ECRONICON OPEN ACCESS

EC MICROBIOLOGY
Research Article

Preliminary Studies of *Ganoderma lucidum* and *Pleurotus ostreatus* Trapping of a Sciarid Insect

Elijah Ige Ohimain[1]* and Dorcas Dauta Suotonye Bawo[2]

[1]*Department of Microbiology, Niger Delta University, Nigeria*

[2]*Department of Biological Sciences, Niger Delta University, Nigeria*

***Corresponding Author:** Elijah Ige Ohimain, Department of Microbiology, Niger Delta University, Nigeria.

Received: October 21, 2020; **Published:** March 29, 2021

Abstract

Insect infestation is a major challenge in mushroom farming. A dipteran insect suspected to belong to the family of Sciaridae was found infesting a mushroom farm growing *Pleurotus ostreatus* (oyster mushroom), *Ganoderma lucidum* (Reishi) among other mushrooms. The insect infestation results in the reduction in the performance of the mushroom. Because of the potential danger of poisoning by insecticides, options for the control of insects in mushroom farm are not many. In this preliminary study, we present the control of insects by the mushroom themselves. We observed that oyster mushroom uses its gills to trap the insect and with its mycelia, grow over the insect. Reishi mushroom uses the pores beneath the pileus to trap and kill the insects. These findings are important for the development of biopesticides for the control of insect infestations in mushroom farms. More research is therefore necessary to understand the mechanism of insect trapping and killing by these mushroom species.

Keywords: *Biopesticides; Entomo-Microbiology; Oyster Mushroom; Fungus Gnat; Microbial Pesticides; Microbial Traps; Mushroom Pests; Production Losses; Reishi Mushroom*

Introduction

Perhaps due to the increasing incidences of chronic diseases especially diabetes, hypertension and cancer, there is increase in mushroom consumption worldwide. Mushrooms have been an important aspect of Asian food and traditional medicine for over 2000 years [1-3]. Mushrooms are classified as nutraceutical containing important nutrients particularly proteins, minerals and vitamins especially B, C and D and other bioactive substances including polysaccharides and triterpenes [4]. Extracts from mushroom have many established health benefits including antidiabetic, immune boosting, anti-inflammatory, antihypertension, antioxidant, anticancer among others [5]. Wild mushrooms used to be an important component of traditional Asian and African dishes. But wild mushroom is decreasing while the global demand is increasing, hence, the renewed interest in commercial mushroom cultivation at various scales. Cultivation of edible and medicinal mushrooms have increased in Asia, Europe and North America, where it has become famous [6], while domestic cultivation in Africa is still at infancy.

The domestic cultivation of mushroom is challenged by several pests and diseases. Microbial contamination could occur at any of the various stages of mushroom production, right from substrate sterilization, through inoculation, incubation and fruiting. House rats also consume the sorghum and other grains used in mushroom spawn production and in the process contaminate the substrates. Wall geckos have appetite for mushroom fruiting bodies especially oyster mushrooms. Bellettini., *et al*. [4] reported that the intensive cultivation of mushrooms can be affected by some bacteria, moulds, viruses, insects and mites, nematodes, molluscs, rodents etc. infestation leading to reduction in performance.

Among the various pests, insects have emerged as a recurrent pest of mushroom farms resulting in the loss of quality and yield. Insect infestation is particularly high during the fruiting stage of mushroom. The cold, moist and shaded mushroom fruiting room, seems to provide the ideal conditions for insect infestation and breeding. Nigeria currently have few mushroom farms, which are being threatened by insect infections. The control of insects in mushroom farm is faced with several challenges. The traditional use of insecticides is unsafe in mushroom farms due to potential toxicity problems. Options for the control of insects in mushroom farms are not many including the use of insect nets, electric insect killer lamps and coloured sticky traps [7]. Keil and White [8] reported the use of various biocontrol methods for the control of insect pests in mushroom farms including insect parasitoids, entomopathogenic nematodes, predators and microbes such as pathogenic fungi and bacteria. Here, we report the preliminary observation of insect-trapping and killing mechanism by *Pleurotus ostreatus* (oyster mushroom) and *Ganoderma lucidum* (Reishi).

