Sudan University of Science and Technology

College of Graduate Studies and Scientific Research

Synthesis of Molecular Imprinted Polymers for Assay of Non-Steroidal Anti-inflammatory Drugs Using Different Functional Monomers

تخليق بوليمرات الطبعة الجزيئية لقياس العقاقير الغير ستيرويدية المضادة للالتهابات باستخدام مونمرات وظيفية مختلفة

A thesis submitted in fulfillment of the requirements for Ph.D.

in chemistry

BY

Mohammed Madlool Mohammed Salih

B .Sc. , M.Sc. Chemistry

Supervisors

Prof. Dr. Mohammed Elmubarak Osman

Prof. Dr. Yehya Kamal Khalil Al-Bayati

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صدق الله العظيم

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الإهداء

إلى من أرسله الله رحمة للعالمين سيدي ونور قلبي

مـحـــمـــــد ﷺ

إلى من كلله الله بالهيبة والوقار

إلى من أحمل أسمه بكل افتخار

اعظم النعم ومنبع العطاء والكرم

والدي الغالي بارك الله بعمره

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الى القلوب التي احبتنا في الله واحببناها في الله

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الى كل الذين رددوا لي دعوات التوفيق والنجاح
الى كل من ساعدني

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Abstract

The aim of this study was prepare MIPs using Ibuprofen and diclofenac sodium as templates Three MIPs prepared of Ibuprofen using 1-vinylimidazole (1-VI) , 2-hydroxy ethyl metha acrylate (2-HEMA) and Styrene as functional monomers, as well as Ethylene glycol dimethacrylate (EGDMA) and N-N methylene bis acrylamide as cross linkers and benzoyl peroxide (BPO)as an initiator,. In addition, three MIPs were prepared from Diclofenec sodium using on1-vinylimidazole (1-VI), acrylamide (AA) and Styrene as active monomers. Ethylene glycol dimethacrylate (EGDMA) as cross linker and benzoyl peroxide (BPO)as initiator .

The parameters studied to detect Ibuprofen and diclofenac sodium included concentration range, slope, detection limit, response time, life time, correlation coefficient and the working pH range, Interferences were also studied selectivity against(K^{+},Ca^{+2},Al^{+3}, TSC, MP,PP)

Five membranes were prepared from MIP for IBP (IBP-MIPs)two each for MIP1and MIP3 and one from MIP2 The membrane were prepared by mixing an appropriate plasticizers Dioctyl phthalate (DOPH), Nitro benzene (NB), Tri tolyl phosphate (TTP) , Dibutyle phthalate (DBPH),and Dibutyle Sebacate (DBS) with IBP and DFS (as template) in PVC matrix. The membrane electrodes for IBP-MIP1+DOPh , IBP-MIP1+NB, IBP-MIP2 + TTP , IBP-MIP3+DBPH and IBP-MIP3+DBS gave the following results**:** slops (30.5, 29.9, 19.04, 19.003, 20.46)mV/decade respectively ,linear concentration range(10^{-6}-10^{-1})M, detection limits ($1.2\times10^{-7,}$ 2.3×10^{-8} ,1.86×10^{-7} ,$7\times10^{-7}$and 7.1×10^{-7}) M respectively ,correlation coefficient (0.9996 ,0.9996 ,0.9999 0.9996 and

0.9995) respectively and life time (45, 12, 25,40 and 30) days respectively the working pH was studied for IBP electrodes and it was effective in the range (1 to 9±1)

Three membranes(MIPs),however were prepared from Diclofenac sodium (DFS) one each of MIP1,MIP2 and MIP3

DFS membranes DFS-MIP1+TEHP, DFS-MIP2+DBPH , and DFS-MIP3+DOPH gave results of showed that slopes (17.87,19.415 and 19.168) mV/decade, linear concentration (10^{-6}-10^{-1})M, detection limits (7×10^{-6},$2.9\times10^{-7,}$ and 4.5×10^{-7}) M ,correlation coefficient (0.9997 ,0.9998 , and 0.9996) and life time (37 , 38, and37)days respectively the working pH was studied for DFS electrodes and was effective in the range (1 to 9±1)

These ISEs have been tested in the detection of of Ibuprofen and diclofenac sodium pharmaceuticals using direct method (DM).standard addition (SAM), and multiple standard addition (MSA) method as well the separate solution method was used to calculatc the selectivity coefficient .The accuracy and precision were examined and calculating recovery Rec.% and relative standard deviation RSD% , respectively for The eight ISEs.

المستخلص

تمت عملية تخليق بوليمرات الطبعة الجزيئية باستخدام اثنين من الادوية كقالب وهما الايبوبروفين والدايكلوفيناك صوديوم. حضرت ثلاث من بوليمرات الطبعة الجزيئية لعقار الايبوبروفين باستخدام 1- فينايل اميدازول و 2- هايدروكسي اثيل ميثا اكريليت والستايرين كمونمرات فعالة و استخدام اثلين كلايكول ثنائي مثل اكريليت وN,N ميثايلين بس اكرلامايد كرابط تشابك عرضي وبنزويل بيروكسيد كبادئ للتفاعل على التوالي .بالأضافة الى ذلك تم حضير ثلاثة من بوليمرات الطبعة الجزيئية للدايكلوفيناك صوديوم باستخدام 1- فينايل اميدازول و اكريل امايد و الستايرين كمونمرات فعالة و استخدم الاثلين كلايكول ثنائي مثل اكريليت كرابط تشابك عرضي للبوليمرات الثلاث ونفس بادئ التفاعل المستخدم في تحضير بوليمرات الطبعة الجزيئية للايبوبروفين .

المعلمات التي قيست لكل من الايبوبروفين و الديكلوفيناك صوديوم تتضمن : مدى التركيز، الميل الخطي ،حد الكشف ،زمن الاستجابة ، عمرالقطب، معامل التصحيح و مدى عمل الدالة الحامضية كذلك تم دراسة الانتقائية للمتداخلات. ضد الايونات أحادية وثنائية وثلاثية الشحنة ومركبات كيميائية ثلاثي صوديوم ستريت وبروبايل بارابين وميثايل بارا

خمسة اغشية حضرت من بوليمرات الطبعة الجزيئية لعقار الايبوبروفين اثنان لكل من بوليمرات الطبعة الجزيئية الأول والثالث وغشاء من بوليمر الطبعة الجزيئية الثاني تم تحضير الاغشية بواسطة مزج كمية مناسبة من الملدنات مثل

Dioctyl phthalate (DOPH), Nitro benzene (NB), Tri tolyl phosphate (TTP) , Dibutyle phthalate (DBPH),and Dibutyle Sebacate (DBS)

مع الدواء كقالب ممزوج مع بولي فاينيل كلورايد .الطرق المقاسة والخصائص لأغشية الاقطاب

IBP-MIP1+DOPh , IBP-MIP1+NB, IBP-MIP2 + TTP , IBP-MIP3+DBPH، and IBP-MIP3+DBS

اعطت النتائج التالية : الميل الخطي (30.5, 29.9, 19.04, 19.003, 20.46) ملي فولت /عقدة ، مدى الخطي للتركيز(10^{-1}-10^{-6}) مولاري و حد الكشف (7×10^{-7}, 1.86×10^{-7}, 2.3×10^{-8}, 1.2×10^{-7}و 7.1×10^{-7}) مولاري ، معامل التصحيح (0.9995 and 0.9996 0.9999, 0.9996, 0.9996) وعمر

الحياة (عمر القطب) (45, 12, 25,40 and 30) يوم لكل الاقطاب على التوالي كذلك تم دراسة الدالة الحامضية لكل قطب للايبوبروفين اذ كانت الأقطاب فعالة ضمن المدى (1±9-1)

تم بناء ثلاثة اغشية لعقار الديكلوفيناك صوديوم واحد لكل من بوليمرات الطبعة الجزيئية الأول والثاني والثالث

DFS-MIP1+TEHP, DFS-MIP2+DBPH , and DFS-MIP3+DOPH

أظهرت النتائج الميل الخطي (17.87,19.415و 19.168) ملي فولت /عقدة ، مدى التركيز الخطي(10^{-1}-10^{-6})مولاري ، حد الكشف (4.5×10^{-7} and $2.9\times10^{-7,}$ 7×10^{-6}) مولاري ومعامل التصحيح (0.9996 and 0.9998 , 0.9997) عمر الحياة (عمر القطب)(37 ,38, and 37 , 37) يوم لكل الاقطاب على التوالي كذلك تمت دراسة الدالة الحامضية لكل قطب للديكلوفيناك صوديوم اذ كانت الأقطاب فعالة ضمن المدى (1±9-1) هذه الاقطاب تم اختبارها في تقدير المستحضرات الصيدلانية للديكلوفيناك صوديوم و الايبوبروفين باستخدام عدة طرق مثل طريقة المباشرة ،طريقة الاضافة القياسية و الاضافة القياسية المتعددة بالإضافة الى طريقة فصل المحاليل لحساب معامل الانتقائية ثم حساب نسبة الخطأ و نسبة الانحراف القياسي لثمانية اقطاب انتقائية .

List of abbreviations		
1	AA	Acrylamide
2	BP	Benzoyl peroxide
3	DBPH	Dibutyle phthalate
4	DBS	Dibutyle Sebacate
5	DFS	Diclofenec sodium
6	DOPH	Dioctyl phthalate
7	DPM_s	Direct potentiometric methods
8	EGDMA	Ethylene glycol dimethacrylate
9	$\mathbf{E_{rel}}$	Relative Error
10	F	False
11	Fig	Figure
12	FIM	Fixed Interference method
13	FPM	Fixed primary ion method
14	FTIR	Fourier-transform infrared spectroscopy
15	2HEMA	2-hydroxyethyl methacrylate
16	IBP	Ibuprofen
17	ISE	Ion selective electrodes
18	Log C	Logarithm Concentration
19	MIP	Molecularly Imprinted Polymer
20	MIT	Molecularly Imprinted Technology
21	μm	Micro mole
22	MPM	Matched potential method
23	M.P	Methylparaben
24	MSA	Multiple standard additions
25	NIP	Non Imprinted polymer
26	N-N MBAA	N-N methylene bis acrylamide
27	NB	Nitro benzene
28	pH	Puffer hydrogen
29	PMA	Phospho molybdic acid
30	P.P	Propylparaben
31	PVC	Polyvinyl chloride
32	Rec	Recovery

33	RSD	Relative Standard division
34	SAM	Standard addition method
35	SEM	Scanning Electron Microscopy
36	SCE	Saturated calomel electrode
37	SSM	separate solution method
38	TEHP	Tris (2-ethyl hexyl) phosphate
39	THF	Tetra hydro furan
40	T.S.C	Trisodium citrate
41	TSM	Two solutions Method
42	TTP	Tritolyl phosphate
43	1-VI	1-Vinylimidazol
44	UV	Ultra violet
45	Calc Con^{c}	Calculate Concentration

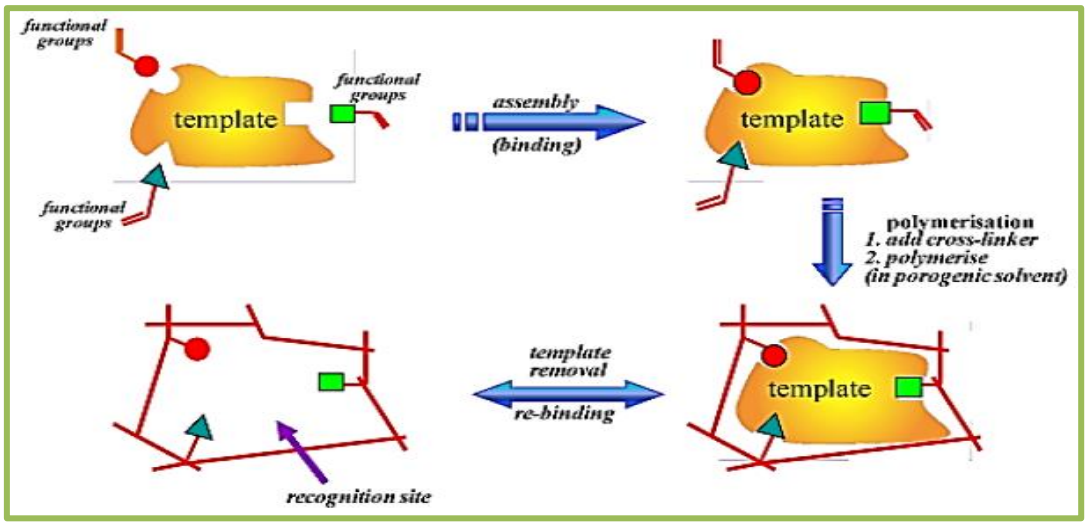
Chapter One

1-Introductions and Literatures Review

1-1 Molecularly Imprinted Technology (MIT)

Molecular Imprinting technology is defined as a technique of copolymerization of functional and cross-linking monomers in the presence of the imprint molecule which is the target analyte, acting as a molecular template. Initially, a complex of the functional monomer's forms through the molecule imprint. Their efficient groups are grasped in status by the extremely cross-linked polymeric frame after the process of polymerization (Alun.1998; Lorenzo and Concheiro.2013). as demonstrated in Fig.1.1 In addition, the spatial arranging of these interactions around a given substance, molecular matrix, is a vital characteristic essential to formation of binding pockets providing complementary size, style, and functionality for facilitating selective recognition accompanied by a high affinity in the direction of the target. As a consequence, the practicability of recognition in molecular imprinted polymers may be defined in resemblance with behavior proven for (enzyme– substrate-complexes), e.g., the lock- and- key model (Andersson.1996).

Molecular imprinting the method for the formation of specific cavities in the composition of prepared polymers with a memory of template molecules, which has led to a significantly expanded list of functional substances for molecular imprinted polymers is gaining a strong position in materials science and technology (Anderson et al.1995). The molecularly imprinted polymer has high analytical properties in the ideal, being physically stable, resistant to mechanical stress, resistant to high pressure and high temperatures, and has more than one hundred times an imprint memory without loss its memory. The same composition was used in preparation of non-imprinted polymers (NIPs), but without the template. Theoretically, the NIP is completely structure are non-selective. Theoretically, the NIP is completely structure are non-eclectic. So, the non-imprinted Polymer can be used as an indicator for determine the selectivity of the molecularly imprinted polymer such as recovery and season as reported in the papers published by (Andrade et al. 2005).



Fig(1-1) Statement the foundation of molecular imprinting

1-2 Molecularly Imprinted Polymer

Molecularly Imprinted Polymers (MIPs) are conditions of polymerization that accomplished with the use of imprinting technology. These polymers have strong molecular recognition components which mimic the natural recognition bodies as antibodies and the biological receptors. The best separation and identification of complex samples such as biological fluids and environmental samples in particular. Molecular fingerprinting is very important as it is used to create interlocking polymers that are able to select molecules selectively. Polymerization occurs when the monomer is combined in the matrix of the polymer with the target molecule. The pyrogenic solvent is used to dissolve the template, monomer, cross-linking agent and initiator when the polymerization process begins. The selection of appropriate monomers associated with the template is an important and vital role for molecular identification success in obtaining a stable (template-monomer) complex. The character of the polymer matrix obtained is a macro porous matrix with micro cavities and a three-dimensional structure complementing the template structure. Thus, by washing the mixture with the solvent, the template molecules are removed from the polymer, leaving the template complementary binding sites (Andrea et al.2001). There are techniques (microscopic examination) by which the morphological

characteristics of the polymer molecular edition can be studied with high precision. For example, the optical microscope is used to verify the natural safety of polymer beads. The optical scanning electron microscopy is used to imagine the polymer's total pores (Armstrong et al.1998). The recognition behavior of the molecular depends on a very important level of characterization for MIPs, such as the binding capacity. One of the best methods for evaluating binding capacity and selectivity is the batch rebinding. MIPs provide a quick and easy method for analyzing when used as a direct chromatographic stationary phase (Bar et al.2006; Berggren et al.2000; Boon job.2014).

1-3 Condensation Polymerization (Step Growth)

The interaction of two different functional groups with the loss of small molecules, such as water when forming the new bond, the polymer is formed in this way which is called condensation polymerization. The formation of polyester and nylon is an example of this type of polymerization.

1-4 Addition Polymerization (Chain Growth)

Adding one monomer unit to itself continuously and repeatedly leads to chain growth polymers being formed, where by adding the monomer fraction leads to the transition of the interactive site to the end of the new series. The process of forming a straight or linear series continues until in a certain way the process is completed. Typical steps in this type of polymerization can be illustrated as follows:

There are different ways of initiating polymerization reactions and naming each type of polymerization reaction according to the initiation mechanism. These include:

1. Anionic polymerization. 2. Cationic polymerization. 3. Free radical polymerization. In a first type the propagating chain is a carbanion ion(an organic anion in which the negative charge is located on a carbon atom), either in the second type carbocation (some examples of positively charged

electrophiles are the hydronium ion, neutronium ions, metal ions, and carbocation's the third type is free-radical polymerization where monomers are added to an interactive site with free radicals, most molecular imprinting reactions are from type three (Cacho et al.2004; Castro et al. 2001; Chanda.2013).

1-5 Approaches For Preparing Molecularly Imprinted Polymers

Depending on the nature of binding between the functional groups of the monomers and the template molecule in the pre polymerization step; the major techniques for result MIP they can be divided into two groups, namely, covalent bonding and non-covalent bonding. Other derivatives of these approaches have been applied to or imprinting (Chen et al.1997).

1-5-1 Covalent Imprinting Method

The technique known as pre organized technique is the manner shown for the interaction of the template molecule with polymerized monomers by reversible bonds.

The polymerization process is performed with a significant increase of cross-linker to produce an insoluble solid grid. Covalent links must be cleaved to extract the template, leading to specific binding sites for the complementary static and functional nature of the template molecule. The formation of covalent bonds is essential in the composition of the template molecule (Cormack, Elorza. 2004).

1-5-2 Non-Covalent Imprinting Method

Self-assembly method the known name of this method, which is inspired by nature. As non-covalent reactions play a major role in molecular excellence processes. This method is accepted as the most successful and widely applied method of MIP synthesis. The polymerization complex is already installed between the template molecule and the functional monomer through weak reactions, such as electrostatic reactions (charge-charge), bipolar reactions,

London dispersion or hydrogen bonding, which will also control the rebinding process (Craggs et al.1974).

1-5-3 Semi-Covalent Imprinting Method

In the semi-covalent method, the template is chemically linked to the polymerization assemblies to synthesize the polymers, but the re-bonding of the template is through non-covalent reactions after polymerization with an excess of the cross-linker. This method generally combines the advantages and disadvantages of covalent and non-covalent imprinting (Del Sole et al.2007; Dickert et al.2001; and Djozan, Assadi .2001).

1-6 Molecular Imprinted Polymers Components

The MIP is made up of the necessary components previously described from the template as a correlation particle, one or more functional monomers in abundance, crosslinkers, the initiator and the solvent used.

1-6-1 Template Molecule

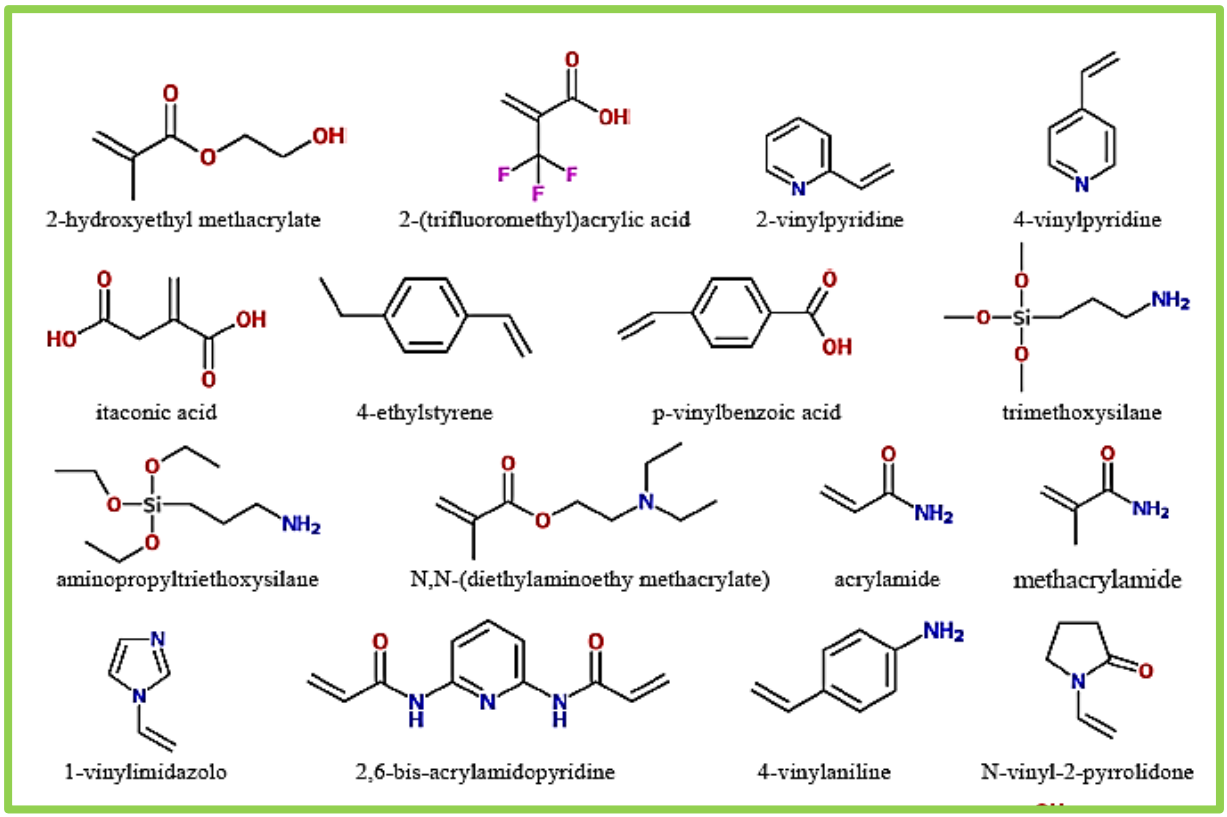
Different materials can be used as template particles in molecular imprinting technique. For example, carbohydrates with their derivatives, organic amino acids, vitamins, proteins, amino acids of course with derivatives of these substances and other molecules successfully used as template molecules in the synthesis of MIPs. Usually, the above molecules contain high polar groups (like carboxyl and amine). High-performance MIPs can be easily developed because more stable molecular complexes can be formed by powerful polar groups and functional monomers. Polymers can produce a selective molecular pattern and a high affinity of printing molecules that can form hydrogen bonds with functional monomers, because of the salient advantages of hydrogen bonds in terms of their orientation, saturation, and strength. There are macromolecules, supra molecular and metal ions that can be used as a template molecule (Djozan et al.2004).

1-6-2 Functional Monomer

The functional monomer is responsible for providing functional groups whose role is to perform correlations with the target molecule in the imprinted grooves. Thus, stronger interactions occur during printing between the template and the functional monomer result in MIP high binding capacity and selective quality. In certain cases, the efficiency of the monomer may be affected when the complex is formed with the template molecule so that functional monomers provide specific functional groups in polymerization as well as in copolymerization.

Free radical polymerization is the most widely used method of polymerization. The molar ratio of the template molecule during the polymerization process with the functional monomer has a significant impact on the formation of the identified cavities.

The differences in the proportions of polymer components in particular (template molecule and functional monomer) make the completeness and ease of non-covalent interactions of these components, this is observed when increasing the ratio of the template molecule to the ratio of functional monomers, On the other hand, it is possible to damage the polymerization when there is a high percentage of functional monomers. The increase in functional monomers in the mix leads to an increase in non-selective binding sites resulting from the formation of non-covalent bonds with the rest of the polymer's functional monomer, thus reducing selective link sites. Template and functional monomers are controlled by the mole ratio and the overall ratio is 1:4. Furthermore, during the preparation period, functional groups should be considered in the imprinted molecules and solvent properties. Fig.1.2. showed of some common functional monomers used in practice in the preparation of non-covalent molecular imprinting (Ebewele,2000,).



Fig(1-2) Some functional monomers used in preparation of non-covalent molecular imprinting.

1-6-3 Cross-Linker

The cross-linkers bind linear molecules to interconnect molecules in order to form a network, for strengthening or regulating the formation of the polymer chain. The advantages of the cross-linkers bridge are the synthesis of molecularly imprinted polymers in three aspects(Emmanuel Pakade,2012,).

1. Controls the structural shape of MIPs.

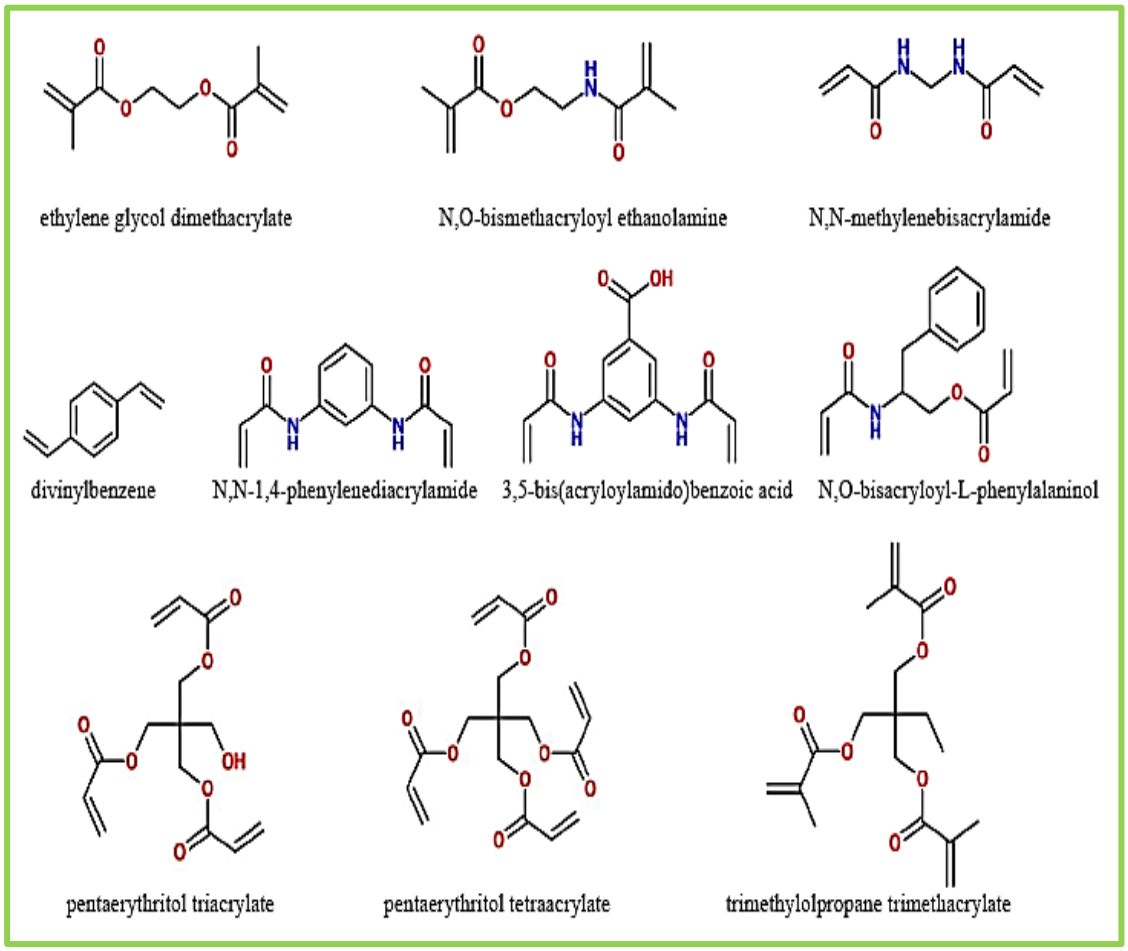
2. Repair sites that distinguish the edition.

3. Affects the mechanical stability of the MIP.

The number and degree of cross-linking of active functional monomers is directly affected by the number of interlocking cross-links in the imprinted polymer unit mass, while the effect of the number of active functional

monomers and the degree of cross-linkage on the MIPs selectivity and binding capacity is a direct effect.

Thus, the ratio of functional monomers to the cross-linker has a significant impact on the molecular properties of polymers. When the amount of cross-linking is less, the MIP cavity configuration cannot maintain itself in a stable state because of the non-reciprocal coupling. However, an excess of interconnect links reduces the number of functional monomers in the mass unit and reduces the number of locations of the molecule (template molecule). Fig.1.3. showed some cross-linkers used in the non-covalent molecular imprinting method (Fan et al.2005; Ferrer et al.2000).



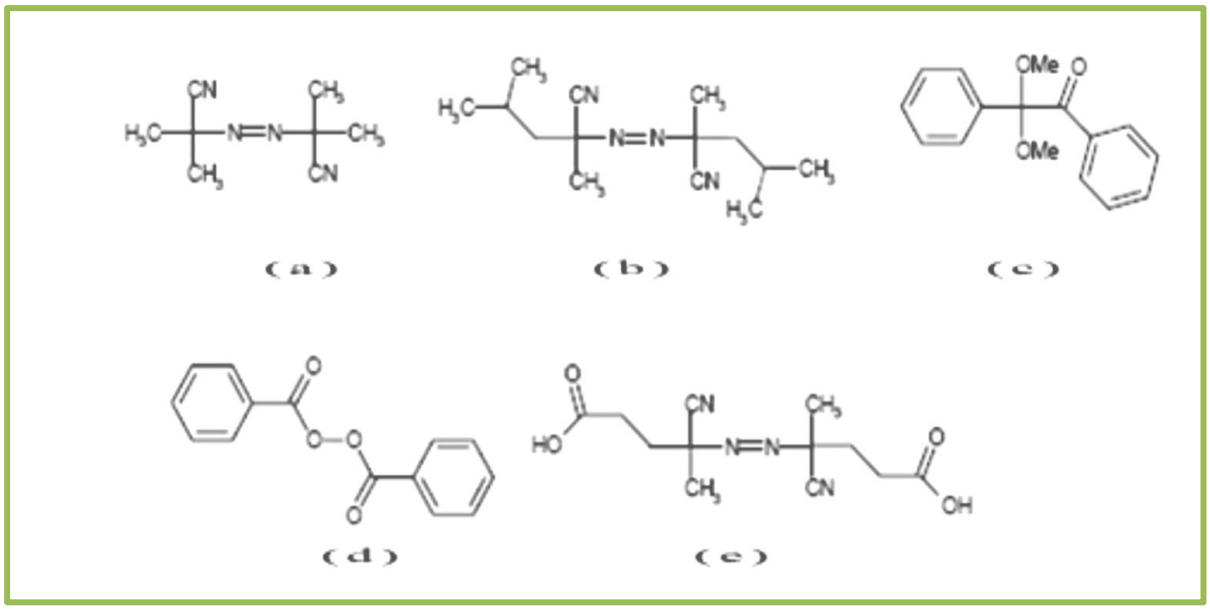
Fig(1-3) Some cross-linkers used in non-covalent molecular imprinting method.

1-6-4 Initiator

Most MIPs are synthesized using (Free radical polymerization) (FRP), either thermally or optically. The process consists of three main steps:

1. Initiation.
2. Propagation.
3. Termination.

In the first step, free radicals are usually generated by initiator degradation, and increased primer concentration leads to higher polymerization rates and reduced molecular weight of the polymer. One of the most important initiators in free radical polymerization is azo compounds, peroxy compounds and oxidation systems. Free radicals can be generated from the iso primers either by ultraviolet radiation at the maximum absorption of the wavelength of the whole compound or by heating to the decomposition temperature. Fig.1.4. Show some common initiators applied in non-covalent molecular imprinting (Fitzhenry. 2011; Gierak et al .2006).



Fig(1-4) Some common initiators used in non-covalent molecular imprinting method: (a) 2,2'-azobis- isobutyronitrile; (AIBN), (b) azo-bis-dimethylvaleronitrile; (ABDV), (c) dimethylacetal of Benzyl; (d) benzoyl peroxide; (BPO) and (e) 4,4'-azo (4-cyanovaleric acid).

1-6-5 Solvent

Solvents play an important role in the imprinting process, where solvents are used to form pores, and are referred to as porogens during the composition of the edition because the main objective is to obtain a large porous polymeric network to facilitate mass transport and allow easy access to the binding sites to be analyzed. Polymerization components (template, monomer, cross-link and initiator) are in one phase and have a significant impact on the texture (distribution and shape of pores) and the physical shape of the synthesized materials and enhanced bonding with host molecules (Gonza´lez-Marino et al .2009; Haginaka ,2008).

1-7 Polymerization Conditions

Several studies have shown that MIP polymerization at low temperatures forms with polymers more selective against polymers at high temperatures. 60℃ is the temperature that is usually used for polymerization. However, controlling on this temperature is difficult because of the initiation of the polymerization reaction is very fast, resulting in low molecular cloning Imprinted polymer. Also, there is a negative impact on stability of the complex by the relatively high temperatures; this impact is decreasing the reproducibility of stationary phase and resulting in dropping in high pressure column. Thus, to obtain a more reproducible polymerization, selection of low temperatures is essential with a relatively prolonged reaction time. Because the complexation of MIP is a result of hydrogen bonding, low temperature of polymerization is chosen, also at this low temperature; photo chemically active initiators can operate efficiently. For example, a study of the enation selectivity 1-PheNHPh imprinted polymers, which was presented by Mossback et al (Hedborg et al .1993). one polymer is thermally polymerized at 60 ℃, and the other Photo polymerization at 0 ℃. The

results revealed that the lower temperature versus the identical polymers thermally polymerized gives better selectivity (Haupt. 2012).

1-8 Applications of Molecular Imprinted Polymers

a. Affinity Chromatography

The first application of MIP was using it as stationary phases. This was particularly because of the enation separation of mixtures which are called (racemic mixtures) which composed of dextrorotatory and levorotatory forms of a compound in equal proportion of chiral compounds, and because of this aspect, numerous of the early work on MIPs was consecrate. The characteristic property of the MIPs which is that they are custom-made for a specific purpose molecule; this gives MIP its specialty compared with conventional chiral stationary phases this gives MIP its specialty compared with conventional chiral stationary phases, therefore their selectivity is determined as in separation between enantiomer of an amino acid from L type and the D-enantiomer; when imprinted polymer of enantiomer of an amino acid from L type is prepared and the MIP is filled in the HPLC column, the L-enantiomer ought to be retained more than the D-enantiomer , while in the same procedure but with NIP The column cannot be capable of separating finite elements. The typical values of the interference factor are (1.5-5), although higher values are observed in some cases. MIP identified for cinchona alkaloids (cinchonidine, cinchonine) showed the most obvious stereo selectivity that has been detected, resulting in chromatographic a value of up to (Hendrickson et al . 2004).

b. Capillary Electro Chromatography

When MIPs technique is combined with capillary electro chromatographic technique; this combination gives considerable separation and resolution factors(Huangxian . 2011).

C. Solid phase extraction

From 1998, scientists have been studied the SPE technique most intensively with respect to the possible extraction of significant materials by using of

imprinted materials. (Issa et al.1999; Jamal etal.2014; Jiang et al.2009). SPE has many advantages over liquid-liquid extraction (LLE) including the high stability in different environments, less time consuming and more reproducibility, obtaining cleaner extracts, decreasing solvent consumption, cheapest price and requiring smaller sample sizes. Moreover, incorporation SPE into automated analytical procedures can be easily done. Extract the purpose analysis for both blood plasma and serum (Kamal, Krabet .2015). as well as urine (Kobayashi et al.1998). and bile (Komiyama et al.2003). In addition, chewing gum (Kraemer, Maurer.1998). sediment (Kriz Mosbach.1995). diesel (Kriz et al.1994). and plant tissue (Kriz et al.1996). has been achieved by using MIP-SPE. Using imprinted polymers in SPE in the quantification of the atrazine which is an herbicide in the liver of beef is a good expressive example for the advantages of this technique.

d. Other Technologies

MIPs can as well be used in many separation techniques, like TLC (Kriz et al.1995). MIPs is utilized in separation techniques which are membrane based (Labarre et al.2011). and in adsorptive bubble floatation fractionation (Lee et al.2008). On the other hand, investigations of using thin layer chromatography with finely ground imprinted polymer mixed with binders which are spread on a support have been studied. Moreover, as adsorbents; MIPs can be used when stirred with a large volume of liquid then it collects by filtration. This method is suitable in the process of product recovery from fermentation broths or production waste streams, and also it is useful for pre-concentration of dilute samples (Leonhardt and Mosbach.1987).

e. Binding Assays

MIPs could possibly be utilized in immunoassay type binding assays in place of antibodies because they arrow with the antibodies one of their utmost

important features which is the selective capability to link a target molecule. Mosbach's group, who sophisticated MIP based assay for a bronchodilator theophylline and the calmative diazepam was the first who demonstrated this utility. An express reactivity profile mimic to that of the naturalistic monoclonal antibodies was yielded by this assay. Very high affinity and selectivity for the template has shown from later imprints against morphine (Li, et al,2012). glycosides (Lofgreen and Ozin.2014). and propranolol (Lord and Pawliszyn.1997). Catalytic polymers can be produced by using molecular imprinting based on non-covalent interactions. Monomers of imidazole have been used to prepare Polymers that simulator to the hydrolytication of proteases on amino acid esters (Marie.2014). In recent times further methods have been developed to advance enzyme mimicking polymers. Antibodies that prepared by imprinting the transition state analogue which is p-nitro phenyl methyl phosphonate against a phosphoric ester for alkaline ester hydrolysis, enhance ester hydrolysis more than one hundred times because of the favored binding of the reaction transition state (Martin et al.1997).

f. Polymeric Sensors

In sensor technology, specific recognition phenomena play a vital and a key role. Analysis of food, monitoring of the environmental and biomedical analysis need sensors which relay on biomolecules like enzymes and antibodies as the specific recognition components. Artificial receptors are achieving a lot of attention since biomolecules have reduced chemical and physical stability.

Developing chemical sensors based on these materials as the recognition elements was one of the most important topics that scientists tried to study because of its exceptional advantage of the tailor made of the recognition sites, with its incorporation into a solid polymeric support, considering the extraordinary specificity that can be achieved as well as the high stability both chemically and physically of imprinted polymers (Marty and Mauzac.2005; Matsui et al.1996; Mayes et al.1994). Devices have been developed by scientists

to exploite the advantage of this recognition properties of MIPs but the challenge currently facing them is about transforming the binding event into a measurable signal in a transducing mechanism. Several systems based on MIP sensing have been proposed, including sensors utilizing field effect devices (Mirsky et al.2011).Conductometric measurements (Moeller et al.1998). amperometric measurements (Mohammadi et al .2005). fluorescence measurements (Muldoon and Stanker.1997). Huge number of imprinted polymers of various kinds was mentioned because studies on molecular imprinting commonly choose a template of biological or environmental importance, even MIPs of the toxic compound, like chloramphenicol which is a broad-spectrum antibiotic, was developed which serves as a model system fo

1-9 Electro Analytical Technique

Electro-analytical procedures incorporate a gathering of quantitative logical techniques that rely upon electrical properties of a solution. These techniques are capable of detecting exceptionally low concentrations of chemicals. Therefore, provide us with a wealth of information including the characterization of chemicals. These techniques show high sensitivity, accuracy, and precision with good linear range (Brett.1993).

1-10 Classification of Electro Analytical Techniques

These methods can be classified into three major types (Vankeirsbilck et al.2002).

1-10-1 Potentiometry

This type of electro-analytical method is based on measuring the potential of the electrochemical cell. The measurement setup consists of two electrodes in potentiometry: the measurement electrode, also known as the indicator electrode, and the reference electrode. There are half cells in both electrodes. They create a certain potential when the two electrodes are placed in solution.

These measurements are recorded and the transition between the solution and the electrode surface, for example, is determined at the phase boundary (Bakker.2004).

1-10-2 Conductimetry

Conductimetry works by measuring a solution's resistance. Use of this type when the total ion concentration is below a certain allowable maximum level or online detector after ion chromatography has separated the ion mixture. Conductivity measures the solution's conductance by using inert electrodes, alternating current and an electrical null system (Patnaik and Dean.2004).

1-10-3 Voltammetry and Amperometry

These are the last types of electro analysis methods. In voltammetry and Amperometry, the electrode has an affixed potential, which causes the ion to react and a current to pass through. The current is directly proportional to the analyte concentration. The common feature of all voltammetric techniques is the application of electrode potential and the recording of the resulting current through the electrochemical cell (Wang.2002 and Bakker.2004).

1-11 Sensors

A sensor could be defined as a component that detects the substance or the analyte. It is also known as a device that can measure and convert a physical quantity to a signal that can be read by an observer or a device. Sensors are designed to detect and respond to analytes in various physical (solid, liquid and gaseous) conditions. Sensors can be categorized as physical and chemical sensors. Physical sensors are designed to accommodate physical characteristics such as temperature, pressure and magnetic field. Chemical sensors are tools that react to an analysis by chemical reaction and can be used for qualitative or quantitative analysis. Chemical sensors can also provide important information

on our environment's chemical status. Four types of chemical sensors are available (Brett.1993).

1-12 Chemical Sensors Types (Bard and Faulkner.2001).

Chemical sensors can be classified into four types depending on the transducer types.

1-12-1 Electro-Chemical Sensors

This could include potentiometric sensors such as selective electrodes for ions and transistors for selective field effects. In addition to voltammetric sensors, including solid electrolyte gas sensors.

1-12-2 Optical Sensors

A spectroscopic measurement is associated with a chemical reaction in this type of sensors. Sometimes optical sensors are called optodex and use optical fiber as a common material. In different types of optical sensors, absorption, reflectance and luminescence measurements are used.

1-12-3 Mass Sensitive Sensors

This type is piezoelectric and includes devices such as the acoustic wave sensor on the surface. Mass sensors are especially useful as gas sensors. They depend on a mass change on the surface of an oscillating crystal that changes the oscillation frequency. This frequency shift scale is a measure of the quantity of material adsorbed to the surface.

1-12-4 Heat Sensitive Sensors

A transducer such as a thermistor or a platinum thermometer monitors the heat of a chemical reaction involving an analyte. They are often referred to as calorimetric sensors. Electrochemical sensors are particularly attractive in comparison to optical, mass and thermal sensors due to their remarkable

detectability, experimental simplicity, and low cost. They have a leading position among the sensors currently available, which have reached the commercial stage and have found a wide range of important applications in clinical, industrial, environmental and agricultural analyzes (Hulanicki et al .1991).

1-13 Potentiometric Sensors

Potentiometric sensors are classified in the electrochemical sensor class. They take advantage of the development of electrical potential on the surface of solid material when placed in an ion-containing solution. In the 1930s, potential metric sensors were discovered and are still used because of their simplicity, familiarity and low cost (Janata.1990).

There are four basic types of potentiometric sensors:

1. Ion selective electrodes.

2. Coated wire electrodes.

3. The transistor of field selective ions.

4. Graphite electrodes.

Only orientation to the first type of potentiometric sensors because the study is related to this type.

1-14 Ion Selective Electrodes

Friedrich Wilhelm Ostwald, Nobel laureate in 1909, was the first scientist to give an intelligible description of the idea of measuring the voltage of the electrode. Then, his student, Walther Nernst, continued his work and further studied the conditions of the thermodynamic balance on the surfaces of the electrode and in 1896 derived his equation. The equation connects the voltage of the electrode to the concentrations of ions in the solution (Bagotsky.20064).

Today, almost all analytical processes and phenomena that are specific to the electrodes are based on this equation.

The origin of ionic selective electrodes has been associated with biological membrane research. In 1906, a plant scientist named Cremer discovered the thin glass membrane that separated the galvanic cell electrodes and made the electromotive force of this cell dependent on the concentration of hydrogen ion (Koryta.1986; Pungor.2001; and Skoog.2000).

However, the glass electrode we know now was discovered three years later by Donnan (Cheng and Pungor.2004; Pungor .1992). Since then, the glass electrode has become an important common tool in analytical laboratories. Then, the first solid ionic selective membrane electrodes were designed. The most versatile one is the ionic selective electrode of fluoride.

An ionic selective electrode can be defined as a vector or sensor that converts the efficiency of a given ion dissolved in the solution to a voltage that can be measured by a voltmeter or a pH meter (Bard and Faulkner. 2000; Pretsch,2001). According to the Nernst equation, the voltages theoretically depend on the logarithm of ionic efficiency. The ionic electrode is used in the medical and pharmaceutical fields (Oesch et al.1986). water purification, biochemical research, and biophysical sciences. There are several benefits to calculating the concentration of ions in a water solution using ionic selective electrodes. Firstly, it will not affect the solution that's being tested. Secondly, ionic selective are mobile. Third, they can be used for direct measurements and correction sensors. They are also not expensive (Levy.1981).

1-15 ISE Measurements Theory

Ion-selective electrodes (ISE) are electrochemical transducers that selectively, directly and continuously respond to the free ion activity of interest in the solution. Koryta regularly reviews the theoretical and practical aspects of ISE

technology and methodology every 2-3 years (Koryta.1986). The electromotive for an electrochemical cell (Ecell) consisting of an ISE for the I and I ions and a reference electrode is described by the Nernst equation:

$$\mathbf{Ecell = E_a + 2.303\ RT/ZF\ log}\ a_x^z \quad \cdots\ldots \quad \mathbf{1\text{-}1}$$

Where $\mathbf{E_{cell}}$ signalize potential (mv) between the indicator electrode and the user reference electrode.

$\mathbf{E_a}$ = a constant for a given cell in the system of the electrochemical reaction.

R, T, F = The ideal gas constant, Temperature in Kelvin, Faraday constant respectively. (8.314 joule mole^{-1}K^{-1}), (298K (25℃)), (96500 coulombs).

Z = Ionic charge

a_x^z = Activity of the ion.

In addition to the commercially available membrane electrodes selective to the common inorganic anion and cation, a large number of ISES have been developed by several research groups selective to pharmaceutical-interest organic ions (Cosofret,1982.). Ion-selective electrodes seem to have some major advantages, such as sufficiently high selectivity and sensitivity, a broad analytical range of analyte concentrations, optical interference insensitivity, low cost, fast response and flexibility in the construction of flow-through sensors for analyzers (Thomas.1973; Thomas and Voilley.1982).

1-16 Ion Selective Electrode Cell Measurements

Ion-selective electrodes (ISE) is one of the sensors that considered most common which used voltage through measurements. Used this measurement in the laboratory tests, industry, process control, physiological measurements, and environmental monitoring (Skoog et al.2007). Electrodes membranes that responded to the concentration analysis using a chemical reaction to generate ions that can be monitored with ion selective electrode (Wroblewski et al.2004).

These membrane electrodes included two main categories are ions selective electrodes which be sensitive to ionic species and molecular selective electrodes that applied to the determination of molecular analyte (Korotenkov.2011; Moody and Thomas.1988).The principle working of ion-selective electrodes consist of two different types of electrical conductivity which are in metals the electric current is carried by electrons while in Liquids the electric current is carried by ions (Mahajan and sood.2007). The measurement of conductivity for each electrochemical process can be achieved in one of this type of galvanic cell, electrolysis, and electrical analysis.

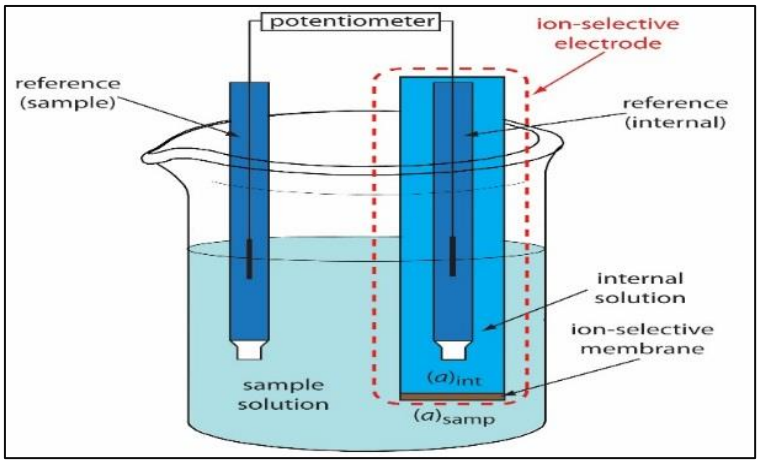
This type of cells must be contacted with the solution on both sides of the cell membrane also there are some ISE arrangements with wire connection to one side of the membrane. Traditional composition of the cell is:

Outer ref. | Test solution | Membrane | Internal ref.

Or

Outer ref. | Test solution | Ion-selective electrode

The current which passed through the electrolytic cell must be equals zero depending on this condition the cell is designed according to the basic rule of designing of electrolytic cells.



Fig(1-5) Schematic diagram showing a typical potentiometric cell with an ion-selective electrode.

$$E_{cell} = E_{IRE} + E_{memb.} - E_{ERE} \ldots\cdots \ 1\text{-}2$$

Although the classification of electrodes varies from one type to another, they all have the same mechanism of work and method of measurement. Ionic selective membranes are classified into six classes depending on the composition of the membrane (Skoog and West.1980; Hauser.2016; and Rundle.2011).

1-16-1 Glass Membrane Electrodes

This electrode is used to measure the hydrogen function. It is one of the first glass electrodes to be discovered. Its flask consists of thin glass (containing silica oxides and sodium oxides) and is connected to a thick glass tube. The bulb is filled with a standard hydrochloric acid solution (0.1 moles/ L) saturated with silver chloride. The electrode contains a silver wire that reaches the solution in the bulb and the other end is connected to the pH device on the other. AgCl Ag Reference internally in the glass electrode(Kimura, et al,2001) The way in which the glass electrode responds to hydrogen ions is that when the glass electrode is immersed in a solution to measure the hydrogen function, the membrane of the thin glass electrode is in contact with the inner solution of the cell and with the model solution being tested (Bard, Faulkner,2001). This results in multiple layers of water silica. The inner and outer membranes become smooth, forming a thin layer of gel, while the glass between the two surfaces is dry and the gel layer has the ability to spread hydrogen ions from the solutions to replace the sodium ions or other metal ions found in the glass installation to balance the following (Skoog and leary.1998).

$$H^+ + Na^+\text{-}GL \rightleftharpoons Na^+ + H^+\text{-}GL$$

There are electrodes of selective membranes for other ions such as Ag^+, K^+, Li^+, and Na^+. These latter electrodes are similar to electrodes of the hydrogen function, except for the internal solution containing the selective ions. The glass

membrane contains silica oxides, aluminum oxides and alkali element oxides with different percentages Na_2O - Al_2O_3 – SiO_2. These electrodes have given a good selective coefficient to other ions. These electrodes are classified as non-crystalline membranes (Izutsu.2002).

1-16-2 Solid State Electrodes

Crystalline membranes contain the materials responsible for the electrochemical behavior of the membranes only. They can either be mono crystalline or multi crystalline.

In mono-crystalline, the membrane can be obtained by pressing the salt powder or its fusion and then affixed to the end of the electrode body made of suitable material, not affected by the temperature of the atmosphere, It is resistant to chemical changes and the main benefits of homogeneous electrodes have a very short reaction time and a long operational life and relatively cheap price (Patnaik,2004) One of these electrodes is the selective fluoride electrode, which is made up of a single crystalline crystal and is properly treated with LaF_3 and inlaid with EuF_2.

The other type of polycrystalline is a multi-crystalline powder that can be prepared from Ag_2S, CuS, CdS, AgCl, AgI or AgBr powder, which is selective for sulphide ions, chloride, iodide or bromide, respectively (Alejandro and Aldana . 2011).

1-16-3 Liquid Membrane Electrodes

In this type of ionic selective polarity, a waterproof membrane is used. This hydrophobic membrane contains a complex organic liquid complex and there are three types of organic liquid used: cation exchangers, anion exchangers, and neutral ionophores. One of the of liquid membrane electrodes can be used to estimate the calcium as the electrode consists of a porous plastic membrane

saturated with material (di- (n- decyl) phosphate) (Harvey.2000)The membrane is attached to two tanks at the end of the cylindrical cylinder. The outer reservoir includes (di-(n-decyl) phosphate) (DDPH) dissolved in (di-(n-octyl phenyl phosphonate) (DOPPH), The membrane is soaked in the internal reservoir contains a standard water solution of calcium Ca^{2+}. The reference electrode is Ag / AgCl electrode (Gross et al.2011). In the most recent and currently available design, (DDPH) is inhibited in the (PVC) or silicon rubber membrane, which eliminates the need for a tank containing (DDPH). The electrode voltage is shown here as a result of the difference in the equilibrium position of the complex interaction below.

$$Ca^{2+}(aq) + 2(C_{10}H_{21}O)_2PO_2^-(m) \rightleftharpoons Ca[(C_{10}H_{21}O)_2PO_2]_2(m)$$

Here, (m) represents the type of membrane on both sides. The lifetime of the (PVC) is proportional to the amount of time exposed to water solution. Therefore, it is recommended to store electrodes, cover the membrane with something like a plug containing a small amount of wet surgical tape. The membrane should be soaked for (30-60) minutes in the solution to be analyzed before use. PVC membranes are currently used to estimate different ions such as (K^+, Li^+, NH_4^+, ClO_4^- and NO_3^-) (Koryta et al.1993).

1-16-4 Gas Sensor Electrodes

Gas-sensitive probes consist of a tube containing a reference electrode, an ionic selective electrode, an electrolyte solution, and a replaceable superfine, gas-permeable membrane. This membrane is attached at the end of the tube and acts as a barrier between the internal solution and the solution to be analyzed. It consists of a microbial membrane made of a hydrophobic polymer. This membrane is very porous as the size of the pore is less than 1 micrometer and allows the gas to pass freely. There is no direct contact between the solution to be measured and the poles. Thus, the term probe or electrode is replaced by the term sensor. As a result, these sensors are complete electrochemical cells. One

of the examples for this kind of sensor is the CO_2 gas sensor. The CO_2 gas sensor detects the quantity CO_2 by initially allowing the CO_2 to interact with the membrane. Given that the membrane is permeable, the CO_2 gas passes through the pores and reaches the internal solution, producing H_3O^+. This leads to a change in pH of the internal solution. This change refers to the amount of measured CO_2 gas (Skoog,waste,2004, Cretescu,et al,2017).

$$CO_{2\,(eq.)} + 2H_2O \rightleftharpoons HCO_3^- + H_3O^+$$

The gas-sensitive sensor was found to be widely used in estimating dissolved gases in water and other solvents, e.g. (HF, H_2S, NH_3, NO_2, SO_2) (Patnaik,2004). In order to measure with gaseous electrodes, we have to control for several factors including temperature, pH, and osmotic pressure.

1-16-5 Potentiometric Biosensors

The electrodes for the analysis of molecular biochemical can be built with a design similar to that used in gas-sensitive electrodes. The difference is that the gap between the ionic electrode and the barrier polymer is filled with a tissue that prevents the enzyme from passing freely. For example, the urease enzyme with electrolyte buffer is held in a polyacrylamide gel by forming a side bond between the polymer chains. The most common category of biochemical sensors is the so-called enzymatic electrodes. The enzymatic electrode can be defined as the electrode that responds to the concentration of the substrate. This response is in the form of a reaction between the base material and the enzyme trapped in the tissue. This often results in the production of an ion that can be monitored with a selective ion electrode (Harvey.2004). Bio-sensors are specifically designed to quantify several different biological species, including antibodies, pathogenic particles, tissues and receptors of hormones. The urea pole is an example of an enzyme polarity (Brett.1993). When the electrode is immersed in the test solution, urea passes through the membrane to reach the gel that contains urease enzyme. The resulting chemical reaction takes place:

$$CO(NH_2)_2 + 2H_2O + H^+ \xrightarrow{\text{Urease enzyme}} HCO_3^- + 2NH_4^+$$

the product is ammonium ions, that can be detected by using a sensitive glass membrane of positive ions (Damp.2001).

1-16-6 Micro Electrodes

Microspheres are special electrodes that enable us to measure small volume solutions such as the ones used by microbial biology. These poles are like microsatellites. They are made of extremely fine glass which is about several microns in diameter and is filled with an ion exchange solution(Stulik et al .2000). The membrane consists of water-negative ionic ions acting as ion exchangers and positive ions dissolved in an organic solvent. They are not mixed with water or vice versa. The solution to be analyzed contains salt from positive ions and negative ions that are water-resistant. By Gibbs energy, negative ions are transferred to the inner solution of the polar pole containing the electrode (Bakker.2004).

1-17-1 Membrane Electrodes Based on PVC

The ionic selective electrodes with polymeric membranes are one of the most powerful sensors. They can select various elements and sense them depending on the charge and volume of the desired ion. The rapid estimation of micro amounts of ions in this simple way gave them great importance in analytical chemistry (Faridbod et al.2008). Each ionic electrode membrane contains four main components: (Polymeric matrix, Ionosphere, Plasticizer, Ionic additives).

The nature and properties of the ionic electrode are largely influenced by the nature of each component and its quantity. To build porous liquid membranes for ionic selective electrodes, the materials used are soaked in a viscous organic liquid that is not to be mixed with water and is non-volatile and contains the ionic carrier dissolved in it. For the preparation of the sensitive

membrane, the ideal components are 33% PVC as a polymer fabric, 66% plasticizer for tissue homogenization and 1% ion carrier (Faridbod, et al,2008).

The first polymer membrane for ionic electrode was manufactured using valinomycin as a portable ion carrier in silicone rubber or PVC with no ionic additives. The appropriate polymer used in the manufacture of the sensitive membrane is defined by the glass transition temperature (Tg). This is the temperature at which solid materials are not crystalline (such as glass or polymer) and they become delicate when cooling and loose when heating. The value of Tg must be under room temperature and as a result, the membranes designed are sufficiently liquid. These environmental conditions allow membrane components to spread (Mohr.2002; Fhakri et al.2005).

The use of plasticizers is necessary to reduce the glass transition temperature if the polymer label has a high Tg value. For example, the Tg value of Polyvinyl Chloride with a large molecular weight is 80. Conversely, the use of plasticizers is not necessary if the Tg value of a polymer is as low as polyurethanes with a low content of crystalline units such as silicone rubber, pol y (vinylidene chloride) and polysiloxanes (Faridbod et al .2008). There are many obstacles related to the use of PVC as a polymeric tissue for more than 30 years, which is (Faridbod et al.2008)

1. Plasticized leakage.
2. Shorter life-time.
3. Unstable response and model disturbance caused by plasticization of the sensitive membrane.
4. The lower level of plasticizer in the membrane leads to a reduction in the solubility of the ionic carrier and ion exchange within the membrane, resulting in high sensitivity and low selectivity.

The ionic carrier is the most vital component in determining the selectivity and sensitivity of the sensitive polymer membrane.

The ion carrier may be an ion exchanger or a neutral macro-cyclic chemical. An ionic carrier can be defined as a molecule with volumetric dimensions containing cavities or semi-cavities to surround and encircle the desired ion. The additives that increase the elasticity of the membrane are called plasticizers. The selectivity of ionic selective electrodes is affected by the significantly used plasticizer. For example, if we changed the plasticized of Nitrobenzene (NB) *o* – nitro phenyl octyl ether (*o*-NPOE) to di butyl phthalate (DBP), the selective electrode trend of the M^{2+} ion decreases.

The addition of ionic additives (lipophilic ion salt) is useful for several reasons are (Faridbod et al .2007).

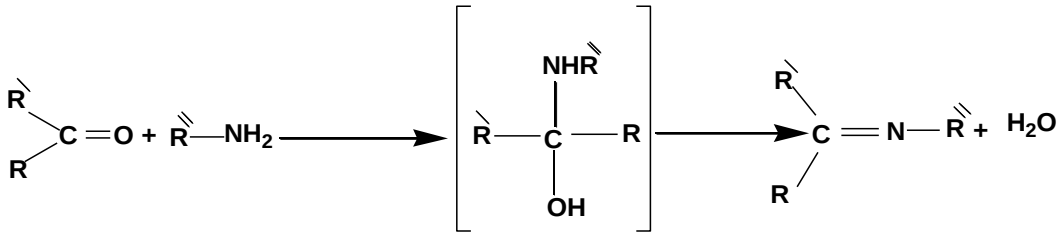
1. Reduce the overlap of negative ions: It was noted that in the case of lipophilic anions such as thiocyanate, the addition of tetra phenyl borate salt to the membrane increases the polar selection of positive ions.
2. Ionic additives reduce electrical resistance automatically and this characteristic is especially important in micro-electrodes.

The most common salts used as lipid additives are (Faridbod, et al,2008).

1. Cationic additives include:
   a) Potassium tetra kis (p-chloro phenyl) borate (KTPClPB). b) Sodium tetra phenyl borate (NaTPB). c) Tetra kis(4-fluorophenyl) borate (TFPB).
2. Anionic additives include a) Trioctylmethylammonium chloride (TOMACl). b) Hexadecyltrimethylammonium bromide (HTMAB).
   c) Hexadecyl pyridinium bromide (HDPB).

1-17-2 Schiff's Bases

Organic compounds containing the azomethane group (-CH = N-) resulting from a simple condensation reaction of aldehydes or ketones with primary amines. This is represented by the following formula (Faridbod et al .2008).



(1) (2) (3) (4)

The group of azomethane (C = N) in the infrared spectrum for Schiff's bases appears in the region of frequencies (1603-1680) cm^{-1} when a hydrogen atom or alkyl or aryl group is associated with the azomethane group (Coates.2000; Silverstien et al .2005; Smith .2017).

1-17-3 Schiff's Base as Ionophore In ISE_S Membranes

The compounds of the Schiff's bases are a branch of Supramolecular Chemistry. These compounds can be used as an ionic carrier in the construction of ionic selective electrodes. Supramolecular Chemistry can be defined as a chemical field that studies the formation of multiple molecular complexes that have relatively simpler structures (Ganjali et al.2006). This fairly recent field was subject to intensive research between 1999 and 2007, during which more than one hundred ion electrons were used in the system composition. Quantities of 29 positive ions and 7 negative ions were detected in various scientific branches such as biomedical, pharmacy and biochemistry, environmental chemistry, and food and agriculture technology (Faridbod et al .2007).

1-18 Reference Electrodes

Reference electrodes are used in cases where the electrical potential in a solution is to be imposed or measured. It also has a stable and well-defined electrochemical potential to refer to the potentials applied or measured in an electrochemical cell. In order to calculate the change in the potential difference between the selective ion membrane and the ionic concentration changes, a

stable reference voltage must be included in the circuit, which acts as a half cell to measure the relative deviations (jeonghan et al.2005)

1-19 Ion-selective Electrode Characterization

An ion selective electrode 's properties are characterized by parameters such as:

1-19-1 Calibration Curve

The procedure of selective ion electrodes is based on the premise that a linear relationship exists between the electrical potential formed between an ISE and a reference electrode immersed in the same solution and the ion activity logarithm in the solution (Guilbault.1981). The Nernst equation describes this relationship.

Figure 1.6. shows a fairly typical plot of the electrochemical cell (i.e. the potential difference between the ISE and the external RE of a given ion-selective electrode cell assembly) versus the single ionic activity (concentration) logarithm of the species (Rundle .2011).

It is suggested that the electrochemical cell be attributed to the ordinate (vertical axis) with the most positive potential at the top of the graph and that paA (-log activity of measured species A) or pcA (-log concentration of measured species A) be attributed to the (horizontal axis) with increased activity or concentration at the right. The linear range is a part of the calibration curve through which a linear regression shows that the data points do not differ more than 2 mV from the linearity (Solomon .1998).

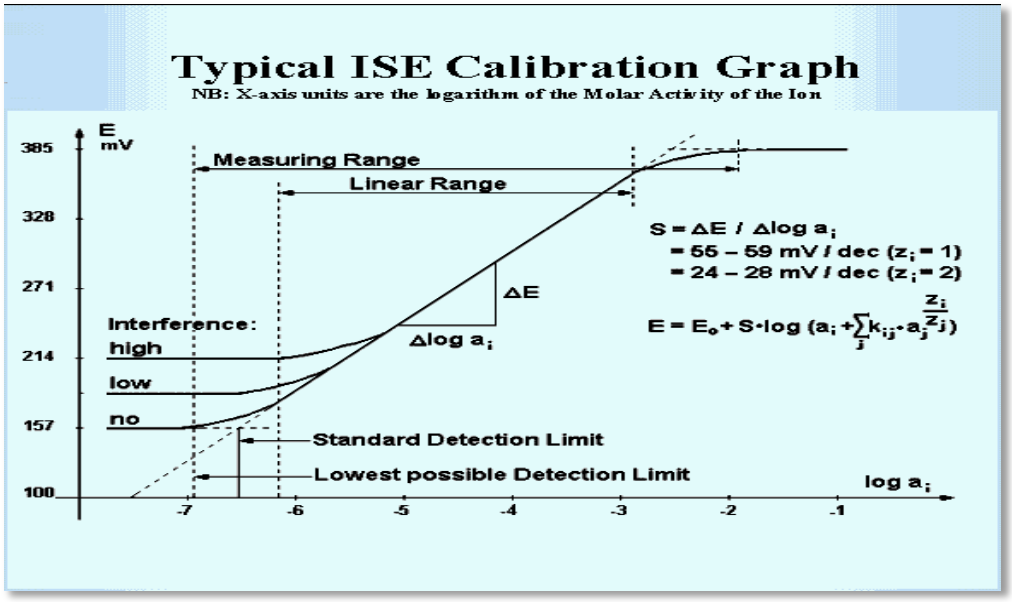


Fig.(1-6) Typical ISE calibration graph

1-19-2 Slope

The slope is the linear part of the electrode measurement calibration curve. The theoretical value for the Nernst equation is 59.16 mV/decade for a single load ion at 298 k or 59.16/2= 29.58 mV/decade for a double load ion. However, this value of the electrode slope is not critical in certain applications and its value does not exclude its utility (Moody and Thomas.1972).

1-19-3 Detection Limit

The detection limit is defined by a cross-section of the two extrapolated linear parts of the selective ion calibration curve in accordance with the IUPAC recommendation. For the majority of ion-selective electrodes, the limit of the order of 10-4-10-6 M is reported in practice. The detection limit observed is often subject to other interfering ions or impurities. If metal buffers, for example, are used to eliminate the effects leading to the contamination of very dilute solutions, the detection limit can be increased to 10-5 M (Rundel.2011).

1-19-4 Range of Linear Response

The linear range of the electrode is characterized as the part of the calibration curve by which a linear regression shows that the data points do not differ by

more than 2 mV from the linearity. This range can range from 1 molar to 10-6 or even 10-7 molars for many electrodes (Buck and Lindner.1994).

1-19-5 Response Time

In earlier IUPAC recommendations, it was simply defined as the time between the instant at which the ion selective electrode and the reference electrode are dipped into the sample solution and the first moment at which the cell's potential equals its steady-state value of ±1mV for the final equilibrium potential. Electrodes with a liquid ion exchanger membrane generally have a longer response time than solid membrane electrodes, due to the slow rate of reaction between the determined ion and the ion exchanger, which leads to a slower transport of the ions across the membrane solution interface. The main factors influencing the response time, however, are the type of membrane and the presence of interferences, all of which slow the response time of these electrodes (Baily and Thomas.1976).

1-19-6 Stability and Lifetime

Lifetime is characteristically associated with ISEs ' response behavior. The stability and durability of PVC-based electrodes are affected by many problems. They include the concentration of the solution, the interfering ions that contaminate the electrode surface, the limited solubility of the active material and the solvent that affects the leakage content of the membrane. Most of these lead to a positive or negative drift in the response and slope values, which indicates that the electrode approaches the end of its life (Evans.1987).

1-19-7 Selectivity

Ion electrodes are not completely ion-specific. That means they can be sensitive to those other ions in a system to some extent. Interferences can be ignored in some situations where the ratio of interference to the primary ion (ion of interest) is low. There are rare cases in which the electrode can be much more sensitive to the interfering ion than to the primary ion and can only be used if the

interfering ions are present only in trace amounts or are totally absent. Chemical complexation or precipitation may remove the interfering ion. The selective ion electrode 's ability to distinguish different ions in the same solution is expressed as the coefficient of selectivity. The coefficient of potentiometric selectivity is conveyed in the Nicol sky-Eisenman (N-E) equation as:

$$\mathbf{E = E^{\circ} + R\,T / ZAF \ln [aA + \Sigma KA, B\,(aB)Z_a/Z_b]} \text{ .....1.3}$$

Whereas:

E = is the potential measured.

E°= is a constant which includes the standard electrode, the reference electrode potential and the junction potential.

Za, Zb= charge numbers.

aA, aB= activities of the primary ion A and interfering ion B.

$K_{A,\,B}$= is the potentiometric selectivity coefficient.

For calculated the selectivity coefficient measurement was used the separate solution method or match method, consisting of both analyzes A and overlapping ions (B) (Buck.1994; Eric andErno.2000).

1-19-7-1 Mixed Solution Methods

They are popular and rapid techniques for measuring the selectivity coefficient (Umezawa et al.2000). K_{AB} can be assessed by:

(a) Fixed Interference Method (FIM)

This is a situation in which we have constant interfering ion activity, aB, and various primary ion activity, aA. The EMF values obtained are plotted against the logarithm of the primary ion activity. The intersection of the linear extrapolated portions of this plot shows the value of an A to be used to calculate K^{pot} AB from the following equation:

$$\mathbf{K^{pot}_{AB} = a_A / a_B{}^{Z_A / Z_B}} \text{ …… 1- 4}$$

In which ZA and ZB have the same signs, either positive or negative [68].

(b) Fixed Primary Ion Method (FPM)

This is the opposite of the method of fixed interference. There is the constant activity of the interest ion, aA, and varying activity of the interfering ion, aB.The intersection of this plot's extrapolated linear portions indicates the value of aB to be used to calculate Kpot AB from equation (1-4) (Umezawa et al.1995).

(c) Two Solutions Method (TSM)

This method involves measuring the potential of a pure primary ion solution , EA, and a mixed solution containing the primary and interfering EA+B ions. The Kpot A, B is calculated by inserting the value of the potential difference, E = EA+B -EA, into the following equation (Umezawa et al.1995).

$$K^{pot}_{A,B} = a_A (e^{\Delta E z_A F / (R T)} - 1) / (a_B)^{Za/Zb} \ldots\ldots\ldots \text{1- 5}$$

(d) Matched Potential Method (MPM)

A theory is discussed that describes the match potential method (MPM) for the determination of the potentiometric selectivity coefficients Kpot A, B of selective ion electrodes when the primary ion charge is not equal to the charge of interfering ions and if it is not possible, Nernstian responses for a given interfering ion are achieved. This technique is based on electric diffuse layers on both the membrane and the aqueous side of the interface, the primary ion A solution with a fixed activity is used as the reference solution. The aA activity is calculated by the solution's ionic strength. When the primary ion is gradually added, the potential change is measured and plotted against aA (curve IA) in Fig.1.7, another curve, IA+B, is obtained by gradually adding the interfering ion B to the reference solution with the same composition as the IA curve. Only when the potential change (TEE) of the IA curve at aA matches that of the IA+B curve at aA+B, the ratio between the primary ion A activities and the interfering ion B denotes the selectivity coefficient Kpot A, B.

K^{pot} A, B signalize (selectivity coefficient) is thus obtained as (Umezawa,et al,1995and Tohda, et al,2001).

$$\textbf{Kpot A, B} = \Delta a_A / a_B \ldots\ldots. \textbf{1-6}$$

Which $\Delta a_A = (aA' - aA)$

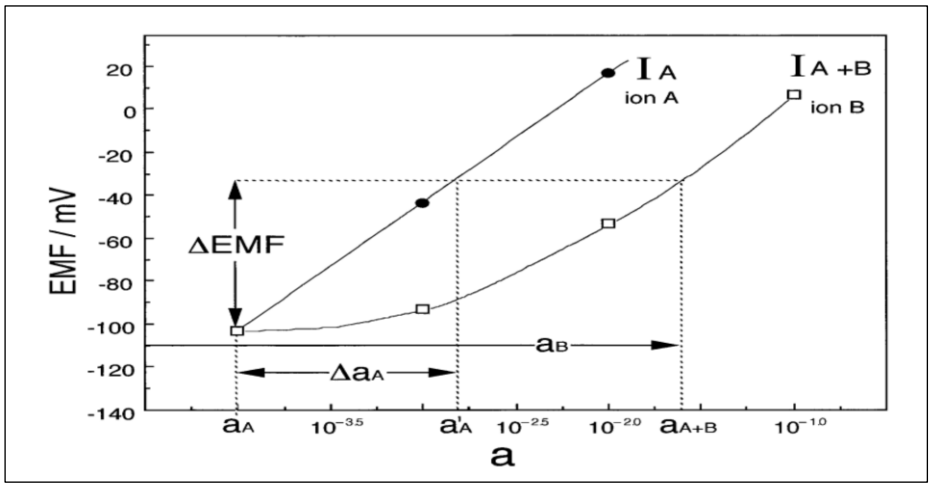


Fig (1-7) Determination of coefficients of selectivity by (MPM).

1-19-7-2 Separate Solution Methods

(a) If $a_A = a_B$

The potential of a cell encompasses an ion selective electrode and a reference electrode is measured with two separate solutions, first, one containing ion A that have activity aA, while the second solution containing the ion B that have same activity aA=aB. the value of Kpot A, B is calculated by the equation below, after measured values EA and EB, respectively.

$$\log K^{pot}_{A,B} = (E_B - E_A) Z_A F / R T \ln 10 + (1 - Z_A/Z_B) \log a_A \ldots\ldots. \quad \textbf{1-7}$$

the formula shall be as follows if compensated ($Z_A F / R T \ln 10$) =1/S

$$\log K^{pot} A, B = (E_B - E_A) / S + (1 - Z_A / Z_B) \log a_A \quad \ldots\ldots. \textbf{1-8}$$

Where S = is the slope of the electrode.

This method is only tailored if the electrode has a Nernstian response. It is less desirable because It also does not represent the actual conditions under which the electrodes are used (Zurawska and Lewenstam.2011).

(b) If $E_A = E_B$

The potential of an ISE for the ion to determine its concentration and interfering ions are obtained freely. Then, the activities corresponding to the same electrode potential value are then used to determine the value of K^{POT} A, B by (Umezawa,et al,1995).

$$K^{pot} A, B = a_A / (aB) Za/Zb \ldots\ldots 1\text{-}9$$

1-20 Analytical Methods

1-20-1 Potentiometric Measurement

The method used depends on many parameters such as analysis and the accuracy and accuracy required for such analyzes. These methods are divided into the direct potentiometric method, standard addition method, and potentiometric titrations method.

a- Direct Potentiometric Methods (DPM_s)

Using selective ion electrodes is the simplest and most widely used method of achieving a quantitative outcome. For many solutions at known concentrations, a calibration graph is created by measuring the potential of the equilibrium cell. The focus is read directly from the graph after measuring the sample's potential at the same time circumstances. The speed of this method, allowing full measurements in 2 or 3 minutes. This method is suitable for analyzing all samples in which the analyte of benefit is present in uncomplicated free states (Evans.1978).

b- Standard Addition Method (SAM) (single point)

The method involves the addition of standard solutions known to concentrate in small quantities to the model to be estimated. Using a more standard method of addition, the standard solution should be added several times and the voltage measured in each case. By neglecting the effect of dilution as a result of adding the standard solution, we obtain the following equation the unknown concentration can be obtained (Evans.1987).

$$Cu=Cs/10\Delta E/s(1+Vu/Vs)-(Vu/Vs) \ldots\ldots 1.10$$

Whereas Cu= concentration of the unknown solution.

Cs= concentration of standard solution.

Vu= volume of an unknown solution.

Vs= volume of the standard solution.

S= slope of the electrode.

This method is more accurate than the direct method in the analysis of complex models, as the coefficient of selectivity remains constant is not affected by the presence of interfering ions on the units of concentrations of the standard solution added and unknown solution.

c- Multiple Standard Additions (MSA)

In order to increase accuracy and reduce error, many standard solutions are added to the same model for measurement. It is an expansion of method standard addition. The response of (ISEs) to confirmed analyte A only in solution free from interfering ions can be acted by Nernstian equation:

$$\mathbf{E=E_0 +S \log (C+X\ Vs/Vu) \ldots\ldots\ldots 1.11}$$

Whereas: slope(S), the volume of added standard (Vs), the volume of unknown (Vu), the concentration of unknown(C), the concentration of the added standard(X).

Vu is generally set to be 100 times more than Vs. Rearrangement of the equation and taking the antilog gives:

$$\log^{-} (E/S) = \text{constant } (C+X\ Vs/Vu)$$

Whereas: $\log^{-} (E/S)$ is constant thus the $\log^{-} (E/S)$ is proportional to V_s (Gran.1952).

A plot of log- (E/S) against Vs, a straight line is obtained, the intercept of which with the volume axis indicate the end point of the unknown concentration in an addition method.

1-20-2 Method Potentiometric Titration

The solution of the material to be titration is given with appropriate titrant and then the selective electrode voltage changes due to the continued decrease in the concentration of the ions in the solution. The potential changes slightly at the

beginning of the titration but the potential becomes significant at the equivalent point versus the added quantity of the titrant material, the end point is identified by knowing the volume of the added solution at the point, where the rate of change in the potential amount to its maximum end. The equivalence point is easily determined if the slope of the curve is sharp from the middle of the Straight-line curve, this method using to calibration colorless solutions (Rundle.2011; Hanna.2000).

1-21 Applications of ISE (guide .2016)

The ionic selective electrodes are used in a variety of fields including:

1. The agricultural field:
    a. To estimate nitrate, potassium, calcium, and chloride in soil.
    b. To analyze the contents of animal food.
    c. To analyze the nutrients of plants including nitrates, potassium, calcium, chloride, fluoride, iodine and cyanide
    d. To quantify nitrates in fertilizers
2. Medical and pharmaceutical laboratories:
   To detect serum levels of potassium, calcium, and chloride in human bodies as well as in any other fluids produced by the human.
    a. To test for fluoride in the human skeleton.
    b. To analyze fluoride levels in dentistry.
    c. To test for chloride in cystic fibrosis.
    d. To detect sodium levels in the blood
3. Monitoring pollution:
   To monitor levels of pollutants such as cyanide, fluoride, and sulfate in natural water as well as sewage.
4. Manufacturing cleaners:
   To quantify the amount of calcium and barium as they can be used to study the effect of cleaning solutions on the quality of water.
5. Research and advanced studies:

a. All types of electrodes are used as sensors in many experiments studying mechanism of action, kinetics, equilibrium and solubility of substances.
b. The electrodes are simple and affordable by university students and graduate students.
c. The electrodes are suitable to be used in nuclear applications as these electrodes do not get affected by radiation and can be remote controlled.

6. Flammables:

To quantify the amount of chloride, fluoride, and nitrates in bombs and flammables

7. Food Production:

a. Determining nitrates in meat additives.
b. Determining salts in meat, fish, milk, dairy products, and fruit juices.
c. Detecting fluoride levels in drinking water, spring water, fish & tea.
d. Determining calcium levels in milk and dairy products.
e. Determining potassium levels in fruit juices and beer.
f. Monitoring the effect of nitrates in canned food.
r investigations.

1-22 Ibuprofen (IBP)

Ibuprofen, 2-[4-(2-methyl propyl) phenyl] propanoic acid,(Fig1-8) is a type of drug known as NSAIDs. Ibuprofen has anti-inflammatory properties may be weaker than some other NSAIDs. It is used in light management to moderate pain and inflammation in cases such as dysmenorrhea, headache, including migraine, and post-operative pain and dental pain, muscle and bone and joint disorders such as ankylosing spondylitis, arthritis, rheumatoid arthritis, including rheumatoid arthritis idiopathic events, peri- detailed such as bursitis and inflammation of the tendon sheath disorders, and disorders of the soft

tissues, such as sprains and strains. It is also used to reduce fever (Martindale . 2002; Algobahi and Younis.2012).

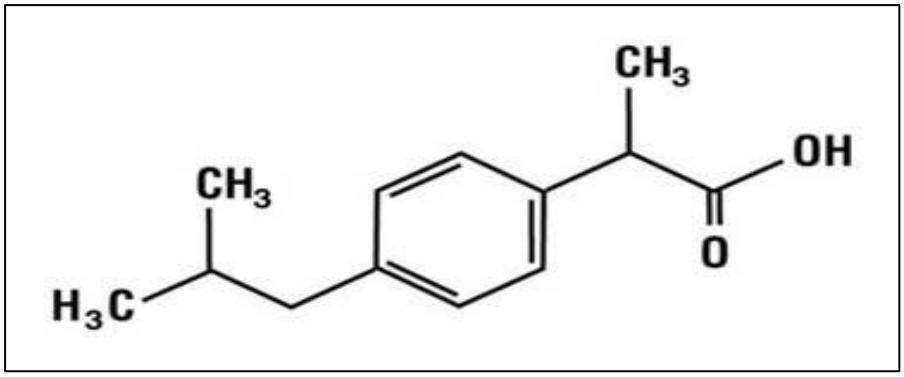


Fig (1-8) Chemical the Structure of ibuprofen

Literature shows a variety of styles (supported and unsupported by government agencies and health) for the analysis of raw ibuprofen (IBP brevity) and pharmaceuticals, such as: direct titration with sodium hydroxide in methanol(European Pharmacopoeia.2002; British Pharmacopoeia .2005; The United States Pharmacopoeia.2004), calibration scale voltage, high-performance liquid chromatography(Pierina et al .2003; Canaparo et al.2000; Chit Lange et al .2008; MI tic et al.2008 ; Rafifa and Marie.2006; Dhavse et al.1997; Lippstone and Sharma.1995; Khoshayand et al.2008). spectroscopy to ultraviolet radiation(Sari miser et al.2017; European Pharmacopoeia.2002) and flow injection analysis of infrared radiation(European Pharmacopoeia .2002; British Pharmacopoeia .2005; The United States Pharmacopoeia .2004). More recently, it was also used electric capillary electrophoresis and consistent speed for the analysis of ibuprofen, pharmaceuticals and other NSAID(Thomas et al .2008; Huidobro et al.2006; Sádecká .2001; Wei et al.2004). Direct calibration and sodium hydroxide in economic terms, it is easy to apply and described in the constitution of the european medicines to estimate the size of the raw IBP(European Pharmacopoeia .2002 ; British Pharmacopoeia .2005; The United States Pharmacopoeia .2004). However, color or excipient is soluble in tablets may intervene in the control of the completion of the reaction by the acid-base

chemical index. Calibrations potentiometers avoid interfering in the excipient is detected since the completion of the reaction by changing the slope of the electromagnetic fields of electrical power (or pH) compared to the size of a calibrated solution. This method is suitable for the analysis of raw IBP tablets and the use of tetrabutylammonium in acetonitrile. IBP analysis is used by high-performance liquid chromatography in all over the world to monitor the quality of medicines. This method allows to analyze both IBP and products of degradation such as, 4-isobutylacetophenone(Matkovic et al.2005). However, the treatment of the eye may be difficult if the excipients or active ingredient is soluble in the mobile phase(Pierina et al.2003; Canaparo et al.2000; Chit Lange et al .2008; MI tic et al.2008; Rafifa and Marie.2006; Dhavse et al.1997; Lippstone and Sharma .1995; Khoshayand et al. 2008). Electrical and capillary electrophoresis consistent speed economic ways, which easily applicable and accurate analysis of IBP(Thomas et al.2008; Huidobro et al.2006; Sádecká 2001 ; Wei et al.2004) Moreover, non-ionic species such as those involving the excipients, do not interfere in the analysis.. In spite of the infrared spectrum is the way described by the pharmaceutical materials to determine the IBP, and literature investigation shows only one quantitative related to the bar through infrared (Moeder et al.2000) have been used methods. To determine the different ibuprofen in the pharmaceutical and biological samples.

1-23 Diclofenec Sodium(DFS)

Diclofenec sodium has the structure, 2-[(2, 6-dichlorophenyl)amino]benzene acetic acid sodium salt (Fig.1.7) , which belongs to the group of non-steroidal anti-inflammatory drug (NSAID) .That is widely used for the treatment of analgesic, rheumatoid arthritis, osteoarthritis and ankylosing spondylitis (Iliescu et al .2004; Bilal and Ciltas.2015). It is used as a suitable drug on the treatment of chronic diseases like arthritis and pain after surgical operations. It facilitate pain and reduces inflammation (Gostick et al.1990; Roskar and Kmetec .2003) Water crystallizes diclofenec sodium which has melting point from 283-285 °C

which dissolved at room temperature in deionized water, acetone ,methanol, acetonitrile, cyclohexane, HCl, and phosphate buffer (The Merck index .2006; Albayate and Alsafi .2018). According to review, diclofenec sodium was determination by several methods such as HPLC(Manikandan et al 2019; Birajdar et al. 2011; Arcelloni et al. 2001). spectrophotometry(Sastry et al.1989; Agrawal and Shivramchandra .1991). thin layer chromatography (Thongchai et al.2006). GC-Mass(Sioufi et al.1991) and spectroscopic methods (De Souza and Tubino.2005; Agatonovic-Kustrin et al.1997 ; Matin et al.2005; Sastry et al.1989; Sena et al.2004).

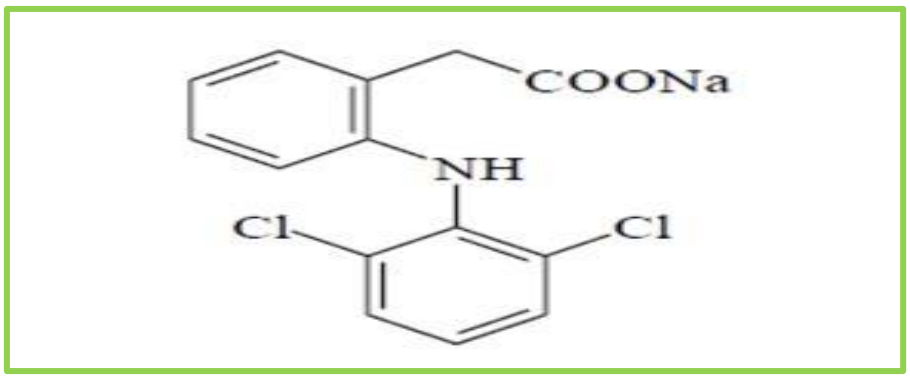


Fig. (1-9) Chemical structure of the diclofenec sodium.

An extensive literature survey revealed that there were several HPLC methods for the determination of diclofenec in blood plasma, whereas there was little other work disclosed only for the quantitative determination of diclofenec in pharmaceutical formulation samples.

Selective electrodes were used as a technique for determination of drugs due to several properties, rapid, easy preparation, fast response time, selectivity, wide linearity and low cost. For above characteristics that led to used sensors for determination for ionic species, and the list of available electrodes has grown largely over the past years (Faridbod et al.2011; Ganjali et al.2008; Zamani et al.2008; Faridbod et al.2010; Mittal et al.2010; Faridbod et al.2012; Gupta et al.2005; Bera et al.2010; Ganjali et al.2007; Zamani et al.2008). PVC

membrane electrodes are one of the types of potentiometric sensors which were widely used and have different application in analysis of ionic species (Faridbod et al. 2007; Abedi et al. 2007; Mersal, Arida and Ganjali et al.2008; Ganjali et al. 2007; Zamani et al. 2007; Gupta et al. 2006; Zamani et al. 2008; Ganjali et al. 2009).

Molecularly imprinted polymers (MIPs) were used for drugs as formation a complex between the analyte and a functional monomer with presence of a cross-linking agent and initiator .Several reports described the use MIPs as ionospheres in ion selective electrodes for a variety of drugs and chemicals such as ibuprofen (Al-Bayati and Al-jabari.2015), warfarin (Al-Bayati and Al-Saidi. 2016), phenytoin (Al-Bayati and Al-Khafaji. 2017) and metronidazole benzoate (Turiel and Marten-Esteban. 2010).

1-24 Objective of Study

Determination of Pure and pharmaceutical formulations drugs of IBP and DFS using electrode membranes is the main aim of this study. These membranes electrodes based on PVC and solid phase extraction by using the molecularly imprinted polymer(MIP) technique involve some of these objectives which can be presented as the follows

1. Preparation of MIPs and NIPs for the (IBP) as templates using three kinds of functional monomers, 1-vinylimidazol (1-VA) ,2-Hydroxy ethyl meth acrylate (2-HEMA) and Styrene (S)basic monomer.
2. Preparation of MIPs and NIPs for the (DFS) as templates using three kinds of functional monomers ,1-vinylimidazol (1-VA), Acrylamide (AA) and Styrene (S)
3. Use of MIPs and NIPs prepared in selective construction of (IBP) and (DFS).
4. Characterization of these electrodes' specification after IUPAC commendation.
5. Determination of pure and pharmaceutical medicines for IBP and DFS by application of electrode membranes and comparison of results with the British Pharmacopoeia.

Chapter Two

2-Materials and Methods

2-1 Materials and Equipment

In this study, the following in struments used in the study are showed in table(2-1)

Table (2-1): The Instruments used in this study

No	Instrument	Source and Model
1	Calomel Electrode (single junction)	Gallenkamp, USA
2	Electronic balance (Sensitive)	Germany ACS120-4Kern&Sohn GmbH
3	Expandable ion analyzer	Hanna / Italia Model / pH meter 211
4	Expandable ion analyzer	WTW / Germany Model / kl pH meter 720
5	Hotplate and magnetic stirrer	Electrothermal - England
6	Infrared spectrophotometer	SHIMADZU / Japan FTIR-8000
7	Nitrogen gas system	Local made
8	Scanning Electron Microscopy (SEM)	Tokyo / Japan - JSM-6390A
9	Sieve (125µm)	Germany
10	Silver / Silver chloride wire	Local made
11	Soxhlet - apparatus	W / Germany - SONOREX
12	Vacuum desiccator	Barn ant company
13	Water bath.	Germany / Memmert-854
14	Ultra-Sonic devise (ultrasonicator)	W / Germany - SONOREX
15	UV-Visible spectrophotometer (double beam)- Version -1.10	SHIMADZU / Japan Model (UV-1650 PC)

2-2 Materials and Plasticizer

In this study the following chemical compounds were used which are listed in Table (2-2)

Table(2.2): chemicals.

Materials	Chemical Formula	M.W gm mlo^{-1}	Assay %	Company
Ibuprofen	$C_{13}H_{18}O_2$	206.29	99.99	SDI-IRAQ
Diclofenec sodium	$C_{14}H_{10}Cl_2NNaO_2$	318.1	99.99	SDI-IRAQ
1-vinylimidazol	$C_5H_6N_2$	94.11	99.9	sigma-aldrich
2-hydroxyethyl methacrylate	$C_4H_6O_2$	130.14	99.99	sigma-aldrich
Styren	C_8H_8	104.15	99.9	sigma-aldrich
Acrylamide	C_3H_5NO	71.08	99	BDH
Ethylene glycol dimethacrylate	$C_{10}H_{14}O_4$	198.22	98%	sigma-aldrich
N-N methylene bis acrylamide	$C_7H_{10}N_2O_2$	154.17	99.9%	sigma-aldrich
Benzoyl peroxide	$C_{14}H_{10}O_4$	242.23	78	sigma-aldrich
Methanol	CH_3OH	32.04	99.99	Merck
Chloroform	$CHCl_3$	119.38	99.7	Analar
Acetic acid	$C_2H_4O_2$	60.05	99	BDH
Acetonitrile	C2H3N	41.05	99.9	sigma-aldrich
Tetra hydro furan	C_4H_8O	72.11	99.5	Fluka AG
Polyvinyl chloride	PVC	High M.WT	99.5	BDH
Phospho molybdic acid(PMA)	$H_3PO_4.12MoO_3.24H_2O$	2257.6	99.6	BDH

Aluminum (III) chloride	$Alcl_3$	133.34	99.5	BDH
Calcium chloride	$CaCl_2$	110.99	99.5	BDH
Potassium chloride	KCL	54.77	99	sigma-aldrich
Propylparaben	$C_{10}H_{12}O_3$	96.80	180.20	Samarra-Iraq
Methylparaben	$C_8H_8O_3$	152.15	95	Samarra-Iraq
Trisodium citrate	$Na_3C_6H_5O$	258.06	95	Samarra-Iraq
Hydrochloric acid	HCl	36.45	37.00	BDH, Fluka
Sodium hydroxide	NaOH	40	97	BDH

- The plasticizers were obtained from Fluka and sigma- Aldrich, their Chemicals composition and assay are tabulated in Table (2.2).

