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# Biological Activity of Some Local Plant Powders against the Saw- Toothed Grain Beetle, Oryzaephilus *surinamensis* (L.)

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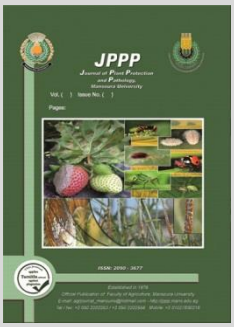

## ABSTRACT

The present study aimed to investigate the bio-efficiency of five plant powders (clove, black pepper, cinnamon, thyme and capsicum) against the adult stage of the saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.) under open laboratory conditions at 27.13ºC and 47.67% RH. The botanical powders were admixed with the standard diet at various concentrations (0.5, 1, 2, 4, 5, 6, 7, 8, 12, 16 and 18 % w/w) and infested by adults to determine the percentage of adult mortality and some biological effects. The results showed that the percentage of adult mortality increased by increasing both of concentration of the tested plant powder and the exposure period. Generally, clove powder was the most effective plant powder against *O. surinamensis* recording the lowest values of $LC_{50}$ 6.787, 5.562, 5.390, 5.256 and 5.256 after 1, 3, 5, 7 and 15 days, respectively. The tested plant powders affected the insect biological characters with various degrees, it was found that both clove and cinnamon powders shortened the growth period, while thyme prolonged the growth period compared to control. All tested powders reduced the progeny number compared to control, whereas clove was the most promising powders in control process where it produced the least progeny number (18.81 insects), while those of capsicum achieved activity on progeny number (64.20 insects). further, all tested powders reduced the percentage of weight loss compared with control.

***Keywords:*** plant powders, *Oryzaephilus surinamensis* (L.), adult mortality, biological characters.

## INTRODUCTION

The saw-toothed grain beetle, *Oryzaephilus surinamensis* (Linnaeus) (Coleoptera: Silvanidae), is one of the key stored grain pests which occurs worldwide (Rossiter *et al*., 2001 and Hashem *et al*., 2012). The insect is a secondary feeder since it attacks the grains and their products, as well as it infests dry fruits such as stored dates, dried meat and many other products that are used by humans such as sugar and types of sweets *e.g.*, biscuits. This insect is widespread in the world (Thomas, 2006) because of its small size, the shape its body is flat and the running speed which helped the adult to reach the grain bags and stored materials. This insect causes huge damage for grains such as weight decrease as well as its ability to break grains and make tunnels inside it and eventually increasing its moisture. Also, the accumulation of larvae and adults leads to poor grain taste and damage it (Highland, 1991). Synthetic insecticides like organochlorides, carbamates and synthetic pyrethroids were considered as one of the most important means which used against the pests of stored materials because they are easy application and most effective (Hidalgo *et al.*, 1998), however their extensive use led to several problems like environmental disturbances, emergence of genetically resistant strains and their deadly effects on non – target organisms as well as toxicity to users and consumers (Prakash and Rao, 1997 and Tapondjou *et al.* , 2002). Due to the detrimental usage of the synthetic insecticides, there is a strong need to search for safe alternatives from plant origin that are readily biodegradable, safe on the environment, less toxic to humans and mammals, selective in action, available in our local environment, less expensive compared to those chemical pesticides and suggested as one of the important new approaches of insect pest management programs (IPM). Hence, the current study was designed to investigate the biological activity of some local plant powders as clove, black pepper, cinnamon, thyme and capsicum as safe control agents which were tested against the adult stage of this pest. The bio- efficiency of these plant powders were tested on insect mortality, development, reproduction and survival when mixed with the insect diet at various mixing ratios.

## MATERIALS AND METHODS

The present investigation was carried out in Plant Protection Department, Faculty of Agriculture, Zagazig University under open laboratory conditions at 27.13ºC and 47.67% RH.

**Insect rearing**

The insects used in this work were obtained from the Stored Grain Insect Pests Department, Plant Protection Research Institute, A.R.C., Giza, Egypt. The stock cultures were set up by introducing newly emerged beetles (about three hundred adults) in two-kg capacity jars, half filled with previously sterilized and conditioned standard diet. The insect standard diet was composed of wheat flour, crushed wheat and dry yeast powder at 5:5:1, respectively according to the method described by Leelaja *et al*. (2007) and Kolar *et al*. (2017). The jars were tightly covered with muslin cloth, held in place by rubber bands and the adults were left to oviposit for two weeks, then removed by sieving. The

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glass jars were labeled and kept within an incubator adjusted at 29±1$^{O}$C and 65±5% RH.

