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MORINGA PLANT POWDERS AS REPELLENT EFFECT AGAINST THE STORED PRODUCT INSECTS

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Abstract

Ephestia kuehniella and *Tribolium castaneum* were the most important insect pests that attacking the wheat grains and flour storages. These insects were caused quality and quantity losses in wheat and flour stores reach more than 40.0%. Moringa is one of the most promising plants in protecting different grains and flour from insect infestation in stores. The parts of the Moringa plant contained the active ingredient substances have a repellent effect to insects.

Moringa leaves, flower, stem bark and seeds as fine powders of the moringa plant and traditional gunny sacks were used. Gunny sacks pre-filled with wheat grains and flour were dusting from the outside by any previous fine powders of the target plant parts. The treated gunny sacks and untreated put on the store and left for 1, 2 and 3 months to exposed infestation. *Ephestia kuehniella* and *Tribolium castaneum* were released in each store with the first month. After the first month and at interval, the number of the adult stage and % weight loss in wheat grain and flour were recorded.

The results showed that seed powders were more effective followed by flower powders, while the stem barks was the least effect against the two insects. The efficiency of the different fine powders were loss with the increasing the storage periods (negative correlation).

Moringa seeds powder is one promising plant part which could be used in stored product protection and a good alternative to synthetic insecticides.

Key words : *Moringa oleifera,* stems, leaves, flowers, seeds, powder, repellent effects, *E. kuehniella, T. castaneum,* weight loss, hand duster.

Introduction

The moringa, *Moringa oleifera* tree is grown in various tropical countries. All the parts of this plant have been studied. The local people has been using the parts of the moringa plant for the cure of the different diseases from many decades (Makkar and Backer, 1996, 1997). Medicinal effects of some plants have been used by all world peoples since ancient times (Naik *et al.,* 2003). Moringa plant has been growing interest in exploiting biological activities of different chemical components due to their lesser side effects and costs. *Moringa oleifera* is commonly known as drumstick tree, and also is native to many countries such as Egypt. Beside the important of moringa plant towards the medicinal uses, there are other plants very important for this side such as mint and rosemary oil neem seeds, which can used as botanical insecticides (Zebitz, 1984; Salem *et al.,* 2016; 2017; Abd El-Salam *et al.,* 2018, 2019). The use of synthetic insecticides in insect control caused pollution in environment and evolution of resistant in insects (Tovignan *et al.,* 2001). Chemical insecticides especially the dust and gaseous forms of methyl bromide are recommended for storage. Moringa contains promising active substances in its various parts such as seeds, fruits and leaves (Coldebella *et al.*,, 2017; Lennon *et al.,* 2018). The seeds of Moringa are used in food, medicine and the production of diesel oil (Anwer *et al.,* 2007; Rashed *et al.,* 2008). Despite the popular use of moringa plant leaves and seeds for medicinal treatment there is limited data available regarding to agricultural treatments. The leaves are also rich source of essential amino acids such as methionine, cystine, trytophan and lysine with a high content of protein (Metha *et al.,* 2003). (Adenekan, 2013) found that some

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different pests attacking drumsticks tree and it is also used for insect control. The Mediterranean flour moth, *Ephestia kuehniella* and *Tribolium castaneum* are a native of Egypt. Gunny bags are commonly used in handling and store of grains, flour and grain products. Storage losses of different materials, stored in gunny sacks reached around 65 to 70% due to insect infestations (Singh and Ghabal 1975; Matter *et al.,* 2008; Abd El-Salam *et al.,* 2019). Though insecticides impregnated sacks could provide satisfactory protection for packaged food materials (Highland *et al.,* 1984), their use would carry many hazards since the protected matter is human diet. The idea of using bio-agents as a safe alternate for sack treatments was previously attempted by many authors (Matter *et al.,* 1990& Salem, *et al.,* 2007). Treating surface of gunny sacks or mixed the powder of the test materials is one the method for controlling the insects. Many researches confirmed on found the lectins in moringa seeds and others plants. Plants containing lectin were found to have different effects on the different stages of many orders insects such as Coleoptera, Lepidoptera and others that diminish crop production (Eisemann *et al.,* 1994; Santo *et al.,* 2008; Katre *et al.,* 2009; Boleti *et al.,* 2009; Ramalho de Oliveira *et al.,* 2011; Hamshou *et al.,* 2012,2013,2014; Walski *et al.,* 2014). The aim of this study was to evaluate the repellent activity of the different part moringa (leaves, flowers, stems and seeds), as powder to explore the protective capacity and the term protection of gunny sacks contain some products (flour and wheat grains) treated with moringa powder.

