Susceptibility of Ruttus norvegicus, Arvicanthis niloticus and Rattus rattus to Five Anticoagulant Rodenticides.

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ABSTRACT

Susceptibility of Rattus norvegicus , Arvicanthis niloticus and Rattus rattus to five different anticoagulant rodenticides were studied by feeding free-choice tests. These anticoagulants were brodifacoum (0.005 %); difenacoum (0.005 %) ; flocoumafen (0.005 %) and chlorophacinone (0.005 %) ; each as whole wheat grains baits ; in addition to chlorophacinone (0.012) + sulfachinoxaline (0.019 %) as crushed maize mixed with husks of sun -flower seeds. The results showed that difenacoum proved to be more effective against R. norvegicus and Arvicanthis niloticus ; chlorophacinone/sulfachinoxaline mixture was more effective against A. niloticus but chlorophacinone and brodifacoum were more effective against Rattus rattus ; at the recommended dosages. These compounds completely killed the mentioned rats with lowest cumulative dose during the shortest time to death. On the other hand , A. niloticus and Rattus rattus was less susceptible to chlorophacinone and difenacoum at the recommended dosage , respectively. Therefore, the recommended dosage of chlorophacinone and difenacoum should be increased to be more effective against A. niloticus and R. rattus, respectively. It could be said that, all the tested anticoagulant rodenticides could be used for controlling R. norvegicus, A. niloticus and R. rattus except difenacoum and chlorophacinone against R. rattus and A. niloticus, respectively. In other wards , R. rattus and A. niloticus may be gained resistance to difenacoum and chlorophacinone at the recommended dosage, respectively.

INTRODUCTION

Control of the rodents is necessary both for economic and public health reasons. However , many of different formulated anticoagulant rodenticides have been used in rodent control progra-

mme in our developing countries. Almost nothing is known in Egypt about the suscepibility of different common rats species to the anticoagulant rodenticides. However , the anticoagulants have been particularly successful in controlling Norway rats (Rattus norvegicus) whereas the roof-rats (R. rattus) are less susceptible (1). In the same respect , difenacoum (0.005 %) by feeding tests was found to be valuable for controlling warfarin-resistant common rats (Rattus norvegicus), but it was less favourable against ship rats (R. rattus) (2). Anticoagulant bromodiolone (0.005 %) in laboratory feeding tests completely killed warfarin non-resistant R. norvegicus and R. rattus after 1 and 5 days, respectively whereas warfarin-resistant R. norvegicus were all killed in 4 days and resistant Mus musculus in 12 days (3). Brodifacoum (0.005 %) gave a complete mortality against Rattus rattus, R. norvegicus and Mus musculus after one day feeding (4). Ship rats (Rattus rattus) was found more susceptible to lower concentrations of calciferol (vitamin. D2)(5). On the other hand , it was found that, most rats that have survived six-days, feeding are able to survive much longer periods of feeding on the same concentration of warfarin(6).

Therefore, this research was to study the susceptibility of Rattus norvegicus ; Arvicanthis niloticus and Rattus rattus to five different anticoagulant rodenticides ; to detect and develop an results in this respect in our developing countries.

MATERIALS AND METHODS

I. Tested Anticoagulant Rodenticedes :

1 - Kelerat (0.005 % brodifacoum) as whole wheat grains (red bait).
2 - Ratak (0.005 % difenacoum) as whole wheat grains (deep green bait).
3 - Storm (0.005 % flocoumafen) as whole wheat grains (deep green bait).
4 - Cereal-C (0.005 % Chlorophacinone) as whole wheat grains (red bait).
5 - Lepit-E (0.012 % Chlorophacinone/0.019 % Sulfachinoxaline) as crushed maize mixed with husks of sun-flower seeds(red bait).

II. Tested Animals :

Three species were trapped from Abbis-area, include : Norway rats (Rattus norvegicus) roof-rats (Rattus rattus) and Nile rats (Arvicanthis niloticus).

