MUTAGENIC POTENTIAL OF p-DITHIANE

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and
DON W. KORTE JR, PhD, MAJ MSC

TOXICOLOGY GROUP
DIVISION OF RESEARCH SUPPORT

AUGUST 1985

Toxicology Series 95
GLP Study 84031

LETTERMAN ARMY INSTITUTE OF RESEARCH
PRESIDIO OF SAN FRANCISCO, CALIFORNIA 94129
Mutagenic potential of p-dithiane (Toxicology Series 95)—Sano and Korte

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EDWIN S. BEatrice, M.D.
Colonel, MC
Commanding, LAIR

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The mutagenic potential of \( p \)-dithiane was assessed by using the Ames Salmonella/Mammalian Microsome Mutagenicity Assay. Tests were performed on strains TA98, TA100, TA1535, TA1537, and TA1538 were exposed to doses ranging from 5 mg/plate to 0.6016 mg/plate. The test compound was not mutagenic under conditions of this assay.
ABSTRACT

The mutagenic potential of p-dithiane was assessed by using the Ames Salmonella/Mammalian Microsome Mutagenicity Assay. Tester strains TA98, TA100, TA1535, TA1537, and TA1538 were exposed to doses ranging from 5 mg/plate to 0.0016 mg/plate. The test compound was not mutagenic under conditions of this assay.

Key Words: Mutagenicity, Genetic Toxicology, Ames Assay, p-Dithiane
PREFACE

TYPE REPORT: Ames Assay GLP Study Report

TESTING FACILITY: US Army Medical Research and Development Command
Letterman Army Institute of Research
Presidio of San Francisco, CA 94129-6800

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US Army Medical Bioengineering Research and
Development Laboratory
Fort Detrick, MD 21701-5010

WORK UNIT: 3516277A875 Medical Defense Against Chemical
Agents Projects; WU 308; APC TL05

GLP STUDY NUMBER: 84031

STUDY DIRECTOR: Maj Don W. Korte Jr, PhD

PRINCIPAL INVESTIGATOR: SP4 Steven K. Sano, BA

REPORT AND DATA MANAGEMENT: A copy of the final report, study protocols,
raw data, retired SOPs, and an aliquot of the test compound will be retained in the
LAIR Archives.

TEST SUBSTANCE: p-Dithiane (TA039)

INCLUSIVE STUDY DATES: 24 September – 12 October 1984

OBJECTIVE: The objective of this study was to determine the mutagenic
potential of p-dithiane (Batch Number 3030TH, LAIR Code TA039)
by using the Ames Salmonella/Mammalian Microsome
Mutagenicity Assay.
ACKNOWLEDGMENTS

The authors wish to thank SP6 James Justus, BA; SP4 Paul Mauk, BA; PFC James Martin; and Mr. John Dacey, for their assistance in performing the research.
SIGNATURES OF PRINCIPAL SCIENTISTS AND MANAGERS INVOLVED IN THE STUDY

We, the undersigned, declare that GLP study number 84031 was performed under our supervision, according to the procedures described herein, and that this report is an accurate record of the results obtained.

DON W. KORTE, JR. Ph.D. / DATE
MAJ, MSC
Study Director

STEVEN K. SANO, B.A. / DATE
SP4, USA
Principal Investigator

CONRAD WHEELER, Ph.D. / DATE
DAC
Analytical Chemist
MEMORANDUM FOR RECORD

SUBJECT: Report of GLP Compliance

1. I hereby certify that in relation to LAIR GLP Study 84031 the following inspections were made:
   10 October 1984
   12 October 1984

2. The report and raw data for this study were audited on 10 May 1984.

3. Routine inspections with no adverse findings are reported quarterly, thus these inspections are also included in the 21 January 1985 report to Management and the Study Director.