Table (2.3): plasticizer used in this study

Name of Plasticizer	Chemical composition	Assay %	company
Dioctyl phthalate (DOPH)	$C_6H_4[CO_2C_8H_{17}]_2$	99	Fluka
Nitro benzene (NB)	$C_6H_5NO_2$	99	Sigma-Aldrich
Tri tolyl phosphate (TTP)	$C_{21}H_{21}O_4P$	97	Fluka
Dibutyle phthalate (DBPH)	$C_{16}H_{22}O_4$	99	Fluka
Dibutyle Sebacate (DBS)	$C_{18}H_{34}O_4$	97	Sigma- Aldrich
Tris (2-ethyl hexyl) phosphate (TEHP)	$C_{24}H_{51}O_4P$	97	Fluka

2-3 The Drugs

Table (2-4)shows the pharmaceutical formulation and their companies manufacturers

Table (2-4)the pharmaceuticals formulations and their companies manufactures

No	pharmaceuticals formulations	manufactures companies
	Ibuprofen	
1	PROFEDIN tablet (400mg)	SDi – Samarra - Iraq
2	Profinal (400mg)	Julphar –Ras Al khaimah- UAE
3	Maximum strength Ibuprofen tablet(400mg)	WOCKHARDT- UK
	Diclofenec sodium	
4	Voldic tablet (100mg)	Pharma international – Jordan
5	Clofen tablet (100mg)	Julphar –Ras Al khaimah- UAE
6	Refen retard tablet (100mg)	Hemofarm – surbi

Figure(2-1)shows tablet forms used in the study

Fig (2-1) Tablet forms used in the study

2-4 Preparation of Standard Solutions for ISEs Studies

Standard solution of 0.1 M Ibuprofen was prepared by dissolving 2.0629 g of standard Ibuprofen in methanol and completed to 100 mL in a

volumetric flask. The other solutions were prepared in 100 mL at the ranged from 10^{-6} to 10^{-1} M using the same procedure.

2. Standard solution of 0.1 M Diclofenec sodium was prepared by dissolving 3.181g of standard Diclofenec sodium in methanol and completed to 100 mL in volumetric flask. The other solutions were prepared in 100 mL in the range from 10^{-6} to 10^{-1} M in the same procedure.

3- Standard solutions of 1×10^{-3} , 1×10^{-4} M phosphomolybdic acid (PMA) were prepared by dissolving (0.2258 g) and (0.02258 g) respectively in deionized distilled water and diluted up to 100 mL .

4-A series of solutions were prepared from 0.1M of each of interfering salt;(0.5477)g of KCl, (1.1099)g of $CaCl_2$,(1.3334)g of $Alcl_3$, ()g of Methylparaben $C_8H_8O_3$, ()g of Propylparaben $C_{10}H_{12}O_3$ and ()g of tri sodium citrate $Na_3C_6H_5O$, in deionized distilled water and diluting to the mark in a 100mL volumetric flask. Ranges of several standard solutions from 10^{-6} to 10^{-1}M, were freshly prepared.

5- Hydrochloric acid (1N and 0.1N) was prepared from (0.81 mL and 8.36 mL) of concentrated HCl respectively and diluted by deionized water to 100 mL.

6- Standard solution (1N and 0.1N) of sodium hydroxide were prepared dissolving (4g)and (0.4g) respectively in deionized distilled water and diluted up to 100mL .

7- Standard solution of (100ppm) of Ibuprofen and Diclofenec sodium were prepared by dissolving 0.01 g of standard Ibuprofen and Diclofenec sodium in each 10ml methanol and completed to 100 mL in the volumetric flask. The other solutions were prepared in 50 mL at the range from 1 to 60 ppm from stock solutions by using the dilution law.

8- Standard solutions of (1×10^{-3}M) of trading Ibuprofen(tablets)were prepared by dissolving (0.0143 g of profedin),(0.013g of profinal) and(0.088g of Maximum strength ibuprofen) each in 10ml methanol and completed to 100 mL in the volumetric flask. The solutions(1×10^{-4}M) were prepared in 100 mL from stock solution by using the dilution law.

9- Standard solutions of (1×10^{-3}M) of trading Diclofenec sodium (tablets) were prepared by dissolving (0.0144 g of Voldic),(0.0228g of CLOFEN) and(0.022g of REFEN) each in 10Ml methanol and completed to 100 mL in the volumetric flask. The solutions(1×10^{-4}M) were prepared in 100 mL from stock solution by using dilution law.

2-5 The Classical Approach Of Process Imprinting

The essential substances were the important constituents to achieve imprinting and complete the polymerization process these compound monomers, cross linkers and initiators were dissolved in suitable solvent and then mixed and reacted together until the interaction occurred and process imprinting was done. The conditions playing important role in imprinting process upon which an imprinting depend includes as temperature, solvents and ratio of mixed substances to preparation polymers (Fig 2-2)

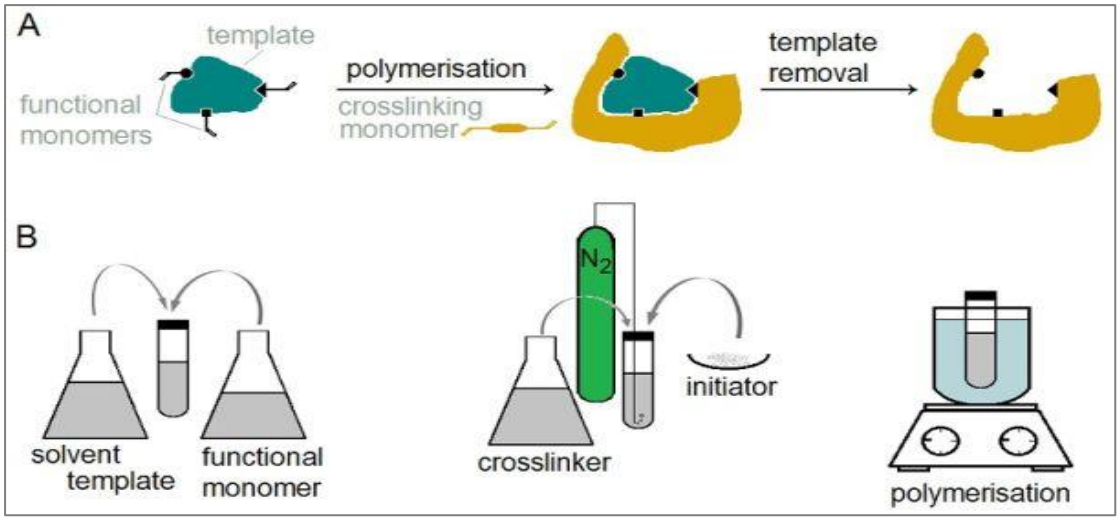


Fig (2-2) Steps of synthesis of Molecular imprinted polymers

The type of the solvent in which the monomers dissolve of cross linkers and initiators and mixing together with shaking for a few minutes until the components become homogeneous were considered in formations of MIP (Turiel,Esteban,2010,). When the polymer was formed and became colored, solid or elastic, it was grinded and filtered by the sieve. The drug was then extracted by soxlet to be used to prepare the membranes electrodes. These photos in the Figure (2.3) below demonstrate the steps of the preparation process MIPs.

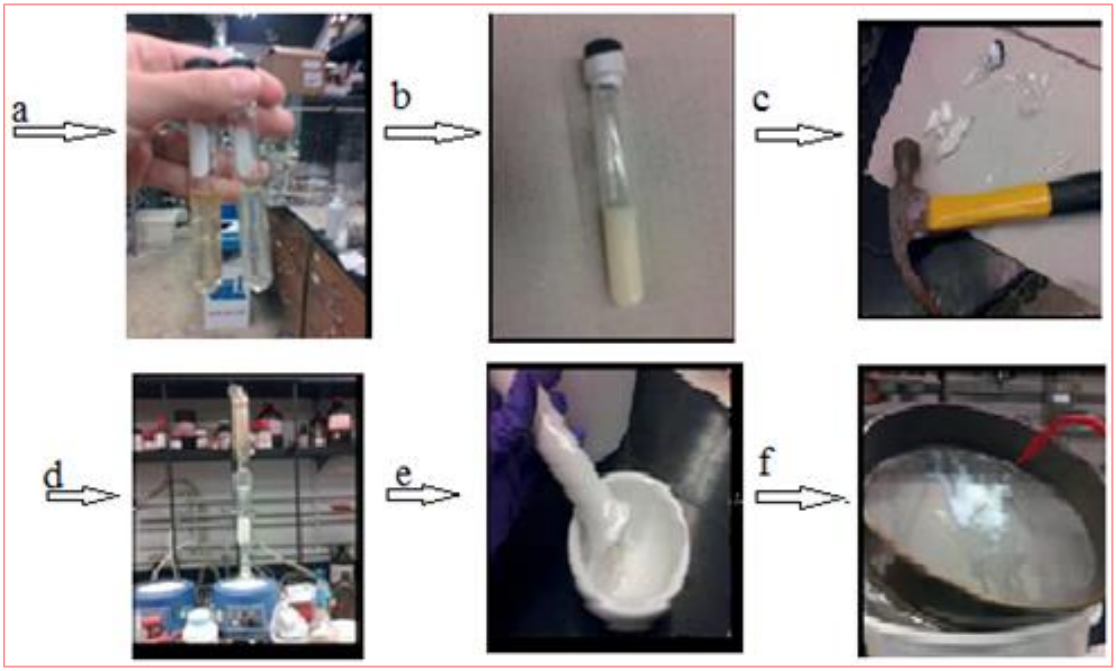


Figure (2-3)The preparations of Molecular Imprinted polymers

Fig.(2-3): The preparation of imprinting polymer illustration in the laboratory: (a.) combinations crosslinker with template, monomer and initiator and dissolution in solvent (porogen) (b.) polymerization process and formation of solid MIP(c.) process removal of MIP (d.) Transfer of MIP to Saxolite to separate the template (e.) After separate the template, crushing of MIP to the required particle size (f.) washing and grinding until an appropriate amount of materials was obtained to less size for the particle (using 125µm and 53µm mesh sieves).

2-6 Theoretical Background Of Ibuprofen MIPs (IBP)

Three MIPs for Ibuprofen were synthesized by polymerization process. The composition of polymerization method required the drug as the template and it was important to choose the monomers so as to play effective role in interaction with template. Preparation of molecularly imprinted polymers and Non-molecularly imprinted polymers were used three monomers which are 2-vinyl imidazole (1-VI), 2-hydroxyethylmethaacrylate (2-HEMA) and Styrene that achieved printing process.

The formation of the molecularly imprinted polymers and non-molecularly imprinted polymers required the amount and suitable type of cross linker to complete the polymerization process and to form polymer with more rigidity and high selectivity.

Additionally, the polymerization method was limited affected by the type of solvent used. Aprotic and a polar organic solvent were used for bulk polymerization mainly with low dielectric constant. The porogen is strongly influence the stability of the functional monomer-template complexes in the pre-polymerization step. Additionally, many solvents were tested including methanol, chloroform, DMSO, Acetonitrile; chloroform and methanol were found to be a suitable porogenic solvents.

The suggested schemes shown in Figure (2-4) ,(2-5) and (2-6) illustrate the synthesis of molecular imprinted polymers for (IBP) based on 1-vinyl imidazole (1-VI) , 2-hydroxyethylmethaacrylate (2-HEMA) and Styrene respectively.

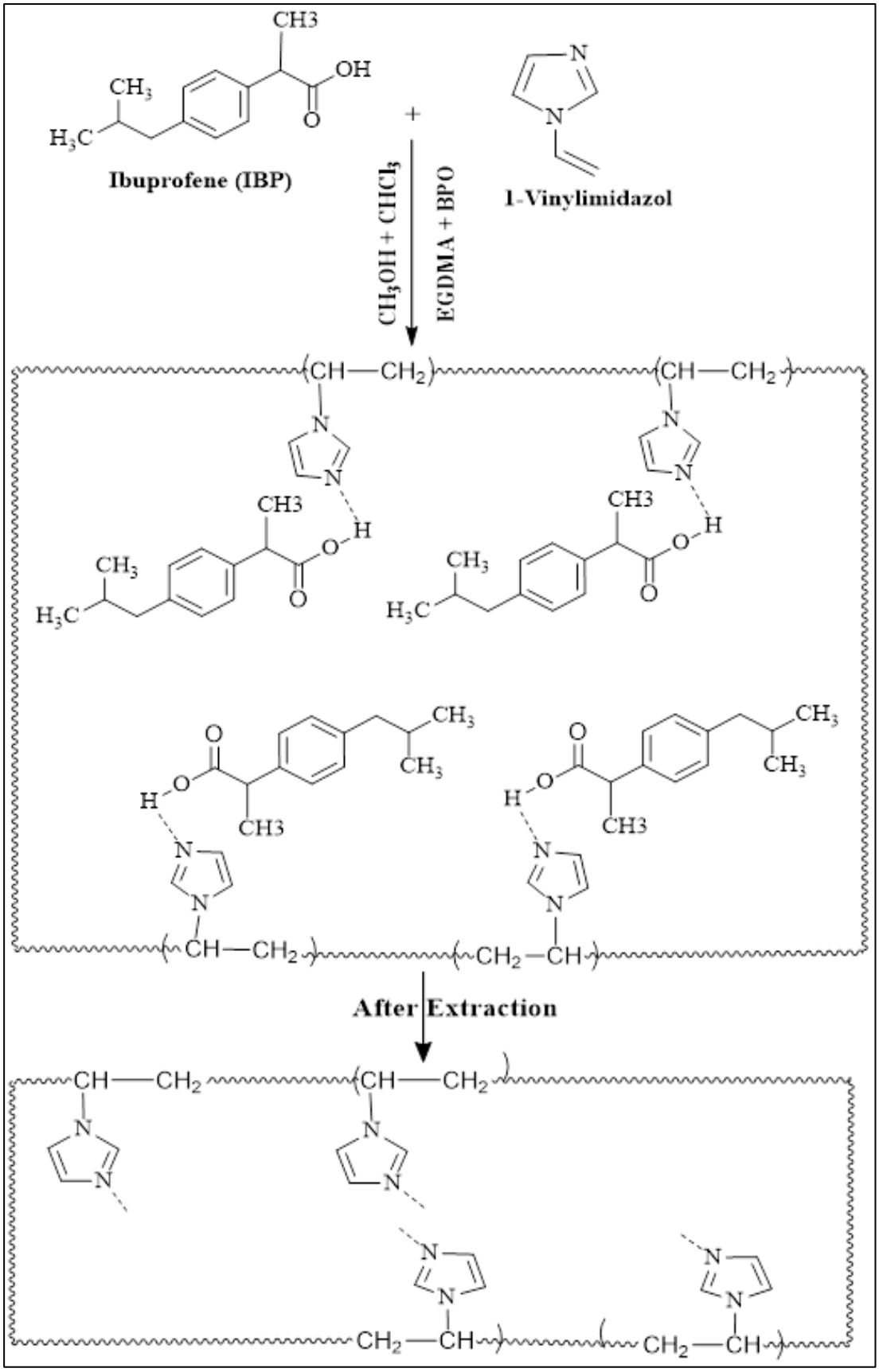


Fig (2-4) Scheme of IBP-MIP1 synthesis, using 1-vinyl imidazole as a basic functional monomer.

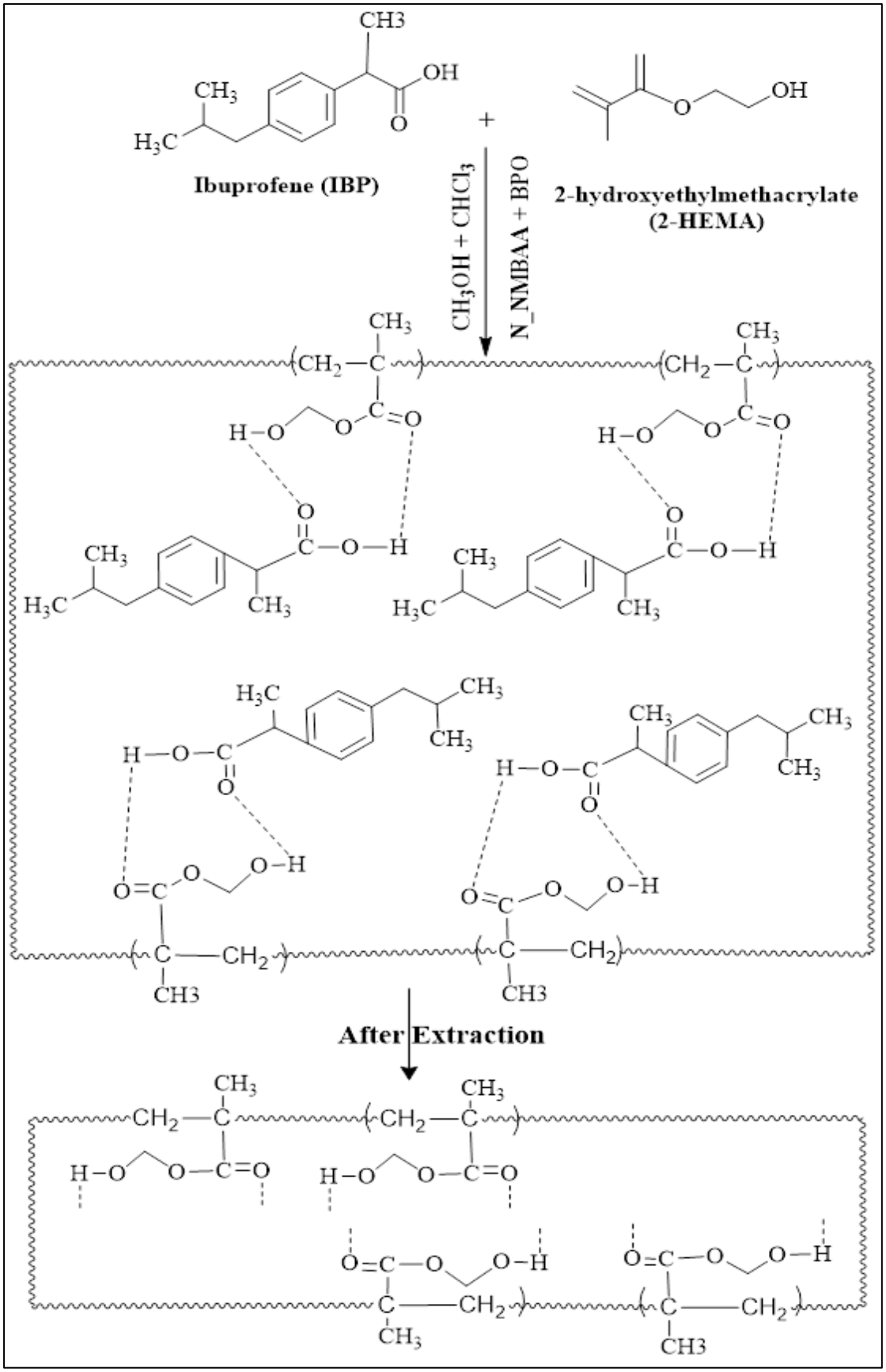


Fig (2-5) Scheme of IBP-MIP2 synthesis, using 2-Hydroxyethylemethacrylate as a basic functional monomer

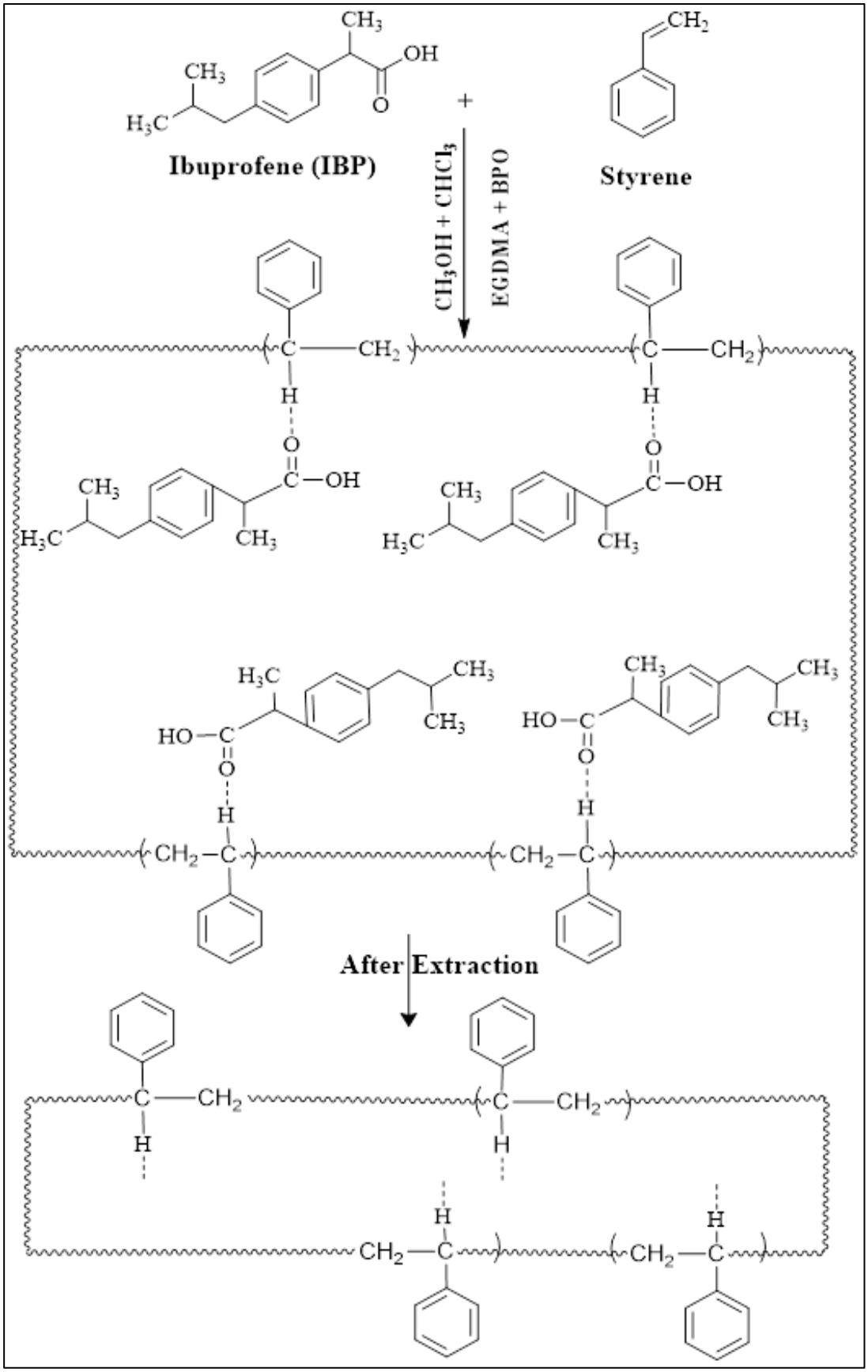


Fig (2-6)Scheme of IBP-MIP3 synthesis, using Styrene as a basic functional monomer

2-7 Synthesis Of Molecular Imprinted Polymers for Ibuprofen by polymerization Process

For preparing Ibuprofen molecularly imprinted polymer (IBP-MIP), (0.0687) 0.333 mmol of IBP was dissolved in methanol (CH_3OH), then mixed with (0.6009g) 6.4 mmol of 1-vinylimidazol(1-Vi), (0.8305g) 6.4 mmol of 2-hydroxy ethyl meth acrylate (2-HEMA) and (0.6651g) 6.4mmol of styrene as the monomer which dissolved in 5± mL methanol (CH_3OH) , after ther (0.8048g) 4mmol of Ethylene glycol Di methyl acrylate (EGDMA) and (0.6259g) 4mmol (N-Nmethylene bis acrylamide) (N-N MBAA) the last dissolved in 10± mL methanol was added to the previous solution as the cross linker , followed by adding (0.025g) of benzoyl peroxide (BPO) as the initiator which also dissolved in 3± mL chloroform. The mixture was stirred for 5 minutes to obtain a homogeneous solution. N_2 gas passé was for 30 minutes through the mixture to remove oxygen from solution. After that the solution was placed in a water path at 65℃. When the reaction complete the resulting white colored polymer of the molecularly imprinted polymer was obtained and became hardened after (24-48h), after the polymerization process the polymer was dried and crushed to obtain polymer particles. The MIP were put in tubes (thimble) were washed repeatedly with excess amount of a mixture containing methanol /acetic acid/ (8:2v/v) in the soxhlet extraction apparatus for (24-50h) until template and the non-reacted compounds were removed and dried for 1 h in vacuum. The synthesized MIP prepared were left for 1 h at 30 ℃ in a drying oven for drying. After that the polymers were crushed and grounded using mortar and pestle and sieved to particles size 150µm (using 100 mesh sieve). Before extraction, of the sampling device and used as extraction needles, the plastic syringe (Column) was packed with prepared (MIP) . The resulting solution (urine or standard solution) was poured from the

top of thecolumn; and the movement of the solution was affected by electric vacuum at99- 100 rpm. The preparation of non-molecularly imprinted polymer using the same substances and conditions that formed MIP but without Ibuprofen (template).Figure (2-7) The non-molecularly imprinted polymers were achieved by removing the template from MIPs, which achieved by UV-visible absorbance. As well as FTIR showing the compare between MIPs and NIPs by active sites of functional groups.

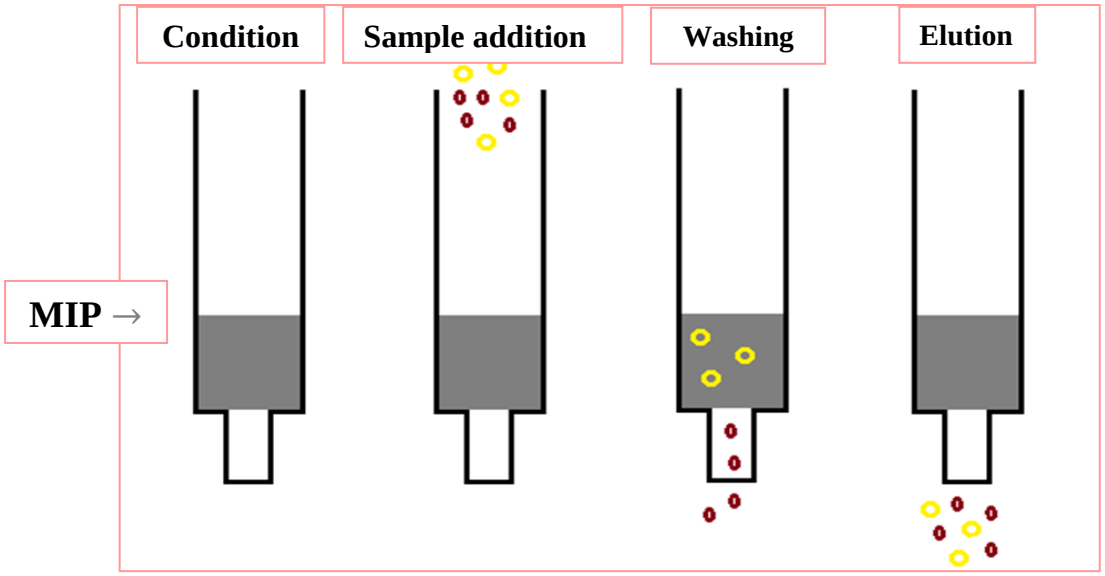


Fig (2-7):General shape for Solid phase extraction using MIP

2-8 Theoretical Of MIPs Diclofenec Sodium (DFS)

Three MIPs for diclofenec sodium were synthesized by polymerization process. The composition of polymerization method required the drug as the template and it was important to choose the monomers so as to effect its for interaction with template. Preparation of molecularly imprinted polymers and Non-molecularly imprinted polymers used three monomers, 1-vinyl Imidazole (1-VI) ,Acryl amide (AA)and Styrene that achieved printing process.

The formation of the molecularly imprinted polymers and non-molecularly imprinted polymers were required the amount and suitable type of cross linker(EGDMA) to complete the polymerization process and to form polymer with more rigidity and high selectivity Additionally, the polymerization method was effected by the type of solvent used. Aprotic and a polar organic solvent were used for bulk polymerization

mainly with low dielectric constant. The porogen is strongly influence the stability of the functional monomer-template complexes in the pre-polymerization step. Additionally, many solvents were tested including methanol, chloroform, DMSO, Acetonitrile; chloroform and methanol were found to be a suitable porogenic solvents.

The suggested schemes showed in Figures (2-8),(2-9) and (2-10) illustrate the synthesis of Molecular imprinted polymers for (DFS) based on (1-VI) (AA) and(Styrene) respectively.

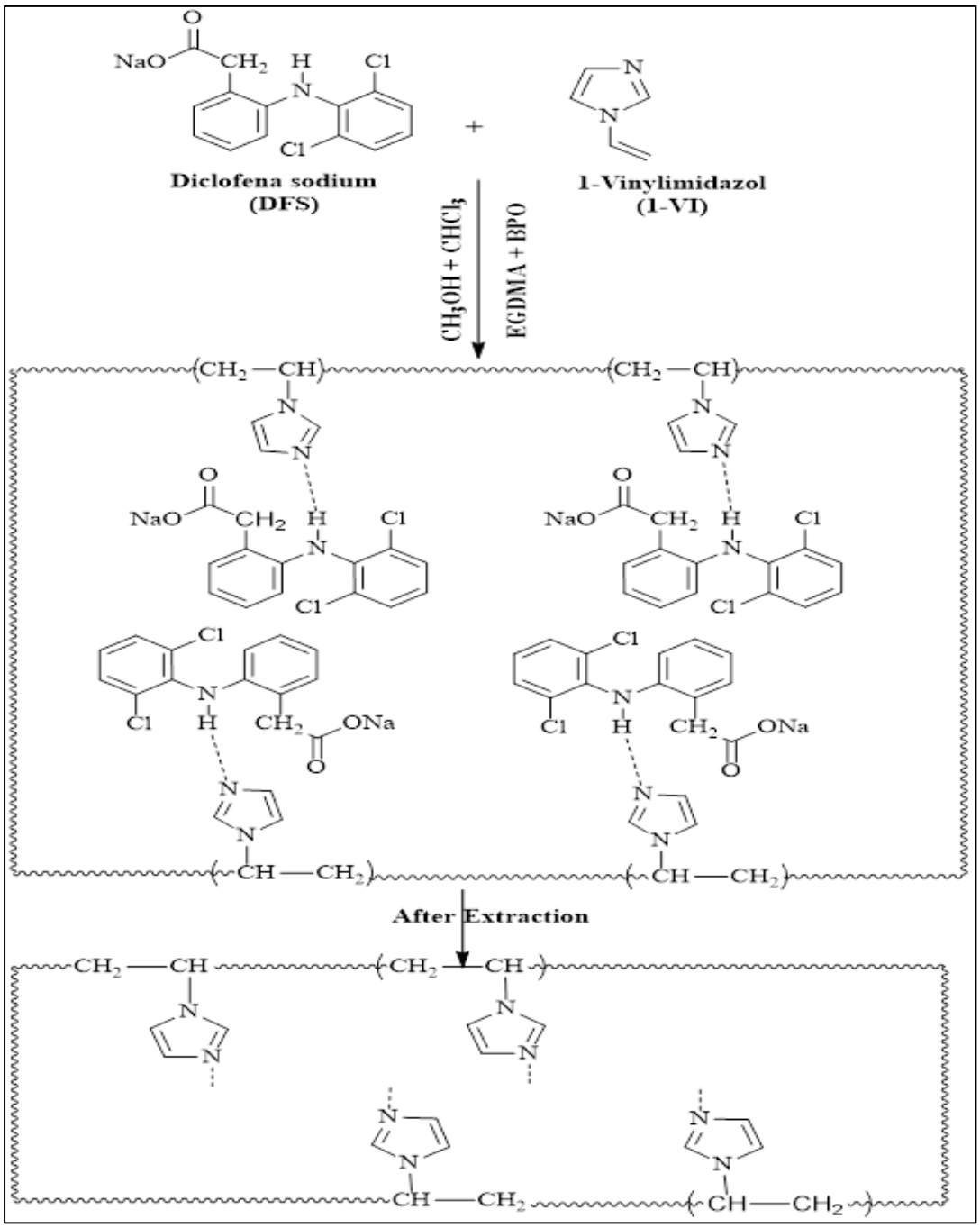


Fig (2-8): Scheme of DFS-MIP1 synthesis, using 1-vinyl imidazole as a basic functional monomer

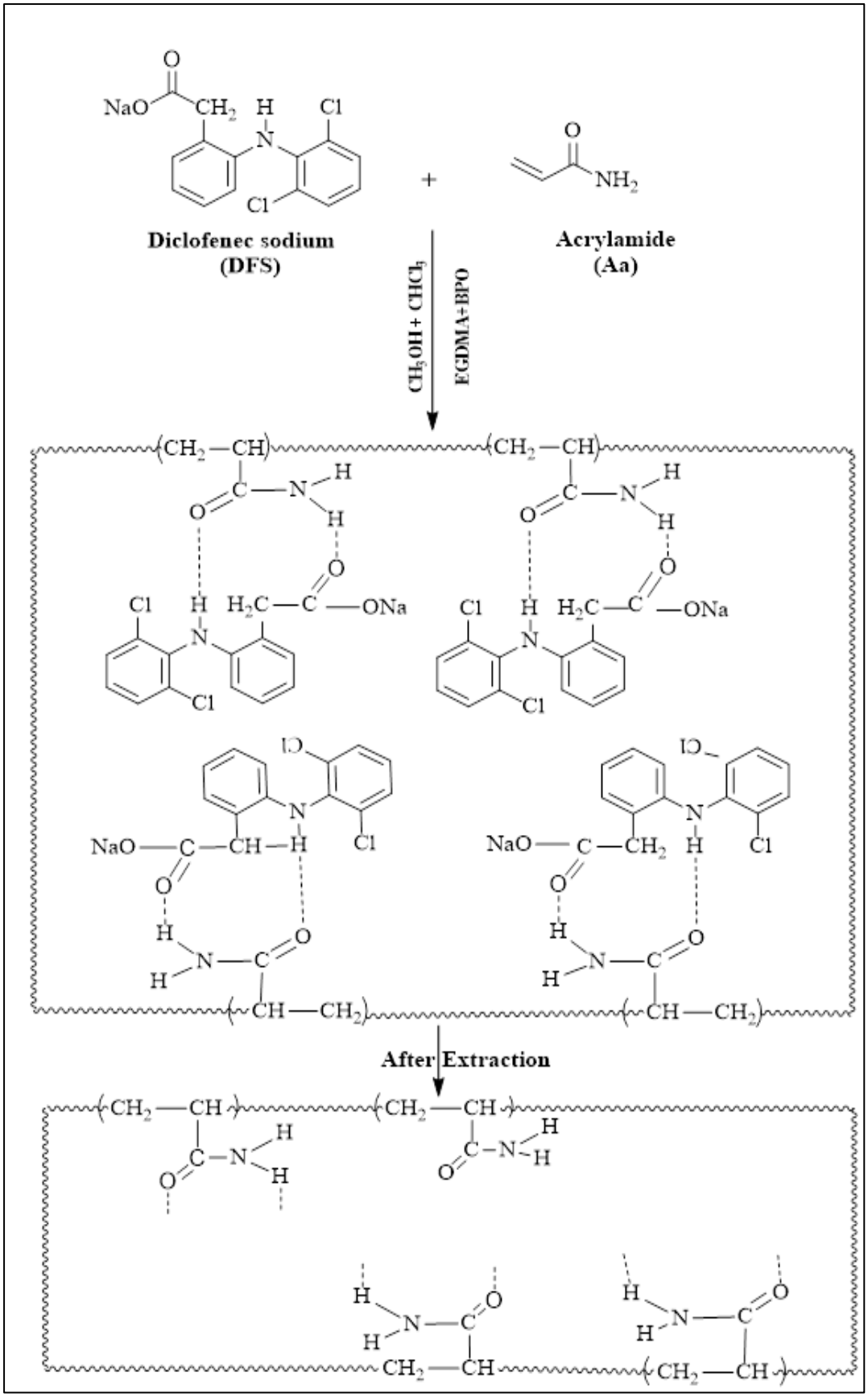


Fig (2-9): Scheme of DFS-MIP2 synthesis, using Acrylamide as a basic functional monomer

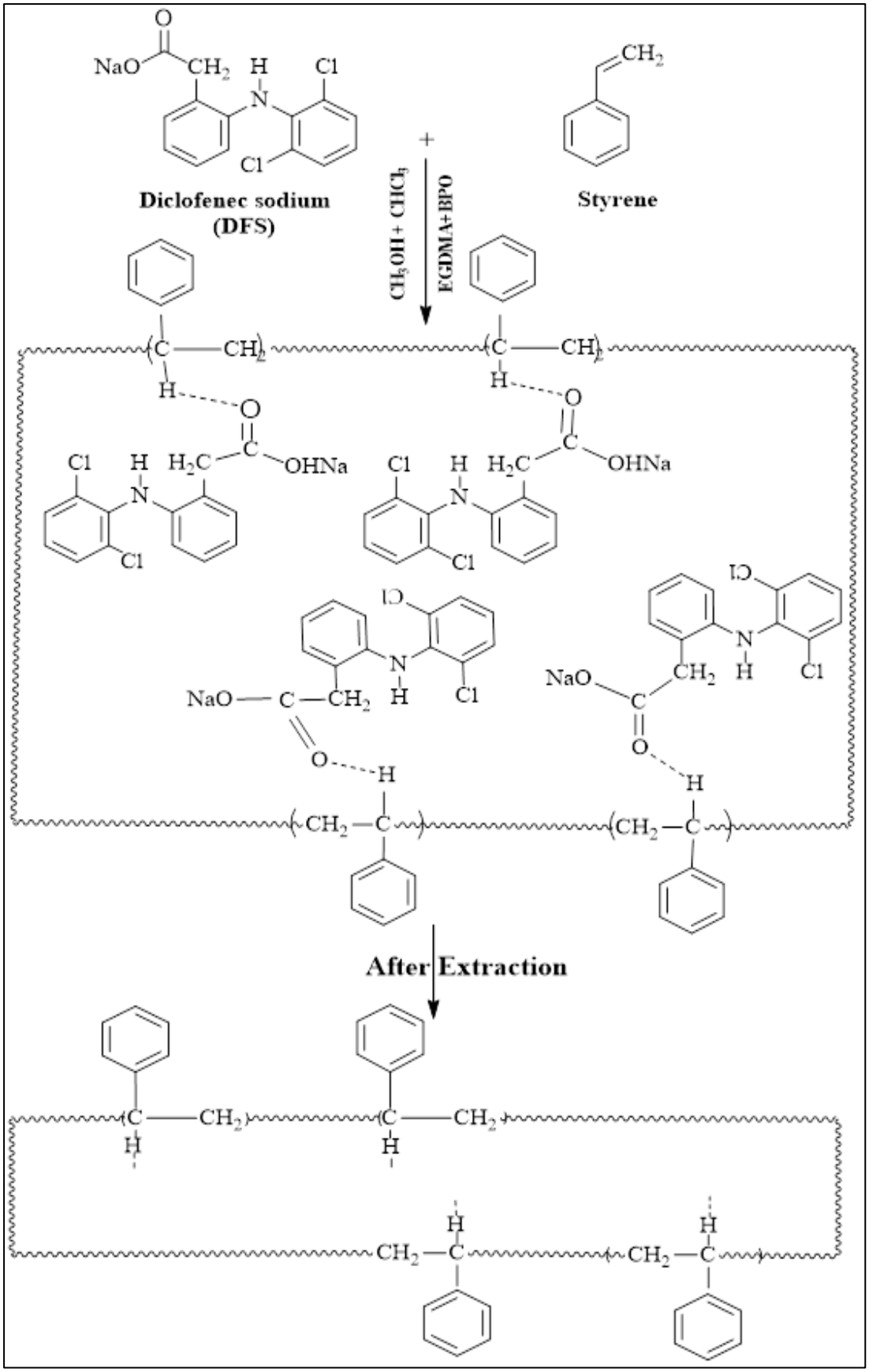


Fig (2-10): Scheme of DFS-MIP3 synthesis, using Styrene as a basic functional monomer

2-9 Synthesis of Molecular Imprinted Polymers For Diclofenec Sodium by Polymerization Process

For preparing Diclofenec sodium molecularly imprinted polymer (DFS-MIP), (0.1590g) (0.5 mmol)of DFS was dissolved in methanol (CH_3OH), then mixed with (0.4340g) (4.61 mmol) of 1-vinylimidazol (1-Vi), (0.3277g) (4.61 mmol) of Acryl amide (AA) and (0.4802g) (4.61mmol) of Styrene as the monomer which dissolved in 5± mL methanol (CH_3OH) , Then (1.98g) (9.99mmol)of Ethylene glycol Di methyl acrylate (EGDMA) was added to the previous solution as the cross linker , followed by adding (0.05g) of benzoyl peroxide (BP) as the initiator which also dissolved in 5± mL chloroform. The mixture was stirred for 5 minutes to obtain a homogeneous solution. N_2 gas was passed for 30 minutes on through the mixture to remove oxygen from solution. After that the solution was placed in a water path at 65℃. When the reaction was complete the resulting white colored polymer of the molecularly imprinted polymer was obtained and became hardened after (24-72h), after the polymerization process the polymer was dried and crushed to obtain polymer particles The MIP was but in tubes (thimble) washed repeatedly with excess amount of a mixture containing methanol /acetic acid/ (8:2v/v) in the soxlet extraction apparatus for (24-50h) until template and the non-reacted compounds were removed and dried for 1 h in vacuum. The synthesized MIP prepared were left for 1 h at 30 ℃ in a drying oven for drying. the polymers were then crushed and grounded using mortar and pestle and sieved to particles size (μm) (using 100 mesh sieve). Before extraction, of the sampling device and use as extraction needles, the plastic syringe (Column) was packed with prepared (MIP) The resulting solution (urine or standard solution) was poured from the top of the column; and the movement of the solution was effected by

electric vacuum at99- 100 rpm. The preparation of non-molecularly imprinted polymer used the same substances and conditions that formed MIP but without Ibuprofen (template). The non-molecularly imprinted polymers were achieved by removal of the template from MIPs, The NIPs were proved by UV-visible and FTIR showing the compare between MIPs and NIPs by active sites of functional groups.

2-10 Physical Characterization and Structure Of IBP-MIPs and DFS-MIPs

The structure of IBP –MIPs and DFS-MIPs can be estimated by using techniques showing the structure of polymers. One of these techniques that was used in this study was Scanning Electron Microscopy (SEM). Other technique was FTIR- spectrometry, which measured infrared absorption spectra of the drugs and the polymers synthesized in this study between 400 to 4000 cm^{-1}.

2-11Synthesis of Membrane of Molecularly Imprinted Polymers Electrode

IBP -MIP (0.36g) was mixed with different plasticizers (0.45g) used in this work such as DOPH, NB, TTP, DBPH, and DBS .Then added (0.2g) of PVC powder was scattered on 7± mL of tetra hydro furan with stirring until a clear viscous solution was acquired. Was added The solutions mixed with than stirred until the mixture became homogeneous. The mixture was casted into a glass ring (30-35 mm diameter) and unwind on a glass plate and a ribbon of filter was placed on top of the glass. The solvent was then allowed to evaporate at room temperature for more than 24 hours at least. The thickness of the membrane obtained was different from one membrane to another The thickness was about (0.4 -0.7) mm. That size of membrane was adequate to preparing electrodes.

2-12Collection and Formation of the Ion Selective Electrode

The building of the electrode body and the immobilization were achieved as portrayed by Mahajan et al. (2004 ,811). The PVC tube (1-2 cm long) was flattened and polished by putting it on a glass plate and soaking with THF. The membrane was cut similar to the external diameter of the PVC tubing and pasted on the polished end. The other direction of the PVC tubing was then linked to the electrode body. Ibuprofen and Diclofenec sodium solution (0.1 M) was filled in the glass tube as an internal solution. Preferred immersing the membrane in standard solution of 0.1 M of Ibuprofen and Diclofenec sodium for at least three hours before measurements which represents stipulations of membrane electrode and to make the electrodes more sensitive.Fig2.11

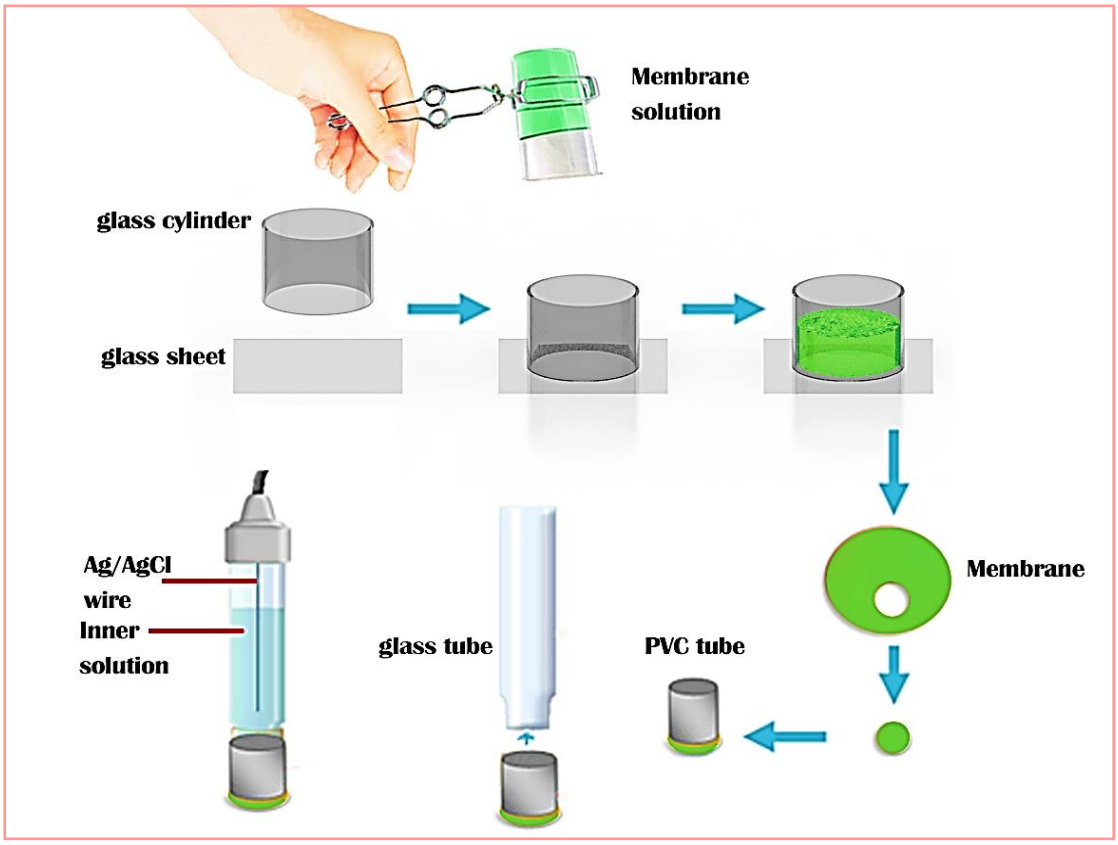


Fig. (2-11): Collection process of the Ion selective electrode[194].

2-13 Potential Measurement

The largest group of potentiometric sensors is represented by ion selective electrodes (ISEs). The signal is generated by the charge separation at the interface between the membrane and the solution, due to the selective partitioning of ionic species between these two phases. A line diagram of the ISE cell can be represented by the figure (2.12).

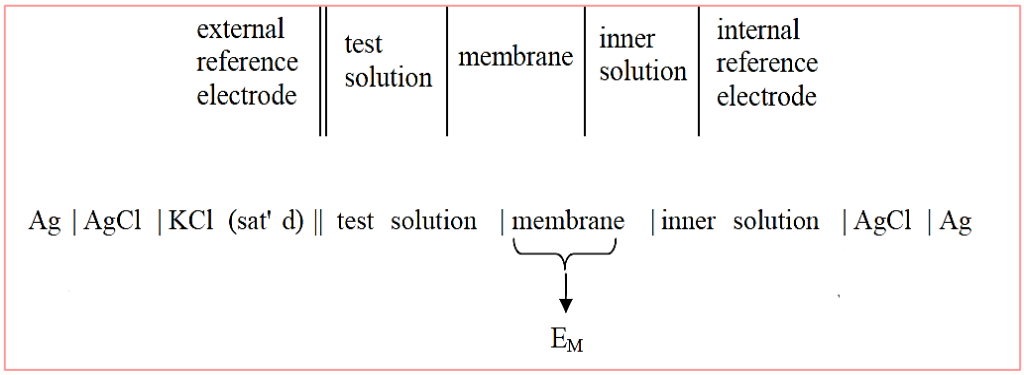


Fig. (2-12): a line diagram of the ISE cell

And the potential of (ISE) cell is given by the equation(Wroblewski,2004)

$$E_{cell} = (E_m - E_{ref}) + E_j \quad \text{..... (2.1)}$$

Where:

E_{cell} = the potential of the cell

E_m = is the membrane potential.

E_{ref} = the potential of the reference electrode.

E_j = the liquid junction potential, formed at the sample–salt bridge interface.

The Ibuprofen-MIP and Diclofenec sodium electrode combined with Ag-AgCl electrode and the reference electrode was 0.1M internal solution of Ibuprofen and Diclofenec sodium

The measurement of calibration curve can be achieve for each electrode by using appropriate ranging of standard solutions which at ranged (10^{-6}-

10^{-1}M) of Ibuprofen and Diclofenec sodium. The magnetic stirrer was used when measuring to obtain a more homogeneous solution if the solution requires homogeneity as well as increasing the response rapid of the solution. The calibration curve calculated by plotted the potential measurements against the concentrations on Orion paper semi-logarithmic or on graph (for simplicity usually was used manually the Microsoft Excel program to plotting the calibration curve). The calibration curve for all electrodes based on IBP-MIP membranes, DFS-MIPmembranes and the characteristics obtained included: Nernstain slopes, linearity range, correlation coefficients, detection limit (M) and life time (day). The effect of the acidic and basal function on the membrane electrode response was investigated by using the solutions of hydrochloric acid and sodium hydroxide in appropriate quantities. The concentrations which were prepared (1×10^{-3} and 1×10^{-4}) M for the study of the hydrogen function and the range used for the pH from (1.0-11.0).

2-14 Calibration Curve of The Membranes Electrodes

The operation of ion selective electrodes is based on the fact that there is a linear relationship between the electrical potential developed between an ISE and a reference electrode immersed in the same solution, and the logarithm of the activity of the ions in the solution. This relationship is described by the Nernst equation(Guilbault, et al.,1981):

E = constant ± (2.303 RT / nF) log a …… (2.2)

All the measurements of the ISEs for drug-MIPs (DFS-MIPs and TR-MIPs) were achieved at room temperature (25±˚C). The measurement of e.m.f by using the drug-electrode immersed in 0.1 M of standard solution of drug as the work solution connected with a SCE as the reference electrode. The calibration curve of drug-electrode was prepared at the range of the concentrations from (10^{-6}-10^{-1})M. For obtained a

homogeneous solutions were used a beaker contained magnetic stirrer in the measurement. The calibration curve was calculated and drawed these concentrations against the readings of e.m.f values(Rundle,2011). These value of the calculated calibration curve was used in other calculations in this study.

2-15 Titration Method

The stock standard solution of 1×10^{-3} M, 1×10^{-4} M phosphomolybdic acid was prepared by dissolving 0.226g, 0.0226g of phosphomolybdic acid respectively in distilled water and completed to 100 mL. For determination the Ibuprofen and Diclofenec sodium and pure and pharmaceuticals by using the phosphomolybdic acid (PMA) as a titrant. The titration was measurements based on IBP-MIPs electrode and DFS - MIPs electrode. The Ibuprofen and Diclofenec sodium was reduced PMA and precipitate when reaching at the end point during the titration potentiometry and showed by the shift in the reading of the potential electrode (Rundle .2011; Hanna instrument .2000)

2-16 Selectivity Measurements and Interference Studies

The calculation of selectivity coefficient measurement was used the separate solution method. This separate equation for this measurements according to the equation below.

$$\textbf{Log K pot} = [(E_B - E_A)/(2.303RT/z\,F)] + (1 - zA/zB)\log aA \quad \ldots\ldots (2.3)$$

EA, EB; zA, zB; and aA, represents the potentials, charge numbers, and activities for the primary A and interfering B ions, respectively at aA = aB.

The obtained results for selectivity coefficients of primary ion and interfering ions like Methylparaben, Propylparaben and Trisodium citrate were used in this work(Zurawska and Lewenstam.2011)The selectivity

coefficients depends on charges of both primary ion and interfering ions also depends on concentration, as well as the composition of electrodes. The Methylparaben, Propylparaben and Trisodium citrate solutions were prepared at concentration 0.1M of Methylparaben, Propylparaben and Trisodium citrate at range from ($10\times^{-6}$-$10\times^{-1}$) M. These interfering ions such Methylparaben, Propylparaben and Trisodium citrate were prepared and diluted to 100 mL.

2-17 Standard Solution Analysis

Various analytical methods were used to estimate drugs such as Ibuprofen and Diclofenec sodium. These analytical methods such as direct, standard addition and titration using drawing except for direct in estimate Ibuprofen and Diclofenec sodium by preparation two concentrations (1×10^{-3} and 1×10^{-4}) M of Ibuprofen and Diclofenec sodium.

In the direct method was used in the calibration curve as a primary role in determination both Ibuprofen and Diclofenec sodium by measuring the e.m.f. for the sample directly and used as indicator electrode.

In the standard addition method the calculation e.m.f. of depended on equation (2.4) which based on five additions of 0.1mL of 0.1M of standard solution to 10mL concentration of (1×10^{-3} and 1×10^{-4}) of Ibuprofen and Diclofenec sodium The increasing in one point of these additions depended on electric potential (V) versus the concentration (M) was a logarithmic curve. So that, any increase in the amount of (mV) response was due to an increasing in amount of the concentration (M) (i.e. the slop value of the curve) will only fit in one part of a unique curve, and thus the concentration before and after the addition can be identified. Concentration can be calculated of each sample (MSA method) by extrapolating the x-axis of the calibration line(Alun,1998).

Precipitation titration of the Ibuprofen and Diclofenec sodium samples was performed. In this procedure a (1×10^{-3} and 1×10^{-4})M of 10 mL

sample solution containing Ibuprofen and Diclofenec sodium were titrated against (1×10^{-3} and 1×10^{-4}) M phosphomolybdic acid solution. After each addition, potentiometric was measured by ISEs.

$$\mathbf{C_{unk.} = Cs / [10^{(E2-E1)/S}] (1+V_{unk.}/Vs) – (V_{unk.}/Vs)] \ldots (2.4)}$$

Where:

$\mathbf{C_{unk.}}$ = concentration of the unknown sample solution.

Cs = concentration of the standard solution.

$\mathbf{V_{unk.}}$ = volume of the unknown sample solution.

Vs = volume of the standard solution.

E1 = electrode potential (mV) in the sample solution.

E2 = electrode potential (mV) after the addition of the standard.

S = the electrode slope.

2-18 Preparation Of Pharmaceutical Samples.

The powder of tablets pharmaceutical tablets of Ibuprofen and Diclofenec sodium samples was obtained by using pestle and mortar to grinding the tablets, then a suitable weight for preparation in 100 mL of solutions was taken. Appropriate amount of methanol (CH_3OH) was used to dissolve pharmaceutical samples, as well as magnetic stirrer was used for more than 30 minutes. Then the solution was filtered off by using 0.07µm cellulose filter paper to prepare the following concentrations $1x10^{-3}$M and 1×10^{-4}M of Ibuprofen and Diclofenec sodium. In this study three types of samples were used to determine the concentration of Ibuprofen and Diclofenec sodium.

1- profiden tablet (400mg) from (SDI – Sammara- IRAQ), profinal tablet (400mg) from (Julphar –Ras Al khaimah- UAE) and Maximum strength Ibuprofen tablet (400mg) (WOCKHARDT- UK) purchased from local pharmacies . The powder was made from these tablets by crushing ,

grinding ,then dissolving in methanol (CH_3OH) and completing to 100 mL of methanol in the volumetric flask.

2-Voldic tablet (100mg) from (Pharma International CO. Amman–Jordan), Clofen tablet (100mg) from (Julphar –Ras Al khaimah- UAE) and Reffen tablet (100mg) (Hemofarm – surbi) were purchased from local pharmacies . The powder was made from these tablets by crushing grinding , then dissolving in methanol (CH_3OH) and completing to 100 mL of methanol in the volumetric flask.

It was taken all tablets from every types of Ibuprofen and Diclofenec sodium after the crushed were well mixed. From the powder were taken the equivalent of one tablet weight was taken and transferred in a volumetric flask which was then dissolved in10 ml of methanol with constant stirring for about 5-10

min and It was taken all tablets from every types of Ibuprofen and Diclofenec sodium after the crushed and well mixed. This solution was filtered to remove any insoluble matter.

2-19 pH Effect

The effect of pH on Ibuprofen and Diclofenec sodium membranes electrodes was showed by preparation various concentrations of both drugs (1×10^{-3} and 1×10^{-4}) M. The hydrochloric acid (0.1N, 1N) and/or sodium hydroxide (0.1N, 1N) were used to determine the values of pH at range from (1.0to11.0). The obtained results were by adding Appropriate volume (drops) of HCl / NaOH were added and the pH result were recorded. The change in potentials at differential pH values might be due to the composition of electrodes. This composition also effected on the response and life time for electrodes.

Chapter three

3Results and Discussion

3-1 The Physical Characterization of DFS-MIPs

3-1-1FTIR of Acidic MIP of (IBP)

The FTIR spectra of the Ibuprofen, and MIPs of IBP, were based on (1-vinylimidazol) as basic functional monomer (before and after the removal of drug) were shown in Figures (3-1), (3-2) and (3-3) for (IBP) drug. Table (3-1) summarizes characteristic peaks that appeared in these figures.

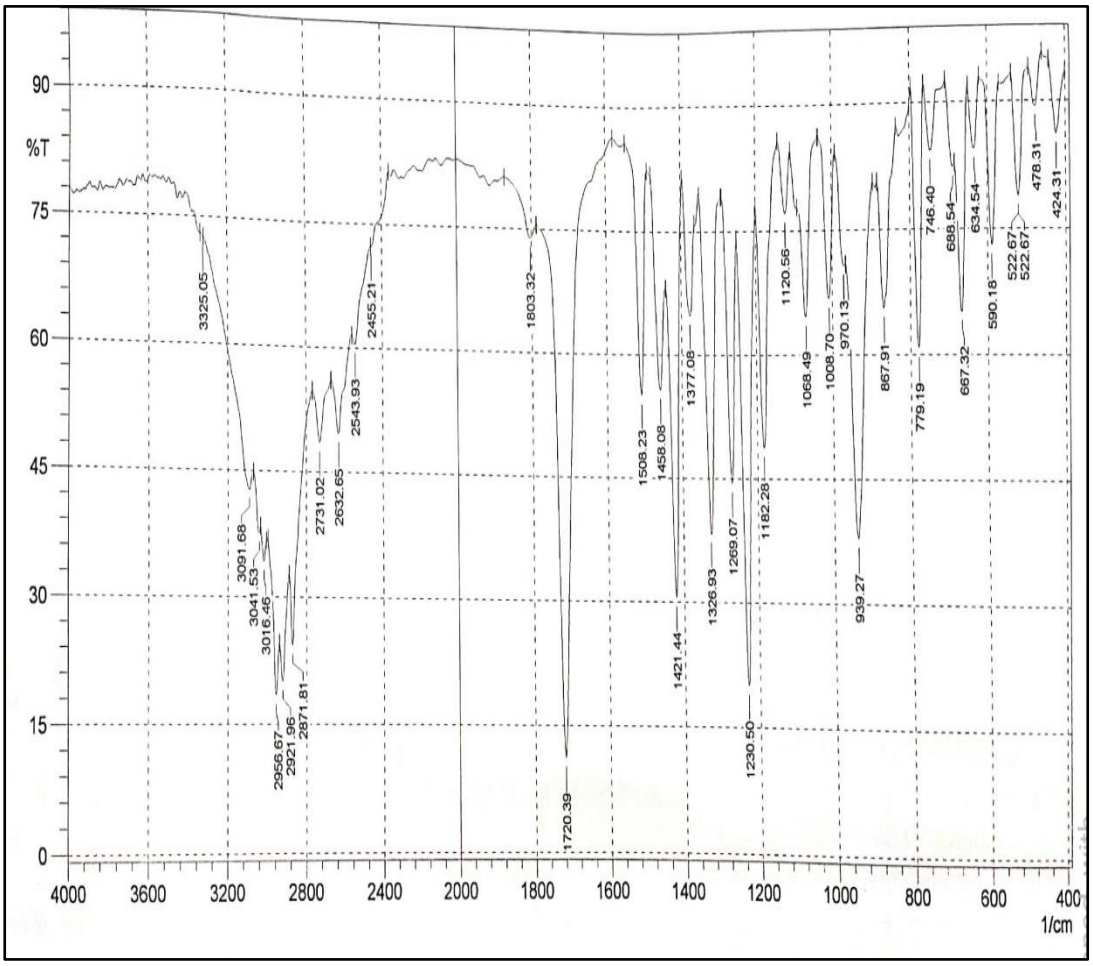


Fig. (3-1): FTIR of (IBP) drug.

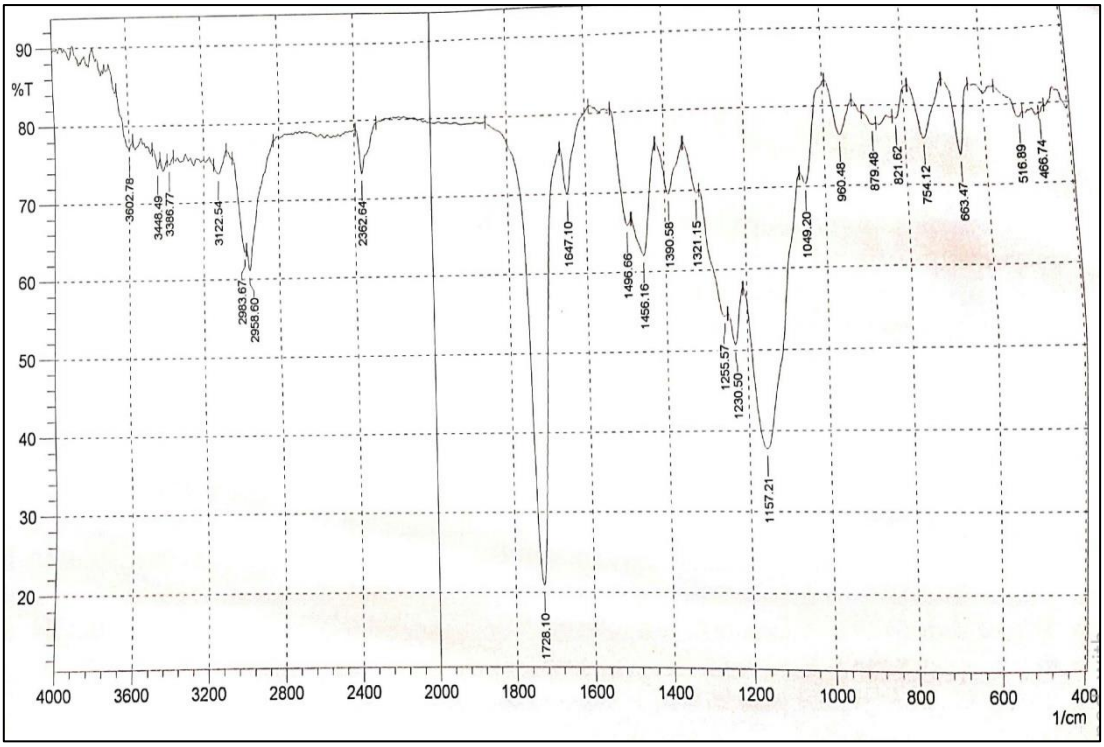


Fig. (3-2): FTIR of IBP-MIP (1-Vi) before the removal of (IBP).

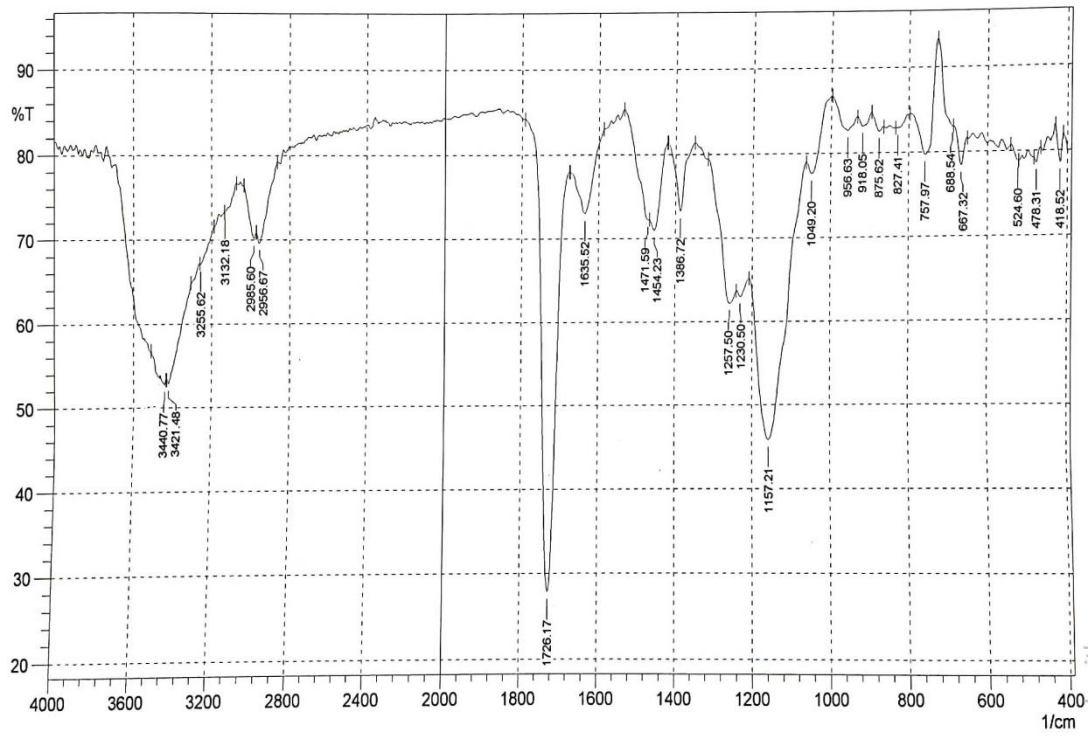


Fig. (3-3): FTIR of IBP-MIP (1-Vi) after the removal of (IBP).

Table (3-1): The most characteristic peaks of FT-IR spectra for IBP-imprinted polymer using 1-vinylimidazol (1-Vi) as a functional monomer.

No.	Functional Group	IBP	IBP -MIP (1-Vi) before template removal	IBP -MIP (1-Vi) After template removal
1	O-H	3325-2543 cm^{-1}	-	---
2	C-H(aliphatic)	2956-2871 cm^{-1}	2983-2958 cm^{-1}	2985-2956 cm^{-1}
3	C=O acid	1720 cm^{-1}	1728 cm^{-1}	1726 cm^{-1}
4	C-O-C	1230 cm^{-1}	1230 cm^{-1}	1230 cm^{-1}
5	P-di-subs.	867 cm^{-1}	821 cm^{-1}	---
6	C=C	---	1647	1635
7	C=O ester	---	---	1726

The Fourier transmission infrared spectrometry (FTIR) spectra of leached and unbleached diclofenec sodium imprinted polymers MIP before and after removal template were recorded in the range of 400–4000 cm-1 by the KBr pellet Method (Table 3.1).

The FTIR spectrum of Ibuprofen (IBP) shows abroad band at 3325-2543 cm^{-1} for hydroxyl group stretching attributed to carboxylic acid isomer of IBP. While the FTIR spectrum of IBP-MIP before and after template removal. shows a small band at 1647 and 1635 cm^{-1} belonging to C=C of vinyl group stretching in comparison with the FTIR spectrum of IBP which does not contain this group but shows a sharp band at 1726cm^{-1}belong C=O of ester While the FTIR spectrum of IBP-MIP before and template not showed. and the figure show band at (867 ,821) cm^{-1} for the of out of plane bending of mono substituted benzene ring respectively

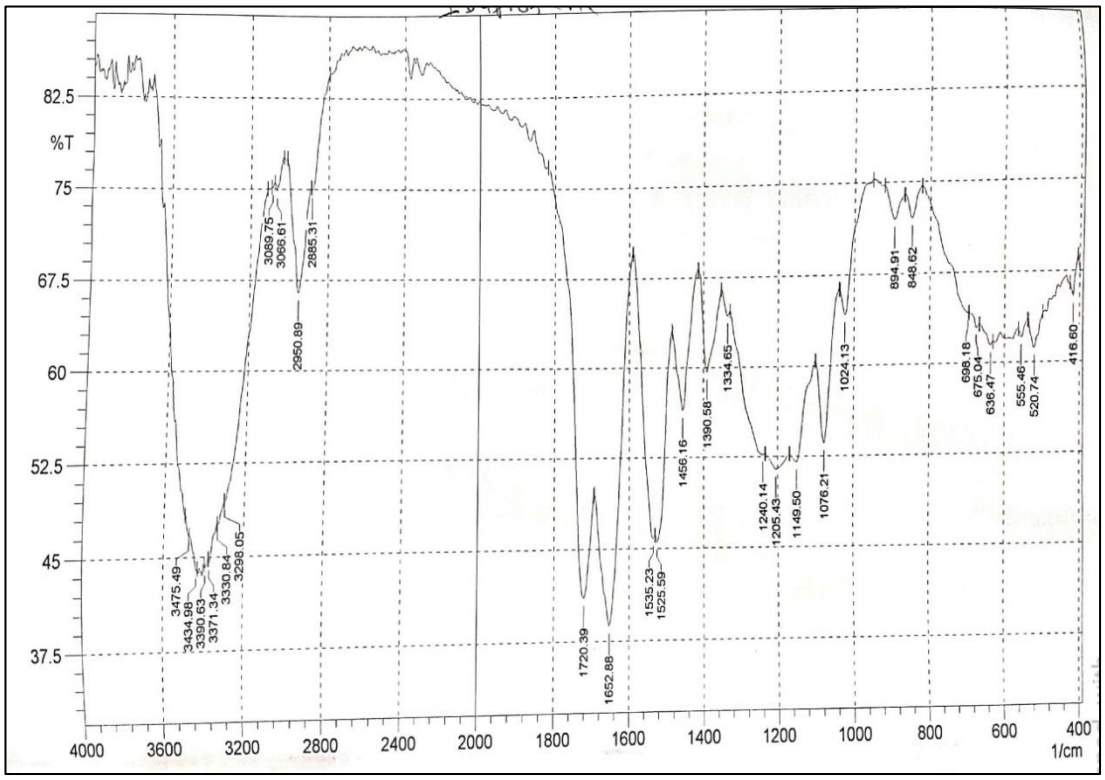


Fig. (3-4): FTIR of IBP-MIP (2-HEMA) Before the removal of (IBP).

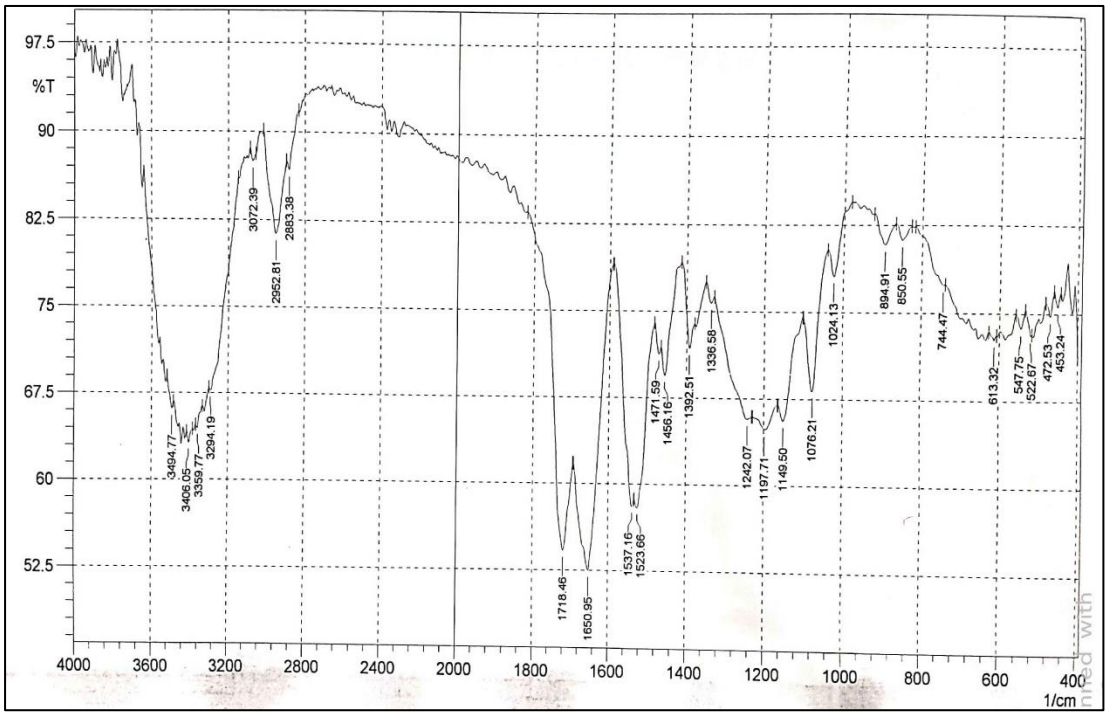


Fig. (3-5): FTIR of IBP-MIP (2-HEMA) after the removal of (IBP).

Table (3-2): The most characteristic peaks of FT-IR spectra for IBP-imprinted polymer using 2-Hydroxy Ethyl methacrylate (2-HEMA) as a functional monomer

No.	Functional Group	IBP	IBP -MIP (1-Vi) before template removal	IBP -MIP (1-Vi) After template removal
1	O-H	3325-2543 cm^{-1}	3475-3298 cm^{-1}	3406 cm^{-1}
2	C-H(aliphatic)	2956-2871 cm^{-1}	2950-2885 cm^{-1}	2952-2883 cm^{-1}
3	C=O acid	1720 cm^{-1}	1652 cm^{-1}	---
4	C-O-C	1230 cm^{-1}	1240 cm^{-1}	1149 cm^{-1}
5	P-di-subs.	867 cm^{-1}	848 cm^{-1}	---
6	C=C	---	1535 cm^{-1}	1650 cm^{-1}
7	C=O ester	---	1720 cm^{-1}	1718 cm^{-1}

The Fourier transform infrared spectrometry (FTIR) spectra of leached and unleached Ibuprofen imprinted polymers MIP and NIP were recorded in the range of 400–4000 cm-1 by the KBr pellet Method. The FTIR spectrum of IBP and IBP-MIP before and after removal Figures (3-4and 3-5) respectively, showed a small band at 3475, 3298 and 3406 cm^{-1} for stretching of hydroxyl group we can see the appearance of one band for C=O carbonyl acid groups stretching at (1652) cm^{-1} of Ibuprofen MIP before removal of the template, and disappearance after removal of the template, and the figure showed band at (848 cm^{-1}) [1] for the of out of plane bending of mono substituted benzene ring respectively . before removal of the template, and disappearance after removal of the template These results were good indication for the formation of polymer which not effected when extraction the Ibuprofen from the polymer.

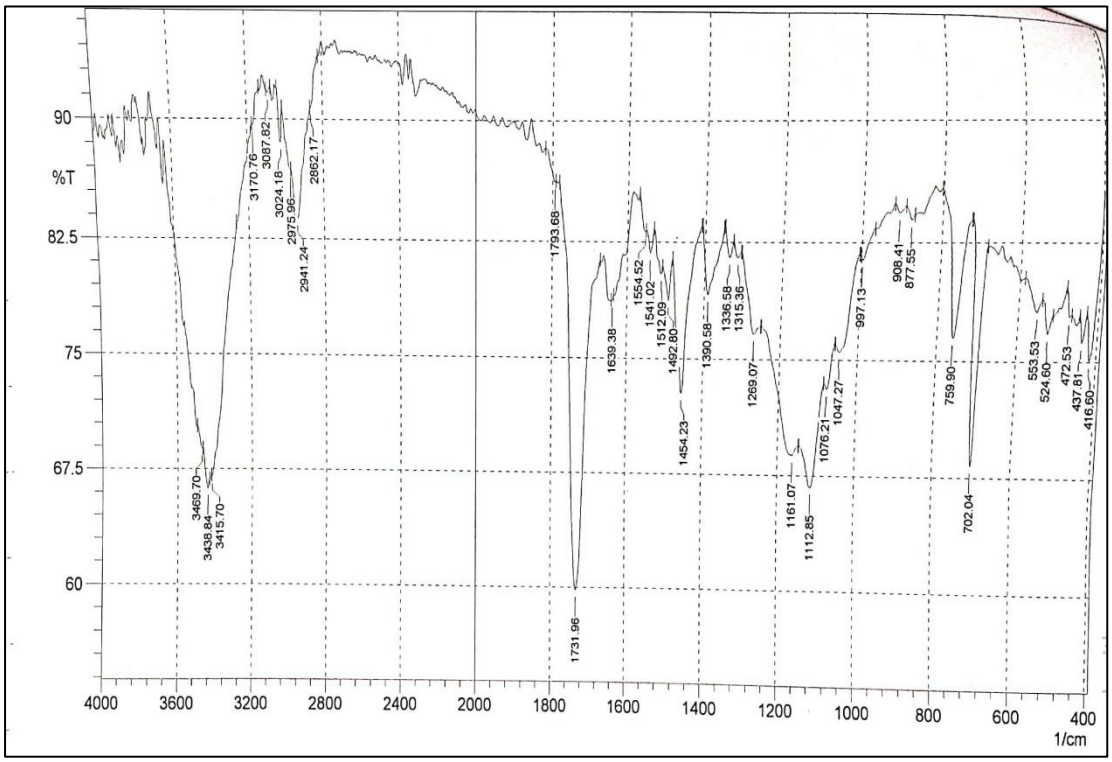


Fig. (3-6): FTIR of IBP-MIP (styrene) Before the removal of (IBP).

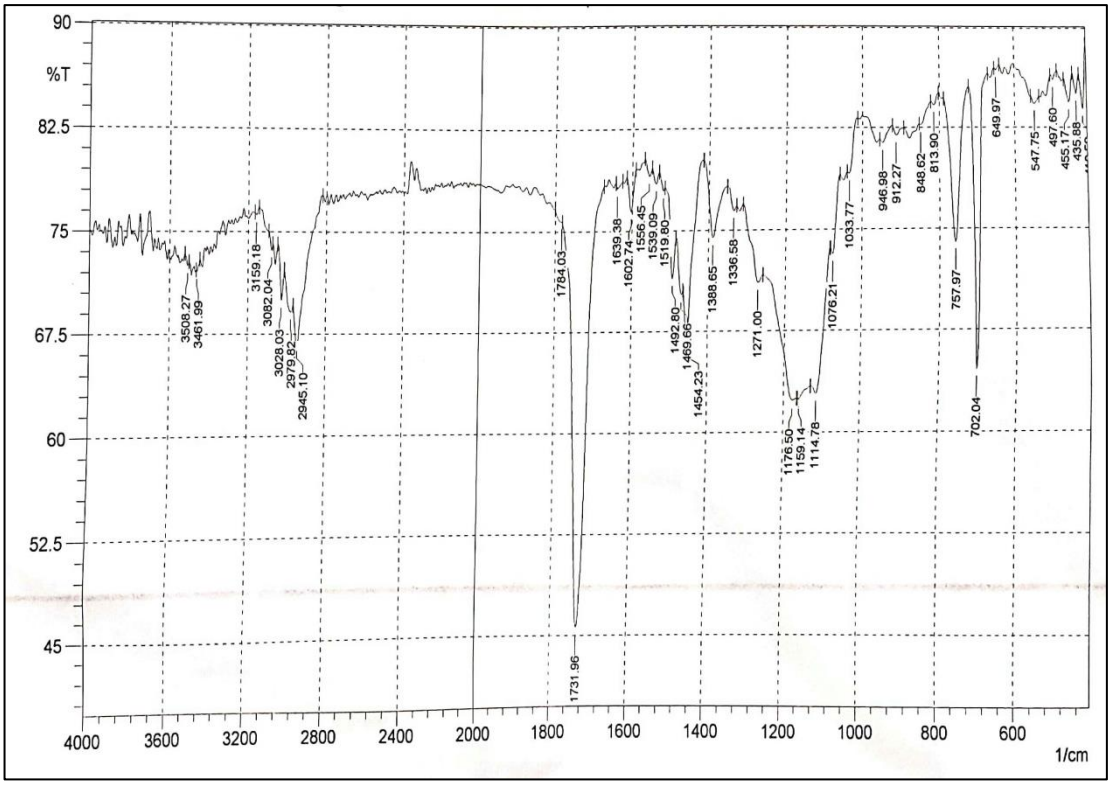


Fig. (3-7): FTIR of IBP-MIP(styrene) after the removal of (IBP).

Table (3-3): The most characteristic peaks of FT-IR spectra for IBP-imprinted polymer using Styrene as a functional monomer

No.	Functional Group	IBP	IBP -MIP (1-Vi) before template removal	IBP -MIP (1-Vi) After template removal
1	O-H	3325-2543 cm^{-1}	3469-3415 cm^{-1}	---
2	C-H aliphatic	2956-2871 cm^{-1}	2941-2862 cm^{-1}	2979-2945 cm^{-1}
3	C=O acid	1720 cm^{-1}	1631 cm^{-1}	---
4	C-O-C	1230 cm^{-1}	1269 cm^{-1}	1159 cm^{-1}
5	P-di-subs.	867 cm^{-1}	877 cm^{-1}	---
6	C=C	---	1639 cm^{-1}	1639 cm^{-1}
7	C=O ester	---	1718 cm^{-1}	1731 cm^{-1}

The figures (3-6 and 3-7), show FTIR spectrum of IBP and IBP -MIP respectively showing three bands before removal a small band at 3469-3415cm^{-1} for stretching of hydroxyl group but disappearing after removal of the template and band for C=O carbonyl acid groups stretching at (1631) cm^{-1} of Ibuprofen MIP before removal of the template, but disappearing after removal of the template, and a band at (877 cm^{-1}) [1] for the of out of plane bending of mono substituted benzene ring before removal of the template, but disappearing after removal of the template .

3-2 Morphological Characterization

The technology of molecular imprinting Polymer permitted for the preparation of polymers with specific binding sites for a target molecule. This can be achieved if the target was synthesized through the polymerization process, thus acting as a molecular template. Monomers carrying certain functional groups were arranged around the template through either no covalent or covalent interactions. Following polymerization with a high degree of cross-linking, the functional groups

are held in position by the polymer network. Subsequently removal of the template by solvent extraction or chemical cleavage leaving the cavities that are complementary to the template in terms of size, shape and arrangement of functional groups. (Fig3-8)These highly specific receptor sites are capable of rebinding the target molecule with a high specificity, sometimes comparable to that of antibodies. Molecularly imprinted polymers have been called "antibody mimics". It has been show that they can be substituted for biological receptors in certain formats of immunoassays and biosensors. They also have been used as stationary phases for affinity separations, for the screening of combinatorial libraries, and as enzyme mimics in catalytic applications. (Alexander, et al, 2006).

