RESEARCH ARTICLE

A Synthesis of New Liquid Electrodes for the Determination of Ibuprofen, based on a Molecularly Imprinted Polymer

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ABSTRACT

Liquid electrodes of Ibuprofen (IBP) imprinted polymer were synthesis based on precipitation polymerization mechanism. The molecularly imprinted (MIP) and non-imprinted (NIP) polymers were synthesized using IBP as a template. By 1-Vinylimidazole (VIZ) and Styrene as monomers, Ethylene glycol dimethyl acrylate (EGDMA) cross-linkers and benzoyl peroxide (BPO) as an initiator. The molecularly imprinted membranes were synthesis using Di-octyl phthalate(DOPH) Nitro benzene (NB), Di-butyl phthalate (DBPH), and Di-butyl Sebacate (DBS) plasticizers in PVC matrix. The slopes and limit of detection of liquid electrodes obtained from the calibration curves ranged from (30.5, 29.9) (19.003, 20.46) mV/decade and 1.2 x 10^{-7}–2.3 x 10^{-8} and 7 × 10^{-7}, 7.1 × 10^{-7} M, respectively and the response time was about 60 seconds. The liquid electrodes were filled with a typical 10^{-1} M drug solution and demonstrated a consistent response across a pH scale of 1 to 10, as well as good selectivity across a wide range of species. State-of-the-art electrodes have been successfully used to detect Ibp in pharmaceutical samples without any time-consuming pre-treatment steps.

Keywords: Ibuprofen, Molecularly imprinted electrodes, Nitrobenzene, Potentiometric method, Styrene, (VIZ) monomers.

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INTRODUCTION

Molecularly imprinted polymers (MIPs) are a promising alternative to tailor-made receptor binding sites through template rearrangement and functional monomer[1-4] Rearrangement. The molecularly influenced technique is based on a process method of copolymerizing functional monomers and cross-linkers in the presence of template molecules. Formation of Cavities the prototype is built in. In the first step, the template interacts with a functional monomer through hydrogen bonding, reversible covalent bonds, electrostatic interactions, and van der Waals forces. In phase two, The monomer-template complex is polymerized in the presence of a significant excess cross-linking agent. The chemical bonds between the monomer and the transverse linker set the position of the functional monomer around the template. Eventually, after polymerization, The template can be extracted from the Superimposing polymer, exposing binding sites with the completed form, size, and chemical functions.

Supplemental to it,[5,6] Non-steroid anti-inflammatory drugs (NSAIDs) are today's forded world's more commonplace user of some alleviators.[7] They are primarily used to treat animal and human fever and inflammation they can lead to toxicity. Results in overdose cases or substance neglect.[8] Ibuprofen, 2-[4-(2-methyl propyl) phenyl] Another type of drug known as NSAIDs is propanoic acid. Ibuprofen may have poorer anti-inflammatory effects than some other NSAIDs. It is used in mild treatment to reduce pain and inflammation in situations such as dysmenorrhea, headache like migraine and post-operative pain, muscle and bone And joint conditions including ankylosing spondylitis, arthritis, rheumatoid arthritis such as idiopathic rheumatoid arthritis, peri-details such as bursitis and inflammation Disorders of the tendon sheath, and soft tissue disorders such as sprains and strains. It also helps to reduce fever.[9-12] Literature reveals a variety of styles for the study of raw ibuprofen (IBP brevity) and pharmaceuticals (supported and opposed by government agencies and health), such as direct titration with sodium hydroxide in methanol,[13-15] Voltage calibration scale, chromatography of high-performance liquids[16-23] based on polymer method with molecular imprinting. In this study, imprinted polymer electrodes were prepared based on Ibuprofen as a template in the PVC matrix membrane, and the membranes' specification was studied.

