Relationship of Acceptance and Mortality of Anticoagulant Baits to Rats

by STEVE D. PALMATEER and JOHN A. MCCANN
Animal Biology Laboratory, Technical Services Division
Environmental Protection Agency
Beltsville, Md. 20705

The Federal Insecticide, Fungicide, Rodenticide Act as amended has created a need for information relating to rodenticide evaluation. The measurement of the palatability and acceptance of an anticoagulant rodenticide is a subject of renewed interest and is a controversial area (Miller 1974). Regulatory agencies and methods development committees are developing standard test methods and establishing evaluation criteria relative to rodenticides (Beck 1974). There have been many publications on the relative merits of the five anticoagulant rodenticides discussed in this paper. Examples are: (Hayes and Gaines 1950), (Crabtree and Robinson 1953), (Sanders 1955), (Bentley and Larthe 1959), (Crabteee 1962), (Marsh et al 1967),(Palmateer 1974), and (Colvin and Wang 1974).

There is little meaningful data in the literature concerning the relationship of anticoagulant bait acceptance (percentage of total food consumed that was poisoned with anticoagulant) and subsequent mortality. The assumption that the more attractive a toxic bait is to rats the higher mortality to be expected seems obvious, but it is not well documented. Most of the information relates mortality to the concentration of the anticoagulant (either stomach tubed or free fed) or to the formulation of ingredients in the bait. In our laboratory, we have investigated the relationship of mortality and consumption of anticoagulant rodenticides when offered with a non-poisonous alternate diet. In this paper, we are studying the relationship of a free choice acceptance of a toxicant and resulting mortality in a laboratory situation and will make no attempt to relate the data to actual field use. However, we agree with the assumption of Bentley (1958) ..."that if the anticoagulant has little or no adverse effect on acceptance in a bait in the laboratory, it is safe to assume that the presence of the poison in the bait will not impair acceptance in the field".

METHODS

Wistar strain albino rats, 50 to 60 days old were maintained in a room at approximately 23 C^{O}. The test procedure was described by Palmateer (1974) but will be outlined briefly.

Bulletin of Environmental Contamination & Toxicology,
Vol. 15, No. 6 © 1976 by Springer-Verlag New York Inc.

Twenty rats (equal sexes) were individually housed in a suspended wire cage. The rats were offered an anticoagulant treated bait and a standard laboratory challenge diet in separate cups in excess of the daily food requirements. All anticoagulant rodenticides evaluated were commercial products formulated by more than a hundred different manufacturers and were acquired from virtually all geographical regions of the United States over a 5-year period.

The standard laboratory challenge diet consists of 65 percent whole ground yellow corn meal, 25 percent steamed rolled oats, 5 percent corn oil, and 5 percent confectioners sugar. Anticoagulants tested and reported upon in this paper are: Diphacinone (2-diphenyl-1, 3-indandione), Pival (2-pivalyl-1, 3-indandione), Warfarin [3-(alpha-acetonylbenzyl)-hydroxycoumarin] Prolin is warfarin plus sulfaquinoxaline [N' -(2-quinoxaly) - sulfanilamide] . Fumarin [3-(alpha-acetonylfurfuryl)-4-hydroxycoumarin].

RESULTS AND DISCUSSION

The correlation of the percent acceptance of the various anticoagulant baits and the resulting mortality from the 747 tests (Palmateer 1974) conducted at the laboratory were compared using the statistical methods of Alder and Roessler (1964). The correlation of mean anticoagulant rodenticide bait acceptance and subsequent mortality is highly significant (<0.001) under laboratory conditions (Table 1). The value of the correlation coefficient and the size of the standard error of estimate indicates that all of the data does not lie on the regression line but a substantial trend in coherence is present.

In computing a line with an exponential curve $Y=AX^B$ (Steel and Torrie 1960) with the data from Table 1, a mean expected acceptance for any mortality can be ascertained (figures 1-5). As an example, a Diphacinone bait with a 20.7 percent acceptance could be expected on the average to produce a mortality of 90 percent, and Pival with an acceptance of 22.2 percent could expect an 85% mortality. All formulations are assumed to be at label concentrations.

