Acute and Sub-acute Toxicity of Sumithion in Japanese Quails. Tadaomi KADOTA and Junshi MIYAMOTO (Research Department, Pesticides Division Sumitomo Chemical Co., Ltd., Takarazuka, Hyogo, Japan) Received Jan. 16, 1975 *Botyu-Kagaku* 40, 54, (1975).

9. ウズラにおけるスミチオンの急性および亜急性毒性

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有機リン殺虫剤スミチオンのウズラにおける急性経口毒性ならびに4週間の摂食による産卵率，血液，脳コリンエステラーゼに及ぼす影響を検索した．

スミチオンのウズラにおける急性経口投与による LD_{50} は雄：110，雌：140 mg/kg であった．

ウズラの産卵率はスミチオン 15ppm 4週間の摂食（2.08mg/kg/day）によって変化はなかった．50ppm では摂食期間のみごく軽度低下，更に大量の 150ppm では摂食期間中 1/3に産卵率を低下したが摂食後2週間で回復する可逆性の変化であった．

ウズラにスミチオン 1.5，5，15，50ppm を4週間摂食させ，その間血液，脳コリンエステラーゼを測定した．脳コリンエステラーゼは雄 50ppm，雌 15，50ppm 以上で阻害されるが摂食後2～4週間で正常に回復した．血液コリンエステラーゼは脳コリンエステラーゼよりも，つよく阻害されたが，回復は速やかであった．

スミチオンの無影響量はこの条件下において飼料中 5ppm，体重換算雄：0.65，雌：0.69mg/kg/day を若干下廻ると考えられる．

Introduction

Several acute toxicity studied of Sumithion have been carried out on birds including mallard ducks, ringnecks, pheasants and hens and they indicate that the toxicity of Sumithion is variable with bird species just like other organophosphorus insecticides.[1-4] The present studies were designed to assess acute and sub-acute toxicity of Sumithion in Japanese quails.

Materials and Methods

Sumithion technical, purity 97.2%, was used in this study.

Young Japanese quails, 3～6 week old, were purchased from Nihon Dobutsu Co., Ltd. and kept in an atmosphere of 27 ± 1°C with the relative humidity of 60 ± 10%. The birds had free access to the diet (Quail mush, Nihon Nosan Kogyo, Nagoya) and water.

Acute oral toxicity testing was conducted as follows. Sumithion suspended in 10% Tween-80 aqueous solution was administered orally to groups of 8 male and 8 female 7～8 week old Japanese quails in a dosis of 1 ml/100g body weight. The symptoms and death were observed for 2 weeks and LD_{50} was calculated by the Litchfield and Wilcoxon method.

Table 1. Experimental designs for feeding study of Sumithion in Japanese quails.

Concentration of Sumithion in food, ppm	Number of birds used male	female	Experimental period, week 0	2	4	6	8	10	12
50	60	60	———	s	s	s	s	s	s
15	60	60	———	s	s	s	s	s	s
5	60	60	———	s	s	s	s	s	s
1.5	20	20	———	s	s				
0	60	60	———	s	s	s	s	s	s

s ; Ten male and 10 female quails were sacrificed for cholinesterase activity assay.
———; Diet containing Sumithion, ····· Basal diet

Four week feeding study : 260 males and 260 females of 4~5 week old Japanese quails were distributed by the experimental designs in Table 1 and twenty quails were housed in one cage. Sumithion dissolved in corn oil were mixed with the basal diet. Corn oil concentration in the diet was 3%. The diet was freshly prepared every week. The test group received on an *ad. libitum* basis water and diet containing 50, 15, 5 and 1.5ppm Sumithion for 4 weeks and thereafter they were kept on the basal diet for further 8 weeks. Twenty males and 20 females in each group were selected to examine toxic symptoms, body weight, food consumption everyday. Eggs laid by all females were also counted.