EXPERIMENTAL

Chemicals

Ibuprofen was purchased by the State Pharmaceutical Companies and Medical Appliances Company (IRAQ-Medial

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East- Baghdad). The Commercial Ibuprofen tablets B.P (400 mg), sammara UAE and UK. All drugs were purchased from local pharmacies.

Di-octyl phthalate(DOPH) and Nitrobenzene (NO), Di-butyl phthalate(DBPH), and Di-butyl Sebacate (DBS), as well as metal salts were purchased from Sigma-Aldrich and were used as they were received. 1-Vinyl imidazole (VIZ) (99%), Styrene (99.9%), EGDMA (99.99%), and benzoyl peroxide (BPO) (78%) were purchased from Sigma-Aldrich. The chemicals used in the search, possess high purity, and does not need to purify.

Apparatus

Potentiometric measurements were taken using a wireless voltmeter (HANA pH 211 instrument Microprocessor pH meter). pH measurements were made with a digital pH meter (wissenschaftlich-TechnischeWerkstätten GmbH WTW/pH meter in lab pH720-Germany), a UV-Visible spectrophotometer double-beam model (UV-1650 PC) SHIMADZ (Japan), and a SHIMADZU UV probe data system. The ability of Ibuprofen solutions with concentrations ranging from 10-1 to 10-6 M were measured at room temperature to investigate electrode efficiency. The potential of solutions was calculated for accuracy after the internal and external solutions to the equilibrium, and then the potential was reported.

Synthesis of the Imprinted Polymer (MIP)

MIP was prepared using a bulk polymerization process. The hour was dissolved 0.0687g (0.333) mmol (IBP) in a thick-walled glass tube (50mL capacity) filled with 10 mL chloroform. The first MIP was synthesized with 0.6009 g (6.4 mmol) of 1-phenylimidazole (VIZ) and 0.8048g (4) mmol EGDMA as the cross-link, and the second MIP was synthesized using 0.6651 g (6.4 mmol) of 1 Phenilimidazole (VIZ) and 0.8048 g. 0.025 gm (0.1 mmole) BPO was used as the initiator. The solution was mixed for 30–40 minutes in an ultrasonic water bath, and the mixture was purged with nitrogen gas during this time. After 40 minutes, seal the tube and position it in a water bath at 60 degrees Celsius to enable the reaction to begin. The time is now. MIPs were repeatedly washed in 100mL portions of 20% (v/v) acetic acid/methanol at (35–45)ºC for (48–55) hours. After crushing and grinding the polymers with a mortar and pestle, they were sifted to a particle size of 125 m (using a 100 mesh sieve) and used as active material in the selective sensor membrane after drying at room temperature. The NIP was created in the same way as the prototype but without the drug. PVC (total molecular weight) (0.2 g). These are combined with MIP (0.036 g) and plasticizer (0.45 g) and then stirred until the solution was homogenized, then added THF (4-5 mL). The solution was transferred to a glass vessel of 5 cm diameter and in the form of a glass sheet. A circular section was added to allow the mixture to evaporate over 24 hours. One end of the Tygon tube was closely attached to a glass tube containing a silver wire painted with silver chloride and filled with 0.1 M regular Ibuprofen solution, while the other end was fastened to it. A circular PVC membrane disk with a diameter of 10 mm was created using a concentrated PVC/THF solution as glue for electrode growth. A scanning electron microscope (SEM) was used to understand the particle morphology and architecture better. After washing a porous surface (Figure 1A), the morphology of the MIP and NIP membranes for Metronidazole benzoate is shown by the electron microscope. Around 20 m can indicate the binding sides to the polymer. Figure 1B indicates that transparent holes measuring 50 m in diameter have been drilled.

Potential Measurements

Under laboratory conditions, measurements were taken in a 50mL double-walled glass cell with magnetic stirring to obtain a homogeneous solution. By dilution in sequence, the electrodes' efficacy was tested by calculating the potential of standard drug solutions prepared with concentrations ranging from 10^{-1} to 10^{-6} M. The operating life of the slope, detection limit, and response time were computed from the calibration curve.