Dose-response bioassays conducted by intubing exact amounts of the toxicant into the test animal tend to produce results that are more precise. Dieke and Richter (1946) chose to administer toxicants by stomach tube because toxicity is influenced by many factors and they wanted to conduct their tests under uniform optimum conditions. As a result, the standard error of their results is small.

Reference to trade names does not imply endorsement of commercial products by the Federal government.

TABLE 1

Relationship to rats of anticoagulant bait acceptance (Percentage of total food that was poisoned) and mortality. The rats received a free choice between treated and untreated food. Average expected values for any percent acceptance or mortality can be calculated by formula $Y=AX^B$ or [acceptance = A mortality ^{B}]

Anticoagulant	n rats	Correlation* coefficient	Standard error of estimate	B	A
Diphacinone	2100	+0.49	7.93	1.826	0.1059
Pival	1440	+0.76	11.03	1.996	0.0847
Warfarin	3140	+0.65	8.21	2.169	0.0320
Prolin	6420	+0.65	8.51	1.427	0.2736
Fumarin	1840	+0.71	6.14	3.760	0.0004

* All correlation coefficients are statistically significant to less than 0.001.

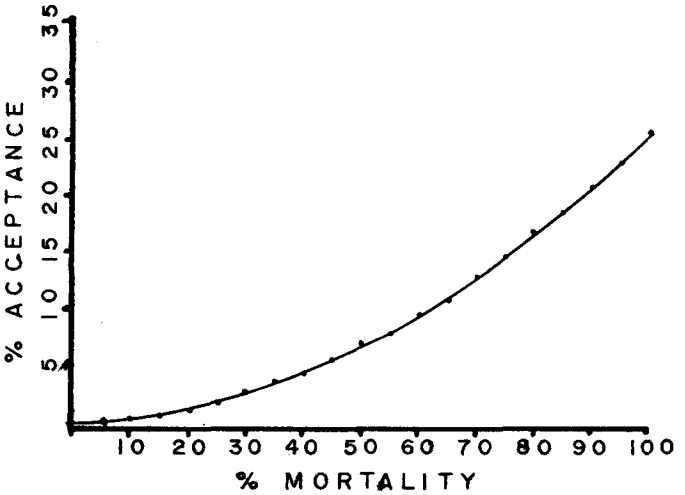

Figure 1. Relationship of percent acceptance of diphacinone rodenticides and mortality.

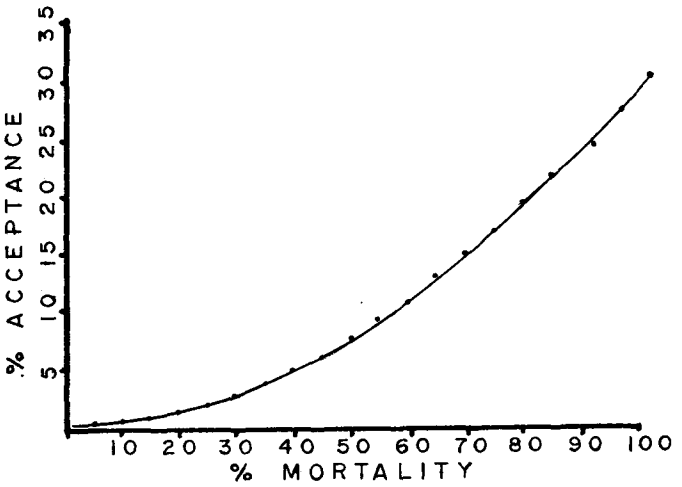

Figure 2. Relationship of percent acceptance of pival rodenticides and mortality.