III. Method of Experiment :

The trapped rats (A. niloticus, R. rattus and R. norvegicus) were individually caged and kept for 7-10 days with adequate water and food supply (5). Rats were preconditioned to the test diet from the time they were caged, and then fed on whole wheat diet until starting the test. Fresh bait and clean food pots were provided daily(7).

Two cups were placed inside the cage, one containing the non-poison bait (20 gm. whole wheat) and the other cup containing the poison bait (20 gm.). Daily, fresh baits were supplied and the position of the two bait cups were interchanged. Untreated rats were concurrently caged in separate cages with non-poison bait (wheat grains).

Five rats from each species were used as one treatment. The results were recorded daily on bait consumption (poison and non -poison baits). The total consumption of non-poison and poison baits/rat and mean percentage of appetite were calculated by the following equation (5) :

$$\% \text{ Appetite} = \frac{\text{Mean consumption of choice non-poison baits}}{\text{Mean consumption of non -poison baits for control}} \times 100$$

Mean percentage of palatability was determined by the following equation (5).

$$\% \text{ Palatability} = \frac{\text{Mean weight of choice poison bait/24 hrs}}{\text{Mean weight of choice non-poison bait/24 hrs}} \times 100$$

Mortality percentage and death time of each rat were maintained. The average amount of consumed poison bait in gm/kg body weight as well as from active ingrediant in mg/kg were determined. In addition, the LFP_{50} and LFP_{98} (lethal feeding periods) in days , to obtain 50 and 98 % mortalities were recorded on log probit paper.(8).

RESULTS AND DISCUSSION

A - Effect of anticoagulants on Rattus norvegicus :

The results of the effects of five different anticoagulant rodenticides against Norway rats (Rattus norvegicus) are recorded in Table 1. The amounts consumed by the individual rat from different anticoagulants were low. The lower amounts consumed from poison baits may be due to the choice effect with non-poison baits in the same cage.

In relation to non-poison treatments , the appetite and palatabilly of R. norvegicus to anticoagulants were slightlt low. However, kelerat was found to be more palatable for R. norvegicus whereas ratak was more appetite for this rat.

Concerning the time to death and mortality percent, it was found that cereal-C and ratak poison baits resulted in 100% kill to the tested rat (R. norvegicus) during 4.2 days (3-5 days range) and 4.7 days (3-7 days range), respectively. Kelerat caused 100% mortality during 4.8 days (4-5 days range), lepit-E and storm caused 100 % kill(40-100 and 20-100 %)respectively, during longer time equal to 6.6 (5-8 days range) and 6.2 (5-7 days), respectively.

It was observed that ratak with low cumulative dose (5.25 mg/kg) caused 100 % mortality to the tested rat during short time to death equal to 4.7 days, storm with low cumulative dose (5.63 mg/kg) caused also 100 % kill to the tested rat but during long time to death equal to 6.2 days, whereas kelerat with relatively high cumulative dose (6.67 mg/kg). On the other hand, cereal-C and lepit-E required higher cumulative dosages to cause complete mortality against Norway rat during 4.7 and 6.6 days, since it required 7.15 and 9.4 mg/kg body weight.

Table 1 : Effects of five different anticoagulant rodenticides on R. norvegicus

Anticoagulant rodenticides	Concentration (%)	Mean body weight (gm)	Mean poison bait consumed (gm)	Mean poison bait consumed %	Mean non-poison bait consumed (gm)	Mean non-poison bait consumed %	% appetite	% palatability	% mortality Range	% mortality Final	Time to death (days) Range	Time to death (days) Mean	Average consumed kg body Bait (gm)
Kelerat Brodifacoum	0.005	234.0	38.5	30.5	31.9	31.90	37.22	95.60	20-100	100	4-5	4.8	138.8
Ratak Difenacoum	0.005	248.4	26.1	18.6	47.8	34.10	56.80	54.60	40-100	100	3-7	4.7	105.1
Storm Flocoumafen	0.005	234.5	26.4	18.9	31.1	22.16	39.40	69.80	20-100	100	5-7	6.2	112.6
Cereal-C Chlorophacinone	0.005	249.8	35.7	35.7	47.0	47.00	53.90	75.95	40-100	100	3-5	4.2	142.9
Lepit-E		246.0	19.3	12.1	33.9	21.20	42.40	56.90	40-100	100	5-8	6.6	78.5
Chlorophacinone	0.012												
Sulfoquinoxaline	0.019												