**Preparation of plant powders**

The tested plant powders which used in the present study were purchased from the local supermarket thereafter milled and placed in plastic bags, then stored in the refrigerator till use in the experiment. The names of these plants and its sources were shown in Table (1).

**Table 1. Common and scientific names of the tested local plant powders and its sources.**

| Plant powder (English name) | Scientific name | Family name | Used part | Source |
|---|---|---|---|---|
| Clove | *Syzygium aromatic* | Myrtaceae | Dry flowers | |
| Black pepper | *Piper nigrum* | Piperaceae | Dry fruits | |
| Cinnamon | *Cinnamomum verum* | Lauraceae | Bark stems | Super market |
| Thyme | *Thymus vulgaris* | Lamiaceae | Leaves and flower tops | |
| Capsicum | *Capsicum annuum* | Solanaceae | Dry fruits | |

**Experimental design**

To determine the effect of tested plant powders on the adult mortality and biology of *O. surinamensis* about 100 grams of the untreated standard diet was admixed with the different plant powders at various concentrations. The whole treated diet was then divided into five equal replicates of 20g each. The tested concentrations were 0.5, 1, 2, 4, 5, 6, 7, 8, 12, 16 and 18% w /w. Each replicate was infested with 20 unsexed adults of saw-toothed grain beetle and left to move freely and feed from the treated diet for two weeks under open laboratory conditions at 27.13ºC and 47.67% RH. The adult mortality was recorded after 1, 3, 5, 7 and 15 days. Percentage of mortality was calculated using the following formula: [(Number of dead insects ÷ Total number of insects] × 100.

Toxicity index (TI) was calculated according to the following formula given by Sun (1950): Toxicity index = ($LC_{50}$ of the most effective compound / $LC_{50}$ of other tested compound) x 100, where the best plant powder (which has the smallest $LC_{50}$ value) given a value of 100. Adults were separated and discarded after two weeks and all replicates were incubated and left undisturbed then examined after 2-3 weeks later to record date of mean developmental period, progeny number, sex ratio according to Halstead (1963) who cleared that it was easily accomplished by examining the hind legs of adults, as one tooth and several spines occur in the femora of the hind legs of males, while in the females these characters are absent (Fig. 1) .

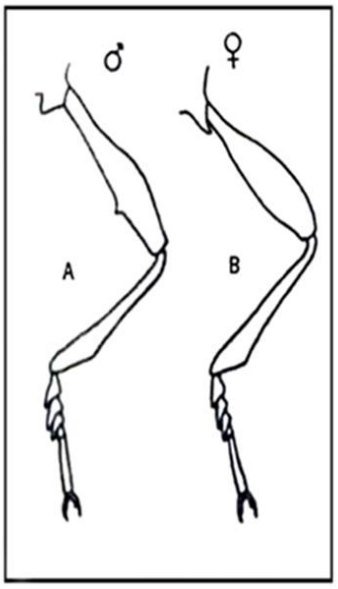


**Fig. 1. Legs of male (♂) and female (♀) of *O. surinamensis*.**

After adult emergence, the efficiency of plant powders against the insect infestation was determined by calculating the percentage of weight loss from both the untreated diet and treated one with the various plant powders. Moreover, the reduction of adult emergence% in $F_1$ progeny from treatments was calculated according to El-Lakwah *et al*. (1996) from the following equation: [(Number of adults emerged in control – Number of adults in treatment) ÷ Number of adults in control] × 100. The bio-effects of the tested plant powders on the adult weight were also investigated by weighing groups of ten newly emerged adults from the treated and untreated diets and calculating the mean adult weight. Data of this part were subjected to the statistical analysis to know the best effective plant powder.

**Statistical analysis**

The obtained data was analyzed by analysis of variance (ANOVA) using Proc. ANOVA in SAS (Anonymous, 2003) and means were separated by the least significant difference (LSD) at 5% probability level ($p \leq 0.05$) in the same program.

## RESULTS AND DISCUSSION

Generally, all the tested plant powders have various adulticidal effect against *Oryzaephilus surinamensis*. The insect mortality was depending on the plant powder, its concentration and the exposure period.

