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CHEMICAL AND BIOLOGICAL STUDIES ON WHEAT GRAINS TREATED WITH PLANT OILS AND PLANT OILS - MALATHION MIXTURE, AGAINST SITOPHILUS ORYZAE AND RHIZOPERTHA DOMINICA DURING STORAGE.

KASSIS SHEREEF R. AND SAWSAN A. SHEMAIS

Plant protection Research Institute Agricultural Research Centre, Doki , Giza, Egypt.

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Abstract

Olive oil, soybean oil, oil-malathion mixture beside malathion as a typical insecticide were tested to protect wheat grains against *Sitophilus oryzae* and *Rhizopertha dominica* infestation during storage.

The efficiency of soybean oil was higher than olive oil where the LC_{50} of both treatments were 3.92 and 8.85 ml/kg wheat grains for *Sitophilus* oryzae and 12.53 and 14.60 ml/kg wheat grains for *Rhizopertha dominica,* respectively.

Malathion at the extremely lowest concentration used had immediate lethal effect than plant oils.

Olive oil at any tested dose, gave a complete protection for wheat grains during six months, meanwhile soybean oil failed to give the same protection after two months. The adult mortality increased by increasing the concentration of the tested oils or the addition of malathion.

Application of oils showed an increase in fat acidity value and a negligible decrease in percentage of germination.

KEY WORDS: *Sitophilus oryzae* (L.), *Rhizopertha dominica* (F.), Malathion, olive and soybean oils.

INTRODUCTION

Insect damage to stored grains and cereal products has been of great concern to man throughout the ages. The loses in crops have resulted in a waste of his labour and a shortage in his food supply.

Chemicals used for controlling insect pests represented a source of pollution and cause insect resistance. Here in lie the advantages of a second method of using plant extracts for insect control which were more readily biodegraded to mammals and proved quite successful in minimizing the population of many insect pests, (Jaipai *et al.*, 1984; Pathak and Krishna 1985; Salwa M.S. Ahmed and Kassis, 2000) .

The present work was directed to evaluate the efficiency of plant oils in preserving wheat grains against insect pests as compared to the traditional insecticide malathion.

MATERIALS AND METHODS

I. Test insects: Artificial insect infestation of wheat grains were made with the rice weevil, *Sitophilus oryzae* L. and the lesser grain borer, *Rhizopertha dominica* L. The jars contained infested wheat grains were maintained under laboratory conditions of 30±2°C and 65-70% R.H.

II. Chemical used: Crude olive and soybean oils obtained from commercial sources and Malathion (O,O dimethyl-S-1,2 dicarbo-ehthoxy ethyl thiophosphate) obtained from Kafr El-Zayat Pesticides & Chemicals Co (K.Z., A.R.E.) were used.

III. The insecticideal toxicity of the oil: Batches of wheat grains were divided into several sets each weighed one kg. Each set was mixed with olive or soybean oil at the rates of 15 ml/kg and 20 ml/kg or malathion at 10 ppm. Combined effect of oil and malathion mixtures was also carried out by mixing 20 or 15 ml of the oil with 5 ppm of the insecticide to treat one kg of wheat grains. Four replicates were carried out for each concentration.

Ten pairs of *Sitophilus oryzae* and *Rhizopertha dominica* (1-2 weeks old) were supplied with 20 gms of treated wheat grains in glass jar and mixed thoroughly. Mortality counts were recorded after 7 days for tested oils compared with those recorded after exposing insects to several doses of malathion with the same technique for one day. The percentage mortality was calculated and corrected using Abbott's formula (Abbott, 1925). The data of each treatment were converted into their probits (Fisher, 1948). The slopes of the probit lines and the LC_{50} were estimated by the probit method of analysis (Bliss, 1935).

IV. Residual effects of natural oils on experimental insects: For each treatment, four replicates were performed. Treated and untreated grains (as control) were stored under laboratory conditions of 30 ± 2°C and 65-70% R.H. for six months.

A sample of 20 gms from each replicate of all treatments was taken soon after application, then monthly till the sixth one, and kept in glass tube. 20 adults of the tested insects were added and incubated at 30 ± 2°C. Mortality counts were carried out seven days after infestation.

V. Fat acidity value "F.A.V.": It was determined by the method recommended by American Association of cereal Chemist (A.A.C.C., 1962). Fat acidity value was expressed as milligrams of KDH required to neutralize the free fatty acids in 10.0 of grain flour (dry base).