Another 3 supplementary groups of 15 female quails were set up to estimate sub-acute effects of Sumithion on egg-laying. These groups received diet containing 0, 50 and 150ppm Sumithion. Rate of egg-laying was calculated as follows ;

$$\text{Rate of egg-laying} = \frac{\text{Total eggs in a week}}{\text{No. of quails} \times 7} \times 100$$

Each 10 male and 10 female quails were sacrificed biweekly for 6 times (only on 2nd and 4th week at 1.5ppm) to determine brain and blood cholinesterase activity by delta pH method.[5]

Results and Discussions

Acute oral toxicity : LD_{50} value of Sumithion was calculated to be 115 mg/kg and 140 mg/kg in males and females, respectively, as shown in Table 2, which also includes the toxic symptoms.

Four week feeding study :

Toxic symptoms and mortality : During the test period all animals survived and did not show any toxic symptoms.

Body weight : The body weight gain in test groups was comparable to the control, as shown in Fig. 1.

Food intake : Food intake in test groups was comparable to the control group. Table 3 summarizes average intake of Sumithion.

Cholinesterase activity : The results of whole blood cholinesterase activity determined during the experimental period are reproduced in Fig. 2. A significant reduction of cholinesterase activity was observed in males and females at 15 ppm and above. At 50 ppm the depression was most marked on 2nd week, over 80%, but the enzyme activity tended to recover during the latter half of feeding period. At 15ppm maximum depression was 40% in males and more than 60% in females. At 5 ppm the reduction was about 25~30% in females, while no reduction was observed in males. One and half ppm Sumithion showed no adverse effect on the enzyme activity. Recover of cholinesterase activity was rapid after completion of administration of Sumithion. In 2 weeks the inhibited enzyme activity recovered to the control level.

As shown in Fig. 3, a significant reduction of brain cholinesterase activity was observed only in males and females at 50 ppm. The degree of inhibition was about 50% on 4th week and a little more marked inhibition was found in females. The reduction of the enzyme activity

Table 2. Acute oral toxicity of Sumithion in Japanese quails.

Dosage, mg/kg	Mortality Male	Mortality Female	Toxic symptoms
67.8	0/8	0/8	Decrease of spontaneous motor activity and slight motor ataxia after 30 min. All recovered after 24 hours.
95	3/8	2/8	Irregular respiration, ataxia.
133	5/8	3/8	Tremor, salivation and lacrimation 10 to 30 min.
186	8/8	8/8	post-treatment. Death occurred within 48 hours.
260	8/8	8/8	Toxic signs of survived quails disappeared after 2 to 5 days.

LD_{50}; Male; 115 mg/kg (95% confidence limit 80~166)
Female; 140 mg/kg (95% confidence limit 105~186)

