



# An Overview of Enalapril by UV Spectrophotometer and HPLC



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## Abstract

Present review article determine the analytical methods for the quantitative determinations of Enalapril (ACE Inhibitor) by one of the spectroscopic technique (UV spectrophotometry) and separation technique such as High-Performance Liquid chromatography (HPLC). Pharmaceuticals dosage formulations and human serum is needed for effective analytical procedure and quality control of Enalapril in clinical and pharmaceutical practices. An extensive survey of the literature published in various pharmaceutical and analytical chemistry related journals has been compiled in its review. A synopsis of reported spectrophotometer and high-performance liquid chromatographic methods for Enalapril is integrated. This appraisal illustrate that majority of the HPLC methods reviewed are based on the quantitative analysis of drug in API (active Pharmaceutical ingredients) biological fluids and they are appropriate for therapeutic drug monitoring purpose.

**Keywords:** HPLC; UV spectrophotometer; Quality control analysis; Method development; Validation

## Introduction

Angiotensin converting enzyme that cleaves the terminal two peptides from angiotensin I (decapeptide) is blocked by the ACE inhibitors to form the powerful vasoconstrictor angiotensin II (octapeptide) and decreases the BP by reducing peripheral vascular resistance, it neither increases the rate of cardiac output nor contractility. Almost all ACE inhibitors have relatively same antihypertensive ability they efficiently block the angiotensin 1 conversion to angiotensin II and have alike therapeutic indications, contraindications and adverse effect profile.

Enalapril(S)-1-[N-[1-(ethoxycarbonyl)-3-phenylpropyl]-L-alanyl]-L-proline, (Z)-2-butenedioate [1] is the maleate enalapril salt a derivative of 2-amino acid, L-alanine and L-proline. Soluble in Aqueous, MeOH and ethanol preparations. Enalapril maleate comprises of crystalline white to off-white powder which is synthesized chemically; an antihypertensive and a vasodilator in congestive cardiac failure, and for managing hypertension it is used with hydrochlorothiazide [2]. The pro-drug enalapril is biologically activated by hydrolysis of the ethyl ester to active form enalaprilate. Now, enalaprilate after this conversion inhibits angiotensin-converting enzyme (ACE) in mammals. Conversion of angiotensin I is catalyzed by ACE i.e. peptidyl dipeptidase to the vasoconstrictor substance. Angiotensin II works on adrenal cortex and stimulates aldosterone secretion. The primary effects of enalapril in cardiac failure and high blood pressure seems from suppression of the renin-angiotensin-aldosterone system. Reduced

plasma angiotensin II results from inhibition of ACE, which leads to reduced vasopressor activity and reduced aldosterone secretion.

## Methods of Assay

Enalapril maleate was determined in pharmaceutical tablets using first-derivative ultraviolet spectrophotometry [3-5]. Spectrophotometric and paleographic determination of enalapril and lisinopril using 2, 4-dinitrofluorobenzene has been studied [6]. Isothermal microcalorimetry and HPLC were used to determine the stability of enalapril, EM and other different tablet formulations [7]. The reversed phase high-performance liquid chromatography (RP-HPLC) was implied to view the kinetics of Z-(cis)/E-(trans) isomerization of enalapril [8,9]. For indirect method of enalapril in human plasma [10] a Lichrosphere® (125mm×4.0mm i.d.) column at flow rate of 1.0mLmin<sup>-1</sup> was done by high-performance liquid chromatography. The lowest concentration to be quantities was 3.0ngmL<sup>-1</sup> with the acceptable accuracy and precision, the time taken was 6.5 minutes and this method was used for bioequivalent and pharmacokinetics study of enalapril. The influence of temperature (from 383 to 348K) and relative humidity (from 25.0 to 76.4%) on the stability of enalapril maleate in the solid phase was investigated and. changes in the concentration of enalapril maleate were followed by a HPLC method with UV detection [11]. The kinetic and thermodynamic parameters [Ea (kJ mol<sup>-1</sup>) = 168.5±27 for RH=0% and 149.1±48 for RH=76.4%; ΔH‡ (kJ mol<sup>-1</sup>) = 166.1±30 for RH=0% and 146.6±50 for RH=76.4%; ΔS‡ (J (K-1

mol<sup>-1</sup>) = 120.3±169 for RH=0% and 82.1±110 for RH=76.4%) of the decomposition reaction were calculated.