VI. Percentage of germination: The percentage of germination was calculated as outlined in International Seed Testing Association Proceeding (Anonymous, 1959).

RESULTS AND DISCUSSION

I.Toxicity of olive and soybean oils: The efficiency of oils in protecting stored grains against insects depends mainly on kind and concentration of oil (Ali *et al.*, 1983 and Zewar 1986).

Data obtained seven days after exposure to treated wheat were compared with those recorded after exposing insects to several doses of malathion (as typical insecticide) with the same technique for one day. The data are recorded in Tables 1 & 2.

Table 1. Corrected mortality of Sitophilus oryzae and Rhizopertha dominica adults, 7 days after exposing insects to different doses of olive and soybean oils under laboratory conditions. (30 ± 2°C and R.H 65-70%).

Dose ml/kg grains	*Sitophilus oryzae*		*Rhizopertha dominica*	
	Olive oil	Soybean oil	Olive oil	Soybean oil
2	--	9.15	--	--
3	--	17.5	--	--
4	--	34.53	--	--
4.5	--	61.37	--	--
5	--	85.89	--	--
8	45	--	--	--
11	60	--	12.5	22.93
12	--	--	--	33.33
13	--	--	--	54.66
14	95	--	30	69.33
15	--	--	--	96
17	97.5	--	67.5	--
20	100	--	97.5	--

As for efficiency of malathion, the lowest concentration used was needed to obtain mortality percentage such as those given by plant oils. This mortality appeared after one day of exposure, while oils needed more time not less than seven days, Table 2.

Here again *S. oryzae* was found to be highly sensitive to malathion as compared to *R. dominica* .

Table 2. Corrected mortality of *Sitophilus oryzae* and *Rhizopertha dominica* adults, 1 day after exposing insects to different doses of mala thion under laboratory conditions (30 ± 2 °C and R.H. 65-70%) .

Dose (ppm)	*Sitophilus oryzae*	*Rhizopertha dominica*
1	13.92	--
1.5	35.44	--
2	55.69	--
2.5	87.34	--
3	88.6	--
5	--	29.21
12.5	--	47.66
20	--	63.42
27.5	--	78.7
35	--	92.82

Comparison based on the LC_{50} values, Table 3 showed that the efficiency of soybean oil was higher than olive oil, where the LC_{50} of both treatments were 3.92 ml/kg and 8.85 ml/kg for *S. oryzae* and 12.53 ml/kg and 14.60 ml/kg for *R. dominica,* respectively.

Table 3. LC_{50}'s[(2)], LC_{95}'s[(2)] and slopes for olive and soybean oils to adults of *Sitophilus oryzae* and *Rhizopertha dominica.*

Insects	*Sitophilus oryzae*			*Rhizopertha dominica*		
Treatments	Slope	LC_{50}	LC_{95}	Slope	LC_{50}	LC_{95}
Olive oil	7.13	8.85	15.02	11.33	14.6	20.37
Soybean oil	5.54	3.92	7.76	17.53	12.53	15.53

(1) LC_{50} : Medium lethal concentration.

(2) LC_{95} : Concentration that causes 95% kill.

From the fore-mentioned results, it could be concluded that *S. oryzae* was more sensitive to oil treatments than *R. dominica* which showed a remarkable resistance, e.g. the LC_{50} value for soybean oil was 9.92 ml/kg wheat grains for *S. oryzae* and 12.53 ml/kg wheat grains for *R. dominica* which represented more than 3 folds.

Effectiveness of soybean against *S. oryzae* at relative lower doses has been reported by Salas (1985), Mahgoub (1987) and Vinucla *et al.* (1990). Meanwhile, the available literature did not clarify the sensitivity of *R. dominica* to oil treatments, as compared with that of *S.oryzae.*

II. Residual effect of tested plant oils on *S. oryzae* and *R. dominica* during different periods of wheat storage: Data given in Tables 4 and 5 clearly showed that olive oil proved highly efficiency in preserving grains against insects than soybean oil especially on the long run, (till 6 months).

Table 4. Corrected percentage mortality of *Sitophilus oryzae* in wheat grains treated with olive, soybean oils, mixture of each oil and malathion alone at different storage periods.

