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Study of electrical conductance of Albumine in water and it's reaction with alkali metal ions

Omar A. Shareef

Department of Chemistry, Collage of Science , Mosul University , Mosul , Iraq

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Corresponding Author:

Name: Omar A. Shareef

E-mail: omaradel75a@gmail.com

Tel:

ABSTRACT

Interactions of bovine serum albumin with some alkali earth metal ions Na^{+}, K^{+}, Mg^{+2},Ca^{+2},were investigated to give the effect of metal molecular structure on complex formation of metal-protein molecules. To elucidate the interactions, the protein-metal combination in aqueous buffer solution of pH values (4,7and8.2) and at37°Cwere investigated using conductivity, straight lines from the plot of specific conductivity against its concentration were gives at pH 7 which is chosen because it is near the pH of blood serum. Besides, the conductivities of albumin with each of solutions of some alkali earth metal chlorides (NaCl, KCl, $MgCl_2$, $CaCl_2$) at pH7 were measured. The plot of specific conductivity against each mixture solution were discussed.

Introduction

It is well known that proteins possess different charges that interact electrostatically due to the different component basic and acidic amino acids. These charges varies with the variation of protein pH [1]. The conductivity effect on proteins dielectric measurements was studied, hence the dielectric spectra of serum myoglobin and albumin (0.30-13 MHz) were recorded in solutions of varied conductivities [2]. Buzatu et al., showed that lysozym (an antimicrobial enzyme) charge in the binary lys-water and ternary lys-salt-water systems was determined by the use of conductimetric method which considered to be adequate to electrolytes. The same conditions pH=4.5 and T=298K , was used in order to measure the viscosities of the above solutions which allow to see the effect of viscosity on cations mobilities and implicitly on the lysozym charge [3] .

A breakdown of the Debye-Stokes-Einstein relation occur throughout a comparison between the γ-relaxation time and the analysis of the temperature-dependent direct current conductivity, i.e. instead of the solution molecules motions, different energy barriers governed the ionic charge transport. Interestingly, Wolf and his co-workers found that instead the δ-relaxation and charge transport, i.e. the reorientation of bound water molecules, are determined by identical energy barriers, an unexpected and so far unexplained behavior [4] , so it's important to examine proteins within their common environment. Protein dynamics is a very active field of research, due to its importance to obtain a deeper understanding of biological processes [5-8], which concentrate on the interaction of protein-water [9-13].

Complixities that formed by interaction of the amphiphilic drug amitriptyline-hydrochloride and human serum albumin (HSA) in aqueous solution at different pH values 3.2, 4.9 (the isoelectric point) and 6.0, were studied at 25°C by the use of different physicochemical techniques. The conductometric measurements was used to investigate complexation process on HSA/amitriptyline solutions of increasing drug concentration from which values of the critical concentration at which adsorption of drug commenced and also the critical micelle concentration of amitriptyline in the presence of protein were determined [14] .

Renault and Dzyadevych present the principles of conductometric measurements in ionic media and the equivalent electrical circuits of different designs for conductometric measurements. The conductometric microtransducers was used in the case of pollutant detection for environmental monitoring. Over these types of transducers the conductometric biosensors which have advantages over the others; since they can be produced through inexpensive thin-film standard technology, no need for reference electrode and it

allows cancellation of a lot of interference throughout differential mode measurements [15].

The present work undertaken in an attempt to clarify the general principle involved in protein-small ion interaction. For these purposes bovine albumin and some alkali metal chlorides (NaCl, KCl, $MgCl_2$ and$CaCl_2$) were selected as a relatively simple salts to study such a system in our laboratory using conductivity technique.

Material and Method

Conductivity water was prepared by redistilling distilled water three times with the addition of a little amount of potassium permanganate and small pellets of KOH to obtain deionized water. The specific conductance of this water was less than $1x10^{-6}$ ($S.cm^{-1}$). The alkali metal chlorides (NaCl, KCl, $MgCl_2$ and$CaCl_2$) and bovine albumin are used without farther purification. Conductivities of solutions of salts and salts\albumin complex were measured with Jenway PCM3 meter.A water bath (HAAKSB NK22) was used to maintain the temperature at 25 $\pm$0.1°C and the conductance was measured after thoroughly mixing and temperature equilibrium. The pH was measured by pH-meter (Hana instrument microprocessor).

Stock solution of bovine serum albumin (BSA) of $1x10^{-5}$M and stock solution of each salt of $1x10^{-3}$M concentration were prepared for the experiment . A certain amount (25ml) of conductivity water was placed in the conductivity cell at constant temperature 37°C for a constant time (few minutes) and then the pH and conductivity were measured. Then 5 ml of stock solution of albumin was added to the conductivity cell and again the conductivity was measured. Finally, small amount(0.1ml) of stock solution of salt solution at 37°C was added to the cell then the conductivity of the solution was measured. The last procedure was repeated for about 20 time for each run.

