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Laboratory trials of five rodenticides for the control of *Mesocricetus auratus* Waterhouse

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SUMMARY

The efficacy of five rodenticides for use in bait against the golden hamster (*Mesocricetus auratus* Waterhouse) was investigated in the laboratory. The species proved to be resistant to warfarin (up to 0·5%) and difenacoum (0·005%), but brodifacoum (0·005%) gave complete mortality after three days' feeding. Calciferol (0·1%), though toxic, was significantly unpalatable. Zinc phosphide (5·0%) presented in a choice test for two days against unpoisoned feed gave 100% mortality, and appears to be the most suitable of these compounds for the control of *M. auratus* in the field.

INTRODUCTION

The first reported case of free-living golden hamsters (*Mesocricetus auratus* Waterhouse) occurred in 1959 at Bath, Somerset (Rowe, 1960). On that occasion, though only six animals were known to have escaped, a total of 52 were captured. Several similar cases have occurred since (Rowe, 1968), all originating from pet shops. Several methods have been employed to control hamster infestations, including the use of live-traps, kill-traps and poisoned bait, but there is still little information available as to the effectiveness of such measures. At Bath, warfarin, then a widely used poison for control of rats and mice, was used against the hamsters, but although a large amount of bait was taken, there was no apparent reduction in hamster activity.

In February 1982, the Environmental Health Department of the London Borough of Barnet reported that a substantial number of hamsters had been captured or killed in a small residential area, which also included vegetable gardens, and that control was proving difficult. It was then decided that an investigation should be carried out, to determine the response of hamsters to a number of rodenticides in current use, and the results are presented here.

METHODS

The hamsters used were either caught in the wild or obtained from a commercial breeder. They were caged singly in wire cages and maintained on a standard laboratory animal diet (diet 41B, Oxoid (London) Ltd or FFG(M), Dixon & Sons

(Ware) Ltd) and water *ad lib.* Feeding tests with rodenticides, using oatmeal as the bait base, were carried out according to standard procedures (European and Mediterranean Plant Protection Organization, 1982; World Health Organization, 1982). Bait consumption was measured daily with very few exceptions. The rodenticides were obtained as technical grade compounds or as concentrates; warfarin, brodifacoum, difenacoum and calciferol from Sorex Ltd, Widnes and zinc phosphide from BDH Chemicals Ltd, Poole.

RESULTS

Anticoagulants

The concentrations of warfarin and difenacoum in no-choice feeding tests (Table 1) were those normally recommended for rat and mouse control but, with warfarin, two higher concentrations were also used. Neither compound was very toxic to the hamsters. With 0·005% brodifacoum, the most active of the anticoagulants, complete mortality occurred after three days' feeding, with the time to death ranging from nine to fifteen days. However, with continuous feeding, one male did not die until day 21, by which time it had consumed a total dose of 64·5 mg/kg of brodifacoum.

Calciferol and zinc phosphide

The results of no-choice feeding tests with calciferol and zinc phosphide are shown in Table 2. Calciferol at 0·1% gave a complete kill after either one or two days' feeding, the time to death being shorter and less variable after the longer feeding period. Zinc phosphide gave the quickest kill, with complete mortality occurring within 24 h when bait containing 5·0% zinc phosphide was presented.

Palatability tests, in which the hamsters were given a choice between poisoned bait and the same bait unpoisoned, were carried out on zinc phosphide and calciferol (Table 3). Zinc phosphide at 5·0% appeared to be palatable though the consumption of both poisoned and plain baits was very low, presumably because the poison acted quickly and prevented further feeding. However, with 4·0% zinc phosphide three hamsters survived, indicating that they could detect the poison and thus avoid consuming a lethal dose. The calciferol bait was slightly, but significantly unpalatable; consumption of the poisoned bait decreased on the second day in both the no-choice and the choice tests by two-thirds, and in the latter, the plain bait eaten dropped by about a half.

DISCUSSION

The results with warfarin show exceptional resistance. This agrees with the observation by Fulton, Lutz & Pierce (1953) that hamsters were largely unaffected by dicumarol at up to 75 mg/kg/day for four and a half months, and by Shah & Suttie (1975) that a dose of 100 mg/kg of warfarin was required to block prothrombin synthesis within 24 h. Similarly, the results for difenacoum are comparable with those of Dubock & Kaukeinen (1978), who give the acute LD50 of difenacoum to the golden hamster as 100 mg/kg.

