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Review on cyclic voltammetric and spectrophotometric approaches for the analysis of drugs (antihypertensive) using different electrodes and wavelength

Habibur Rahman[a], Iqbal Hussain[a] and S. K. Manirul Haque[b]*

[a]*Department of General Studies, Jubail Industrial College, Jubail Industrial City, Saudi Arabia*
[b]*Department of Chemical & Process Engineering Technology, Jubail Industrial College, Jubail Industrial City, Saudi Arabia*

ABSTRACT

Hypertension is the most prevalent cardiovascular disease in the developed as well as developing countries, affecting about 20 – 30% of the adult population. It is an independent risk factor for cardiovascular disease and is associated with an increased incidence of stroke and coronary heart disease. To control the risk factors several types of antihypertensive drugs are used in the world. Therefore, pharmacodynamic and pharmacokinetic studies are utmost important for the quality control. The advent of electronics has allowed to develop more sensitive, reliable and less expensive instrumentations which have significant contribution in the field of drug development and analysis. The use of various types of modified electrodes in the voltammetrictechniques and spectrophotometric method play an important role due to its advantages over other sophisticated instruments in terms of low cost, simplicity and portability.

Keywords: cardiovascular disease; antihypertensive drugs; spectrophotometry; voltammetry.

INTRODUCTION

Antihypertensive drugs play a very crucial role in the treatment and lifesaving of cardiac patients. In spite of their crucial role, they create specifically desired effect as administered by the most desired route at minimal dosage and dosing frequency. Almost all the drugs are harmful or even poisonous at high dose levels. Therefore it is utmost important to determine the activity of drug and their pharmacokinetic and pharmacodynamics studies in pharmaceutical formulations. The analysis of drug is an integral part of overall drug development process.It involves the determination of not only for active components but also impurities, excipients, stability of active components (degradation intermediates or end-products) and other parameters such as content uniformity, solubility and dissolution rate.

Keeping these points in consideration, various analytical methods, including gas chromatography (GC) [1, 2] high-performance liquid chromatography (HPLC) [3, 4] liquid chromatography mass spectrometry (LC-MS, LC-MS-MS) [5, 6], cyclic voltammetricand spectrophotometric method have been developed for the determination of antihypertensive drugs in commercial dosage forms. All these analytical techniques are well established and recommended as good and validated methods for the analysis. However, our concern is to review the development of cyclic voltammetric (electrochemical method) and spectrophotometric approach for the analysis of antihypertensive drugs because ofits wide range of applications, sensitivity, selectivity, accuracy, precision, rapid analysis time, large linear dynamic range, low cost instrumentation, portability and instrument simplicity. Moreover, electrochemical techniques are useful tools for the study of adsorption and crystallization phenomena at electrode surfaces [7-11]. It has been alsoused as a complementary technique to spectrophotometry due to its high sensitivity, speed of analysis, reduction in solvent and sample consumption [8-12]. The principal advantages of these electrochemical techniques such as linear sweep, cyclic, differential pulse, square wave etc. are that the excipients

do not interfere and generally the separation and extraction procedures are not necessary. Therefore, the utility of these techniques increased in pharmaceutical industries.

Among instrumental analytical techniques, spectrophotometry occupies aunique position because of its simplicity, speed, precision, accuracy and economical compared to other methods such as chromatography and electrophoresis [13]. These methods are widely used for the determination of organic substances, drugs in pharmaceutical formulations, biological fluids, blood serum, ointment and urine samples [14-18]. Various review papers are available for the drug analysis by different electroanalytical and spectrophotometric techniques [19-30]. But to the best of our knowledge, a review especially focused on the analysis of antihypertensive drugs using cyclic voltammetry and spectrophotometry is not available. Therefore, the main objective of this review is to present the advantages and use of cyclic voltammetric and spectrophotometric techniques for the analysis of antihypertensive drugs.

MATERIALS AND METHODS

Electrochemical methods have worldwide reputation for the analysis of drugs and pharmaceuticals due to their high sensitivity, versatile, low detection limits and inexpensive instrumentations [31]. These modalities involve the direct conversion of chemical information into signals in terms of current, potential and charge. Electrochemical methods are highly capable for assaying the concentration of electroactive analyte at trace level and supply useful information concerning its physical and chemical properties such as oxidation potential, diffusion coefficients, electron transfer rates and electron transfer number. Besides, their analytical advantages, these techniques play an important role in the study of pharmacologically active compounds and metabolites produced by different metabolic pathways involving redox reactions [32]. Consequently, electrochemical data develop the relationship between the biological activity and electrodic processes of the drugs, whichhelp to provide the hints about the action mechanism of the specific drug and correlate to the molecular structure and pharmacological activity. Moreover, the interaction of drug with metals, proteins and the degradation of photo or pH sensitive drugs werealso studied by using electrochemical techniques [33].

Voltammetry

Voltammetry is in fact a set of analytical methods used to determine the properties of an analyte by measuring the reactivity of analyte to an electrical charge while the potential of the current is varied [34]. This technique based on the continuous variation of the potential applied across the electrode-solution interface, being the resulting current recorded. The resulting voltammamogram is analogous to a conventional spectrum in the sense that it conveys information as a function of energy scan. Voltammetric methods can also be used to perform solubility and stability studies to understand the interaction among drugs and living cells [35, 36]. Nowadays, voltammetric techniques associated to flowing or convective systems have intensely been employed for the analysis of a variety of samples (although in reduced extension) even for drug analysis [37-41]. Voltammetric techniques have been extremely useful in measuring blood levels, metabolites and urinary excretion of drugs following low doses, especially when coupled with chromatographic methods. In many cases, modern electro-analytical techniques like square wave voltammetry (SWV) are also available alternative to more frequently used spectrometric or separation methods [42,43]. Voltammetric measurements can also be applied directly to the colored and suspended colloidal systems. Although biological or complex environmental samples required pretreatment, but this process is faster, cheaper and easier as compared to the pretreatment of samples analyzed for chromatographic techniques [44]. In this modality solid or mercury based electrodes are served as working electrode where the reaction of interest occurs. The field of modified solid electrodes has become very popular and applied in industries, quality control of drugs and foods, determination in pharmaceutical formulations and environmental monitoring [45-47]. Various scientists used different voltammetric techniques such as potential step, linear sweep, differential pulse, square wave, stripping and cyclic voltammetry for the analysis of drugs in dosage forms [48-56]. These techniques have been successfully applied for trace measurement of important pharmaceutically active compounds due to its high sensitivity and selectivity.

Cyclic Voltammetry

Cyclic voltammetry is often the first experiment performed in an electrochemical study based on potential control and most widely used for acquiring qualitative information about electrochemical reactions [57-61]. It is widely applicable in the study of redox reactions, detection of reaction intermediate and the observation of follow up reaction of products formed at the electrode and most versatile electroanalytical tool for the analysis of pharmaceuticals and biologically active compounds [62-65].

Cyclic Voltammetric analysis of some miscellaneous drugs

Acuna et al. studied the kinetics of the hydrolytic decomposition of droxicam and established the pharmacological action of the drug in the organism of the human body [66]. Bollo et al. carried out the experiment for the formation and stability of the radical anion from PA-824 and compared with metronidazole [67]. Wang et al. discussed the cyclic voltammetry study along with bulk electrolysis and deduced the redox reaction mechanism of nicotinic acid and nicotinamide in which it was rationalized by the formation/disappearance of the new nitrogen-oxygen bonds in pyridine rings [68]. The determination of acetaminophen in paracetamol tablets was performed by using cyclic voltammetry in phosphate buffer with good linearity and precision range [69]. Topal et al. investigated the electrochemical oxidation of loracarbef by using cyclic, linear sweep, differential pulse and square-wave voltammetric techniques. The results obtained from this study indicated that the oxidation process of loracarbef is irreversible and diffusion controlled on glassy carbon electrodes and the quantitative determination of loracarbef was in the range of 6×10^{-6} to 2×10^{-4} M. This method was also proposed for the determination of loracarbef in pharmaceutical dosage forms [70]. Liu et al. studied the electrochemical behavior of isorhamnetin at glassy carbon electrode and a linear dependence on theconcentration of isorhamnetin in the range of 1×10^{-7} to 4×10^{-6} M and 1×10^{-6} to 1×10^{-5} M were obtained [71]. Norouzi et al.developed the method for the determination of rantidine in pharmaceutical formulations with the detection limit 24 pg ml^{-1} [72]. The relevant analytical data based on the cyclic voltammetric study of same antihypertensive drugs is given in Table 1 [61, 73-94].

