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A Review of Current Trends and Advance in Analytical Methods for Determination of Simvastatin Electrochemical by different electrodes

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ABSTRACT

Simvastatin is a hypolipidemic drug used with exercise, diet and weight – loss to control elevated cholesterol or hypercholesterolemia. It is a member of the Statin class of pharmaceuticals. This paper delives voltammetric techniques is an electrochemical technique used in analytical applications and fundamental studies of electrode mechanism. This review summarizes some of the recent development and application of direct different electrodes in electrochemical for drug Simvastatin in their dosage forms and biological samples as reported in the period 1948 till 2017 years.

Keywords: Simvastatin (SMV); advance current method; Electrochemistry

INTRODUCTION

Simvastatin (fig 1), a hypolipidemic drug belonging to the class of pharmaceuticals called Statins is chemically designed as [(1S,3R,7R,8S,8aR)-8-[2[(2R,4R)-4-Hydroxy -6-oxan-2-yl]ethyl]-3,7-dimethyl-1,2,3,7,8,8ahexahydronaphthalen-1-yl]2,2-dimethyl butanoate. It is used for the treatment of hypercholesterolemia [1]. Statins are potent and effective inhibitors of cholesterol biosynthesis that are widely used to treat hypercholesterolemia.

Different analytical methods have been reported for the determination of Simvastatin (table.1) which include derivative spectrophotometry [2-5], RP-HPLC [6-10], HPTLC [11-12], Gas chromatography [13], capillary electrophoresis [14], LC-MS-MS [15-16] and Voltammetric technique [17].

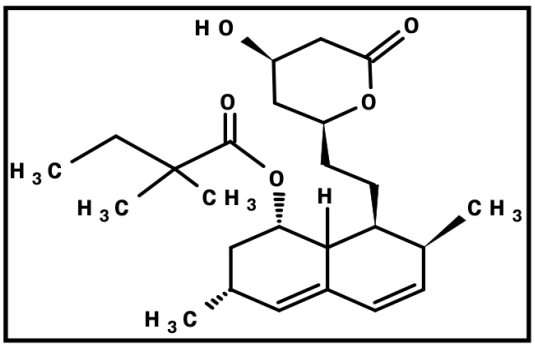

Fig. 1. chemical structure of Simvastatin.

High-performance liquid chromatography with ultra-violet or electrochemical detection methods typically has a higher limit of quantification and is usually time-consuming. The RP-HPLC method is based on using a polar mobile phase, a complete description of the ionization

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profile of simvastatin and its metabolites have been used for the evaluation of retention behavior and solubility.

Ultra high performance liquid chromatography (UHPLC), a new separation technique utilizing sub-2 µm diameter HPLC stationary phases, has brought great attention in the field of separation science. High speed separations with increased sensitivity and resolution allow the analyzing time to be dramatically reduced while excellent separation efficiency and retention factor are maintained. The statin separation by USP 30-NF25 monograph with conventional LC systems requires approximately 10 minutes, while a UHPLC system can accomplish the same separation in less than 2 minutes. MS detection is sensitive without analyte derivatization and provides analyte confirmation. However, the 1-2 s peak widths and relatively high mobile phase flow rates typical of UHPLC methods demand a robust, fast scanning MS detector. In this application note, the recent approach of using a UHPLC/MS method for high throughput separation, quantitation and confirmation of simvastatin in pharmaceutical dosage form will be described [18]

Gas chromatography meets the required of limit of quantification but it needs complex derivatization steps. GC-FID method was also proposed for identification of simvastatin.

To the best of our knowledge, currently there is no HPLC method employing optimization techniques for determination of simvastatin and its metabolites in biological sample. This work is an attempt of establishing an HPLC method which would be simple and sensitive and could be an alternative method to LC/MS/MS. Liquid chromatography-tandem mass spectrometry (LC-MS/MS) is suitable since MS/MS detection is sensitive and enables effective elimination of interferences from endogenous components. Because of the limitations of all previously mentioned instrumental methods [19-23].

