1-16-90

Shaughnessy No.: ~~028501~~ 006315
Date Out of EAB: JAN.16,1990

To: Jeff Kempter
Product Manager #32
Registration Division (TS-767C)

From: Paul Mastradone, Ph.D.,Chief for
Environmental Chemistry Review Section #1
Environmental Fate and Ground Water Branch/EFED (TS-769C)

Through: Henry Jacoby, Chief Henry Jacoby
Environmental Fate and Ground Water Branch/EFED (TS-769C)

Attached, please find the EAB review of . . .

Reg./File # : 5785-65 & 5785-63

Chemical Name : Dimethylhydantoin

Type Product : Microbiocide

Product Name : BromoCide Tablets, BromoCide Granules

Company Name : Great Lakes Chemical Company

Purpose : Review amendment request for additional use pattern and additional brand name (BromoCide Tablets and Granules)

Date Received: 12/1/88

Action Code: 310

Date Completed: ______

EFGWB # (s): 90174

Monitoring Study Requested: ______

Total Reviewing time: 8.0 days

Monitoring Study Volunteered: ______

Deferrals to:

_____ Ecological Effects Branch, EFED

_____ Science Integration and Policy Staff, EFED

_____ Non-Dietary Exposure Branch, HED

_____ Dietary Exposure Branch, HED

_____ Toxicology Branch, HED

1. CHEMICAL: Common name:

Dimethylhydantoin.

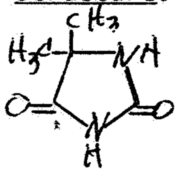
Chemical name:

5,5-Dimethylhydantoin.

Trade name(s):

BromoCide Tablets, BromoCide Granules.

Structure:



Formulations:

92.5% P/T and 93.5% G.

Physical/Chemical properties:

Molecular formula: $C_5H_8O_2N_2$.
Physical state: White crystalline odorless solid.
Solubility: 13.5 g/100 g water at 20°C.
Vapor Pressure:

2. TEST MATERIAL:

Studies 1-7: Active ingredient.
Study 8: Test substance not identified.

3. STUDY/ACTION TYPE:

Review amendment request for additional use pattern and additional brand name (BromoCide Tablets and Granules).

4. STUDY IDENTIFICATION:

Carpenter, M. 1987. Determination of photodegradation of 5,5-dimethylhydantoin in pH 7 buffer solution. Laboratory Project ID 35178. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West LaFayette, IN. (40804602)

Craine, E.M. 1987. The octanol-water partition coefficient of dimethylhydantoin. WIL Laboratory Project ID WIL-80192 and WIL-12087. Unpublished study prepared by WIL Research Laboratories, Inc., Ashland, OH, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN.

and submitted by Great Lakes Chemical Corporation, West Lafayette, IN. (40685201)

Daly, D. 1987. Hydrolysis as a function of pH at 25°C with ^{14}C-5,5-dimethylhydantoin. Laboratory Project ID 35181. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West LaFayette, IN. (40804601)

Daly, D. and J. Schmidt. 1987. Aerobic aquatic metabolism of ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35186. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN. (40804607)

Daly, D. and J. Schmidt. 1988a. Aerobic soil metabolism of ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35184. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN. (40804603)

Daly, D. and J. Schmidt. 1988b. Anaerobic aquatic metabolism of ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35185. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN. (40804604)

Warren, J. 1986. Soil/sediment adsorption desorption of ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35182. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN. (40804605)

Warren, J. 1987. Leaching characteristics in soil with ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35183. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN. (40804606)

5. REVIEWED BY:

H. Manning, Ph.D.
Microbiologist
EFGWB/EFED/OPP
Review Section #1

Signature: Herbert I. Manning

Date: ____________

6. APPROVED BY:

Paul Mastradone, Ph.D.
Section Chief
EFGWB/EFED/OPP
Review Section #1

Signature: Paul J Mastradone

Date: 16 1990

7.0 CONCLUSION:

7.1 The EFGWB (Environmental Fate & Ground Water Branch) concludes that the registrant has fulfilled all the submission and guideline data requirements to amend its dimethylhydantoin label (for cooling towers use) except for Aquatic (sediment) Field Dissipation and Aquatic Nontarget Accumulation studies, which are data gaps.

