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Note

Electrophoresis of cholesterol particles dispersed in aqueous solutions of carbohydrates

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The study of electrokinetic phenomena has found wide application, particularly for biological systems[1]; these systems consist, for the most part, of lipids, proteins, and carbohydrates[2,3]. Electrophoresis of Pyrex and ion-exchanger particles dispersed in alcohol–water has been conducted by various workers[4–6]. Electro-osmotic studies of cholesterol–carbohydrate systems have been reported in an earlier communication[7]. In order to supplement such researches, the electrophoresis of cholesterol particles dispersed in aqueous solutions of carbohydrates has been studied, and the results are reported herein.

EXPERIMENTAL

Materials, and preparation of suspensions. — Cholesterol obtained from E. Merck, Germany, was used. A. R.-grade samples of D-fructose, D-glucose, and sucrose obtained from BDH were employed, as such, without purification.

Solutions of D-fructose, D-glucose, and sucrose were prepared in doubly distilled, conductivity water having a specific conductance of the order of 10^{-6} $ohm^{-1}.cm^{-1}$. Suspensions were prepared by homogenizing finely ground particles of cholesterol in the chosen solutions.

Measurement of electrophoretic velocity. — Measurements of electrophoretic velocity were made using an apparatus described elsewhere[4,8]. A distinct boundary between the suspension and the experimental liquid was formed, and its movement under the action of a potential difference of known magnitude, applied by means of an electronically operated power supply (Toshniwal Co., India), was recorded. A slow, downward movement of the boundary was also observed, even when no electric field was applied. The data given in Figs. 1–3 have been corrected to allow for this effect. All of the measurements were made in an air thermostat maintained at 30 $\pm 0.5°$.

RESULTS AND DISCUSSION

The dispersed, cholesterol particles undergo electrophoretic migration due to the formation of an electrical double-layer at their interface that is endowed with an electrical potential called the zeta potential. The electrophoretic mobility and zeta potential are related as follows[9]:

$$V_e = [D\zeta/(f\pi\eta l)]\Delta\phi, \qquad (1)$$

or

$$L_{12} = D\zeta/f\pi\eta l, \qquad (2)$$

where L_{12} is the electrophoretic mobility, D is the dielectric constant, ζ is the zeta potential, η is the viscosity of the medium, and l is the distance between two electrodes. The factor f accounts for the dependence of the electrophoretic mobility on the size and shape of the particles[10]. Eq. *1* is strictly valid only when the thickness of the double layer is much smaller than the radius of the particle[11,12]. When the magnitude of the layer thickness becomes similar to that of the radius, $f = 6$ when the particles move; the diffuse double-layer is left behind, and exerts a retarding force on the particles.

Eq. *1* predicts a linear dependence of V_e on $\Delta\phi$. The results plotted in Figs. 1–3 show that electrophoretic velocities depend linearly on the electrical potential-

