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Edward F. Marshall
Bell Laboratories, Madison, Wisconsin

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EDWARD F. MARSHALL, Bell Laboratories, 3699 Kinsman Blvd., Madison, Wisconsin 53704

More than once the phrase has been heard, "I don't know what's in your bait, I don't have time to read the label, but it sure does work good." To be quite frank, a pest control operator (PCO) or for that matter, any pesticide user cannot afford not to read and understand pesticide labels.

Commensal rodent control has been practiced for centuries, utilizing a variety of devices and poisons. However, in the last three decades new toxicants and bait forms have been developed, but are not fully understood. It is of great importance that first we take a common sense look at modern day anticoagulant active ingredients and the bait forms in which these toxicants are used.

Anticoagulants in general can be broken into two main chemical families: hydroxycoumarins and indandiones. The family of hydroxycoumarin anticoagulants contains such chemicals as:

1. WARFARIN - 3-(a-Acetonylbenzyl)-4-hydroxycoumarin
2. FUMARIN - 3-(a-Acetonylfurfuryl)-4-hydroxycoumarin
3. PROLIN - Warfarin + Sulfaquinoxaline

Warfarin is the best known and safest of all anticoagulants. Developed in Madison, Wisconsin by the Wisconsin Alumni Research Foundation (WARF), Warfarin was the first chronic (multidose) rodenticide which did not exhibit any bait shyness. However, Warfarin is not without its problems. The Acute Oral LD_{50} of Warfarin for rats is 50 mg/kg, however the LD_{50} for mice is much higher. (Generally mice are much more difficult to control with anticoagulants.) Technical grade warfarin also has a bitter impurity called Alice's ketone which is accentuated in finished meal formulations. Due to the characteristic bitter taste of Warfarin, it is found that to increase the palatability of finished bait forms, it is necessary to hide or disguise the flavor of the active ingredient by a process known as microencapsulation. Microencapsulation succeeded in disguising the flavor of Warfarin, but it increased the costs of the active ingredient by 10 fold. Also, such a good job was done encapsulating the Warfarin that rats and mice ate more bait, but the animals could not break down the wall of the capsule, resulting in a longer period of time before the rodents would succumb to the toxicants. Because Warfarin is a relatively safe compound and based upon its oral LD_{50}, it is used at 0.025% in finished bait forms.

Shortly after the introduction of Warfarin, a second anticoagulant was introduced by the Amchem Corporation called Fumarin. Fumarin is very similar in chemical structure to Warfarin but is claimed not to have the characteristic bitter flavor that Warfarin exhibits. Fumarin has an Acute Oral LD_{50} for rats of 125 mg/kg. Based upon the oral LD_{50}, Fumarin is used at 0.025% in finished bait. Even though Fumarin has performed satisfactorily for a number of years and is relatively safe, the compound is not without its problems. Fumarin is currently undergoing Environmental Protection Agency (EPA) reregistration and, surprisingly enough, not a lot of technical data has been generated over the years. Union Carbide (parent company of Amchem) estimates

that data and testing necessary to support reregistration of Fumarin will run approximately $350,000.00. Needless to say, the future of Fumarin looks gray.

Hydroxycoumarin anticoagulants including the two new "third generation" anticoagulants, brodifacoum and bromadiolone, work by attacking an enzyme responsible for producing Vitamin K. Due to this mode of action, WARF felt that if a bacteriacide (sulfaquinoxaline) that would attack the natural fauna bacteria found in the rodent's stomach which helped in the production of Vitamin K, was added to warfarin for a dual action product, it would increase the effectiveness of the compound. This combination of warfarin and sulfaquinoxaline is called PROLIN and has the same toxicity rating of Warfarin and is used at 0.025% in finished bait forms. EPA is doubtful whether Prolin formulations perform any better than plain Warfarin, and its future too is somewhat gray.

Generally speaking, Warfarin, Fumarin and Prolin are the safest of all anticoagulants and should be utilized when there is a danger of children or non-target animals disturbing the bait placements.

Second generation anticoagulants belong to the chemical family of indandiones which include the following compounds:

1. Diphacinone - 2-Diphenylacetyl-1,3-indandione
2. Chlorophacinone - 2-{(p-chlorophenyl)phenylacetyl}-1,3-indandione
3. Pindone - 2-pivalyl-1,3-indandione
4. Isovaleryl - 2-Isovaleryl-1,3-indandione

Diphacinone was first patented by the Upjohn Corporation as the human drug diphenadione. Considerably more toxic than the hydroxycoumarin products, Diphacinone has an acute oral LD_{50} for rats of 3 mg/kg. Based upon the oral LD_{50}, Diphacinone is used at a rate of 0.005% in a finished bait form. Usually 3 oz. of a finished bait utilizing Diphacinone is sufficient to kill a Norway rat. Not only is Diphacinone more toxic to rats and mice, but conversely the same is true for non-target animals and subsequently the applicators must be more discriminate in their bait placements.

