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Efficacy of *two plants* leaves powders on adults of *Tribolium confusum* (*Coleoptera: Tenebrionidae*) and *Sitophilus zeamais* (Coleoptera: Curculionidae)

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ABSTRACT

This study was conducted to investigate insecticidal potency of two plants leaves powder including *Moringa oleifera*, (Moringaceae) and *Trianthema portulacastrum* (Aizoaceae) against the adults of maize weevil (*Sitophilus zeamais*) and the confused flour beetle *Tribolium confusum* on wheat grains. The powders were incorporated into 20 g of wheat grains assessed in term of mean mortality percent. Mortality of *S. zeamais* and *T. confusum* depended on the plant powder concentrations and exposure time. It can be concluded that adults of *S. zeamais* were more susceptible than *T. confusum* to the two leaves powders. The results showed that 100% mortality of *S. zeamais* was observed when treated with concentrations (5, 10 and 25 w/w) of *M. oleifera* after the 6th day of treatment with LC_{50} equals 1.2 w/w and at concentration 2.5 w/w reached 91.67 % during the same period of exposure. On the other hand, mortality of *T. confusum* was 46.33% at the highest concentration (25 w/w) after the tenth day of treatment. In addition, the results concluded that *T. portulacastrum* was more toxic on *S. zeamais than T. confusum.* Mortality of *S. zeamais* was 100% when treated with *T. portulacastrum* after the 6th day of treatment with LC_{50} equals 2.4 w/w at the highest concentration (25 w/w) and it was 96.66, 70.0 and 61.67 % at concentrations 10, 5 and 2.5 w/w, respectively. While fifty six percent of mortality was observed on *T. confusum* at the highest concentration after 10 days post treatment.

Key words: *Moringa oleifera, Sitophilus zeamais, Tribolium confusum, Trianthema portulacastrum.*

INTRODUCTION

The major cereal grains Wheat is infested by various insect pests between harvest and storage. The most economically important insect pest of stored wheat is maize weevil, *S. zeamais* (Motschulsky) (Coleoptera: Curculionidae) it is a major pest of stored maize grains in the tropics and temperate regions of the world (Adedire and Lajide 2003). Also, the most widespread and destructive major insect pest of stored cereals throughout the world is *T. confusum* (Coleoptera: Tenebrionidae).

The problems of many synthetic insecticides which include high persistence, poor knowledge of application, increasing costs of application, pest resurgence, genetic resistance by the insect and lethal effects on non-target organisms in addition to direct toxicity to users (Akinkurolere *et al*., 2006; Oni and Ileke, 2008). To minimize use of pesticides and to avoid pollution of the environment, currently attention is being given to the use of edible plant materials as grain protectants (Adedire and Lajide, 2003; Akinkurolere *et al*., 2006; Adedire *et al*., 2011) Botanical insecticides are good alternatives to chemical insecticides and proved their efficiency to control insect pests (Rehman *et al*., 2009).

M. oleifera, commonly called "Miracle" Plant belongs to a monogeneric family of shrubs and trees, Moringaceae and is considered to have its origin in North West region of India (Faizi *et al*., 1999). This plant has many potential uses both in agriculture and industries. Moringa benefits are quite plentiful, and these are clearly evident in its exceptional nutritional values and remarkable medicinal property (Faidi *et al.*, 2001). The pulverized leaves of moringa have been found to be effective against storage pest like *Tribolium castaneum* (Anita *et al*., 2012). *M. oleifera* powder was found to have insecticidal effects on the oviposition, eclosion and development of bruchid beetles on cowpea seed (Adenekan *et al*., 2013).

Trianthema portulacastrum belonging to the family Aizoaceae, is one of the common weed, which has enormo *Moringa oleifera,* also traditional uses against diseases and some bioactive compounds have been isolated from this weed. Phytochemical constituents in the various parts of the plant are very significant. The methanolic extract was screened for the presence of various phyto-constituents such as steroids, alkaloids, terpenoids, glycosides, flavonoids, phenolic compounds, and carbohydrates (Shanmugam *et al*., 2007). There were significant antifeedant activities of *Trianthema portulacastrum* against *Spodoptera lituralis* protecting the leaves from larval feeding (Nelson *et al*., 2006).

