ADSORPTION OF ANTIBACTERIAL SUBSTANCES ON ATTAPULGITE AND LIGHT KAOLIN

I.Y.M. Fulayyeh, R.J. McBride, J.B. Murray, A. Qawas, G. Smith, Department of Pharmacy, Heriot-Watt University, 79 Grassmarket, Edinburgh, EH1 2HJ.

Bean & Dempsey (1971) showed that adsorption of benzalkonium chloride on suspended particles of light kaolin or procaine benzylpenicillin in water was reversible in part and that the bactericidal activity of such suspensions against Escherichia coli was greater than that of the corresponding supernatant solutions after removal of the particles; limited evidence for a similar effect against Staphylococcus aureus of cetylpyridinium chloride in talc suspensions had been noted by Batuyios & Brecht (1957). In the present work the adsorption of various antibacterial substances on attapulgite in aqueous suspension was investigated and the effects of adsorption on the bactericidal activity of cetylpyridinium chloride were evaluated; in addition, the influence of light kaolin particles on the adsorption and bactericidal activity of chlorhexidine acetate was examined.

From the results of physico-chemical experiments there was no evidence of adsorption on attapulgite of benzoic acid, bronopol, chlorocresol, methyl hydroxybenzoate, phenylethanol, phenylpropanol or phenol. Elution experiments showed that adsorption of cetylpyridinium chloride, chlorhexidine acetate and crystal violet was reversible in part whereas adsorption of benzalkonium chloride appeared to be completely reversible. In all experiments where adsorption was detected the results appeared to fit the L2 isotherm (Giles et al 1960).

Sterilisation times against Escherichia coli NCTC 9001 (8×10^5 cells ml^{-1}) of cetylpyridinium chloride (initial concentration 0.0295 to 0.0340%) in 0.5% aqueous suspensions of attapulgite (Pharmasorb Regular, Lawrence Industries) were determined at 25°; sterilisation times of the corresponding supernatant solutions and of aqueous solutions of the bactericide in the same concentrations were also determined. Suspensions were more bactericidal than the corresponding supernatant solutions; since the adsorption of cetylpyridinium chloride on attapulgite was reversible in part, some of the adsorbed phase would be released into solution after uptake by bacteria of the bactericide in solution. Since the sterilisation times of the suspensions, for a fixed equilibrium concentration of cetylpyridinium chloride, were less than 25 minutes, it was uncertain whether an increase in attapulgite concentration from 0.5 to 2.5% reduced these times and made a direct contribution to the bactericidal activity of the suspensions, as reported by Bean & Dempsey (1971) for benzalkonium chloride and light kaolin. The range of equilibrium concentrations (0.0002 to 0.0009%) of cetylpyridinium chloride used in the sterilisation-time experiments on attapulgite suspensions corresponded to the steep slope in the first part of the L2 isotherm; in the work of Bean & Dempsey (1971) the bactericidal concentrations of benzalkonium chloride fell within the plateau region of the isotherm where the monolayer was practically complete.

The bactericidal activity of the supernatant solutions was lower than that of aqueous solutions of the same concentration of cetylpyridinium chloride probably because of the release from the clay of cations such as magnesium which inactivate quaternary ammonium compounds. For a fixed equilibrium concentration of the bactericide the activity of supernatant solutions decreased as the amount of attapulgite was increased from 0.5% to 2.5%; the same effect was observed when a fixed amount of cetylpyridinium chloride was added to supernatant solutions removed from suspensions in water that contained different amounts of attapulgite (0.5 to 15%).

Similar results were obtained in physico-chemical and microbiological experiments on the adsorption of chlorhexidine acetate on light kaolin.

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0022-3573/81/120110P-01$02.50/0