Results and Discussion

Functional groups on proteins have a charges, each of these groups has a pK_a that proportion with the pH value at which half of these groups are protonated . By changing pH value the net charge on the surface of protein will change as a consequent . So that, above or below the pK_a value, the surface groups will be either fully protonated or deprotonated respectively. Addition of many protons (i.e. low pH value), the net charge of most proteins is positive, and this in contrast with high pH value that leads to deprotonation of surface groups of most proteins and the net charge is negative . At some intermediate pH that every protein has a different value and the net charge of proteins in such case is zero (i.e. the protein carries an equal number of both of negative and positive charges) and the pH of this is designated its isoelectric point (IP). In most cases, the electrostatic interactions were dominated by the distortion of the electrical double layer surrounding the proton, leading to a district maximum in proton transmission at the protein isoelectric point. Attractive electrostatic interaction did occur when the protein molecules had a large opposite charges, causing a second maximum in transmission at pH between the isoelectric points of the protein molecules The conductivity of bovine serum albumin[16] solutions were measured and converted to specific conductance (after subtraction of the contribution of the solvent to the conductivity) with its concentration at three pH values (pH 4, 7 and 8.2).The variation of the measurements are shown in Table 1 and Figure 1, this figure shows that at pH 7 the plot is almost straight line since there is some association between molecules of albumin, so it is chosen because the pH of the body almost at pH 7 and the relation between specific conductivity and albumin concentration is more clear.

An attempt to study the nature of interaction between bovine serum albumin with different metal ions, the specific conductivity of each certain concentration of (NaCl, KCl, $MgCl_2$ and $CaCl_2$) at pH(4, 7 and 8.2) are shown in Table 2 A-D and Figure 2 A-D, and each one with albumin at pH7 are shown in table 3 A-D and Figure 3A-D.The tables and figures show that the relation between specific conductivity and concentration for each metal chloride with albumine at the three different pH values have a clear association.

Table (1): variation of specific of conductivity (L) of albumin solutions with its molar concentration at three different pH values (pH 4,7 and 8.2) at pH 37 ^{0}C.

pH 4		pH 7		pH 8.2	
Concentration M/Lx10^7	Specific conductance (L) S.cm^{-1}.x 10^6	Concentration M/Lx10^7	Specific conductance (L) S.cm^{-1}.x 10^6	Concentration M/Lx10^7	Specific conductance(L) S.cm^{-1}.x 10^6
0.398	1.660	0.398	0.377	0.398	2.233
0.793	1.672	0.793	0.387	0.794	2.264
1.200	1.683	1.200	0.418	1.190	2.264
1.575	1.703	1.575	0.438	1.570	2.254
1.961	1.713	1.961	0.479	1.960	2.244
2.344	1.723	2.344	0.510	2.340	2.233
2.724	1.734	2.724	0.530	2.720	2.238
3.101	1.744	3.101	0.550	3.100	2.213
3.475	1.744	3.475	0.571	3.470	2.203
3.846	1.754	3.846	0.591	3.850	2.193
4.580	1.764	4.580	0.693	4.580	2.193
5.303	1.774	5.303	0.765	5.300	2.193
6.015	1.785	6.015	0.795	6.020	2.193
6.716	1.805	6.716	0.816	6.720	2.193
7.407	1.815	7.407	0.836	7.410	2.203
8.088	1.825	8.088	0.856	9.090	2.223
8.759	1.836	8.759	0.897	1.070	2.305
9.422	1.846	9.422	0.918	1.230	2.325
10.007	1.856	11.070	0.979	1.380	2.356
10.711	1.866	12.600	1.030	1.530	2.386
12.281	1.887	14.100	1.030	1.670	2.417
13.790	1.907	15.500	1.193		
15.252	1.938	16.900	1.244		
16.674	1.958	18.300	1.305		

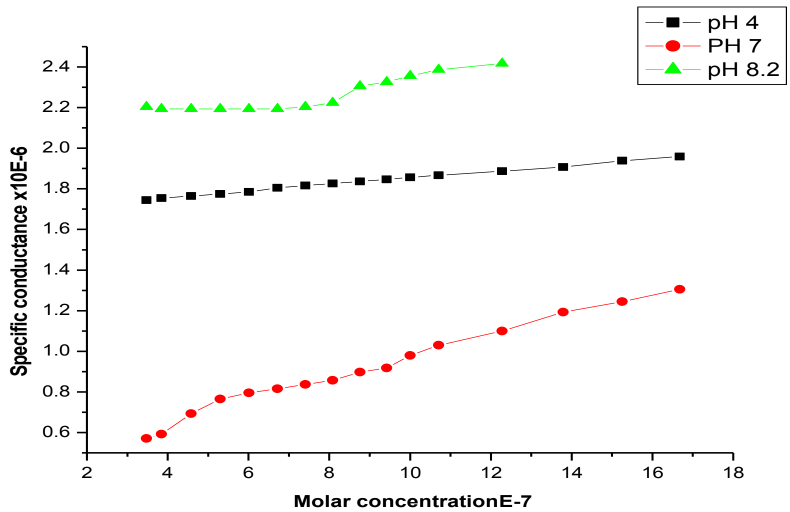


Figure (1) : Specific conductance against molar concentration.

