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Stability-indicating methods for determination of terazosin in presence of its degradation product

Moataz A.Yehia*, Mamdouh R.Rezk, Mohamed A.El-Sayed, Mohamed Abdel Kawy

Department of Analytical Chemistry, Faculty of Pharmacy, Cairo University, Kasr El-Aini Street, ET 11562, Cairo, (EGYPT)

E-mail: mayehialiaa2010@hotmail.com; boodim3@yahoo.com

ABSTRACT

Four different stability indicating assay methods were developed and validated for the determination of terazosin in the presence of its degradation product. The first and second method was based on the derivative and derivative ratio spectrophotometric technique using methanol as a solvent. In the third method, we used TLC-densitometric technique using high performance thin-layer chromatography plates with a developing system consisting of chloroform: acetone: ammonia (6:4:0.1, by volumes). The fourth method was a high performance liquid chromatography. Separation of terazosinfrom itsdegradate using C_{18} column and a mobile phase consisting of acetonitrile: methanol: water: tri-ethyl amine (v/v pH 5.6), in the ratio of (45: 45: 10: 0.2, by volume) at ambient temperature was achieved.

The developed methods were successfully applied to the analysis of pharmaceutical formulations containing terazosinwith excellent recoveries.

KEYWORDS

Terazosin;
Spectrophotometry;
Densitometry;
Stability;
HPLC.

INTRODUCTION

Terazosin (TR), Piperazine, 1-(4-amino-6, 7-dimethoxy-2-quiazolinyl)-4-[(tetrahydro-2-furanyl)-carbonyl]-, mono-hydrochloride. (Figure 1)[1] It is Antihypertensive drugs act on the two most important regulatory systems of blood pressure

The sympathetic nervous system: responsible for the rapid moment-to-moment regulation of blood pressure.

The rennin-angiotensin-aldosterone system: responsible for the long- term control of blood pressure by altering the blood volume[2,3].

The literature has analytical methods for quantitative estimation of terazosin, in pharmaceutical formulations by spectroscopic method[4-12] Electrochemical[13,14], Densitometric[15]. and HPLC[16-24].

The present work aimed to develop feasible, sensitive and specific analytical procedures for the analysis of terazosin in presence of its degradation products. Adaptation of the proposed procedures to the analysis of the available dosage forms was also an important task in order to solve problems encountered in quality control and analysis of expired samples.

EXPERIMENTAL

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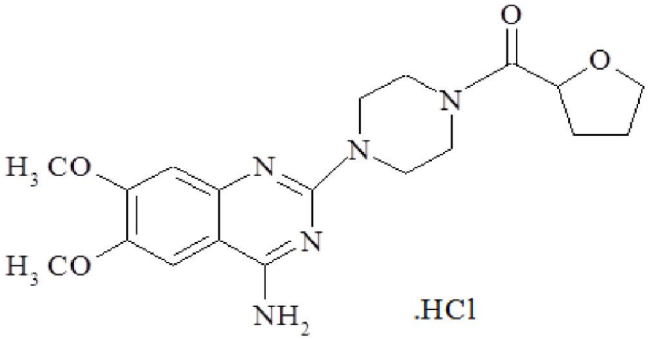

Figure 1 : Chemical structure of terazosin

Samples

- Terazosin powder was kindlysupplied by Pharaonia Pharmaceuticals, New Borg El-Arab City (Alexandria, Egypt).
- Pharmaceutical formulation Itrin® tablets (labeled to contain 5 mg ofterazosin), manufactured by byKahira Pharm. & Chem. Ind. Co. Under License from ABBOTT Laboratories, Egypt

Reagents

The materials used were chloroform, aceton, sodium hydroxide, ammonia,methanol, ADWIC, El Nasr Pharmaceutical Co. (Cairo, Egypt); Purified water was prepared using a Millipore Milli-Q water purification system, all were of analytical grade. Phosphate buffer: 0.05 M potassium di-hydrogen phosphate; (pH 5.6); by Sigma Aldrich.Acetonitrile, methanol: Merck(Darmstadt, Germany). all were of HPLC grade, all Chemical were purchased from local market (Cairo, Egypt).

Standard solutions

Terazosin standard and degradate solution ($100\mu gmL^{-1}$) in methanol.

Apparatus

- A double beam UV-vis spectrophotometer (SHIMADZU, Japan) Model UV-1601 PC connected to IBM compatiblecomputer and HP 680 inkjet printer. The bundled software was UVPC personal spectroscopy software version 3.7. The spectra bandwidth was 2 nm and wavelength scanning speed was 2800 nm min^{-1}.
- Pre-coated TLC-plates, silica gel 60 F_{254} (20 cm x 20 cm, 0.2 mm) Fluka, (Switzerland).
- Camag TLC-scanner 3 S/N 130319 with winCATS software.
- CamagLinomat 5 auto sampler (Switzerland).
- Camag micro syringe (100 µL) (Switzerland).
- Liquid chromatograph consists of a "La-Chrom" HPLC instrument (Hitachi-Merck) Germany, pump model L-7110, connected with a detector model L-7420.

The injector was a manual Rheodyne injector (Model 7161, Catati, California, USA) equipped with a $10\mu L^{-1}$ injector loop and a 100µL Hamilton syringe. The instrument was connected to an IBM compatible PC bundled with Merck- Hitachi Model D-7000 chromatography Data Station software HPLC septum manager and an HP 800 inkjet printer.

A Lichrocart RP-18 column (250mm×4.6mm i.d.) particle size 5 µm (Merck, Germany) was used for the analysis.

Procedures

Degradation of terazosin[1]

Into a round bottom conical flask weighed, an amount of 100 mg terazosinhydrochloride was dissolved in 90-mL of methanol transferred 10-mL of 1N sodium hydroxide were added, (portions of methanol were added periodically to maintain the volume). After 3 hours reflux, complete degradation was achieved, as tested by TLC using chloroform: acetone: ammonia (6:4:0.1, by volumes) as a developing solvent. Solvent was evaporated and solid powder was characterized.

Spectrophotometric methods

Spectral characteristics of terazosin and its degradation product.

