THE ACTION OF PROPYL GALLATE (N-PROPYL 3,4,5-TRIHYDROXYBENZOATE) ON ESCHERICHIA COLI NCTC 5933

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

The esters of gallic acid are used in the pharmaceutical and food industries as antioxidants and their known antimicrobial activity led Mossel (1971) to suggest their additional use as antimicrobial preservatives. Quantitative relationships between physico-chemical properties and antibacterial activities of a series of alkyl esters of gallic acid have been reported by Beveridge & Boyd (1971).

Propyl gallate added to growing cultures of E.coli gave progressive inhibition of growth with increase in concentration up to the minimum inhibitory concentration, but no obvious changes in morphology were observed. The addition of shikimic acid to the growth medium did not interfere with this inhibitory effect, in contrast to the claims of Carvajal & Carvajal (1959) that shikimate reversed the inhibition of E.coli by gallate and their suggestion of a shikimate antimetabolite role.

Damage to the cytoplasmic membrane was minimal as indicated by the failure to detect purine, pyrimidine or pentose containing cytoplasmic constituents in the supernatant from treated cell suspensions. Only low levels of phosphate ions and other ionic materials were released.

Propyl gallate does not appear to act as an uncoupler of oxidative phosphorylation since it failed to stimulate the translocation of protons across the cytoplasmic membrane.

The respiration of externally added substrates by washed cell suspensions, as determined by oxygen electrode measurements, was markedly inhibited by propyl gallate, the degree of inhibition varying in the order glucose < lactate < pyruvate < succinate < malate.

Dehydrogenase enzymes of the TCA cycle in cell extracts varied in sensitivity to propyl gallate. Lactate dehydrogenase and α-ketoglutarate dehydrogenase were not significantly affected; isocitrate dehydrogenase was weakly inhibited; whilst malate dehydrogenase was more strongly inhibited. Measurements of an effect on succinate dehydrogenase could not be made as propyl gallate interfered with the various assays attempted.

Appreciable changes in the cytochrome difference spectra between gallate treated cells and untreated cells suggested interference with the terminal cytochrome system of E.coli.

Incorporation of ^{14}C labelled compounds into the cells indicated that the synthesis of general cell polymers, RNA, DNA and protein by washed suspensions was inhibited by propyl gallate although no readily observable selectivity of action could be seen.

Of the possible sites of action investigated, the later stages of the respiratory pathways would seem to be the most sensitive to propyl gallate.

Beveridge, E.G. & Boyd, I. (1971). J. gen. Microbiol., 66 (3), iii - iv.

Carvajal, G. & Carvajal, E.J. (1959). Rev. latinoam. microbiol., 2, 133 - 138.

Mossel, D.A.A. (1971). in "Microbes and Biological Productivity" edited by D.E. Hughes & A.H. Rose, The University Press, Cambridge, U.K.