DETERMINATION THE PERIODS OF BAIT SHYNESS TO ZINC PHOSPHIDE IN DIFFERENT RODENT SPECIES

EL-DEEB, H. I.[1], A. M. METWALLY[2], M. H. MOWAFI[2], W. M. GABR[1] AND A. E. AL-WAKEEL[1]

1. *Plant Protection Research Institute, ARC, Giza, Egypt.*
2. *Faculty of Agric., Al-Azhar Univ. Cairo.*

(Manuscript received 11 July 2006)

Abstract

Several laboratory experiments were conducted to determine the required period for different rodent species to accept zinc phosphide bait again after previous intake sublethal dose ($^1/_4$ LD_{50}). Results showed that the period of bait shyness differed considerably according to rodent species. Whereas this period was relatively long for rat species i.e. Norway rat, *Rattus norvegicus* (87 days) and roof rat, *Rattus rattus* (61 days) followed by lesser gerbil, *Gerbillus gerbillus* (59 days),while the shorter periods were recorded in case of mice species i.e. house mouse, *Mus musculus* (32 days) and spiny mouse, *Acomys cahirinus* (38 days). The differentiation between those periods may be due to the differeces in feeding patterns among the rodent species.

INTRODUCTION

Zinc phosphide is an important rodenticide, since it is effective against rats and mice, rather cheap, locally produced and is an acute poison with a quick mode of action. It is especially useful for the rapid reduction of large population of rodents (El-Deeb *et al.*, 2001). Also, zinc phosphide is probably the acute poison of choice when anticoagulants cannot be used or are not available. Bait shyness is the major drawback in using zincphosphide against different rodent spcies (Meehan, 1984).

The present work was carried out to determine the precisely period which required to accept zinc phosphide bait again after previouse intake sublethal dose in different rodent species i. e roof rat, *Rattus rattus* , Norway rat, *Rattus norvegicus*, house mouse, *Mus musculus*, spiny mouse, *Acomys cahirinus* and lesser gerbil, *Gerbillus grbillus*, which were the most common and harmful roodent species in Egypt.

MATERIALS AND METHODS

1- Tested Compound :

Zinc phosphide 94% ($Zn_3 P_2$) greyish black powder supplied from KZ Company. It was used as a bait at a rate of 1.0% on crushed maize.

2- Tested Animals:

Five rodent species were used in the present study i.e., roof rat, *Rattus rattus*, Norway rat, *Rattus norvegicus*, house mouse, *Mus musculus*, spiny mouse, *Acomys*

cahirinus and lesser gerbil, *Gerbillus gerbillus*. Individuals of roof rat, house mouse and spiny mouse were trapped from the fields of Yousif El-Sideek district at Fayoum Governorate, while animals of Norway rat and lesser gerbil were caught from Serabium district at Ismailia Governorate. The trapped animals were transported to laboratory and caged individually at least for two weeks for acclimatization and fed on a free crushed maize and water. The unhealthy and pregnant animals were excluded. A few days before the test, animals of each species were sexed, weighed and given a reference number for each one.

3- LD_{50} Determination:

The acute oral toxicity of zinc phosphide to the different tested rodent species was determined according to Horn (1956). Serial four doses of zinc phosphide were selected for each species, measured as mg/kg b.w. and suspended in corn oil. Four adult animals of each species were used for each dose and administered by oral intubation. Animals were fasted for about 12 hrs before treatment. A parallel control test was conducted using plain oil. Mortality was recorded up to 48 hrs after treatment. The LD_{50} values were calculated using special tables given by Horn (1956).

4- Determination The Periods of Bait Shyness:

Several laboratory trails were conducted to determine the period which required for each rodent species to accept zinc phosphide bait again after they had succumbed to them before. Animals of each tested rodent species were divided into groups (each of 10 animals) and caged individually. All animals were fasted at least 12 hrs and treated with sublethal dose ($^1/_4$ LD_{50}) of zinc phosphide on crushed maize to develop the aversion reaction. Zinc phosphide bait 1 % was offered to animals of each group once after 1 month for the first group, 2 months for the second group...etc, respectively until the complete mortality achieved. Animals were fed on a plain diet between treatments. Two successive periods were detected for each tested rodent species. The first one, in which bait consumption and mortality began considered the beginning of removing zinc phosphide bait shyness. The second is the period in which all animals accepted the poison bait resulting in complete mortality. The accurate period for eliminate the adverse effect of zinc phosphide on the treated animals was

Determined using the same procedure but on weekly periods within months and daily periods between weeks.

