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Laboratory trials of three anticoagulant rodenticides for use against the Indian field mouse, *Mus booduga* Gray

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SUMMARY

The efficacy of three anticoagulant rodenticides for use against the Indian field mouse, *Mus booduga*, was evaluated in the laboratory. The poisons, namely warfarin, bromadiolone and brodifacoum, were all found to be toxic enough at the concentrations normally used against other commensal and field rodents. With brodifacoum (0·00125%), bromadiolone (0·005%) and warfarin (0·025%), 83% of the animals died respectively after 1, 1 and 6 days' feeding. It is suggested that brodifacoum and bromadiolone might be more economical than warfarin for use in practical rodent control.

INTRODUCTION

The Indian field mouse, *Mus booduga*, is reported to be fairly abundant in India, particularly in Andhra Pradesh, Maharashtra, Orissa, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal, causing loss to many crops (Prakash, 1976). In Andhra Pradesh the infestation ratio of this species to the lesser bandicoot rat, *Bandicota bengalensis*, was reported to be 7:3 (Purushotham & Mohana Rao, 1979). In spite of the well-established role of the Indian field mouse as an agricultural pest in South India (Chandrahas, 1974; Mohana Rao, 1977), very little work has been done on aspects relating to its control.

The present study was therefore undertaken to investigate the toxicity of anticoagulants to *M. booduga* in Tirupati, Andhra Pradesh. It should be noted, however, that no attempt has been made to establish the optimum concentrations of the poisons tested. The study was designed so as to establish whether the concentrations generally recommended for other species, and therefore often commercially available, could be effective against the test animal also.

METHODS

Mice were live-trapped at Tirupati in crop fields and grasslands that had no prior exposure to poisons. The animals were transferred to the laboratory, sexed and weighed. Animals weighing 10 ± 2 g (mean $\pm$ S.D.) were selected and housed individually in cages measuring approximately $20 \times 30 \times 30$ cm. Experiments included an equal number of males and females, all healthy and not pregnant.

Table 1. *Mortality and bait consumption of* Mus booduga *given a sole diet of different concentrations of warfarin in cracked bajra*

Poison concentration	Feeding period (days)	Poison bait consumed (g): mean ± S.D.		Warfarin consumed (mg/kg): mean ± S.D.		Mortality	Days to death	
		Dead	Survived	Dead	Survived		Mean	Range
0·0125%	2	4·90	4·08 ± 0·74	54·68	49·76 ± 10·66	1/6	12·0	—
	4	8·16 ± 1·46	8·30 ± 1·90	98·18 ± 23·61	96·29 ± 23·04	3/6	11·6	8–14
	6	11·20 ± 0·93	11·30 ± 2·12	144·37 ± 16·70	142·88 ± 38·64	4/6	10·0	7–13
0·025%	2	5·15 ± 0·22	4·73 ± 2·08	126·51 ± 9·26	124·40 ± 17·20	3/6	11·3	7–15
	4	8·25 ± 0·68	7·37 ± 0·32	208·39 ± 22·62	188·09 ± 4·04	4/6	9·0	6–16
	6	10·38 ± 0·95	10·50	266·86 ± 27·12	246·47	5/6	8·6	6–11
0·05%	2	4·16 ± 0·41	3·66 ± 0·37	199·08 ± 24·68	155·53 ± 22·65	3/6	12·3	9–17
	4	8·70 ± 0·54	7·40 ± 0·14	419·34 ± 31·11	312·28 ± 3·35	4/6	9·2	6–15
	6	11·38 ± 0·70	11·00	550·82 ± 40·29	482·45	5/6	8·6	6–13

The anticoagulant rodenticides used were warfarin (4-hydroxy-3-(3-oxo-1-phenyl butyl)-2H-1-benzopyran-2-one), bromadiolone (3-(4-hydroxy-3-coumarinyl)-3-phenyl-1-(4-bromo-P-biphenylyl)propanol) and brodifacoum (3-(3-(4′-bromobiphenyl-4-yl)-1,2,3,4-tetrahydro-1-naphthyl)-4-hydroxycoumarin). The anticoagulants were dry-mixed by hand into the maintenance diet (cracked bajra), to give the required concentrations.

The anticoagulant diet was then offered continuously, 'no-choice' for 1, 2 or 3 days for bromadiolone and brodifacoum and for 2, 4 or 6 days for warfarin. The test observations continued for 21 days after the last day feeding on the anticoagulant. The intake of poisoned bait was recorded, freshly prepared bait offered and mortality noted down daily. The mortality due to poison was confirmed by autopsy and signs of anticoagulant poisoning. Only those showing signs such as pale yellow liver and haemorrhage were recorded to have died of rodenticide poisoning.

Feeding tests were carried out by the method given in the guidelines for the development and biological evaluation of rodenticides prepared by the European Plant Protection Organisation (EPPO, 1975).

RESULTS AND DISCUSSION

The results of the tests show that all three poisons caused satisfactory mortality within a reasonable time. With warfarin, mortality occurred on days 6–17, mainly between 6 and 10 days. Doubling of the dosage of warfarin from 0·025% to 0·05% did not increase mortality or rate of kill and, with the maximum feeding period of 6 days, both concentrations achieved only 83% mortality (Table 1).

