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Food preferences of wild house-mice (*Mus musculus* L.)*

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SUMMARY

The relative acceptance of various plain foods by wild house-mice (*Mus musculus* L.) was compared in laboratory choice tests. The palatability of glycerine and six oils, each included at 5 % in pinhead oatmeal, was compared in a similar manner.

The most favoured food was found to be whole canary seed (*Phalaris canariensis*). Pinhead oatmeal and wheat were also comparatively well accepted. Glycerine, corn oil, arachis oil and mineral oil were more palatable than either olive, linseed or cod-liver oils.

The results of the choice tests are considered in relation to the use of poison baits for the control of free-living mice.

INTRODUCTION

The house-mouse (*M. musculus* L.) is cosmopolitan, occurring in cities and towns throughout the world. It is capable of causing significant economic losses, and adequate measures for its control are also important to prevent hazard to human health.

Most control work carried out against infestations of mice involves the close distribution of solid poison baits. Clearly the efficiency of this control method is dependent on having both effective poisons and attractive bait-bases at hand. The development of resistance to the hitherto effective anti-coagulant poisons (Rowe & Redfern, 1965) and the paucity and limitations of existing acute poisons has emphasized the need for more efficient poisons for the control of mice and stimulated a search for alternative chronic and acute acting compounds (Rowe, Greaves, Redfern & Martin, 1970). Apart from recent work by Norris (1973), however, less attention has been given to ensure that the most appropriate bait-bases are employed in poison treatments. For this reason a variety of different foods that are either currently used in Britain or that were considered to have potential use as bait-bases have been compared under laboratory conditions. Furthermore, since an oil is often incorporated as a sticker in formulating coarsely particled poison bait, the relative acceptability of different oils to mice was also investigated.

MATERIALS AND METHODS

The adult male and female mice that were used were the descendants of wild stock drawn originally from a corn-rick. Each animal was weighed, sexed and isolated in a metal test cage measuring $36 \times 30 \times 20$ cm. for at least 2 weeks before a choice test was begun. During this period it was provided with laboratory food (diet 41B), placed in a metal container that was situated centrally at the front of the cage, and with water *ad lib*. At the beginning of a test the food container and any spilled diet 41B were removed and two similar containers each holding a weighed amount of bait under test were positioned opposite each other at the front of the cage. The choice tests were conducted for 2 days using 5 mice and in some comparisons supplementary tests were run. The amount of bait eaten from each container was measured daily, the positions of the baits being reversed after 24 hr. to reduce the possible effects of place preference. A few mice were employed in more than one test, but in that event they were not offered a previously experienced bait.

The relative palatability of glycerine and six oils was compared in a similar manner. Each oil was included in a standard bait-base, pinhead oatmeal, at a concentration of 5 %. In all tests the significance of the data was assessed using Student's '*t*' test.

RESULTS

Initial exploratory tests using a varied range of foods showed that some items were clearly preferred to others and only the most promising foods were closely examined in subsequent tests. Of the latter, whole canary seed (*Phalaris canariensis*), pinhead oatmeal and whole wheat were the most favoured. The results of choice tests conducted with each of these baits are shown in Tables 1, 2 and 3 respectively.

Overall, mice ate more whole canary seed than any other alternative food that was offered (Table 1), the relative difference in bait consumption reaching a significant level ($P < 0{\cdot}05$) in all but one of the 14 tests when flour was made available. Pinhead oatmeal was significantly less preferred than canary seed but it was consumed in greater amount than the 11 other baits (including flour) that were offered as a choice and in 8 cases significantly more pinhead oatmeal was eaten (Table 2). Although wheat was less preferred than either canary seed or pinhead oatmeal it was eaten in greater amount than 13 other baits, the difference in consumption being significant in 9 of the tests (Table 3).

