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Review

Potential of *Cleisthopholis patens* Elliot as a maize protectant against the stored product moth, *Plodia Interpunctella* (Hubner) (Lepidoptera; Pyralidae)

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The root bark powder, stem bark powder and leaves powder of *Cleisthopholis patens* were tested for their insecticidal activity as a stored product protectant at four different concentrations (0.5, 1.0, 2.0 and 3.0 g) on the moth, *Plodia interpunctella*, at ambient tropical storage conditions of temperature and relative humidity. Moth mortality, egg hatchability, adult emergence were used as indices of insecticidal activity. The result obtained shows that the root bark powder was effective at 1.0, 2.0 and 3.0 g/20 g of the maize evoking 100% adult moth mortality within 72 h of application. The stem bark powder of *C. patens* at 1.0, 2.0 and 3.0 g/20 g of the maize produced 78 – 100% moth mortality within 72 h of treatment. But the stem bark powder caused 100% adult moth mortality of *P. interpunctella* at 3.0 g/20 g maize in 96 h post-treatment. The leaf powder was moderately effective against the adult moth at 3.0 g/20 g of the maize grain in evoking 70 – 80% adult mortality within 96 h of treatment. The root and stem bark powder inhibited development of egg to adult at all the concentrations evaluated and therefore prevented adult emergence. However, 2 – 11% adult emergence of *P. interpunctella* was obtained in the maize grain treated with the leaf powder.

Key words: *Cleisthopolic patens, Plodia interpunctella,* adult emergence, root, bark, leaves

INTRODUCTION

Storage pests annually destroy approximately one third of the world's food production, valued at more than $100 billion among which the highest losses (43% of potential production) occur in developing and Asian countries (Ahmed and Grainage, 1986). In Nigeria alone, the dry weight loss due to *Callosobruchus maculatus* (F) exceeded 2,900 tonnes each year (Caswell, 1973). In USA and Canada, 20 – 26% of stored wheat was infested by stored-product pests (White et al., 1985). In India, losses caused by insect pest accounted for 6.5% of stored grains (Raju, 1984). The huge post-harvest losses and quality deterioration of food grain and tubers caused by insect pests and microorganisms during storage are major problems of assuring food security in developing countries such as Nigeria, Ghana and Gambia. Climate and storage conditions, especially in the tropics, are often highly favourable for insect growth and development and the necessity to control these pests becomes imperative. Control of these pests by synthetic insecticide, has serious drawbacks (Sharaby, 1988). The indiscriminate use of synthetic pesticides has given rise to many serious problems, including genetic resistance by pest species, toxic residues, increasing cost of application, pollution of storage environment, and hazard from handling (Ahmed et al., 1981; Khanam et al., 1990). In view of these facts, researchers for the last two decades or so have diverted their attention towards age-old practices of using alternative eco-friendly insect pest control methods which are readily biodegraded, less toxic to mammal, easy to use and specific in their action (Freedman et al., 1979).

Peasant farmers and researchers often claim successful use of material of plant origin in insect pest control including ash (Ofuya, 1986; Ajayi et al., 1987), vegetable oil (Nezan, 1983) spices and powders of plant parts (Ajayi et al., 1987; Lajide et al., 1998). Comprehensive review of relatively recent literature on this subject had been undertaken by Boeke et al. (2001). Jackai and Dao-ust (1986) reported that plant materials and local traditio-

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nal methods are much safer than chemical insecticides and suggested that their use needed exploitation. In many areas of Africa and Asia locally available plants and minerals are being widely used to protect stored products against damage by insect infestation, as alternatives to chemical insecticides (Golob and Webley, 1980; Su et al., 1982; Zehreri, 1984). Use of bioactive pesticide to control stored product pest seems to offer desirable solutions, especially in developing tropical countries where plants are found in abundance throughout the year.

Although few investigations have been carried out on anti-insect properties of natural products on stored-product moths, such research offer a good opportunity to open a new area of natural control. It is against this background that this present study sought to evaluate the efficacy of root bark, stem bark and leaves of *C. patens* (Apako) against the cereal moths, *P. interpunctella*.