**Toxicity of the tested plant powders**

Data presented in Table (2) and illustrated graphically in Figures 2, 3, 4 and 5 show the toxicity of four plant powder (clove, black pepper, cinnamon and thyme) against *O. surinamensis* adults after 1, 3, 5, 7 and 15 days post – treatment. According to $LC_{50}$, clove powder was the most effective powder recording the lowest values of $LC_{50}$ of 6.787, 5.562, 5.390, 5.256 and 5.256 after 1, 3, 5, 7 and 15 days, respectively. Respecting the values of the tested powders, it was found that the lowest values of $LC_{90}$ of 9.233, 7.553, 7.257, 6.857 and 6.857 were recorded with clove powder after 1, 3, 5, 7 and 15 days, successively. The slope values of the tested powders ranged between 1.575 (cinnamon) – 9.589 (clove), 2.500 (cinnamon) – 9.648 (clove), 3.258 (cinnamon) – 9.925 (clove), 3.488 (cinnamon) – 11.102 (clove) and 3.062 (thyme) – 11.102 (clove) after 1, 3, 5, 7 and 15 days, respectively. As regards the toxicity index it is obvious that clove powder was the superior toxicant against the adults of *O. surinamensis* after 1, 3, 5, 7 and 15 days post – treatment recording 100.000 % toxicity index. On the contrary, thyme powder was the least efficient powder revealing the lowest toxicity indices of 20.020, 20.020 and 17.512 after 5, 7 and 15 days post –

treatment, successively. In case of capsicum powder, the results prove that all tested concentrations of capsicum powder (0.50, 1, 2, 4 and 8 % w/w) did not cause any apparent or significant mortality for *O. surinamensis*.

**Table 2. LC values of some plant powders against the saw – toothed grain beetle, *Oryzaephilus surinamensis* (L.) adults 1, 3, 5, 7 and 15 days post – treatment with the tested plant powders under open laboratory conditions (27.13ºC and 47.67% RH).**

| Post – treatment period (by days) | Plant powder | $LC_{50}$ | $LC_{90}$ | Slope | Toxicity index |
|---|---|---|---|---|---|
| 1 | Clove | 6.787 | 9.233 | 9.589 | 100.000 |
| | Black pepper | – | – | – | – |
| | Cinnamon | 89.51 | 583.066 | 1.575 | 7.582 |
| | Thyme | – | – | – | – |
| 3 | Clove | 5.562 | 7.553 | 9.648 | 100.000 |
| | Black pepper | 33.269 | 85.370 | 3.131 | 16.718 |
| | Cinnamon | 33.226 | 108.199 | 2.500 | 16.740 |
| | Thyme | – | – | – | – |
| 5 | Clove | 5.390 | 7.257 | 9.925 | 100.000 |
| | Black pepper | 19.920 | 38.714 | 4.441 | 27.058 |
| | Cinnamon | 22.721 | 56.217 | 3.258 | 23.722 |
| | Thyme | 26.923 | 51.119 | 4.603 | 20.020 |
| 7 | Clove | 5.256 | 6.857 | 11.102 | 100.000 |
| | Black pepper | 13.383 | 20.809 | 6.686 | 39.273 |
| | Cinnamon | 20.437 | 47.635 | 3.488 | 25.718 |
| | Thyme | 26.923 | 51.119 | 4.603 | 20.020 |
| 15 | Clove | 5.256 | 6.857 | 11.102 | 100.000 |
| | Black pepper | 12.238 | 18.366 | 7.270 | 42.948 |
| | Cinnamon | 20.437 | 47.635 | 3.488 | 25.718 |
| | Thyme | 30.013 | 78.683 | 3.062 | 17.512 |

**- indicates that no mortality was detected in most concentrations of the tested powder after the exposure period.**

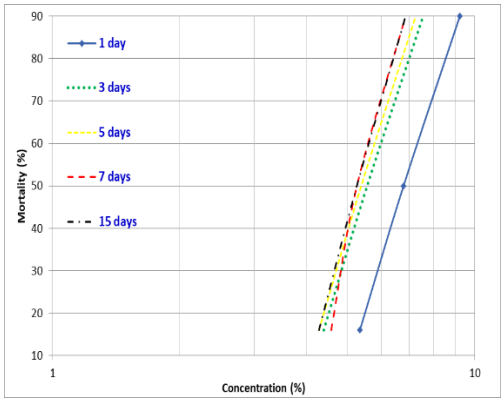


**Fig. 2. Toxicity lines of clove powder against *Oryzaephilus surinamensis* (L.) adults 1, 3, 5, 7 and 15 days post-treatment under open laboratory conditions (27.13ºC and 47.67% RH).**