RESULTS AND DISCUSSION

1- Acute Oral Toxicity (LD_{50}):

The LD_{50} of zinc phosphide was determined in order to choose the suitable dose for further experiments. Data in Table (1) exhibited the determined LD_{50} of zinc phosphide to the five tested rodent species. Roof rat, *Rattus rattus* proved to be the

most susceptible one to zinc phosphide as LD_{50} value was 21.5 mg/kg followed by 26.1 mg/kg for both spiny mouse, *Acomys cahirinus* and lesser gerbil, *Gerbillus gerbillus*, house mouse, *Mus musculus* 31.6 mg/kg while Norway rat, *Rattus norvegicus* was the most tolerant as its LD_{50} was 46.4 mg/kg. The obtained results agree approximately with those obtained by Hon and Mulligan (1982) and Meehan (1984) they reported that LD_{50} in mg/kg for zinc phosphide ranged between 32.3 – 53.3 for *M. musculus* and 27.0 – 40.5 for *R. norvegicus*, while it was 46.4 and 27.8 mg/kg for Norway rat, *R. norvegicus* and spiny mouse, *Acomys cahirinus*, respectively (El-Deeb *et al.*, 2001). Also, this value was determined for albino Norway rat, *R. norvegicus* by El-Deeb *et al.*, (1991) as it was 31.7 mg/kg. Hilton and Robinson (1972) found that LD_{50} of zinc phosphide was 21.3 mg/kg for roof rat *R. rattus*. Htun and Brok (1979) recorded that LD_{50} of the same compound was 25.0 mg/kg for lesser bandicoot *Bandicota bengalenses.* Mean while it was 28.3 mg/kg for the same species (Poche *et al.*, 1979).

2- Periods of Bait Shyness:

Bait shyness to zinc phosphide has been unquestionably shown with several rodent species, a phenomenon representing a drawback for using this acute rodenticide against rats and mice (Meehan, 1984).

2-1- Norway Rat, *Rattus norvegicus*:

Data in Table (2) indicate the response of Norway rat, *Rattus norvegicus* which previous intake sublethal dose ($^1/_4$ LD_{50}) of zinc phosphide to repeate treatments to the same compound. Results showed that rats of the first group did not approach the toxic bait (incorporating 1% zinc phosphide) after one month from the administering the sublethal dose. However, after two months, animals of the second group consumed 8.3 g/rat causing 30% mortality. In the third group, 60% of animals were killed when exposed to the poison bait in the third month consuming 10.8 g/rat. Complete mortality occurred in the fourth month when the animals of the fourth group consumed 10.5 g/rat. These results cleared that bait shyness was induced by zinc phosphide bait and aversion to the poison bait until the fourth month.

The second experiment was conducted to determine the weekly periods of retention of the aversion to zinc phosphide. Data revealed that 60% of the first group of animals were killed during the 12^{th} week after intaking 9.6 g toxic bait/rat. Regarding the second group, 100% mortality achieved during the 13^{th} week because of eating 10.7 g/rat poison bait. It means that bait aversion was mitigated or partially eliminated after 12 weeks from the treatment with sublethal dose of zinc phosphide. The next trail was run to determine more precisely the period of persistence of the aversion to zinc phosphide bait daily among the week. Results showed that 40%

mortality occurred between animals of the first group in the first day from the 13th week (the 85th day) by consuming 9.7 g/rat toxic bait. Also, 60% mortality was given by the second group individuals which consumed 6.8 g/rat poison bait on the 86th day. Concerning the third group, all rats were killed in the 87th day after intaking 8.5 g/rat. These results showed that bait shyness completely disappeared through the 3rd day of the 13th week (after 87 days).

2-2- Roof Rat, *Rattus rattus*:

Concerning the response of the roof rat, *R. rattus* to repeated zinc phosphide bait treatments, data in Table (3) showed that rats which previously treated with sublethal dose of zinc phosphide began feeding the poison bait after two months for animals of the second group giving 50% mortality because of consuming 10.6 g bait/rat, while the aversion of toxic bait was still persist in the first month by animals of the first group. Complete mortality induced during the third month for rats of the third group when consumed 8.9 g/rat poison bait.