Insect culture

P. intrpunctella (Hubner) adults used to establish the culture were obtained from farm, at Modebiayo camp near Ondo town, Ondo Nigeria. The infested maize cobs were removed from the sheath and the grains were loosed from the straw into 500 ml Kilner jar capped with muslin cloth fastened with rubber band and kept inside insect breeding wire mesh cage measuring (70 cm x 60 cm x 50 cm). The set up was maintained at ambient tropical temperature of 28±2^{o}C and 75±5% relative humidity. After emergence, 20 males and 20 females of the moths were reared on clean, uninfested yellow maize in four Kilner jars containing 300 g of maize grains capped with mushin cloth, and fastened with rubber band. The muslin cloth allowed for ventilation but prevented entry or exit of the moths and other insects. From the stock, new generations of *P. interpunctella* were raised and the culture were maintained by continually replacing the devoured and infested maize grains with fresh, uninfested maize grains, and introduction of copulating pairs of adult *P. interpunctella* into the jar.

Preparation of plant materials

C. patens plant used in this study is a perennial flowering plant with moderately broad green leaves. It is a native to Africa and mostly found in Southern Nigeria. This tree is mostly found beside rivers in the southern Nigeria. The root bark, stem bark and leaf of the plant were harvested from Oboto camp near Ondo in Ondo East Local Government Area of Ondo State Nigeria. The harvested parts were washed thoroughly with tap water and air-dried in the Laboratory for 30 days. Each part was pulverized separately into fine powder in an electric grinding machine. The powders were separately sieved to pass through 1 mm^2 perforations, kept in cellophane bags and bottled with screw-capped lids. They were stored at room temperature until use.

Effect of root bark, stem bark and leaf powder of *C. patens* on mortality of adult *P. interpunctella*

The root bark, stem bark and leaf powder of *C. patens* were tested against adult of *P. interpunctella* at 0, 0.5, 1.0, 2.0 and 3.0 g/20 g of clean uninfested yellow maize grains in separate 9 cm diameter petri dishes. Each treatment was prepared in triplicates. The powder and maize grains were thoroughly mixed by manual agitation and also with the aid of glass rod.

Each replicate was infested with 30 unsexed (0 – 24 h) old adult moths. Moth mortality was recorded daily for four days after treatment. The insect will be considered as dead when they did not move, fly or response to gentle touch.

Effect of *C. patens* root bark, stem bark and leaf powder on development of *P. interpunctella*

Thirty freshly laid eggs (0 – 24 h) old were introduced on top of treated maize grain with the aid of camel brush at four treatment levels using of 0.5, 1.0, 2.0 and 3.0/20 g of maize grain inside a plastic container measuring 12.50 cm diameter and 13.50 cm deep.

This was done to all the plant part (samples) and each treatment replicated thrice. The plastic containers containing the treated maize grain were observed daily and the number of egg hatch and the number of adult emerging from each replicate were noted and recorded. A control experiment was set-up, without the plant powder and replicated thrice.

Statistical analysis

Data obtained were subjected to one way analysis of variance and where significant differences ($P < 0.05$) existed, means were separated by New Duncan's Multiple Range Test.

RESULTS

Effect of *C. patens* root bark powder on mortality of adult *P. interpunctella*

The effect of root powder of *C. patens* on *P. interpunctella* at different treatment levels is presented in Table 1. Mortality varied with powder concentration and exposure periods. In each treatment, mortality of *P. interpunctella* increased with exposure period. At 0.5 g/ 20 g concentration 14.67% mortality was obtained within 24 h post-treatment, while 24, 31 and 32% adult mortalities were recorded at 48, 72 and 96 h, respectively, at 0.5 g/20 g concentration. At 1.0/20 g of maize, 54% adult mortality of the moth was produced at 48 h after treatment but at 1.0, 2.0 and 3.0 g-powder concentration, 100% adult mortality of the moth was produced within 72 h after application. Therefore, there was no significant dif-

Table 1. Effect of C*leisthopholis patens* root powder on the mortality of adult *Plodia interpunctella*.