Table (2-A): variation of specific of conductivity (L) of KCl solutions and molar concentration with albumin at three different pH values (pH 4,7 and 8.2) at pH 37 ^{0}C.

Concentration M/Lx10^5	pH 4	pH 7	pH 8.2
	Specific conductance S.cm^{-1}.x 10^6 (L)		
0.332	0.612	0.918	0.512
0.662	1.122	1.122	0.816
0.990	1.531	1.532	1.122
1.320	1.836	1.938	1.428
1.640	2.142	2.346	1.836
1.960	2.346	2.754	2.142
2.280	2.754	3.069	2.448
2.621	3.062	4.088	2.754
2.914	3.264	4.488	2.958
3.235	3.575	5.117	3.366
3.852	4.284	5.814	3.876
4.468	4.794	6.635	4.488
5.064	5.304	7.344	5.147
5.663	5.615	7.854	5.712
6.259	6.528	8.466	6.222
6.832	7.242	9.282	6.834
7.410	7.752	9.792	7.344
7.983	8.167	10.506	7.956
8.544	8.568	12.954	8.568
9.093	9.185	16.014	9.282
10.412	10.608	17.345	10.404
11.815	11.526		11.628
13.236	12.342		12.852
14.378	14.076		13.872

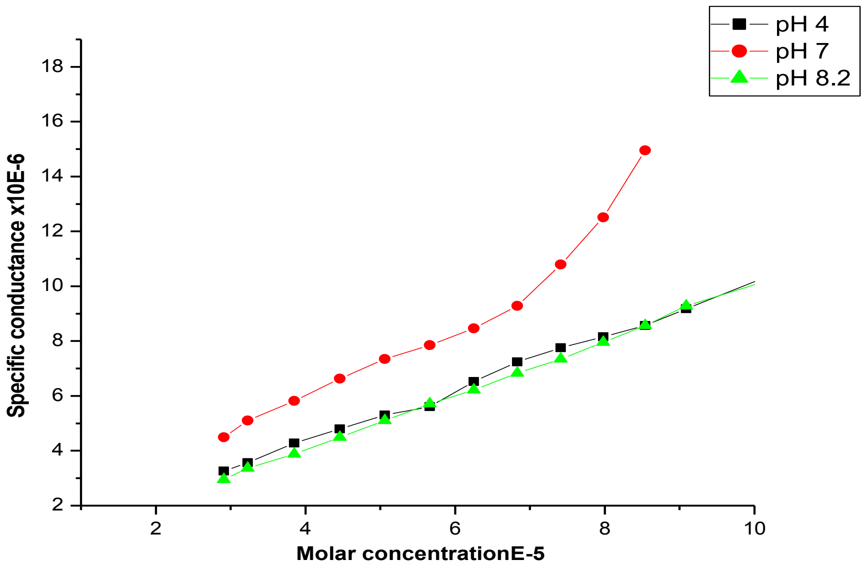


Figure (2-A): Plot of specific conductance against molar concentration of KCl solution with albumin

Table (2-B): variation of specific of conductivity (L) of NaCl solutions and molar concentration with albumin at three different pH values (pH 4,7 and 8.2) at pH 37 ^{0}C.

Concentration M/Lx10^5	pH 4	pH 7	pH 8.2
	Specific conductance S.cm^{-1}.x 10^6 (L)		
0.332	0.612	6.426	0.5124
0.662	1.326	6.936	0.918
0.990	2.142	7.446	1.326
1.320	2.754	7.956	1.734
1.640	3.264	8.058	2.244
1.960	3.978	8.976	2.652
2.280	4.386	9.486	3.06
2.621	4.794	9.996	3.468
2.914	5.202	10.506	3.876
3.235	5.508	10.914	4.284
3.852	6.324	11.526	5.304
4.468	7.854	12.75	6.018
5.064	8.364	14.484	6.834
5.663	9.69	15.3	7.548
6.259	11.016	16.32	8.364
6.832	12.036	17.136	9.185
7.410	12.648	18.054	9.894
7.983	13.362	18.87	10.812
8.544	13.872	19.686	11.424
9.093	14.994	20.604	12.138
10.412	16.728	22.746	13.974
11.815	18.462	24.786	15.708
13.236	20.094	26.622	17.442
14.378	21.624	28.56	18.972

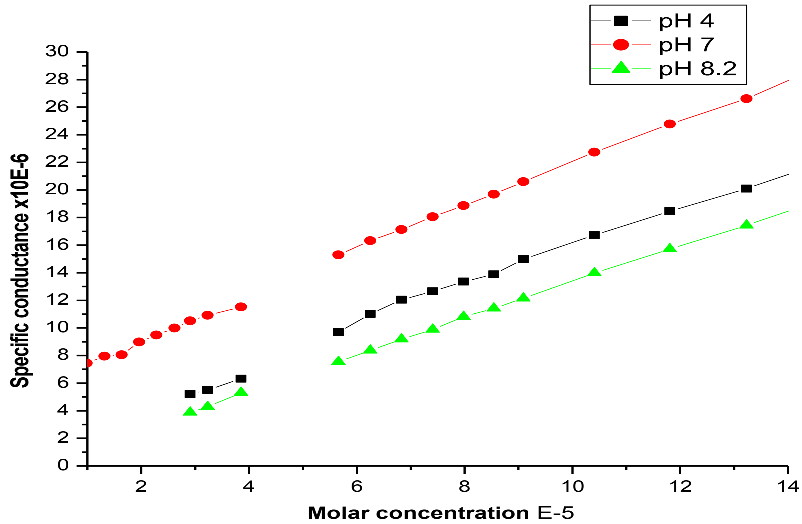


Figure (2-B): Plot of specific conductance against molar concentration of NaCl solution with albumin.