Table 1: Use of cyclic voltammetry in the analysis of antihypertensive drugs

Name of drug	Working electrode	Detection limit	References
Amlodipine	GCE	--	[73]
Captopril	MCPE	1.1×10^{-6} M	[74]
Carvedilol	GCE	0.10 µg ml^{-1}	[75]
Diosmin	GCE	3.5×10^{-8} M	[76]
Dipyridamole	Pt, Pd, Au, Carbon	--	[77]
Dopamine	Mod. GCE	5×10^{-6} M	[78]
Hydrochlorothiazide	GCE	0.10 µg ml^{-1}	[79]
Imipramine	Au microelectrode	4.55 pg ml^{-1}/14-22400 pg ml^{-1}	[80]
Indapamide	MCPE	5 nM	[81]
Irbesartan	HMDE	$5.33 \times 10^{-6} – 1\times 10^{-4}$ M	[82]
	GCE	5.33×10^{-7} M	[83]
Lercanidipine	Mod. GCE	0.02 – 3 µg ml^{-1}	[84]
Losartan	Au microelectrode	--	[61]
Nifedipine	GCE	2×10^{-5} M	[85]
Nimodipine	HMDE	7.11 ng ml^{-1}	[86]
	Mod. GCE	0.025 – 3 µg ml^{-1}	[84]
Ramipril	DME, Pt. electrode	4.8×10^{-8} M	[87]
Rutin	HMDE	4.9×10^{-9} M	[88]
Terazosin	GCE	6×10^{-7} M	[89]
Timolol	Au microelectrode	1.58 ng ml^{-1}	[90]
	SMDE	2.5 ppb	[91]
Tramadol	Au disk microelectrode	0.32 pg ml^{-1}	[92]
Trimetazidine HCl	GCE	2×10^{-8} M	[93]
Verapmil	DME,PCE	5×10^{-10} M	[94]

Abbreviations:

GCE = glassy carbon electrode,
DME= dropping mercury electrode
HMDE = hanging mercury drop electrode
SMDE = static mercury drop electrode
MCPE = modified carbon paste electrode
CPE= carbon pasteelectrode
PCE= platinum counter electrode

SPECTROPHOTOMETRIC METHOD

Analytical methods based on measurements of ultraviolet or visible (UV-Visible) light absorption belongs to the most popular and most often used laboratory practices. UV-Visible spectrophotometry can be regarded as one of the most suitable and economical methodin the laboratories of research, hospitals and pharmaceutical industries due to its low cost, portability and inherent simplicity [95, 96].Moreover, it's coupling with other modalities increases the application of spectrophotometry. However, direct spectrophotometric methods are not suitable for simultaneous determination ofdrugs due to their spectral overlapping. To overcome this problem derivative spectrophotometric approach is widely applicable to enhance the sensitivity and specificity by using the information from overlapping bands of the analytes and interferences [97, 98]. It also has been commonly used for the analysis of several

antihypertensive drugs and reviewed by various scientists [99-101]. Salem et al. developed the method for the determination of domperidone maleate and cinnarizine in a binary mixture by using derivative ratio spectrophotometry [102].

Interferences from active substances were eliminated by applying derivative spectrophotometry for determination of irbesartan and hydrochlorothiazide in CoAprowel 150/12.5 [103], hydrochlorothiazide and losartan in Losazid and Neo Lotan Plus [104], candesartan and hydrochlorothiazide [105]. Perindopril and indapamide were also determined in Pretrax using derivative spectrophotometry and liquid chromatographic method, as a reference one [105]. This approach is able to eliminate the interferences from degradation products, co-formulated drugs and also excipients, however their uses in highly complex samples such as biological fluids are limited. The use of UV spectrophotometry as detector in flow injection analysis (FIA) systems for drug analysis is another important application of this technique [106]. Several drugs and metals have been determined using UV-FIA in dosage forms [107-108]. A second generation of flow analysis designated as sequential injection analysis was proposed by Ruzicka and Marshal in 1990, which provides a powerful and versatile instrument for the automation of diverse analytical procedures[109]. This technique has been associated with a large numberof detectors including UV-Visible spectrophotometry and has been applied in chemistry areas as diverse as pharmaceutical, environmental, food and beverage radiochemical kinetic studies of chemical reactions [110, 111]. Representative examples of spectrophotometric method for the analysis of antihypertensive drugs have been published are summarized in Table 2 [112-255].

Table 2: Use of spectrophotometric methods forthe analysis of antihypertensive drugs

Name of drug	Reagents/Method	Absorption maxima λ_{max} (nm)	References
Ramipril	Cu (II) and eosin	535	[112]
	Fe (III) + ammonium thiocyanate		[113]
	7,7,8,8-tetracyanoquinodimethane	840	[114]
	p-chloranilic acid	520	[114]
	2,3-dichloro-5,6-dicyano-p-benzoquinone		[114]
	p-chloranilic acid	524	[115]
	Picric acid	370	[115]
	Bromocresol green	412	[115]
	Alkaline $KMnO_4$	610	[116]
	7-fluoro-4-nitrobenzo-2-oxo-1,3-diazole	460	[117]
	KIO_3 and KI	352	[118]
	1-chloro-2,4-dinitrobenzene	420	[119]
	Excess Ce (IV)+ amaranth dye	523	[120]
	UV	210	[121]
	Tropaelin 000	489	[122]
	Sodium nitroprusside acetaldehyde	560	[123]
	UV	250	[124]
	Molybdenum (V) thiocyanate	517	[125]
	Benzalkonium chloride	545	[125]
	Brucine + Sodium metaperiodate	525.6	[126]
	UV	200–350	[127]
	UV	201–270	[128]
Perindopril	Bromothymol blue	--	[129]
	$FeCl_3$ in the presence of KSCN	--	[129]
	2,3-dichloro-5,6-dicyano-p-benzoquinone	588	[130]
	7,7,8,8-tetracyanoquinodimethane	843	[130]
	Tetracyanoethylene	419	[130]
	Chloranil	550	[130]
	p-chloranilic acid	520	[130]
	1-chloro-2,4-dinitrobenzene	420	[131]
	Zn (II) and eosin	510	[132]
	Iodine	365	[132]
	Cu (II) and eosin	535	[112]
	UV	215	[133]
	UV	213	[134]
	$KMnO_4$ in alkaline medium	603	[135]
	2, 4 dinitrofluorobenzene	410	[136]
	Sanranin - O	520	[137]
	Bromothymol blue	410	[137]
	$KMnO_4$	605	[137]
	Ammonium molybdate	750	[137]
Enalapril maleate	2,4-dinitrofluorobenzene	356,420	[138]
	$KMnO_4$ with acidic dyes	510, 521,484	[139]
	KIO_3 and KI	352	[140]

