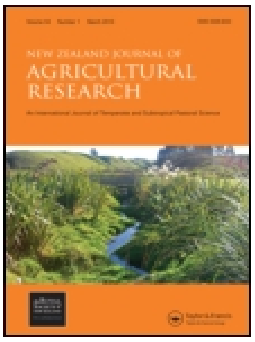

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Absorption of sodium monofluoroacetate (“1080”) solution by carrot baits

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ABSORPTION OF SODIUM MONOFLUOROACETATE ("1080") SOLUTION BY CARROT BAITS

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ABSTRACT

The absorption of sodium monofluoroacetate ("1080") by carrot baits of various thicknesses has been studied. Whole carrots, peeled or unpeeled, or carrots chopped into cubes or slices of different thicknesses were immersed in solutions containing ½ lb, 1 lb, and 2 lb of "1080" in 6 gal of water for varying lengths of time (5 sec, 1 min, and 5 min). Absorption of "1080" was decreased by the skin of the carrot. Although there was some absorption through the intact skin, the amount of poison absorbed by peeled whole carrots was 58% to 138% greater than for similarly treated unpeeled carrots. The trial confirmed that "1080" was absorbed into the body of the carrot. For chopped carrot the "1080" content of the baits was almost inversely proportion to the thickness. Time of immersion did not have a very marked effect on absorption.

INTRODUCTION

Poisoning by carrot impregnated with sodium monofluoroacetate ("1080") has proved to be an efficient method of mammalian pest control in New Zealand, and has been used with much success in poisoning operations against the wild rabbit *(Oryctolagus cuniculus)*, opossums (*Trichosurus vulpecula*), Himalayan thar (*Hemitragus jemlahicus*), wallabies (*Macropus rufogrisea* and *M. eugenii*), and various species of deer.

Although this method of control has been used extensively in both Australia and New Zealand for the past 15 years, there has been very little study of the absorption of "1080" by carrot baits. M. J. Daniel (pers. comm.), in collaboration with officers of the Department of Scientific and Industrial Research, found that carrot baits (30 per lb as cubes slightly less than 1 in. thick) treated at the rate of 1½ lb "1080" per ton of chopped carrot and left for 24 hr lost 10% of their original "1080" concentration when immersed in water for 1 hr with occasional agitation. Another 10% was removed after 4 more hr and 15% more after 21 hr. Another day's immersion dissolved out a further 18%. Later work by Staples (1968) on the leaching of "1080" from carrot baits supported the finding that "1080" was absorbed into the carrot. Daniel (1966) found that approximately 4 hr after the baits were treated with "1080" absorption was complete.

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Bait size should be varied according to the animals it is intended to poison. For the control of deer and opossums in forest areas, large pieces of carrot treated with a high level of "1080" (i.e. 2 lb of "1080" per ton (894 g/1,000 kg) of bait material) seem necessary, since baits should remain toxic for as long as possible. For rabbit control in areas where there is a danger to domestic livestock, the preference is for smaller pieces of thinly sliced carrot treated with a lower level of "1080", i.e. $\frac{1}{2}$ lb per ton (Staples 1968).

There is some evidence that large pieces of unpeeled carrot do not absorb "1080" as readily as small pieces. Douglas and Staples (unpublished) found that 50% of the poison was removed by 1.5 in. of rain from pieces of carrot weighing up to 200 g and treated with 2 lb of "1080" per ton. It was suspected that this result was partly due to reduced absorption of "1080" through those areas where the skin remained intact.

Early methods of bait preparation were laborious, and carrots were either cut by hand or chopped up with a spade. With the advent of aerial pest poisoning large quantities of bait were required, and bait-cutting machines capable of handling several tons of carrot an hour have been designed.

Theoretically, the size of carrot bait may be varied by altering the number of knives in the cutter, but these machines do not produce baits of a uniform size and there is much wastage due to the "chaff" (i.e. very finely cut carrot).

The "1080" solution may be applied to the carrot baits with a sprinkler while they are agitated in a revolving drum or concrete mixer. Some bait-cutting machines are fitted with an injection device which sprays the "1080" solution on the chopped carrot as it falls from the cutters. Fluctuations in the rate of flow of the "1080" solution or a blocked jet can result in uneven distribution of the poison. Both methods of impregnating the baits are suspected of producing baits with a variable poison loading. Complete immersion of the carrot baits in a "1080" solution has been suggested as a method of giving more uniformity.