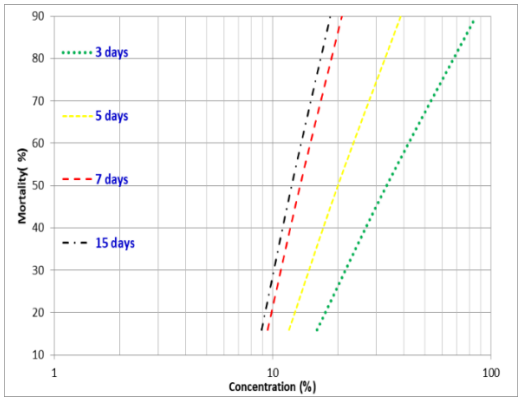


**Fig. 3. Toxicity lines of black pepper powder against *Oryzaephilus surinamensis* (L.) adults 3, 5, 7 and 15 days post- treatment under open laboratory conditions (27.13ºC and 47.67% RH).**

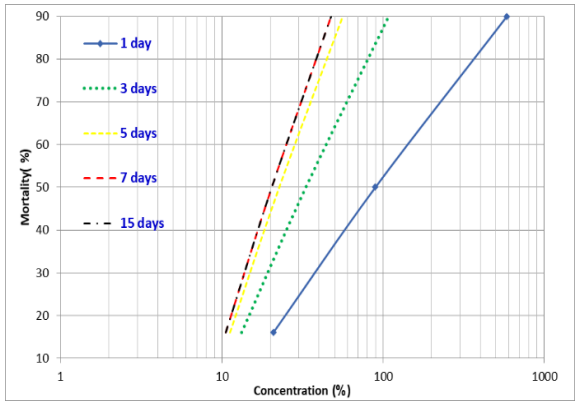


**Fig. 4. Toxicity lines of cinnamon powder against *Oryzaephilus surinamensis* (L.) adults 1, 3, 5, 7 and 15 days post – treatment under open laboratory conditions (27.13ºC and 47.67% RH).**

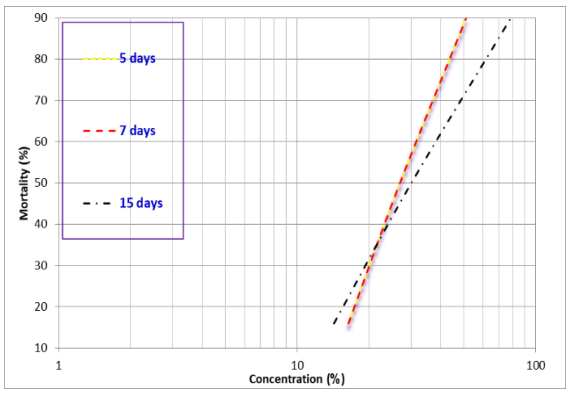


**Fig. 5. Toxicity lines of thyme powder against *Oryzaephilus surinamensis* (L.) adults 5, 7 and 15 days post – treatment under open laboratory conditions (27.13ºC and 47.67% RH).**

**Biological effects**

**1. Clove powder**

From the results compiled in Table 3, it is evident that the lower concentrations of clove powder affected the biological characters of the tested insect *i.e*, the tested concentrations of dry clove powder ranged from 0.50 to 4.00 % (w/w) and significantly affected the different biological activities of *O. surinamensis* as the mean developmental period (MDP), progeny number, weight loss (%), mean adult weight of male and female and the reduction of adult emergence (%). The progeny number was prohibited completely at 4.00% (w/w) compared to the control (89.75 adults). The treated diet suffered from a significantly lower weight loss (%) with increasing the clove concentrations since there are no progeny. At 2.00%, weight loss (%) was 3.43% compared to 15.48% in the control.

**2. Black pepper powder**

The powder of dry black pepper also affected the various aforementioned biological parameters of the tested insect (Table 4). MDP (days) was lengthened with increasing the powder concentration, for example, it reached 41.0 days at 8.00% compared to 25.75 days in the control. The powder of dry black pepper affected the progeny number which was decreased from 75.50 to 5.75 when the powder concentration increased from 0.50% to 8.00%. Also, increasing of the powder concentration affected other biological characters of the test insect as weight loss (%), adult weight of the male and the female.

**Table 3. Biological activity of clove powder against *Oryzaephilus surinamensis* ±SE under open laboratory conditions (27.13 ºC and 47.67% RH).**

| Concentration (%) | MDP (days) | Progeny no. | Reduction (%) | Sex ratio (male/ female) | Weight loss (%) | Mean weight of female (mg) | Mean weight of male (mg) |
|---|---|---|---|---|---|---|---|
| 0.50 | 26.25±0.24b | 48.00±1.66b | 46.52±1.79c | 0.92±0.01b | 7.10±0.17b | 1.80±4.87b | 1.63±4.18b |
| 1.00 | 26.75±0.13b | 20.25±0.52c | 77.44±0.56b | 1.32±0.03a | 6.33±0.07b | 1.75±0.01c | 1.50±0.00c |
| 2.00 | 37.25±0.24a | 7.00±0.35d | 92.20±0.38a | 0.59±0.19c | 3.43±0.10c | 0.00±0.00d | 0.00±0.00d |
| 4.00 | 0.00e | 0.00e | 100.00e | 0.00e | 0.00e | 0.00e | 0.00e |
| Control | 25.75±0.52b | 89.75±0.13a | 0.00d | 0.94±0.01b | 15.48±0.32a | 2.22±0.00a | 2.19±0.00a |
| F. test | * | * | * | * | * | * | * |