	p-chloranilic acid	510	[140]
	2,3-dichloro-5,6-dicyano-p-benzoquinone	565	[140]
	Iodine	365	[140]
	p-chloranilic acid	534	[115]
	Picric acid	370	[115]
	Bromocresol green.	412	[115]
	UV	200-400	[141]
	Molybdenum (V) thiocyanate	517	[125]
	Benzalkonium chloride	545	[125]
Captopril	KIO_3 in acidic medium	510	[142]
	$KMnO_4$ + methylene blue	660	[143]
	$KMnO_4$ + Acid blue 74	610	[143]
	$KMnO_4$ + Acid red 73	510	[143]
	$KMnO_4$ + Amarnath dye	520	[143]
	$KMnO_4$ + Acid Orange 7	458	[143]
	Hexacyanoferrate (III)	510	[144]
	Dichlone	347	[145]
	Excess KIO_3 in acidic medium	606	[146]
	Excess Ce (IV) + Methyl Orange	510	[147]
	Fe (III) + Hexacyanoferrate (III)	700	[148]
	Bromine + indigo carmine	610	[149]
	Bromine + Fe (II) + 1,10 phenanthroline	510	[149]
	Bromine + Fe(II) + thiocyanate	478	[149]
	$KBrO_3$ + Celestine blue	540	[150]
	$NaNO_2$ + HCl	555	[151]
	2,2- diphenyl 1-picryl-hydrazyl	--	[152]
	$PdCl_2$	380	[153]
	N-bromopthalimide in 50% H_3PO_4	516	[154]
	Molybdophosphoric acid	685	[154]
	Cr (VI) + Diphenylcarbazide	540	[155]
	Excess Fe (II) + Pot. Ferricyanide	730	[156]
	$FeCl_3$ + bipyridyl or I_2	523,351, 620	[157]
	Cu (II) + neocuproine	448	[158]
	Sodium azide and I_2	348	[159]
	$AgNO_3$ +methyl orange	520	[160]
	$AgNO_3$ + eosin + 1,10 phenanthroline	550	[160]
	Excess bromide + methyl orange	510	[161]
	Excess Chloramine T + metol + sulphanillic acid	520	[162]
	Chloramine T	610	[163]
	2,6- dichloroquinone-4 chlorimide	443	[164]
	KIO_3+2',7'-dichlorofluorescein	520	[165]
	• Fluorescein natrium($C_{20}H_{10}Na_2O_5$)	436	[166]
Lisinopril	2,4-dinitrofluorobenzene	400, 365	[138]
	7,7,8,8,tetracyanoquinodimethane	743	[167]
	p-chloranilic acid	525	[167]
	N-bromosuccinimide	353	[168]
	$KMnO_4$ with acidic dyes	509, 521, 485	[139]
	Sodium 1,2-Naphthoquinone-4-sulphonate	481	[169]
	Fluorescein	228	[170]
	Ninhydrin in the presence of bicarbonate	420	[171]
	Chloranil	346	[172]
	Dichlone	580	[172]
	Acetyacetone and formaldehyde	356	[172]
	1-fluoro-2, 4-dinitrobenzene	356.5 or 405.5	[173]
	Sodium hypochlorite and phenyl hydrazine	362	[174]
	Ninhydrin and ascorbic acid	420, 530	[175]
	Ninhydrin	600	[176]
	Ninhydrin	410	[177]
	Ninhydrin	420	[178]
	UV	220, 340	[179]
	Cu(II) +Nile Blue A with H_2O_2 in Borate buffer	635	[180]
	Ninhydrin + Sodium molybdate	570	[181]
Methyldopa	2,6-dichloroquinone-4-chlorimide	400	[182]
	Ammonium molybdate	410	[183]
	$FeCl_3$	423	[184]
	Fe(III)-*o*-phenanthroline	510	[185]
	Fe(III) in acidic medium	510	[186]
	Isoniazid in presence of *N*-Bromosuccinamide	480-490	[187]
	Sodium nitroprusside + hydroxylamine hydrochloride	635-660	[187]
	Diazotised sulphanilamide + molybdate ions	500	[188]
	Barbituric acid	540	[189]

	Semicarbazide hydrochloride + potassium perssulfate	460-470	[190]
	p-Chloranil	535	[191]
	Polyphenol oxidase enzyme	480	[192]
	Neotetrazolium chloride	--	[193]
	Bromate – bromide mixture	670	[194]
	Fe(III) +Salicylic acid +HCl	525	[195]
	Fe(III) chloride and nitroso-R-salt	708	[196]
Prazosin	2,3,-dichloro-5,6-dicyano-*p* benzoquinone	460	[197]
	Bromophenol blue	410	[197]
	p-*N*-methyl aminophenol sulphate	520	[198]
	3-methyl-2-benzothiazolinone hydrazone hydrochloride	620	[198]
	Orange-II	490	[198]
	Alizarin violet 3B	570	[198]
	UV	356,346	[199]
	Britton–Robinson buffer (pH 1.8)	246 and 329	[200]
	1,2-naphthoquinone-4- sulphonic acid sodium	400	[201]
Doxazosin	Bromocresol purple	403	[202]
	Bromophenol blue	410	[202]
	2,3-dichloro-5,6-dicyano-p-benzoquinone	457	[202]
	7,7,8,8,tetracyanoquinodimethane	838	[202]
	Bromocresol green	418	[203]
	Bromothymol blue	414	[203]
	Methyl orange	425	[203]
	Alizarin red- S	426	[203]
Indapamide	Ammonium molybdate	710	[204]
Terazosin	p-dimethyl amino cinnamaldehyde	450	[205]
	3-methyl-2-benzothiazolinone hydrazone	641	[205]
	3-methyl-2-benzothiazolinone hydrazone + $FeCl_3$	660	[206]
	UV	250	[206]
	p-dimethyl amino cinnamaldehyde	410	[207]
	Bromocresol purple	420	[207]
	Chloranil	340	[208]
	Mercurochrome	543	[208]
	Bromocresol purple	412	[208]
	Bromocresol green	419	[203]
	Bromothymol blue	415	[203]
	Methyl Orange	425	[203]
	Alizarin Red- S	428	[203]
	$NaNO_2$ + HCl + 1-Naphthol	560	[209]
Losartan Potassium	$KMnO_4$ in alkaline medium	603	[210]
	UV	234	[211]
	UV	220,320,232.5	[212]
	Bromocresol purple	415	[213]
	Cresol- red	435	[213]
	UV	240.8	[214]
	Iodine	365	[215]
	7,7,8,8,tetracyanoquinodimethane	842	[215]
	2,3-dichloro-5,6-dicyano-p-benzoquinone	460	[215]
	1,3,5- trinitrobenzene	438	[215]
	p-Chloranilic acid	520	[215]
	Tetrcyanoethylene	414	[215]
	Bromanil	500	[215]
	Chloranil	463	[215]
	2,4,7-trinitro-9-fluoreenone	413	[215]
	Bromocresol green	612.4	[216]
	Bromophenol blue	607	[216]
Irbesartan	Bromocresol purple	415	[213]
	Cresol- red	435	[213]
	KIO_3 + KI	352	[217]
	UV	263	[218]
	Picric acid	416	[219]
	Bromocresol red	410	[219]
	Bromothymol blue	415	[219]
	Cobalt thiocyanate	625	[219]
	Molybdenum(V) thiocyanate	475	[220]
	Tropaeoline 000	484	[220]
	Alizarin red-S	420	[220]
	UV	200-300	[221]
	UV	230.1	[222]
	Bromophenol blue	420	[223]
	Bromocresol purple	420	[223]

