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Control of Murids using Water as Carrier of Anticoagulant Rodenticides

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Water was tested as a carrier for two single-dose anticoagulant rodenticides, viz. brodifacoum and bromadiolone, in the semi-arid conditions of Srinagar Garhwal. In laboratory, brodifacoum (0.0025%) and bromadiolone (0.005%) treated water produced 100% mortality of *Rattus rattus* and *Mus musculus* when offered for 24 hr. All house treatments either with treated water only or with treated water and treated food simultaneously, resulted in more than 84% mortality. It is suggested that water be used as a carrier for both bromadiolone and brodifacoum in semi-arid regions on account of its acceptability, economy and efficiency.

Key Words: **Bromadiolone, Brodifacoum, Control of murids,** *Rattus rattus*, *Mus musculus*, **Water as carrier**

Introduction

Water is a major metabolic necessity, and it is particularly important in the tropics. Moist foods have been reported to be preferred by rodents because of the extra water contents (Chitty 1954, Barnett 1969, Siddiqui & Khan 1982, unpublished data of authors).

Bromadiolone (Grand 1976, Redfern & Gill 1980, and Chopra et al. 1983a) and brodifacoum (Dubock & Kaukeinen 1978, Lund 1981, Soni & Prakash 1981, and Chopra et al. 1983b) have been reported to produce 100% mortality in various murids, and have suitable antidotes. These can be used safely in houses. Their commercial liquid concentrates are fairly miscible in water, and it motivated us to study the possibility of using water as a bait carrier for brodifacoum and bromadiolone to control rodent population in residential areas.

Material and Methods

Laboratory Tests

Rats, *Rattus rattus*, and mice, *Mus musculus* were live trapped from the houses of rural areas of Srinagar Garhwal; (Lat. 30° 13′ N, Long. 78° 48′ and altitude 570 m), caged individually and acclimatized for 15 days before the start of experiment, food and water being provided *ad lib.* A set of 6 healthy animals was taken for each laboratory experiment.

Water consumption: Daily water consumptions of both the murids were observed when given dry or wet (moist kneaded) wheat flour. Each animal was provided 100 ml of water,

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and either 25 g of dry wheat flour or 40 g of wet wheat flour (moisture 67%). In the case of moist food, the actual amount of dry ingredient ingested was calculated by adjusting mean daily evaporation from control moist wheat flour. Water consumption from water cup was corrected by adjusting water of evaporation.

Rodenticide consumption: 100 ml of 0·0025% brodifacoum or 0·005% bromadiolone water solution and 25 g of dry wheat flour were given to each subject. The amount of rodenticide consumed was calculated as follows:

$$\textit{Rodenticide consumed (mg/kg body weight)} = \frac{(C_1+C_2)}{2} \times b \times 100$$

where C_1 is initial concentration of rodenticide (g/100 ml); C_2, the final increased concentration of rodenticide in water due to evaporation (g/100 ml); and b the actual volume of treated water consumed in ml/100g body weight.

The animals were kept under observation till death to record mortality period.

House Trials

In each experimental house (3 to 5 houses for each trial), two baiting points were selected in comparatively undisturbed and darker areas of the house. 200 ml of water in a water cup and 100 g of wheat flour on a sheet of paper (0·36m²) were placed about 45 cm apart daily at each baiting point. Pre-treatment and post-treatment (15 days after rodenticide treatment) bait censuses were taken by recording food (g/house) and water (ml/house) consumption for 3 days. Mortality of murids was calculated from water and food census according to procedure described in EPPO (1975).

In two sets of three houses each, daily water consumptions were recorded in the presence of food for 5 days. Then the food was removed from the houses of the first set and water consumptions were observed in both sets of houses for next 5 days.

Rodenticide in water alone: Separate sets of houses were treated with 0·0025% brodifacoum and 0·005% bromadiolone solutions in water by offering 200 ml of fresh rodenticide solution only at each baiting point for 2 days daily (no food).

Rodenticide in water and a cereal grain bait: Houses were treated using both food and water as rodenticide carrier. Treated grains Jhangora—*Echinochloa frumentacea* (100 g daily) and treated water (200 ml daily) were placed for 48 hr at each baiting point simultaneously (brodifacoum and bromadiolone were used at 0·00125% and 0·0025% concentration respectively in each carrier).

Results and Discussion

Laboratory tests showed that the daily normal water consumption (in ml/100 g body weight) of the two murids did not differ significantly (table 1). Both *R. rattus* and *M. musculus* consumed significantly higher ($P < 0·05$) amounts of water when dry wheat flour was given than when wet wheat flour was offered. However, in *R. rattus*, the difference between two was non-significant on third day (figure 1). This clearly indicates that moisture content present in food decreases the amount of the daily water consumption.

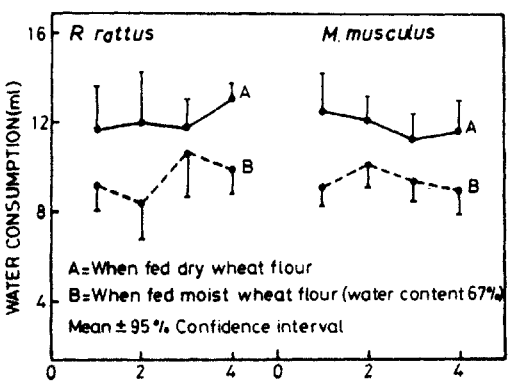

Figure 1 Mean daily water consumption (ml/100 g body weight) by ***Rattus rattus*** and ***Mus musculus***

In houses, the daily water consumption increased until the third day (figure 2) suggesting that more and more murids were becoming aware of the baiting points. After third day, the daily water consumption levelled off. When food was removed from the first set of houses on the fifth day, the water consumption decreased only non-significantly (figure 2) suggesting that the presence of food will have no significant effect on water consumption and therefore, water baits alone can be used for treatment.

