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**Faculty of Agriculture (Saba Basha)  
Plant Protection Department**

**EVALUATION OF CERTAIN SAFE POWDERS AND  
PLANT EXTRACTS AS ALTERNATIVES FOR  
CONTROLLING THE RICE WEEVIL *Sitophilus  
oryzae* (COLEOPTERA: CURCULIONIDAE)**

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requirements for the degree of Master of Science**

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## 5. SUMMARY

Rice (*Oryza sativa* L.) (Gramineae) is one of the world's most important cereal crops providing food for more than one third of the world's population. Stored insect pests are a major problem throughout the world as they significantly reduce the quantity and quality of rice. The rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) is considered as the most widespread and destructive primary insect-pest of stored legumes and cereals. It is widespread throughout tropical, sub-tropical and temperate areas on all continents. It also attacks most cereal grains (rice, sorghum, wheat, barley and maize) before harvest and in store. Losses of rice grains ranging from 10 to 20% of overall production due to this insect pest have also been reported.

The control of stored grain pests stands mostly on broad action insecticides and fumigants. Synthetic pesticides have been considered the most effective and accessible means to control insect pests of stored products. These chemicals are associated with undesirable effects on the environment due to their slow biodegradation in the environment and some toxic residues in the products for mammalian health. In addition, the main problem in controlling pests in stored grain is the resistance to pesticides. Regarding the resistance of grain pests and pesticide residues, it seems that chemical control is not an appropriate approach for controlling the populations of these pests. The adverse effects of synthetic pesticides have amplified the need for effective and biodegradable pesticides.

**Therefore, the present study is investigating the following points:**

1. The loss and changes of grains components due to the infestation by *Sitophilus oryzae*.
2. The entomocidal activity of certain botanical powders (admixed with two rice varieties).
3. The biological activity of certain essential oils (EOs) (as fumigants) against *S. oryzae* adults.
4. Determination of the insecticidal efficacy of nono- (as a new insecticide alternative), normal particles of silica and diatomaceous earth (DE) commercial formulation (Celatom<sup>®</sup>) against *S. oryzae* adults.
5. The possibility of using the formulations of essential oils carried on the diatomaceous earth commercial compound (Celatom<sup>®</sup>) as natural botanical insecticides protectants against the rice weevil, *S. oryzae*.

**The obtained results can be summarized as follows:**

### **1. Susceptibility and quantitative and qualitative losses of local rice varieties due to the infestation with the rice weevil *Sitophilus oryzae***

#### **A- The susceptibility and quantitative loss**

Sample of 250 g rice grains were artificially infested with a level of 50 unsexed adults of *S.oryzae* (L.) and stored for 4 months. The quantitative and qualitative changes of rice grains were determined in addition to the counting of the emerged adults during a period of 4 months of storage. The Egyptian local cultivars Giza 4000 was found to be the least susceptible to the attack by *S. oryzae*, while Sakha 102 was the highly susceptible or most preferable throughout 4 months of storage. Comparatively, the data revealed that Sakha 102 cultivar developed significantly the highest adult population of *S. oryzae* showing its preference while the local cultivar Giza 4000 developed significantly the least adult population showing its great tolerance (unpreferable) to *S. oryzae*. The

debris percentage increased as the time of storage increased. It was found that Sakha 102 cultivar recorded the higher percentages of loss and debris and also it was found to be the most preferable cultivar to the tested insect where a high yield of population individual was detected on that cultivar.

#### **B- The effect of *S. oryzae* infestation on the components of rice grains (qualitative loss)**

- a. Maximum increase of crude protein of 0.94% was observed in the case of **Giza 178** cultivar followed by **Sakha 104** and Giza **4000** cultivars with increases of 0.80 and 0.40 %, respectively. It is evident that protein level increased after infestation by *S. oryzae* in all tested rice cultivars except **Sakha 102** (-0.34%).
- b. For crude fat, the maximum increase in crude fat of rice grains after the artificial infestation with *S. oryzae* was observed in both Giza 178 and Giza 400 cultivars with the same percentage of 0.09 and the latter cultivar as previously mentioned showed the lowest number of emerged adults. On the other hand, crude fat was found to be decreased in both cultivars of Sakha 102 and Sakha 104 (-0.35 and -0.26%, in respect).
- c. The only increase of crude fiber of 0.39% was observed in Sakha 102 cultivar which being considered as the most preferable one.
- d. A maximum increase of ash content (0.08%) was observed in Giza 4000 cultivar followed by Sakha 102 and Sakha 104 cultivars with 0.07 and 0.06 % increase, respectively. A decrease of 0.09% was observed in Giza 178.
- e. The present investigation showed that infestation with *S. oryzae* had a negative effect on carbohydrate contents of the different evaluated cultivars of rice grains. Maximum reduction of 2.7% of carbohydrate was observed in Sakha 104 cultivar.
- f. There was a significant increase in moisture content of all the tested rice cultivars after subjecting them to artificial infestation of *S. oryzae* for a period of four months. Giza 4000 (the least susceptible cultivar) showed minimum increase of moisture content (0.04 %) after infestation and the maximum increase of moisture content was found to be + 2.1% in the case of the infestation of Sakha 104 cultivar (the most preferable variety to *S. oryzae*).

