International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 14, Issue 5 [May. 2025] PP: 34-37

Interaction of Antimalarial Drug (Artemisinin) With Bovine Serum Albumin Using Uv-Visible Spectroscopic Technique

I. B. Okoro, L. G. Galadima and L. M. Jodi
[1]*Department of Basic/Integrated Science,*
Shehu Shagari University of Education, Sokoto State, Nigeria.

ABSTRACT
Understanding the interaction of drugs can give an insight on optimal dosage and administration strategies to minimize adverse side effects. The binding interaction between bovine serum albumin (BSA) and artemisinin was explored in this study. The mechanism involved in the interaction was studied using UV-Visible spectroscopy. Absorption spectrum of bovine serum albumin in the presence and absence of artemisinin were recorded. The maximum peak of Bovine Serum Albumin (BSA's) absorption was 202nm at room temperature and at pH 7.40 and that of artemisinin was 199nm. The maximum absorption of BSA increased to 204nm after addition of equivalent amount of artemisinin which indicates that there is an interaction and some complex formation between artemisinin and BSA.
Keywords: *UV-Vis spectroscopy, Bovine Serum Albumin, Artemisinin, Protein, Binding.*

Date of Submission: 23-04-2025 Date of acceptance: 03-05-2025

I. INTRODUCTION

A major proportion of serum albumin is comprised of extra cellular plasma and binds to various ligands such as hormones, fatty acids, drugs, hence playing a significant role in the pharmacokinetics behavior of these ligands (Wani *et al.,* 2018; Yadav *et al.,* 2020). The therapeutic efficiency of the ligands depends on their ability to bind to BSA and the mechanism involved in the binding (Wani *et al.,* 2017). An understanding of the features of drug interactions with albumin can therefore provide insight into drug therapy and design (Wang *et al.,* 2008). Much attention has been focused on binding of drugs to albumin. Bovine serum albumin (BSA) is usually employed as model protein because of its low cost, availability and because of its structural similarities with human serum albumin (HSA) (Zhang *et al.,* 2016).Spectral methods are employed in establishing the understanding of these mechanisms because they can reveal the binding of drugs with albumin at low concentrations (Wang *et al.,* 2008).

Artemisinin remains at the vanguard of antimalarial chemotherapy due its safety, high potency and its outstanding capability of rapid devaluation of the parasite biomass (Yadav *et al.,* 2020; Chaturvedi *et al.,* 2010).The effect of artemisinin and its derivatives have been greatly extended, and these compounds are widely used as antitumor (Wang *et al.,* 2017), antifibrosis (Cao *et al*., 2016), immunosuppressor (Li *et al*., 2013), antivirus (Sharma *et al*., 2014), anti-atherosclerosis (Jiang *et al.*, 2020), anti obesity (Lu *et al.,* 2016) and anti diabetes (Ho *et al.,* 2014) treatments.

Liu *et al.,* (2013) reported the comparative studies on the interactions of dihydroartemisinin and artemisinin with bovine serum albumin using spectroscopic methods. The interactions of dihydroartemisinin (DHA) and artemisinin (ART) with bovine serum albumin (BSA) have been investigated using fluorescence; UV/Vis absorption and Fourier Transform Infrared (FTIR) spectra under simulated physiological conditions. The binding characteristics of DHA/ART and BSA were determined by fluorescence emission and resonance light scattering (RLS) spectra. The quenching mechanism between BSA and DHA/ART is static. The binding constants and binding sites of DHA/ART–BSA systems were calculated at different temperatures (293, 298, 304 and 310 K). According to Förster's non-radiative energy transfer theory, the binding distance of BSA to DHA/ART was calculated to be 1.54/1.65nm. The effect of DHA/ART on the secondary structure of BSA was analyzed using UV/vis absorption, FTIR, synchronous fluorescence and 3D fluorescence spectra. In addition, the effects of common ions on the binding constants of BSA–DHA and BSA–ART systems were also discussed by various researchers (Wang *et al.,* 2017, Jiang *et al.,* 2020).

It is therefore significantly important to study the mode of interaction of the drug with BSA in order to comprehend the transportation and distribution of drugs in the body on a molecular level and this will provide valuable information for designing more effective drugs.