	Bromothymol blue	420	[223]
	Naphthol blue black	625	[223]
Dihydralazine	2-hydroxy-1-naphthaldehyde	420	[224]
Hydralazine	2-hydroxy-1-naphthaldehyde	408	[225]
	UV	314-316	[226]
	Folin Ciocalteu reagent	640	[227]
	Fe (III)	720	[227]
	Vanillin	390	[228]
	p-dimethylaminobenzaldehyde	470	[229]
Reserpine	Fe(II) + 1,10 phenanthroline	510	[230]
	4-caboxyl-2,6-dintrobenzene diazonium ion	470	[231]
	Iodine	369	[232]
Clonidine	Bromocresol green	---	[233]
	UV	228.4	[234]
Benazepril	UV	240, 244	[235]
	Bromocresol green	412	[235]
	3-methylbenzothialozone hydrazone	593	[235]
	UV- derivative methods	214.8	[236]
	Second order derivative method	241. 2	[236]
	Ratio spectra derivative method	217.7	[237]
	Safranin-O	525	[238]
Cilazapril	UV	238.1	[237]
Valsartan	UV	205.6,221.6, 231.2	[239]
	UV	200-400	[142]
	UV	250	[240]
	Safranin-O	525	[240]
	Ratio derivative UV	231.5,260.5	[241]
Telmisartan	Alizarin in presence of thionyl chloride	427	[242]
	Phenol red	--	[243]
	Cresol red	--	[244]
Larcanidipine	Vanillin	600	[245]
	Citric acid/acetic anhydride	555	[245]
	Chloranil-acetaldehyde	585	[245]
	Diazotization with nitrous acid + β-Naphthol	553	[246]
	UV (D_0, D_2,D_3)	236,238, 234	[247]
Milrinone	2,3,-dichloro-5,6-dicyano-*p*-benzoquinone	356	[248]
	p-chloranilic acid	519	[248]
Fosinopril	Molybdenum (V) thiocyanate	517	[125]
	Benzalkonium chloride	545	[125]
Disopyramide	Picric acid	416	[219]
	Bromocresol red	410	[219]
	Bromothymol blue	415	[219]
	Cobalt thiocyanate	625	[219]
	Molybdenum(V) thiocyanate	475	[219]
Candesartan	UV	254	[249]
Lacidipine	Dimethylaminobenzaldehyde	615.7	[250]
	UV	240,230	[251]
	UV	218	[252]
	p-dimethylaminobenzaldehyde	415	[253]
	p-dimethyl amino cinnamaldehyde	420	[253]
	Vanillin	520	[253]
	$FeCl_3$ + potassium ferricyanide + HCl	740	[254]
	Tropaeolin 000	420	[255]
	Bromocresol green	500	[255]
	Azocarmine G	540	[255]

Furthermore, interactions of an antihypertensive drug with anti-inflammatory drugs were also investigated to monitor their pharmkokinetic studies using UV-Visible spectrophotometry and cyclic voltammetry [256].

CONCLUSION

This review is aimed at focusing the role of cyclic voltammetric and spectrophotometric methods in the assay of pharmaceuticals and giving a thoroughliterature survey of these two methods involved in pharmaceutical analysis. In recent decade the electrochemical and spectrophotometric techniques are well established and fast growing areas with a number of possible research applications in the area of pharmaceutical analysis. Of course, various sensitive, fast, and advanced analytical methods are developing in the field of clinical and analytical sciences but the demand and usability of these modalities cannot be replaced as it has a lot of significant features such as easily available,

cost effective, accurate, sensitive and user friendly. Moreover, the use of various types of modified electrodes enhances the electroanalytical properties of the volammetric techniques. On the other hand spectrophotometry plays a very important role due to its advantages over other sophisticated instruments in terms of low cost, simplicity and portability. Many people are now a days suffering from cardiovascular diseases. Hence, the continuous research and attention to the analysis of antihypertensive drugs by the analytical chemistry community and scientists will eradicate this life threating diseases.

REFERENCES

[1] J.D. Ehrhardt, *Biomed Mass Spectrom*., **1985**, 12, 593.
[2] E. Melnikov, M. Belova, G. Ramenskaya, *J. Anal. Chem.*,**2014,** 69, 1337.
[3] S. Perlman, J. Kirschbaum, *J. Chromatogr. A.*, **1981**, 206, 311.
[4] M. Gumustas, S. Sanl, N. Sanli, S. A. Ozkan, *Talanta*, **2010**,82, 1528.
[5] M. Tomaszewski, C. White, P. Patel, N. Masca, R. Damani, J. Hepworth, N. J. Samani, P. Gupta, W. Madira, A. Stanley, B. Williams, *Heart.*,**2014**; 100, 855.
[6] O. Agostini, G. Moneti, G. Bonacchi, M. Fedi, S. Manzini, *J. Chromatogr.*,**1989,** 487, 331.
[7] V. S. Bagotsky; Fundamentals of Electrochemistry, 2nd ed. New Jersey, Wiley Inter science, John Wiley & Sons, **2005**.
[8] V. Mirceski, S. K. Lovric, M. Lovric; Square wave voltammetry theory and application, Scholz, F., Ed.; Berlin, Springer- Verlag, **2007**.
[9] J. Wang; Analytical Electrochemistry; 3rd edition, New Jersy, Wiley-VCH, **2006.**
[10] C. G. Zoski; Handbook of Electrochemistry, 1st edition, Amsterdam, Elsevier, **2007**.
[11] S. Otles; Handbook of food analysis instruments. In: Electroanalytical techniques and Instrumentation in Food Analysis, CRC Press, Taylor and Francis Group, **2008,**379.
[12] A. Z. A. Zuhri, W. Voelter, *Fresenius J. Anal. Chem.*,**1998,** 360, 1.
[13] F. S. Rojas, C. B. Ojeda, *Anal. Chim. Acta.*,**2009,** 635, 22.
[14] E. R. M. K. Hackmann, E. A. S. Gianotto, M. I. R. M. Santoro, *Anal. Lett.*,**1997,** 30, 1861.
[15] D. Agbaba, S. Eric, K. K. Rajic, S. Vladimirov, D. Z. Stavic, *Spectrosc. Lett.*,**1997,** 30, 309.
[16] A. M. El-didamony, H. M. Khater, I. I. Ali, *J. Pharm. Educ. Res.*,**2013,** 4, 54.
[17] A. Sheibani, M. R. Shishehbore, E. Mirparizi, *Spectro. Acta Part A: Mol. Biomol. Spectro.*,**2010,** 77, 535.
[18] A. M. El-didamony, W. S. Hassan, *J. Chil. Chem. Soc.*,**2012,** 57, 1404.
[19] S. A. Ozkan, *Curr. Pharm. Anal.*,**2009,** 5, 127.
[20] S. A. Ozkan, B. Uslu, H. Y. A. Enein, *Crit. Rev. Anal. Chem.*, **2003,** 33, 155.
[21] R. Bonfilio, M. B. D. Araujo, H. R. N. Salgado, *Wseas Trans. Biol. Biomed.*,**2010,** 7, 316.
[22] M. Stolarczyk, A. Maslanka, A. Apola, J. Krzek, *Acta Pol. Pharm. Drug Res.*,**2010,** 67, 441.
[23] C. K. Zacharis, P. D. Tzanavaras, *J. Pharm. Biomed. Anal.*,**2008,** 48, 483.
[24] A. L. Santos, R. M. Takeuchi, N. R. Stradiotto, *Curr. Pharm. Anal.*, **2009,** 5, 69.
[25] R. Kalvoda, *Fresenius J. Anal. Chem.*,**1994,** 349, 565.
[26] P. M. Bersier, J. Howell, J. C. Bruntlet, *Analyst*,**1994,** 119, 219.
[27] G. Pandey, *Der Pharmacia Lett.*,**2011,** 3, 257.
[28] M. Starek, J. Krzek, *Talanta*,**2009,** 77, 925.
[29] R. N. Rao, S. Meena, A. R. Rao, *J. Pharm. Biomed. Anal.*,**2005,** 39, 349.
[30] M. Starek, *Talanta.*,**2011,** 85, 8.
[31] V. S. Bagotsky; Fundamentals of Electrochemistry; 2nd ed, Wiley Interscience, John Wiley & Sons Pub.: New Jersey, **2006**.
[32] B. Blankert, J. M. Kaufmann; Reviews in Pharmaceutical & Biomedical Analysis, *Electroanalytical methods as tools for predictive drug metabolism studies*, Bentham Science Publishers, Sharjah, **2010,**6, 76.
[33] M. R. Smyth, J. G. Vas; Analytical Voltammetry; Elsevier Science Publishers B.V., Amsterdam, **1992**.
[34] L. I. Antropov, A. Beknazarov; Theoratical Electrochemistry; University Press of the Pacific, **2001**.
[35] P. M. Brersier, J. Bersier, *Crit. Rev. Anal. Chem.*,**1985,** 16, 15.
[36] P. M. Brersier, J. Bersier, *Crit. Rev. Anal. Chem.*,**1985,** 16, 81.
[37] H. P. A. Nouws, C. D. Matos, A. A. Barros, J. A. Rodrigues, *J. Pharm. Biomed. Anal.*,**2005,** 39, 290.
[38] H. P. A. Nouws, C. D. Matos, A. A. Barros, J. A. Rodrigues, A. S. Silva, F. Borges, *Anal. Lett.*,**2007,** 40, 1131.
[39] M. A. G. Fernandez, M. T. F. Abedul, A. C. Garcia, *Electroanalysis*,**2000,** 12, 483.
[40] K. C. Leandro, J. C. Moreira, P. A. M. Farias, *J. Pharmaceutics.*,**2013,** Article ID 495814, 1.
[41] K. C. Leandro, J. C. Moreira, P. A. M. Farias, *Am. J. Anal. Chem.*,**2013,** 4, 47.
[42] B. D. Topal, S. A. Ozkan, B. Uslu, *The Open Chem. Biomed. Meth. J.*,**2010,** 3, 56.
[43] B. Uslu, S. A. Ozkan, *Anal. Lett.*,**2011,** 44, 2644.
[44] L. Codognotoa, V. G. Zuinb, D. D. Souzaa, J. H. Yariwakeb, S. A. S. Machadoa, L. A. Avaca, *Microchem. J.*,**2004,** 77, 177.