   GARY L. DUTCHER
   SP6, USA
   Quality Assurance Unit
# TABLE OF CONTENTS

Abstract

Preface

Acknowledgments

Signatures of Principal Scientists

Report of Quality Assurance Unit

Table of Contents

**BODY OF REPORT**

**INTRODUCTION**

Objective of the Study

**METHODS**

Test Compound

Test Solvent

Chemical Preparation

Test Strains

Test Format

**RESULTS**

**DISCUSSION**

**CONCLUSION**

**RECOMMENDATION**

**REFERENCES**

**APPENDIX**

**DISTRIBUTION LIST**
Mutagenic Potential of: p-Dithiane (TA039)--Sano and Korte

The Ames Salmonella/Mammalian Microsome Mutagenicity Assay is a short-term screening assay that utilizes histidine auxotrophic mutant strains of Salmonella typhimurium to detect those compounds which are potentially mutagenic in mammals. A mammalian microsomal enzyme system is incorporated in the assay to increase sensitivity by simulating in vivo metabolic activation of the test compound. The Ames assay is an inexpensive yet highly predictive and reliable assay for detecting mutagenic activity and thus carcinogenic potential.

Objective of the Study

The objective of this study was to determine the mutagenic potential of p-dithiane (Batch Number 3030TH, LAIR Code TA039) by using the Ames Salmonella/Mammalian Microsome Mutagenicity Assay.

METHODS

Test Compound

Chemical name: p-Dithiane

Chemical Abstract Service Registry No.: 51330-42-8

Structural formula:

Empirical formula: C₄H₅S₂
Storage: Ten grams of p-dithiane (Batch Number 3030TH) were received from Aldrich Chemical Company, Inc (Milwaukee, WI) on 22 August 1984 and assigned the LAIR Code number TA039. The test compound was stored in a dessicator at room temperature (21°C) until use.

Chemical Properties/Analysis: Data characterizing the chemical composition and purity of the test material were obtained from Aldrich Chemical Co, Inc and confirmed by Infrared Spectrometer performed by the Toxicology Group, LAIR (Presidio of San Francisco, CA) (Appendix A).

Test Solvent

The test compound and the positive control chemicals were dissolved in grade I dimethyl sulfoxide (Lot Number 100F-0269) obtained from Sigma Chemical Co (St. Louis, MO).

Chemical Preparation

p-Dithiane was stored in a dessicator at room temperature (21°C) until used. On the day before dosing, 300 mg of the test compound was measured into a sterile vial and again stored at room temperature. On the day of dosing, the 300 mg sample was dissolved in a 6 ml volume of grade I dimethyl sulfoxide (Lot Number 100F-0269) to achieve a 5% (w/v) solution. Aliquots of this solution were used to dose the test plates. The dosing procedure was completed within 20 minutes of dissolving the test compound.

Test Strains

Salmonella strains TA98, TA100, TA1535, TA1537, and TA1538, obtained directly from Dr. Bruce Ames, University of California, Berkeley, were used. These strains were maintained in our laboratory at -80°C. Quality controls were run concurrently with the test substance to establish the validity of their special features and to determine the spontaneous reversion rate. Descriptions of the strains, their genetic markers, and the methods for strain validation are given in the LAIR SOP, OP-STX-1 (2).

Test Format

p-Dithiane was evaluated for mutagenic potential according of Ames et al (3). A detailed description of the test methods methodology is given in LAIR SOP, OP-STX-1 (2).

Toxicity Tests

Toxicity tests were conducted to determine a sublethal concentration of the test substance. This toxicity level was found by
using minimal glucose agar (MGA) plates, concentrations of p-dithiane ranging from $1.6 \times 10^{-3}$ mg/plate to 5 mg/plate, and approximately $10^8$ cells of TA100 per plate. Top agar containing trace amounts of histidine and biotin were placed on the plates. Strain verification was confirmed on the bacteria, along with a determination of the spontaneous reversion rate. After incubation, the growth on the plates was observed. Since none of the plates showed decreased macrocolony formation (below the level of the spontaneous reversion plates) or an observable reduction in the density of the background lawn, a maximum "limit" dose of 5 mg per plate was used in the mutagenicity assay.