Two aliquot of terazosin hydrochloride and itsdegradate were separately, transferred into two 10-mL volumetric flasks from their secondary stock solutions (100 µg mL^{-1}) and the volume was completed with methanol, to prepare (22 µg mL^{-1}) solutions.

The zero, first, second, third and fourth order spectra of the prepared solutions were recorded and investigated.

Fourth derivative method

Different aliquots (0.2 – 2.2 mL) were taken from

terazosin secondary stock solution (100 μg mL^{-1}) into 10-mL volumetric flasks then the volume was completed with methanol, to get a concentration range (2 – 22 μg mL^{-1}) TABLE 1. The fourth derivative of the standard spectra for terazosin and its degradation product were obtained using (Δλ= 4 nm) and scaling factor 100, the peak amplitudes at 329.2 nm were recorded, and plotted against the corresponding concentration. The regression equation was obtained that was used for determination of terazosin in unknown sample.

Derivative ratio method

The spectra of the prepared standard solutions were scanned from 200 to 400 nm and stored in the computer. The stored spectra of terazosin were divided (amplitude at each wavelength) by the spectrum of 8 μg mLterazosindegradate.

The first derivative of the ratio spectra (^{1}DD) were obtained at $\Delta\lambda$= 4 nm and scaling factor was 10. The amplitude of the first derivative peak of terazosin was measured at 310.6 nm and used to calculate the concentration of terazosin. Calibration graph was constructed relating the peak amplitude of $^1DD_{310.6}$ to the corresponding concentrations of terazosinhydrochloride.

Densitometric method

Aliquot portions (5 – 80 μL) equivalents to 0.5 to 8 μg $spot^{-1}$of terazosin stock solution (100μgmL^{-1}) in methanol was spotted on HPTLC plates using a Camag Applicator. Plates were developed by solvent system consisting of chloroform: acetone: ammonia (6:4:0.1, by volumes) at room temperature. Plates were left to dry then the spots were detected under UV-lamp (291 nm). A calibration curve relating the area under the peak to the corresponding concentrations of terazosin was constructed over a range of (0.5 to 8μg$spot^{-1}$) TABLE 1.

Liquid chromatographic method

Linearity

Aliquot portions(0.5 – 8 mL) of terazosin stock solution (100μgmL^{-1}) were transferred into a series of 10-mL volumetric flasks. The flasks were completed to volume with methanolin concentration range of (5 – 80 μg mL^{-1}) TABLE 1. Aliquots (10μL) of the prepared solutions were injected into HPLC apparatus. The peak area was measured at 225 nm using a mobile phase consisting of (acetonitrile: methanol: water: tri-ethyl amine (v/v pH 5.6), in the ratio of (45: 45: 10: 0.2, by volume), and a Lichrocart RP-18 (250mm×4.6mm i.d.) column, particle size(5μm) at a flow rate 1.0 $mLmin^{-1}$. A calibration graph representing the relative peak area of terazosin to that of terazosin external standard (20μgmL^{-1}), versus the corresponding concentrations of terazosin

TABLE 1 : Determination of terazosin in pure samples by derivative and derivative ratio methods

Fourth derivative spectroscopic method(μg mL^{-1})at 329.2nm			Derivative ratio spectroscopic method (μg mL^{-1}) at 310.6nm			Densitometry (μg $spot^{-1}$)			HPLC (μg mL^{-1})		
Taken	Found	Found %	Taken	Found	Found %	Taken	Found	Found%	Taken	Found	Found %
2.00	2.02	101.00	2.00	2.01	100.50	0.50	0.49	99.93	5.00	4.98	99.60
4.00	3.98	99.50	4.00	4.04	101.00	1.00	0.99	99.37	10.00	9.91	99.17
6.00	6.04	100.66	6.00	6.08	101.33	2.00	1.98	99.38	20.00	20.09	100.47
8.00	8.12	101.50	8.00	7.94	99.25	3.00	3.01	100.63	30.00	30.23	100.78
10.00	9.93	99.30	10.00	10.03	100.30	4.00	3.98	99.63	40.00	39.95	99.89
12.00	12.05	100.41	12.00	11.88	99.00	5.00	5.01	100.20	50.00	49.60	99.20
14.00	14.07	100.50	14.00	13.91	99.35	6.00	6.01	100.29	60.00	60.76	101.28
16.00	15.98	99.87	16.00	16.20	101.25	7.00	7.02	100.36	70.00	69.49	99.27
18.00	18.20	101.11	18.00	18.02	100.11	8.00	7.96	9.55	80.00	80.23	100.29
20.00	20.08	100.40	20.00	20.36	101.80						
22.00	21.99	99.95									
Mean		100.38			100.39			99.93			99.99
SD		0.682			0.965 0.962			0.465			0.755
RSD%		0.679						0.337			0.755

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TABLE 2 : Determination of terazosin in laboratory prepared mixtures by the proposed derivative, derivative ratio, densitometry and HPLC method

Recovery for terazosin by (%)						
Spectroscopy(μg Ml^{-1})			HPLC (μg mL^{-1})		Densitometry (μg spot $^{-1}$)	
Conc.	Fourth Derivative Recovery %	Derivative ratio Recovery %	Conc.	Recovery %	Conc	Recovery %
2.00	99.62	100.07	8.00	101.12	0.80	99.30
4.00	100.55	100.47	16.00	101.17	1.60	99.22
6.00	101.41	101.13	24.00	101.54	2.40	100.54
8.00	99.2	99.92	32.00	100.59	3.20	100.06
10.00	101.09	99.51	40.00	100.82	4.00	99.63
12.00	100.61	100.59	48.00	99.92	4.80	101.68
14.00	101.34	99.65	56.00	100.76	5.60	100.57
16.00	100.03	101.62	64.00	100.74	6.40	100.86
18.00	99.19	100.17	72.00	100.72	7.20	101.09
Mean	100.33	100.34		100.82		100.33
S.D	0.870	0.687		0.449		0.839

was constructed.