The aim of this study was to elucidate the binding interaction of antimalarial drug artemisinin with bovine serum albumin and to obtain important information about binding interaction mode UV-visible spectroscopic method. This study is expected to provide important insight into further elucidating the storage and transport process of artemisinin in the body.

II. MATERIALS AND METHODS

Chemicals and Stock Solutions

Bovine serum albumin (BSA fraction V) and Artemisinin (analytical grade), were obtained from Sigma Chemical Company, St. Louis, USA. 75% Ethanol, Tris-HCl buffer (0.1M, pH 7.40), Tris–Base (purity of no less than 99.5%), NaCl all of analytical grade, were obtained from the Department of Biochemistry, Usmanu Danfodiyo University, Sokoto, Nigeria. The UV-visible Spectrophotometer, of the Cary-100 model (Shimadzu, Japan), was obtained and used at the same University.

A concentration of 1.0×10^{-3}molL^{-1} of Artemisinin was prepared in ethanol by dissolving 0.03g in 100ml of ethanol, while a 1.5×10^{-5}molL^{-1} of BSA was prepared by dissolving 12.0g in 100 ml of 0.1M Tris-HCl.

Ultraviolet-visible Absorption Measurements

Absorbance spectrum of BSA was obtained by first warming the UV-Visible spectrophotometer and then zeroed with 2 ml of Tris-HCl buffer in a quartz cuvette. 4.0 ml BSA into a cuvette and placed inside the spectrophotometer and ran thrice at temperature of 37^0C and pH 7.4. The absorbance was obtained in the range of 200-400nm and the spectrum obtained. Similarly, absorbance spectrum of ART was obtained by zeroing the machine with ethanol which served as the buffer. Exactly 4.0 ml of ART was pipetted into a cuvette and ran thrice at 37^0C and pH 7.4 and the spectrum was obtained. The absorbance of Bovine Serum Albumin combined with Artemisinin was also obtained by firstly zeroing the machine to standard using Artemisinin solution. 2.0 ml of ART and 2.0 ml of BSA (1:1) were measured out into a cuvette and ran thrice between the wavelength of 200-400nm at a temperature of 37^0C. The absorbance spectrum was also obtained and comparison was made with the other spectra (Hu *et al.*,2004)

