

IMPACT OF DIET TREATMENT WITH DILL, ANETHUM GRAVEOLENS AND PARSLEY, PARSLEY (*Apium sativum*.) SEEDS POWDER ON *SITOPHILUS ORYZAE* L AND *Tribolium castaneum* H. POPULATIONS.

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ABSTRACT

Experiments were conducted in the laboratory at $26 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ R. H. to study the effect of adding 2, 4 and 8 % dill, (*Anethum graveolens* L.) and parsley (*Apium sativum*.) seed powders to the diet, on the mortality and population growth of *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst). The recorded results during the period of the first three weeks rearing indicated that, there are relations between the mortality percentages and the concentrations added to the diet from the used two tested powders. By increasing the conc., and exposure period, increased the impact mortality.

Meanwhile the mortality average the value of period from the first to the third month of treatment, revealed that addition of parsley, *Apium* sp. powder to the food of *S. oryzae*, obviously increased the adult mortalities at all concentrations compared with dill powder. But the mortality mean value of *T. castaneum*, recorded during the period from the 7st to 5th month of rearing was greater for the diet at 8% than other treatments and control. However *S. oryzae* was more susceptible to the dill powder than *T. castaneum*. Results concerning addition of the seeds powder of dill and parsley to the diet at 2, 4 and 8 % concentrations showed also marked decline in the adult populations during the first period of rearing of *S. oryzae* compared with *T. castaneum*.

At the same time, *Apium* spp. seed powder gave accepted protection to wheat grains against these insects species up to 6 months.

INTRODUCTION

Dill plant, *Anethum graveolens* L. is one of the Apiacea family. *A. graveolens* is a herb which originated in Europe and was introduced all over the globe by the early part of the 19th century. It was used firstly for culinary and medicinal purposes. *Apium* spp. is also used as a condiment for flavoring salads and sauces (Darwish, 1992 and Halawa, 2003).

Stored product pests are considered as serious pests and cause a great damage to many seeds in the storage (Su, H. C. F., 1984 and 1985).

New compounds with few side effect and less hazardous to man and environment and in mean time have an effect on the development of insects are very desirable. Many plants contain highly toxic materials, which could be extracted and used against insects (El-Lakwah *et al.*, 1999). Such compounds may have less effect in environment and could be used safely to control pests. Using of plant extracts and their powders to control and protect stored product from pests becomes a necessity to reduce and overcome the hazards caused by pesticides and poisonous gases. There have been numerous studies about the uses of plant parts such as leaves, fruits, roots, flower and seeds to control stored product insects (Ivbijaro 1983; Sighamony

et al., 1985; SU 1985; Darwish, 1992; EL-lakwah *et al.*, 1997 and Halawa, 2003).

The present investigation aims to study the effect of treated diet with dill, *Anethum graveolens*, L. and *Apium sativum* seed powders on the populations growth of *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst).

MATERIALS AND METHODS

Source of insects: Laboratory strains of *Tribolium castaneum* H. reared in wheat flour and *Sitophilus oryzae* L. reared on wheat kernels were used in this study.

Experiments were conducted at 26 ± 1 °C and $65 \pm 5\%$ RH. in an incubator condition at the laboratory of Plant Protection Department, Faculty of Agriculture, Moshtohor – Zagazig University.

preprtion of insect feeding media:

Dill, *A. graveolens* seeds contain 3 – 4% volatile oil, (V. O.) containing as carvone from 43 – 63% (Trease and Evans, 1978) and (Evans, 1994).

Parsely, contains 2 to 3% volatile oil and some fixed oil, which contains limonene and about 55% of carvone (Prakish and Rao, 1997). The seeds of dill and *Apium spp.* were bought from the local market, dried at room temperature for two weeks and grinded into fine powder in an electric mill. The powders was mixed with the insects feeding media to give the prober concentration.

Population studies

Adults (7–14 days old) of both insects were used in the experiments. In case of *S. oryzae* three replicates of a 100 gm wheat grain mixed with dill and parsely seed powders to achives concentrations of 2, 4 and 8 gm / 100 gm grains. For *T. castaneum* a 100 gm of crushed wheat grains were also mixed with the above mentioned materials to achieve the same concentrations (2, 4 and 8 g / kg) and placed in 500 ml. jars, three replicates of control experiment were also conducted for both insects. Sixteen adults of *T. castaneum* and *S. oryzae* were taken from the culture and introduced to the jars. Glass jars containing the media and the initial number of the adult insects were kept under controlled condition of 26 ± 1 °C and $65 \pm 5\%$ RH. For 12 and 5 months as shown in the Tables (3 & 4). During that period, the alive and dead adults were counted monthly and recorded.

To investigate the toxic effect of dill and parsely powders on the adults of the two insect species, mortality was assessed after 2, 3, 5, 7, and 14 days. The rate of population growth was calculated according to the following formula (EL – Lakwah *et al.*, 1989) :

$$K = \{(\log N / N_0) / (\log e / t)\}$$

Where K = Rate of growth

N = No. of individuals after a certain times.

T = times

No = Number of the individuals at the beginning (at the time 0 = initial time)

e = Basic of the natural logarithm = 2.7.