Analysis of laboratory prepared mixturescontaining different ratios from terazosin and itsdegradation product

Fourth derivative and derivative ratio method

Accurately aliquot portions (0.2 – 1.8 mL) for derivative and derivative ratio,of terazosin and terazosindegradate from their corresponding stock solutions (100 μg mL^{-1} in methanol) were transferred into a series of 10-ml volumetric flasks as shown in TABLE 2. The volumes were completed with methanol. Terazosin concentration was calculated as mentioned under (Section 5.2.2) starting from (The peak amplitudes of the obtained fourth derivative……..) for the fourth derivative and (Section 5.2.3) starting from (The spectra of the prepared standard solutions…..) for the derivative ratio method.

Densitometric method

Aliquot portions (8– 72μL) of terazosin and degradatefrom their corresponding stock solutions (100μgmL^{-1} in methanol were transferred into a series of 10mL volumetric flasks as shown in TABLE 2. Aliquot portions 2.5 μL of the prepared mixtures were spotted on a HPTLC plate and developed as mentioned under (Section 5.3.1) starting from (Plates were developed by……..…).

Liquid chromatographic method

Aliquot portions (0.8 – 7.2mL) of terazosin anddegradatefrom their stock solutions (100μgmL^{-1} inmethanolwere transferred into a series of 10 mL volumetric flasks as shown in TABLE 2.

Aliquot portions 10 μL of the prepared mixtures were injected into HPLC adopting the conditions under (Section 5.4.1) starting from (The peak area was measured……..).

Analysis of terazosin in pharmaceutical formulation

Twenty tablets were weighed to determine the average weight per tablet then grinded. A mass of Itrin® powder tablets equivalent to 10 mg terazosin was transferred into a 100-mL volumetric flask. A volume of 50-mL methanol was added. Stirring was done for 10 minutes using a vortex then filtration was done and the procedure under linearity with secondary stock solution (100 μg mL^{-1}) and concentration range (2 – 22 μg mL^{-1}), was done for the derivative ratio method. The concentration of terazosin was estimated from the regression equation.