7.2 The studies indicated below are required because cooling tower uses are considered a direct discharge, as shown by the following statement in our guideline definition of direct discharge: "Since cooling tower water is commonly discharged into lakes, streams, and rivers, most pesticides used to control bacteria or other pests in cooling towers are considered to have direct discharge uses."

7.3 Environmental Fate Assessment

The following is a brief summary of the data we hgave reviewed that were submitted or are required for use in cooling towers:

In summary, dimethylhydantoin is stable to hydrolysis and photolysis, degrades very slowly (t1/2 = >one year) in soil under aerobic or anaerobic conditions, is very mobile in soil (the leachate from four soil columns using different soil types ranged from 90.1 to 100.0%), and ~~will~~ is likely not to accumulate in fish (K_{OW} ranged from 0.32 to 0.40).

It should be noted that throughout the studies the technique used to "identify" degradates/metabolites was TLC (Thin Layer Chromatography). This procedure does not give positive, confirmatory identification. Gas chromatography/mass spectrometry are the analytical methods we strongly recommend using to identify degradates/metabolites.

1. 161-1 Hydrolysis (40804601)

The study is acceptable and satisfies EPA data requirements.

The compound was stable during the 30 day test period, with 90.0 to 96.4% of the chemical being recovered in the buffered test solutions.

2. 161-2 Photodegradation in Water (40804602)

The study is acceptable and satisfies EPA data requirements.

The compound was stable after exposure to a Xenon lamp for 30 days; only the parent was recovered at 97.0-104% of applied activity.

3. 162-1 Aerobic Soil Metabolism (40804603)

The study is acceptable and satisfies EPA data requirements.

The compound degraded with a half-life of >one year (duration of study) in the sandy loam soil. Undegraded parent was 82.6% of applied; volatile residues ($^{14}CO_2$) were 3.37%.

4. 162-3 Anaerobic Aquatic Metabolism (40804604)

The study is acceptable and satisfies EPA data requirements.

The compound degraded with a half-life of >one year (duration of study) in the flooded sandy loam soil. Undegraded parent was 84.1% of applied; volatile residues were 0.17%.

5. 162-4 Aerobic Aquatic Metabolism (40804607)

The study is acceptable and satisfies EPA data requirements.

The chemical was stable after one month incubation in the flooded sandy loam soil; the undegraded parent was 108.5% of applied, volatile residues were 0.42%, and unextractable residues were 0.58%.

6. 163-1 Mobility - Leaching and Adsorption/Desorption (40804605)

The study is acceptable and satisfies EPA data requirements.

The chemical was very mobile in each of the four test soils (the data did not fit a Freundlich model for adsorption); "K_d" was 0.051 for sandy loam soil, 0.077 for silt loam, 0.092 for loam, and 0.138 for the clay loam soil. Adsorption increased with increasing organic matter, clay content, and CEC of the soils.

163-1 Mobility - Leaching and Soil Column (40804606

The study is acceptable and satisfies EPA data requirements.

The chemical was shown to be very mobile in soil columns of the four test soils; leachate effluent from the sandy loam averaged 90.1%, from the silt loam and loam it was >100%, and from the clay loam soil it was 95.2%.

7. 165-4 Ancillary Study - Octanol/Water Partition Coefficient (40685201)

The study is scientifically sound and provides useful information.

The potential for the chemical to bioaccumaulate in fish is expected to be low since the K_{OW} ranged from 0.32 to 0.40.

Therefore, a study to test for Accumulation in Fish is not required.

8.0 RECOMMENDATIONS:

8.1 Inform the registrant that all the data required to amend the dimethylhydantoin label (cooling tower use) have been satisfied except Aquatic (sediment) Field Dissipation an Aquatic Nontarget Accumulation, which are data gaps.

9.0 BACKGROUND:

A. Introduction

The registrant is requesting an amendment for additional uses and additional brand name.