M. oleifera, and *T. portulacastrum,* had not been evaluated in Egypt for controlling insect pest during storage. The availability of these plants, their non-toxicity to man or other mammals, the fact that they are eco-friendly, their medicinal value and their potential as bio-pesticides make them candidates for upgrading traditional post-harvest protection practices; this led to the present study to evaluate the efficacy of two leaves powders *M. oleifera* and *T. portulacastrum* against *S. Zeamais* and *T. confusum* adults.

MATERIALS AND METHODS

Insect culture

Adults of *S. zeamais* and *Tribolium Confusum* used for this study were obtained from already existing culture in the Laboratory of the Department of Entomology, Faculty of science, Benha University. Twenty adults of both *S. zeamais and T. confusum*, were put in glass jars each containing 20g of wheat grains and covered with muslin cloth which tight with rubber

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bands. The jars were placed in an insect rearing cage at ambient temperature of 28.0±3.0°C and 70.0±5.0% relative humidity.

Plant materials

The plant materials used in this study were leaves of *M. oleifera* and *T. portulacastrum* plants. The two mentioned leaves were washed with rinsed water, shade dried and well grounded to a fine powder with an electric blender to ease the extraction of active compounds. The plants were used in pulverized form as the powders contain complex chemicals which may show overall bioactivity when compared to isolated plant constituents by extraction or other methods (Baki *et al*., 2005). Also, insecticidal property of any plant material would depend on the active constituents of the plant material (Asawalam *et al*., 2007).

Insect bioassay

Portions of 0.5, 1.0, 2.0 and 5.0 g of each plants leaves powder corresponding to 2.5, 5.0, 10.0 and 25.0 w/w. Concentrations were weighed and each added to a 20 g of clean and uninfected wheat grains in glass jars. The grains in the control groups contained no plants powder. Jars with their contents were gently shaken to ensure thorough admixture of the wheat grains and treatment powders. Twenty adults of both *S. zeamais* and *T. confusum* were introduced to each jar and covered with muslin cloth and tight with rubber bands. Three replicates of the treatments and untreated controls (prepared without any leaves powders) maintained under the same experimental conditions. The adult mortality was assessed daily by counting the dead adults. Statistical analysis: Data were subjected to one way ANOVA test using SPSS program version 21, the values of mean percentage mortality and their stander error (SE) were calculated.

Moreover, the obtained results were analyzed according to the method adopted by Finney (1952) to determine the LC_{50}, correlation coefficient (R^2) and slop.

RESULTS AND DISCUSSIONS

Botanical source insecticides may serve as alternatives to popularly used synthetic chemical insecticides as many of them have often been used against a number of species of stored products insect pests, including Coleoptera and Lepidoptera (Nathan *et al*., 2007). Figs. (1 and 2) showed the effect of leaves powder of *M. oleifera* on mortality of both *S. zeamais* (MS) *and T. confusum* (MT) adults with error bar. Fig. (1) illustrates the mortality of *S. zeamais* treated with *M. oleifera* reached 81.66% in the 4th day at concentration 25.0 w/w.

These results disagree by the finding of Ileke and Oni, (2011), who evaluated the toxic effects of four plants powders including *Azadirachta indica, Alstonia boonei, Garcina kola* and *Moringa oleifera* on the mortality adults of maize weevil (*S. zeamais*). They concluded that *Moringa oleifera* was the least toxic causing 59.45% adult mortality after 96 hours (4th day) of exposure at concentration (25.0 w/w). These results also disagree with Kayode and Olaniyi, (2014) they reported that the powder of *M. oleifera* was less potent on the three tested insects, *Sitophilus oryzae* (L), *Oryzaephilus Mercator* (Faur) and *Ryzopertha dominica* (Faur), mortality ranged between 30.00 to 72.24% at all the used concentrations (2%, 4%, 6% and 8%). The powders of *Moringa olifera* at concentrations 5.0%, 10.0% and 25.0% w/w were able to cause complete mortality (100%) of *S. zeamais* after six days of exposure, while the lowest concentration 2.5 w/w caused 91.67% mortality at the same period of exposure.

