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THE EFFICIENCY OF SOME ANTI-COAGULANT RODENTICIDES AGAINST HOUSE MICE *Mus musculus* AND SHIP RATS *Rattus rattus*

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ABSTRACT

Laboratory feeding tests were carried out to determine the efficacy of four anticoagulant rodenticides, brodifacoum 0.001%, flocuomafin 0.005%, coumatetralyl 0.0375% and chlorophacinone 0.005% baits against the house mice *Mus musculus* and the ship rats *Rattus rattus* which were trapped from Etay El- Baroud district El-Behera Governorate . "No- choice" feeding tests were carried out in the laboratory.

Results indicated that all anticoagulants caused complete mortality for rats of the two species. Brodifacoum killed all animals after a shorter time (3. 5 and 4.8 days) than flocoumafin (4.5 and 4.9 days) followed by coumatetralyl (5.13 and 6.1 days) and then chlorophacinone (5.17 and 6.4 days) for *Rattus rattus* and *Mus musculus*, respectively with less quantity of consumed bait. For mean time to death no significant differences were observed between sexes of the two species. All rats had decreased food consumption after the second day of treatment. In general, the results seemed that the entire tested compound showed good effect with the order being brodifacoum, followed by flocoumafin then coumatetralyl and chlorophacinone baits under laboratory conditions.

INTRODUCTION

Rats and mice compete with man for food, causing economic loss everywhere. In some developing countries it can cause starvation. Rodents are also a reservoir for human diseases such as plague and occasionally bite people Hayes (1982). The control of rodent pests is essential in many environments, indeed it is a legal requirement for land owners and local authorities. The main weapons in the battle against rats and mice are anticoagulant rodenticides, which inhibit the vitamin-K cycle, prevent blood clotting and cause death from internal bleeding. Warfarin, developed in the 1950s, is probably the best known anticoagulant, but second-generation compounds, such as brodifacoum, difenacoum and bromadiolone, are now the most widely used. Anticoagulants are acutely toxic to most mammals and are highly effective control agents because of their cumulative effect and low lethal dosage Meehan (1984). Many investigators have evaluated the efficacy of some anti- coagulants in the laboratory. Hadler, *et al* (1975) found that difenacoum is valuable against warfarin resistant common rats. Mathur and Prakash (1981) found that feeding tests with 0.002% and 0.005% brodifacoum produced a 100% mortality after three day feeding period in the gerbils and after a four day period in *R. rattus*. Lund (1981) noticed in laboratory feeding tests on a number of European rodent species that anti-coagulants warfarin, difenacoum and brodifacoum caused toxicity to all species, the highest with brodifacoum and the lowest with warfarin. Abou El-

Khear (2000) showed that flocoumafin was more effective than coumatetralyl. The LT_{50} values were 8 and 20 days for the tested rodenticides respectively.

The aim of the present work was to evaluate the efficiency of four anti-coagulants rodenticides baits coumatetralyl, chlorophacinone, brodifacoum and flocuomafin baits against house mice *Mus musculus* and wild ship rats *Rattus rattus* under laboratory conditions.

MATERIALS AND METHODS

Anticoagulant rodenticides :-

First – generation anticoagulant (Multi - dose group)

Coumatetraly (Racoumin®) (4-hydroxy-3-(1,2,3,4-tetrahydro-1-naphthyl) coumarin). Chlorophacinone (Caid®) 2-[(p-chlorophenyl) phenylacetyl]- 1, 3-indandione.

Second-generation anticoagulants (single – dose group):

Brodifacoum (Talon®, Final®) 3-[3-(4'bromo [1, 1'-biphenyl]-4-yl)-1, 2, 3, 4, - tetrahydro- 1-naphalenyl]-4-hydroxy-2H-1-benzophyran-2-one. Flocuomafin (Storm®) 4-hydroxy-3- [1,2,3,4- tetrahydro-3- [4-(4-trifluoromethylbenzyloxy) phenyl]-1-naphthyl] coumarin.

The wild rats, *M. musculus* and *R. rattus* were trapped from Etay El Baroud district El – Behera governorate. They were weighed, sexed and left for three weeks with food and water *ad lib* for adaptation before treatment. Forty eight animals from each species were used for every compound. Feeding tests were carried out on wild, individually caged *R. rattus* and *M. musculus* and treated with baits as follow: coumatetralyl (0.0375%), chlorophacinone (0.005%), brodifacoum (0.001%), flocoumafin (0.005%) and crushed maize as control. Each animal was provided with 50 gm of fresh bait daily during the test, El- Deeb *et al* (1992). The bait consumption was estimated and time elapsed from the beginning of the test till death was recorded. Rats which stayed alive 21 days after treatment were considered alive, Buckle *et al* (1982). All the data were expressed as mean ± standard deviation. Statistical significance of data was performed by student's t- test, Motulsky (1987).