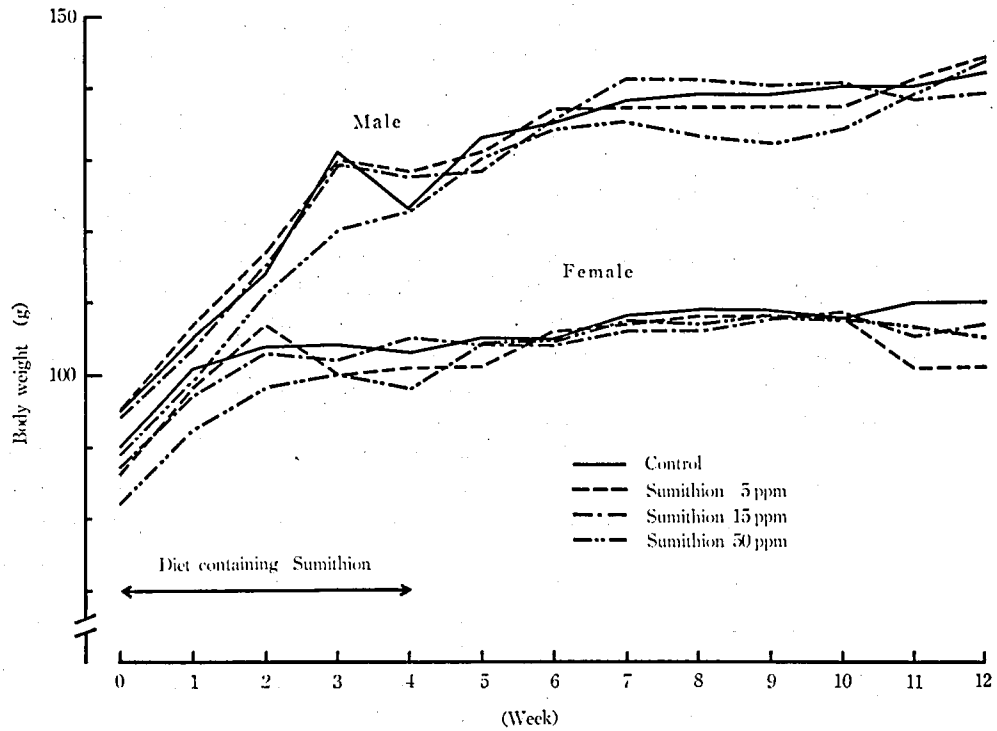

Fig. 1. Mean body weight curves of Japanese quails treated with Sumithion for 4 weeks.

Table 3. Intake of Sumithion in Japanese quails during 4 week feeding period.

Week	Intake of Sumithion, mg/kg/day							
	Male				Female			
	50ppm	15ppm	5ppm	1.5ppm	50ppm	15ppm	5ppm	1.5ppm
1	6.60	1.73	0.640	0.180	7.45	2.22	0.650	0.230
2	6.55	1.86	0.560	0.205	7.30	2.10	0.630	0.251
3	6.85	1.88	0.715	0.190	6.95	2.00	0.720	0.212
4	5.60	1.68	0.685	0.181	7.10	2.03	0.675	0.210
Mean	6.40	1.78	0.650	0.189	7.20	2.08	0.690	0.226

was about 30% at 15 ppm and 60% at 50 ppm in females, while male brain cholinesterase was inhibited only at 50 ppm, being 50% of the control. Recovery of brain cholinesterase activity was slightly slower than blood cholinesterase.

Rate of egg-laying: Five and 15 ppm Sumithion feeding did not affect rate of egg-laying. Fifty ppm Sumithion adversely affected the rate slightly, but the rate recovered to the normal level 2 weeks after termination of feeding (Table 4).

In the supplementary experiment, the rate of egg-laying at 50 ppm was comparable to the control (Table 5). The rate decreased significantly (one-third of control) by dietary administration of 150 ppm Sumithion. However, it recovered 2 weeks after termination of feeding. The difference in the effects of Sumithion between these two 50 ppm dosage groups might be related to the age of animals. Actually the former birds were 4~5 old at the initiation of feeding, while the latter, 7~8 week old. Young quails might be more susceptible to Sumithion.

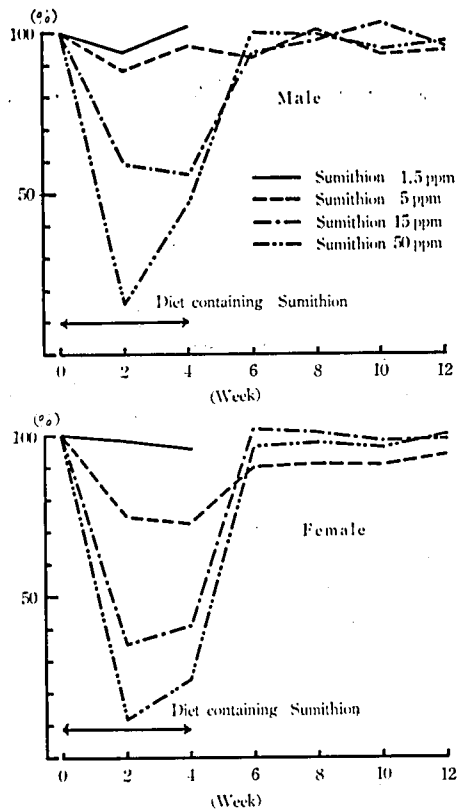

Fig. 2. Changes of whole blood cholinesterase activity in Japanese quails treated with Sumithion for 4 weeks.

