J. Pest Control & Environ. Sci., Vol 2 pp 111-16, 1990
Symposium of IPM & E.P. Nov. 7-8, 1990 Alex. Egypt.

FATE OF MALATHION IN STORED FABA BEANS. TOXICITY OF BOUND RESIDUES

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Abstract

Residues of ^{14}C-malathion in stored faba beans were studied after 30 weeks. Data showed that the percentage of penetration and its binding was not dose dependent. Feeding mice with bound residues of malathion in beans for 90 days led to the appearance of toxic effects on blood, liver and kidney functions.

1. Introduction

Malathion S-1,2-di(ethoxycarbonyl) ethyl O,O-dimethyl phosphorodithioate is an important and widely used organophosphorus insecticide. It has been accepted for the control of pests on vegetables and field crops, fruits and nuts, stored grains (1-2) and domestic animals. Because of its low mammalian toxicity (3), the insecticide can mixed directly with grain where it controls pest by both contact and vapour activity.

The purpose of this research is to study the fate of ^{14}C-malathion in stored faba beans after 30 weeks. For these studies ^{14}C-malathion labelled at 2,3-succinate carbon atom (I_a) and O-methyl groups (I_b) were used. The toxicological effects on mice fed with its bound residues for 90 days has also been investigated.

2. Materials and Methods

2.1. The Chemical

(a) Malathion ^{14}C-labelled at 2,3-succinate carbon atoms (I_a), was purchased from Amersham International Corporation, U.K. Its specific activity 112 μCi/mg (37mCi/mmol).

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(b) Malathion ^{14}C-labelled at O-methyl groups (I_b) was synthesized in our laboratory using a one-vesseled reaction, mainly according to known procedures (4-5), by condensing labelled O,O-dimethyl phosphorodithioic acid and diethyl maleate (Scheme 1). It had a specific activity 0.27 mCi/g and radiometric purity over 98% as determined by thinlayer chromatography (tlc). For feeding studied, pure non-labelled malathion was synthesized in our laboratory.

2.2. Treatment

Vicia faba beans (Var. Giza 1) with moisture content (11-12%) and relative humidity (60-70%) were used. Seeds were treated with the radioactive insecticide in way similar to that described by Zayed and Farghaly (6). Three doses were used 15, 30 and 60 ppm; the lower dose approximates that usually recommended in practice. Grains were stored for 30 weeks at room temperature.

2.3. Analysis

The treated grains were washed rapidly with 50% aqueous ethanol (3 x 30 ml) for quantitive removal of any residue on seed coat (external extract). The washed grains were ground thoroughly in a mortar and extracted with 95% aqueous methanol for 24 h in a Soxhlet apparatus (internal extracts). The radioactivity in these extracts was directly determined by liquid scintillation counting (LSC). Sub-samples of extracted grains, after drying, were combusted in a packard tri-carb sample oxidizer (Model 306) and then assayed for un-extracted radioactivity by LSC. Internal standard technique was used for quench correction.

2.4. Toxicity

Bound residues prepared from a parallel experiment with non-labelled malathion was used for feeding study. A group of 40 healthy male Swiss mice of 4 weeks old were fed with standard diet mixed with the extracted crushed faba beans to ensure daily dose of the residue of 1.5 ppm insecticide equivalent over a period of 90 days. Another group of 20 mice were used as controls and fed with the same diet mixed with non-contaminated crushed faba beans. Animals were weighed, examined, for body weight gain, water, feed intake and behaviour were observed. Plasma and erythrocyte cholinesterase activity was determined (7). The haematological study, activity of liver, kidney enzymes and blood urea nitrogen were also investigated.

3. Results and Discussion

Table (1) shows the residues of malathion (I_a and I_b) in treated faba beans stored for 30 weeks. It was observed that the percentage of penetration of the toxicant and its binding are not dose dependent. The incomplete recovery of applied radioactivity may be attributed, at least partially, to volatility of malathion. The determined binding percentage of I_a was higher than that of I_b. The possible binding of desmethyl-malathion to the grain constitutents would explain the observed low percentage of I_b-binding. The formation of desmethyl-malathion has been previously reported to be formed upon treatment of stored rice grains with the insecticide (8).

Feeding mice with bound malathion residues at a level of 1.5 ppm in diet for 90 days caused a reduction of body weight gain (20-30%). Only the erthrocyte cholinesterase activity was inhibited by about 25% after 90 days (Table 2). An increased activity of serum glutamic oxaloacetic transaminase (S. GOT) and alkaline phosphatase enzymes was also observed (Table 3). The haematological results showed significantly lower leucocytic count and a higher count of segmented lymphocytes which denoting the decrease of immunity (Table 4). The above mentioned data indicate a toxic effect of malathion bound residues in stored faba beans on mice.

