THE ACTION OF 2-PHENOXYETHANOL UPON PSEUDOMONAS AERUGINOSA NCTC 6749

E.G. Beveridge, Ian Boyd and G.W. Jessen, School of Pharmacy, Sunderland Polytechnic, Sunderland. SR1 3SD, U.K.

The action of phenoxyethanol upon Pseudomonas aeruginosa NCTC 6749 was studied using cultures growing in various media and washed suspensions prepared from stationary phase (2 hours) carbon-limited (succinate) liquid cultures.

Up to the minimum growth inhibitory concentration (MIC) (circa 0.25% w/v) phenoxyethanol did not induce gross morphological changes in growing cultures, and little bactericidal activity occurred with washed suspensions below 0.8% w/v (LT 90% = 240 min.).

A 1% w/v solution had modest bactericidal activity (LT 90% = 10.3 min.)and a concentration exponent (η) of 11.8 was determined. Appreciable quantities of drug were adsorbed and a C-type adsorption isotherm obtained without an inflexion or saturation plateau.

Treatment of the cells with phenoxyethanol, even at markedly bactericidal concentrations (LT 99% < 0.5 min.), resulted in leakage into the suspending menstruum of only low levels of general ionic materials as estimated by conductivity measurements. A small proportion of this was shown to be inorganic phosphate ions, and only very low levels of pentose-containing and purine, or pyrimidine-containing cytoplasmic metabolites could be detected. This indicates that phenoxyethanol did not cause gross damage to the osmo-regulatory properties of the cytoplasmic membrane.

The ability of phenoxyethanol to uncouple oxidative phosphorylation was indicated by its ability to translocate protons across the cytoplasmic membrane even at low drug levels (0.1% w/v). The ready efflux of potassium ions from cells similarly occurred at these low drug levels. The respiration of externally added substrates by cell suspensions was markedly sensitive to phenoxyethanol, 0.5% w/v causing almost complete inhibition. The degree of inhibitions varied slightly in the order glucose < succinate < lactate < oxaloacetate < pyruvate < malate.

Complete, irreversible, oxidation of the terminal respiratory cytochrome chain was induced by bactericidal drug levels (1% w/v and above). Lower phenoxyethanol concentrations induced a similar but increasingly transient and less extensive oxidation with no observable effect at the MIC.

These findings suggest differences in the mode(s) of action of phenoxyethanol upon Ps. aeruginosa and Escherichia coli (Gilbert, Beveridge and Crone 1977 a,b,c). Both organisms demonstrated similar high sensitivites to potassium ion efflux, proton translocation and inhibition of exogenous substrate respiration. However, generalised gross damage to the cytoplasmic membrane was associated with bactericidal activity in E. coli and its respiratory cytochrome system was not attacked. The much higher concentration exponent of 11.8 for Ps. aeruginosa (E. coli, η = 6.3) may reflect its greater resistance to penetration of phenoxyethanol and, or, possible different sites of action in both organisms.

Gilbert, P., Beveridge, E.G. and Crone, P.B. (1977 a) Microbios 19: 17 - 26

Gilbert, P., Beveridge, E.G. and Crone, P.B. (1977 b) Microbios 19: 125 - 41

Gilbert, P., Beveridge, E.G. and Crone, P.B. (1977 c) Microbios 20: 29 - 37