B. Directions for Use

Dimethylhydantoin is a microbicide developed for use as a disinfectant and sanitizer (bactericide, slimicide, and algicide) in recirculating and once-through cooling water systems and wastewater treatment systems, and for the control of microbial slime in air conditioners, dehumidifiers, and evaporative coolers. It is formulated as a 92.5% Tablet (P/T) and a 93.5% Granular (G); the available bromine:chlorine ratio is ca. 61:28. Dimethylhydantoin is applied to cooling water, evaporative coolers, and wastewater at 0.1 to 0.6 lb/1000 gallons (0.24-0.72 kg/10000 L); the application is repeated at 0.1 to 0.3 lb/1000 gallons until the concentration of bromine residues in the treated water is maintained at 1 to 3 ppm for cooling water and evaporative cooler systems or at 0.5 to 5.0 ppm for wastewater. In air conditioners and dehumidifier basins, dimethylhydantoin tablets or granules are used "as necessary to maintain the cleanliness of the system".

According to the label instructions, dimethylhydantoin should not be discharged into lakes, streams, ponds, or public water "unless in accordance with an NPDES permit". Treated wastewater should not be used to irrigate crops.

10. DISCUSSION OF INDIVIDUAL TESTS OR STUDIES:

See individual DERs (DATA EVALUATION RECORD).

11. COMPLETION OF ONE-LINER:

The ONE-LINER has been completed and updated.

12. CBI APPENDIX: There is no CB in this review.

DYNAMAC CORPORATION

DIMETHYLHYDANTOIN

Task 1: Review and Evaluation of Individual Studies

Task 2: Environmental Fate Assessment

February 10, 1989

Initial Draft Report

Contract No. 68-02-4250

Submitted to:
[illegible]
[illegible]

Submitted by:
[illegible]
[illegible]
[illegible]
[illegible]

Dimethylhydantoin

Table of Contents

INTRODUCTION

Dimethylhydantoin is a microbicide developed for use as a disinfectant and sanitizer (bactericide, slimicide, and algicide) in recirculating and once-through cooling water systems and wastewater treatment systems, and for the control of microbial slime in air conditioners, dehumidifiers, and evaporative coolers. It is formulated as a 92.5% Tablet (P/T) and a 93.5% Granular (G); the available bromine:chlorine ratio is ≈61:28. Dimethylhydantoin is applied to cooling water, evaporative coolers, and wastewater at 0.1 to 0.6 lb/1000 gallons (0.24-0.72 kg/10000 L); the application is repeated at 0.1 to 0.3 lb/1000 gallons until the concentration of bromine residues in the treated water is maintained at 1 to 3 ppm for cooling water and evaporative cooler systems or at 0.5 to 5.0 ppm for wastewater. In air conditioners and dehumidifier basins, dimethylhydantoin tablets or granules are used "as necessary to maintain the cleanliness of the system".

According to the label instructions, dimethylhydantoin should not be discharged into lakes, streams, ponds, or public water "unless in accordance with an NPDES permit". Treated wastewater should not be used to irrigate crops.

DATA EVALUATION RECORD

STUDY 1

CHEM 028501 Dimethylhydantoin 161-1

FORMULATION—00—ACTIVE INGREDIENT

STUDY ID 40804601

Daly, D. 1987. Hydrolysis as a function of pH at 25 C with ^{14}C-5,5-dimethylhydantoin. Laboratory Project ID 35181. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West LaFayette, IN.

DIRECT REVIEW TIME = 10

REVIEWED BY: W. Hurtt TITLE: Staff Scientist

EDITED BY: K. Patten TITLE: Task Leader

APPROVED BY: W. Spangler TITLE: Project Manager

ORG: Dynamac Corporation
Rockville, MD
TEL: 468-2500

APPROVED BY: H. Manning H. J. Manning
TITLE: Microbiologist
ORG: EFGWB/EFED/OPP
TEL: 557-7323

SIGNATURE:

CONCLUSIONS:

Degradation - Hydrolysis

1. This study is acceptable and fulfills EPA Data Requirements for Registering Pesticides by providing information on the hydrolysis of [^{14}C]5,5-dimethylhydantoin in sterile aqueous solutions buffered to pH 5, 7, and 9.

2. The compound was stable during the 30 day test period, with 90.0 to 96.4% of the chemical being recovered in the buffered test solutions.