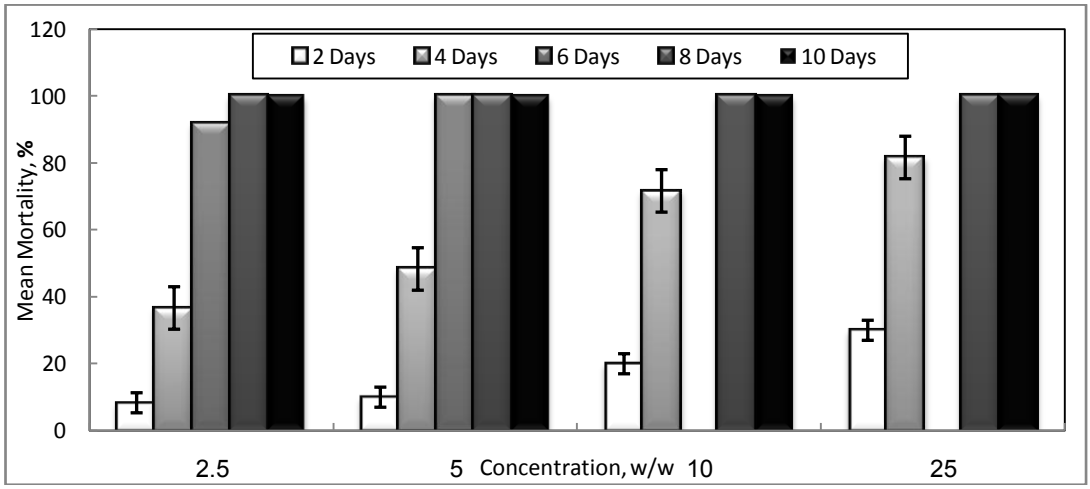
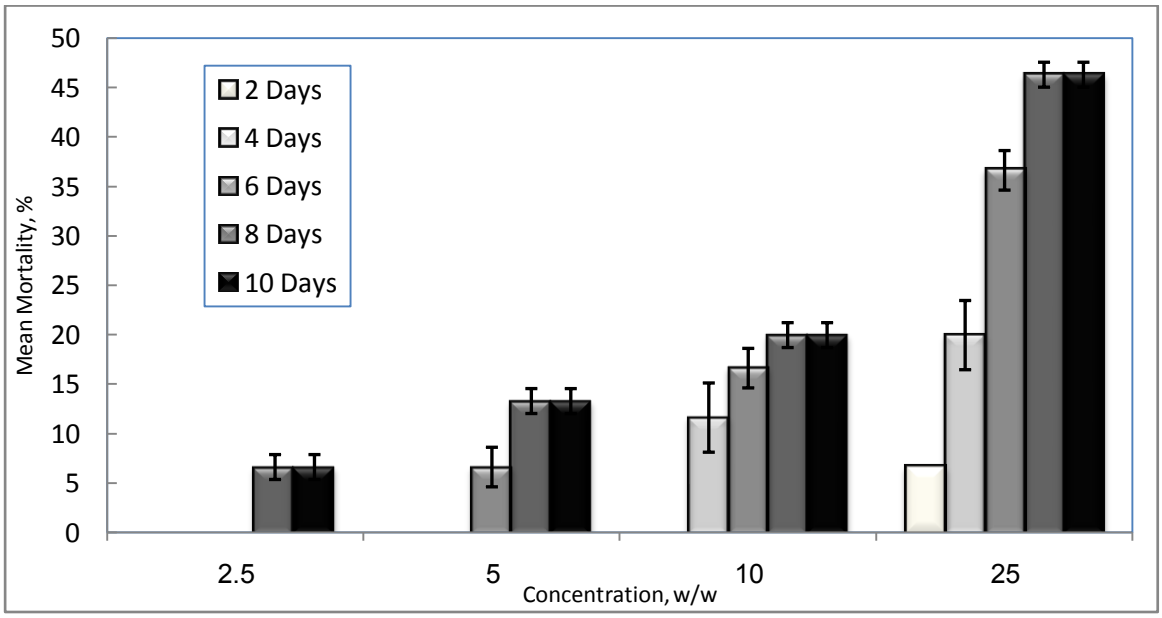


Figure (1): The mean mortality % of Sitophilus zeamais treated with different concentrations (w/w) of Moringa oleifera leaves powder.



Figure(2): The mean mortality % of Tribolium confusum treated with different concentrations (w/w) of Moringa oleifera leaves powder.

