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Spectroscopic Studies of Triton X-114 and Quercetin/ Rutin Solutions

Abstract

The behaviour of aqueous solutions of the nonionic surfactant, Triton X-114 (TX114) with quercetin and rutin was investigated using the UV-vis and fluorescence spectroscopic techniques. The interactions between flavonoid and the surfactant were examined in a wide range of surfactant concentration and at temperature 293K. From the obtained spectra the micropolarity of the pyrene environment in these solutions as well as the flavonoid-surfactant binding constant were determined.

Keywords: Aqueous solutions; Nonionic surfactant; Triton X-114; Fluorescence; Spectroscopic techniques; Surfactant; Flavonoid; Micropolarity; Solubilization; Liposomes; Nanocapsules

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Introduction

Flavonoids belong to a large group of natural polyphenol compounds and have a broad spectrum of pharmacological activities. Many natural flavonoids are characterized by extremely low solubility in aqueous media and body fluids. To improve the solubility of drugs, various methods were developed and are used in pharmaceutics: solubilization, preparation of solid disperse systems with soluble and insoluble matrices, inclusion in liposomes, nanocapsules, and others.[1] Previously it was found that the solubility of the flavonoids quercetin and rutin increases substantially in the aqueous solutions of β-cyclodextrin, biopolymers, polyvinyl pyrrolidone and human serum albumin due to the formation of supramolecular complexes and that the spectral and protolytic properties of flavonoids in these organized media also change. Another type of organized media are self organized supramolecular micellar systems based on surfactants in which the solubility of hydrophobic substances can increase substantially due to solubilization.[2] Thus the purpose of the presented studies was to determine the interactions between the nonionic surfactant, Triton X-114 (TX114) micelles ($C=8x10^{-4}$ -$8x10^{-3}$M) and quercetin as well as between the surfactant and quercetin glycoside, rutin (quercetin and rutin concentration C1 =$2x10^{-5}$, $4x10^{-5}$ and $6x10^{-5}$M) by spectroscopic methods at 293K.

Results and Discussion

The intensity ratio I_1/I_3 of the first (372nm) and the third (384nm) vibronic peaks of the pyrene fluorescence spectrum is related to the micropolarity of the microenvironment in which pyrene is solubilized. Therefore its variation shows a change in the hydrophobic environment with respect to composition. As follows from Figure 1 as the total concentration of TX114 increases, the I_1/I_3 values display an abrupt drop to the relative stabilization at C higher than 10-3M only in the case of quercetin solutions. This abrupt sigmoid decrease in I_1/I_3 clearly indicates that the aggregation of TX114 was formed, and pyrene preferentially resides in a more hydrophobic microenvironment of the aggregates. In the case of rutin solutions the I_1/I_3 values decrease at C higher than 10^{-3}M. At smaller concentration of surfactant the higher the rutin concentration the lower the values of the I_1/I_3 ratio. This means that the interactions of quercetin and rutin with the micelles of the studied nonionic surfactant are quite different and as a result, also the location of fluorescence probe in the mixture changes.

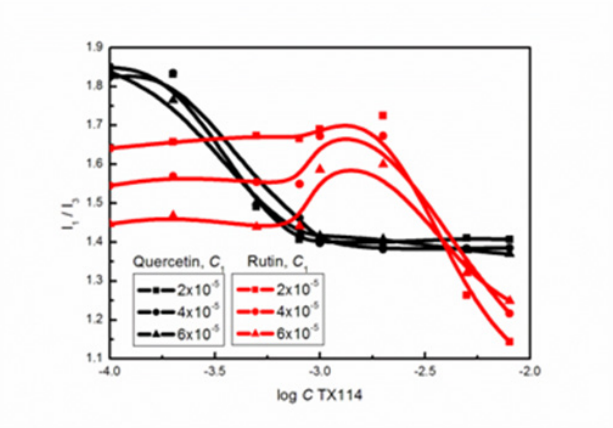

Figure 1 A plot of the I_1/I_3 values for aqueous solutions of quercetin and rutin at the concentration in the bulk phase equal to $2x10^{-5}$, $4x10^{-5}$ and $6x10^{-5}$ M vs. log *C* of TX114 at 293K.

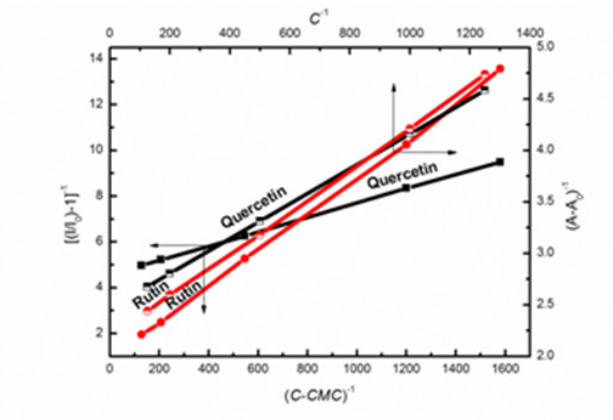

Figure 2 A plot of the values of $(I/I0^{-1})$-1 vs. $(C\text{-}CMC)^{-1}$ as well as $(A\text{-}A_0)^{-1}$ vs. C^{-1} for quercetin and rutin at $C_1=2x10^{-5}$M.

This fact is confirmed by the values of the binding constant, K, of the quercetin/rutin-surfactant system for C_1 =$2x10^{-5}$M calculated on the basis of the Uv-vis spectra and the relation between ($A\text{-}A_0$

$)^{-1}$ and C^{-1} (Figure 2).[3] These values of K are equal to $1.46x10^3$ and $0.11x10^3$ for quercetin and rutin, respectively, and are very close to those obtained on the basis of the fluorescence emission spectra of quercetin and rutin and the relation between $(I/I_0 -1)^{-1}$ vs. $(C-CMC)^{-1}$.[4] where CMC is the critical micelle concentration of TX114.[5]

Conclusion

The interactions between quercetin and TX114 micelles are stronger than those between this surfactant and rutin molecules which was confirmed by the values of the calculated binding constant which in turn, can be applicable in the search for new ways of quercetin transportation.

Acknowledgments

None.

Conflicts of Interset

None.

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