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Comparative Studies Between Zinc Phosphide and Oshar Leaves Extract As A Rodenticide Against Norway Rat *Rattus Norvegicus* (Berkenhout) Under Laboratory and Field Conditions

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ABSTRACT

The rodenticidal effect of ethanolic leaves extract of Oshar, *Calotrips procera* (Ait.) was studied comparatively with zinc phosphide under laboratory and field conditions at (Qaha region) Qaluobia Governorate against the Norway rat, *Rattus norvegicus* (Berkenhout). Results showed that zinc phosphide was more toxic than Oshar extract whereas the acute oral LD_{50} values were 0.27 and 88.0 mg/kg b.w., respectively. The efficiency test showed that in non-choice and free-choice feeding test a bait containing 1 % either zinc phosphide or Oshar plant extract gave 100 % mortality with short time to death for zinc phosphide treatment. Oshar bait was more palatable to mice than zinc phosphide with 56.2 and 40.6 % bait acceptance, respectively. Under the field condition, zinc phosphide caused 78.4 5 % reduction whereas Oshar plant extract reduced 66.5 % the population of the Norway rat, respectively.

INTRODUCTION

Rodents are very common animals in many Egyptian governorates, Shoukry *et al*., (1986), Morsy *et al.,* (1988) and considered as one of the most important pest groups in Egypt. Beside their economic hazard causing damage to agriculture and problems and contamination of stored food materials. They also play an important role as reservoir host for many zoonotic diseases such as plaque and murine. Also, they cause great economic losses to growing and stored crops, poultry and animal farms, food manufactories as well as structure and fabric of buildings. Anticoagulants compounds are generally effective against most rodents species, when used with surplus baiting although long periods of feeding may be required in some cases. However, some species e.g. the Egyptian spiny mouse, *Acomys cahirinus* and the house mouse, *Mus musculus* have a naturally low sensitive to certain anticoagulants and their use would almost certainly lead to control failure (Gill, 1992). In this respect, the sequential treatments of acute poisone fallowed by the anticoagulants was recommended to achieve good control success (Mahmoud and Rennison 1986). Zinc phosphide is the most commonly used acute rodenticide and has a relatively long history of use and it is becoming a standard to compare with newly developed rodenticides (Meehan, 1984).The search for naturally occurring pesticides had in a discovery of some plant-derived compounds that are active against pest species, although their commercial viability is yet to be established. Oshar plant *Calatropis procera* is a common plant containing natural constituents with different biological properties (Lin *et al.,* 1996). The use of toxic plants is especially prevalent in the developing countries, where plants grown locally are cheaper than the synthetic chemical pesticides (El-Gengaihi *et al.*, 1997).The present work aims to study the laboratory toxicity and field preference of zinc phosphide and Oshar plant extract against *R. norvgicus* as one of the most widely distributed rodent species.

MATERIALS AND METHODS

Tested compounds:

Zinc phosphide.Technical grade zinc phosphide (94 % active ingredient) was obtained from Kafr El-Zayat (Kz) Pesticide Company, Egypt.

Oshar leaves extract. Oshar plant *Calotrips procera* was obtained from Aswan Governorate and extracted by ethanol as follows: Oshar leaves were dried and grounded with a mill into fine powder and sieved through 400 M sieve. One hundred gram of sieved powder was macerate in 500 ml of absolute ethanol for three days. The extract was filtered through filter paper satisfied with 2 g anhydrous sodium sulphate and the filtrate was evaporated by rotary evaporate under vacuum at 50 ºC.The ethanolic Oshar crude extract was weighted and kept frozen at – 20 ºC as stocked till required, (Freedman *et al.,* 1979).

Tested animals:

Adult individuals of the Norway rat, *R.norvegicus* were trapped from field at Qaha district, Qaluobia Governorate. Animals were transported to the laboratory, and weighted. Animals were retained individually caged for three days acclimatization and fed on a standard (65 % crushed maize + 25 % ground wheat + 5 % sugar + 5 % corn oil) and water. The sick and pregnant animals were eliminated.