Treatment	Dose	Periods of storage (month)							
		0	1	2	3	4	5	6	Mean ± SE
Olive oil (ml/kg)	20	94.73	100	94.59	91.2	100	100	100	96.13 ± 1.5005 a
	15	89.47	92.3	92.97	90.5	100	100	100	
	Mean	**92.1**	**96.15**	**93.78**	**90.85**	**100**	**100**	**100**	
Olive oil (ml/kg) + Malathion (ppm)	20 + 5	100	100	100	98	100	100	100	98.41 ± 0.8206 a
	15 + 5	100	100	93.2	91.25	95.25	100	100	
	Mean	**100**	**100**	**96.6**	**94.63**	**97.63**	**100**	**100**	
Soybean oil (ml/kg)	20	100	100	86.48	71.25	69.76	68.94	32	71.45 ± 9.1675 b
	15	94.73	100	78.37	60	58.13	52.6	28	
	Mean	**97.37**	**100**	**82.43**	**65.63**	**63.95**	**60.77**	**30**	
Soybean oil (ml/kg) + malathion (ppm)	20 + 5	100	100	100	92.5	81.39	84.2	50	84.93 ± 7.5298
	15 + 5	100	100	100	86.25	76.74	78.94	39	
	Mean	**100**	**100**	**100**	**89.38**	**79.07**	**81.57**	**44.5**	
Malathion (ppm)	**10**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	100 ± 00

Means with the same letter are not significantly different. Using Duncan multiple range test in SAS.

Table 5. Corrected percentage mortality of *Rhizopertha dominica* in wheat grains treated with olive, soybean oils, mixture of each oil and malathion alone at different storage periods.

Treatment	Dose	Periods of storage (month)							Mean ± SE
		0	1	2	3	4	5	6	
Olive oil (ml/kg)	20	81.25	93.42	97.33	93.48	91.66	96	100	91.95 ± 2.2529ab
	15	81.25	86.05	96	89.68	89.16	92	100	
	Mean	**81.25**	**89.74**	**96.67**	**91.58**	**90.41**	**94**	**100**	
Olive oil (ml/kg) + malathion (ppm)	20 + 5	100	97.36	93.33	83.53	81.25	90	94	87.11 ± 3.3181 b
	15 + 5	87.5	94.73	81.33	69.96	64.58	88	94	
	Mean	**93.75**	**96.05**	**87.33**	**76.75**	**72.92**	**89**	**94**	
Soybean oil (ml/kg)	20	100	96.05	36	31.16	20.83	14	5	37.70 ± 13.4644c
	15	75	82.89	21.33	18.98	12.5	11	3	
	Mean	**87.5**	**89.47**	**28.67**	**25.07**	**16.67**	**12.5**	**4**	
Soybean oil(ml/kg)+ malathion (ppm)	20 + 5	100	94.73	50.66	40.5	27	28	20	45.12 ± 12.2308c
	15 + 5	87.5	78.94	37.33	26.25	18.75	13	9	
	Mean	**93.75**	**86.84**	**44**	**33.38**	**22.88**	**20.5**	**14.5**	
Malathion	10	100	100	100	100	100	100	100	100 ± 00 a

Means with the same letter are not significantly different. Using Duncan multiple range test in SAS.

These results may be due to its highly constitution of oleic acid, where olive oil contains 65-85% oleic acid, meanwhile soybean oil contains only 22-30%. The mortality increased after addition of 5 ppm malathion . In this respect Hill and Schoonhoven (1981) reported that oleic acid was effective against insects. Also, this study indicates that treatment with olive oil caused a remarkable increase in FAV of treated wheat grains than soybean treatment, Table 7.

Seed germination: A negligible decrease in percentage of germination was noticed in grains treated with oils directly after treatment, Table 6.

These results may be due to a direct bad effect of free fatty acids in seed oils on seed germ, while treatment with malathion recorded a lowest decrease in percentage of germination . The same results were reported by Yun-Taiop (1981) and Salas (1985), Meanwhile Zewar (1986) and Mahgoub (1987) reported that oil treatment has no negative effect on seed germination.

Table 6. Percentage of seed germination* of wheat grains treated with olive, soybean oils, mixture of each oil and malathion, in addition to malathion alone at different periods of storage.

