RELATIVE SUSCEPTIBILITY OF RATTUS RATTUS POPULATIONS TO WARFARIN ANTICOAGULANT

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Abstract

Variations in the susceptibility were found in different Rattus rattus populations reared either in areas exposed to the extensive anticoagulant treatment for long time before or in areas its back history ensured that the anticoagulants were not applied for at least three years at Menofia, Kafr El-Sheikh and Beni Suef Governorates. Therefore, series of field and laboratory trials were done. Results showed that rat populations in treated areas exhibited noticeable tolerance to warfarin when applied in the field as compared with those in areas free from any anticoagulant treatments. Warfarin baits induced 57.5 & 90.0; 81.5 & 95.8 and 87.2 & 93.4% reduction in rat populations in fields treated before or not at the three governorates. Data of laboratory trials supported those obtained from field experiments, whereas warfarin toxic effect was considerably lower against animals populations collected from agricultural lands treated before than those from untreated ones at the three governorates, i.e. LD50 values were 90.5, 88.0 and 79.4 mg a.i./kg b.wt. for animals from the first areas in comparison to 79.4, 82.5 and 75.0 mg/kg b.wt. for animals from untreated areas, respectively.

A parallel trend was measured against warfarin administration as bleeding time (B.T.) and prothrombin time (P.T.) did not considerably alter before and after warfarin treatment in the case of animals exposed for anticoagulant treatment before, while a noticeable prolongation in their values was observed after warfarin treatment in case of animals obtained from untreated areas.

INTRODUCTION

Rodents are the most important vertebrate pests in the world. Food loss due to rodent has been assessed as 33 million metric ton per year of stored grains (mjo, 1969). Egypt suffered from rodent problem in agricultural areas at the beginning of the 1980’s. Anticoagulant rodenticides have been used for the purpose of rodent control allover the world. These compounds have two main advantages over the older acute poisons; firstly they do not induce bait shyness, secondly safe in the use.
All the anticoagulant rodenticides are of two chemical groups, i.e. hydroxycouma-
rine and indanedione derivatives. All anticoagulant rodenticides differ in their chem-
ical structure but exert the same mode of action, i.e. preventing the normal mecha-
nisms that controls blood clotting rendering blood incapable of coagulation and
causing death which generally results from internal haemorrhage. The toxicity
symptoms take some days to develop, therefore, bat shyness does not occur.

Different species of rodents vary in their natural level of resistance to anti-
coagulant rodenticides. Accordingly, it is important to distinguish clearly between
species that evolve a new and abnormal level of resistance and those possessed ini-
tially a high level of natural resistance.

In Egypt, anticoagulant rodenticides have long been used on a large scale to
control rodents. However, there are very little, if any, studies carried out to de-
termine the susceptibility level of the Egyptian commensal rodents after this long
and extensive use of anticoagulants (Kandil et al., 1994; Gabr, 1997).

Previous studies made by Harmful Animal Department, plant protection Re-
search Institute, A.R.C., Egypt revealed that the roof rat Rattus rattus has the upper
hand among rodent fauna of most agricultural lands (Hussein, 1991; Ibrahim,
1995; Mikhail, 1995; Youssef, 1996; Mourad, 1997; Gabr, 1997).

The present trials were conducted to detect the relative susceptibility of
R.rattus populations infested areas treated before with anticoagulant in comparison
to those in area free from any previous anticoagulants treatment.

MATERIALS AND METHODS

Rodenticides

Warfarin: active ingredient (98%), water soluble, was obtained from KZ
Pesticides Company, Egypt. Chemical name: 3- (α-acetonylbenzyl)-4-hydroxy cou-
marine.

1. Field Experiment

The field trials were conducted in orchards at Quesna district (Menofia Govern-
orate), Sakha area (Kaf El-Shekh Governorate) in Lower Egypt and El-Wasta dis-
trict (Bani-Suef Governorate) in Middle Egypt. In each district, two orchards were
assigned, the first its back history showed that it was treated with anticoagulant
rodenticides for a long time, while the other free from anticoagulant treatment at
least three years before. In orchards of each district, the population density of rats
was estimated before and after application using crushed maize consumption (Hussein, 1991). Saturation baiting method was used where 20 bait stations were distributed in both orchard of each district and 250 grams warfarin bait (0.025% on wheat) per station were exposed to rats. The consumed warfarin bait was recorded and replaced at 3-day intervals until the consumption was stopped. Reduction in *Rattus* population in both orchards was estimated from the following equation.

\[
\text{Population reduction} = \frac{A - B}{A} \times 100
\]

Where:

- A = consumed maize bait before treatment
- B = consumed maize bait after treatment

Efficacy of warfarin bait and its consumed amount per feddan were estimated in orchards previously treated with anticoagulant and compared with those free from anticoagulant treatment.