RESULTS AND DISCUSSION

Degradation of terazosin

Terazosin is a stable drug, however, forced sta-

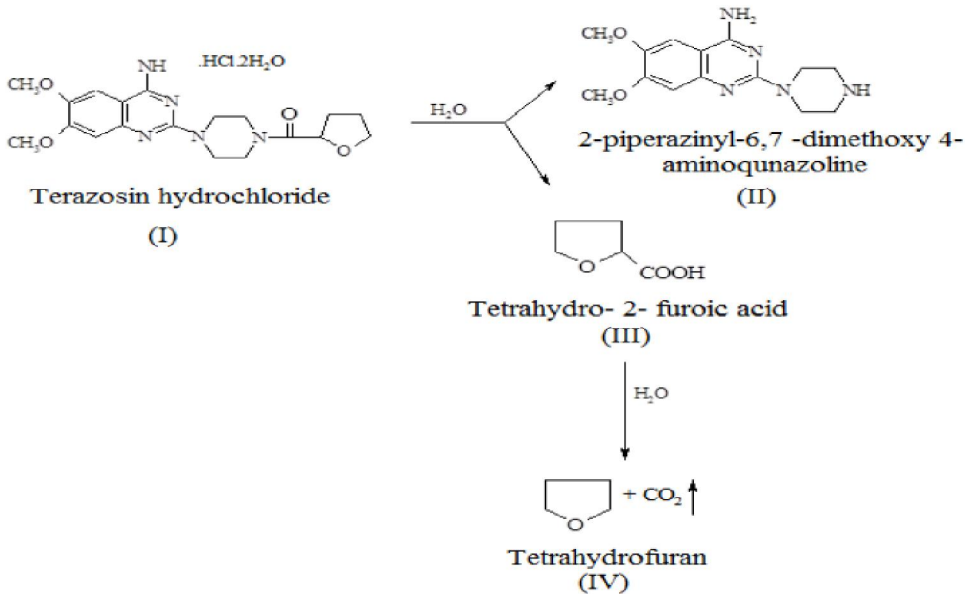

Figure 2 : Scheme degradation of terazosin

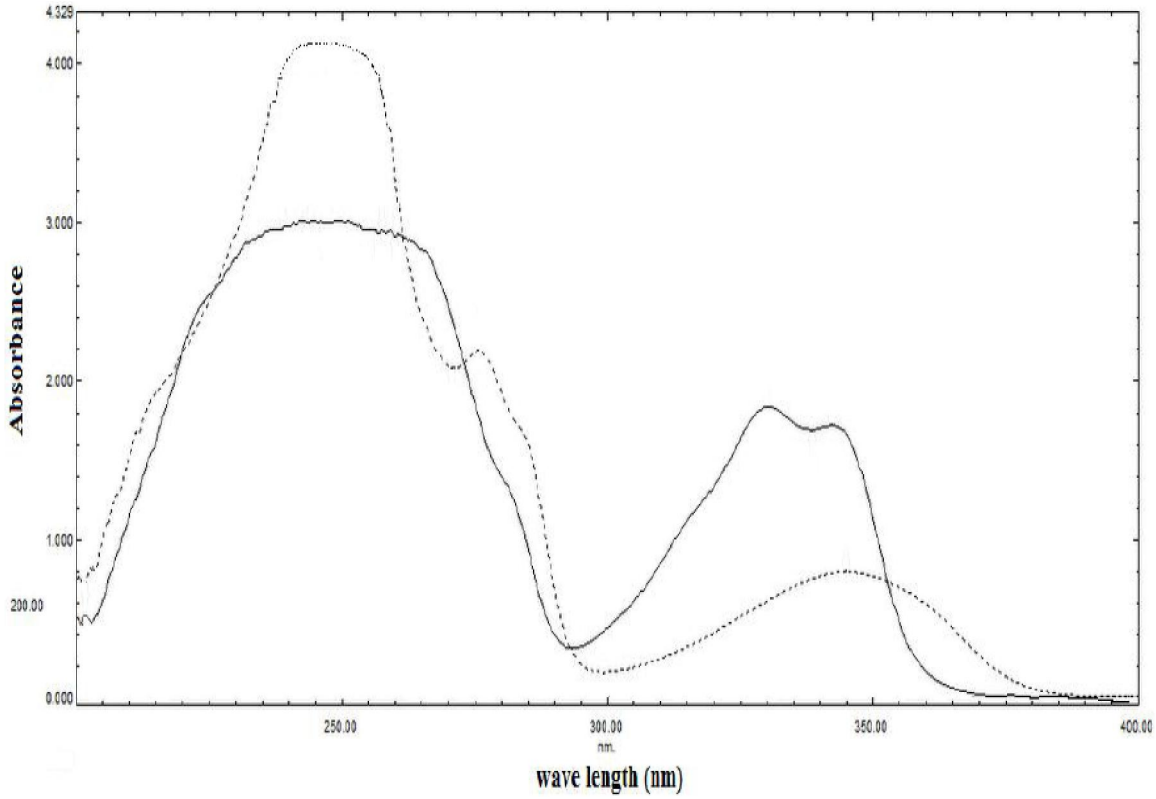

Figure 3 : Absorption spectrum of terazosin(___) and its degradation product22µg mL^{-1}(——), using methanol as a solvent

bility study under stress conditions revealed the instability of the drug in presence of sodium hydroxide (Figure 2).

Terazosin is soluble in methanol. The molecular weight of terazosindegradate was confirmed by mass spectroscopy. It was noted that 3 hours reflux using1N sodium hydroxidewas enough for complete degradation of terazosin (Figure 2); this was demonstrated by the use of thin layer chromatography. Furthermore, complete shift of terazosin UV-spectrum in methanoltakes place.

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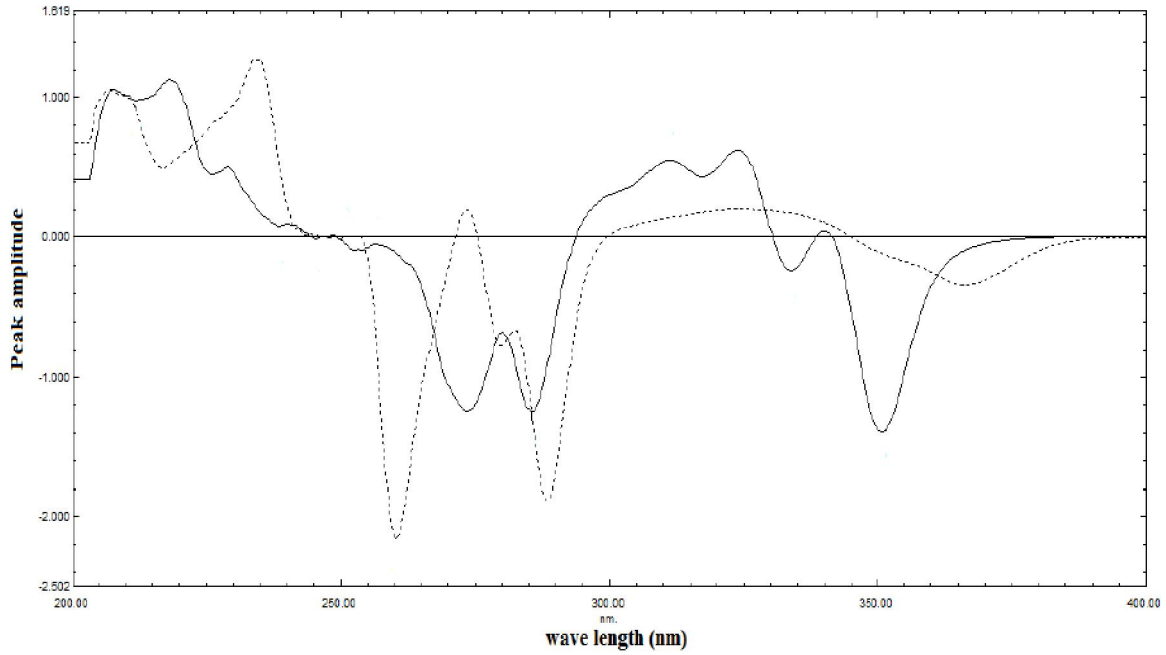

Figure 4 : First derivative spectra of terazosin(—) and its degradation product 22µg mL^{-1} (- - - -) using methanol as a solvent

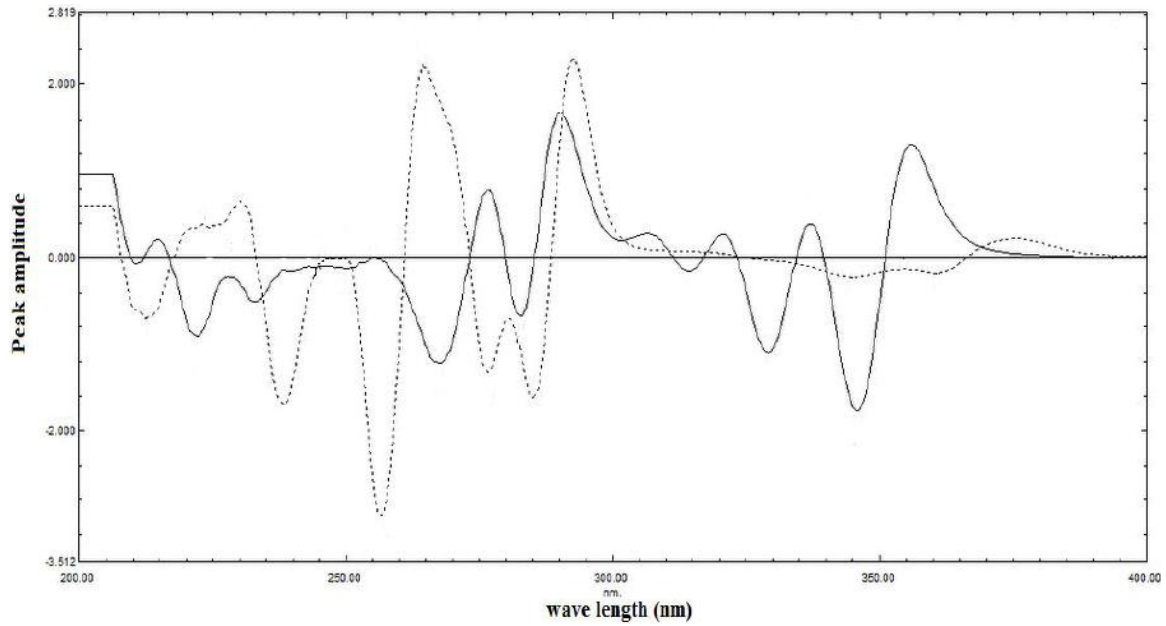

Figure 5 : Second derivative spectra of terazosin(—) and its degradation product 22 µg mL^{-1} (- - - -) using methanol as a solvent

Derivative and derivative ratio spectrophotometric method

Derivative spectrophotometric method

The zero, first, second and third order absorption spectra of terazosin and its degradation products (Figure 3, 4, 5and 6) respectively showed severe overlap that prevented the use of direct and derivative spectrophotometry for the analysis of terazosin in presence of its degradation products.