Materials and Methods

Several visits were undertaken to the mushroom production farm of Rohi Biotechnologies Limited in Port Harcourt in September - October 2020 for sample collection. The farm cultivates *Pleurotus ostreatus* (oyster mushroom), *Ganoderma lucidum* (Reishi) among other mushrooms. The infecting insects were sampled randomly into a Ziplock bag and taken to the laboratory for analysis. The insects were studied using a Vividia UM38 tabletop standalone 3.5-inches LCD Digital Microscope with 500x Magnification and 5MP Resolution camera. The insects were identified using the identification keys of Marshall., *et al*. [9], Kirk-Spriggs and Sinclair [10] and several online resources.

Results and Discussion

One of the dominant insects in the farm was identified to belong to the order Diptera suspected to be in the family Sciaridae (sciarids), which are also referred to as fungus gnat. The source of the insect infestation of the farm is not known. But Bellettini., *et al*. [4] speculated that microbial and insect infections of mushroom farm can be facilitated by the particular conditions under which mushroom are cultivated such as warm temperatures, high humidity and carbon dioxide (CO_2) levels. They however admitted that there is not much bibliographic information related to pests of mushrooms and their substrates. Studies on insect pest of mushroom farms in Nigeria is not common. In a recent preliminary study, Egbon., *et al*. [11] reported ten families of insects with an unidentified nymph associated with *Pleurotus tuberregium* (king tuber oyster mushroom) in Benin City, Nigeria, but did not encounter members of the Sciaridae family. Elsewhere, the sciarids have been frequently encountered in mushroom farms. Keil and White [8] reported that sciarid flies infest commercially grown mushrooms and that the species *Lycoriella solani* Winnertz was the most damaging fly pest until the introduction of organophosphorous pesticides into mushroom production in the 1970s. Cloona., *et al*. [12] also recognized that the sciarids are among the most severe pests of the cultivated white button mushroom, *Agaricus bisporus*. Both Cloona., *et al*. [12] and Keil and White [8] observed that the sciarids are more attracted to mushroom substrate/composts rather than the mushroom fruiting bodies. The females are attracted to the parasitic green mould, *Trichoderma aggressivum* [12], which could be a positive impact for mushroom production.

Our preliminary observations showed that the sciarids has a preference for *Pleurotus* than *Ganoderma*. They tend to focus more on *Ganoderma* only after the *Pleurotus* have been harvested. The reasons for their preference for oyster mushroom are not immediately known, but it is suspected that it might be due to a combination of physical, chemical and biological factors such as tastes, texture, colour, type of spores, fragrance, bioactive substance etc. (Table 1). The insects seemed to be attracted by the sweet anise smell of the oyster mushroom. *Ganoderma*, which is a medicinal mushroom, is slightly bitter and has a tough texture, unlike the oyster mushroom that is sweet and tender in texture. Notwithstanding, the tissues underneath the *Ganoderma* cap has pores and are less tough than the ones on top, perhaps that explains why the insect seemed to attack *Ganoderma* more from underneath the cap.

Characteristics	Oyster mushroom	Reishi mushroom
Fruiting bodies		
Family	Pleurotaceae	Ganodermataceae
Use	Culinary mushroom	Medicinal mushroom
Type of spores	Basidiospores	Basidiospores, secondary spores and gasterospores
Texture	Soft	Tough
Fibre	High	Higher
Colour	White/creamy	Reddish-brown
Fragrance	Anise, bittersweet aroma	Floral fragrance, woodsy scent
Flavour	Sweet	Bitter
Bioactive substance	Polysaccharides	Polysaccharides, triterpenes and 400 others

Table 1: *Possible reasons for the preference of sciarid on the mushroom they infest.*