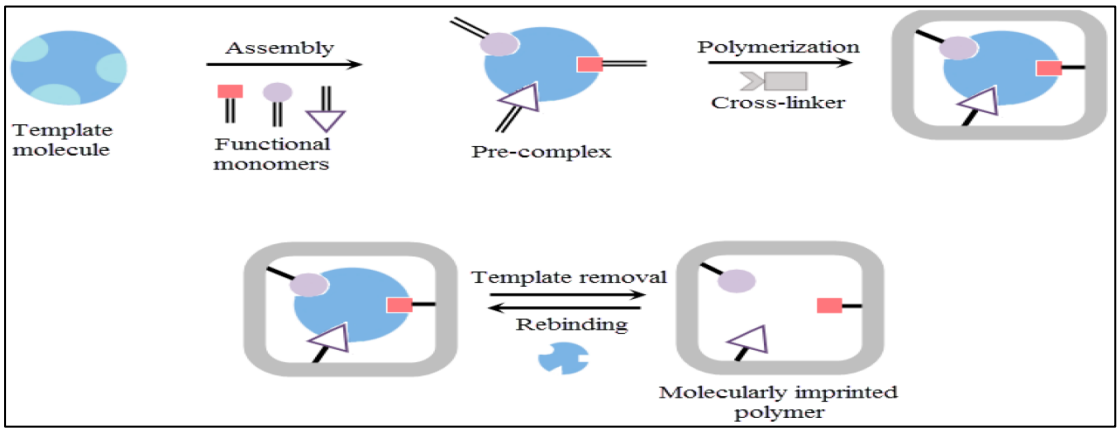


Fig. (3-8): The steps of molecularly imprinted polymer preparation

In scanning electron microscopy (SEM), a fine beam of electrons was scanned the membrane surface. This causes several kinds of interactions generating different signals, also used in image formation. The SEM can be used to get an idea about the size, geometry, and distribution of pore surface of the membranes. SEM analysis showed that the highly ordered and regular pore structure of the molecular imprinted polymer surface and the cross-section. Several researches showed that the molecular imprinted membranes recognized the template molecule effectively and transported it with good efficiency due to porous structures of the molecular imprinted polymer. The ordered porous and cross section on surface

showed that the sites of interaction, and MIP was highest transport rate towered the template molecule.(fig 3-9) to (3-14)

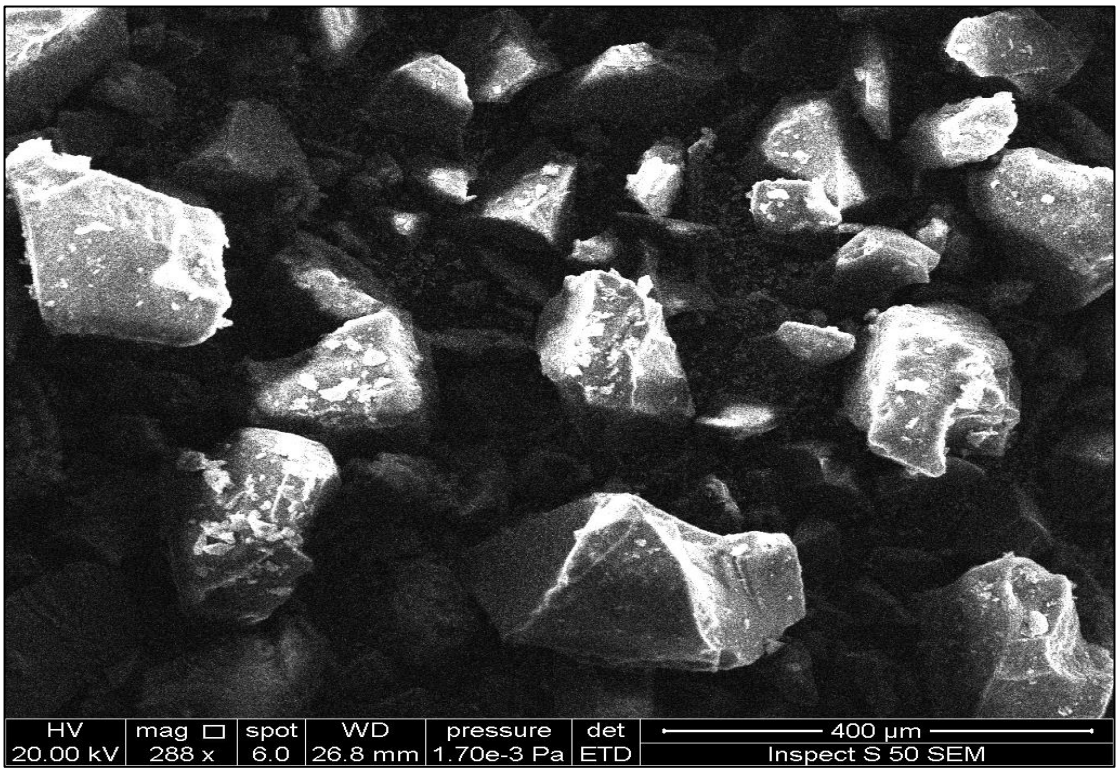


Fig. (3-9): SEM Micrograph of the MIP1 before removal (IBP)

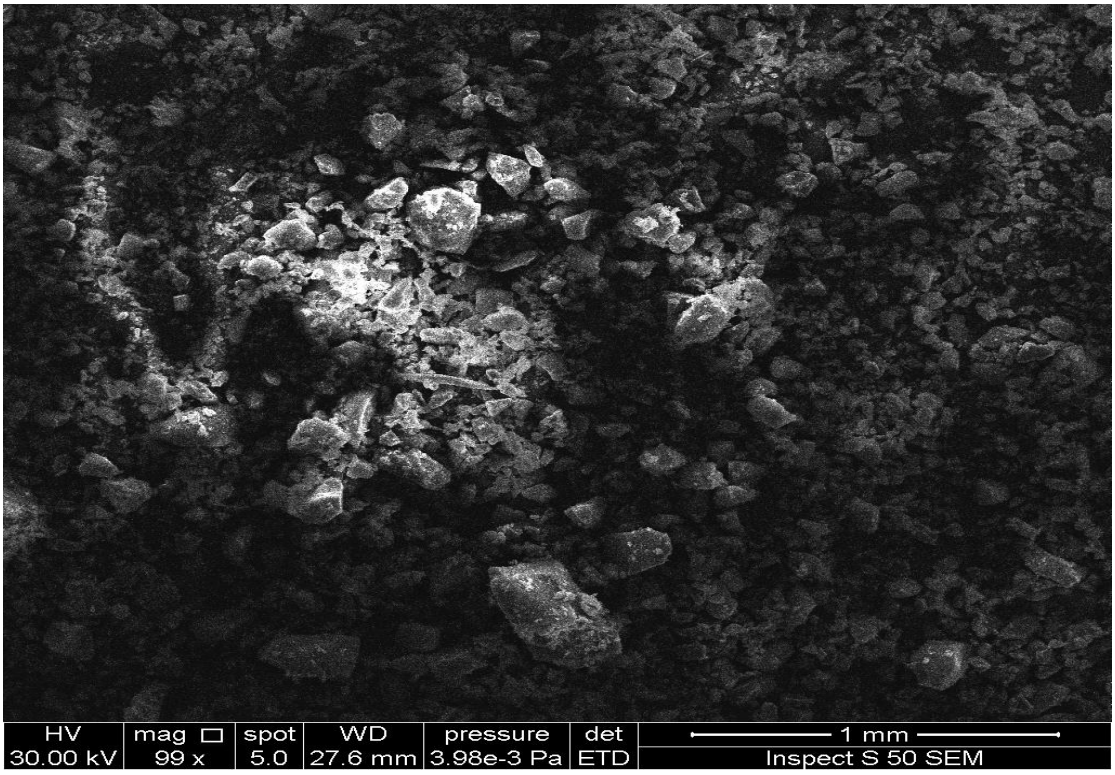


Fig. (3-10): SEM Micrograph of the MIP1 after removal (IBP)

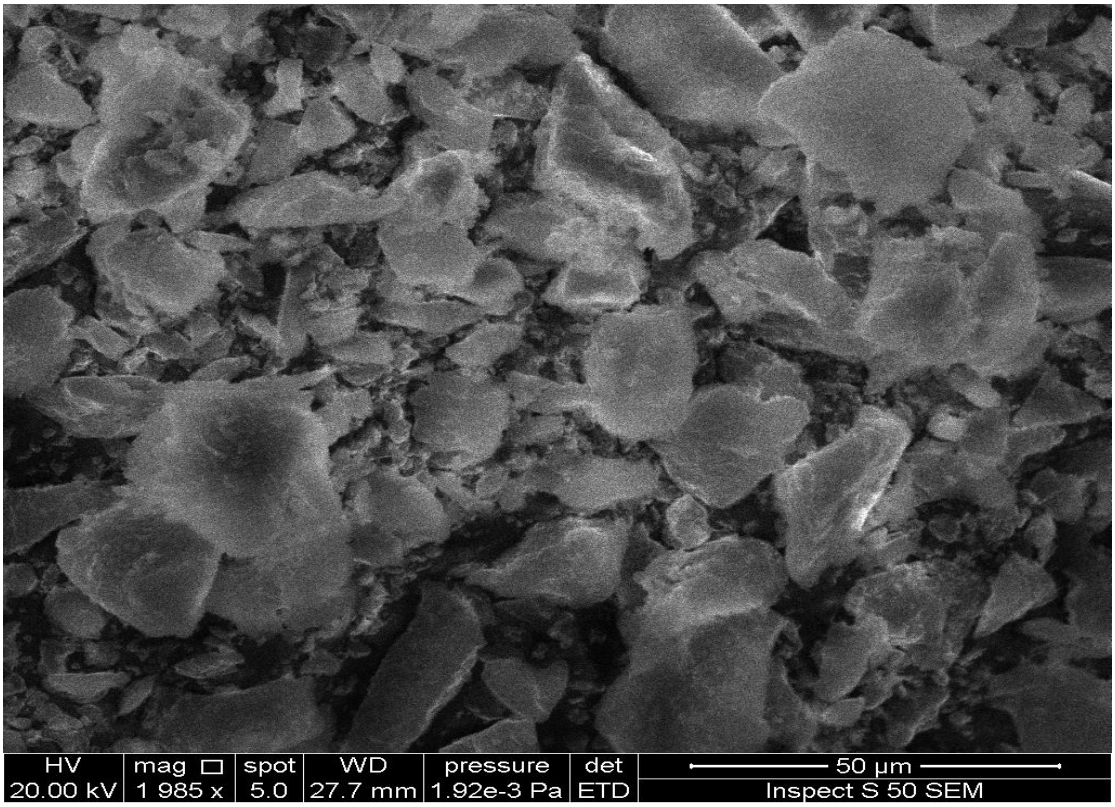


Fig. (3-11): SEM Micrograph of the MIP2 before removal (IBP)

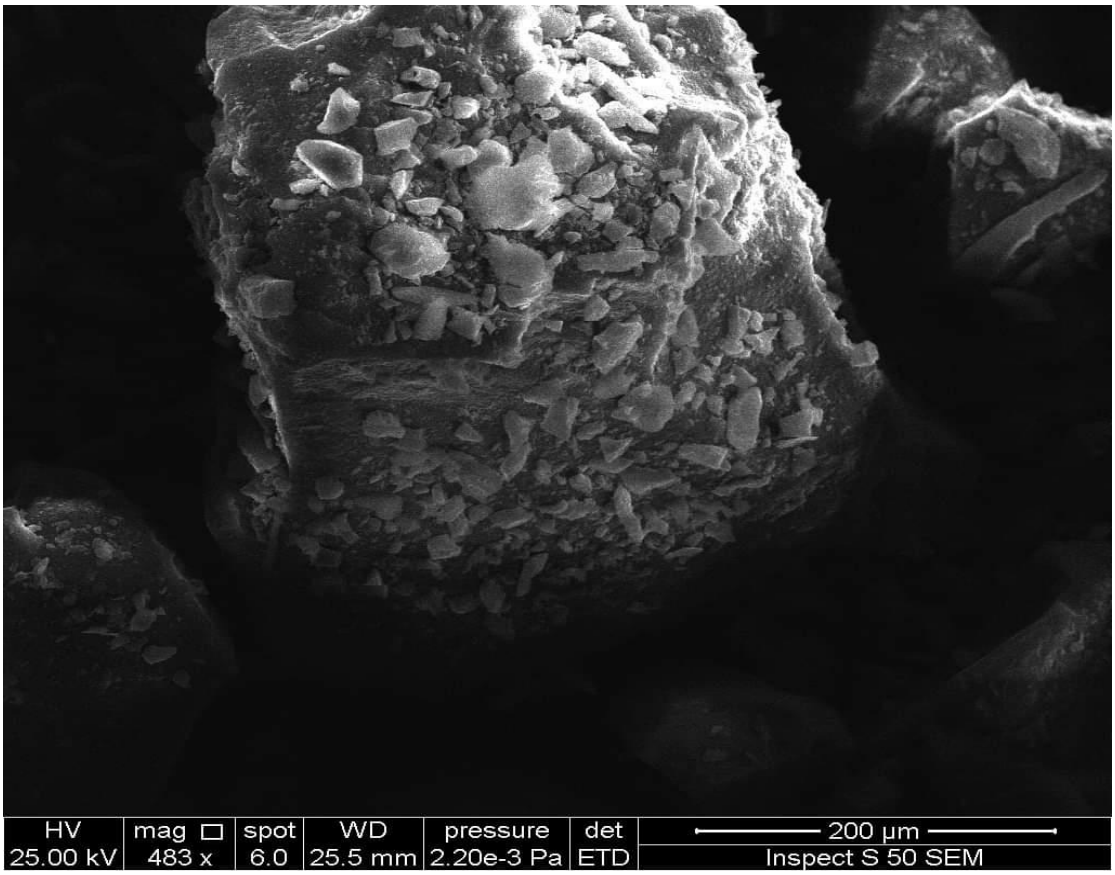


Fig. (3-12): SEM Micrograph of the MIP2 after removal (IBP)

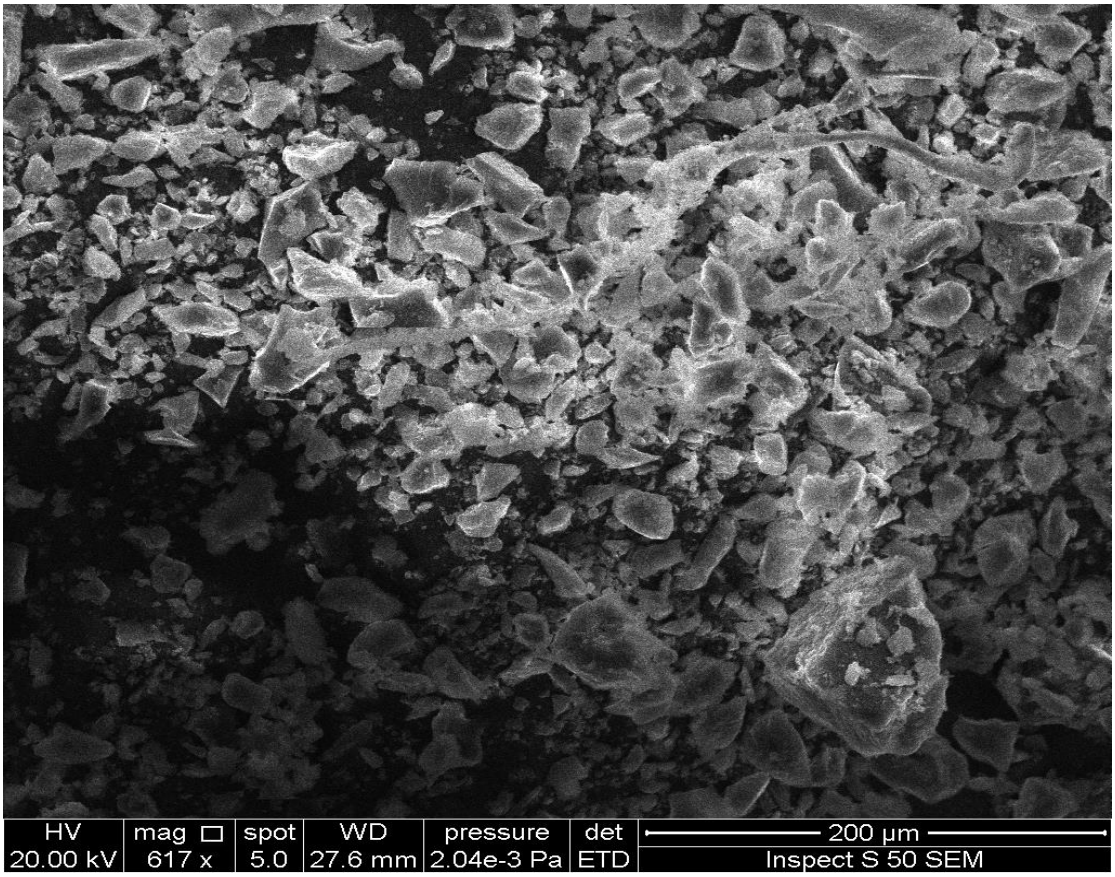


Fig. (3-13): SEM Micrograph of the MIP3 before removal (IBP)

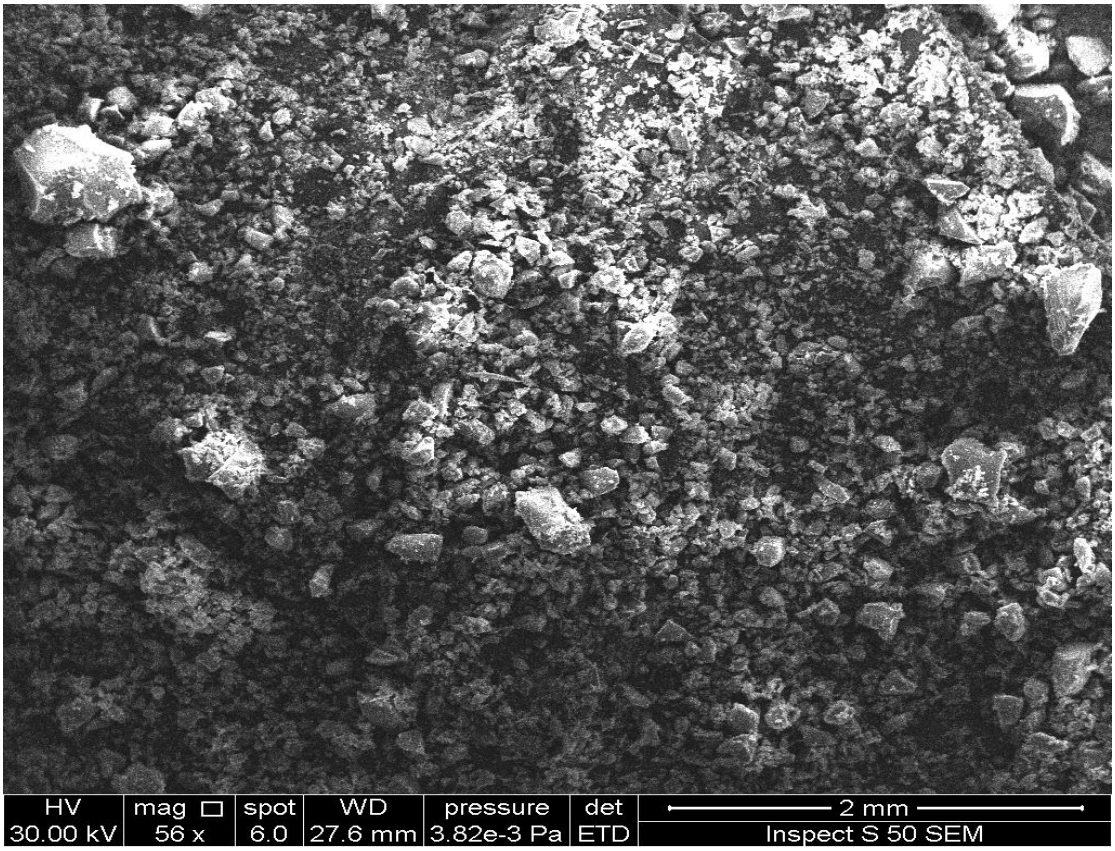


Fig. (3-14): SEM Micrograph of the MIP3 after removal (IBP)

3-3 Sensor Characteristic of the ISEs for Ibuprofen (IBP)

Construction of ISEs based on MIPs of IBP can be used in preparation of electrodes of IBP depending on the composition of 1-vinylimidazol (1-Vi) ,2-hydroxyethylmethaacrylate (2-HEMA) and Styren as efficient monomers. These monomers were incorporated with PVC in the building of electrodes as well as using different plasticizers such as Di octyl phthalate (D)PH) , Nitro benzene (NB), Tritolyl phosphate (TTP), Di butyl phthalate(DBPH),and Dibutyle Sebacate (DBS) The responded electrodes were measured in the suitable working domain.

Fundamentally, the electrodes with good characteristics were used for further more studies. It was plotted figures of potential for these electrodes against the logarithm for the Ibuprofen concentration (the target drug). Priority of using prepared electrodes had to be drenched in 1×10^{-1} M drug solutions from (3-4) hours before measurement.

Table (3-4) shows up Number of MIP, mem and plasticizer use with every MIP

Drug	NO. MIP	Plasticizer	NO. Membrane
Ibuprofen	MIP 1	DOPH	Mem1(I)
		NB	Mem2(II)
	MIP 2	TTP	Mem3(III)
	MIP 3	DBPH	Mem4(IV)
		DBS	Mem5(V)

3-4 Ibuprofen ISEs

3-4-1 (IBP-MIP1 +DOPH) membrane (I)

First electrode was based on MIP (1) that used monomer (1-Vi) and used Di octyl phthalate (DOPH) as a plasticizer; The calibration curve measurement for this electrode was shown in the Figure (3-15).

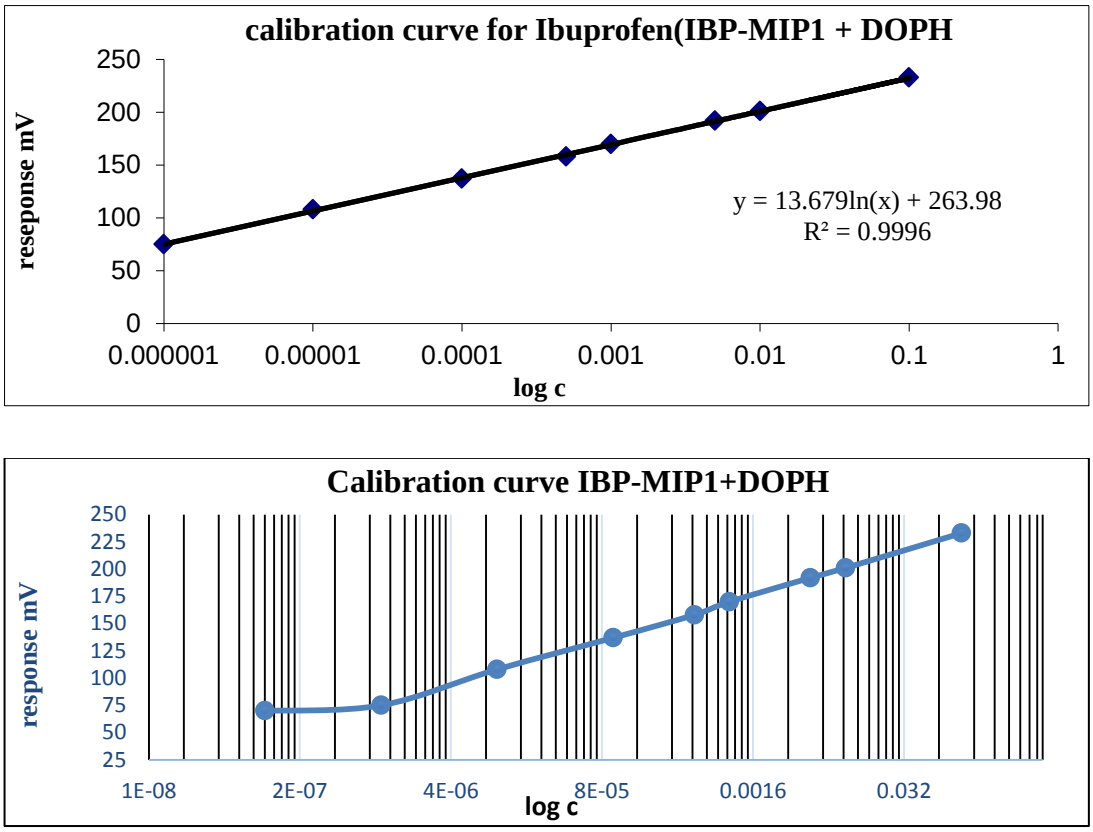


Fig. (3-15): Calibration curve of IBP– MIP1 selective electrode using (DOPH) as plasticizer.

The calibration was measured against different concentration of Ibuprofen which gave a slope value of 30.5 mV/decade, linear range (1×10^{-6}-$1\times10^{-1)}$ M, detection limit 1.2×10^{-7} M and life time around 45 days and correlation coefficient was equal to 0.9996.This electrode showed that the long life time was a result of the high plasticizer viscosity which made the electrode more stable and the structure of compound and compositions affecting electrode response. Moreover, the relative standard deviation value was calculated from multiple

measurement calibration (n=5) and gave the value (RSD =0.4 %) from average slope, all these parameters are represented in the Table (3-5).

3-4-2 (IBP-MIP1 +NB) membrane (II)

The second membrane construction by using the Nitro benzene as plasticizer and represented the calibration curve of this electrode in the figure (3-16).

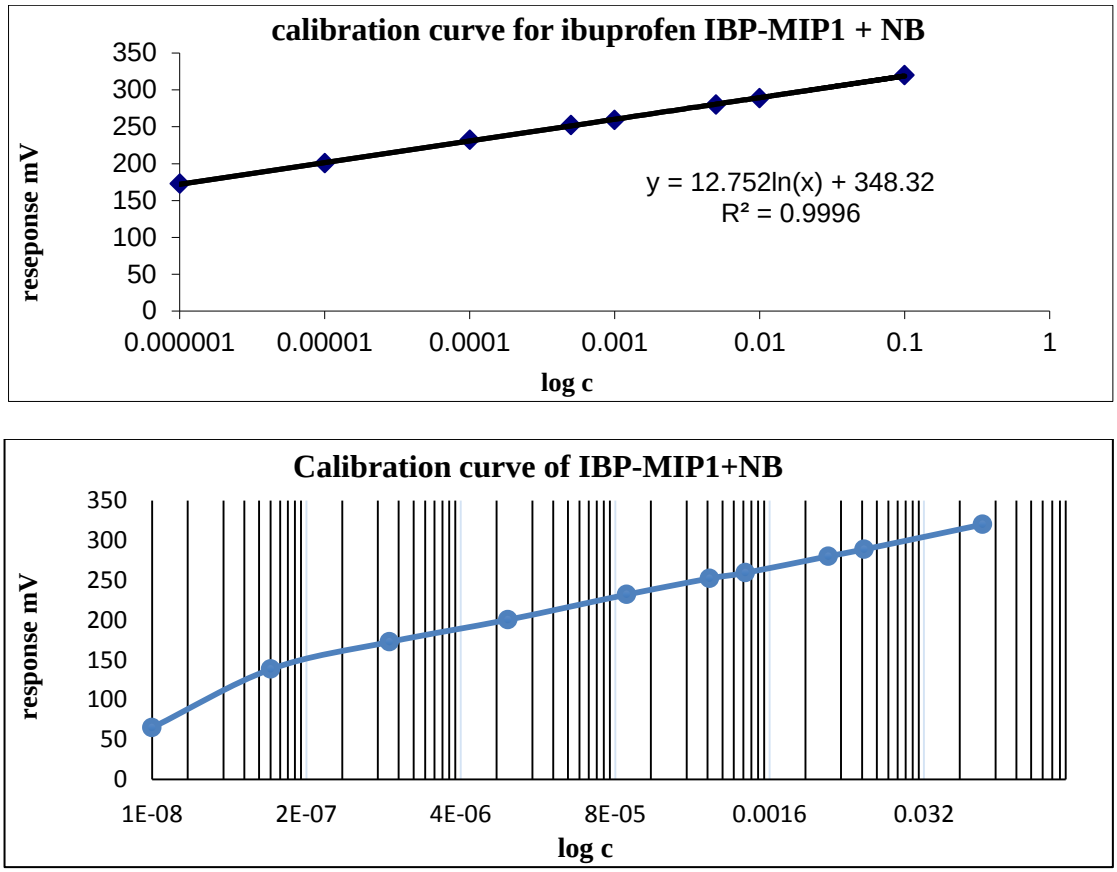


Fig. (3-16): Calibration curve of IBP– MIP1-mem2 selective electrode using (NB) as plasticizer.

Different concentrations of Ibuprofen were used to calculate the calibration curve and finding the parameters such: slope value of 29.9 mV/decade, linear range (1×10^{-6}-1×10^{-1}) M, detection limit 2.3×10^{-8} M, life time around 12 days and correlation coefficient value was 0.9996. The relative standard deviation was calculated from average slop of calibration electrode (n= 5) which gave the value (RSD = 0.6%), these parameters above represented in the Table (3-5).

3-4-3 (IBP-MIP2 +TTP) membrane (III)

The third construction of electrode by using Tritolyl phosphate (TTP) as a plasticizer which based on MIP2 that used monomer 2hydroxyethylmetha acrylate (2-HEMA) in the composition The calibration curve measurement are represented in the Figure (3-17)

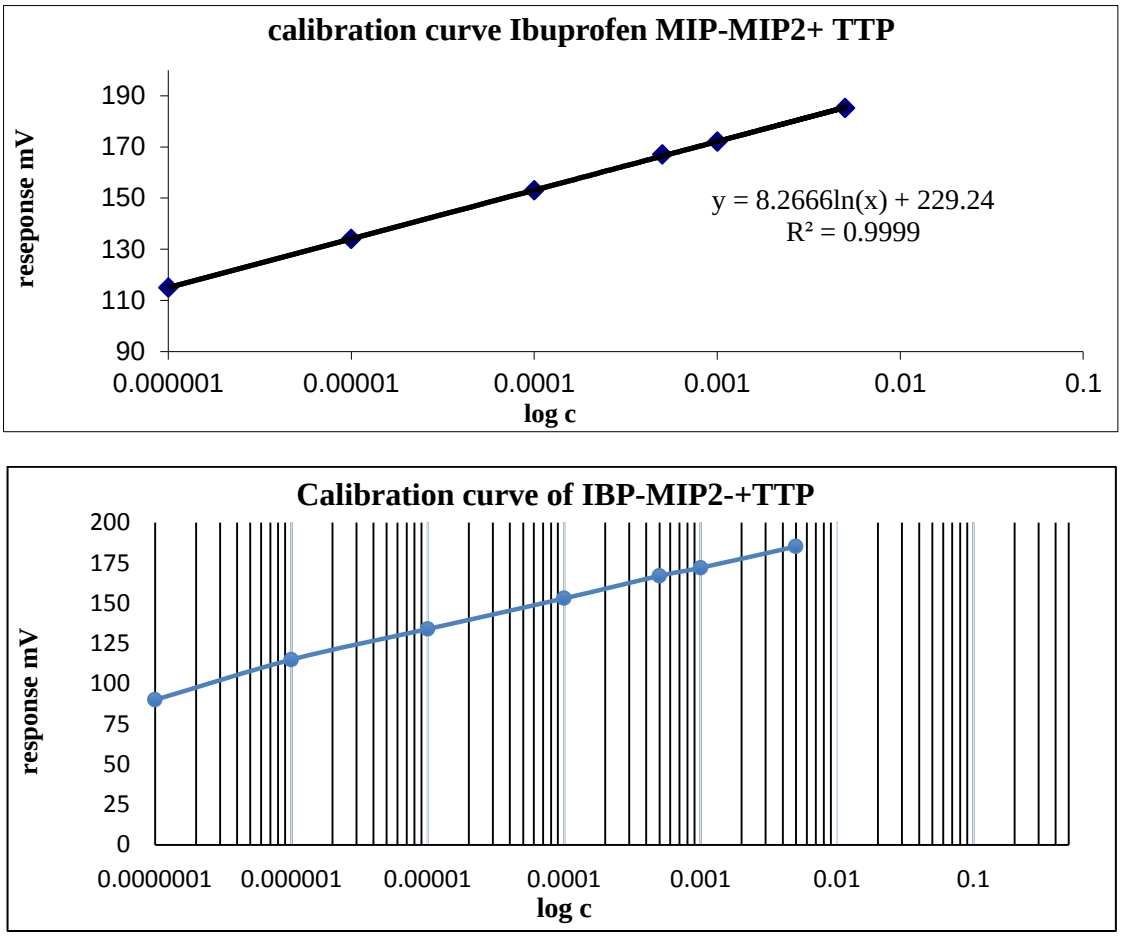
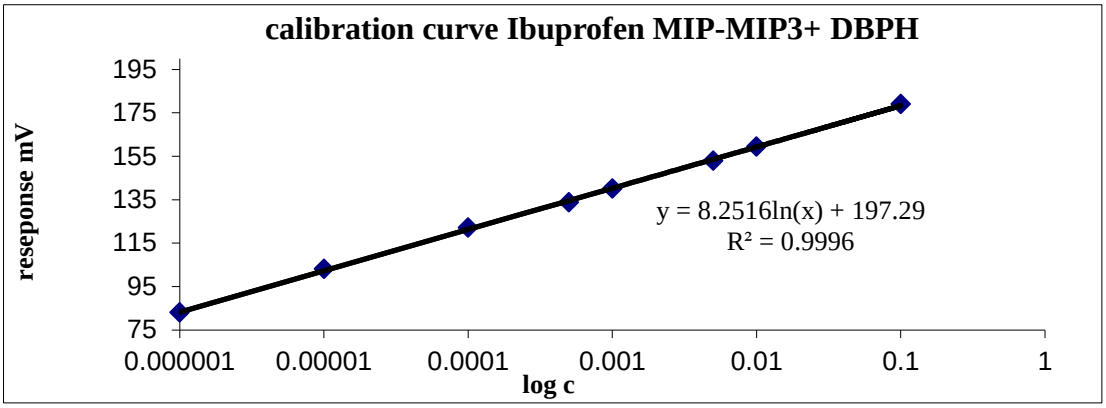


Fig. (3-17): Calibration curve of IBP– MIP2mem3 selective electrode using (TTP) as plasticizer

The calibration curve have been measured from linear equation and the slop value was 19.04 mV/decade and the parameters were calculated such as: linear range (1×10^{-6}-5×10^{-3}) M, detection limit 1.86×10^{-7} M , life time around 25 days and correlation coefficient value was 0.9999. The measurement of average slope gave a value of relative standard deviation (RSD=0.5%) for numerous calibration to this membrane electrode (n =4).

3-4-4 (IBP-MIP3 +DBPH) membrane (IV)

The Forth construction of electrode by using Di Butyl phthalate (DBPH) as a plasticizer which based on MIP3 that used monomer Styrene in the composition .The calibration curve measurement are represented in the Figure(3-18).



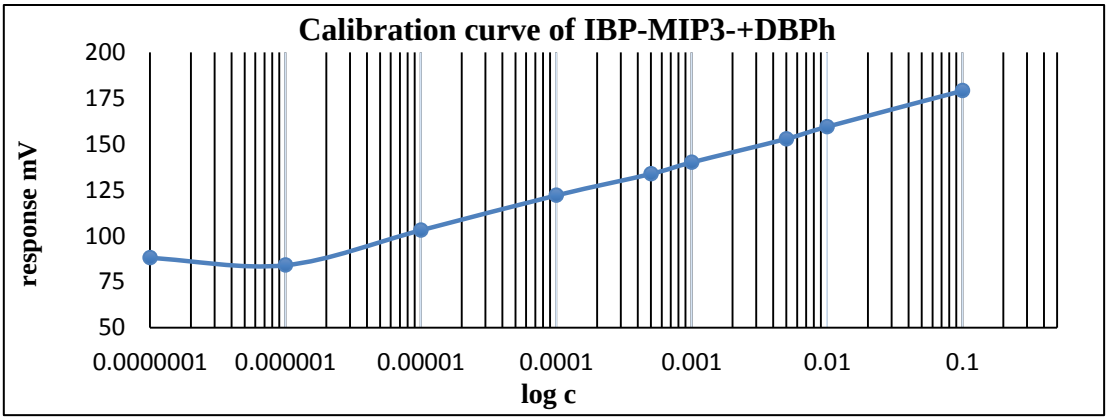


Fig. (3-18): Calibration curve of IBP– MIP3mem4 selective electrode using (DBPh) as plasticizer

The calibration curve have been measured from linear equation and the slop value was 19.003 mV/decade and the parameters were calculated such as: linear range (1×10^{-6}-1×10^{-1}) M, detection limit 7×10^{-7} M , life time around 40 days and correlation coefficient value was 0.9996. The measurement of average slope gave a value of relative standard deviation (RSD=0.47%) for numerous calibration to this membrane electrode (n =4).

3-4-5 (IBP-MIP3 +DBS) membrane (V)

Di Butyl Sebacate (DBS) was used in synthesis of electrode membrane as a plasticizer .This electrode depended on MIP3 in the construct fifth electrode. the slop value was 20.46 mV/decade and the linear range for electrode was (10^{-2} -10^{-6}) M which be shown in the Fig. (3-19).

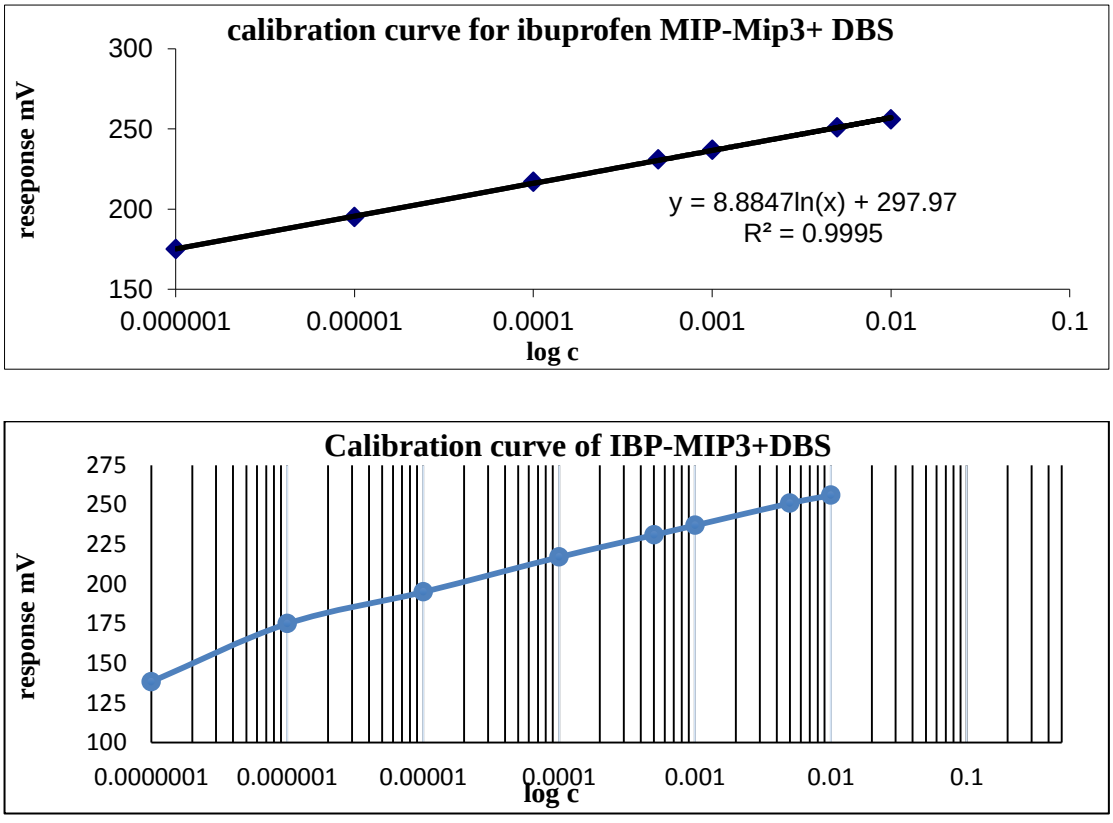


Fig. (3-19): Calibration curve of IBP– MIP3mem5 selective electrode using (DBS) as plasticizer

Other parameters which have been measured and gave good response for electrode membrane were detection limit 7.1×10^{-7} M, life time around 30 days and correlation coefficient value was 0.9995. The relative standard deviation was (RSD = 0.52%) for numerous calibration curve and also calculated the average to this electrode (n=4) .The electrode response was affected by the mixture of molecularly imprinted polymers with plasticizer because of that's materials playing important role in the structure and composition of the electrode thus affecting the membrane response.

Table (3-5): The parameters of IBP-MIP1, IBP-MIP2 and IBP-MIP3 of selective electrodes using different plasticizers

Parameter					
Electrode No.	**I**	**II**	**III**	**IV**	**V**
Membrane composition	MIP1 + PVC + DOPH	MIP1 + PVC + NB	MIP2 + PVC + TTP	MIP3 + PVC + DBPH	MIP3 + PVC + DBS
Slop (mV/decade)	30.5	29.9	19.04	19.003	20.46
R^2	0.9996	0.9996	0.9999	0.9996	0.9995
Linearity range (M)	10^{-6}-10^{-1}	10^{-6}-10^{-1}	10^{-6}-5×10^{-3}	10^{-6} - 10^{-1}	10^{-6}-10^{-2}
Detection limit (M)	1.2×10^{-7}	2.3×10^{-8}	1.86×10^{-7}	7×10^{-7}	7.1×10^{-7}
Life time (day)	45	12	25	40	30
RSD%	0.4	0.6	0.5	0.47	0.52

3-5 Effect of pH

In The effect of pH on the electrode potentials for (IBP) selective membrane electrodes was studied by measuring the e.m.f. of the cell in (IBP) solutions at two different concentrations (1×10^{-3} and 1×10^{-4}) M in which the pH ranged from (1.0-11.0). The pH was adjusted by adding appropriate amounts of hydrochloric acid and/or sodium hydroxide solution as shown Figure (3.20),(3-21) and (3-22) and Table (3-6). At pH values less than 1.5 or in very high acidity, the electrode response increased rather irregularly. This might be due to that the electrode responded to both H^+ activities and Ibuprofen ions and in an alkaline solution (pH greater than 8) the electrode response decreased might attribute to the decrease in the solubility of Ibuprofen**.**

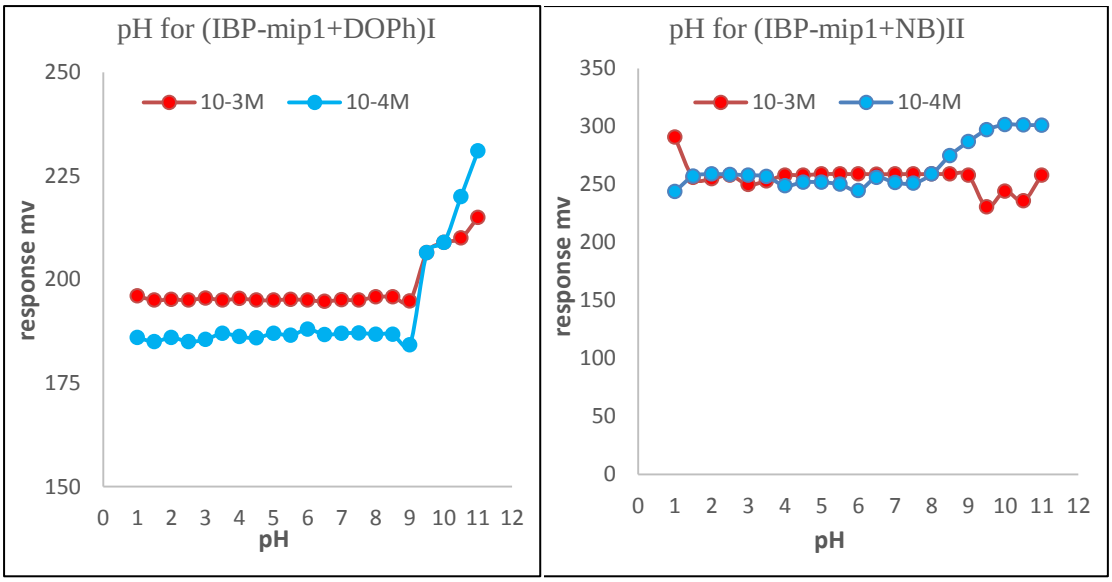


Fig.(3-20) Effect of pH on the Ibuprofen { IBP-MIP1 + DOPh (I) and IBP-MIP1 +NB (II) } electrodes at concentration 1×10^{-3} and 1×10^{-4}.

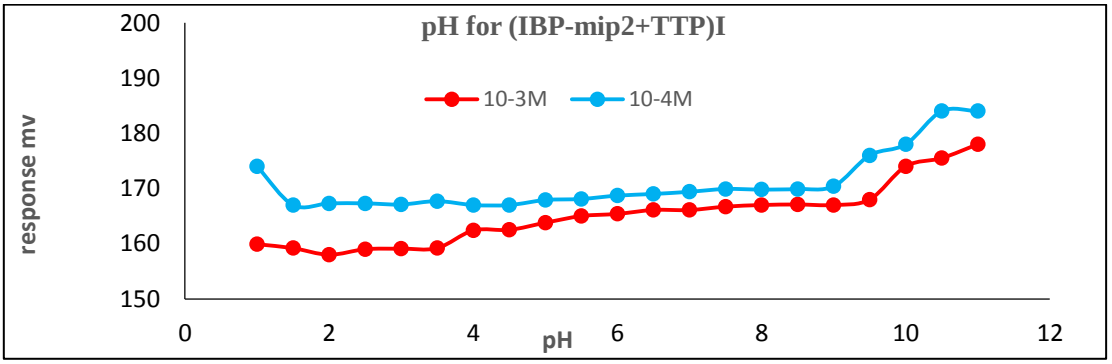


Fig.(3-21) Effect of pH on the Ibuprofen { IBP-MIP2 + TTP (I) } electrodes at concentration 1×10^{-3} and 1×10^{-4}

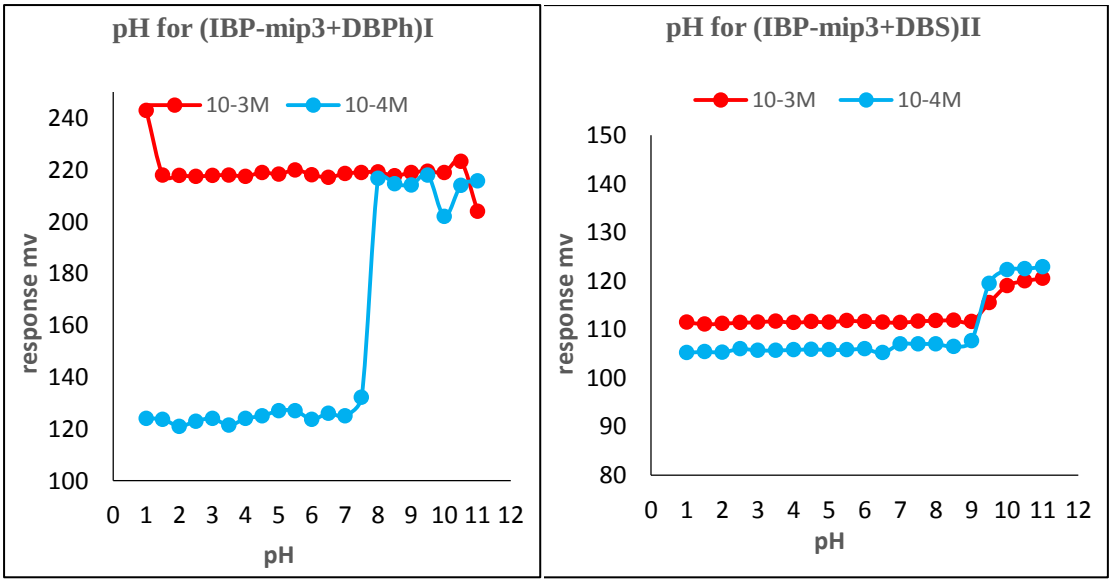


Fig.(3-22) Effect of pH on the Ibuprofen { IBP-MIP3 + DBPh (I) and IBP-MIP1 +DBS (II) } electrodes at concentration 1×10^{-3} and 1×10^{-4}.

Table (3- 6): Working pH ranges for Ibuprofen selective electrodes

Drug	No. Mem	Membrane composition	pH Range	
			1×10^{-4}	1×10^{-3}
Ibuprofen	I	IBP-MIP1 + DOPh	1-9	1-8.5
	II	IBP-MIP1 +NB	1.5-9	1.5-9.5
	III	IBP-MIP2 +TTP	1.5-9	4-9.5
	IV	IBP-MIP3 +DBPh	1-8	1.5-10
	V	IBP-MIP3 +DBS	1-8.5	1-9

3-6 Response Time

Response time is the time required for the electrode membrane to reach achievement constant potential during ranging ±1 mV values of the final equilibrium value(Baily and Thomas,1976). it was noticed that the response time value for higher concentrations was less than that of low concentration because of the access to the equilibrium state in high concentration was shorter than the low solutions This proves that the response time was dependent upon concentration of Ibuprofen. The average response time (t 95%=) of the Ibuprofen membranes are listed in Table (3-7).

Table (3-7): Representation the response time of Ibuprofen membranes

Membrane composition	Concentration (M)	Potential (mV) at t/100	Time (s) at 95%	Time (s) at 100%
IBP-MIP1+DOPH (I)	1×10^{-1}	30	28.5	44
	1×10^{-2}	40	38	46
	5×10^{-3}	44	41	47
	1×10^{-3}	40	44	48
	5×10^{-4}	50	47	48
	1×10^{-4}	52	49	51
	1×10^{-5}	54	51	53
	1×10^{-6}	56	53	54

IBP-MIP1 +NB (II)	1×10^{-1}	33	31	35
	1×10^{-2}	39	37	41
	5×10^{-3}	43	40.8	45.2
	1×10^{-3}	47	44.6	48
	5×10^{-4}	50	47.5	49.5
	1×10^{-4}	52	49.4	51.5
	1×10^{-5}	55	50.5	52.3
	1×10^{-6}	57	54.1	55.8
IBP-MIP2+TTP (III)	1×10^{-1}	--	--	--
	1×10^{-2}	--	--	--
	5×10^{-3}	3	3.99	42
	1×10^{-3}	4.2	7.6	44
	5×10^{-4}	7.5	8.55	49
	1×10^{-4}	9	7.12	52
	1×10^{-5}	15	14.25	57
	1×10^{-6}	15.1	14.3	59
IBP-MIP3+DBPH (IV)	1×10^{-1}	25.3	24	31.57
	1×10^{-2}	30	28.5	34.7
	5×10^{-3}	37	35.1	42
	1×10^{-3}	41	39	43
	5×10^{-4}	44	41.8	47.36
	1×10^{-4}	46.2	47.7	50.21
	1×10^{-5}	50.5	47.9	50.5
	1×10^{-6}	51	48.5	51.6
DFS-MIP2 +DBS (V)	1×10^{-1}	--	---	---
	1×10^{-2}	30	28.5	34.7
	5×10^{-3}	35	33.25	36.8
	1×10^{-3}	40	38	49
	5×10^{-4}	26.3	25	49.6
	1×10^{-4}	46.2	47.7	50.21
	1×10^{-5}	30.8	50.4	53
	1×10^{-6}	60.7	56	58.9

3-7 Selectivity of Ibuprofen Selective Electrodes

The selectivity is obviously one of the important characteristics of ion-selective electrodes, determining whether reliable measurement in target sample is possible. It was investigated by separate solution method (SSM) , and the matched potential method (MPM). The separate solution method (SSM) that is recommended by IUPAC determine the selectivity coefficient of the ISEs. SSM is based on Nickolsky-Eisenman equation. However, it has been shown that this method suffers some limitations in terms of the values for ions of unequal charges, anon-Nernstain behavior of interfering ions. Therefore another method named the "matched potential method (MPM) is recommended especially when the primary ion or the interfering ion dissatisfies with the Nernst response or when the involved ions are unequal in charge.

3-7-1 Selectivity Measurement by Separation Solution Method (SSM)

Potentiometric selectivity coefficients was achieved by Separation solution method using sex Ibuprofen concentrations ranging from (10^{-4} to10^{-1})M and (K^{+}, Ca^{+2},Al^{+3},methylparapen,Propylparapen,Trisodium citrate), the potentiometric measurement of selectivity coefficients were calculated by equation below:

$$\mathbf{Log\ K^{pot}_{A,B} = [(E_B - E_A)/(2.303RT/Z_A F)] + (1 - Z_A/Z_B) \log a_A} \quad \ldots\ldots \mathbf{(3\text{-}1)}$$

EA, EB; zA, zB; and aA, represents the potentials, charge numbers, and activities for the primary A and interfering B ions, respectively at aA = aB (Zurawska and Lewenstam .2011). The obtained results for selectivity coefficients and interfering ions were listed in the Table (3-8) until (3-12), as well the selectivities versus the studied species are represented in Fig. (3-23) and Fig. (3-27).

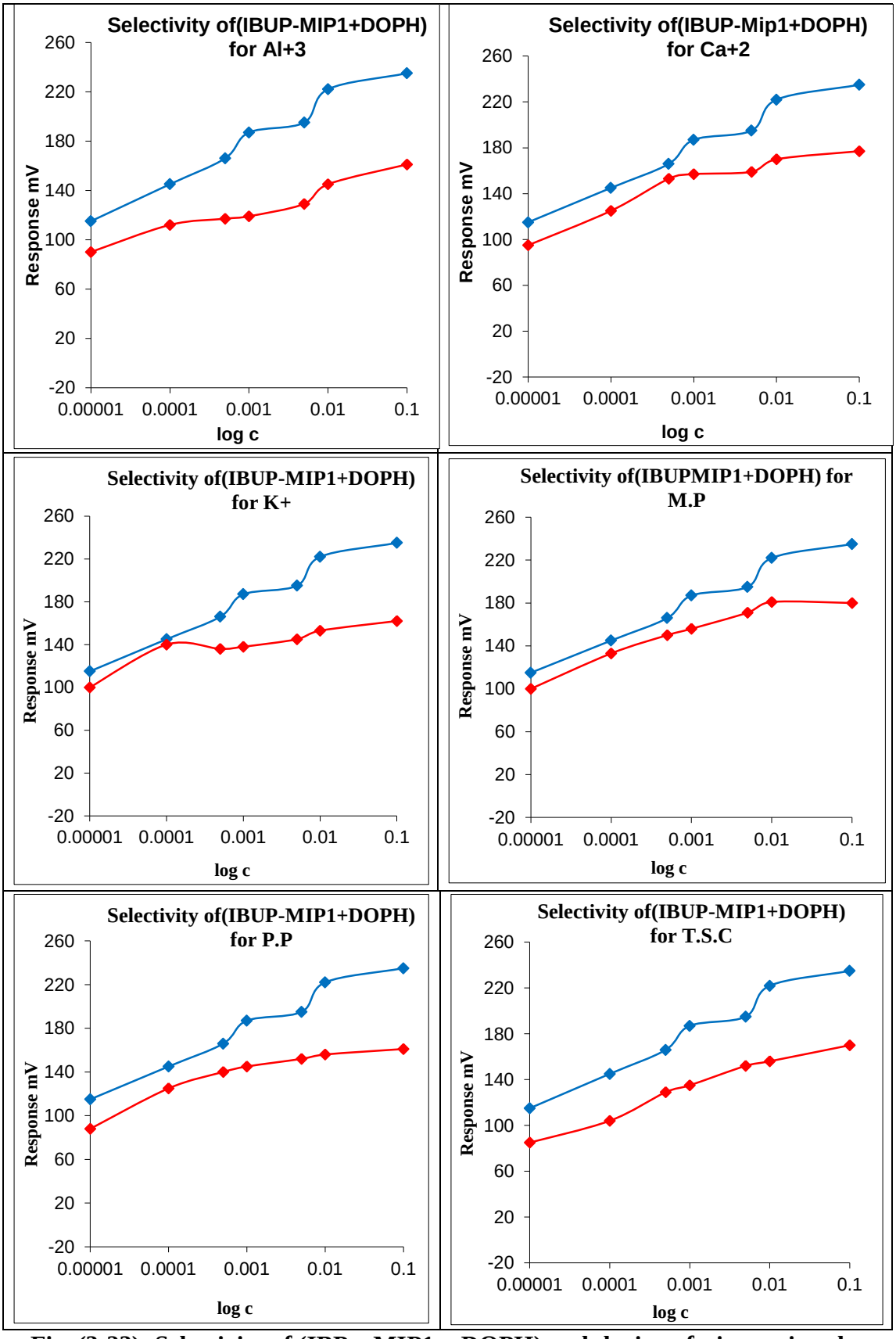


Fig. (3-23): Selectivity of (IBP – MIP1 + DOPH) and the interfering cations by separation method, ♦ ibuprofen, ▲ Solution of interfering cations.

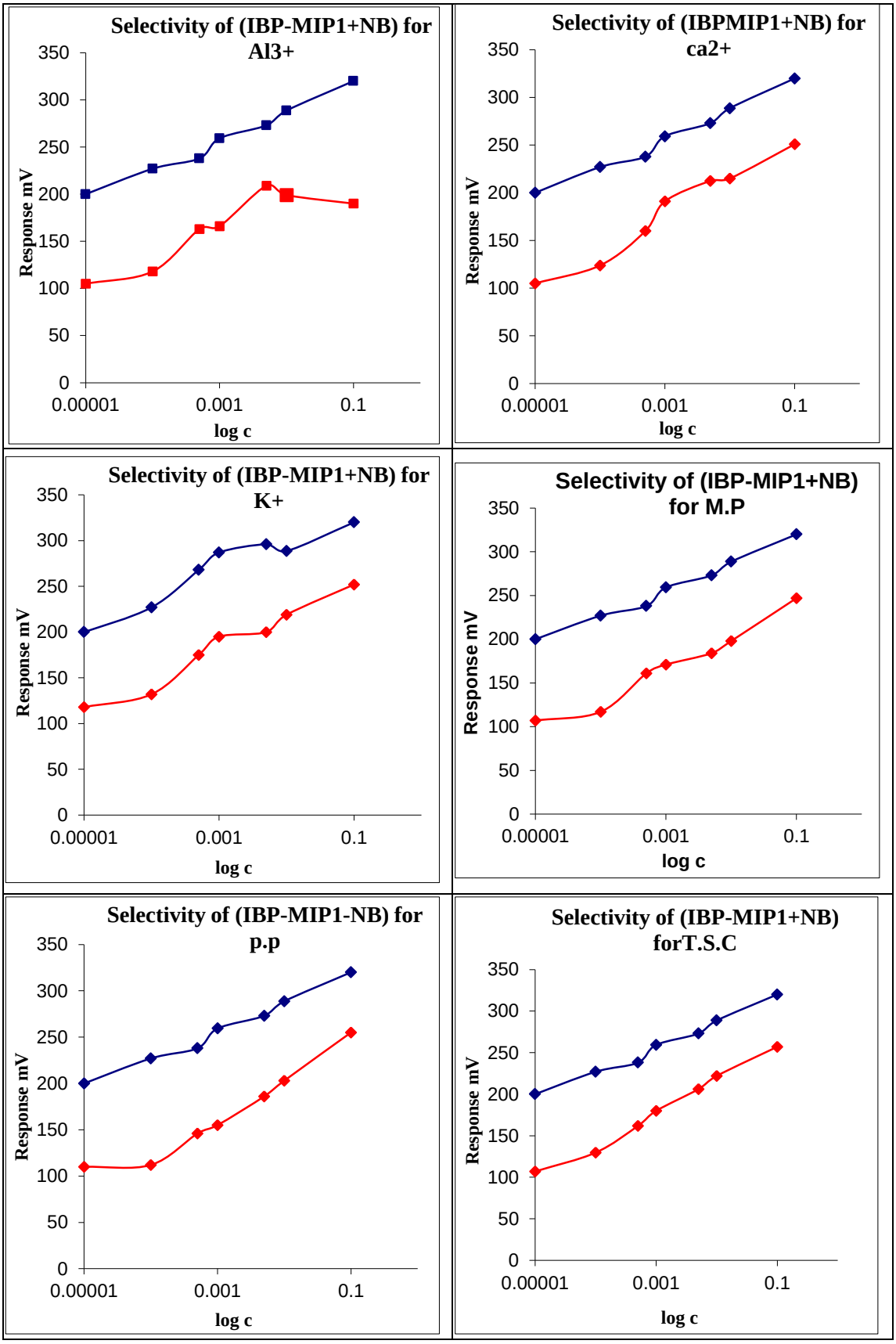


Fig. (3-24): Selectivity of (IBP – MIP1 + NB) and the interfering cations by separation method, ♦ ibuprofen, ▲ Solution of interfering cations.

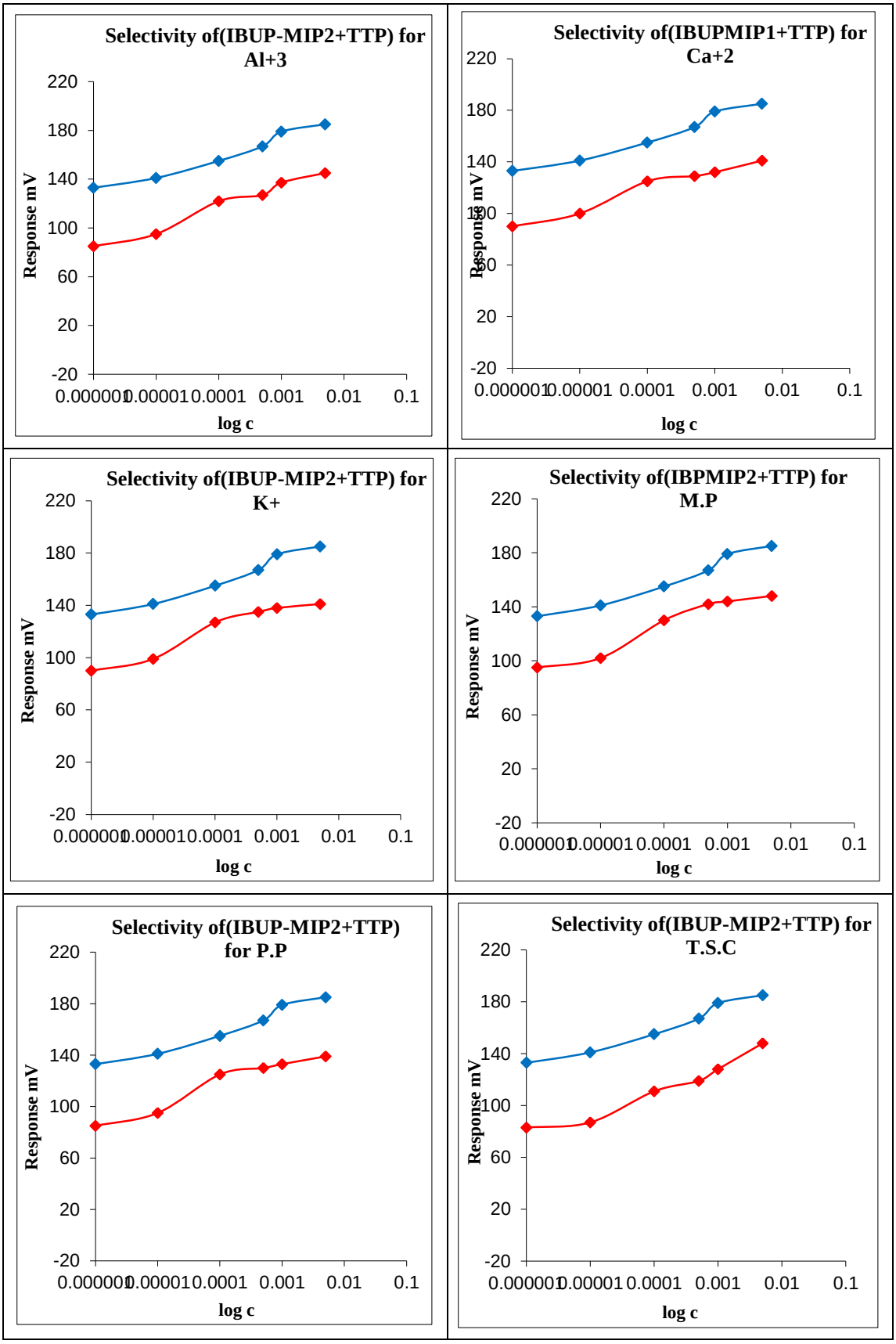


Fig. (3-25): Selectivity of (IBP – MIP2 + TTP) and the interfering cations by separation method, ♦ ibuprofen, ▲ Solution of interfering cations.

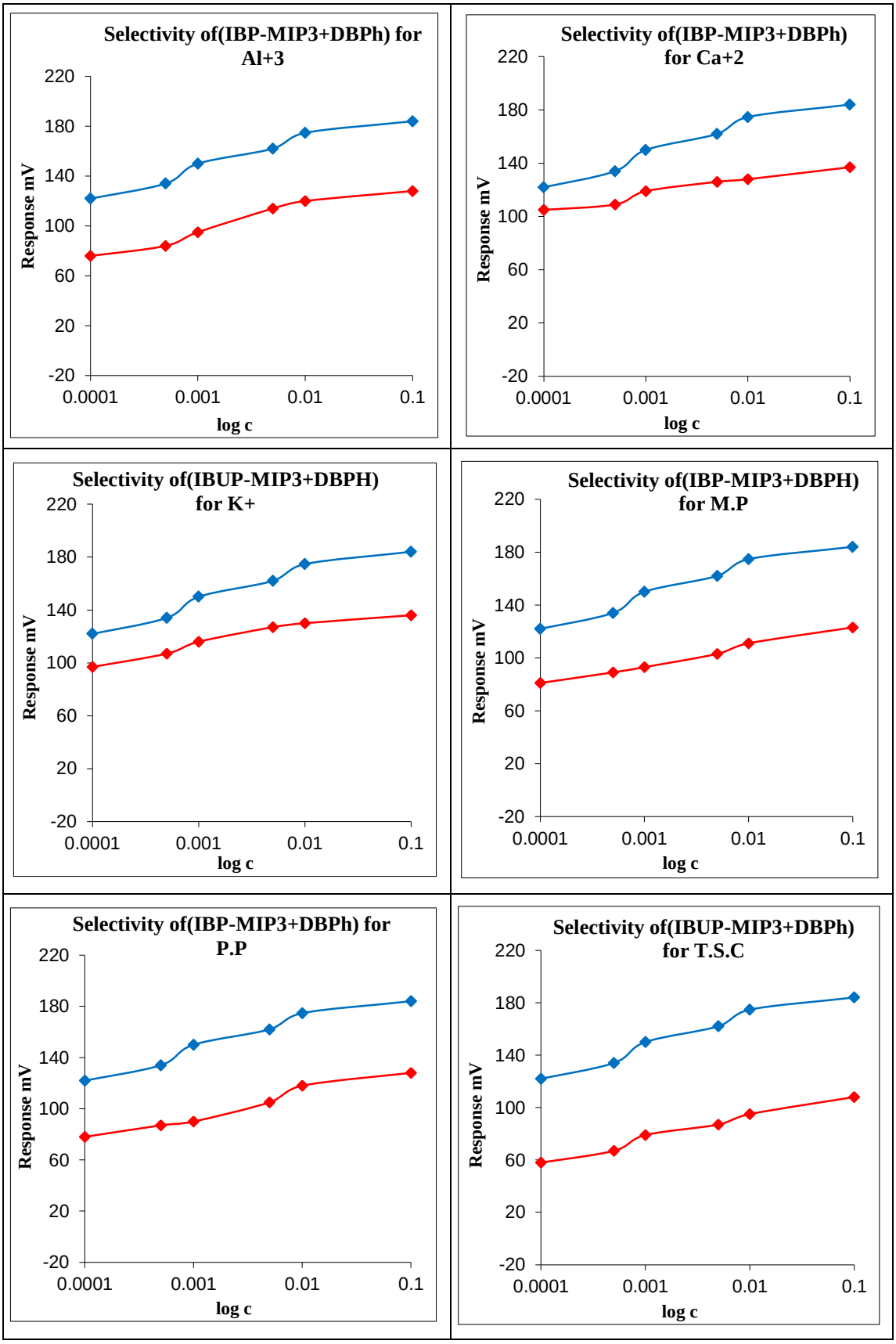


Fig. (3-26): Selectivity of (IBP – MIP3+ DBPh) and the interfering cations by separation method, ♦ ibuprofen, ▲ Solution of interfering cations.

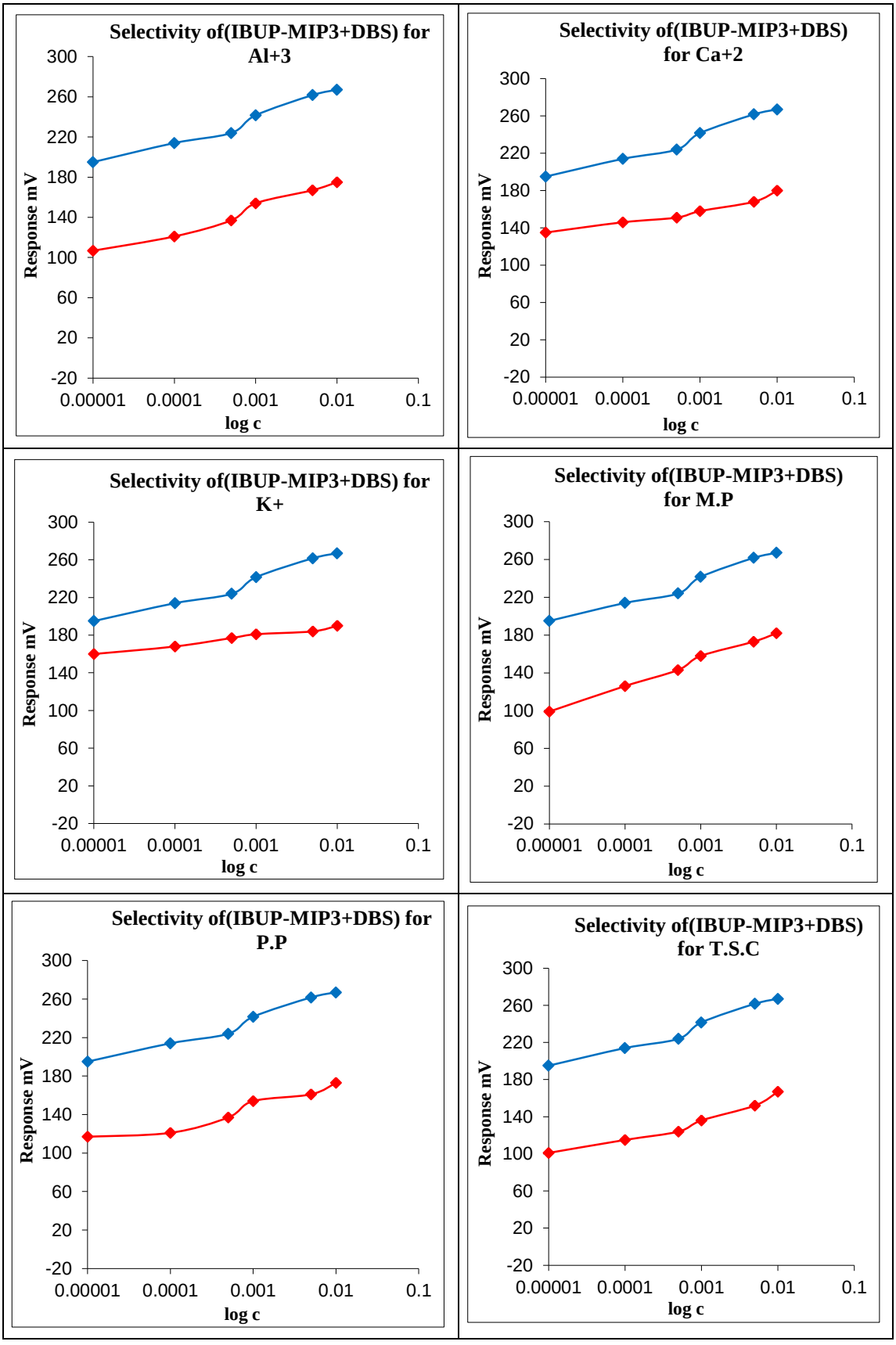


Fig. (3-27): Selectivity of (IBP – MIP3+ DBS) and the interfering cations by separation method, ♦ ibuprofen, ▲ Solution of interfering cations.

Table (3-8): Selectivity coefficients for (IBP –MIP1 +DOPH) electrode at different concentrations of Ibuprofen

Concentrations of Ibuprofen (M): Concentrations of interference ions (M)												
Con of IBP	**Interfering ions**											
	K^+		**Ca^{+2}**		**Al^{+3}**		**T . S . C**		**M . P**		**P . P**	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}	162	1.8×10^{-3}	177	2.1×10^{-3}	161	3.6×10^{-4}	170	7.8×10^{-4}	180	8.6×10^{-3}	161	1.7×10^{-3}
1×10^{-2}	153	4.4×10^{-3}	170	1.7×10^{-3}	145	1.1×10^{-4}	156	2.6×10^{-4}	181	4.0×10^{-2}	156	5.6×10^{-3}
5×10^{-3}	145	2.0×10^{-2}	159	4.2×10^{-3}	129	1.6×10^{-4}	152	9.9×10^{-4}	171	1.5×10^{-1}	152	3.4×10^{-2}
1×10^{-3}	138	2.1×10^{-2}	157	3.0×10^{-3}	119	4.8×10^{-5}	135	1.7×10^{-4}	156	8.7×10^{-2}	145	3.7×10^{-2}
5×10^{-4}	136	9.4×10^{-2}	153	8.0×10^{-3}	117	1.3×10^{-4}	129	3.4×10^{-4}	150	2.8×10^{-1}	140	1.3×10^{-1}
1×10^{-4}	126	2.2×10^{-1}	125	2.1×10^{-3}	112	1.6×10^{-4}	104	8.6×10^{-5}	133	3.9×10^{-1}	125	2.1×10^{-1}
1×10^{-5}	100	3.1×10^{-1}	95	6.6×10^{-4}	90	6.5×10^{-5}	85	4.4×10^{-5}	100	3.1×10^{-1}	88	1.2×10^{-1}

Table (3-9): Selectivity coefficients for (IBP –MIP1 +NB) electrode at different concentrations of Ibuprofen

Concentrations of Ibuprofen (M): Concentrations of interference ions (M)												
Con of IBP	Interfering ions											
	K^{+}		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}	252	2.8×10^{-3}	251	8.1×10^{-4}	190	2.8×10^{-6}	257	9.2×10^{-4}	247	1.8×10^{-3}	255	3.6×10^{-3}
1×10^{-2}	219	4.2×10^{-3}	215	3.0×10^{-4}	199	4.2×10^{-5}	222	2.4×10^{-4}	198	8.0×10^{-4}	203	1.2×10^{-3}
5×10^{-3}	200	5.3×10^{-4}	212	6.1×10^{-4}	209	1.9×10^{-4}	206	1.5×10^{-4}	184	9.1×10^{-4}	186	1.1×10^{-3}
1×10^{-3}	195	7.2×10^{-4}	191	1.5×10^{-4}	166	6.5×10^{-6}	180	2.0×10^{-5}	171	9.6×10^{-4}	155	2.7×10^{-4}
5×10^{-4}	175	6.6×10^{-4}	160	4.8×10^{-4}	163	1.7×10^{-5}	162	1.6×10^{-5}	161	2.3×10^{-3}	146	7.2×10^{-4}
1×10^{-4}	132	5.7×10^{-4}	123	3.0×10^{-6}	118	4.1×10^{-7}	130	1.0×10^{-6}	117	1.7×10^{-4}	112	1.2×10^{-4}
1×10^{-5}	118	1.6×10^{-3}	105	1.8×10^{-6}	105	2.6×10^{-7}	107	3.1×10^{-7}	107	6.6×10^{-4}	110	8.4×10^{-4}

Table (3-10): Selectivity coefficients for (IBP –MIP2 +TTP) electrode at different concentrations of Ibuprofen

Concentrations of Ibuprofen (M): Concentrations of interference ions (M)												
Con of IBP	Interfering ions											
	K^+		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}												
5×10^{-3}	141	3.1×10^{-2}	141	2.2×10^{-3}	145	1.3×10^{-3}	185	1.6×10^{-3}	148	5.4×10^{-2}	139	2.7×10^{-2}
1×10^{-3}	138	4.0×10^{-2}	132	7.8×10^{-4}	137	3.7×10^{-4}	179	1.8×10^{-4}	144	6.4×10^{-2}	133	2.7×10^{-2}
5×10^{-4}	135	8.1×10^{-2}	129	1.1×10^{-3}	127	2.7×10^{-4}	167	1.4×10^{-4}	142	1.4×10^{-1}	130	5.4×10^{-2}
1×10^{-4}	127	1.1×10^{-2}	125	9.4×10^{-4}	122	1.6×10^{-4}	155	6.8×10^{-5}	130	1.4×10^{-1}	125	9.4×10^{-2}
1×10^{-5}	99	3.7×10^{-2}	100	1.3×10^{-4}	95	1.2×10^{-5}	141	6.6×10^{-6}	102	4.7×10^{-2}	95	2.7×10^{-2}
1×10^{-6}	90	3.4×10^{-2}	90	3.4×10^{-5}	85	2.3×10^{-6}	133	2.0×10^{-6}	95	5.0×10^{-2}	85	2.3×10^{-2}

Table (3-11): Selectivity coefficients for (IBP –MIP3+DBPH) electrode at different concentrations of Ibuprofen

Concentrations of Ibuprofen (M): Concentrations of interference ions (M)												
Con of IBP	Interfering ions											
	K^{+}		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}	136	1.6×10^{-2}	137	5.4×10^{-3}	128	1.7×10^{-3}	108	3.0×10^{-4}	123	5.1×10^{-3}	128	7.8×10^{-3}
1×10^{-2}	130	3.0×10^{-2}	128	2.5×10^{-3}	120	6.3×10^{-4}	95	8.8×10^{-5}	111	6.7×10^{-3}	118	1.2×10^{-2}
5×10^{-3}	127	6.4×10^{-2}	126	4.2×10^{-3}	114	6.7×10^{-4}	87	8.0×10^{-5}	103	9.6×10^{-3}	105	1.1×10^{-2}
1×10^{-3}	116	6.9×10^{-2}	119	2.8×10^{-3}	95	1.3×10^{-4}	79	3.8×10^{-5}	93	1.1×10^{-2}	90	8.9×10^{-3}
5×10^{-4}	107	1.2×10^{-1}	109	3.1×10^{-3}	84	1.2×10^{-4}	67	3.2×10^{-5}	89	2.9×10^{-2}	87	2.5×10^{-2}
1×10^{-4}	97	1.4×10^{-1}	105	2.6×10^{-3}	76	5.8×10^{-5}	58	1.4×10^{-5}	81	4.0×10^{-2}	78	3.1×10^{-2}

Table (3-12): Selectivity coefficients for (IBP –MIP3+DBS) electrode at different concentrations of Ibuprofen

Concentrations of Ibuprofen (M): Concentrations of interference ions (M)												
Con of IBP	Interfering ions											
	K^+		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-2}	190	2.3×10^{-3}	180	1.1×10^{-4}	175	3.3×10^{-5}	167	1.8×10^{-5}	182	1.2×10^{-3}	173	6.1×10^{-4}
1×10^{-3}	184	2.2×10^{-3}	168	4.4×10^{-5}	167	1.7×10^{-5}	152	5.2×10^{-6}	173	9.3×10^{-4}	161	3.6×10^{-4}
5×10^{-3}	181	8.5×10^{-3}	158	4.4×10^{-5}	154	1.0×10^{-5}	136	2.5×10^{-6}	158	1.4×10^{-3}	154	1.0×10^{-3}
1×10^{-4}	177	2.5×10^{-2}	151	7.2×10^{-5}	137	6.7×10^{-6}	124	2.4×10^{-6}	143	1.7×10^{-3}	137	1.1×10^{-3}
5×10^{-4}	168	2.7×10^{-2}	146	4.8×10^{-5}	121	1.4×10^{-6}	115	8.9×10^{-7}	126	9.9×10^{-4}	121	6.6×10^{-4}
1×10^{-5}	160	6.4×10^{-2}	135	2.8×10^{-5}	107	1.3×10^{-6}	101	8.3×10^{-7}	99	5.3×10^{-4}	117	2.2×10^{-3}

The data given in tables (3-8) to (3-12) revealed that the selectivity coefficient obtained by the proposed electrodes for all cations tested were on order of (3-5), which indicated good selectivity for ibuprofen against common transition metal ions. Preferably selectivity coefficient of less than one because if the largest lead the electrode starts to response to the interfering ion instead of the analyte. The results showed that the selectivity coefficients for monovalent interfering ions is in the order mono> di> trivalent. This might be attributed to the difference in ionic size, mobility and permeability. When the concentration of monovalent ion decreased, the difference in potential measurement decreased.

Therefore, the selectivity coefficient increasesd and the interference of monovalent ion is also increased. The values of log $K^{pot.}$ were found to range from (1.2×10^{-1} to 5.3×10^{-4}) for monovalent from ($1.7x10^{-3}$ – to $1.8x10^{-6}$) for divalent and from ($1.3x10^{-3}$ to$1.3\ x10^{-6}$) for trivalent interfereing ions. While the compounds tri sodium citrate , methylparaben and propylparaben were found to range from($1.6\times^{10-}3$ – to 8.3×10^{-7}) ,(1.5×10^{-1} to $5.3\ \times10^{-4}$) and (1.2×10^{-4} to 1.2×10^{-1}) respectively The results in the above tables also show that the selectivity was influenced by the plasticizer used.

3-7-2 Selectivity Measurement by Match Potential Method (MPM)

The matched potential method (MPM) is used for the determination of the potentiometric selectivity coefficients ($K^{pot}_{A,B}$) of ion-selective electrodes for two ions with any charge. This MPM theory is based on electrical diffuse layers on both the membrane and the aqueous side of the

interface, and is therefore independent of the Nicolsky-Eisenman equation. The MPM-selectivity coefficients of ions with equal charge (ZA = ZB) are expressed as the ratio of the concentrations of the primary and interfering ions in aqueous solutions at which the same amounts of the primary and interfering ions per meate selectively extracted into the membrane surface. For ions with unequal charge (ZA not equal to ZB), the selectivity coefficients are expressed as a function not only of the amounts of the primary and interfering ions permeated into the membrane surface, but also of the primary ion concentration in the initial reference solution and the change in E.M.F value.

In this method the selectivity coefficient is given by using equation (4). The results of selectivity coefficient are shown in Fig. (3-28) to (3-37) and in the Tables (3-13)to(3-17) and were calculated from The concentration of the interfering ion which endued the same amount of the potential change as that induced by the increase of the concentration of primary ion.

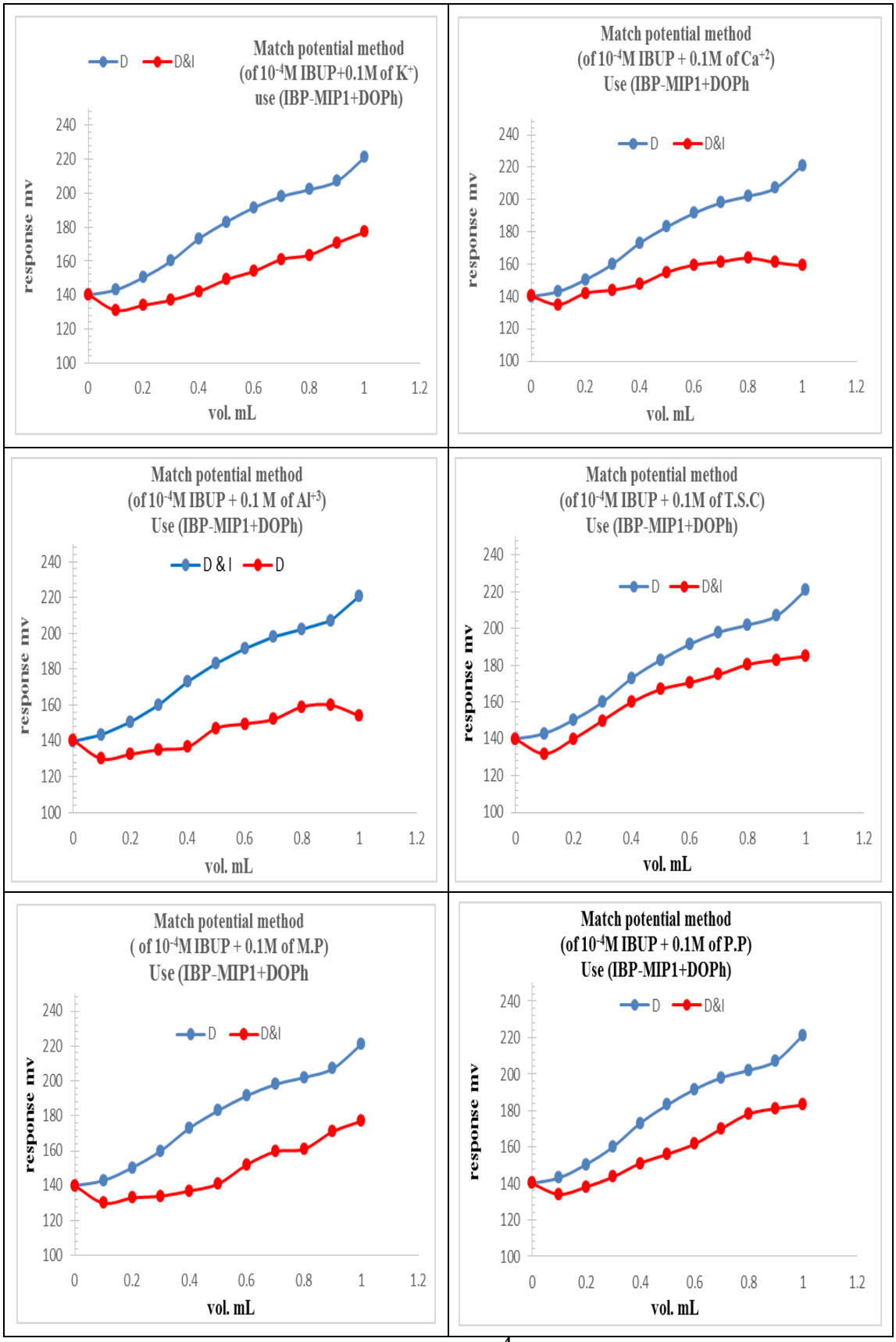


Fig. (3-28): Selectivity of electrode for (10^{-4}) M based on DOPh for cations interfering by Match potential method solution♦ of cations interfering ♦ IBP solution.

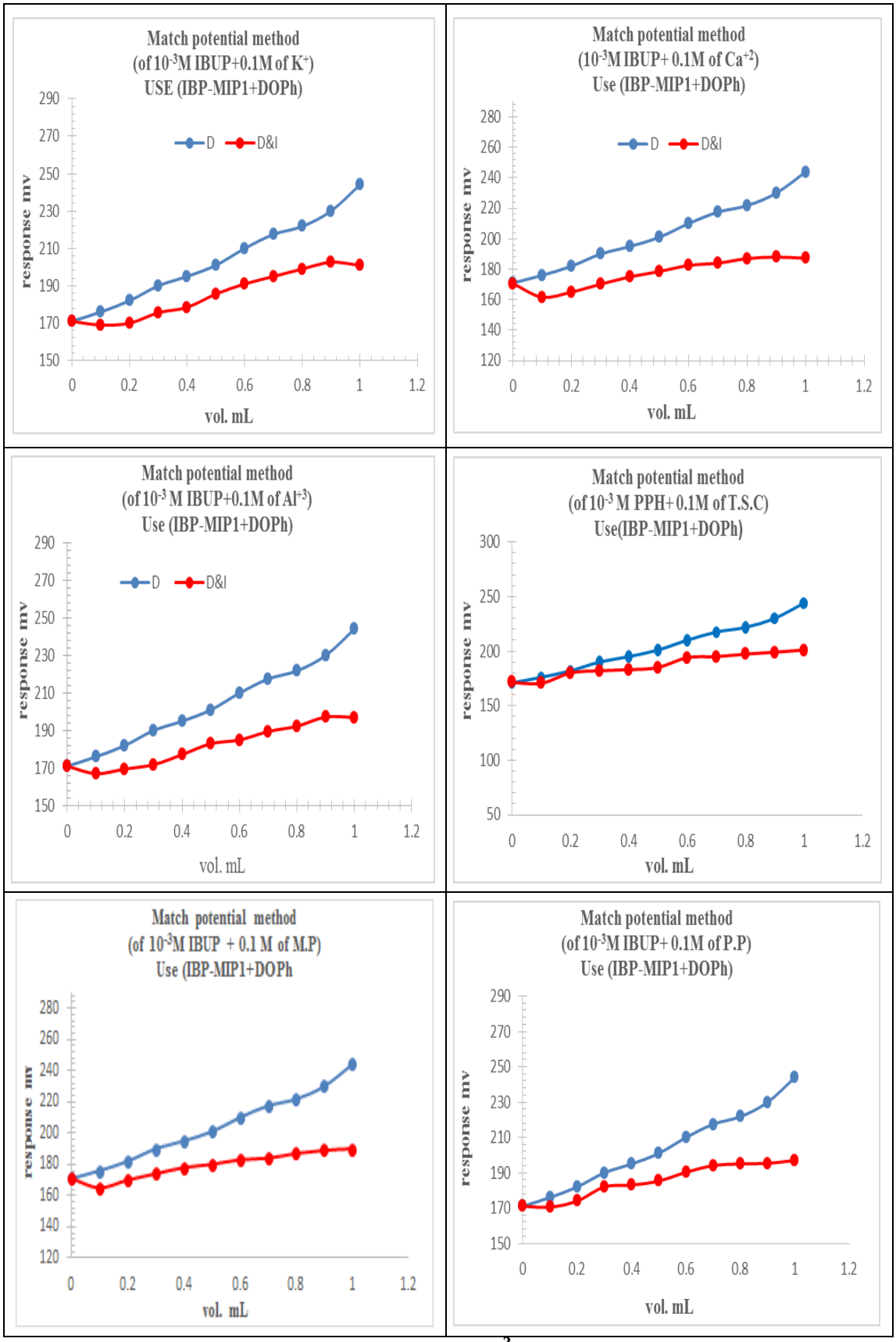


Fig. (3-29): Selectivity of electrode for (10^{-3}) M based on DOPh for cations interfering by Match potential method solution♦ of cations interfering ♦ IBP solution.

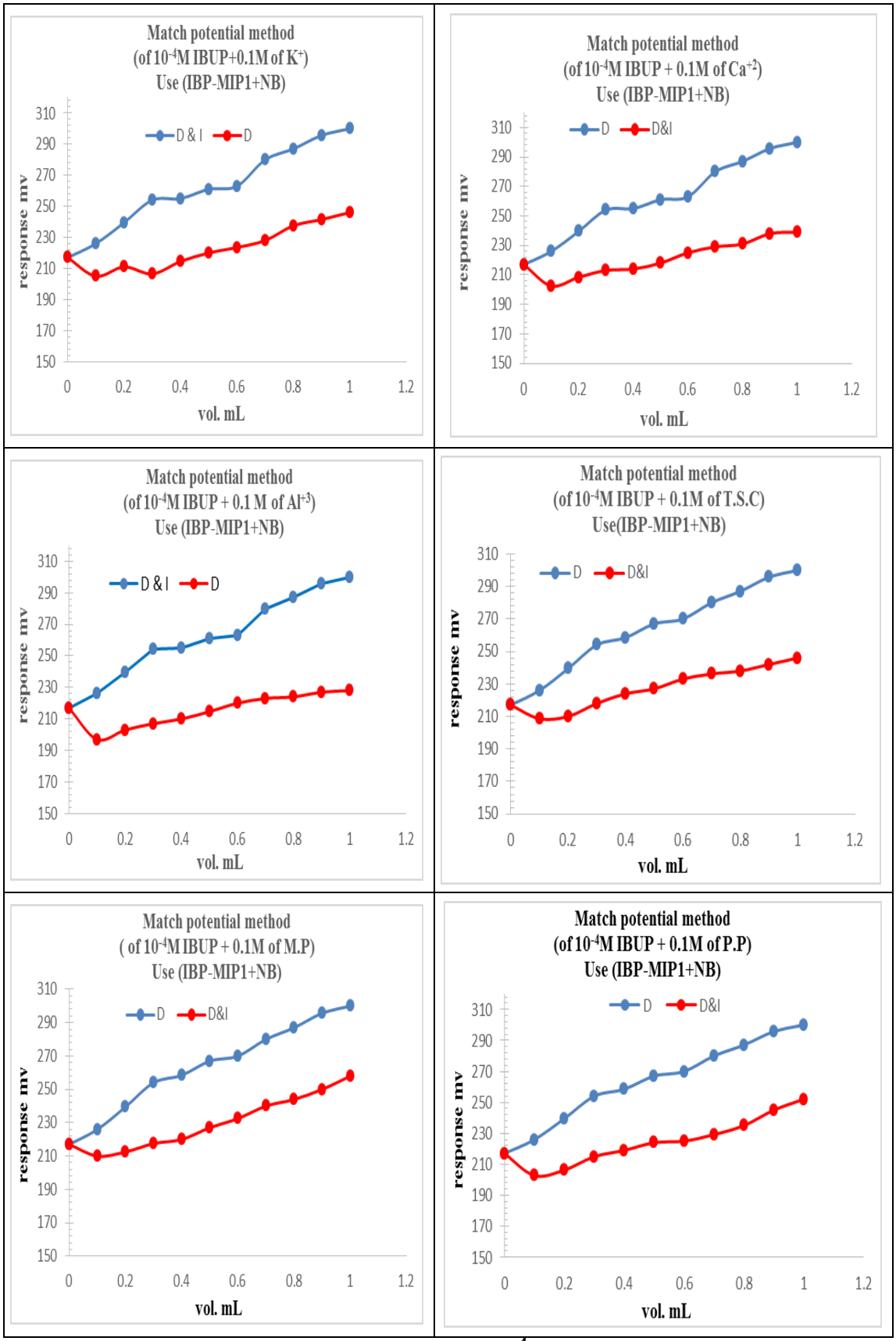


Fig. (3-30): Selectivity of electrode for (10^{-4}) M based on NB for cations interfering by Match potential method solution♦ of cations interfering ♦ IBP solution.

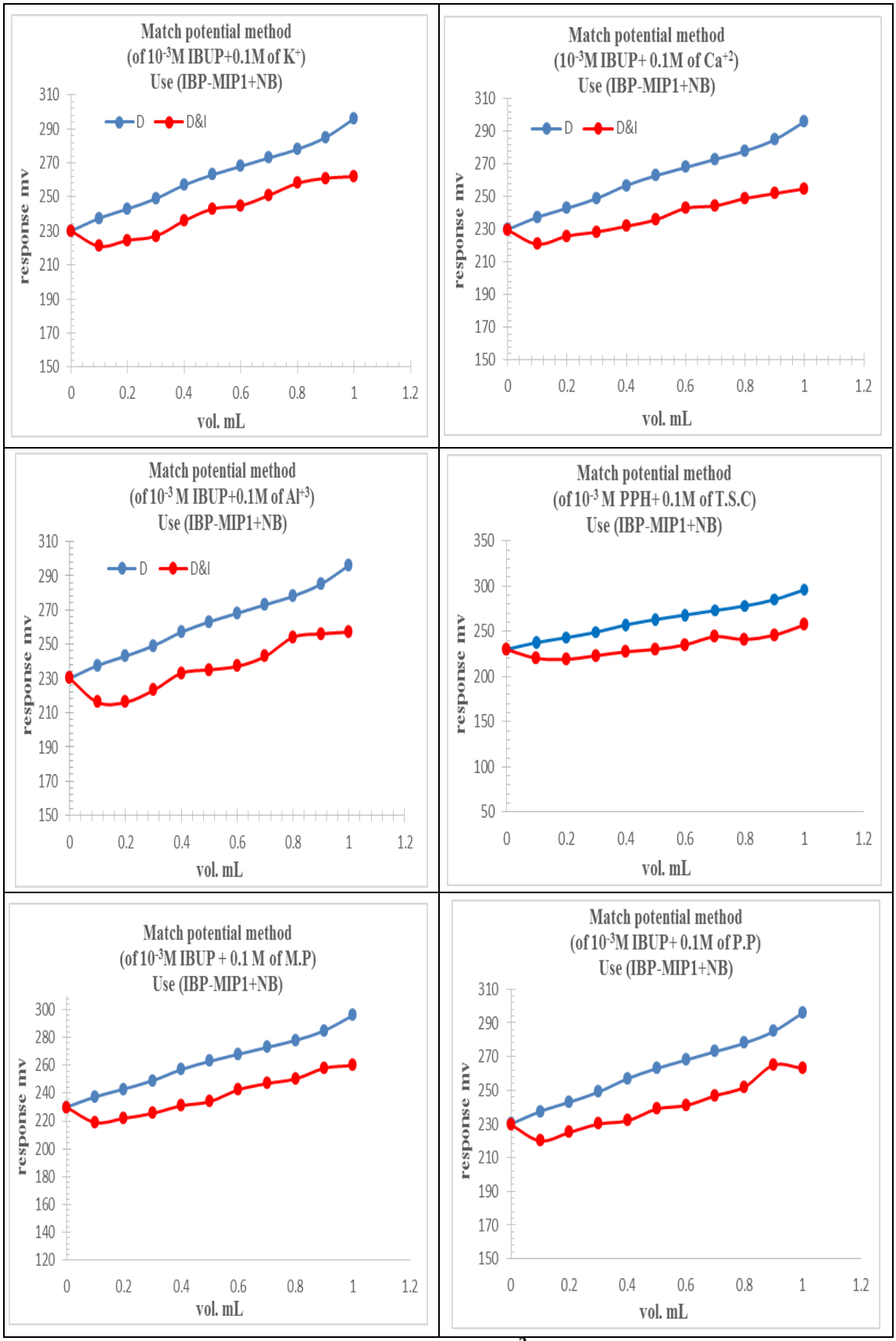


Fig. (3-31): Selectivity of electrode for (10^{-3}) M based on NB for cations interfering by Match potential method solution♦ of cations interfering ♦ IBP solution.

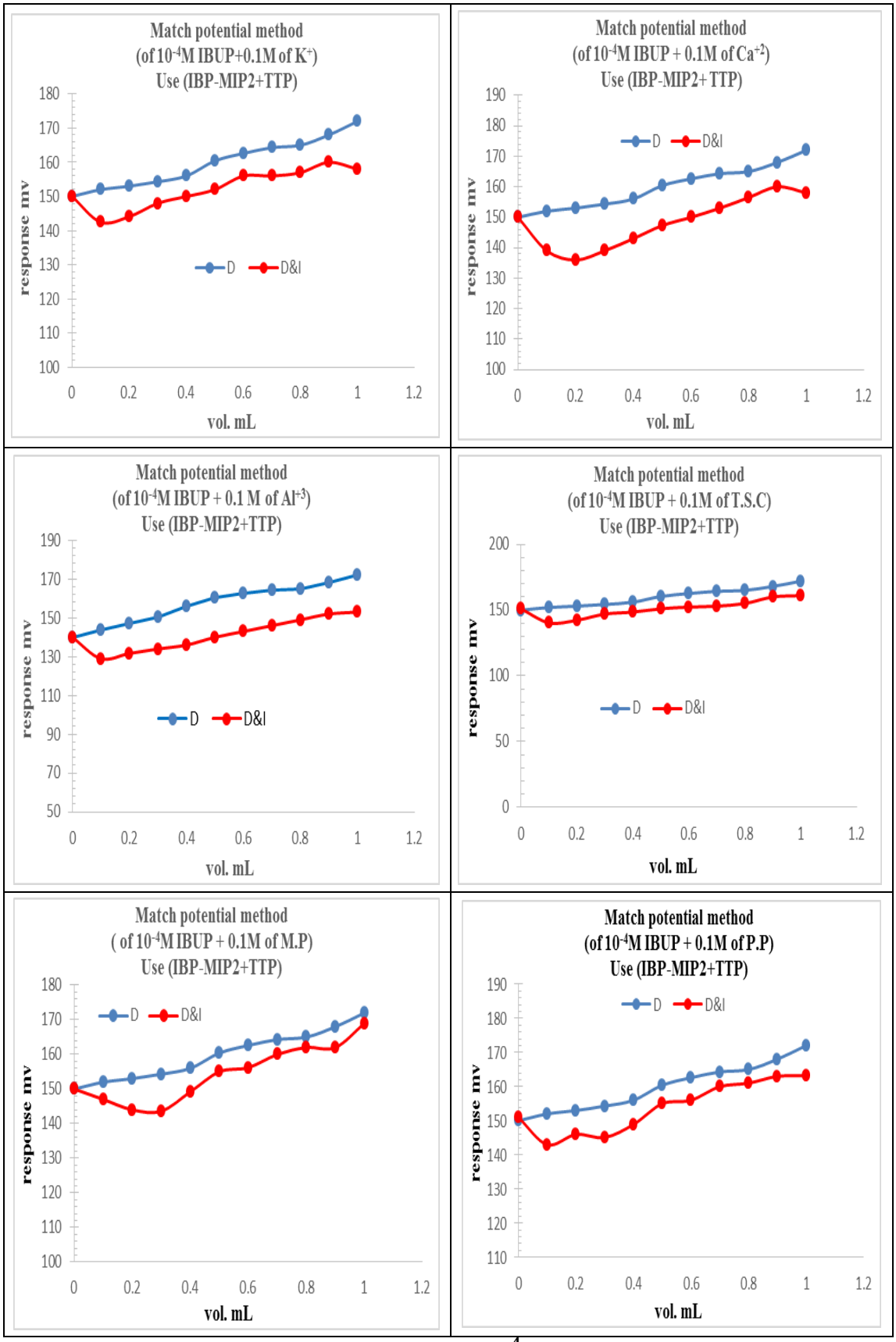


Fig. (3-32): Selectivity of electrode for (10^{-4}) M based on TTP for cations interfering by Match potential method solution♦ of cations interfering ♦ IBP solution.