**Mutagenicity Assay**

The test substance was evaluated over a 1000-fold range of concentrations, decreasing from the minimum toxic level (the maximum or limit dose) by a dilution factor of 5 both with and without 0.5 ml of the S-9 microsome fraction. The S-9 was purchased from Litton Bionetics (Kensington, MD). The optimal titer of this S-9, as determined by Litton Bionetics, was 0.75 mg protein/plate. After all the ingredients were added, the top agar was mixed, then overlaid on MGA plates. These plates contained 2% glucose and Vogel Bonner "E" Concentrate (4). The water used in this medium and in all reagents came from a Polymetric model 200-3 Water Purifier (Sunnyvale, CA). Plates were incubated upside down in the dark, at 37°C for 48 hours. Plates were prepared in triplicate and the average revertant counts were recorded. The average number of revertants at each dose level was compared to the average number of spontaneous revertants (negative control). The spontaneous reversion rate (with and without S-9) was monitored by averaging the counts from two determinations run simultaneously with the test compound assay. The spontaneous reversion rate was determined by inoculating one set of plates before and one set after the test compound assay plates so that any change in spontaneous reversion rate during the dosing procedure would be detected. This spontaneous reversion rate was also compared with historical values for this laboratory and those cited in Ames et al (3). Concurrent sterility and strain verification controls were run. All reagents, test compounds, and media were checked for sterility by plating samples of each on MGA media and incubating them at 37°C with the test plates. The Salmonella strains were verified by a standard battery of tests. The following tests were run to determine if:

- Lipopolysaccharide layer (LP) alteration causes growth inhibition in the presence of crystal violet.

- An ampicillin-resistant R factor has allowed growth in strains TA98 and TA100 in the presence of ampicillin impregnated disks.

- Absence of excision repair mechanism has inhibited growth in the presence of ultraviolet light.
Four known mutagens were tested as positive controls to confirm the responsiveness of the strains to the mutation process. These compounds, benzo [a] pyrene, 2-aminofluorene, 2-aminoanthracene and N-methyl- N'-nitro-n-nitrosoguanidine, were obtained from Sigma Chemical Co (St. Louis, MO). The test compound and mutagens were handled during this study in accordance with the standards published in NIH Guidelines for the Laboratory Use of Chemical Carcinogens (DHHS Publication No. (NIH) 81-2385, May 1981).

Data Interpretation

According to Brusick (5), a compound is considered mutagenic if the following criteria are met:

1. For strain TA98 and TA100, a positive dose response (correlated dose response) over three dose concentrations is achieved with at least the highest dose yielding a revertant colony count greater than or equal to twice the spontaneous revertant colony count for the strain. A strong correlated dose response in strain TA100 without a doubling of the individual colony count may also be considered positive.

2. For strains TA1535, TA1537, and TA1538, a correlated dose response over three concentrations is achieved with at least one dose yielding a revertant colony count three times the spontaneous colony count for the strain.

RESULTS

On 3 October 1984, the toxicity level determination was performed on p-dithiane (Table 1). For this experiment all sterility, strain verification, positive and negative controls were normal (Table 2). No toxicity was observed after exposure of the tester strain (TA100) to the highest dose used (5 mg/plate).

Normal results were obtained for all sterility, strain verification, and negative controls during the Ames Assay performed during the 3-day period 10 to 12 October 1984 (Tables 3-4). p-Dithiane did not induce any appreciable increase in the revertant colony counts relative to those of the negative control cultures (Table 5).
TABLE 1
TOXICITY LEVEL DETERMINATION

Substance assayed: p-DITHIANE (TA039)  Substance dissolved in: DMSO
Study Number: 84031  Date: 5 OCT 84  Performed by: SANO