Determination of LD_{50}:

Acute oral LD_{50} of zinc phosphide and Oshar crude extract were determined. Animals of the Norway rat were fasted for about 12 h before treatment. Serial doses of both compounds were measured as mg / kg body weight and mixed with small amount of vegetable oil and orally administered to the animals using stomach tubes, and then water and diet were offered 2 hours after treatment. Five animals were used for each dose. A parallel control test was conducted using plain vegetable oil. Mortality and time to death were recorded up to 4 and 10 days post–zinc phosphide and Oshar treatments, respectively. Dead animals were aulopsied to confirm symploms of poisoning. LD_{50} values were calculated using special tables given by Horn (1956).

Evaluation of zinc phosphide and Oshar extract as rodenticides:

Non choice feeding method:

A group of 10 Norway rat individually caged were used per each treatment. Each mouse was offered 20 g of crushed maize containing either 1 % zinc phosphide or 1% Oshar plant extract. In addition, another group was offered plain crushed maize as check control. The consumed amount of treated bait was recorded daily for 4 successive days then the treated bait was removed. The survivor animals were fed on the standard diet and observed for 28 days. During this period, mortality was recorded and animals were autopsied to observe the symptoms of poisoning.

Free choise feeding method:

The free choice feeding method according to Palmateer (1974) was used to determine the poisoned bait acceptance by comparing its consumption with that of standard challenge diet. Group of 10 animals caged individually were used for each compound and another one as cheek control. Each rat was affected 20 g of crushed maize containing either 1 % zinc phosphide or 1 % Oshar extract and 20 g standard challenge diet in small separate dishes. The position of the two dishes was altered daily to avoid feeding preference for a certain location. The consumed amount of the poisoned bait and standard diet was recorded daily for 4 successive days then the poisoned bait was removed and the survivor animals were fed on the standard diet. Dead animals were counted daily up to 28 days. Bait acceptance was recorded as follows:

$$\text{Acceptance \%} = \frac{\text{Consumed amount of treated bait} \times 100}{\text{Consumed amount of treated bait + standard diet}}$$

Field performance:

Field evaluation of crushed maize bait contains either 1 % zinc phosphide and 1 % Oshar extract was carried out under the field conditions of Qaha district, Qaluobia Governorate. An infested area with the Norway rat, *R.norvegicus* was chosen and divided into 5 plots, each of one feddan. Two plots were chosen for each compound and one plot was left without treatment as cheek control. The population density of *R. norvgicus* was estimated pre- and post-treatment using food consumption method accrding to Dubock (1984). Two kilograms of the candidate bait were packed into plastic sacks each contained 50 gram and distributed in the chosen plot for one week. The consumed amount of each tested bait was recorded. The percentage of population reduction was calculated as follows:

$$\text{Population reduction \%} = \frac{\text{(Pre-treatment)- (post-traetment census)} \times 100}{\text{Pre-treatment census}}$$

RESULTS AND DISCUSSION

Acute oral toxicity:

It has become a common practice to use LD_{50} values for express and compare the toxicity of different pesticides. Data in Table (1) showed that the dose of zinc phosphide (rodenticide) 0.16, 0.19, 0.23, 00.27, 0.33 and 0.39 mg / kg caused 0.20 %, 40 %, 60 %, 80 % and 100 % mortality, respectively. Treated and calculated LD_{50} values were 0.27 mg / kg whereas the doses of Oshar crude plant extract 21.5, 46.4, 100.0 and 215.0 mg / kg caused 20 %, 20 %, 60 % and 80.5 mortality, respectively. Treated and calculated LD_{50} values were 88.0 mg / kg. The average time to death was decreased with increasing the dose of both compound whereas it was 16 and 36 h at dose level of 0.27 and 46.4 mg/kg and reached to 12 and 28 h at dose level of 0.39 and 100 mg/kg for zinc phosphide and Oshar crude extract, respectively. The obtained results clear that on the bases of LD_{50} values, zinc phosphide and Oshar extract proved to be effective against the Norway rat, however, zinc phosphide was more toxic. These findings are in harmony with those of Caughley *et al*, (1998) who mentioned that, the acute oral LD_{50} of zinc phosphide for house mice, *Mus domesticus* was 32 mg / kg b. w. and death occurs within a few hours of ingestion.

