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Spectroscopic determination of Potassium Salts with Egg Yolk

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ABSTRACT

Understanding the fundamental interactions between egg yolk and potassium salts is essential in the area of implantable medical devices. Fluorescence methods offer sensitivity required to study the interaction of egg yolk with the potassium salts. The complex formation was studied with the help of the UV absorption also. Further, it was conformed by X-ray diffraction and Scanning electron microscope (SEM) analysis. The differences in fluorescence lifetimes may indicate the structural changes induced in egg yolk by potassium salts.

Key Words: Egg yolk, Potassium salts, Fluorescence study.

INTRODUCTION

Implanted materials in the human body are exposed to fluids that contain various protein types, which immediately start getting absorbed on their surfaces [1,2]. Current thinking suggest that conformational changes of these absorbed protein molecules can indirectly cause adverse reaction studies such as, inflammation and thrombosis after implantation of the foreign material / medical device [3]. A number of fundamental processes of the interaction of proteins on the surfaces implanted medicines are still unknown, e.g. structural details of proteins during the absorption process [4,5].

Potassium chloride usually mixed with regular salt (sodium chloride) to improve the taste to do away with its weak, bitter, unsalted flavor, when it is used as a salt substitute for food. Medically it is used in the treatment of hypokalemia and associated conditions, for digitalis poisoning, and as an electrolyte replenisher.

Potassium iodide (KI) is a drug that provides iodine. Iodine is used in medicine to treat many different conditions, especially of the thyroid gland. Potassium iodide is commonly given to treat hyper thyroidsm and help prepare the thyroid gland for thyroid surgery. Potassium iodide has also been used to treat certain skin conditions. Once used to suppress coughs and clear mucus from the chest, it is now thought to be ineffective. Potassium iodide should generally only be used under the prescription or advice of a health care professional with prescriptive authority. Use of some potassium Iodide products are intended to protect the thyroid gland against radiation injury (e.g: thyroshield R non-prescription oral solution); they are used only to protect the thyroid gland from exposure to radioactive iodine, which may occur in the event of a nuclear plant accident after or an attack involving nuclear weapons. To be effective, such oral solutions need to be taken as soon as possible in the event of the spread of radioactivity, preferably within a few hours. Potassium iodide cannot be a protection against all types of radiation exposure or injury. At this point of time, only certain products are FDA-approved for this purpose.

KI is used as a nutritional supplement in animal feeds, and is a component of disinfectants. Potassium iodide is also added to hair chemicals, and sometimes to table salt in small quantities to make it “iodized”. KI is also used as a fluorescence quenching agent in biomedical research because of its characteristic of collisional quenching by iodide ion.

MATERIALS AND METHODS

2.1. Materials

Egg yolk was obtained from Sigma Aldrich Company, Bangalore. All the other material, were of analytical reagent grade; double distilled water was used throughout.

2.2 Apparatus

2.2.1 Fluorescence measurements Steady-state

Fluorescence measurements were performed on a spectrofluorimeter, JASCO Model FP~550 equipped with a 150W Xenon lamp; it has a slit width of 10nm and is available at the Centralized Instrumentation and Services Laboratory (CISL), Annamalai University, Annamalainagar.

The time-resolved fluorescence spectra were recorded using HORIBA JOBIN YNON-SPEX F_{13}-111 Spectrofluorimeter available at Pondicherry University.

2.2.2 UV Measurements

The absorption spectra were recorded using a JASCO-UVIDEC-650, Spectrophotometer available at the Instrumentation laboratory of the Department of Chemistry, Annamalai University, Annamalainagar.

2.2.3 XRD Measurements

The X-ray diffraction patterns were recorded on a PAN Analytical X’Pert Philip X-ray diffractometer, available at CIF, Pondicherry University, Pondicherry.

2.2.4 SEM Analysis

The scanning electron microscope JSM - 5610 used for the surface analysis is available at CISL, Annamalai University.

RESULTS AND DISCUSSION

3.1 Steady-state and time –resolved fluorescence studies

Fluorescence measurements can give information of the binding of small molecular substances to protein. A variety of molecular interactions, viz., ground-state Complex formation, excited-state complex formation, and charge transfer energy transfer, etc. can decreases the fluorescence intensity of a compound. Such decrease in intensity is called quenching.

Fluorescence spectra of egg yolk in the absence and presence of different concentrations of KCl and KI were recorded in the range of 200-500 nm on excitation at 284 nm and 287 nm respectively.

There was no change in the emission maximum and shape of the peaks by different concentrations of the both the quenchers KCl and KI. These results indicate the prescence of interaction between potassium salts and egg yolk.The interaction of potassium salts and egg yolk was further confirmed by UV-VIS absorption, XRD and SEM Analysis.

Fluorescence quenching data were analyzed by the stern-volmer equation

$$\frac{Io}{I} = 1 + K_{SV}\,[Q]$$

where I_o and I are steady-state fluorescence intensities in the absence and presence respectively of quenchers. K_{SV} is the stern-volmer quenching constant and [Q] is the concentration of the quenchers KCl and KI. The values of K_{SV} and the regression coefficient (r) are shown in Table 1. The linearity of I_o / I versus [Q] plots (Fig.1) for both the quenchers reveal whether quenching is static or dynamic.

The values of the quenching rate constant kq (Table 1) from the eqation

$$kq = \frac{K_{SV}}{\tau_o}$$

where τ_o is life time of egg yolk without quencher confirm the formation of the complex. Stoke's shift, Molar extinction coefficient, energy, ionization potential and electron affinity values are given in Table 1.