- Parsely persistence and weight loss of grain

Persistence of *Apium sativum* powder was conducted after 5 months for treatment and was examined 15,30 and 60 days at 8 and 4% concentration after infected wheat grains.

Weight loss of grain was also estimated 5 month after treatment.

RESULT AND DISCUSSION

1- Toxic effect of the dill, *Anethum graveolens* L. and *Apium sativum* seed powders on the tested insects:

Results concerning the effect of dill, *Anethum graveolens* L. powder treatment on the mortality of *S. oryzae* and *T. castaneum* during the first fourteen days period of rearing are presented in Table (1). Mortality of *S. oryzae* and *T. castaneum* was increased as dill powder concentration increased. At 8% concentration mortalities were 16, 30, 40, 65 & 75% and 5, 5, 20, 29, & 40% at 2, 3, 5, 7, and 14 days for *S. oryzae* and *T. castaneum* respectively. Lowest mortalities were noticed at 0.4 and 0.2% concentration for both insects. Mortalities were 0; & 0 15& 5; 25 & 5, 25 & 15, and 45 & 19 for *S. oryzae* and 0 & 0, 0 & 0, 5 & 3, 17 & 15, 35 & 32 for *T. castaneum* at 4 & 2% concentration after 2, 3, 5, 7 and 17 days respectively. A negligible mortality were achieved for control .

Table (1): Effect of dill, *Anetham graveolens*, seed powder treatment on mortality of *Sitophilus sryzae* and *Tribolium castaneum* H. during the first two weeks of rearing at different concentrations.

Days	Insects	% Adult mortality			
		8%	4%	2%	Control
2	<i>S. oryzae</i>	16 ± 3	0 ± 0	0 ± 0	0 ± 0
	<i>T. castaneum</i>	5 ± 2	0 ± 0	0 ± 0	0 ± 0
3	<i>S. oryzae</i>	30 ± 6	15 ± 5	5 ± 2	0 ± 0
	<i>T. castaneum</i>	15 ± 3	0 ± 0	0 ± 0	0 ± 0
5	<i>S. oryzae</i>	40 ± 4	25 ± 3	5 ± 0	3 ± 0
	<i>T. castaneum</i>	20 ± 5	5 ± 1	3 ± 0.5	0 ± 0
7	<i>S. oryzae</i>	65 ± 5	25 ± 6	15 ± 6	0 ± 0
	<i>T. castaneum</i>	29 ± 3	17 ± 2	15 ± 3	0 ± 0
14	<i>S. oryzae</i>	75 ± 8	45 ± 6	14 ± 7	3.3 ± 1
	<i>T. castaneum</i>	40 ± 6	35 ± 8	32 ± 3	0 ± 0

Table (2): Effect of (*Apium spp.*) powder treatment on mortality of *Sitphilus oryzae* and *Tribolium castaneum* during the first two weeks of rearing at different concentrations.

Days	Insects	% Adult mortality			
		8%	4%	2%	Control
2	<i>S. oryzae</i>	19 ± 4	6 ± 3	1 ± 1	0 ± 0
	<i>T. castaneum</i>	16 ± 4	14 ± 6	4 ± 1	0 ± 0
3	<i>S. oryzae</i>	34 ± 4	32 ± 12	21 ± 6	0 ± 0
	<i>T. castaneum</i>	28 ± 10	18 ± 7	10 ± 2	0 ± 0
5	<i>S. oryzae</i>	59 ± 6	46 ± 9	12 ± 4	0 ± 0
	<i>T. castaneum</i>	38 ± 4	31 ± 3	26 ± 6	0 ± 0
7	<i>S. oryzae</i>	80 ± 10	77 ± 13	48 ± 15	2 ± 1
	<i>T. castaneum</i>	48 ± 4	50 ± 0	37 ± 0	6 ± 3
14	<i>S. oryzae</i>	93 ± 9	89 ± 9	81 ± 6	9 ± 1
	<i>T. castaneum</i>	57 ± 5	62 ± 4	60 ± 2	4 ± 2

Toxic effect of *Apium sativum* seed powder treatment on the mortality of *S. oryzae* and *T. castaneum* during the first two week of rearing achieved in Table (2). Similar result was achieved with Chili powder (El-Lakwah *et al.*, 1999). Mortality of *S. oryzae* adults increased as *Apium sativum* powder concentration was increased. Also, mortalities increased with time lapses. After two days from treatment, mortalities were 19, 6 and 1% at 2, 4 and 2% concentration respectively. These values increased to reach 93, 89% and 81% after two weeks from treatment. In case of *T. castaneum*, the highest concentration used (8%) gave moderate mortality value even at 14 days after the last treatment, indicating that the adult of *T. castaneum* were more tolerant to the dill and *A. sativum*, powder than *S. oryzae* adults (Table 1, 2).

It was obvious from the above results that higher concentrations produced higher percentage of mortalities. However *S. oryzae* was more susceptible to the *Apium sativum* powder than *T. castaneum*.

The obtained results are in harmony with the findings of El-Lakwah *et al.*, 1999, who, studied the effect of diet treatment with black pepper seed powder and the populations of *S. oryzae* and *T. castaneum*.