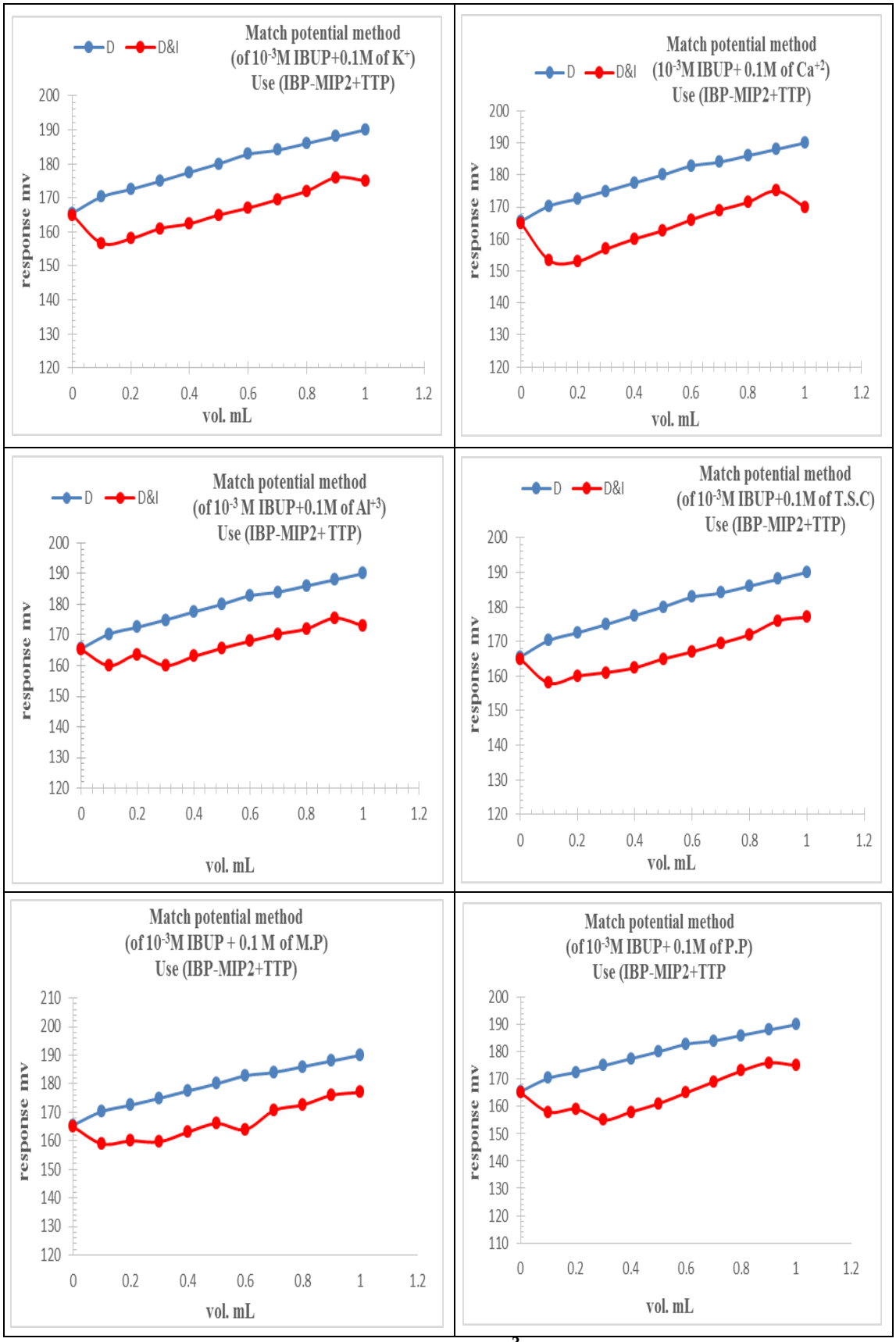


Fig. (3-33): Selectivity of electrode for (10^{-3}) M based on TTP for cations .interfering by Match potential method solution♦ of cations interfering ♦ IBP Solution

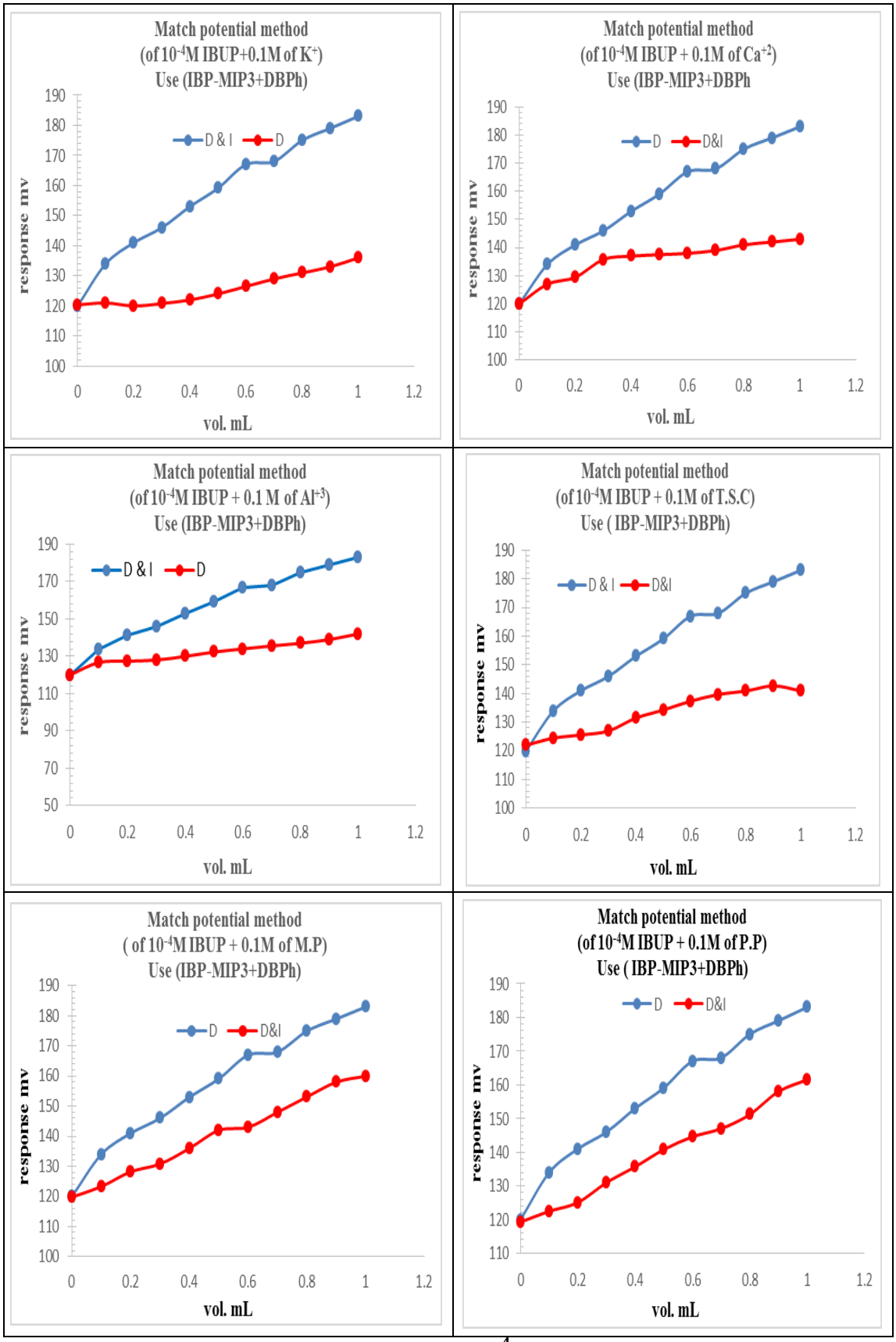


Fig. (3-34): Selectivity of electrode for (10^{-4}) M based on DBPH for cations .interfering by Match potential method solution♦ of cations interfering ♦ IBP Solution

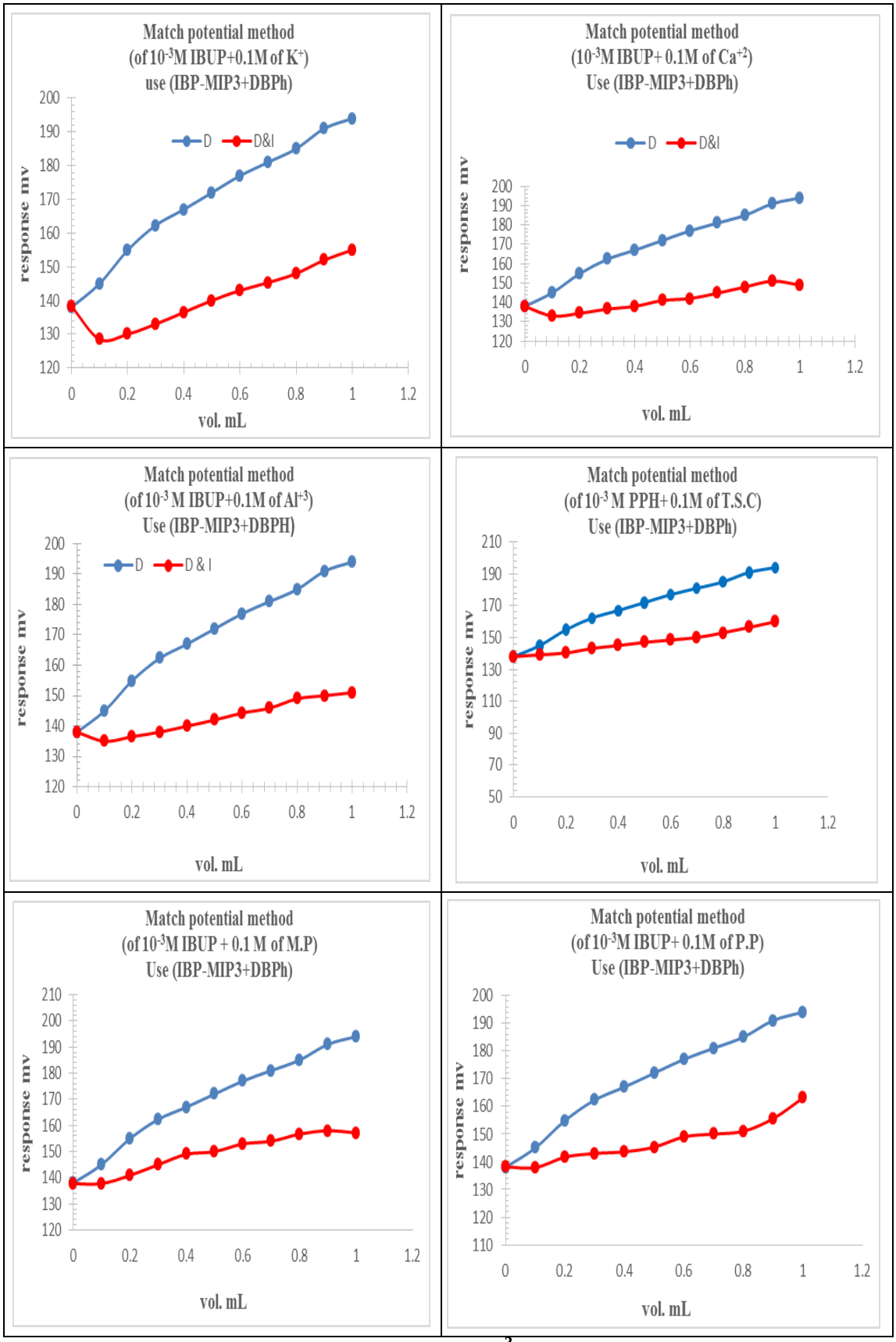


Fig. (3-35): Selectivity of electrode for (10^{-3}) M based on DBPh for cations .interfering by Match potential method solution♦ of cations interfering ♦ IBP Solution

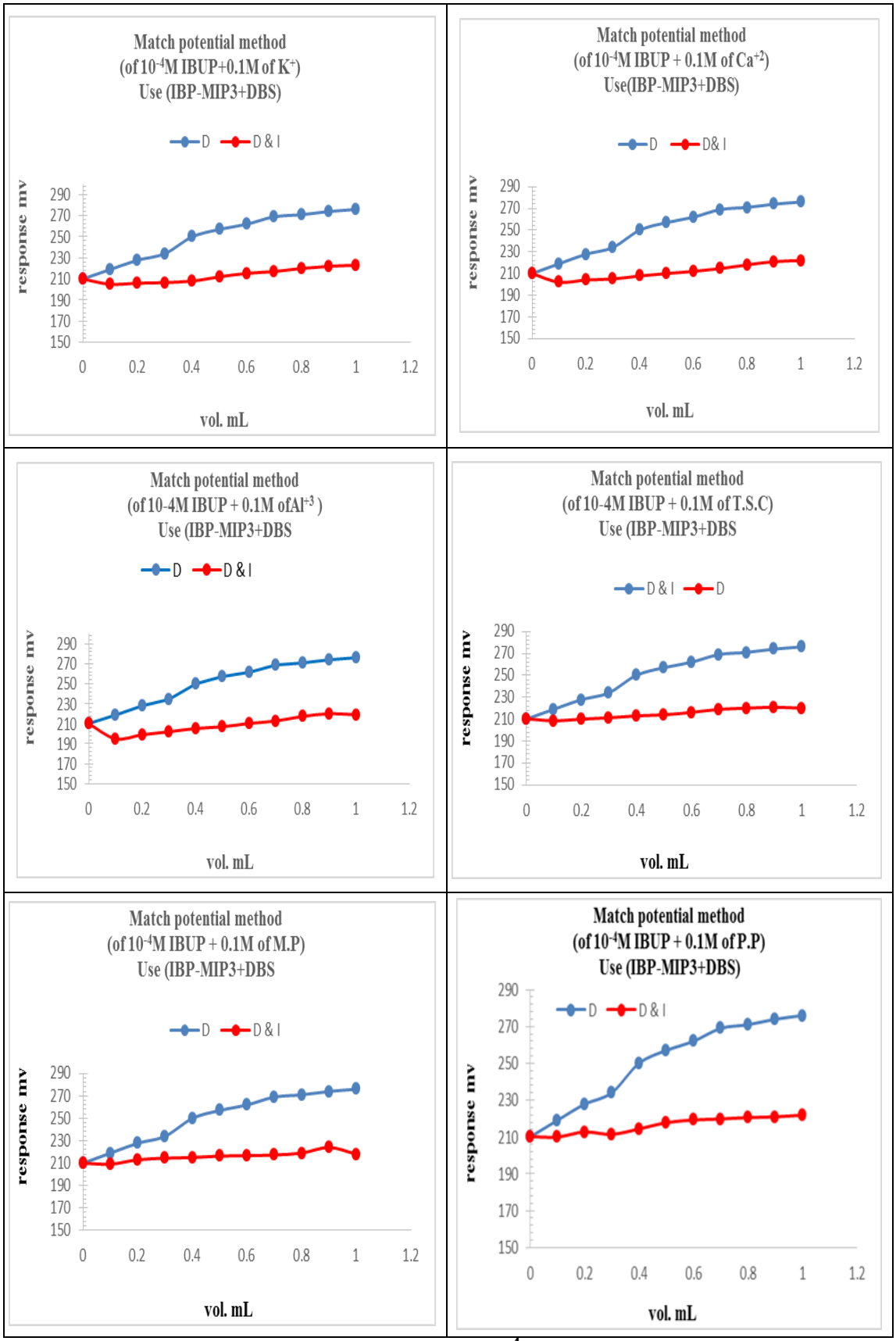


Fig. (3-36): Selectivity of electrode for (10^{-4}) M based on DBS for cations .interfering by Match potential method solution♦ of cations interfering ♦ IBP Solution

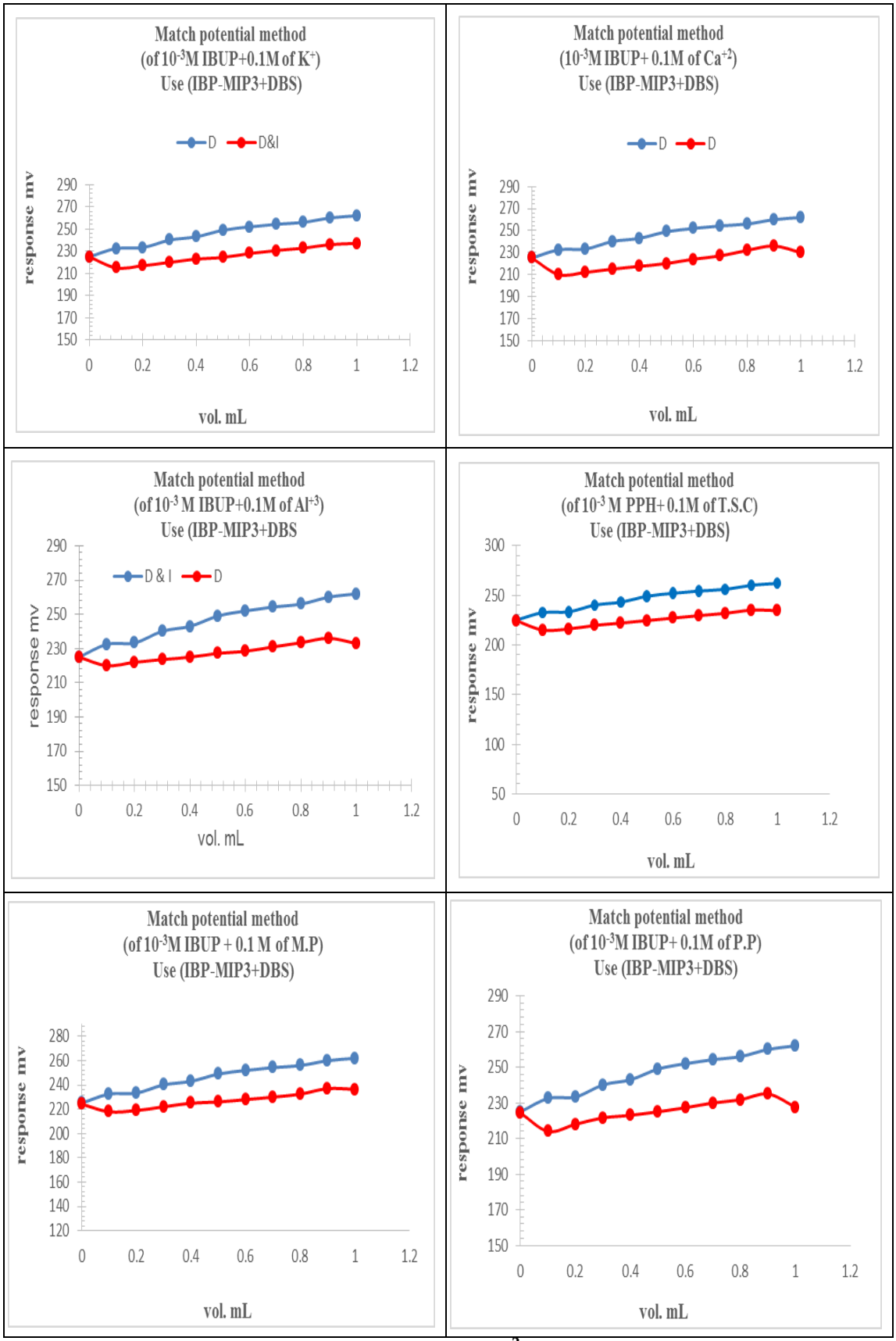


Fig. (3-37): Selectivity of electrode for (10^{-3}) M based on DBS for cations .interfering by Match potential method solution♦ of cations interfering ♦ IBP Solution

Table (3-13): Selectivity coefficients for the ibuprofen electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
IBP-MIP1+DOPH (Mem I)	K^{+}	8.1×10^{-1}	6.3×10^{-1}
	Ca^{+2}	8.3×10^{-1}	6.5×10^{-1}.
	Al^{+3}	8×10^{-1}	5.9×10^{-1}
	T . S . C	8.5×10^{-1}	6.8×10^{-1}
	M . P.	8×10^{-1}	6×10^{-1}
	P . P.	8.2×10^{-1}	6.5×10^{-1}
	1×10^{-3}		
	K^{+}	8.1×10^{-1}	5.7×10^{-1}
	Ca^{+2}	7.2×10^{-1}	4.9×10^{-1}
	Al^{+3}	7.2×10^{-1}	5.2×10^{-1}
	T . S . C	8×10^{-1}	6.4×10^{-1}
	M . P.	7.4×10^{-1}	5.1×10^{-1}
	P . P.	8.1×10^{-1}	7×10^{-1}

Table (3-14): Selectivity coefficients for the ibuprofen electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
IBP-MIP1+NB (Mem II)	K^{+}	6.4×10^{-1}	3.7×10^{-1}
	Ca^{+2}	8×10^{-1}	6.6×10^{-1}
	Al^{+3}	5.5×10^{-1}	1.9×10^{-2}
	T . S . C	7.1×10^{-1}	4.5×10^{-1}
	M . P.	7×10^{-1}	4.4×10^{-1}
	P . P.	6.6×10^{-1}	3.4×10^{-1}
	1×10^{-3}		
	K^{+}	7.2×10^{-1}	4.7×10^{-1}
	Ca^{+2}	7.2×10^{-1}	4.6×10^{-1}
	Al^{+3}	5.9×10^{-1}	3.6×10^{-1}
	T . S . C	5.6×10^{-1}	2.5×10^{-1}
	M . P.	6.4×10^{-1}	4.4×10^{-1}
	P . P.	6.3×10^{-1}	4.2×10^{-1}

Table (3-15): Selectivity coefficients for the ibuprofen electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
IBP-MIP2+TTP (Mem III)	K^{+}	0.28	5.8×10^{-2}
	Ca^{+2}	0.19	6×10^{-2}
	Al^{+3}	0.6	0.26
	T . S . C	0.2	6.3×10^{-2}
	M . P.	0.27	0.11
	P . P.	0.18	0.11
	1×10^{-3}		
	K^{+}	0.31	0.12
	Ca^{+2}	0.29	4.6×10^{-4}
	Al^{+3}	0.32	1×10^{-3}
	T . S . C	0.57	0.15
	M . P.	0.24	4.28×10^{-3}
	P . P.	0.29	5×10^{-3}

Table (3-16): Selectivity coefficients for the ibuprofen electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
IBP-MIP3+DBPH (Mem IV)	K^{+}	0.84	0.64
	Ca^{+2}	0.9	0.8
	Al^{+3}	0.89	0.77
	T . S . C	0.89	0.75
	M . P.	0.87	0.78
	P . P.	0.91	0.77
	1×10^{-3}		
	K^{+}	0.7	0.3
	Ca^{+2}	0.68	0.26
	Al^{+3}	0.74	0.28
	T . S . C	0.83	0.55
	M . P.	0.84	0.62
	P . P.	0.85	0.57

Table (3-17): Selectivity coefficients for the ibuprofen electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
IBP-MIP3+DBS (Mem V)	K^{+}	8.4×10^{-1}	5.7×10^{-1}
	Ca^{+2}	8×10^{-1}	5.3×10^{-1}
	Al^{+3}	7.9×10^{-1}	5.1×10^{-1}
	T . S . C	8.5×10^{-1}	5.4×10^{-1}
	M . P.	8.7×10^{-1}	6×10^{-1}
	P . P.	8.6×10^{-1}	6.5×10^{-1}
	1×10^{-3}		
	K^{+}	8.4×10^{-1}	4.8×10^{-2}
	Ca^{+2}	4.1×10^{-1}	3.7×10^{-2}
	Al^{+3}	5.1×10^{-1}	5×10^{-2}
	T . S . C	4.5×10^{-1}	1.2×10^{-2}
	M . P.	5×10^{-1}	7.2×10^{-2}
	P . P.	4.8×10^{-1}	1.1×10^{-2}

3-8 Standard solution analysis

For determination of the standard ibuprofen solutions all electrodes were and four techniques namely were applied direct, standard addition (SAM), multiple standard addition (MSA) and titration methods. The relative error $E_{rel\%}$ and relative standard deviation RSD% were calculated for each method

3-8-1 Direct potentiometric method

This is the simplest method of obtaining quantitative results using ISEs. Standard solutions were prepared by serial dilution. The calibration curve was constructed and the concentration of the unknown was calculated by linear equation of the calibration curve, the results are listed in Table (3-18) .

Table (3-18): Ibuprofen Standard and forms pharmaceutical sample analyses by using Direct potentiometric method for IBP electrodes

Electrode No.	sample	Measured using Direct Methode	RSD %	E_{rel}%	REC %
IBP-MIP1 + DOPh (I)	**1×10^{-4}**				
	Standard	9.92×10^{-5}	0.9	-0.80	99.2
	PROFEDIN	1.088×10^{-4}	0.64	0.88	100.88
	Profinal	1.007×10^{-5}	0.76	0.7	100.7
	Maximum strength Ibuprofen	9.923×10^{-5}	0.88	-0.77	99.23
	1×10^{-3}				
	Standard	1.007×10^{-3}	0.82	0.79	100.79
	PROFEDIN	1.099×10^{-3}	0.81	0.99	100.99
	Profinal	9.924×10^{-4}	0.9	-0.76	99.24
	Maximum strength Ibuprofen	1.007×10^{-3}	0.91	0.71	100.71
IBP-MIP1 + NB (II)	**1×10^{-4}**				
	Standard	1.0098×10^{-4}	0.78	0.98	100.98
	PROFEDIN	1.0074×10^{-4}	0.77	0.74	100.74
	Profinal	9.90×10^{-5}	0.84	-1	99
	Maximum strength Ibuprofen	9.928×10^{-5}	0.8	-0.72	99.28
	1×10^{-3}				
	Standard	1.0098×10^{-4}	0.78	0.98	100.98
	PROFEDIN	1.0074×10^{-4}	0.77	0.74	100.74
	Profinal	9.90×10^{-5}	0.84	-1	99
	Maximum strength Ibuprofen	9.928×10^{-5}	0.8	-0.72	99.28
IBP-MIP2 + TTP (III)	**1×10^{-4}**				
	Standard	1.013×10^{-4}	0.82	1.31	101.3
	PROFEDIN	$9.\ 9\times10^{-5}$	0.85	-0.99	90.01
	Profinal	9.91×10^{-5}	0.83	-0.9	99.1
	Maximum strength Ibuprofen	9.97×10^{-5}	0.99	-0.28	99.72

IBP-MIP2 + TTP (III)	**1×10^{-3}**				
	Standard	9.928×10^{-4}	0.98	-0.72	99.28
	PROFEDIN	1.009×10^{-3}	0.73	0.94	100.94
	Profinal	1.006×10^{-3}	0.77	0.62	100.62
	Maximum strength Ibuprofen	1.008×10^{-3}	0.73	0.87	100.87
IBP-MIP3 + DBPH (IV)	**1×10^{-4}**				
	Standard	9.98×10^{-4}	0.84	-1.04	98.96
	PROFEDIN	1.009×10^{-4}	0.92	0.96	100.96
	Profinal	9.91×10^{-5}	0.9	-0.86	99.14
	Maximum strength Ibuprofen	1.08×10^{-4}	0.72	0.86	100.86
	1×10^{-3}				
	Standard	1.007×10^{-3}	0.82	0.75	100.75
	PROFEDIN	1.005×10^{-3}	0.7	0.52	100.52
	Profinal	1.009×10^{-3}	0.91	0.92	100.92
	Maximum strength Ibuprofen	9.916×10^{-4}	0.72	-0.84	99.16
IBP-MIP3 + DBS (V)	**1×10^{-4}**				
	Standard	1.096×10^{-4}	0.65	0.96	100.96
	PROFEDIN	9.903×10^{-5}	0.85	0.97	99.03
	Profinal	9.9×10^{-5}	0.79	-1	99
	Maximum strength Ibuprofen	9.912×10^{-5}	0.855	-0.98	99.12
	1×10^{-3}				
	Standard	1.007×10^{-3}	0.82	0.75	100.75
	PROFEDIN	1.005×10^{-3}	0.7	0.52	100.52
	Profinal	1.009×10^{-3}	0.91	0.92	100.92
	Maximum strength Ibuprofen	9.916×10^{-4}	0.72	-0.84	99.16

3-8-2 Incremental Methods

In these methods, a procedure involves preparing several solutions containing the same amount of unknown, but different amounts of standard. But the concentration of standard solution of ibuprofen used for measurement was approximataly ≈100 times higher than the concentration of sample that was used to decrease the dilution effect. It is carried out by a procedure with 0.1mL increment of 10^{-1} M ibuprofen as standard and was added to 10 mL of sample as unknown. The calculation could be used as follows.

1-Standard Addition Method (SAM)

2-Multiple Standard Addition (MSA)

3-8-2-1 Calculation of Standard Addition Method SAM

In this method two solution of Ibuprofen (1×10^{-3} & 1×10^{-4}) were prepared for used in the measurement of IBP concentration .The RSD% and Erel.% calculations for Ibuprofen electrodes were measured by using the following equation the the results are listed in the Tables (3-19) to (3-58).

$$\mathbf{C_{unk.}=Cs/10\,\Delta\,E/s\,(1+V_{unk./}Vs)-(Vu/Vs)} \ldots\ldots (3\text{-}2)$$

Where $\mathbf{C_{unk.:}}$ the concentration of unknown solution.

Cs: the concentration of standard solution. $V_{unk.:}$ the volume of unknown solution.

Vs: the volume of standard solution. **S**: the slope of electrode.

E1: electrode potential (mV) in the sample solution

$\mathbf{E_2}$: electrode potential (mV) after the addition of the standard

Table (3-19) Potential of 10^{-4}M ibuprofen against the volume of standard ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Ibuprofen pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	137	3.1E+04				
0.1	168.6	3.4E+05	31.63	1.1E+01	100	1.0001E-04
0.2	177	6.4E+05	40.03	2.1E+01	50	1.0028E-04
0.3	182	9.3E+05	45.03	3.0E+01	33.33	1.0051E-04
0.4	185.6	1.2E+06	48.63	3.9E+01	25	1.0031E-04
0.5	188.4	1.5E+06	51.43	4.9E+01	20	1.0004E-04
MSA	con found=1.0023×10^{-4} RE%=0.23 REC%= 100.23 RSD%=0.27					
SAM	con found=1.0027×10^{-4} RE%=0.27 REC%= 100.27 RSD%=0. 32					
SD1= 0.46 RSD% = 0.25 Mv = 181.5 , 182.4, 182.1						

Table (3-20) Potential of 10^{-4}M ibuprofen against the volume of PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Profedin 400mg - 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	140	3.9E+04				
0.1	171.6	4.2E+05	31.6	1.1E+01	100	1.0026E-04
0.2	180.0	8.0E+05	40	2.0E+01	50	1.0052E-04
0.3	185.2	1.2E+06	45.2	3.0E+01	33.33	9.9184E-05
0.4	188.6	1.5E+06	48.6	3.9E+01	25	1.0055E-04
0.5	191.4	1.9E+06	51.4	4.8E+01	20	1.0027E-04
MSA	conc found=1.0015×10^{-4} RE%=0.15 REC%= 100.15 RSD%=0.2					
SAM	conc found=9.97×10^{-5} RE%=-0.24 REC%= 99. RSD%=0.52					
SD1=0.65 RSD%= 0.35 mv= 185.2 , 184.5, 185.8						

Table (3-21) Potential of 10^{-4}M ibuprofen against the volume of Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Profinal 400mg (UAE) 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	138.5	3.5E+04				
0.1	170.1	3.8E+05	31.6	1.1E+01	100	1.0026E-04
0.2	178.6	7.2E+05	40.06	2.1E+01	50	1.0004E-04
0.3	183.6	1.0E+06	45.09	3.0E+01	33.33	1.0004E-04
0.4	187.1	1.4E+06	48.6	3.9E+01	25	1.0055E-04
0.5	189.9	1.7E+06	51.42	4.9E+01	20	1.0011E-04
MSA	conc found=1.0020×10^{-4} RE%=0.20 REC%= 100.20 RSD%=0.24					
SAM	conc found=1.0022×10^{-4} RE%=0.22 REC%= 100.22 RSD%=0. 38					
SD1=0.65 RSD%= 0.35 mv= 187.8 , 186.5, 187						

Table (3-22) Potential of 10^{-4}M ibuprofen against the volume of Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Maximum strength Ibuprofen400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	137.7	3.3E+04				
0.1	169.4	3.6E+05	31.72	1.1E+01	100	9.9261E-05
0.2	177.7	6.7E+05	40.02	2.1E+01	50	1.0036E-04
0.3	182.7	9.8E+05	45.02	3.0E+01	33.33	1.0059E-04
0.4	186.3	1.3E+06	48.62	3.9E+01	25	1.0039E-04
0.5	189.1	1.6E+06	51.42	4.9E+01	20	1.0011E-04
MSA	conc found=1.0014×10^{-4} RE%=0.14 REC%= 100.14 RSD%=0.15					
SA	conc found=9.979×10^{-5} RE%= -0.21 REC%= 99.79RSD%=0.52					
SD1=0. 7 RSD%= 0.41 mv= 168. 7, 169.4, 170.1						

Table (3-23) Potential of 10^{-3}M ibuprofen against the volume of Standard and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Ibuprofen pure 1×10^{-3}						
Vs mL add	E(mv)	Antilog E/S	ΔE	Antilog ΔE/S	Vu/Vs	Cu (M)
0	169.8	3.7E+05				
0.1	178.9	7.3E+05	9.07	2.0E+00	100	9.9693E-04
0.2	184.1	1.1E+06	14.27	2.9E+00	50	1.0023E-03
0.3	187.8	1.4E+06	17.97	3.9E+00	33.33	1.0001E-03
0.4	190.6	1.8E+06	20.77	4.8E+00	25	1.0027E-03
0.5	192.9	2.1E+06	23.07	5.7E+00	20	1.0016E-03
MSA	Con found=1.0007×10^{-3} RE%=0.07 REC%= 100.07 RSD%=0.11					
SA	Con found=9.99×10^{-4} RE%=-0.11 REC%= 99. 89RSD%=0.33					
SD= 0.5 RSD%=0.28 mv= 178.9 , 178.4, 179.4						

Table (3-24) Potential of 10^{-3}M ibuprofen against the volume of PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

PROFEDIN 400mg- 1×10^{-3}						
Vs mL add	E(mv)	Antilog E/S	ΔE	Antilog ΔE/S	Vu/Vs	Cu (M)
0	168.1	3.2E+05				
0.1	177.2	6.5E+05	9.1	2.0E+00	100	9.9244E-04
0.2	182.4	9.5E+05	14.28	2.9E+00	50	1.0011E-03
0.3	186	1.3E+06	17.9	3.9E+00	33.33	1.0072E-03
0.4	188.9	1.6E+06	20.8	4.8E+00	25	9.9991E-04
0.5	191.2	1.9E+06	23.1	5.7E+00	20	9.9885E-04
MSA	con found=9.999×10^{-4} RE%=-0.01 REC%= 99.99 RSD%= 0.1					
SA	con found=9.968×10^{-4} RE%=-0. 32 REC%= 99.68RSD%=0.43					
SD= 0. 62 RSD%= 0.35 mv= 176.7, 177, 177.9						

Table (3-25) Potential of 10^{-3}M ibuprofen against the volume of Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Profinal 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	170	3.7E+05				
0.1	179.1	7.4E+05	9.1	2.0E+00	100	9.9244E-04
0.2	184.4	1.1E+06	14.4	3.0E+00	50	9.8763E-04
0.3	187.9	1.4E+06	17.9	3.9E+00	33.33	1.0072E-03
0.4	190.7	1.8E+06	20.7	4.8E+00	25	1.0094E-03
0.5	193	2.1E+06	23	5.7E+00	20	1.0079E-03
MSA	Con found=1.0009×10^{-3} RE%=0.09 REC%= 100.09RSD%=0.11					
SA	Con found=9.942×10^{-4} RE%=-0.58 REC%= 99.42 RSD%=0.59					
SD= 0.7 RSD%= 0.38 mv= 183.7, 184.4, 185.1						

Table (3-26) Potential of 10^{-3}M ibuprofen against the volume of MAXIMUM Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ DOPH electrode

Maximum Strength Ibuprofen 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	172	4.4E+05				
0.1	181	8.6E+05	9.05	2.0E+00	100	9.9994E-04
0.2	186.3	1.3E+06	14.3	2.9E+00	50	9.9886E-04
0.3	189.9	1.7E+06	17.9	3.9E+00	33.33	1.0072E-03
0.4	192.8	2.1E+06	20.8	4.8E+00	25	9.9991E-04
0.5	195.1	2.5E+06	23.06	5.7E+00	20	1.0025E-03
MSA	Con found=1.0017×10^{-3} RE%=0.17 REC%= 100.17 RSD%=0.17					
SAM	Con found=1.0020×10^{-3} RE%=0.20 REC%= 100.20RSD%=0.52					
	SD=0.65 RSD%=0.35 mv= 185.7, 186.2, 187					

Table (3-27) Potential of 10^{-4}M ibuprofen against the volume of standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Ibuprofen pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	232	5.8E+07				
0.1	263	6.3E+08	31	1.1E+01	100	1.0005E-04
0.2	271.3	1.2E+09	39.26	2.1E+01	50	1.0011E-04
0.3	276.2	1.7E+09	44.2	3.0E+01	33.33	1.0003E-04
0.4	279.7	2.3E+09	47.7	3.9E+01	25	1.0007E-04
0.5	282.4	2.8E+09	50.4	4.9E+01	20	1.0015E-04
MSA	Con found=1.0008×10^{-4} RE%= 0.08 REC% = 100.08 RSD% = 0.1					
SAM	Con found=1.0011×10^{-4} RE%= 0.11 REC% = 100.11 RSD%=0. 2					
SD1= 0. 5 RSD% = 0.18 Mv = 2812 , 282.3, 283						

Table (3-28) Potential of 10^{-4}M ibuprofen against the volume of PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Profedin400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	234	6.7E+07				
0.1	265	7.3E+08	31	1.1E+01	100	1.0005E-04
0.2	273.3	1.4E+09	39.29	2.1E+01	50	9.9871E-05
0.3	278.2	2.0E+09	44.2	3.0E+01	33.33	1.0003E-04
0.4	281.6	2.6E+09	47.6	3.9E+01	25	1.0086E-04
0.5	284.4	3.3E+09	50.4	4.9E+01	20	1.0015E-04
MSA	Con found=1.0002×10^{-4} RE%=0.02 REC%= 100.02 RSD%=0.2					
SAM	Con found=9.972×10^{-5} RE%= -0.28 REC%= 99.72 RSD%=0.6					
SD1=0.72 RSD%= 0.26 mv= 272.6 , 273.6 , 274						

Table (3-29) Potential of 10^{-4}M ibuprofen against the volume of Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Profinal 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	231.9	5.7E+07				
0.1	262.9	6.2E+08	31	1.1E+01	100	1.0005E-04
0.2	271.1	1.2E+09	39.2	2.0E+01	50	1.0060E-04
0.3	276.2	1.7E+09	44.3	3.0E+01	33.33	9.9241E-05
0.4	279.6	2.2E+09	47.7	3.9E+01	25	1.0007E-04
0.5	282.2	2.7E+09	50.3	4.8E+01	20	1.0005E-04
MSA	Con found=1.0018×10^{-4} RE%=0.18 REC%= 100.18 RSD%=0.11					
SAM	Con found=9.98×10^{-5} RE%= -0.19 REC%= 99.81 RSD%=0.53					
SD1=0.82 RSD%= 0.3 mv= 275.5 , 276 , 277.1						

Table (3-30) Potential of 10^{-4}M ibuprofen against the volume of Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Maximum strength Ibuprofen 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	232	5.8E+07				
0.1	262.9	6.2E+08	30.9	1.1E+01	100	1.0090E-04
0.2	271.3	1.2E+09	39.25	2.1E+01	50	1.0019E-04
0.3	276.2	1.7E+09	44.2	3.0E+01	33.33	1.0003E-04
0.4	279.7	2.3E+09	47.7	3.9E+01	25	1.0007E-04
0.5	282.5	2.8E+09	50.5	4.9E+01	20	9.9363E-05
MSA	Con found=1.0011×10^{-4} RE%=0.11 REC%= 100.11 RSD%=0.11					
SA	Con found=9.98×10^{-5} RE%= -0.19 REC%= 99.81 RSD%=0.53					
SD1=0. 75 RSD%= 0.35 mv= 282.2 , 281.9 , 283.4						

Table (3-31) Potential of 10^{-3}M ibuprofen against the volume of standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Ibuprofen pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	271.7	1.2E+09				
0.1	280.6	2.4E+09	8.85	2.0E+00	100	1.0032E-03
0.2	285.8	3.6E+09	14.1	3.0E+00	50	9.8940E-04
0.3	289.3	4.7E+09	17.6	3.9E+00	33.33	1.0017E-03
0.4	292	5.8E+09	20.3	4.8E+00	25	1.0085E-03
0.5	294.3	7.0E+09	22.6	5.7E+00	20	1.0029E-03
MSA	Con found=1.0011×10^{-3} RE%=0.11 REC%= 100.11 RSD%=0.12					
SA	Con found=9.967×10^{-4} RE%=-0.33 REC%= 99. 67RSD%=0.65					
SD= 1.08 RSD%=0.38 mv= 285.5 – 284.9 - 287						

Table (3-32) Potential of 10^{-3}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

PROFEDIN 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	269	9.9E+08				
0.1	277.9	2.0E+09	8.9	2.0E+00	100	9.9553E-04
0.2	283	2.9E+09	14	2.9E+00	50	1.0009E-03
0.3	286.6	3.9E+09	17.6	3.9E+00	33.33	1.0017E-03
0.4	289.4	4.8E+09	20.4	4.8E+00	25	9.9887E-04
0.5	291.6	5.7E+09	22.6	5.7E+00	20	1.0029E-03
MSA	Con found=9.999×10^{-3} RE%=0 REC%= 100 RSD%= 0.1					
SA	Con found=9.987×10^{-4} RE%=-0. 13 REC%= 99.87 RSD%=0.31					
SD= 0. 62 RSD%= 0.22 mv= 277.9 , 278.2 , 277						

Table (3-33) Potential of 10^{-3}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Profinal 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	271.2	1.2E+09				
0.1	280	2.3E+09	8.8	2.0E+00	100	1.0110E-03
0.2	285.3	3.5E+09	14.1	3.0E+00	50	9.8940E-04
0.3	288.8	4.6E+09	17.6	3.9E+00	33.33	1.0017E-03
0.4	291.6	5.7E+09	20.4	4.8E+00	25	9.9887E-04
0.5	293.8	6.7E+09	22.6	5.7E+00	20	1.0029E-03
MSA	Con found=1.0008×10^{-3} RE%=0.08 REC%= 100.08 RSD%=0.14					
SA	Con found=9.968×10^{-4} RE%=-0.32 REC%= 99.65 RSD%=0.65					
SD= 1.1 RSD%= 0.41 mv= 286.6 , 284.3 , 285,						

Table (3-34) Potential of 10^{-3}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP1+ NB electrode

Maximum strength Ibuprofen 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	269	9.9E+08				
0.1	277.9	2.0E+09	8.9	2.0E+00	100	9.9553E-04
0.2	283	2.9E+09	14	2.9E+00	50	1.0009E-03
0.3	286.7	3.9E+09	17.7	3.9E+00	33.33	9.9145E-04
0.4	289.3	4.7E+09	20.3	4.8E+00	25	1.0085E-03
0.5	291.6	5.7E+09	22.6	5.7E+00	20	1.0029E-03
MSA	Con found=9.998×10^{-4} RE%= -0.01 REC%= 99.99 RSD%=0.15					
SA	Con found=9.96×10^{-4} RE%= -0.34 REC%= 99.66 RSD%=0.44					
SD=0.95 RSD%=0.33 mv= 285.8, 286.6, 287.7						

Table (3-35) Potential of 10^{-4}M ibuprofen against the volume Standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

Ibuprofen pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	144.8	4.0E+07				
0.1	164.5	4.4E+08	19.7	1.1E+01	100	1.0056E-04
0.2	169.8	8.3E+08	25	2.1E+01	50	1.0008E-04
0.3	172.9	1.2E+09	28.1	3.0E+01	33.33	1.0057E-04
0.4	175.2	1.6E+09	30.4	4.0E+01	25	9.9712E-05
0.5	176.9	2.0E+09	32.1	4.9E+01	20	1.0002E-04
MSA	Con found=1.0019×10^{-4} RE%=0.19 REC%= 100.19 RSD%=0.18					
SAM	Con found=9.97×10^{-5} RE%=-0.21 REC%= 99.97 RSD%=0.53					
SD1= 0.755 RSD% = 0.43 Mv = 175. 1,176 , 174.5						

Table (3-36) Potential of 10^{-4}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

PROFEDIN 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	144.16	3.7E+07				
0.1	163.9	4.1E+08	19.74	1.1E+01	100	1.0002E-04
0.2	169.2	7.7E+08	25.04	2.1E+01	50	9.9570E-05
0.3	172.3	1.1E+09	28.14	3.0E+01	33.33	1.0006E-04
0.4	174.5	1.5E+09	30.34	3.9E+01	25	1.0046E-04
0.5	176.2	1.8E+09	32.04	4.8E+01	20	1.0077E-04
MSA	Con found=1.0018×10^{-4} RE%=0.18 REC%= 100.18 RSD%=0.22					
SAM	Con found=9.97×10^{-5} RE%=-0.29 REC%= 99.71 RSD%=0.49					
SD1=0.8 RSD%= 0.47 mv= 169.2, 168.4,170						

Table (3-37) Potential of 10^{-4}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

Profinal 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	143	3.3E+07				
0.1	162.7	3.5E+08	19.71	1.1E+01	100	1.0042E-04
0.2	168.0	6.7E+08	25	2.1E+01	50	1.0008E-04
0.3	171.1	9.7E+08	28.1	3.0E+01	33.33	1.0057E-04
0.4	173.4	1.3E+09	30.37	3.9E+01	25	1.0008E-04
0.5	175.1	1.6E+09	32.1	4.9E+01	20	1.0002E-04
MSA	Con found=1.0023×10^{-4} RE%=0.23 REC%= 100.23 RSD%=0.24					
SAM	Con found=1.0026×10^{-4} RE%=0.26 REC%= 100.26 RSD%=0.3					
SD1=0.5 RSD%= 0.29 mv= 171,171.7, 170.6						

Table (3-38) Potential of 10^{-4}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

Maximum Strength Ibuprofen400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	149.7	7.3E+07				
0.1	169.4	7.9E+08	19.7	1.1E+01	100	1.0056E-04
0.2	174.7	1.5E+09	25	2.1E+01	50	1.0008E-04
0.3	177.8	2.2E+09	28.1	3.0E+01	33.33	1.0057E-04
0.4	180.1	2.9E+09	30.41	4.0E+01	25	9.9588E-05
0.5	181.8	3.6E+09	32.1	4.9E+01	20	1.0002E-04
MSA	Con found=1.0016×10^{-4} RE%=0.16 REC%= 100.16 RSD%=0.25					
SA	Con found=9.96×10^{-5} RE%= -0.37 REC%= 99.639RSD%=0.35					
SD1=0. 6 RSD%= 0.33 mv= 179.5,180.7, 180.1						

Table (3-39) Potential of 10^{-3}M ibuprofen against the volume Standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

Ibuprofen pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	169.97	8.5E+08				
0.1	175.6	1.7E+09	5.63	2.0E+00	100	1.0044E-03
0.2	178.9	2.5E+09	8.93	2.9E+00	50	9.9796E-04
0.3	181.2	3.3E+09	11.23	3.9E+00	33.33	9.9782E-04
0.4	182.9	4.1E+09	12.93	4.8E+00	25	1.0078E-03
0.5	184.4	4.9E+09	14.43	5.7E+00	20	9.9703E-04
MSA	Con found=1.0010×10^{-3} RE%=0.10 REC%= 100.10 RSD%=0.1					
SA	Con found=9.98×10^{-4} RE%=-0.12 REC%= 99. 98RSD%=0.19					
SD= 0.3 RSD%=0.17 mv= 181.2 , 180.9, 181.5						

Table (3-40) Potential of 10^{-3}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

PROFEDIN 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	167.4	6.2E+08				
0.1	173	1.2E+09	5.61	2.0E+00	100	1.0093E-03
0.2	176.3	1.8E+09	8.91	2.9E+00	50	1.0016E-03
0.3	178.6	2.4E+09	11.21	3.9E+00	33.33	1.0010E-03
0.4	180.4	3.0E+09	13.01	4.8E+00	25	9.9568E-04
0.5	181.8	3.6E+09	14.41	5.7E+00	20	9.9993E-04
MSA	con found=1.0015×10^{-3} RE%=0.15 REC%= 100.15 RSD%= 0.25					
SA	con found=9.96×10^{-4} RE%=-0. 38 REC%= 99.62 RSD%=0.35					
SD= 0. 6 RSD%= 0.33 mv=180.4 , 179.8 , 181						

Table (3-41) Potential of 10^{-3}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

Profinal 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	169	7.5E+08				
0.1	174.6	1.5E+09	5.64	2.0E+00	100	1.0020E-03
0.2	177.9	2.2E+09	8.9	2.9E+00	50	1.0034E-03
0.3	180.2	2.9E+09	11.2	3.9E+00	33.33	1.0027E-03
0.4	182	3.6E+09	13	4.8E+00	25	9.9718E-04
0.5	183.4	4.3E+09	14.4	5.7E+00	20	1.0014E-03
MSA	Con found=1.0013×10^{-3} RE%=0.13 REC%= 100.13 RSD%=0.22					
SA	Con found=9.98×10^{-4} RE%=-0.19 REC%= 99.81 RSD%=0.26					
SD= 0.5 RSD%= 0.27 mv= 180 , 182.5, 181.5						

Table (3-42) Potential of 10^{-3}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP2+ TTP electrode

Maximum Strength Ibuprofen 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	172.2	1.1E+09				
0.1	177.9	2.2E+09	5.7	2.0E+00	100	9.8757E-04
0.2	181.1	3.3E+09	8.9	2.9E+00	50	1.0034E-03
0.3	183.4	4.3E+09	11.2	3.9E+00	33.33	1.0027E-03
0.4	185.1	5.3E+09	12.9	4.8E+00	25	1.0124E-03
0.5	186.6	6.3E+09	14.4	5.7E+00	20	1.0014E-03
MSA	Con found=1.0015×10^{-3} RE%=0.15 REC%= 100.15 RSD%=0.20					
SA	Con found=9.92×10^{-4} RE%=-0.71 REC%= 99.29RSD%=0.49					
	SD=0.8RSD%=0.45 mv= 177.1, 177.9, 178.7					

Table (3-43) Potential of 10^{-4}M ibuprofen against the volume Standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

Ibuprofene pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	120	2.1E+06				
0.1	139.7	2.2E+07	19.7	1.1E+01	100	1.0011E-04
0.2	145.0	4.2E+07	24.95	2.1E+01	50	1.0017E-04
0.3	148.1	6.2E+07	28.1	3.0E+01	33.33	9.9966E-05
0.4	150.3	8.1E+07	30.3	3.9E+01	25	1.0031E-04
0.5	152	1.0E+08	32	4.8E+01	20	1.0059E-04
MSA	Con found=1.0023×10^{-4} RE%=0.23 REC%= 100.23 RSD%=0.23					
SAM	Con found=100.29×10^{-4} RE%=0.29 REC%= 100.29 RSD%=0. 35					
SD1= 0.3 RSD% = 0.2 Mv = 151.7,152.3 , 152						

Table (3-44) Potential of 10^{-4}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

PROFEDIN 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	123.7	3.2E+06				
0.1	143.4	3.5E+07	19.7	1.1E+01	100	1.0011E-04
0.2	148.6	6.6E+07	24.9	2.0E+01	50	1.0081E-04
0.3	151.8	9.7E+07	28.09	3.0E+01	33.33	1.0009E-04
0.4	154	1.3E+08	30.3	3.9E+01	25	1.0031E-04
0.5	155.8	1.6E+08	32.1	4.9E+01	20	9.9351E-05
MSA	Con found=1.0013×10^{-4} RE%=0.13 REC%= 100.13 RSD%=0.23					
SAM	Con found=9.978×10^{-5} RE%=-0.22 REC%= 99.78 RSD%=0.39					
SD1=0.5 RSD%= 0.32 mv= 155.8 , 156.3 , 155.3						

Table (3-45) Potential of 10^{-4}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

Profinal 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	122.7	2.9E+06				
0.1	142.4	3.1E+07	19.69	1.1E+01	100	1.0024E-04
0.2	147.7	5.9E+07	24.99	2.1E+01	50	9.9663E-05
0.3	150.8	8.6E+07	28.09	3.0E+01	33.33	1.0009E-04
0.4	153	1.1E+08	30.29	3.9E+01	25	1.0044E-04
0.5	154.8	1.4E+08	32.04	4.9E+01	20	1.0009E-04
MSA	Con found=1.001×10^{-4} RE%=0.1 REC%= 100.1 RSD%=0.20					
SAM	Con found=9.982×10^{-5} RE%=-0.18 REC%= 99.82 RSD%=0. 51					
SD1=0.5 RSD%= 0.34 mv= 147.7, 148.2 , 147.2						

Table (3-46) Potential of 10^{-4}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

Maximum Strength Ibuprofen400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	149.7	7.3E+07				
0.1	169.4	7.9E+08	19.7	1.1E+01	100	1.0056E-04
0.2	174.7	1.5E+09	25	2.1E+01	50	1.0008E-04
0.3	177.8	2.2E+09	28.1	3.0E+01	33.33	1.0057E-04
0.4	180.1	2.9E+09	30.41	4.0E+01	25	9.9588E-05
0.5	181.8	3.6E+09	32.1	4.9E+01	20	1.0002E-04
MSA	Con found=1.0011×10^{-4} RE%=0.11 REC%= 100.11 RSD%=0.19					
SA	Con found=9.972×10^{-5} RE%= -0.28 REC%= 99.72RSD%=0.53					
SD1=0. 7 RSD%= 0.44 mv= 159.1,160.5, 159.8						

Table (3-47) Potential of 10^{-3}M ibuprofen against the volume Standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

Ibuprofen pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	141.13	2.7E+07				
0.1	146.8	5.3E+07	5.67	2.0E+00	100	9.9237E-04
0.2	150	7.8E+07	8.87	2.9E+00	50	1.0061E-03
0.3	152.3	1.0E+08	11.17	3.9E+00	33.33	1.0044E-03
0.4	154.1	1.3E+08	12.97	4.8E+00	25	9.9831E-04
0.5	155.5	1.5E+08	14.37	5.7E+00	20	1.0021E-03
MSA	Con found=1.0007×10^{-3} RE%=0.07 REC%= 100.07 RSD%=0.13					
SA	Con found=9.971×10^{-4} RE%=-0.29 REC%= 99. 71RSD%=0.42					
SD= 0.5 RSD%=0.34 mv= 147.3 ,146.8 , 146.3						

Table (3-48) Potential of 10^{-3}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

PROFEDIN 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	137.2	1.7E+07				
0.1	142.83	3.3E+07	5.63	2.0E+00	100	1.0020E-03
0.2	146.1	4.9E+07	8.9	2.9E+00	50	1.0006E-03
0.3	148.4	6.4E+07	11.2	3.9E+00	33.33	9.9952E-04
0.4	150.1	7.9E+07	12.9	4.8E+00	25	1.0090E-03
0.5	151.6	9.5E+07	14.4	5.7E+00	20	9.9776E-04
MSA	Con found=1.0018×10^{-3} RE%=0.18 REC%= 100.18 RSD%= 0.23					
SA	Con found=9.8×10^{-4} RE%=-0. 2 REC%= 99.62 RSD%=0.35					
SD= 0. 4 RSD%= 0.26 mv=151.2 ,152, 151.6						

Table (3-49) Potential of 10^{-3}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

Profinal 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	140.04	2.3E+07				
0.1	145.7	4.6E+07	5.66	2.0E+00	100	9.9477E-04
0.2	148.9	6.8E+07	8.86	2.9E+00	50	1.0079E-03
0.3	151.2	9.0E+07	11.16	3.9E+00	33.33	1.0060E-03
0.4	153	1.1E+08	12.96	4.8E+00	25	9.9982E-04
0.5	154.4	1.3E+08	14.36	5.7E+00	20	1.0036E-03
MSA	Con found=1.0024×10^{-3} RE%=0.24 REC%= 100.24 RSD%=0.25					
SA	Con found=9.96×10^{-4} RE%=-0.31 REC%= 99.69 RSD%=0.27					
SD= 0.36 RSD%= 0.25 mv= 145.3 , 145.8, 146						

Table (3-50) Potential of 10^{-3}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBPh electrode

Maximum Strength Ibuprofen 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	139.2	2.1E+07				
0.1	144.9	4.2E+07	5.7	2.0E+00	100	9.8523E-04
0.2	148.1	6.2E+07	8.9	2.9E+00	50	1.0006E-03
0.3	150.4	8.2E+07	11.2	3.9E+00	33.33	9.9952E-04
0.4	152.1	1.0E+08	12.9	4.8E+00	25	1.0090E-03
0.5	153.5	1.2E+08	14.3	5.7E+00	20	1.0124E-03
MSA	Con found=1.0013×10^{-3} RE%=0.13 REC%= 100.13 RSD%=0.18					
SA	Con found=9.94×10^{-4} RE%=-0.59 REC%= 99.41RSD%=0.77					
	SD=0.6RSD%=0.41 mv= 145.5, 144.3, 144.9					

Table (3-51) Potential of 10^{-4}M ibuprofen against the volume Standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

Ibuprofen pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	224	8.8E+10				
0.1	245.2	9.6E+11	21.23	1.1E+01	100	9.9876E-05
0.2	250.8	1.8E+12	26.83	2.0E+01	50	1.0058E-04
0.3	254.2	2.7E+12	30.23	3.0E+01	33.33	1.0027E-04
0.4	256.6	3.5E+12	32.63	3.9E+01	25	1.0025E-04
0.5	258.5	4.3E+12	34.53	4.9E+01	20	9.9723E-05
MSA	Con found=1.0014×10^{-4} RE%=0.14 REC%= 100.14 RSD%=0.19					
SAM	Con found=9.98×10^{-5} RE%=-0.16 REC%= 99.84 RSD%=0. 32					
SD1= 0.65 RSD% = 0.25 Mv = 257.9, 259.2 ,258.4						

Table (3-52) Potential of 10^{-4}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

PRPFIDEN400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	225	9.9E+10				
0.1	246.2	1.1E+12	21.2	1.1E+01	100	1.0025E-04
0.2	251.9	2.0E+12	26.87	2.1E+01	50	1.0010E-04
0.3	255.3	3.0E+12	30.25	3.0E+01	33.33	1.0003E-04
0.4	257.6	3.9E+12	32.6	3.9E+01	25	1.0059E-04
0.5	259.5	4.8E+12	34.5	4.9E+01	20	1.0007E-04
MSA	Con found=1.0021×10^{-4} RE%=0.21 REC%= 100.21 RSD%=0.21					
SAM	Con found=1.26×10^{-4} RE%=0.26 REC%= 100.26 RSD%=0.41					
SD1=0.72 RSD%= 0.28 mv= 257, 258.3 , 257.5						

Table (3-53) Potential of 10^{-4}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

Profinal 400mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	218.8	4.9E+10				
0.1	240	5.4E+11	21.25	1.1E+01	100	9.9629E-05
0.2	245.6	1.0E+12	26.85	2.1E+01	50	1.0034E-04
0.3	249	1.5E+12	30.25	3.0E+01	33.33	1.0003E-04
0.4	251.4	1.9E+12	32.65	3.9E+01	25	1.0002E-04
0.5	253.2	2.4E+12	34.46	4.8E+01	20	1.0053E-04
MSA	conc found=1.0011×10^{-4} RE%=0.11 REC%= 100.11 RSD%=0.18					
SAM	conc found=9.984×10^{-5} RE%=-0.16 REC%= 99.84 RSD%=0. 48					
SD1=1 RSD%= 0.42 mv= 241, 239, 240						

Table (3-54) Potential of 10^{-4}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

Maximum Strength Ibuprofen1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	220	5.6E+10				
0.1	241.2	6.1E+11	21.24	1.1E+01	100	9.9753E-05
0.2	246.9	1.2E+12	26.94	2.1E+01	50	9.9277E-05
0.3	250.2	1.7E+12	30.24	3.0E+01	33.33	1.0015E-04
0.4	252.6	2.2E+12	32.64	3.9E+01	25	1.0013E-04
0.5	254.4	2.7E+12	34.44	4.8E+01	20	1.0076E-04
MSA	Con found=1.0001×10^{-4} RE%=0.01 REC%= 100.01 RSD%=0.08					
SA	Con found=9.973×10^{-5} RE%= -0.27 REC%= 99.73RSD%=0.59					
SD1=0. 8 RSD%= 0.32 mv= 246.1 , 246.9 , 247.7						

Table (3-55) Potential of 10^{-3}M ibuprofen against the volume Standard Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

Ibuprofen pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	242.1	6.8146E+11				
0.1	248.2	1.3E+12	6.07	2.0E+00	100	1.0002E-03
0.2	251.7	2.0E+12	9.57	2.9E+00	50	1.0028E-03
0.3	254.2	2.7E+12	12.07	3.9E+00	33.33	9.9796E-04
0.4	256.1	3.3E+12	13.97	4.8E+00	25	9.9767E-04
0.5	257.6	3.9E+12	15.47	5.7E+00	20	1.0025E-03
MSA	Con found=1.0002×10^{-3} RE%=0.02 REC%= 100.02 RSD%=0.12					
SA	Con found=9.98×10^{-4} RE%=-0.11 REC%= 99. 89RSD%=0.27					
SD= 0.56 RSD%=0.22 mv= 255.6 – 256.7 - 256						

Table (3-56) Potential of 10^{-3}M ibuprofen against the volume PROFEDIN and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

PROFEDIN 400mg1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	240	5.3E+11				
0.1	246.1	1.1E+12	6.14	2.0E+00	100	9.8467E-04
0.2	249.5	1.6E+12	9.54	2.9E+00	50	1.0079E-03
0.3	252	2.1E+12	12.04	3.9E+00	33.33	1.0025E-03
0.4	253.9	2.6E+12	13.94	4.8E+00	25	1.0019E-03
0.5	255.4	3.0E+12	15.44	5.7E+00	20	1.0066E-03
MSA	conc found=1.0007×10^{-3} RE%=0.07 REC%= 100.07 RSD%= 0.11					
SA	conc found=9.93×10^{-4} RE%=-0. 71 REC%= 99.62 RSD%=0.74					
SD= 0. 4 RSD%= 0.26 mv=151.2 ,152, 151.6						

Table (3-57) Potential of 10^{-3}M ibuprofen against the volume Profinal and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

Profinal 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	240.44	5.6E+11				
0.1	246.5	1.1E+12	6.06	2.0E+00	100	1.0025E-03
0.2	250	1.7E+12	9.56	2.9E+00	50	1.0045E-03
0.3	252.5	2.2E+12	12.06	3.9E+00	33.33	9.9945E-04
0.4	254.4	2.7E+12	13.96	4.8E+00	25	9.9907E-04
0.5	255.9	3.2E+12	15.46	5.7E+00	20	1.0039E-03
MSA	Con found=1.0016×10^{-3} RE%=0.16 REC%= 100.16RSD%=0.18					
SA	Con found=9.98×10^{-4} RE%=-0.18 REC%= 99.82 RSD%=0.25					
SD= 0.6 RSD%= 0.24 mv= 254.4, 253.8, 255,						

Table (3-58) Potential of 10^{-3}M ibuprofen against the volume Maximum Strength Ibuprofen and the calculation of five additions using MSA and SAM. for IBP-MIP3+ DBS electrode

Maximum Strength Ibuprofen 400mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	139.2	2.1E+07				
0.1	144.9	4.2E+07	5.7	2.0E+00	100	9.8523E-04
0.2	148.1	6.2E+07	8.9	2.9E+00	50	1.0006E-03
0.3	150.4	8.2E+07	11.2	3.9E+00	33.33	9.9952E-04
0.4	152.1	1.0E+08	12.9	4.8E+00	25	1.0090E-03
0.5	153.5	1.2E+08	14.3	5.7E+00	20	1.0124E-03
MSA	Con found=1.0013×10^{-3} RE%=0.13 REC%= 100.13 RSD%=0.18					
SA	Con found=9.94×10^{-4} RE%=-0.59 REC%= 99.41RSD%=0.77					
	SD=0.6RSD%=0.41 mv= 145.5, 144.3, 144.9					

3-8-2-2 Calculation of Multiple Standard Method (MSM)

The plot of antilog E/S versus the volume of the five addition for ibuprofen electrodes are shown in Fig .from(3-38)to(3-77) for ibuprofen electrodes; IBP-MIP1+DOPH, IBP-MIP1 +NB, IBP-MIP2+TTP, IBP-MIP3+DBPH and IBP-MIP3+DBS. From the equations (7) of calibration curves, the volume (V) mL at intercept with X axis for each curve was calculated. Their correlation coefficients, (V) and (C_U) were listed in Table (3-59).

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.10E+04
0.1	3.40E+05
0.2	6.40E+05
0.3	9.30E+05
0.4	1.20E+06
0.5	1.50E+06

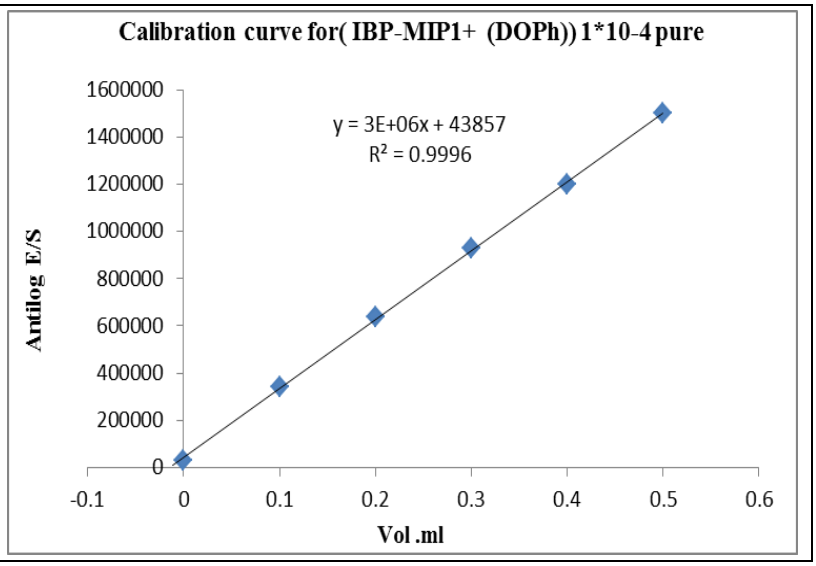


Fig. (3-38): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution (10^{-4}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.90E+04
0.1	4.20E+05
0.2	8.00E+05
0.3	1.20E+06
0.4	1.50E+06
0.5	1.90E+06

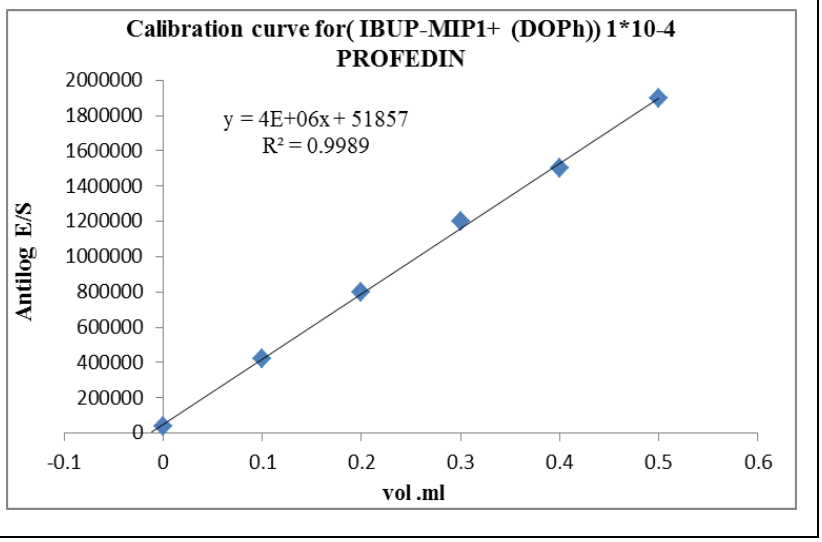


Fig. (3-39): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-4}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.50E+04
0.1	3.80E+05
0.2	7.20E+05
0.3	1.00E+06
0.4	1.40E+06
0.5	1.70E+06

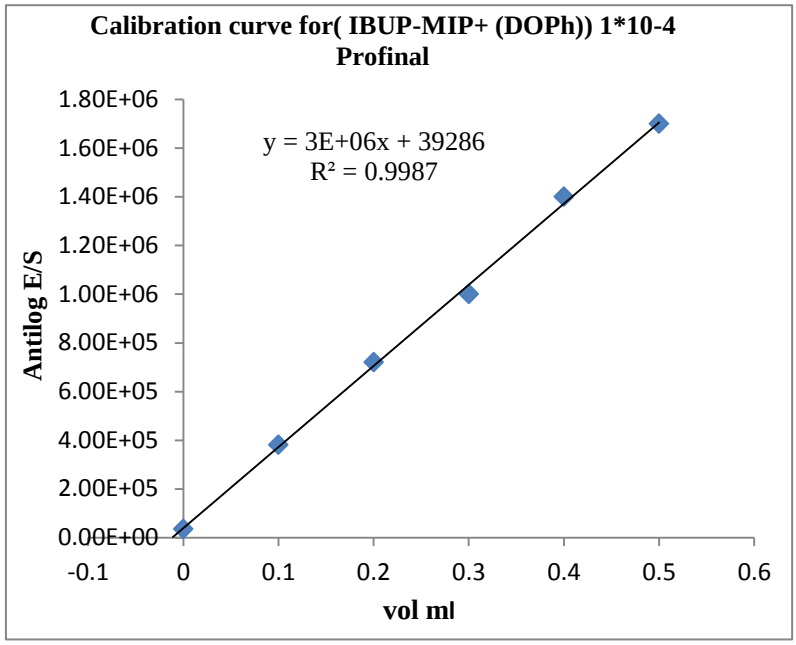


Fig. (3-40): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-4}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.30E+04
0.1	3.60E+05
0.2	6.70E+05
0.3	9.80E+05
0.4	1.30E+06
0.5	1.60E+06

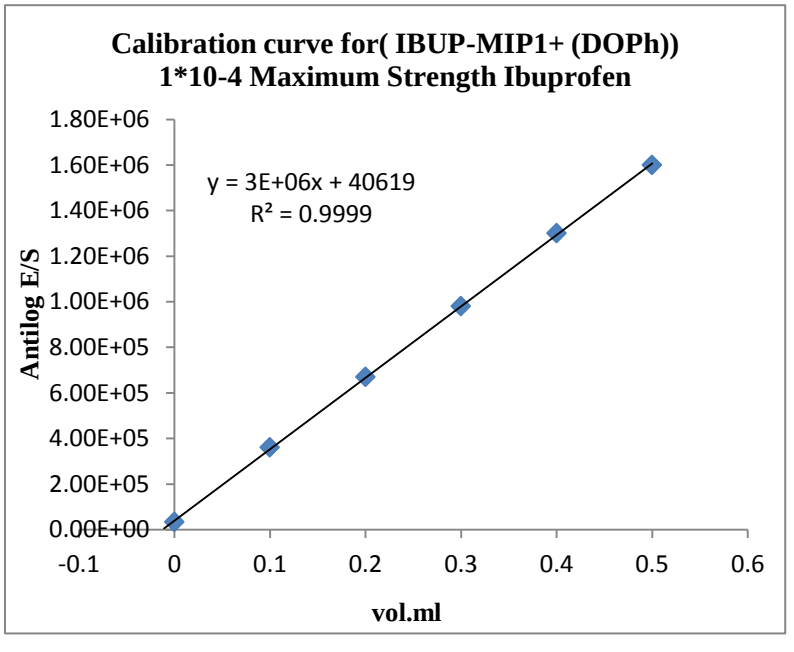


Fig. (3-41): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-4}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.20E+05
0.1	6.50E+05
0.2	9.50E+05
0.3	1.30E+06
0.4	1.60E+06
0.5	1.90E+06

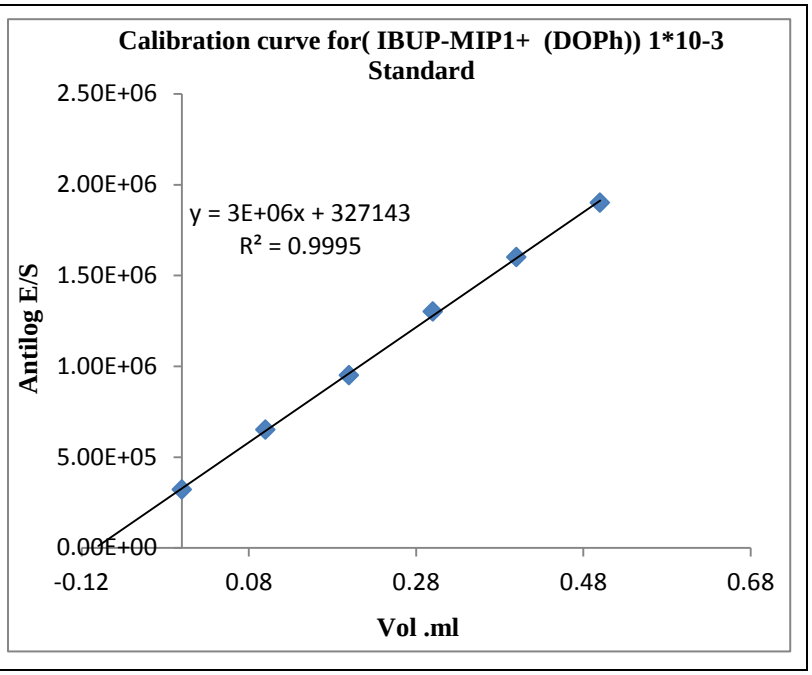


Fig. (3-42): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-3}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.70E+05
0.1	7.30E+05
0.2	1.10E+06
0.3	1.40E+06
0.4	1.80E+06
0.5	2.10E+06

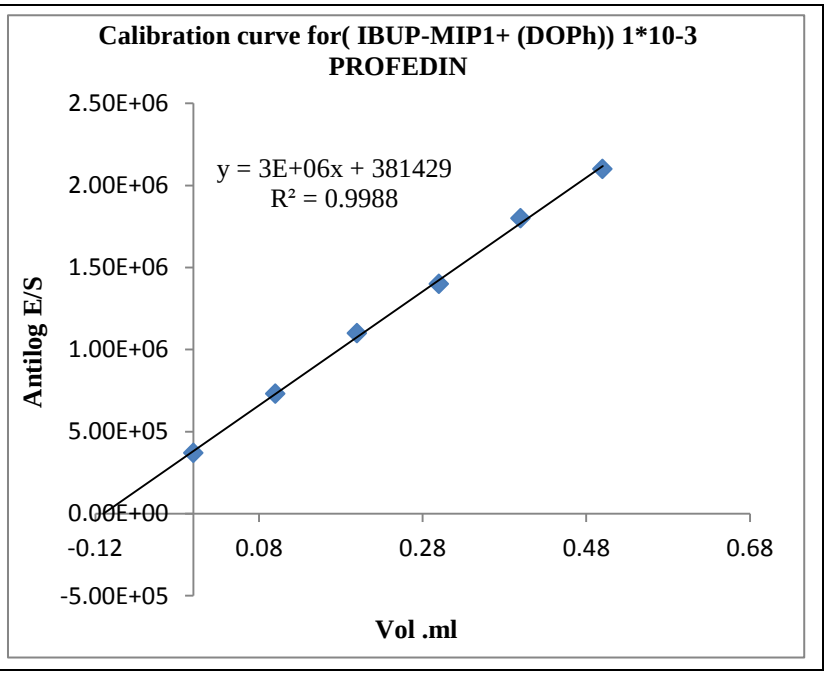


Fig. (3-43): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-3}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	3.70E+05
0.1	7.40E+05
0.2	1.10E+06
0.3	1.40E+06
0.4	1.80E+06
0.5	2.10E+06

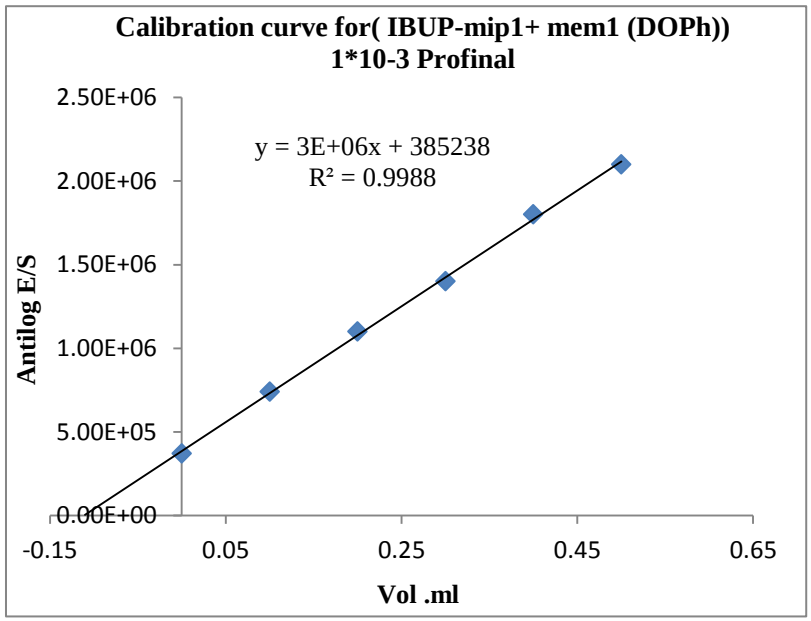


Fig. (3-44): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-3}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+DOPH Slope = 30.5 Reading	
Vol. ml	**Antilog E/S**
0	4.40E+05
0.1	8.60E+05
0.2	1.30E+06
0.3	1.70E+06
0.4	2.10E+06
0.5	2.50E+06

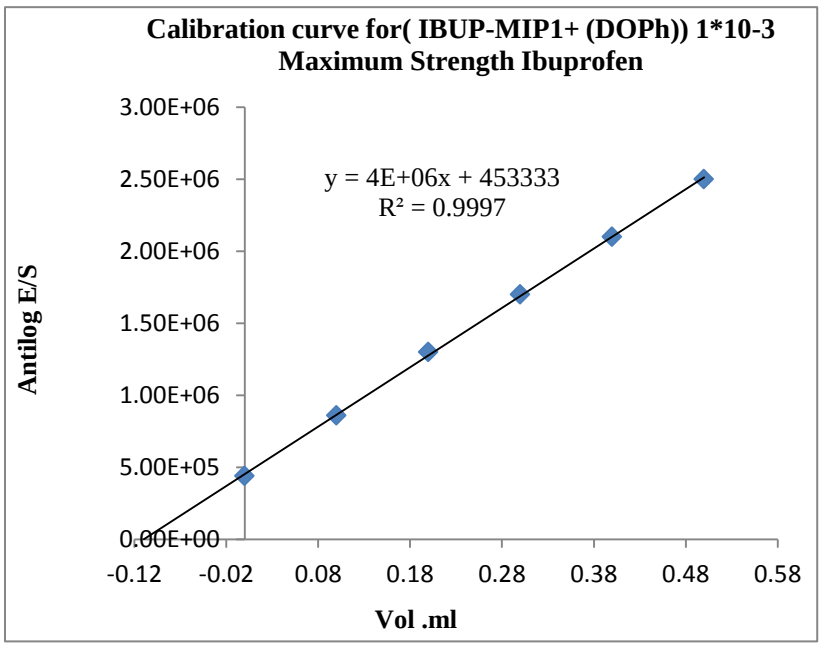


Fig. (3-45): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-3}M) by MSM using IBP-MIP1+DOPH electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	5.80E+07
0.1	6.30E+08
0.2	1.20E+09
0.3	1.70E+09
0.4	2.30E+09
0.5	2.80E+09

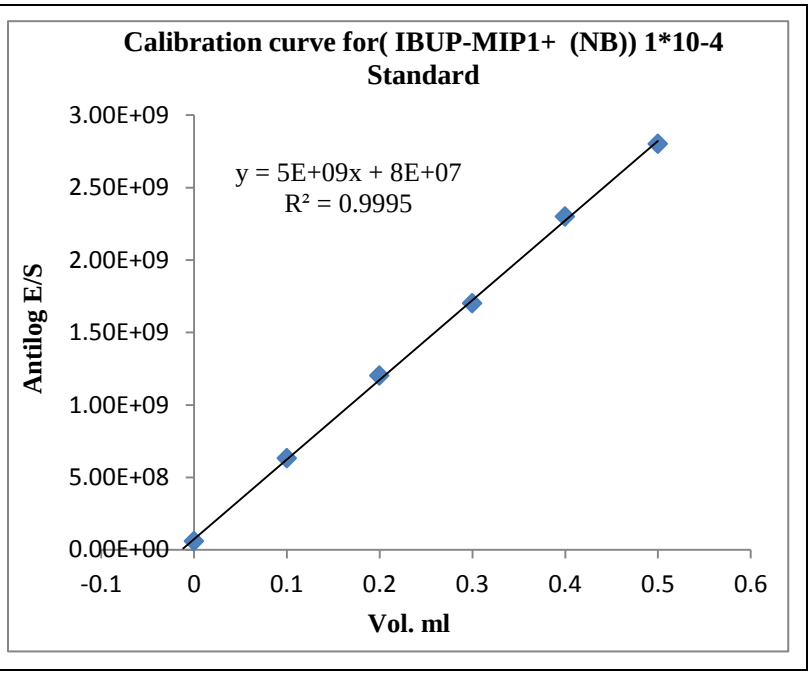


Fig. (3-46): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-4}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	6.70E+07
0.1	7.30E+08
0.2	1.40E+09
0.3	2.00E+09
0.4	2.60E+09
0.5	3.30E+09

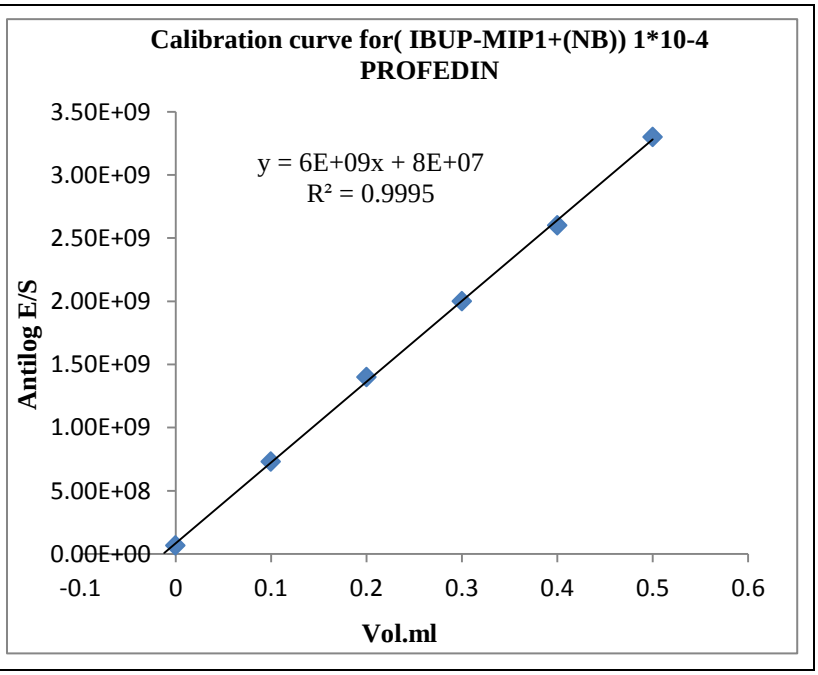


Fig. (3-47): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-4}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	5.70E+07
0.1	6.20E+08
0.2	1.20E+09
0.3	1.70E+09
0.4	2.20E+09
0.5	2.70E+09

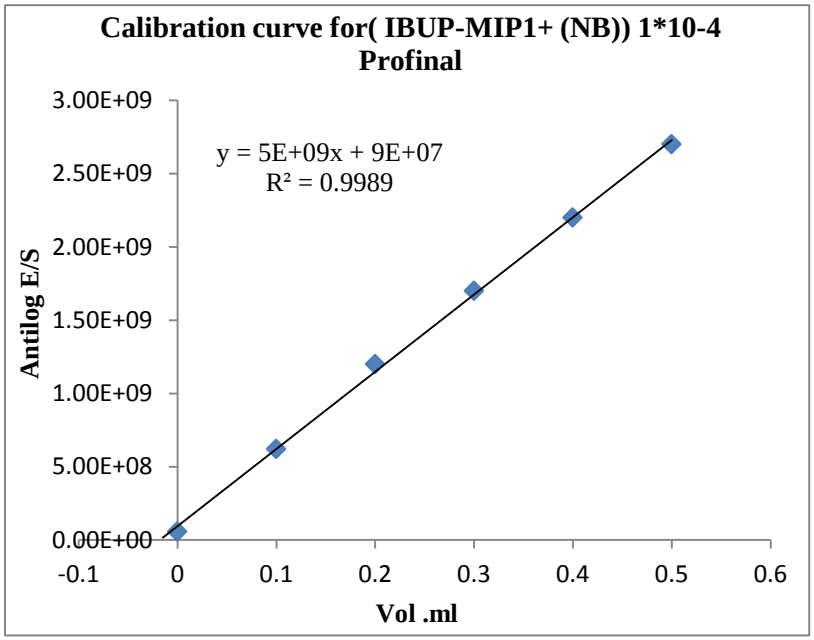


Fig. (3-48): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-4}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	5.80E+07
0.1	6.20E+08
0.2	1.20E+09
0.3	1.70E+09
0.4	2.30E+09
0.5	2.80E+09

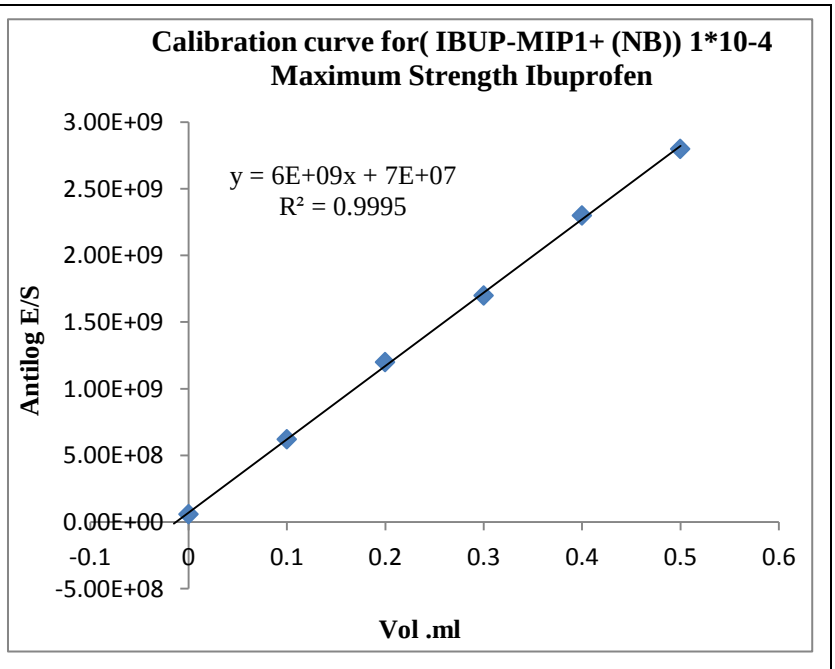


Fig. (3-49): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-4}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	1.20E+09
0.1	2.40E+09
0.2	3.60E+09
0.3	4.70E+09
0.4	5.80E+09
0.5	7.00E+09

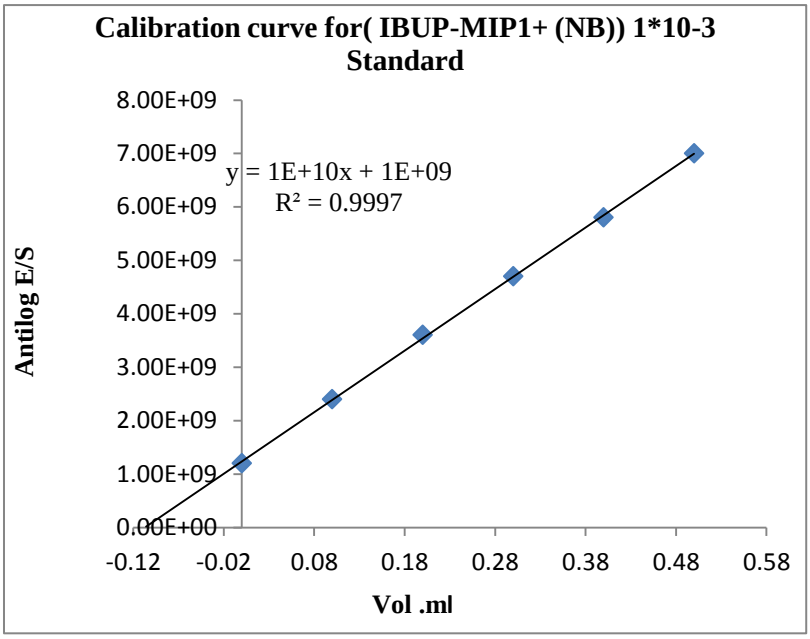


Fig. (3-50): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-3}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	9.90E+08
0.1	2.00E+09
0.2	2.90E+09
0.3	3.90E+09
0.4	4.80E+09
0.5	5.70E+09

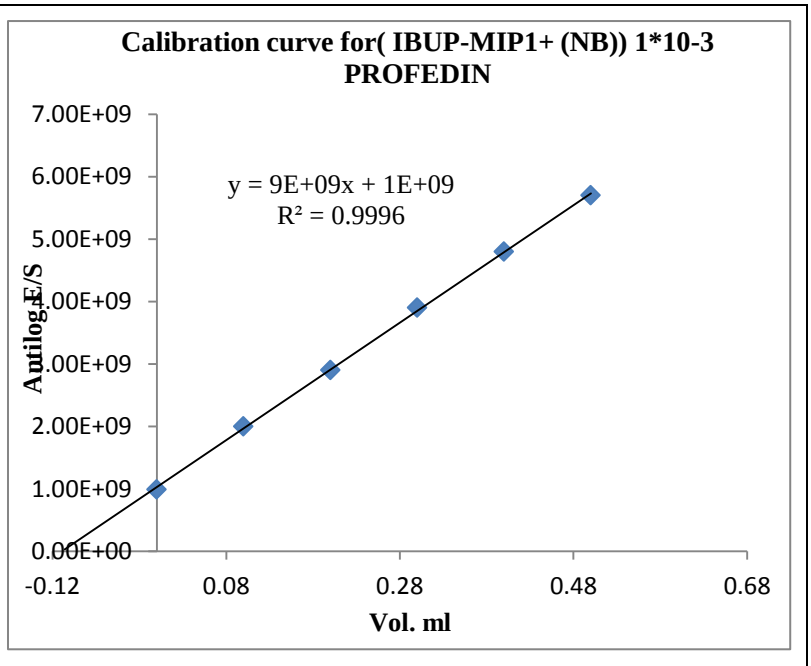


Fig. (3-51): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-3}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	1.20E+09
0.1	2.30E+09
0.2	3.50E+09
0.3	4.60E+09
0.4	5.70E+09
0.5	6.70E+09

