The effectiveness of silver and silica nanoparticles on productivity and adult emergence of *T. castaneum* and *C. maculatus*

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Abstract

Silver and silica nanoparticles and *Nerium oleander* (neem) leaves extract were used in different concentrations on the adults of *Callosobruchus maculatus* (cowpea seed beetle) and *Tribolium castaneum* (flour beetle) to detect their activity on productivity (number of eggs) and adult emergence.

Introduction:

*Tribolium castaneum* (Herbst) is an important worldwide pest of stocked products that is observed among several commodities. This insect pest may cause considerable economic losses if not adequately controlled because it has a very high rate of population increase (Sabbour et al. 2015). The cowpea seed beetle, *Callosobruchus maculatus* (Fab.), is the most substantial storage insect pest of cowpea seeds throughout the tropical countries (NRI, 1996). It considered as one of the main insect pests of stored legumes. As it infect starts in fields and continues its life cycle in storehouses. This insect pest is serious because their larvae nutrition and development is mainly inside the seeds, thus they consume all the nutritional component, increasing damage and decreasing nutritional value and germination of seeds (Bhalla, et al. 2008). controlling stored products insect pests is mainly depending on pesticides and fumigants but unfortunately these methods leads to contamination of food by toxic wastes (Debnath, et al. 2011) In addition, the exposure to these pesticides can lead to resistance against them, therefore the chemical control is unfavorable (Rouhani, et al, 2012).
Nanotechnology is concerned with materials and particles of the nanosize $10^{-9}$ nm, and it became one of the best technologies that are used in pests control nowadays (Bhattacharyyal, et al, 2010).

**Materials and methods:**

**Materials:**

Silver nanoparticles (20 - 30) nm spherical 98% purity and silica nanoparticles (10 – 20) nm white spherical particles, both from Skyspring company, Houston, USA. *N. oleander* leaves, AgNO₃, deionized water, ethylene, cowpea seeds, white flour and adults of *T. castaneum* and *C. maculatus*.

**Methods:**

Silver nanoparticles have been bio-synthesized using water extract of *N. oleander* leaves extract and characterized by (UV-Vis. Spectroscopy, FTIR, XRD, SEM and EDX) and Concentrations (500, 1000, 1500, 2000) PPM of pure silver nanoparticles, bio-synthesized silver nanoparticles, crude extract of *N. oleander* leaves extract and silicon oxide (silica) nanoparticles were prepared separately and their effectiveness have been tested on productivity (number of eggs) and emergence of adults of *T. castaneum* and *C. maculatus*.

**Results and discussion:**

Silica nanoparticles was very effective on decreasing number of produced eggs in both tested insects, particularly at its highest concentration (2000) ppm, *T. castaneum* was mostly affected by silica nanoparticles with a range of (58) egg/female, compared to control treatment of a range (291) egg/female.

*C. maculatus* treatment control showed a range of (98) egg/ female for control treatment, and (2000) PPM of silica nanoparticles showed a range (9) eggs/ female.

Pure and bio-synthesized silver nanoparticles at their highest concentration showed ranges of (77) and (85) egg/ female respectively on *T. castaneum* while on *C. maculatus* bio-synthesized silver showed effect of (18) egg/ female and pure silver nanoparticles (22) egg/ female (table 1).
(Table 1): effect of pure and bio-synthesized silver nanoparticles, silica nanoparticles and *N. oleander* leaves extract on *T. castaneum* and *C. maculatus* productivity (number of eggs)

| Concentration PPM on | Pure silver NPs | Bio-synthesized silver NPs | N. oleander leaf extract | Silica NPs |
|----------------------|-----------------|-----------------------------|--------------------------|------------|
| **T. castaneum**     |                 |                             |                          |            |
| Control              | 291             | 291                         | 291                      | 291        |
| 500                  | 134             | 162                         | 199                      | 86         |
| 1000                 | 119             | 128                         | 136                      | 71         |
| 1500                 | 81              | 110                         | 113                      | 68         |
| 2000                 | 77              | 85                          | 106                      | 58         |
| **C. maculatus**     |                 |                             |                          |            |
| Control              | 98              | 98                          | 98                       | 98         |
| 500                  | 62              | 54                          | 91                       | 36         |
| 1000                 | 45              | 41                          | 84                       | 28         |
| 1500                 | 36              | 39                          | 76                       | 16         |
| 2000                 | 22              | 18                          | 55                       | 9          |

Previous study of (DE) and (Nano-DE) has been performed on *T. castaneum* showed an effect range (58.6) egg/ female compared to control treatment (198.6) egg/ female, and on *T. confusum* the effect range was (48.6) egg/ female compared to control treatment (144.6) (48.6) egg/ female (Abd El-Aziz and Sabbour 2015).

Among all substances, (2000) ppm of silica nanoparticles was highly effective on *T. castaneum* adults emergence with effect range (8.33)% compared to control (95.00)% , and (6.66) % effect range on *C. maculatus* compared to (90.00)% control treatment . pure silver nanoparticles affected emergence of *T. castaneum* and *C.*
maculatus with an effect range (58.33)% , while bio-synthesized silver nanoparticles showed effect ranges (68.33)% for T. castaneum and (71.66) for C. maculatus (table 2).

Nano-DE results on T.confusum adults emergence showed a strong effect with (01)% compared to control (90) % during (20) days (Abd El-Aziz and Sabbour 2015).

(Table 2) : effect of pure and bio-synthesized silver nanoparticles ,silica nanoparticles and N.oleander leaves extract on T. castaneum and C. maculatus adult emergence

| Concentration PPM on | Pure silver NPs | Bio-synthesized silver NPs | N. oleander leaf extract | Silica NPs |
|----------------------|-----------------|-----------------------------|--------------------------|-----------|
|                      | T. castaneum    |                             |                          |           |
| Control              | 95.00           | 95.00                       | 95.00                    | 95.00     |
| 500                  | 80.00           | 88.33                       | 91.66                    | 23.33     |
| 1000                 | 76.66           | 86.66                       | 85.00                    | 16.66     |
| 1500                 | 73.33           | 75.00                       | 81.66                    | 13.33     |
| 2000                 | 58.33           | 68.33                       | 76.66                    | 08.33     |
|                      | C. maculatus    |                             |                          |           |
| Control              | 90.00           | 90.00                       | 90.00                    | 90.00     |
| 500                  | 75.00           | 85.00                       | 90.00                    | 20.00     |
| 1000                 | 70.00           | 83.33                       | 86.66                    | 13.33     |
| 1500                 | 66.66           | 76.66                       | 83.33                    | 11.66     |
| 2000                 | 58.33           | 71.66                       | 75.00                    | 6.66      |

Conclusion:

The efficacy of nanoparticles of silica, pure and biosynthesized silver is shown in the obtained results against productivity of both T. castaneum and C. maculatus regarding to decreasing number of produced eggs, as well as affecting number of emerged adults.
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