Table 2: Effect of five different anticoagulant rodenticides on A. niloticus

Anticoagulant rodenticides	Concentration (%)	Mean body weight (gm)	Mean poison bait consumed (gm)	Mean poison bait consumed %	Mean non-poison bait consumed (gm)	Mean non-poison bait consumed %	% appetite	% palatability	% mortality Range	% mortality Final	Time to death (days) Range	Time to death (days) Mean	Average amount consumed kg body weight Bait (gm)	Active ingredient (mg
Kelerat Brodifacoum	0.005	123.20	19.53	12.10	28.5	17.80	68.40	67.9	20-100	100	6-8	7.6	158.5	7.9
Ratak Difenacoum	0.005	79.70	10.70	7.64	26.4	18.86	81.20	40.3	20-100	100	6-7	6.8	134.2	6.7
Storm Flocoumafen	0.005	86.76	16.10	10.06	24.6	15.37	67.95	65.4	20-100	100	3-8	6.4	181.3	9.0
Cereal-C Chlorophacinone	0.005	88.90	10.70	10.70	33.4	33.40	80.30	32.1	60-100	100	7-10	8.2	120.4	6.0
Lepit-E		90.70	15.00	15.00	24.10	24.10	73.70	62.2	20-100	100	3-5	4.4	165.4	
Chlorophacinone	0.012													19.8
Sulfaquinoxaline	0.019													31.4

It could be concluded that ratak proved to be more effective against R. norvegicus, since it completely killed the Norway rats with lowest cumulative dose (5.25 mg/kg body weight) during the shortest time to death (4.7 days).

Generally, it could be said that all the examined anticoagulant rodenticides were effective killers against Rattus norvegicus.

B. Effect of anticoagulants on Arvicanthis niloticus :

The results of the effects of five different anticoagulant rodenticides against the Nile rats (A. niloticus) are recorded in Table 2. The amounts consumed by individual rat from different anticoagulant were very low. These lower amounts consumed from the poison baits may be due to the choice effect with non-poison baits in the same cages.

In relation to non-poison treatments, it was found that the appetite of A. niloticus was nearly good for ratak and cereal-C, whereas it was moderate for lepit-E, kelerat and storm. On the other hand, in relation to the choice non-poison bait , it was observed that kelerat, storm and lepit-E were slightly palatable to A. niloticus , whereas ratak and Cereal-C were nearly less palatable.

With respect to the mortality percentages and time to death, it was observed that the mortality pereentages against A. niloticus caused by lepit-E, storm, ratak and kelerat were nearly equal, it was within range 20-100 %, whereas cereal-C caused mortality within range 60-100 %. On the other jhand , lepit-E caused 100 %. mortality in shortest time equal to 4.4 days (3-5 days range). The time to death caused by storm and ratak was 6.4 days (3-8 days) and 6.8 days (6-7 days range), respectively. Kelerat caused 100 % mortality in 7.6 days (6-8 days range), whereas cereal-C needed to longer time to cause completely death to A. niloticus, it needed 8.2 days (7-10 days range).

On the other hand , the average amounts consumed from poison bait in gramme/kg body weight indicated that the anticoagulant poison baits were highly accepted by A. niloticus. However, the average dosages cumulated inside the rat body which required to

kill the animal were calculated in mg active ingredient per kg body weight.

It was found that ratak with the lowest cumulative dose (6.7 mg ai/kg body weight) and short time to death (6.8 days) caused 100 % kill to the Nile rats (A. niloticus). Cereal-C with the lowest cumulative dosage (6.02 mg a.i/kg body weight) and the longest periods to death (8.2 days), whereas storm with large cumulative dosage (9.1 mg/kg body weight) and short time to death (6.4 days) completely killed the Nile rats (A. niloticus). Complete killing was also caused by kelerat with moderate cumulative dose (7.9 mg a.i/kg body weight) and moderate time to death (7.6 days) whereas lepit-E caused also 100 % mortality with largest cumulative dosage (19.84 mg a.i/kg body weight) and shortest time to death (4.4 days).

