

## ドブネズミの硝酸タリウム摂取性におよぼすショ糖の効果

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Notes

## Effect of Sucrose on the Acceptability of Thallous Nitrate in Norway Rats

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An investigation was made on the effect of the addition of a 7.8% sucrose solution to the acceptability of thallous nitrate solutions (0.09% and 0.18%) by wild Norway rats. The addition of sucrose resulted in a ten-fold increase in the acceptability of the 0.09% thallous nitrate solution. Furthermore, 100% mortality was obtained among test animals offered sucrose-sweetened 0.09% and 0.18% thallous nitrate, while only 20% mortality was obtained with unsweetened 0.09% thallous nitrate. Thus, it was suggested that sweetened thallous nitrate solutions (of appropriate concentrations) might prove to be an effective rodenticide in warehouses.

### INTRODUCTION

Under dry conditions, such as in a warehouse holding dry foods or grains, water baits are often employed as a means of rodent control. In Japan, sodium monofluoroacetate (compound 1080) and sodium warfarin have been used as poisons in the preparation of such baits. To increase the acceptability of water baits, sucrose has frequently been used as an additive.<sup>1-3)</sup>

In the present experiment, the effect of the addition of sucrose on the acceptability of a thallous nitrate solution to wild Norway rats was investigated using a two-choice drinking test monitored with electronic drinkometers.

### MATERIALS AND METHODS

#### 1. Materials

Thirteen male Norway rats, *Rattus norvegicus*, with a mean body weight of 314 g were used. The animals were housed for three months in experimental cages (38×26×21 cm) and were fed a diet of pellet chow and water *ad lib*. The laboratory was maintained on a 14 L : 10 D photoperiod, with lights on at 0500 hr and lights off at 1900 hr. Since, in

most of the rats, consumption of water or of a sucrose solution was markedly high immediately following lights off, the test solutions were set at 1748 hr (72 min before lights off) and the monitoring of consumption was begun immediately.

The chemicals used in the experiment, sucrose and thallous nitrate, were obtained from Wako Pure Chemical Industries, Ltd. (Tokyo).

#### 2. Measurement of Consumption with No-choice and Two-choice Tests

Cumulative consumption was recorded at 56 sec intervals from 1748 hr to 0700 hr the next morning using two electronic drinkometers and printers (Nihon Ika Kiki Co., Ltd. maker).

In the investigation of the palatability of sweetened thallous nitrate, eight rats were first offered water alone in a one-bottle, no-choice test.

These animals' preference for pure (unpoisoned) 7.8% sucrose solution was then determined by offering them a choice between plain water and pure 7.8% sucrose solution in a two-bottle, two-choice test. Finally, four of these animals were offered a choice between

plain water and 0.09% thallos nitrate in a 7.8% sucrose solution, while the remaining four animals were offered a similar choice between plain water and 0.18% thallos nitrate in a 7.8% sucrose solution. Each of these groups was also measured a subsequent day.

To determine the relative palatability of unsweetened thallos nitrate, an additional five animals were first offered plain water in a one-bottle, no-choice test; then they were offered a choice between plain water and unsweetened 0.09% thallos nitrate.

All toxic test solutions were removed 13 hrs from the onset of the test, and the survival of the animals was observed for 10 days. A preference value for the test solution during the two-choice test was calculated as the ratio of the total number of licks of the test solution to the total number of licks of the plain water.

## RESULTS

### 1. Consumption of Water Alone

The records of the eight rats (A-H) which

were offered water alone followed by a choice between plain water and pure, unpoisoned sucrose solution are given in Fig. 1. With water alone, the cumulative number of licks increased linearly. However, the rats did not lick the water at a constant rate, but instead showed periods of consumption interspersed with pauses of various lengths. The functional origin of this uniform, linear consumption in all of the rats is unknown. The pauses in consumption are not unexpected, since Kawamura and Kasahara (1964)<sup>5)</sup> reported that albino rats in modified Skinner boxes showed eating and drinking activity with a rhythmic cycle of 1.5-2 hr. Additionally, Shimizu and Kusano<sup>4)</sup> also reported similar periodicities in the consumption of plain water or of 7.8% sucrose solutions in a no-choice test.