[45] B. Uslu, S. A. Ozkan, *Anal. Lett.*,**2007,** 40, 817.
[46] B. Uslu, S. A. Ozkan, *Comb. Chem. High Throug. Scr.*,**2007,** 10, 495.
[47] H. Kassa, A. Geto, S. Admassie, *Bull. Chem. Soc. Ethiop.*,**2013,** 27, 321.
[48] J. M. Kauffmann, J. C. Vire, *Anal. Chim. Acta*,**1993,** 273, 329.
[49] G. J. Patriarche, J. C. Vire, *Anal. Chim. Acta*,**1987,** 196, 193.
[50] L. G. Chatten, *J. Pharm. Biomed. Anal.*,**1987,** 1, 491.
[51] W. F. Smyth, A. D. Woolfson, *J. Clin. Pharm. Therap.*, **1987,** 12, 117.
[52] V. K. Gupta, R. Jain, K. Radhapyari, N. Jadon, S. Agarwal, *Anal. Biochem.*,**2011**, 408, 179.
[53] B. Dogan, S. A. Ozkan, B. Uslu, *Anal. Lett.*,**2005,** 38, 641.
[54] I. Tapsoba, J. E. Belgaied, K. Boujlel, *J. Pharm. Biomed. Anal.*,**2005,** 38, 162.
[55] B. Uslu, B. T. Demircigi, S. A. Ozkan, Z. Senturk, H. Y. A. Enien, *Pharmazie*,**2001,** 56, 938.
[56] I. H. I. Habib, S. A. Weshahy, S. Toubar, M. M. A. El-Alamin, *Port. Electrochim. Acta.*,**2008,** 26, 315.
[57] A. J. Bard, R. F. Faulkner; Electrochemical methods. John Wiley, New York, **1980**.
[58] D. K. J. Gosser; Cyclic voltammetry Simulation and Analysis of Reaction Mechanism, VCH Publisher, Inc.: New York, **1993**.
[59] P. T. Kissinger, W. R. Heineman, *J. Chem. Edu.*,**1983,** 60,702.
[60] R. Greef, R. Peat, L. M. Peter, D. Pietcher, J. Robinson; Instrumental Methods in Electrochemistry, Ellis Harvood Limited, New York, **1990**.
[61] S. A. Ali, A. Hassan, *Int. Res. J. Pure Appl. Chem.*,**2014,** 4, 128.
[62] H. Guo, H. Lin, L. Liu, J. Song, *J. Pharm. Biomed. Anal.*,**2004,** 34, 1137.
[63] J. P. Hart; Electroanalysis of biological important compounds: Ellis Horvood Limited, New York, **1990**.
[64] A. C. de Sa, L. L. Paim, O. B. de Urquisa, D. R. do Carmo, *Int. J. Electrochem. Sci.*, **2011,**6, 3754.
[65] M. A. El – Shal, *Adv. Pharm. Bull.*, **2013,**3, 339.
[66] J. A. Acuna, C. D. L. Fuente, M. D. Vasquez, M. D. Tascon, M. I. Gomez, F. Mata, P.S. Batanero, *J. Pharm. Biomed. Anal.*, **2002,**29, 617.
[67] S. Bollo, L. J. N. Vergara, J. A. Squella, *J. Electroanal. Chem.*, **2004,**562, 9.
[68] X. Wang, Y. Yang, Q. Wan, *Electrochim. Acta*, **2006,**52, 361.
[69] M. L. S. Silva, M. B. Q. Garcia, J. L. F. C. Lima, E. Barrado, *Anal. Chim. Acta.*, **2006,**573, 383.
[70] B. D. Topal, A. Golcu, S. A. Ozkan, *Anal. Lett.*, **2009,** 42, 689.
[71] A. L. Liu, S. B. Zhang, W. Chen, L. Y. Huang, X. H. Lin, X. H. Xia, *Talanta*, **2008,**77, 314.
[72] P. Norouzi, M. R. Ganjali, P. A. Daneshga, *J. Pharm. Toxi. Methods*, **2007,** 55, 289.
[73] A. A. K. Gazy, *Talanta.*,***2004,*** 62, 575.
[74] S. Shahrokhian, M. Karimi, H. Khajesharifi, *Sens. Acutators B.*, **2005,**109, 278.
[75] A. Radi, T. Elmogy, *IL Farmaco*, **2005,**60, 43.
[76] M. S. El – Shahawi, A. S. Bashammakh, T. Elmogy, *Anal. Sci.*, **2006,**22, 1351.
[77] L. E. Almeida, M. Castilho, L. H. Maza, M. Tabak, *Anal. Chim. Acta*, **1998,**375, 223.
[78] Y. Sun, B. Ye, W. Zhang, X. Zhou, *Anal. Chim. Acta*,**1998,** 363, 75.
[79] O. A. Razak, *J. Pharm. Biomed. Anal.*,**2004,**34, 433.
[80] P. Norouzi, M. R. Ganjali, B. A. Adergani, *Acta Chim. Solv.*,**2006**, 53, 499.
[81] A. Radi, *J. Pharm. Biomed. Anal.*,**2001**, 24, 413.
[82] B. Bozal, B. D. Topal, B. Uslu, S. A. Ozkan, H. Y. A. Enein, *Anal. Lett.*,**2009**, 42,2322.
[83] V. K. Gupta, R. Jain, S. Agarwal, R. Mishra, A. Dwivedi, *Anal. Biochem.*, **2011**, 410, 266.
[84] M. Sikkander, C. Vedhi, P. Manisankar, *Der Chimica Sinica*,**2012**, 3, 413.
[85] Z. Senturk, S. A. Ozkan, Y. Ozkan, *J. Pharm. Biomed. Anal.*, **1998,**16, 801.
[86] V. K. Gupta, R. Jain, M. M. Antonijevic, H. Khan, M. N. Siddiqui, A. Dwivedi, R. Mishra, S. Agarwal, *Int. J. Electrochem. Sci.*, **2011,**6,37.
[87] A.A. Al-Majed, F. Belal, A. Abadi, A. M. Al-Obaid, *IL Farmaco*,**2000**, 55, 233.
[88] Y. M. Temerk, H. S. M. Ibrahim, W. Schuhmann, *Microchim. Acta.*, **2006,**153, 7.
[89] M. M. Ghoneim, M. A. El-Ries, E. Hammam, A. M. Beltagi, *Talanta*,**2004**, 64, 703.
[90] P. Nourozi, M. R. Ganjali, A. Sepehri, M. Ghorbani, *Sens. Acutat.*,**2005**, 110, 239.
[91] M. H. Türkdemir, G. Erdögdu, T. Aydemir, A. A. Karagözler, A. E. Karagözler, *J. Anal. Chem.*,**2001**, 56, 1196.
[92] P. Norouzi, R. Dinarvand, M. R. Ganjali, A. S. M. Meibodi, *Anal. Lett.*,**2007**, 40, 2252.
[93] M. M. Ghoneim, P. Y. Khashaba, A. M. Beltagi, *J. Pharm. Biomed. Anal.*, **2002**,27, 235.
[94] E. A. Kasim, M. A. Ghandour, M. T. El-Haty, M. M. Ahmed, *J. Pharm. Biomed. Anal.*, **2002**,30, 921.
[95] A. A. Gouda, M. I. K. El-Sayed, A. S. Amin, R. El Sheikh, *Arabian J. Chem.*,**2013**, 6,145.
[96] H. E. Abdellatef, *Spectrochim. Acta Part A: Mol. Biomol. Spectr.*,**2007**, 66, 701.
[97] S. Kus, Z. Marczenko, N. Obarski, *Chem. Anal. (Warsaw)*,**1996**, 41, 899.
[98] G. Talsky; Derivative Spectrophotometry, 1st ed., VCH, Weinheim, **1994.**
[99] J. Karpinska, *Talanta*,**2004**, 64, 801.