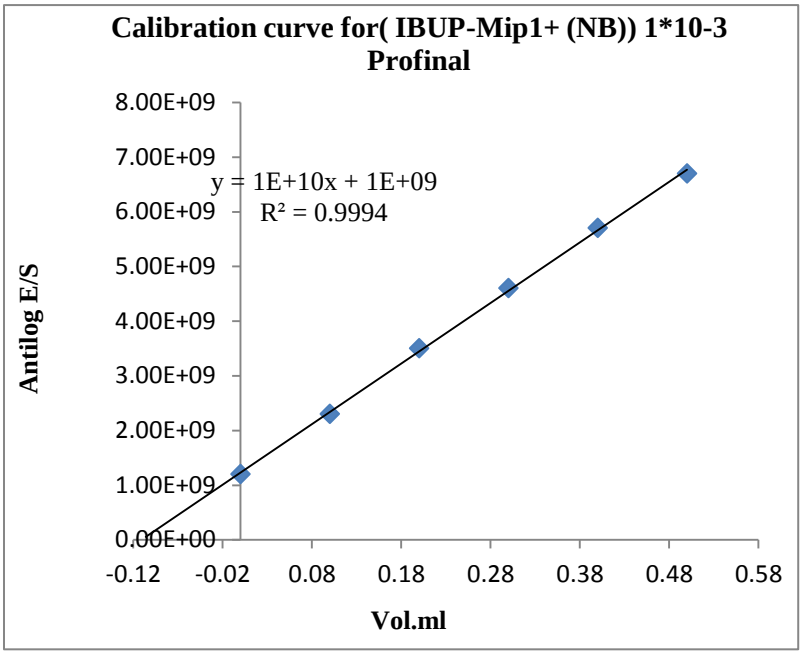


Fig. (3-52): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-3}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+NB Slope = 29.9 Reading	
Vol. ml	**Antilog E/S**
0	9.90E+08
0.1	2.00E+09
0.2	2.90E+09
0.3	3.90E+09
0.4	4.70E+09
0.5	5.70E+09

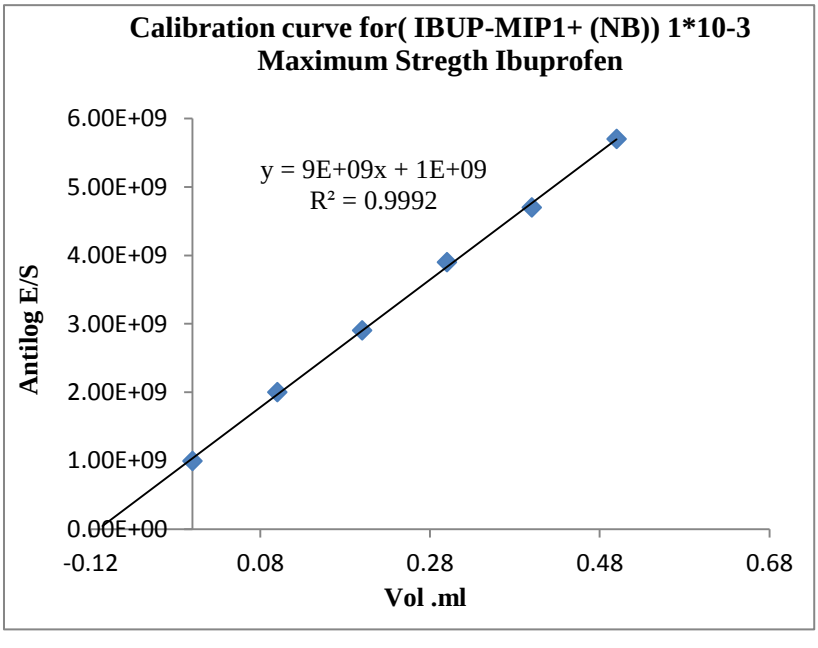


Fig. (3-53): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-3}M) by MSM using IBP-MIP1+NB electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	4.00E+07
0.1	4.40E+08
0.2	8.30E+08
0.3	1.20E+09
0.4	1.60E+09
0.5	2.00E+09

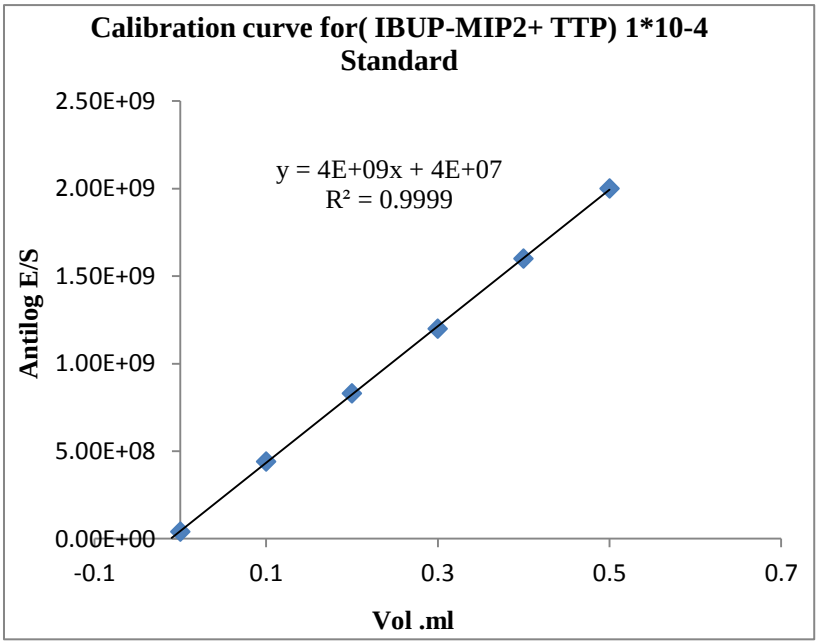


Fig. (3-54): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-4}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	3.70E+07
0.1	4.10E+08
0.2	7.70E+08
0.3	1.10E+09
0.4	1.50E+09
0.5	1.80E+09

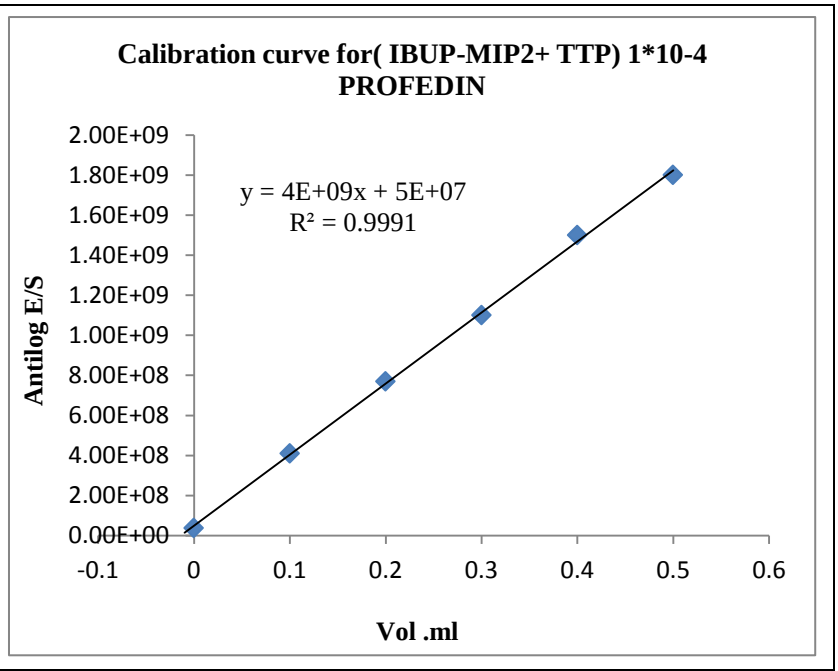


Fig. (3-55): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-4}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	3.30E+07
0.1	3.50E+08
0.2	6.70E+08
0.3	9.70E+08
0.4	1.30E+09
0.5	1.60E+09

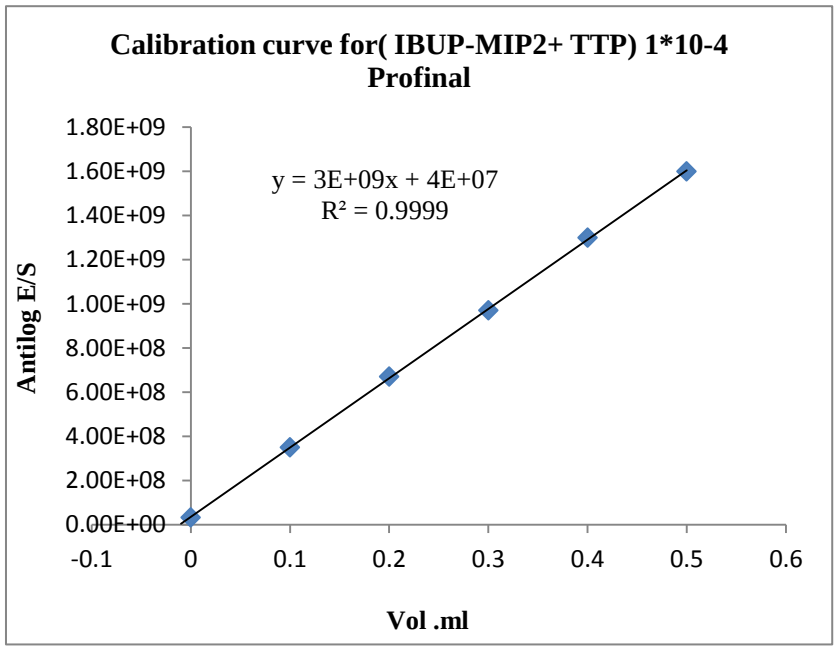


Fig. (3-56): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-4}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	7.30E+07
0.1	7.90E+08
0.2	1.50E+09
0.3	2.20E+09
0.4	2.90E+09
0.5	3.60E+09

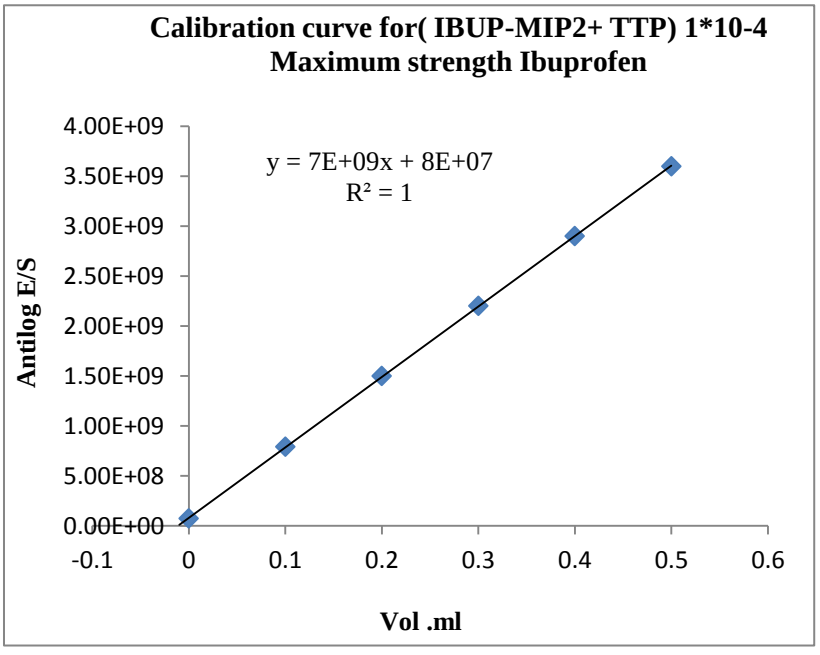


Fig. (3-57): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-4}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	8.50E+08
0.1	1.70E+09
0.2	2.50E+09
0.3	3.30E+09
0.4	4.10E+09
0.5	4.90E+09

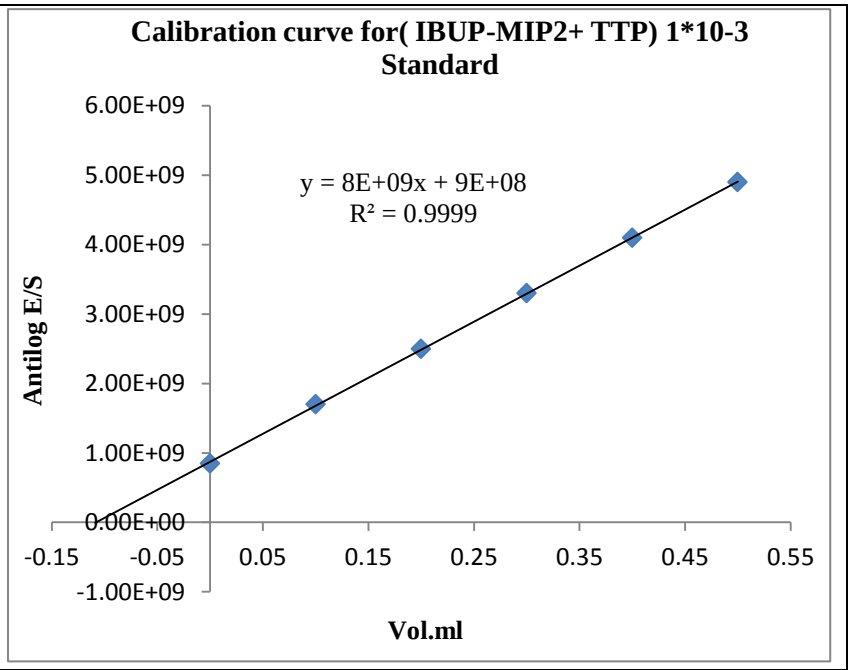


Fig. (3-58): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-3}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	6.20E+08
0.1	1.20E+09
0.2	1.80E+09
0.3	2.40E+09
0.4	3.00E+09
0.5	3.60E+09

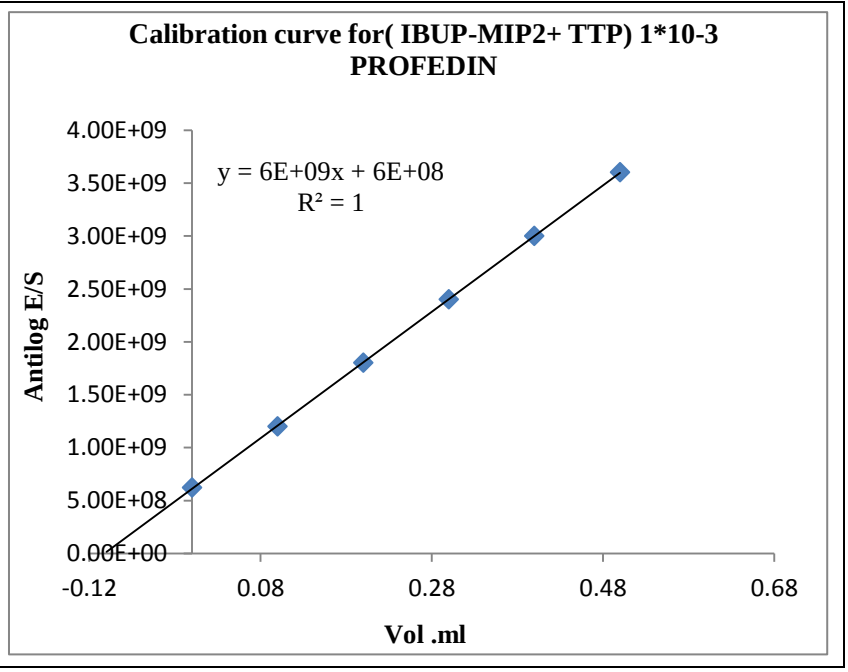


Fig. (3-59): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-3}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	7.50E+08
0.1	1.50E+09
0.2	2.20E+09
0.3	2.90E+09
0.4	3.60E+09
0.5	4.30E+09

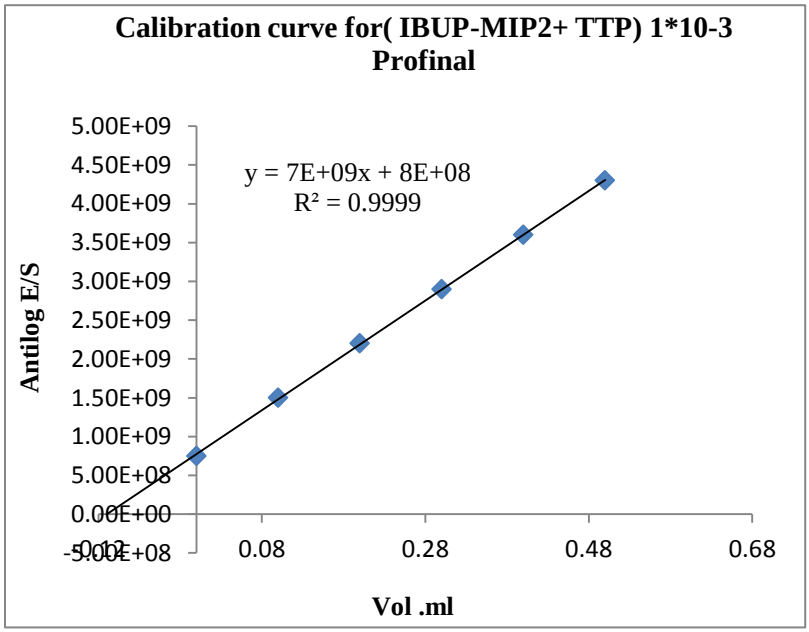


Fig. (3-60): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-3}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+TTP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	1.10E+09
0.1	2.20E+09
0.2	3.30E+09
0.3	4.30E+09
0.4	5.30E+09
0.5	6.30E+09

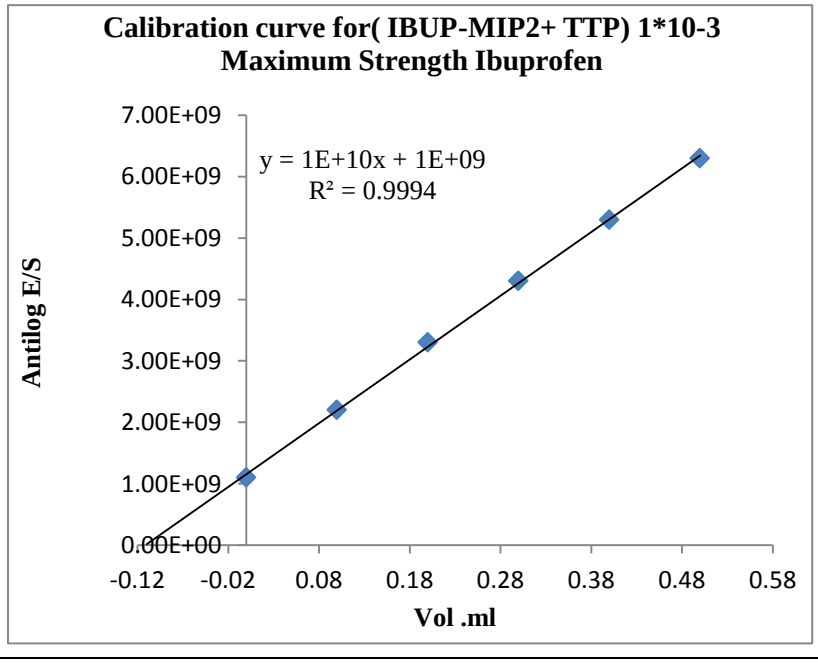


Fig. (3-61): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-3}M) by MSM using IBP-MIP2+TTP electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	2.10E+06
0.1	2.20E+07
0.2	4.20E+07
0.3	6.20E+07
0.4	8.10E+07
0.5	1.00E+08

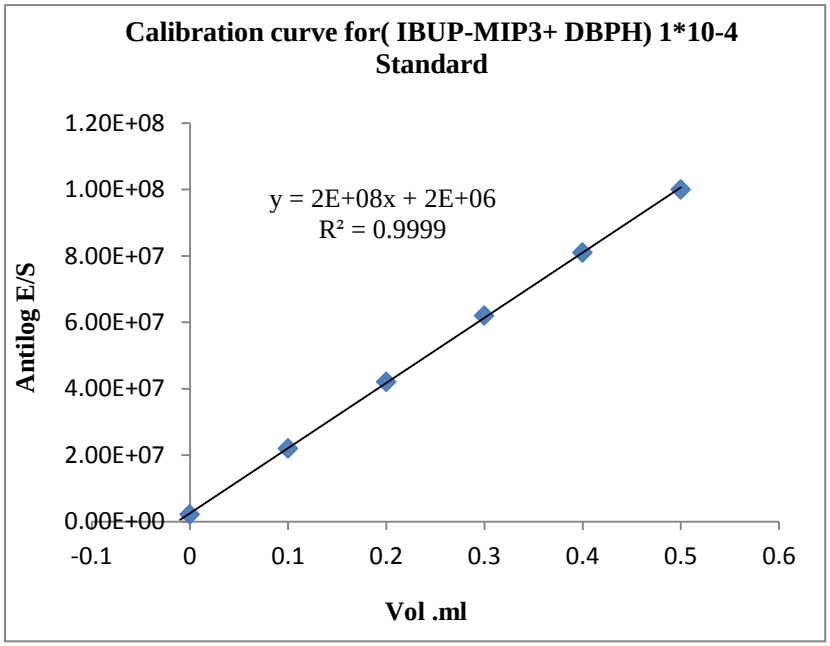


Fig. (3-62): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-4}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	3.20E+06
0.1	3.50E+07
0.2	6.60E+07
0.3	9.70E+07
0.4	1.30E+08
0.5	1.60E+08

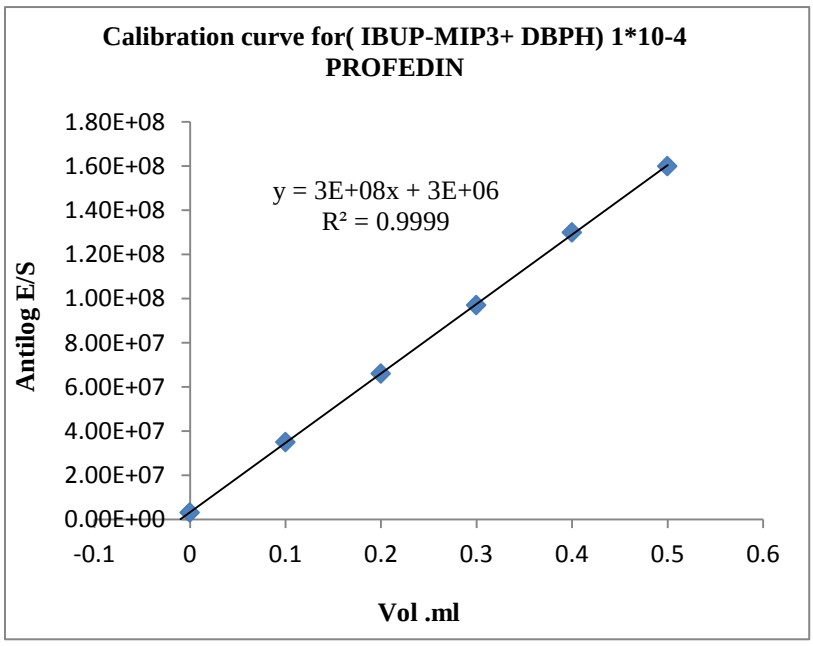


Fig. (3-63): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-4}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	2.90E+06
0.1	3.10E+07
0.2	5.90E+07
0.3	8.60E+07
0.4	1.10E+08
0.5	1.40E+08

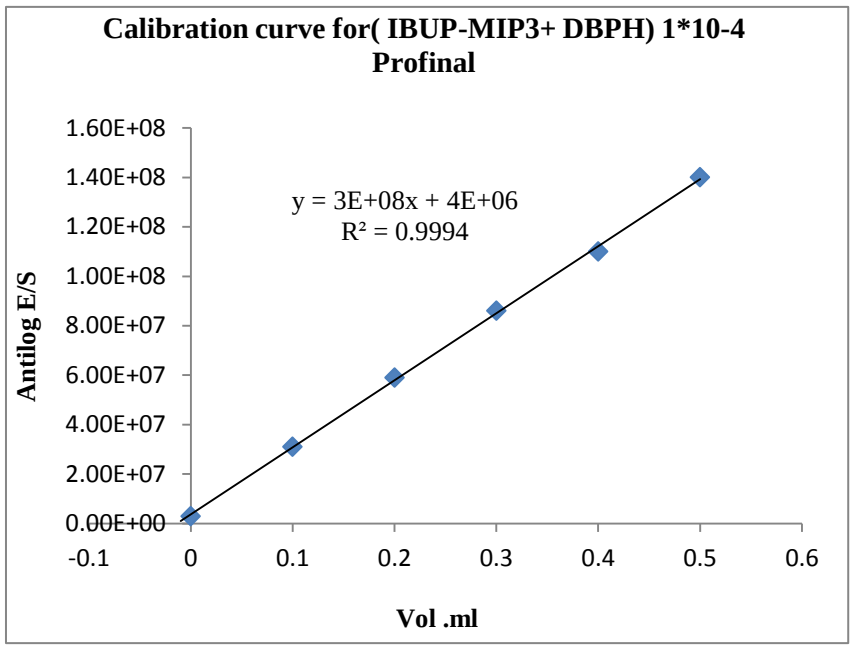


Fig. (3-64): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-4}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	7.30E+07
0.1	7.90E+08
0.2	1.50E+09
0.3	2.20E+09
0.4	2.90E+09
0.5	3.60E+09

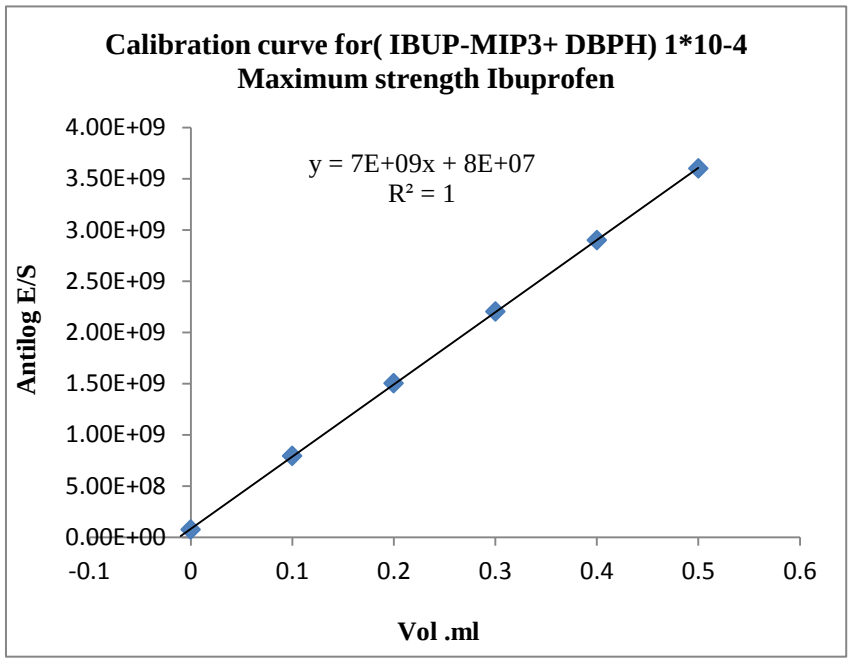


Fig. (3-65): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-4}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	2.70E+07
0.1	5.30E+07
0.2	7.80E+07
0.3	1.00E+08
0.4	1.30E+08
0.5	1.50E+08

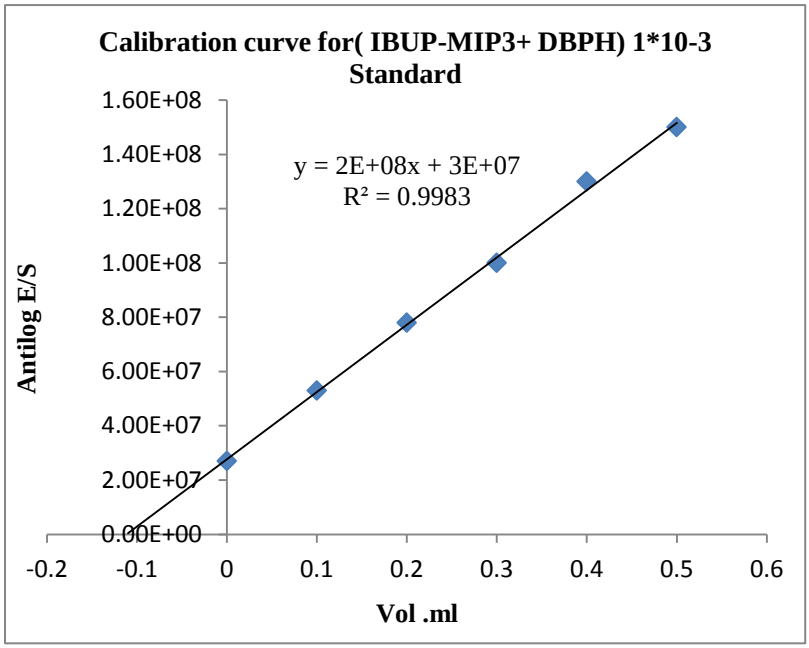


Fig. (3-66): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-3}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	1.70E+07
0.1	3.30E+07
0.2	4.90E+07
0.3	6.40E+07
0.4	7.90E+07
0.5	9.50E+07

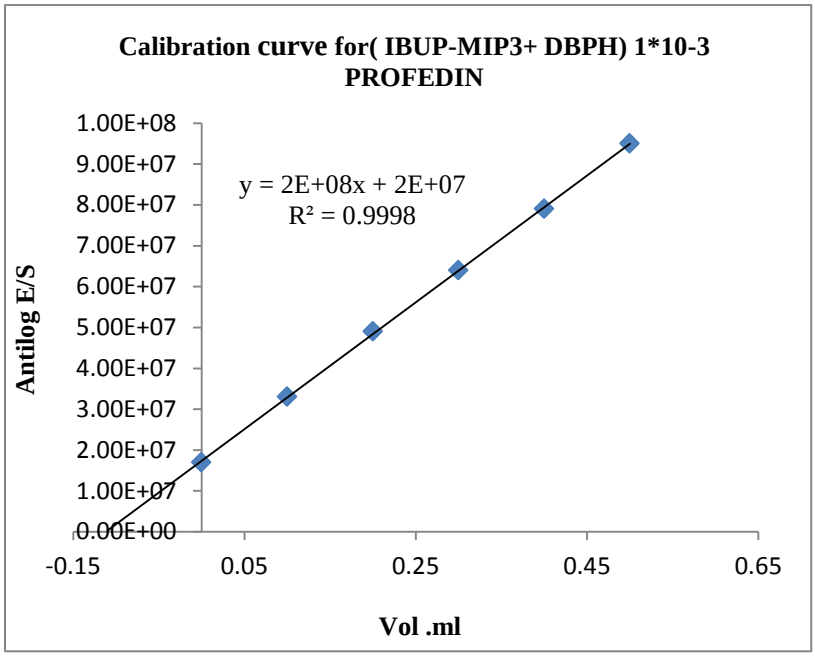


Fig. (3-67): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-3}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	2.30E+07
0.1	4.60E+07
0.2	6.80E+07
0.3	9.00E+07
0.4	1.10E+08
0.5	1.30E+08

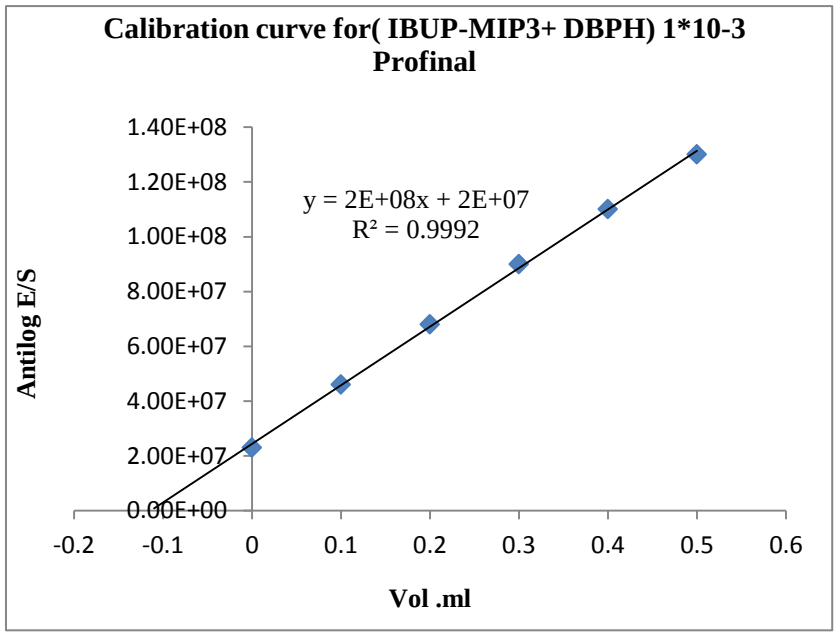


Fig. (3-68): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-3}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBPH Slope = 19.0034 Reading	
Vol. ml	**Antilog E/S**
0	2.10E+07
0.1	4.20E+07
0.2	6.20E+07
0.3	8.20E+07
0.4	1.00E+08
0.5	1.20E+08

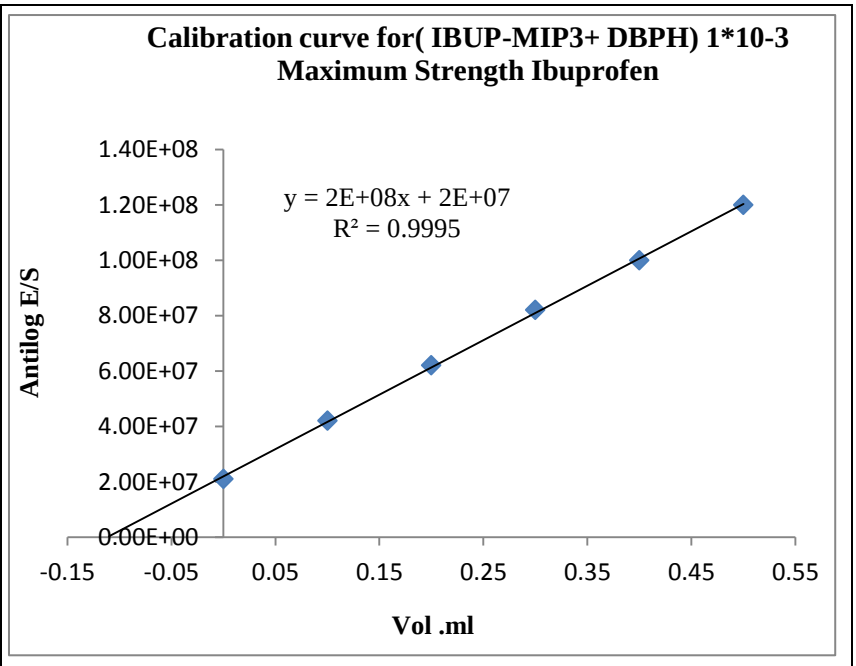


Fig. (3-69): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-3}M) by MSM using IBP-MIP3+DBPH electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	8.80E+10
0.1	9.60E+11
0.2	1.80E+12
0.3	2.70E+12
0.4	3.50E+12
0.5	4.30E+12

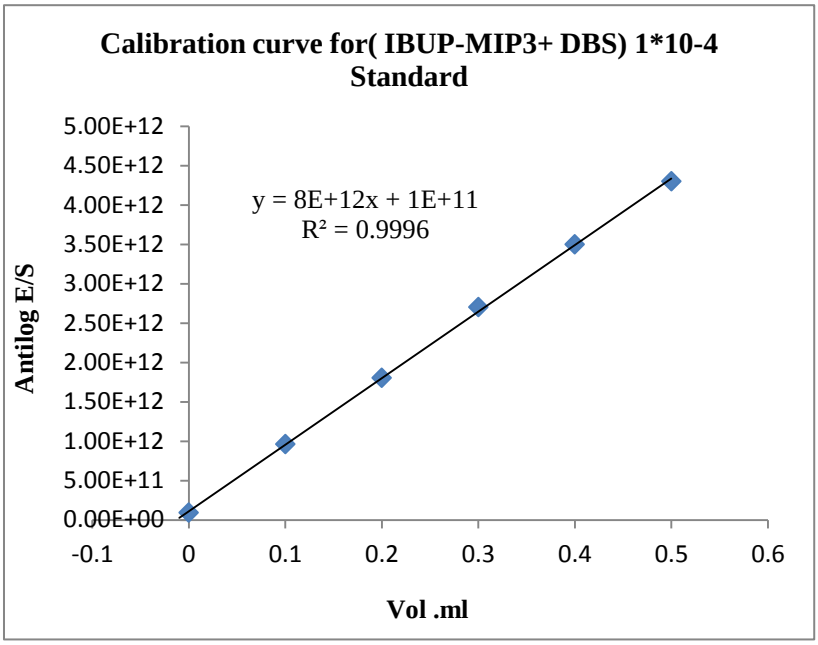


Fig. (3-70): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-4}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	9.90E+10
0.1	1.10E+12
0.2	2.00E+12
0.3	3.00E+12
0.4	3.90E+12
0.5	4.80E+12

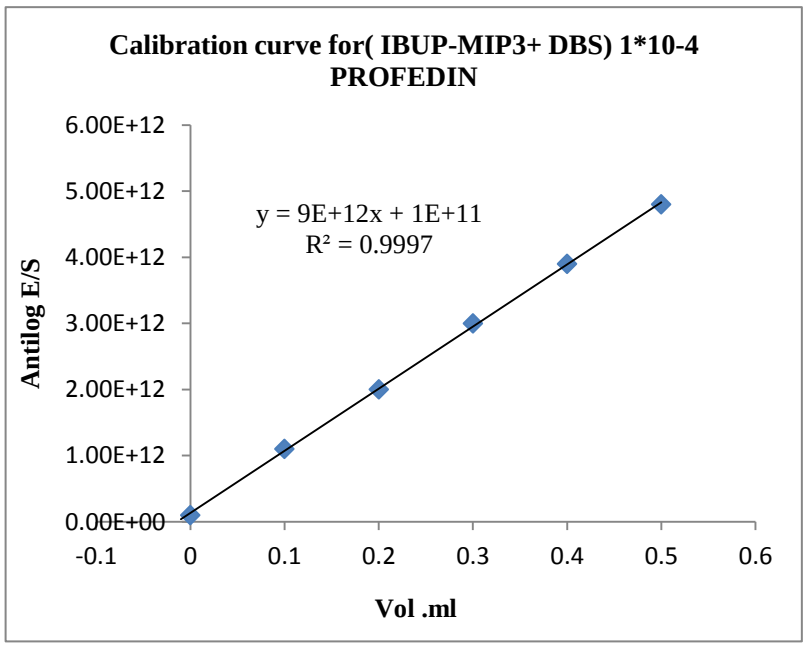


Fig. (3-71): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-4}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	4.90E+10
0.1	5.40E+11
0.2	1.00E+12
0.3	1.50E+12
0.4	1.90E+12
0.5	2.40E+12

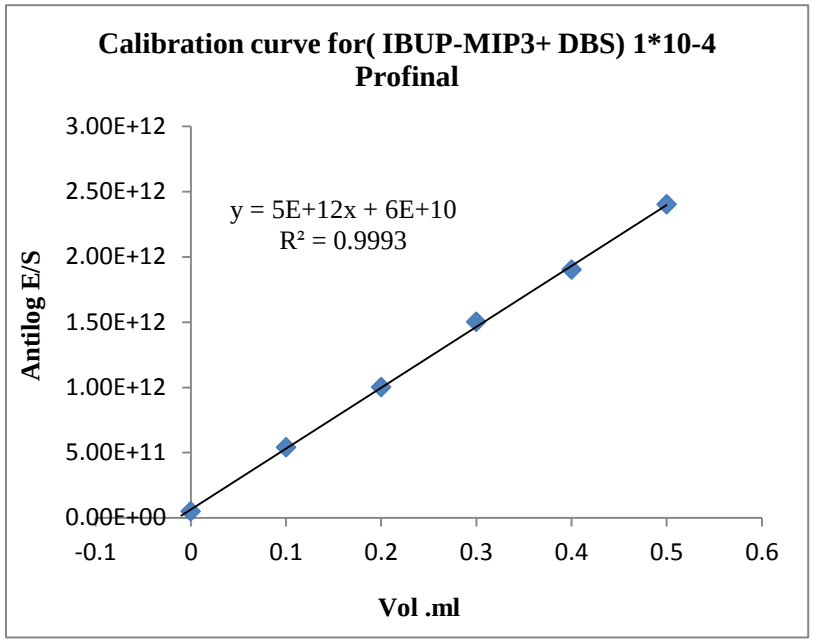


Fig. (3-72): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-4}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	5.60E+10
0.1	6.10E+11
0.2	1.20E+12
0.3	1.70E+12
0.4	2.20E+12
0.5	2.70E+12

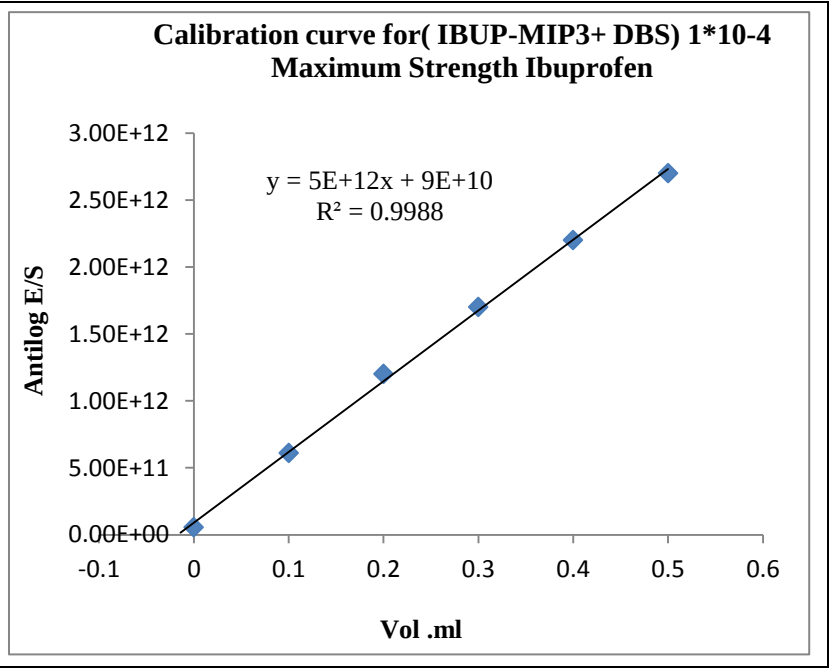


Fig. (3-73): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-4}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	6.81E+11
0.1	1.30E+12
0.2	2.00E+12
0.3	2.70E+12
0.4	3.30E+12
0.5	3.90E+12

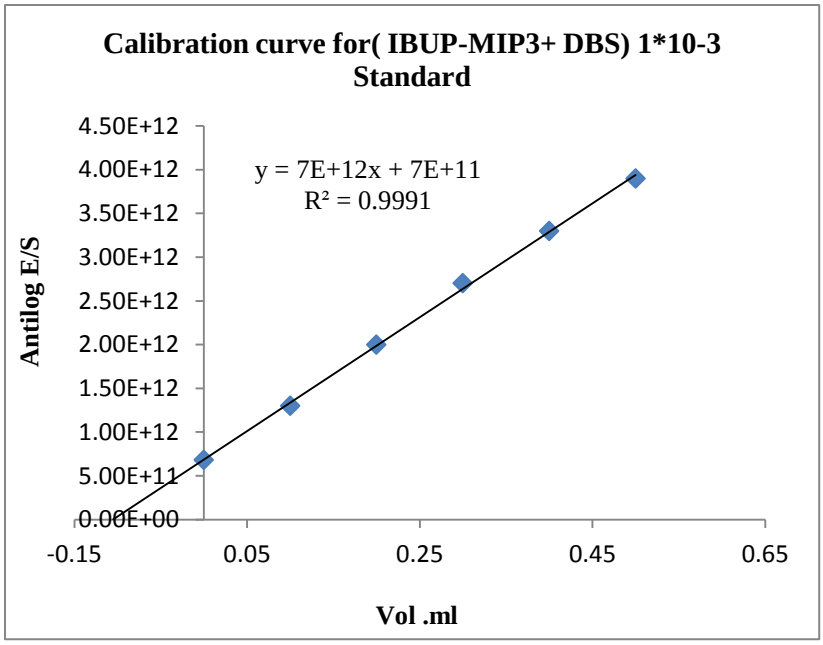


Fig. (3-74): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Standard) (10^{-3}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	2.30E+07
0.1	4.60E+07
0.2	6.80E+07
0.3	9.00E+07
0.4	1.10E+08
0.5	1.30E+08

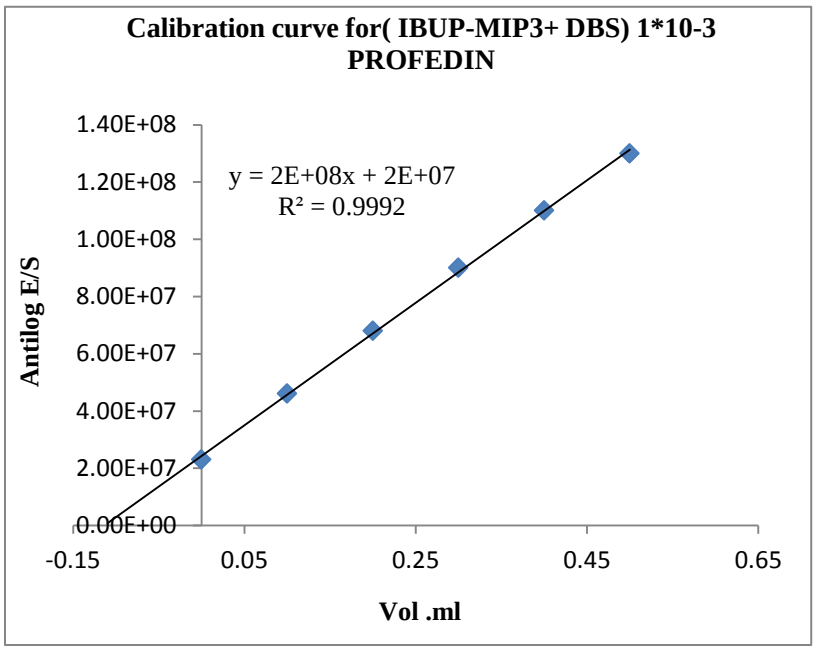


Fig. (3-75): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(PROFEDIN) (10^{-3}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	4.70E+11
0.1	9.30E+11
0.2	1.40E+12
0.3	1.80E+12
0.4	2.30E+12
0.5	2.70E+12

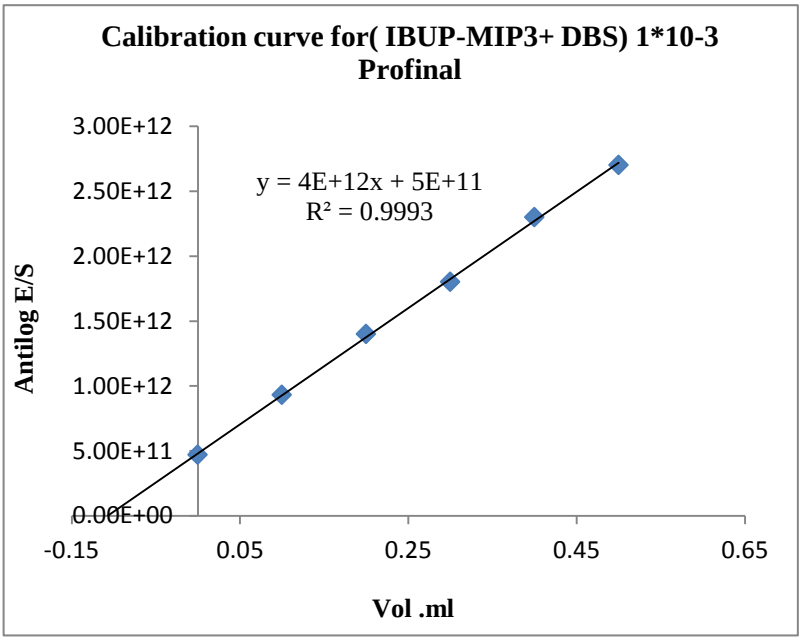


Fig. (3-76): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Profinal) (10^{-3}M) by MSM using IBP-MIP3+DBS electrode

IBP-MIP1+DBS Slope = 20.46 Reading	
Vol. ml	**Antilog E/S**
0	5.60E+11
0.1	1.10E+12
0.2	1.70E+12
0.3	2.20E+12
0.4	2.70E+12
0.5	3.20E+12

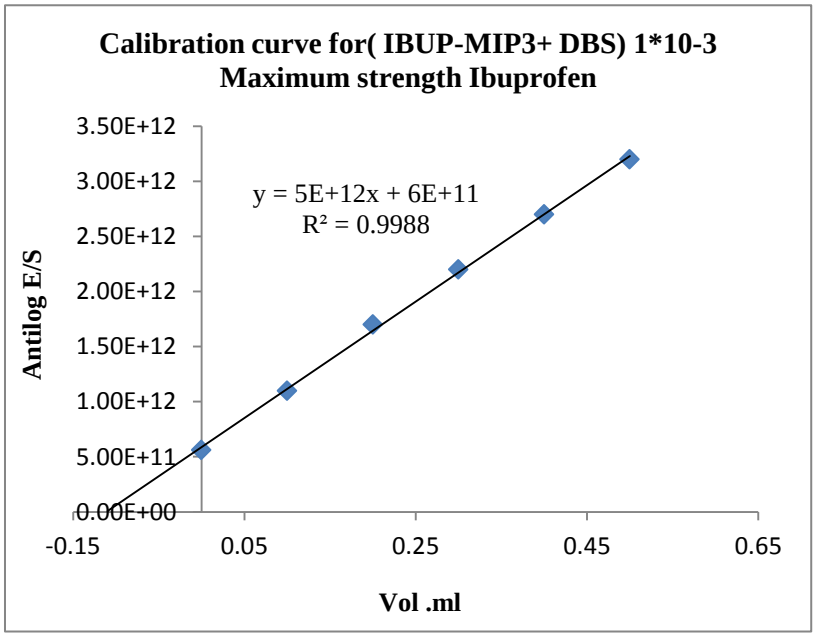


Fig. (3-77): Antilog (E/S) versus the volume of the added standard for the determination of ibuprofen solution(Maximum strength Ibuprofen) (10^{-3}M) by MSM using IBP-MIP3+DBS electrode

Table (3-59): Summary of the linear equations of the calibration curves for MSA, and correlation coefficients, volume at intercept with X axis and the concentration (C_U) for Ibuprofen electrodes

Membrane Combustion	Con M	Linear equation	R^2	Volume at intercept (mL)	C_U M
IBP-MIP1 + DOPH	1×10^{-4}	y = 3E+06x + 43857	0.9996	-0.012	1.2×10^{-4}
	1×10^{-3}	y = 3E+06x + 327143	0.9995	-0.1	1×10^{-3}
IBP-MIP1 + NB	1×10^{-4}	y = 5E+09x + 8E+07	0.9995	-0.012	1.2×10^{-4}
	1×10^{-3}	y = 1E+10x + 1E+09	0.9997	-0.106	1.06×10^{-3}
IBP-MIP2 + TTP	1×10^{-4}	y = 4E+09x + 4E+07	0.9999	-0.01	1×10^{-4}
	1×10^{-3}	y = 8E+09x + 9E+08	0.9999	-0.109	1.09×10^{-3}
IBP-MIP3 + DOPH	1×10^{-4}	y = 2E+08x + 2E+06	0.9999	-0.01	1×10^{-4}
	1×10^{-3}	y = 2E+08x + 3E+07	0.9983	-0.11	1.1×10^{-3}
IBP-MIP3 + DBS	1×10^{-4}	y = 8E+12x + 1E+11	0.9996	-0.01	1×10^{-4}
	1×10^{-3}	y = 7E+12x + 7E+11	0.9991	-0.105	1.05×10^{-3}

3-8-3 Titration method.

These method is dependent on valuable as a technique for detecting the end-point of titrations where there is often a drastic change in the concentrations of the reactants and thus a big shift in the electrode potential. Fig. (3-78) to (3-87) shows the titration curves of 10^{-3} and 10^{-4} M ibuprofen sample with phosphomolybdic acid as a ligand solution. The RSD% , Rec % and E_{rel} % were calculate and the results obtained for each method are given in Table(3-60)

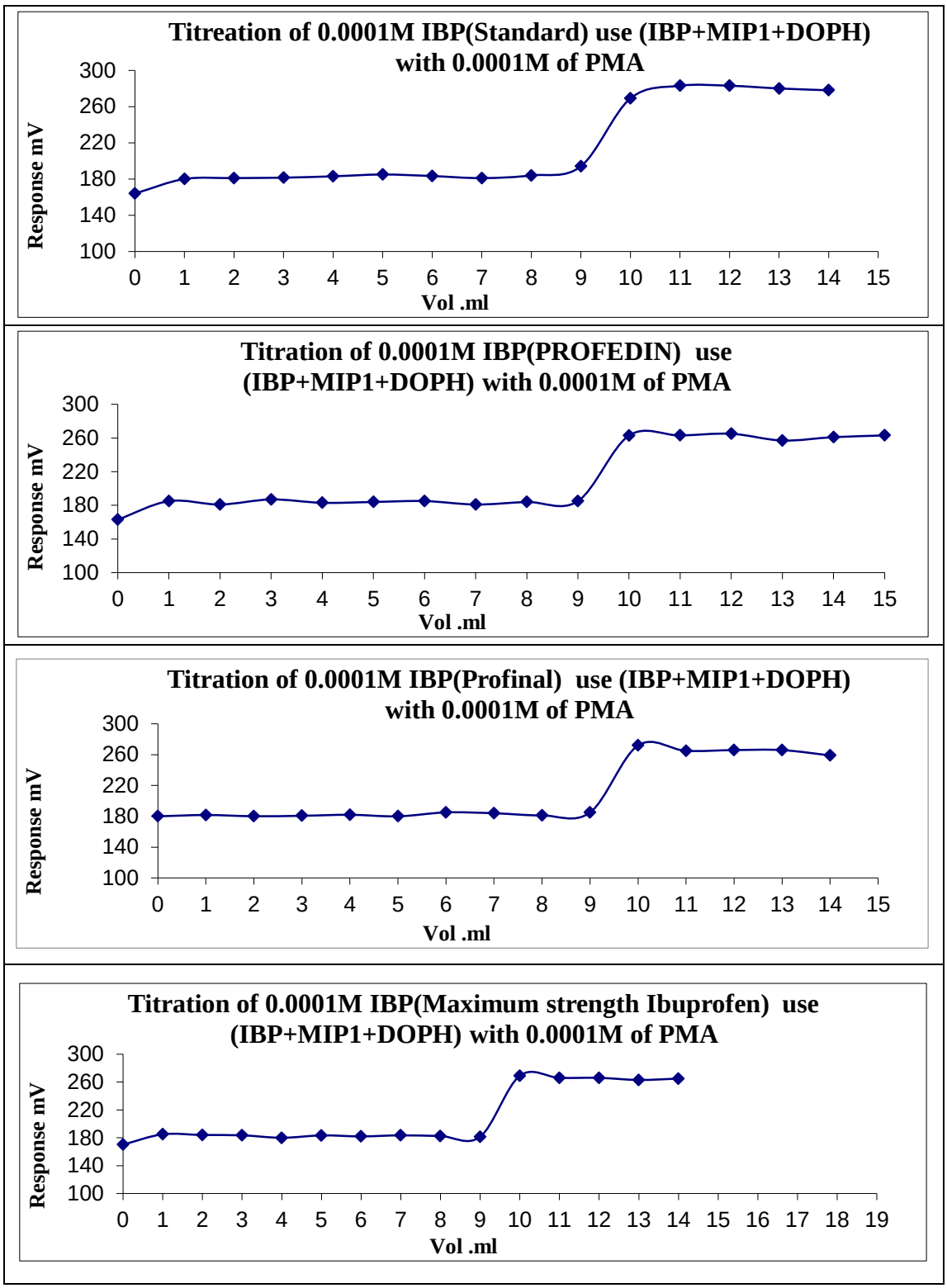


Fig. (3-78) Potentiometric Titration of each 10^{-4}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-4} PMA solution using (IBP-MIP1+DOPH) electrode

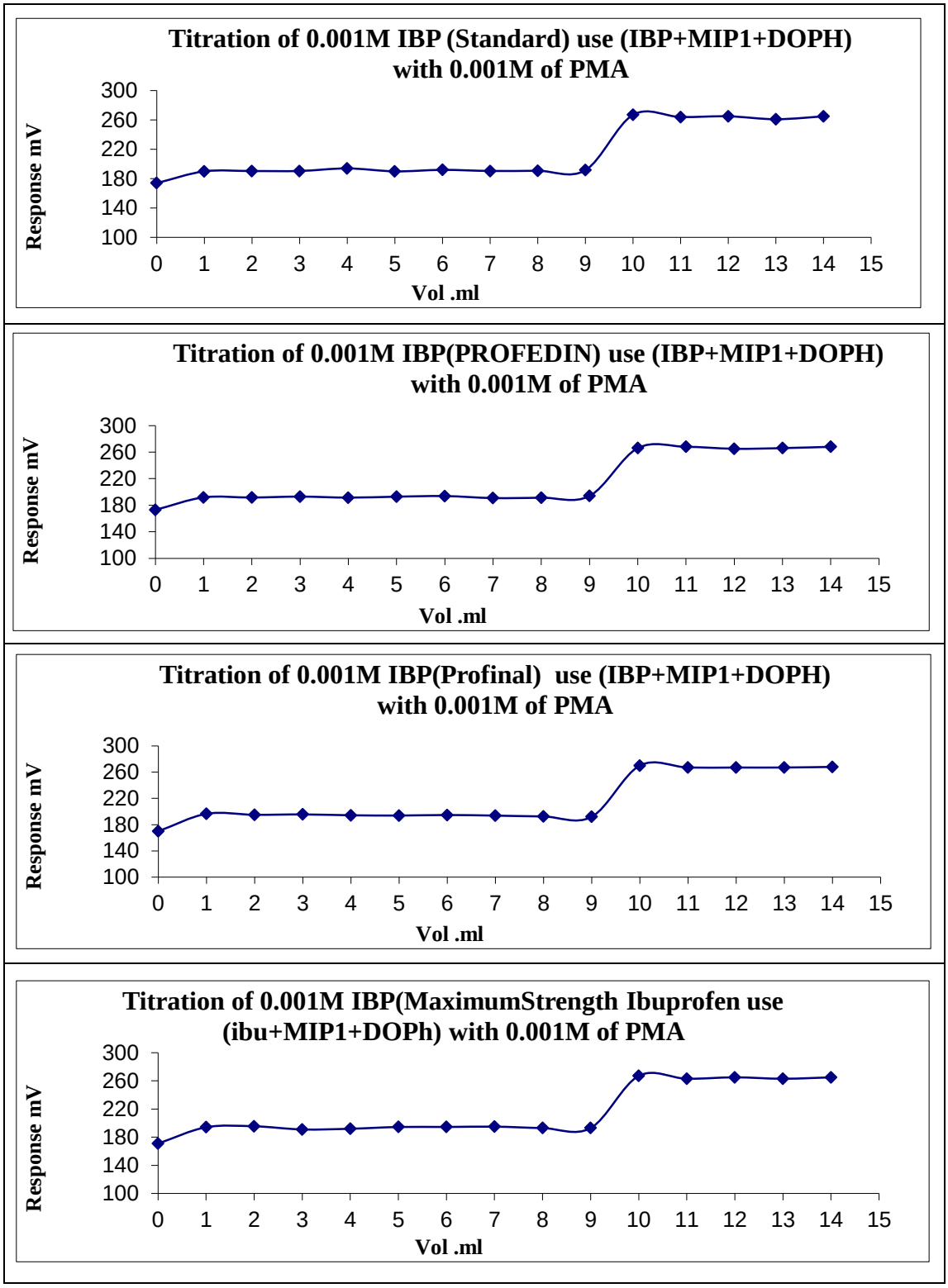


Fig. (3-79) Potentiometric Titration of each 10^{-3}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-3} PMA solution using (IBP-MIP1+DOPH) electrode

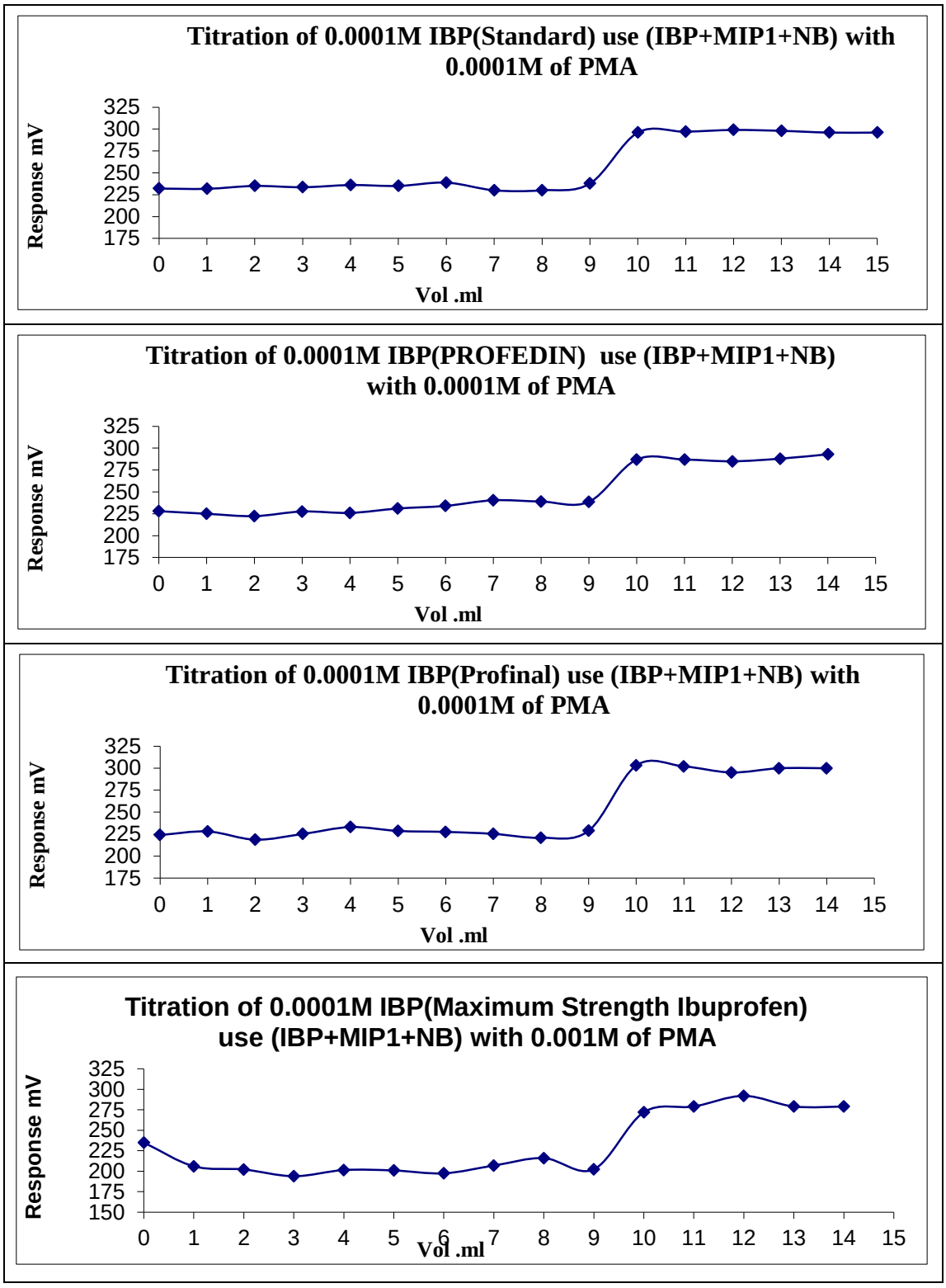


Fig. (3-80) Potentiometric Titration of each 10^{-4}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-4} PMA solution using (IBP-MIP1+NB) electrode

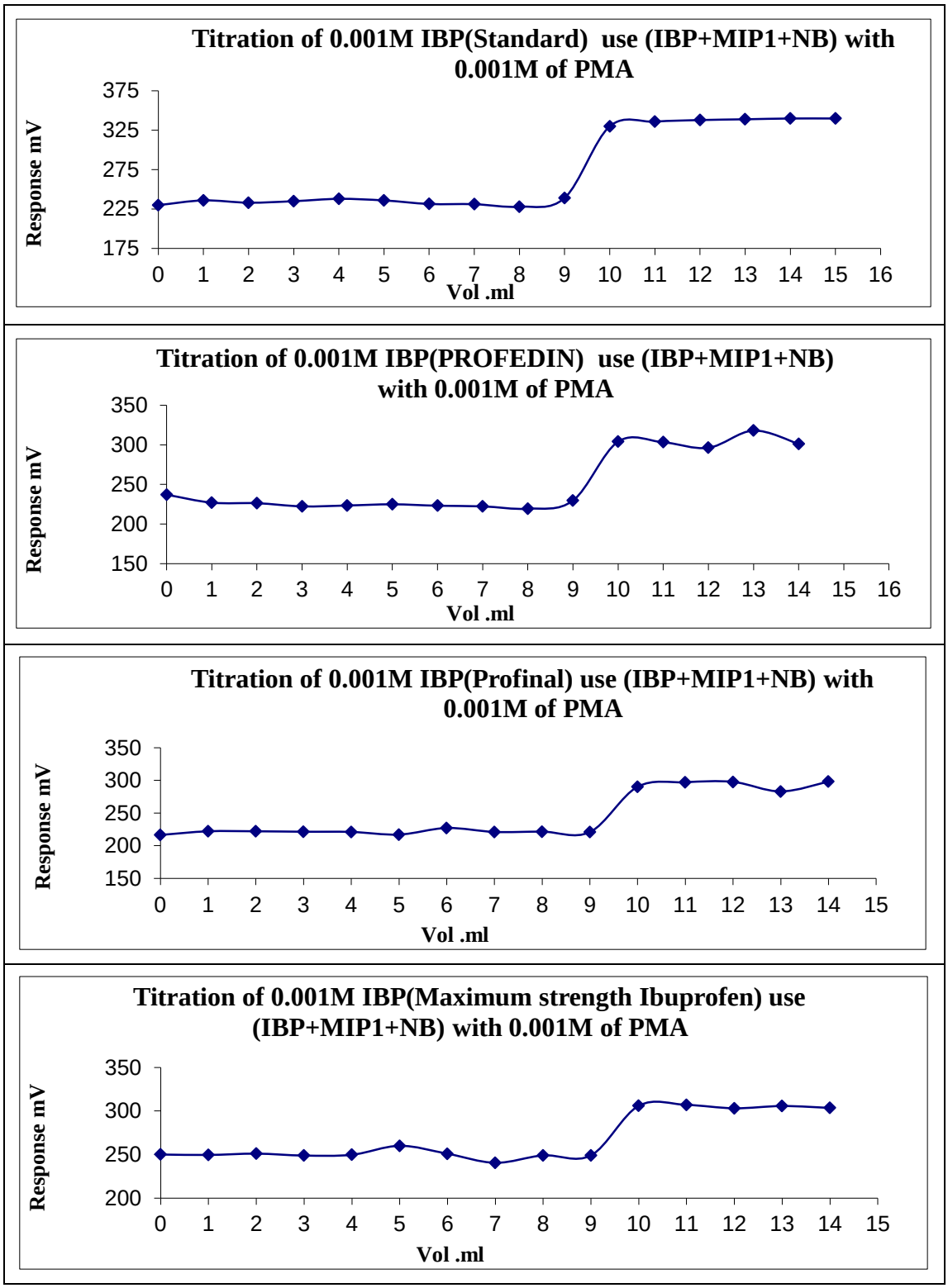


Fig. (3-81) Potentiometric Titration of each 10^{-3}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-3} PMA solution using (IBP-MIP1+NB) electrode

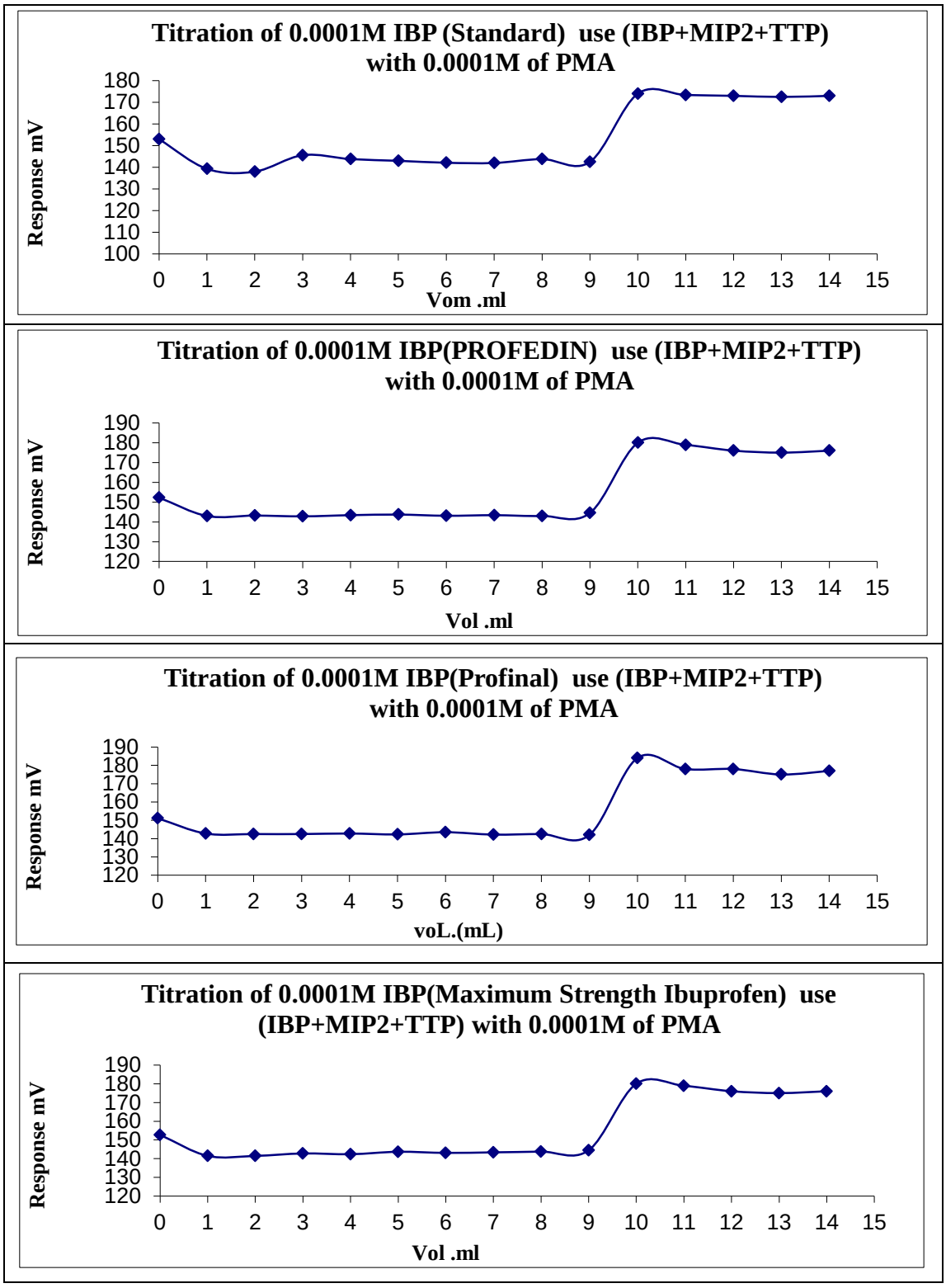


Fig. (3-82) Potentiometric Titration of each 10^{-4}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-4} PMA solution using (IBP-MIP2+TTP) electrode

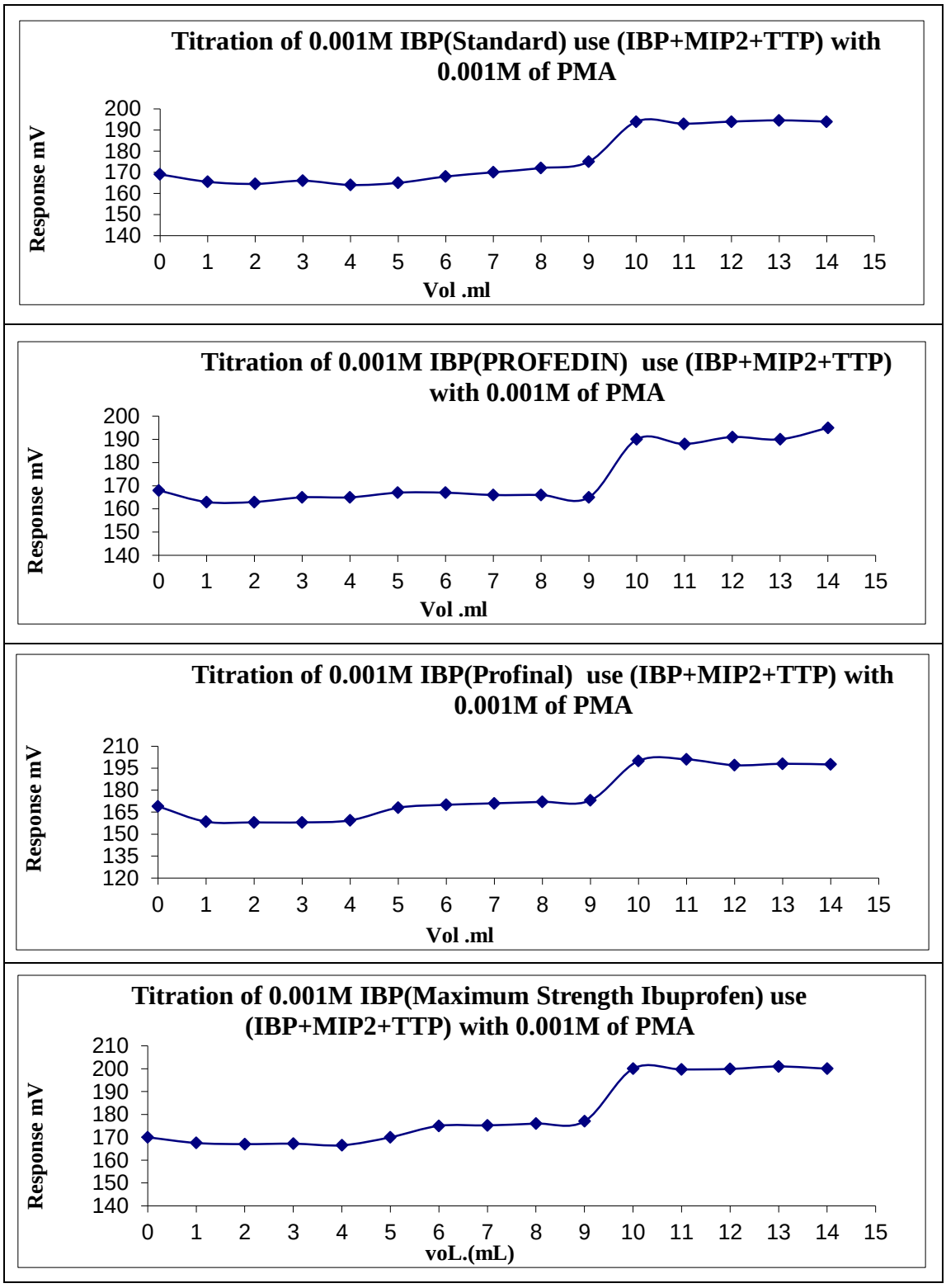


Fig. (3-83) Potentiometric Titration of each 10^{-3}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-3} PMA solution using (IBP-MIP2+TTP) electrode

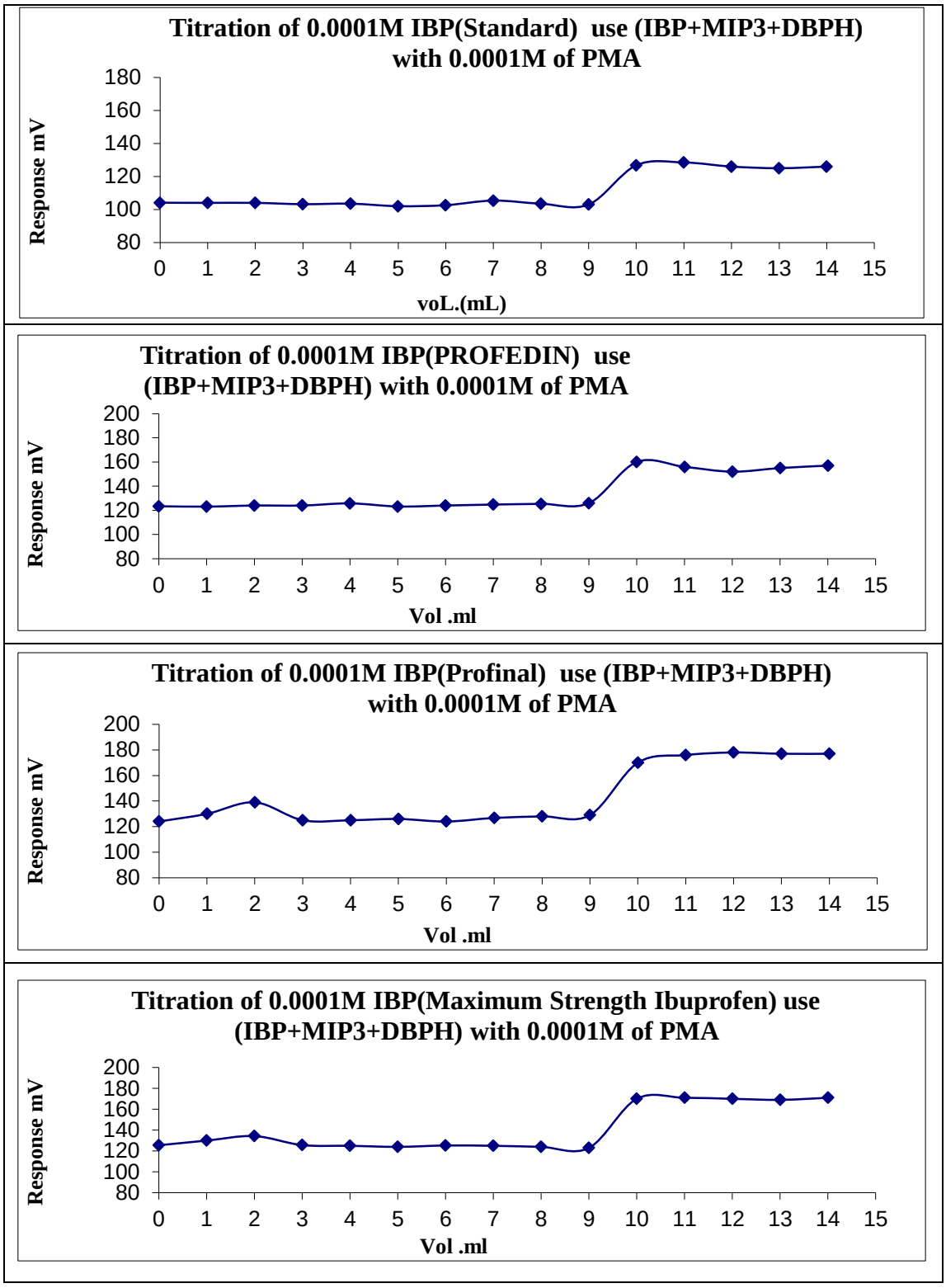


Fig. (3-84) Potentiometric Titration of each 10^{-4}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-4} PMA solution using (IBP-MIP3+DBPH) electrode

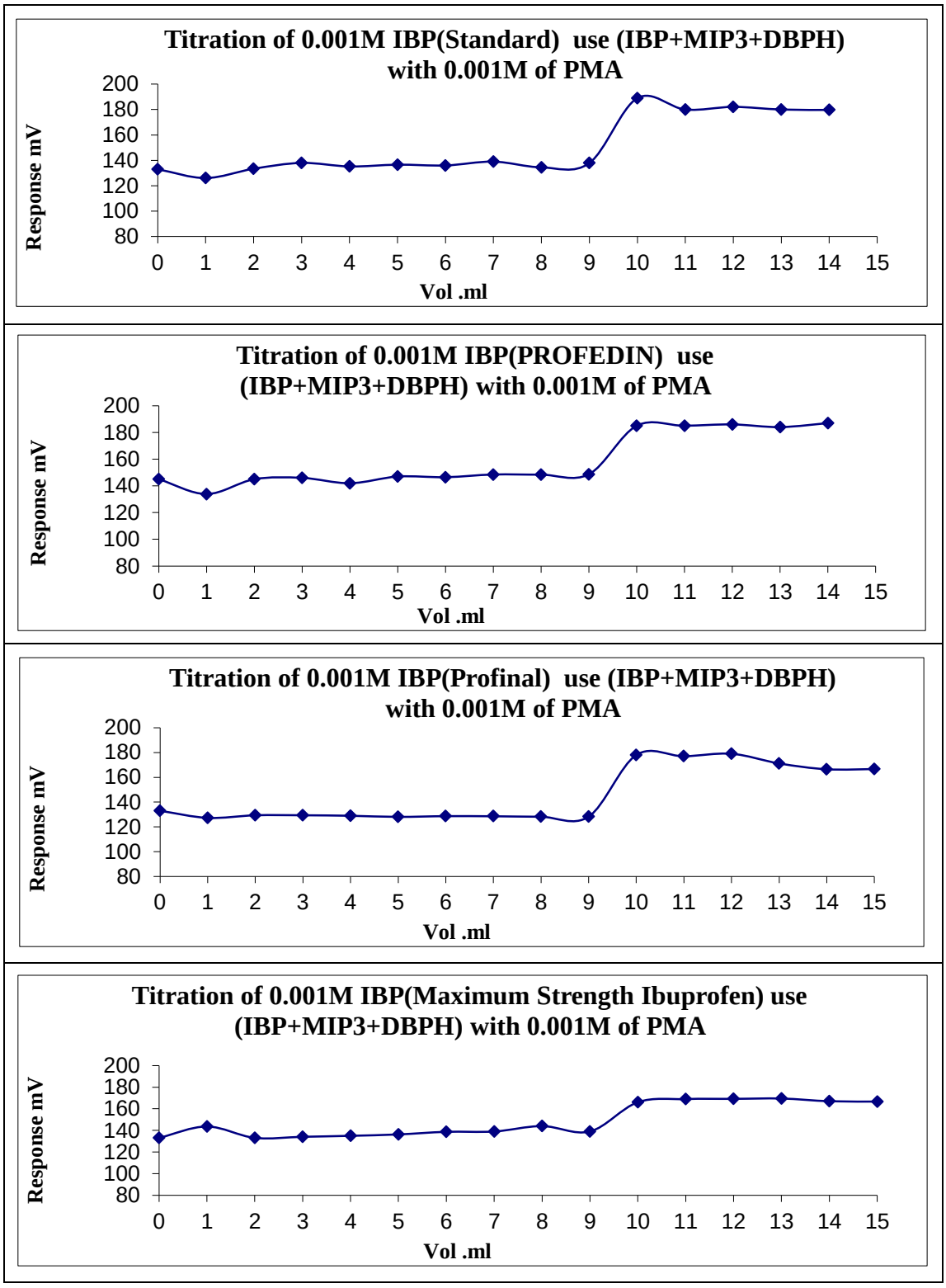


Fig. (3-85) Potentiometric Titration of each 10^{-3}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-3} PMA solution using (IBP-MIP3+DBPH) electrode

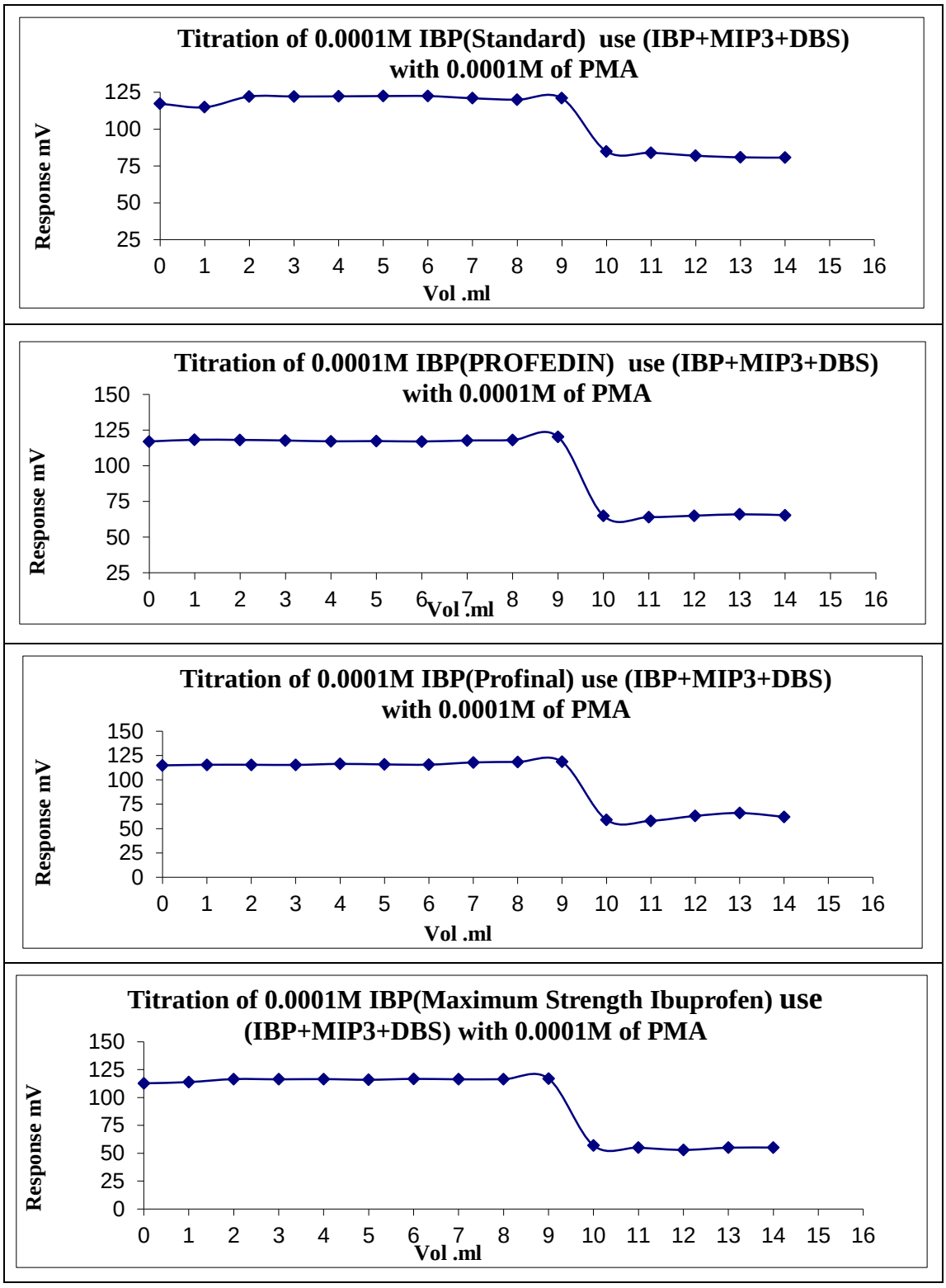


Fig. (3-86) Potentiometric Titration of each 10^{-4}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-4} PMA solution using (IBP-MIP3+DBS) electrode

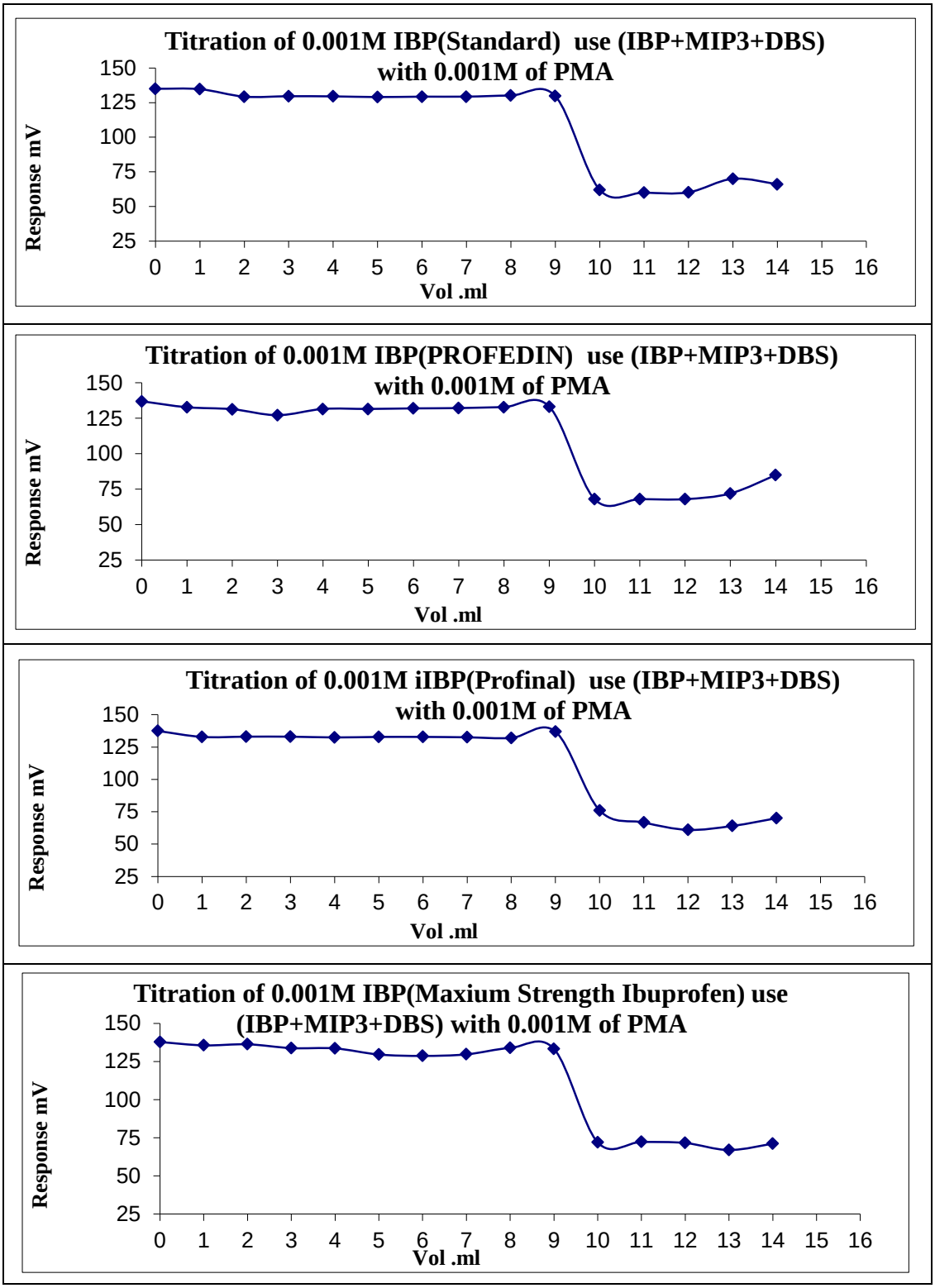


Fig. (3-87) Potentiometric Titration of each 10^{-3}M IBP(Standard , PRODEDIN, Profinal and Maximum Strength Ibuprofen solution with10^{-3} PMA solution using (IBP-MIP3+DBS) electrode

Table (3-60): Ibuprofen Standard and forms pharmaceutical sample analyses by using titration method for IBP electrodes

Electrode No.	sample	Measured using PMA as titrant	RSD %	E_{rel}%	REC %
IBP-MIP1 + DOPH (I)	**1×10^{-4}**				
	Standard	1.025×10^{-4}	0.96	2.5	102.5
	PROFEDIN	1.028×10^{-4}	0.93	2.8	102.8
	Profinal	1.033×10^{-4}	0.99	3.3	103.3
	Maximum strength Ibuprofen	1.03×10^{-4}	0.95	3	103
	1×10^{-3}				
	Standard	1.026×10^{-3}	0.95	2.6	102.6
	PROFEDIN	1.028×10^{-3}	1	2.8	102.8
	Profinal	1.031×10^{-3}	1	3.1	103.1
	Maximum strength Ibuprofen	1.03×10^{-3}	0.88	3	103
IBP-MIP1 + NB (II)	**1×10^{-4}**				
	Standard	1.027×10^{-4}	0.99	2.6	102.7
	PROFEDIN	1.038×10^{-4}	1.6	3.8	103.8
	Profinal	1.029×10^{-4}	1.1	2.9	102.9
	Maximum strength Ibuprofen	1.033×10^{-4}	1	3.3	103.3
	1×10^{-3}				
	Standard	1.025×10^{-3}	0.86	2.5	102.5
	PROFEDIN	1.03×10^{-3}	0.99	3.	103.
	Profinal	1.031×10^{-3}	0.97	3.1	103.1
	Maximum strength Ibuprofen	1.028×10^{-3}	1	2.8	102.8
IBP-MIP2 + TTP (III)	**1×10^{-4}**				
	Standard	1.039×10^{-4}	1.1	3.9	103.9
	PROFEDIN	1.04×10^{-4}	1.12	3.8	103.8
	Profinal	1.038×10^{-4}	0.74	3.6	103.6
	Maximum strength Ibuprofen	1.039×10^{-4}	0.84	3.8	103.8

IBP-MIP2 + TTP (III)	**1×10^{-3}**				
	Standard	1.028×10^{-3}	0.93	2.8	102.8
	PROFEDIN	1.029×10^{-3}	0.88	2.9	102.9
	Profinal	1.031×10^{-3}	1.32	3.1	103.1
	Maximum strength Ibuprofen	1.036×10^{-3}	1.2	3.6	103.6
IBP-MIP3 + DBPH (IV)	**1×10^{-4}**				
	Standard	1.03×10^{-4}	0.94	3	103
	PROFEDIN	1.03×10^{-4}	1	3.2	103.2
	Profinal	1.04×10^{-4}	1.7	3.8	103.8
	Maximum strength Ibuprofen	1.04×10^{-4}	1.5	3.8	103.8
	1×10^{-3}				
	Standard	1.028×10^{-3}	0.85	2.8	102.8
	PROFEDIN	1.032×10^{-3}	1.1	2.9	103.2
	Profinal	1.031×10^{-3}	1. 2	3.7	103.7
	Maximum strength Ibuprofen	1.029×10^{-3}	1.1	2.9	102.9
IBP-MIP3 + DBS (V)	**1×10^{-4}**				
	Standard	1.026×10^{-4}	0.99	2.6	102.6
	PROFEDIN	1.029×10^{-4}	1.1	2.9	102.9
	Profinal	1.04×10^{-4}	1.7	3.8	103.8
	Maximum strength Ibuprofen	1.04×10^{-4}	1	3.3	103.3
	1×10^{-3}				
	Standard	1.025×10^{-3}	0.86	2.5	102.5
	PROFEDIN	1.034×10^{-3}	1.1	3.4	103.4
	Profinal	1.031×10^{-3}	0.97	3.1	103.1
	Maximum strength Ibuprofen	1.03×10^{-3}	1	3	103

Table (3-61) Determination of Ibuprofen pure samples by ion selective electrodes (ISEs) techniques based on PVC membranes

Electrode NO and composition	Measurement by using ISEs methods				
	Standard sample			1×10^{-4} (M)	
IBP-MIP1 + DOPH (I)	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1.025×10^{-4}	0.96	2.5	102.5
	DM	9.92×10^{-5}	0.9	-0.80	99.2
	SAM	1.0027×10^{-4}	0.32	0.27	100.27
	MSA	1.0023×10^{-4}	0.27	0.23	100.23
	Standard sample			1×10^{-3} (M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1.026×10^{-3}	0.95	2.6	102.6
	DM	1.007×10^{-3}	0.82	0.79	100.79
	SAM	9.99×10^{-4}	0.33	-0.11	99. 89
	MSA	1.0007×10^{-3}	0.11	0.07	100.07
IBP-MIP1 + NB (II)	Standard sample			1×10^{-4} (M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1.027×10^{-4}	0.99	2.6	102.7
	DM	1.0098×10^{-4}	0.78	0.98	100.98
	SAM	1.0011×10^{-4}	0. 2	0.11	100.11
	MSA	1.0008×10^{-4}	0.1	0.08	100.08
	Standard sample			1×10^{-3}(M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1.025×10^{-3}	0.86	2.5	102.5
	DM	1.007×10^{-3}	0.76	0.7	100.7
	SAM	9.967×10^{-4}	0.65	-0.33	99. 67
	MSA	1.0011×10^{-3}	0.12	0.11	100.11
IBP-MIP2 + TTP (III)	Standard sample			1×10^{-4}(M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1.039×10^{-4}	1.1	3.9	103.9
	DM	1.013×10^{-4}	0.82	1.31	101.3
	SAM	9.97×10^{-5}	0.53	-0.21	99.97
	MSA	1.0019×10^{-4}	0.18	0.19	100.19

IBP-MIP2 + TTP (III)	**Standard sample**			**1×10^{-3}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	1.028×10^{-3}	0.93	2.8	102.8
	DM	9.928×10^{-4}	0.98	-0.72	99.28
	SAM	9.98×10^{-4}	0.19	-0.12	99. 98
	MSA	1.0010×10^{-3}	0.1	0.10	100.10
IBP-MIP3 + DBPH (IV)	**Standard sample**			**1×10^{-4}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	1.03×10^{-4}	0.94	3	103
	DM	9.98×10^{-4}	0.84	-1.04	98.96
	SAM	100.29×10^{-4}	0. 35	0.29	100.29
	MSA	1.0023×10^{-4}	0.23	0.23	100.23
	Standard sample			**1×10^{-3}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	1.028×10^{-3}	0.85	2.8	102.8
	DM	1.007×10^{-3}	0.82	0.75	100.75
	SAM	9.971×10^{-4}	0.42	-0.29	99. 71
	MSA	1.0007×10^{-3}	0.07	0.13	100.07
IBP-MIP3 + DBS (V)	**Standard sample**			**1×10^{-4}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	1.026×10^{-4}	0.99	2.6	102.6
	DM	1.096×10^{-4}	0.65	0.96	100.96
	SAM	9.98×10^{-5}	0. 32	-0.16	99.84
	MSA	1.0014×10^{-4}	0.19	0.14	100.14
	Standard sample			**1×10^{-3}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	1.025×10^{-3}	0.86	2.5	102.5
	DM	1.007×10^{-3}	0.82	0.75	100.75
	SAM	9.98×10^{-4}	0.27	-0.11	99. 89
	MSA	1.0002×10^{-3}	0.12	0.02	100.02

Table (3-62): Sample analysis of pharmaceuticals IBP(PROFEDIN) by using ISE

Pharmaceutical		PROFEDIN 400mg			
IBP-MIP1 + DOPH (I)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.028×10^{-4}	1.088×10^{-4}	9.97×10^{-5}	1.0015×10^{-4}
	REC%	102.8	100.88	99. 7	100.15
	E_{rel} %	2.8	0.88	-0.24	0.15
	RSD%	0.93	0.64	0.52	0.2
	F test	12.4	11.6	9.87	
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	**1.028×10^{-3}**	**1.007×10^{-3}**	**9.968×10^{-4}**	**9.999×10^{-4}**
	REC%	102.8	100.79	99.68	99.99
	E_{rel} %	2.8	0.79	-0. 32	-0.01
	RSD%	1	0.82	0.43	0.1
	F test	7.89	12.21	5.09	
	F theoretical	**19.2**			
IBP-MIP1 + NB (II)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	**1.038×10^{-4}**	**1.0074×10^{-4}**	**9.972×10^{-5}**	**1.0002×10^{-4}**
	REC%	103.8	100.74	99.72	100.02
	E_{rel} %	3.8	0.74	-0.28	0.02
	RSD%	1.6	0.77	0.6	0.2
	F test	5.3	2.6	6.4	
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	**1.03×10^{-3}**	**9.924×10^{-4}**	**9.987×10^{-4}**	**9.999×10^{-4}**
	REC%	103.	99.24	99.87	99.99
	E_{rel} %	3.	-0.76	-0.13	0.0001
	RSD%	0.99	0.81	0.31	0.1
	F test	2.5	8.19	7.65	-
	F theoretical	**19.2**			
IBP-MIP2 + TTP (III)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.04×10^{-4}	$9.\ 9\times10^{-5}$	9.97×10^{-5}	1.0018×10^{-4}
	REC%	103.8	99.01	99.71	100.18
	E_{rel} %	3.8	-0.99	-0.29	0.18
	RSD%	1.12	0.85	0.49	0.22
	F test	10	8.09	13	-

IBP-MIP2 + TTP (III)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.029×10^{-3}	1.009×10^{-3}	9.96×10^{-4}	1.0015×10^{-3}
	REC%	102.9	100.94	99.62	100.15
	E_{rel} %	2.9	0.94	-0.38	0.15
	RSD%	0.88	0.73	0.35	0.25
	F test	12	7.5	9.06	
	F theoretical	**19.2**			
IBP-MIP3 + DBPH (IV)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.03×10^{-4}	1.009×10^{-4}	9.978×10^{-5}	1.0013×10^{-4}
	REC%	103.2	100.96	99.78	100.13
	E_{rel} %	3.2	0.96	-0.22	0.13
	RSD%	1	0.92	0.39	0.23
	F test				
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.032×10^{-3}	1.005×10^{-3}	9.98×10^{-4}	1.0018×10^{-3}
	REC%	103.2	100.52	99.8	100.18
	E_{rel} %	2.9	0.52	-0.2	0.18
	RSD%	1.1	0.7	0.35	0.23
	F test	14.5	16	18.01	-
	F theoretical	**19.2**			
IBP-MIP3 + DBS (V)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.029×10^{-4}	9.903×10^{-5}	1.0026×10^{-4}	1.0021×10^{-4}
	REC%	102.9	99.03	100.26	100.21
	E_{rel} %	2.9	-0.97	0.26	0.21
	RSD%	1.1	0.85	0.41	0.21
	F test	10.6	11	9.08	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.034×10^{-3}	1.005×10^{-3}	9.93×10^{-4}	1.0007×10^{-3}
	REC%	103.4	100.52	99.3	100.07
	E_{rel} %	3.4	0.52	-0.7	0.07
	RSD%	1.1	0.7	0.74	0.11
	F test	14.6	12.85	17	-
	F theoretical	**19.2**			

*Each measurement repeated three times.