Information on the absorption of "1080" by different preparations of carrot baits after immersion in the poison solution could be most useful if a carrot-cutter giving baits of uniform thickness could be designed.

The present experiments were designed, firstly, to study the effect of the carrot skin on the absorption of "1080"; and secondly, to study the absorption of "1080" by carrot baits of various thicknesses immersed in "1080" solutions of different strengths for varying lengths of time.

EXPERIMENTAL

Freshly dug carrots were washed, drained, and subsequently handled in 2 lb batches for the various treatments.

Trial A

This experiment was designed to study the effect of the skin on the absorption of "1080". Whole carrots, peeled or unpeeled, were selected so that each batch contained an equal number of carrots and the ranges of carrot size were approximately similar for all batches.

A batch of each type of carrot preparation was subjected to one of nine different "1080" treatments. Each batch was immersed in "1080" solutions of one of three different concentrations ($\frac{1}{2}$ lb, 1 lb, or 2 lb in 6 gal of water, i.e. 0.83%, 1.67%, or 3.32% respectively) for one of three different lengths of time (5 sec, 1 min. or 5 min) as shown in Tables 1 and 2. After immersion each batch was left to drain in a wire basket for 4 hr. The batch was then immersed in fresh water and agitated for 5 sec. It was then drained for 10 min and shaken occasionally to remove excess moisture. Care was taken to avoid breaking of the skins, or bruising, of unpeeled carrots. Batches were then minced and analysed for "1080" content.

Trial B

This experiment was designed to study the absorption of "1080" by carrot baits of different cube sizes or slices of different thicknesses. The washed carrots were chopped by a bread slicer into cubes of 1 in. or $\frac{1}{2}$ in. and slices $\frac{1}{4}$ in. or $\frac{1}{8}$ in. thick.

A batch of each type of carrot preparation was subjected to one of the nine different "1080" treatments used in Trial A. The fresh water treatment used in Trial A was omitted in Trial B. After the "1080" treatments (Trial B) each batch was drained for 4 hr in a wire basket (as for Trial A) before being minced and analysed.

Analytical

The analytical technique described by Staples (1968) was used. Results are expressed as mg "1080"/100 g moisture-free carrot.

RESULTS

Trial A

Results are shown in Table 1.

The effect of the skin on the absorption of "1080" by carrot baits is clear. Although there was some absorption through the intact skin, the concentration of "1080" in peeled carrots was 58% to 138% higher than in unpeeled carrots similarly treated.

The greatest percentage differences occurred when the solution containing the lowest concentration (0.83%) of "1080" was used.

Immersion time did not have a very marked effect on the amounts of "1080" absorbed by the carrots, although in all cases there was some increase in concentrations with longer immersion. The largest percentage difference was for peeled carrots immersed in a 1.67% solution for 5 min. These contained 52% more of the poison than those immersed for 5 sec in the same strength of solution.

Trial B

Results are shown in Table 2.

TABLE 1—Effect of Skin on the Absorption of "1080" (mg/100 g moisture-free carrot) by Whole Carrots

"1080" Concentration (%)	Immersion Times					
	5 sec		1 min		5 min	
	Unpeeled	Peeled	Unpeeled	Peeled	Unpeeled	Peeled
0.83	42	98	45	106	50	119
1.67	101	159	102	210	132	241
3.32	176	312	184	320	216	360

TABLE 2—Absorption of "1080" (mg/100 g moisture-free carrot) by Carrot Baits of Various Thicknesses

Preparation	"1080" Concentration (%)	Immersion Times		
		5 sec	1 min	5 min
1 in. cube	0.83	98	143	165
	1.67	280	310	370
	3.32	507	660	665
½ in. cube	0.83	196	233	321
	1.67	295	355	405
	3.32	624	805	813
¼ in. slice	0.83	202	262	313
	1.67	426	399	466
	3.32	827	811	1063
⅛ in. slice	0.83	423	516	564
	1.67	804	900	950
	3.32	1543	1550	2007

With the two exceptions, there was an increase in the "1080" concentration of the baits with increased time of immersion. The apparent anomalies (¼ in. slices immersed for 1 min in the 1.67 or 3.32% solution) cannot be explained. Generally, however, the time of immersion did not have a very marked effect on the "1080" concentration of the baits. For comparable "1080" solutions the "1080" level in the ⅛ in. slices was about three or four times greater than that in the 1 in. cubes. This could be attributed to the greater surface area per lb of bait material.