Materials and Methods

Residues of remains meal food materials left in mills, stores or stored gunny bags, currently used in packing grains and grain products are the main breeding sites and source of the store pests, *E. kuehniella* and *T. castaneum.* The samples were collected from old mills and kept in glass vials till adult emergence. The adults of both species were used in raising two laboratory colonies. Adults representing the progeny of F2 and succeeding generations were used in the experimental studies. The flour and wheat grains were purchased from the local market and maintained in refrigerator at 2.0 ºC for week before the use in the storage experiments to kill any pest.

Storage experimental

Gunny sacks 30x30 cm. were made to simulate the traditional one, which use normally for these purposes. Gunny sack was filled with kilogram wheat grains for *T. castaneum* or wheat flour for *E. kuehniella*. Moringa leaves, flower, stem bark and seeds fine powder was prepared for treatment as dusty application. Handle mini duster (50 gm capacity, made in Japan, Taki company) was used in treated the sacks. Ten gram of leaves, flower, bark or seeds fine powder was dust the gunny sacks by the duster. The repellent effect of the tested materials against *E. kuehniella* & *T. castaneum* was studied. Three storage periods of 1, 2 and 3 months were tested. At each interval and for each tested materials, as well as the check, 20 sacks in three groups were represented 3 periods for each insect (represented 5 replicates), were transferred to a small experimental room simulating the normal store conditions (27.0 ± 2.0 ºC and 40.0± 5.0 % R.H.). The gunny sacks previously filled with flour or wheat grain were left open till allow the insect to enter the sacks. 150 pairs of newly emerged of the moths and / or the Red flour beetle were released in the experimental room. The place of the experiments was tightly closed for 1,2 and 3 months. Monthly, the gunny sacks group removed from the storage of *E. kuehniella* & *T. castaneum* for inspection. At the same previous technique, another sacks group untreated was used for *E. kuehniella* & *T. castaneum* as control.

Evaluation of the weight loss and the materials

For each sack sample, the weight was recorded before sieving off the insects. Sieves 40 meshes (0.41 mm aperture standard) were used to separate the insects and wheat grains for *T. castaneum*. Then the undamaged and damaged grains were counted and weighted. As for, *E. kuehniella* adults were counted and the clean flour weighted as undamaged which was isolated by sieves. The insect counts per kilogram were counted for each sack sample. Grain moisture content was measured using a pre-calibrated Grain Pro moisture meter (model GMK-303CF, GrainPro Inc, Philippines). Damaged and undamaged grains were separated by sieves and weighted.

Grain weight loss was calculated using the count and weigh assessment method (Equation (1):

The weight loss of the stores was calculated by use the equation of (Boxal 1986).

$$\text{Weight loss \%} = \frac{\text{Wd}}{\text{Wd} + \text{Wud}} \times 100$$

Where Wd = weight of damaged grains or flour in a sample, Wud = weight of undamaged grains or flour in a sample.

The repellent effect was calculated by equation of Lundgren, 1975 (2):

$$\text{Repellent effect} = \frac{C - T}{C + T} \times 100$$

Where, C= Weight loss in untreated & T= Weight loss in treated

Statistical Analysis

Analysis of variance between treatments was carried out in every time interval and when F value was significant L.S.D. was calculated by SPSS, V 16.