2. Laboratory experiments

By the termination of the field experiment, individuals of *Rattus* collected from the two tested orchards of each district were directly transported to be used in the laboratory trials, i.e. LD50, bleeding and prothrombin time. Animals were caged individually for at least 3 weeks for acclimatization and given a daily fresh supply of water and standard diet.

2.1. Acute oral LD50 determination

Series of different dosages of warfarin anticoagulant calculated on the basis of mg active ingredient/kg body weight (b.wt.) were prepared. Mortality and time to death were recorded up to 28 days post-treatment. LD50 was derived by moving average method using special tables given by Bell (1952) and simplified calculation according to Horn (1956).

2.1. Bleeding and prothrombin time measurement

Tested animals (20 animals) from each district were administered orally 1.0 mg warfarin/kg b.wt. Blood samples were taken before and after treatment with 24 hours. Bleeding time (B.T.) was measured using the method of Duke (1910). Prothrombin time (B.T.) was measured using the method of Duke (1910). Prothrombin time (B.T.) was measured according to Dacie and Lewis (1984).

RESULTS AND DISCUSSION

1. Field Studies

According to Agric. Credit Bank and Egyptian German Project of Rodent Con-
trol, Menofia Governorate applied the highest amount of anticoagulant; either belonged to first or second generation as compared with consumed ones in the other governorates.

1.2. Efficacy of warfarin anticoagulant against *R. rattus* populations

Data in Table 1 showed that using of warfarin bait induced 90.0, 95.8 and 93.4% population reductions when applied in orchards untreated before with anticoagulants at Menofia, Kafr El-Sheikh and Beni-Suef Governorates, respectively. On the other hand, warfarin efficacy against *R. rattus* was noticeable less when applied in orchards previously treated. Corresponding values were 57.5, 81.5 and 87.2% for the three governorates. This means that rats on areas treated before exhibited a considerable tolerance than those on areas free from anticoagulant treatment in all cases and this tolerance relatively varied depending on the tested governorate. Variations in rat susceptibility at both treated and untreated areas with anticoagulants before were obvious at Menofia Governorate than those of the other two tested governorates. In the same time, the relative susceptibility of *R. rattus* population considerably varied between the two tested populations of each Governorate when measured by the total consumed poisoned bait. Amount noticeably increased from 592 to 725g, 540 to 895 g and 1670 to 1950 g when it was applied on areas treated before and free from anticoagulants treatment at the three governorates, respectively. These findings are in harmony with (El-Zemaitly et al., 1991; Gill, 1992; Mikhail, 1995; Gabr 1997).

Table 1. Efficacy of warfarin rodenticide under field conditions at different governorates.

<table>
<thead>
<tr>
<th>Governorate</th>
<th>Efficacy %</th>
<th>Consumed rodenticide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
</tr>
<tr>
<td>Menofia</td>
<td>90.0</td>
<td>57.5</td>
</tr>
<tr>
<td>Kafr El-Sheikh</td>
<td>95.8</td>
<td>81.5</td>
</tr>
<tr>
<td>Beni-Suef</td>
<td>93.4</td>
<td>87.2</td>
</tr>
</tbody>
</table>
2. Laboratory Studies

2.1. Warfarin LD50 determination

Data in Table 2 showed the same trend of field results, whereas rats collected from treated areas of Menofia Governorate were more tolerant than those from the untreated areas (LD50 90.5, 79.4 mg/kg b.wt.). The variation in response of the two populations at Kafr El-Sheikh and Beni-Suef Governorates to warfarin was less (88.0, 82.5 and 79.4,75.0 mg/kg b.wt., respectively). It is to be noted that the variation among strains should be taken into account when testing anticoagulant compounds. Our findings are in accordance with those obtained by Greaves and Ayres (1976), Mikhail (1995), Gabr (1997) and Hussein (1997).

Table 2. LD50 values of warfarin to Rattus rattus collected from different governorates.

<table>
<thead>
<tr>
<th>Governorate</th>
<th>Treated orchards</th>
<th>Untreated orchards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dose mg/kg</td>
<td>Animal dead/total</td>
</tr>
<tr>
<td>Menofia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.5</td>
<td>1/5</td>
<td>20.0</td>
</tr>
<tr>
<td>46.4</td>
<td>0/5</td>
<td>0.0</td>
</tr>
<tr>
<td>100.0</td>
<td>2/5</td>
<td>40.0</td>
</tr>
<tr>
<td>215.0</td>
<td>5/5</td>
<td>100.0</td>
</tr>
<tr>
<td>Kafr El-Sheikh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.5</td>
<td>2/5</td>
<td>40.0</td>
</tr>
<tr>
<td>46.4</td>
<td>1/5</td>
<td>20.0</td>
</tr>
<tr>
<td>100.0</td>
<td>2/5</td>
<td>40.0</td>
</tr>
<tr>
<td>215.0</td>
<td>5/5</td>
<td>100.0</td>
</tr>
<tr>
<td>Beni-Suef</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.5</td>
<td>0/5</td>
<td>0.0</td>
</tr>
<tr>
<td>46.4</td>
<td>2/5</td>
<td>40.0</td>
</tr>
<tr>
<td>100.0</td>
<td>2/5</td>
<td>40.0</td>
</tr>
<tr>
<td>215.0</td>
<td>5/5</td>
<td>100.0</td>
</tr>
</tbody>
</table>