2- influence of dill powder on the tested insect populations.

Table (3) presents the population growth of *S. oryzae* and *T. castaneum* adults at various treatment with dill (*Anethum graveolens*) compared to the control.

2.1. On *S. oryzae* population.

The numbers of alive insects for *S. oryzae* at 8, 4 and 2% concentrations reached their peak after 45, 105 and 105 days (fig. 1), where the numbers were 20, 174 and 1293 at 8, 4 and 2% concentration, respectively, However, the peak of alive insects in case of control was recorded after 90 days as (1720). The dead adults insect peak number was observed after 30, 120, 120 and 120 days for all treatments including control (Fig.1) . The peak numbers were 13.223, 1004 and 617 for 8, 4, 2 and control respectively (Table 3). The number of alive insects declined after 1.5, 3 and 3.5 months in case of all concentration and control. After 4 month from treatment the alive insects number reached 1,52, 11 and 10 for 8, 4, 2% and control respectively. However number of dead adults were 0, 75, 43 and 40 at 8, 4, 2% and control for *S. oryzae*.

The population growth curves of *S. oryzae* adults, reared on the various media (fig. 1) showed following one month of a stationary phase rapid increase from the 1st to the certain time. The recorded maximum numbers of alive adults were 20, 174 and 1293 adults in the treated diet at 8, 4 and 2%, respectively. These values were achieved after 45 and 105 days from starting the experiment, Meanwhile, the population Maximum was 1720 adults for the control and reached after three moths (Table 5).

From the obvious time to 120 days the number of the survival was slightly decreased in the treated diet. On the other hand, during this period the survival number was gradually increased in the control.

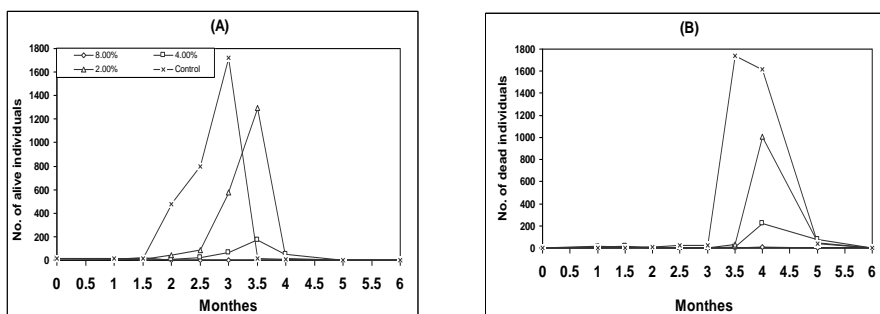


Fig. (1): Alive (A) and dead (B) populations of *S. oryzae* adults after treatment with dill (*Anethum graveolens* L.) seed powder.

Table (3): Population growth of *S. oryzae* and *T. castaneum* adults after treatment with with differnt concentration of dill, *Anethum graveolens* powder.

Month	Alive & dead adults	<i>S. oryzae</i>				<i>T. castaneum</i>			
		concentration			Control	concentration			Control
		8%	4%	2%		8%	4%	2%	
0.0	Alive dead	16 0	16 0	16 0	16 0	16 0	16 0	16 0	
1.0	Alive dead	5 13	13 6	14 3	17 3	15 1	17 1	16 0	18 0
1.5	Alive dead	20 5	2 13	8 7	15 3	25 1	40 2	39 0	18 0
2.0	Alive dead	1 2	7 3	40 4	478 9	344 1	407 2	32 0	276 0
2.5	Alive dead	3 1	20 3	88 2	795 22	404 18	628 18	379 26	373 50
3.0	Alive dead	2 1	67 2	574 3	1720 20	484 9	647 10	443 22	356 14
3.5	Alive dead	3 2	174 6	1293 34	11 1740	565 181	706 172	437 223	397 24
4.0	Alive dead	1 4	52 223	11 1004	10 1617	418 212	601 127	276 108	421 177
5.0	Alive dead	0 0	0 75	0 43	0 40	933 42	503 41	674 31	701 35
6.0	Alive dead	0 0	0 0	0 0	0 0	182 157	337 121	108 74	455 136
7.0	Alive dead					130 58	267 53	90 20	329 62
8.0	Alive dead					89 28	240 44	78 6	310 29
9.0	Alive dead					83 9	202 27	55 2	301 5
10	Alive dead					78 10	176 24	47 9	380 15
11	Alive dead					53 15	139 29	42 6	411 16
12	Alive dead					59 22	118 22	38 14	402 14

The carrying capacity level, recorded during the 1.5th 3.5th month period for the treated media and form the 2^{sc} to 3rd month for the control, was 12, 98, 626, and 842 adults for the media at 8, 4, 2% and the control,

respective., (Table 5) the volutes indicate that the adults population size of the media at 2% was markedly greater than other media.

From the 4th month, the adult population slowed down and reached a lower level after 6 months in the treated and untreated media.

The rapid drop of the pest population during the period from the 4th to 6th month in the various media may be due to the influence of the ecological factors, which affect the population density of the insects, such as food shortage, over crowding effect.