But fourth derivative applied to resolve such a mixture and to determine the concentration of terazosin, (Figure 7)

The linearity was checked between the peak amplitude at the selected wavelength (329.2 nm for concentration range from 2 – 22 µg mL^{-1}. Figure (8).

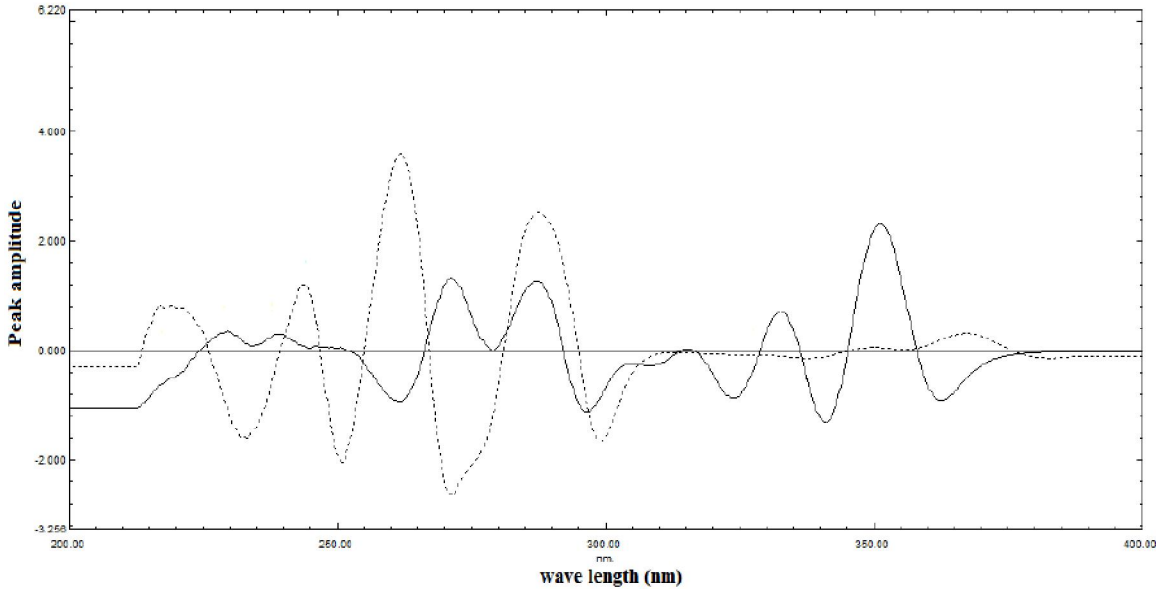

Figure 6 : Third derivative spectra of terazosin (—) and its degradation product 22µg mL^{-1} (- - - -) using methanol as a solvent

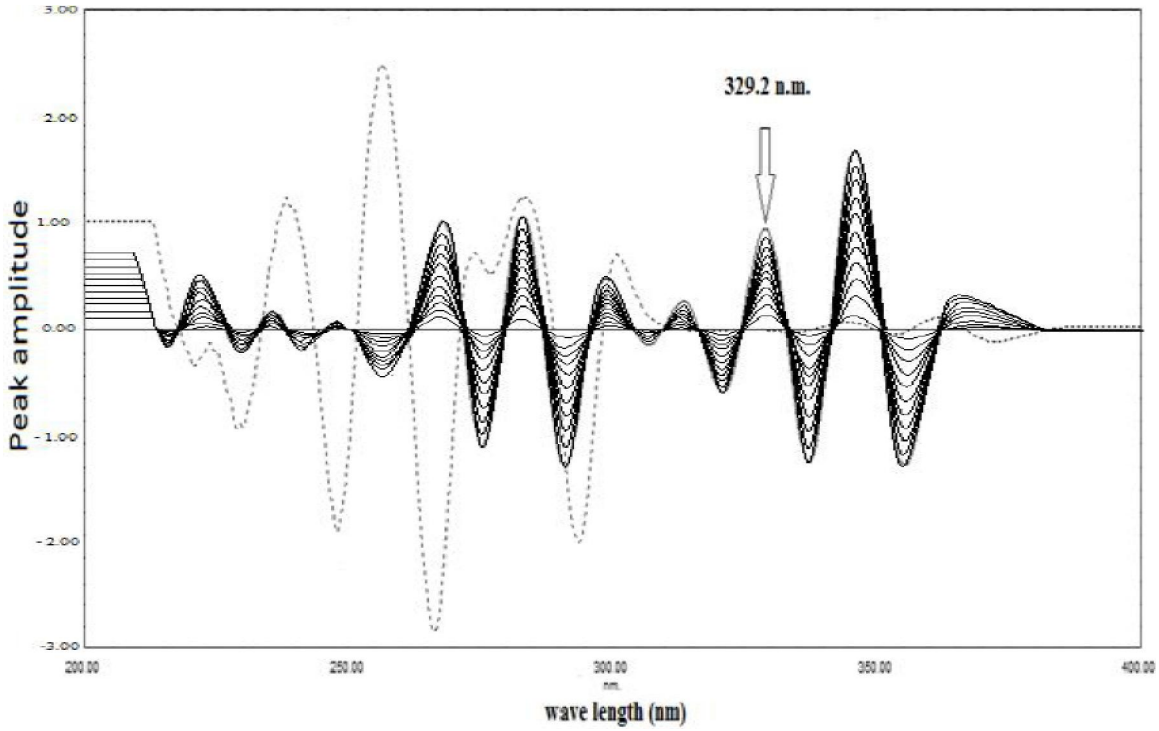

Figure 7 : Fourth derivative spectra of terazosin(—) and its degradation product 22µg mL^{-1} (- - - -) using methanol as a solvent

The regression equation was found to be:

$^4D_{329.2}$= 0.0397*X*+ 0.0821*r* = 0.9997

Where *X* is the concentration of terazosin in µg mL^{-1}, ($^4D_{329.2}$) is the amplitude of fourth derivative curve (terazosin and its degradation) at 329.2 nm and *r* is the correlation coefficient.