RESULTS AND DISCUSSION

Data in table (1) reveal the efficacy of the four anticoagulants against house mice *Mus musculus*. Results showed that brodifacoum and flocuomafin caused complete kills after 4.8 and 4.9 days of treatment, respectively. There is no significant effect between the different sexes. Male and female mice were killed after (6.1- 6.4) and (6.5 - 6.6) days with treatment by (10.76 – 10.43) and (1.43 – 1.49) mg active ingredient / kg body weight of coumatetralyl and chlorophacinone, respectively. Little difference was seen between brodifacoum and flocoumafin, while there were significantly effects between coumatetralyl and brodifacoum. With

brodifacoum, all mice had decreased poison consumed by second day. Some animals on coumatetralyl showed no effect until third day.

Table (1):-Mortality and bait consumption of house mouse *M.musculus* feed on different poison baits at several days intervals (No-choice).

Treatment	Feeding period (days)	sex	Body weight Gm.	Mortality	Bait consumed Gm/kg	Poison consumed Mg/kg	Days to death Days
Brodifacoum	1	M	21.5±1.21	1/6	154±5.6	0.154±0.02 [a]	6.1±0.04
		F	18.9±1.32	1/6	165±4.5	0.165±0.05 [a]	6.8±0.1
	2	M	17.6±1.23	3/6	185±7.2	0.185±0.04 [a]	5.4±0.2
		F	19.6±1.40	2/6	197±7.5	0.197±0.06 [a]	5.3±0.09
	3	M	21.4±1.31	5/6	224±6.5	0.224±0.02 [a]	5.8±0.11
		F	23.5±1.12	4/6	234±5.8	0.234±0.04 [a]	5.7±0.14
	4	M	18.5±1.41	6/6	265±9.5	0.265±0.03 [a]	4.8±0.22
		F	19.6±1.35	6/6	274±8.4	0.274±0.06 [a]	5.2±0.17
Flocoumafin	1	M	22±1.36	2/6	165±6.4	0.825±0.12 [b]	6.7±0.13
		F	23.4±1.14	2/6	176±7.8	0.88±0.14 [b]	6.4±0.5
	2	M	22.5±1.12	3/6	242±9.5	1.21±0.15 [b]	5.4±0.23
		F	19.6±1.30	2/6	254±8.4	1.27±0.12 [b]	5.7±0.21
	3	M	18.5±1.22	4/6	267±7.2	1.335±0.13 [b]	5.0±0.23
		F	21.3±1.34	4/6	287±5.3	1.435±0.14 [b]	5.1±0.24
	4	M	22.4±1.42	6/6	290±5.4	1.45±0.17 [b]	5.9±0.13
		F	21.7±1.22	6/6	295±6.2	1.475±0.18 [b]	5.6±0.17
coumatetralyl	1	M	20.9±1.13	0/6	164±7.1	6.15±0.51 [c]	-
		F	19.7±1.12	1/6	169±5.4	6.33±0.61 [c]	9.2±0.21
	2	M	18.7±1.32	2/6	221±6.5	8.28±0.42 [c]	8.2±0.31
		F	21.3±1.16	2/6	236±6.8	8.85±0.43 [c]	8.1±0.25
	3	M	22.7±1.20	3/6	256±7.5	9.60±0.52 [c]	7.5±0.41
		F	21.2±1.22	2/6	274±7.8	10.27±0.63 [c]	7.6±0.22
	4	M	19.8±1.13	6/6	285±8.5	10.76±0.54 [c]	6.1±0.14
		F	17.8±1.12	6/6	278±6.7	10.43±0.87 [c]	6.4±0.12
chlorophacinone	1	M	21.4±1.4	1/6	187±8.7	0.935±0.10 [b]	8.7±0.25
		F	20.5±1.12	0/6	196±6.4	0.98±0.13 [b]	8.9±0.13
	2	M	23.1±1.2	1/6	242±9.1	1.21±0.09 [b]	7.6±0.31
		F	19.6±1.14	2/6	253±9.3	1.27±0.15 [b]	7.8±0.26
	3	M	22.3±1.13	3/6	280±8.5	1.40±0.17 [b]	6.4±0.24
		F	21.4±1.25	3/6	297±7.3	1.485±0.11 [b]	6.8±0.27
	4	M	22.1±1.20	6/6	287±8.7	1.43±0.12 [b]	6.5±0.22
		F	21.7±1.23	6/6	298±9.6	1.49±0.18 [b]	6.6±0.32

Means followed by the same letter in a column are not significantly differences at the 5% level of probability.