Table (4): Population growth of *S. oryzae* and *T. castaneum* adults after treatment with differnt concentration of paruly *Apium sativum* seed powder.

Month	Alive & dead adults	<i>S. oryzae</i> concentration				<i>T. castaneum</i> concentration			
		concentration			Contra	concentration			Contra
		8%	4%	2%		8%	4%	2%	
0.0	Alive dead	16	16	16	16	16	16	16	16
		0	0	0	0	0	0	0	0
1.0	Alive dead	16	33	8	7	16	20	2	3
		10	17	11	2	2	1	0	2
1.5	Alive dead	0	3	13	40	1	2	5	116
		9	12	14	0	1	0	0	5
2.0	Alive dead	0	3	15	56	0	3	48	182
		1	7	7	3	0	1	1	32
2.5	Alive dead	0	1	18	342	0	3	32	114
		0	2	3	3	0	2	3	6
3.0	Alive dead	0	1	62	666	0	1	73	173
		0	0	4	0	0	2	5	3
4.0	Alive dead	0	0	30	511	0	0	13	160
		0	0	50	392	0	0	63	30
5.0	Alive dead	0	0	12	220	0	0	0	93
		0	0	13	139	0	0	16	37

The population growth rate of *S. oryzae* was very greater for the control than various treated diet (Table 6). The total number of the dead adults which recorded during the 1st to 3rd month of rearing was 22, 27, 19 and 57 imagines with mean mortalities of 92, 29, 3, 20 and 32, 1% for the treated grain at 8, 4, 2% and untreated diet, respectively. Results revealed that addition of dill seeds powder to the diet of *S. oryzae* at various concentrations did not induce higher mortalities during the 1st to 3rd month of rearing in comparison to the untreated media. The results was similar with the finding EL-Lakwah *et al.* (1999) they revealed that addition of African chili fruits powder to diet of *S. oryzae* at 8, 4 and 2% concentrations did not induce higher mortalities during the first to the three month of rearing in comparison control.

2.2. On *T. castaneum* population:

The effect of dill seeds (*A. graveolens*) powder treatment on population growth of *T. castaneum* is presented in Table (3). The numbers of alive insects at 8%, and 2% concentrations reaches its peak 933 and 674 after 5 months. However the peak number of 4% treatment was 706 after 3.5

months, also this peak of alive insect 701 in case of control was recorded after 4 months. The insect growth was followed by a decline in their numbers after it reached its peak. The alive insects numbers were 59, 118, 38 and 402 at 8, 4, 2, % and control after 12 months from treatment. The number of dead adults was fluctuated for all treatments and at all concentrations, the first month showed no insects mortality. The dead adult's insect peak number was observed after 4 months for 8% treatment and control respectively. The peak numbers were 212 and 177 for 8% and control, respectively. However the number of dead adults reached its peak in the diet at 4 and 2% after 3.5 months from treatment, the peak numbers were 172 and 223 respectively (Table 3).

The population growth curve of *T. castaneum* adults are presented in Figure (2). After a stationary phase of one month, the adult populations of the various media increased rapidly during the following two months showing a logarithmic phase. From the 3rd to the 5th months of rearing the rate of increase was slightly declined. From the 5th month, the populations decreased gradually to reach low levels after 12 months.

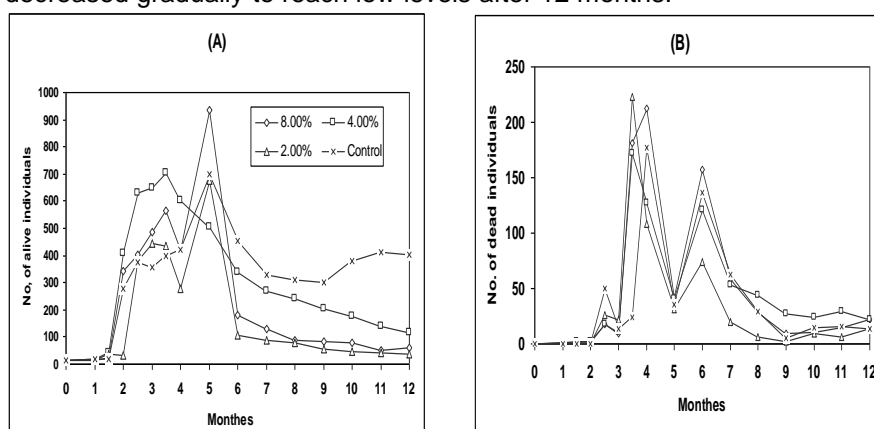


Fig. (2): Alive (A) and dead (B) populations of (*T. castaneum* adults after treatment with dill (*Anethum graveolens* L.) seed powder.

The maximum number of the alive adults recorded in the various media was 933, 706, 674 and 455 imagines and was obtained after 3.5 months for the diet at 4% dill powder, and 5 months for the other treatments (Table 5).

The growth rate of *T. castaneum* (Table 6) indicates that it was slightly lower for the treated diet at 2% and control than at 8 and 4%.