Treatments	Periods of storage in month							
	0	1	2	3	4	5	6	Mean ±
Untreated	92	91	90	90	89	89	88	89.86 ± 0.5084 a
Olive oil (20 ml/kg)	88	85	83	82	82	81	79	82.86 ± 1.1004 d
Olive oil (15 ml/kg) + malathion (5ppm)	90	90	88	86	86	83	82	86.43 ± 1.1924 bc
Soybean oil (20 ml/kg)	89	87	85	81	81	81	80	83.43 ± 1.3427 cd
Soybean oil (15 ml/kg) + malathion (5ppm)	91	90	89	86	86	85	83	87.14 ± 1.1004 ab
Malathion (10ppm)	91	90	90	88	86	85	84	87.71 ± 1.0400 ab

*Percentage of seed, that showed normal sprouts after 7 days.

- Means with the same letter are not significantly different. Using Duncan multiple range test in SAS.

III. Side effect of treating wheat grains with tested natural oils and malathion

A. Fat Acidity Value (FAV) Results in Table 7 showed that treatment with oils increased fat acidity value of treated grains directly after treatment. Pronounced increased was recorded in olive oil treatments especially at high dose (20 ml/kg), which indicate that olive oil, have considerable amounts of free fatty acids.

High rate of increase in FAV was recorded during six months storage period in grains treated with olive or soybean oil. This increase represents the difference between fatty acids produced by lipase enzyme of the associated fungi and fatty acids consumed by these fungi as a carbon source.

Table 7. Effect of application with olive, soybean oils, mixture of each oil and malathion in addition to malathion alone on the fat acidity value of wheat grains at different periods of storage.

Treatments	Periods of storage in month							
	0	1	2	3	4	5	6	Mean ± SE
Untreated	16.89	20.46	23.94	23.25	22.93	30.11	34.25	24.55 ± 2.2097 d
Olive oil (20 ml/kg)	106.31	170.9	183.6	202.52	205.5	260.5	261.66	198.71 ± 20.3427 a
Olive oil (15 ml/kg) + malathion (5ppm)	85.48	132.5	162.0	172.2	181.4	190.0	195.67	159.69 ± 14.7135 b
Soybean oil (20 ml/kg)	27.61	57.9	58.73	81.5	90.9	100	122.86	77.07 ± 11.9358 c
Soybean oil (15 ml/kg) + malathion (5ppm)	25.91	37.32	43.86	70.09	68.00	70.9	100.00	59.41 ± 9.5432 cd
Malathion (10ppm)	17.1	21.58	24.12	24.26	26.26	32.46	36.45	26.03 ± 2.4703 d

Means not followed by the same letter are significantly different ($P < 0.01$). Using Duncan multiple range test in SAS.

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دراسات كيميائية وبيولوجية على حبوب القمح المعامل بزيت الزيتون وزيت فول الصويا ومخلوط من كل منهما مع الملاثيون والملاثيون منفردا لمقاومة حشرتى سوسة الأرز وثاقبة الحبوب الصغرى أثناء التخزين

شريف رينيه قسيس، سوسن عبد العزيز شميس

معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - الجيزة - مصر

- تم دراسة تأثير زيت الزيتون وزيت فول الصويا ومخلوط من كل منهما مع الملاثيون والملاثيون منفردا كمبيد نموذجي لحماية حبوب القمح ضد حشرتى سوسة الأرز وثاقبة الحبوب الصغرى أثناء التخزين .

- كانت كفاءة زيت فول الصويا أعلى من زيت الزيتون حيث كانت قيم الـ LC_{50} (التركيز اللازم لموت ٥٠٪ من الحشرات بعد فترة تعريض محدودة) للمعاملتين ٣,٩٢ و ٨,٨٥ مل/كجم قمح لحشرة سوسة الأرز بينما كانت ١٢,٥٣ و ١٤,٦٠ مل/كجم قمح لحشرة ثاقبة الحبوب الصغرى على التوالي .

- كان المالاثيون بأقل التركيزات أسرع تأثيرا على الحشرات المختبرة بالمقارنة بتأثير الزيوت النباتية .

- زيت الزيتون أعطى وقاية كاملة لحبوب القمح ضد حشرتى سوسة الأرز وثاقبة الحبوب الصغرى بالجرعات المستخدمة (١٥ و ٢٠ مل/كجم قمح) خلال الستة شهور، بينما اخفق زيت فول الصويا فى ان يعطى نفس الوقاية بعد شهرين بنفس الجرعات.

- ازدادت نسب الموت بزيادة تركيز الزيوت المستخدمة أو بإضافة المالاثيون إليها.

- بتعريض الحبوب للزيوت السابقة ظهرت زيادة فى كمية الأحماض الدهنية المنفردة مع انخفاض طفيف فى نسبة إنبات الحبوب .