The high mortalities of *S. zeamais* adults were observed on wheat grains treated with *M. olifera* powders may be due to high toxic effect of the moringa on *S. zeamais* adult. This toxicity has been attributed to the presence of many chemical ingredients such as some alkaloids allied to ephedrine – benzylamine (moringine), spirachin (a nerve paralyzed) and the potent antibiotic and fungicide, pterygospermin (Panchall *et al.*, 2012). According to Madukwe *et al*., (2012), they reported that *Moringa oleifera* contains alkaloids, flavonoids, anthocyanins and cinnamates. Also, Kasolo *et al.*, (2011) stated that *M. oleifera*, ether, ethanol and aqueous extracts contain gallic, tannins, steroids and triterponoids, anthraxquinones, catechol, tennins, saponins and alkaloids.

On the other hand, there was lower mortality (46.33%) of *T. confusum* was obtained when grains treated with *M. olifera* at the highest concentration (25.0w/w) and 10 days of exposure (Fig. 2). No mortality was recorded on the control test. This result justified by Ashfaq *et al.*, (2012) who found that the powder of *M. oleifera* leaves was effective against adults of *Trogoderma granarium* and showed repellent properties. While these results disagree with Anita *et al*., 2012 who have been found the pulverized leaves of moringa to be effective against storage pest like *Tribolium castaneum*. The effects of leaves powder of *T. portulacastrum* on mortality of both *S. zeamais* (RS) *and T. confusum* (RT) adults with error bar are shown in (Figs. 3 and 4).

The results showed that leaves powder of *T. portulacastrum* caused 100% mortality on *S. zeamais* at concentrations (10 and 25 w/w) after seven and six days of exposure respectively. The reminder concentrations caused 100% mortality after ten days (Fig. 3). When *T. portulacastrum* was assessed on *T. confusum* at the highest concentration (25 w/w) after the 10th day post treatment the mortality reached 56% as shown in (Fig. 4). No mortality was recorded on the control test. This toxic action of *T. portulacastrum* might be related to the potent content reported by Manoj *et al*., (2012). They revealed that the *Trianthema portulacastrum* is one of the species which contain tetraterpenoid 1 (Trianthenol) as an oil, and the presence of steroids, flavonoid, fats, terpenes, carbohydrates, tannins and alkaloids trianthemine. Muhammad *et al.*, (2013) found that *T. portulacastrum* significantly affected the nymphal mortality, life span and duration of 1st, 2nd and 3rd instars of cotton bug *Phenacoccus solenopsis* due to its constituents. They revealed that the *Trianthema portulacastrum* is one of the species which contain tetraterpenoid 1 (Trianthenol) as an oil, and the presence of steroids, flavonoid, fats, terpenes, carbohydrates, tannins and alkaloids trianthemine. Muhammad *et al.*, (2013) found that *T. portulacastrum* significantly affected the nymphal mortality, life span and duration of 1st, 2nd and 3rd instars of cotton bug *Phenacoccus solenopsis* due to its constituents.

Figure (5) illustrates the comparison between the effect of two leaves powders *M. oleifera* and *T. portulacastrum* on mortality with error bar of both insects *S. zeamais and T. confusum* adults. From this figure it is noticed that *M. olefeira* caused complete mortality (100%) on *S. zeamais* (MS) at the highest concentration (25.0 w/w) with LC_{50}=1.2 after six days of exposure, while causing 36.66% mortality on *T. confusum* (MT) at the same concentration and time of exposure with LC_{50} = 47.86, (Table 1). After ten days from exposure the mortality reaches 46.33% only for *T. confusum* at the highest concentration. From this finding it can be concluded that the leaves powder of *M.*

oleifera was more toxic on *S. zeamais* than *T. confusum*. Ojo *et al*., (2013) observed that the treatments of the *moringa* leaves powder had high potency of insecticidal properties against *Callosobruchus maculatus*. The insect mortality of *Callosobruchus maculatus* increased with increasing application rate or dosage of moringa. The percentage of mortality obtained at 2.0/20g seeds application dosage was 89.17% at the 6th day and 92% at the 7th day. These observations were agreed with earlier study of Anita *et al*., (2012) which reported 100% mortality of *Callosobruchus maculatus* by application rate of 2.0g/10g wheat at 9th day in grains treated with pulverized leaves of moringa. Table (1) illustrates the comparison between the effects of *M. oleifera* leaves powder *on S. zeamais and T. confusum*. It's noticed that for all exposure times the values of LC_{50} for *S. zeamais* were lower than that of *T. confusum*. Also, the obtained values of the slops for *S. zeamais*, were higher than that for *T. confusum* which indicated that *S. zeamais* is more susceptible to *M. oleifera* than *T. confusum.*

