INTERACTION OF Na^+, K^+, Ca^{+2} AND Mg^{+2} WITH D-MANNOSE AND D-GLUCOSE IN AQUEOUS SOLUTION—ULTRASONIC STUDY

A. K. PURI and APARNA SHUKLA
Department of Chemistry, University of Allahabad, Allahabad 211 002, *India.*

ULTRASONICS has been used as a versatile tool[1-7] to investigate the composition of complexes. When two non-interacting aqueous solutions are mixed, ultrasonic velocity and isentropic compressibility vary linearly with the concentration between the corresponding values of the two individual solutions. Ultrasonic velocity and isentropic compressibility exhibit a number of minima or maxima in these interactions. In the present communication the results of ultrasonic studies of interaction of metal ions with D-glucose and D-mannose in aqueous solutions are reported. Recently[8] viscosity B-coefficient has been used to study the effect of concentrated alkali halides on aqueous D-glucose solution. Strong alignment of carbohydrate with Ca^{+2} has been shown by x-ray and NMR studies[9]. We have considered the effect of Na^+, K^+, Ca^{+2} and Mg^{+2} on aqueous solutions of D-glucose and D-mannose.

Experimental studies were carried out using AR grade chemicals. Using double-distilled water, 0.2 M solutions of D-glucose and D-mannose were prepared; 0.1 M solutions of all the metal ions were used. Ultrasonic velocity was measured using ultrasonic interferrometer (2 Mz/sec) with an accuracy of 0.2%. Density of solutions was determined with bicapillary pyknometer with an estimated accuracy of 0.001%. Isentropic compressibility (β_s) of solutions was obtained from the velocity and density data using the relations $\beta_s = 1/U^2\rho$. Solutions of different compositions were prepared according to Job's method of continuous variation.

Ultrasonic velocity of solutions at different mole compositions of metal ions has been determined from these values of ultrasonic velocity, the isentropic compressibilities of solvent and solution was obtained. For this purpose, the effect of Na^+, K^+, Ca^{+2}, Mg^{+2} ions on D-glucose and D-mannose solutions has been studied. Variation of ultrasonic velocity and compressibility lowering ($\Delta\beta = \beta_0 - \beta_s$) with $M/M + L$ (where M stands for metal ions and L for ligand *i.e.* D-glucose or D-mannose) has been studied. For D-glucose, U *vs.* M/M + glucose plots are shown in figure 1. On the addition of each metal ion to the solution of D-glucose