SUMMARY OF DATA BY REVIEWER:

Ring-labeled [^{14}C]5,5-dimethylhydantoin (radiochemical purity 98.3%), at 10 ppm, was relatively stable in sterile buffered aqueous solutions (pH 5, 7, and 9) incubated in the dark at 25 C for 30 days. [^{14}C]Dimethylhydantoin was the only compound identified in the buffer solutions at all the pH 7 solutions, and 90.0% of the recovered from the pH 9 solution. Other radioactivity in the solutions (not quantified) remained at the origin of the TLC plates or was characterized as "remainder". During the 30-day study, the material balances ranged from 93.6 to 107.1% of the applied.

DISCUSSION:

1. Insufficient data were available to extrapolate an accurate half-life. The study authors computed half-lives for dimethylhydantoin ranging from 182 to 1070 days; the estimated half-life increased 888 days on the basis of a concentration difference at 30 days posttreatment of 6.4% of the recovered.

MATERIALS AND METHODS

MATERIALS AND METHODS:

Ring-labeled $[^{14}C]$5,5-dimethylhydantoin (radiochemical purity 98.3%, specific activity 2.14 x 10^5 dpm/µg, WIL Laboratories) dissolved in acetone was added to four 150-mL volumetric flasks, and the excess solvent was evaporated from the flasks with a stream of nitrogen. Sterile buffer (prepared in boiled deionized, distilled water filtered through a 0.22-µ filter) was added to each flask to produce a final $[^{14}C]$dimethylhydantoin concentration of 10 ppm. The buffered solutions were: pH 5—0.5 M acetic acid and 0.2 M sodium acetate; pH 7(A)—0.2 M tris(hydroxymethyl)aminomethane and 0.2 M HCl; pH 7(B)—0.1 M KH_2PO_4 and 0.1 M NaOH; and pH 9—0.2 M boric acid and 0.2 M sodium borate. The pH of the buffers was measured at the initiation and at the termination of the hydrolysis experiments. Aliquots (9 mL) of the four test solutions were transferred to culture tubes and incubated in the dark in an environmental chamber at 25 ± 1°C. Duplicate tubes of each pH were sampled at 0, 3, 7, 14, 22, and 30 days posttreatment.

At each sampling period, aliquots of each buffer solution were analyzed without extraction for total radioactivity using LSC and for specific compounds using TLC on reverse-phase plates developed in ethyl acetate. The samples were cochromatographed with a stock dimethylhydantoin solution. After development, the TLC plates were air-dried and analyzed using a TLC linear scanner. The 0- and 30-day TLC plates were also autoradiographed to confirm the results of the scan.

DATA EVALUATION RECORD

STUDY 4

CHEM 028501 Dimethylhydantoin 162-3

FORMULATION—00—ACTIVE INGREDIENT

STUDY ID 40804604
Daly, D. and J. Schmidt. 1988b. Anaerobic aquatic metabolism of ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35185. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN.

DIRECT REVIEW TIME = 8

REVIEWED BY: E. Hirsh TITLE: Staff Scientist

EDITED BY: K. Patten TITLE: Task Leader

APPROVED BY: W. Spangler TITLE: Project Manager

ORG: Dynamac Corporation
Rockville, MD
TEL: 468-2500

APPROVED BY: H. Manning H. J. Manning
TITLE: Microbiologist
ORG: EFGWB/EFED/OPP
TEL: 557-7323

SIGNATURE:

CONCLUSIONS:

Metabolism - Anaerobic Aquatic

1. This study is acceptable and fulfills EPA Data Requirements for Registering Pesticides by providing information on the anaerobic aquatic metabolism of [2-^{14}C]5,5-dimethylhydantoin in flooded sandy loam soil at 25 C.

2. The compound degraded with a half-life of >one year (duration of study) in the flooded sandy loam soil. Undegraded parent was 84.1% of applied; volatile residues were 0.17%.

SUMMARY OF THE DATA BY REVIEWER:

[2-^{14}C]5,5-Dimethylhydantoin (radiochemical purity 98.8%), at ca. 10 ug/g, degraded with a half-life of >1 year in flooded sandy loam soil that was incubated in the dark at 25 C for 1 year. The sandy loam soil was flooded and incubated for 33 days prior to treatment with dimethylhydantoin. At 1 year posttreatment, undegraded [^{14}C]dimethylhydantoin was 82.4%, volatile [^{14}C]residues (primarily $^{14}CO_2$) totaled 0.18%, unextractable [^{14}C]residues accounted for 0.38%, and extractable 17.2% of the applied. The distribution of radioactivity between the water and soil fractions (after agitation) ranged from 4.7-7.5:1. The material balance during the study (reviewer-calculated) ranged from 95.7 to 105.8% of the applied.

