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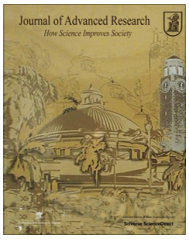

ORIGINAL ARTICLE

Dynamic potential and surface morphology study of sertraline membrane sensors

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ABSTRACT

New rapid, sensitive and simple electrometric method was developed to determine sertraline hydrochloride (Ser-Cl) in its pure raw material and pharmaceutical formulations. Membrane sensors based on heteropolyacids as ion associating material were prepared. Silicomolybdic acid (SMA), silicotungstic acid (STA) and phosphomolybdic acid (PMA) were used. The slope and limit of detection are 50.00, 60.00 and 53.24 mV/decade and 2.51, 5.62 and 4.85 μmol L^{-1} for Ser-ST, Ser-PM and Ser-SM membrane sensors, respectively. Linear range is 0.01–10.00 for the three sensors. These new sensors were used for the potentiometric titration of Ser-Cl using sodium tetraphenylborate as titrant. The surface morphologies of the prepared membranes with and without the modifier (ion-associate) were studied using scanning and atomic force microscopes.

Introduction

Several HPLC, electrometric and spectrophotometric methods were reported in a review for the determination of Ser^+ and its metabolites in pharmaceutical formulations [1]. Potentiometric chemo sensor for the selective determination of sertraline based on the molecular imprinting technique and electrometric methods using voltammetric technique were developed [2–4]. Several spectroscopic methods have been reported for the determination of Ser^+ and their metabolites in its pharmaceutical formulations [5–7].

As ion-selective sensors (ISSs) have found wide use for the direct determination of ionic species in complex samples [8–19], it is a point of view in this study. In the early days, their selectivity was often the limiting factor in determining low levels of analyte ions. Potentiometric detectors based on ISSs offer advantages such as selectivity, sensitivity, good precision, simplicity, wide linear concentration range and long lifetime.

This study involves construction and analytical applications of membrane sensors for the determination of sertraline hydrochloride. Due to the low solubility of the formed Ser-SM, Ser-PM and Ser-ST ion-associates, their suitability as active ingredients in membrane sensors was examined. The sensitivity and selectivity of a potentiometric sensor is related to the composition of membrane, nature of the plasticizer, plasticizer/PVC ratio and type of additive [20–22].

(1S-cis)-4-(3,4-dichlorophenyl)-l,2,3,4-tetrahydro-N-methyl-l-naphthalenamine hydrochloride is known as sertraline hydrochloride, a widely used antidepressant belonging to the selective serotonin reuptake inhibitor class. It is a white

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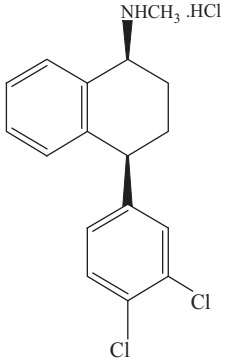

Scheme 1 Structural formula of sertraline HCl.

crystalline powder slightly soluble in water and isopropyl alcohol and sparingly soluble in ethanol. Its efficacy has been demonstrated in the treatment of major depression, obsessive compulsive and panic disorders, eating, premenstrual dysphoric and post-traumatic stress disorders [1] (see Scheme 1).

Characterization of a surface of different solids is often of vital importance in a number of fields, including heterogeneous catalysis, semiconductor thin-film technology, corrosion and adhesion mechanisms, activity of metal surfaces, embrittlement properties and studies of the behavior and functions of biological membranes [23–28]. The surface of a solid is considered as a part of the solid that differs in composition from the average composition of its bulk [29]. This study deals with construction of membrane sensors and their surface characterization using scanning and atomic force microscope.

Methodology

Reagents and materials

All reagents used were chemically pure grade. Doubly distilled water was used throughout all experiments. Sertraline HCl (Mol. wt. = 342.7 g mol^{-1}), and its pharmaceutical preparations (Serlift® tablets, 100 mg/tablet, Global Napi Pharmaceuticals, Egypt) and Moodapex® tablet (50 mg/tablet, Multi-Apex phama-Badr City-Cairo, Egypt), were used throughout this study.

Silicotungstic acid ($H_4[W_{12}SiO_{40}]$), silicomolybdic acid $H_4[SiMo_{12}O_{40}]$, phosphomolybdic acid ($H_3[PMo_{12}O_{40}]$), dibutyl phthalate (DBP), dioctyl phthalate (DOP), tricresyl phosphate (TCP), ethylhexyl adipate (EHA), ortho-nitrophenyl phenyl ether (o-NPPE), ethylhexyl sebacate (EHS), ortho-nitophenyloctyl ether (o-NPOE), poly (vinyl chloride) (PVC) of high relative molecular weight and tetrahydrofuran (THF), sodium tetrakis-[3,5-bis(trifluoromethyl)phenyl]borate (NaTFMPB) were obtained from Aldrich chemical company.

Preparation of solutions

Stock solution of Ser-Cl was prepared by dissolving 342.7 mg in hot doubly distilled water and then completed to 100 mL. Lower concentrations were prepared by appropriate dilutions and kept in dark bottles at room temperature. Aqueous solutions of 0.1 mol L^{-1} NaTPB, STA, SMA, and PMA were prepared using analytical grade purity chemicals. Lower concentrations were prepared by dilution.

Preparation of the ion-associates

The ion-associates, sertraline silicotungstate (Ser-ST), sertraline silicomolybdate (Ser-SM) and sertraline phosphomolybdate (Ser-PM) were prepared by addition of 100 mL of 10.0 mmol L^{-1} Ser-Cl solution to 2.5, 2.5 and 3.3 mmol L^{-1} of STA, SMA and PMA, respectively. The resulting precipitates were left in contact with their mother liquor overnight to assure complete coagulation. The precipitates were then filtered and washed thoroughly with distilled water, dried at room temperature and ground to fine powders. The chemical compositions of the precipitates were confirmed by C, H and N elemental analyses using automatic CHN analyzer (Perkin–Elmer model 2400) in the Micro Analytical Center, Faculty of Science, Cairo University, and the results are given in Table 1.

From the elemental analyses, it was found that the molar ratios were 4:1, 4:1 and 3:1 (D:R) for Ser-ST, Ser-SM and Ser-PM, respectively, as seen in the following equations.

$$4Ser^{+} + ST^{4-} \leftrightarrow Ser_4ST$$
$$4Ser^{+} + SM^{4-} \leftrightarrow Ser_4SM$$
$$3Ser^{+} + PM^{3-} \leftrightarrow Ser_3PM$$

These stoichiometric ratios were confirmed using conductimetric titrations. It was performed to give further insight into the nature and stoichiometry of ion-associates. The conductance of 50 mL 1.0 mmol L^{-1} R (STA, SMA or PMA) was titrated against 0.1 mmol L^{-1} Ser-Cl solution. Volume corrections due to volume change were done and the molar concentrations of R and drug solutions were calculated after each addition. [R]/[Ser-Cl] was plotted against the corrected specific conductance. Characteristic breaks at molar ratio 4:1, 4:1 and 3:1 (D:R) were observed for Ser-ST, Ser-SM and Ser-PM, respectively.

Table 1 Elemental analyses of the ion-associates.

Ion-associate	Color		C (%)	H (%)	N (%)
Ser-PM	Yellowish green	Found	23.63	2.07	1.53
		Calc.	22.33	1.96	1.53
Ser-SM	Yellowish green	Found	27.20	2.36	1.76
		Calc.	26.77	2.36	1.84
Ser-ST	White	Found	20.02	1.76	1.17
		Calc.	19.88	1.75	1.36