Brodifacoum shows some potential as a rodenticide to control hamsters, in view

Table 1. *Results of no-choice feeding tests with three anticoagulants*

Poison and concentration (%)	Number of days feeding	Sex	Mean body wt (g)	Mortality	Lethal dose of active ingredient (mg/kg)		Survived dose of active ingredient (mg/kg)		Days to death	
					Mean	Range	Mean	Range	Mean	Range
Warfarin										
0·025	28	M	100	0/8	—	—	474	393–566	—	—
0·25	28	M	86	0/4*	—	—	4544	3755–5112	—	—
0·5	56	M	107	3/4*	5891	5784–6081	15037	—	27·3	26–29
Difenacoum										
0·005	21	M	94	1/5	41	—	54	37–75	17·0	—
		F	99	4/6	17·5	9·0–29·0	64	58–70	12·3	8–20
Brodifacoum										
0·005	1	M	106	3/3	2·8	2·2–3·9	—	—	9·7	8–12
		F	120	4/6	2·6	1·9–3·3	2·6	2·1–3·0	15·5	5–25
	2	M	93	4/5	6·9	5·9–8·1	7·2	—	15·8	13–18
		F	95	5/5	7·1	5·0–10·1	—	—	14·8	10–19
	3	M	109	5/5	8·7	7·7–10·6	—	—	11·6	9–15
		F	127	5/5	6·1	5·3–6·7	—	—	12·0	10–13
	21	M	106	5/5	31·8	12·7–64·5	—	—	17·0	7–21
		F	100	4/4	19·0	10·4–25·9	—	—	10·8	5–16

* Survivors of 0·025% warfarin test.

Table 2. *Results of no-choice feeding tests with calciferol and zinc phosphide*

Poison and concentration (%)	Number of days feeding	Sex	Mean body wt (g)	Mortality	Lethal dose of active ingredient (mg/kg)		Survived dose of active ingredient (mg/kg)		Days to death	
					Mean	Range	Mean	Range	Mean	Range
Calciferol										
0·1	1	M	91	5/5	87	60–115	—	—	5·4	3–12
		F	89	5/5	64	48–73	—	—	5·8	4–13
	2	M	95	5/5	108	75–147	—	—	5·0	4–7
		F	88	5/5	128	81–186	—	—	5·0	4–7
Zinc Phosphide										
3·0	1	M	109	1/2	231	—	104	—	1·0	1
4·0	1	M	111	6/7	482	183–674	70	—	1·0	1
		F	108	3/3	113	69–198	—	—	1·0	1
5·0	1	M	115	6/6	373	192–542	—	—	1·0	1
		F	116	4/4	334	254–385	—	—	1·0	1

Table 3. *Bait consumption and mortality given a choice between poisoned and plain baits*

Poison and concentration (%)	Mean body wt (g)	Duration of test (days)	Mean bait intake (g)* Poison	Plain	Number of animals preferring poison	Significance (P)*	Mortality
Zinc phosphide							
4·0	96	2	0·37	1·36	2/10	0·1–0·05	7/10
5·0	90	2	0·49	0·9	5/10	< 0·5	10/10
Calciferol							
0·1	91	2	3·0	5·9	1/10	0·01–0·005	7/10

* Significance of difference between uptake of plain and poisoned bait was calculated from the day 1 data using Student's t test. Bait consumption on day 2 of the test was very variable owing to the onset of the toxic effects of the poison.

of the complete mortality obtained after three days' feeding. However, the survival of one individual for 21 days of continuous feeding on 0·005 % brodifacoum suggests that some animals may show considerable tolerance. The observations indicate hamsters to be considerably less susceptible to brodifacoum than previously suggested by Dubock & Kaukeinen (1978), who report having obtained complete mortality after feeding hamsters on 0·001 % brodifacoum for only one day. Since hamsters are rather susceptible to deficiency of vitamin K (the antidote to anticoagulant poisoning) it could well be that variations in test conditions affecting vitamin K intake could explain the contrasting results (Shah & Suttie, 1975). On the whole, however, it would be expected that our use of wire cages which, by reducing coprophagy, tends to reduce vitamin K intake, would make the hamsters more sensitive to brodifacoum treatment.

The toxicity of calciferol at 0·1 % in bait appears to be adequate for the purpose of controlling hamster infestations. It seems possible, however, that in field conditions its marginal unpalatability and rather rapid action might hinder some animals from consuming a lethal dose. The uniformly complete kills obtained with 5·0 % zinc phosphide suggest that this bait would be effective in control.

The habit of carrying food in the cheek pouches might enable hamsters to detect the noxious properties of poisoned bait and thus prevent their being poisoned easily in field conditions. However, other species with cheek pouches, such as *Thomomys* (pocket gopher) and *Spermophilus* (ground squirrel) can apparently be readily controlled with acute poisons (Marsh & Howard, 1977). Trials are now needed to test the effectiveness of these rodenticides against hamsters in the field.

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