Table (2-C): variation of specific of conductivity (L) of $CaCl_2$ solutions and molar concentration with albumin at three different pH values (pH 4,7 and 8.2) at pH 37 ^{0}C.

Concentration M/Lx10^5	pH 4	pH 7	pH 8.2
	Specific conductance S.cm^{-1}.x 10^6 (L)		
0.332	0.816	21.216	1.023
0.662	1.734	22.443	1.632
0.990	2.448	23.465	2.346
1.320	3.57	24.786	3.366
1.640	4.386	25.806	4.182
1.960	5.1	26.826	4.998
2.280	5.814	27.744	5.916
2.621	6.528	28.356	6.834
2.914	7.14	29.682	7.548
3.235	7.854	30.498	8.364
3.852	9.792	32.13	9.588
4.468	11.22	33.762	11.22
5.064	12.648	35.292	12.75
5.663	13.974	36.727	14.178
6.259	15.606	38.148	15.402
6.832	16.932	39.474	16.728
7.410	18.258	40.902	18.054
7.983	19.992	42.024	19.176
8.544	21.114	43.35	21.012
9.093	22.644	45.288	22.236
10.412	26.214	48.144	25.806
11.815	29.58	52.024	28.866
13.236	32.946	60.282	31.824
14.378	35.598	65.076	34.884

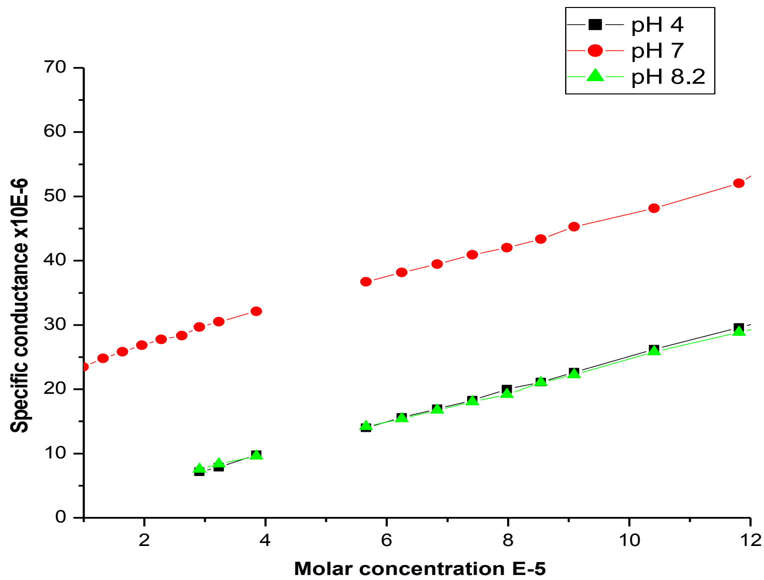


Figure (2-C): Plot of specific conductance against molar concentration of $CaCl_2$ solution with albumin.

Table (2-D): variation of specific of conductivity (L) of $MgCl_2$ solutions and molar concentration with albumin at three different pH values (pH 4,7 and 8.2) at pH 37 ^{0}C.

Concentration M/Lx10^5	pH 4	pH 7	pH 8.2
	Specific conductance S.cm^{-1}.x 10^6 (L)		
0.332	0.816	11.016	1.122
0.662	1.632	12.546	1.734
0.990	2.55	13.158	2.652
1.320	3.366	14.484	3.264
1.640	4.182	15.328	4.182
1.960	5.1	16.218	4.794
2.280	5.916	17.544	5.814
2.621	6.732	18.363	6.631
2.914	7.446	19.278	7.446
3.235	8.364	20.094	8.162
3.852	9.996	21.624	9.588
4.468	11.424	23.256	11.228
5.064	12.954	24.888	12.648
5.663	14.382	26.524	13.974
6.259	15.708	28.051	15.708
6.832	17.238	29.58	17.034
7.410	18.564	31.112	18.462
7.983	19.788	32.436	19.89
8.544	21.828	33.762	21.216
9.093	22.95	35.496	22.542
10.412	24.174	37.842	25.908
11.815	25.5	40.392	29.172
13.236	26.928	43.146	31.824
14.378	28.152	45.696	35.088