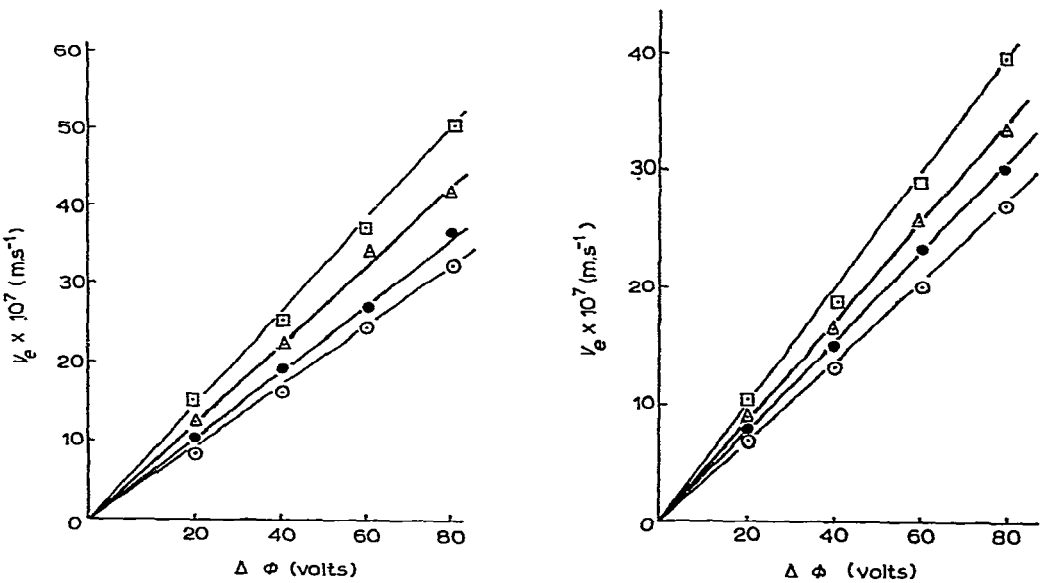

Fig. 1. Dependence of electrophoretic velocity (V_e) on applied potential-difference, $\Delta\phi$, for the cholesterol–aqueous solutions of the D-fructose system: (⊙) 0.01M; (●) 0.02M; (△) 0.04M; (⊡) 0.10M.

Fig. 2. Dependence of electrophoretic velocity (V_e) on applied potential-difference, $\Delta\phi$, for cholesterol–aqueous solutions of the D-glucose system: (⊙) 0.01M; (●) 0.02M; (△) 0.04M; (⊡) 0.10M.

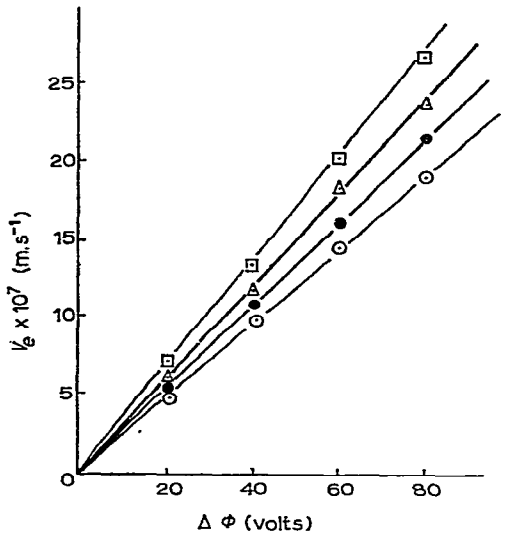

Fig. 3. Dependence of electrophoretic velocity (V_e) on applied potential-difference, $\Delta\phi$, for cholesterol–aqueous solutions of the sucrose system: (⊙) 0.01M; (●) 0.02M; (△) 0.04M; (⊡) 0.10M.

TABLE I

ELECTROPHORETIC COEFFICIENTS (L_{12})

Concentration (M)	$L_{12} \times 10^8$ ($m.s^{-1}.V^{-1}$) D-*Fructose*	D-*Glucose*	*Sucrose*
0.01	4.17	3.45	2.50
0.02	4.62	3.75	2.67
0.04	5.43	4.28	3.00
0.10	6.25	5.00	3.75

TABLE II

ZETA POTENTIALS ESTIMATED FROM ELECTROPHORETIC-MOBILITY DATA

Concentration (M)	ζ(V) D-*Fructose*	D-*Glucose*	*Sucrose*
0.01	11.93	9.87	7.15
0.02	13.22	10.73	7.64
0.04	15.54	12.25	8.58
0.10	17.88	14.30	10.72

difference applied. The linear dependence of V_e on $\Delta\phi$ shows that the electrical double-layer retains its undeformed, equilibrium character within the range of investigation. Electrophoretic mobilities estimated from the slopes in Figs. 1–3 are given in Table I.

Using Eq. *1*, the zeta potential can be expressed in volts, as follows:

$$\zeta = (6\pi\eta l/D)L_{12} \times 9 \times 10^4 \text{ volts} \qquad (3)$$

The values of the zeta potential, calculated by using Eq. *1*, are given in Table II.

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