III. RESULTS AND DISCUSSION

Results

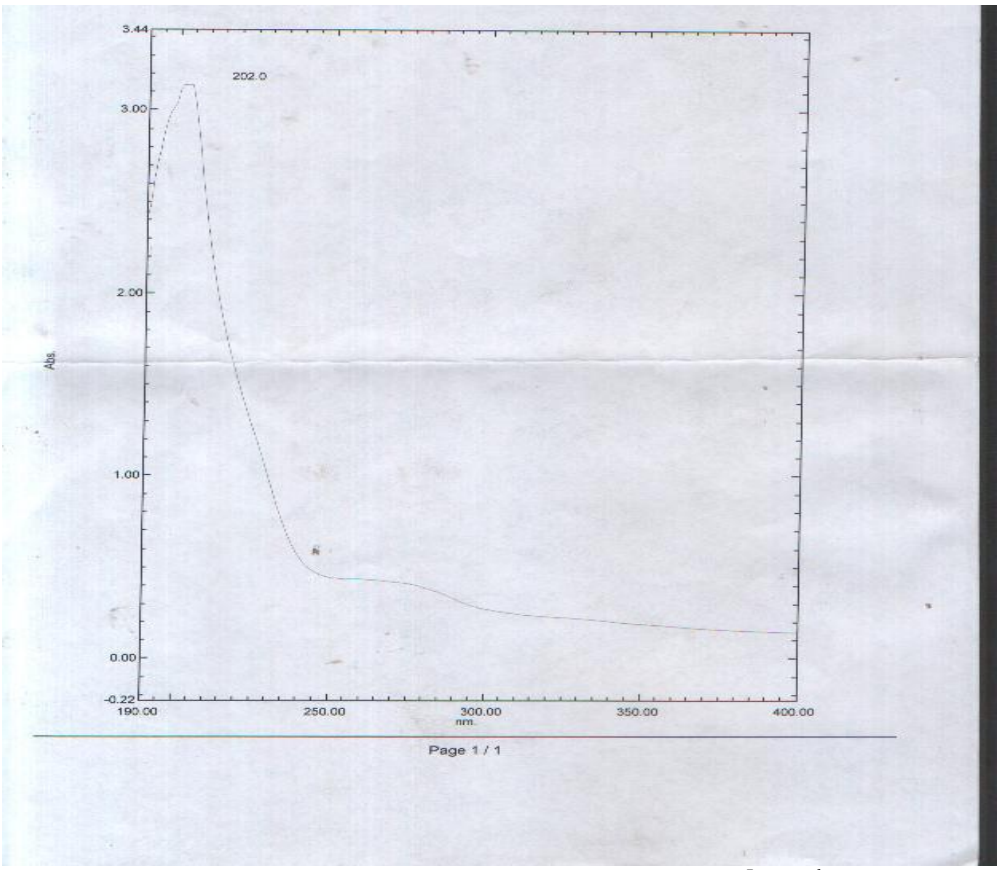

Figure1: Absorption Spectrum of Bovine Serum Albumin (1.5×10^{-5}molL^{-l}) at 37^{o}C, pH 7.4

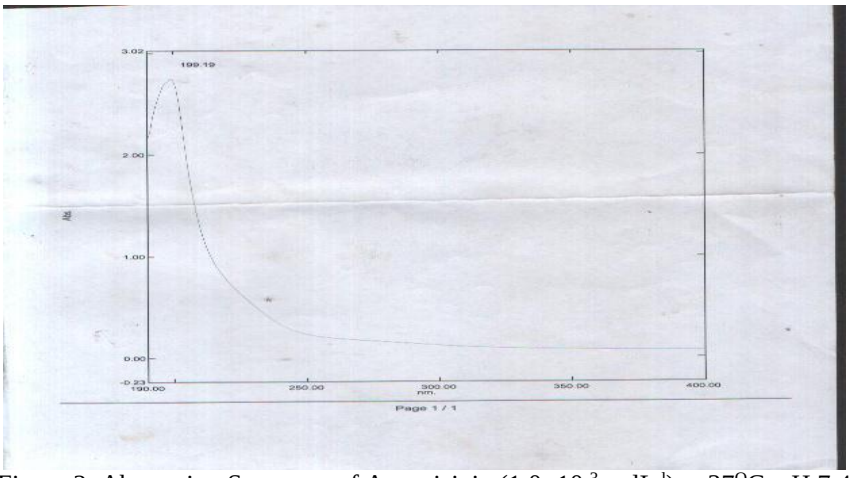

Figure 2: Absorption Spectrum of Artemisinin (1.0×10^{-3}molL^{-1}) at 37^{O}C, pH 7.4