However, some of these methods require expensive equipment and are time-consuming. In some cases, the methods entail an extraction and derivatization procedures due to their relatively low sensitivities. Hence, a more rapid and simpler method for identification and determination of simvastatin at trace levels is highly desirable.

Table 1. Results of analysis of simvastatin by different methods

Separation technique	Stationary phase	Mobile phase	Detector	RSD	Applications	Ref
HPLC	Symmetry C18(250×4.6mm ×0.25µm)	ACN: WATER (70:30) PH2.5 1.2ml/min	UV246nm	.27	Pharmaceutiacal Dosage from	24
GC	HP-1 (30m×.25mm ×0.25µm)	ACN: WATER (70:30) PH2.5 2.9ml/min	FID	.28	Pharmaceutiacal Dosage from	25 - 26
LC-MS	Symmetry shield RP 18(250×4.6mm ×5µm)	ACN: WATER (85:15)	UV240 nm ESI- ion trape	-	Impurity profiling	27
UHPLC	Acquity BEH C18(100×2.1mm ×1.7µm)	Gradient elution CAN :ammonium acetate pH6	Q-TOFMS	-	Combine dosage from	28

CAN: acetonitrile , SIM: Simvastatin

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It is known that highly sensitive electrochemical techniques are well established in the analysis of selected drugs. Electrochemistry has always provided analytical techniques characterized by instrumental simplicity, moderate cost and portability [29-33]. Modern electrochemical methods are now sensitive, selective, rapid and easy techniques application to analysis.

Voltammetry is a powerful electrochemical technique that can be applied in both electrokinitic and quantitative determination of redox couples strongly immobilized on the electrode surface [34]

Cyclic voltammetry (CV) is often the first experiment performed in an electrochemical study of pharmaceutical compound. Cyclic voltammetric studies of simvastatin showed one well defined oxidation peak in Britton Robinson buffer.

A pulse technique was in order to increase the sensitivity of the technique and to lower the detection limits for electroactive species. Differential pulse voltammetry (DPV) is very useful for the determination of trace amounts of electroactive compound in pharmaceuticals and biological fluids [35].

Square- wave voltammetry (SWV) is one the four major voltammetry techniques provided by modern computer–controlled electroanalytical instruments. Square wave voltammetric technique is among the most sensitive means, for the direct evaluation of concentration it can be widely used for the trace analysis, especially on pharmaceutical compound [36].

The advantage of SWV is that a response can be found at a high effective scan rate, thus reducing the scan time. [37-38] Table2 Comparison of different methods for measuring the Simvastatin drug in pharmaceutical products.

The concept of chemistry modified electrodes (CME's) is one the exciting developments in the field of electroanalytical chemistry [39].

Glassy carbon electrode (GCE) is modified with electropolymerised film of glycine. This polymer (glycine) modified electrode is used to study the simultaneous electrochemical detection of Simvastatin and showed an excellent electrocatalytic effect on the oxidation of SMV [40-41]. Glassy carbon electrode has been very popular because of it's excellent electrical and mechanical properties, wide potential range, low cost, extreme chemical inertness and relatively reproducible performance [42-44] Pyrolytic carbon (pyrocarbon) electrode was prepared duration of chemical vapor deposition (CV) process flowing of methane and nitrogen gases in atmospheric pressure and 1100◦C temperature through a quartz reactor and deposition on graphic cylinder as a substrate. During this processes, a thin film of pyrocarbon was formed on graphite. The pyrocarbon coated was identified using Raman, X-ray diffraction (XRD) and scanning electron microscopy (SEM) techniques Some recent advances in preparing these electrodes and their use in pharmaceutical analysis are present next. Table 3 summarises electrode characteristics.

Probable reaction mechanism for the oxidation of SMV

The chemical structure of SMV contains a β-hydroxy-lactone (A in figure 2). The physiologically active form of the drug is the β-hydroxy acid (B in figure 2), which is formed by a ring opening reaction of the lactone ring. This undergoes oxidation to form the product C.