Table (2) presents the results of the comparative response of the male and female ship rats *Rattus rattus* to the four anticoagulant rodenticides. Complete kill of *R. rattus* after 3 and 4.1 days feeding of male and female, respectively with 0.001% brodifacoum. No significant difference in the susceptibility was shown in the different sexes under the same conditions. The most toxic compounds were brodifacoum and flocoumafin and both were equieffective in this experiment. However, chlorophacinone was the least effective and 7.9 days were required to induce total mortality for females and 11.6 days for males. Coumatetralyl induced a moderate effect. It was required 5.13 and 5.4 days to induce the 100% mortality for males and

females, respectively.When these four anticoagulnts were compared in terms of active ingredient used to cause full mortality, brodifacoum was the more effective followed by flocoumafin then chlorophacinone, while coumatetralyl was the least effective. It is clear that the roof rats *Rattus rattus* were more susceptible for all anticoagulants than the house mouse *Mus musculus*.

Table (2):-Mortality and bait consumption of roof rats *Rattus rattus* feed on ifferent poison baits at several days intervals (No-choice).

Treatment	Feeding period (Days)	sex	Body weight Gm.	Mortality	Bait consumed Gm/kg	Poison consumed Mg/kg	Days to death days
brodifacoum	1	M	79.4 ±2.3	2/6	536±15.6	0.536±0.07 [a]	4.72±0.49
		F	86.6±3.4	3/6	488±13.2	0.488±0.03 [a]	4.91±0.38
	2	M	81.3±2.2	4/6	666±11.5	0.353±0.01 [a]	3.8±0.51
		F	97.6±3.6	4/6	681±15.4	0.681±0.02 [a]	4.1±0.53
	3	M	87.5±4.4	6/6	747±18.5	0.747±0.04 [a]	3.6±0.64
		F	89.3±2.1	5/6	735±15.4	0.736±0.07 [a]	4.0±0.54
	4	M	84.3±3.5	6/6	748±16.8	0.748±0.08 [a]	3.5±0.63
		F	91.4±2.7	6/6	725±11.3	0.725±0.01 [a]	4.1±0.34
flocoumafin	1	M	96.8±4.3	2/6	431±9.8	2.16±0.21 [b]	5.6±0.53
		F	101.3±3.5	1/6	487±10.5	2.43±0.13 [b]	6.1±0.33
	2	M	85.7±4.8	3/6	558±11.3	2.79±0.17 [b]	5.5±0.52
		F	98.1±3.4	3/6	524±12.4	2.62±0.18 [b]	5.8±0.47
	3	M	73.8±3.1	4/6	663±7.3	3.315±0.22 [b]	4.8±0.32
		F	84.9±2.8	4/6	681±9.8	3.405±0.18 [b]	5.1±0.43
	4	M	89.9±3.7	6/6	720±2.8	3.6±0.004 [b]	4.5±0.24
		F	95.6±2.4	6/6	734±4.6	3.67±0.02 [b]	4.9±0.34
coumatetralyl	1	M	88.6±3.6	0/6	513±13.4	19.23±0.45 [c]	8.5±0.25
		F	91.3±3.4	0/6	573±14.5	21.48±0.34 [c]	9.1±0.27
	2	M	93.4±3.4	2/6	598±10.8	22.42±0.64 [c]	7.8±0.18
		F	87.6±2.3	2/6	611±13.4	22.91±0.75 [c]	8.1±0.27
	3	M	94.6±2.3	3/6	638±11.3	23.925±0.61 [c]	6.7±0.29
		F	86.9±3.5	4/6	664±12.4	24.29±0.43 [c]	6.8±0.13
	4	M	99.8±4.3	6/6	728±3.9	27.3±0.33 [d]	5.13±0.11
		F	86.4±4.3	6/6	753±1.4	28.24±0.49 [d]	5.40±0.14
chlorophacinone	1	M	97.6±4.5	0/6	487±10.4	2.44±0.14 [b]	7.6±0.12
		F	81.7±4.1	0/6	504±12.2	2.52±0.12 [b]	7.9±0.13
	2	M	110.1±2.4	2/6	591±3.8	2.96±0.22 [b]	7.1±0.06
		F	87.8±2.3	1/6	581±4.5	2.91±0.08 [b]	7 5±0.04
	3	M	95.4±4.6	3/6	634±6.3	3.17±0.16 [b]	6.3±0.05
		F	88.52.3	3/6	679±7.4	3.39±0.21 [b]	6.8±0.17
	4	M	97.5±4.3	6/6	717±8.7	3.59±0.08 [b]	5.17±0.21
		F	88.3±4.1	6/6	738±9.9	3.69±0.03 [b]	5.70±0.21

Means followed by the same letter in a column are not significantly differences at the 5% level of probability.