Chlorophacinone is an indandione that is soluble in mineral oil, exhibiting an Acute Oral LD_{50} for rats of 2.3 mg/kg. As Diphacinone, Chlorophacinone is used in a finished bait at 50 ppm or 0.005%.

Pindone is a fascinating anticoagulant developed by Motomco Ltd. which has an Acute Oral LD_{50} of 10 mg/kg. Pindone, being an effective anticoagulant, also exhibits insecticidal, mold inhibiting and fungicidal qualities even when used at the commercial level of 0.025% in a finished bait form.

Isovaleryl is chemically very similar to Pindone but has an Acute Oral LD_{50} of 250 mg/kg. Due to this compound's relatively high LD_{50}, the product is most often used in the calcium salt form as a tracking powder at a level of 2.18%.

Generally speaking, the indandione compounds are approximately four times more toxic to rats and mice than the standard hydroxycoumarin and should be utilized with care so that non-target animals, etc. are not exposed to the bait placements.

Third generation anticoagulants that are now available are two compounds which are analogous of the standard hydroxycoumarin, namely brodifacoum and bromadiolone.

Brodifacoum is chemically similar to Warfarin, however, a bromine ring is attached in a strategic and potentiating point making the compound considerably more toxic than Warfarin. The Acute Oral LD_{50} for rats is 0.2 mg/kg. Brodifacoum is a very good compound for killing rats and mice, but due to its toxicity poses some problems to exposure to non-target animals and secondary poisoning.

Bromadiolone is also very similar to Warfarin, but the bromine ring is again attached in a different location causing the compound to have an Oral LD_{50} of 1.125 mg/kg. Bromadiolone is an effective compound to control rats and mice but does not have as severe hazards associated with it as more toxic compounds.

Generally speaking, brodifacoum and bromadiolone are single feeding anticoagulants, meaning that an animal can consume a lethal dose in just one feeding, but the time to death will still be that of a standard conventional anticoagulant.

The anticoagulant active ingredients which have been discussed are available in several finished bait forms, namely: wax blocks, meals, pellets, liquid and tracking powders. Each of these bait forms has certain advantages and disadvantages which should be understood so that the applicator can choose the bait form appropriate for the particular control situation.

Wax blocks are designed primarily to be used in wet or damp areas. The blocks themselves contain paraffin which "weatherizes" the product. However, due to the paraffin content, wax blocks in many instances are not as palatable as other bait forms. To determine the palatability of one particular wax block over another, simply review the label. The more rodents, use sites, etc. generally the more palatable the product.

Meal baits are very palatable because manufacturers can incorporate various grains and particle sizes into the baits. Also, rodent populations can be determined by the food consumption. Meal baits are most useful for indoor baiting or in enclosed stations away from inclement weather conditions which will cause the bait to mold and become unpalatable.

Pelleted baits, like meals, are very palatable. Rodents, at times, will remove bait from one location to another where they feel more secure and will then go through the feeding process. Pellets, of course, allow rodents to perform this "translocation". However, the process of translocation can at times contaminate sensitive areas with bait, which is the major disadvantage of pelleted baits. Like meal baits, pellets must also be used indoors or in protected outdoor stations.

Place packs can contain either pelleted or meal baits which allow such products to be placed down burrows and used under adverse conditions where open meal or pellets could not be used. Remember, however, that once the packs are open, the baits will deteriorate rapidly if exposed to high humidity, etc.

Liquid baits are extremely useful when entering a control situation that has an abundance of naturally occurring foods (e.g. grain elevator). Rats have a daily dietary necessity for water and mice will drink water if it is available. The obvious disadvantage to water baits is that they cannot be used during the winter months in many locations because of freezing.

Tracking powders are an extremely useful tool that can be utilized in wall voids, false bottoms to kitchen cabinets, between floors or areas with an abundance of naturally occurring foods. Rats and mice walk through small amounts of the powder, picking the product up on their foot pads and hair and then ingest it during the grooming process.

Toxicants only play a small role in an overall rodent control program. Sanitation, mechanical exclusion and environmental manipulation are imperative criteria that must be addressed. Only after the before-mentioned criteria have been addressed can an applicator introduce toxicants. At this point, he should read the label and choose the best toxicant and bait form or combination thereof to get the job done in the safest and most prudent manner. Any by all means, utilize some good common sense.