Results

Ephestia kuehniella

Moringa plant powders were found to have repellent effect on the adult stage of the two main pests in the stores on flour sacks after the different periods studied 1,2 and 3 months for the different of powder sources (leaves, flowers, stem bark and seeds) (Table 1). The results recorded in table 1 revealed that the seeds powder of moringa plant was more repellent effect followed by flower, leaves and the stem bark powder was the least effect. Seeds powder was more repellent than the other powders to achieved 87.17, 85.8 and 64.2% repellent effects after 1, 2 and 3 storage months, respectively. The noticed that the repellent effect was decreased with increased the storage periods. As for flower powder was median effect to achieved 69.76, 55.73 and 53.2% repellent effect after 1, 2 and 3 storage periods, respectively. The leaves and stem bark powders were weakly effect and did not achieved the completely protection against *Ephestia kuehniella* adults. There are significant differences to found between treatments and untreated. The results illustrated in Fig. 1 revealed that the sacks treated with seeds powder was more protecting to flour against *E. kuehniella* infestation. However, the percentage of weight loss in the storage flour reached 0.04, 1.13 and 1.56% after 1, 2, 3 months storage, respectively. While, the percentage of weight loss recorded 15.96, 20.96 and 28.92% in the untreated sacks after 1, 2 and 3 months storage, respectively. Flowers powder came in second place, where the percentage of weight loss for the treated sacks to 0.52, 3.36 and 5.52% after the same periods of storage. The sacks treated with leaves and stem bark powders gave had produced good results but needs other additives to increase its effectiveness as an insect repellent and in the near future will be considered.

Tribolium castaneum

The results obtained in table 2 revealed that the weevils exposed to wheat grains sacks treated with moringa plant powders. Seeds powder was the best repellent effect followed by leaves; flower and stem bark was the lowest effect. The sacks treated with seeds powder achieved protection to wheat grains reached 76.15, 72.4 and 63.4% repellent effects after 1, 2 and 3 months storage, respectively. The leaves and stem bark showed to median effect against *Tribolium castaneum* adults. The results that the efficiency of the moringa powders decreased with increased the storage periods. Also, the sacks treated with seeds powder achieved the lowest percentage of weight loss in grain reached 0.2, 0.4 and 1.2 % after 1, 2 and 3 months storage, respectively. While, the untreated sacks reached the percentage of weight loss to 15.96, 20.96 and 28.92 % after the storage periods (Fig.1). The results were significant between all different treatments and untreated.

Results indicated that the powder of *M. oleifera* seeds showed potentials in the control of the two main pests of wheat grains and flour in the stores. The botanical activities of the moringa plant powders for the control of stored insect pests merit further scientific investigation.

Discussion

The residual activity of seed powders was found significantly effective within the first two months storage, while flower powders had a powerful repellent (Matter *et al.*, 1993). His indicated that the persistence of protection in rather related to seed powder. However, satisfactory results with seed powders could be explained in the light of previous studies describing certain detrimental biological properties of seed powder. It is suggested that seed powder treatment caused rejection of preferable oviposion sites as gunny sacks packed with flour and consequently lower the frequency or prevent oviposion. Meanwhile, full grown larvae coming out sacks to pupate on the outer surface are vulnerable to seeds toxicity. However, the present studies indicated that on feeding *T. castaneum* larvae on seeds treated flour, growth disruption in terms of reduced number of survivors and rate of growth, was significantly evaluated on commencement with pupal formatting. This was in agreement with (Pereira and Wohlgenuth 1982). Thus the results indicated the seeds powder was the highest as repellent effect and protection from *Ephestia kuehniella* and *Tribolium castaneum* adults infestations. The moringa seeds powder is a promise plant in controlling the stored products insects. Irikannu *et al.*, (2015) determined the insecticidal activities of *M. oleifera* seed oil extract against *Tribolium castaneum* and *Tribolium confusum* on milled maize. The authors found that direct application against *T. castaneum* and *T. confusum* achieved LD_{50} values, 1.78 and 1.67 μl/ml, respectively.

Table 1: Repellent effect of different moringa plant powders against *E. kuehniella* in store.