It could be concluded that ratak was found to be more effective against the Nile rats (Arvicanthis niloticus), it completely killed the Nile rats with lowest cumulative dosage during short time to death. Also, lepit-E was very effective against A. niloticus, since it caused 100 % mortality with highest cumulative dosage during the shortest periods to death. Cereal-C may be needed to increase the concentration of its formulation to decrease the time of death.

It could be arranged the effective anticoagulant rodenticides against A. niloticus, in descending order according to the cumulative dose and time of death into : ratak and/or lepit-E, kelerat, storm and cereal-C.

Generally; it could be asaid that all the tested anticoagulants can be used to control the Nile rats (Arvicanthis niloticus) in the field except cereal-C (Chlorophacinone).

C - Effect of Anticoagulants on Rattus rattus :

The results of the effect of five different anticoagulant rodenticides against roof-rats (Rattus rattus) are recorded in Table 3 from which the following points could be deduced : The choice between poison and non-poison baits in the same cage decreased the consumption from each by roof-rats (R. rattus). So, the amounts consumed by individual rat from different anticoagulant

baits were very low.

The roof-rats (R. rattus) showed slightly appetite to anticoagulant rodenticide baits with relation to appetite of non-poisoned treatments. On the other hand, lepit-E, storm, kelerat and cereal-C were good palatable to R. rattus, whereas ratak was relatively less palatable.

Concerning the mortality percentages and time to death, it could be said that the anticoagulant rodenticides caused 100% mortality to R. rattus within the same range 20-100 % except ratak which caused 60 % mortality within range 20-60 %. Time to death by all the tested anticoagulant were nearly caused within the same range. Time to death caused by storm and cereal-C were 5.6 and 5.8 days whereas it was 6.4 and 6.6 days in the case of kelerat and lepit-E, respectively.

With respect to the amounts consumed from anticoagulants baits in gramme/kg body weight and the average cumulative dosages inside the body of rat in milligramme active ingredient/kg body weight which required for killing roof-rats; it was observed that cereal-C and kelerat were more effective against R. rattus , since they caused 100 % mortality with low cumulative dosages (8.3 and 8.1 mg a.i/kg body weight) during the short periods to death (5.8 and 6.4 days) , respectively. Storm, with moderate dose equal to 9.0 mg a.i/kg body weight, completely killed the roof -rats during short time of death equal to 5.6 days. Lepit-E , with highest cumulative dosages equal to 21.5 mg a.i/kg body weight , caused 100% mortality in 6.6 days. On the other hand, ratak was not able at the recommended dose to kill all the tested roof-rats, since it caused 60 % mortality against R. rattus during 6.3 days. Therefore , it could be said that R. rattus may be tolerant to ratak at the recommended dosages which should be increased to be killer to the roof-rats.

It could be arranged the effective anticoagulant rodenticides against the roof-rats (R. rattus) in a descending order according to the cumulative dose and time to death into : cereal-C , kelerat, storm and lepit-E.

Table 3: Effect of five different anticoagulant rodenticides on Rattus rattus

Anticoagulant Arodenticides	Concentration (%)	Mean body weight (gm)	Mean poison bait consumed		Mean non-poison bait consumed		% appetite	% palatability	% Mortality		Time to death (days)		Avera cons kg bo
			Weight (gm)	%	Weight (gm)	%			Range	Final	Range	Mean	bait (gm)
Kelerat Brodifacoum	0.005	108.8	17.63	11.01	18.67	11.7	42.6	94.4	20-100	100	4-8	6.4	162.0
Ratak Difenacoum	0.005	117.1	15.40	7.70	33.40	16.7	68.7	46.1	20- 60	60	5-7	6.3	131.5
Storm Flocoumafen	0.005	138.8	19.90	20.80	21.20	17.7	47.2	95.7	20-100	100	4-8	5.6	149.4
Cereal-C Chlorophacinone	0.005	146.8	24.30	20.30	26.60	22.2	51.9	91.4	20-100	100	5-6	5.8	165.5
Lepit-E Chlorophacinone Sulfoquinoxaline	0.012 0.019	191.2	33.60	24.50	34.30	24.4	60.7	97.9	20-100	100	5-7	6.6	179.4

Generally, it could be concluded that all the examined anticoagulant rodenticides except ratak could be used for controlling roof-rats (R. rattus).