DISCUSSION:

1. The material balances reported by the study authors were based not on the total radioactivity recovered at a given sampling interval (which is the standard practice) but on the sum of the total radioactivity recovered at a given sampling interval and the total radioactivity recovered at all previous sampling intervals. The result of the approach adopted by the study authors is that recoveries at early sampling intervals mask low and high recoveries at later sampling intervals. Also, the material balances reported by the study authors do not include total volatilized material.

   The material balances reported by the study authors ranged from 99.4 to 104% of the applied (Table VIII). However, the material balances range from 95.7 to 105.8% of the applied if they are calculated from total radioactive residues in a particular sample (9.49 to 10.5 ug/g, "Total Residues" plus "Cumulative Volatiles") divided by the total radioactive residues in the time 0 sample (9.92 ug/g) (Table V).

2. Data were reported by the study authors in terms of "percent of total recovered radioactivity" and "percent of recovered from the TLC plates". To simplify the data summary and allow comparisons to be made between sampling intervals, data were recalculated in terms of "percent of applied" using data from Tables V, IX, and X and the equations:

   (total ug of radioactivity in system/g soil at time y
   total ug of radioactivityin system/g soil at time 0) x 100 =
   % of applied radioactivity recovered at time y

   % of applied radioactivity recovered at time y x
   % recovered radioactivity in a given fraction at time y =
   % of applied radioactivity in a given fraction

   % of applied radioactivity in a given fraction at time y x
   % of recovered radioactivity as dimethylhydantoin (TLC) at time y =
   % of applied as dimethylhydantoin in fraction.

   % of applied as dimethylhydantoin in extractable fraction +
   % of applied as dimethylhydantoin in water-soluble fraction =
   % of applied as dimethylhydantion in system.

For example:

(7.80 + 1.63 + 0.04 + 0.02)ug/g at 12 months
  - (9.92 ug/g at 0 days)(100) =
    95.7% of the applied radioactivity was recovered at 12 months

95.7% of applied radioactivity recovered at 12 months x
  17.2% of recovered in the extractable fraction at 12 months =
    16.5% of the applied radioactivity was extractable at 12 months

16.5% of the applied radioactivity extractable at 12 months x
  93.5% of recovered as dimethylhydantoin (TLC) at 12 months =
    15.4% of the applied was dimethylhydantoin at 12 months (soil).

Repeating the calculations for the water fraction:

95.7% of applied radioactivity recovered at 12 months x
  82.4% of recovered in the extractable fraction at 12 months x
    87.1% of recovered as dimethylhydantoin (TLC) at 12 months =
      68.7% of the applied was dimethylhydantoin at 12 months (water).

15.4% of the applied in soil + 68.7% of the applied in water =
  84.1% of the applied radioactivity in the system was
    dimethylhydantoin at 12 months.

MATERIALS AND METHODS

MATERIALS AND METHODS:

Twenty-eight 10-gram samples of sieved (2 mm) sandy loam soil (72% sand, 16% silt, 12% clay, 1.0% organic matter, pH 6.1, CEC 9.0 meq/100 g) were weighed into silanized culture tubes, flooded with 30 mL of deionized water, and incubated in the dark at 25 ± 1°C for 33 days. At the end of the incubation period, the soil:water slurries were amended with glucose (1 g) and treated with ≈10 ppm of [2-^{14}C]5,5-dimethylhydantoin (radiochemical purity 98.8%, specific activity 12.33 mCi/mMol, Pathfinder Laboratories) dissolved in acetonitrile. The treated slurries were homogenized on a vortex mixer, then divided between two "metabolism vessels". Humidified air was pumped continuously (10-100 mL/minute) into 3-L glass jars adapted to hold 14 tubes of soil, then sequentially through ethylene glycol, 1 N sulfuric acid and 1 N potassium hydroxide (2 tubes) trapping solutions. The samples were maintained in the dark at 25 ± 1°C. Duplicate soil:water samples were collected and trapping solutions changed at 0, 1, 3, 7, 14, 31, 60, 90, 121, 182, 274, and 365 days posttreatment. Trapping solutions were also changed at 151, 212, 243, 304, and 335 days posttreatment.