#### **2. The entomocidal activity of certain botanical powders (admixed with two rice varieties)**

This part was conducted to determine the insecticidal activity of four botanical powders against the adults of the rice weevil *S. oryzae*. Different concentrations of each of the tested powders were admixed with two varieties of rice grains (Giza 4000 and Sakha 102) and bioassayed for a week.

The results showed that weevil mortality increased with increasing doses of the evaluated plant materials. Pomegranate peel and Lemon grass powders at the lowest tested concentration (0.1g/100g rice grains) caused as high adult mortalities as 76.6 & 65.0 and 73.3& 60.0% on the two tested rice grains (Giza 4000 and Sakha102, respectively) as compared with the other two tested powders. However, all the tested powders were highly effective as entomocidal materials that elicited complete weevil mortality (100%) at the highest concentration of 2.0g/10g of rice except Marjoram (91.6-96.6%).



### **3. The entomocidal activity of certain botanical essential oils as fumigants against *Sitophilus oryzae***

Certain essential oils of four species of plants were obtained and extracted by Clevenger-type water distillation and their fumigant toxicities were tested against adults of the rice weevil, *Sitophilus oryzae* (Curculionidae). For assaying the fumigant toxicities of the evaluated EOs, the mortality was determined after 24, 48 and 72 hrs from beginning of exposure and LC<sub>50</sub> values of each essential oil were estimated. Fumigation bioassays revealed that essential oils of two plants (Clove and Lemon) had strong insecticidal activity on the experimental insect. Based on LC<sub>50</sub> values, the order of toxicity of the evaluated EOs to *S. oryzae* from highest to lowest is: Clove (*Syzygium aromaticum*) > Lemon (*Citrus limon*) > Orange (*Citrus aurantium*) > Thyme (*Thymus vulgaris*).

### **4. Entomotoxicity of silica-based dusts (silica and diatomite) against the rice weevil, *Sitophilus oryzae***

#### **A- Entomotoxicity of Nano Silica Particles (NSPs) against *S. oryzae***

1. It could be noticed that as both the concentration and exposure period increased the responded (mortality) also increased. Form the toxicological point of view and considering the fiducial limts, it seems that there was no effect of the tested rice variety on the entomocidal effect of NSPs.
2. NSPs induced dehydration and this was the main reason behind their nanocidal property. Due to their ultra-small size, NSPs got impregnated in insect cuticle and damaged the cuticular water barrier.

#### **B- Entomotoxicity of normal silica (Aluminum silicates) against *S. oryzae***

1. It could be noticed also that as both the concentration and exposure period increased the responded individuals (mortality) also increased. Form the toxicological point of view and considering the fiducial limts, it seems that there was no effect of the tested rice variety on the entomocidal effect of normal silica (Aluminum silicates).
2. When the efficiency of both silica nano particles (NSPs) and normal silica were assessed against the rice weevil *S. oryzae* adults under laboratory conditions of 28 ±2°C and 70±5% R.H for 72 hrs, it was found that NSPs pronounced more insecticidal activity against the rice weevil *S. oryzae*.

#### **5. Entomotoxicity of diatomaceous earth (Celatom<sup>®</sup>) against *S. oryzae***

1. Celatom<sup>®</sup> was admixed with two rice grains cultivars (Egyptian Giza 4000 and Sakha102) to evaluate its entomocidal activity against the targeted insect-pest to reduce the dependence on synthetic chemical pesticides for its control.
2. The results showed that as the exposure time and Celatom<sup>®</sup> concentration increased, the mortality of the adults increased, while the LC<sub>50</sub> values decreased. Rice grains variety did not affect the toxicity of Celatom<sup>®</sup>.

### **6. The comparative entomotoxicity of the three silica types tested against *S. oryzae***

- 1- NSPs were the most effective against *S.oryzae* as they were admixed with both rice cultivars (Giza 4000 and Sakha 102) after an exposure period of 48 hrs.
- 2- The same trend of results as that has been recorded after 48 hrs-bioassay was also recorded for 72 hrs-bioassay.

3- Nano silica (NSPs) was far more effective on adults and this mortality could be attributed to the impairment of the digestive canal or to surface enlargement of the integument as a consequence of dehydration or blockage of spiracles and tracheas.

**7. Toxicity of certain essential oils carried on Celatom<sup>®</sup> against the rice weevil *S. oryzae***

1. Lemon and Orange EOs/Celatom<sup>®</sup> formulations were the most effective against the rice weevil *S. oryzae*. These two formulations showed the lower LC<sub>50</sub> after they have been exposed to insects for 7 days. Clove EOs/Celatom<sup>®</sup> formulation was more toxic than Thyme/Celatom<sup>®</sup> formulation which has been proved to be the least toxic evaluated formulation.

Therefore, the combination of botanical substances (powders or EOs) and DEs would be effective against stored product insects and it could be concluded that the essential oil and botanical powders technology is a simple applicable and outstanding promising technology and the EOs/Celatom<sup>®</sup> (DE) formulations or the combinations of diatoms and plant powders and plant extracts would be effective strategy for controlling the insect-pests of rice grains.