Majority of the insects perch on the *Pleurotus* and attempt to feast on the gills, which they deteriorate in the process. It appears that the oyster mushroom has developed a trapping mechanism for the insect. Several dead insects with their heads stuck to the mushroom tissues were also noticed (Plate 1). It appeared that oyster mushroom trapped and digested the soft tissues of the insect sparing the hard parts/chitinous materials like the head, wings and legs, which were left stuck out of the mushroom gills. On close examination under the microscope, it was found that the mushroom is growing fresh mycelium over the trapped insect (Plate 2). It therefore appears that the mushroom spores are using the insect as a medium for mycelium growth. The reason for this behaviour is not understood yet. Bellettini., *et al*. [4] reported the following damages of flies on oyster mushroom, which includes perforation of the stipe and pileus, opening galleries in the interior, spreading of diseases and mites, and causing the overall depreciation of yield. It therefore appears that the insect got trapped in the gills while attempting to open galleries in the interior of the oyster mushroom. Some authors have recently reported that *Pleurotus ostreatus* is a carnivorous fungus that preys on nematodes to supplement its nitrogen intake under nutrient-limiting conditions and that its hyphae can paralyze nematodes within a few minutes of contact [13,14]. Other authors have similarly reported the activities of nematode-trapping fungi (NTF) as microbial predators that consume nematodes under nutrient-limiting conditions [15]. In our study, it is however not clear whether it is the same mechanism that the fungi are using against the sciarid insects, but we observed that the soft portions of the insect were consumed sparing the chitinous materials in the head, legs and wings. Notwithstanding, Navarro and Gea [16] used two nematode species, *Steinernema feltiae* and *S. carpocapsae*, for the control of mushroom sciarid flies, *Lycoriella auripila* during the production of *Agaricus bisporus*.

Figure 1: *Sciarid insect stuck on the gills of oyster mushroom.*

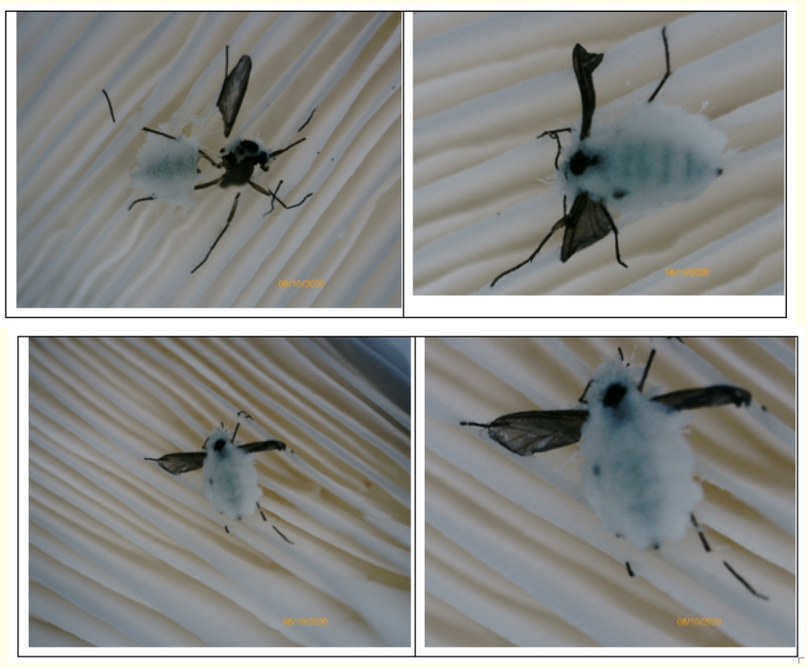

Figure 2: *Sciarid insects trapped in the gills of oyster mushroom.*

The probable mechanism of insect trapping and killing by Reishi mushroom is somewhat different, but the position is the same i.e. beneath the pileus (Plate 3). The insect appeared to be trapped by the pores under the cap of the mushroom. Again, it is unclear how the trapping occurred. But we observed a creamy mucoid secretion at the point of trapping, it is uncertain whether the substance is from the insect or the mushroom.

Figure 3: *Trapping of sciarid insect in pores beneath the pileus (cap) of Ganoderma mushroom.*

Conclusion

Insect infestation has continued to cause losses in mushroom farms. Here we report our preliminary observation of a dipteran suspected to be sciarid, which infested a mushroom farm in Port Harcourt, Nigeria. Because of the danger of poisoning, the use of chemical insecticides is restricted in mushroom farming, which have reduced the options for the control of insects in mushroom farms. Our study has revealed the trapping and killing of the insects by two mushroom species, *Pleurotus ostreatus* and *Ganoderma lucidum*. The mechanisms of the trapping are not fully understood, but it appears that the insect got trapped while attempting to access the interior of the mushroom cap from underneath. It also appeared that the spores of the oyster mushroom uses the insect as a medium for mycelium growth, while the pores of Reishi mushroom traps the insects. More research is therefore needed to fully understand the biopesticide behaviors of these mushrooms.