Following sampling, the soil:water solutions were vortexed for 2 minutes and centrifuged. The soil fraction was extracted three times with methanol; the methanol extracts were separated from the soil by centrifugation, combined, and analyzed for total radioactivity by LSC and for specific compounds using reverse-phase TLC on plates developed in 100% ethyl acetate. The methanol extracts were cochromatographed with a [^{14}C]dimethylhydantoin reference standard; the radioactive compounds were visualized by autoradiography and quantified by TLC linear scanning. Unextractable [^{14}C]residues remaining in the extracted soil were quantified by LSC following combustion. The water fraction was analyzed for total radioactivity by LSC and for specific compounds using reverse-phase TLC as described. Radioactivity in the gas trap solutions was quantified by LSC.

DATA EVALUATION RECORD

STUDY 5

CHEM 028501 Dimethylhydantoin 162-4

FORMULATION--00--ACTIVE INGREDIENT

STUDY ID 40804607
Daly, D. and J. Schmidt. 1987. Aerobic aquatic metabolism of ^{14}C-5,5-dimethylhydantoin. ABC Final Report #35186. Unpublished study performed by Analytical Bio-Chemistry Laboratories, Inc., Columbia, MO, and submitted by Great Lakes Chemical Corporation, West Lafayette, IN.

DIRECT REVIEW TIME = 8

REVIEWED BY: E. Hirsh TITLE: Staff Scientist

EDITED BY: K. Patten TITLE: Task Leader

APPROVED BY: W. Spangler TITLE: Project Manager

ORG: Dynamac Corporation
Rockville, MD
TEL: 468-2500

APPROVED BY: H. Manning H. J. Manning
TITLE: Microbiologist
ORG: EFGWB/EFED/OPP
TEL: 557-7323

SIGNATURE:

CONCLUSIONS:

Metabolism - Aerobic Aquatic

1. This study is acceptable and fulfills EPA Data Requirements for Registering Pesticides by providing information on the aerobic aquatic metabolism of [2-^{14}C]5,5-dimethylhydantoin in flooded sandy loam soil at 25 C.

2. The chemical was stable after one month incubation in the flooded sandy loam; the undegraded parent was 108.5% of applied; volatile residues were 0.42%, and unextractable residues were 0.58%.

SUMMARY OF THE DATA BY REVIEWER:

[2-^{14}C]5,5-Dimethylhydantoin (radiochemical purity 98.8%), at ca. 10 ug/g, was relatively stable in flooded sandy loam soil that was incubated in the dark at 25 C for 1 month. The sandy loam soil was flooded and treated immediately with dimethylhydantoin. At 1 month posttreatment, undegraded [^{14}C]dimethylhydantoin was 108.5% of the applied, volatile [^{14}C]residues (primarily $^{14}CO_2$) totaled 0.42% of the applied, and unextractable [^{14}C]residues accounted for 0.58% of the applied. The distribution of radioactivity between the water and soil fractions (after agitation) ranged from 5.4-8.4:1. The material balance during the study (reviewer-calculated) ranged from 82.4 to 113.7% of the applied.

DISCUSSION:

1. Total [^{14}C]residues recovered from the soil:water system varied from 8.12 to 11.2 ug/g soil and, in general, increased with time. As a result, more dimethylhydantoin was recovered at 1 month posttreatment than at time 0. The increasing material balance did not affect the study conclusions. Dimethylhydantoin comprised 95.9-96.6% of the radioactivity recovered from the test water, and 94.5-97.8% of the radioactivity recovered from the soil extracts. Scans and autoradiography indicated only a single [^{14}C]compound was present; the remaining radioactivity appeared to be located at the origin.

2. The material balances reported by the study authors were based <u>not</u> on the total radioactivity recovered at a given sampling interval (which is the standard practice) but on the sum of the total radioactivity recovered at a given sampling interval <u>and</u> the total radioactivity recovered at all previous sampling intervals. The result of the approach adopted by the study authors is that recoveries at early sampling intervals mask low and high recoveries at later sampling intervals. Also, the material balances reported by the study authors <u>do not</u> include total volatilized material.