TA 100 REVERTANT PLATE COUNT

<table>
<thead>
<tr>
<th>Test Compound Concentration</th>
<th>Plate #1</th>
<th>Plate #2</th>
<th>Plate #3</th>
<th>Average</th>
<th>Background Lawn (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mg/plate</td>
<td>86</td>
<td>95</td>
<td>104</td>
<td>95</td>
<td>NL</td>
</tr>
<tr>
<td>1 mg/plate</td>
<td>115</td>
<td>104</td>
<td>106</td>
<td>108</td>
<td>NL</td>
</tr>
<tr>
<td>0.2 mg/plate</td>
<td>105</td>
<td>97</td>
<td>108</td>
<td>103</td>
<td>NL</td>
</tr>
<tr>
<td>0.04 mg/plate</td>
<td>107</td>
<td>85</td>
<td>104</td>
<td>99</td>
<td>NL</td>
</tr>
<tr>
<td>0.008 mg/plate</td>
<td>78</td>
<td>82</td>
<td>97</td>
<td>86</td>
<td>NL</td>
</tr>
<tr>
<td>0.0016 mg/plate</td>
<td>108</td>
<td>95</td>
<td>113</td>
<td>105</td>
<td>NL</td>
</tr>
</tbody>
</table>

(1) NG = No Growth  ST = Slight Growth  NL = Normal Lawn
### TABLE 2

**STRAIN VERIFICATION FOR TOXICITY LEVEL DETERMINATION**

<table>
<thead>
<tr>
<th>Strains</th>
<th>Histidine Requirement</th>
<th>Ampicillin Resistance</th>
<th>Sensitivity to UV</th>
<th>Sensitivity to Crystal Violet</th>
<th>Sterility Control</th>
<th>Response (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>G</td>
<td>G</td>
<td>NG</td>
<td>NG (16mm)</td>
<td>NG</td>
<td>+</td>
</tr>
<tr>
<td>Wild Type</td>
<td>NT</td>
<td>NT</td>
<td>G</td>
<td>NT</td>
<td>NT</td>
<td>+</td>
</tr>
</tbody>
</table>

### STERILITY CONTROL FOR TOXICITY LEVEL DETERMINATION

- **His-Bio Mix**: Initial: NG, End: NG, MCA Plates: NG
- **Top Agar**: Initial: NG, End: NG
- **Diluent**: DMSO: NG
- **Nutrient Broth**: NG
- **Test Compound**: (a) T0037: NG, (b) T0038: NG, (c) T0039: NG, (d) NG, (e) NG

**G** = Growth  **NG** = No Growth  **NT** = Not Tested  **NA** = Not Applicable

**Spontaneous Revertants**: TA 100, No 5-9 (102, 111, 90) 101

(1) + = expected response  - = unexpected response

**Study Number**: 84031  **Dates**: 4 OCT 84  **By**: SANO
<table>
<thead>
<tr>
<th>Strains</th>
<th>Histidine Requirement</th>
<th>Ampicillin Resistance</th>
<th>UV</th>
<th>Sensitivity to Crystal Violet</th>
<th>Sterility Control</th>
<th>Response (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>NG</td>
<td>G</td>
<td>NG</td>
<td>NG (17mm)</td>
<td>NG</td>
<td>+</td>
</tr>
<tr>
<td>100</td>
<td>NG</td>
<td>G</td>
<td>NG</td>
<td>NG (20mm)</td>
<td>NG</td>
<td>+</td>
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<tr>
<td>1535</td>
<td>NG</td>
<td>NT</td>
<td>NG</td>
<td>NG (18mm)</td>
<td>NG</td>
<td>+</td>
</tr>
<tr>
<td>1537</td>
<td>NG</td>
<td>NG (15mm)</td>
<td>NG</td>
<td>NG (17mm)</td>
<td>NG</td>
<td>+</td>
</tr>
<tr>
<td>1538</td>
<td>NG</td>
<td>NT</td>
<td>NG</td>
<td>NG (16mm)</td>
<td>NG</td>
<td>+</td>
</tr>
<tr>
<td>Wild Type</td>
<td>NT</td>
<td>NT</td>
<td>G</td>
<td>NT</td>
<td>NT</td>
<td>+</td>
</tr>
</tbody>
</table>