Table 2. Comparison of different methods for measuring the simvastatin drug in pharmaceutical products

	CV	**DPV**	**SWV**
Labeled claim (mg)	20	20	20
Amount found* (mg)	19.98	19.92	19.88
RSD%	1.2	1.02	1.12
Bias%	-	0.40	0.60
Recovered*	99.76	99.56	99.08
RSD% of recovery	4.43	1.06	0.91

Table 3. Summarizes electrode characteristics

Electrode type	**Medium SOLUTION**	**LOD/LOQ**	**Applications**	**Scan rate**	**Ref**
Glassy carbon electrode (GCE)	PH 1-6 BR buffer .1M H_2SO_4 10%ethanoL	.1 Mm	Pharmaceutiacal Dosage froms , human serum	١٠٠ mv/s	45
Mercury Electrode	pH 7, .1 $molL^{-1}$ $Na_2B_4O_7$ – KH_2PO_4 buffer	4.50×10^{-9} $molL^{-1}$	Pharmaceutiacal Dosage froms , human serum	١٠ mv/s	46
HMDE	PH 2.5 BR buffer	1×10^{-6} $molL^{-1}$	Pharmaceutiacal Dosage froms	50 mv/s	47
Graphite electrode Hg	0.1 M Na 2B4O7- KH2PO4, pH 7.0, (buffer)		Pharmaceutical dosage formulations	50 mv/s	48
Pyrolitic carbon	pH 7 acetate buffer		pharmaceutical	50 mV/s	49

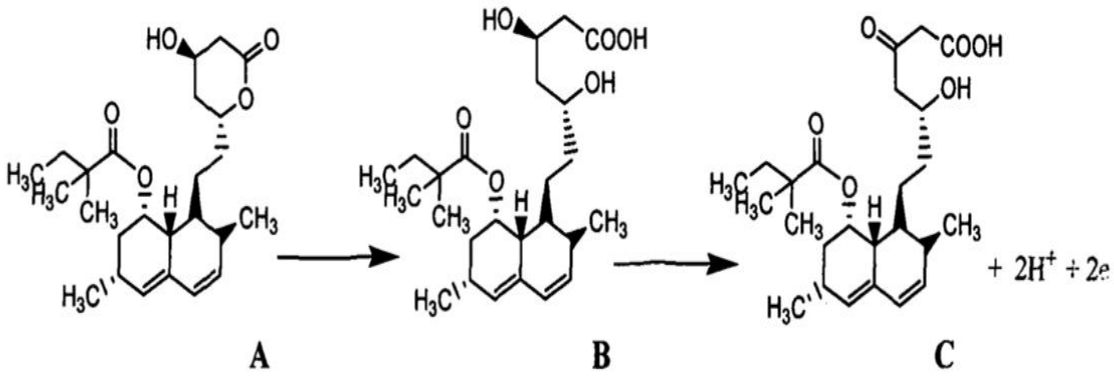

Fig. 2. probable reaction mechanism for the oxidation of SMV.

RESULTS AND DISCUSSION

The present study demonstrates an effective approach for the development difftent electrodes voltammetric for the electrochemical determination of simvastatin. Different electrodes showed electrocatalytic action for the oxidation of simvastatin characterizing by the enhancement of the peak current and the reduction of peak potential. The electrochemical response is adsorption controlled and irreversible in nature. The electrodes showed excellent sensitivity, selectivity and antifouling properties and can separated oxidation peaks towards SMV, which are indistinguishable at the bare electrode pyrolitic carbon very good performance for the determination of SMV present in pharmaceutical tablets. In hence with low cost and ease preparation new electrodes seems to be of good utility for further analysis development.

CONCLUSION

Achieving high sensitivity, selectivity and cost effectiveness has always been the primary goal to design methods .Electroanalytical methods are simples, sensitive, fast.

Cost – effective, reliable, and efficient compared to other analytical methods. As we have summarized in this review, we can by improving the electrodes and electrods standardization and make analyzes with low cost and high precision and sensivity and accuracy in the future.

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