Powder (g/20 g maize)	No of adult introduced	Daily mean mortality after treatment (%)			
		24 h	48 h	72 h	96 h
0.0	30	2.67 ± 1.15[a]	4.67 ± 1.15[a]	8.00 ± 2.00[a]	8.67 ± 2.31[a]
0.5	30	14.67 ± 4.16[b]	24.00 ± 3.46[b]	31.33 ± 2.31[b]	32.67 ± 3.06[b]
1.0	30	22.67 ± 2.31[c]	54.67 ± 4.16[c]	100.00 ± 0.00[c]	100.00 ± 0.00[c]
2.0	30	39.33 ± 3.06[d]	79.33 ± 5.03[d]	100.00 ± 0.00[c]	100.00 ± 0.00[c]
3.0	30	58.67 ± 3.06[e]	92.67 ± 1.15[e]	100.00 ± 0.00[c]	100.00 ± 0.00[c]

Means followed by the same letter are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

Table 2. Effect of *Cleisthopholis patens* bark powder on the mortality of adult *Plodia interpunctella*.

Powder (g/20 g maize)	No of adult introduced	Mean % Mortality after treatment (h)			
		24 h	48 h	72 h	96 h
0.0	30	3.33 ± 1.15[a]	4.67 ± 1.15[a]	6.00 ± 4.00[a]	7.33 ± 3.06[a]
0.5	30	14.00 ± 2.00[b]	21.33 ± 1.15[b]	21.33 ± 1.15[b]	26.00 ± 2.00[b]
1.0	30	22.00 ± 2.00[c]	35.33 ± 3.06[c]	78.00 ± 4.00[c]	87.33 ± 6.43[c]
2.0	30	38.00 ± 2.00[d]	67.33 ± 9.02[d]	90.00 ± 5.29[d]	96.67 ± 3.06[d]
3.0	30	46.00 ± 4.00[e]	84.00 ± 6.00[e]	100.00 ± 0.00[e]	100.00 ± 0.00[d]

Means followed by the same letter are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

Table 3. Effect of *Cleisthopholis patens* leaf powder on the mortality of adult *Plodia interpunctella*.

Powder (g/20 g maize)	No of adult introduced	Mean % Mortality after treatment (h)			
		24 h	48 h	72 h	96 h
0.0	30	2.67 ± 1.15[a]	4.00 ± 0.00[a]	6.00 ± 0.00[a]	7.33 ± 1.15[a]
0.5	30	11.33 ± 5.03[b]	22.00 ± 2.00[b]	37.33 ± 4.16[b]	41.33 ± 3.06[b]
1.0	30	14.67 ± 6.11[b]	19.33 ± 5.03[b]	48.00 ± 5.29[c]	54.00 ± 2.00[c]
2.0	30	23.33 ± 3.06[c]	32.00 ± 5.29[c]	60.00 ± 3.46[d]	61.33 ± 3.06[c]
3.0	30	33.33 ± 1.15[d]	51.33 ± 3.06[d]	75.33 ± 6.11[e]	70.33 ± 11.02[d]

Means followed by the same letter are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

ference (P > 0.05) in the mean mortality of the moth between 1.0, 2.0 and 3.0 g powder concentration at 72 h after treatment. The root powder significantly (P < 0.05) affected mortality of *P. interpunctella* at all levels of treatment but varied with the exposure period and powder concentration.

Effect of *C. patens* stem bark powder on mortality of adult *P. interpunctella*

The biological effect of stem bark of *C. patens* on *P. interpunctella* is presented in Table 2. At 24 h post-treatment, 14 – 46% moth mortality was obtained at all levels of treatment, but there was significant difference (P < 0.05) when compared with control where 3.3% mortality was obtained. At 1.0 and 2.0 g powder concentration, moth mortalities of 78% and 90% were obtained within 72 h after treatment. At 3.0 g powder concentration, 100% moth mortality was obtained at 72 h post-treatment. At 96 h post-treatment, using 2.0 and 3.0g powder concentration, 96% and 100% moth mortalities were obtained. The stem bark powder significantly (P < 0.05) affected mortality of *P. interpunctella* at 1.0, 2.0 and 3.0 g levels of concentration but varied with the exposure period and powder concentration.