**STERILITY CONTROL FOR ASSAY**

- **His-Bio Mix**
  - Initial: NG
  - End: NG
  - Diluent: DMSO: NG

- **Top Agar**
  - Initial: NG
  - End: NG
  - NCA Plate: NG

- **S-9 Mix**
  - Initial: NG
  - End: NG
  - Nutrient Broth: NG

- **Test Compound**
  - (a) TA037: NG
  - (b) TA038: NG
  - (c) TA039: NG
  - (d) ____________
  - (e) ____________
  - (f) ____________

- **G** = Growth  
- **NG** = No Growth  
- **NT** = Not Tested  
- **NA** = Not Applicable

**Study Number:** 84031  
**By:** SANO  
**Date:** 11 OCT 84  
(1) + = expected response  
- = unexpected response
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<th>Compound</th>
<th>Dose Level</th>
<th>S-9 Added</th>
<th>TA98</th>
<th>TA100</th>
<th>STRAIN NUMBER</th>
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<td></td>
<td></td>
<td></td>
<td>TA1535</td>
<td>TA1537</td>
<td>TA1538</td>
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<tr>
<td>AF</td>
<td>2 ug/plate</td>
<td>YES</td>
<td>(772, 825, 982)</td>
<td>(1053, 878, 1216)</td>
<td>(913, 966, 820)</td>
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<td>860</td>
<td>1049</td>
<td>900</td>
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<tr>
<td>BP</td>
<td>2 ug/plate</td>
<td>YES</td>
<td>(230, 175, 387)</td>
<td>(335, 132, 302)</td>
<td>(32, 25, 21)</td>
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<td></td>
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<td></td>
<td>264</td>
<td>323</td>
<td>70</td>
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<tr>
<td>AA</td>
<td>2 ug/plate</td>
<td>YES</td>
<td>(1488, 1613, 1734)</td>
<td>(1725, 1495, 1994)</td>
<td>(224, 205, 211)</td>
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<td></td>
<td></td>
<td></td>
<td>1618</td>
<td>1738</td>
<td>(927, 1073, 1089)</td>
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<tr>
<td>NSNG</td>
<td>2 ug/plate</td>
<td>NO</td>
<td>(1935, 1737, 2129)</td>
<td>(1934, 1806, 1953)</td>
<td>(1852, 1781, 2053)</td>
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<tr>
<td></td>
<td>20 ug/plate</td>
<td>NO</td>
<td>(1896)</td>
<td>(1896)</td>
<td>(1896)</td>
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</table>

**Spontaneous Reversion Rate (Negative Control)**

| Before Assay | YES | (15, 13, 15) | (89, 102, 94) | (15, 13, 12) | (5, 6, 1) | (12, 14, 16) |
| After Assay  | YES | (27, 14, 16) | (113, 113, 106) | (20, 15, 16) | (4, 3, 5) | (10, 8, 8) |
|             | 17  | 103          | 15            | 4             | 12          |

| Before Assay | NO  | (13, 24, 18) | (86, 88, 87) | (13, 14, 16) | (1, 4, 6) | (13, 11, 16) |
| After Assay  | NO  | (13, 17, 20) | (99, 79, 108) | (17, 15, 16) | (6, 4, 9) | (9, 15, 8) |
|             | 18  | 91           | 15            | 5             | 12          |