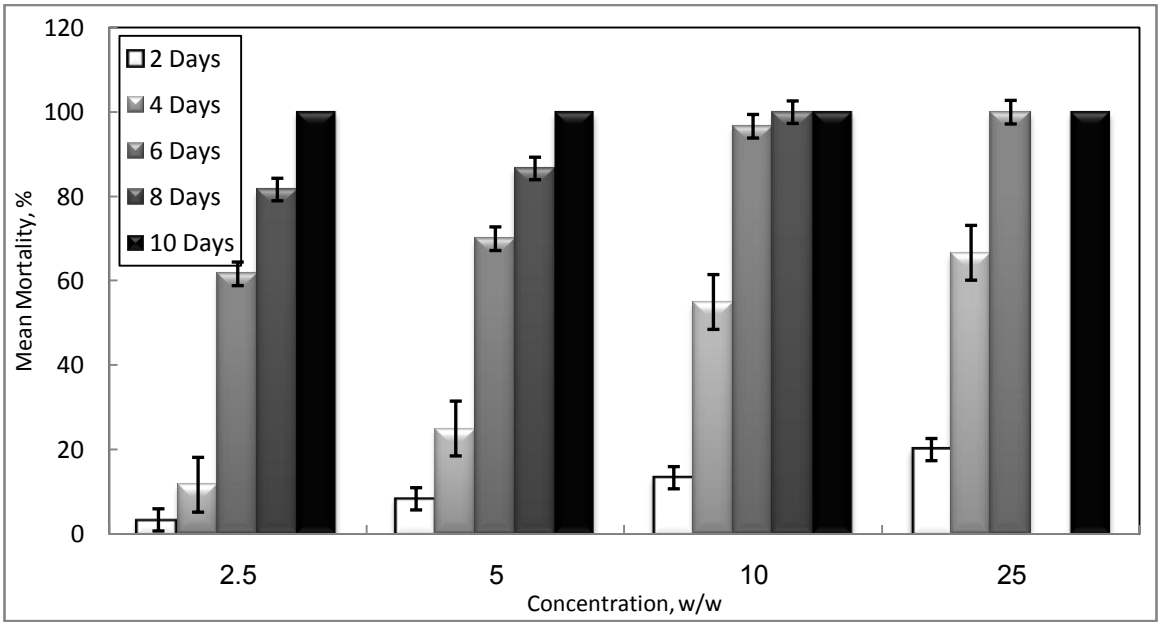


Figure (3): The mean mortality % of *Sitophilus zeamais* treated with different concentrations (w/w) of *Trianthema Portulacastrum* leaves powder.

