 Preferential Effect of Dichlorvos (Vapona) on Bacteria Deficient in DNA Polymerase¹

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SUMMARY

Bacteria deficient in DNA polymerase are much more susceptible than are normal cells to the lethal action of dichlorvos [Vapona, O,O-dimethyl O-(2,2-dichlorovinyl) phosphate], a widely used insecticide. The results are taken to indicate that dichlorvos is capable of altering the cellular DNA.

The anticholinesterase compound DDVP³ is widely used as an insecticide in agriculture (9, 10), as an antimosquito agent for eradicating malaria (3, 4, 11, 17), as a disinfectant of commercial aircraft (16), and for the control of flea infections (10). Hence, human exposure to and inhalation of this pesticide occurs frequently. As normally used, this substance has not exhibited acute toxicity except for the occasional lowering of plasma cholinesterase levels (2–4, 6, 10, 12, 15).5 If the reaction were also to occur in vivo, then DDVP could present a real hazard to health in view of the established relationship between the ability of agents to alkylate DNA and their potential carcinogenicity and mutagenicity.

In this report it is shown (Tables 1 and 2) that bacteria (Escherichia coli) deficient in DNA polymerase are more sensitive to DDVP than are the parents from which they were derived. This is a property also exhibited by other DNA-alkylating agents (Table 2, Group 2) that are known to be carcinogens as well. On the other hand, substances that do not act on the cellular DNA did not inhibit the DNA polymerase-deficient strain preferentially (Table 2, Group 1).

DNA polymerase has been implicated in the DNA repair process (1, 7); bacterial strains lacking this enzyme are more sensitive than their parents to agents that react with the cellular DNA (1, 5, 18, 20), presumably, because they are unable to repair efficiently the damage to their DNA. The present data suggest that DDVP reacts with the DNA of living cells—a reaction which already has been demonstrated in vitro (8, 15). A reexamination of the potential hazard (carcinogenicity and mutagenicity) to human health of this widely used substance seems, therefore, imperative.

ACKNOWLEDGMENTS

DDVP was kindly provided by the Shell Chemical Co., San Ramon, Calif.

REFERENCES

Effects of agents on the growth of a DNA polymerase-deficient strain of E. coli

The procedure used has been described (18). Bacteria [E. coli W3110 thy⁻ (pol A⁺), the parent strain, and E. coli p3478 (pol A⁻), the DNA polymerase-deficient strain (1)] were spread onto the surface of agar plates [Medium HA plus 5 μg thymine per ml (13, 14)]. When the plates had dried, discs impregnated with the substances to be tested were deposited on the surface of the agar; after incubation at 37° for 16 hr, the diameters of the zones of inhibition were measured.

<table>
<thead>
<tr>
<th>Group</th>
<th>Agent</th>
<th>Amount</th>
<th>Diameter of zone of inhibition (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chloramphenicol</td>
<td>30 μg</td>
<td>pol A⁺: 24</td>
</tr>
<tr>
<td></td>
<td>Streptomycin</td>
<td>10 μg</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Kanamycin</td>
<td>30 μg</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Erythromycin</td>
<td>15 μg</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Methylmethanesulfonate</td>
<td>0.13 μmole</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Ethylmethanesulfonate</td>
<td>0.11 μmole</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>N-Methyl-N-nitrosourea</td>
<td>0.05 μmole</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>N-Ethyl-N-nitrosourea</td>
<td>0.02 μmole</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 μmole</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>DDVP</td>
<td>0.06 μmole</td>
<td>21</td>
</tr>
</tbody>
</table>

1969.

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