Meanwhile, the rate of growth of *T. castaneum* population was greater than *S. oryzae* at 8 and 4% but it was lowest at 2% and control respectively.

The carrying capacity level, calculated during the period from the 3.5 to 5th month was 516, 651, 353 and 526 adults for the treated diet at 8, 4, 2% and the untreated diet, respectively, (Table 5). These values indicated that, the addition of dill powder to the diet at 86 concentration decreased the

population of *T. castaneum* during the period from the 6th to 12th month of rearing when compared with the other treatments and untreated check.

The total number of dead adult which was achieved during the 1st to 5th month of rearing was 465, 373, 410 and 300 imagines for the diet at 8, 4, 2% and control, respectively. These values were obviously higher than in case of *S. oryzae*. Thus the mean mortality value was 33.3, 42.6, 38.0 and 30%, respectively (Table 5).

These values show clearly that addition of dill seed powders at 8% to the diet of *T. castaneum* induced slightly higher mortality value during the period from the 1st to 5th month of rearing in comparison with the other treatments as well as control.

In conclusion the results indicated that *S. oryzae* was more sensitive to treatment with dill seed powder than *T. castaneum*. The population of *S. oryzae* declined sharply after it reached its peak but the decline was slow in case of *T. castaneum* (Fig. 2). *S. oryzae* alive number was smaller than control at 8% after 4 months from the treatment. However by the end of experiment the alive insect number was very higher in control than treatment. *S. oryzae* insect mortality increased at 8% and did not increase at other treatments during the 1st to 3rd month after the addition of dill powder to food. But in case of *T. castaneum*, it was slightly higher during the period from the 1st to 5th month of rearing.

The numbers of *S. oryzae* alive insects at 8, 4 and 2% concentrations reaches its Peak after 1.5, 3.5 and 3 months, respectively., this peak in case of control was recorded after 3 months, also. The dead adult's insect peak number was observed after 4 months for all treatments including control. The numbers of *T. castaneum* alive insects at 4% concentration reached its peak after 3.5 months. However the number of alive insects at 8, 2% and control reached its peak after 5 months from treatment. The insect growth was followed by a decline in their number after it reaches peaks. The number of dead adults was fluctuated for all treatments.

The population rates of growth of *S. oryzae* were 0.0049, 0.029, 0.045 and 0.052, in case of *T. castaneum* amounted 0.043, 0.045, 0.043 and 0.041 for the diet at 8, 4 and 2% concentrations, as, well as untreated diet, respectively. These values were greater for *T. castaneum* than *S. oryzae*.

It could also be concluded that the lower concentration of dill powder had an activation effect upon the population growth rate in both insects and this rate was higher in *T. castaneum* than *S. oryzae*. In a study on the effect of fenugreek seed flour on *T. castaneum* and *S. oryzae* the rate of population growth was higher in case of *T. castaneum* than *S. oryzae*. But in general, the obtained results are in harmony with the findings reported by EL- Lakwah *et al.*, 1989 on the population of the two insects species under study for diet, treated with the *Melia azederach* fruit powder as well as for insect media treated with African chili fruits powder (El-Lakwah *et al.*, 1995 and 1999).

3- Influence of *Apium sativum* seed powder on the growth tested insects populations.

The population growth of *S. oryzae* and *T. castaneum*, adults at various treatments with *Apium sativum* powder compared to the control is showed in Table (4) and Figure (3& 4).

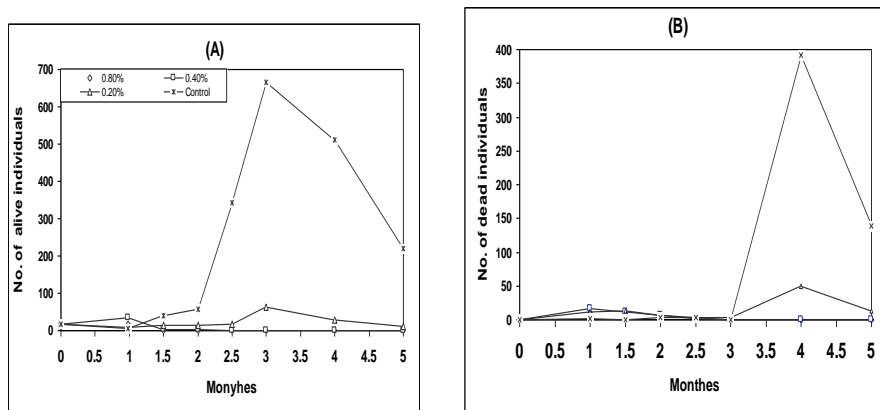


Fig. (3): Alive (A) and dead (B) populations of *S. oryzae* adults after treatment with dill (*Apium sativum*) seed powder.

