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Interaction of some cardiovascular drugs with bovine serum albumin at physiological conditions using glassy carbon electrode: A new approach

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ABSTRACT

In this report, for the first time, the non-modified glassy carbon electrode was used for detection of cardiovascular drug interaction with bovine serum albumin (BSA). These interactions were tested at physiological conditions (T = 37 °C and pH = 7.4 phosphate buffer solution) in different incubation times (0–4 h) by cyclic voltammetry (CV), differential pulse voltammetry (DPV) and square wave voltammetry (SWV). The applications of DPV for quantitative investigation of some cardiovascular drug interaction with BSA (as a model of serum albumin proteins) were discussed. The herein described approach is expected to promote the exploitation of electrochemically-based methods for the study of drug-serum albumin protein interaction which is necessary in biochemical and biosensing studies. This report may open a new window to application of electrochemical sensors towards interactions of cardiovascular drugs with BSA and human serum albumin (HAS) in the near future.

1. Introduction

One of the most predominant topics which has been extensively studied in the field of pharmaceutical analysis, biomedical science and drug delivery is protein folding and the relation between protein structure, sequences and function with the drug binding mechanisms [1]. So far, substantial methods such as fluorescence [2], spectrometry [3], circular dichroism (CD) [4], calorimetry [5], molecular modeling [6], nuclear magnetic resonance (NMR) [7] and or Raman spectroscopy [8] have been used to investigate the interaction between drugs and proteins. Due to high sensitivity of fluorescence and easy procedure, among all of the above mentioned methods, it has become the inseparable part of the drug-protein interactions studies [9]. Particularly, the existence of tryptophan in the bovine serum albumin (BSA) structure which is considered as the source of the fluorescence activity of BSA [10]. Electrochemistry is another approach which has drawn a lot of interests and attentions due to the low cost instruments, very easy operation, non-destructive procedures and appropriate sensitivity [11–21]. However, it suffers from some drawbacks like its limitation in using specific proteins without any redox active properties. Nevertheless, BSA is listed as a redox active protein due to the presence of tyrosine or tryptophan residues [22,23]. Since the tyrosine or tryptophan is usually held in the interior parts of BSA molecule, so protein folding becomes more and more important. This feature has been used in the evaluating of drug binding studies.

BSA is a major protein in the blood serum and plays an inevitable role in the regulation of osmotic pressures and delivery of so many endogenous compounds [24]. It takes about 60% of a body's blood proteins and almost being used because of high stability, low cost and the undeniable structural resemblance to human serum albumin (HSA) in human blood [8]. So, rudimentary or primitive investigations and examinations are done using BSA. BSA also binds to a wide variety of drugs which makes it very essential factor in studying drug delivery or drug-plasma interactions [7,24,25]. It gets more interested by considering that the drugs in the blood, are circulated in two probable forms, *i.e.*, bounded. Only the free drugs interact with the receptor to produce therapeutic effects, and since the unbound drug concentrations is proportional and depends on the plasma unbound drug, so study and evaluation of the BSA:drugs interactions are found to be a primary and important factor in understanding of the pharmacological and pharmacokinetics effects of drugs [25–27].

Similarly, drugs have to be some major characteristics in order to interact with serum albumin. Degree of protein binding which depends on drug solubility, elimination half-life and volume of bio-distribution and interaction ability with other drugs [28]. Meanwhile, cardiovascular drugs become one of the most frequently used drugs prescribed for in general, cardiovascular disorders like arrhythmias, or hypertension.

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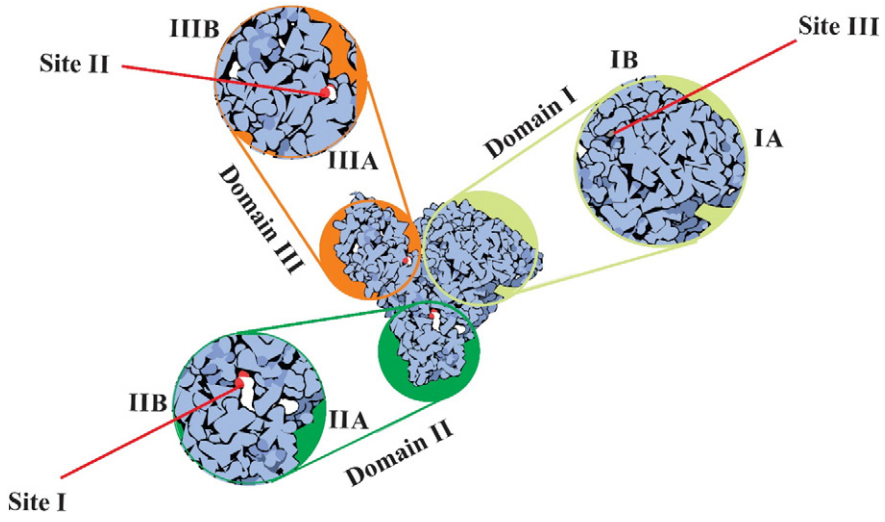