Effect of *C. patens* leaf powder on the mortality of adult *P. interpunctella*

The insecticidal effect of leaf powder of *C. patens* on mortality of adult *P. interpunctella* is presented in Table 3. At 2.0 g and 3.0 g-powder concentration, moth mortalities of 23 – 51% were obtained within 48 h of application. At 72 h post-treatment, 60 – 75% mortality was obtained from the treated seeds compared with untreated where 6.0% mortality was obtained. The powder significantly

Table 4. Effect of *Cleisthopholis patens* root powder on the development of *Plodia interpunctella* from egg to adult.

Powder (g/20 g maize)	No of eggs introduced	Hatchability# (%)	Adult emergence# (%)
0.0	30	86.90 ± 5.04[b]	78.10 ± 5.04[b]
0.5	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]
1.0	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]
2.0	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]
3.0	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]

#Values are mean ± S.D.
Means followed by the same letter are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

Table 5. Effect of *Cleisthopholis patens* bark powder on the development of *Plodia interpunctella* from egg to adult.

Powder (g/20 g maize)	No of eggs introduced	Hatchability# (%)	Adult emergence# (%)
0.0	30	82.50 ± 8.73[b]	71.50 ± 12.49[b]
0.5	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]
1.0	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]
2.0	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]
3.0	30	0.00 ± 0.000[a]	0.00 ± 0.000[a]

#Values are mean ± S.D.
Means followed by the same letter are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

Table 6. Effect of *Cleisthopholis patens* leaf powder on the development of *Plodia interpunctella* from egg to adult.

Powder (g/20 g maize)	No of eggs introduced	Hatchability# (%)	Adult emergence# (%)
0.0	30	70.63 ± 4.74[c]	61.60 ± 5.04[c]
0.5	30	12.10 ± 1.91[b]	11.00 ± 5.04[b]
1.0	30	11.00 ± 1.91[ab]	4.40 ± 1.91[ab]
2.0	30	11.00 ± 1.91[ab]	4.40 ± 1.91[ab]
3.0	30	6.60 ± 0.00[a]	2.20 ± 1.91[a]

#Values are mean ± S.D.
Means followed by the same letter are not significantly different p>0.05 from each other using New Duncan's Multiple Range Test.

(P<0.05) affected mortality of *P. interpunctella* at higher concentration but varies with exposure periods.

Effect of *C. patens* root bark, stem bark and leaf powder on development of *P. interpuntella*

The effect of various plant parts powder of *C. patens* on development of *P. interpuntella* from egg to adult are presented in Tables 4, 5 and 6. Four concentrations of 0.5, 1.0, 2.0 and 3.0 g/20 g of maize were used. When 30 eggs of *P. interpunctella* were introduced into each plastic container containing the treated samples, the percentage egg hatched and adult emergence was noted and recorded. There was no egg hatched in all the grains protected with root and bark powder of *C. patens* (Tables 4 and 5) except leaf powder where 12% eggs were hatched and 11% adult emerged. At 1.0 g/20 g of maize, 11% eggs were hatched and 4% adult emerged and there was no significant difference when compared with the 2.0 g protectant concentrations. There were no significant difference (P > 0.05) in the mean hatchability and adult emergence at 1.0, 2.0 and 3.0 g-powder concentration. Also, at 3.0 g/20 g of maize, 6% eggs were hatched and only 2% adult emerged. There was significant difference (P < 0.05) in the mean number of egg hatched and adult emergence when compared with the control, which had 86% hatchability, and 78% adult emergence. The root, bark and the leaf powder were effective in inhibited development of *P. interpunctella* at all levels of concentration. However, there were significant difference (P < 0.05) in the mean number of egg hatched and adult emergence in root and bark powder when compared with the leaf powder treated and untreated grain.