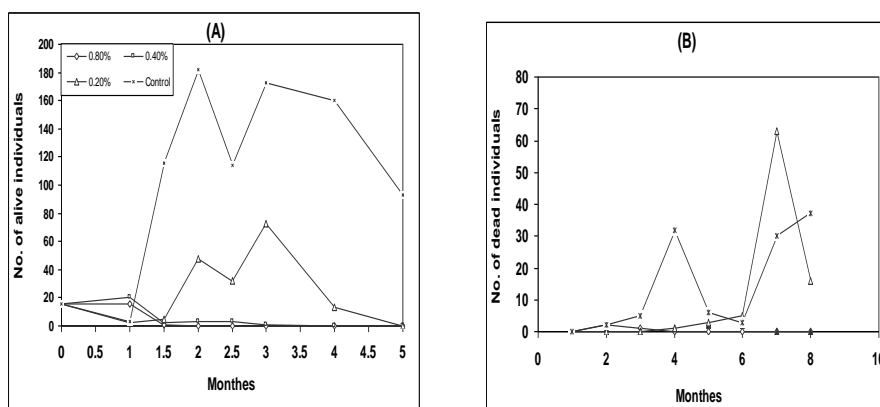


Fig. (4): Alive (A) and dead (B) populations of *T. castaneum* adults after treatment with dill (*Apium sativum*) seed powder.

3.1. On *S. oryzae* population.

Results in Table (4) indicate that the initial number of alive insects was obviously reduced after one month from treatment for the various treated media as compared with the control. Then, the number of alive adults increased rapidly after 60 days post-treatment to reach 62 and 666 adults after 3 months from rearing for 2% concentrations and untreated diet, respectively. However the peak of alive adults was decreased sharply after one month for the treated media at 8% and 4% concentrations respectively. (Table 4). After 5 months of rearing the number of alive adults declined to zero, zero, 12 and 220 for the various media, respectively. The peak of the dead adult was achieved after 1, 1, 4 and 5 month for treated media at 8, 4, 2% concentrations and control, respectively.

The population growth curves of *S. oryzae* reared in the various media (Fig.3) showed following one month of a stationary phase rapid increase from the 1st to the 3rd month. From the 3rd to the 5th month the number of survival

decreased slowly for the media at 2% concentration and untreated and was decreased sharply for the other media. The recorded carrying capacity level during the period from the 1st to the 3rd month of rearing was 11, 17, 37 adults for the media at 8.4 and 2% Meanwhile, it was 506 adults for the control (Table 5).

However, after the 4th month, the number of the alive insects decreased slowly and was 30 and 511 adults to reached 12, 220 adults after 5 months at 0.2% and control but, in the treated diet at 8% and 0.4% the number of survivals declined rapidly and diminished at the 6th month of rearing.

The high drop of the population during the period form the 3rd to 5th month in the concentration 2% and untreated diet was due to influence of the ecological factor, which affect the population density of the insects, such as food shortage over-crowding effect etc., but, this high drop of the population at 8% and 4% concentrations due to the fact that these plants contain terpenoids, glycosides or similar substances which posses antifeedant, repellency or led to a molting disturbance which is often lethal (Champagne *et al.*, 1989).

The carrying capacity level of the various media and the population maximum of alive adults were obviously very lower for the media at 8% and 4% concentrations than the treated media at 2% and control (Table5).

Also, the rate of population growth for *S. oryzae* was high lower at 0.8% and 0.2% concentration as compared with the treated diet at 0.2% and the control (Table 6). Mean mortality values recorded during the 1st to the 3rd month of rearing (Table 5) revealed that addition of *Apium sativum* powder to the diet of *S. oryzae* at various concentration did induce higher mortalities in comparison to the untreated diet.

Results revealed clearly that the addition of *Apium spp.* powder to diet of *S.oryzae* at various concentration, especially 0.8% and 0.4% concentrations showed on obvious very decline in the adult population during the first months of rearing compared to the untreated food. This result is similar to the findings achieved with Fenugreek seed flour and black pepper powder for the same insect species (EL – Lakwah *et al.*, 1989 and 1999).

These results in line with the findings of Halawa (2003) he can be concluded that *Petroselinum crispum* seed powder gave complete protection to crushed grains against *T. castaneum* up to 9 months approximately.

3.2. *T. castaneum* population

The effect of *A. sativum* powder treatment on population growth of *T. castaneum* is presented in Table (4). The number of alive insect at 8% concentration reaches its peak zero after 1.5 month. However, the peak number of 4% and 2% treatment was 20 and 73 adults which reached after 1 and 3 month, respectively. This peak of alive adults in case of untreated media (182) was recorded after 2 month. The inscet increase was followed by a decline in their number and reached zero, zero, zero and 93 adults after 5 months at 8% 4%, 2% and control, respectively.

The number of dead adults fluctuated for all media from the 1st to the 5th months between the different treatments.

The population growth curves of *T. castaneum* adults are presented in Figure (4). After a stationary phase of one month, the adult populations of the various media slightly increased during the following two months showing a logarithmic phase. From the 3rd to the 5th month of rearing the rate of population increase was decreased. Then the adult populations declined sharply to reach very low level after 5 months. The carrying capacity level calculated during the period from the period from the 1st to 3rd month was 11, 13 46 and 137 adults for the treated diet at 8, 4, and 2% and the untreated diet, respectively (Table 5). These values revealed, that the addition of *A. sativum*. powder to the diet at 8% and 4% concentrations decreased the adult population of *T. Castaneum* during the period from the 1.5th to 4th month of rearing, when compared with the treated diet 2% and the untreated check.

