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Virucidal Properties of Dimethyl Sulfoxide

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Dimethyl sulfoxide (DMSO) has been shown to possess bacteriostatic, bacteriocidal, and fungicidal properties (2, 3). The effect of DMSO on other microorganisms, such as the viruses, has not been reported. Therefore, we were prompted to initiate the present study.

TABLE 1. *Effect of DMSO (80%, v/v) on infectivity of viruses*

Virus	Treatment[a]		
	Reagent	Exposure (min)	Infectivity titer
R-8	Buffer[b]	30	6.50
		60	N
		30 + dialysis	5.75
	DMSO	5	N
		10	N
		30	N
		60	N
		30 + dialysis	N
Jap 305	Buffer	30	4.6
	DMSO	30	N
NDV	Buffer	30	7.4
	DMSO	30	N
SFV	Buffer	30	4.4
	DMSO	30	N
VV	Buffer	30	4.38
	DMSO	30	N
T_2	Tris buffer	30	16.8×10^7
	DMSO (in Tris)	30	N

[a] Virus exposure to reagent at 25 C for indicated interval of time. Infectivity values are positive logarithms of titers per ml except for T_2 (plaques/ml); units are ELD_{50}/ml, except SFV (MLD_{50}/ml) and T_2 (plaques/ml); N = $<10^{1.0}$ ELD_{50} or MLD_{50}/ml, or no plaques (T_2).

[b] Buffer = M/15 Sorensen's buffered saline, unless indicated otherwise.

Four RNA viruses, influenza A (PR-8), influenza A_2 (Jap. 305), Newcastle disease (NDV), Semliki Forest (SFV), and two deoxyribonucleic acid (DNA) viruses, vaccinia (VV), and *Escherichia coli* phage (T_2), were suspended in appropriate concentrations of pharmaceutical-grade DMSO (Crown Zellerbach Corp., San Francisco, Calif.), in M/15 Sorensen's buffered saline (*p*H 7.2), or in tris(hydroxymethyl)aminomethane (Tris)- buffered saline (*p*H 6.8) at 25 C for specified periods of time. Residual infectivity was assayed as follows: (i) in 9-day-old embryonated hen's eggs, allantoic route, 0.2 ml/egg (PR-8, Jap. 305, NDV); (ii) in CFl-S female mice, 16 to 18 g, intraperitoneal route, 0.5 ml/mouse (SFV); (iii) in 9-day-old eggs, yolk sac route, 0.2 ml/egg (VV); or (iv) by plaque assay on 2.5% MacConkey agar at 37 C for 18 hr (T_2).

TABLE 2. *Effect of various concentrations of DMSO on influenza A (PR-8) infectivity*[a]

Treatment with PR-8 + DMSO (%)	Residual infectivity (ELD_{50}/ml)
80	N
70	N
60	5.38
50	6.62
40	6.50
Buffer	6.62

[a] Virus exposure to reagent at 25 C for 30 min. Infectivity values are positive logarithms of titers/ml; N = $<10^{1.0}$ ELD_{50}/ml.

At a concentration of 80%, DMSO inactivated the infectivity of every virus tested (Table 1). In the case of PR-8, the inactivation occurred rapidly (<5 min) and was concentration-dependent (Table 2). Overnight dialysis after exposure of PR-8 to 80% DMSO could not restore infectivity. No significant change in infectivity was observed at DMSO concentrations below 50%.

The effect of DMSO on viral hemagglutinating activity (HA) was determined with the aid of two viruses, PR-8 and Polyoma (PV). A fixed volume of each virus was mixed with sufficient quantities of DMSO and Sorensen's buffered saline to achieve selected final concentrations of DMSO that ranged from 10 to 80%. The mixtures were allowed to stand at 25 C for 30 min; they were

TABLE 3. *Effect of DMSO on hemagglutinating activity of polyoma and influenza A (PR-8) viruses*

Expt	Treatment with[a]		Residual HA (ml)
	virus	DMSO (%)	
1	PV	80	40
		70	640
		60	1280
		Buffer	1280
	PR-8	80	40
		70	20
		60	20
		50	320
		Buffer	320
2	PV	80	8
		80 + dialysis	16
		Buffer	128
		80 + dialysis	128
	PR-8	80	0
		80 + dialysis	0
		Buffer	128
		80 + dialysis	128

[a] Virus exposure to reagent at 25 C for 30 min; overnight dialysis after exposure, as indicated.

then subdivided, and samples were titrated for HA activity immediately and after overnight dialysis against distilled water. For HA titration, twofold serial dilutions were followed by the addition of 0.5% washed guinea pig erythrocytes. In both instances, HA activity was adversely affected, but in a differential manner. Whereas the HA activity of PV was greatly reduced by exposure to 80% DMSO, it was relatively unaffected by lower concentrations (Table 3). By contrast, exposure of PR-8 to 60% DMSO was sufficient to denature all titratable activity. Overnight dialysis could not restore the HA activity of either virus.

Experiments designed to study the chemotherapeutic value of DMSO have shown the compound to possess no beneficial effect when administered parenterally to mice infected with influenza PR-8 or with SFV at nontoxic levels.

In addition to the multitude of uses suggested for DMSO (1), we would like to add the following uses, based partly on the fact that DMSO at concentrations of 30 to 50% is both bacteriocidal and fungicidal (2): (i) as an aid in the isolation of enteric or respiratory viruses from animal hosts [contaminating bacteria that are often found in sputum or stool samples can be eliminated by the use of a differential concentration of DMSO (about 50%), thus allowing the selective isolation of viruses; and (ii) for sterilization of inanimate objects where autoclaving or other means cannot conveniently be applied.

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