Table (1): Acute oral toxicity of zinc phosphide and Oshar extract to the Norway rat, *R. norvegicus*

Compound	Group No.	Dose mg/ kg.	mortality	Time to death		LD_{50} mg/kg
				Range	Mean	
Zinc phosphide	1	0.16	0/5	-	-	0.27 mg/kg
	2	0.19	0/5	-	-	
	3	0.23	1/5	-	18	
	4	0.27	2/5	8-24	16	
	5	0.33	3/5	4-22	15	
	6	0.39	4/5	6-18	12	
Oshar extract	1	21.5	1/5	-	48	88.0
	2	46.4	1/5	-	36	
	3	100.0	3/5	24.36	28	
	4	215.0	4/5	12.48	28	

Evaluation of zinc phosphide and Oshar extract as rodenticides:

Laboratory performance: Data in Table (2) showed that in non-choice feeding test a bait containing either 1% zinc phosphide or 1% Oshar extract gave complete mortality with average bait consumption of 2.1 and 3.8 g / Norway rat, respectively. A considerable variation in the time to death was observed whereas it ranged 6–18 h with an average of 12 h for zinc phosphide and ranged between18-60 h with an average of 32 h for Oshar extract. The palatability and efficacy of 1% zinc phosphide and Oshar extract were tested using free choice method, data in Table (3) indicated that both compounds induced complete mortality 100%

regarding the mean time required to death, results revealed that it was 15 h for zinc phosphide and 42 h for ethanolic Oshar extract. On the other hand, Oshar bait was more palatable to Norway rat than zinc phosphide with 56.2 and 40.6 % bait acceptance, respectively. Reviewing the aforementioned results, it is obvious that both compounds proved to be efficient to house mouse, however, zinc phosphide was more effective. Asran (1994) mentioned that 1 % zinc phosphide bait gave complete mortality of the mouse, *Mus musculus* in choice and non-choice feeding methods. The palatability of the tested animals had a negative correlation with the used concentration and the palatability of *Arvicanthis niloticus* to zinc phosphide at 1.2 and 3 % was 38.5, 21.7 and 17.66 %, respectively. Also, in non-choice and free choice feeding tests, bait containing 1 % Oshar leaves gave 100 % mortality of albino rat, *Rattus norvgicus* followed by Oshar extract by hexane and petroleum ether, while the water extraction had the lowest effect (Gabr *et al.*, 2004).

Table (2): Effect of bait containing 1 % zinc phosphide and 1 % Oshar extract against the Norway rat *R. norvegicus* for 4 successive days using non choice method

Compound	Average bait consumption (g) Norway rat	Mortality	Time to death	
			Range	Mean
Zinc phosphide	2.1	100	6-18	12
Oshar extract	3.8	100	18-60	32

Table (3); Effect of bait containing 1 % zinc phosphide or 1 % Oshar extract against the Norway rat *R. norvgicus* for 4 successive days using free choice method

Compound	Acceptance %	Mortality %	Time to death (h)	
			Range	Mean
Zinc phosphide	40.6	100	6-22	15
Oshar extract	56.2	100	18-70	42

Field performance:

