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Efficiency of varied formulations of zinc phosphide (1%) against *Rattus norvegicus* (Rodentia: Muridae) under laboratory and field conditions

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Abstract:

Laboratory and field studies were carried out to show efficiency of varied formulations of zinc phosphide (1%) against *Rattus norvegicus* (Berkenhout) (Rodentia: Muridae). The gained data cleared that the average of daily bait consumption of zinc phosphide and malathion as tracking powder by males of the Norway rat was 4.0 gram and 3.2 gram for females. The data cleared also the same concentration gave 80% kill for males and complete kill of females with average 1.7 day to death for both sexes. The mortality because of 1% zinc phosphide mixed with malathion 1% gave 90% kill of *R. norvegicus* for both sexes. The obtained data cleared that the palatability of zinc phosphide formulations was (17.2% and 19.0%), (18.1% and 17.5%) and (12.0% and 20.3%) for cake, crushed maize and wax block for Norway rat males and female respectively. There were 49 active burrows of *R. norvegicus* were chosen, divided into 12 burrows were treated with cake, 12 treated with crushed maize, 16 treated with tracking powder and 10 treated with wax block, the number reopened burrows were 2, 4, 4 and 4 for the mentioned formulations, respectively. The data showed that zinc phosphide cake was the more effective (83%), and then tracking powder (75%), crushed maize, (66.7%) and the lowest effect was the wax block (50%) on the numbers of *R. norvegicus*. Applied zinc phosphide formulations plus snap traps gave a high control against Norway rats.

Introduction

Until the late 1940s the acute toxicants were the only rodenticides available. They are still widely used today, and users preferred by many users despite their relatively low efficacy. Rodents that succumb to acute toxicants do so quickly, within a few hours usually and having consumed only a small amount of bait. Most uneducated users, incorrectly, interpret the sight of dead rodents soon after placing small amounts of baits, with only low labour inputs, as a proof of cheap and effective control. The effect of zinc phosphide against different species of rodents was studied by several

investigators (Bradfield and Gill, 1984; Abdallah *et al.*, 1991 and Asran, 2001).

Formulation research must be directed to distinguish as far as possible between different mechanisms of availability and activity. If the toxicant is applied directly to the target rodents, it may be possible to reduce its activity and at the same time retard for reduce its loss. As a matter of fact, the modification of the activity by formulation is essentially a matter of altering its availability to the pest. Since the problems of rodents in Egypt are seriously increasing in both agricultural and public health aspects, research must be directed to reach a quick and effective way of control.

An attempt is made in this study to formulate baits in the form of zinc phosphide, using local raw materials wherever it is possible, that could be considered as successful methods to ensure the activity of the toxicant.

**Materials and methods**

**1. Tested chemicals materials:**

The used Zinc phosphide was brought from Abou Zaalpal Company it has 94% active ingredient. Meanwhile the Malathion powder 1% was provided by Kafer El-Zayat company. The other materials were brought from the market such as, crushed maize ,wheat flour , cotton seed oil and paraffin wax.

**2. Tested formulations:**

**2.1.** Zinc phosphide cake (48.5 crushed maize +48.5 flour +2 oil cotton seeds+ 1% zinc phosphide). **2.2.** Zinc phosphide crushed maize as bait (1% zinc phosphide +crushed maize). **2.3.** 1% Zinc phosphide + malathion 1% as tracking powder. **2.4.** Zinc phosphide wax block.

**3. Tested animals:**

The experimental animals Norway rat, *R. norvegicus* were brought from different fields in Ismailia district, Ismailia Governorate .Rats were individually reared acclimatized under laboratory conditions .Active and healthy rats of both sexes were chosen for each formulation 10 (5 males and 5 females). The rats were weighed to the nearest gram and sex determined. Animals were retained in individual cages, 42, 24, 17 cm small animals or obviously pregnant individuals were omitted from the experiment.

**4. The procedure:**

For bait tow feeding system were carried to determine the efficiency against the Norway rat, free and obliged feeding test. The choice feeding test was described by Htun and Brooks (1979), two cups were to individually caged animals, and one contains plain bait wheat and the other poison bait. Fifty grams of treated and untreated food was provided daily, for non choice feeding test introduce 50 gram from poisoned bait only ( One cup). The bait consumption was calculated to the nearest .01 gram daily .The consumed bait were computed to the body weight of the tested rat. The third group (Control), 5 males and 5 females were caged singly with plain bait

and enough water for the whole period of the experimental. Mortality and the mean death length in day were observed and recorded for 2 weeks. Also, in the case of free choice test the palatability percentages was calculated according to the following equation:

$$\% \text{ Palatability} = \frac{\text{Consumed weight of poison bait}}{\text{Consumed weight of poison bait} + \text{Consumed weight of plain bait}} \times 100$$

Water was available to the tested rat through the experiments. Mortality was observed daily and recorded for three weeks after poisoning. The mean death length in days was calculated. In non choice test, bait consumption was recorded daily and weighed to the nearest 0.01 gram. Another group of 5 rats, 5 mice and 5 meriones of both sexes were caged singly with unpoisoned bait and enough water for the whole period of the experiments.