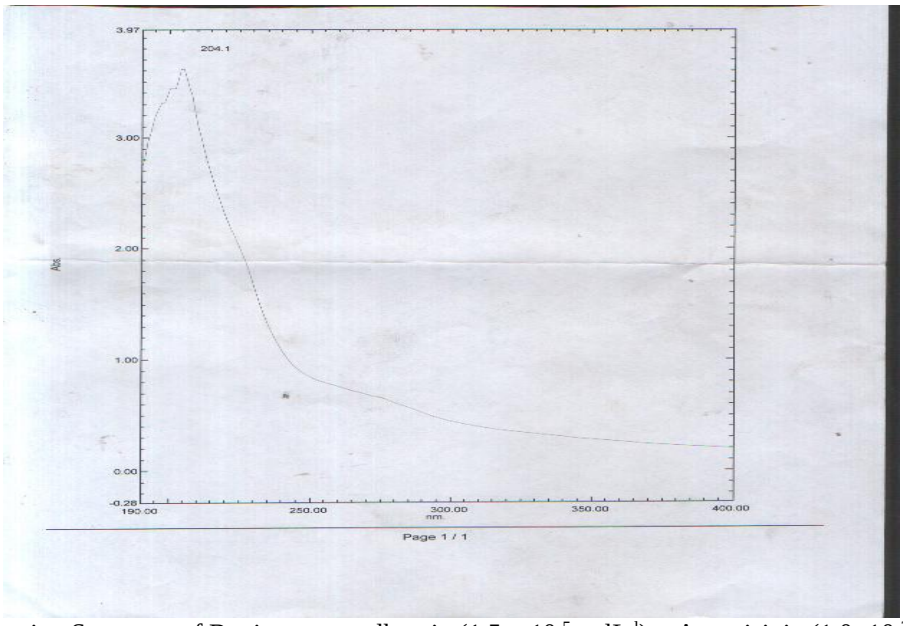

Figure 3: Absorption Spectrum of Bovine serum albumin (1.5×10^{-5}molL^{-1}) + Artemisinin (1.0×10^{-3}moL^{-1})(1:1) at 37^{o}C and pH of 7.4

IV. Discussion

UV−vis absorption spectroscopy is a widely employed technique for the analysis of drug-protein interactions.UV absorption measurement is a very simple and effective method for inquiring into the change in the conformation of protein resulted from binding ligand to protein and understanding the complex formation. The UV spectra of the BSA solutions in the presence and absence of ART were shown in Fig 1-3. The results revealed that there were two absorption bands for all BSA solutions. The strong absorption band at near 209 nm reflects the framework conformation of BSA and the weak absorption bands at near 280 nm belongs to the $\pi\rightarrow\pi^*$ transition of the aromatic amino acids such as Trp, Tyr and Phe (Yadav *et al.,* 2020; Shi *et al.,* 2015). The maximum absorption of BSA increased obviously to 204nm after addition of equivalent amount of artemisinin which indicates that there is an interaction and some complex formation between artemisinin and BSA as described by Hu *et al.,* (2004). This result is also in line with the observation made by Liu*et al.,* (2014),when they studiedcomparative interactions ofdihydroartemisinin and artemisinin with bovine serum albumin using spectroscopic methods.

In the present study, it is evident that the UV absorption intensity of BSA increased upon addition of artemisinin. The maximum peak position (Soret band) of BSA-Artemisinin complex shifted slightly towards longer wavelength region (red shift) from 202nm to 204nm, that is a hyperchromic effect is observed. The change in λ_{max} indicated the change in polarity around the tryptophan residue and the change in peptide strand of BSA molecule and hence the change in hydrophobicity as described by Dezhampanah *et al.,* (2018). This

indicates that the binding between BSA and artemisinin leads to change in protein conformation (Francis *et al.*, 2020).

V. CONCLUSION

This study presents an analysis of interaction of potent antimalarial artemisinin to BSA, using UV-visible spectroscopic technique. The hyperchromicity obtained in UV−vis spectra displayed the interaction of artemisinin with BSA.

REFERENCES

[1]. Cao, J., Wang, W., Li, Y., Xia J., Peng, Y., Zhang, Y., Zia, A. (2016): Artesunate Attunuates Unilateral Urethral Obstruction-induced Renal Fibrosis by Regulating the Expressions of Bone Morphogenetic Protein-7 and Uterine Sensitiation-Associated Gene-1 in Rat. International Urology and Nephrology **48**(4), 619-629.

[2]. Chaturvedi, D., Goswami, A., Saikia, P.P., Banu, N. C., Rao., P. G. (2010): Artemisinin and its Derivatives: A Novel Class of Antimalaria and Anticancer Agent, *Chem SocRev***39**, 435-454.

[3]. Dezhampanah, H., Esmaili, M., Dafrazi, A. A., and Mehdizadeh, P. (2018): Investigation of new indole derivatives of bovine serum albumin using spectroscopic and molecular docking techniques, *Biotechnic & Histochemistry*, DOI: 10.1080/10520295.2018.1537510

[4]. Francis, J. A., Shalauddin, M. D., Farrah, N., Ridzwan, W., Mohamad, S. B., Basirun, W. J., and Tayyab, S. (2020): Interaction mechanism of an antimalarial drug, sulfadoxine with human serum albumin, *Spectroscopy Letters*, DOI: 10.1080/00387010.2020.1764588

[5]. Ho, W. E., Peh, H. Y., Chan, T. K., and Wong, W. S. (2014). Artemisinins: Pharmacological Actions Beyond Antimalarial. 142 **(1)**: 126-139.

