The Toxicity of Four Anticoagulant Rodenticides to Common Field Rat in the Laboratory

Alemayehu Woldeamanuel, Merid Kumsa, Million Teshome
Shola Plant Protection Laboratory
Ministry of Agriculture
P.O. Box 62347, Addis Ababa, Ethiopia

Abstract

The efficacy of four anticoagulant rodenticides, viz. coumatetralyl, chlorophacinone + sulfaquinoxaline, bromadiolone and brodifacoum was evaluated under choice and no-choice regimes in the laboratory against the common field rat, *Arvicanthis abyssinicus*. In a no-choice test, brodifacoum was most toxic followed by bromadiolone, chlorophacinone + sulfaquinoxaline, and coumatetralyl. In all choice tests, poison consumption was significantly lower than the alternative plain bait. Acceptability test results among wheat-based anticoagulants revealed that bromadiolone was the most accepted poison while there was no difference among the rest of the chemicals. Except for bromadiolone and liquid coumatetralyl, the acceptance of each test poison was below the USEPA acceptance threshold of 33%.

Introduction

The common field rat, *Arvicvanthis abyssinicus*, is one of the most widely distributed and economically important field rodent pests in Ethiopia. It breeds from September to January and the peak population is expected from January onwards (Fiedler 1985), by which time damage to field crops is high.

Rodent control in Ethiopia and elsewhere in eastern Africa includes physical, biological and chemical methods (Fiedler 1985). In Ethiopia, zinc phosphide has been the most frequently used rodenticide because farmers respond well to its overnight killing effect (Jackson 1986). However, zinc phosphide causes bait shyness in animals ingesting sublethal doses and leads to limited control success. Besides, it is broadly toxic, so that the risk to non-target animals is high. At present anticoagulants are becoming very popular for the control of rodents than acute toxicants because of their efficacy and safety.

Gill and Redfern (1977) tested warfarin (0.025%), chlorophacinone (0.005%), coumatetralyl (0.0375%), difenacoum (0.005%) and calciferol (0.1%) against *Arvicanthis niloticus* in the laboratory and reported that all of these rodenticides were effective. In Ethiopia Abebe (1986) used a four-day test period for determining the toxicity of some anticoagulants but his test did not establish the relationship between duration of the test and mortality. In addition, his experiments did not consider sex difference in the toxicity and acceptance of the anticoagulants.

The objective of our experiment was therefore to determine the response of male and female *A. abyssinicus* to the test anticoagulants and establish dosage-mortality relationships.

Materials and Methods

Rats were collected from crop fields and grazing land from Adele in Arsi. The animals were weighed, sexed and housed individually in cages measuring 37 cm x 33 cm x 21 cm prior to the laboratory poison test. The field collected rats were acclimatized to the laboratory conditions for 21 days before the test to screen out pregnant females. They were provided with food and water throughout the familiarization period. In all tests, pregnant and juvenile rats were rejected and only healthy adults were used.

Except for brodifacoum (where technical grade 93% active ingredient was used) and liquid coumatetralyl (a 0.8% liquid concentrate was diluted with pure water to obtain 0.0375% bait mix), each poison was converted to finished baits by adding the concentrate of each poison to a bait base consisting of whole wheat and vegetable oil. The poison was first added to fine wheat flour to obtain 0.5% brodifacoum master

mix. The master mix was then added to a bait base containing whole wheat, vegetable oil and blue food dye to obtain finished baits of 0.002% and 0.005% brodifacoum. Treatments, their concentrations, and number of rats used in each treatment were as follows:

Treatment	Concentration (%)	No. rats
Coumatetralyl	0.0375	10
Chlorofacenone + sulfaquinixaline	0.0060 + 0.0190	5
Bromadiolone	0.0050	10
Brodifacoum	0.0020	6
Brodifacoum	0.0050	10

Two types of tests were conducted: choice and no choice. In choice tests the rats were allowed to choose from treated and untreated wheat bait of equal weight (20 g, each placed in a separate bait container). Positions of the food bowls were interchanged daily throughout the test period to reduce feeding position bias. In no-choice tests, by contrast, the rats were offered only the treated wheat. Additional 20 g poison and plain baits were separately put in empty cages for adjusting the daily moisture gain or loss by the poison and plain baits.

Six graduated drinking bottles were used in each group cage. Three of them contained 200 ml of either liquid coumatetralyl or pure water. The bottles were placed symmetrically on either side of the cages. Positions of the poison and plain liquid bait bottles were reversed daily to reduce drinking position bias. This test was conducted under choice test regime and the test rats were provided with plain wheat throughout the test period and pure water was put near the test cages to adjust poison liquid or water loss due to evaporation. In all tests, control groups were included to avoid bias from accidental deaths due to infections, malnutrition, etc.