Another attempt was carried out to determine the relative actual period to remove the poison bait shyness within month. Results cleared that for the first group of animals 80% mortality induced through the eighth week by consuming 10.4 g/rat from zinc phosphide bait in average. The second group, all animals were killed during the ninth week by having 9.6 g bait consumption per rat. In case of daily response, 30% mortality was recorded at the first day of the ninth week (57th day) by consuming 4.3 g/rat in average for the first group. In the 58th day, 50% mortality had done for rats of the second group after they had intaken 6.7 g/rat from the offered poison bait. Concerning animals of the third group they fed on 8.6 g/rat of the toxic bait in the 59th day causing 60% mortality. Also, 80% mortality occurred in the 60th day when animals of the fourth group ate 9.8 g/rat poison bait. The complete mortality achieved in the 61st day in animals of the fifth group with 10.2 g toxic bait consumption/rat. The former data proved that bait shyness to zinc phosphide disappeared after 61 days for roof rat, *R. rattus*.

2-3- House Mouse, *Mus musculus*:

Regarding the house mouse, *M. musculus*, data in Table (4) showed the response of this species to repeated zinc phosphide bait treatments. Results cleared that after one month, mice of the first group avoid the poison bait, while those of the second group began eating the toxic bait in the second month and all mice were killed with 3.5 g/mouse in average. In case of weekly treatment 70% of mice of the first group intake zinc phosphide bait with average 4.8 g/mouse and killed during the fourth week. Through the fifth week, complete mortality occurred for animals of the second group by consuming 3.2 g/mouse poison bait. Regarding the daily treatments,

results pointed out that house mouse ate 2.8 g/mouse from zinc phosphide bait causing 50% mortality in the first day of the fifth week (29th day) for the first group. During the 30th day, mice of the second group ate 3.1g poison bait/mouse giving 60% mortality. In the 31st day, 90% of mice were killed after consuming 3.4 g/mouse from zinc phosphide bait. All the individual animals of the fourth group were completely killed in the 32th day when consumed 3.2 g/mouse from the toxic bait. The previous results cleared that the aversion to zinc phosphide bait disappeared after 32 days for house mouse

2-4- Spiny Mouse, *Acomys cahirinus*:

Data in Table (5) showed the reaction of spiny mouse *A. cahirinus* to repeated zinc phosphide bait treatments. Results revealed that animals of the first group did not approach the toxic bait post one month from the treatment with sublethal dose of zinc phosphide. After two months 100% of the second group of mice were killed when fed the poison bait and consumed 4.8 g/mouse. For weekly response, data indicated that at the fourth week, mice of the first group consumed 5.6 g/mouse from zinc phosphide bait resulting in 50% mortality while 80% of the second group of mice were killed after consuming 4.8 g/mouse during the fifth week. All mice of the third group were killed during the sixth week when ate 5.3 g/mouse. Regarding the daily treatment, 40% of spiny mice of the first group were killed after eating 4.3 g zinc phosphide bait / mouse during the 36th day. Also, mice of the second group ate 3.5 g/mouse from the poison bait causing 60% mortality in the 37th day. Complete mortality achieved in the 38th day for the spiny mice after consuming 5.4 g/ mouse for animals of the third group. These findings reported that the bait shyness period could be broken after 38 days for spiny mouse.

2-5- Lesser Gerbil, *Gerbillus gerbillus*:

The required period for lesser gerbil, *G. gerbillus* to accept zinc phosphide bait again (after previously intake sublethal dose) was shown in Table (6). Results revealed that there was no consumption from zinc phosphide bait after one month for animals of the first group. Eighty percent of the second group of animals were killed when consumed 6.4 g of poison bait/animal during the second month. Through the third month, complete mortality achieved in case of gerbils of the third group after consuming 7.2 g/animal from the toxic bait. These results showed that bait aversion was induced and confined between the first and second month for *G. gerbillus*. In case of weekly response, data showed that during the eighth week, the individuals of the first group ate 5.4 g/rat from zinc phosphide bait giving 70% mortality, while all animals were killed through the ninth week by consuming 6.4 g/rat from the toxic bait. These data proved that zinc phosphide bait shyness was excluded after the ninth week

from the first treatment with sublethal dose. The daily reaction of *G. gerbillus* to repeated zinc phosphide treatment indicated that 50% of animals of the first group were killed when ate 3.6 g poison bait/animal in the first day of the ninth week (57^{th} day). Animals of the second group intake 4.8 g/individual from the toxic bait in the 58^{th} day and gave 80% mortality for the second group. The third group individuals consumed 5.3 g from the toxic bait/animal during the 59^{th} day causing complete morality. This finding confirmed that poison bait shyness of *G. gerbillus* disappeared after 59 days from the initial exposure to zinc phosphide bait.