Table (3-63): Sample analysis of pharmaceuticals IBP(Profinal) by using ISE

Pharmaceutical		Profinal 400mg			
IBP-MIP1 + DOPH (I)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.033×10^{-4}	1.007×10^{-5}	1.0022×10^{-4}	1.0020×10^{-4}
	REC%	103.3	100.7	100.22	100.20
	E_{rel} %	3.3	0.7	0.22	0.20
	RSD%	0.99	0.76	0. 38	0.24
	F test	18	17	16.52	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	1.031×10^{-3}	9.924×10^{-4}	9.942×10^{-4}	1.0009×10^{-3}
	REC%	103.1	99.24	99.42	100.09
	E_{rel} %	3.1	-0.76	-0.58	0.09
	RSD%	1	0.9	0.59	0.11
	F test	13.43	12.56	9.86	
	F theoretical	19.2			
IBP-MIP1 + NB (II)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.029×10^{-4}	9.90×10^{-5}	9.98×10^{-5}	1.0018×10^{-4}
	REC%	102.9	99	99.81	100.18
	E_{rel} %	2.9	-1	-0.19	0.18
	RSD%	1.1	0.84	0.53	0.11
	F test	10.43	13.3	15.5	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	1.031×10^{-3}	1.007×10^{-3}	9.968×10^{-4}	1.0008×10^{-3}
	REC%	103.1	100.70	99.68	100.08
	E_{rel} %	3.1	0.70	-0.32	0.08
	RSD%	0.97	0.8	0.65	0.14
	F test	12	11	14	
	F theoretical	19.2			
IBP-MIP2 + TTP (III)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.038×10^{-4}	9.91×10^{-5}	1.0026×10^{-4}	1.0023×10^{-4}
	REC%	103.6	99.1	100.26	100.23
	E_{rel} %	3.6	-0.9	0.26	0.23
	RSD%	0.74	0.83	0.3	0.24
	F test	7.829	5.768	11.862	-

IBP-MIP2 + TTP (III)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.031×10^{-3}	1.006×10^{-3}	9.98×10^{-4}	1.0013×10^{-3}
	REC%	103.1	100.62	99.81	100.13
	E_{rel} %	3.1	0.62	-0.19	0.13
	RSD%	1.32	0.77	0.26	0.22
	F test	10.629	13.943	7.397	
	F theoretical	**19.2**			
IBP-MIP3 + DBPH (IV)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.04×10^{-4}	9.91×10^{-5}	9.982×10^{-5}	1.001×10^{-4}
	REC%	103.8	99.14	99.82	100.1
	E_{rel} %	3.8	-0.86	-0.18	0.1
	RSD%	1.7	0.9	0. 51	0.20
	F test	14.739	7.926	10.528	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.031×10^{-3}	1.009×10^{-3}	9.96×10^{-4}	1.0024×10^{-3}
	REC%	103.7	100.92	99.69	100.24
	E_{rel} %	3.7	0.92	-0.31	0.24
	RSD%	1. 2	0.91	0.27	0.25
	F test	12.87	8.445	10.512	
	F theoretical	**19.2**			
IBP-MIP3 + DBS (V)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.04×10^{-4}	9.9×10^{-5}	9.984×10^{-5}	1.0011×10^{-4}
	REC%	103.8	99	99.84	100.11
	E_{rel} %	3.8	-1	-0.16	0.11
	RSD%	1.7	0.79	0. 48	0.18
	F test	14.21	16.58	18.01	
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.03×10^{-3}	1.009×10^{-3}	9.98×10^{-4}	1.0016×10^{-3}
	REC%	103	100.92	99.82	100.16
	E_{rel} %	3	0.92	-0.18	0.16
	RSD%	0.97	0.91	0.25	0.18
	F test	16	15	18.74	
	F theoretical	**19.2**			

*Each measurement repeated three times.

Table (3-64): Sample analysis of pharmaceuticals IBP(Maximum Strength Ibuprofen) by using ISE

Pharmaceutical		Maximum Strength Ibuprofen 400mg			
IBP-MIP1 + DOPH (I)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.03×10^{-4}	9.923×10^{-5}	9.979×10^{-5}	1.0014×10^{-4}
	REC%	103	99.23	99.79	100.14
	E_{rel} %	3	-0.77	-0.21	0.14
	RSD%	0.95	0.88	0.52	0.15
	F test	10.632	11.09	12.893	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	1.03×10^{-3}	1.007×10^{-3}	1.0020×10^{-3}	1.0017×10^{-3}
	REC%	103	100.71	100.20	100.17
	E_{rel} %	3	0.71	0.20	0.17
	RSD%	0.88	0.91	0.52	0.17
	F test	11.931	11.295	9.357	-
	F theoretical	19.2			
IBP-MIP1 + NB (II)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.033×10^{-4}	9.928×10^{-5}	9.98×10^{-5}	1.0011×10^{-4}
	REC%	103.3	99.28	99.81	100.11
	E_{rel} %	3.3	-0.72	-0.19	0.11
	RSD%	1	0.8	0.53	0.11
	F test	13.943	7.397	10.629	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	1.028×10^{-3}	9.92×10^{-4}	9.96×10^{-4}	9.99×10^{-4}
	REC%	102.8	99.2	99.66	99.99
	E_{rel} %	2.8	-0.8	-0.34	-0.01
	RSD%	1	0.72	0.44	0.15
	F test	13.398	6.827	12.329	-
	F theoretical	19.2			
IBP-MIP2 + TTP (III)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.039×10^{-4}	9.97×10^{-5}	9.96×10^{-5}	1.0016×10^{-4}
	REC%	103.8	99.72	99.69	100.16
	E_{rel} %	3.8	-0.28	-0.31	0.16
	RSD%	0.84	0.99	0.35	0.25

	F test	14.728	6.921	11.318	-
IBP-MIP2 + TTP (III)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.036×10^{-3}	1.008×10^{-3}	9.92×10^{-4}	1.0015×10^{-3}
	REC%	103.6	100.8	99.29	100.15
	E_{rel} %	3.6	0.8	-0.71	0.15
	RSD%	1.2	0.73	0.49	0.2
	F test	14.6	18.1	12.5	
	F theoretical	**19.2**			
IBP-MIP3 + DBPH (IV)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.04×10^{-4}	1.08×10^{-4}	9.972×10^{-5}	1.0011×10^{-4}
	REC%	103.8	100.86	99.72	100.11
	E_{rel} %	3.8	0.86	-0.28	0.11
	RSD%	1.5	0.72	0.53	0.19
	F test	15.9	12.6	4.3	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.029×10^{-3}	9.916×10^{-4}	9.94×10^{-4}	1.0013×10^{-3}
	REC%	102.9	99.16	99.41	100.13
	E_{rel} %	2.9	-0.84	-0.59	0.13
	RSD%	1.1	0.72	0.77	0.18
	F test		16.2	11.1	14.1
	F theoretical	**19.2**			
IBP-MIP3 + DBS (V)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.04×10^{-4}	9.912×10^{-5}	9.973×10^{-5}	1.0001×10^{-4}
	REC%	103.3	99.12	99.73	100.01
	E_{rel} %	3.3	-0.98	-0.27	0.01
	RSD%	1	0.855	0.59	0.08
	F test	13.08	14	17.68	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.03×10^{-3}	9.916×10^{-4}	9.94×10^{-4}	1.0013×10^{-3}
	REC%	103	99.16	99.41	100.13
	E_{rel} %	3	-0.84	-0.59	0.13
	RSD%	1	0.72	0.77	0.18
	F test	13	15	17.65	-
	F theoretical	**19.2**			

*Each measurement repeated three times.

3-10The Physical Characterization of Drug-imprinted polymers

3-10-1 Spectroscopic Techniques

Infrared spectroscopy, especially FTIR, this technique was important to identifying the functional groups of polymers and was largely applied to the analysis of imprinted substances. FT-IR spectroscopy have high sensitively towards structural features such as functional groups combined with substances (carbonyl, aromatics…etc) of copolymer composition.

3-10-1-1 FTIR of Acidic MIP of (DFS)

The FTIR spectra of the diclofenac sodium, and MIPs of DFS, were based on (1-vinyl imidazole) as basic functional monomer (before and after the removal of drug) were shown in figures (3-91), (3-92) and (3-93) for (DFS) drug. Table (3.65) summarized characteristic peaks that appeared in these figures.

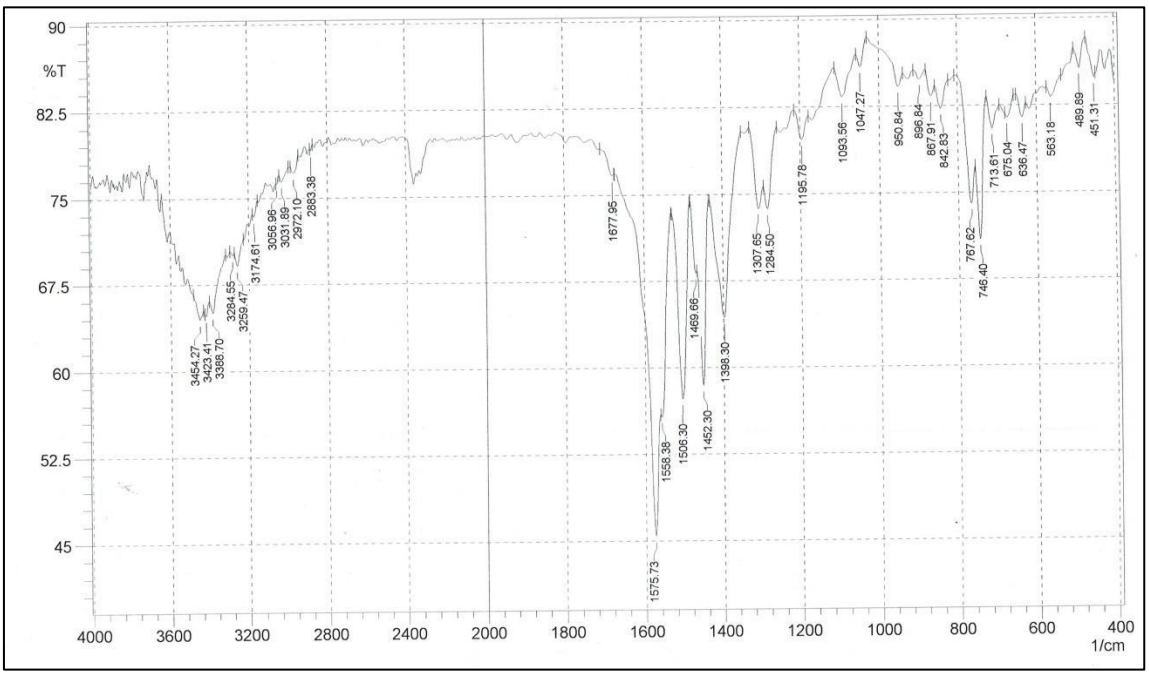


Fig. (3-91): FTIR of (DFS) drug.

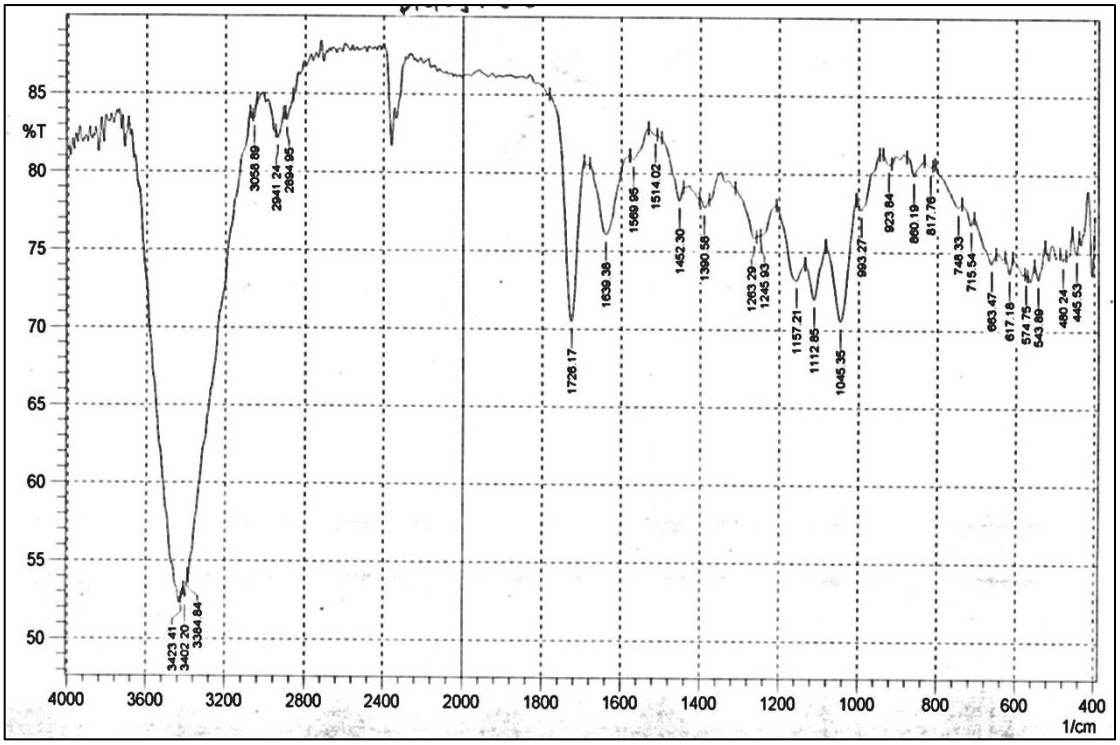


Fig. (3-92): FTIR of DFS-MIP1 (1-VI) before the removal of (DFS).

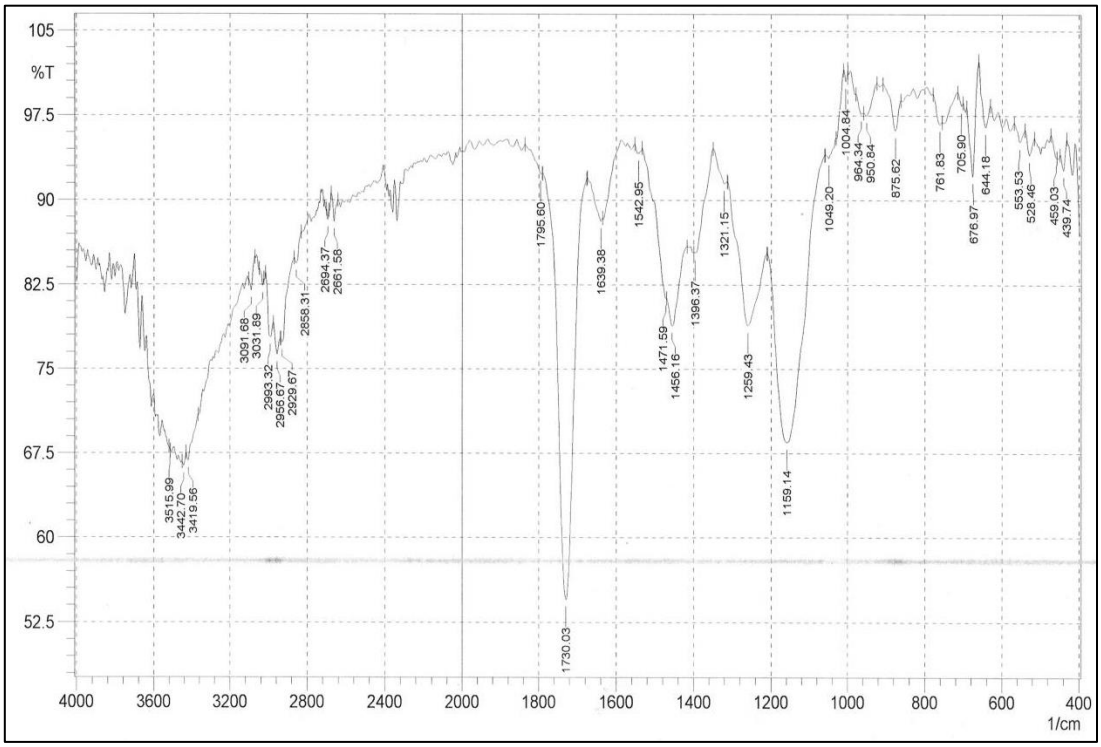


Fig. (3-93): FTIR of DFS-MIP1 (1-VI) after the removal of (DFS).

Table (3-65): The most characteristic peaks of FT-IR spectra for DFS-imprinted polymer using 1-vinylimidazol (1-Vi) as a functional monomer.

No.	Functional Group	DFS	DFS -MIP (1-Vi) before template removal	DFS -MIP (1-Vi) After template removal
1	N-H	3423 cm^{-1}	3402cm^{-1}	3442cm^{-1}
2	C-H aromatic	3056 cm^{-1}	3058 cm^{-1}	
3	O=C-O salt	1677 cm^{-1}	---	--
4	C=C	1575 cm^{-1}	1569 cm^{-1}	---
5	C-Cl	636 cm^{-1}	663 cm^{-1}	---
6	C-H Aliphatic	---	2941-2894 cm^{-1}	2956-2858 cm^{-1}
7	O=C-O ester	---	1726 cm^{-1}	1730 cm^{-1}
8	C=C Vinyl	---	1639 cm^{-1}	1639 cm^{-1}

The Fourier transmission infrared spectrometry (FTIR) spectra of leached and unbleached diclofenec sodium imprinted polymers MIP before and after removal template were recorded in the range of 400–4000 cm-1 by the KBr pellet Method (Table 3-65).

The FTIR spectrum of diclofenec sodium (DFS) showed abroad band at 3056 cm-1 for C-H aromatic DFS and showed same this at 3058cm^{-1} DFS-MIP1 before extraction While the FTIR spectrum of DFS-MIP after template removal. also showed at1677cm^{-1} (O=C-O) to salt but While the FTIR spectrum of DFS-MIP before and after template removal. showed a small band at 1575 cm-1 C=C belong and 1569 in DFS-mip1 before extract but not appear after extraction also chloride group showed at 636cm^{-1} and 663cm^{-1} and While the FTIR spectrum of DFS-MIP1 after template removal. but (C-H aliphatic , O=C-O ester and C=C vinyl group) it did not appear in FTIR –DFS but appear in FTIR DFS-MIP1 before and after extraction at (2956-2858cm^{-1}) , (1730-1726 cm^{-1})and (1639 cm^{-1}) respectively . These results were good indication for the formation of polymer which not effected when extraction the DFS from the polymer.

3-9-1-2 FTIR of molecular imprinted polymers for (DFS)

The FTIR spectra of the diclofenac sodium, The MIPs of DFS, were based on Acrylamide(AA) as basic functional monomer (before and after the removal of drug) were shown in figures (3-94) and (3-95) for (DFS) drug. Table (3-66) summarized the characteristic peaks that appeared in these figures

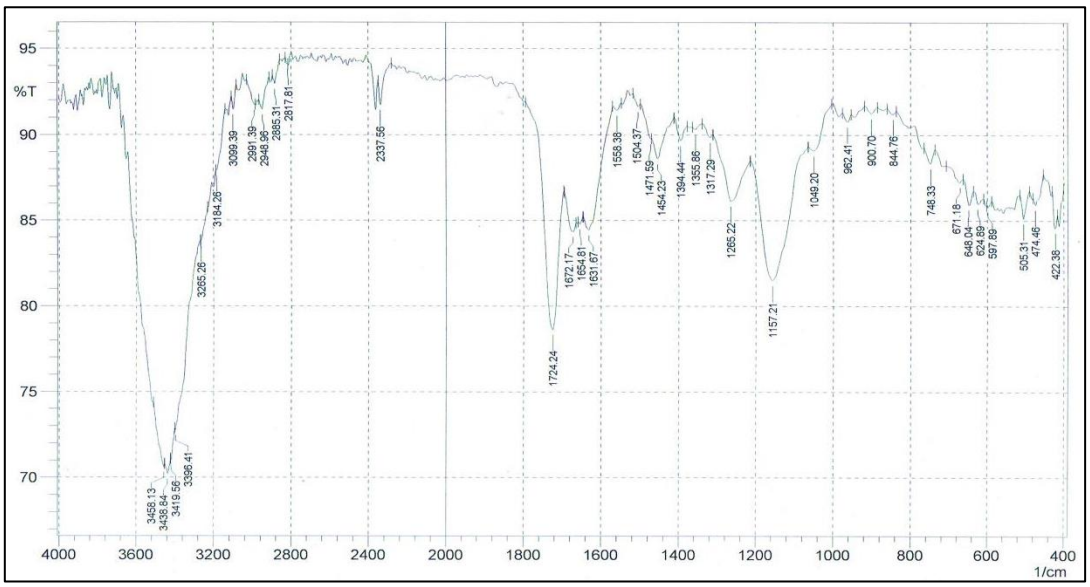


Fig. (3-94): FTIR of DFS-MIP2 (AA) before the removal of (DFS).

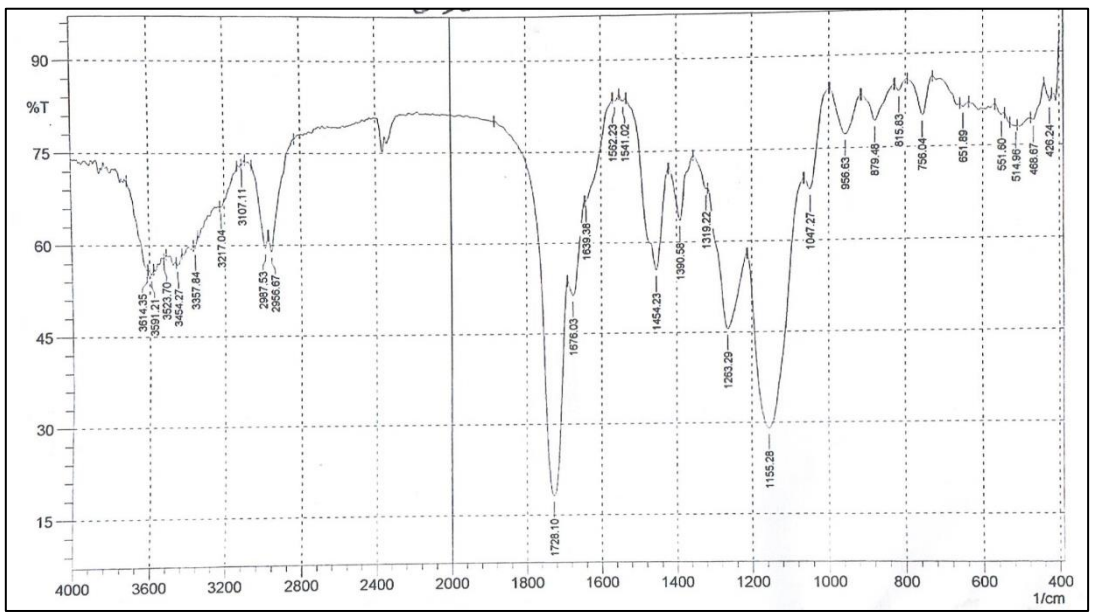


Fig. (3-95): FTIR of DFS-MIP2 (AA) after the removal of (DFS)

Table (3-66): The most characteristic peaks of FT-IR spectra for DFS-imprinted polymer using Acrylamide (AA) as a functional monomer.

No.	Functional Group	DFS	DFS -MIP (1-Vi) before template removal	DFS -MIP (1-Vi) After template removal
1	NH_2	---	3438-3419 cm^{-1}	3454-3357cm^{-1}
2	C=O amid	---	1672 cm^{-1}	1676 cm^{-1}
3	C=O ester	---	1724 cm^{-1}	1728 cm^{-1}
4	C-H Aliphatic	---	2941-2894 cm^{-1}	2956-2858 cm^{-1}

The Fourier transmission infrared spectrometry (FTIR) spectra of leached and unbleached diclofenec sodium imprinted polymers MIP and NIP were recorded in the range of 400–4000 cm-1 by the KBr pellet Method (Table 3-66).

The FTIR spectrum of DFS and DFS-MIP2 before and after removal showed a band at 3438-3419 cm^{-1} and3454-3357cm^{-1} for stretching of amine group also showed sharp streach at 1728-1724cm^{-1} for carbonyl group ester and showed The FTIR spectrum of DFS-MIP2 before and after template removal a small band at 1676-1672 for carbonyl to amide group. The FTIR spectrum of DFS-MIP2 before and after template removal showed at 2941-2894 cm^{-1} and 2956-2858 cm^{-1} for stretching C-H aliphatic . These results were good indication for the formation of polymer which not effected when extraction the DFS from the polymer

3-9-1-3 FTIR of molecular imprinted polymers for (DFS)

The FTIR spectra of the diclofenec sodium, The MIPs of DFS, were based on Styrene as basic functional monomer (before and after the removal of drug) were shown in figures (3-96) and (3-97) for (DFS) drug.

Table (3-67) summarized the characteristic peaks that appeared in these figures.

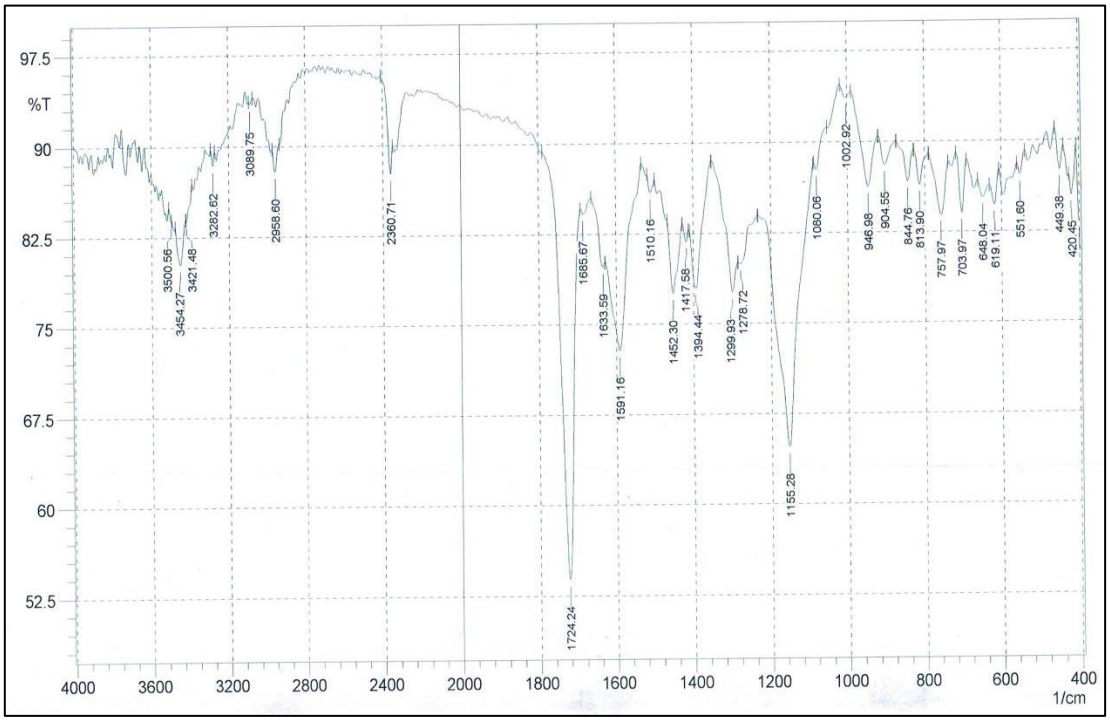


Fig (3-96): FTIR of DFS-MIP2 (Styrene) before the removal of (DFS)

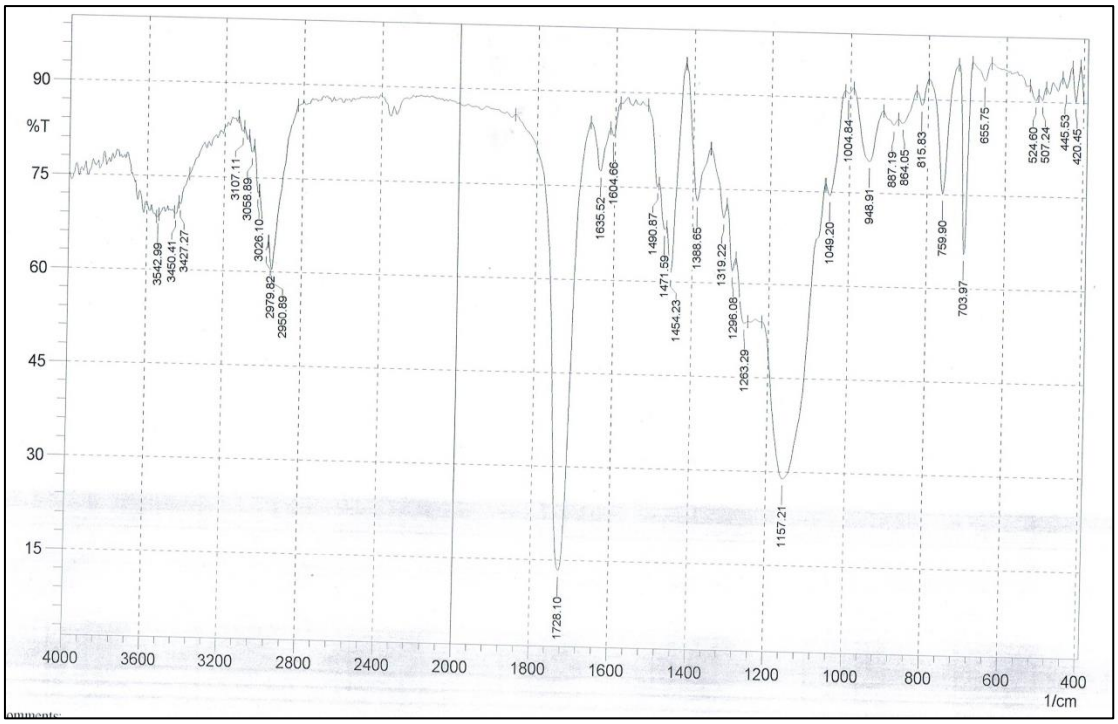


Fig (3-97): FTIR of DFS-MIP2 (Styrene) after the removal of (DFS)

Table (3-67): The most characteristic peaks of FT-IR spectra for DFS-imprinted polymer using Styrene as a functional monomer.

No.	Functional Group	DFS	DFS -MIP (1-Vi) before template removal	DFS -MIP (1-Vi) After template removal
1	N-H	---	3454cm^{-1}	---
2	C-H aromatic	---	3089 cm^{-1}	3058 cm^{-1}
3	C-H Aliphatic	---	2958cm^{-1}	2979-2850 cm^{-1}
4	O=C-O ester	---	1724 cm^{-1}	1728 cm^{-1}
5	C=C	---	1633 cm^{-1}	1635

The Fourier transmission infrared spectrometry (FTIR) spectra of leached and unbleached diclofenec sodium imprinted polymers MIP and NIP were recorded in the range of 400–4000 cm-1 by the KBr pellet Method (Table 3-67).

The FTIR spectrum of diclofenec sodium (DFS) shows at 3454cm^{-1} for stretching amine group before removal drug from mip3 but did not appear in FTIR- MIp3after removal. also showed abroad band at 3089 cm-$^{-1}$ and 3058cm^{-1} for C-H aromatic in FTIR-MIP3 before and after removal. the FTIR –MIP3shows small stretching band for C-H alephatic before and after removal appeared at 2958cm^{-1} and 2979-2850 cm^{-1} and showed sharp stretching for (O=C-O) ester group at1724cm^{-1} and 1728cm^{-1} While the FTIR spectrum of DFS-MIP3 showes a small band at 1633 cm-^{1}and 1633 cm-^{1} for starching C=C before and after template removal These results are good indication for the formation of polymer which was not affected when extraction the DFS was extracted from the polymer

3-10MorphologicalCharacterization

The technology of molecular imprinting Polymer permitted for the preparation of polymers with specific binding sites for a target molecule.

This can be achieved if the target is synthesized through the polymerization process, thus acting as a molecular template. Monomers carrying certain functional groups are arranged around the template through either non covalent or covalent interactions. Following polymerization with a high degree of cross-linking, the functional groups are held in position by the polymer network. Subsequently removal of the template by solvent extraction or chemical cleavage leaving the cavities that are complementary to the template in terms of size, shape and arrangement of functional groups. These highly specific receptor sites are capable of rebinding the target molecule with a high specificity, sometimes comparable to that of antibodies. Molecularly imprinted polymers have been called "antibody mimics". It has been show that they can be substituted for biological receptors in certain formats of immunoassays and biosensors. They also have been used as stationary phases for affinity separations, for the screening of combinatorial libraries, and as enzyme mimics in catalytic applications.

In scanning electron microscopy (SEM), a fine beam of electrons scans the membrane surface. This causes several kinds of interactions generating different signals, and it is also used in image formation. The SEM can be used to get an idea about the size, geometry, and distribution of pore surface of the membranes. SEM analysis showed that the highly ordered and regular pore structure of the molecular imprinted polymer surface and the cross-section. Several researches showed that the molecular imprinted membranes recognized the template molecule effectively and transported it with good efficiency due to porous structures of the molecular imprinted polymer. The ordered porous and cross section on surface showed that the sites of interaction, and MIP was highest transport rate towardd the template molecule.

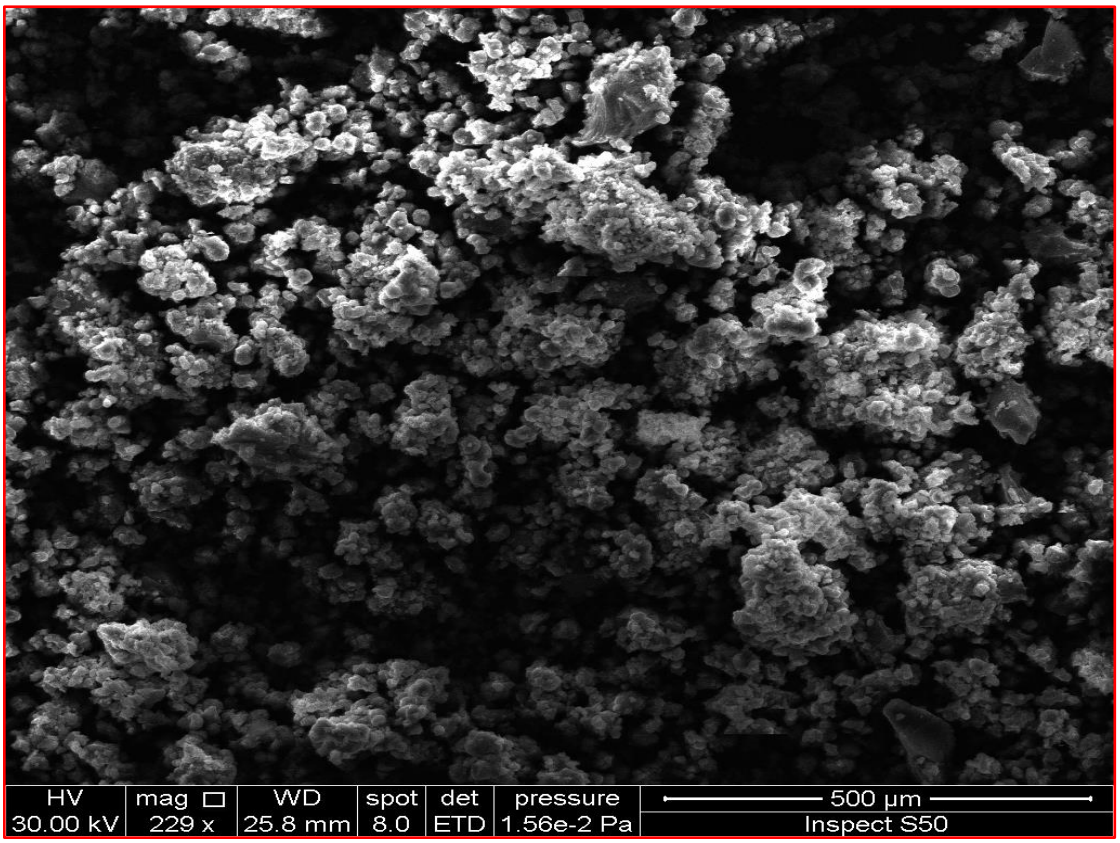


Fig. (3-98): SEM Micrograph of the MIP1 before removal (DFS)

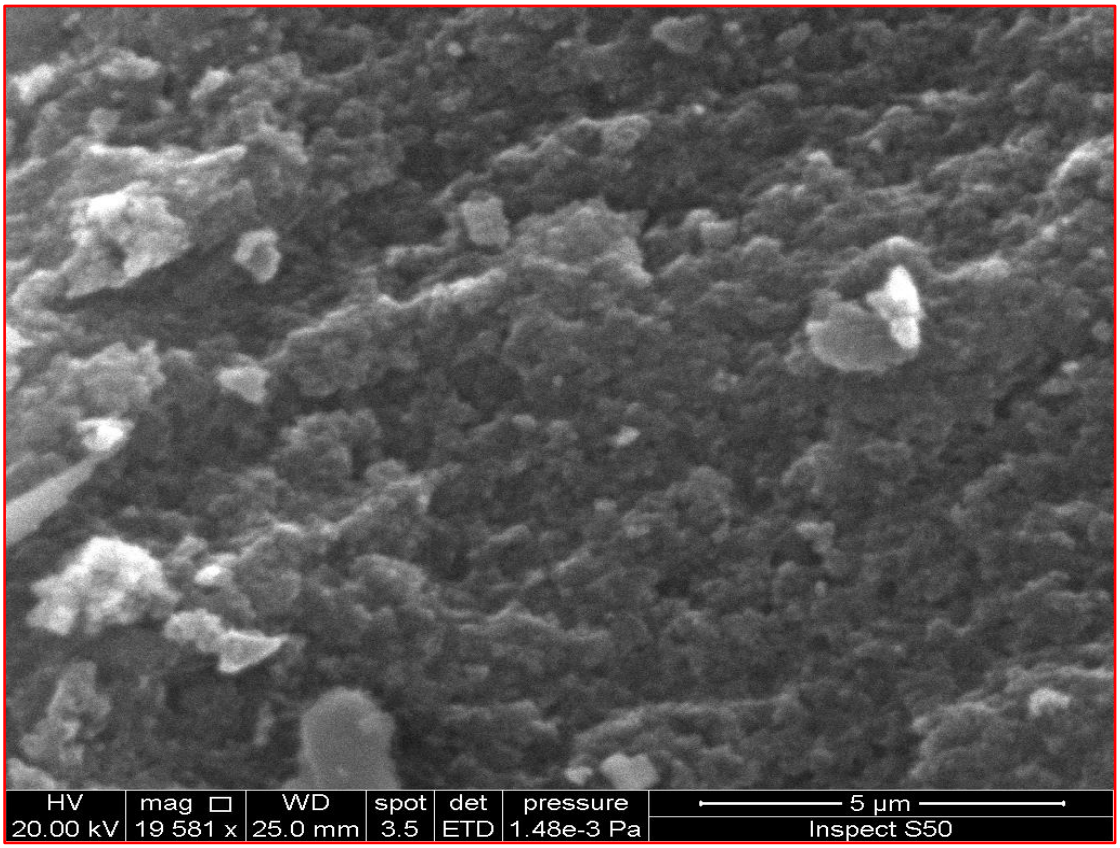


Fig. (3-99): SEM Micrograph of the MIP1 after removal (DFS)

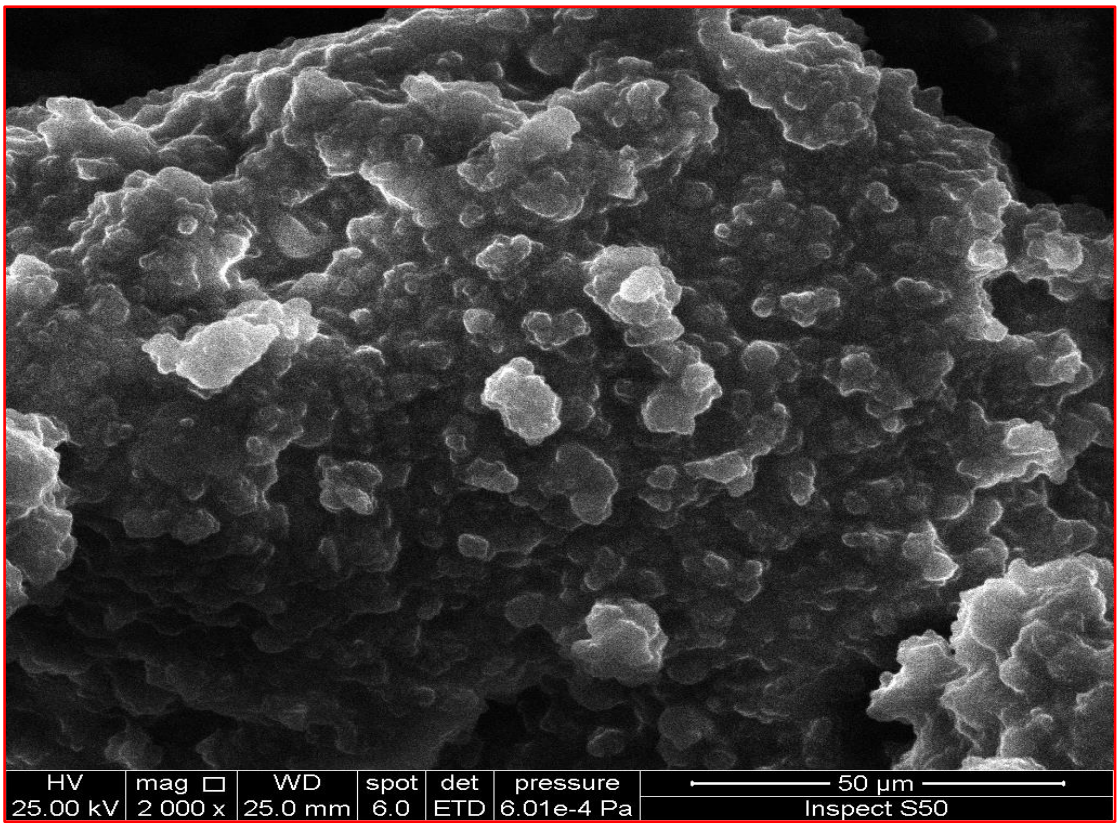


Fig. (3-100): SEM Micrograph of the MIP2 before removal (DFS)

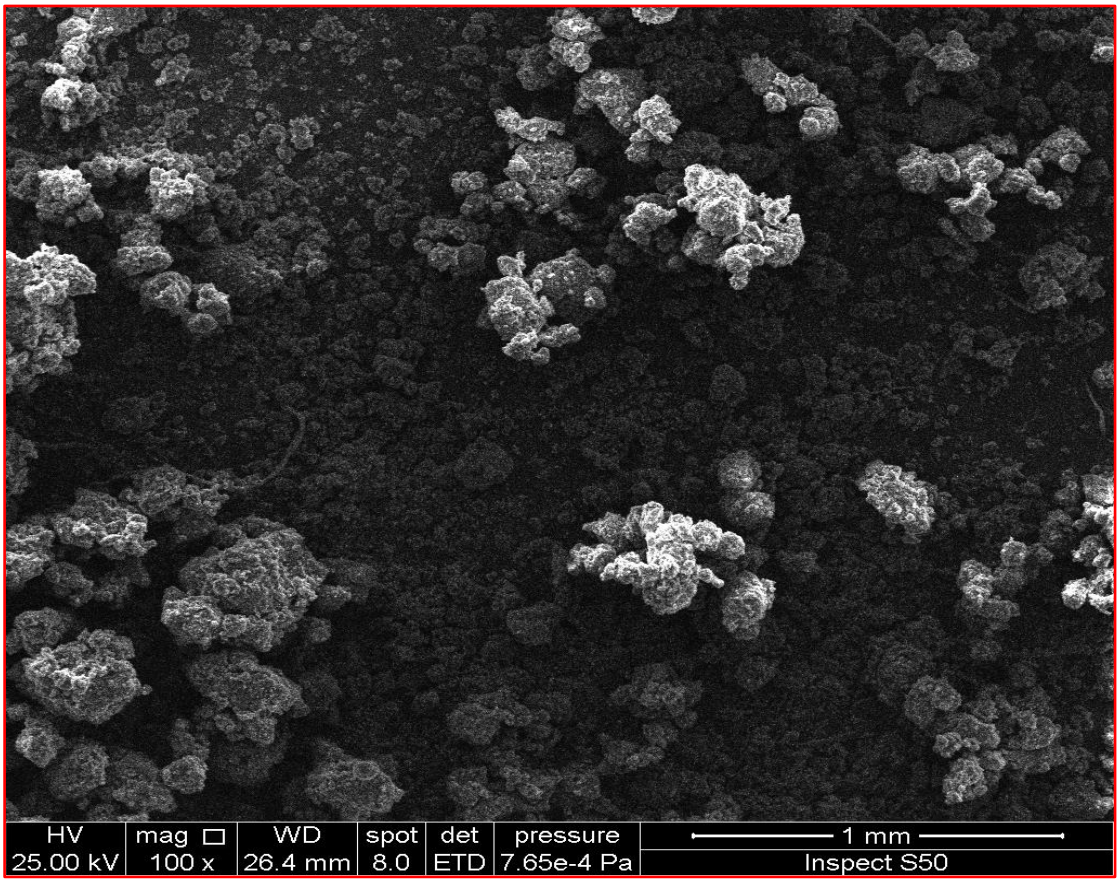


Fig. (3-101): SEM Micrograph of the MIP2 after removal (DFS)

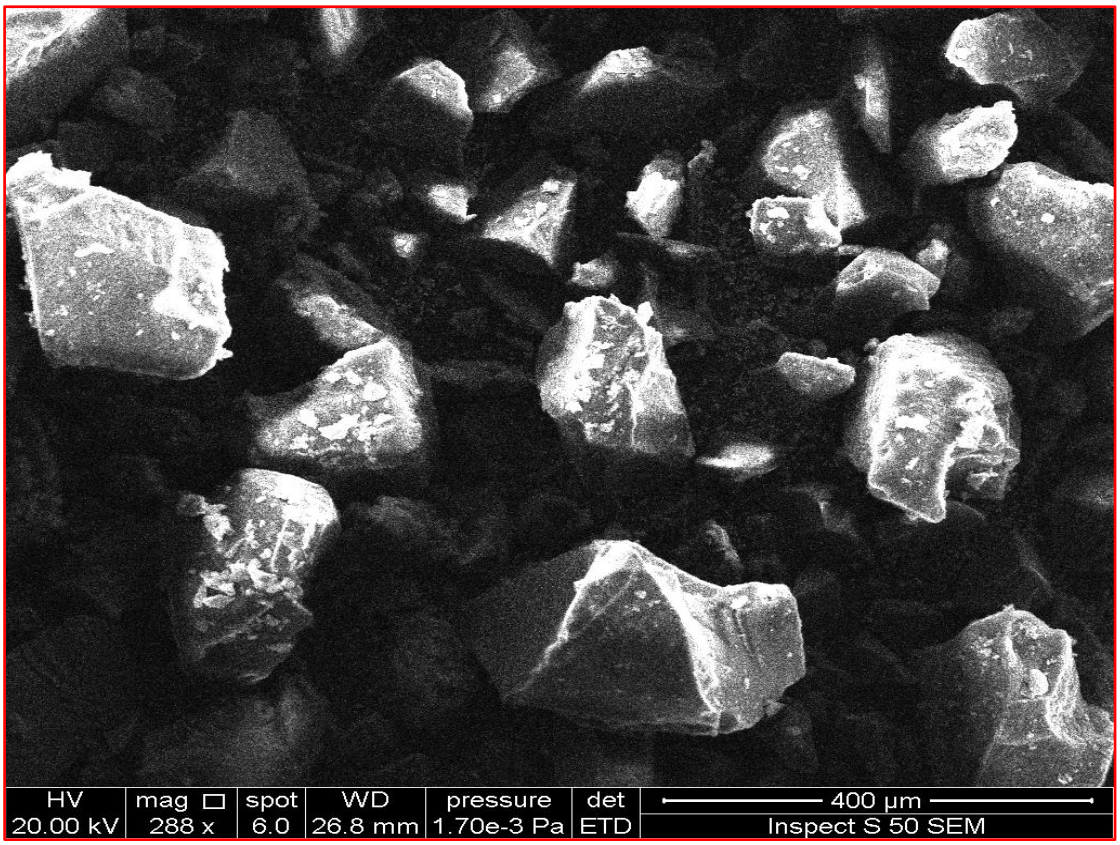


Fig. (3-102): SEM Micrograph of the MIP3 before removal (DFS)

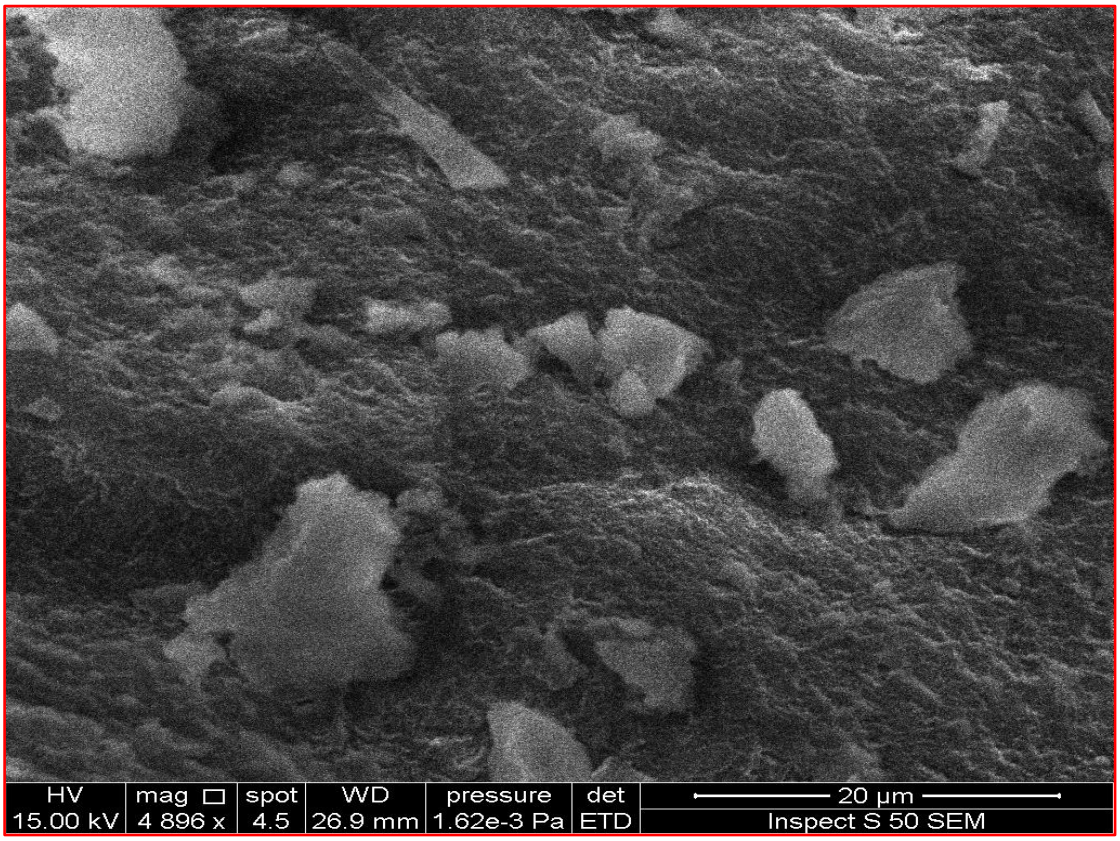


Fig. (3-103): SEM Micrograph of the MIP3 after removal (DFS)

3-11Sensor Characteristics of the ISEs for Diclofenec Sodium (DFS)

Construction of ISEs based on MIPs of DFS can be used in preparation of electrodes of DFS depended on 1-vinylimidazole (1-VA) ,Acrylamide (AA) and Styrene in the composition as efficient monomers. These monomers were incorporated with PVC in the building of electrodes as well as using different plasticizers such as tris(2-ethyl hexyl)phosphate (TEHP), Di butyl Phthalate (DBPH), Di Octyl Phthalate (DOPH) The responded electrodes were measured in the suitable working domain. Fundamentally, the electrodes with good characteristics were used for further more studies. It plotted figures of potential for these electrodes against the logarithm for the diclofenec sodium concentration (the target drug). Priority of using prepared electrodes had to be drenched in 1×10^{-1} M drug solutions from (3-4) hours before measurement.

Table (3-68) shows up Number of MIP, Mem and plasticizer use with every MIP

Drug	NO. MIP	Plasticizer	NO. Membrane
Diclofenec sodium	MIP 1	TEHP	Mem1(I)
	MIP 2	DBPH	Mem2(II)
	MIP3	DOPH	Mem3(III)

3-12 Diclofenec Sodium ISEs

3-12-1 (DFS-MIP1 +TEHP) membrane (I)

First electrode was based on MIP (1) that used monomer (1-VI) and used tris(2-ethylhexyl)phosphate (TEHP) as a plasticizer; The calibration curve measurement for this electrode was shown in the Figure (3-104)

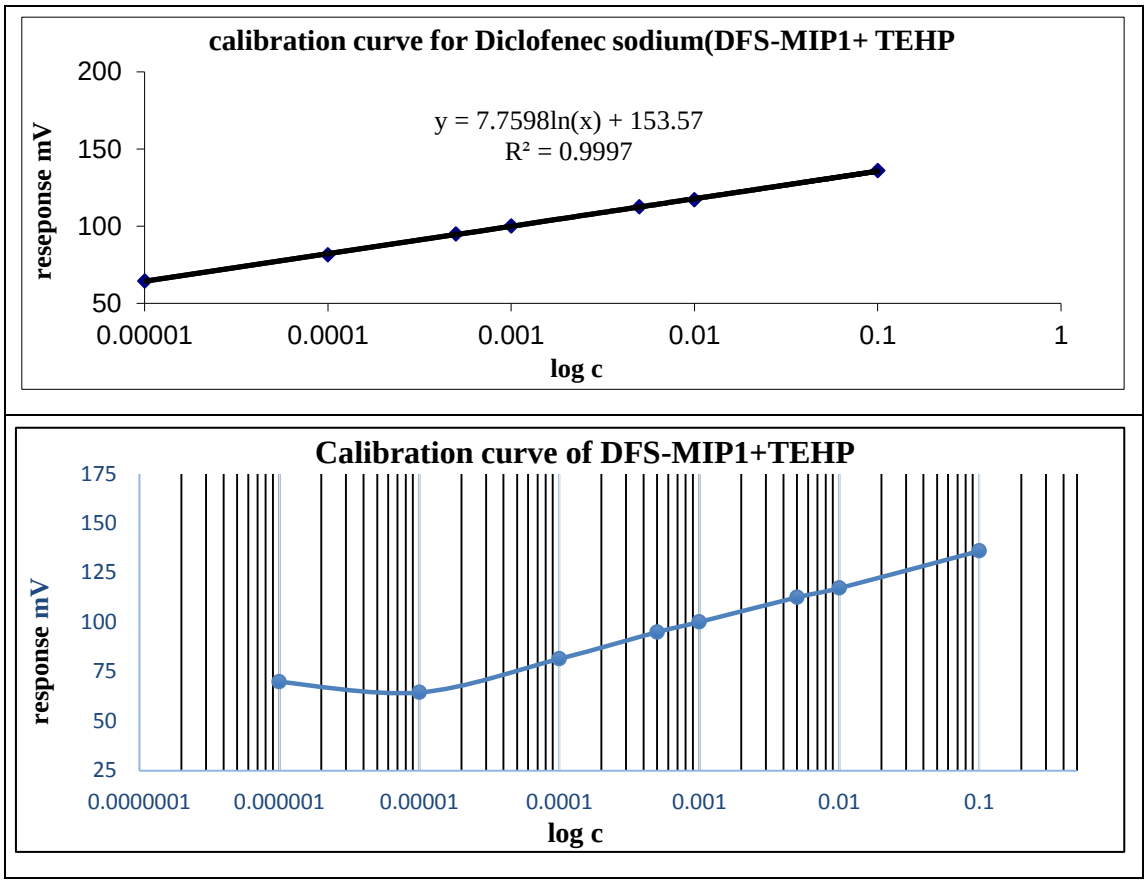


Fig. (3-104): Calibration curve of DFS– MIP1 selective electrode using (TEHP) as plasticizer.

The calibration was measured against different concentrationsof diclofenec sodium which gave a slope value of 17.87 mV/decade, linear range ($1\times10^{-1}$to 1×10^{-5}) M, detection limit 7×10^{-5} M and life time around 37 days and correlation coefficient was equal to 0.9997.This electrode showed that the long life time resulting from to the high plasticizer viscosity (~9.0217Cst) which make the electrode more stable and from the structure of compound and compositions affecting the electrode response. Moreover, the relative standard deviation value was calculated from multiple measurement calibration (n=3) giving a value (RSD=0.5 %) from average slope, all these parameters are represented in Table (3-69)

3-12-2 (DFS-MIP2 +DBPH) Membrane (II)

The second electrode was based on MIP2 used the Di butyl phthalate (DBPH) as plasticizer The calibration curve measured for of this electrode is shown in Figure (3-105).

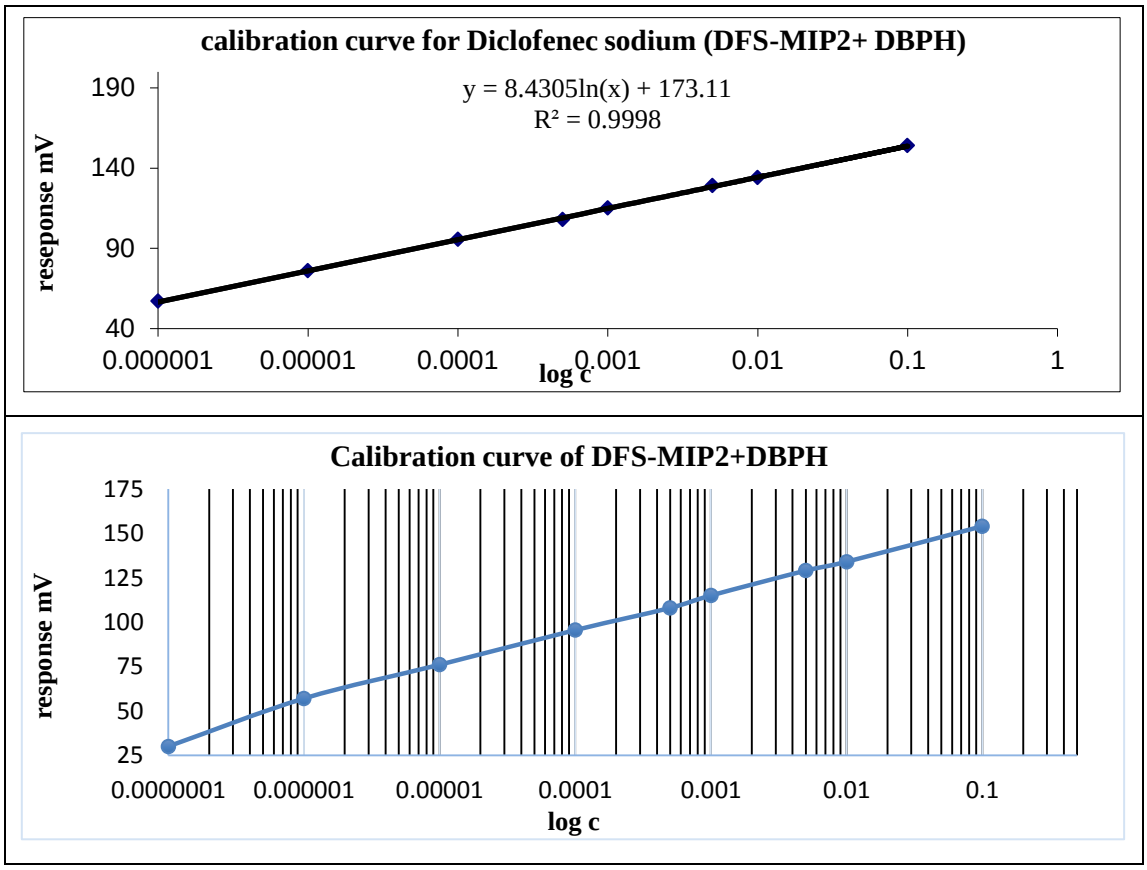


Fig. (3-105): Calibration curve of DFS– MIP2 selective electrode using (DBPH) as plasticizer

Different concentrations of diclofenec sodium were used to calculate the calibration curve and tofind the parameters such as slope value 19.415 mV/decade, linear range (1×10^{-1}-1×10^{-6}) M, detection limit (2.9×10^{-7} M) life time (around 38 days) This electrode has the long life time resulted from high plasticizer viscosity and gaves correlation coefficient value of 0.9998. The relative standard deviation was calculated from average slop of calibration electrode (n= 3) which gives a value (RSD = 0.6%) these parameters are represented in the Table (3-69).

3-12-3 (DFS-MIP3 +DOPH) Membrane (III)

The third construction of electrode based on MIP3 used monomer Styrene in the composition and Di Octyl phthalate(DOPH)as plasticizer The calibration curve measurement is represented in the Figure(3-106).

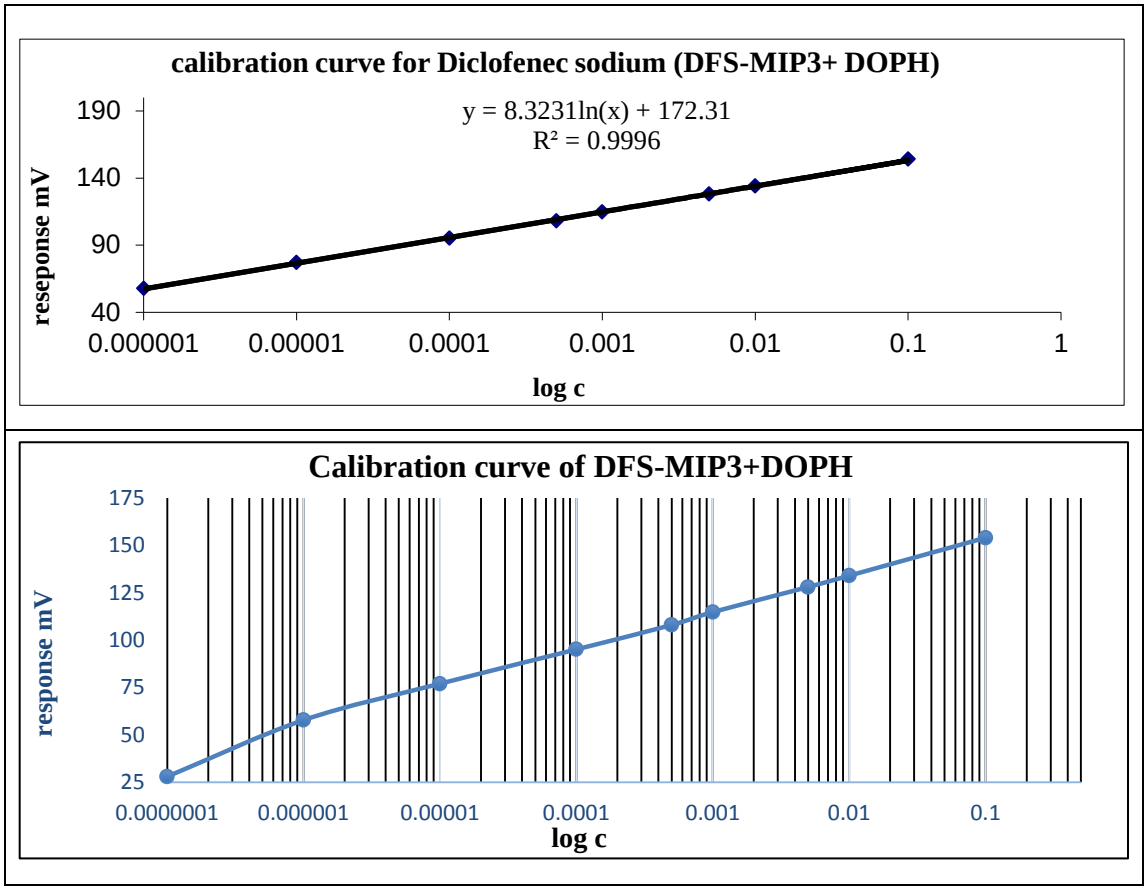


Fig. (3-106): Calibration curve of DFS– MIP3 selective electrode using (DOPH) as plasticizer

The calibration curve was measured from linear equation and the slope value is 19.168 mV/decade and the parameters were calculated including linear range (1×10^{-1}-1×10^{-6}) M, detection limit 4.5×10^{-7} M , life time around 37 days This electrode showed plasticizer viscosity resuited from the long time (and correlation coefficient value equals 0.9996. The measurement of average slope gave a value of relative standard deviation (RSD=0.47%) for numerous calibration to this membrane electrode (n =4).

Table (3-69): The parameters of DFS-MIP1 , DFS-MIP2 and DFS-MIP3of selective electrodes using different plasticizers.

Parameter			
Electrode No.	I	II	III
Membrane composition	DFS-MIP2 + TEHP	DFS-MIP2 + DBPH	DFS-MIP3 + DOPH
Slop (mV/decade)	17.87	19.415	19.168
R^2	0.9997	0.9998	0.9996
Linearity range (M)	1×10^{-1}-1×10^{-5}	1×10^{-1}-1×10^{-6}	1×10^{-1}-1×10^{-6}
Detection limit (M)	7×10^{-6}	2.9×10^{-7}	4.5×10^{-7}
Life time (day)	37	38	37

3-13 Effect of pH

The effect of pH on the electrode potentials for (DFS) selective membrane electrodes by measuring the e.m.f. of the cell in (DFS) solutions at two different concentrations (1×10^{-4} and 1×10^{-3}) M in which the pH ranged from (1.0-11.0).was studied The pH adjusted by adding appropriate amounts of hydrochloric acid and/or Sodium hydroxide solution as shown in Figures (3-107) , (3-108) ,(109) and Table (3-70). At pH values less than 1or in very high acidity, the electrode response increased rather irregularly. This might be due to that the electrode response to H^+ activities as well as diclofenec sodium ions and in an alkaline solution (pH greater than 8) the electrode response has been decreased due to the decrease in the solubility of diclofenec sodium**.**

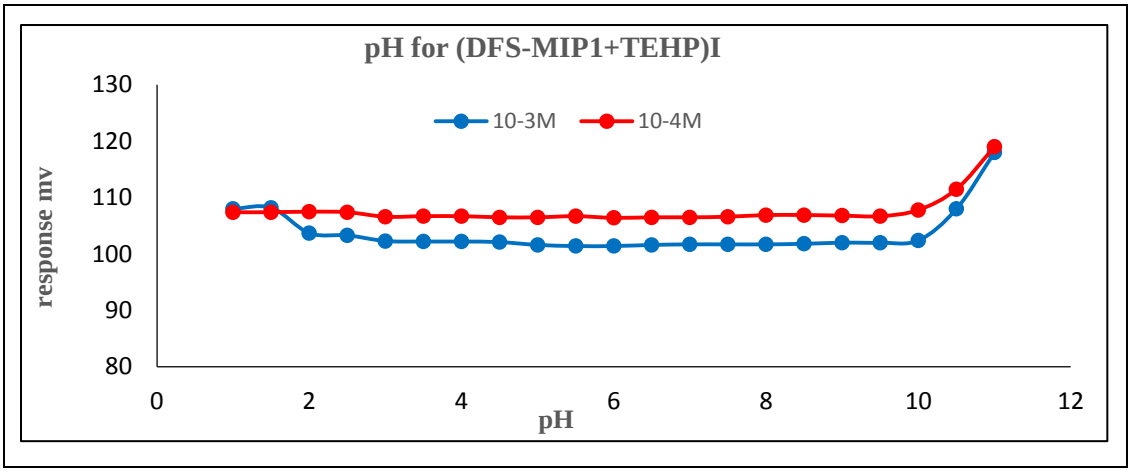


Fig.(3-107) Effect of pH on the Diclofenec sodium { DFS-MIP1 + TEHP} (I) electrode at concentration 1×10^{-3} and 1×10^{-4}

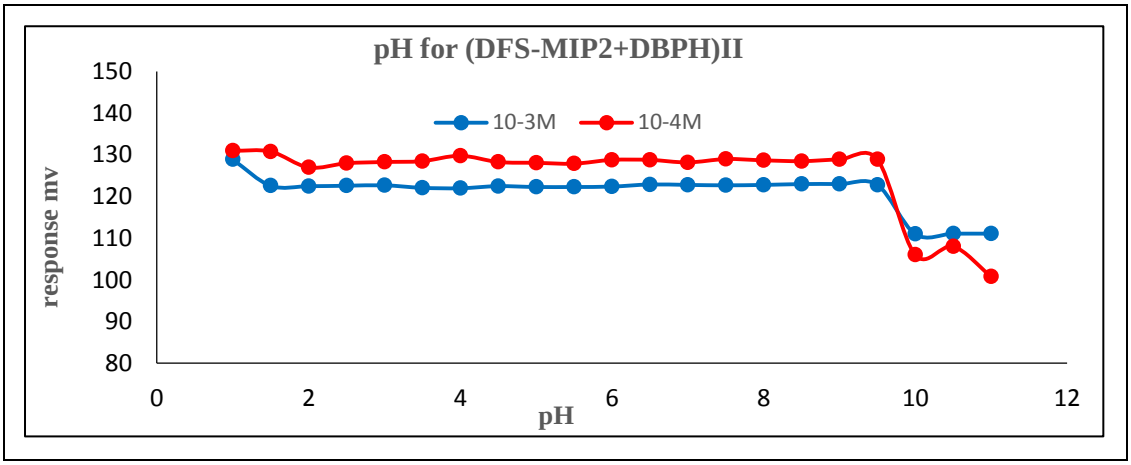


Fig.(3-108) Effect of pH on the Diclofenec sodium { DFS-MIP2 + DBPH }(II) electrode at concentration 1×10^{-3} and 1×10^{-4}

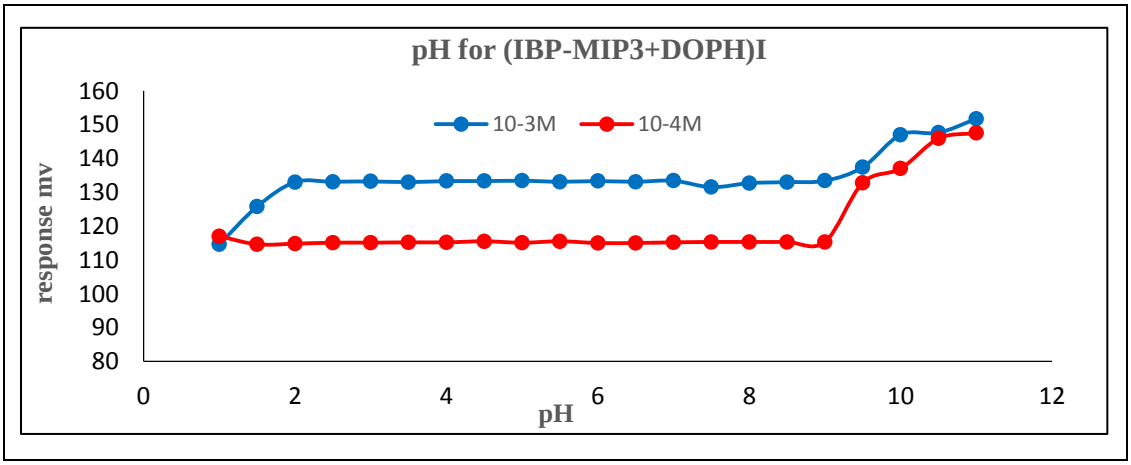


Fig.(3-109) Effect of pH on the Diclofenec sodium { DFS-MIP3+ DOPH} (III) electrode at concentration 1×10^{-3} and 1×10^{-4}

Table (3-70): Working pH ranges for Diclofenec sodium selective electrodes

Drug	No. Mem	Membrane composition	pH Range	
			1×10^{-4}	1×10^{-3}
Diclofenec sodium	I	DFS-MIP1 + TEHP	1-9.5	3-10
	II	DFS-MIP2 +DBPH	1-9.5	2-9.5
	III	DFS-MIP3 +DOPH	2-9	1-9

3-14 Response Time

Response time is the time required for the electrode membrane to reach achievement constant potential during values ranging ±1 mV of the final equilibrium value). In the response measurement it has been noticed that the response time value for higher concentrations was less than that of low concentration because of the access to the equilibrium state in high concentration was shorter than the low solutions this proves that the response time was dependent upon concentration of diclofenec sodium. The average response time (t 95%=) of the diclofenec sodium membranes are listed in Table (3-71).

Table (3-71): The response time of diclofenec sodium membranes

Membrane composition	Concentration (M)	Potential (mV) at t/100	Time (s) at 95%	Time (s) at 100%
DFS-MIP1+TEHP (I)	1×10^{-1}	17	2.74	15
	1×10^{-2}	19	3.04	50
	5×10^{-3}	22	6.75	50.5
	1×10^{-3}	23	7.41	51
	5×10^{-4}	25	8.1	52.3
	1×10^{-4}	27	12.7	54
	1×10^{-5}	28.6	13.3	58

DFS-MIP2+DBPH (II)	1×10^{-1}	17	33.2	35
	1×10^{-2}	19	35	38.4
	5×10^{-3}	22	37	42
	1×10^{-3}	23	38.9	43.1
	5×10^{-4}	25	40.8	45.7
	1×10^{-4}	27	44.6	50.4
	1×10^{-5}	28.6	45.6	52.6
	1×10^{-6}	28.5	46.55	54.7
DFS-MIP3+DOPH (III)	1×10^{-1}	15	16.15	32.3
	1×10^{-2}	17	20	36
	5×10^{-3}	21	21	38
	1×10^{-3}	23	22	39
	5×10^{-4}	26	23	42
	1×10^{-4}	27	25	43
	1×10^{-5}	28	26.6	46.3
	1×10^{-6}	29	28.5	51.6

3- 15Electrode Selectivity for Diclofenec Sodium Selective

The selectivity is considered one of the important characteristics that specifies the ion-selective electrode to verify the possibility of dependable measurement in target sample. There are different methods for measure Ming the selectivity and one of these methods the separate

solution method (SSM). The measurement by the SSM dependeds on Nickolsky-eisenman equation which is recommended by IUPAC to calculate

the selectivity coefficient for ion selective electrodes ,though it have some limitations regarding the values for ions of unequal charges with anon-nernstain behavior of interfering ions.

3-15-

1 Selectivity Measurement by Separation Solution Method (SSM)

Potentiometric selectivity coefficients have been achieved by Separation Solution Method with using Ibuprofen concentrations sex ranging (10^{-5}-10^{-1})M and (K^{+}, Ca^{+2},$Al^{+3,}$methylparapen,Propylparapen,Trisodium citrate), the potentiometric measurement of selectivity coefficients have been calculated by equation below:

$$\mathbf{Log\ K^{pot}_{A,B} = [(E_B - E_A)/(2.303RT/Z_A F)] + (1 - Z_A/Z_B) \log a_A} \quad \ldots \textbf{(3-1)}$$

EA, EB; zA, zB; and aA, represents the potentials, charge numbers, and activities for the primary A and interfering B ions, respectively at aA = aB (Zurawska, Lewenstam,2011, 295-301). The obtained results for selectivity coefficients and interfering ions were listed in Table (3-72) until (3-74), as well the selectivity versus the studied species are represented in Fig. (3-110) to Fig. (3-112).

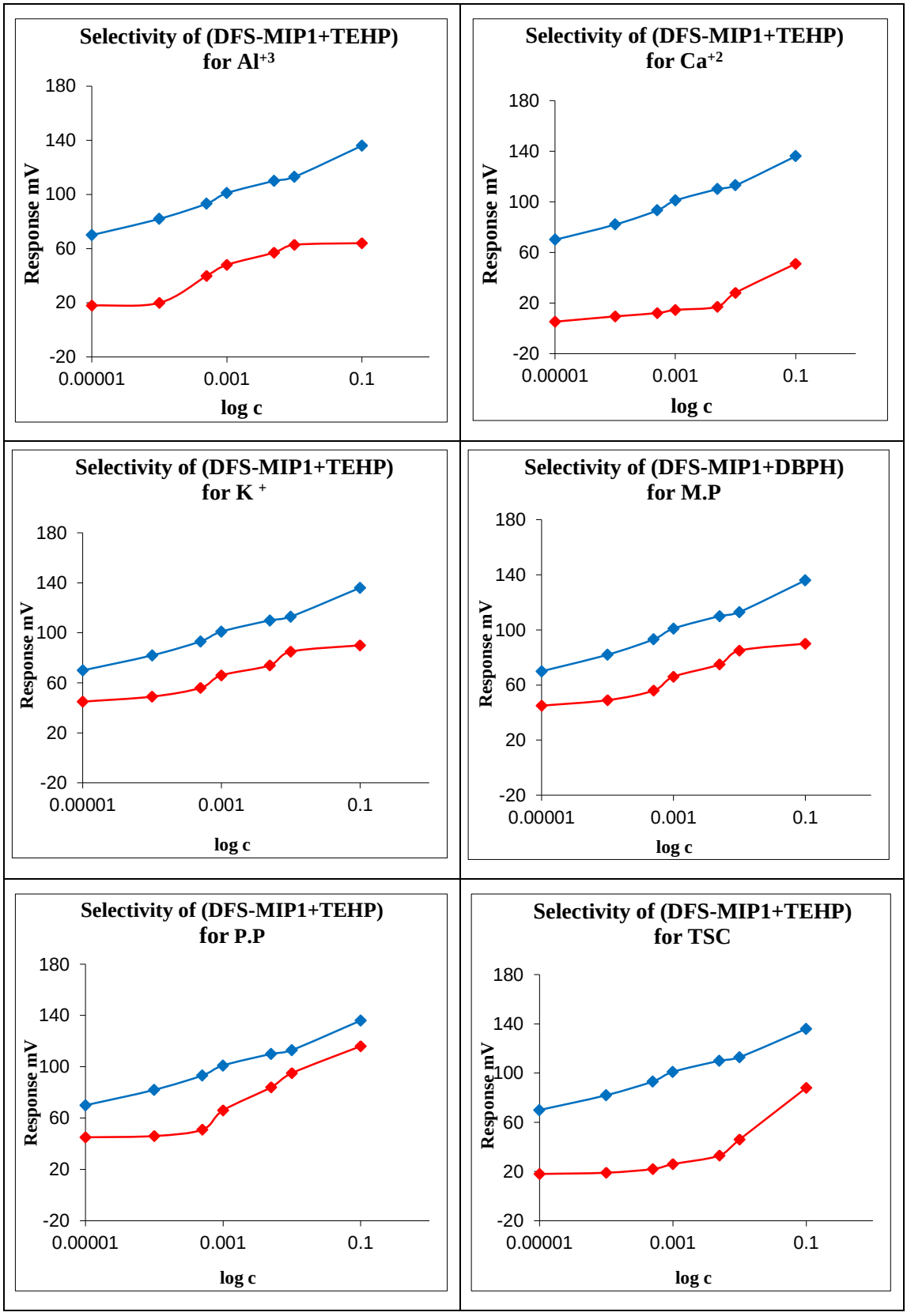


Fig. (3-110): Selectivity of (DFS – MIP1 + TEHP) and the interfering cations by separation method, ♦ Diclofenec sodium ▲ Solution of interfering cations.

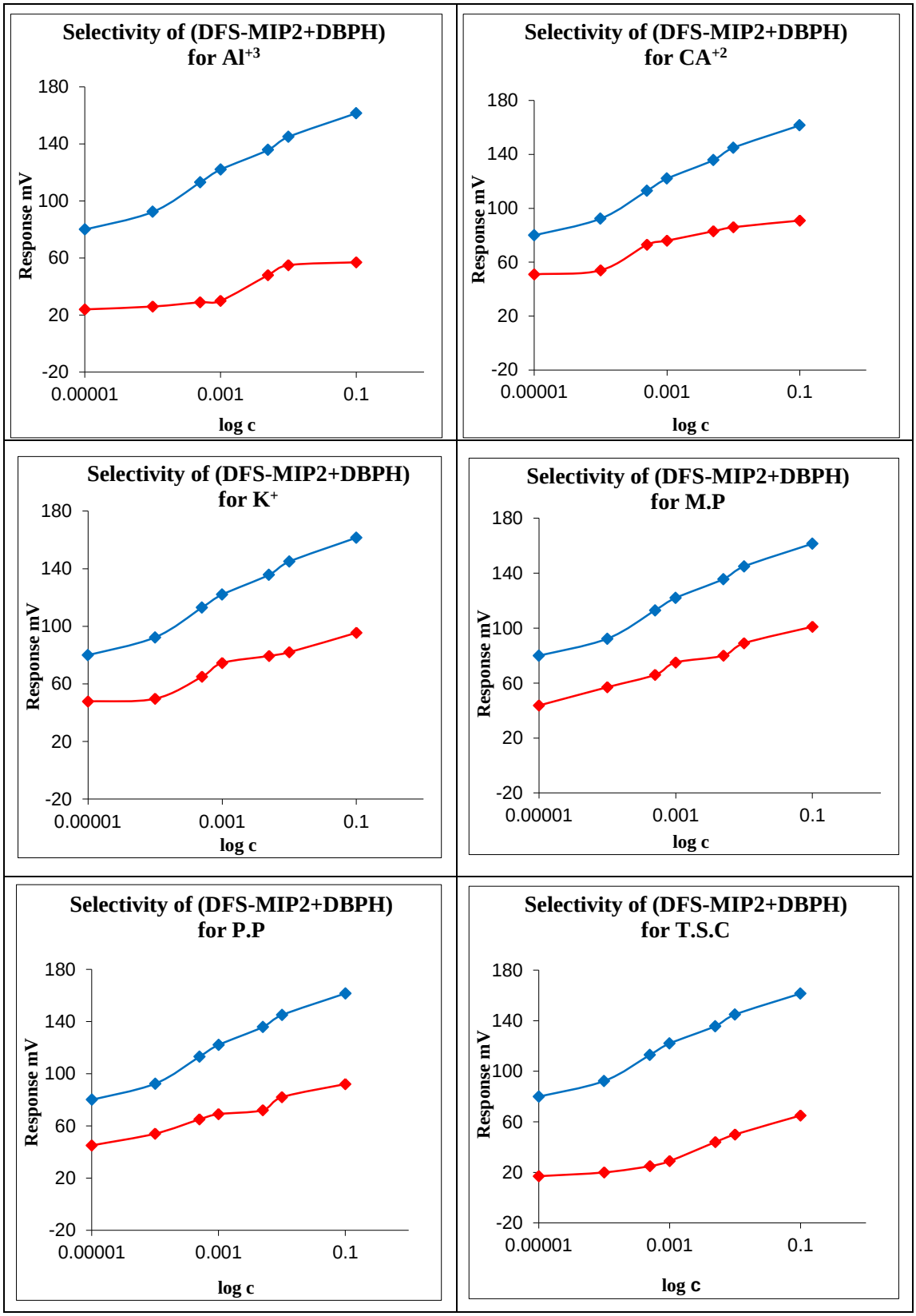


Fig. (3-111): Selectivity of (DFS – MIP2 + DBPH) and the interfering cations by separation method, ♦ Diclofenec sodium ▲ Solution of interfering cations.