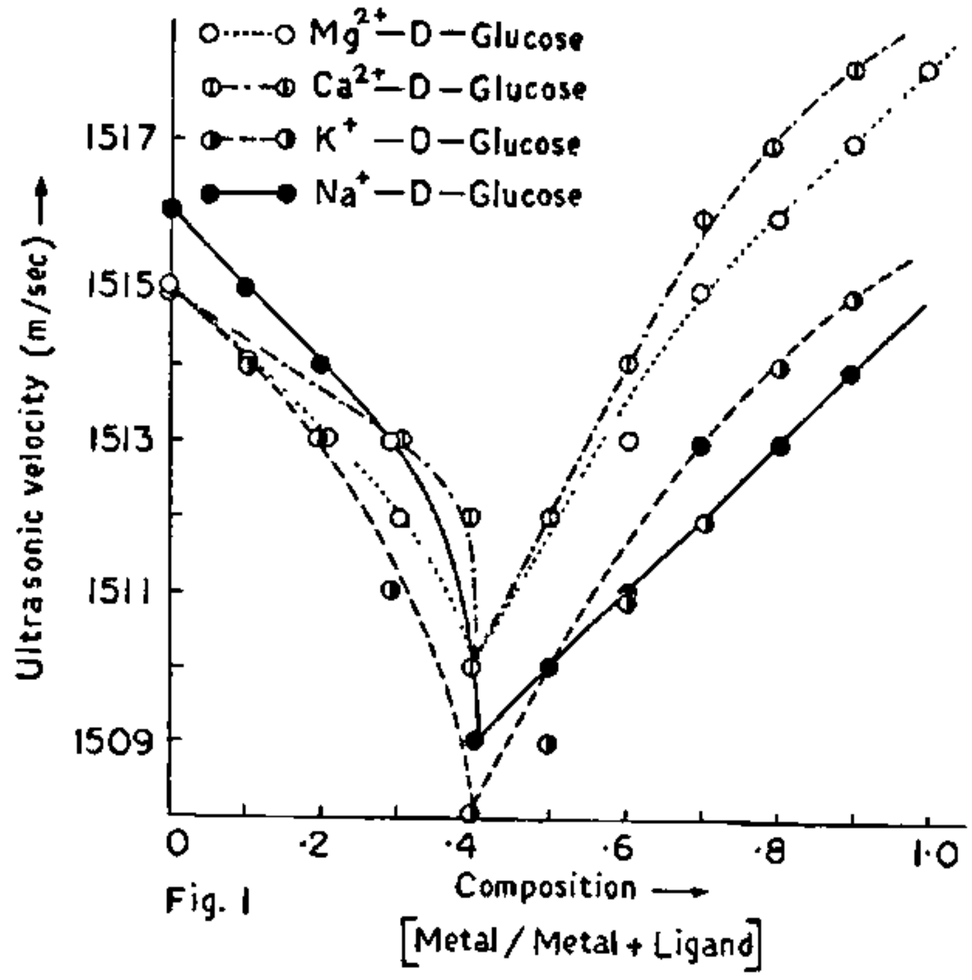

Fig. 1

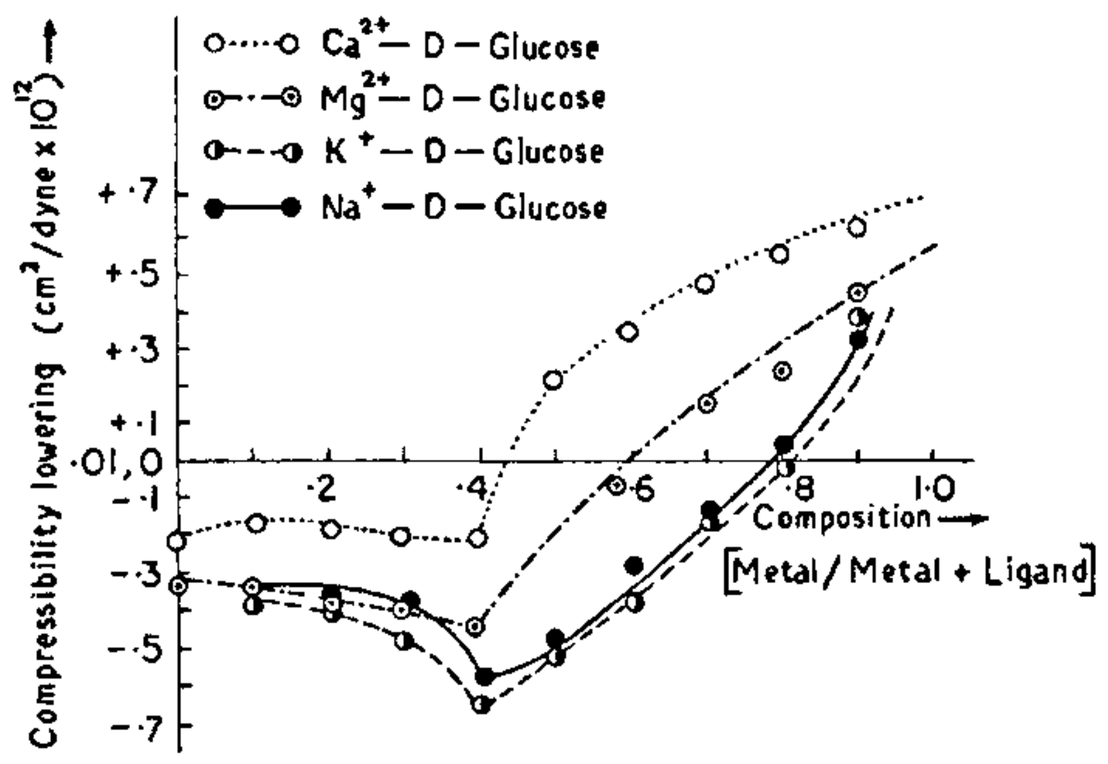

Fig. 2

Figures 1&2. 1. Variation of ultrasonic velocity with metal/metal + ligand where $M = Na^+$, K^+, Mg^{+2} & Ca^{+2}, L = Glucose. **2** Variation of compressibility lowering with metal/metal + ligand where $M = Na^+$, K^+, Mg^{+2} & Ca^{+2}, L = Glucose.

the ultrasonic velocity gradually reaches a minimum value at a certain point and then again increases. The minimum occurs at a point (0.4) of the above ratio in the equimolecular set of solutions. The corresponding mole ratio being 1:4, indicating maximum complex formation at this point.