Derivative ratio spectrophotometric method

The derivative ratio spectroscopy could be applied to resolve such a mixture and to determine the concentration of terazosin. The zero order of the derivative ratio spectra of terazosin, (Figure 9), and the first order of the derivative ratio spectra are pre-

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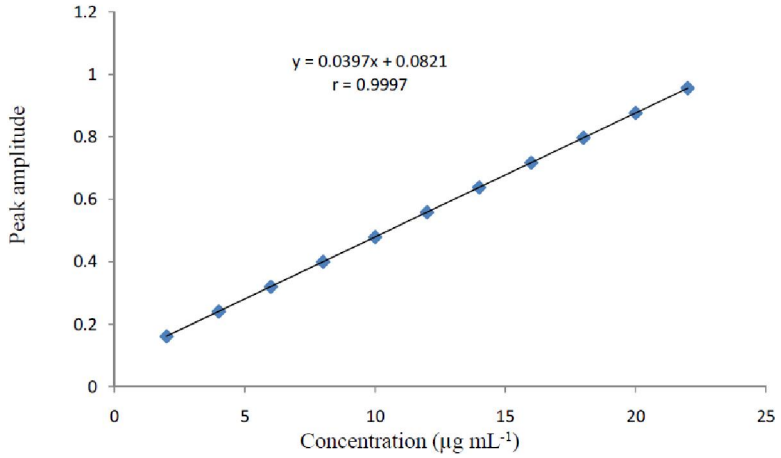

Figure 8 : Linearity of the peak amplitude of the forth derivative curve at 329.2 nm to the corresponding concentration of terazosin

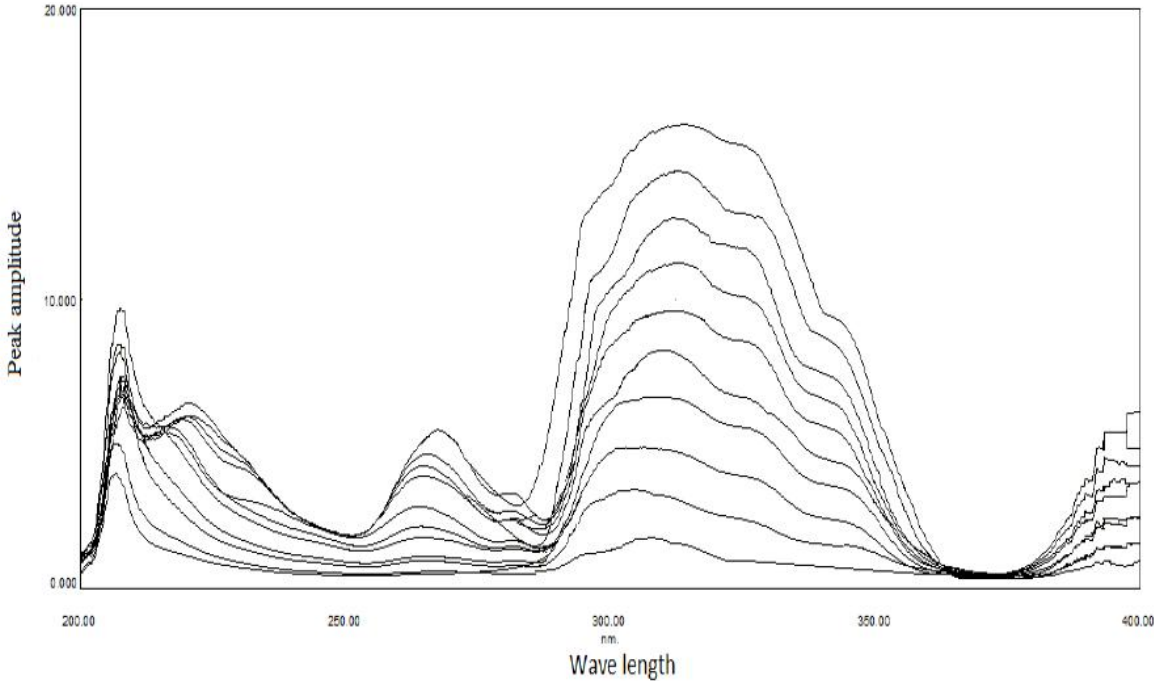

Figure 9 : Ratio spectra of terazosin hydrochloride 2 – 20 µg mL^{-1} using 8 µg mL^{-1} of its degradation product as a divisor and methanol as a solvent

sented in (Figure 10). The concentration of the devisor was also studied.

It was found that upon dividing by the spectrum of 8 µg mL^{-1} degradation productsgave the best results in terms of sensitivity, repeatability and signals to noise ratio. The linearity was checked between the peak amplitude at the selected wavelength (310.6 nm) and the corresponding concentrations of terazosin. Figure (11).

A linear response was obtained for concentration range from 2– 20µgmL^{-1}.

The regression equation was found to be:

$$^{1}DD_{310.6}=0.0896X+\ 0.0047 \quad r\ =\ 0.9998$$

Where *X*is the concentration of terazosin in µg mL^{-1}, ($^{1}DD_{310.6}$) is the amplitude of first derivative curve (terazosin andits degradate) at 310.6 nm and *r* is the correlation coefficient.