Study Number: 84031  Date: 12 Oct 84  Performed by: SANU & MARTIN

Compounds: AF = 2-aminofluorene, BP = Benzo (a) pyrene, AA = 2-aminoanthracene, NSNG = N-methyl-N'-nitro-N-nitrosoguanidine
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<th>COMPUND</th>
<th>DOSE LEVEL</th>
<th>S-9 ADDED</th>
<th>TA98</th>
<th>TA100</th>
<th>STRAIN NUMBER</th>
<th>TA1535</th>
<th>TA1537</th>
<th>TA1538</th>
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<td>TA019</td>
<td>5 mg/plate</td>
<td>YES</td>
<td>16, 14, 16</td>
<td>84, 73, 79</td>
<td>9, 11, 9</td>
<td>3, 1, 2</td>
<td>14, 9, 11</td>
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<td></td>
<td>NO</td>
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<td>15, 19, 13</td>
<td>92, 90, 96</td>
<td>11, 10, 9</td>
<td>5, 3, 2</td>
<td>10, 10, 20</td>
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<td>16</td>
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<td>TA019</td>
<td>1 mg/plate</td>
<td>YES</td>
<td>18, 15, 18</td>
<td>90, 70, 112</td>
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<td>98, 84, 91</td>
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<td></td>
<td>15</td>
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<tr>
<td>TA019</td>
<td>0.2 mg/plate</td>
<td>YES</td>
<td>19, 22, 18</td>
<td>98, 86, 104</td>
<td>15, 16, 12</td>
<td>4, 5, 5</td>
<td>6, 15, 8</td>
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<td>99, 87, 98</td>
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<td>7, 2, 4</td>
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Study Number: 80131  
Date: 12 Oct 86  
Performed by: SANI & MARTIN
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<th>COMPOUND</th>
<th>DOSE LEVEL</th>
<th>S-9 ADDED</th>
<th>TA98</th>
<th>TA100</th>
<th>STRAIN NUMBER</th>
<th>Date: 12 Oct 84</th>
<th>Study Number: 84031</th>
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<td>TA039</td>
<td>0.04 mg/plate</td>
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<td>(14, 18, 20)</td>
<td>(109, 92, 105)</td>
<td>(19, 12, 10)</td>
<td>(2, 4, 4)</td>
<td>(8, 11, 15)</td>
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<td></td>
<td>NO</td>
<td>(8, 15, 17)</td>
<td>(106, 95, 104)</td>
<td>(21, 24, 15)</td>
<td>(5, 3, 5)</td>
<td>(13, 5, 6)</td>
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<td>(22, 26, 10)</td>
<td>(101, 81, 105)</td>
<td>(13, 14, 15)</td>
<td>(9, 5, 5)</td>
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<td>(14, 4, 2)</td>
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<td>(112, 105, 125)</td>
<td>(9, 11, 15)</td>
<td>(1, 4, 3)</td>
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<td></td>
<td></td>
<td>NO</td>
<td>(25, 13, 7)</td>
<td>(99, 109, 85)</td>
<td>(15, 17, 16)</td>
<td>(9, 7, 7)</td>
<td>(18, 13, 9)</td>
</tr>
</tbody>
</table>

TABLE 5 (cont.)
p-DITHIANE (TA039)
(Revertants/Plate)
Mean
DISCUSSION

Certain test criteria must be satisfied before an Ames assay can be considered a valid assessment of a compound's mutagenic potential. First, the special features of the Ames strains must be verified. These features include demonstration of ampicillin resistance, LP layer alterations, and DNA excision repair deficiencies. Second, the Salmonella strains must be responsive to the mutagenic process by exposing the strains to known mutagens. Third, the optimal concentration of the test compound must be determined by treating TA100 with a broad range of doses and observing the potential toxic effects on macrocolony and microcolony formation. If these tests are performed and expected data are obtained, then the results of Ames assay can be considered valid.

After validation of bacterial strains and selection of optimal sublethal doses, p-dithiane was evaluated in the Ames assay. Criteria for a positive response are a correlated dose-response relationship for the positive strains and a two-fold (strains TA98 or TA100) or three-fold (strains TA1535, TA1537, or TA1538) increase in revertant colony counts relative to the respective negative control counts (5). p-Dithiane did not induce the requisite dose-response relationship or the increase in revertant colony counts necessary for a positive response. Thus, the results of this assay indicate that p-dithiane is not mutagenic when evaluated in the Ames assay.

CONCLUSION

p-Dithiane, both with and without metabolic activation, is not mutagenic in the Ames assay as conducted in this study.