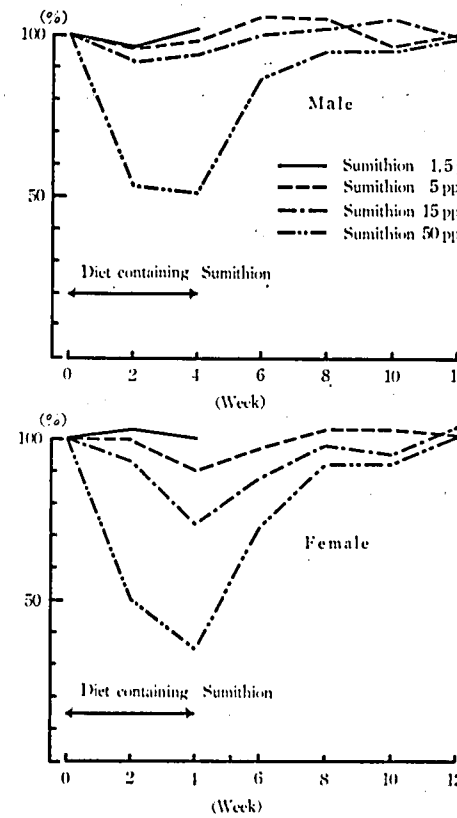

Fig. 3. Changes of brain cholinesterase activity in Japanese quails treated with Sumithion for 4 weeks.

Table 4. Egg-laying rate of Japanese quails during 4 week Sumithion feeding.

Dosage level, ppm	Egg-laying rate, %											
	Treatment, week				Post-treatment, week							
	1	2	3	4	1	2	3	4	5	6	7	8
0	0	0	13.7	57.9	54.2	80.0	88.5	87.2	86.6	94.4	90.2	85.7
5	0	0	16.4	53.4	68.4	70.6	85.0	79.3	81.0	88.0	88.8	88.5
15	0	0	14.0	58.6	50.8	77.1	82.8	90.7	83.6	85.0	87.0	85.4
50	0	0	5.0	37.9	45.0	60.7	80.8	73.6	76.7	88.7	89.8	81.4

Table 5. Egg-laying rate of Japanese quails during 4 week Sumithion feeding. (Supplementary group)

Dosage level ppm	Egg-laying rate, %						
	Treatment, week				Post-treatment, week		
	1	2	3	4	2	3	4
0	37.7	63.7	75.1	52.8	64.2	54.2	47.4
50	41.0	50.5	67.6	62.7	54.2	61.4	73.7
150	28.8	18.2	25.4	19.0	38.0	53.1	63.8

With regards to the sub-acute toxicity and reproduction of Sumithion on birds, two other studies have been conducted.[6,7] Sub-acute dietary administration of 3 and 10 ppm of Sumithion to bobwhite quails did not adversely affect both parental generation and egg production as well as its hatchability and F_1 generation. Similarly, 30 and 100 ppm of Sumithion caused no harmful effects on parental and F_1 generation of mallard ducks.

These results suggest that Sumithion residue in/on crops or in fish does not give any untoward reactions on various species of wildlife including their reproductive performance, since the organophosphorus insecticide is of relatively shorter persistency and that the residue seldom exceeds 1 ppm under usual application conditions.[8,9] Actually, extensive field monitorings in Canada indicate that aerial spraying of Sumithion on forest areas did not cause any adverse effects on bird populations.[10]

Summary

The acute oral LD_{50} values of Sumithion in male and female Japanese quails were 110 and 140 mg/kg, respectively.

By dietary administration of as high as 50ppm of Sumition for 4 weeks no adverse effects were observed with respects to behavioral reaction and body weight. The rate of egg-laying was not affected by the administration of 15 ppm dietary Sumithion. Only slight effect on the egg-laying was observed at 50 ppm. At 150 ppm the rate was inhibited to one-third of the control, but it recovered 2 weeks after completion of Sumithion feeding.

The cholinesterase in blood and brain was adversely affected at 15 ppm and above and blood cholinesterase was more susceptible than the brain enzyme. Female cholinesterase was inhibited more easily. The recovery of the enzyme activity was rapid and complete after termination of the feeding (2~4 weeks).

The maximum no-effect level of Sumithion in this experiment estimated from the effect on cholinesterase was determined to be a little less than 5 ppm or 0.65 mg/kg/day in males and 0.69 mg/kg/day in females.

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