**5. Tracking powder:**

Rodents, *R. norvegicus*, *Mus musculus* and *Meriones shawi* placed individually in cages at least 24 hrs before the treatment. The test commenced when the trays of tracking powder (1% zinc phosphide +1% malathion) were placed in the tunnels. Ten mature animals (5 males and 5 females) were used forced to touch tracking powder for 4 days .The consumed powder by each animal was estimated daily. Survived animals were observed for an additional 10 days, mortality percentages and day to death calculated for each treatment.

**6. Field trials:**

Two traditional areas were chosen at Nafisha village at Ismailia district ( Found active burrows of *R. norvegicus* ) to apply zinc phosphide formulations, cake, crushed maize, tracking powder and wax block. Twenty traps per one Fadden were put beside every formula of zinc phosphide to calculate the total efficiency for both zinc phosphide formula plus traps. There were 49 active burrows of *R. norvigicus* were chosen, divided into 12 burrows were treated with cake ,12 treated with crushed maize, 16 treated with tracking powder and 10 treated with wax block.

The efficiency calculated as follow:

$$\frac{\text{Closed burrows after treatment}}{\text{Total active burrows before treatment}} \times 100$$

## Results and discussion

### 1. Laboratory trials:

The recorded data in Table (1) showed that the effect of certain concentration of 1% zinc phosphide and malathion 1% as a tracking powder against of *R. norvegicus*. The data cleared that the average of daily bait consumption of zinc phosphide and malathion tracking powder by males of the Norway rat was 4.0 gram and 3.2gram for females. The data cleared also the same concentration gave 80% kill for males and complete kill of females with average 1.7 day to death for both sexes. The compiled results in Table (2) showed that the applied zinc phosphide formulations, crushed maize, wax block, and cake (1% concentration) under two feeding systems, choice and non-choice test against the investigated rodents. The data cleared that *R. norvegicus* males and females consumed in average 3.25 gram, 3.9 gram, 1.9 gram. Under choice test, and 4.24, 4.5 and 2.3 gram under non choice test for the applied formulations cake, crushed maize and wax block respectively (Table 3). The applied, crushed maize gave (100% and 100%) kill and wax block (80% and 80%) kill for both males and females of Norway rat under non choice and choice feeding test. The average time to death was (3.12 day and 2.55 day), (2.5 day and 1.5 day) and (4.12 day and 2.9 day) for cake, crushed maize and wax block against males and females of Norway rat for free and obliged feeding system. The obtained data cleared that the palatability of zinc phosphide formulations was (17.2% and 19.0%), (18.1% and 17.5%) and (12.0% and 20.3%) for cake, crushed maize and wax block for Norway rat males and female respectively. Samol (1972) found that cracked corn was better accepted than a pellet formulation. Asran (1994) found that in his toxicity studies to zinc phosphide (Zn<sub>3</sub>P<sub>2</sub>) on some Egyptian rodents in both choice and non choice tested animals could be arranged in descending order according to their susceptibility to zinc phosphide at 1% concentration as follows; *M. musculus*

> *A. niloticus* > *R. rattus* > *R. norvegicus*. Abd El-Razek (1997) found that the whole used concentrations of zinc phosphide gave entirely kill for each of male and female of the climb rat for either choice or no-choice feeding test.

### 2. Field trials:

The recorded data at Table (4) cleared that the applications of the zinc phosphide formulations, cake, crushed maize, tracking powder and wax block at the field inside the burrows of *R. norvegicus* and their efficiency comparing with traps efficiency. There were 49 active burrows of *R. norvegicus* were chosen, divided into 12 burrows were treated with cake, 12 treated with crushed maize, 16 treated with tracking powder and 10 treated with wax block, the number reopened burrow were 2, 4, 4 and 4 for the mentioned formulations respectively. The data showed that zinc phosphide cake was the more effect (83%), and then tracking powder (75%), crushed maize, (66.7%) and the lowest effect was the wax block on the numbers of *R. norvegicus*. The compiled data at Table (4) showed that the efficiency of the snap traps which put after phosphide zinc formulations treatment. It gave 75% efficiency after wax block treatment. Also, the results cleared that the efficiency of traps were 70%, 65% and 65% after zinc phosphide cake, crushed maize and tracking powder treatments. Generally, applied zinc phosphide formulations plus snap traps gave a high control against Norway rats. Ocampo and Lontoc (2006) found that all the rodenticides treated plots had significantly lower rat damage compared with the untreated. There was significant reduction in rat activities based on tracking of feeding census. Khan (2007) found that after 5 applications of the bait, the rodent activity decreased by 90-96%, except for zinc phosphide treatment the rodent activity decreased by 76.04%.