   The material balances reported by the study authors ranged from 84.5 to 105% of the applied (Table 7). However, the material balances range from 82.4 to 113.7% of the applied if they are calculated from total radioactive residues in a particular sample (8.12 to 11.2 ug/g, "Total Residues" from Table 5) divided by the total radioactive residues in the time 0 sample (9.92 ug/g).

3. Data were reported by the study authors in terms of "percent of total recovered radioactivity" and "percent of recovered from the TLC plates". To simplify the data summary and allow comparisons to be made between sampling intervals, data were recalculated in terms of "percent of applied" using data from Tables 5, 8, and 9 and the equations:

   (total ug of radioactivity in system/g soil at time y -
   total ug of radioactivityin system/g soil at time 0) x 100 =
   % of applied radioactivity recovered at time y

   % of applied radioactivity recovered at time y x
   % recovered radioactivity in a given fraction at time y =
   % of applied radioactivity in a given fraction

% of applied radioactivity in a given fraction at time y x
% of recovered radioactivity as dimethylhydantoin (TLC) at time y =
% of applied as dimethylhydantoin in fraction.

% of applied as dimethylhydantoin in extractable fraction +
% of applied as dimethylhydantoin in water-soluble fraction =
% of applied as dimethylhydantion in system.

For example:

(11.2 ug/g at 1 month - 9.85 ug/g at 0 days)(100) =
113.7% of the applied radioactivity was recovered at 1 month

113.7% of applied radioactivity recovered at 1 month x
10.6% of recovered in the extractable fraction at 1 month =
12.0% of the applied radioactivity was extractable at 1 month

12.0% of the applied radioactivity extractable at 1 month x
94.5% of recovered as dimethylhydantoin (TLC) at 1 month =
11.3% of the applied was dimethylhydantoin at 1 month (soil).

Repeating the calculations for the water fraction:

113.7% of applied radioactivity recovered at 1 month x
88.9% of recovered in the water-soluble fraction at 1 month x
96.2% of recovered as dimethylhydantoin (TLC) at 1 month =
97.2% of the applied was dimethylhydantoin at 1 month (water).

11.3% of the applied in soil + 97.2% of the applied in water =
108.5% of the applied radioactivity in the system was
dimethylhydantoin at 1 month.

MATERIALS AND METHODS

MATERIALS AND METHODS:

Eighteen 10-gram samples of sieved (2 mm) sandy loam soil (72% sand, 16% silt, 12% clay, 1.0% organic matter, pH 6.1, CEC 9.0 meq/100 g) were weighed into silanized culture tubes, flooded with 30 mL of deionized water, and treated with ≈10 ppm of [2-^{14}C]5,5-dimethylhydantoin (radiochemical purity 98.8%, specific activity 12.33 mCi/mMol, Pathfinder Laboratories) dissolved in acetonitrile. The treated slurries were homogenized on a vortex mixer, then divided between two "metabolism vessel". Humidified air was pumped continuously (10-100 mL/minute) into 3-L glass jars adapted to hold tubes of soil, then sequentially through ethylene glycol, 1 N sulfuric acid and 1 N potassium hydroxide (2 tubes) trapping solutions. The samples were maintained in the dark at 25 ± 1°C. Duplicate soil:water samples were collected and trapping solutions changed at 0, 1, 2, 7, 14, and 31 days posttreatment.

Following sampling, the soil:water solutions were vortexed for 2 minutes and centrifuged. The soil fraction was extracted three times with methanol; the methanol extracts were separated from the soil by centrifugation, combined, and analyzed for total radioactivity by LSC and for specific compounds using reverse-phase TLC on plates developed in 100% ethyl acetate. The methanol extracts were cochromatographed with a [^{14}C]dimethylhydantoin reference standard; the radioactive compounds were visualized by autoradiography and quantified by TLC linear scanning. Unextractable [^{1}4C]residues remaining in the extracted soil were quantified by LSC following combustion. The water fraction was analyzed for total radioactivity by LSC and for specific compounds using reverse-phase TLC as described. Radioactivity in the gas trap solutions was quantified by LSC.