CATION INDUCED CHANGES IN THE BIOPHYSICAL PROPERTIES OF MUCINS

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It has been observed that certain divalent cations can induce thickening of mucus gels (Marriott, Shih & Litt, 1979) and that calcium ions precipitate mucus glycoproteins which have been purified from intestinal goblet cell mucus (Forstner & Forstner, 1976). It has been postulated that the observed effects could contribute to the mediation of contraception by cervical mucus since the concentration of a range of divalent ions in cervical mucus has been shown to vary during the menstrual cycle (Kosasky et al, 1973). Similarly, the mucostasis which occurs in cystic fibrosis may also be associated with the observed changes in the ion content of the mucus gel. Therefore, it is obviously of importance to understand the nature of the interaction between ions and mucus glycoproteins and this communication describes some basic studies with cations of differing valencies, an area which has not been investigated previously.

The glycoproteins were separated and purified by a technique which has been described elsewhere (Brown & Marriott, this conference). A typical mucus gel could be produced by concentration although all experiments were carried out in dilute solution of the glycoproteins which had been exhaustively dialysed against distilled, deionised water. The cations that were investigated were sodium, calcium, cupric, ferric and aluminium all of which were used in the form of the chloride salt. The techniques that were used to monitor interaction were (a) measurement of solution turbidity at 700 nm (b) U-tube viscometry and (c) determination of the electrophoretic mobility of the glycoproteins after adsorption onto monodisperse polystyrene spheres (Najib, Kellaway & Marriott, 1977). All experiments were carried out at 25°.

An increase in turbidity was observed for ferric, aluminium and cupric ions in the concentration range 0.1 to 1.0 mM. The two former ions produced a two-fold increase in optical density whereas with cupric ions only a 25% increase was observed. Calcium ions even in concentrations as high as 30 mM did not affect turbidity. The electrophoretic mobility studies showed that, once the latex surface had been completely covered, the glycoprotein exhibited an isoelectric point in the region of pH 1 and at higher pH possessed a net negative charge. All the cations reduced this charge over a broad pH range and the greater the valency of the ion then the greater the reduction in mobility. However, ions of equal valency did not produce similar effects and, for example, ferric was more effective than aluminium. A concentration of 0.44 mM ferric ions produced the lowest measurable mobility and increase in concentration resulted in complete charge neutralisation. In a similar manner all the cations produced a reduction in dilute solution viscosity. The change that was observed for 1.0 mM calcium ions was a reduction of 8%. This reduction in viscosity presumably results from a decrease in hydration and asymmetry of the glycoprotein molecule. However, the results from the other techniques do not rule out the possibility that binding occurs between positively charged ions and the negatively charged sites on mucus glycoproteins. Forstner and Forstner (1975) have shown this to be the case with calcium ions albeit at low ionic strength and if it occurs with other cations then the significance in gel formation would be considerable.

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