Supporting Information

Densities and speeds of sound for sucrose in aqueous solutions of ammonium phosphate salts at different temperatures through density and speed of sound measurements

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Partial molar volume of transfer

Transfer volumes of sucrose from water to aqueous ADP and DAP solutions at infinite dilution was measured by using the equation:

$$\Delta_{tr}V_{\phi}^{o} = V_{\phi}^{o}\ (in\ aqueous\ solution\ of\ ADP/DAP) - V_{\phi}^{o}\ (in\ water) \qquad \text{(E1)}$$

The measured values of $\Delta_{tr}V_{\phi}^{o}$ are noted in Table S1.

Temperature Dependence of Partial Molar Volume

The variation of apparent molar volume with temperature at infinite dilution can be asserted by the general equation as follows:

$$V_{\phi}^{o} = a + b(T-T_{ref}) + c(T-T_{ref})^2 \qquad \text{(E2)}$$

where$T$ is the temperature in Kelvin, T_{ref} = 298.15 K. *a, b,* and *c* are the empirical constants . The value of these constants for sucrose in aqueous solutions of ADP/DAP were determined using weighted regressions and are listed in Table S2. We have also calculated the theoretical V_{ϕ}^{o} values with the above parameters reported in Table S2. The deviations obtained from the experimental and theoretical V_{ϕ}^{o} values, using Equation E3 are also reported in Table S2. Making use of the following equation, the deviation ARD (σ) is calculated as follows

$$\sigma = (1/n)\Sigma[abs((Y_{exptl.} - Y_{calc.})/Y_{exptl.})] \qquad \text{(E3)}$$

where $Y = V_\phi^o$ (apparent molar volume at infinite dilution). The very small values of ARD (σ) reported in Table S2 fits the polynomial equation very well in the present article.

The variation of partial molar volume (V_ϕ^o) with temperature can be articulated in terms of the absolute temperature (T) by utilizing the following relation (E4). The partial molar expansibilities are determined as follows:

$$E_\phi^o = (\partial V_\phi^o / \partial T)_p = b + 2c\,(T - T_{ref}) \qquad \text{(E4)}$$

The values of limiting apparent molar expansibilities E_ϕ^o are reported in Table S3.

Partial molar isentropic compression

The following equation adequately represents the deviation of apparent molar isentropic compression $K_{\phi,s}$ with the molal concentration as follows

$$K_{\phi,s} = K_{\phi,s}^o + S_K^* m_A \qquad \text{(E5)}$$

where $K_{\phi,s}^o$ is the partial molar isentropic compression and S_K^* is the experimental slope indicative of solute–solute interactions, m_A is the molality of sucrose in aqueous ADP/DAP solutions. The values of $K_{\phi,s}^o$ and S_K^* together with standard errors derived by least squares fitting are reported in Table S4

Partial molar isentropic compression of transfer

The elucidation of transfer apparent molar isentropic compressions at infinite dilutions from water to aqueous ADP/DAP solutions have been done by using following equation

$$\Delta_{tr}K_{\phi,s}^o = K_{\phi,s}^o \textit{ (in aqueous solution of ADP/DAP)} - K_{\phi,s}^o \textit{ (in water)} \qquad \text{(E6)}$$

These values of $\Delta_{tr}K_{\phi,s}^o$ are reported in Table S5.

Pair and triplet interaction coefficients

Mc-Millan and Mayer [1,2] theory of solutions have been used to determine the pair and triplet interaction coefficients. This was further extended by Friedmann and Krishnan[3] and Franks *et al.*[4], so that solute–cosolute interactions can be included in the solvation spheres thereby consenting the separation of effects due to its interaction between more than two solute molecules and those interactions between the pairs of solute molecules. Consequently, apparent molar isentropic compression of transfer and apparent molar volume of transfer of sucrose can be expressed as follow:

$$\Delta V_{\phi}^{o}\ \textit{(water to aqueous ADP/DAP solution)} = 2V_{AB}m_{\mathrm{B}} + 3V_{ABB}m_{\mathrm{B}}^{2} \qquad \text{(E7)}$$