**Means of the same column followed by different letters are significantly different at P≤ 0.05 when analyzed using ANOVA test.**
***= significant.**

**Table 4. Biological activity of dry black pepper fruits powder against *Oryzaephilus surinamensis* ±SE under open laboratory conditions (27.13 ºC and 47.67% RH).**

| Concentration (%) | MDP (days) | Progeny no. | Reduction (%) | Sex ratio (male/ female) | Weight loss (%) | Mean weight of female (mg) | Mean weight of male (mg) |
|---|---|---|---|---|---|---|---|
| 0.50 | 26.25±0.24d | 75.50±1.01b | 15.88±1.09e | 0.93±0.01a | 7.01±0.23b | 1.90±0.00b | 1.75±0.01b |
| 1.00 | 27.25±0.13cd | 37.25±0.77c | 58.50±0.83d | 0.89±0.01a | 5.69±0.04c | 1.85±0.01c | 1.73±0.01b |
| 2.00 | 28.00±0.00bc | 32.50±0.43d | 63.79±0.47c | 0.86±0.05a | 5.40±0.01c | 1.73±0.01d | 1.60±0.00c |
| 4.00 | 29.50±0.14b | 10.25±0.31e | 88.58±0.34b | 0.58±0.11b | 5.23±0.04c | 0.00±0.00e | 0.00±0.00d |
| 8.00 | 41.00±0.29a | 5.75±0.24f | 93.59±0.26a | 0.65±0.07b | 2.14±0.22d | 0.00±0.00e | 0.00±0.00d |
| 12.00 | 0.00e | 0.00g | 0.00e | 0.00c | 0.00e | 0.00e | 0.00d |
| Control | 25.75±0.52d | 89.75±0.13a | 0.00f | 0.94±0.01a | 15.48±0.32a | 2.22±0.00a | 2.19±0.00a |
| F. test | * | * | * | * | * | * | * |

**Means of the same column followed by different letters are significantly different at P≤ 0.05 when analyzed using ANOVA test.**
***= significant.**

**3. Cinnamon powder**

Data of Table 5 shows that the cinnamon powder also affected significantly the various biological parameters of *O. surinamensis*, especially with increasing both its concentration and the exposure period. MDP (days) was shortened (27.00 days) at the lower concentrations (0.50%) as compared to the control (25.75 days). With increasing the cinnamon concentration to 8.00%, MDP was lasted longer to reach 38.50 days. Progeny number and adult weight also were significantly affected by increasing the powder concentration.

**4. Thyme powder**

The thyme powder prolonged the mean growth period and reduced both the progeny number and the percent of weight loss (%). The mean growth period was significantly affected with the increasing concentration of the thyme powder; it was 26.00 days at 0.50% but it reached 34.00 days at the highest concentration (18.00%). Also, progeny number was reached from 77.75 to only 8.00 adults emerged when the concentration raised from 0.50% to 18.00%. As well, the percent weight loss, reached 2.83% at 18.00 % compared to 15.48% in the control. The mean adult weight of the male and the female was significantly reduced compared to adult weights of either male or female in the control (Table 6).

**5. Capsicum powder**

From the results compiled in Table (7), it is evident that the powder affected the growth period, reduced progeny number from 78.50 to 36.00% at 0.50% and 8.00% concentrations, respectively compared to control (89.75). The lowest percent of the weight loss was 4.99 % at the highest concentration (8.00 %) compared to 15.48 % in the control.

With comparing all tested plant powders at various concentrations on the different biological parameters, the data of each plant powder at its various concentrations when analyzed statistically with other tested plant powders on the various biological studied parameters showed significant differences (Table 8).

From the present results, it is clear that the tested powders of cinnamon and thyme lengthened significantly the mean growth period to 25.17 and 29.13 days compared to control (25.75 days). Clove and black pepper were the most promising powders in reducing the progeny number and the percentage of the weight loss compared to the control. The other powders also affected the tested parameters of the insect *O. surinamensis* but with less

degrees. All powders reduced amount of weight loss compared to control. The effect of the tested plant powders on the adult mortality was apparent at the highest concentrations. Among the tested powders, those of clove flower exerted a toxic and harmful effect on both adult mortality, feeding and the reproductive state of *O. surinamensis*. Diet treatment reduced the progeny production significantly compared to control. The present investigation indicates that clove can be used for protecting stored grains or dry fruits as dates against the insect attack by *O.surinamensis* as a serious pest.