The total number of dead adults achieved during the 1st to 3rd month of rearing was 3, 6, 8, and 48 imagines for the diet at 8, 4, 2% and control, respectively. The corresponding mean mortality values was 100, 86, 9.9 and 21.7% respectively (Table 5). The values show clearly that addition of *A. sativum* powder at 8, 4% and 2% to the diet of *T. castaneum* induced higher mortality values during the period from the 1st to 3rd month of rearing than the control.

The population growth rates of *T. castaneum* were zero, zero, 0.030 and 0.036 for the diet at 8, 4, 2% and the untreated diet respectively. These values were very smaller for the diet at 8% and 4% than the untreated media and the media treated with 2% *Apium spp.* powder, (Table 6).

Table (6): Rate of growth for *Sitophilus oryzae* and *Tribolium castaneum* population.

Concentration of dill powder	Initial number (No.)	Number after go days (N)	Rate of growth (K)	Concentration of A. sativum.	Initial number (No.)	Number after go days (N)	Rate of growth (K)
<i>S. oryzae</i>				<i>S. oryzae</i>			
8%	16	2	0.0049	8%	16	0	0.0
4%	16	67	0.029	4%	16	1	0.0
2%	16	574	0.045	2%	16	62	0.030
Control	16	1720	0.052	Control	16	666	0.046
<i>T. castaneum</i>				<i>T. castaneum</i>			
8%	16	484	0.043	8%	16	0	0
4%	16	647	0.045	4%	16	1	0
2%	16	443	0.043	2%	16	73	0.030
Control	16	356	0.041	Control	16	173	0.036

In this respect, El-Lakwah *et al.* (1999) mentioned that addition of 8% black pepper powder to the food of *T. castaneum* caused an obvious decline in the population during the first three months of rearing. Also, addition of Chinaberry tree fruit dust to the diet of *T. castaneum* showed an obvious decline in the adult population during the first five months of rearing (El – Lakwah *et al.*.,1995).

The obtained results showed clearly that powder of *A. sativum* at various concentration gave complete protection to grains against pest species, this might be due that *A. sativum* an adverse effect on egg deposition, hatchability, progeny percentage or acted as repellency material.

These findings are in agreement with earlier reports of Mahgoub *et al.* (1997) who, use *Petroselinum sativum* oil against *S. oryzae* and *C. maculatus* adults after 48 h. from treatment, a great reduction in hatchability of the produced eggs at the two first levels (LC25 & LC50), in case of LC90, no hatching noticed, also. The percentage of progeny was several affected which 56 and 1 adults at LC25 and LC50, but the higher concentration (LC95), no progeny could emerge or 100% relative protection was achieved to mung seeds from *C. maculatus* infestation at this level.

4- Persistence of *A. sativum* powder activity on *S. oryzae* and *T. castaneum*.

Table (7) further indicates that, for any tested concentration adult mortality of *S. oryzae* and *T. castaneum* after storage was greater than or equal to the initial mortality, i.e. no decrease in the material powder activity was noted. In this respect Abd-Kway and El-khayat (1998) stated that no decrease in insecticidal activity was noticed on *R. dominica* by *B. thuringiensis*. Also, this data, as it is, of obvious results to Mahgoub *et al.* (1997).

Table (7): Persistence of *A. sativum* powder activity on *S. oryzae* and *T. castaneum* re-reared on wheat grains stored after 5 month at $26 \pm 2^\circ\text{C}$ and $65 \pm 5\%$ RH.

Concentration	Average No. of adults within certain after storage of infected wheat grains					
	<i>S. oryzae</i>			<i>T. castaneum</i>		
	15 days	30 days	60 days	15 days	30 days	60 days
8%	65 ± 6	32 ± 3	22 ± 6	28 ± 12	20 ± 2	11 ± 1
4%	50 ± 2	21 ± 6	20 ± 1	14 ± 4	10 ± 3	10 ± 2
Control	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0

5- weight loss in wheat grains.

As shown in Table (8) *Apium spp* powder had a significant effect on the feeding behavior of both *S. oryzae* and *T. castaneum*. Treatment of wheat grains with *Apium* powder decreased food consumption of adults and consequently, reduced insect feeding damage. A correlation existed between increase of material powder concentration of *Apium* and decrease of weight losses of wheat grains. With *S. oryzae* adult decrease in grain weight was 61% in the control compared to zero and 7.04% in grains treated with 0.8% and 0.4% after 150 days of storage. After the same storage period, decrease in weight for *T. castaneum* was, as it is in *S. oryzae*. This result in respect of Abd el – Kawy and EL – khayat (1998) presented that weight loss of wheat grains treated with *B. Thuringiensis* Vri. Kurstuki, due to infestation with both species *R. dominica* and *S. granarius* was evidently less than untreated grains.

The above results lead to the conclusion that *Apium sativum* powder may help reducing deterioration of stored wheat grains and inhibiting the development and reproduction of both *S. oryzae* and *T. castaneum* on them.

It is concluded that these plant powder can be successfully used for reducing the weight losses caused certain stored grains insect speccies in addition to their efficiency they are safe and easy to use.

