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Routes of Dieldrin Elimination in Fed and Starved Chickens

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Discovery of dieldrin (HEOD) residues above tolerance levels acceptable for human consumption in body fat of turkeys in two flocks in North Dakota in 1974 stimulated research on methods for removing dieldrin from bodies of turkeys (DAVISON and SELL 1978a, SELL et al. 1977) and chickens (DAVISON and SELL 1978b). COOK (1970) demonstrated dieldrin in saliva, bile, urine and feces of a goat given dieldrin intravenously, and HEDDE et al. (1970) isolated dieldrin metabolites in urine of sheep given [^{14}C]-dieldrin orally. Reported herein are results of experiments conducted to determine routes through which chickens eliminate dieldrin or its metabolites from their bodies.

MATERIALS AND METHODS

Balance experiments were conducted with 13- to 15-week-old White Leghorn roosters. They were housed individually in wire cages, and, except when starved, each rooster was fed 70 g/day of a commercial feed. Water was always available. Droppings were collected on stainless steel trays suspended beneath the cage floors.

Each chicken was given 25 µg of technical dieldrin (contains 87% HEOD) and 1.2 µCi of [^{14}C]dieldrin (described by DAVISON and SELL 1978a) in gelatin capsules daily for 7 days to build residues in its body. On the 8th day, bile ducts were cannulated or colostomies were performed on some chickens so that the amount of carbon-14 eliminated through bile, feces or urine could be determined. Beginning on the 8th day, some chickens were starved in tests to determine the effects of starvation on the route of elimination of carbon-14.

At the end of the experiments, the chickens were exsanguinated and plucked, and the blood and feathers were discarded. The gastrointestinal (GI) tracts were removed, and in one experiment the gallbladders were removed. The carcass remains and GI tracts were ground separately, mixed and sampled, and the samples were lyophilized. Gallbladders were lyophilized intact. Assay procedures for radioactivity in lyophilized samples, feces, urine and fresh bile have been described previously (DAVISON and SELL 1978a).

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TABLE 1

Recovery of ^{14}C from Starved or Bile-cannulated Roosters Given [^{14}C]Dieldrin (Experiment 1)[a]

Item	Control (%)	Starved (%)	Cannulated bile duct (%)
Droppings, 0-7 days	17.2±2.2	14.9±3.5	15.0±0.8
8th day	3.2±0.5	1.9±0.7	1.2±0.3
9-10 days	19.2±3.2	22.1±4.9	17.6±3.8
Bile, 8-10 days	-	-	8.1±0.8
Gastrointestinal tract	4.6±0.7	6.3±1.1	3.1±0.7
Carcass	50.6±5.3	43.4±8.7	48.5±4.4
Total	94.8±1.0	88.6±3.0	93.6±2.4

[a]Data are means ± standard errors of the means. N was 4, 4 and 3 chickens in the control, starved and cannulated groups, respectively. Starvation was begun and the bile ducts were cannulated on the 8th day.

TABLE 2

Recovery of ^{14}C from Fed or Starved Roosters Given [^{14}C]Dieldrin (Experiment 2)[a]

Item	Control (%)	Cannulated bile duct	
		Fed (%)	Starved (%)
Droppings, 0-7 days	21.5±0.5	21.1±0.8	20.8±1.0
8-18 days	26.6±1.9	27.0±2.9	18.7±0.9
Bile, 8-18 days	-	9.4±0.5	9.9±1.3
Gallbladder and contents	0.22±0.08	0.14±0.03	0.76±0.27
Gastrointestinal tract	2.1±0.4	1.8±0.1	2.4±0.1
Carcass	42.6±2.4	34.6±4.2	36.9±2.6
Total	93.0±0.9	93.8±1.1	89.4±1.4

[a]Data are means ± standard errors of the means. N was 7, 6 and 6 for the control, fed and starved groups, respectively. Starvation was begun and the bile ducts were cannulated on the 8th day.

