Microbial Degradation of 2,3,5-Triiodobenzoic Acid in Soil

PHILIP L. MOY and ANDREW G. EBERT

Abstract

The metabolic fate of the plant growth regulator 2,3,5-triiodobenzoic acid was determined in soil using 14C-carboxyl-labeled 2,3,5-triiodobenzoic acid. 14C-2,3,5-Triiodobenzoic acid was degraded to 14CO2 by the microflora in soil; no radioactive CO2 was evolved from sterilized soil. Following incubation of 14C-2,3,5-triiodobenzoic acid in soil, unchanged 2,3,5-triiodobenzoic acid and three metabolites (2,5-diiodobenzoic acid, 3,5-diiodobenzoic acid, and one unknown) were recovered. Peak concentrations of 2,5-diiodobenzoic acid and 3,5-diiodobenzoic acid were 15-20 and 14-15%, respectively, at 8 weeks of incubation and decreased thereafter.

Keyphrases

2,3,5-Triiodobenzoic acid—microbial degradation in soil, identification of metabolites (2,3- and 3,5-Diiodobenzoic acids—formation from microbial degradation of 2,3,5-triiodobenzoic acid [Microbial degradation in soil—2,3,5-triiodobenzoic acid] Plant growth regulators—microbial degradation of 2,3,5-triiodobenzoic acid

2,3,5-Triiodobenzoic acid is used as a plant growth regulator on soybeans. It has been the subject of numerous metabolic fate studies in a variety of animals and plants. This note summarizes studies on the degradation of 2,3,5-triiodobenzoic acid by the microflora of soil.

EXPERIMENTAL

Apparatus—Four 50-ml conical flasks were connected in series with glass tubes and rubber stoppers so that attachment to a vacuum source would create a slow rate of aeration through the flasks. The contents of the flasks, beginning at the source of air, were as follows: Flask 1 contained 200 ml. of 0.5 N NaOH to remove CO2 from the air; Flask 2, a light-protected conical flask, contained 100 g. of soil and 20 ml. of an aqueous solution of 14C-2,3,5-triiodobenzoic acid as the sodium salt; and Flasks 3 and 4 each contained 100 ml. of 0.1 N NaOH to trap any 14CO2 liberated from the soil. Periodically, portions of the sodium hydroxide solutions were removed and counted in a liquid scintillation spectrometer.

Reagents—The carboxyl-labeled 14C-2,3,5-triiodobenzoic acid obtained1 had a specific activity of 10.5 μc./mg. (5248 μc./mole). The compound was shown to be radiochemically pure on the basis of paper chromatography in three solvent systems (1).

Thixotropic gel (5 g./100 ml. Bray's solution) was used for counting 14C in soil suspension.

Peotone soil, a silty clay loam indigenous to the Great Lakes region, was used for this experiment. As determined by plate counts, the soil contained 4.6 × 108 microorganisms/g. soil sample, not differentiated between bacteria, yeasts, and actinomycetes.

 Procedures—Twenty 10-g. air-dried Peotone soil samples were put into tared 60-ml. glass-stoppered bottles. Two milliliters of 14C-2,3,5-triiodobenzoic acid in the form of the sodium salt (1.884 × 106 d.p.m.) was added to the soil. The zones were identified, on the basis of chromatography with reference compounds, as unchanged 2,3,5-triiodobenzoic acid, 2,5-diiodobenzoic

1 Packard Tri-Carb.

2 From Dr. J. E. Christian and associates, Biochemistry Department, Purdue University, Lafayette, Ind.

Figure 1—Cumulative release of 14CO2 resulting from application of 14C-2,3,5-triiodobenzoic acid to Peotone soil.
acid, and 3,5-diiodobenzoic acid. An unknown metabolite was also found on the chromatograms. These data demonstrate that 2,3,5-
iodobenzoic acid and/or 3,5-diiodobenzoic acid also occurred,
reaching a peak at approximately 8 weeks. 2,3,5-Triiodobenzoic
acid was metabolized more rapidly at higher soil moisture content
than at 20% moisture.

Spitznagle et al. (4), in their studies of 2,3,5-triiodobenzoic acid
metabolism in soybeans, reported that the radioactivity decreased
rapidly in 14C-2,3,5-triiodobenzoic acid-treated soybeans. Resi-
dues of 14C-2,3,5-triiodobenzoic acid, 14C-2,5-diiodobenzoic
acid, and 14C-3,5-diiodobenzoic acid were found in the various
plant parts and in the harvested seeds. Some 14C activity as a
hexane-soluble material was also found in the seeds. However,
studies on the expiration of 14CO2 were not carried out.

Decarboxylation of 2,3,5-triiodobenzoic acid appears to be a
major metabolic route by soil microorganisms. Metabolic fate
studies on 2,3,5-triiodobenzoic acid in a variety of laboratory and
domestic animals provided no evidence of decarboxylation in the
metabolism of 2,3,5-triiodobenzoic acid. Rowles et al. (5), using
14C-2,3,5-triiodobenzoic acid, reported 95.3% of the dose in the
excreta of chickens at the end of 4 days. These authors identified
2,3,5-triiodobenzoic acid, 2,3-diiodobenzoic acid, 2,5-diiodobenzoic
acid, and 3,5-diiodobenzoic acid in the excreta of chickens. Barker
et al. (1), using 14C-2,3,5-triiodobenzoic acid, found 72–75% of the
radioactivity in rat urine and 24–28% in feces over the 4 days after
dosing. Gutenmann et al. (6) recovered 67% of a dose of 2,3,5-
triiodobenzoic acid in bovine urine in 9 days after 2,3,5-triiodo-
benzoic acid feeding. No expiration of CO2 was reported in these
studies.

Alexander and Aleem (7) studied the effect of molecular struc-
ture on the persistence and microbial decomposition of several
phenoxyalkyl carboxylic acid herbicides and chlorophenols. They
found that the aromatic nucleus of halogenated compounds re-
mained intact for long periods when a halogen was in the meta-
position. DeRose and Newman (8) reported that 2,4,5-trichloro-
phenoxycetic acid persisted for 147 days under greenhouse condi-
tions or 93 days in the field. 2,4-Dichlorophenoxyacetic acid and 2-
methyl-4-chlorophenoxyacetic acid disappeared more rapidly, ap-
parently due to the lack of a substituent in the meta-position.

In this study of 2,3,5-triiodobenzoic acid metabolism in soil with
20 and 40% moisture content, 42 and 17%, respectively, of the
original radioactivity were recovered from the soil at the end of
14 weeks, of which 12.5 and 3% were due to unchanged 2,3,5-
triiodobenzoic acid. This disappearance of radioactivity showed
that 2,3,5-triiodobenzoic acid was metabolized at a moderate rate.
In contrast, many halogenated herbicides such as monuron and
insecticides such as DDT or chlordane persist for 1.5–3 and 6–12
years, respectively, in soil (9).

REFERENCES

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Table I—Percent Radioactivity of 2,3,5-Triiodobenzoic Acid and Metabolites following Incubation in Soil

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<th>2,3,5-Triiodobenzoic Acid</th>
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