RECOMMENDATION

p-Dithiane should be tested in other genetic toxicity assays in accordance with the Toxic Substance Control Act.
REFERENCES


**CHEMICAL DATA**

Chemical name: 1,4-Dithiane

Chemical Abstracts Service Registry No.: 505-29-3

Chemical structure:

![Chemical structure diagram]

Molecular formula: \( \text{C}_4\text{H}_6\text{S}_2 \)

Molecular weight: 120.24

Physical state: White crystals

Melting point: 110-112°C (data supplied by source)

Source: Aldrich Chemical Co.

Milwaukee, WI

Lot number: 3030TH

Analytical data: Compound was described as 97% pure by source. Analysis provided by sponsor demonstrated a purity of 99.92%.* NMR and IR analyses were performed after receipt of the compound: NMR (60 MHz, \( d_6 \)-DMSO): \( \delta \) 2.82 (Singlet, 8 H, \(-\text{CH}_2\)).† IR (KBr): 2945, 2905, 1410, 1280, 1270, 1150, 990, and 890 cm\(^{-1}\).‡ NMR and IR data were identical to published standard IR and NMR spectra.

Stability: No decomposition of 1,4-dithiane was detected by NMR after 66 h in DMSO.*

---

*Rosencrance AB. [Memorandum for Dr. Reddy]. SUBJECT: Results from the chemical analysis of three compounds slated for toxicity testing (24 July 1984). Frederick, Maryland: USAMDRL.


‡Ibid. p75.

§Pavlak, GT. The Aldrich Library of 1H Spectra. Vol 1, 2nd ed. Milwaukee: Aldrich Chemical Co., 1981. 211, Spectrum B.


APPENDIX A
ANALYTICAL DATA

Date: June 18, 1984

Our: D21770-0 Para-dithiane, 97%
Batch No.: 3010TH

Analytical Results:

Appearance: Off white crystals
m.p. 111-113 deg. C
b.p. 105-107 deg. C
nD 1.548 [a]0

Spectral Data:
I.R. Conforms to structure and standard as illustrated on page 160 B of Edition III, of "The Aldrich Library of Infrared Spectra".

U.V.
N.M.R.

Assay:
V.P.C.
Titracion 99.9%, S-Content

Other

KB/kb

Anna Napiorkowski, Manager
Quality Control/Quality Assurance

APPENDIX A (cont.)
MEMORANDUM FOR DR. REDDY

SUBJECT: Results from the Chemical Analysis of Three Compounds Elisted for Toxicity Testing

Benzothiazole, 1,4-thioxane and 1,4-dithiane were given by Dr. Reddy for analysis on 15 June 84. The following is a summary of the results from these analyses:

<table>
<thead>
<tr>
<th>% of Total</th>
<th>Formula</th>
<th>Compound</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C₆H₃NS</td>
<td>Benzothiazole</td>
<td></td>
</tr>
<tr>
<td>0.61</td>
<td>C₅H₈NS</td>
<td>2-Methylbenzothiazole</td>
<td>(Isomer)</td>
</tr>
<tr>
<td>0.26</td>
<td>C₇H₈N₂</td>
<td>Aniline</td>
<td>3 or 4-Octylpyridine</td>
</tr>
<tr>
<td>0.12</td>
<td>C₅H₇NO₂</td>
<td>Diphenylidihalide</td>
<td></td>
</tr>
<tr>
<td>0.11</td>
<td>C₄H₄N₂</td>
<td>Toluidine (Isomers)</td>
<td>Benzylamine, N-Methylaniline</td>
</tr>
<tr>
<td>0.03</td>
<td>C₆H₅NS</td>
<td>Methylbenzothiazole</td>
<td>(Isomers)</td>
</tr>
<tr>
<td></td>
<td>C₅H₆NS</td>
<td>1,4-Thioxane</td>
<td></td>
</tr>
<tr>
<td>0.92</td>
<td>C₄H₈NO₂</td>
<td>1,4-Dithiane</td>
<td></td>
</tr>
<tr>
<td>0.03</td>
<td>C₆H₄O₂</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dr. Reddy's signature

CP:
Dr. Kulkarni
Dr. Estrada
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