$$\Delta K_{\phi,s}^{o}\ \textit{(water to aqueous ADP/DAP solution)} = 2K_{AB}m_{\mathrm{B}} + 3K_{ABB}m_{\mathrm{B}}^{2} \qquad \text{(E8)}$$

where A denotes sucrose, B denotes ADP/DAP, m_B is the molality of ADP/DAP. Pair and triplet interaction coefficients for studied saccharide are denoted by the corresponding parameters V_{AB}, V_{ABB} for volume and K_{AB}, K_{ABB} for isentropic compression, respectively. These constants were obtained by fitting ΔV_{ϕ}^{o} and $\Delta K_{\phi,s}^{o}$ values to the above equations and are indexed in Table S6.

Table S1

Partial molar volume of transfer, $\Delta^{tr}V_{\phi}^{0}$ of sucrose in different aqueous solutions of ADP and DAP at different temperatures.

$^{a}m_B$ / (mol·kg^{-1})	$\Delta^{tr}V_{\phi}^{0} \times 10^{6}$ (m^{3}·mol^{-1})			
	T = 288.15 K	T = 298.15 K	T = 308.15 K	T = 318.15 K
		ADP		
0.5	1.59(±0.005)	1.30(±0.009)	1.41(±0.008)	1.97(±0.004)
1	2.36(±0.009)	2.06(±0.008)	2.03(±0.015)	2.53(±0.001)
1.5	3.32(±0.010)	3.05(±0.006)	3.05(±0.009)	3.56(±0.005)
		DAP		
0.5	2.70(±0.010)	2.13(±0.009)	1.94(±0.017)	2.03(±0.004)
1.0	3.55(±0.012)	3.03(±0.010)	2.83(±0.008)	2.93(±0.002)
1.5	4.50(±0.007)	4.00(±0.013)	3.85(±0.007)	3.90(±0.005)

$^{a}m_B$is the molality of aqueous solutions of ADP and DAP.

Table S2

Values of empirical parameters of Eq. E2 for sucrose in aqueous ADP and DAP solutions.

[a]m_B / (mol·kg^{-1})	a x10^6 / (m^3·mol^{-1})	b x10^6 / (m^3·mol^{-1}·K^{-1})	c x10^6/ (m^3·mol^{-1}·K^{-2})	R^2	$ARD(\sigma)$
			ADP		
0.0	212.60(±0.034)	0.153(±0.003)	-0.0015(±0.0002)	0.9999	0.00001
0.5	213.89(±0.027)	0.144(±0.0025)	0.0006(±0.0001)	0.9999	0.00010
1.0	214.62(±0.007)	0.138(±0.0006)	0.0005(±0.00005)	0.9999	0.00002
1.5	215.62(±0.003)	0.141(±0.0003)	0.0004(±0.00002)	0.9999	0.00001
			DAP		
0.5	214.74(±0.049)	0.115(±0.0044)	0.0001(±0.0003)	0.9999	0.0001
1.0	215.64(±0.040)	0.117(±0.0036)	0.0000(±0.0002)	0.9999	0.0001
1.5	216.62(±0.058)	0.120(±0.0053)	-0.0001(±0.0003)	0.9999	0.0002

[a]$m_B$is the molality of aqueous solutions of ADP and DAP.

Table S3

Partial molar expansibilities, E_{ϕ}^{o} for sucrose in aqueous and different aqueous ADP and DAP solutions at different temperatures.

$^{a}m_B$ / (mol·kg^{-1})	E_{ϕ}^{o} x10^{6} / (m^{3}·mol^{-1}·K^{-1})			
	T = 288.15 K	T = 298.15 K	T = 308.15 K	T = 318.15 K
		ADP		
0.0	0.1834	0.1529	0.1225	0.0920
0.5	0.1316	0.1441	0.1565	0.1690
1.0	0.1524	0.1408	0.1291	0.1175
1.5	0.1535	0.1408	0.1281	0.1155
		DAP		
0.5	0.1121	0.1146	0.1171	0.1197
1.0	0.1164	0.1167	0.1170	0.1174
1.5	0.1219	0.1195	0.1172	0.1148

$^{a}m_B$ is the molality of aqueous solutions of ADP and DAP.