DISCUSSION

The root bark powder and the stem bark powder of *C. Patens* were the most effective on mortality of adult *P. interpunctella* at the three treatment levels investigated. The leaf powder of *C. patens* was slightly effective since the percentage mortality produced at 96 h post-treatment was significantly higher than the control. The ability of this plant material to affect the mortality of *P. interpuntella* within 96 h after treatment can be attributed to both contact toxicity and the fumigant effect of the plant powder on the moth. The root, bark and leaf powders were able to prevent egg hatch and adult emergence because there were significant differences ($P < 0.05$) when compared with the untreated. Powder of various plant species with insecticidal activities has been used previously by several researchers in the laboratory trials for the control of stored product pests (Adedire and Ajayi, 1996; Ashamo and Odeyemi, 2001; Lale, 2002; Ashamo and Akinneye, 2004). The results of this study are consistent with observation of Lajide et al. (1998) that the powders of *E. aromatica*, *U. afzelli* and *A. melegueta* were highly toxic to *Sitophilus zeamais* within 24 h post – treatment. The observations are also in agreement with the findings by Ashamo and Akinneye (2004) that the powders of *E. aromatica, Z. offficinales* and *U. afzelli* were effective against *Euzopherodes vapidella,* the yam moth at 0.3% and 1.0%/15 g concentration within 72 h of application producing 100% mortality of the moths. The root bark and the stem bark powder of *C. patens* was effective against *P. interpunctella* at 1.0, 2.0 and 3.0 g concentration per 20 g of maize, producing 100% mortality within 96 h post-treatment. These observations also tallies with the findings of Adedire and Lajide (2001) that the pulverized powder of *Piper umbrellatum* seed and *E. aromatica* were toxic to *C. maculatus* producing 100% mortality at 24 h post–treatment with all concentration tested. The toxic effect of the root and bark powder of *C. patens* in this study could be attributed to their pungency which evoked suffocating action on the moths. The leaf powder was the least effective of all the *C. patens* part tested but there was significant difference ($p < 0.05$) in the mortality recorded with the leaf powder when compared with the control. Hence, the leaf powder was effective at higher concentration.

The performance of plant materials in the present study coincides with previous findings (Ashamo, 2000) that *Allium cepa was* very effective against *Dasyses rugosella* adults at 0.25 g/16 g of yam concentration within 48 h of application producing 100% mortality of the moths. The observed mortality may be due to the pepperish and pungency of the root and bark powder of *C. patens*. The powder of *C. patens* acted mainly through fumigation and contact modes of action. This powder may cause death through respiratory inhibition, inhibition of oxidative phosphorylation and amine metabolism (Ashamo, 2000). The powder may also bind to the enzyme, cholinesterase thus preventing the removal and resultant accu-mulation of acetycholine, the neurotransmitter. Restless-ness convulsion and paralysis may occur resulting in death of the moth (Ashmo, 2000).

The root bark, stem bark and leaf powder of *C. patens* were found effective against the development of *P. interpunctella* from egg to adult at all levels of concentration except in leaf powder which produced 2 – 11% adult emergence and there was significant difference ($P < 0.05$) when compared with the control which had 61 – 78% adult emergence. The root bark and stem bark powders of *C. patens* were the most effective against the development of *P. interpunctella* producing zero percent (0%) adult emergence. The result showed that all the powder inhibits egg hatch and adult emergence. The plant powder may inhibit gaseous exchange between the egg and external environment (Akinneye, 2003). The performance of the root, bark and leaf powders of *C. patens* in this study agreed with the findings of Echendu (1991) that the powdered rhizome of *Zingiber officinales* when admixed at 2.5 g/500 g brown cowpea seed reduced the emergence of F1 adult by 96% compared to the untreated control.

The plants used in this study are readily available, inexpensive and used as medicine. This plant grows freely in riverbanks in many Nigerian rivers. Since adult moths do not feed on food commodities but may visit to deposit their eggs, the use of ovicidal, insecticidal and anti-oviposition bio-insecticides would be advantageous for the control of lepidopterous pest, as it has been demonstrated here against egg and adult *P. interpunctella.* This minimizes the use of synthetic pesticides and reduces the development of insect resistance. However, the biological activities of *C. patens* may merit further investigation to determine the active ingredient responseble for the insecticidal action.

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