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Comparative Evaluation of Three Second Generation Single-dose Anticoagulant Rodenticides in Short Feeding Trials against Three Rodent Species

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Three second generation single-dose anticoagulant rodenticides, brodifacoum, flocoumafen and bromadiolone at their 0.005% concentration in the baits, were evaluated in short feeding trials against three South Asian rodents, *Rattus rattus*, *Bandicota bengalensis* and *Tatera indica*. It was found that these rodents ingest sufficient amount of poison within 2-3 hr of no-choice feeding to give 80 to 100% mortality with brodifacoum and flocoumafen. Bromadiolone was less effective. Feeding of the poison baits to *R. rattus* for 4 hr in choice with the plain alternative resulted in 50% mortality with brodifacoum and 20% each with flocoumafen and bromadiolone. During the test periods, the consumption of different poison baits by rodents varied from 15.7 to 34.1% and 11.0 to 15.7% of their daily food intake in no-choice and choice tests respectively.

Key Words: **Anticoagulant rodenticides,** *Bandicota bengalensis*, **Bromadiolone, Brodifacoum, Flocoumafen,** *Rattus rattus*, *Tatera indica*

Introduction

The second generation single-dose anticoagulant rodenticides, brodifacoum (Dubock 1980, Mathur & Prakash 1981, Parshad et al. 1985), flocoumafen (Parshad & Chopra 1986) and bromadiolone (Marsh et al. 1980), compared to first generation multi-dose warfarin-type anticoagulants, are more effective, require lesser feeding periods, baits and possess broad spectrum activity against rodent species. Unlike warfarin, which must be consumed on several consecutive days, the lethal dose of second generation anticoagulants can be ingested in a single day's food intake as shown in many species of rodents (Dubock 1980, Lund 1981, Mathur & Prakash 1981, Parshad et al. 1985, Parshad & Chopra 1986). Because of the sporadic feeding behaviour of rodents, any rodenticide which can result in maximum mortality with minimum time of feeding and exposure to baits would give better results in the field control of rodents. Therefore, the potential of broadifacoum, flocoumafen and bromadiolone has been investigated against three South Asian rodents, *Rattus rattus*, *Bandicota bengalensis* and *Tatera indica* in 2–3 hr no-choice and 4 hr choice feeding tests against *R. rattus*.

Materials and Methods

The specimens of the house rat, *Rattus rattus*, were trapped from poultry farms and houses and of the Indian mole rat, *Bandicota bengalensis*, and the Indian gerbil, *Tatera indica*, from crop fields around Ludhiana (Lat. 30°56′N, Long. 75°52′E). These animals were acclimatized individually in cages for atleast 10 days prior to the feeding trials. Equal number of healthy males and females were used in each trial. During the acclimatization period cereal food and water were supplied *ad libitum* to the rodents.

Table 1 *The effect of feeding three anticoagulant rodenticides for short periods on three rodent species*

Species	Poison (0.005%)	Body wt. (g) (mean SE)	Poison feeding period (hr)	Mean bait consumption g per 100 g body weight			Percent poison bait consumption of daily food intake	Percent mortality (number of animals)	Days to death mean (range)
				Plain*		Poison (test period)			
				24 hr	Test period				
				No choice tests					
Rattus rattus	Brodifacoum	113.3±9.2	2	12.14±1.28	1.72±0.18	1.90±0.21^{ns}	15.7	90 (10)	6.1(3.5–10.5)
	Flocoumafen	149.3±11.2	3	8.29±1.15	1.68±0.32	2.83±0.44^{s}	34.1	80(10)	8.6(6.5–13.5)
	Bromadiolone	110.3±4.4	3	10.70±1.52	1.62±0.23	3.52±0.41^{s}	32.9	60(10)	6.2(4.5–7.5)
Bandicota bengalensis	Brodifacoum	157.2±15.3	3	8.72±1.25	2.59±0.32	2.31±0.40^{ns}	26.5	100(6)	8.7(5.5–12.5)
	Flocoumafen	200.3±18.2	3	7.52±0.78	1.86±0.24	1.79±0.39^{ns}	23.8	100(6)	11.3(6.5–14.5)
	Bromadiolone	167.3±10.6	3	8.58±0.73	2.17±0.13	2.78±1.22^{ns}	32.4	17(6)	10.5
Tatera indica	Brodifacoum	141.0±16.1	3	7.96±1.41	1.49±0.24	1.51±0.20^{ns}	19.0	100(6)	6.2(3.5–8.5)
	Flocoumafen	151.7±8.7	3	10.65±1.36	2.06±0.32	2.19±0.47^{ns}	20.6	83(6)	11.3(6.5–14.5)
	Bromadiolone	146.3±14.7	3	8.95±0.76	1.99±0.43	2.31±0.32^{ns}	25.8	50(6)	8.2(4.5–13.5)
				Choice tests					
R. rattus	Brodifacoum	123.3±4.8	4	11.76±0.33	1.22±0.31	1.41±0.32^{ns}	12.0	50(10)	7.5(5.5–9.5)
	Flocoumafen	142.5±12.4	4	10.94±0.56	2.19±0.61	1.72±0.57^{ns}	15.7	50(10)	10.5(5.5–14.5)
	Bromadiolone	114.9±4.6	4	11.96±0.94	1.89±0.61	1.32±0.67^{ns}	11.0	20(10)	7.0(4.5–9.5)