3.2. UV – VIS absorption studies

A study of the UV-VIS absorption spectral data, will evidence the complex formation of potassium salts and egg yolk. The UV-visible intensity of egg yolk decreases with the addition of both quenchers. Blue shift of the maximum peak position was noticed and it is due to the formation of the complex.

3.3. XRD analysis

A mixture of egg yolk and potassium salts was subjected to x-ray diffraction analysis. They were compared with the XRD pattern of egg yolk alone. The JCPDS values were compared with values obtained and the hkl values are given in table 2.

Table 1: The results for the steady state, time – resolved fluorescence spectra, energy, ionization potential and electron affinity of egg yolk

Quencher	K_{SV} By Calculation	K_{SV} By Graph	r By Calculation	r By Graph	Life time (τ) x 10^{-4}	Relative amplitude (A)	χ^2	Kq x 10^5	Stoke's Shift	Log ε	E	I_D	EA
Without Q	-	-	-	-	4.3596	44.26	1.2967	-	-	-	-	-	-
KCl	100.2	99.8	0.99	0.96	6.4508	0.00	1.2570	1.2570	7493	7.4256	4.6618	11.077	-0.567
KI	109	110	0.98	0.98	6.5123	-2.69	1.2831	1.2831	12069	7.3729	4.6705	11.088	-0.576

Table 2: XRD spectral data and hkl values of egg yolk

Egg Yolk + KCl				Egg Yolk + KI			
Pos.[°2Th.]	**h**	**k**	**l**	**Pos. °2Th.]**	**h**	**k**	**l**
5.1673	1	1	1	5.2578	1	1	1
5.8888	2	0	0	5.8187	2	0	0
17.6051	2	2	0	21.9189	2	2	0
23.9961	3	1	1	25.3142	3	1	1
24.1051	2	2	2	36.0433	2	2	2
29.9444	4	0	0	42.4988	4	0	0
30.8917	3	3	1	44.4781	3	3	1
34.2055	4	2	0	51.8120	4	2	0
35.3893	4	2	2	56.8660	4	2	2
38.5925	5	1	1	58.4653	5	1	1
40.7903	4	4	0	64.6717	4	4	0
45.9120	-	-	-	69.1156	5	3	1
46.6565	-	-	-				
47.8527	-	-	-				
55.2662	-	-	-				
59.0402	-	-	-				
64.1374	-	-	-				
69.8867	-	-	-				
71.7128	-	-	-				

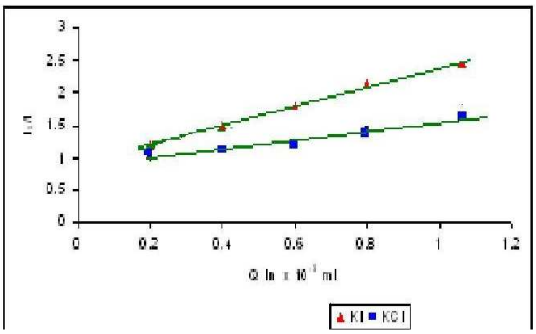

Fig. 1. Stern-volmer plot for egg yolk in water with different quenchers

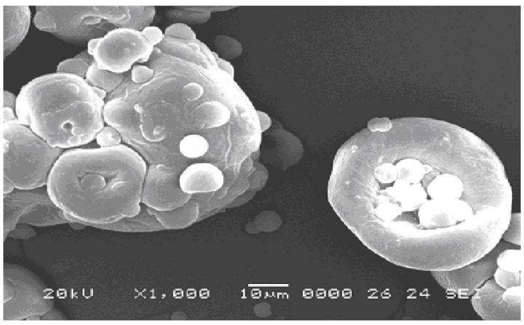

Fig. 2. SEM micrograph of Egg yolk (X 1000)

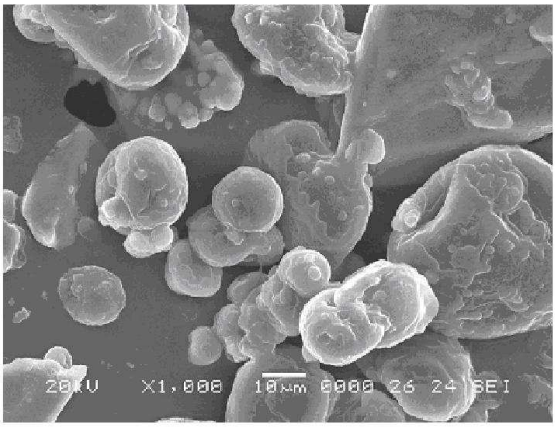

Fig. 3. SEM micrograph of Egg yolk with KCl (X 1000)

Fig. 4. SEM micrograph of Egg yolk with KI (X 1000)

3.4. SEM Analysis

The fractured samples of egg yolk with and without KCl and KI were subjected to SEM micrograph analysis to identify the surface morphology. The surface micrographs of egg yolk, egg yolk + KCl and egg yolk + KI are shown in Figs. 2, 3 & 4 respectively. Changes in SEM photographs confirmed the formation of complexes of egg yolk and potassium salts.

CONCLUSION

That Complexes form of egg yolk and potassium salts were successfully determined by steady state and time-resolved fluorescence techniques and it has been confirmed by UV-VIS absorption studies, X-ray diffraction studies and SEM analysis.

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