[100]C. b. Ojeda, F. S. Rojas, *Microchem. J.*,**2013,**106, 1.
[101]V. D. Hoang, N. P. Nhung, H. Y. A. Enein, *Curr. Pharm. Anal.*,**2013,**19, 261.
[102]M. Y. Salem, M. G. El-Bardicy, M. F. El-Tarras, E. S. El-Zanfally, *J. Pharm. Biomed. Anal.*,**2002**, 30, 21.
[103]J. J. Charles, S. Brault, C. Boyer, M. H. Langlois, L. Cabrero, J. P. Dubosi, *Anal. Lett.*,**2003**, 36, 2485.
[104]C. Vetuschi, A. Giannandrea, *Anal. Lett.*, **2003**, 36, 1051.
[105]N. Erk, *J. Pharm. Biomed. Anal.*, **2001**, 26,43.
[106]P. D. Tzanavaras, D. G. Themelis, *Anal. Chim. Acta*,**2007**, 588, 1.
[107]B. Stachel, O. Elsholz, H. Reincke, *Frenesius J. Anal. Chem.*,**1995**, 353, 21.
[108]Y. J. Azeez, *J. Zankoy Sulaimani.*,**2009**, 12,67.
[109]J. Ruzicka, G.D. Marshall, *Anal. Chim. Acta*, **1990**, 237, 329.
[110]A. M. Pimenta, M. C. B. S. M. Montenegro, A. N. Araujo, J. M. Calatayud, *J. Pharm. Biomed. Anal.*,**2006**, 40, 16.
[111]C. E. Lenehan, N. W. Barnett, S. W. Lewis, *Analyst*, **2002,**127, 997.
[112]H. E. Abdellatef, M. M. Ayad, E. A. Taha, *J. Pharm. Biomed. Anal.*,**1999,**18, 1021.
[113]M. M. Ayad, A. A. Shalaby, H. E. Abdellatef, M. M. Hosny, *J. Pharm. Biomed. Anal.*,**2002**, 28, 311.
[114]F. M. Salama, O. L. A. El-Sattar, N. M. El-Aba Sawy, M. M. Fuad, *Al AzharJ. Pharm. Sci.*,**2001**, 27, 121.
[115]S. M. Blaih, H. H. Abdine, F. A. El-Yazbi, R. A. Shaalan, *Spectrosc. Lett.*,**2000**, 33, 91.
[116]A. A. Al-Majed, F. Belal, A. A. Al-Warthan, *Spectrosc. Lett.*,**2001**, 34, 211.
[117]A. A. Al-Majed, J. Al Zehouri, *IL Farmaco*, **2001**, 56, 291.
[118]N. Rahman, Y. Ahmad, S. N. H. Azmi, *AAPS PharmSci Tech.*,**2005**, 6,E543.
[119]N. Rahman, H. Rahman, S. N.H. Azmi, *WASET*,**2006,***13*, 200.
[120]K. Sayanna, G. Venkateshwarlu, *IJMER*,**2013**, 3, 3079.
[121]O. E. Afieroho, O. Okorie, T. J. N. Okonkwo, *Trop. J. Pharm. Res.*,**2012**, 11, 275.
[122]B. Kalyanaramu, K. Raghubabu, *Asian J. Pharm. Clinical Res.*, **2011**, 4, 82.
[123]B. Kalyanaramu, K. Raghubabu, Y. Vamsikumar, *J. Chem. Pharm. Res.*, **2011**, 3, 863.
[124]S. R. Karajgi, R. V. Kulkarni, *Univ. J. Pharmacy*,**2013,**2, 92.
[125]M. M. Baraka, M. El-Sadek, E. M. M. Moussa, N. M. A. A. Alaty, *Chem. Pharm. Bull.*, **2008.**,56, 1521.
[126]B. Kalyanaramu, K. Raghubabu, *Asian J. Pharm. Clinical Res.*, **2011**, 4, 82.
[127]S. L. Thamake, S. D. Jadhav, S. A. Pishawikar, *Asian J. Res. Chem.*,**2009**, 2,52.
[128]N. Gowda, R. Tekal, R. Thangavelu, K. Vipul, M. Rajashree, *J. Food Drug. Anal.*,**2012.**, 20, 577.
[129]H. E. Abdellatef, H. G. Ragab, M. M. Baraka, *Zagazig J. Pharm. Sci.*, **1998,** *7*, 59.
[130]H. E. Abdellatef, *J. Pharm. Biomed. Anal.*, **1998**, 17, 1267.
[131]N. Rahman, N. Anwar, M. Kashif, *Chem. Pharm. Bull.*, **2006,**54, 33.
[132]N. Rahman, H. Rahman, *Spectroscopy*,**2011**,25, 123.
[133]K.N. Tarkase, P. B. Mahajan, S. D. Suruse, *IJPRR*, **2013**,2, 7.
[134]M. Ratnaparkhi, P. Patil, S. Jagadale, *AJPCT*, **2013**, 1, 78.
[135]N. Rahman, H. Rahman, S. M. Haque, *Arab. J. Chem.*,**2013**, *In press.*
[136]N. Rahman, H. Rahman, A. Khatoon, *J. Chil. Chem. Soc.*, **2012**, 57, 827.
[137]A.P. Rani, C. Nagalakshimi, S. Bhawani, C. B. Sekaran, *Jord. J. Chem.*,**2012,**7, 413.
[138]O. A. Razak, S. F. Belal, M. M. Bedair, N. S. Barakat, R. S. Haggag, *J. Pharm. Biomed. Anal.*,**2003**, 31, 701.
[139]S. A. Shama, A. S. Amin, H. Omara, *J. Chil. Chem. Soc.*,**2011**, 56, 566.
[140]N. Rahman, S. M. Haque, *Anal. Chem. Insights.*,**2008**, 3, 31.
[141]M. Stolarczyk, A. Masilanka, J. Krzek, J. Milczarek, *Acta Pol. Pharm.*, **2008**, 65, 275.
[142]N. Rahman, M. Singh, M. Hoda, *IL Farmaco*,**2005,**60, 569.
[143]S. A. Shama, A. A. El-Sayed, H. Omara,*J. Quant. Spectros. Rad. Trans.*,**2006**, 102, 261.
[144]H. Chandru, A. C. Sharda, *E. J. Chem.*, **2007,**4, 216.
[145]D. H. Mohammed, I. A. Shehab, H. Ahmed, *J. Baghdad Sci.*,**2013**, 10, 965.
[146]N. R. Ahmed, *Iraqi Nat. J. Chem.*,**2013**, 49, 1.
[147]A. M. E. Didamony, E. A. H. Erfan,*J. Chil. Chem. Soc.*,**2011**, 56,875.
[148]W. T. Saurez, P. O. D. Neto, B. C. Janegitz, H. J. Vieria, R. C. Faria, O. F. Filho, *Anal. Lett.*, **2011**, 44, 2394.
[149]A. M. E. Didamony, E. A. H. Erfan, *Spectrochimica Acta Part A: Mol. Biomol. Spectro.*, **2010,**75, 1138.
[150]C. S. P. Sastry, S. G. Rao, Y. P. Naidu, K. R. Srinivas, *Anal. Lett.*,**1998**, 31, 263.
[151]C. S. P. Sastry, K. R. Srinivas, K. M. M. K. Prasad, *Anal. Lett.*, **1996**, 29, 1329.
[152]K. M. Emara, A. I. M. Maboud, H. F. Askal, I. A. Darwish, *Anal. Lett.*,**1993,**26, 2385.
[153]T. Jovanovic, B. Stanovic, Z. Koricanac, *J. Pharm. Biomed. Anal.*,**1995,**13, 213.
[154]S. M. E. Ashry, F. A. Ibrahim, *Anal. Lett.*, **1992**, 25,1657.
[155]Z. Moldovan, I. A. Badia, *Quimica Nova.*,**2012**, 35, 1668.
[156]N. Rahman, N. Anwar, M. Kashif, N. Hoda, *Acta Pharm.*,**2006,**56, 347.
[157]H. F. Askal, *Talanta.*, **1991**, 38, 1155.
[158]A. A. Gouda, A. S. Amin, *Arabian J. Chem.*,**2010**, 3, 159.