This work is supported in part by "Academy of Scientific Research and Technology" to whom we are grateful.

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Table (1) : Residues of ^{14}C-Malathion in Stored Faba Beans.
(expressed as mg insecticide/kg grains)

[illegible]	Compound*	Applied dose	External Residues		Internal Residues		Non-Extractable Residues		Recovery of Radioactivity
			mg	%**	mg	%	mg	%	%
[illegible]	a	14.5	4.20	29	5.08	35	2.61	18	82
	b	[illegible]	8.32	32	10.92	42	4.42	17	91
[illegible]	a	14.5	4.35	30	5.80	40	1.45	10	80
	b	57.6	19.61	34	27.74	48	6.94	12	94

*I_a : Malathion ^{14}C-Succinate

I_b : Malathion ^{14}C-Methyl

**Applied dose = 100%

Table (2) : Effect of Feeding Mice with Bound Malathion in Faba Beans on Cholinesterase Activity.

Time (Days)	% Remaining Activity of		% Reduction of Body weight Gain
	Plasma Ch.E.	Erythrocyte Ch.E.	
24 h	93	> 100	-
10	95	100	5
30	89	100	10
60	71	98	30
90	> 100	75	20

Table (3) : Effect of Bound Malathion Residues on Liver and Kidney Function.

Time (Months)		S. GOT°	S. GPT°	Alk.° Phosphatase	B.U.N.°°
1	C	151	59.6	15	17
	T	482	93.9	66	33
2	C	619	100.2	13	45
	T	310	73.3	39	32
3	C	112	132.5	24	53
	T	418	44.6	68	29

C = Control

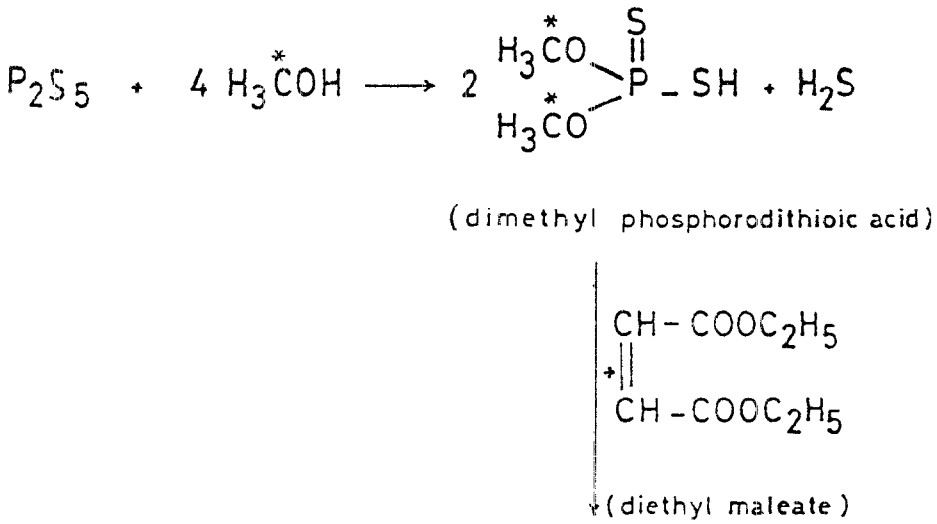
T = Treated

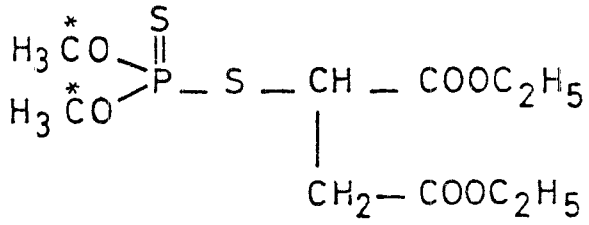
° = u/L

°° = mg/dL

Table (4) : Haematological Results in Mice Fed with Bound Malathion Residues.

Time (Months)		HB	RBC_s	WBC_s	Differential Count					
					Eosino	Staff	Seg.	Lymph	Mono.	Baso
1	C	12.5	7.43	9.1	0	2	18	78	2	0
	T	14.6	8.37	5.5	0	3	32	62	3	0
2	C	11.6	6.56	21.6	0	0	16	82	1	1
	T	14.2	8.68	8.3	2	0	34	60	4	0
3	C	15.2	8.70	17.1	0	0	23	74	1	1
	T	15.6	9.47	6.5	0	4	32	60	3	0





Malathion (Ib)

(Ia)= 2,3- ^{14}C-Succinate labelled Malathion

Scheme.1: Synthesis of (Methyl-^{14}C) Malathion.