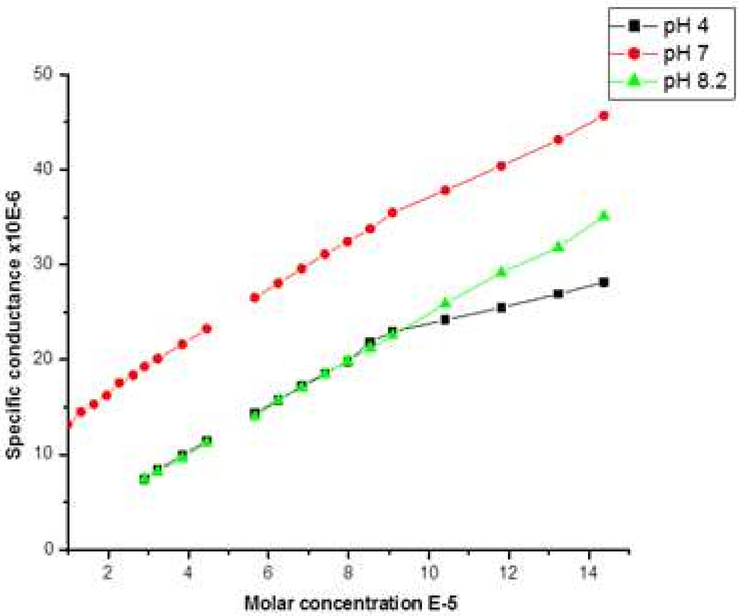


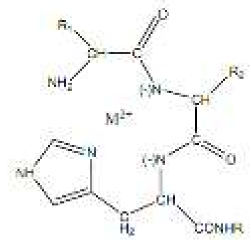
Figure (2-D): Plot of specific conductance against molar concentration of $MgCl_2$ solution with albumin

In the tables above, the values of specific conductance of monovalent salt (KCl, NaCl) which interact with BSA were low than that of divalent salt ($MgCl_2$, $CaCl_2$) ,this because of the tendency of the divalent salt to a positive influence in getting single crystal or crystal-growing rate, which means more interaction rate than monovalent salts[17]. Ca and Mg were bound to a maximum of about 8 ions per albumin molecules. This maximum corresponds to only a fraction on the net charge. The results are in agreement with those of other workers[18].

The usefulness of conductivity measurements in the study of an interaction with proteins provide to be of value for simple will-defined system and has the advantage that all the difficulties in counter in the use of membranes and potential are avoided. Moreover, it may be used when only small amounts of protein are available.

Spectral and titrimetric studies have showed that the binding of copper (II) ions with bovine serum albumin is on a unique and well-defined binding site at its N−terminus.

The binding site is composed of the first three amino acids Asp−Thr−His− (D−T−H−) from the amino terminal end of BSA molecule.



M = Ca, Mg

Figure 3: The square planar coordination of the metal ions (Ca^{+2} and Mg^{2+}) interact with BSA

By using the equation of conductivity[19]:

$1/\sum = 1/\sum_0 + X\sum / K_\alpha \sum_o^2$ ------ 1

The value of K_a and $\sum_o$(equivalent conductivity when diluting to infinity) can be calculated from equation 1, $\sum_o$ represent equivalent conductance in infinite dilution, k_a represent the equilibrium constant .

The value of $\sum$(equivalent conductance $S.cm^2.eq^{-1}$), $X\sum$ and $1/\sum$, all results as shown in table (3-7) for albumin only at different pH

Table 3: The value of Λ , CΛ and1/Λ for albumin at different pH

pH 4			PH 7			pH 8		
Λo	CΛ	1/Λ	Λo	CΛ	1/Λ	Λo	CΛ	1/Λ
417.085	166	0.002398	94.8241206	37.74	0.01054584	17.81717	39.8	0.056126
210.945	167.28	0.004741	48.8776797	38.76	0.02045924	35.06448	79.4	0.028519
140.25	168.3	0.00713	34.85	41.82	0.0286944	52.55255	119	0.019029
108.152	170.34	0.009246	27.847619	43.86	0.03590971	69.64777	157	0.014358
87.3839	171.36	0.011444	24.4467109	47.94	0.0409053	87.34403	196	0.011449
73.5409	172.38	0.013598	21.7576792	51	0.04596078	104.7542	234	0.009546
63.6563	173.4	0.015709	19.4713656	53.04	0.05135747	121.7656	272	0.008213
56.2463	174.42	0.017779	17.7620123	55.08	0.05629993	140.056	310	0.00714
50.1928	174.42	0.019923	16.4374101	57.12	0.06083683	157.4982	347	0.006349
45.6162	175.44	0.021922	15.3822153	59.16	0.06501014	175.5586	385	0.005696
38.5283	176.46	0.025955	15.1441048	69.36	0.0660323	208.8463	458	0.004788
33.46785	177.48	0.029879	14.4257967	76.5	0.06932026	241.6781	530	0.004138
29.6758	178.5	0.033697	13.2269327	79.56	0.07560332	274.5098	602	0.003643
26.88207	180.54	0.0372	12.1500893	81.6	0.08230392	306.4295	672	0.003263
24.5119	181.56	0.040796	11.2920211	83.64	0.08855811	336.329	741	0.002973
22.5741	182.58	0.044298	10.5934718	85.68	0.09439776	408.7965	909	0.002446
20.9613	183.6	0.047707	10.2477452	89.76	0.09758244	46.4168	107	0.021544
19.5945	184.62	0.051035	9.74315432	91.8	0.10263617	52.88958	123	0.018907
18.5510	185.64	0.053905	8.84233339	97.92	0.11309232	58.56888	138	0.017074
17.4269	186.66	0.057382	8.17619048	103.02	0.12230635	64.10256	153	0.0156