Table S4

Partial molar isentropic compression, $K^{o}_{\phi,s}$ and experimental slopes, S^{*}_{K} for sucrose in different aqueous solutions of ADP and DAP at different temperatures.

$^{a}m_B$ / (mol·kg^{-1})	$K^{o}_{\phi,s} \times 10^{6}$ /(m^{3}·mol^{-1}·GPa^{-1})				$S^{*}_{K} \times 10^{6}$ / (kg· m^{3}·mol^{-2}·GPa^{-1})			
	T = 288.15 K	T = 298.15 K	T = 308.15 K	T = 318.15 K	T = 288.15K	T = 298.15 K	T = 308.15 K	T = 318.15 K
				ADP				
0.5	-14.16(±0.064)	-12.30 (±0.051)	-10.64(±0.05)	-9.39(±0.056)	5.20(±0.164)	4.92(±0.132)	4.65(±0.130)	4.41(±0.144)
1.0	-8.63 (±0.097)	-6.20 (±0.197)	-2.94(±0.29)	-0.28(±1.044)	4.01(±0.249)	4.33(±0.507)	-0.43(±0.763)	-3.62(±2.688)
1.5	2.61 (±0.041)	3.67 (±0.035)	4.50(±0.04)	5.22(±0.034)	2.22(±0.104)	2.07(±0.091)	1.96(±0.104)	1.84(±0.087)
				DAP				
0.5	-11.61(±0.061)	-9.86 (±0.059)	-8.81 (±0.06)	-7.85(±0.054)	5.09(±0.157)	4.88(±0.153)	-12.59(±0.19)	4.48(±0.139)
1.0	-5.91(±0.275)	-3.07 (±0.046)	-2.26 (±0.03)	-1.74(±0.044)	6.10(±0.710)	3.14(±0.118)	3.05(±0.095)	2.94(±0.114)
1.5	2.96(±0.031)	3.82 (±0.035)	4.28 (±0.03)	4.72(±0.030)	1.93(±0.080)	1.78(±0.091)	1.71(±0.090)	1.76(±0.076)

$^{a}m_B$ is the molality of aqueous solutions of ADP and DAP.

Table S5

Partial molar isentropic compression of transfer, $\Delta_{tr}K^{o}_{\phi,s}$ of sucrose in different aqueous solutions of ADP and DAP at different temperatures.

[a]m_B / (mol·kg^{-1})	$\Delta^{tr}K^{o}_{\phi,s} \times 10^{6}$ (m^{3}·mol^{-1}.GPa^{-1})			
	T= 288.15 K	T= 298.15 K	T= 308.15 K	T= 318.15 K
		ADP		
0.5	10.35	4.64	0.13	-2.36
1.0	15.88	10.74	7.83	6.75
1.5	27.12	20.61	15.27	12.25
		DAP		
0.5	12.90	7.08	1.96	-0.82
1.0	18.60	13.87	8.51	5.29
1.5	27.47	20.76	15.05	11.75

[a]m_B is the molality of aqueous solutions of ADP and DAP.

Table S6

Pair and triplet interaction coefficients of sucrose in different aqueous solutions of ADP and DAP at different temperatures.

T / (K)	$V_{AB} \times 10^6$ / ($m^3.mol^{-2}.kg$)	$V_{ABB} \times 10^6$ / ($m^3.mol^{-3}.kg^2$)	$K_{AB} \times 10^6$ / ($m^3.mol^{-2}.kg.GPa^{-1}$)	$K_{ABB} \times 10^6$ / ($m^3.mol^{-3}.kg^2.GPa^{-1}$)
		ADP		
288.15	1.60	-0.22	8.66	0.09
298.15	1.26	-0.11	3.04	1.69
308.15	1.33	-0.15	2.57	-0.56
318.15	0.85	-0.04	2.88	-2.14
		DAP		
288.15	2.85	-0.62	12.46	-1.54
298.15	2.23	-0.41	7.12	-0.09
308.15	2.00	-0.33	1.48	1.61
318.15	1.04	-0.03	1.69	-2.54

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