On the other hand, the lethal feeding periods (in days) from anticoagulants required to obtain 50 and 98 % mortalities for different rodents (LFP_{50} and LFP_{98}) are recoreded in Table 4 and Figures 1,2 and 3). The results indicate that the values of LFP_{50} and LFP_{98} for different rodents. LFP_{50} against Rattus norvegicus were 3.2, 3.8 , 4.6, 5.2 and 5.2 days in the case of cereal-C, kelerat, lepit-E, ratak and storm in ascending order, respectively. Then , the lethal feeding periods required to obtain 50 % mortality by cereal-C and kelerat against R. norvegicus are less than that of any of the other tested rodenticides , whereas LFP_{50} for ratak or storm (5.2 days) are the longer followed by lepit-E (4.6 days) , respectively. LFP_{98} against R. norvegicus are still the shortest in the case of cereal-C (4.0 days) and kelerat (4.8 days), whereas it is nearly equal in the case of storm (6.1 days), lepit-E (6.33days) and ratak (6.8 days) , respectively. So, kelerat and cereal-C proved to be more effective against R. norvegicus.

Lethal feeding periods required to obtain 50 % mortalities against Arvicanthis niloticus were 3.6, 4.3, 5.9, 6.0 and 6.9 days in case of lepit-E, storm , ratak , kelerat and cereal-C, respectively. Lepit-E and storm were very effective against A. niloticus because of their shortest LFP_{50} than that of the other tested rodenticides. On the other hand, LFP_{98} against A. niloticus is shortest one in case of Lepit-E (4.3 days), whereas it is longer in case of storm (6.0 days), ratak (6.4 days), kelerat (7.2 days) and cereal-C (8.3 days), respectively. It could be said that Lepit-E was found to be more effective against A. niloticus because of its shorter lethal feeding periods whereas cereal-C is less effective because of its longer lethal feeding than that of any of the tested rodenticides.

With respect to R. rattus, it was found that storm showed short LFP_{50} equal to 4.9 days whereas the other tested rodenticides exhibited longer LFP_{50} values against R. rattus. These values were

Table 4: Lethal feeding periods (LFP_{50} and LFP_{98}) to different rodent species by different rodenticides (in days).

Rodenticides	Concentration (%)	R. norvegicus		A. niloticus		R. rottus	
		LFP_{50}	LFP_{98}	LFP_{50}	LEP_{98}	LFP_{50}	LFP_{98}
Kelerat Brodifacoum	0.005	3.8	4.8	6.0	7.2	5.1	6.5
Ratak Difenacoum	0.005	5.2	6.8	5.9	6.4	6.1	<10
Storm flocoumafen	0.005	5.2	6.1	4.3	6.0	4.9	6.4
Cereol-C Chloropnacinon	0.005	3.2	4.0	6.9	8.3	5.1	5.4
Lepit-E Chlorophacinon Sulfaquinoxaline	0.012 0.019	4.6	6.3	3.6	4.3	5.2	6.1

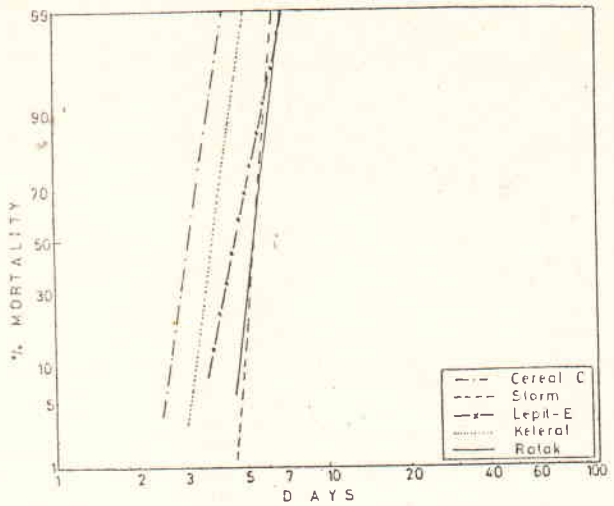


Fig 1 : Lethal-Feeding Period (LFP_{50} and LFP_{98}) for Rattus norvegicus by the anticoagulants.