### 2. Consumption of Water vs. Pure Sucrose

All of the test animals showed a strong preference for the sucrose solution when paired with water, with the cumulative number of licks directed toward the sucrose

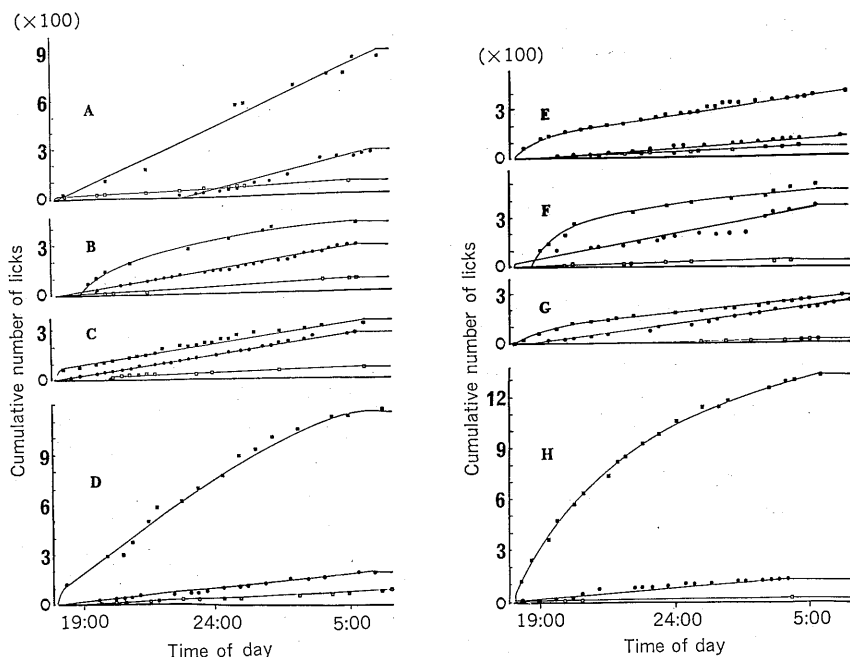


Fig. 1 Cumulative licking numbers by 8 rats.

Solid black circles indicate water consumption in water-alone tests. Solid black squares indicate sucrose consumption and open squares indicate water consumption in two-bottle tests. The parts lacking symbols of circles or squares indicate pauses in drinking during which no consumption occurred.

Table 1 No-choice or two-choice preference tests with sucrose or with thallous nitrate solutions in wild rats.

Test solution*	Number of animals used	Mean cumulative number of licks**				Preference value***	Mortality****
		1 hr	3 hr	6 hr	13 hr		
W	8	8	54	98	228		
W	8	7	21	32	51	12.7	0/8
S		98	255	392	647		
W	4	1	29	61	185		
W	4	0	6	17	262	2	4/4
0.09% Tl+S		139	190	352	511		
W	4	14	78	134	271		
W	4	5	17	151	702	0.2	4/4
0.18% Tl+S		71	127	152	170		
W	5	18	33	68	224		
W	5	97	169	284	768	0.2	1/5
0.09% Tl		2	131	136	143		

\* Test solutions were as follows: water (W), 7.8% sucrose solution (S), 0.09 and 0.18% thallous nitrate solution in 7.8% sucrose (Tl+S), 0.09% thallous nitrate solution (Tl).

\*\* Mean cumulative number of licks were counted over 13 hr from the onset of the test.

\*\*\* Preference values were calculated as follows: S/W, (Tl+S)/W, Tl/W.

\*\*\*\* Tl or Tl+S solutions were removed after 13 hr from the onset of the test, then water alone was offered to the rats. Following this, the mortality of the test animals was observed for 10 days.

increasing markedly with time (Fig. 1 and Table 1). The licking activity patterns were apparently of two types: a linear pattern similar to that obtained with water alone, and a curvilinear pattern (possibly parabolic). These lick patterns in three animals (A, C, G) showed a synchronization with water alone lick patterns. The total number of licks per individual during the 13-hr test was 647 for the sucrose and 51 for the water, giving a calculated preference value for the sucrose of 12.7.

### 3. Consumption of Water vs. Unsweetened Thallous Nitrate

The 0.09% (unsweetened) thallous nitrate solution was less acceptable than plain water, showing a preference value of only 0.2 (Table 1). Interestingly, in this situation the consumption of the plain water was markedly greater than when plain water was offered alone. This phenomenon is perhaps due to the occurrence of thallium-induced dehydration and diarrhea.

From the discrimination and absolute-rejection thresholds determined through a direct choice method over 24 hr, Kusano

(1978)<sup>6)</sup> showed that in albino rats the acceptability of 0.0625% thallous nitrate was very high, while that of a 0.125% solution decreased slightly. Thus, in albino rats the threshold for the discrimination of thallous nitrate seems to fall roughly between 0.0625 and 0.125%. In the present experiment, wild rats discriminated between plain water and 0.09% thallous nitrate, suggesting that 0.09% may be the threshold for thallous nitrate discrimination in wild rats as well as in albino rats.<sup>6)</sup>

### 4. Consumption of Water vs. Sweetened Thallous Nitrate

The sweetened 0.09% thallous nitrate solution was more acceptable than plain water, with a calculated preference value of 2.0 (Table 1). When this value of 2.0 is compared with the preference value of 0.2 obtained with unsweetened thallous nitrate at the same concentration, it becomes apparent that the addition of sucrose markedly increases the palatability of the thallous nitrate solution. It is obvious that the addition of the sucrose also increases the efficacy of thallous nitrate as a rodenticide, since 100% of the

test animals drinking sweetened 0.09% thal-  
lous nitrate died, while only 20% of those  
drinking unsweetened 0.09% thal-  
lous nitrate did so.