Table (3) showed the calculated LFP_{50} (Lethal Feeding Period to obtain 50 % mortality) for the tested anticoagulant rodenticides. The susceptibility of the *Mus musculus* to all tested anticoagulant was such that all required less than 7.55 days feeding for an expected 50% mortality, while *Rattus rattus* required less than 5.65 days for the same results. This data were revealed with Brooks *et al* (1980), Redfern and Gill (1980), El Deeb *et al* (1992), El-Gendy *et al* (1996) and Abou El – Khear (2000). Similar results were reported by Gill and

Redfern (1979) and Apperson *et al* (1981). Thus, the results of the present investigation and the previously reported data on the other populations, all agree that the anticoagulant brodifacoum is well accepted by rats in poison baits, and that it might be more economical than coumatetralyl and chlorophacinone for use in field rodent control.

Table (3):- *Baseline susceptibility* of *M. musculus* and *R. rattus* to the tested anticoagulant rodenticides (95 % confidence limits in days given for each lethal feeding period)

Anticoagulant	Species	No. of rats	Slope function	$LEFP_{50}$ days	$LEFP_{95}$ days
Brodifacoum	*M. musculus*	48	1.92	5.35[a]	5.75
	R. rattus	48	1.76	2.91[b]	3.6
Flocoumafin	*M. musculus*	48	1.84	5.55[a]	5.95
	R. rattus	48	1.65	5.65[a]	5.9
Coumatetralyl	*M. musculus*	48	1.36	7.55[c]	8.5
	R. rattus	48	1.48	5.3[a]	6.9
chlorophacinone	*M. musculus*	48	1.54	6.4[c]	7.8
	R. rattus	48	1.32	5.4[a]	6.9

Means followed by the same letter in a column are not significantly differences at the 5% level of probability.

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فعالية بعض مبيدات القوارض المسيلة للدم على فؤيرة المنازل والفأر المتسلق

ربيع كامل أبو الخير

معهد بحوث وقاية النباتات – محطة بحوث إيتاى البارود

أجريت دراسة معملية لتقييم فعالية أربع مبيدات مانعة للتجلط وهى الفينال (بروديفـاكوم ٠,٠٠١ %) والأستورم (فلوكومافين ٠,٠٠٥%) ممثلة لمبيدات الجيل الثانى من مانعات التجلط و الراكومين (كوماتترالين ٠,٠٣٧٥ %) والسوبر كايد (كلوروفاسينون ٠,٠٠٥%) مـن الجيـل الأول ضد نوعين من الفئران البريةالواسعة الإنتشار وهى فـؤيرة المنـازل *M. musculus* والفأر المتسلق *R. rattus* والتى تم إصطيادها من منطقة ايتاى البـارود محافظـة البحيـرة ٠ أجريت التجربة بطريقة عدم الاختيارية الغذائية (NO Choice) ٠ وأوضحت النتائج أن مركـب البروديفاكوم تسبب فى قتل كل الأفراد فى مدة ٤,٨ يوم بأقل كمية مستهلكة من الطعم إذا ما قورن ب ٤,٩ و ٦,١ و٦,٥ يوما بالنسبة لكل من الفلوكومافين والكوماتترالين و الكلوروفاسـينون عـل التوالى وذلك بالنسبة لفؤيرة المنازل ٠

كما أوضحت النتائج أن المبيدات كان لها نفس التأثير بالنسبة للفأر المتسلق حيث أعطت نسبة موت ١٠٠ % بعد ٣,٥ و ٤,٥ و ٥,١٣ و٥,١٧ يوم لكل من البروديفاكوم و الفلوكومافين و الكوماتترالين والكلوروفاسينون على التوالى٠ مع ملاحظة أن فؤيرة المنازل كانت أكثـر تحمـلا للمبيدات من الفأر المتسلق ٠ أيضا لوحظ أنه لا توجد فروق معنوية بين الـذكور والانـاث لكـلا النوعين من الفئران٠