DISCUSSION

The results of Trial A illustrate two points clearly. Firstly, much of the "1080" was actually absorbed into the carrot and not retained on or near the surface. The poison is extremely soluble in water and the 5 sec rinse to which the carrots were subjected would have removed any residues on or near the surface. This result supports the findings of Daniel (pers. comm.) and Staples (1968), who concluded that uneaten poisoned baits needed to be subjected to several inches of rain to render them harmless to stock.

Secondly, the skin of the carrot markedly reduces the absorption of "1080". This fact should be considered if large pieces of carrot are to be used as bait. The 50% loss of "1080" from large pieces of carrot after 1½ in. of rain (Douglas and Staples, unpublished) could be partly attributable to ease of removal from the high proportion of skin remaining on the large baits. The trial showed that although there was some absorption through the intact skin, there were big differences in the "1080" level between the peeled and unpeeled carrots. For circumstances in which baits should remain toxic as long as possible, the aim should be to ensure maximum absorption of the "1080" into the carrot. With large baits some method of abrading the carrots before "1080" treatment is desirable. This would allow greater absorption of the poison through the broken skin.

Uniform distribution of the poison is very important in the preparation of poisoned baits. The present methods of impregnating chopped carrot do not produce baits of uniform toxicity. Staples (1968) found large differences in the "1080" loading of batches of carrot prepared for weathering trials, despite every endeavour to ensure uniform application of the poison. The difference between batches could be attributed to the "1080" adhering to the sides of the concrete mixer. Douglas (1967) also suspected variation in toxicity of carrot baits prepared to poison thar, due to nozzle blockages in the injection device on the bait-cutting machine. Undoubtedly an immersion technique for impregnating pieces of carrot with "1080" would promote uniformity in toxicity of baits.

The advantage of using an immersion technique for impregnating carrot baits with "1080" can be seen from the results of Trial B (Table 2), especially if thin slices of carrot, as recommended for rabbit poisoning, are used. The ⅛ in. slices immersed in the weakest "1080" solution (0.83%) for 5 sec contained 4½ times the concentration of "1080" found in the 1 in. cubes treated similarly. Twice the lethal dose of "1080" for a 3½ lb rabbit would be contained in 25 g of the 1 in. cubes, but the same amount would be contained in only 5 or 6 g of the ⅛ in. slices. Theoretically, carrot baits prepared by the methods at present used and treated at the rate of ½ lb "1080" per ton of chopped carrot should contain 22.3 mg "1080" for 100 g wet carrot. This level of "1080" is approximately half that found in the ⅛ in. slices of carrot immersed for 5 sec in the 0.83% solution. With baits of this thickness it seems possible, if an immersion technique were used, that the concentration of the "1080" solution could be reduced to 0.42% (¼ lb "1080" to 6 gal water) to maintain a level of approximately 20 mg "1080" per 100 g wet carrot. With a greater number of baits per lb treated at this level the danger to domestic livestock would also be reduced.

An immersion technique would also be practicable for impregnating larger pieces of carrot for poisoning deer and opossums in forest areas. The 1 in. cubes of carrot immersed in a 3.32% solution for 5 sec contained 507 mg "1080" per 100 g moisture-free carrot, i.e. about 1 kg wet carrot. Assuming that the lethal dose of "1080" for a deer is the same as for the sheep (0.45 mg per kg body weight), a lethal dose for a 50 kg deer would be contained in 44 g (a little more than 1½ oz) of the 1 in. cubes (3.32% "1080" concentration). In a series of poisoning trials on deer using "1080" poisoned carrot, Daniel (1966) found that some animals had consumed more than 4 lb (1.8 kg) of poisoned bait. The minimum lethal dose of "1080" for an opossum is 1.2 mg per kg (J. Bell pers. comm.). Therefore a twice lethal dose for an opossum weighing 3½ kg would be contained in 16.5 g or just over ½ oz of the 1 in. cubes treated with the 3.32% solution. Thus a bait material of this toxicity should be effective against both deer and opossums. Where whole carrots or large pieces of carrot are used even higher concentrations might be obtained if they were abraded before the baits were prepared.

Providing a bait-cutting machine that will cut the carrots to a uniform thickness can be devised, immersion techniques should make it possible to produce baits of uniform and predictable toxicity.

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