Moringa powders	Storage periods at indicated by month ±SE					
	1st		2nd		3rd	
	Avg. No. adults	%repellent	Avg.No. adults	%repellent	Avg.No. adults	%repellent
Leaves	12.0±0.7c	34.46	26.4±1.2b	31.25	30.4±2.18c	24.75
Stem park	15.2±1.49b	31.53	30.0±3.1b	13.54	41.4±2.89b	9.8
Flowers	5.2±0.48d	69.76	11.2±1.5c	55.73	15.4±2.6d	53.2
Seeds	2.0±0.7e	87.17	3.0±0.4d	85.8	11.0±1.5d	64.2
Control	29.2±1.01a	....	39.4±3.8a	....	50.4±2.9a	....
F	124.37*	....	37.53*	....	50.8*	....
$LSD_{0.5}$	2.8	....	7.07	....	6.92	....

Means within columns followed by the same letter are not significantly different.

Table 2: Repellent effect of different moringa plant powders against *T. castaneum* in store.

Moringa powders	Storage periods at indicated by month ±SE					
	1st		2nd		3rd	
	Avg. No. adults	%repellent	Avg.No. adults	%repellent	Avg.No. adults	%repellent
Leaves	5.0±0.6c	68.35	8.0±1.14cd	59.18	13.2±1.39cd	50.6
Stem park	13.0±1.7b	34.34	17.4±3.6b	28.4	24.4±2.42b	24.5
Flowers	8.0±1.58c	53.75	13.2±1.39bc	40.54	17.2±1.2bc	40.1
Seeds	3.6±0.5c	76.15	5.0±1.14d	72.4	9.0±1.48d	63.4
Control	26.6±2.35a	....	31.2±2.76a	....	40.2±4.67a	....
F	35.47*	....	21.28*	....	21.85*	....
$LSD_{0.5}$	4.6	....	6.65	....	7.72	....

Means within columns followed by the same letter are not significantly different.