Preparation of Pharmaceutical Samples

The concentration of ibuprofen was determined using three types of tablets,Iraq-(SDI): B.P(400) mg (profiden) tablets, U.A.E (Julphar), B.p (400) mg (profinal tablets), UK-(Wockhardt) B.P (400 mg) (maximum strength ibuprofen) tablets were grinded (0.0143 g) (0.013) and (0.0088) dissolved in 5 mL methanol and completed in volumetric flask to (100 mL).

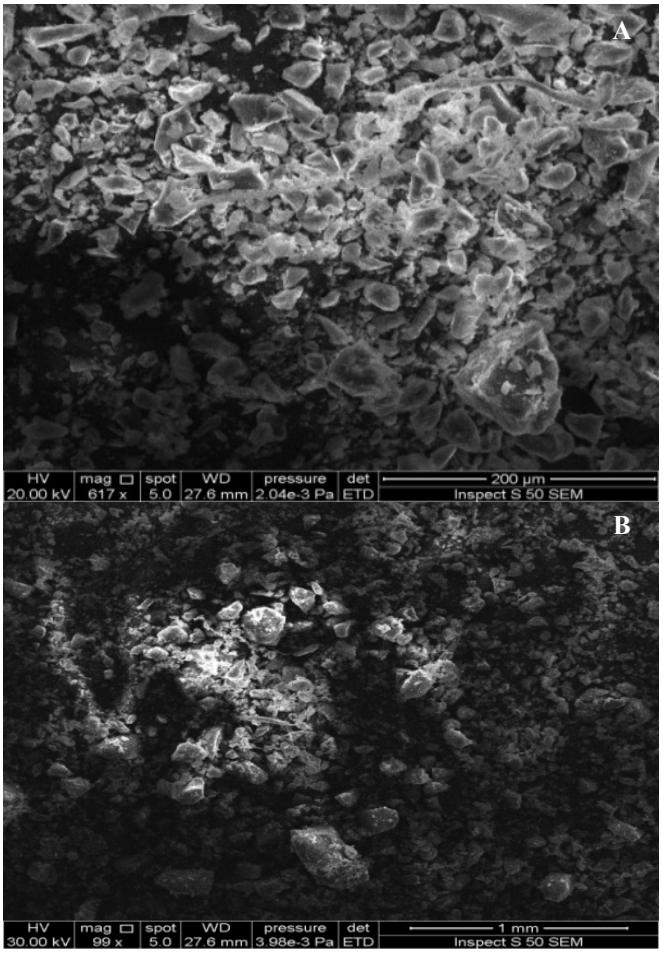

Figure 1: SEM photograph of the surface of A) MIP1and B) MIP2

RESULTS AND DISCUSSION

Liquid Membranes Electrode

MIP-dependent liquid electrodes, their range of concentrations, and the response of slopes to the Nernstian equation were investigated. MIP membranes formed of 1-Vinyl imidazole, Styrene with PVC matrix use 4 plasticizers NB, DOPH, DBPH, and DBS. The internal solution used was a 0.1M aqueous standard drug solution for all liquid electrodes. Experimental results of molecularly impressed (MIP) and non-imprinted polymers (NIP) synthesis based on two monomers VIZ and styrene, suggest that both monomers can prepare successful IBP MIP. The plasticizer is an essential part of the sensing membrane, which plays an important role as a solvent for the various components and determines the analyte's mobility within the membrane. The two plasticizers' used, NB, DOPH, DBPH, and DBS, are suitable for the manufacture of IBP electrodes based on MIP. Table 1 View the parameters of the produced and tested electrodes. Four different compositional membranes were prepared using four different viscosity plasticizer's, Nitrobenzene(NB), Dioctylphthalate (DOPH), Di-butyl phathalate (DBPH), and di-butyl sebacate (DBS) (ν=11.0042cSt), and Electrode specification results were obtained from the calibration curves as listed in Table 1. The electrode slopes ranged from 19.003-30.5 mV/decade and linear dynamic ranges from 1 x10-6-1 x10-1 M. In general, the electrodes in the preparation have a limited response time (about 60 seconds), Mostly at elevated concentrations. The values listed in Table 1 also indicate the good results given by the electrodes IBP and IV IBP. Therefore the liquid electrode was used to determine both drugs in pharmaceutical samples.