Table 4: The value of Λ , CΛ and1/Λ for albumin with KCl at different pH

pH 4			PH 7			pH 8		
Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$
184.3373	61.2	0.005425	276.506	91.8	0.003617	153.6145	51	0.00651
169.4864	112.2	0.0059	169.4864	112.2	0.0059	123.2628	81.6	0.008113
154.5455	153	0.006471	154.5455	153	0.006471	113.3333	112.2	0.008824
139.0909	183.6	0.00719	146.8182	193.8	0.006811	108.1818	142.8	0.009244
130.6098	214.2	0.007656	143.0488	234.6	0.006991	111.9512	183.6	0.008932
119.6939	234.6	0.008355	140.5102	275.4	0.007117	109.2857	214.2	0.00915
120.7895	275.4	0.008279	134.2105	306	0.007451	107.3684	244.8	0.009314
116.7939	306	0.008562	155.7252	408	0.006422	105.1145	275.4	0.009513
112.1649	326.4	0.008915	154.2268	448.8	0.006484	101.6495	295.8	0.009838
110.5263	357	0.009048	157.8947	510	0.006333	104.2105	336.6	0.009596
111.2727	428.4	0.008987	151.013	581.4	0.006622	100.6753	387.6	0.009933
107.4888	479.4	0.009303	148.6547	663	0.006727	100.6278	448.8	0.009938
104.8221	530.4	0.00954	145.1383	734.4	0.00689	100.7905	510	0.009922
99.11661	561	0.010089	138.7633	785.4	0.007207	100.9187	571.2	0.009909
104.448	652.8	0.009574	135.456	846.6	0.007382	99.552	622.2	0.010045
106.0322	724.2	0.009431	135.9004	928.2	0.007358	100.0586	683.4	0.009994
104.6154	775.2	0.009559	132.1457	979.2	0.007567	99.10931	734.4	0.01009
102.2556	816	0.009779	131.6541	1050.6	0.007596	99.69925	795.6	0.01003
100.3279	856.8	0.009967	151.6862	1295.4	0.006593	100.3279	856.8	0.009967

Table 5: The value of Λ , CΛ and1/Λ for albumin with NaCl at different pH

pH 4			PH 7			pH 8		
Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$
184.3373	61.2	0.005425	1935.542	642.6	0.000517	153.6145	51	0.00651
200.3021	132.6	0.004992	1047.734	693.6	0.000954	138.6707	91.8	0.007211
216.3636	214.2	0.004622	752.1212	744.6	0.00133	133.9394	132.6	0.007466
208.6364	275.4	0.004793	602.7273	795.6	0.001659	131.3636	173.4	0.007612
199.0244	326.4	0.005025	491.3415	805.8	0.002035	136.8293	224.4	0.007308
202.9592	397.8	0.004927	457.9592	897.6	0.002184	135.3061	265.2	0.007391
192.3684	438.6	0.005198	416.0526	948.6	0.002404	134.2105	306	0.007451
182.9771	479.4	0.005465	381.5267	999.6	0.002621	132.3664	346.8	0.007555
178.7629	520.2	0.005594	361.0309	1050.6	0.00277	133.1959	387.6	0.007508
170.5263	550.8	0.005864	337.8947	1091.4	0.00296	132.6316	428.4	0.00754
164.2597	632.4	0.006088	299.3766	1152.6	0.00334	137.7662	530.4	0.007259
176.0987	785.4	0.005679	285.8744	1275	0.003498	134.9327	601.8	0.007411
165.2964	836.4	0.00605	286.2451	1448.4	0.003494	135.0593	683.4	0.007404
171.2014	969	0.005841	270.318	1530	0.003699	133.3569	754.8	0.007499
176.256	1101.6	0.005674	261.12	1632	0.00383	133.824	836.4	0.007473
176.2225	1203.6	0.005675	250.8931	1713.6	0.003986	134.407	918	0.00744
170.6883	1264.8	0.005859	243.6437	1805.4	0.004104	133.5223	989.4	0.007489
167.4436	1336.2	0.005972	236.4662	1887	0.004229	135.4887	1081.2	0.007381
162.4356	1387.2	0.006156	230.5152	1968.6	0.004338	133.7705	1142.4	0.007475

