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Fluorescence Lifetime Study of Curcumin with β-Cyclodextrin

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Abstract: Curcumin, with its recent success as an anti-tumor agent, has been attracting research from wide ranging fields of physics, chemistry, biology and medicine. The chemical structure of curcumin has two o-methoxy phenols attached symmetrically through α, β- unsaturated β-diketone linker, which also induces keto-enol tautomerism. Due to this, curcumin exhibits many interesting photophysical and photochemical properties. The absorption maximum of curcumin is ~ 408-430nm in most of the organic solvents, while the emission maximum is very sensitive to the surrounding solvent medium (460-560nm) and Stoke's shift varied from 2000 to 6000cm^{-1}. The decay curves were recorded from curcumin without and with different concentrations of β-cyclodextrin.

Keywords: Curcumin, β-cyclodextrin, lifetime measurements, SEM.

INTRODUCTION

Curcumin, a major polyphenolic pigment of the root turmeric or curcuma longa belonging to the zingerberacea family, is widely cultivated in several tropical parts of Asia [1]. Turmeric commonly finds use as a spice in Indian cooking, a cosmetic agent for skin care and a traditional Indian and Chinese medicine. For thousands of years, people had used turmeric for the treatment of common cold, fever, skin diseases, stomachache, liver diseases, open wounds, chronic inflammations, etc. The anticancer

potential of the spice gained prominence after epidemiological studies showed 10-50% lower incidence in certain types of cancer among those who consumed turmeric regularly [2].

MATERIALS AND METHODS

Fluorescence lifetime measurements: Fluorescence lifetime measurements were carried out in a Hariba – Jobin Yvon [spex-sf 13-11] spectrofluorimeter. The interchangeable nano LED (280 nm) was used as excitation source. The fluorescence decay of GA was measured with a monochromator – Photo multiplier setup. The data points were fitted by mono exponential decay functions. The data analysis was carried out by the software.

SEM analysis: Joel Sem Model, Jsm – 5610 Lv Scanning Electron Microscope was used to record the SEM photographs of Curcumin with different concentrations of β-Cyclodextrin.

Reagents: Curcumin and β-cyclodextrin were purchased from Sigma-Aldrich Company (Bangalore). The double distilled water was used to prepare the solutions.

RESULTS AND DISCUSSION

Fluorescence Lifetime measurements: Initial literature reports on the fluorescence of curcumin in turmeric were mainly aimed at assaying curcumin in turmeric, food items or for detecting trace elements like boron in soils [3]. Tonnesen and Karlsen [4] first reported systematic fluorescence studies of curcumin. Much later, detailed investigations on the excited state properties of curcumin in different organic solvents have been reported [5-10]. Unlike the steady state fluorescence measurements, there are not many reports on the fluorescence lifetimes of curcumin. The competing non-radiative processes shortened the fluorescence lifetimes considerably. The fluorescence decay profiles, obtained from time correlated single photon counting (TCSPC) studies, in most of the organic solvents showed multi-exponential f is and the fluorescence lifetime values as well as their relative amplitudes varied significantly with the nature of the solvent [10, 11]. Figure 1 shows the decay curve of curcumin without and with different concentrations of β cyclodextrin. Table-1 comprises the lifetime data and the calculated average lifetime values. Relative amplitude values have also been given in Table-1.

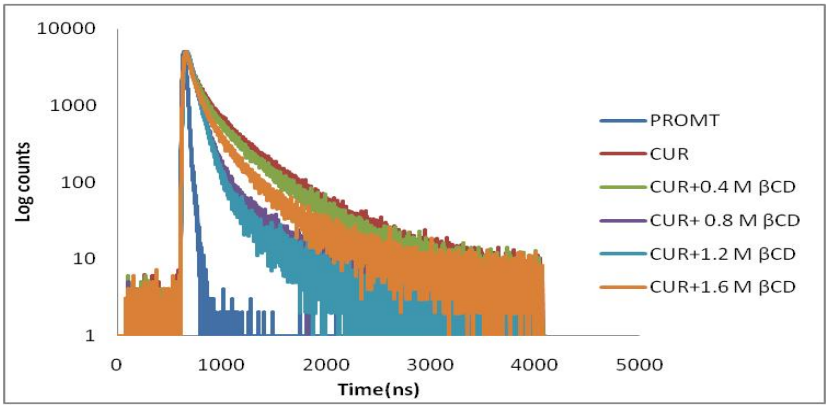

Figure 1: Decay curves of curcumin in different of concentrations of β-Cyclodextrin

Table-1: Fluorescence lifetime and amplitudes of Curcumin without and with different concentration βCD.

Concentration of βCD (M)	Lifetime (ns)		Average life time <τ> 10^{-9} sec	Relative amplitude		χ^2	S.D 10^{-11} sec	
	τ_1	τ_2		B_1	B_2		τ_1	τ_2
0	2.15	9.71	2.84	90.82	9.18	1.04	0.58	10.7
0.4	2.10	9.59	3.22	84.98	15.02	1.15	0.70	7.56
0.8	2.34	9.50	5.73	61.03	38.97	1.54	1.52	4.58
1.2	2.42	10.8	6.40	47.98	52.02	1.40	1.67	3.70
1.6	2.62	11.36	7.59	43.13	56.87	1.38	1.89	3.47

SEM analysis: Scanning electron microscopy was used to study the microscopic aspects of the raw material (β cyclodextrin, curcumin) and the product obtained by co-precipitation / evaporation [12-15]. The difference in crystallization state of the raw material and the product seen under electron microscope indicates the formation of the inclusion complexes [16-18], even if there is a clear difference in crystallization state of the raw material and the product obtained by co-precipitation. This method is inadequate to affirm inclusion complex formation [19-21]. SEM image of the complex of (curcumin + β cyclodextrin) are shown in Figure 2.

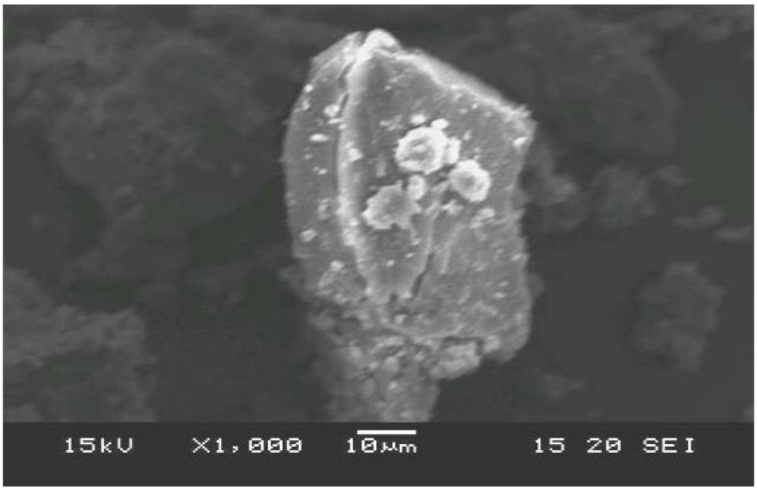

Figure 2: SEM image of Curcumin- β Cyclodextrin complex.

CONCLUSION

The characterization of curcumin- β cyclodextrin inclusion complexes were carried out by fluorescence lifetime measurements successfully. The inclusion complexes have been confirmed by scanning electron microscope (SEM) analysis.

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