Table (1): Effect of 1% zinc phosphide concentration and malathion 1% as tracking powder on certain rodents under laboratory conditions.

Rodents	Sex	Av. weight		Weight reduction%	Av. Cons. of powder day/individual (gram)			Av. Cons. of powder in gram /Kg. of body eight			Mortality %		Day to death		
		Before	After		Min	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean.		
<i>Rattus norvegicus</i>	Males	275	246	10.5	1.9	6.1	4.0	13.4	16.4	15.1	80	1.0	2.0	1.5	
	Females	209	194.6	7.0	2.5	3.9	3.2	8.8	24.3	14.8	100	2.0	2.0	2.0	
	Average	242	220.3	8.7	2.2	5.0	3.6	11.1	20.3	14.9	90	1.5	2.0	1.7	
Control	Males	215	215.3	-	2.6	3.9	3.25	-	-	-	0.0	0.0	0.0	0.0	
	Females	134	134.5	-	3.8	6.5	5.15	-	-	-	0.0	0.0	0.0	0.0	
Average		174.5	174.9	-	3.2	5.2	4.2	-	-	-	0.0	0.0	0.0	0.0	

Table (2): Efficiency of certain zinc phosphide formulations (1% concentration) against *Rattus norvegicus* under laboratory conditions (Choice test).

Zinc ph. Form.	Sex	Weight		Weight fluctuation%	Av. cons. of poison bait	Av. cons. of plain bait	Av. cons. of poison bait gr /k gr b w	- Av. cons. of plain bait gr /k gr b w	Palatability%	Mortality%	Time to death		
		Before	after								Min.	Max.	Mean
Cack	Males	214.0	209.3	2.19	3.5	16.8	16.3	78.5	17.2	80	2.0	4.5	3.25
	Females	250.4	240.8	3.8	3.0	12.8	12.0	47.9	19.0	80	2.5	3.5	3.0
	Average	232.2	225.1	3.05	3.25	14.8	14.2	63.2	18.0	80	2.25	4.0	3.12
Crushed maize	Males	300.4	290.5	3.3	4.1	18.5	11.0	61.6	18.1	100	1.5	3.5	2.5
	Females	231.5	221.4	4.4	3.8	17.9	16.4	77.3	17.5	80	1.0	4.0	2.5
	Average	265.9	255.9	3.8	3.9	18.2	13.7	69.5	17.7	90	1.25	3.8	2.5
Wax block	Males	221.8	217.6	2.9	1.5	11.0	6.8	49.6	12.0	80	3.0	5.0	4.0
	Females	207.5	200.4	3.4	2.3	9.0	11.1	43.4	20.3	80	2.5	6.0	4.25
	Average	214.7	209.0	2.6	1.9	10.0	9.0	46.5	15.9	80	2.8	5.5	4.12

Table(3) : Efficiency of certain zinc phosphide formulations (1% concentration) against *Rattus norvegicus* under laboratory conditions (Non choice test).

Zinc ph. Form.	Sex	Weight		Av. cons. of poison bait	Weight fluctuation %	Av. cons. of poison bait gr /k gr b w	Mortality %		Time to death	
		Before	after				Min.	Max.	Mean	
Cack	Males	140.8	134.3	7.5	4.6	53.3	100	1.5	3.0	2.25
	Females	135.0	129.8	6.2	3.9	40.5	80	2.1	3.0	2.55
	Average	137.9	132.05	6.8	4.24	49.3	90	1.8	3.0	2.5
Crushed maize	Males	179.9	173.5	11.2	3.55	62.2	100	1	2	1.5
	Females	199.0	188.4	10.1	5.32	50.7	100	1	2	1.5
	Average	189.4	180.9	10.6	4.5	55.9	100	1	2	1.5
Wax block	Males	223.0	217.6	4.5	2.4	20.2	80	1.5	3.5	2.5
	Females	207.5	203.0	5.2	2.2	20.2	80	2.5	4.0	3.25
	Average	215.2	210.3	4.8	2.3	22.3	80	2.0	3.75	2.9

Table (4) : Efficiency of different formulations of 1% zinc phosphide and traps against certain field rodents in Ismailia Governorate.

Species	Zn. Ph. formulation	Burrows technique		Efficiency% (A)	Total No. of pre applied trap/fed.	Traps		Efficiency% (B)
		No. of active burrows	No of reopened burrow			Av. No. of entrapped rodents/3nights		
<i>Rattus norvegicus</i>	Cack	12	2	83	20	14		70
	Crushed maize	12	4	66.7		13		65
	Tracking powder	16	4	75		13		65
	Wax block	9	5	50		15		75

Tracking powder = mixture from 1% Zn ph.+ 1% malathion

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