

UNUSUAL TIME-DEPENDENT SURFACE RHEOLOGICAL PROPERTIES OF POTASSIUM HYALURONATE

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In the course of a study into the surface rheology of human synovial fluid in the presence of antirheumatic drugs, it was thought necessary to investigate the surface rheological properties of synovial fluid components that are known to have some function in joint lubrication. The first compound studied, potassium hyaluronate, proved to have an unusual time-dependent behaviour that was affected by solute concentration and pH.

Measurements were made with the oscillating ring surface rheometer (Warburton 1978) at room temperature. Potassium hyaluronate solutions (0.5-4.0mg/ml) were investigated. The results (see Fig. 1) were unusual in that the compound forms a non-stationary viscous film with little or no elastic properties at 6.0Hz. When the pH of a solution of potassium hyaluronate (3.0mg/ml) was reduced by the addition of 0.01M HCl, the results indicated that there was a progressively decreased rate of film formation.

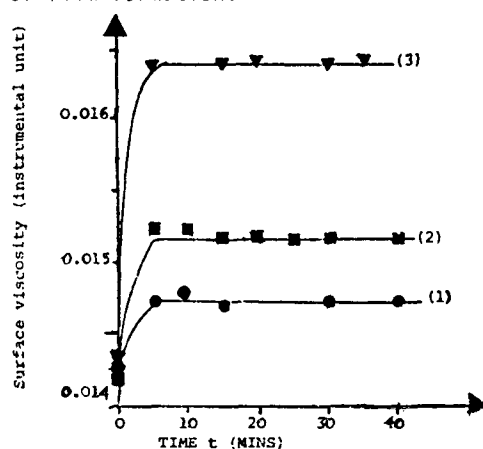


Fig.1 Graph showing the effect of varying the concentration of potassium hyaluronate. (1) 0.71, (2) 2.22, (3) 3.65 mg ml⁻¹

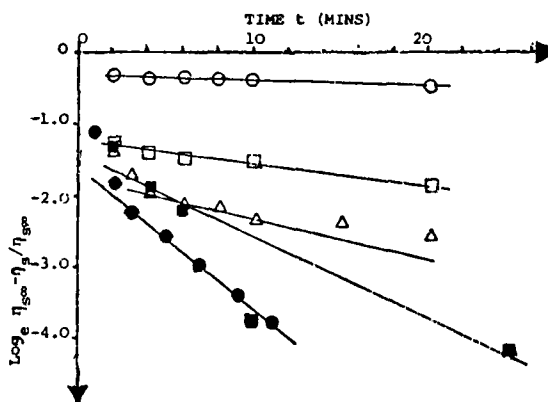


Fig.2 Graph showing the effect of varying the pH of a solution of potassium hyaluronate (3.0 mg ml⁻¹) on the rate of film formation pH = 2.4 ○, 4.0 □, 4.9 △, 5.4 ▽, 6.0 ●

The rate of film formation followed first order kinetics as shown in Fig.2 where the dependent variable is the function $\log_e \frac{\eta_{s\infty} - \eta_s}{\eta_{s\infty}}$.

The results can be interpreted on the basis that hyaluronic acid is a surface active polyanionic molecule that exists in solution as a random coil (Laurent 1970) and concentrates at an interface or surface. The dielectric constant of the surface of water is very much lower than its bulk dielectric constant. Theory predicts that the force of repulsion between two negatively charged groups on the molecule will be very much greater at the surface and this will tend to make the molecule expand and hence the viscosity will increase. The rate at which this expansion occurs will depend on both the degree of ionisation of the molecule and the surface viscosity of the molecular film.

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