n.s., Non-significant differences between poison and plain food consumption

s, Significant differences ($P<0.05$) between poison and plain food consumption

*, Consumption of plain food during pretreatment period in no-choice and of alternative food in choice feeding tests

The poison baits containing 0.005% concentration of the poison were prepared from 0.25% liquid concentrate of brodifacoum (ICI Ltd., Plant Protection Division, England), 0.5% master mix of flocoumafen (Shell Research Ltd., England) and 0.25% powder concentrate of bromadiolone (Pest Control India Ltd., Madras), using a mixture of wheat flour, sugar and arachis oil (96:2:2). After acclimatization, the singly caged animals were weighed and provided with plain food for 3 days with constant access to water. The poison baits were offered to the rodents on the 4th day between 1700 to 2100 hr for 2–3 hr in no-choice and 4 hr in choice feeding tests. On the day of poisoning, no food was provided to the animals between 1000 to 1700 hr. In the choice tests the locations of cups containing the poison and plain foods were altered after 2 hr to avoid the effects of any site preference on feeding.

Records of food consumption of pre- and post-treatment periods, symptoms of poisoning and time to death were maintained. To test the significance of the differences between the plain and poison food consumption, students 't' test was applied.

Results and Discussion

The summarized results of the short feeding tests with three anticoagulant rodenticides are given in table 1. In no-choice 2–3 hr feeding tests, brodifacoum at its 0.005% concentration in the bait resulted in 100% mortality of three rodent species except one survivor of *R. rattus* which did not ingest any amount of the poison bait during 2 hr of test period. Similarly, with flocoumafen high mortality was obtained but few individuals with low intake survived. Bromadiolone caused relatively less mortality of three rodent species.

The effects of no-choice feeding of brodifacoum, flocoumafen and bromadiolone for 2–3 hr were very close to their 24 hr feeding to these species (Mathur & Prakash 1981, Chopra & Parshad 1985, Parshad et al. 1985, Parshad & Chopra 1986) as well as to several others in case of brodifacoum (Dubock 1980). Though the consumption of poison baits was only 15.7 to 34.1% of the daily food intake of rodents in no-choice and 11.0 to 15.7% in choice tests but the amounts were sufficient for nearly 100% mortality of rodents with brodifacoum and flocoumafen in no-choice and 50% with brodifacoum in choice feeding tests. Earlier, Parshad et al. (1985) have shown that feeding of a small proportion of brodifacoum in 20% of the daily food requirement of *B. bengalensis* and *R. rattus* was sufficient for their complete kill. Similarly, Lund (1981) obtained 100% mortality of *Clethrionomys glareolus* with 0.0005% concentration of brodifacoum in the bait. Though bromadiolone caused relatively low mortality than the other two poisons in the present short feeding trials but with 1–2 days of feeding it has been shown to result in mortality equivalent to that of brodifacoum (Chopra & Parshad 1985).

The differences in the effect of the three anticoagulant rodenticides on rodents were related to their relative toxicities. The acute LD_{50} values of brodifacoum (Redfern et al. 1976), flocoumafen (Shell Research Ltd., Unpublished information) and bromadiolone (Grand 1976) are 0.26, 0.40 and 1.125 mg/kg respectively.

Compared to no-choice, the mortality due to poisoning with all the three rodenticides declined drastically in choice tests (table 1). In field situations, the availability of alternate food over a much larger space would further reduce the response of rodents to the poison baits. Due to this reason, to achieve nearly 100% rodent control in fields, the poison baits containing brodifacoum and bromadiolone are exposed for several (3 to 9) days (Mathur & Prakash 1984, Parshad et al. 1985, Malhi et al. 1986). However, the present study has clearly revealed that the rodents can ingest the lethal dose of brodifacoum, flocoumafen and bromadiolone in short feeding period and only in part of a single day's food intake.

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