Another HPLC method with UV-detection [12] has been developed for the determination of enalaprilate this method produced linear response over the wide concentration range of 1-200µg/mL. A reversed-phase high-performance liquid chromatographic (RP-HPLC) method was for the simultaneous determination of enalapril and its degradation and felodipine and its degradation product, in the combined enalapril/felodipine (5mg/5mg) formulation [13] using a Spherisorb C8 column with a CH<sub>3</sub>CN-0.001M KH<sub>2</sub>PO<sub>4</sub> (pH2) (35:65, v/v) mobile phase. Carlucci et al. [4] determined enalapril maleate and hydrochlorothiazide in pharmaceutical formulations by HPLC by utilizing the linear relationship between substances concentration and derivative peak amplitude detectable by derivative spectrophotometry.

Several examinations using HPLC for determination of Enalapril in bulk drug substances and their formulations have been reported [14]. Direct Determination of Four ACE-Inhibitors Lisinopril, Enalapril, Captopril and Fosinopril in Pharmaceuticals and Serum by HPLC, Good separation of the analytes was achieved by gradient RP-HPLC with the mobile phase composed as acetonitrile: water (60:40, v/v) adjusted to pH 3.0 by ortho phosphoric acid [15]. The in vitro interaction studies of enalapril with hypoglycemic agents were monitored by LC-UV [16].

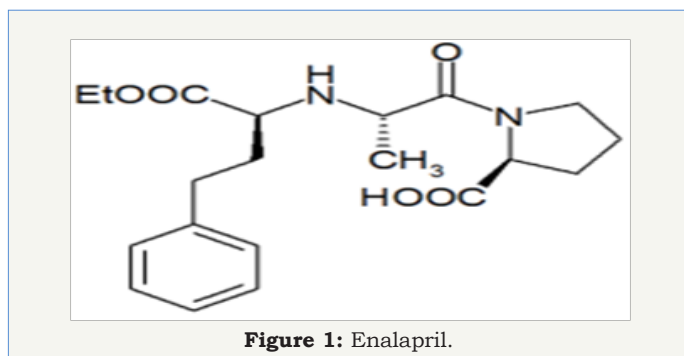


Figure 1: Enalapril.

Another Manifest and Facile Liquid Chromatographic Method for the Simultaneous determination of NSAIDs, Enalapril Maleate in API and Pharmaceutical Formulations is reported and ENP was separated from NSAIDs using a Purospher STAR C18 column (250×4.6mm, 5µm) and a mobile phase consisting of methanol, water (80:20v/v, pH was adjusted by ortho phosphoric acid to 2.8 at a flow rate of 1.8mL min<sup>-1</sup> and at ambient temperature. Effluents from the column were monitored at 225nm. [17] ACE inhibitors alone are not sufficient to decrease high blood pressure hence, they are used in as combination with other particular classes of drug compounds such as calcium channel blocker antihypertensives, diuretics, and etc another method is reported of enalapril with diuretic Hydrochlorothiazide and Furosemide in Active Pharmaceutical Ingredients, Pharmaceutical Dosage Forms and Human Serum [18]. Simultaneous LC determination of, lisinopril, rosuvastatin, captopril, and enalapril in API, pharmaceutical dosage formulations, and human serum [19] other methods of enalapril with hypoglycemics (glibenclamide, metformin, glimepiride) statins

and H<sub>2</sub> receptor antagonist in bulk, formulations and human serum by RP-HPLC [20-22] are reported (Figure 1).

## Conclusion

Patients who are diagnosed with hypertension are prescribed with the large number of medications for appropriate therapy, while, increasing risk of drug interactions and side effects. In this article UV and HPLC methods for the determination of Enalapril in bulk material, pharmaceutical formulations and biological specimens are reviewed alone or in combination with other drugs. Spectrophotometric techniques provided practical and significant economic advantages over other methods; therefore, they are a choice for pharmaceutical analyses. The provision for use and disposal of solvents, expensive equipment, labor-intensive sample preparation procedure and personally competent in chromatographic techniques are generally required in HPLC method. Additionally, almost all of the HPLC methods studied has the potential application to multi-drug pharmacokinetics studies, clinical research of drug combination, and interactions studies.

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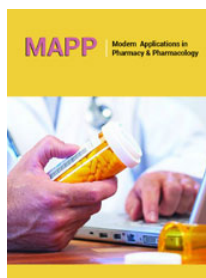
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