Data in Table (7) summarized the comparative bait shyness periods associated with zinc phosphide between the different tested rodent species. Results showed that the period of bait shyness differed considerably according to rodent species. Whereas this period was relatively long for rat species i.e. Norway rat (87 days) and roof rat (61 days) followed by lesser gerbil (59 days) while the shorter periods were in case of mice species i. e. house mouse (32 days) and spiny mouse (38 days). The differentiation between those periods may be due to the differences in feeding patterns among the rodent specie. In this respect, Meehan (1984) mentioned that however the mechanism of feeding is different for the three major commensal species, Norway rats are wary feeders, mice are inquisitive feeders and black rats some where in between. Also mice are not affected by neophobia, they are sporadic and peripatic feeders. The present findings are in harmony with those obtained by El-Deeb *et al* (2001) they found that bait shyness lasted only 7 weeks after intaking sublethal dose of zinc phosphide for spiny mouse, *A. cahirinus*, while it confined until the eleventh week in case of Norway rat, *R. norvegicus*. Also, Saxina and Mathur (1995) studied the poison aversion in house mouse, *M. musculus* after the consumption of a sublethal dose of zinc phosphide, they noticed that the intensity of aversion depends on the period of exposure to the poisoned bait. When exposure period was 1 day the aversion lasted for 15 days and 25 days with 4 days exposure. Also, Prakash and Jain (1971) recorded that bait shyness developed aversion to zinc phosphide after one day exposure to sublethal dose. The poison shyness persisted for at least 115 and 35 days for *Tetra indica* and *Meriones hurrianae*, respectively. The consumption of a small quantity of zinc phosphide ($^1/_4$ LD_{50}) at the first time is likely to be sufficient to elicit unpleasant symptoms but not cause death. The fast onset of toxicosis enables rodents then to associate cause and effect. Affected animals will usually refuse to consume the poisoned food on subsequent occasions or may be reluctant to feed again from bait receptacles (Prakash, 1988).

Table 1 . LD_{50} values of zinc phosphide to different rodent species.

Rodent species	Scientific name	LD_{50} value mg/kg	Confidence limits
Norway rat	*Rattus norvegicus*	46.4	25 - 33
Roof rat	*Rattus rattus*	21.5	10 - 44
House mouse	*Mus musculus*	31.6	16 - 59
Spiny mouse	*Acomys cahirinus*	26.1	17 - 38
Lesser gerbil	*Gerbillus gerbillus*	26.1	14 - 46

Table 2 . Response of Norway rat *Rattus norvegicus* previously treated with $^1/_4$ LD_{50} of zinc phosphide to repeated treatments.

Group No.	Monthly treatments								Weekly treatments				Daily treatments					
	1st month		2nd month		3rd month		4th month		12th week		13th week		85th day		86th day		87th day	
	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality
1	0.0	0.0	-	-	-	-	-	-										
2	-	-	8.3	30	-	-	-	-										
3	-	-	-	-	10.8	60	-	-										
4	-	-	-	-	-	-	10.5	100										
1									9.6	60	-	-						
2									-	-	10.7	100						
1													9.7	40	-	-	-	-
2													-	-	6.8	60	-	-
3													-	-	-	-	8.5	100

Table 3 . Response of roof rat *Rattus rattus* previously treated with $^1/_4$ LD_{50} of zinc phosphide to repeated treatments.