In figure 2, the compressibility lowering versus M/M + glucose has been plotted for all sets of mixtures. Compressibility lowering shows maximum complex formation between K^+, Na^+, Ca^{+2} and Mg^{+2} with D-glucose at 1:4. The decrease in compressibility of water resulting from the addition of an electrolyte is due to the electrostatic field of the ions

surrounding the water molecule. The lowering in compressibility[4-5] ($\Delta\beta = \beta_0 - \beta_s$) has been directly proportional to the number of ions in the solution. When a non-electrolyte is added to such an electrolyte solution, it shows a nonlinear variation which indicates the maximum complex formation at the corresponding point. Similar observations have been recorded for D-mannose solution. Thus ultrasonic velocity and compressibility lowering predict the complex formation between Na^+, K^+, Ca^{+2} and Mg^{+2} with D-glucose and D-mannose in aqueous solution. The composition of the complex can also be assessed from such studies.

The authors are highly indebted to Dr J. D. Pandey for helpful advice and discussion.

16 November 1982.

1. Satyavati, T., Reddy, P. G. and Subramanyam, S. V., *J. Phys. Soc. Jpn*, 1962, **17**, 1061.
2. Pandey, J. D., Prakash, S. and Ichhaporia, F. M., *J. Phys. Chem.*, 1964, **68**, 3078.
3. Pandey, J. D., Prakash, S. and Ichhaporia, F. M., *Naturwissenschaften*; 1965, **52**, 1.
4. Prakash, S. and Prakash, S., *J. Phys. Chem.*, 1966, **70**, 3325.
5. Laxmi, S. and Prakash, S., *Z. Phys. Chem. (N.F.)*, 1968, **61**, 247.
6. Laxmi, S. and Prakash, S., *Z. Phys. Chem. (N.F.)*, 1967, **55**, 259.
7. Prakash, S., Prakash, O. and Jain, S. K., *Roczniki Chem. Ann. Soc.*; 1969, **43**, 37.
8. Vishnu and Singh, *Indian J. Chem.*, 1981, **20**, 24.
9. Taga, T., Kuroda, Y. and Osaki, K., *Bull. Chem. Soc.(Jpn)*, 1977, **50**, 3079.

BACTERIOPHAGE BURST SIZE AS A FUNCTION OF MULTIPLICITY OF INFECTION

I. R. PATEL and K. K. RAO
Microbiology Division, Department of Pharmacy, Faculty of Technology and Engineering, M. S. University of Baroda, Baroda 390 001, India.

THE last few decades have witnessed phenomenal advances in our understanding of the detailed mechanism of phage growth and reproduction. Studies on the burst size of bacterial viruses was reported earlier by a few workers[1-3]. The burst size of a particular phage may be determined by (a) the nutritional and physiological status of the host bacterium,[4] (b) phage-coded functions such as polymerases and regulatory proteins essential for phage production[5-7]. The inherently low efficiency of polymerases and regulatory proteins may not permit the phage to make full use of bacterial resources and consequently the burst size may be limited. In the present investigation the burst size of bacteriophage PIK in *Pseudomonas aeruginosa* PAO1 has been measured under conditions of varying multiplicity of infection (MOI).

The host *P. aeruginosa* PAO1 (gift from Dr B. W. Holloway, Monash University, Victoria, Australia) and the virulent bacteriophage PIK[8] were mixed in trypticase soy broth. The number of bacteria in each experiment was added in such a way that the final concentration of bacteria remained 1×10^7 cells/ml. The number of phage particles varied in each experiment to get the desired MOI. Phage adsorption was carried out using the procedure of Adams[9]. Various factors like MOI, burst size, effective MOI and effective burst size were calculated using the following equations:

(i) B/A = MOI, where B and A represent the number of phage and the number of bacteria respectively.
(ii) C–$D = X$, the number of unadsorbed free phage particles. Where C represents the number of infected bacteria plus the number of free phage particles and D, the number of infected bacteria.
(iii) $B - X = Y$, the number of phages adsorbed.
(iv) Y/D = effective MOI (mean number of phages adsorbed per infected bacterium).
(v) E/D = burst size (mean number of phages liberated per infected bacterium), where E represents the total number of phages liberated at the end of one cycle of phage growth.
(vi) E/Y = effective burst size (mean number of phages liberated per phage adsorbed).

The experiments were repeated four to five times at each MOI. The data were statistically analysed by the student's t test and the level of significance is indicated.

When MOI and the burst size were computed, a significant positive correlation was obtained (figure 1). The total production of phage particles was limited to certain MOI (MOI = 5). This cannot be a result of increased number of infected bacteria because the burst size tends to decrease if there would be any further increase in the MOI. At lower MOI, however, it may be possible that phages could not utilize the bacterial machinery completely and thus leading to lower burst size.

Although it is known that the burst size increases