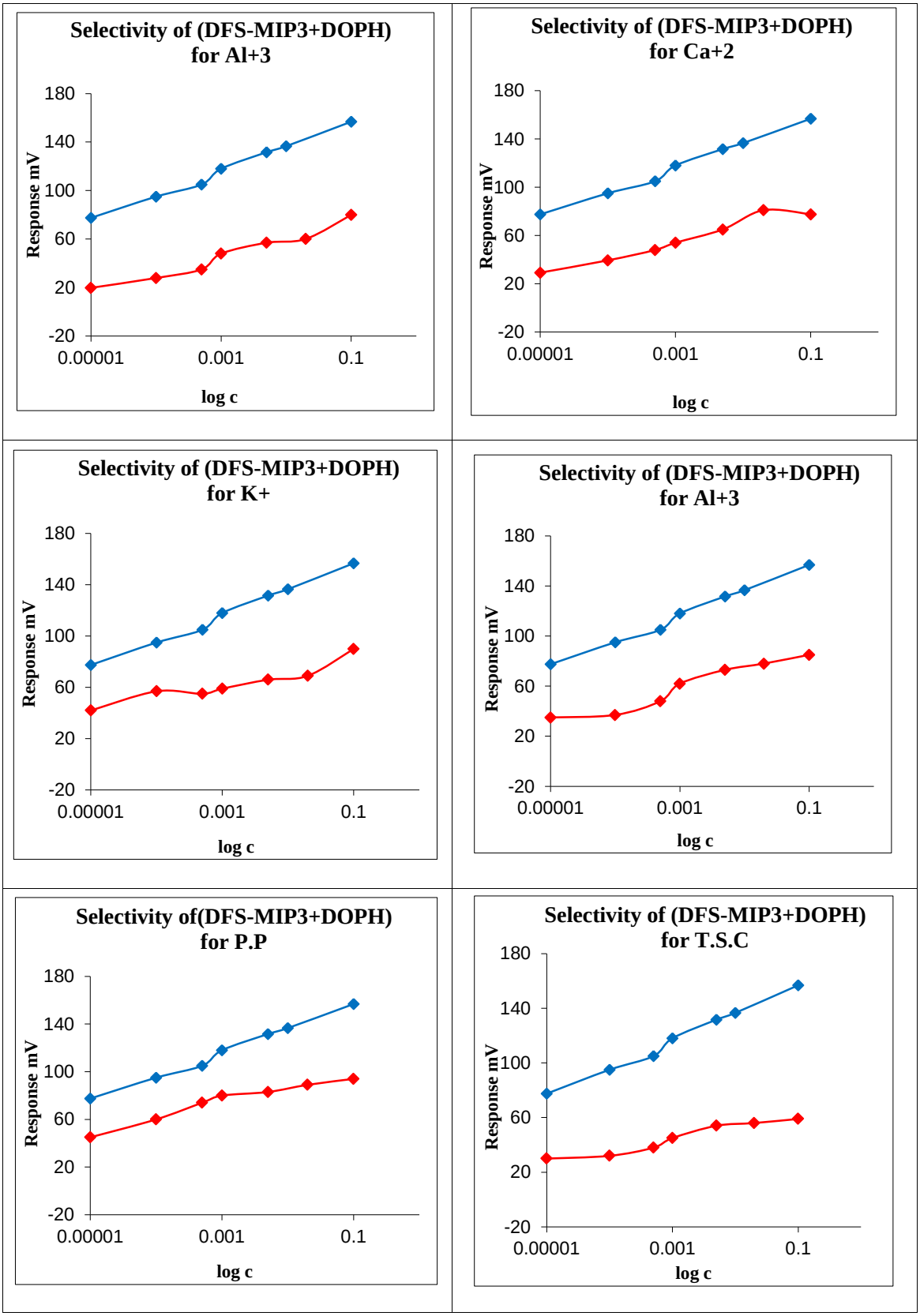


Fig. (3-112): Selectivity of (DFS – MIP3 + DOPH) and the interfering cations by separation method, ♦ Diclofenec sodium ▲ Solution of interfering cations.

Table (3-72): Selectivity coefficients for (DFS –MIP1 +TEHP) electrode at different concentrations of Diclofenec sodium

Concentrations of Diclofenec sodium (M): Concentrations of interference ions (M)												
Con of DFS	Interfering ions											
	K^+		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}	90	1.9×10^{-2}	51	2×10^{-4}	64	4.2×10^{-4}	65	3.4×10^{-3}	90	1.9×10^{-2}	116	1.8×10^{-1}
1×10^{-2}	85	1.1×10^{-1}	28	1.3×10^{-4}	63	8.9×10^{-4}	50	2.4×10^{-4}	85	1.1×10^{-1}	95	2.4×10^{-1}
5×10^{-3}	74	5.9×10^{-2}	17	4.7×10^{-5}	57	4.5×10^{-4}	44	6.8×10^{-5}	75	6.4×10^{-2}	84	1.3×10^{-1}
1×10^{-3}	66	6.4×10^{-2}	15	3.8×10^{-5}	48	1.5×10^{-4}	29	2.7×10^{-5}	66	6.4×10^{-2}	66	6.4×10^{-2}
5×10^{-4}	56	5.4×10^{-2}	12	3.8×10^{-5}	40	9.4×10^{-5}	25	2.3×10^{-5}	56	5.4×10^{-2}	51	3.6×10^{-2}
1×10^{-4}	49	7.5×10^{-2}	9.4	3.3×10^{-5}	20	1.6×10^{-5}	20	1.5×10^{-5}	49	7.5×10^{-2}	46	5.9×10^{-2}
1×10^{-5}	45	1.4×10^{-2}	5.2	1.9×10^{-5}	18	7.7×10^{-6}	17	7.8×10^{-6}	45	1.4×10^{-1}	45	1.4×10^{-1}

Table (3-73): Selectivity coefficients for (DFS –MIP2 +DBPH) electrode at different concentrations of Diclofenec sodium

Concentrations of Diclofenec sodium (M): Concentrations of interference ions (M)												
Con of DFS	Interfering ions											
	K^+		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}	95.5	3.3×10^{-3}	91	7×10^{-4}	57	2.5×10^{-5}	65	5.1×10^{-5}	101	5.3×10^{-3}	92	1.7×10^{-5}
1×10^{-2}	82	7×10^{-3}	86	9.7×10^{-4}	55	3.9×10^{-5}	50	2.7×10^{-5}	89	1.2×10^{-2}	82	1.1×10^{-5}
5×10^{-3}	79.4	1.2×10^{-2}	83	1.1×10^{-3}	48	2.9×10^{-5}	44	2.2×10^{-5}	80	1.2×10^{-2}	72	1.1×10^{-4}
1×10^{-3}	74.5	2.4×10^{-2}	76	8.5×10^{-4}	30	7.2×10^{-6}	29	6.6×10^{-6}	75	2.4×10^{-2}	69	$1.\times10^{-4}$
5×10^{-4}	65	2.3×10^{-2}	73	9.6×10^{-4}	29	8.6×10^{-6}	25	6.2×10^{-6}	66	2.5×10^{-2}	65	1.1×10^{-4}
1×10^{-4}	49.7	3.5×10^{-2}	54	4.9×10^{-4}	26	1.2×10^{-5}	20	7.3×10^{-6}	57	6.2×10^{-2}	54	3.6×10^{-4}
1×10^{-5}	47.8	7.9×10^{-2}	51	3.2×10^{-4}	24	5.7×10^{-6}	17	3.3×10^{-6}	44	5.7×10^{-2}	45	7.4×10^{-4}

Table (3-74): Selectivity coefficients for (DFS –MIP3 +DOPH) electrode at different concentrations of Diclofenec sodium

Concentrations of Diclofenec sodium (M): Concentrations of interference ions (M)												
Con of DFS	Interfering ions											
	K^+		Ca^{+2}		Al^{+3}		T . S . C		M . P		P . P	
	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$	E_B mv	$K_{A,B}$
1×10^{-1}	90	3×10^{-3}	77.5	3×10^{-4}	157	2.9×10^{-4}	59	4.5×10^{-5}	85	2×10^{-3}	94	4×10^{-3}
1×10^{-2}	69	5×10^{-3}	81	1.3×10^{-3}	137	1.2×10^{-4}	56	8.1×10^{-5}	78	1×10^{-2}	89	2.4×10^{-2}
5×10^{-3}	66	6×10^{-3}	65	3.8×10^{-4}	132	8.3×10^{-5}	54	6.5×10^{-5}	73	1×10^{-2}	83	2.2×10^{-2}
1×10^{-3}	58	9×10^{-3}	54	2.1×10^{-4}	118	4.0×10^{-5}	45	3.2×10^{-5}	62	1.2×10^{-2}	80	5×10^{-2}
5×10^{-4}	55	2×10^{-2}	48	3×10^{-4}	105	2.5×10^{-5}	38	3.2×10^{-5}	48	1.1×10^{-2}	74	8.7×10^{-2}
1×10^{-4}	57	5×10^{-2}	39.4	1.3×10^{-4}	95	1.1×10^{-5}	32	1.5×10^{-5}	37	1×10^{-2}	60	6.4×10^{-2}
1×10^{-5}	42	6×10^{-2}	29.2	7.08×10^{-5}	78	5×10^{-6}	30	1.1×10^{-5}	35	3.5×10^{-2}	45	7.8×10^{-2}

The data given in tables (3-72) to (3-74) revealed that the selectivity coefficient obtained by the proposed electrodes for all cations tested was in order of (3-69), which indicated good selectivity for Diclofenec sodium against common transition metal ions. Preferably selectivity coefficient of less than one because if the largest lead the electrode starts to response to the interfering ion instead of the analyte. From the results show that the selectivity coefficients for monovalent interfering ions is in the order mono> di> trivalent. This might be attributed to the difference in ionic size, mobility and permeability. When the concentration of monovalent ion decreases, the difference in potential measurement decreases. Therefore, the selectivity coefficient increased and the interference of monovalent ion was also increased. The values of log $K^{pot.}$ were found to range from ($1.1\times10^{-1} - 3\times10^{-3}$) for monovalent , ($1.1\times10^{-3} - 1.9\times10^{-5}$) for divalent and ($1.2\times10^{-4} - 5.7x10^{-6}$) for trivalent interferes ions. The results in the above tables also showed that the selectivity was influenced also by the plasticizer used. Meanwhile the compound tri sodium citrate , Methylparaben and Propylparaben were found to range from(3.4×10^{-3} - 3.3×10^{-6}) ,($1\times10^{-2} - 5.3\times10^{-3}$) and ($1\times10^{-4} - 1.3\times10^{-1}$) respectively The results in the above tables showed also that the selectivity also influenced by the plasticizer used.

3-15-2 Selectivity Measurement by Match Potential Method (MPM)

The matched potential method (MPM) for the determination of the potentiometric selectivity coefficients ($K^{pot}_{A,B}$) of ion-selective electrodes for two ions with any charge. This MPM theory is based on electrical diffuse layers on both the membrane and the aqueous side of the interface, and is therefore independent of the Nicolsky-Eisenman equation. The MPM-selectivity coefficients of ions with equal charge (ZA = ZB) are expressed as the ratio of the concentrations of the primary and interfering ions in aqueous solutions at which the same amounts of the primary and interfering ions perm selectively extracted into the membrane surface. For ions with unequal charge (ZA not equal to ZB), the selectivity coefficients are expressed as a function not only of the amounts of the primary and interfering ions permeated into the membrane surface, but also of the primary ion concentration in the initial reference solution and the change in E.M.F value. In this method the selectivity coefficient is given by using equation (4). The results of selectivity coefficient are shown in Fig. (3-113) to (3-118) and in the Table (3-75) and (3-77) were calculated from The concentration of the interfering ion which endued the same amount of the potential change as that induced by the increase of the concentration of primary ion.

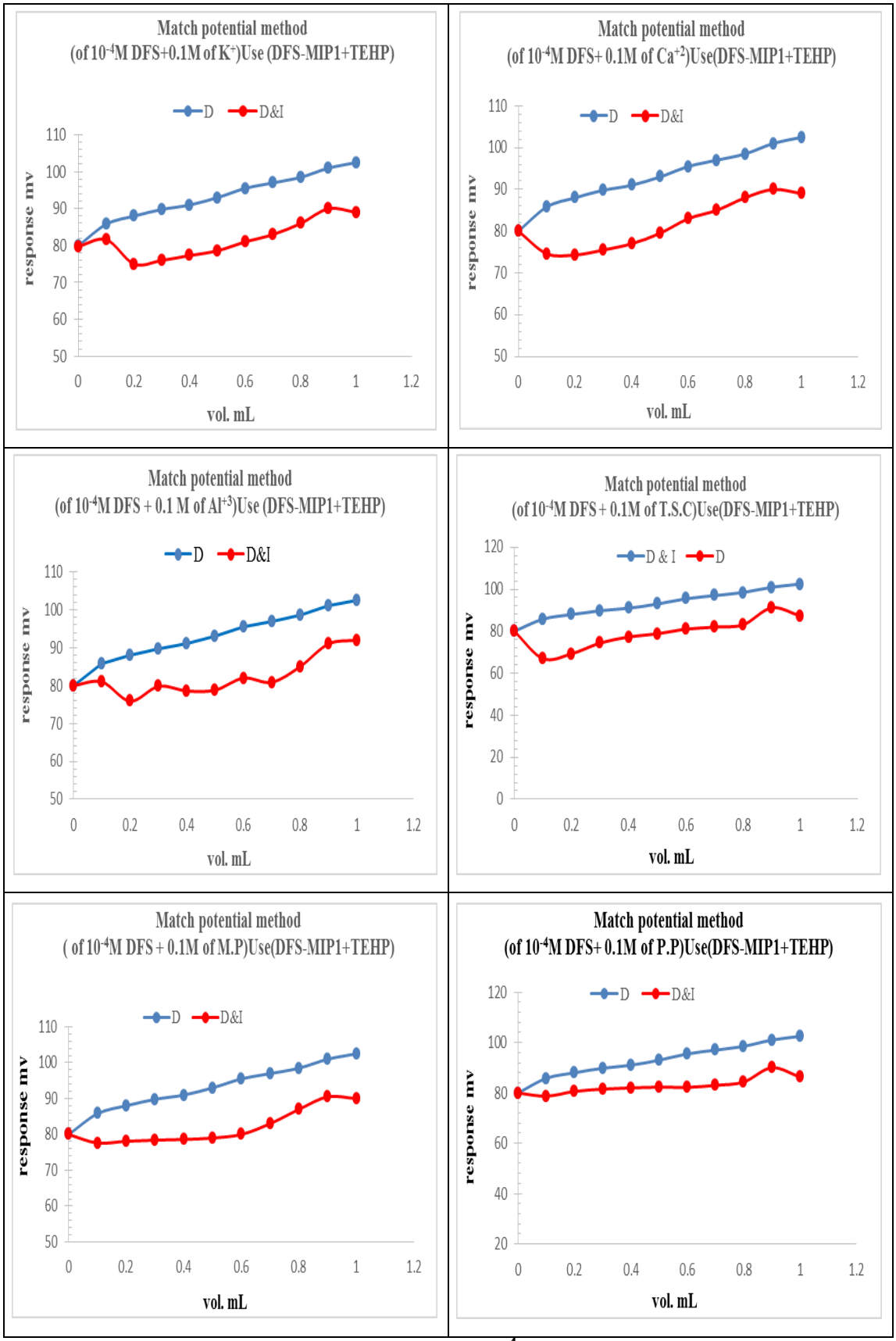


Fig. (3-113): Selectivity of electrode for (10^{-4}) M based on TEHP for cations .interfering by Match potential method solution♦ of cations interfering ♦ DFS Solution

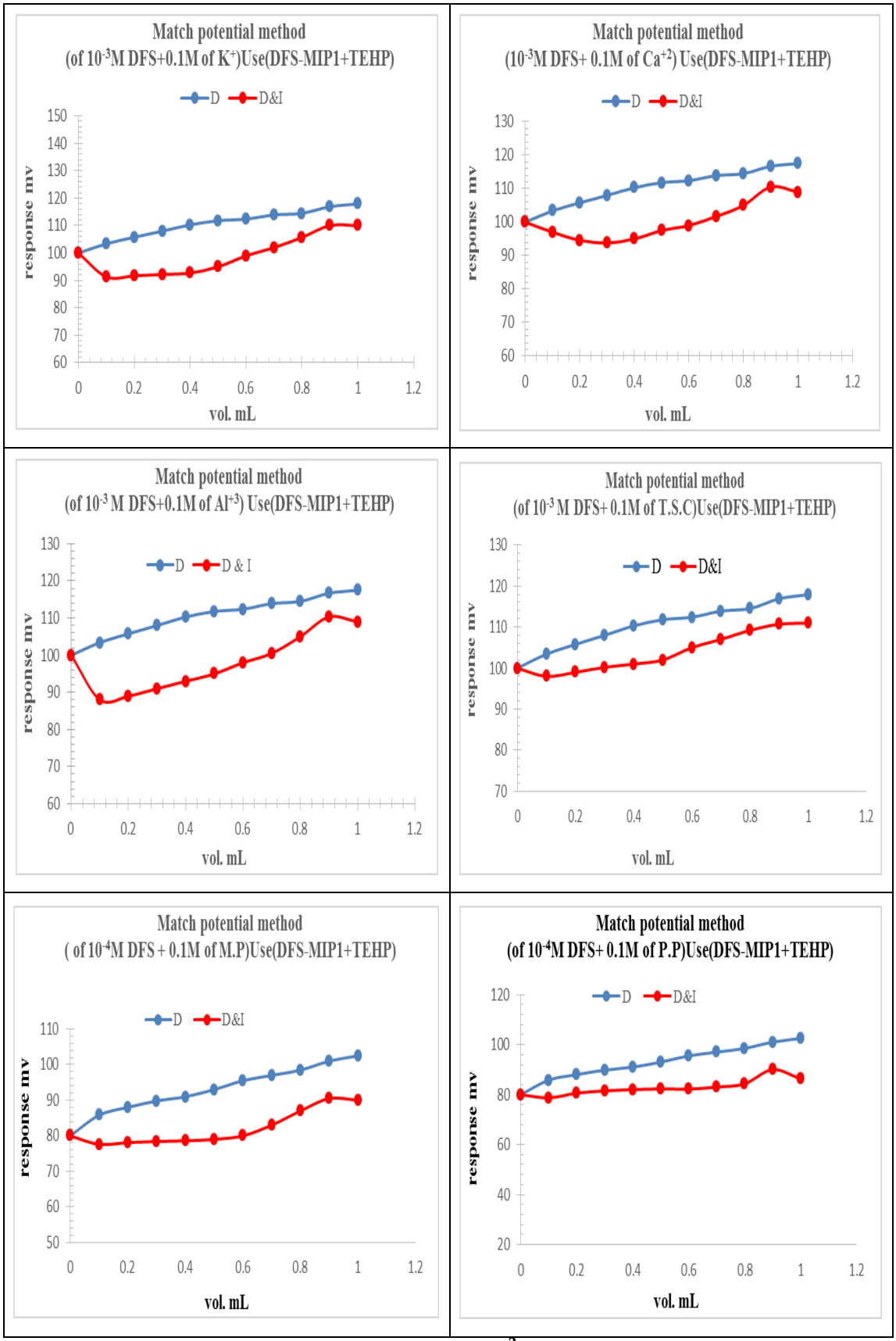


Fig. (3-114): Selectivity of electrode for (10^{-3}) M based on TEHP for cations .interfering by Match potential method solution♦ of cations interfering ♦ DFS Solution

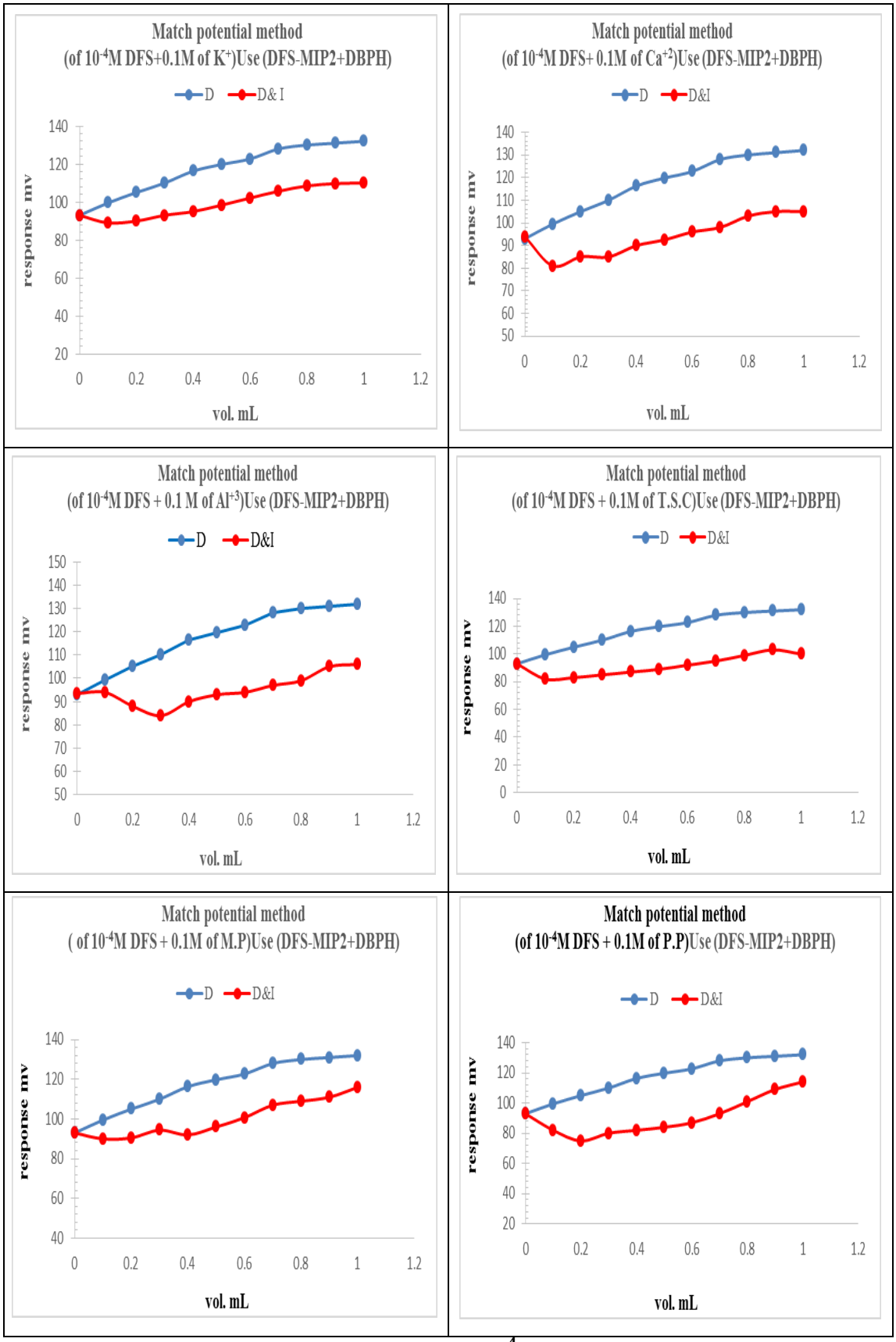


Fig. (3-115): Selectivity of electrode for (10^{-4}) M based on DBPH for cations .interfering by Match potential method solution♦ of cations interfering ♦ DFS Solution

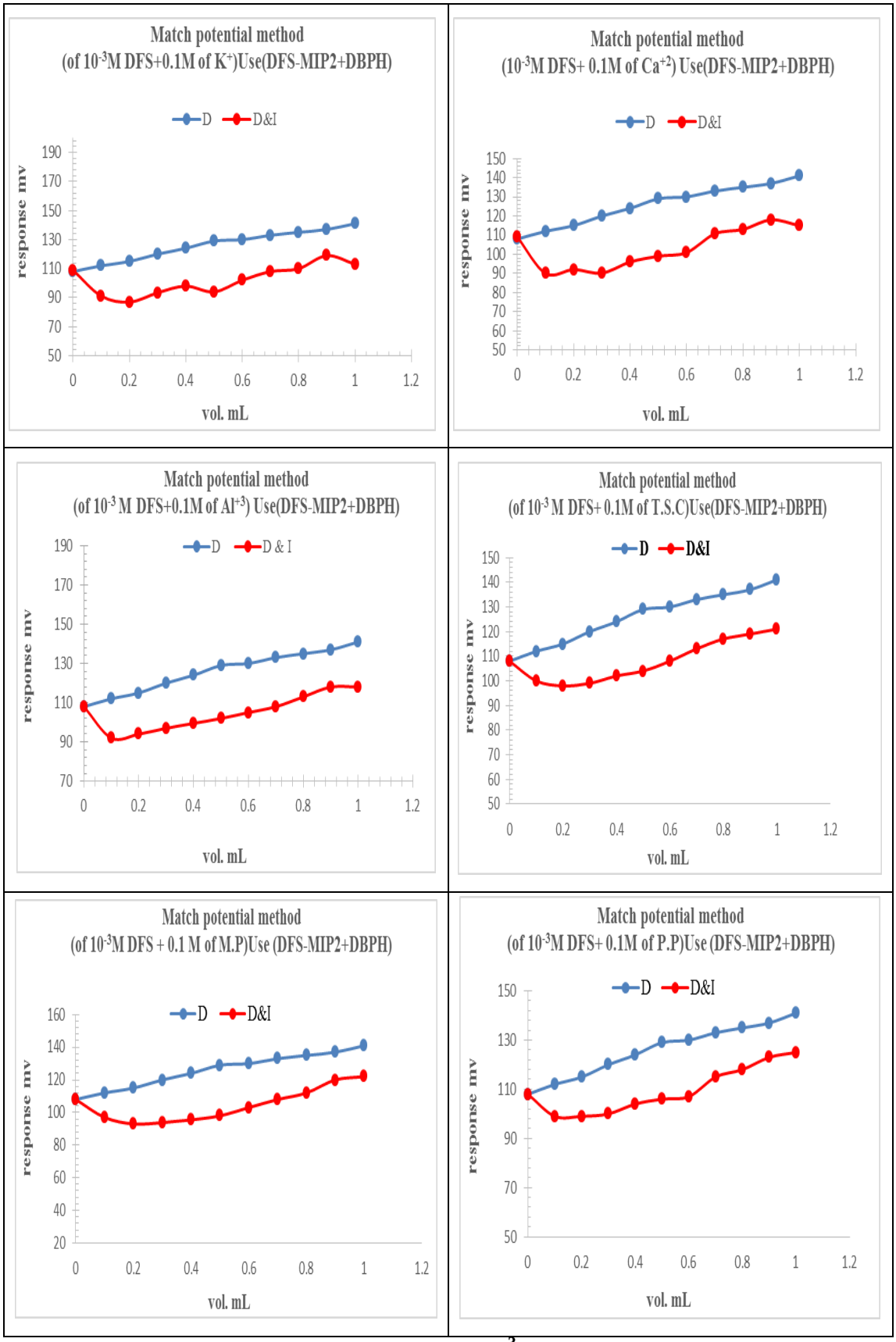


Fig. (3-116): Selectivity of electrode for (10^{-3}) M based on DBPH for cations .interfering by Match potential method solution♦ of cations interfering ♦ DFS Solution

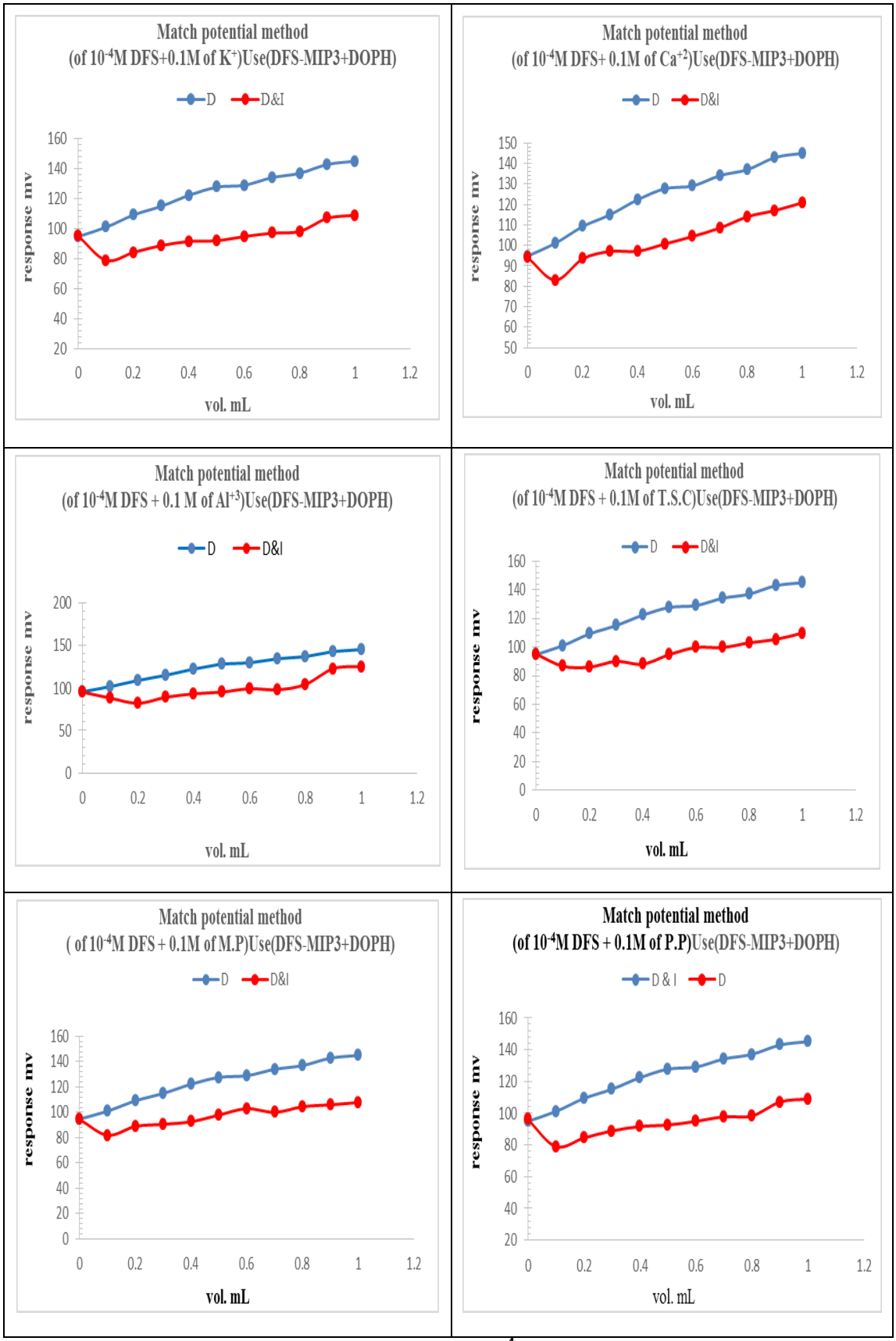


Fig. (3-117): Selectivity of electrode for (10^{-4}) M based on DOPH for cations .interfering by Match potential method solution♦ of cations interfering ♦ DFS Solution

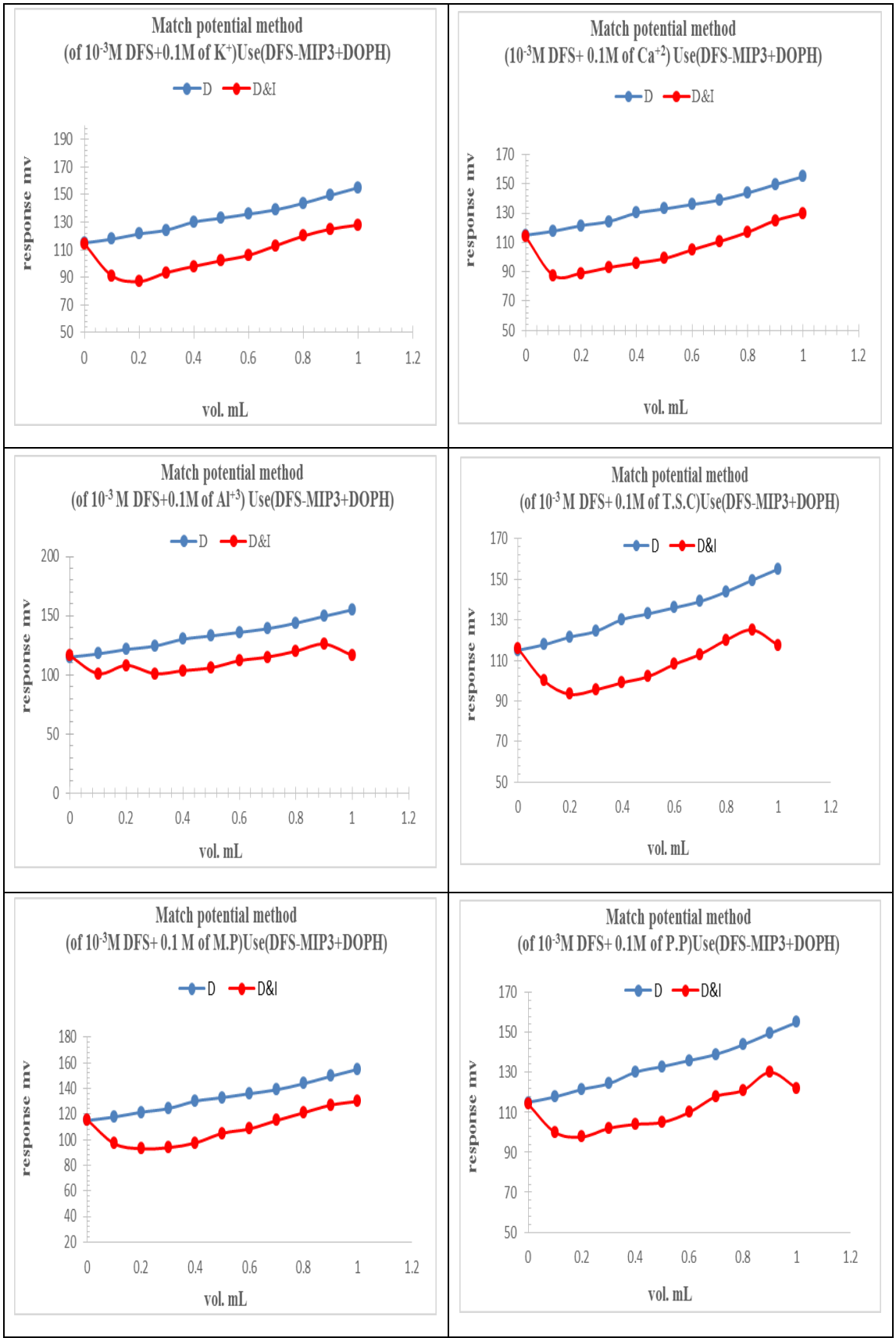


Fig. (3-118): Selectivity of electrode for (10^{-3}) M based on DOPH for cations .interfering by Match potential method solution♦ of cations interfering ♦ DFS Solution

Table (3-75): Selectivity coefficients for the Diclofenec sodium electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
DFS-MIP1+TEHP (Mem I)	K^{+}	0.59	0.2
	Ca^{+2}	0.6	0.19
	Al^{+3}	0.58	0.23
	T . S . C	0.47	0.22
	M . P.	0.56	0.21
	P . P.	0.57	0.19
	1×10^{-3}		
	K^{+}	0.15	7.9×10^{-5}
	Ca^{+2}	0.17	4.6×10^{-4}
	Al^{+3}	0.13	1.63×10^{-4}
	T . S . C	0.35	7.5×10^{-4}
	M . P.	0.15	2.1×10^{-3}
	P . P.	0.22	7.4×10^{-5}

Table (3-76): Selectivity coefficients for the Diclofenec sodium electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
DFS-MIP2+DBPH (Mem II)	K^{+}	0.799	0.58
	Ca^{+2}	0.75	0.46
	Al^{+3}	0.73	0.46
	T . S . C	0.71	0.41
	M . P.	0.79	0.54
	P . P.	0.45	0.55
	1×10^{-3}		
	K^{+}	5.6×10^{-5}	2.2×10^{-5}
	Ca^{+2}	0.1	3.7×10^{-3}
	Al^{+3}	0.28	4.6×10^{-3}
	T . S . C	0.35	1.5×10^{-2}
	M . P.	0.27	1.7×10^{-2}
	P . P.	0.35	5×10^{-2}

Table (3-77): Selectivity coefficients for the Diclofenec sodium electrodes Using($10^{-4}$and 10^{-3}) M of Interfering-Ion determined by match potential method(MPM)

Membrane Composition	Interfering ion 1×10^{-4}	K pot	
		ΔE=5	ΔE=10
DFS-MIP3+DOPH (Mem III)	K^+	7.2×10^{-1}	5.1×10^{-1}
	Ca^{+2}	7.9×10^{-1}	6.4×10^{-1}
	Al^{+3}	8.7×10^{-1}	7.3×10^{-1}
	T . S . C	7.6×10^{-1}	5×10^{-1}
	M . P.	7.39×10^{-1}	5×10^{-1}
	P . P.	6×10^{-1}	5.2×10^{-1}
	1×10^{-3}		
	K^+	1.3×10^{-1}	1.62×10^{-3}
	Ca^{+2}	1.5×10^{-1}	1.72×10^{-3}
	Al^{+3}	2.2×10^{-1}	5.62×10^{-3}
	T . S . C	1.54×10^{-1}	1×10^{-3}
	M . P.	1.8×10^{-1}	4.21×10^{-3}
	P . P.	2.2×10^{-1}	1.69×10^{-2}

3-16 Standard solution analysis

The standard ibuprofen solution was determined using have been used all electrodes and applying four techniques namely direct, standard addition (SAM), multiple standard addition (MSA) and titration were methods. The relative error $E_{rel\%}$ and relative standard deviation RSD% calculate for each method.

3-16-1 Direct Potentiometric Method

This method is easy and commonly uses ion-selective electrodes to determination concentration .The calibration curve was prepared the linear equation was written and the concentration of the unknown was calculated ,table (3-78).

Table (3-78): Direct potentiometric analysis of Diclofenec sodium Standard and forms pharmaceutical samples using IBP electrodes

Electrode No.	sample	Measured using Direct Method	RSD %	E_{rel}%	REC %
DFS-MIP1 + TEHP (I)	**1×10^{-4}**				
	Standard	9.8×10^{-5}	0.68	-1.2	98.8
	Voldic	9.89×10^{-5}	0.85	-1.04	98.96
	Clofen	1.01×10^{-4}	0.92	1.24	101.24
	Refen retard	1.01×10^{-5}	0.99	1	101
	1×10^{-3}				
	Standard	1.009×10^{-3}	0.95	0.95	100.95
	Voldic	1.008×10^{-3}	0.87	0.81	100.81
	Clofen	9.92×10^{-4}	0.98	-0.78	99.22
	Refen retard	1.015×10^{-3}	1	1.15	101.15
DFS-MIP2 + DBPH (II)	**1×10^{-4}**				
	Standard	1.006×10^{-4}	0.9	0. 63	100.63
	Voldic	1.007×10^{-4}	0.81	0.71	100.71
	Clofen	1.0074×10^{-4}	0.86	074	100.74
	Refen retard	0.91×10^{-5}	0.997	-0.90	99.10
	1×10^{-3}				
	Standard	1.008×10^{-3}	0.87	0.8	100.80
	Voldic	9.96×10^{-4}	0.92	-0.94	99.6
	Clofen	1.008×10^{-4}	0.84	0.88	100.88
	Refen retard	1.0095×10^{-3}	0.8	0.95	100.95
DFS-MIP3 + DOPH (III)	**1×10^{-4}**				
	Standard	9.9×10^{-5}	0.7	-1	99
	Voldic	9.97×10^{-5}	0.71	-0.3	99.7
	Clofen	9.932×10^{-5}	1.2	-0.68	99.32
	Refen retard	1.01×10^{-4}	1	1	101
	1×10^{-3}				
	Standard	1.005×10^{-3}	1.3	0.55	100.55
	Voldic	9.92×10^{-4}	0.95	-0.80	99.2
	Clofen	1.013×10^{-3}	0.7	1.3	101.3
	Refen retard	9.99×10^{-4}	0.919	-0.1	99.94

3-16-2 Incremental Methods

In these methods, a procedure involves preparing several solutions containing the same amount of unknown, but different amounts of standard. But must be the concentration of standard solution of ibuprofen used for measurement was ≈100 times higher than the concentration of sample that was used to decrease the dilution effect. It is carried out by a procedure with 0.1mL increment of 10^{-1} M ibuprofen as standard and was added to 10 mL of sample as unknown. The calculation can be used as following;

1-Standard Addition Method (SAM)

2-Multiple Standard Addition (MSA)

3-16-2-1 Calculation of Standard Addition Method SAM

In this method two synthetic solutions of ibuprofen at concentrations of (10^{-3} and 10^{-4})M were used to plot antilog E/S versus volume of standard Ibuprofen, using equation (6) are listed in tables (3-79) to (3-102),and fig from (3-113)to(3-135) The RSD% and RE % were calculate from the results obtained for each method are given in table(3-39)

Table (3-79) Potential of 10^{-4}M Diclofenec sodium against the volume of standard Diclofenec sodium and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Diclofenec sodium pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	80.5	3.19E+04				
0.1	99	3.47E+05	18.51	1.1E+01	100	1.0032E-04
0.2	104.0	6.60E+05	23.51	2.1E+01	50	9.9519E-05
0.3	106.9	9.60E+05	26.41	3.0E+01	33.33	1.0015E-04
0.4	109	1.26E+06	28.51	3.9E+01	25	1.0008E-04
0.5	110.6	1.55E+06	30.11	4.8E+01	20	1.0034E-04
MSA	Con found=1.0008×10^{-4} RE%=0.08 REC%= 100.08 RSD%=0.18					
SAM	Con found=9.977×10^{-5} RE%=-0.23 REC%= 99.77 RSD%=0.5					
SD1=0.4 RSD%= 0.38 Mv=104,103.6,104.4						

Table (3-80) Potential of 10^{-4}M Diclofenec sodium against the volume of Voldic and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Voldic 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	81	3.41E+04				
0.1	99.52	3.71E+05	18.52	1.1E+01	100	1.0018E-04
0.2	104.5	7.04E+05	23.5	2.1E+01	50	9.9654E-05
0.3	107.4	1.02E+06	26.4	3.0E+01	33.33	1.0028E-04
0.4	109.5	1.34E+06	28.5	3.9E+01	25	1.0021E-04
0.5	111.1	1.65E+06	30.1	4.8E+01	20	1.0047E-04
MSA	Con found=1.0016×10^{-4} RE%=0.16 REC%= 100.16 RSD%=0.23					
SAM	Con found=9.98×10^{-5} RE%=-0.18 REC%= 99.82 RSD%=0.47					
SD1=0.46 RSD%= 0.44 mv= 104.4 ,104.1, 105						

Table (3-81) Potential of 10^{-4}M Diclofenec sodium against the volume of Clofen and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Clofen100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	78.5	2.47E+04				
0.1	97	2.68E+05	18.51	1.1E+01	100	1.0032E-04
0.2	101.9	5.06E+05	23.45	2.1E+01	50	1.0033E-04
0.3	104.9	7.42E+05	26.41	3.0E+01	33.33	1.0015E-04
0.4	107	9.72E+05	28.51	3.9E+01	25	1.0008E-04
0.5	108.6	1.19E+06	30.11	4.8E+01	20	1.0034E-04
MSA	Con found=1.0024×10^{-4} RE%=0.24 REC%= 100.24 RSD%=0.26					
SAM	Con found=1.0028×10^{-4} RE%=0.28 REC%= 100.30 RSD%=0.35					
SD1=0.36 RSD%= 0.33 mv= 109,108.3, 108.5						

Table (3-82) Potential of 10^{-4}M Diclofenec sodium against the volume of Refen retard and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Refen retard 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	79.9	2.96E+04				
0.1	98.4	3.21E+05	18.5	1.1E+01	100	1.0046E-04
0.2	103.3	6.04E+05	23.41	2.0E+01	50	1.0087E-04
0.3	106.3	8.88E+05	26.4	3.0E+01	33.33	1.0028E-04
0.4	108.4	1.16E+06	28.5	3.9E+01	25	1.0021E-04
0.5	110.1	1.45E+06	30.2	4.9E+01	20	9.9158E-05
MSA	Con found=1.0020×10^{-4} RE%=0.20 REC%= 100.20RSD%=0.23					
SAM	Con found=9.96×10^{-5} RE%= -0.31 REC%= 99.69RSD%=0.46					
SD1=0.46 RSD%= 0.42 mv= 109.6 ,110.2, 110.5						

Table (3-83) Potential of 10^{-3}M Diclofenec sodium against the volume of standard Diclofenec sodium and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Diclofenec sodium pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	101.4	4.7E+05				
0.1	106.7	9.4E+05	5.3	2.0E+00	100	1.0006E-03
0.2	109.8	1.4E+06	8.4	3.0E+00	50	9.9470E-04
0.3	111.9	1.8E+06	10.5	3.9E+00	33.33	1.0051E-03
0.4	113.58	2.3E+06	12.18	4.8E+00	25	1.0010E-03
0.5	114.9	2.7E+06	13.5	5.7E+00	20	1.0042E-03
MSA	Con found=1.0011×10^{-3} RE%=0.11 REC%= 100.11 RSD%=0.19					
SAM	Con found=9.97×10^{-4} RE%=-0.21 REC%= 99. 78RSD%=0.28					
SD= 0.3 RSD%=0.27 mv= 109.8,110.1, 109.5						

Table (3-84) Potential of 10^{-3}M Diclofenec sodium against the volume of Voldic and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Voldic 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	92.17	1.4E+05				
0.1	97.5	2.9E+05	5.33	2.0E+00	100	9.9287E-04
0.2	100.5	4.2E+05	8.33	2.9E+00	50	1.0083E-03
0.3	102.7	5.6E+05	10.53	3.9E+00	33.33	9.9990E-04
0.4	104.3	6.9E+05	12.13	4.8E+00	25	1.0091E-03
0.5	105.7	8.2E+05	13.53	5.7E+00	20	9.9952E-04
MSA	Con found=1.0019×10^{-3} RE%=0.19 REC%= 100.19 RSD%= 0.29					
SAM	Con found=9.95×10^{-4} RE%=-0. 5 REC%= 99.5 RSD%=0.44					
SD= 0.36 RSD%= 0.37 mv=97.4, 97.2, 97.9						

Table (3-85) Potential of 10^{-3}M Diclofenec sodium against the volume of Clofen and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Clofen 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	100.87	4.4E+05				
0.1	106.2	8.8E+05	5.33	2.0E+00	100	9.9287E-04
0.2	109.2	1.3E+06	8.33	2.9E+00	50	1.0083E-03
0.3	111.4	1.7E+06	10.53	3.9E+00	33.33	9.9990E-04
0.4	113	2.1E+06	12.13	4.8E+00	25	1.0091E-03
0.5	114.4	2.5E+06	13.53	5.7E+00	20	9.9952E-04
MSA	conc found=1.0019×10^{-3} RE%=0.19 REC%= 100.19 RSD%=0.29					
SAM	conc found=9.956×10^{-4} RE%=-0.44 REC%= 99.56 RSD%=0.38					
SD= 0.4 RSD%= 0.38 mv= 105.8, 106.2, 106.6						

Table (3-86) Potential of 10^{-3}M Diclofenec sodium against the volume of Refen retard and the calculation of five additions using MSA and SAM. For DFS-MIP1+ TEHP electrode

Refen retaed 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	99.7	3.8E+05				
0.1	105	7.5E+05	5.34	2.0E+00	100	9.9033E-04
0.2	108	1.1E+06	8.34	2.9E+00	50	1.0063E-03
0.3	110.2	1.5E+06	10.54	3.9E+00	33.33	9.9818E-04
0.4	111.8	1.8E+06	12.14	4.8E+00	25	1.0075E-03
0.5	113.2	2.2E+06	13.54	5.7E+00	20	9.9798E-04
MSA	conc found=1.0001×10^{-3} RE%=0.01 REC%= 100.01 RSD%=0.11					
SAM	conc found=9.96×10^{-4} RE%=-0.39 REC%= 99.6RSD%=0.51					
	SD=0.5 RSD%=0.48 mv= 105, 105.5, 104.5					

Table (3-87) Potential of 10^{-4}M Diclofenec sodium against the volume of standard Diclofenec sodium and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Diclofenec sodium pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	95	7.82E+04				
0.1	115.1	8.48E+05	20.1	1.1E+01	100	1.0046E-04
0.2	120.5	1.61E+06	25.5	2.1E+01	50	1.0006E-04
0.3	123.7	2.35E+06	28.7	3.0E+01	33.33	1.0008E-04
0.4	126	3.09E+06	31	4.0E+01	25	9.9783E-05
0.5	127.7	3.78E+06	32.7	4.8E+01	20	1.0051E-04
MSA	Con found=1.0018×10^{-4} RE%=0.18 REC%= 100.18 RSD%=0.28					
SAM	Con found=9.979×10^{-5} RE%=-0.21 REC%= 99.79 RSD%=0.4					
SD1=0.5 RSD%= 0.4 Mv=116.5,116,115.5						

Table (3-88) Potential of 10^{-4}M Diclofenec sodium against the volume of Voldic and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Voldic 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	94	6.94E+04				
0.1	114.2	7.62E+05	20.2	1.1E+01	100	9.9158E-05
0.2	119.5	1.43E+06	25.5	2.1E+01	50	1.0006E-04
0.3	122.7	2.09E+06	28.7	3.0E+01	33.33	1.0008E-04
0.4	124.96	2.73E+06	30.96	3.9E+01	25	1.0027E-04
0.5	126.7	3.36E+06	32.7	4.8E+01	20	1.0051E-04
MSA	Con found=1.0001×10^{-4} RE%=0.01 REC%= 100.01 RSD%=0.26					
SAM	Con found=9.955×10^{-5} RE%=-0.45 REC%= 99.52 RSD%=0.49					
SD1=0.53 RSD%= 0.46 mv= 114.2 ,115.2, 115						

Table (3-89) Potential of 10^{-4}M Diclofenec sodium against the volume of Clofen and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Clofen 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	92.6	5.88E+04				
0.1	112.7	6.38E+05	20.1	1.1E+01	100	1.0046E-04
0.2	118.1	1.21E+06	25.5	2.1E+01	50	1.0006E-04
0.3	121.3	1.77E+06	28.7	3.0E+01	33.33	1.0008E-04
0.4	123.5	2.32E+06	30.98	3.9E+01	25	1.0003E-04
0.5	125.3	2.84E+06	32.7	4.8E+01	20	1.0051E-04
MSA	Con found=1.0022×10^{-4} RE%=0.22 REC%= 100.22 RSD%=0.27					
SAM	Con found=1.0030×10^{-4} RE%=0.3 REC%= 100.30 RSD%=0.35					
SD1=0.46 RSD%= 0.37 mv= 125.4 ,124.8, 125.7						

Table (3-90) Potential of 10^{-4}M Diclofenec sodium against the volume of Refen retard and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Refen retard 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	92.8	6.02E+04				
0.1	112.9	6.53E+05	20.1	1.08E+01	100	1.0045E-04
0.2	118.3	1.24E+06	25.5	2.06E+01	50	1.0005E-04
0.3	121.5	1.81E+06	28.7	3.01E+01	33.33	1.0007E-04
0.4	123.8	2.38E+06	31	3.95E+01	25	9.9775E-05
0.5	125.5	2.91E+06	32.7	4.83E+01	20	1.0050E-04
MSA	Con found=1.0017×10^{-4} RE%=0.17 REC%= 100.17RSD%=0.26					
SA	Con found=1.0023×10^{-4} RE%=0.23 REC%= 100.23 RSD%=0.294					
SD1=0.4 RSD%= 0.35 mv= 112.9 ,113.3, 112.5						

Table (3-91) Potential of 10^{-3}M Diclofenec sodium against the volume of standard Diclofenec sodium and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Diclofenec sodium pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	114.5	7.90E+05				
0.1	120.3	1.57E+06	5.8	1.99E+00	100	9.9072E-04
0.2	123.6	2.32E+06	9.1	2.94E+00	50	9.9935E-04
0.3	125.9	3.05E+06	11.4	3.87E+00	33.33	1.0063E-03
0.4	127.7	3.78E+06	13.2	4.79E+00	25	1.0059E-03
0.5	129.14	4.48E+06	14.64	5.68E+00	20	1.0081E-03
MSA	Con found=1.0021×10^{-3} RE%=0.21 REC%= 100.21 RSD%=0.30					
SA	Con found=9.96×10^{-4} RE%=-0.34 REC%= 100.55 RSD%=0.51					
SD= 0.9 RSD%=0.71 mv= 127.3,126.4, 128.2						

Table (3-92) Potential of 10^{-3}M Diclofenec sodium against the volume of Voldic and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Voldic 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	113.2	6.77E+05				
0.1	118.96	1.34E+06	5.75	1.98E+00	100	1.0001E-03
0.2	122.3	1.99E+06	9.1	2.94E+00	50	9.9935E-04
0.3	124.6	2.65E+06	11.4	3.91E+00	33.33	9.9053E-04
0.4	126.4	3.24E+06	13.2	4.79E+00	25	1.0059E-03
0.5	127.87	3.86E+06	14.67	5.70E+00	20	1.0038E-03
MSA	Con found=9.999×10^{-4} RE%=-0.01 REC%= 99.99 RSD%= 0.1					
SAM	Con found=9.96×10^{-4} RE%=-0.35 REC%= 99.65 RSD%=0.52					
SD= 0.529 RSD%= 0.42 mv=124.9, 124.1, 125.1						

Table (3-93) Potential of 10^{-3}M Diclofenec sodium against the volume of Clofen and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Clofen 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	114	7.4E+05				
0.1	119.76	1.5E+06	5.76	2.0E+00	100	1.0001E-03
0.2	123.1	2.2E+06	9.1	2.9E+00	50	9.9935E-04
0.3	125.4	2.9E+06	11.4	3.9E+00	33.33	1.0063E-03
0.4	127.22	3.6E+06	13.2	4.8E+00	25	1.0029E-03
0.5	128.7	4.3E+06	14.7	5.7E+00	20	9.9949E-04
MSA	Con found=1.0016×10^{-3} RE%=0.16 REC%= 100.16 RSD%=0.21					
SA	Con found=1.0024×10^{-3} RE%=0.24 REC%= 100.24 RSD%=0.57					
SD= 0.6 RSD%= 0.49 mv= 123.2, 122.6, 123.6						

Table (3-94) Potential of 10^{-3}M Diclofenec sodium against the volume of Refen retard and the calculation of five additions using MSA and SAM. For DFS-MIP2+ DBPH electrode

Refen retard 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	115	8.4E+05				
0.1	120.76	1.7E+06	5.76	2.0E+00	100	1.0001E-03
0.2	124.1	2.5E+06	9.1	2.9E+00	50	9.9935E-04
0.3	126.4	3.2E+06	11.4	3.9E+00	33.33	1.0063E-03
0.4	128.2	4.0E+06	13.2	4.8E+00	25	1.0059E-03
0.5	129.7	4.8E+06	14.7	5.7E+00	20	9.9949E-04
MSA	Con found=1.0022×10^{-3} RE%=0.22 REC%= 100.22 RSD%=0.28					
SA	Con found=1.0031×10^{-4} RE%=0.33 REC%= 100.31RSD%=0.31					
	SD=0.4 RSD%=0.31 mv= 128.2, 127.8, 128.6					

Table (3-95) Potential of 10^{-4}M Diclofenec sodium against the volume of standard Diclofenec sodium and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Diclofenec sodium pure 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	99.8	1.6E+05				
0.1	119.7	1.8E+06	19.9	1.1E+01	100	9.9745E-05
0.2	124.9	3.3E+06	25.1	2.0E+01	50	1.0104E-04
0.3	128.1	4.8E+06	28.3	3.0E+01	33.33	1.0054E-04
0.4	130.3	6.3E+06	30.5	3.9E+01	25	1.0112E-04
0.5	132.1	7.8E+06	32.3	4.8E+01	20	1.0034E-04
MSA	Con found=1.0056×10^{-4} RE%=0.56 REC%= 100.56 RSD%=0.31					
SAM	Con found=9.9415×10^{-5} RE%=0.59 REC%= 99.41 RSD%=0.381					
SD1=1.15226 RSD%= 0.97 Mv=117.5,118,119.7						

Table (3-96) Potential of 10^{-4}M Diclofenec sodium against the volume of Voldic and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Voldic 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**C_{unk} (M)**
0	92.6	6.77E+04				
0.1	112.41	7.31E+05	19.81	1.08E+01	100	1.0094E-04
0.2	117.7	1.39E+06	25.14	2.05E+01	50	1.0053E-04
0.3	120.9	2.03E+06	28.3	2.99E+01	33.33	1.0054E-04
0.4	123.21	2.67E+06	30.61	3.95E+01	25	9.9761E-05
0.5	124.9	3.28E+06	32.3	4.84E+01	20	1.0034E-04
MSA	Con found=1.0042×10^{-4} RE%=0.42 REC%= 100.42 RSD%=0.34					
SAM	Con found=9.952×10^{-5} RE%=0.48 REC%= 99.52 RSD%=0.638					
SD1=0.859 RSD%= 0.70 mv= 123.2 ,124, 122.3						

Table (3-97) Potential of 10^{-4}M Diclofenac sodium against the volume of Clofen and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Clofen 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	96.8	1.1E+05				
0.1	116.6	1.2E+06	19.8	1.08E+01	100	1.0107E-04
0.2	121.9	2.3E+06	25.11	2.04E+01	50	1.0091E-04
0.3	125.1	3.4E+06	28.3	2.99E+01	33.33	1.0054E-04
0.4	127.4	4.4E+06	30.6	3.95E+01	25	9.9884E-05
0.5	129.1	5.4E+06	32.3	4.84E+01	20	1.0034E-04
MSA	Con found=1.005×10^{-4} RE%=0.55 REC%= 100.55 RSD%=0.51					
SAM	Con found=9.9431×10^{-5} RE%=0.57 REC%= 99.43 RSD%=0.642					
SD1=0.88882 RSD%= 0.70 mv= 128.4 ,127.1, 126.7						

Table (3-98) Potential of 10^{-4}M Diclofenac sodium against the volume of Refen retard and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Refen retard 100mg 1×10^{-4}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	94.8	8.82E+04				
0.1	114.7	9.62E+05	19.9	1.09E+01	100	9.9745E-05
0.2	120.0	1.81E+06	25.16	2.05E+01	50	1.0028E-04
0.3	123.1	2.64E+06	28.3	2.99E+01	33.33	1.0054E-04
0.4	125.4	3.48E+06	30.6	3.95E+01	25	9.9884E-05
0.5	127.1	4.27E+06	32.3	4.84E+01	20	1.0034E-04
MSA	Con found=1.0016×10^{-4} RE%=0.16 REC%= 100.16 RSD%=0.41					
SAM	Con found=9.9431×10^{-5} RE%=0.42 REC%= 99.58 RSD%=0.52					
SD1=0.7 RSD%= 0.61 mv= 114.7 ,114, 115.4						

Table (3-99) Potential of 10^{-3}M Diclofenec sodium against the volume of standard Diclofenec sodium and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Diclofenec sodium pure 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	114.2	9.06E+05				
0.1	119.9	1.80E+06	5.7	1.98E+00	100	9.9710E-04
0.2	123.15	2.66E+06	8.95	2.93E+00	50	1.0057E-03
0.3	125.35	3.46E+06	11.15	3.82E+00	33.33	1.0236E-03
0.4	127.3	4.37E+06	13.1	4.82E+00	25	9.9592E-04
0.5	128.7	5.17E+06	14.5	5.71E+00	20	1.0016E-03
MSA	Con found=1.0048×10^{-3} RE%=0.48 REC%= 100.48 RSD%=0.39					
SA	Con found=1.0048×10^{-3} RE%=0.56 REC%= 100.55 RSD%=0.6					
SD= 0.9 RSD%=0.71 mv= 127.3,126.4, 128.2						

Table (3-100) Potential of 10^{-3}M Diclofenec sodium against the volume of Voldic and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Voldic 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	112.8	7.66E+05				
0.1	118.5	1.52E+06	5.7	1.98E+00	100	9.9710E-04
0.2	121.7	2.24E+06	8.92	2.92E+00	50	1.0112E-03
0.3	124.1	2.98E+06	11.3	3.89E+00	33.33	9.9926E-04
0.4	125.8	3.65E+06	13	4.77E+00	25	1.0110E-03
0.5	127.3	4.37E+06	14.5	5.71E+00	20	1.0016E-03
MSA	Con found=1.0040×10^{-3} RE%=0.40 REC%= 100.40 RSD%=0.55					
SA	Con found=9.957×10^{-4} RE%=0.43 REC%= 99.57 RSD%=0.66					
SD= 0.75498 RSD%= 0.67 mv=112.9, 112., 113.5						

Table (3-101) Potential of 10^{-3}M Diclofenec sodium against the volume of Clofen and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Clofen 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	115.9	1.11E+06				
0.1	121.55	2.19E+06	5.65	1.97E+00	100	1.0092E-03
0.2	124.88	3.27E+06	8.98	2.94E+00	50	1.0003E-03
0.3	127.2	4.32E+06	11.3	3.89E+00	33.33	9.9926E-04
0.4	128.95	5.33E+06	13.05	4.79E+00	25	1.0034E-03
0.5	130.4	6.34E+06	14.5	5.71E+00	20	1.0016E-03
MSA	Con found=1.0027×10^{-3} RE%=0.27 REC%= 100.27 RSD%=0.39					
SA	Con found=9.94×10^{-4} RE%=0.49 REC%= 99.4 RSD%=0.55					
SD= 0.7211 RSD%= 0.57 mv= 126.6 , 127, 128,						

Table (3-102) Potential of 10^{-3}M Diclofenec sodium against the volume of Refen retard and the calculation of five additions using MSA and SAM. For DFS-MIP3+ DOPH electrode

Refen retard 100mg 1×10^{-3}						
Vs mL add	**E(mv)**	**Antilog E/S**	**ΔE**	**Antilog ΔE/S**	**Vu/Vs**	**Cu (M)**
0	112.2	7.13E+05				
0.1	117.85	1.40E+06	5.65	1.97E+00	100	1.0092E-03
0.2	121.15	2.09E+06	8.95	2.93E+00	50	1.0057E-03
0.3	123.5	2.78E+06	11.32	3.89E+00	33.33	9.9960E-04
0.4	125.25	3.42E+06	13.05	4.79E+00	25	1.0034E-03
0.5	126.7	4.07E+06	14.5	5.71E+00	20	1.0016E-03
MSA	Con found=1.0032×10^{-3} RE%=0.32 REC%= 100.32 RSD%=0.37					
SA	Con found=9.965×10^{-4} RE%=0.34 REC%= 99.65 RSD%=0.45					
	SD=0.5033 RSD%=0.41 mv= 123, 123.6, 124					

3-18-2-2 Calculation of Multiple Standard Method (MSM)

The plot of antilog E/S versus the volume of the five addition for DFS electrodes are shown in Fig.(3-119)to(3-142) for ibuprofen electrodes; DFS-MIP1+TEHP, DFS-MIP2 +DBPHDFS-MIP3+DOPH From the equations (7) of calibration curves, the volume (V) mL at intercept with X axis for each curve was calculated. Their correlation coefficients, (V) and (C_U) were listed in Table (3-103).

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	3.19E+04
0.1	3.47E+05
0.2	6.60E+05
0.3	9.60E+05
0.4	1.26E+06
0.5	1.55E+06

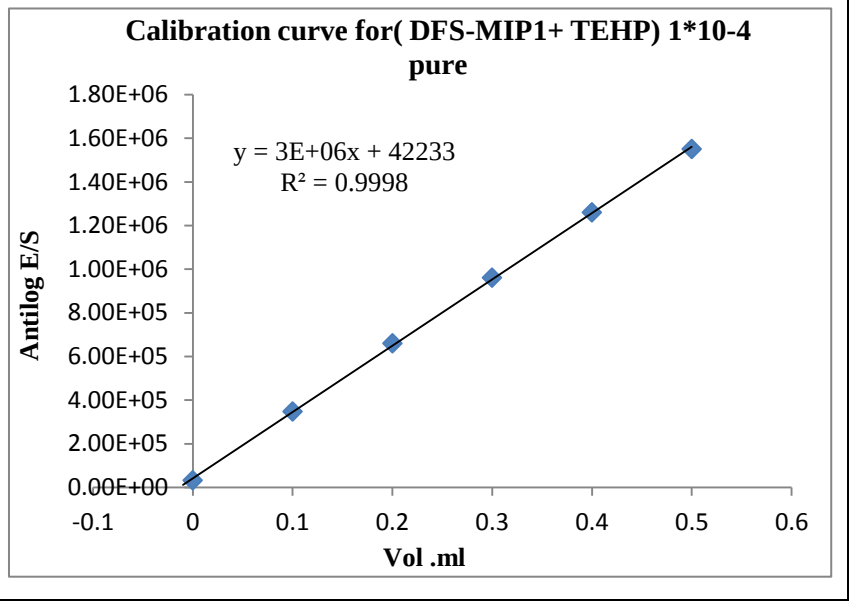


Fig. (3-119): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Standard) (10^{-4}M) by MSM using DFS-MIP1+TEHP

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	3.41E+04
0.1	3.71E+05
0.2	7.04E+05
0.3	1.02E+06
0.4	1.34E+06
0.5	1.65E+06

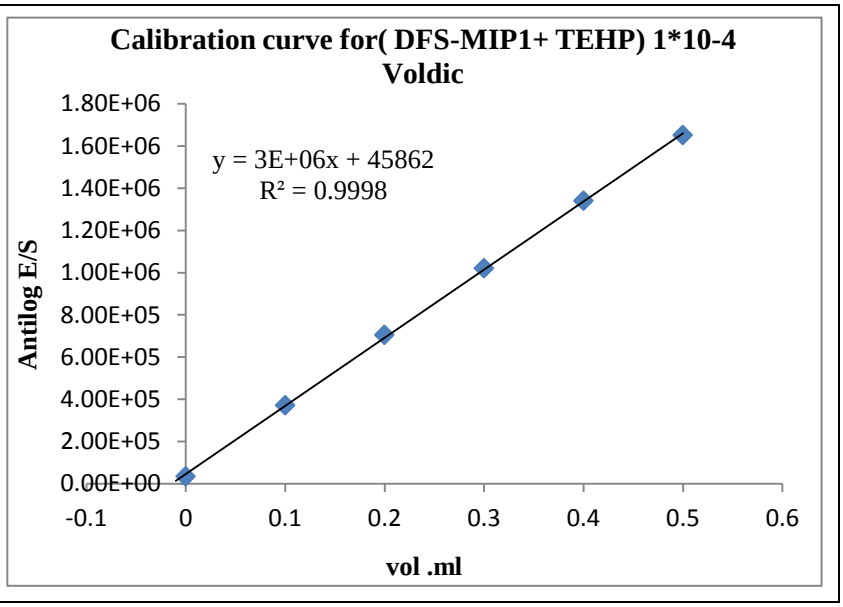


Fig. (3-120): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Voldic) (10^{-4}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	2.47E+04
0.1	2.68E+05
0.2	5.06E+05
0.3	7.42E+05
0.4	9.72E+05
0.5	1.19E+06

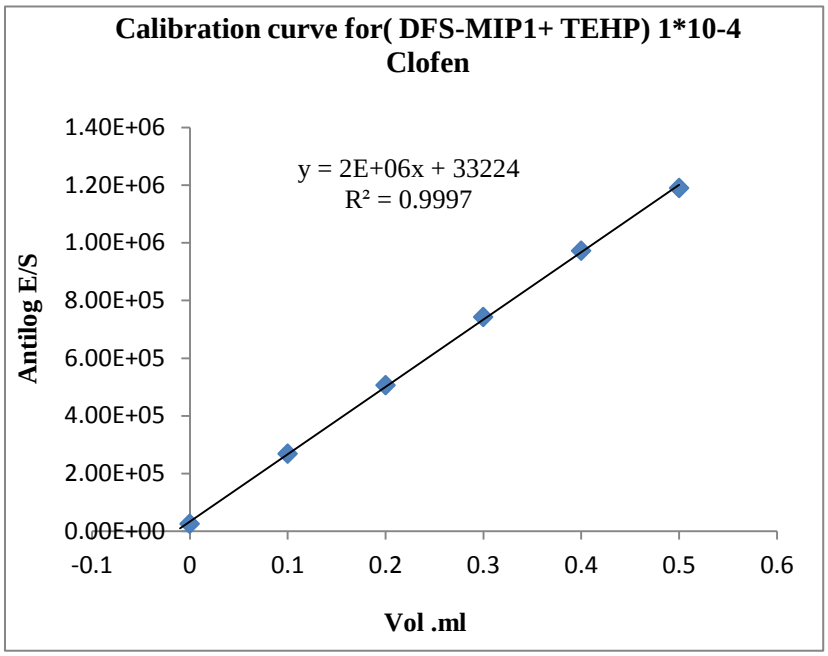


Fig. (3-121): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Clofen) (10^{-4}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	2.96E+04
0.1	3.21E+05
0.2	6.04E+05
0.3	8.88E+05
0.4	1.16E+06
0.5	1.45E+06

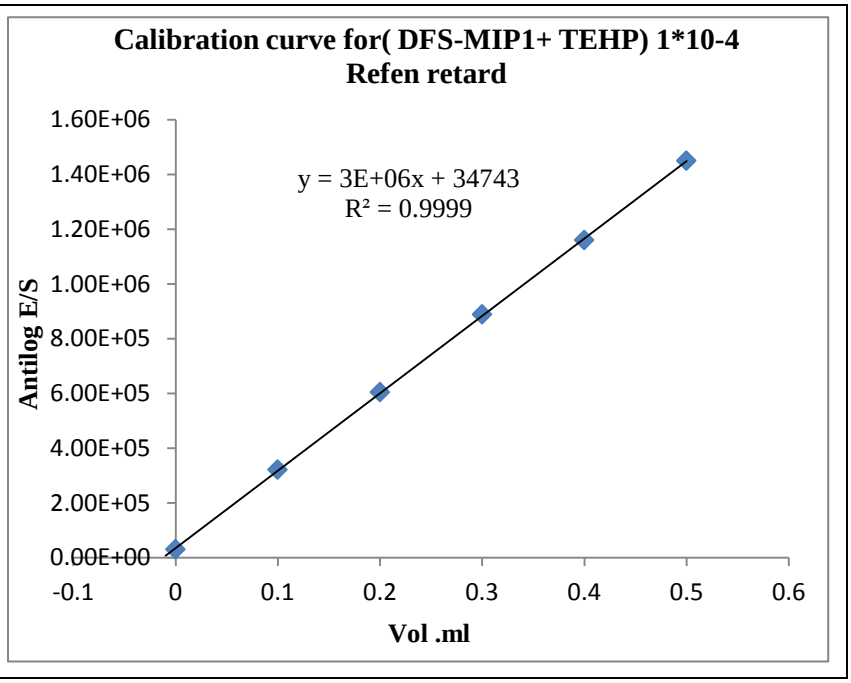


Fig. (3-122): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Refen retard) (10^{-4}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	4.70E+05
0.1	9.40E+05
0.2	1.40E+06
0.3	1.80E+06
0.4	2.30E+06
0.5	2.70E+06

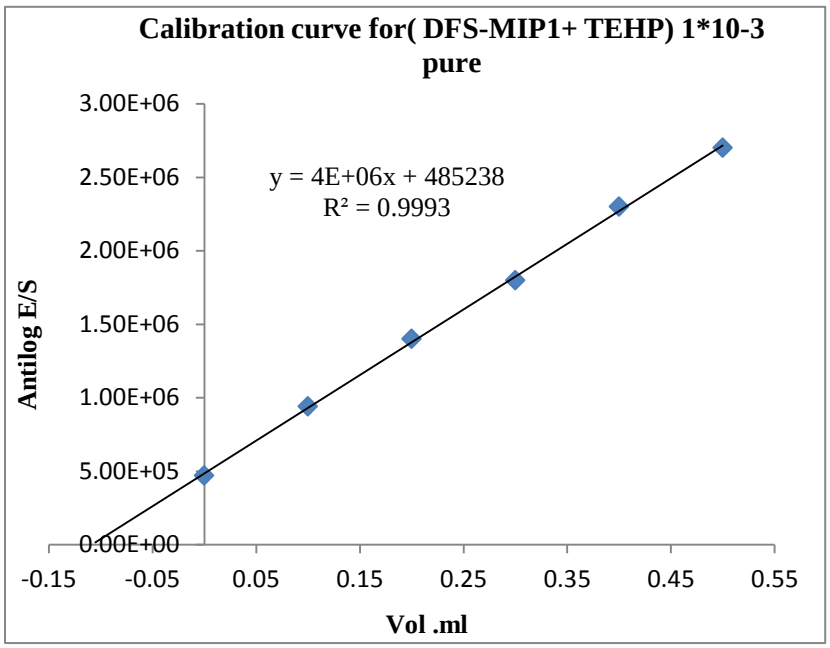


Fig. (3-123): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Standard) (10^{-3}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	
0.1	
0.2	
0.3	
0.4	
0.5	

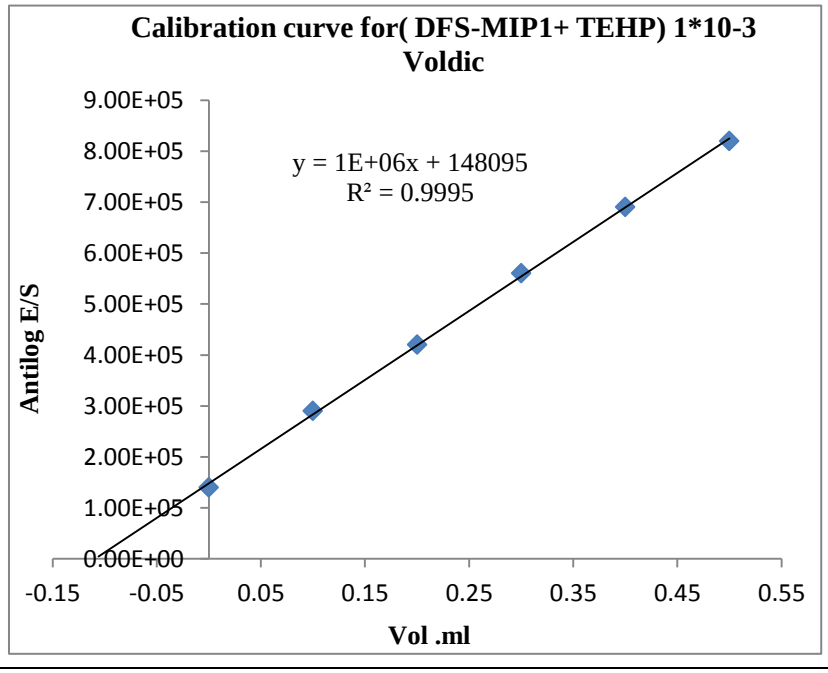


Fig. (3-124): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Voldic) (10^{-3}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	4.40E+05
0.1	8.80E+05
0.2	1.30E+06
0.3	1.70E+06
0.4	2.10E+06
0.5	2.50E+06

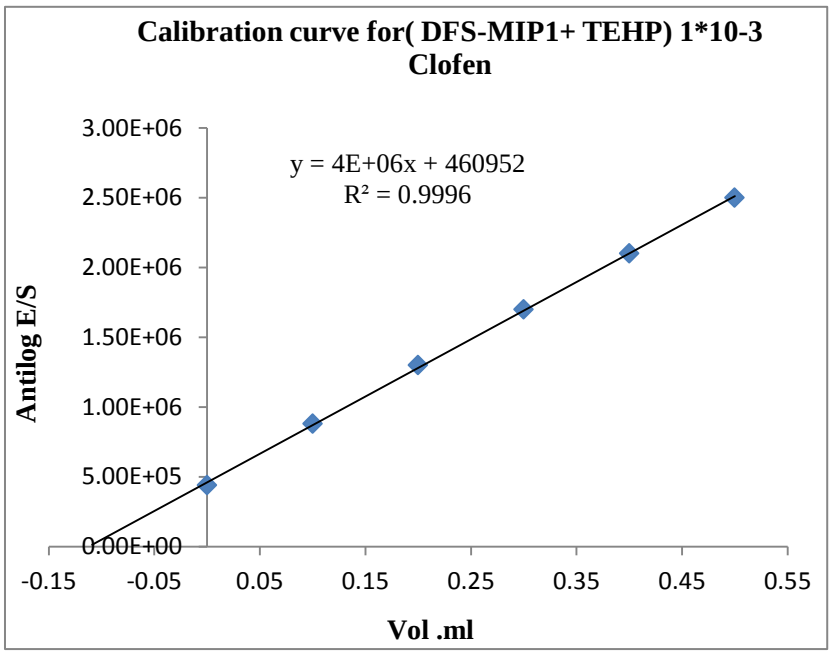


Fig. (3-125): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Clofen) (10^{-3}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP1+TEHP Slope = 17.87 Reading	
Vol. ml	**Antilog E/S**
0	3.80E+05
0.1	7.50E+05
0.2	1.10E+06
0.3	1.50E+06
0.4	1.80E+06
0.5	2.20E+06

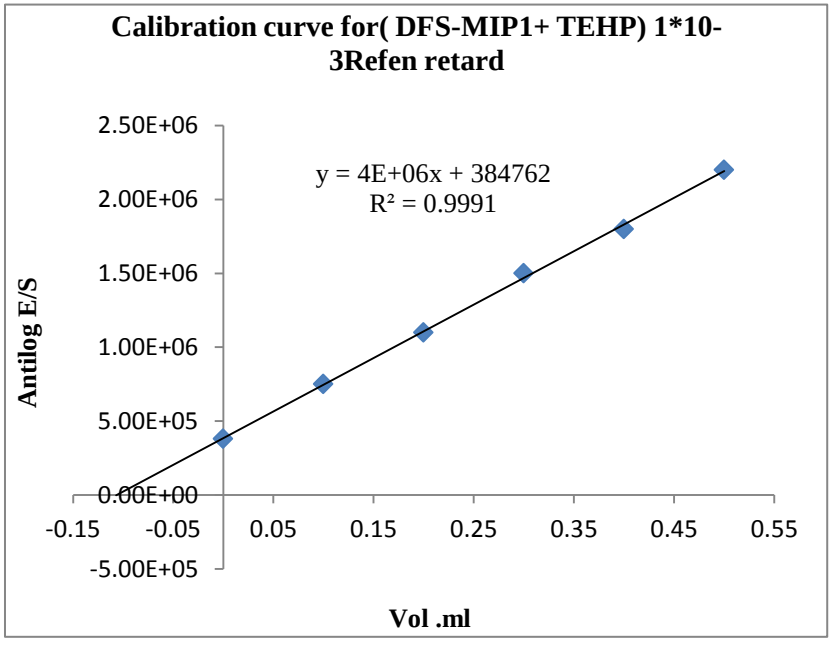


Fig. (3-126): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Refen retard) (10^{-3}M) by MSM using DFS-MIP1+TEHP electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	7.82E+04
0.1	8.48E+05
0.2	1.61E+06
0.3	2.35E+06
0.4	3.09E+06
0.5	3.78E+06

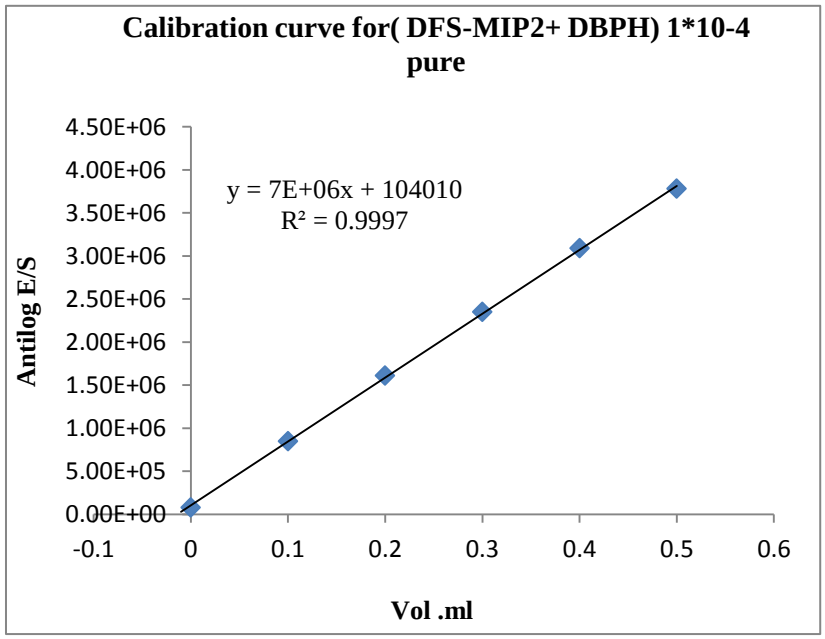


Fig. (3-127): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Standard) (10^{-4}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	6.94E+04
0.1	7.62E+05
0.2	1.43E+06
0.3	2.09E+06
0.4	2.73E+06
0.5	3.36E+06

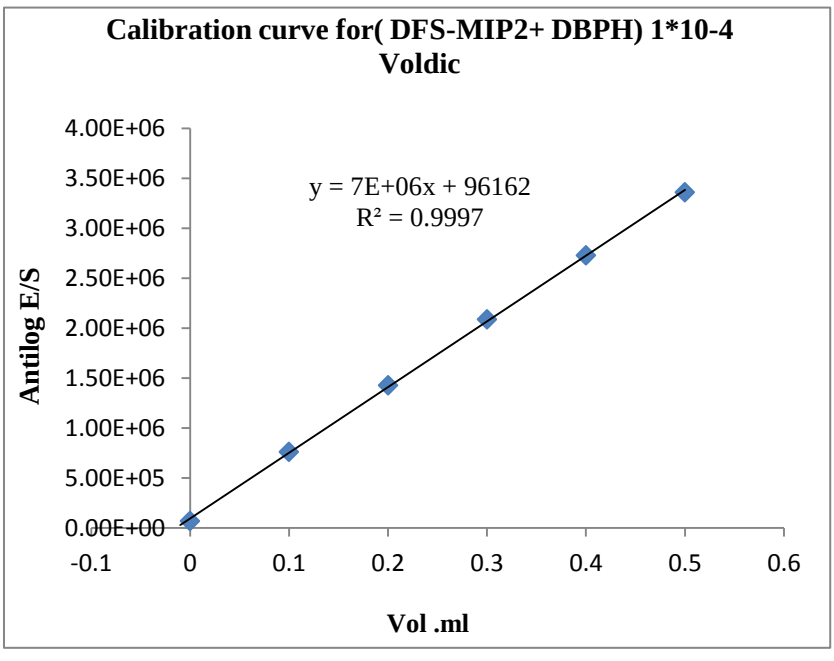


Fig. (3-128): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Voldic) (10^{-4}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	5.88E+04
0.1	6.38E+05
0.2	1.21E+06
0.3	1.77E+06
0.4	2.32E+06
0.5	2.84E+06

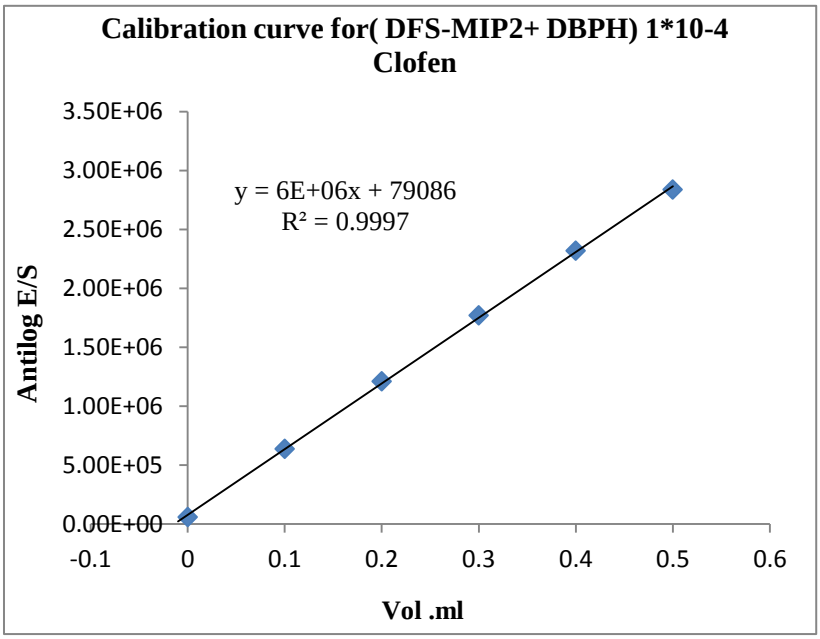


Fig. (3-129): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Clofen) (10^{-4}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	6.02E+04
0.1	6.53E+05
0.2	1.24E+06
0.3	1.81E+06
0.4	2.38E+06
0.5	2.91E+06

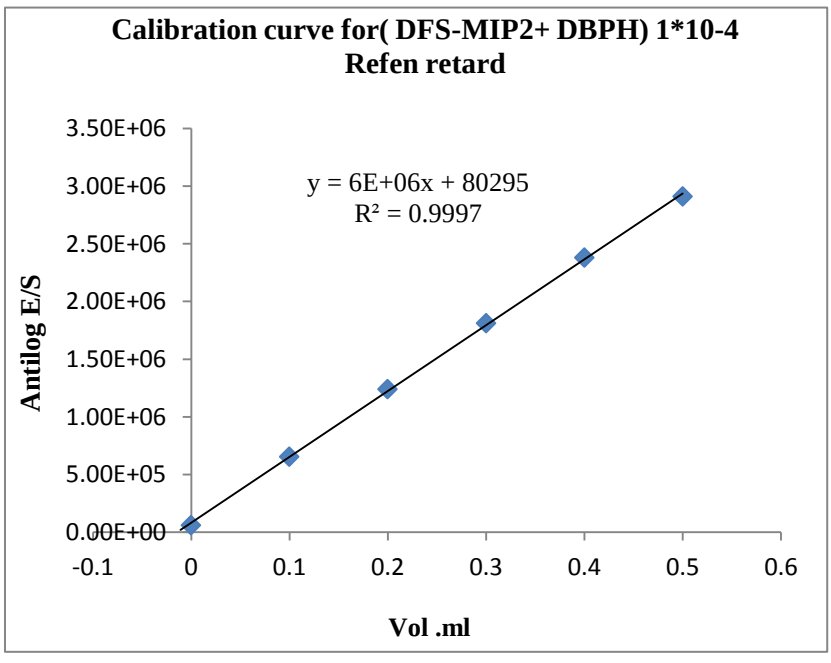


Fig. (3-130): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Refen retard) (10^{-4}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	7.90E+05
0.1	1.57E+06
0.2	2.32E+06
0.3	3.05E+06
0.4	3.78E+06
0.5	4.48E+06

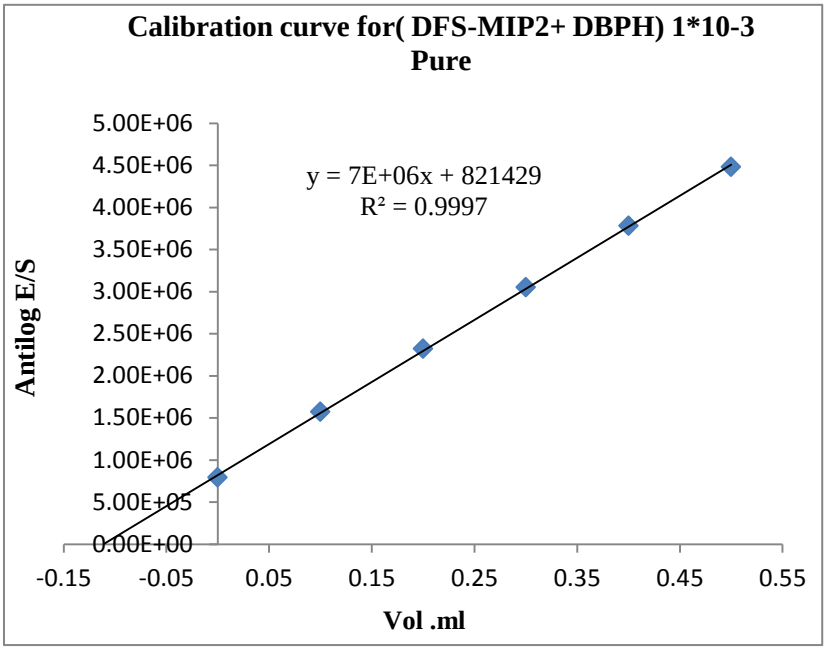


Fig. (3-131): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Standard) (10^{-3}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	6.77E+05
0.1	1.34E+06
0.2	1.99E+06
0.3	2.65E+06
0.4	3.24E+06
0.5	3.86E+06

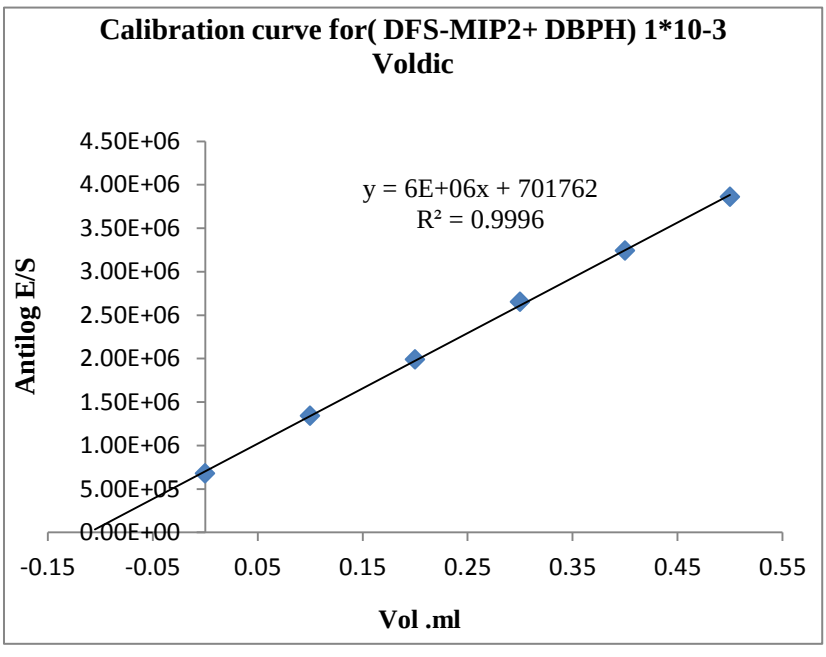


Fig. (3-132): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Voldic) (10^{-3}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	7.40E+05
0.1	1.50E+06
0.2	2.20E+06
0.3	2.90E+06
0.4	3.60E+06
0.5	4.30E+06