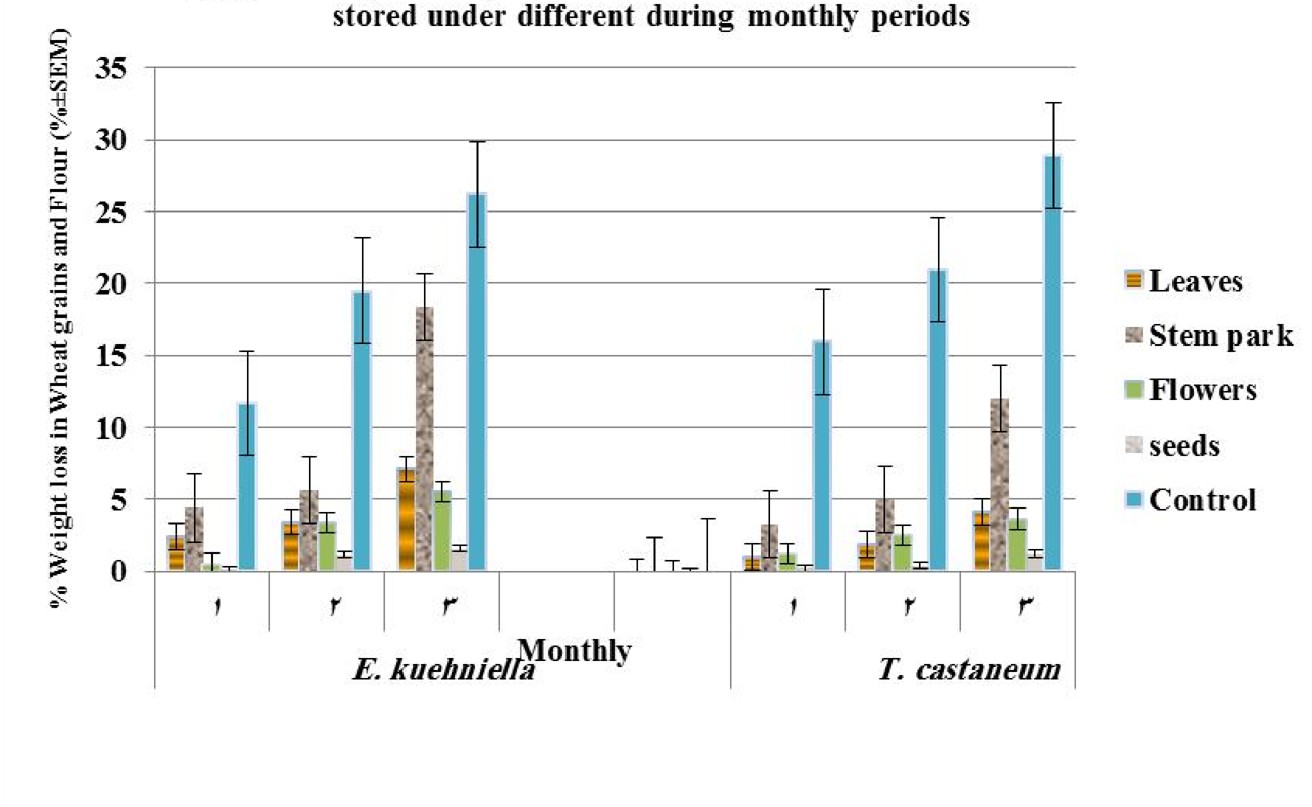

Fig. (1) % Weight loss (% ± SEM) recorded in Wheat grains and Flour stored under different during monthly periods

Abd El-Salam *et al.,* (2019) tested volatile toxicity of *O. basilicum* and *E. globules* oils against sawtoothed beetle, *O. surinamensis*. The results indicated that *O. basilicum* was highly toxic than *E. globulus*. Also, in storage experimental, *Ocimum basilicum* protects dry dates for 3 months from Surinam beetle infestation. Ojiako *et al.,*(2013) found that the seeds from plots sprayed with Actellic had least weevil perforation index (WPI) average of 17.76 %. This was followed by those sprayed with Moringa seed extract (42.10 %). Seeds from plots sprayed with Moringa root extract recorded 58.87 % WPI (Weevil perforation Index) for *Callosobruchus maculatus*. The efficacy of the treatments was dose related. 100 % of the untreated seeds were perforated. Walski *et al.,* (2014) stated that the plants containing lectin attracted attention because of their annihilation and biological effects on insects, but the method of doing these substances has not been studied during the previous decades.

Recently, the toxic and biological effects of three lectins, *Rhizoctonia solani* agglutinin and *Sambucus nigra* agglutinin I & II against aphids (field insect) and *Tribolium castaneum* (stored insect) have been studied. The authors found that all three lectins were toxic against the *T. castaneum* cell line. Larvae feeding on diets containing 2.0% from any previous lectins for 16 day lead to weighed loss of *T. castaneum* larvae and dead. The authors found that the lectins substance were stable in the larval gut and passed through the PM and stopped the activity of digestive enzymes in the gut of the insect.

The negative effects of water-soluble lectin from *Moringa oleifera* seeds on *Anagasta kuehniella* development were studied and found that the chitin-binding lectin impaired the larval weight gain by 50% and affected the activity of the pest's major digestive enzymes (Eisemann *et al.,*, 1994; Ramalho de Oliveira *et al.,*, 2011&2017). Based on their molecular dimension and charge, certain lectins can permeate the PM pores (Walski *et al.,*, 2014), interacting with cell surface structures, and triggering a series of biological effects (Fitches *et al.,* 2010; Hamshou *et al.,* 2012; Tajne *et al.,* 2014; Carrière *et al.,*, 2016). Gatehouse, (2011) stated that evolution of insect resistance with the use of proteins in controlling insects has slow down on the long-term (Wang and Granados 2001; Fitches *et al.,* 2002, 2004, 2010). Also, the combination of lectin with baculovirus or *Bacillus thuringiensis* (Bt) strains should be encouraged (Li *et al.,* 2003; Mitsuhashi *et al.,* 2014). The results confirmed that moringa seeds powder were very good in protecting grains and its products from insect infestation in the store.

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