Medium oatmeal is currently the most employed bait-base in poison treatments against mice in Britain but it was found to be poorly accepted in comparison with either canary seed, pinhead oatmeal or wheat. Rolled oats, another current but less frequently used bait-base, was also found to be less acceptable than either canary seed or pinhead oatmeal although it was significantly preferred to either flour, sausage rusk or maize meal. Flour, which is also used on occasion in poison treatments against mice, was significantly less preferred than pinhead oatmeal; more canary seed (17·5 g.) than flour (8·0 g.) was eaten but the difference in

Table 1. *The relative acceptance of whole canary seed and other baits by mice*

No. of mice tested	Amount of bait eaten (g.) Canary seed	Alternative		Difference (g.)
25	117·3	Wheat	30·5	+86·8*
25	114·9	Pinhead oatmeal	30·8	+84·1*
5	18·9	Medium oatmeal	8·5	+10·4*
5	24·0	Rolled oats	1·6	+22·4*
5	17·5	Flour	8·0	+ 9·5
5	29·6	Chick crumbs	2·2	+27·4*
10	42·2	Peanuts	4·9	+37·3*
5	33·1	Maize meal	4·8	+28·3*
5	24·7	Sunflower seed	3·2	+21·5*
5	16·9	Grass seed	7·9	+ 9·0*
5	24·8	Rape	0·2	+24·6*
5	24·4	Millet	1·6	+22·8*
5	23·2	Chocolate powder	4·1	+19·1*
10	49·9	Ground canary seed	15·6	+34·3*

* Significance of difference ($P < 0{\cdot}05$).

Table 2. *The relative acceptance of pinhead oatmeal and other baits by mice*

No. of mice tested	Amount of bait eaten (g.) Pinhead oatmeal	Alternative		Difference (g.)
25	107·7	Wheat	47·3	+60·4*
5	29·4	Rolled oats	1·3	+28·1*
5	27·3	Chick crumbs	0·6	+26·7*
5	11·6	Peanuts	8·6	+ 3·0
5	22·5	Sunflower seed	9·8	+12·7*
5	18·5	Grass seed	8·4	+10·1
5	6·8	Chocolate powder	3·9	+ 2·9
5	18·4	Sausage rusk	0·0	+18·4*
5	18·5	Medium oatmeal	0·4	+18·1*
5	23·2	Flour	1·8	+21·4*
5	21·4	'Bemax'	1·1	+20·3*

* Significance of difference ($P < 0{\cdot}05$).

consumption did not reach a significant level. In other tests flour was found to be significantly preferred to either fine oatmeal, sausage rusk, chocolate powder or diet 41B.

Two of the baits examined were presented in a different manner, canary seed in either whole or ground form and oatmeal as either pinhead (coarse) or medium grade. The larger particles of both baits were found to be preferred (Tables 1 and 2).

Only glycerine and corn oil were examined against each of the other 6 oils. The results of the tests (Table 4) indicated that glycerine, corn oil, arachis oil and mineral oil, in about that order, were more palatable to mice than either cod-liver, linseed or olive oils.

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Table 3. *The relative acceptance of whole wheat and other baits by mice*

No. of mice tested	Amount of bait eaten (g.) Wheat	Alternative		Difference (g.)
5	12·8	Rolled oats	6·0	+ 6·8
5	15·6	Peanuts	10·1	+ 5·5
5	24·1	Maize meal	5·9	+18·2*
5	20·6	Sunflower seed	7·4	+13·2*
5	17·7	Grass seed	3·9	+13·8*
5	21·7	Chocolate powder	14·5	+ 7·2
5	22·2	Sausage rusk	0·3	+21·9*
5	19·9	Medium oatmeal	4·0	+15·9*
5	19·5	Flour	18·1	+ 1·4
5	21·7	'Bemax'	3·7	+18·0*
5	24·0	Sugar	0·8	+23·2*
5	34·6	Rice	1·1	+33·5*
5	26·1	Pearl barley	1·7	+24·4*

* Significance of difference ($P < 0{\cdot}05$).