Table (8): Weight loss of wheat grains caused by *S. oryzae* and *T. castaneum* treated with *Apium sativum* (5 months after treatment).

Concentration	% weight loss of grain			
	<i>S. oryzae</i>		<i>T. castaneum</i>	
8%	300 ± 0	0	300 ± 0	0
4%	279.17 ± 4	7.04	279.17 ± 4	7.04
2%	139.6 ± 2	53.5	139.6 ± 6	53.5
Control	117.3 ± 2	61.0	117.3 ± 2	61.0

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تأثير معاملة الغذاء بمسحوق بذور كل من الشبث والبقدونس على تعداد سوسة الأرز وخنفساء الدقيق الكستنائية

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لقد أجريت هذه الدراسة معملياً على درجة حرارة ٢٦م ورطوبة نسبية ٦٥% لمعرفة تأثير إضافة تركيبات مختلفة (٨، ٤، ٢%) من مسحوق بذور كل من الشبث والبقدونس إلى الغذاء على نسب الموت ومنحنيات النمو لسوسة الأرز وخنفساء الدقيق الكستنائية. ولقد أظهرت النتائج أن نسب الموت المسجلة خلال فترة الثلاث أسابيع الأولى من المعاملة كانت تتوقف على تركيز المستعمل ومدة التعريض حيث ارتفعت بزيادتها. ووجد أن إضافة مسحوق بذور البقدونس إلى غذاء حشرة سوسة الأرز أدى إلى زيادة واضحة في متوسط الموت الناتجة خلال ١-٣ شهر من المعاملة مع جميع التركيزات المستخدمة مقارنة بمعاملة مسحوق بذور الشبث. بينما خنفساء الدقيق الكستنائية فإن متوسط نسبة الموت الناتجة خلال ١-٥ شهر من المعاملة كانت مرتفعة في الغذاء الذي يحتوى على ٨% من مسحوق بذور البقدونس مقارنة بالمعاملات الأخرى والكنترول. وتبين أن الحشرات الكاملة وسوسة الأرز كانت أكثر حساسية لمسحوق بذور الشبث عن خنفساء الدقيق الكستنائية، مع أنه اتضح أن مسحوق بذور البقدونس كان الأكثر تأثيراً على كلتا الحشرتين. وأظهرت النتائج أن إضافة مسحوق بذور كل من الشبث والبقدونس إلى غذاء سوسة الأرز قد أدى إلى ارتفاع واضح في أعداد الحشرات الكاملة خلال فترات التربية الأولى على غذاء يحتوى على ٨، ٤، ٢% من هذا المسحوق النباتي مقارنة بحشرة خنفساء الدقيق الكستنائية. وقد انخفض تعداد الحشرات الكاملة لسوسة الأرز عند تربيته على بيئة تحتوى على أعلى تركيزين وهما ٨، ٤% من مسحوق بذور النباتين مقارنة بالمعاملات الأخرى وفي نفس الوقت فإن إضافة مسحوق بذور البقدونس للغذاء أعطى حماية كاملة لحبوب القمح خلال ستة أشهر وبذلك يمكن التوصية باستخدامه للوقاية من الإصابه الحشرية خلال فترات التخزين.

Table (5): Carrying capacity level of the media, population maximum of alive adults and number of dead adults for *S. oryzae* and *T. castaneum*.

Media <i>S. oryzae</i>	Carrying capacity	Population maximum		No. of dead adults	Motility %	Media <i>S. oryzae</i>	Carrying capacity	Population maximum		No. of dead adults	Mortality %
	Level of the media	No.	Recorded at months	The 1 st to 3 rd Month	The 1 st to 3 rd Month		Level of the media	No.	Recorded at months	The 1 st to 3 rd Month	
100 gm grain + 8 mg dill powder	12	20	1.5	22	92	100 gm grain + 8 mg Apium spp powder	11	16	1.0	20	100
100 gm grain + 4 mg dill powder	98	174	3.5	27	29	100 gm grain + 4 mg Apium spp powder	17	33	1.0	38	97.
100 gm grain + 2 mg dill powder	626	1293	3.5	19	3.20	100 gm grain + 2 mg Apium spp powder	37	62	3.0	39	38.6
1 00 gm grains = control	842	1720	3.0	57	32.1	100 gm grains = control	506	666	3.0	8	1.2
T. castaneum						T. castaneum					
100 gm crushed grains + 8 mg dill powder	516	933	5.0	465	33.3	1 00 gm crushed grains + 8 mg of Apium spp powder	11	16	1.0	3	100
100 gm crushed grains + 4 mg dill powder	651	706	3.5	373	42.6	100 gm crushed grains + 4 mg of Apium spp powder	13	20	1.0	6	86
100 gm crushed grains + 2 mg dill powder	353	674	5.0	410	38.0	100 gm crushed grains + 2 mg of Apium spp powder	46	73	3.0	8	9.9
100 gm crushed grains = control.	526	455	5.0	300	30.0	100 gm crushed grains = control.	137	182	2.0	48	21.7

* The 1st to the 5th month