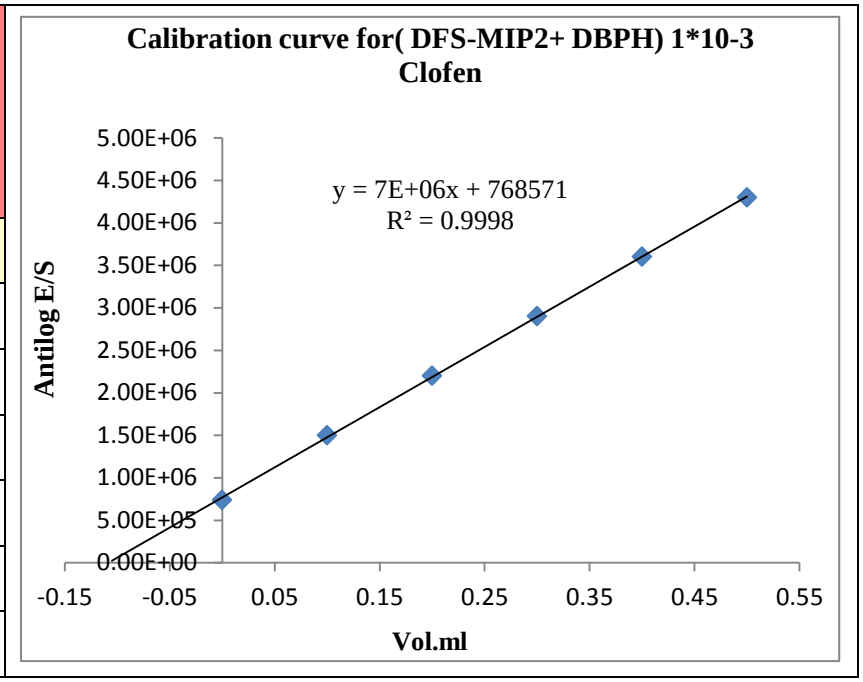


Fig. (3-133): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Clofen) (10^{-3}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP2+DBPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	8.40E+05
0.1	1.70E+06
0.2	2.50E+06
0.3	3.20E+06
0.4	4.00E+06
0.5	4.80E+06

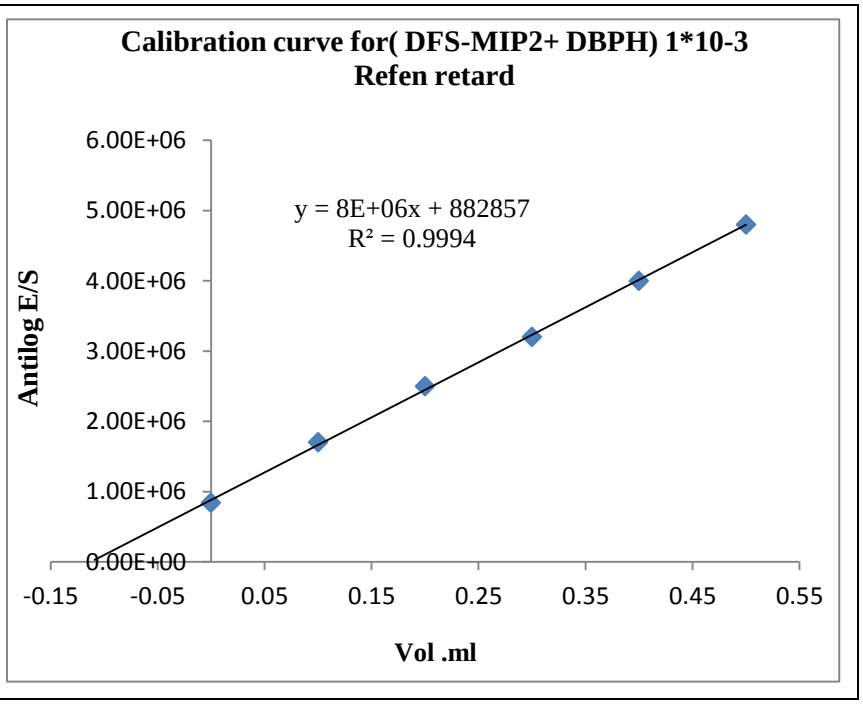


Fig. (3-134): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Refen retard) (10^{-3}M) by MSM using DFS-MIP2+DBPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	2.10E+06
0.1	2.20E+07
0.2	4.20E+07
0.3	6.20E+07
0.4	8.10E+07
0.5	1.00E+08

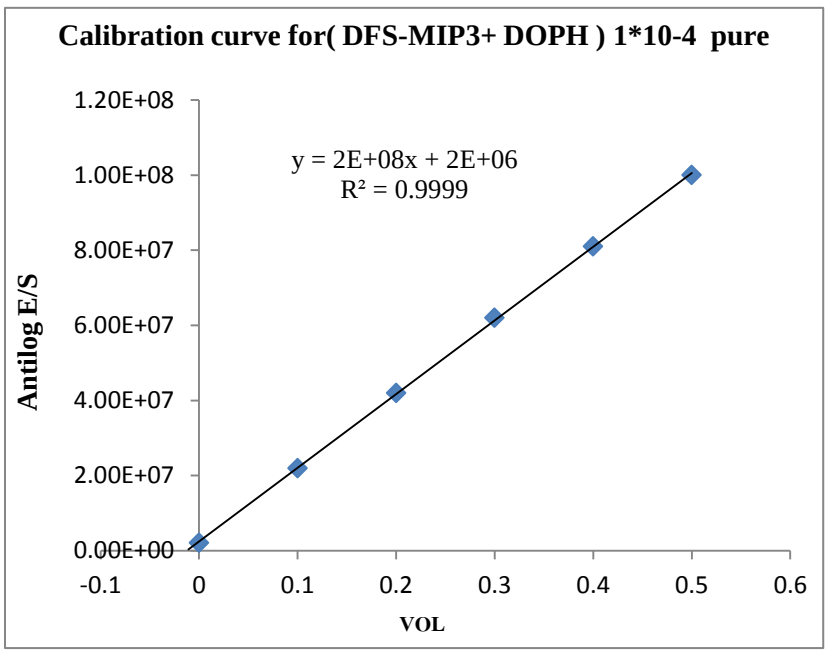


Fig. (3-135): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Standard) (10^{-4}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	6.77E+04
0.1	7.31E+05
0.2	1.39E+06
0.3	2.03E+06
0.4	2.67E+06
0.5	3.28E+06

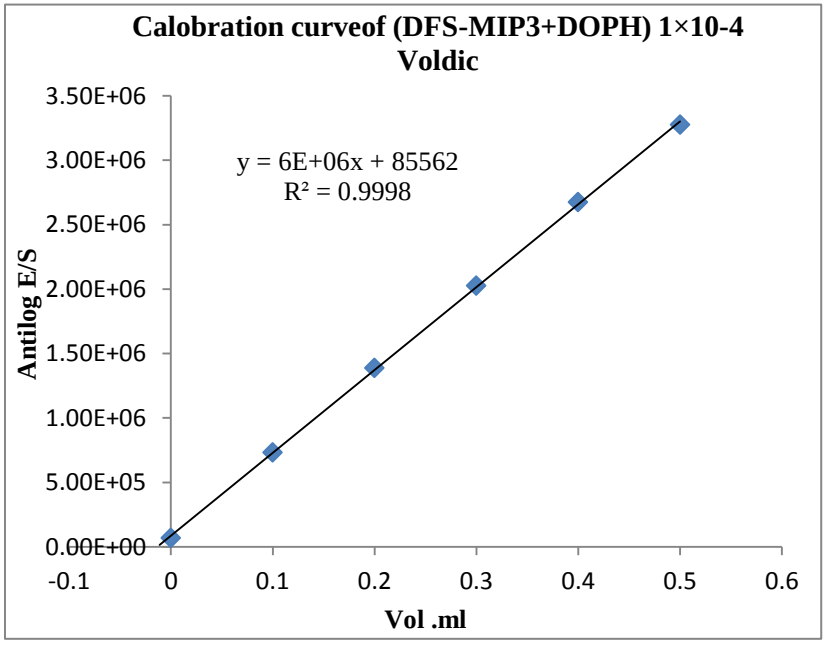


Fig. (3-136): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Voldic) (10^{-4}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	1.12E+05
0.1	1.21E+06
0.2	2.29E+06
0.3	3.36E+06
0.4	4.42E+06
0.5	5.43E+06

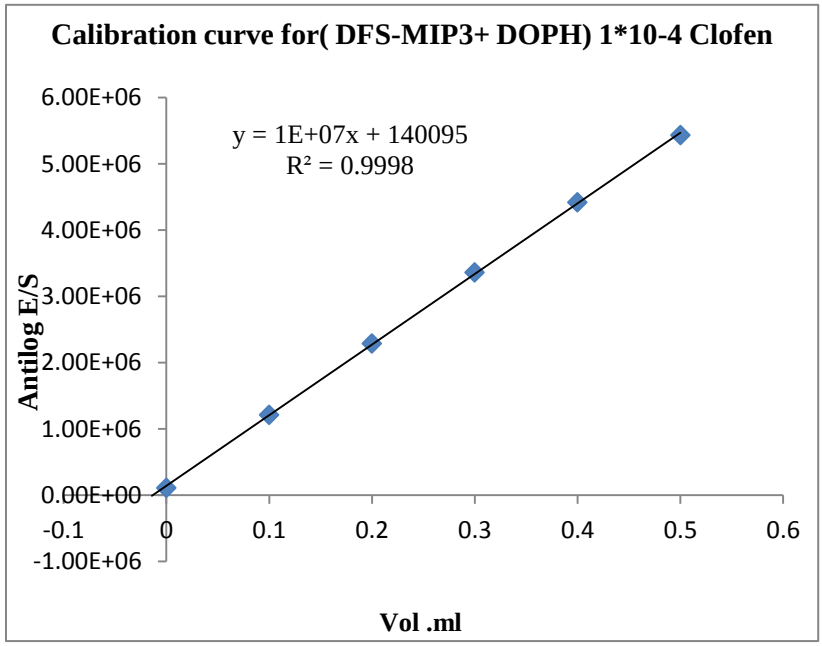


Fig. (3-137): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Clofen) (10^{-4}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	8.82E+04
0.1	9.62E+05
0.2	1.81E+06
0.3	2.64E+06
0.4	3.48E+06
0.5	4.27E+06

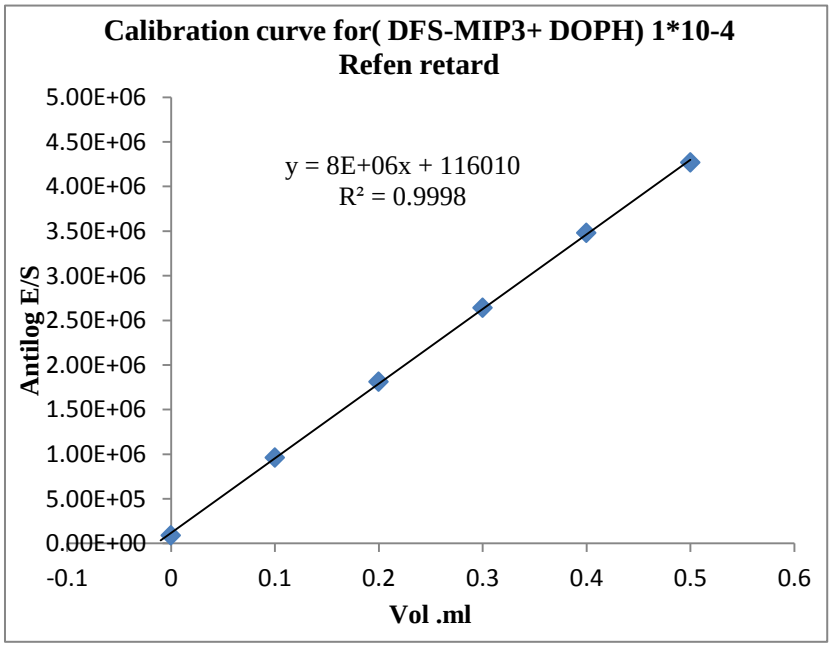


Fig. (3-138): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Refen retard) (10^{-4}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	9.06E+05
0.1	1.80E+06
0.2	2.66E+06
0.3	3.46E+06
0.4	4.37E+06
0.5	5.17E+06

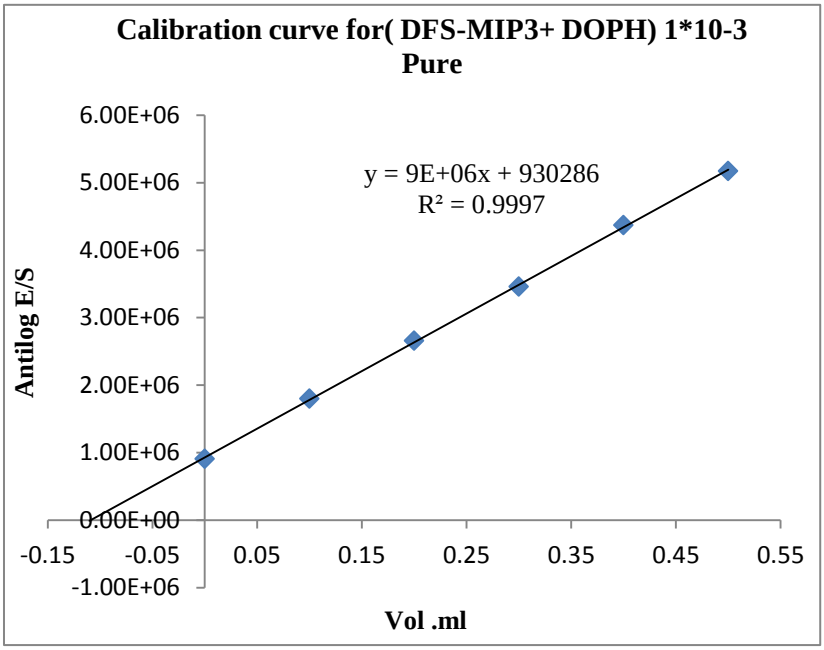


Fig. (3-139): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Standard) (10^{-3}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	7.66E+05
0.1	1.52E+06
0.2	2.24E+06
0.3	2.98E+06
0.4	3.65E+06
0.5	4.37E+06

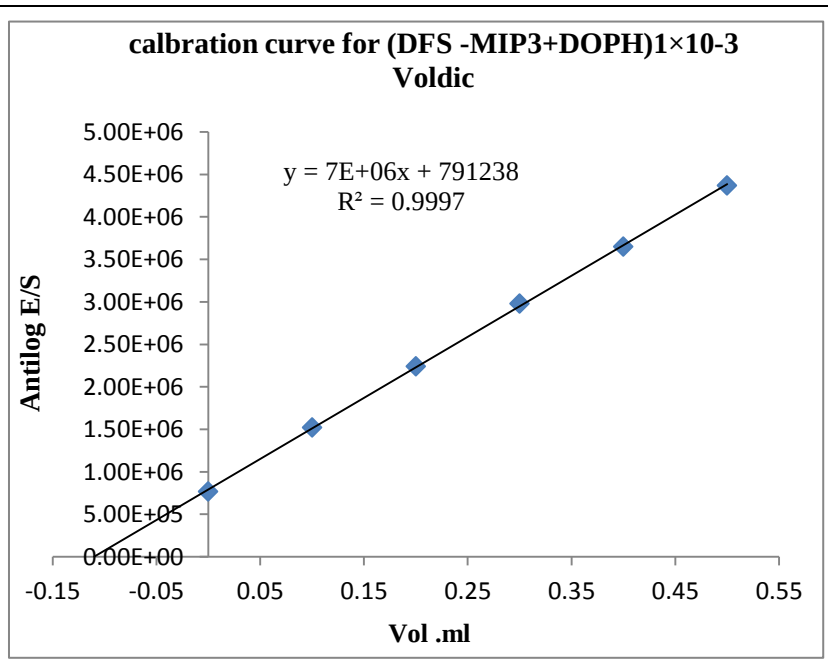


Fig. (3-140): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Voldic) (10^{-3}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	1.11E+06
0.1	2.19E+06
0.2	3.27E+06
0.3	4.32E+06
0.4	5.33E+06
0.5	6.34E+06

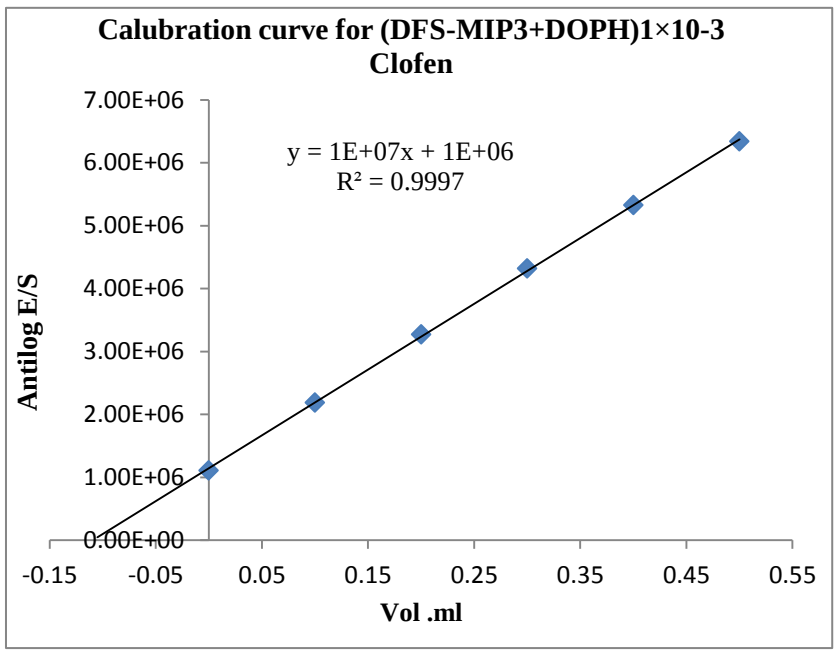


Fig. (3-141): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Clofen) (10^{-3}M) by MSM using DFS-MIP3+DOPH electrode

DFS-MIP3+DOPH Slope = 19.415 Reading	
Vol. ml	**Antilog E/S**
0	7.13E+05
0.1	1.40E+06
0.2	2.09E+06
0.3	2.78E+06
0.4	3.42E+06
0.5	4.07E+06

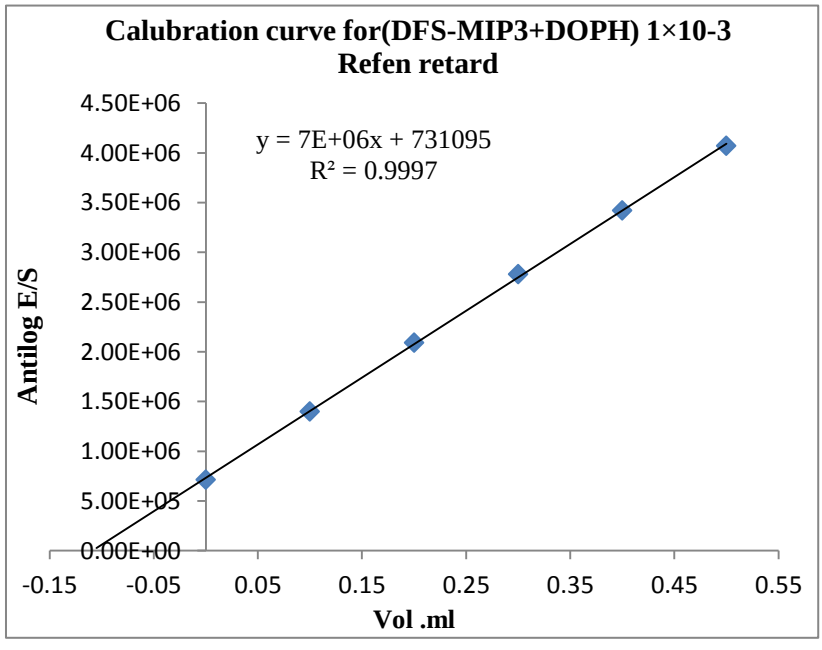


Fig. (3-142): Antilog (E/S) versus the volume of the added standard for the determination of Diclofenec sodium solution(Refen retard) (10^{-3}M) by MSM using DFS-MIP3+DOPH electrode

Table (3-103): Summary of the linear equations of the calibration curves for MSA, and correlation coefficients, volume at intercept with X axis and the concentration (C_U) for Diclofenac sodium electrodes

Membrane Combustion	Con M	Linear equation	R^2	Volume at intercept (mL)	C_U M
DFS-MIP1 + TEHP	1×10^{-4}	y = 3E+06x + 42233	0.9998	-0.01	1×10^{-4}
	1×10^{-3}	y = 4E+06x + 48524	0.9993	-0.105	1.05×10^{-3}
DFS-MIP2 + DBPH	1×10^{-4}	y = 7E+06x + 10401	0.9997	-0.01	1×10^{-4}
	1×10^{-3}	y = 7E+06x + 82143	0.9997	-0.11	1.1×10^{-3}
IBP-MIP3 + DOPH	1×10^{-4}	y = 2E+08x + 2E+06	0.9999	-0.011	1.1×10^{-4}
	1×10^{-3}	**y = 9E+06x + 930286**	0.9997	-0.1	1×10^{-3}

3-16-3 Titration Method

These methods are depend on the detection of the end point of titration. They use volumetric analysis between the sample concentrations and reactant solutions with slight gradual in crease in the electrode response often reach some changes gradually, then these changes lead to a large increase in the electrode response. The titrations between the standard diclofenec sodium and the ligand phosphomolybdic acid (PMA) are shown in the Figure (3-143) to (3-148) The obtained results for parameters RSD%, Rec.% and Erel.% for all electrodes are represented in the Table (3-104).

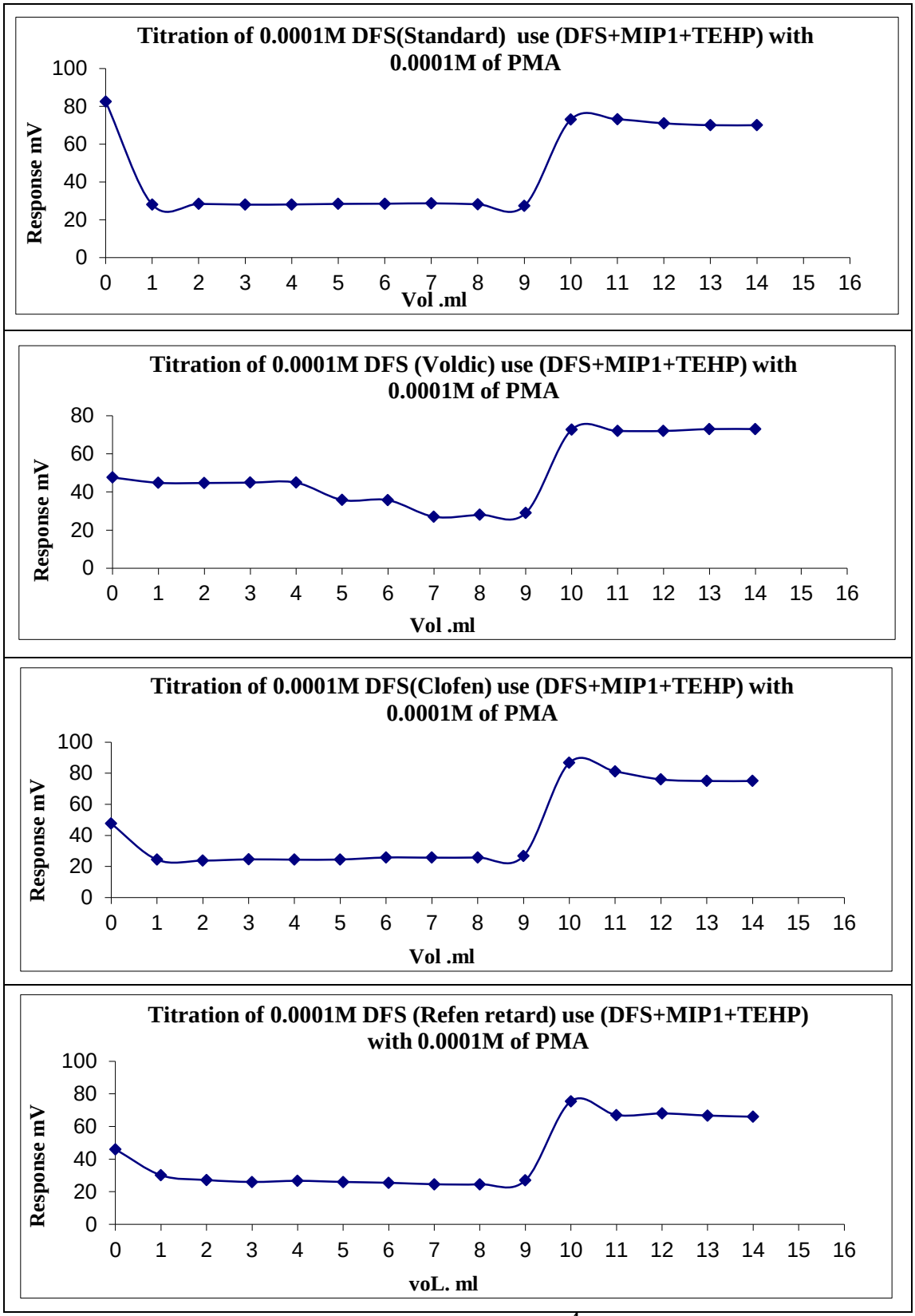


Fig. (3-143) Potentiometric Titration of each 10^{-4}M DFS (Standard , Voldic, Clofen and Refen retard solution with10^{-4} PMA solution using (DFS-MIP1+TEHP) electrode

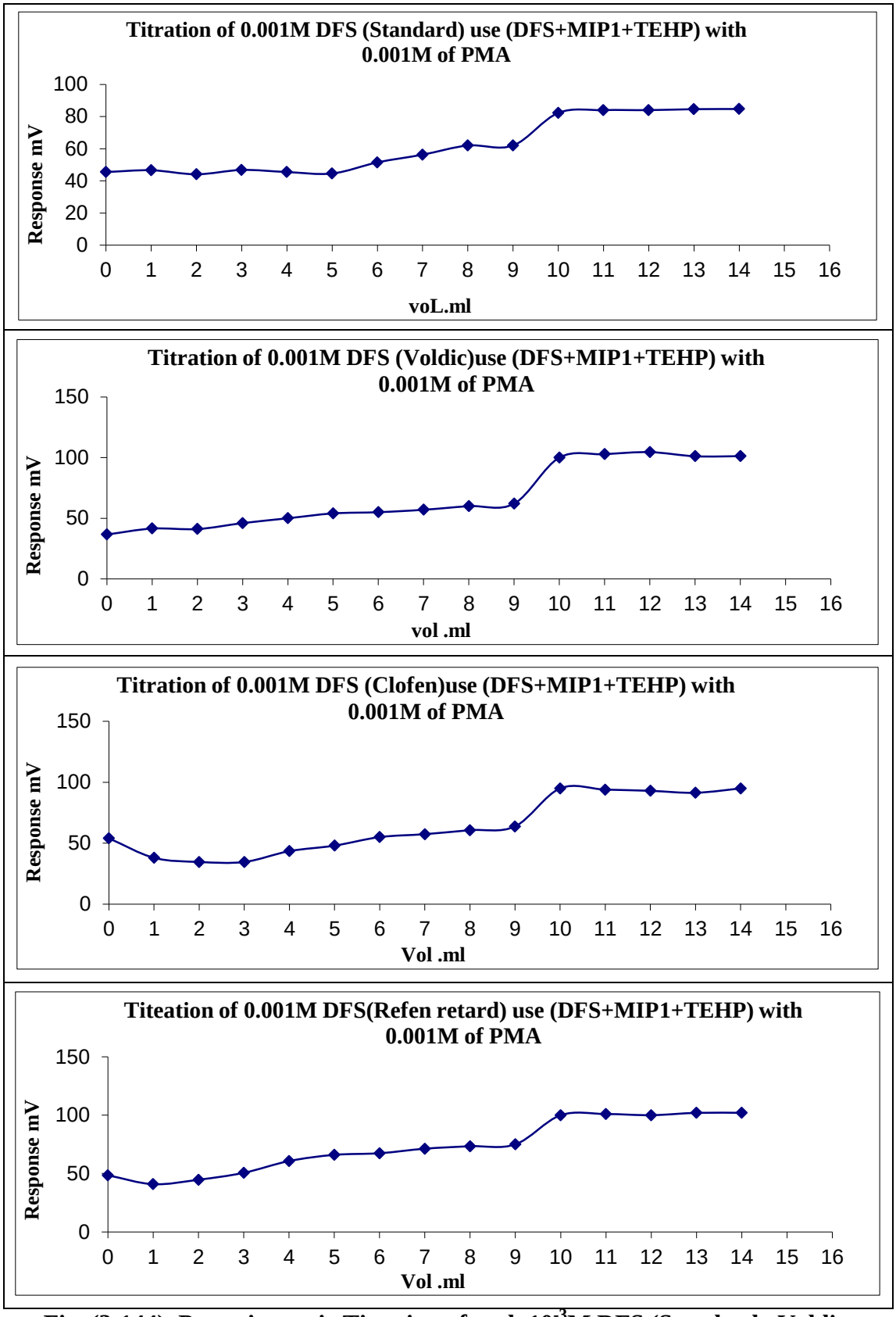


Fig. (3-144) Potentiometric Titration of each 10^{-3}M DFS (Standard , Voldic, Clofen and Refen retard solution with10^{-3} PMA solution of (DFS-MIP1+TEHP) electrode

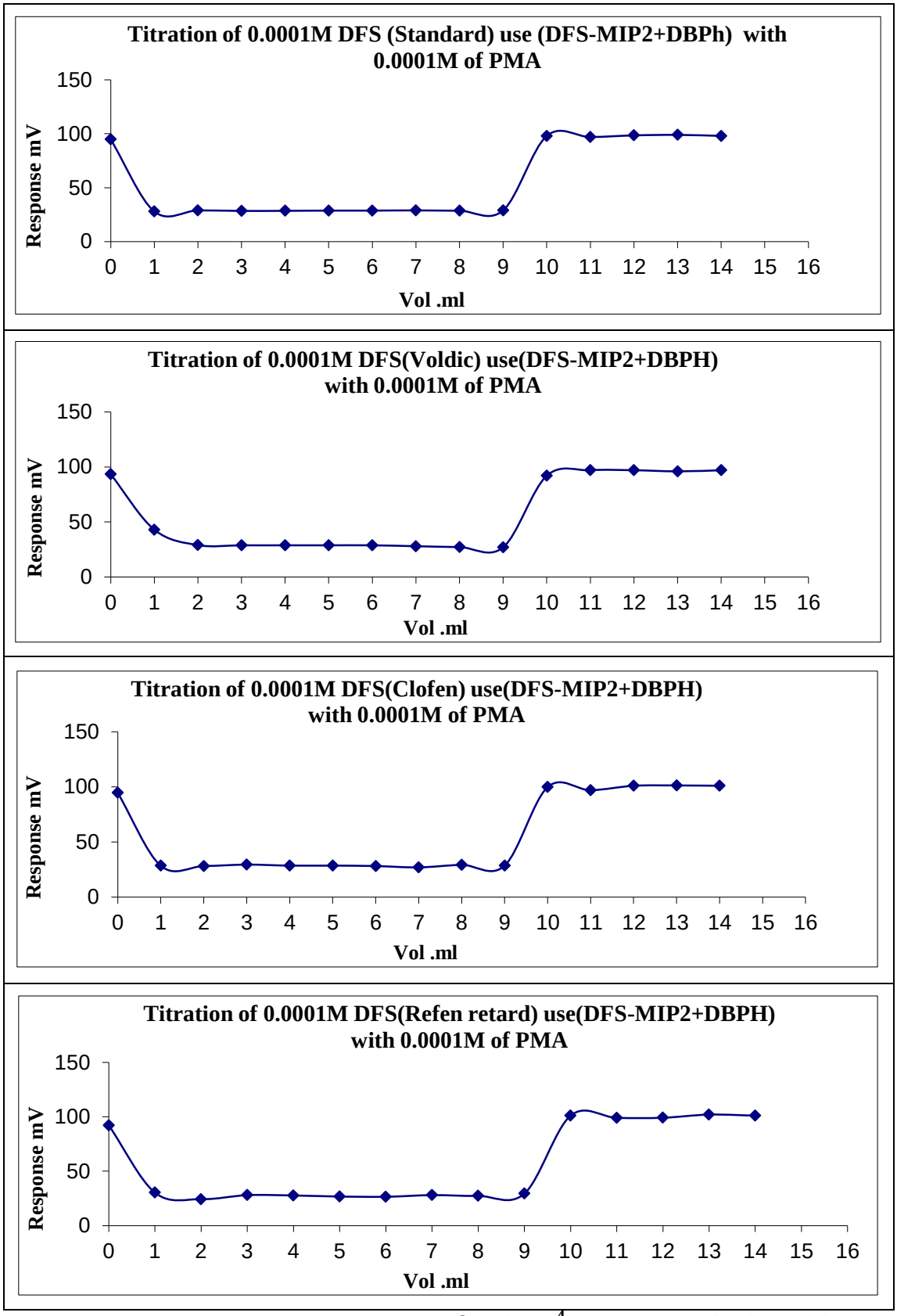


Fig. (3-145) Potentiometric Titration of each 10^{-4}M DFS (Standard , Voldic, Clofen and Refen retard solution with10^{-4} PMA solution using (DFS-MIP2+DBPH) electrode

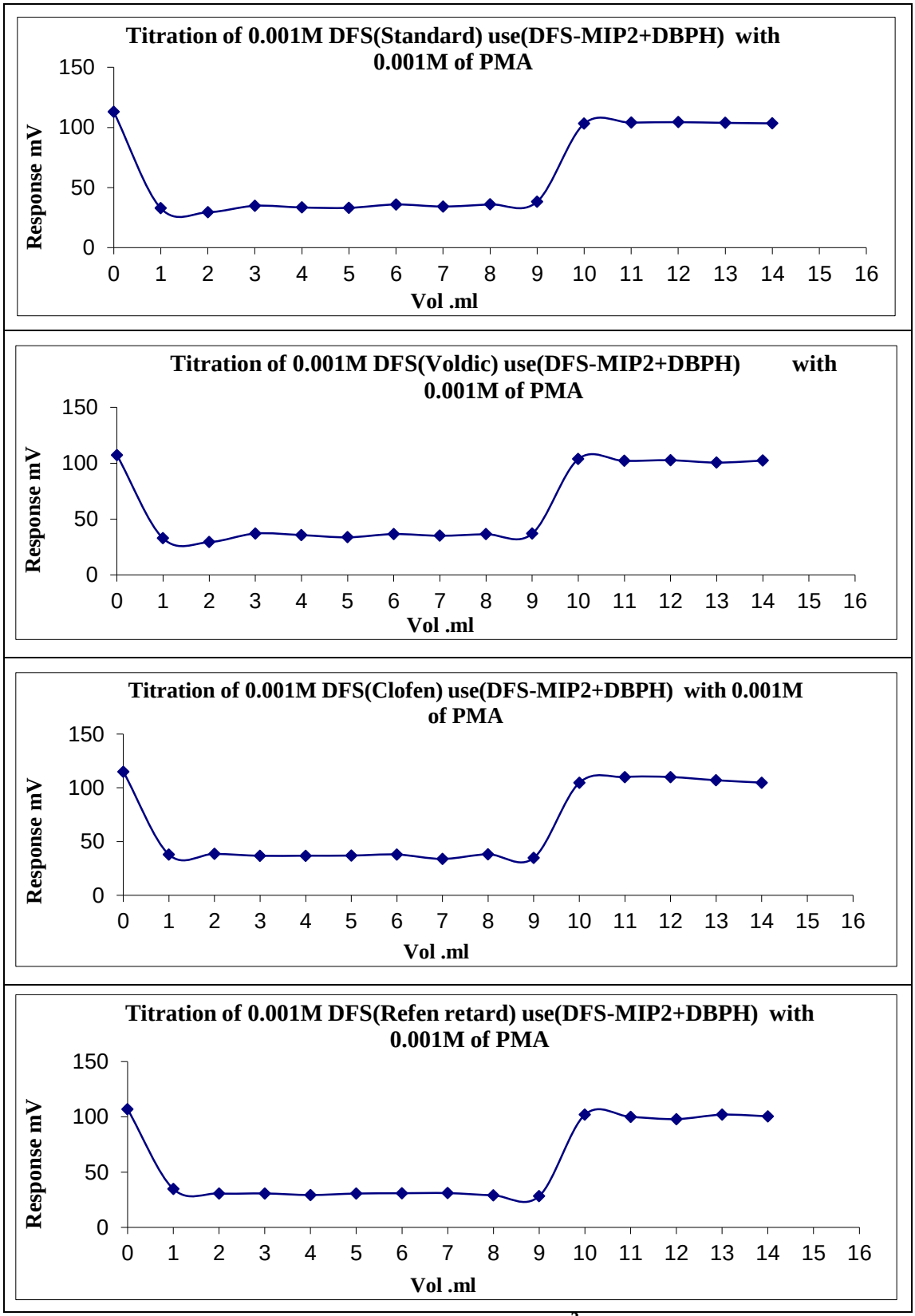


Fig. (3-146) Potentiometric Titration of each 10^{-3}M DFS (Standard , Voldic, Clofen and Refen retard solution with10^{-3} PMA solution using (DFS-MIP2+DBPH) electrode

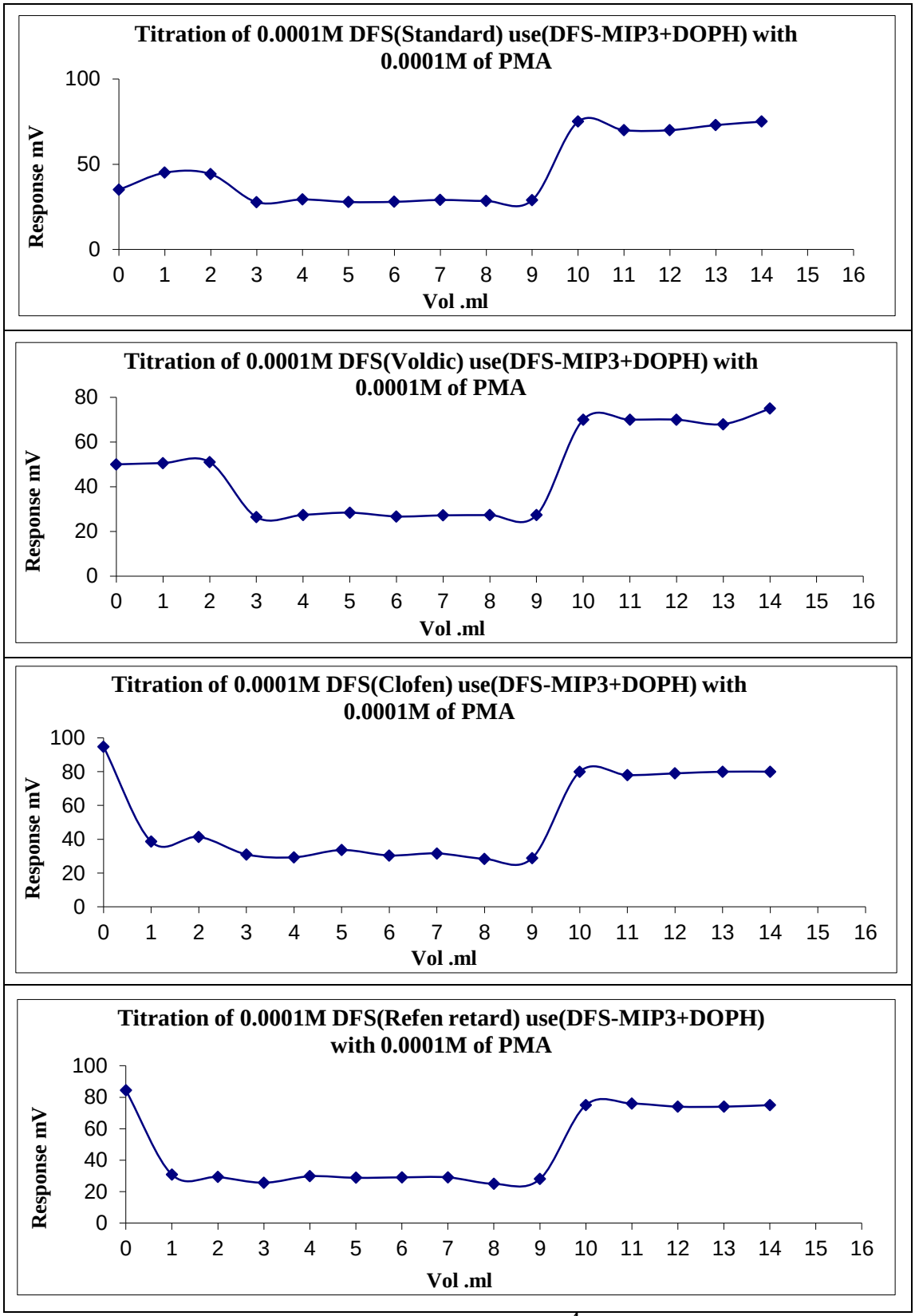


Fig. (3-147) Potentiometric Titration of each 10^{-4}M DFS (Standard , Voldic, Clofen and Refen retard solution with10^{-4} PMA solution using (DFS-MIP3+DOPH) electrode

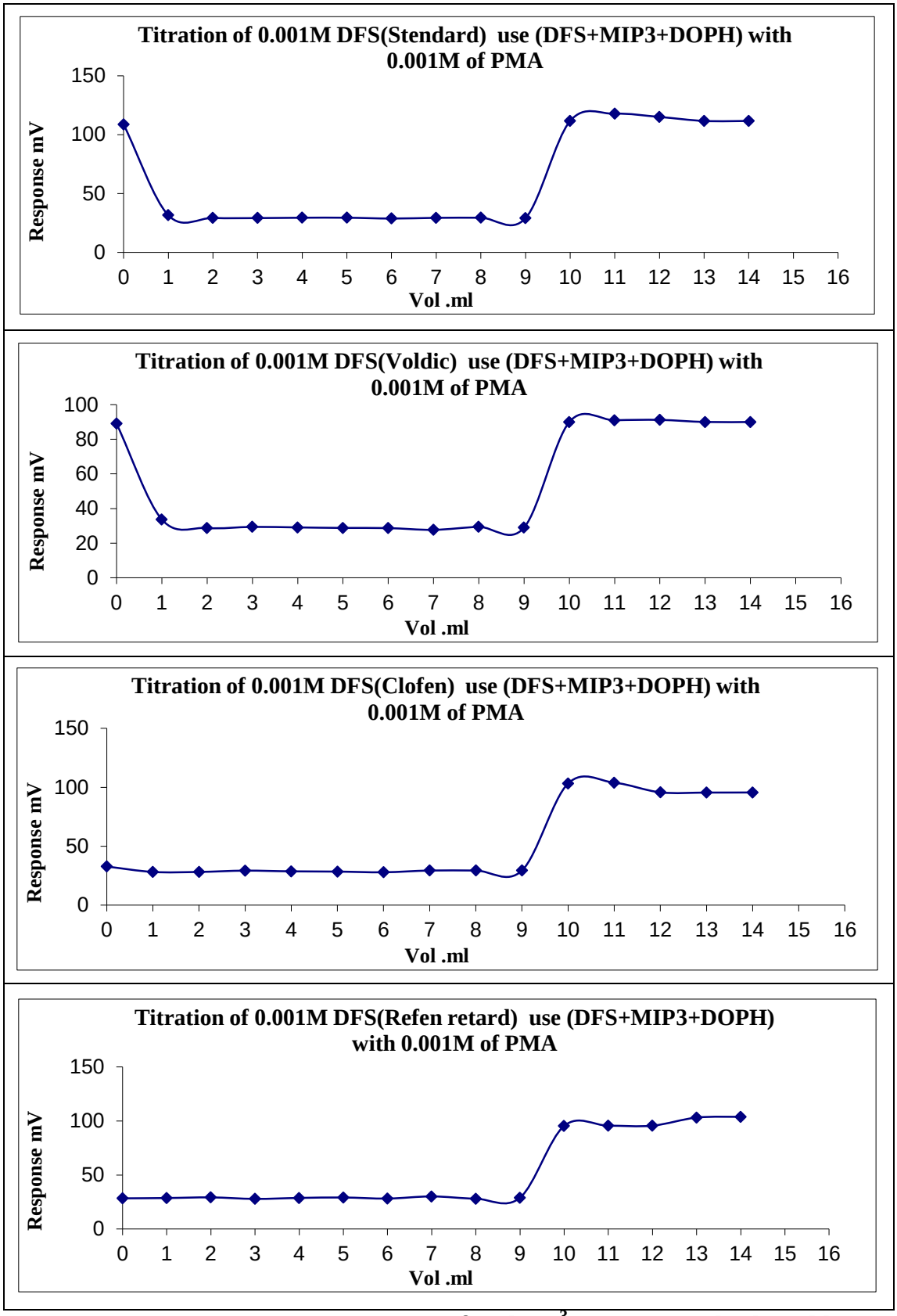


Fig. (3-148) Potentiometric Titration of each 10^{-3}M DFS (Standard , Voldic, Clofen and Refen retard solution with10^{-3} PMA solution using (DFS-MIP3+DOPH) electrode

Table (3-104): Diclofenec sodium Standard and forms pharmaceutical sample analyses by using titration method for IBP electrodes

Electrode No.	sample	Measured using Titration Method	RSD %	E_{rel}%	REC %
DFS-MIP1 + TEHP (I)	**1×10^{-4}**				
	Standard	1.03×10^{-4}	0.9	3.8	103
	Voldic	1.039×10^{-4}	1.12	3.9	103.9
	Clofen	1.038×10^{-4}	1.03	3.8	103.8
	Refen retard	1.039×10^{-4}	1	3.9	103.9
	1×10^{-3}				
	Standard	1×10^{-3}	0.82	1.3	101
	Voldic	1.02×10^{-3}	1.27	3.6	103.6
	Clofen	1.025×10^{-3}	1.11	3.4	103.4
	Refen retard	1.01×10^{-3}	1.1	3	103
DFS-MIP2 + DBPH (II)	**1×10^{-4}**				
	Standard	9.9×10^{-5}	1.4	-1	99
	Voldic	1.01×10^{-4}	1	1.13	101.1
	Clofen	1.02×10^{-4}	1.12	1.26	101.2
	Refen retard	1.02×10^{-4}	1. 39	1.9	101.9
	1×10^{-3}				
	Standard	1×10^{-3}	1.3	0.9	100
	Voldic	1.02×10^{-3}	1	2.4	102.4
	Clofen	1.025×10^{-3}	1.2	2.5	102.5
	Refen retard	1.01×10^{-3}	0.82	1.3	101
DFS-MIP3 + DOPH (III)	**1×10^{-4}**				
	Standard	1.03×10^{-4}	0.848	3.451	103.451
	Voldic	1.04×10^{-4}	1	4	104
	Clofen	1.04×10^{-4}	1.1	3.990	103.99
	Refen retard	1.038×10^{-4}	1.1	3.811	103.811
	1×10^{-3}				
	Standard	1.03×10^{-3}	1.2	3	103
	Voldic	1.038×10^{-3}	0.845	3.809	103.8
	Clofen	1.04×10^{-3}	0.853	4	104
	Refen retard	1.028×10^{-3}	1.6	2.8	102.8

Table (3-105) Determination of Diclofenec sodium pure samples by ion selective electrodes (ISEs) techniques based on PVC membranes

Electrode NO and composition	Measurement by using ISEs methods				
DFS-MIP1 + TEHP (I)	Standard sample			1×10^{-4} (M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1.03×10^{-4}	0.9	3.8	103
	DM	9.88×10^{-5}	0.68	-1.2	98.8
	SAM	9.977×10^{-5}	0.5	-0.23	99.77
	MSA	1.0008×10^{-4}	0.18	0.08	100.08
	Standard sample			1×10^{-3} (M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1×10^{-3}	0.82	1.3	101
	DM	1.009×10^{-3}	0.95	0.9	100.9
	SAM	9.97×10^{-4}	0.28	-0.21	99. 78
	MSA	1.0011×10^{-3}	0.19	0.11	100.11
DFS-MIP2 + DBPH (II)	Standard sample			1×10^{-4} (M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	9.9×10^{-5}	1.4	-1	99
	DM	1.006×10^{-4}	0.9	0. 63	100.63
	SAM	9.979×10^{-5}	0.4	-0.21	99.79
	MSA	1.0018×10^{-4}	0.28	0.18	100.18
	Standard sample			1×10^{-3}(M)	
	Method	Con. Found(M)	RSD%	E_{rel}%	REC%
	Titration	1×10^{-3}	1.3	0.9	100
	DM	1.008×10^{-3}	0.87	0.8	100.80
	SAM	9.96×10^{-4}	0.51	-0.34	100.55
	MSA	1.0021×10^{-3}	0.30	0.21	100.21

DFS-MIP3 + DOPH (III)	**Standard sample**			**1×10^{-4}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	9.9×10^{-5}	1.4	-1	99
	DM	1.006×10^{-4}	0.9	0. 63	100.63
	SAM	9.979×10^{-5}	0.4	-0.21	99.79
	MSA	1.0018×10^{-4}	0.28	0.18	100.18
	Standard sample			**1×10^{-3}(M)**	
	Method	**Con. Found(M)**	**RSD%**	**E_{rel}%**	**REC%**
	Titration	1×10^{-3}	1.3	0.9	100
	DM	1.008×10^{-3}	0.87	0.8	100.80
	SAM	9.96×10^{-4}	0.51	-0.34	100.55
	MSA	1.0021×10^{-3}	0.3	0.21	100.21

Table (3-106): Sample analysis of pharmaceuticals Diclofenec sodium (Voldic) by using ISE

Pharmaceutical		**Voldic 100mg**			
DFS-MIP1 + TEHP (I)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.039×10^{-4}	9.89×10^{-5}	9.98×10^{-5}	1.0016×10^{-4}
	REC%	103.9	98.96	99.82	100.16
	E_{rel} %	3.9	-1.04	-0.18	0.16
	RSD%	1.12	0.85	0.47	0. 23
	F test	14.66	11.67	8.32	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	1.02×10^{-3}	1.008×10^{-3}	9.95×10^{-4}	1.0019×10^{-3}
	REC%	103.6	100.81	99.5	100.19
	E_{rel} %	3.6	0.81	-0. 5	0.19
	RSD%	1.27	0.87	0.44	0.29
	F test	4.48	17.25	11.61	-
	F theoretical	**19.2**			

DFS-MIP2 + DBPH (II)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.01×10^{-4}	$\mathbf{1.007\times10^{-4}}$	$\mathbf{9.955\times10^{-5}}$	$\mathbf{1.0001\times10^{-4}}$
	REC%	101	100.71	99.52	100.01
	E_{rel} %	1	0.71	-0.45	0.01
	RSD%	1.1	0.81	0.49	0.26
	F test	15.88	8.70	15.69	
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.02×10^{-3}	9.96×10^{-4}	9.96×10^{-4}	9.999×10^{-4}
	REC%	102.4	99.6	99.65	99.99
	E_{rel} %	2.4	0.94	-0.35	0.01
	RSD%	1	0.92	0.52	0.1
	F test	13.77	15.19	16.70	
	F theoretical	**19.2**			
DFS-MIP3 + DOPH (III)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.04×10^{-4}	9.97×10^{-5}	9.952×10^{-5}	1.0042×10^{-4}
	REC%	104	99.7	99.52	100.42
	E_{rel} %	4	-0.3	-0.48	0.42
	RSD%	1	0.71	0.638	0.34
	F test	18.40	16.20	13.60	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.038×10^{-3}	9.92×10^{-4}	9.957×10^{-4}	1.0040×10^{-3}
	REC%	103.8	99.2	99.57	100.40
	E_{rel} %	3.8	-0.80	0.43	0.40
	RSD%	0.845	0.95	0.66	0.55
	F test	13.50	3.20	16.20	-
	F theoretical	**19.2**			

***Each measurement repeated three times.**

Table (3-107): Sample analysis of pharmaceuticals Diclofenec sodium (Clofen) by using ISE

Pharmaceutical		Clofen 100mg			
DFS-MIP1 + TEHP (I)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	1.038×10^{-4}	1.01×10^{-4}	1.0028×10^{-4}	1.002×10^{-4}
	REC%	103.8	101.24	100.28	100.24
	E_{rel} %	3.8	1.24	0.28	0.24
	RSD%	1.03	0.92	0.35	0.26
	F test	2.89	15.32	8.65	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	1.025×10^{-3}	9.92×10^{-4}	9.956×10^{-4}	1.0019×10^{-3}
	REC%	103.4	99.22	99.56	100.19
	E_{rel} %	3.4	-0.78	-0.44	0.19
	RSD%	1.11	0.98	0.38	0.29
	F test	8.99	9.23	12.87	-
	F theoretical	19.2			
DFS-MIP2 + DBPH	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con^{c}	**1.02×10^{-4}**	**1.0074×10^{-4}**	**1.0030×10^{-4}**	**1.0022×10^{-4}**
	REC%	101.2	100.74	100.30	100.22
	E_{rel} %	1.12	0.74	0.3	0.22
	RSD%	1.26	0.86	0.35	0.27
	F test	17.35	6.61	14.72	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con^{c}	**1.025×10^{-3}**	**1.008×10^{-4}**	**1.0024×10^{-3}**	**1.0016×10^{-3}**
	REC%	102.5	100.88	100.24	100.16
	E_{rel} %	2.5	0.88	0.24	0.16
	RSD%	1.2	0.84	0.57	0.21
	F test	15.63	5.95	15.43	-
	F theoretical	19.2			

DFS-MIP3 + DOPH (III)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.04×10^{-4}	9.932×10^{-5}	**9.943×10^{-5}**	**1.005×10^{-4}**
	REC%	103.99	99.32	99.43	100.55
	E_{rel} %	3.990	-0.68	0.57	0.55
	RSD%	1.1	1.2	0.642	0.51
	F theoretical	16.20	9.00	16.20	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.04×10^{-3}	**1.013×10^{-3}**	**9.94×10^{-4}**	**1.002×10^{-3}**
	REC%	104	101.3	99.4	100.27
	E_{rel} %	4	1.3	0.49	0.27
	RSD%	0.853	0.7	0.55	0.39
	F test	12.00	5.06	6.23	-
	F theoretical	**19.2**			

***Each measurement repeated three times.**

Table (3-108): Sample analysis of pharmaceuticals Diclofenec sodium (Refen retard) by using ISE

Pharmaceutical		Refen retard 100mg			
DFS-MIP1 + TEHP (I)	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	1.039×10^{-4}	1.01×10^{-5}	9.96×10^{-5}	1.002×10^{-4}
	REC%	103.9	101	99.69	100.20
	E_{rel} %	3.9	1	-0.31	0.20
	RSD%	1	0.99	0.46	0.23
	F theoretical	15.77	8.96	14.32	-
	Con. Prepared	Titration	DM	SAM	MSA
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.01×10^{-3}	1.015×10^{-3}	9.96×10^{-4}	1.0001×10^{-3}
	REC%	103	101.5	99.6	100.01
	E_{rel} %	3	1.15	-0.39	0.01
	RSD%	1.1	1	0.51	0.11
	F test	12.35	3.85	5.96	
	F theoretical	**19.2**			

DFS-MIP2 + DBPH (II)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	**1.02×10^{-4}**	**0.91×10^{-5}**	**1.0023×10^{-4}**	**1.0017×10^{-4}**
	REC%	101.9	99.10	100.23	100.17
	E_{rel} %	1.9	-0.90	0.23	0.17
	RSD%	1. 39	0.997	0.29	0.26
	F test	17.76	8.68	18.68	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	1.01×10^{-3}	**1.0095×10^{-3}**	**1.0031×10^{-3}**	**1.0022×10^{-3}**
	REC%	101	100.95	100.31	100.22
	E_{rel} %	1.	0.95	0.31	0.22
	RSD%	0.82	0.8	0.31	0.28
	F test	13.77	11.57	18.83	-
	F theoretical	**19.2**			
DFS-MIP3 + DOPH (III)	**Con. Prepared**	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
	Calc Con[c]	**1.038×10^{-4}**	**1.01×10^{-4}**	**9.9431×10^{-5}**	**1.0016×10^{-4}**
	REC%	103.811	101	99.58	100.16
	E_{rel} %	3.811	1	0.42	0.16
	RSD%	1.1	1	0.52	0.41
	F test	13.50	5.06	9.00	-
	Con. Prepared	**Titration**	**DM**	**SAM**	**MSA**
		1×10^{-3}	1×10^{-3}	1×10^{-3}	1×10^{-3}
	Calc Con[c]	**1.028×10^{-3}**	9.99×10^{-4}	**9.965×10^{-4}**	**1.0032×10^{-3}**
	REC%	102.8	99.94	99.65	100.32
	E_{rel} %	2.8	0.1	0.34	0.32
	RSD%	1.6	0.91	0.45	0.37
	F test	6.75	2.61	2.25	-
	F theoretical	**19.2**			

***Each measurement repeated three times.**

3-17 Adsorption Isotherm

Adsorption isotherm is useful in understanding the adsorption mechanism of the adsorption template on a polymer surface. The data obtained from the equilibrium of adsorption isotherm were analyzed to show the model of isotherm Langmuir or Freundlich models [201-203]. This was accomplished by plotting the ability of binding (Q) against free concentration of the drug, Q is calculated according to the following equation:

$$\mathbf{Q = [(C_i - C_f)\, V_s * 1000] / M_{MIP}}$$

C_i = initial drug concentration (µmol / ml).

C_f = final drug concentration (µmol / ml).

V_s = volume of solution tested (ml).

M_{MIP} = mass of dried polymer (mg).

Than measuring binding parameter

MIP/drug binding could be calculated by Scat chard analysis using the equation:

$$\mathbf{Q / C_f = (Q_{max} - Q) / K_d}$$

Q_{max} = maximum capacity.

K_d = dissociation constant at binding side.

Adsorption isotherm obtained after shaking different concentrations of MAMP with a synthesis particle for 2 hours in a water bath at 25 °C are given in in Figure (3-149) to (3-152) Experimental data for regrouping experiments were included in Table (31-109)to (3-113).

Table (3-109): Rebinding values of (IBP) using IBP –MIP1 particles based on (1-Vinylimidazole)

IBP-MIP1 (IBP+1-VI+EGDMA+BP)				
Mass of MIP gm	**Ci mm**	**C free mm**	**Q µMole/mg**	**Q/C free L/g**
0.15	2.0629	2.000	4.199	2.100
	4.1258	3.974	10.112	2.545
	8.2516	7.956	19.701	2.476
	12.3774	12.026	23.424	1.948
0.3	2.0629	1.946	3.884	1.996
	4.1258	3.798	10.921	2.875
	8.2516	7.786	15.533	1.995
	12.3774	11.786	19.697	1.671

Table (3-110): Rebinding values of (IBP) using IBP –MIP2 particles based on (2-hydroxyethyl methacrylate)

IBP-MIP2 (IBP+2-HEMA+N-NMBAA+BP)				
Mass of MIP gm	**Ci mm**	**C free mm**	**Q µMole/mg**	**Q/C free L/g**
0.15	2.0629	1.956	7.139	3.650
	4.1258	3.938	12.539	3.184
	8.2516	7.956	19.701	2.476
	12.3774	12.010	24.489	2.039
0.3	2.0629	1.890	5.774	3.056
	4.1258	3.762	12.135	3.226
	8.2516	7.683	18.943	2.465
	12.3774	11.595	26.086	2.250

Table (3-111): Rebinding values of (DFS) using DFS –MIP1 particles based on (1-Vinylimidazole)

DFS-MIP1 (DFS+1-VI+EGDMA+BP)				
Mass of MIP gm	**Ci mm**	**C free mm**	**Q µMole/mg**	**Q/C free L/g**
0.1	3.180	2.891	26.018	9.000
	6.360	5.848	46.055	7.875
	12.720	11.985	66.173	5.521
	19.080	18.122	86.192	4.756
0.2	3.180	2.674	22.766	8.514
	6.360	5.483	39.476	7.200
	12.720	11.544	52.939	4.586
	19.080	17.533	69.616	3.971

Table (3-112): Rebinding values of (DFS) using DFS –MIP2 particles based on (Acrylamide)

DFS-MIP2 (DFS+AA+EGDMA+BP)				
Mass of MIP gm	**Ci mm**	**C free mm**	**Q µMole/mg**	**Q/C free L/g**
0.1	3.180	3.108	6.505	2.093
	6.360	6.199	14.474	2.335
	12.720	12.485	21.175	1.696
	19.080	18.785	26.520	1.412
0.2	3.180	2.963	9.757	3.293
	6.360	5.987	16.777	2.802
	12.720	12.117	27.131	2.239
	19.080	18.306	34.808	1.901

Table (3-113): Rebinding values of (DFS) using DFS –MIP3 particles based on (Styrene)

DFS-MIP1 (DFS+Styrene+EGDMA+BP)				
Mass of MIP gm	Ci mm	C free mm	Q µMole/mg	Q/C free L/g
0.1	3.180	3.122	5.204	1.667
	6.360	6.199	14.474	2.335
	12.720	12.492	20.514	1.642
	19.080	18.778	27.183	1.448
0.2	3.180	3.035	6.505	2.143
	6.360	6.068	13.159	2.169
	12.720	12.419	13.566	1.092
	19.080	18.638	19.890	1.067

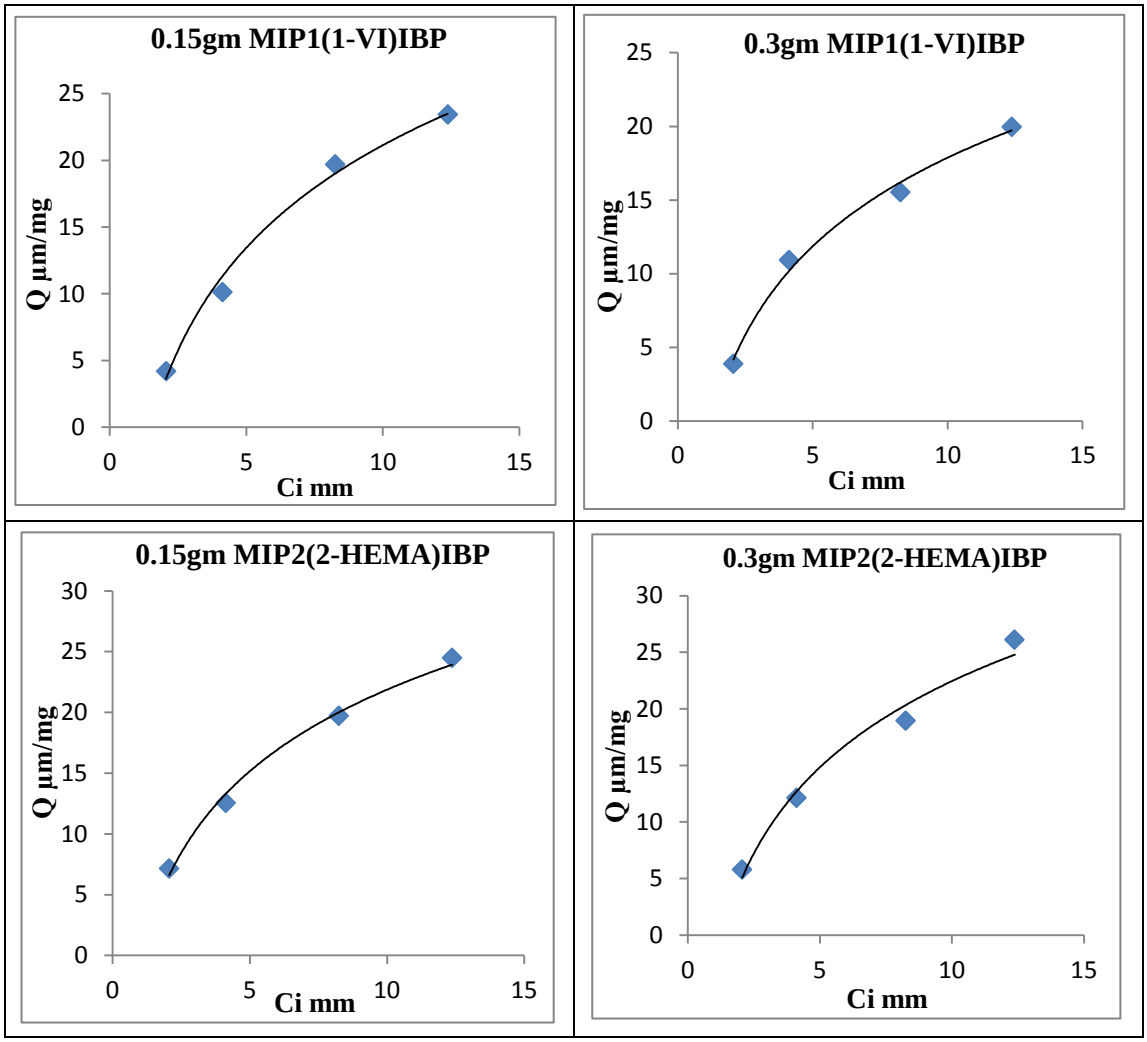


Figure (3-149): Binding isotherm of IBP 1-VI and 2-HEMA monomers

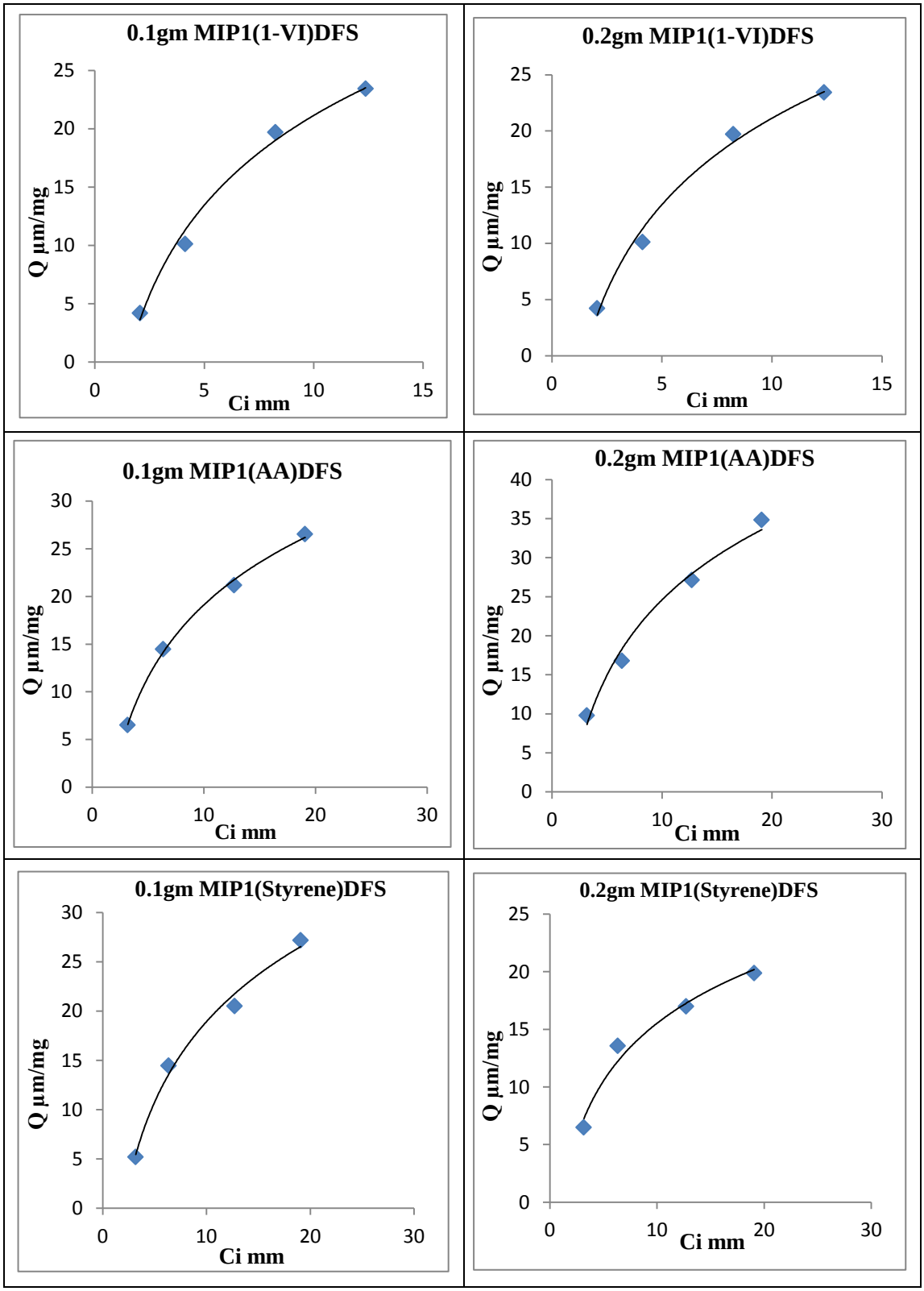


Figure (3-150): Binding isotherm of DFS 1-VI ,AA and Styrene monomers

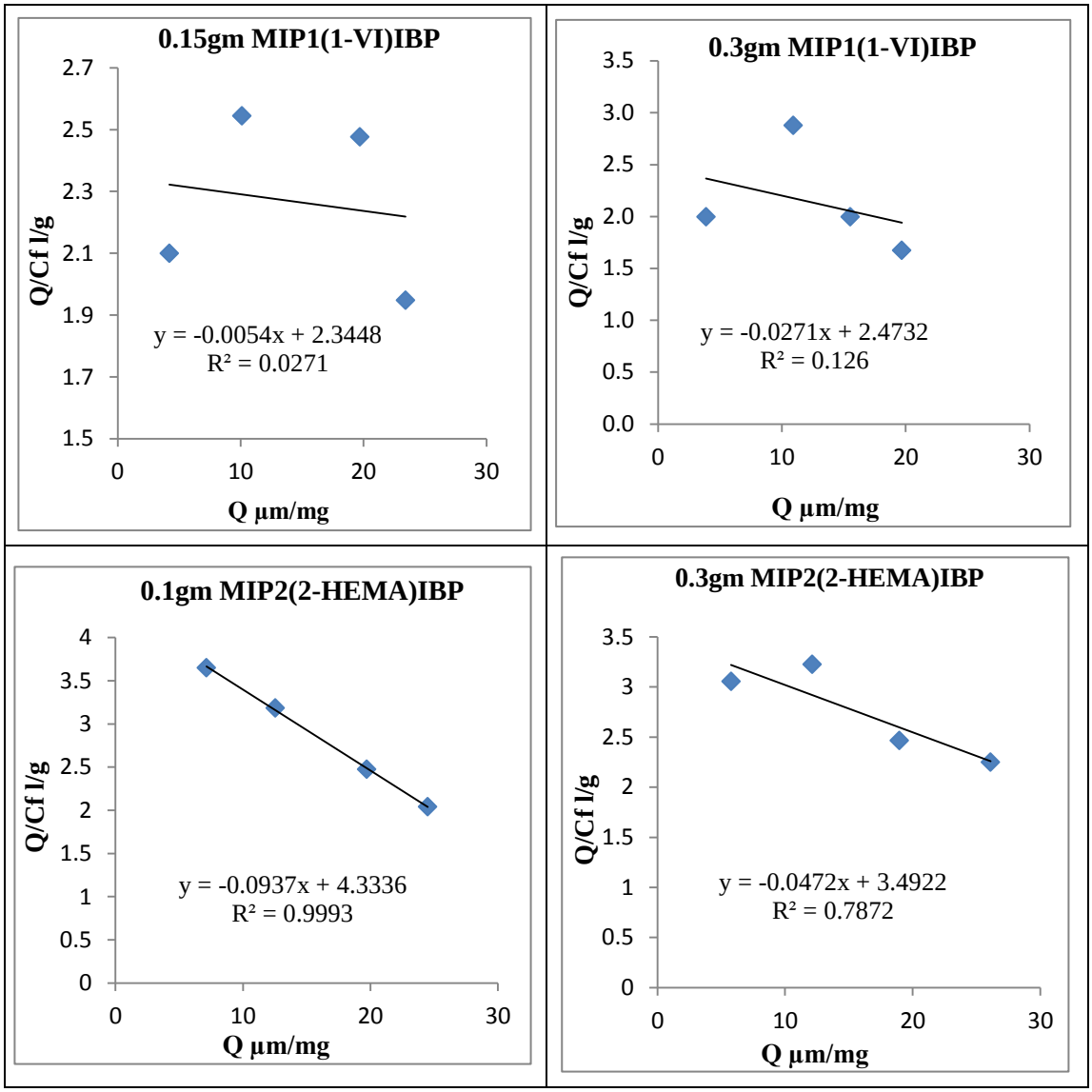


Figure (3-151): Scat chard plot of IBP -MIP based on (1-VI) and (2-HEMA) as a functional monomer

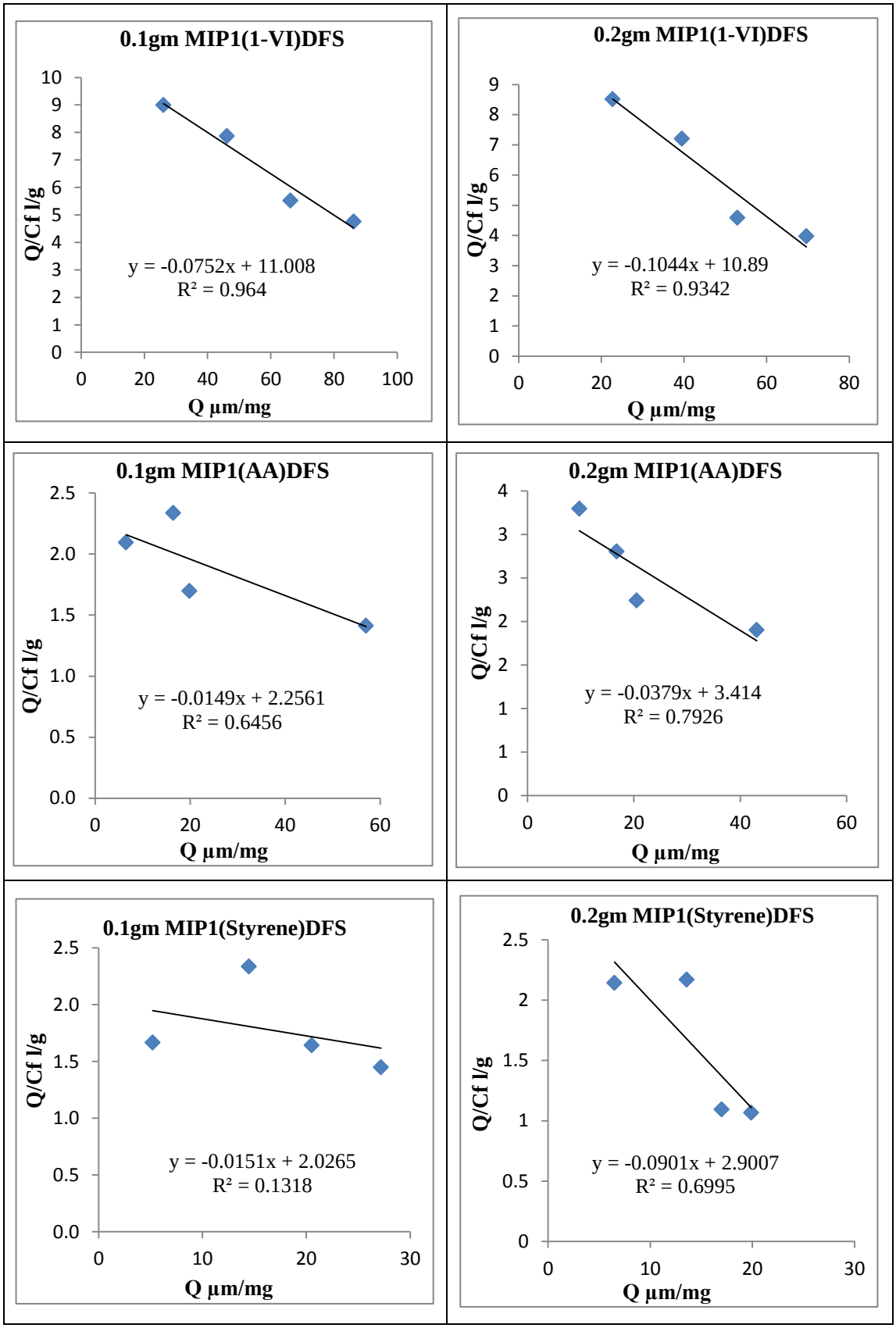


Figure (3-152): Scat chard plot of IBP -MIP based on (1-VI),(AA) and(Styrene) as a functional monomer

3-18 Effect of flow rate

The flow rate of peristaltic pump which was used for extraction of the MAMP from the extraction needle is important since it determines the time needed for extraction. The most important factor is the flow rate of the sample solution through the fabricated extraction needle. It must be enough to prevent waste of time by controlling the total analysis time. On the other hand, the flow rate must be low enough to get effective retention of the analyte. Thus, the effect of the sample loading flow rate was studied in the range of 10-100 rpm to estimate the influence of the time of contact between the MIP and the sample solution on the recovery as shown in the Tables (3-114) to (3-118)

Table (3-114): Effect of flow rate on time of extraction based on IBP-MIP1 (1-VI)

IBP-MIP1(1-vinyl imidazole)										
Mass of MIP gm.	0.15									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	80	75	70	65	60	54	45	40	33	30
Mass of MIP g	0.3									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	120	115	105	100	93	85	75	70	65	60

Table (3-115): Effect of flow rate on time of extraction based on IBP-MIP2 (2-HEMA)

IBP-MIP2(2-Hydroxyethyl methacrlyte)										
Mass of MIP gm.	0.15									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	120	115	110	107	100	91	85	80	77	75
Mass of MIP g	0.3									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	240	235	220	200	185	170	150	140	130	120

Table (3-116): Effect of flow rate on time of extraction based on DFS-MIP1 (1-VI)

DFS-MIP1(1-vinyl imidazole)										
Mass of MIP gm.	0.1									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	60	58	55	50	45	42	40	35	33	30
Mass of MIP g	0.2									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	120	115	105	100	90	80	75	70	65	60

Table (3-117): Effect of flow rate on time of extraction based on DFS-MIP2 (AA)

DFS-MIP2(Acryiamide)										
Mass of MIP gm.	0.1									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	15	14	13	12.5	12	11	10	9	6	5
Mass of MIP g	0.2									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	30	28	27	23	21	19	15	13	11	10

Table (3-118): Effect of flow rate on time of extraction based on DFS-MIP3 (Styrene)

DFS-MIP2(Styrene)										
Mass of MIP gm.	0.1									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	60	58	56	53	51	50	47	45	42	40
Mass of MIP g	0.2									
Flow rate (rpm)	10	20	30	40	50	60	70	80	90	100
Time (min)	120	115	107	97	90	87	83	80	77	75

Experiments were need to determination the minimum time to complete extraction in order to prevent wasting time. A complete extraction was achieved at any flow rate of the peristaltic pump from 10 to 100 rpm. The flow rate in rpm with time in minutes is shown in the following Figures (3-153), (3-154) , (3-155), (3-156) and (3-157). The time decrease as the flow rate increase and we fixed the flow rate of 100 rpm in which the time was 5 minutes and used this time for the following experiments.

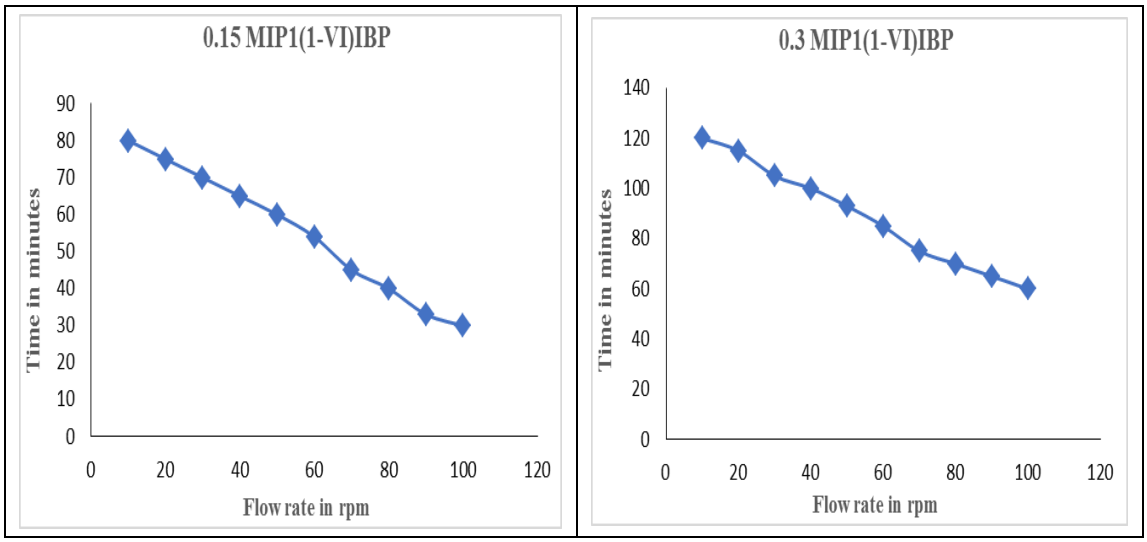


Figure (3-153): Relationship between the flow rate and extraction time based on 0.15and 0.3 gm of IBP-MIP1(1-VI)

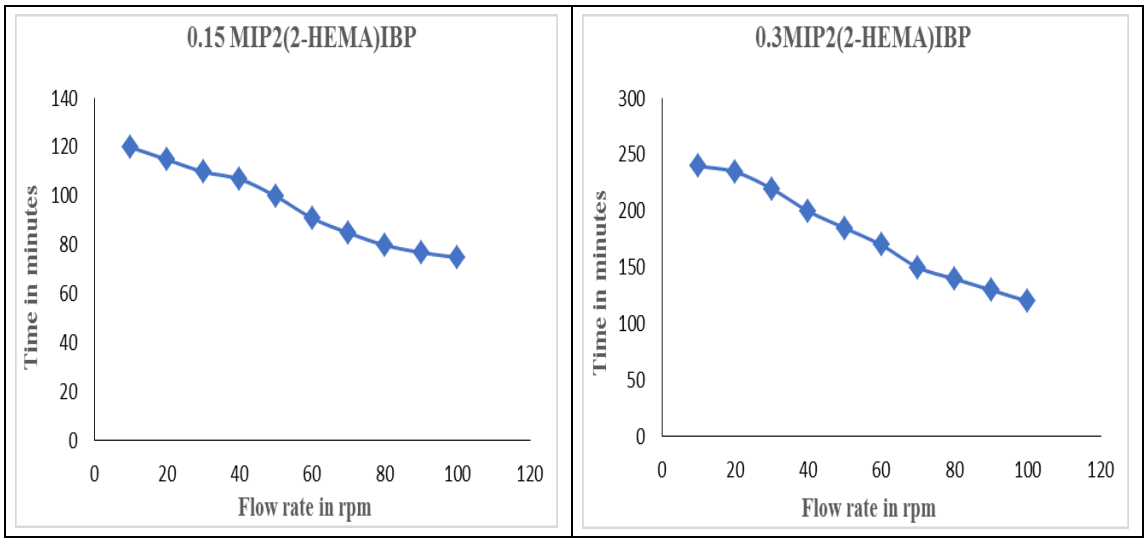


Figure (3-154): Relationship between the flow rate and extraction time based on 0.15and 0.3 gm of IBP-MIP2(2-HEMA)

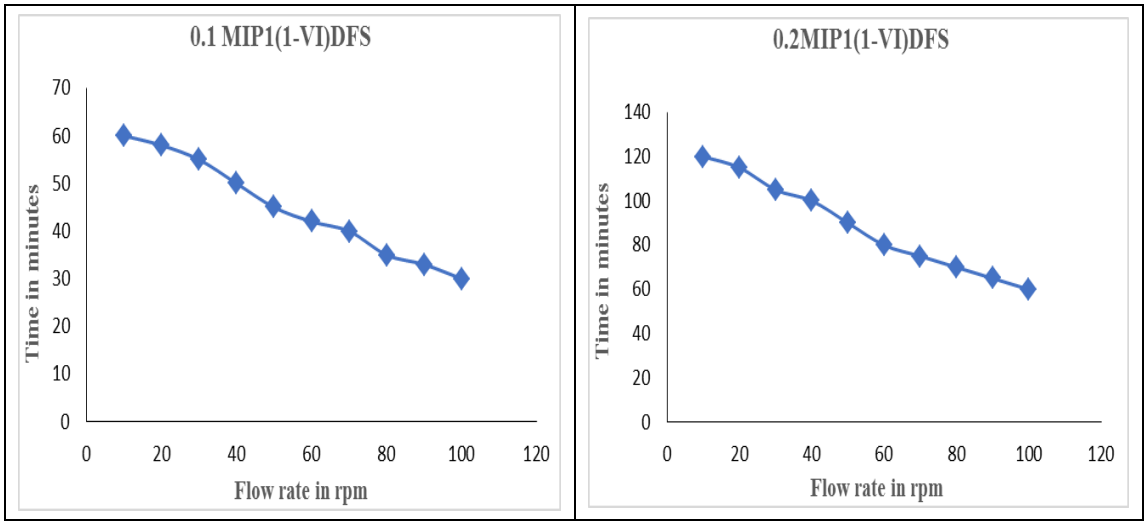


Figure (3-155): Relationship between the flow rate and extraction time based on 0.1and 0.2 gm of DFS-MIP1(1-VI)

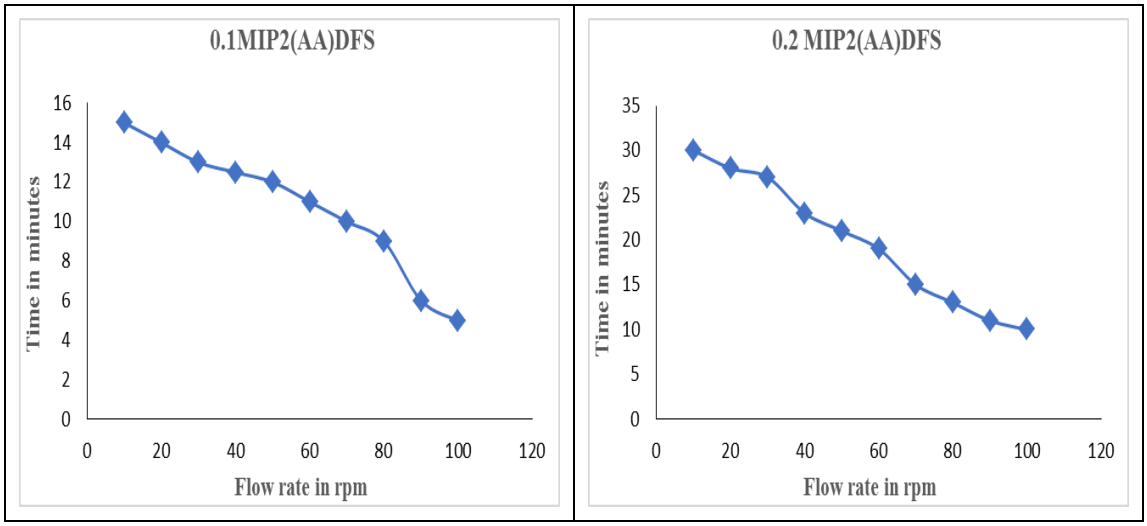


Figure (3-156): Relationship between the flow rate and extraction time based on 0.1and 0.2 gm of DFS-MIP2(AA)

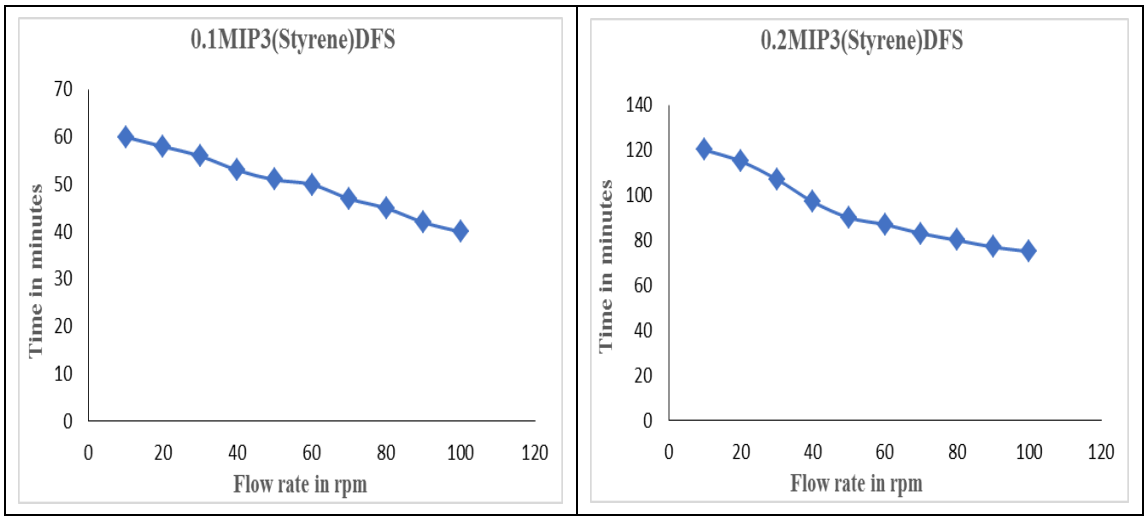


Figure (3-157): Relationship between the flow rate and extraction time based on 0.1and 0.2 gm of DFS-MIP2(AA)

Conclusion

In this study were prepare membranes ions selective electrodes for used in determine of two drugs namely Ibuprofen and diclofenac sodium that depended on molecular imprinting technique. sex molecularly imprinted polymers were prepared by using Ibuprofen and diclofenac sodium as the template. The functional monomers that have been used in synthesis of molecularly imprinted polymers are 1-vinyl imidazole (1-VI), 2-hydroxyethylmethaacrylate (2-HEMA) and Styrene while with DFS used 1-vinyl imidazole (1-VI) ,acryl amide (AA), and styrene respectively. In addition the Ethylene glycol dimethacrylate(EGDMA) and N-N methylene bis acrylamide were used as cross linker Benzoyl peroxide as initiator, respectively. Depending on these MIPs have been prepared eight electrodes Five of IBP and three of DFS within the PVC membrane.

Different methods were used in this study for determination the Ibuprofen and diclofenac sodium which given a good results compared with standard method in British pharmacopeia.

The selective electrodes were prepared for IBP based on three molecularly imprinted polymers depended on different plasticizers such as Dioctyl phthalate (DOPH), Nitro benzene (NB) Tri tolyl phosphate (TTP) Dibutyle phthalate (DBPH),and Dibutyle Sebacate (DBS) respectively.

IBP-MIP electrodes based on (1-VI) , (2-HEMA) and (Styrene) as functional monomers showed results of the slops (30.5, 29.9, 19.04, 19.003, 20.46)mV/decade ,linear concentration(10^{-6}-10^{-1})M and detection limits ($1.2\times10^{-7,}$ 2.3×10^{-8} ,1.86×10^{-7} ,$7\times10^{-7}$and 7.1×10^{-7}) M for electrodes, respectively. The working pH was studied in the estimate of Ibuprofen pure and pharmaceutical samples by using acid/ or base solution at range between (1.0 -11.0) through measurement electrodes.

DFS-MIP electrodes based on (1-VI),(AA) and (Styrene) in the composition as functional monomers. These MIPs were used in the construct of membranes that combined with plasticizers tris(2-ethyl hexyl)phosphate (TEHP),di-butyl phthalate (DBPH) and di-octyl phthalate (DOP) respectively for determine of diclofenac sodium. The results of the Nernstian slops were (17.87,19.415 and 19.168)mV/decade with linear concentration(10^{-6}-10^{-1})M as well as detection limits(7×10^{-6},2.9×10^{-7} , and 4.5×10^{-7}) M three electrodes, respectively. In addition the working pH was studied for electrodes Diclofenac sodium.

The concentrations ($1\times10^{-4}$and 1×10^{-3}) were prepared of standard and pharmaceuticals samples for both drugs to use in measurement of Ibuprofen and diclofenac sodium. The methods applied in the determine of IBP and DFS was direct method (DM),standard addition method (SAM), multiple standard addition (MSA) and titration method (TM).The relative standard deviation RSD% was calculated for all electrodes and of each method.

Recommendations

1- Using the fabrication electrodes for ibuprofen and diclofenac sodium and as detector in flow-injection techniques to determination drugs.

2- Study effected of different plasticizers to get better idea on their influence on the electrode performance.

3- The prepared MIPs can be used as column in HPLC meth

4- Knowledge the other amount and percent of components proportions in membrane, through fixing one of the components and changing the other.

5- Polyurethane and Silicone rubber are using as another matrix instead of PVC in order to compare with PVC matrix.

6- Study the selectivity behavior using other methods and also by using more interfering ions.

7- Synthesis of Molecular Imprinted polymers for Estimation IBP and DFS drugs using new monomer and cross linker.

8- Using the Molecularly Imprinted polymers (MIPs) in the construction of electrodes membranes for determination of other drugs.

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References