Table 6: The value of Λ , CΛ and1/Λ for albumin with $CaCl_2$ at different pH

pH 4			PH 7			pH 8		
Λo ($s^{-1}. cm^2 eq^{-1}$)	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$
245.7831	81.6	0.004069	6390.361	2121.6	0.000156	307.2289	102	0.003255
261.9335	173.4	0.003818	3389.728	2244	0.000295	246.5257	163.2	0.004056
247.2727	244.8	0.004044	2369.697	2346	0.000422	236.9697	234.6	0.00422
270.4545	357	0.003697	1877.727	2478.6	0.000533	255	336.6	0.003922
267.439	438.6	0.003739	1573.537	2580.6	0.000636	255	418.2	0.003922
260.2041	510	0.003843	1368.673	2682.6	0.000731	255	499.8	0.003922
255	581.4	0.003922	1216.842	2774.4	0.000822	259.4737	591.6	0.003854
249.1603	652.8	0.004013	1082.29	2835.6	0.000924	260.8397	683.4	0.003834
245.3608	714	0.004076	1020	2968.2	0.00098	259.3814	754.8	0.003855
243.1579	785.4	0.004113	944.2105	3049.8	0.001059	258.9474	836.4	0.003862
254.3377	979.2	0.003932	834.5455	3213	0.001198	249.039	958.8	0.004015
251.5695	1122	0.003975	756.9955	3376.2	0.001321	251.5695	1122	0.003975
249.9605	1264.8	0.004001	697.4704	3529.2	0.001434	251.9763	1275	0.003969
246.8905	1397.4	0.00405	648.7633	3672	0.001541	250.4947	1417.8	0.003992
249.696	1560.6	0.004005	610.368	3814.8	0.001638	246.432	1540.2	0.004058
247.9063	1693.2	0.004034	577.9502	3947.4	0.00173	244.9195	1672.8	0.004083
246.3968	1825.8	0.004058	551.9838	4090.2	0.001812	243.6437	1805.4	0.004104
250.5263	1999.2	0.003992	526.6165	4202.4	0.001899	240.3008	1917.6	0.004161
247.2365	2111.4	0.004045	507.6112	4335	0.00197	246.0422	2101.2	0.004064
249.1089	2264.4	0.004014	498.2178	4528.8	0.002007	244.6205	2223.6	0.004088

Table 7: The value of Λ , CΛ and1/Λfor albumin with $MgCl_2$ at different pH

pH 4			PH 7			pH 8		
Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$	Λo	CΛ	$1/\Lambda_o$
245.7831	81.6	0.004069	3318.072	1101.6	0.000301	337.9518	112.2	0.002959
246.5257	163.2	0.004056	1895.166	1254.6	0.000528	261.9335	173.4	0.003818
257.5758	255	0.003882	1329.091	1315.8	0.000752	267.8788	265.2	0.003733
255	336.6	0.003922	1097.273	1448.4	0.000911	247.2727	326.4	0.004044
255	418.2	0.003922	932.9268	1530	0.001072	255	418.2	0.003922
260.2041	510	0.003843	827.449	1621.8	0.001209	244.5918	479.4	0.004088
259.4737	591.6	0.003854	769.4737	1754.4	0.0013	255	581.4	0.003922
256.9466	673.2	0.003892	700.7634	1836	0.001427	253.0534	663	0.003952
255.8763	744.6	0.003908	662.4742	1927.8	0.001509	255.8763	744.6	0.003908
258.9474	836.4	0.003862	622.1053	2009.4	0.001607	252.6316	816	0.003958
259.6364	999.6	0.003852	561.6623	2162.4	0.00178	249.039	958.8	0.004015
256.1435	1142.4	0.003904	521.435	2325.6	0.001918	251.5695	1122	0.003975
256.0079	1295.4	0.003906	491.8577	2488.8	0.002033	249.9605	1264.8	0.004001
254.0989	1438.2	0.003935	468.5512	2652	0.002134	246.8905	1397.4	0.00405
251.328	1570.8	0.003979	448.8	2805	0.002228	251.328	1570.8	0.003979
252.3865	1723.8	0.003962	433.0893	2958	0.002309	249.3997	1703.4	0.00401
250.5263	1856.4	0.003992	419.8381	3111	0.002382	249.1498	1846.2	0.004014
247.9699	1978.8	0.004033	406.4662	3243.6	0.00246	249.2481	1989	0.004012
255.5972	2182.8	0.003912	395.3396	3376.2	0.002529	248.4309	2121.6	0.004025

Λo calculated from the intercept and k value from the slope after arrangement the equation.

Table (8) show the results of k for all at different pH

	K_a at pH 4	K_a at pH 7	K_a at pH 8
Albumin	6500.2	13717.4	15000.6
Albumin with KCl	2000	5000	11428.5
Albumin with NaCl	6000	25000	8571.7
Albumin with $CaCl_2$	2272.7	8000	2000
Albumin with $MgCl_2$	2334.2	4000	2500

The values of k showed differences as a result to change of ionic radius and atomic radius

Table (9) show the value of atomic radius and ionic radius.

Ionic radius pm		Atomic radius pm	
Na	0.95	Na	1.90
K	1.32	K	2.35
Ca	0.99	Ca	1.97
Mg	0.65	Mg	1.60

The values of k_a for combination of albumin with Na and K (NaCl and KCl) will vary due to a difference between the atomic radius for them (0.9 Na, K 1.32). This will lead to that value of k_a for albumin with NaCl more than albumin with KCl.