RESULTS AND DISCUSSION

The results of three experiments are shown in Tables 1-3. Severe starvation of chickens or turkeys consistently increased and amount of carbon-14 eliminated in droppings and reduced the amount of carbon-14 remaining in the carcasses (DAVISON and SELL 1978a,b). In experiments 1 and 2, carcasses of starved chickens contained less carbon-14 than carcasses of control chickens (Tables 1 and 2). In experiment 3, carcasses of starved and control chickens contained appoximately equal amounts of carbon-14 (Table 3). This apparent discrepancy is probably explained by

the duration and severity of the starvation. Experiment 3 was ended after only 4 days of starvation because the outcome of the experiment was obvious by then. Starvation in other experiments involved longer periods of time.

From the data in Tables 1 and 2, bile appeared to be an important route for eliminating dieldrin or its metabolites. Furthermore, the amount of carbon-14 eliminated via bile was essentially equal in fed and starved chickens (Table 2), and the amount of carbon-14 remaining in the carcasses of bile-cannulated and fed or of bile-cannulated and starved chickens was nearly equal. Also, the amount of carbon-14 remaining in the carcasses of bile-cannulated chickens (Table 2) was less than that remaining in the carcasses of control chickens.

If one can assume that the carbon-14 collected in bile of cannulated chickens would normally have been secreted into the intestine, then one would think that reduced resorbtion from the intestine would accelerate the elimination of dieldrin from the various anion exchange resins were not effective GI adsorbants for accelerating the elimination of dieldrin from body stores of turkeys (DAVISON and SELL 1978a) or chickens (DAVISON and SELL 1978b).

Because results of experiments with potential GI adsorbants for accelerating removal of dieldrin residues from chickens and turkeys were generally negative and results of experiments involving starvation were generally positive, an experiment was conducted with colostomized chickens to determine the effect of starvation on the elimination in urine and feces of carbon-14 from [^{14}C]dieldrin. That carbon-14 was eliminated in approximately equal amounts in urine and feces of fed chickens (Table 3) and that carbon-14 was eliminated almost exclusively in urine of

TABLE 3

Recovery of ^{14}C from Colostomized Fed or Starved Roosters Given [^{14}C]Dieldrin (Experiment 3)[a]

Item	Fed (%)	Starved (%)
Droppings, 0-7 days	19.6±1.1	20.1±1.7
Feces, 8-11 days	4.8±0.4	0.6±0.1
Urine, 8-11 days	5.4±0.8	8.2±1.6
Urine and Feces, 8-11 days	1.5[b]	-
Gastrointestinal tract	4.7±0.9	5.9±0.3
Carcass	51.9±1.0	51.5±4.4
Total	87.8±1.2	86.2±1.4

[a]Data are means and standard errors of the means for 5 chickens.
[b]Represents 4 spills among 3 chickens. Starvation was begun on the 8th day.

starved chickens was immediately obvious. Starved chickens produced virtually no feces. The GI tracts (included tissue and contents) of starved chickens contained as much carbon-14 as the GI tracts of fed chickens. Apparently, biliary secretion of carbon-14 was low in these starved chickens or the carbon-14 secreted into the intestine via bile was partly reabsorbed; otherwise, more carbon-14 would have appeared in the GI tract or in the small amount of feces eliminated.

Bile and urine were extracted with hexane and subjected to thin-layer chromatographic (HEDDE et al. 1970) and gas-liquid chromatographic (JOHNSON 1965) procedures to determine whether the carbon-14 eliminated was dieldrin or metabolites of dieldrin. The fact that dieldrin was not detected in bile indicated that biliary carbon-14 was contained in metabolites of dieldrin. Traces of dieldrin (about 0.06% of the HEOD equivalents in urine) detected in urine indicated that most of the urinary carbon-14 was also contained in metabolites of dieldrin. These observations pertained to the urine and bile from both fed and starved chickens.

In conclusion, [^{14}C]dieldrin metabolites were present in the urine and bile of chickens after dosing with [^{14}C]dieldrin. The amount of carbon-14 eliminated by fed chickens was about equally divided between urinary and fecal routes, but the carbon-14 eliminated by starved chickens was predominantly via urine.

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