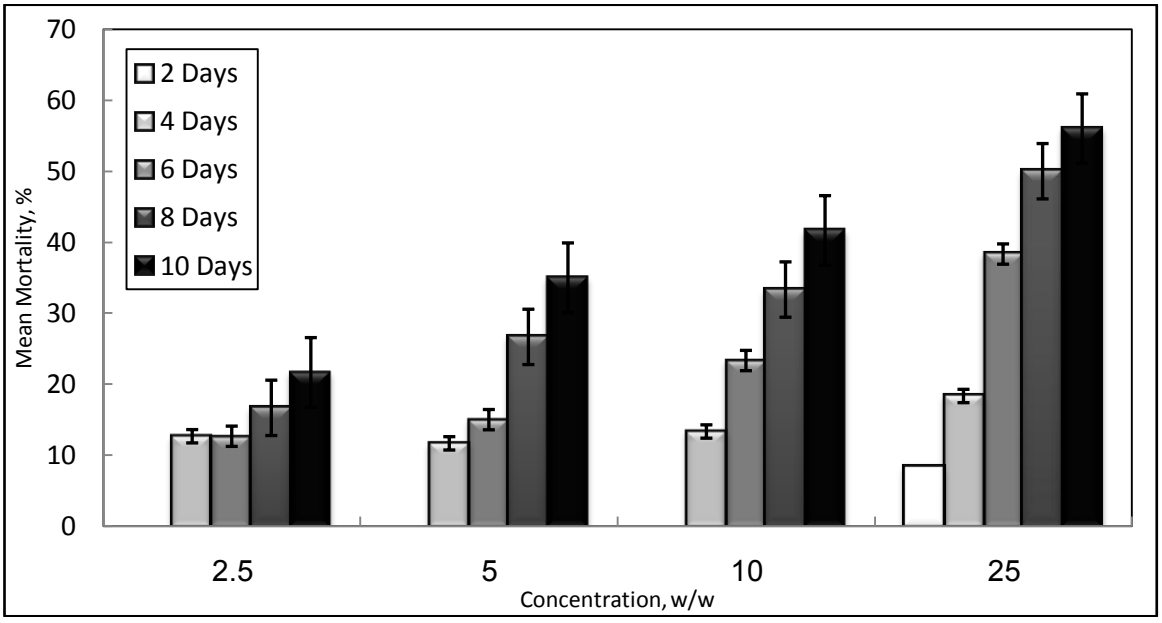


Figure (4): The mean mortality % of *Tribolium confusum* treated with different concentrations (w/ w) of *Trianthema Portulacastrum* leaves powder.

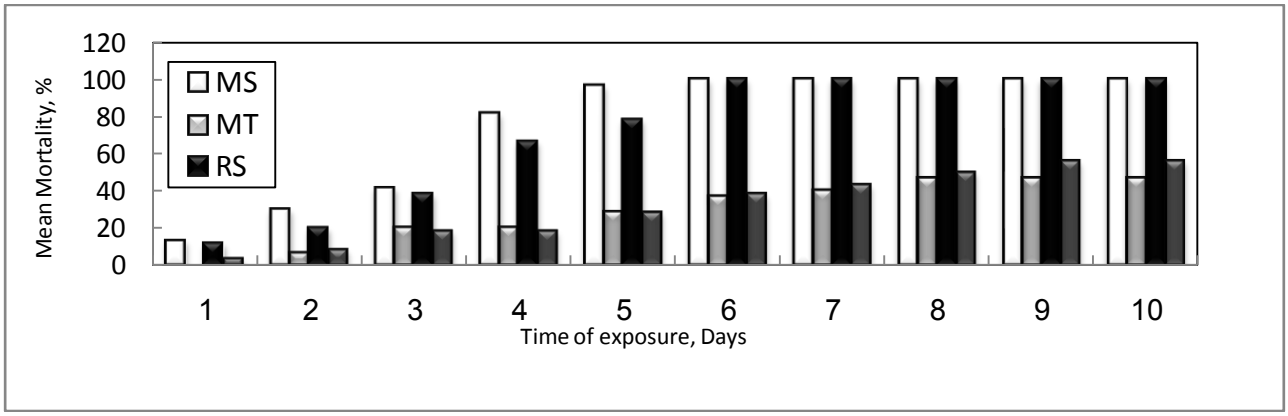


Figure: (5): The comparison between mean mortality% of the two plants powders *Moringa oleifera* (M.) and *Trianthema Portulacastrum* (R.) on two insects *Sitophilus zeamaiz* (S.) and *Tribolium confusum* (T.) at concentration 25 (w/w).

Table (1): The values of LC_{50}, correlation coefficient (R^2) and slop of *Moring oleifera* against *Sitophilus zeamais* and *Tribolium confusum.*

Factor	*Sitophilus zeamais*					*Tribolium confusum*				
	Days					Days				
	2nd	4th	6th	8th	10th	2nd	4th	6th	8th	10th
LC_{50}, (w/w)	70.8	5.01	1.2	-	-	125.9	112.2	47.86	31.62	31.62
R^2	0.94	0.80	1	-	-	-	0.903	0.992	0.99	0.99
Slop	0.97	1.84	3.33	-	-	-	0.89	1.46	1.72	1.72

Table (2) illustrates, also, the comparison between the effects of *T. portulacastrum* leaves powder *on S. zeamais and T. confusum*. It's noticed that for all exposure times the values of LC_{50} for *S. zeamais* were lower than that of *T. confusum*. Also, the obtained values of the slops for *S. zeamais*, were higher than that for *T. confusum* which indicated that *S. zeamais* is more susceptible to *T. portulacastrum* than *T. confusum.* Statistical analysis showed all concentration of *M. oleifera a*nd *T. portulacastrum* leaves powders had significant effect at ($P \leq 0.05$) on adult mortalities of S. zeamais and *T. confusum* in compared to the untreated control. From the previous results it is found that both leaves powders of *M. olefeira* and *T. portulacastrum* more effective on *S. zeamais* than *T. confusum*. This may be due to *Tribolium confusum* was less sensitive to powders than *S. zeamais* or attributed to finding of Fang *et al., (*2002) they indicated that *Tribolium* sp. are classified among the least susceptible stored-product insect pests and often more difficult to kill than other stored product beetles, though the order of toxicity will often vary depending on the particular insecticide.