Laboratory tests revealed that the difference between water consumption by *M. musculus* of untreated and treated water containing either brodifacoum or bromadiolone (table 1) was non-significant. In *R. rattus* the consumption of treated water having bromadiolone was significantly less ($P < 0{\cdot}01$) than normal water consumption, while no such reduction in consumption of treated water with brodifacoum was observed (table 1).

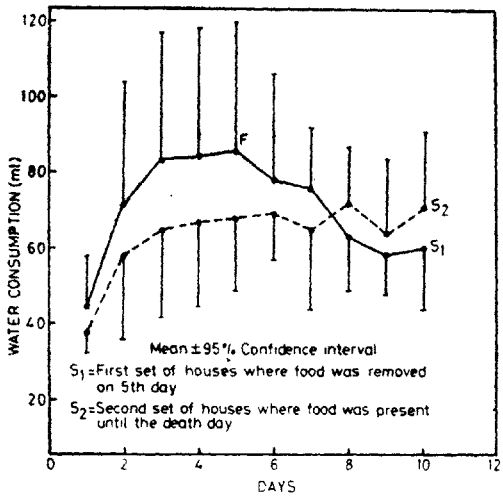

Figure 2 Mean daily water consumption (ml/house)

Table 1 *Acceptability and efficacy of treated water with brodifacoum or bromadiolone (offered for 24 hr)*

Rodenticide and dose %	Species	Water consumption (ml/100 g body weight)		Rodenticide consumed (mg/kg body weight) Mean ± S.E.	Mortality		Significance
		Untreated (control) Mean ± S.E.	Treated Mean ± S.E.		Period (days)	%	
Brodifacoum 0.0025%	*Rattus rattus*	11.24 ± 0.47	12.63 ± 0.64	3.47 ± 0.17	6.67 ± 0.56	100	NS
	Mus musculus	11.96 ± 0.32	11.17 ± 0.59	3.07 ± 0.16	5.67 ± 0.42	100	NS
Bromadiolone 0.005%	*Rattus rattus*	11.74 ± 0.57	9.23 ± 0.32	5.00 ± 0.18	7.33 ± 0.56	100	$P<0.01$
	Mus musculus	11.05 ± 0.54	10.45 ± 0.67	5.65 ± 0.36	7.00 ± 0.26	100	NS

These results suggest that there was no aversion towards treated water (excepting in *R. rattus* towards 0·005% bromadiolone solution).

100% mortality in both murid species was observed with brodifacoum or bromadiolone suggesting that the amount of treated water consumed were sufficient to provide lethal dose of the anticoagulants, in spite of considerable repellency of bromadiolone to *R. rattus*. The acute oral LD_{50} of brodifacoum in *R. rattus* is 0·65 mg/kg body weight (Dubock & Kaukeinen 1978), and in *M. musculus* is 0·04 mg/kg body weight (Redfern et al. 1976).

The time taken to death (mean of mortality period) after treatment by the two species differ nonsignificantly (with both the rodenticides treated) (tables 1 & 2).

In control houses (non-treated) at the time of post-treatment census, both food and water consumptions were slightly higher than those at pre-treatment census. This reveals that there was no mortality of rodents between pre- and post-treatment periods. The treated water resulted in estimated mortality of 84·88±4·32 to 94·66±3·64% based on water census and 88·31±1·69 to 95·29±2·89% based on food census (table 3). Analysis of variance of estimated mortalities based on combined census of water and food showed that there was no difference (nonsignificant) within replicates as well as treatments (table 4). Therefore, any of the treatments can be employed to control house murids effectively. The estimates of mean mortalities based on water and food censuses for respective rodenticidal treatments differ non-significantly (table 3), suggesting that both food and water censuses are equally reliable for the estimation of mortality in rural houses in semi-arid

Table 2 *Analysis of variance of the mortality period of rats and mice*

Source of variance	DF	MS	F	Significance
Treatments	3	3.1111	2.3729	NS
Replicates	5	1.2667	0.9661	NS
Error (within)	15	1.3111		
Total	23			

Table 3 *Index of murid mortality in replicated house trials employing treated water alone or in conjunction with treated cereal grains*

Treatment (48 hr exposure)	Estimated mortality (% Mean±SE)		
	Water census (a)	Food census (b)	Mean of a and b
Brodifacoum, 0.0025% with water only	89.77±4.95	93.44±2.89	91.60±3.81
Brodifacoum, 0.00125% in both water and Jhangora grains	94.66±3.64	95.29±2.89	94.98±3.16
Bromadiolone, 0.005% with water only	84.88±4.32	90.55±4.20	87.72±4.10
Bromadiolone, 0.0025% in both water and Jhangora grains	88.76±3.03	88.31±1.69	88.53±1.82

Ratio a: b is non-significant in each trial

Table 4 *Analysis of variance of estimated mortality of murids based on combined census of water and food*

Source of variance	DF	MS	F	Significance
Treatments	3	54.51	1.2589	NS
Replicates	4	93.20	2.1524	NS
Error (within)	12	43.30		
Total	19			

regions. Further, water as pre-bait as well as carrier of the anticoagulants is economical and acceptable to house rodents. Also the efficacy of the anticoagulants is not lowered. In semi-arid regions, therefore, it can be substituted as bait carrier for rodenticides to control murids in residential premises.

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