Epoxy-Fiberglass Adsorbent for Concentrating Viruses from Large Volumes of Potable Water

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Received for publication 3 June 1974

A simple and compact virus-adsorbing unit for efficiently concentrating human enteric viruses from 100 gallons (about 380 liters) or more of potable water is described.

A number of virus adsorbents and sampling systems have been proposed for concentrating human enteric viruses from water (1, 2, 4–6). Many of the adsorbents have been evaluated with small volumes (10 liters or less) of prefilt- tered or deionized water and high virus concentrations (1 infectious unit/ml or more). However, the application of these procedures to field conditions has been limited by problems of premature clogging of the viral adsorbent, erratic recoveries of virus, or difficulty in handling cumbersome, complicated apparatus. This note describes a virus-adsorbing unit that, in laboratory studies, has reliably concentrated poliovirus from 100 gal (about 380 liters) of drinking water at virus inputs of 1 infectious unit/gal (about 3.8 liters) or less.

The filter unit is 11.43 cm high and 6.67 cm in diameter (4.5 by 2.63 inches) and consists of an aluminum housing with a polycarbonate bowl (type 92, Balston, Inc., Lexington, Mass.). The virus-adsorbing filter tube is 2.54 cm in diameter and 6.35 cm high (1 by 2.5 inches) and is composed of glass microfibers bonded with epoxy resin. The filter tubes are available in nominal porosities of 0.3, 0.9, 2, and 8 μm. Three of the units were assembled in parallel by using stainless-steel, quick-disconnect couplings and fittings (Fig. 1). Experimentally, virus adsorption was enhanced by adding HCl to adjust the pH to 3.5 (5), and sodium thiosulfate was added to a final concentration of 50 mg/liter to neutralize chlorine. The HCl and thiosulfate additives were introduced into the tap-water stream with the use of the hydraulically operated pump system described by Hill et al. (3). The following ranges of physical characteristics of the tap water were obtained from treatment plant records for the period when the experiments were conducted: pH, 8.1 to 9.1; total hardness in milligrams per liter, 110 to 153; total dissolved solids (in milligrams per liter), 195 to 258; conductivity (μmho), 231 to 293. The turbidity of the water at the sample tap in the laboratory ranged from 0.1 to 0.35 turbidity units and the temperature at the time of filtration ranged from 8.4 to 10.3 C. Attenuated poliovirus type 1 (Lsc 2ab strain) was continuously added to the tap water with the thiosulfate solution. The flow rate was controlled at 1 gal/min by a limiting-orifice valve (Dole Valve Co., Morton Grove, Ill.), and 100 gal was processed in each run. At the end of each run, residual water was drained from the filter housings before eluting.

Virus was eluted from the filters in situ with 1-liter volumes of 0.05 M glycine buffer at pH 11.5. The eluate was then adjusted to pH 3.5 with 0.05 M glycine buffer (pH 1.1), and AlCl₃ was added to a final concentration of 0.0005 M. This eluate was reconcentrated by filtering through a stacked series of epoxy-fiberglass disk filters (47 mm) with porosities of 5, 1, and 0.45 μm (series AA Cox M-780, Cox Instrument Corp., Detroit, Mich.) as described by Sobsey et al. (5). The entire final eluate (approximately 10 ml) was assayed by plaquing with the use of the agar overlay technique with HEp-2 cell monolayers in 25-cm² plastic flasks. Counts were expressed as plaque-forming units (PFU).

The recovery of poliovirus from 100-gal volumes of tap water in five representative experimental runs with the 8-μm porosity filter tubes is shown in Table 1. Virus recovery ranged from 42 to 57% at virus inputs of approximately 1 PFU/5 gal to 1 PFU/gal. In experiment 3, the center filter unit was disconnected, and the end units were connected to form a two-filter tube device. No apparent penalty in virus recovery was observed in processing the 100 gal through two rather than three filter tubes. In waters of low turbidity, one or two filter units may suffice to process 100 gal. If, however, suspended particles result in clogging, four or more filter housings may be connected to allow processing the required sample volume. Preliminary exper-
FIG. 1. Three-place Balston holder with filter tubes.

Table 1. Recovery of poliovirus from 100-gallon (about 380-liter) volumes of tap water with 8-μm nominal porosity epoxy-fiberglass filter tubes

| Expt no. | Virus input (PFU/100 gal)* | Virus recovered |
|----------|------------------------------|-----------------|
|          |                              | PFU  | %   |
| 1        | 153                          | 74   | 48  |
| 2        | 95                           | 54   | 57  |
| 3        | 95                           | 49   | 52  |
| 4        | 30                           | 15   | 50  |
| 5        | 19                           | 8    | 42  |

* Determined by assay of the stock poliovirus added to 100 gal (about 380 liters) of tap water.

The filter unit described offers a clog-resistant, compact, low-weight, relatively inexpensive device for concentrating human enteric viruses from 100 gal or more of potable waters.

We thank Ralph J. Cipolla and Robert Yust for their technical assistance, and William H. Benton for supplying cell cultures.

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