Group No.	Monthly treatments						Weekly treatments				Daily treatments									
	1st month		2nd month		3rd month		8th week		9th week		57th day		58th day		59th day		60th day		61st day	
	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality
1	0.0	0.0	-	-	-	-														
2	-	-	10.6	50	-	-														
3	-	-	-	-	8.9	100														
1							10.4	80	-	-										
2							-	-	9.6	100										
1											4.3	30	-	-	-	-	-	-	-	-
2											-	-	6.7	50	-	-	-	-	-	-
3											-	-	-	-	8.6	60	-	-	-	-
4											-	-	-	-	-	-	9.8	80	-	-
5											-	-	-	-	-	-	-	-	10.2	100

Table 4 . Response of house mouse *Mus musculus* previously treated with $^1/_4$ LD_{50} of zinc phosphide to repeated treatments.

Group No.	Monthly treatments				Weekly treatments				Daily treatments							
	1st month		2nd month		4th week		5th week		29th day		30th day		31th day		32th day	
	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality
1	0.0	0.0	-	-	-	-	-	-								
2	-	-	3.5	100	-	-	-	-								
1					4.8	70	-	-								
2					-	-	3.2	100								
1									2.8	50	-	-	-	-	-	-
2									-	-	3.1	60	-	-	-	-
3									-	-	-	-	3.4	90	-	-
4									-	-	-	-	-	-	3.2	100

Table 5 . Response of spiny mouse *Acomys cahirinus* previously treated with $^1/_4$ LD_{50} of zinc phosphide to repeated treatments.

Group No.	Monthly treatments				Weekly treatments						Daily treatments					
	1*st* month		2*nd* month		4*th* week		5*th* week		6*th* week		36*th* day		37*th* day		38*th* day	
	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality
1	0.0	0.0	-	-												
2	-	-	4.8	100												
1					5.6	50	-	-	-	-						
2					-	-	4.8	80	-	-						
3					-	-	-	-	5.3	100						
1											4.3	40	-	-	-	-
2											-	-	3.5	60	-	-
3											-	-	-	-	5.4	100

Table 6 . Response of lesser gerbil *Gerbillus gerbillus* previously treated with $^1/_4$ LD_{50} of zinc phosphide to repeated treatments.

Group No.	Monthly treatments						Weekly treatmens				Daily treatments					
	1st month		2nd month		3rd month		8th week		9th week		57th day		58th day		59th day	
	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality	Bait consum. (g)	% Mortality
1	0.0	0.0	-	-	-	-										
2	-	-	6.4	80	-	-										
3	-	-	-	-	7.2	100										
1							5.4	70	-	-						
2							-	-	6.4	100						
1											3.6	50	-	-	-	-
2											-	-	4.8	80	-	-
3											-	-	-	-	5.3	100

Table 7 . Periods of bait shyness to zinc phosphide in different rodent species.

Rodent species	Scientific name	Period of bait shyness (day)
Norway rat	*Rattus norvegicus*	87
Roof rat	*Rattus rattus*	61
Lesser gerbil	*Gerbillus gerbillus*	59
Spiny mouse	*Acomys cahirinus*	38
House mouse	*Mus musculus*	32

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تقدير فترات النفور من الطعم لفوسفيد الزنك فى الأنواع المختلفة من القوارض

حسن إبراهيم الديب[1] ، عبد الستار محمد متولى [2] ، مصطفى حلمى موافى[2] ، وحيد محمد جبر[1]، الوكيل السيد الوكيل[1]

١ - معهد بحوث وقاية النباتات – مركز البحوث الزراعية
٢ - كلية الزراعة – جامعة الأزهر - القاهرة

تم إجراء العديد من التجارب المعملية لتقدير الفترة اللازمة للأنواع المختلفة من القوارض لقبول طعم فوسفيد الزنك مرة أخرى بعد تناولها جرعة تحت مميتة منه مسبقاً ($^{1}/_{4}$ LD_{50}).

أظهرت النتائج أن فترة النفور من الطعم اختلفت أعتبارياً طبقاً للنوع ، حيث أن هذه الفترة كانت طويلة نسبياً لنوعي الجرذان الجرذ النرويجي *Rattus norvegicus* (87 يوم) والجرذ المتسلق *Rattus rattus* (61 يوم) يليه الجربوع الصغير *Gerbillus gerbillus* (59 يوم) ، بينما أقصر فترة كانت في حالة نوعي الفئران الفأر المنزلي *Mus musculus* (32 يوم) والفأر الشوكي *Acomys cahirinus* (38 يوم). وهذه الإختلافات في مدة النفور من الطعم قد تعزى الي اختلاف النمط الغذائى بين هذه الأنواع المختلفة من القوارض.