Acknowledgement

The authors wish to thank Mr. Emmanuel Ojiyovwi of Rohi Biotechnologies Ltd, Port Harcourt for assistance in insect sampling and microscopic studies.

Bibliography

1. Tran HB., *et al.* "Hypotensive effects and angiotensin-converting enzyme inhibitory peptides of reishi (Ganoderma lingzhi) autodigested extract". *Molecules* 19.9 (2014): 13473-13485.

2. Elkhateeb WA., *et al.* "Anticoagulant capacities of some medicinal mushrooms". *ARC Journal of Pharmaceutical Sciences* 5.4 (2019): 1-9.

3. Klupp NL., *et al.* "Ganoderma lucidum mushroom for the treatment of cardiovascular risk factors". *The Cochrane Database of Systematic Reviews* 2 (2015): CD007259.

4. Bellettini MB., *et al.* "2018 Diseases and pests noxious to *Pleurotus* spp. mushroom crops". *Revista Argentina de Microbiología* 50.2 (2018): 216-226.

5. Dudhgaonkar S., *et al.* "Suppression of the inflammatory response by triterpenes isolated from the mushroom Ganoderma lucidum". *International Immunopharmacology* 9.11 (2009): 1272-1280.

6. Hu G., *et al.* "Optimization of culture condition for ganoderic acid production in Ganoderma lucidum Liquid Static Culture and Design of a Suitable Bioreactor". *Molecules* 23.10 (2018): 2563.

7. Sahin I., *et al.* "Efficacy of coloured sticky traps in capturing mushroom flies (Diptera: Phoridae, Sciaridae and Scatopsidae)". *Fresenius Environmental Bulletin* 25 (2016): 6106-6110.

8. Keil CB and While PF. "Biological control for mushroom". In Biocontrol in Protected Culture (2004): 743-484.

9. Marshal AS., *et al.* "Key to Diptera families – adults". In Kirk-Spriggs, A.H. and Sinclair, B.J. (eds). Manual of Afrotropical Diptera. Volume 1. Introductory chapters and keys to Diptera families. Suricata 4". South African National Biodiversity Institute, Pretoria (2017): 267-355.

10. Kirk-Spriggs AH and Sinclair BJ. "Manual of Afrotropical Diptera. Volumes 1 and 2. South African National Biodiversity Institute, Pretoria, South Africa (2017).

11. Egbon IN., *et al.* "Insects associated with an edible mushroom *Pleurotus tuberregium* (Basidiomycota): first fact-finding approach in Benin City, Nigeria". *Journal of Applied Sciences and Environmental Management* 23.11 (2019): 1919-1922.

12. Cloonan KR., *et al.* "Attraction, oviposition and larval survival of the fungus gnat, *Lycoriella ingenua*, on fungal species isolated from adults, larvae, and mushroom compost". *PLoS ONE* 11.12 (2016): e0167074.

13. Lee CH., *et al.* "Sensory cilia as the Achilles heel of nematodes when attacked by carnivorous mushrooms". *Proceedings of the National Academy of Sciences of the United States of America* 117.11 (2020): 6014-6022.

14. Renahan T and Sommera RJ. "Mechanism of murderous mushrooms paves path for parasitic helminth halt". *Proceedings of the National Academy of Sciences of the United States of America* 117.13 (2020): 6974-6975.

15. Yanga CT., *et al.* "Natural diversity in the predatory behavior facilitates the establishment of a robust model strain for nematode-trapping fungi". *Proceedings of the National Academy of Sciences of the United States of America* 117.12 (2020): 6762-6770.

16. Navarro MJ and Gea FJ. "Entomopathogenic nematodes for the control of phorid and sciarid flies in mushroom crops". *Pesquisa Agropecuária Brasileira* 49.1 (2014): 11-17.

Volume 17 Issue 4 April 2021