toxicity of leaf powder of M. lucida to adult of P. interpunctella.*

Concentration	24 hrs	48 hrs	72 hrs	96 hrs
0.5	0.00 ± 0.00a	23.33 ± 3.33b	44.44 ± 5.56b	.04 ± 6.58b
1	16.67 ± 3.33b	50.00 ± 5.77c	61.85 ± 4.27c	75.19 ± 2.59c
1.5	23.33 ± 3.33b	56.67 ± 3.33cd	75.56 ± 4.44c	82.22 ± 3.39c
2	36.67 ± s3.33c	73.33 ± 3.33de	93.33 ± 3.33d	100.00 ± 0.00d
2.5	46.67 ± 3.33c	90.00 ± 5.77e	100.00 ± 0.00d	100.00 ± 0.00d
Control	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a	0.00 ± 0.00a

NOTE: Means followed by the same alphabets are not significantly different at P < 0.05 using Tukey's Post hoc test.

Fumigant toxicity of leaf powder of M. lucida on the developmental stages of P. interpunctella

The result shows that the use of the powders as fumigant insecticides less effective compared with the results of its contact effects on the pest, most especially in the control of egg and larval stages. It can be seen from Table 4 that the highest dose of 2.5 g could only achieve 26.67% reduction in egg hatchability and just 13% adult emergence was achieved at the same dose. Tables 5 and 6 further shows the fumigant effects of the powder on *P. interpunctella*. The mortality rate was also dosage and period of exposure dependent. The larvicide activity of the powder was slightly less effective as compared with contact toxicity at the same dosage and number of hours of exposure. 100% morality was recorded in 2.0 g dosage after 96 h exposure compare with 1.5 g dosage which achieved 100% larval mortality after 72 h exposure as contact insecticide. The result was similar when the powder was used as fumigant insecticide against the dynamics of the adults. It can be seen from Table 6 that 2.0 g concentration achieved 100% adult mortality after 96 h exposure.

Discussion

The global over-dependence on the use synthetic pesticides for grain storage had been identified with some ecological, health-related and pest resistance challenges [2]. Hence, the on-going research progress in evolving purely organic pesticides to make up for the inadequacies associated with of the synthetic chemicals. ofuya and Dawodu, Adedire and Ajayi, Tan and Luo, et al. [7-9] reported plants that have components which are potent against store grain pests and can be substituted for inorganic pesticides. The result of this study have shown that the botanical powders of various compositions from *M. lucida* is toxic to egg, larval and adult stages of *P. interpunctella* in stored products, most especially maize grains. This is in agreement with Akinneye et al. [10] that showed the efficacy of root bark, stem bark and leaf powders of *Cleisthopholis patens* at varied compositions both as contact and fumigant insecticides in the control of egg and adult emergence stages of some Coleopteran and Lepidopteran storage pests. This result reveals a significant contact effect as compared with the fumigant effects of the powders on the pest. A dosage of 1.5 g leaf powder at all levels effected 100% egg, larval and adult after 72 h exposures when used as contact insecticides. The fumigant effect only achieved 23.37%, 21.67% and 75.56% egg, larval and adult mortalities respectively at the same dosage. As fumigant, 2.0 g achieved 100% larval and adult mortalities after 96 h exposure. The inability of the eggs to hatch may be because powders inhibit gaseous exchange between the eggs and their external environment [11]. The relatively high mortality rate of mortality of *M. lucida* to the pest may be attributed to the chemical composition of the powder just as reported by Ketunku et al. [12] that Saponin found in *Eugenia aromatic* affected the respiratory system of certain storage insects thereby prevented their spread. It may also be attributed to the odour or characteristic bitterness associated with the leaf powder. This corroborates the findings of Lale and Abdurahman et al. [13] that mortality of storage insects could be associated with pungent odour produced by plant powders against them. The finding is also in line with the report of Akinneye et al. [14] that *C. patens* inhibit egg hatchability and development of adult stages of *Ephestia cuatella.* As ahamo and Ogungbite et al. [15] also opined that *E. aromatica* prevented the emergence of some adult storage moths even at concentration of 2%. This result is also in agreement with the work of Adedire and Lajide et al. [16] and Longe et al. [17] that *E. aromatica* powder has significant contact and fumigant actions on *Callosobruchus maculatus* The progressive reduction in percentage adult emergence with increasing concentration and exposure period could suggest the death of the pests at larval stage due to their inability to fully cast off their exoskeleton which remains a link to the posterior parts of their abdomen just as reported by Oigiangbe et al. [18] This result also tallies with the findings of Adedire and Lajide et al. [16] that pulverized powder of *Piper umbellatum* seed and *E. aromatica*were toxic to *C. maculatus*, producing 100% mortality at 24 h post treatment across all concentrations [19].