Scheme 1. BSA and its domains and subdomains schematically.

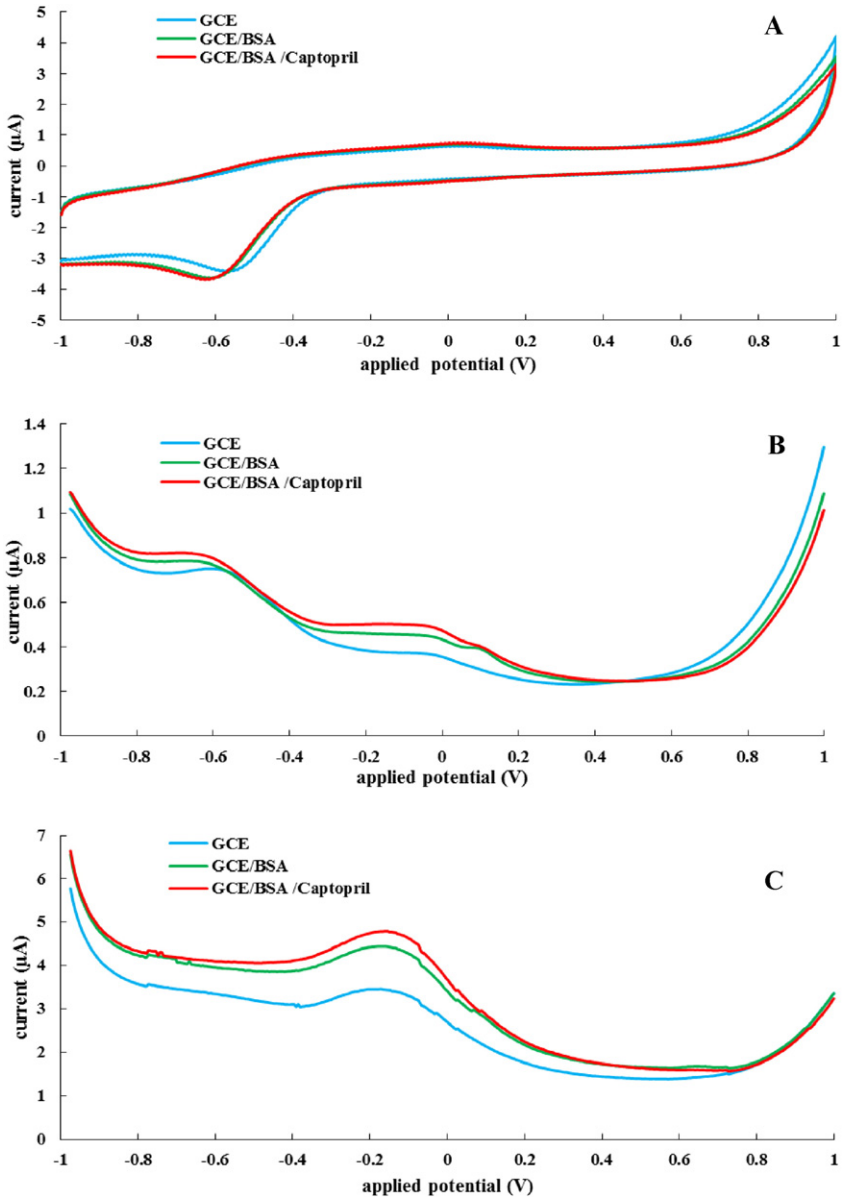

Fig. 1. CVs (A), SWVs (B) and DPVs (C) of GCE in 0.02 mM BSA + PBS (0.1 M, pH = 7.4) in the absence and presence of Captopril.