[159]Y. E. Shabrawy, N. E. Enany, K. Salem, *IL Farmaco*, **2004,** 59, 803.
[160]K. Basavaiah, P. Nagegowda, *J. Iran. Chem. Soc.*, **2004**,1, 106.
[161]K. Basavaiah, P. Nagegowda, *Oxi. Commun.*,**2004,**27, 186.
[162]K. Basavaiah, P. Nagegowda, *Oxid. Commun.*,**2004,**27, 203.
[163]K. Basavaiah, P. Nagegowda, *Bulg. Commun.*,**2003**, 35, 48.
[164]N. E. Enany, F. Belal, M. Rizk,*Int. J. Biomed. Sci.*, **2008,** 4, 147.
[165]K. Basavaiah, U. Chandrashekar, J. Manjunathaswamy, H. C. Prameela, V. S. Charan, P. Nagegowda, *Bulg.Che. Commun.*,**2003,**35, 54.
[166]Z. A. Moldovan, *Rev. Roum. Chim.*,**2012,**57, 721.
[167]N. Rahman, N. Anwar, M. Kashif, *IL Farmaco*,**2005**, 60, 605.
[168]N. Rahman, M. R. Siddiqui, S. N. H. Azmi, *Chem. Anal. (Warsaw)*, **2007,**52, 465.
[169]A. A. A. Ali, A. A. Elbashir, *ISESCO J. Sci. Tech.*, **2012**, 8, 30.
[170]C. M. Jamakhandi, J. I. Disouza, U. S. Chougule, M. C. Mahanthesh, *Int. J. Pharm. Pharm. Sci.*,**2011,**3, 255.
[171]K. Basavaiah, K. Tharpa, S. G. Hiriyanna, K. B. Vinay, *J. Food Drug Anal.*,**2009**, 17, 93.
[172]F. A. E. Yazbi, H. H. Abdine, R. A. Shaalan, *J. Pharm. Biomed. Anal.*,**1999**, 19, 819.
[173]G. Paraskevas, J. A. Politou, M. Koupparis, *J. Pharm. Biomed. Anal.*,**2002**, 29, 865.
[174]A. E. Gindy, A. Ashour, L. A. Fattah, M. M. Shabana, *J. Pharm. Biomed. Anal.*,**2001**, 25, 913.
[175]N. Rahman, M. Singh, M. N. Hoda, *J. Braz. Chem. Soc.*,**2005**, 16, 1001.
[176]A. Raza, T. M. Ansari, A. Rehman, *J. Chin. Chem. Soc.*,**2005**, 52, 1055.
[177]A. Rajasekaran, S. Udayavani, *J. Ind. Chem. Soc.*,**2001,**78, 485.
[178]A. A. E. Emam, S. H. Hansen, M. A. Moustafa, S. M. E. Ashry, D. T. E. Sherbiny, *J. Pharm. Biomed. Anal.*, **2004**,34, 35.
[179]D. Ozer, H. Senel, *J. Pharm. Biomed. Anal.*, **1999**,21, 691.
[180]M. Cakar, G. Popovic, *J. Serb. Chem. Soc.*,**2012**, 77, 1437.
[181]P. Nagaraja, A. K. Shreshtha, A. Shivkumar, N. G. S. Al-Tayar, *J. Food Drug Anal.*,**2011**, 19, 85.
[182]E. A. Gadkariem, K. E. E. Ibrahim, N. A. A. Kamil , M. E. M. Haga, H. A. El-Obeid, *Saudi Pharm. Jour.*,**2009**, 17, 289.
[183]P. R. S. Ribeiro, L. Pezza, H. R. Pezza, *Ecl. Quim. Sao Paulo.*, **2005**, 30, 23.
[184]L. Zivanovic, S. Vasiljevic, D. Radulovic, *Boll. Chim. Farm.*, 1991, 130, 162.
[185]P. B. Issopoulos, *Frenesius J. Anal. Chem.*,**1990**, 336, 124.
[186]T. S. Al-Ghabsha, M. S. Al-Enizzi, Z. Z. Al-Abdaly, *J. Edu. Sci.*, 2007, 19, 1.
[187]P. Nagaraja, K. C. S. Murthy, K. S. Rangappa, N. M. M. Gowda, *Talanta.*,**1998**,46, 39.
[188]P. Nagaraja, R. A. Vasantha, K. R. Sunitha, *Talanta*,**2001,**55, 1039.
[189]T. Aman, I. U. Khan, N. Aslam, I. Ahmed, *Anal. Lett.*,**1998**, 31, 1007.
[190]P. Nagaraja, R. A. Vasantha, K. C. S. Murthy, K. S. Rangappa, *Chemia Analityczna.*, **2001**, 46, 569.
[191]M. A. Gotardo, L. S. Lima, R. Sequinel, J. L. Rufino, L. Pezza, H. R. Pezza, *Eclet. Quim.*, **2008,**33, 7.
[192]I. C. Vieira, O. F. Filho, *Talanta*, **1998,**46, 559.
[193]P. B. Issopoulos, P. T. Economou, *J. Pharm. Pharmacol.*,**1993**, 44, 1020.
[194]M. E. Rani, *World J. Pharm. Res.*,**2013**, 2, 1102.
[195]M. Tubino, D. C. D. V. Batista, J. A. R. Radrigues, *Anal. Lett.*,**2006**, 39, 327.
[196]M. Q. Al Abachi, H. Hadi, *Int. J. Recent Sci. Res.*, **2013,**4,320.
[197]F. M. A. Gawad, *J. Pharm. Biomed. Anal.*,**1997**, 15,1679.
[198]K. Sreedhar, C. S. P. Sastry, M. N. Reddy, D. G. Sankar, *Talanta*,**1996**, 43, 1847.
[199]B. Panzova, M. Ilievska, G. Trendovska, B. Bogdanov, *Int. J. Pharmaceutics.*,**1991**, 70, 187.
[200]A. Arranz, S. F. de Betono, C. Echevarria, J. M. Moreda, A. Cid, J. F. Valentin, *J. Pharm. Biomed. Anal.*,**1999**, 21, 797.
[201]M. U. Ozgur, S. A. Sugur, *Turk. J. Chem.*,**2002**, 26, 691.
[202]Z. Aydogmus, Z. Aydodmup, A. Barla, *AOAC International*,**2009**, 92, 131.
[203]R. El-Sheikh, N. S. Esmail, A. A. Gouda, W. A. Basset, *CICEQ.*,**2012**, 18, 179.
[204]Y. K. Agrawal, F. D. Majumdar, *Anal. Lett.*,**1995**, 28, 1619.
[205]P. S. Sarsambi, G. K. Kapse, M. Shobha, S. A. Raju, *Asian J. Chem.*, **2000**, 12, 1325.
[206]P. S. Sarsambi, S. A. Raju, *Asian J. Chem.*, **2001,**13, 760.
[207]P. S. Sarsambi, G. K. Kapse, S. A. Raju, *Asian J. Chem.*, **2002**, 14, 545.
[208]H. H. Abdine, F. A. El-Yazbi, S. M. Blaih, R. A. Shaalan, *Spectrosc. Lett.*, **1998**, 31, 969.
[209]V. Sankar, S. Raghuraman, V. Srivanand, V. Ravichandran, *Ind. J. Pharm. Sci.*, **2000**, 62, 463.
[210]N. Rahman, M. R. Siddiqui, S. N. H. Azmi, *J. Chin. Chem. Soc.*, **2006**,53, 735.
[211]O. C. Lastra, I. G. Lemus, H. J. S. R. Perez, *J. Pharm. Biomed. Anal.*,**2003**, 33, 175.
[212]M. Ansari, M. Kazemipour, M. Baradaran, H. Jalalizadeh, *IJPT*, **2004,**3, 21.
[213]M. M. El-Sutohy, S. R. El-Shaboury, S. A. Hussein, N. A. Mohamed, *Asian. J. Pharm. Anal.*, **2013,**3, 3.