Conclusion

This study had revealed contact and fumigant effects of *M. lucida* powders on the developmental stages of *P. interpunctella* across the concentration gradient and exposure period. It was more effective when used as contact compared with fumigant pesticide in the management of the pest. The findings suggest that the botanical product could serve as an alternative to synthetic pesticides.

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References

1. Ngamo, LST, Ngassoum MB, Mapong-Mestsem PM, et al. Use of Essential Oil of Aromatic Platsas Protectant of Grainduring Storage. Agricultural Journal 2007;2:204-9.
2. Verma, NK, Dubey AK. Prospectus of Biological and Microbial Products as Pesticides of Tomorrow. Curr Sci 1999;76:172-8.
3. Jeyasankar A, Jesudasan RWA. Insecticidal Properties of Novel Botanicals Against a few Lepidopteran Pest Pestology 2005;29:42-4.
4. USEPA (United State Environmental Protection Agency) Pesticides News Story:EPA releases reports rontaining latest estimates of pesticide use in United States. Bio-efficacy 2011.
5. Sengottaiyan V. Population Dynamics of Spodopteralituura (Lepidoptera:Noctuidae) Outbreak on Soybeans vis a vis Rainfall Events. Journal of Agricultural Meteorology 2013;15:37-40.
6. Rosenthal GA, Berenbaum MR. Habivores:the Interaction with Secondary Plant Metabolites:Ecological and Evolutionary Processes. New York Academic press 1992.
7. Tan QG, Luo XD. MeliaceousLimonoids: Chemistry and Biological Activities. Chem Ref 2011;111:7437-522.
8. Ofuya TI, Dawodu EO. Aspects of Insecticidal Properties of Piper guineensis Powder Against Callosobruchusmaculatus, Nigerian. Journal of Entomology Society 2002;19:40-50.
9. Adedire CO, Ajayi OE. Potentials of Sandbox Huracrepitance (L.) Seed Oil for Protection of Cowpea Seeds from Callosobruchusmaculatus (F.) (Coleoptera:Bruchi dae) Infestation. Journal of Plan Diseases and Protection 2003;110(6):602-10.
10. Akinneye JO, Adedire CO, Arannilewa SA. Potential of Cleithopholis patens (Benth.) as Maize Protectant against Stored Product Pest Plodia interpunctella (Hübner) (Lepidoptera: Pyralidae). African Journal of Entomology (2006) ;5 (25):2510-5.
11. Akinyemi OA, Babarinde SA, Oyerinde MR. Bioactivity of Acetone and Chloroform Extract of Xylopiaaethiopica (Dunal). A Rich Seed against Callosobruchus maculatus(Fabricius) (Coleoptera: Bruchidae). Journal of Biologically Active Products from Nature 2016;6(5-6):412-23.
12. Ketunku DO, gunwolu EO, Uwela MU. ContactToxicityof Canarium schweinfurthii (Engl.) Tissues against Callosobruchusmaculatus in Stored Bambara Groundnut. International Journal of Agronomy and Agricultural Research 2013;5(5):20-8.
13. Lale NE, Abdurlrahman HT. Evaluation of Neem (Azadirachtaindica). A Juss Seed Oil Obtained by Different Methods and Callosobruchusmaculatus (Coleoptera: Bruchidae) in Stored Cowpea. Journal of Stored Product Research 1990;35:135-43.
14. Akinneye JO. Biology and Control of Yam Moth Euzophroidesvapidella (Mann) (Lepidoptera: Pyralidae). Federal University of Technology. Akure M.Tech Thesis 2003;65.
15. Ashamo MO, Ogungbite OC. Extracts of Medicinal Plants as Entomocide against Sitotrogacerealella (Olivier) Infestation on Paddy Rice. Medicinal Plant Research 2014;4(9):1-7.
16. Adedire CO, Lajide I. Efficacy of Powders of Some Plants in the Control of the Pulse Beetle, Callosobruchusmaculatus (F.) (Coleoptera: Bruchidae). Journal of Applied Tropical Agriculture 2001;6:11-5.
17. Longe OO. Fumigant Toxicity of Some Botanical Powders to Eggs and Larvae of Callosobruchusmaculatus (F.) (Coleoptera: Bruchidae) M. Agic. Tech Thesis FUTA Akure 2004.
18. Oigiangbe ON, Igbinosa IB, Tamo M. Insecticidal Properties of an Alkaloid from Alstoniaboonei De Wild. Journal of Biopesticide 2010;3(1):265-70.
19. Olotuah OF. Eugenia aromatica in the Control of Storage Pests. International Journal of Geology, Agricultural and Environmental Sciences 2014;2:4-10. `

***Correspondence to:**

Adeyera OJ
Biology Department
Federal University of Technology
Akure, Nigeria
Tel: 08038685983
E-mail: laoluadeyera@yahoo.com