[6]. Hu, Y. J., Liu, Y., Shen, X. L., Fang, X. Y., and Qu, S. S. (2005): Study of the interaction between monoammonium glycyrrhizinate and bovine serum albumin, *J Pharm Biomed Anal*. **36**: 915-919.

[7]. Jiang, Y., Du, H., Liu, X., Fu, X., and Cao, Q. (2020): Artemisinin Alleviate Atherosclerotic Lesion by Reducing Macrophage Inflammation via Regulation of AMPK/NF-B/NLRP3 Inflammasomes pathway. *Journal of Drug Targeting*. **28** (1), 70-79.

[8]. Li, X., Li, T. T., Zhang, X. H., Hou, L. F., Yang, X. Q., Zhu, F. H., Tang, W., and Zuo, J. P. (2013): Artemisinin Analogue SM934 Ameliorates Murine Experimental Autoimmune Encephalomyelitis through Enhancing the Expansion and Functions of Regulatory T cell. *PLoS ONE* 8**(8)**, e74108.

[9]. Lu, P., Zhang, F. C., Qian, S.W., Li, X., Cui, Z. M., Dang, Y. J., and Tang, Q. Q. (2016): Artemisinin Derivatives Prevent Obesity by Inducing Browning of WAT and Enhancing BAT Function. *Cell Research* 26(10), 1169-1172.

[10]. Sharma, B. N., Marschall, M, and Rinaldo, C. H. (2014): Antiviral Effect of Artesunate on JC Polyomavirus Replication in COS-7 Cells. *Antimicrobial Agent and Chemotheraphy* 58 **(11)**, 6724-6734.

[11]. Shi, J. H., Chen, J., Wang, J. Zhu, Y. Y. (2015): Binding interaction of sorafenib with Bovine Serum Albumin, Spectroscopic Methodologies and Molecular Docking, *Spectrochimica Acta Part A: Molecular andBiomolecular Spectroscopy* Doi.org/10.1016/j.saa.2015.04.034

[12]. Wang, J., Zhang, J., Shi, Y., Xu, C., Wong, Y. K. (2017): Mechanistic Investigation of the Specific Anticancer Property of Artemisinin and its Combination with Aminolevulinic Acid for Enhanced Anticolorectal Cancer Activity. *ACS Central Science*, **3(7)**, 743-750.

[13]. Wang, N., Ye, Li., Zhao, B. Q., Yu, J. X. (2008): "Interaction of Efenidifine with Bovine Serum Albumin", Brazilian Journal of Medical and Biological Research, **41(7)**, 589-595.

[14]. Wani, T. A., Alrabiah, H., Ahmed, H., Abukalam, M. B., and Zargar, S. (2017): Study of Binding Interaction of Rivoraxaban with Bovine Serum Albumin Using Multi-Spectroscopic and Molecular Docking Approach, *Chemistry Central Journal*. 11, 134

[15]. Wani, T. A., Ansari, M. N., Almajid, A. R., Al-Qahani, B.M, and Zarga, S. (2018): "Spectroscopic and Molecular Docking Studies of Binding Interaction between Bovine Serum Albumin and Voflumilast, *Drug Design, Development and Therapy*, **12**, 2627-2634

[16]. Yadav, P., Sharma, B., Sharma, C., Singh, P., and. Awasthi.,S.K. (2020): Interaction between the Antimalarial Drug Dispiro-Tetraoxanes and Human Serum Albumin: A Combined Study with Spectroscopic Methods and Computational Studies. Doi.org/10.1021/acsomega.9b04095.

[17]. Zhang, Y. F., Zhou, K. L., Lou, Y. Y., Pan, D., and Shi, J. H. (2016): Investigation of the Binding Interaction between Estazolam and Bovine Serum Albumin: Multi-Spectroscopic Methods and Molecular Docking Technique, *J Biomol Struct Dyn,* 35**(16)**:132. https://doi.org/10.1080/07391102.2016. 126488