2.2. Haematological effects induced by warfarin treatment

Effect of warfarin treatment (1mg/kg b.wt.) on bleeding time (B.T.) and prothrombin time (P.T.) of the two tested Rattus populations of each governorate was compiled in Table 3. It is obvious that haematological effect of warfarin treatment was noticed in the case of animals collected from the free anticoagulant treatment
orchards of all tested governorates as compared with those collected from treated orchards. B.T. and P.T. values increased after treatment in case of animals from treated orchards of Menofia, Kafr El-Sheikh and Beni-Suef Governorates with 0.07, 0.57, 0.43, 0.85 and 0.47, 0.96 times than pre-treatment, respectively, while the haematological effect of warfarin treatment was clear in case of animals from untreated orchards, i.e. B.T. and P.T. values increased after treatment with 0.67 & 1.49; 1.25 & 4.1 and 3.0 & 2.2 times than before treatment for the same tested governorates. Many investigators agree with our data (Mikhael et al., 1971; Mourad et al. 1982; Kansouh et al., 1990), they reported that Rattus rattus was the dominant rodent species followed by R. norvegicus in most governorates in Egypt.

Table 3. Bleeding and prothrombin time before and after 1 mg warfarin/kg b.w.t. of Rattus rattus in different governorates.

<table>
<thead>
<tr>
<th>Governorate</th>
<th>Bleeding time (B.T.) min.</th>
<th>Prothrombin time (P.T.) sec.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
</tr>
<tr>
<td>Menofia</td>
<td>Treated area</td>
<td>3.21 (0.07)*</td>
</tr>
<tr>
<td></td>
<td>Untreated area</td>
<td>2.55</td>
</tr>
<tr>
<td>Kafr El-Sheikh</td>
<td>Treated area</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>Untreated area</td>
<td>1.55</td>
</tr>
<tr>
<td>Beni-Suef</td>
<td>Treated area</td>
<td>3.10</td>
</tr>
<tr>
<td></td>
<td>Untreated area</td>
<td>1.10</td>
</tr>
</tbody>
</table>

* Ratio of prolongation relative to values before treatment.
REFERENCES


حساسية الفأر المتساقط. لبيد الورفارين

ناطق شؤون المراعي

محمد بهذب وقابلة النباتات، مركز البحوث الزراعية، النفي، مصر.

أجريت هذه الدراسة في منطقة قوبينيا (محافظة النووية)، وسما (محافظة كفر الشيخ)، والواسطى (محافظة بني سويف) لدراسة حساسية الفأر المتساقط للإثاث عليه من مناطق تقع في كل محافظة: الأولى: موقع الفيضانات الساقية لثامرة طويلة والثاني: نمذجة استخدام الورفارين فيها منذ ثلاث سنوات على الأقل. وكانت النتائج كالآتي:

1. التجارب العملية:

الورفارين المتساقط عليه من مناطق مصابة بالبيدات من قبل الفيروس مقاومة لبدء الورفارين بالمقارنة بالفأر المتساقط عليه من مناطق لم يتم فيها استخدام البيدات. حيث أدى استخدام لبدء الورفارين (0.2mg) إلى خفض تعداد الفأر في المناطق العامة من قبل الورفارين بسلاسة لثامرة طويلة في محافظات النووية وكفر الشيخ وسما بني سويف إلى 0.8, 0.88, 0.88, 0.88, 0.88, 0.88, 0.88, 0.88 في المناطق التي لم يتم استخدام البيدات فيها من قبل في المناطق الثلاث.

2. التجارب العملية:

أدت النتائج المتساقط عليه من التجارب العملية النتائج المقبولة حيث التأكد من أن

للورفارين كان أقل له الفأر المتساقط عليه من الأراضي الزراعية المعرضة سابقا بالبيدات من غير العاملة من قبل في كل المحافظات الثلاث. وكانت النتائج المقبولة في المحافظات الثلاث.

ملعبًا جرام من وزن الفأر المتساقط في المحافظات الثلاث. أيضًا فيسأر زم الفيضان بالمنطقة الثانية. أيضا حسب زم الفيضان بمنطقة المنطقتين.

ووضع أن المناظر العاملة السابق بالبيدات أكثر معاينة من المناطق التي لم يتم فيها استخدام الورفارين نقل ودعم بسما من مناطق الجهاز في المناطق الثلاث. وذلك بالاختلاف في المناظر حيث أن الفيضان الذي صيب

من محافظة النووية تمثل أكثر تركيز الورفارين من تلك التي صديده من محافظات بني سويف وكفر الشيخ.