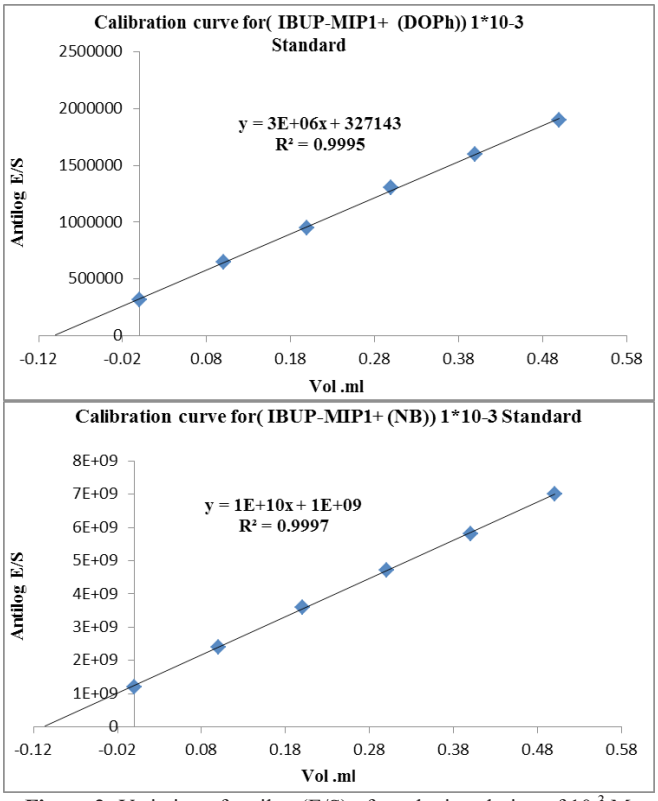

Figure 2: Variation of antilog (E/S) of synthetic solution of 10^{-3} M versus of standard IBP added using IBP-MIP1 electrode (I,II)

Table 1: Parameter of IBP-MIP electrodes based on different plasticizers

		Parameter				
Electrode No.	*Membrane composition*	*Slope mV /decade*	*Correlation Coefficient(r)*	*Linearity range/ M*	*Detection limit/ M*	*Life time / day*
I	IBP-MIP1(MIP+PVC+DOPH)	30.5	0.9996	$1\times(10^{-6}\text{-}10^{-1})$	$1.2\text{x}10^{-7}$	45
II	IBP-MIP1(MIP +PVC+NB)	29.9	0.9996	$1\times(10^{-6}\text{-}10^{-1})$	$2.3\text{x}10^{-8}$	12
III	IBP-MIP2(MIP+PVC+DBPH)	19.003	0.9996	$1\times(10^{-6}\text{-}10^{-1})$	$7\text{x}10^{-7}$	40
IV	IBP-MIP2(MIP+PVC+DBS)	20.46	0.9995	$1\times(10^{-6}\text{-}10^{-2})$	$7.1\text{x}10^{-7}$	30

Table 2: Results of recovery and standard deviation of commercial drugs obtained by using membrane I (MIP1)