The mode of action of high mortality effects could be as result of these botanical powders coating the treated wheat grains which prevented contact between the grains and the weevils. Starvation could be due to the inability of the insects to feed on the wheat grains that has been coated with these botanicals, thereby leading to their starvation. This explanation justified with the previous studies in which powders and oils of *Azdirachta indica, Zanthoxylum. zanthoxyloides, A. occidentale* and *M. oleifera* have been used as protectant against different storage insects (Ileke and Oni, 2011; Akinneye and Ogungbite, 2013).

Table (2): The values of LC_{50}, correlation coefficient (R^2) and slop of *Trianthema portulacastrum* against *Sitophilus zeamais* and *Tribolium confusum.*

Factor	*Sitophilus zeamais*					*Tribolium confusum*				
	Days					Days				
	2nd	4th	6th	8th	10th	2nd	4th	6th	8th	10th
LC_{50}, (w/w)	122.4	10	2.4	1.26	-	-	63.10	25.12	25.12	39.81
R^2	0.91	0.79	0.69	0.99	-	-	0.93	0.98	0.95	0.88
Slop	0.67	2.26	1.58	2.48	-	-	0.28	1.15	1.35	1.33

Conclusion

In conclusion, the plants leaves powders investigated in this study could have practical application in protection of stored grains against *S. zeamais* than *T. confusum,* attack by incorporating them in pest management tactics. More studies are required on these all parts of the two plant species to elucidate their active ingredients, identification and isolation which might suggest their inclusion in pest management of stored product insects.

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تقييم فاعلية مسحوق أوراق نباتين على حشرتي سوسة الذرة وسوسةالدقيق

الملخص العربى

أجريت هذه الدراسة للتحقق من فاعلية وسمية مسحوق ى أوراق نباتى المورينغا (*Moringa oleifera*) والرجلة الأفرنجي (*Trianthema portulacastrum*) ضد البالغين من حشرة سوسة الذرة (*Sitophilus zeamais*) وسوسة الدقيق (*Tribolium confusum*). وتم خلط كل مسحوق مع 20 غراماً من حبوب القمح بتركيزات 2.5, 5, 10 and 25 w/w لتقييم النسبة المئوية للوفيات لكل من الحشرتين حيث وجد أن النسبة المئوية للوفيات تتوقف على تركيزات مسحوق النبات وكذلك على مدة التعرض له. ويمكن أن نخلص إلى أن البالغين من حشرة *S. zeamais* كانوا أكثر حساسية من حشرة *T. confusum* للمسحوقين النباتيين. كما أظهرت النتائج أن النسبة المئوية للوفيات فى حشرة *S. zeamais* بلغت 100% عند التركيزات 5, 10 and 25 w/w وبلغت 91.67٪ عند تركيز 2.5 w/w من مسحوق أوراق المورينغا بعد اليوم السادس من المعاملة. بينما بلغت نسبة الوفيات 46.33% لحشرة *T. confusum* بعد اليوم العاشر من المعاملة عند أعلى تركيز (25w/w) من المورينغا.

ومن هذة النتائج نستنتج أن البالغين من حشرة (*S. zeamais*) أكثر حساسية وتأثرا لسمية أوراق مسحوق نبات (*Moringa oleifera*) من حشرة (*T. confusum*).

أظهرت النتائج ايضاً أنه عند معاملة سوسة (*S. zeamais*) بمسحوق أوراق *T. portulacastrum* وصلت نسبة الوفيات للبالغين من الحشرة 100% عند أعلى تركيز (25w/w) وبلغت (61.67, 70.0 and 96.66%) عند تركيزات (2.5, 5 and 10 w/w) من مسحوق أوراق *T. portulacastrum* على التوالي بعد اليوم السادس من المعاملة، في حين بلغت نسبة الوفيات لحشرة *T.confusum* 56% عند أعلى تركيز (25w/w) من مسحوق أوراق *T. portulacastrum* في اليوم العاشر من المعاملة. ومن النتائج السابقة تبين أن النسبة المئوية للوفيات لحشرة (*S. zeamais*) مرتفعة جداً والحشرة أكثر تأثراً لمسحوق أوراق نباتي المورينجا والرجلة الأفرنجي مقارنة بحشرة (*T. confusum*).