**Table 5. Biological activity of cinnamon powder against *Oryzaephilus surinamensis* ±SE under open laboratory conditions (27.13ºC and 47.67% RH).**

| Concentration (%) | MDP (days) | Progeny no. | Reduction (%) | Sex ratio (male/ female) | Weight loss (%) | Mean weight of female (mg) | Mean weight of male (mg) |
|---|---|---|---|---|---|---|---|
| 0.50 | 27.00±0.00cd | 48.00±0.84b | 46.52±0.91e | 0.89±0.03abc | 6.50±0.07b | 2.20±0.01a | 1.88±0.01b |
| 1.00 | 26.50±0.14cd | 42.00±0.61c | 53.20±0.66d | 0.89±0.02ab | 5.79±0.03bc | 2.08±0.01b | 1.80±0.01c |
| 2.00 | 27.50±0.14c | 37.00±0.41d | 58.77±0.44c | 0.83±0.02bc | 5.56±0.03c | 2.00±0.00c | 1.75±0.01c |
| 4.00 | 31.50±0.60b | 32.75±0.52e | 63.51±0.56b | 0.82±0.02c | 5.16±0.03c | 1.88±0.01d | 1.75±0.02c |
| 8.00 | 38.50±0.25a | 11.25±0.38f | 87.47±0.40a | 0.73±0.04d | 4.20±0.16d | 1.73±0.00c | 1.50±0.00d |
| 12.00 | 0.00e | 0.00e | 0.00e | 0.00e | 0.00e | 0.00e | 0.00e |
| Control | 25.75±0.52d | 89.75±0.13a | 0.00f | 0.94±0.01a | 15.48±0.32a | 2.22±0.00a | 2.19±0.00a |
| F. test | * | * | * | * | * | * | * |

**Means of the same column followed by different letters are significantly different at P≤ 0.05 when analyzed using ANOVA test.**
***= significant.**

**Table 6. Biological activity of thyme powder against *Oryzaephilus surinamensis* ±SE under open laboratory conditions (27.13ºC and 47.67% RH).**

| Concentration (%) | MDP (days) | Progeny no. | Reduction (%) | Sex ratio (male/ female) | Weight loss (%) | Mean weight of female (mg) | Mean weight of male (mg) |
|---|---|---|---|---|---|---|---|
| 0.50 | 26.00±0.20cd | 77.75±0.52b | 13.37±0.56g | 0.95±0.01a | 7.04±0.03b | 1.60±0.00c | 1.48±0.01b |
| 1.00 | 26.50±0.14cd | 70.50±0.43c | 21.45±0.47f | 0.92±0.02a | 6.90±0.02bc | 1.55±0.01d | 1.40±0.02c |
| 2.00 | 26.75±0.13cd | 52.00±0.50e | 42.06±0.54d | 0.91±0.02a | 6.68±0.03bc | 1.50±0.00e | 1.35±0.01d |
| 4.00 | 27.00±0.00cd | 49.50±0.14e | 44.85±0.16d | 0.89±0.02a | 6.30±0.04bcd | 1.43±0.01f | 1.30±0.00e |
| 8.00 | 27.75±0.38c | 26.25±0.59f | 70.75±0.64c | 0.84±0.02ab | 5.88±0.04cd | 1.40±0.00f | 1.28±0.01e |
| 12.00 | 31.50±0.14b | 24.00±1.97d | 73.26±2.20e | 0.93±0.01a | 5.70±0.02bcd | 1.64±0.00b | 1.35±0.00d |
| 16.00 | 33.50±0.14a | 16.25±0.24g | 81.89±0.27b | 0.77±0.06b | 5.60±0.03d | 0.00±0.00g | 0.00±0.00f |
| 18.00 | 34.00±0.00a | 8.00±0.29h | 91.09±0.32a | 0.56±0.27c | 2.83±0.31e | 0.00±0.00g | 0.00±0.00f |
| Control | 25.75±0.52d | 89.75±0.13a | 0.00h | 0.94±0.01a | 15.48±0.32a | 2.22±0.00a | 2.19±0.00a |
| F. test | * | * | * | * | * | * | * |

**Means of the same column followed by different letters are significantly different at P≤ 0.05 when analyzed using ANOVA test.**
***= significant.**