The efficiency of 1 % zinc phosphide and 1 % Oshar extract bait was tested against the rat, *R. norvegicus* under the field conditions of the same region mentioned before. Results in Table (4) show that zinc phosphide caused 78.40 % reduction whereas Oshar extract 66 % reduction of the rat population was recorded. The average of bait consumption was 648 g per feddan, for zinc phosphide, while it was 862 g for Oshar extract. One the light of the obtained results Oshar extract proved to be promising compound that can be effectively used as a rodenticide in comparison with zinc phosphide. El-Deeb *et al.,* (1991) found that 1.5 % zinc phosphide gave 64 and 70 % reduction of *Arvicanthis niloticus* (Geoffrey) and *Meriones shawi* (Duvernoy), respectively. El-Sebaii (1996) indicated that powdered Oshar with LD_{50} of 82 mg/ kg b.w. baited with crushed maize at different ratios proved to have strong lethal effect against rats. On the other hand, Ibrahim (2001) reported that LD_{50} and LD_{90} value of Oshar leaves extract to *R. norvgicus* are 89 and 148 mg/kg, respectively. He added that Oshar extract reduced 85.3 % of rat population. Rizk (2006) found that the poisoned bait of zinc phosphide 2.5 % lost 20 % and 50 % of its effectiveness when exposed to 80 % R.H. for 2 and 7 days, respectively. El-Deeb *et al*., (2011) noticed that golden a shower ethanol extract proved to be promising compound that come to be effectively used as a rodenticide in comparison with zinc phosphide. The rodenticidal effects of seven crude plant extracts were studied under laboratory and field conditions by Abou-Hashem (2012).The results revealed that only three extracts, particularly those extracted by ethanol, promised to be used as a rodenticide against *R. norvegicus*.These are calendula, sumac and camphor extracts.

Table (4): Field performance of zinc phosphide and Oshar extract against the Norway rat, *R norvgicus* at (Qaha region) Qaluobia Governorate

Compound	Average consumption (g / feddan)			Population reduction %
	Pre-treatmnet	Poisonous bait	Post-treatmnet	
Zinc phosphide	463	648	100	78.4
Oshar extract	457	862	155	66.0
control	452	-	461	0

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دراسات مقارنة بين مبيد فوسفيد الزنك ومستخلص اوراق نباتات العشاركمبيد قوارض تحت الظروف المعملية والحقلية على الفار النرويجى *Rattus norvegicus*

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اجريت هذه الدرسة لمعرفة تاثير المستخلص الايثانولى لاوراق نباتات العشار بالمقارنة بمركب فوسفيد الزنك وذلك تحت الظروف المعملية والحقلية فى محافظة القليوبية (منطقة قها) ضد الفار النرويجى *Rattus norvgicus* حيث دلت النتائج المتحصل عليها ان مركب فوسفيد الزنك كان اكثر سمية من المستخلص الايثانولى لاوراق نباتات العشار حيث كانت الجرعة تحت المميتة LD_{50} عن طريق الفم لكلا المادتين ٠.٢٧ و ٨٨.٠ مج / كيلوجرام وحدة وزن على التوالى. واوضحت دراسة الكفاءة انه فى حالة التغذية اللاختيارية non-choice والتغذية الحرة free-choice (الاختيارية) ان الطعم المحتوى على ١ % فوسفيد زنك او ١% مستخلص اوراق العشار اعطى نسبة موت مقدارها ١٠٠ % فى فترة قصيرة لحدوث الموت لمعاملة فوسفيد الزنك. واوضحت الدراسة ايضا ان طعم مستخلص العشار كان اكثر استساغة فى التغذية عن طعم فوسفيد الزنك بنسبة مقدارها ٥٦.٢ و ٤٠.٦ % على التوالى. اما تحت الظروف الحقلية فاعطى مركب فوسفيد الزنك نسبة خفض فى تعداد الفأر النرويجى مقدارها ٧٨.٤ % بينما المستخلص الايثانول لاوراق نباتات العشار اعطت نسبة خفض فى التعداد مقدارها ٦٦ %.