[214]Y. Swetha, P. Malleshwari, Y. Jyotsna, D. P. Ramalingam, D. Hari, H. Theja, K. V. Kumar, *J. Pharm. Res.*, **2011**, 4, 4139.
[215]I. A. Darwish, *Anal. Chim. Acta*, **2005**, 549, 212.
[216]I. Singhvi, M. S. Bhatia, *Asian J. Chem.*,**2006**, 18, 1537.
[217]N. Rahman, M. R. Siddiqui, S. N. H. Azmi, *Chem. Pharm. Bull.*,**2006**, 54, 626.
[218]I. Isabel, V. Rodenas, S. Garcia, C. S. Pedreno, *J. Pharm. Biomed. Anal.*, 2002, 29, 299.
[219]H. E. Abdellatef, *Spectrochim. Acta Part A: Mol. Biomol. Spectr.*,**2007**, 66, 1248.
[220]V. S. Ramakrishna, P. B. S. Lakshimi, C. Rambabu, *Int. J. Pharm. Pharm. Sci.*,**2012**, 4, 86.
[221]N. Erk, *Pharmazie*,**2003**,58, 543.
[222]J. J. Charles, S. Brault, C. M. H. Boyer, L. Langlois, J. Cabrero, J. P. Dubost, *Anal. Lett.*,**2003**, 36,2485.
[223]S. Ashour, F. Chehna R. Bayram, *Res. J. Aleppo Univ.*,**2006**, 49, 49.
[224]G. P. Miralles, R. G. Domenech, J. M. Vinuesa, J. M. Buigues, *J. Pharm. Biomed. Anal.*, **1993**,11, 647.
[225]M. J. Buigues, J. M. Vinuesa, R. G. Domenech, G. P. Miralles, *J. Pharm. Sci.*, 1991, 80,690.
[226]M. H. Barary, M. A. Elsayed, S. M. Mohamed, *Drug Develop. Ind. Pharm.*, **1990**,16, 1539.
[227]K. Siddappa, M. Metre, T. Reddy, M. Tambe, M. Gavanna, *World J. Chem.*,**2009**, 4, 15.
[228]B. H. Ahmed, O. O. Johnson, *J. Pharm. Biores.*,**2004**, 1, 1.
[229]O. A. Adegoke, C. E. Nwoke, *J. Iran. Chem. Soc.*, **2008,**5, 316.
[230]D. K. Singh, B. Srivastava, A. Sahu, *Anal. Sci.*,**2004**, 20, 571.
[231]O. A. Adegoke, S. O. Idowu, A. A. Olaniyi, *Trop. J. Pharm. Res.*,**2007**, 6, 695.
[232]A. Q. N. Manzar, I. Hussain, I. Azhar, *Jour. Chem. Soc. Pak.*,**2000**, 22, 111.
[233]D. Z. Stakic, L. Panic, G. Agbaba, *Farmaco*,**1990**, 45, 381.
[234]R. S. Haggag, S. F. Belal, R. A. Z. Shalan, *J. Food Drug Anal.*, **2011**, 19, 174.
[235]F. A. E. Yazbi, H. H. Abdine, R. A. Shaalan, *J. Pharm. Biomed. Anal.*, **1999**,20, 343.
[236]A. El-Gindy, A. Ashour, L. A. Fattah, M. M. Shabana, *J. Pharm. Biomed. Anal.*,**2001**, 25, 299.
[237]N. Erk, *J. Pharm. Biomed. Anal.*,**1999**, 20, 155.
[238]L. Madhavi, M. Shreesha, G. Tuljarani, *Int. J. ChemTech Res.*, **2011**,3, 1830.
[239]S. Tatar, S. Saglik, *J. Pharm. Biomed. Anal.*, **2002**,30, 371.
[240]K. R. Gupta, A. D. Mahapatra, A. R. Wadodkar, S. G. Wadodkar, *Int. J. ChemTech Res.*,**2010**, 2, 551.
[241]E. Dinc, B. Uslu, S. A. Ozkan, *Anal. Lett.*, **2005,**37, 679.
[242]S. T. Kumbhar, G. K. Chougule, G. B. Gajeli, V. S. Tegeli, Y. S. Thorat, U. S. Shivsaran, *Int. J. Pharm. Sci. Res.*,**2011**, 2, 1254.
[243]T. Rong, Z. H. Qin, M. X. Hui, T. S. Long, L. Y. Sheng, L. H. Sheng,*Phy. Test. Chem. Anal. Part B: Chem. Anal.*, **2010,**4, 390.
[244]Z. H. Qin, H. M. Xia, B. Xie, X. R. Qin, X. Q. Gan, X. D. Pang, B. J. Wan, *Phy. Test. Chem. Anal. Part B: Chem. Anal.*,**2012,**1,90.
[245]T. M. Sastry, K. Ramakrishna, *Indian J. Chem. Tech.*, **2009**, 16, 431.
[246]G. Mubeen, D. S. Rao, K. Uvesh, *Int. J. ChemTech Res.*,**2009**, 1, 1186.
[247]A. S. Kumari, S. Subhasish, D. K. Kaushik, M. M. Annapurna, *Int. J. PharmTech Res.*,**2010**, 2,1431.
[248]M. R. Siddiqui, A. Tariq, A. Ahmad, M. Chaudhary, S. M. Shrivastava, R. K. Singh, *Asian J. Sci. Res.*,**2009,** 2, 135.
[249]P. Jignesh, J. B. Dave, C. N. Patel, D. Patel, *J. Chem. Pharm. Res.*,**2010,** 2, 10.
[250]C. Moorthi, M. Aju, P. Elsadig, G. Sumithira, *J. App. Pharm. Sci.*,**2011,**1, 209.
[251]P. T. Nagaraju, K. P. Channabasavaraj, P. T. Shanthakumar, *Int. J. ParmTech Res.*,**2011,** 3, 18.
[252]P. T. Nagaraju, K. P. Channabasavaraj, P. T. Shanthakumar, K. Chiranjeevi,*Int. J. ChemTech Res.*,**2011,** 3, 955.
[253]G. V. Sagar, N. V. S. G. Rao, B. S. Sastry, *Ind. J. Chem. Sci.*,**2003,** 1, 241.
[254]V. Ravichandran, S. Raghuraman, V. Sankar, V. Kalaisevan, J. Dharuman, A. Dharamsi, *Ind. J. Pharm. Sci.*, **2004,** 66, 797.
[255]G. V. Sagar, N. V. S. G. Rao, B. S. Sastry, *Ind. J. Pharm. Sci.*, **2004,** 66, 353.
[256]E. Jabeen, R. Qureshi, A. Shah, *J. Photochem. Photobiol. B: Bio.*,**2013,** 125, 155.