The sweetened 0.18% thal-  
lous nitrate solution was preferred over plain water at the  
beginning of the test, but by 6 hr into the  
test the cumulative consumption of water and  
thallous nitrate were almost equal, and by  
the end of the 13 hr test water consumption  
had increased greatly yielding a calculated pre-  
ference value for the test solution of only 0.2.  
Despite this low final preference value, the  
test animals consumed enough of the toxic  
solution so that all of the animals died within  
10 days following the test.

#### 5. Relationship of Consumption to Mortality

The mortality was 100% with both sweeten-  
ed (0.09% and 0.18%) thal-  
lous nitrate solutions, while the mortality with the un-  
sweetened 0.09% solution of thal-  
lous nitrate was low (Table 1). A comparison of the ani-  
mals in the sweetened and unsweetened 0.09%  
thallous nitrate groups indicates that rats  
consuming less than 26 licks survived, while  
those consuming more than 116 licks died  
within 2-3 days. Since the intake volume per  
lick was approximately 0.058 ml, the mean  
doses of thal-  
lous nitrate ingested by the ani-  
mals in the groups offered sweetened thal-  
lous nitrate were 64.82 mg/kg of body weight in  
the 0.09% group and 51.73 mg/kg in the 0.18%  
group.

#### DISCUSSION

These results show quite clearly that the  
addition of 7.8% sucrose to thal-  
lous nitrate solution greatly increases the acceptability of  
the solution to wild Norway rats. Indeed,  
under the test conditions employed in the  
present experiment, the acceptability of sweet-  
ened thal-  
lous nitrate solutions was so great  
that 100% mortality was obtained among the  
test animals. It has been shown that for rats  
the acceptability of quinine hydrochloride,  
thiourea, phenylurea, and urea is increased by  
the addition of 8.0% sucrose,<sup>2)</sup> while the ac-  
ceptability of some norbromide derivatives  
has been increased with the addition of 10.0%  
sucrose.<sup>3)</sup> Additionally, it has been shown that

the acceptability of a 0.75% thal-  
lous nitrate solution for albino mice is greatly increased  
by the addition of 7.8% sucrose.<sup>7)</sup>

Thus, the results of the present experiment,  
combined with those of Shimizu *et al.*,<sup>7)</sup> sug-  
gest that a sweetened thal-  
lous nitrate solution may be an effective rodenticide under appro-  
priate conditions, provided care is taken to  
ensure that the concentrations used are ac-  
ceptable to the target populations. Of course,  
further data are required to determine the  
efficacy of thal-  
lous nitrate under conditions  
more closely approximating warehouse ap-  
plication.

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#### REFERENCES

- 1) W. E. Howard, R. E. Marsh & S. D. Palmateer: *Int. Pest Control*. **14**, 17 (1972)
- 2) T. Kusano, Y. Kasahara & Y. Kawamura: *Appl. Entomol. Zool.* **10**, 19 (1975)
- 3) Y. Kawamura, M. Funakoshi, Y. Kasahara, S. Oki & K. Miyoshi: *J. Osaka Univ. Dental Soc.* **13**, 125 (1968)
- 4) T. Shimizu & T. Kusano: *Appl. Entomol. Zool.* **15**, 177 (1980)
- 5) Y. Kawamura & Y. Kasahara: *J. Physiol. Soc. Jpn.* **26**, 537 (1964)
- 6) T. Kusano: *J. Pesticide Sci.* **3**, 353 (1978)
- 7) T. Shimizu, M. Takayanagi & T. Kusano: *J. Pesticide Sci.* **5**, 403 (1980)

#### 要 約

#### ドブネズミの硝酸タリウム摂取性におよぼす シヨ糖の効果

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硝酸タリウムの摂取性におよぼす糖の効果をドブネズミを用いて、2台のリッキング・カウンターで調べた。0.09%硝酸タリウムに7.8%糖を加えることによって、水に対するリッキング・カウントは選好値で2になり、糖無添加の選好値と比較すると、リッキング・カウントは10倍高くなった。また、糖を添加した0.09%、0.18%硝酸タリウムによる死亡率は100%となり、糖無添加の0.09%硝酸タリウムの場合には20%であった。シヨ糖を含む0.09%硝酸タリウムは、倉庫のドブネズミの防除に水溶剤として有効であると思われる。