Densitometric method

A densitometric method is described for the determination of terazosin inpresence of itsdegradate without prior separation. Different solvent systems were tried for the separation of terazosin from its

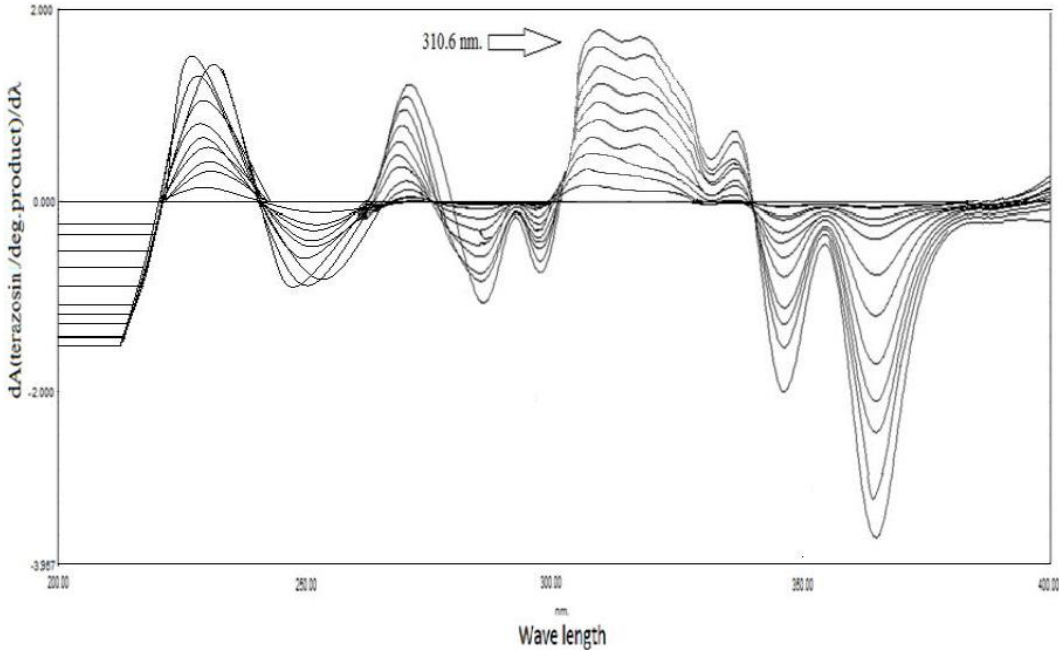

Figure 10 : First order ratio spectra of terazosin hydrochloride 2 – 20 µg mL^{-1} using 8 µg mL^{-1} of its degradation product as a divisor and methanol as a solvent

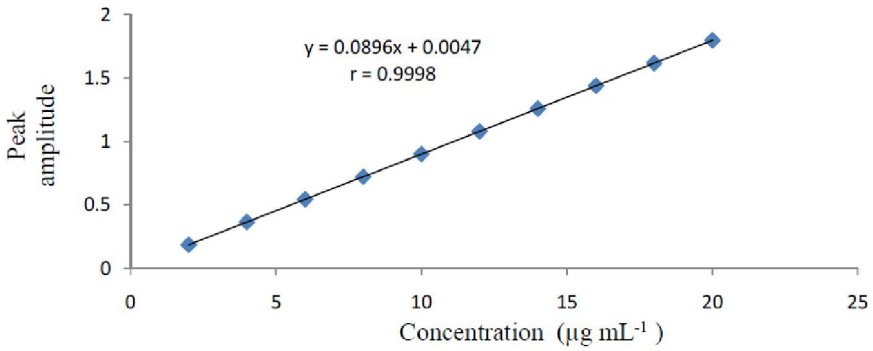

Figure 11 : Linearity of the peak amplitude of the first derivative of the ratio spectra at 310.6nm againstconcentration of terazosin