During post test period, rats were maintained with plain wheat and water *ad lib*. The amounts of poison and plain bait eaten were recorded daily to two significant digits and food bowls were replenished daily with fresh poison and plain baits. For 0.0375% coumatetralyl liquid bait test, daily water and liquid poison bait intake were recorded and replenished with fresh liquid poison and water throughout the test period. For all tests, symptoms of poisoning were recorded and all dead rats were autopsied to confirm that the death was due to the ingested poison. The lethal feeding period corresponding to a 50% and 98% kill and their corresponding 95% confidence intervals of the no-choice test were calculated using the probit method analysis of Finney (1971). Percent acceptance of the poison and corresponding plain bait in choice tests were calculated as follows:-

$$\text{Percent acceptance} = \frac{\text{Poison bait consumption (g)}}{\text{Total bait consumption (poison + plain bait)}} \times 100$$

The percent acceptance data were transformed using arcsine transformation to compare poison baits with plain baits by least significant difference test (LSD). A one-tailed *t*-test recommended by USEPA (1985) was used to compare the percent acceptance of the test poison with 33% percent acceptance threshold level.

$$t = \frac{\text{Acceptance standard (33\%) - mean percent acceptance of the poison}}{\text{Standard error of the sample}}$$

Results and Discussion

No-choice Test

Results of toxicity tests in no-choice feeding tests are summarized in Table 1. In this test 0.005% brodifacoum resulted in a 100% mortality within two days of treatment with mean lethal dose of 3.43 mg/kg and 4.4 mg/kg for male and female rats, respectively. This was the shortest feeding period and lowest lethal dose in both sexes when compared with the other three test poisons.

The ranges in days to 100% mortality in both sexes were 5-12, 6-12, 5-15, 5-14, and 8-10 for coumatetralyl, bromadiolone, brodifacoum (0.002%), brodifacoum (0.005%), and chlorophacinone + sulfaquinoxaline, respectively. It can be seen that ranges for 100% mortality for coumatetralyl and bromadiolone are comparable. Similarly, there was no apparent difference between 0.002% and 0.005% brodifacoum in terms of range for 100% mortality, not taking into account sex

difference. Results of our experiments indicate that all the anticoagulants tested were satisfactory since they resulted in 100% mortality in less than 16 days which is suggested by Mathur and Prakash (1982).

Abebe (1986) did not obtain a complete kill of mixed sex-randomly selected *A. abyssinicus* fed on a 0.006% chlorophacinone + 0.019% sulfaquinoxaline bait for four days. In our study even five days of exposure did not result in complete kill in males. Out of five male rats exposed to the poison, four were killed whereas all female rats exposed to the poison were killed.

The pooled dose/mortality data for three anticoagulants that were subjected to probit analysis are presented in Table 2.

Table 1. Toxicity of four anticoagulants against *Arvicanthis abyssinicus* in a no-choice feeding test[a]

Treatment	Days fed	Sex	Mortality	Dose1	Dose2	Days to death
Coumatetralyl	2	M	5/10	40.8	37.9	6.8
		F	7/10	39.5	37.4	7.6
	4	M	9/10	37.8	38.3	8.8
		F	6/10	44.0	42.3	5.3
	6	M	10/10	31.4	-	8.4
		F	10/10	30.5	-	7.8
Chlorofacinone + sulfaquinoxaline	5	M	4/5	5.3	3.9	-
		F	5/5	4.9	12.4	-
Bromadiolone	2	M	6/10	5.0	5.0	8.0
		F	7/10	5.5	7.6	8.7
	4	M	8/10	5.2	5.6	7.8
		F	9/10	4.7	5.7	6.7
	6	M	10/10	4.7	-	8.3
		F	10/10	5.4	-	9.7
Brodifacoum (0.002%)	1	M	4/6	1.7	1.4	7.0
		F	3/6	1.4	1.6	8.7
	2	M	6/6	1.5	-	7.8
		F	5/6	9.0	1.4	7.0
	4	M	5/6	1.7	0.9	10.0
		F	6/6	1.8	-	7.8
	6	M	6/6	6.6	-	9.5
		F	6/6	7.0	-	11.0
Brodifacoum (0.005%)	1	M	10/10	4.4	-	8.6
		F	9/10	5.5	4.4	7.2
	2	M	10/10	3.4	-	10.5
		F	10/10	4.4	-	9.2

[a]*Dose1 and Dose2 refer to lethal and sublethal dosage, respectively.*

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Habtu Assefa, van den Bosch F, Zadoks JC. 1995. Focus expansion of bean rust in cultivar mixtures. Plant Pathology 44:503-509.

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