The data on the tests with bromadiolone and brodifacoum are given in Tables 2 and 3. Mortality started from day 4 and lasted up to day 18 and maximum kill occurred between day 4 and day 9. The single-day feeding of bromadiolone at 0·005% and of brodifacoum at 0·001 25% resulted in 83% mortality (Tables 2, 3), indicating these dosages to be roughly of equal toxicity to warfarin at 0·025% given for 6 days. The relative toxicity of the three compounds thus seems to be similar in *M. booduga* as compared with other species, namely *Rattus rattus* (Chaturvedi,

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Table 2. *Mortality and bait consumption of* Mus booduga *given a sole diet of different concentrations of bromadiolone in cracked bajra*

Poison concentration	Feeding period (days)	Poison bait consumed (g): mean ± S.D.		Bromadiolone consumed (mg/kg): mean ± S.D.		Mortality	Days to death	
		Dead	Survived	Dead	Survived		Mean	Range
·00125%	1	2·00 ± 0·14	1·37 ± 0·50	1·96 ± 0·30	1·35 ± 0·48	2/6	12·5	10–15
	2	1·50 ± 0·52	0·73 ± 0·20	3·11 ± 0·94	2·02 ± 0·50	3/6	11·6	7–15
	3	5·02 ± 0·71	4·80 ± 1·55	5·27 ± 0·73	4·88 ± 7·71	4/6	13·2	7–17
·0025%	1	2·32 ± 0·45	2·25 ± 0·35	5·78 ± 1·59	5·90 ± 0·40	4/6	9·5	5–18
	2	3·22 ± 1·35	2·90	8·51 ± 1·06	8·43	5/6	8·0	5–12
	3	5·01 ± 1·35	—	10·92 ± 2·20	—	6/6	7·8	5–10
·005%	1	2·33 ± 0·19	1·70	11·39 ± 1·36	8·09	5/6	9·2	6–17
	2	3·62 ± 1·48	2·90	15·74 ± 6·00	13·06	5/6	7·6	5–15
	3	6·80 ± 1·22	—	31·31 ± 7·59	—	6/6	7·0	4–14
·01%	1	1·43 ± 0·32	—	11·96 ± 3·17	—	6/6	8·0	4–14
	2	3·72 ± 1·19	—	33·10 ± 8·58	—	6/6	8·2	4–15
	3	4·58 ± 0·50	—	45·51 ± 4·75	—	6/6	8·3	5–13
·02%	1	1·88 ± 0·49	—	37·90 ± 13·02	—	6/6	5·5	4–7
	2	3·25 ± 0·36	—	49·50 ± 4·92	—	6/6	5·5	4–8
	3	4·72 ± 0·18	—	83·38 ± 12·89	—	6/6	5·2	4–7

Table 3. *Mortality and bait consumption of* Mus booduga *given a sole diet of different concentrations of brodifacoum in cracked bajra*

Poison concentration	Feeding period (days)	Poison bait consumed (g): mean ± S.D.		Brodifacoum consumed (mg/kg): mean ± S.D.		Mortality	Days to death	
		Dead	Survived	Dead	Survived		Mean	Range
·00125%	1	1·90 ± 0·16	2·20	2·98 ± 1·02	2·72	5/6	10·2	6–18
	2	2·12 ± 0·33	1·80	5·43 ± 0·99	5·65	5/6	8·4	5–17
	3	5·64 ± 0·77	5·70	7·45 ± 1·64	8·00	5/6	7·8	5–15
·0025%	1	2·32 ± 0·36	—	6·78 ± 0·98	—	6/6	9·16	5–15
	2	4·02 ± 0·39	—	11·70 ± 1·41	—	6/6	7·16	4–16
	3	6·50 ± 0·28	—	17·35 ± 1·70	—	6/6	7·5	4–13
·005%	1	1·72 ± 0·27	1·50	10·22 ± 1·50	8·42	5/6	9·40	6–14
	2	4·90 ± 0·30	—	23·92 ± 3·33	—	6/6	7·0	5–13
	3	5·78 ± 1·48	—	27·20 ± 7·38	—	6/6	6·66	4–13
·01%	1	2·45 ± 0·48	—	26·18 ± 6·19	—	6/6	7·83	5–11
	2	4·63 ± 0·57	—	47·75 ± 3·28	—	6/6	6·66	4–9
	3	5·28 ± 1·68	—	58·09 ± 16·01	—	6/6	4·83	4–8
·02%	1	2·12 ± 0·77	—	50·85 ± 16·50	—	6/6	8·0	4–12
	2	3·17 ± 0·21	—	69·08 ± 8·02	—	6/6	6·33	4–8
	3	5·23 ± 1·48	—	103·30 ± 25·71	—	6/6	5·16	4–8

Madsen & Thakore, 1975), *Funambulus pennanti* (Mathur & Prakash, 1980), *Sigmodon hispidus* (Gill & Redfern, 1980), *Gerbillus gleadowi* (Soni & Prakash, 1982) and *Rattus rattus*, *R. norvegicus* and *B. bengalensis* (Renapurkar & Kamath, 1982).

In most of the tests it is seen that increase in concentration or feeding period tended to reduce the time to death. However, considerable individual variation

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in susceptibility was found. In a 2-day test with 0·0125 % warfarin, one animal died after eating 54·68 mg/kg of poison, while in a 6-day test (with 0·05 %), another survived after eating 482·45 mg/kg. Similar variation is apparent with 0·001 25 % and 0·005 % concentrations of both bromadiolone and brodifacoum, but as might be expected with these more active compounds, the range is less extreme.

We conclude that warfarin at 0·025 %, bromadiolone at 0·005 % or brodifacoum at 0·0025 %, when applied in suitably formulated bait, may cause effective control of *M. booduga*. Warfarin might, however, require rather lengthy feeding before an acceptably high kill is achieved. Since only warfarin and fumarin are now being used in India, the introduction of either bromadiolone or brodifacoum might effect a saving in the amount of bait and labour required for field treatments.

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