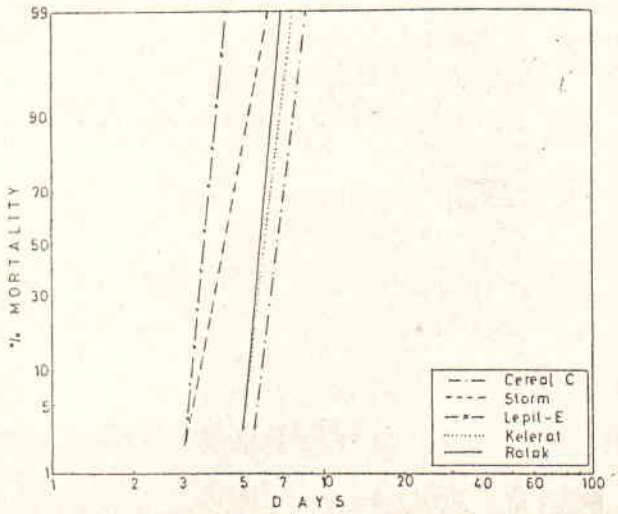
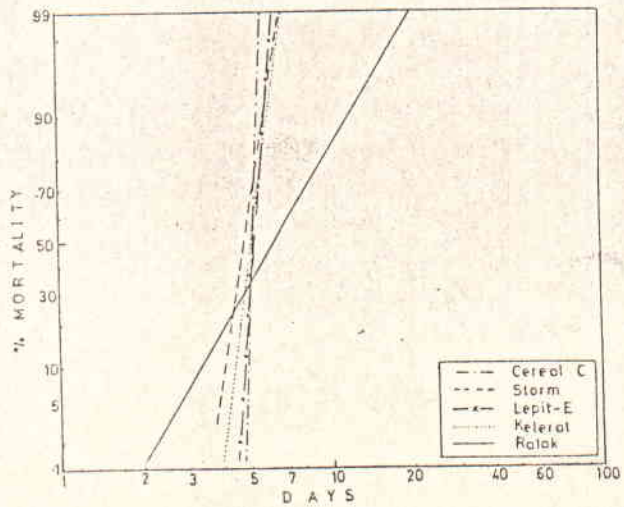


Fig. 2 : Lethal-Feeding Period (LFP_{50} and LFP_{98}) for Arvicanthis niloticus by the anticoagulants.



nearly equal for kelerat, cereal-C and lepit-E (5.1 days), whereas it is equal to 6.1 days for ratak. Concerning LFP_{98} against R. rattus, it was found that there is no difference between LFP_{50} and LFP_{98} for cereal-C, which were equal to 5.1 and 5.4 days, respectively , whereas LFP_{98} was more equally longer in case of lepited-E (6.1 days) , storm (6.4 days) and kelerat (6.5 days), respectively. Rattus rattus may be become tolerant for ratak because it was required LFP_{98} more than ten days (Table 4 and Figs. 1,2 and).

It could concluded that cereal-C and kelerat were more effective against R. norvegicus, followed by lepit-E, storm and ratak, respectively. Lepit-E proved to be more effective against A. niloticus, whereas cereal-C was less effective. The tested rodenticides were equally effective against R. rattus, except ratak which was required more than ten days feeding to cause complete mortality against R. rattus. In other wards, the previousely mentioned results reveals that Rattus rattus and Arvicanthis niloticus may be gained resistance to ratak (0.005 % difenacoum) and cereal-C (0.005 % chlorophacinone), respectively.

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