Pharmaceutical Drug	*Potentiometric methods*	*Concentration Prepared/ M*	*Concentration Found/ M*	*%Rec.*	*%RE*	*%RSD*
Profedin 400mg	Direct method	$1.0\text{ x }10^{-4}$	1.088×10^{-4}	100.88	0.88	0.64
	SAM		9.97×10^{-5}	99.7	-0.24	0.52
	Direct method	$1.0\text{ x }10^{-3}$	1.007×10^{-3}	100.7	0.79	0.82
	SAM		9.968×10^{-4}	99.68	4.72	0.43
Profinal 400mg	Direct method	$1.0\text{ x }10^{-4}$	1.007×10^{-5}	100.7	0.7	0.76
	SAM		1.0022×10^{-4}	100.2	0.22	0.38
	Direct method	$1.0\text{ x }10^{-3}$	9.924×10^{-4}	99.24	-0.76	0.9
	SAM		9.942×10^{-4}	99.42	-0.58	0.59
Maximum strength Ibuprofen 400mg	Direct method	$1.0\text{ x }10^{-4}$	9.923×10^{-5}	99.23	-0.77	0.88
	SAM		9.979×10^{-5}	99.79	-.21	0.52
	Direct method	$1.0\text{ x }10^{-3}$	1.007×10^{-3}	100.7	0.7	0.91
	SAM		1.002×10^{-3}	100.2	0.2	0.52

Table 3: Results of recovery and standard deviation of commercial drugs obtained by using membrane IV (MIP2)

Pharmaceutical Drug	*Potentiometric methods*	*Concentration Prepared/ M*	*Concentration Found/ M*	*%Rec.*	*%RE*	*%RSD*
Profedin 400mg	Direct method	1×10^{-4}	1.009×10^{-4}	100.96	0.96	0.92
	SAM		9.978×10^{-5}	99.78	-0.22	0.39
	Direct method	1×10^{-3}	1.005×10^{-3}	100.52	0.52	0.7
	SAM		9.98×10^{-4}	99.8	-0.2	0.35
Profinal 400mg	Direct method	1×10^{-4}	9.91×10^{-5}	99.1	-0.9	0.9
	SAM		9.982×10^{-5}	99.82	-0.18	0.51
	Direct method	1×10^{-3}	1.009×10^{-3}	100.9	0.9	0.91
	SAM		9.96×10^{-4}	99.6	-0.4	0.27
Maximum strength Ibuprofen 400mg	Direct method	1×10^{-4}	1.08×10^{-4}	100.8	0.8	0.72
	SAM		9.972×10^{-5}	99.72	-0.28	0.53
	Direct method	1×10^{-3}	9.916×10^{-4}	99.16	-0.84	0.72
	SAM		9.94×10^{-4}	99.4	-0.6	0.77

Quantitative Analysis

The accuracy of electrodes I to IV was assessed using the standard addition method to determine Ibuprofen in synthetic solutions of 10^{-3} and 10^{-4} M. Good percentage recovery results were obtained within the range 99.71 to 100.29 A typical plot at the concentration of synthetic solution for membrane I to IV (10^{-3}) M is shown in Figure 2) and the standard solution added was 0.1 M.

Direct method and standard addition method were applied in commercial pharmaceutical tablets to determine Ibuprofen (Profedin 400 mg, profinal 400 mg and Maximum strength of Ibuprofen 400 mg) Obtained via a membrane from local stories based on DOPH and III based on DBPH as a plasticizer. The values of the % recovery (Table 2 and 3) agree with the value given in British Pharmacopeia.[24] There is no intervention of all species on electrode response; hence the recovery values obtained by the standard addition method are following the direct method results.

CONCLUSION

The sensors ion for MIPs using Ibuprofen as a template and EGDMA as cross-linkers and Styrene, (1-Vinylimidazole) (VIZ) as monomers in different plasticizers. Results of MIP High sensitivity, fair selectivity, quick static response, long-term stability, and applicability across a broad pH spectrum have been achieved using electrodes. DBPH and DOPH plasticizers. In comparison with the British Pharmacopoeia, good recovery results were obtained to determine Ibuprofen in commercial tablets.

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