Table 4. *The palatability of differently oiled pinhead oatmeal bait to mice*

Amount of oiled pinhead oatmeal bait eaten (g.)				Difference (g.)
Corn-oil	14·1	Cod-liver	5·8	+ 8·3*
	22·4	Linseed	4·4	+18·0*
	10·5	Arachis	10·3	+ 0·2
	21·6	Olive	1·9	+19·7*
	12·8	Mineral	7·0	+ 5·8
	6·4	Glycerine	11·3	− 4·9
Glycerine	22·0	Cod-liver	0·4	+21·6*
	19·8	Linseed	9·5	+10·3
	13·2	Arachis	8·9	+ 4·3
	17·4	Olive	1·0	+16·4*
	19·1	Mineral	6·6	+12·5
Arachis	16·8	Mineral	10·7	+ 6·1
Mineral	17·5	Linseed	9·9	+ 7·6
	18·6	Olive	5·9	+12·7
Cod-liver	8·3	Linseed	15·3	− 7·0

* Significance of difference ($P < 0{\cdot}05$).

DISCUSSION

Laboratory tests of the present kind can give, at best, a clear indication of those foods that are most likely to be of use as bait-bases in the field and, when a choice exists, the most appropriate form of a particular bait to employ. They cannot take into account, however, the numerous factors, environmental and behavioural, that can influence the acceptance by free-living mice of even the most promising bait-bases found in the laboratory. Southern (1954) pointed out the importance of such factors as the abundance and variety of alternative foods, the availability of cover and water, the effects of conditioning to staple foods and individual bait preference in determining the level of acceptance of bait-bases under field condi-

tions. He investigated a limited number of bait-bases in the laboratory and concluded that rolled oats with 20 % olive oil was the most promising candidate for field use. This bait was not invariably well accepted in field trials, however, and it was therefore advocated that a selection of likely bait-bases should be laid in mouse-infested areas for 1 or 2 days and the most favoured then selected for poisoning. Largely because of economic considerations this ideal approach is rarely, if ever, carried out in practice.

The results of the present laboratory work suggested that whole canary seed, which was not examined by Southern, might come nearer than rolled oats to fulfilling the need for an exceptionally palatable bait-base capable of diverting mice living in varied environments from existing food supplies. The acceptance of plain and of poison-treated whole canary seed has therefore been investigated in the field. In the evaluation of candidate rodenticides during the past 2 years, whole canary seed has been extensively used in census-baiting mice living in urban and rural premises where alternative food supplies were usually abundant. In each case the take of census bait indicated that the canary seed was well accepted. A similar conclusion was reached as a result of recent field trials when whole canary seed was used as the carrier for calciferol (vitamin D). In 6 treatments against mice 97–100 % control was obtained compared with 91–92 % control in 7 treatments using pinhead oatmeal (Rowe, Smith & Swinney, 1974). Although good control (97 %) was also achieved in a single trial using a mixed bait (rolled oats, pinhead oatmeal, wheat and canary seed) recommended by Norris (1973), examination of the baiting points showed that the canary seed was largely selected by the mice.

There is accruing field evidence therefore to support the laboratory findings that whole canary seed is attractive to mice. The attraction may be due in part to its shape or size or both. There is also evidence, tending to limit its general usefulness as a poison carrier, that mice discard the husks before consuming the seed. The success of the calciferol trials is considered to have been largely attributable to the use of impregnated poison bait. The calciferol was dissolved in corn oil and the solution thoroughly mixed with the canary seed. The mixture was then allowed to stand for 3 days to allow for the absorption of the poison solution. In contrast, ineffective control of a confined colony of mice was obtained when whole canary seed bait was merely surface-coated with the acute poison, gophacide (Thomson, 1971), using corn oil as the sticker. In the presence of an unattractive alternative food (diet 41B), a kill of only 10/15 was obtained in 7 days compared with a kill of 11/13 in 2 days using pinhead oatmeal treated with gophacide. This result occurred although the feeding data showed that more canary seed (16·0 g.) than pinhead-oatmeal-treated bait (5·1 g.) was eaten, indicating that some gophacide was discarded during husking. Thus it would seem possible to use whole canary seed as a poison carrier only with those poisons that can be dissolved in an acceptable solvent, e.g. water, glycerine, corn oil or arachis oil, to permit the preparation of impregnated bait.

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