**Table 7. Biological activity of capsicum powder against *Oryzaephilus surinamensis* ±SE under open laboratory conditions (27.13ºC and 47.67% RH).**

| Concentration (%) | MDP (days) | Progeny no. | Reduction (%) | Sex ratio (male/ female) | Weight loss (%) | Mean weight of female (mg) | Mean weight of male (mg) |
|---|---|---|---|---|---|---|---|
| 0.50 | 24.75±0.13c | 78.50±0.25b | 12.53±0.27e | 0.94±0.01a | 7.40±0.02b | 2.20±0.00a | 1.88±0.02b |
| 1.00 | 25.50±0.14bc | 74.75±0.38c | 16.71±0.40d | 0.93±0.01a | 6.11±0.02c | 2.08±0.01b | 1.80±0.02c |
| 2.00 | 26.50±0.14b | 69.25±0.13d | 22.84±0.14c | 0.93±0.00a | 6.09±0.02c | 2.00±0.00c | 1.75±0.01c |
| 4.00 | 26.75±0.13b | 62.50±0.43e | 30.36±0.60b | 0.93±0.01a | 5.95±0.03cd | 1.88±0.01d | 1.75±0.01c |
| 8.00 | 28.75± 0.24 a | 36.00±0.35f | 59.89±0.38a | 0.82±0.02b | 4.99±0.12d | 1.73±0.01e | 1.50±0.00c |
| Control | 25.75±0.52bc | 89.75±0.13a | 0.00f | 0.94±0.01a | 15.48±0.32a | 2.22±0.00a | 2.19±0.00a |
| F. test | * | * | * | * | * | * | * |

**Means of the same column followed by different letters are significantly different at P≤ 0.05 when analyzed using ANOVA test.**
***= significant.**

**Table 8. The comparative biological effect of the tested plant powders at the different concentrations on some biological characters of *O. surinamensis* under laboratory conditions (27.13ºC and 47.67% RH).**

| Powder name | MDP (days) | Progeny no. | Reduction (%) | Sex ratio ( male/ female) | Weight loss (%) | Mean weight of female (mg) | Mean weight of male (mg) |
|---|---|---|---|---|---|---|---|
| Clove | 22.56b | 18.81f | 79.04a | 0.71bc | 4.22c | 0.89c | 0.78d |
| Black pepper | 25.33ab | 26.88e | 70.05a | 0.65c | 4.25c | 0.91c | 0.85d |
| Cinnamon | 25.17a | 28.50d | 68.25a | 0.69ab | 4.54b | 1.65b | 1.45c |
| Thyme | 29.13a | 45.50c | 49.30a | 0.85ab | 5.98b | 1.14bc | 1.02cd |
| Capsicum | 26.45ab | 64.20b | 28.47b | 0.91a | 6.11b | 1.98a | 1.74b |
| Control | 25.75ab | 89.75a | 0.00c | 0.94a | 15.48a | 2.22a | 2.19a |
| F. test | * | * | * | * | * | * | * |

**Means of the same column followed by different letters are significantly different at P≤ 0.05 when analyzed using ANOVA test.**
***= significant.**

The control of the insect pests by chemical insecticides are currently the choice method for eradicating the stored grain insects (White and Leesch,1995; Epidi and Odili, 2009) but the frequent and continuous application has produced a resistant insects (Rehman *et al*., 2009) besides toxic environmental contamination and health hazards

(White and Leesch, 1995). Workers in the field of plant protection seeks about a bioactive plant biopesticides for protecting the stored grains, cereal products, fruits and dry spices (Boeke *et al*., 2004; Talukdar *et al*., 2004; Hassan *et al*., 2006; Epidi *et al*., 2009).

These results agree also with those of Lajide *et al*. (1998) who admixed plant powders with maize grains at 1% (w/w) and recorded higher mortality rates among *Sitophilus zeamais* after seven days. Also, the adult emergence of the pest was significantly affected by these tested plant powders compared to control. The other tested plant powders as black pepper, cinnammon and thyme were not effective as contact insecticides on adults of *O. surinamensis* but affected the growth of the immature stages. Clove powder affected the insect oviposition by reducing it besides its toxic properties in killing the adults and so showed a significant decrease in the progeny number. We could conclude that the tested plant powders had a marked effects on growth of the immature stages which in turn affected the adult emergence. The effect was in general depend on type of the plant powder, its application rates and the insect stage. Other complementary studies are necessary to investigate the biological effects of these plant products on the other immature stages as eggs, larvae at different ages and on the pupae, as well as to clarify other biological properties of these powders as its repellency or attractancy or its anti-ovipostional properties.