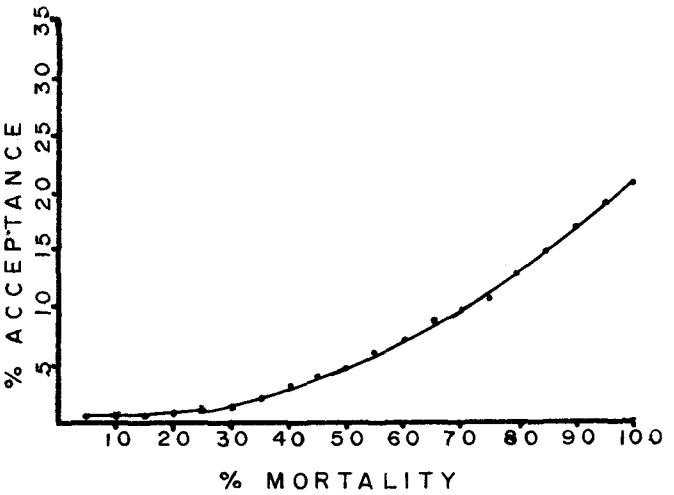

Figure 3. Relationship of percent acceptance of warfarin rodenticides and mortality.

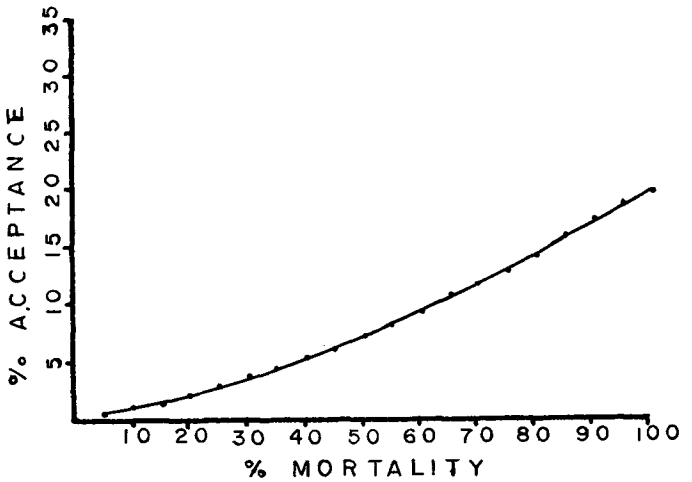

Figure 4. Relationship of percent acceptance of prolin rodenticides and mortality.

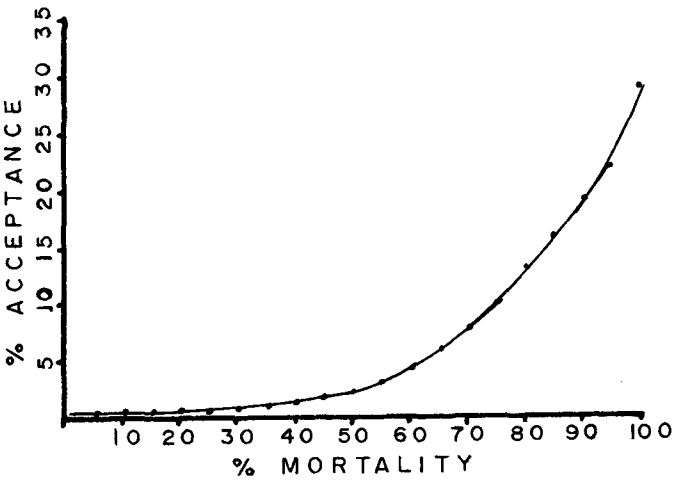

Figure 5. Relationship of percent acceptance of fumarin rodenticides and mortality.

Hayes and Gaines (1959) documented considerable variability of action of toxicants when offered to rats on a food (corn meal). In their study, a nontoxic alternate diet (ground laboratory chow) was offered at the same time. They observed a large variation even though all the rats received the same poison bait and alternate diets.

The data presented in this paper was generated from 747 tests where the rats were offered a free choice between the same standard alternate diet and different commercial baits formulated by more than a hundred manufacturers over a 5-year period. Considering all the variables in our studies, the deviation (standard error of estimate) from the computed value for any mortality-acceptance correlation is relatively small.

CONCLUSION

The data presented in this paper indicates that there is a direct relationship of anticoagulant bait acceptance and mortality. The more acceptable an anticoagulant rodenticide bait is to rats, the greater the mortality to be expected.

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