Which is shown previously the best results which can be obtained at pH 7(figure 4-8) , It has been observed that the behavior of the albumin is ideal at that pH, so all comparisons carried out at pH 7.

For the same reason mentioned above the value of k_a for $CaCl_2$ will be higher than of k_a related to combination of albumin with $MgCl_2$.

Also value of k_a for albumin with NaCl more than that of $MgCl_2$ with albumin , this difference is related to ionic radius of Na more than Mg this will lead to increase the association of protein with Mg to form a large combined molecules which has the value of k_a less than NaCl with albumin.

on the other side the value of k_a of KCl with albumin less than $CaCl_2$ with albumin as shown in table .

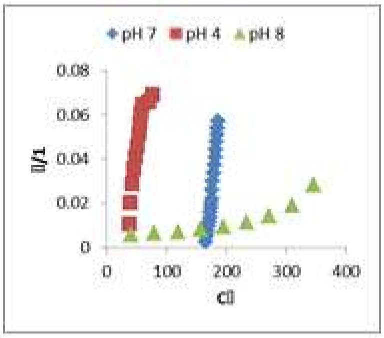


Fig.4: behavior of albumin at different pH

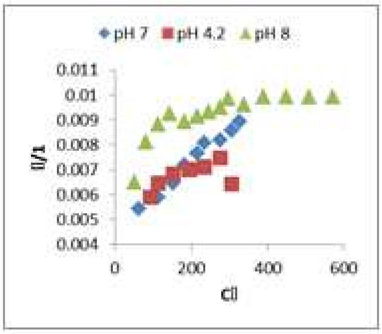


Fig.5: behavior of albumin with KCl at different pH

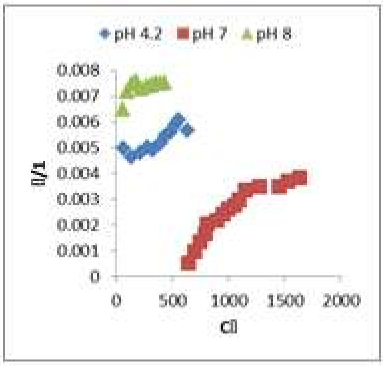


Fig.6: behavior of albumin with NaCl at different pH

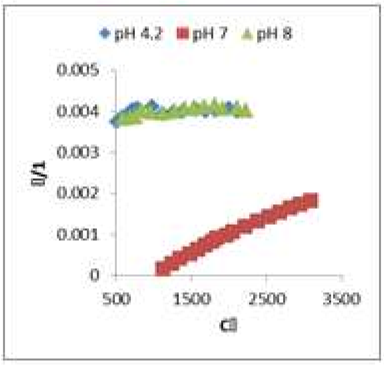


Fig.7: behavior of albumin with $CaCl_2$ at different pH

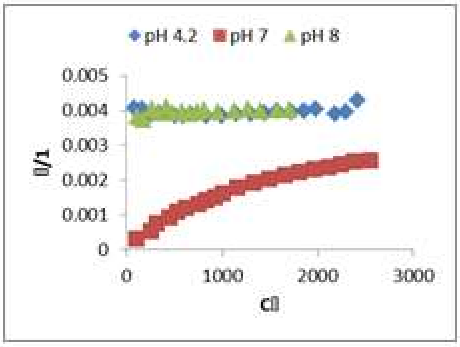


Fig.8: behavior of albumin with $MgCl_2$ at different pH

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دراسة التوصيلية الكهربائية للالبومين في المحلول المائي وتفاعله مع بعض الايونات الفلزية القاعدية

عمر عادل شريف

قسم الكيمياء ، كلية العلوم ، جامعة الموصل ، الموصل ، العراق

الملخص

في هذا البحث تم دراسة تداخل الالبومين البقري مع بعض ايونات الفلزات القلوية $Na^{+}, K^{+}, Mg^{+2}, Ca^{+2}$ ، لاعطاء تأثير التركيب الجزيئي للفلزات المذكورة على المعقد المتكون من جزيئات البروتين–الفلز .

ولتوضيح هذا التداخل بين البروتين–الفلز تم دراسة تركيب المعقد المتكون في محلول منظم مائي وفي ثلاثة قيم لـ pH هي (4,7,8.2) وعند درجة 37 مئوية باستخدام قياس التوصيلية، ولقد تم اختيار قيمة ال pH=7 لأنها قريبة من الرقم الهيدروجيني لمصل الدم حيث اعطت تقريبا خطا مستقيما عند رسم العلاقة بين التوصيل النوعي والتركيز للألبومين للقيم المختلفة لـ pH .

بالإضافة الى ذلك تم قياس توصيلية الالبومين مع كل من محاليل كلوريدات الفلزات القلوية ($NaCl, KCl, MgCl_2, CaCl_2$)، ولقد تم تفسير العلاقة بين تغيير التوصيلية ضد تراكيز المحاليل بدلالة الامتصاص للكاتيونات على سطح الألبومين