Other plant powders affect a wide range of insect pests and have no harmful effect on the non-targeted organisms and the environment (Haq *et al*., 2005). Some plants contain bioactive compounds with insecticidal and or repellent properties against insects of the stored food products and confirm its application as alternative safe control agents than toxic insecticides (Desmarchelier, 1994). The effective plants could also be used to formulate active formulations, non-toxic to humans but be utilized against stored product insects.

Although the screening of plant powders against *O. surinamensis* did not gave a complete protection of the treated products through its effect on adult mortality and did not completely inhibit the adult emergence of the pest but showed a good result.

Our results agree with those of Ravi Kumar *et al*. (2017) who found that these plant powders lowered fecundity, adult emergence and weight loss (%). Neem and garlic powders were effective against three primary pests as *S. oryzae*, *S. zeamais* and *C. maculatus* (Onu *et al*., 2015). Mahmood (2019) tested the bioactivity of three plant powders (black caraway, Sodom apple and mint) at various mixing rates with rice grains against larval and pupal growth of *O. surinamensis.* They found that Sodom apple powder was the most effective on the parameters of the pest as percentage of the larval mortality (reached 33.3%) compared to control, as well as did not affect the vitality of the treated rice grains. Our results agree also with those of Al-joboory (2019) who found that black pepper affected the growth and mortality of the flour beetle, *Tribolium castaneum* when infested crushed wheat treated with it. He explained the larval failure to feed on the crushed wheat because of its toxic compounds which affect the digestive pest tract or its effect on the epithelial cells lining them and so disturbing the digestive enzymes and thus killing the larvae (Bowers, 1984). Black pepper seeds contained also active alkaloids which might directly affect the nerves causing rapid paralysis of the treated insects (Halawah *et al*., 1998).

Our present results indicated that clove was the most effective as control agent against this pest which infest and spoil many agricultural crops as cereal products, fruits as dry dates. Other tested powders showed less bio-activity. These tested powders should be tested against other pests of stored grains for eliciting as good and effective protectant as well as must be investigated on the chemical constituents of the treated products.

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# النشاط البيولوجي لبعض المساحيق النباتية المحلية على حشرة خنفساء الحبوب المنشارية *Oryzaephilus surinamensis* (L.)

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## الملخص

تهدف الدراسة الحالية إلى تقييم النشاط البيولوجي لخمسة مساحيق نباتية (القرنفل، الفلفل الأسود، القرفة، الزعتر وفلفل الشطة) ضد الحشرات الكاملة لحشرة خنفساء الحبوب منشارية الصدر (خنفساء السورينام) تحت الظروف المعملية ٢٧,١٣ °م و٤٧,٦٧ ٪ رطوبة نسبية. تم خلط المساحيق النباتية ببيئة التربية القياسية للحشرة بتركيزات مختلفة (٠,٠,٥، ١، ٢، ٤، ٥، ٦، ٧، ٨،١٢، ١٦ و١٨ ٪ وزن / وزن) وعمل عدوى صناعية بالحشرات لتقدير النسبة المئوية للموت وبعض التأثيرات البيولوجية. أظهرت النتائج أن النسبة المئوية للحشرات الميتة ازدادت بزيادة كل من تركيز المسحوق النباتي المختبر وفترة التعريض. وبصفة عامة، كان مسحوق القرنفل أكثر المساحيق النباتية الفعالة ضد حشرة خنفساء السورينام حيث سجل أقل قيم للتركيز النصفي القاتل (٦,٧٨٧، ٥,٥٦٢، ٥,٣٩٠، ٥,٢٥٦ و ٥,٢٥٦) بعد ١، ٣، ٥، ٧ و ١٥ يوماً، على التوالي. أثرت مساحيق النباتات المختبرة على الصفات البيولوجية لحشرة خنفساء السورينام ولكن بدرجات مختلفة، حيث وجد أن مسحوق كل من القرنفل والقرفة قد قصرت فترة النمو للحشرة، بينما مسحوق الزعتر قد طول فترة النمو مقارنة بالكنترول. وجد أن جميع المساحيق المختبرة قللت من تعداد الذرية الخارجة مقارنة بالكنترول، لكن القرنفل كان أكثر المساحيق الواعدة في عملية المكافحة حيث أنتج ذلك المسحوق أقل تعداد للذرية الناتجة (١٨,٨١ حشرة)، بينما أظهر مسحوق فلفل الشطة نشاط واضح على عدد أفراد الذرية حيث أنتج (٦٤,٢٠ حشرة) وأيضاً، قللت جميع المساحيق المختبرة من النسبة المئوية للفقد في الوزن مقارنة بالكنترول.