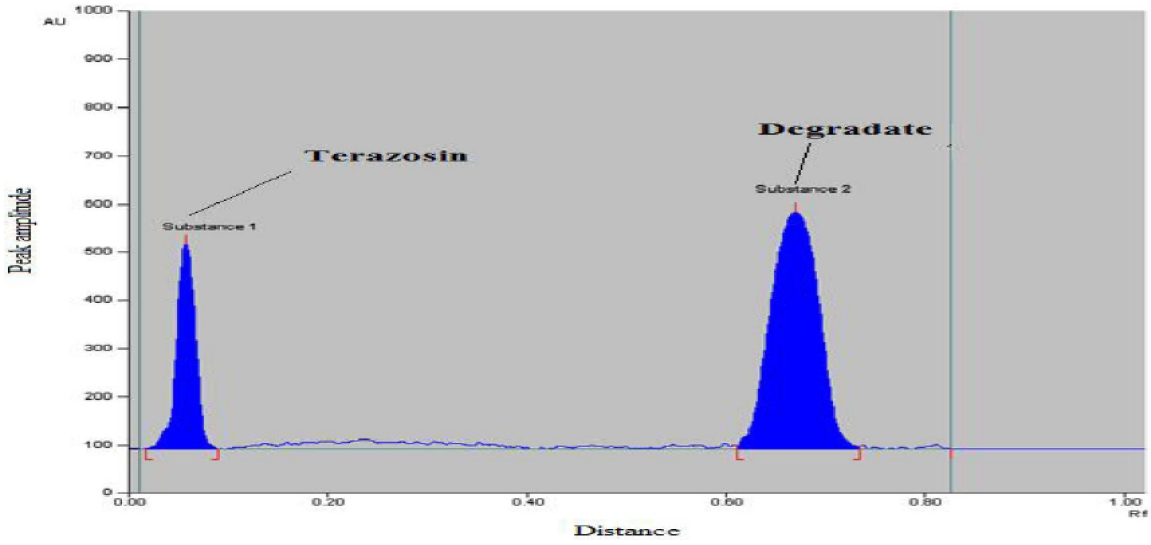

Figure 12 : Two dimensional TLC-Separation of terazosin from it'sdegradate

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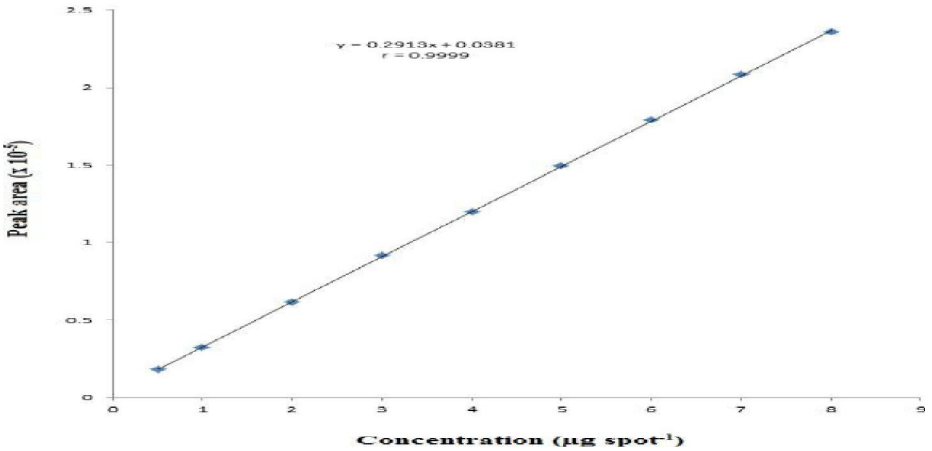

Figure 13 : Linearity of the integrated peak area to the corresponding concentration of terazosin (µg spot^{-1})

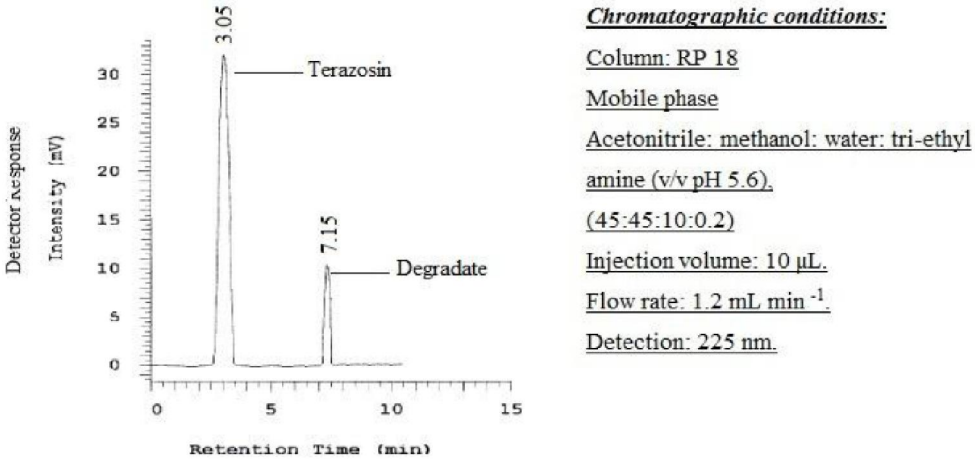

Figure 14 : HPLC chromatogram for separation of terazosin hydrochloride (64 µg mL^{-1}, R_t: 3.05 min) from its degradation product (16µg mL^{-1}, R_t: 7.15 min) using the specified

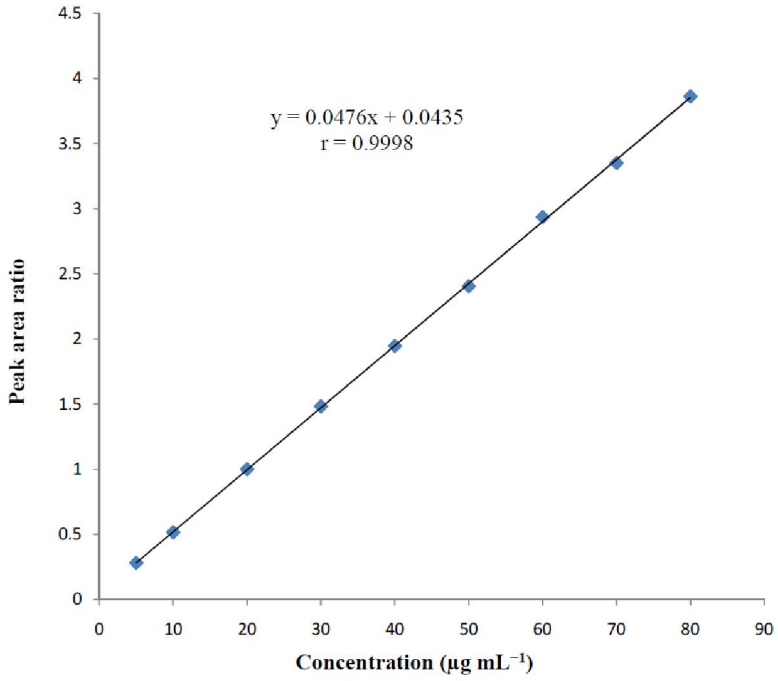

Figure 15 : Linearity of the peak area ratio to the corresponding concentration of terazosin

degradation product. Satisfactory results were obtained by using chloroform: acetone: ammonia (6:4:0.1, by volumes) as a developing system (R_f = 0.08, 0.65 forterazosin and degradate, respectively). The separation allows the determination of terazosin with no interference from itsdegradate (Figure 12).

The linearity was confirmed by plotting the measured peak area versus the corresponding concentration at 291 nm over a range of 0.5 – 8µg spot^{-1} where a linear response was obtained. Figure (13).

The regression equation was found to be:

$A = 0.2913X + 0.0381$, r = 0.9999

Where *A* is the integrated area under the peak (x 10^{-5}),for terazosin, *X*is the concentration in µg spot^{-1} for terazosin and *r* is the regression coefficient.

Liquid chromatographic method

A simple isocratic high-performance liquid chromatographic method is described for the determination of terazosin in presence of its degradation product. System suitability parameters were tested by calculating the capacity factor, tailing factor, the selectivity factor and resolution. Best peak shape was obtainedacetonitrile: methanol: water: phosphate buffer: tri-ethyl amine in the ratio of (45:45:10:0.2 by volume), (pH 5.6)with average retention time 3.05 ± 0.02 min for terazosin hydrochloride, 7.15 ± 0.02 min for its degradation product (Figure 14).

A linear response was obtained between the relative peak area and the corresponding concentrations of the terazosin in the range of 5 – 80µgmL^{-1}. The regression equation was found to be: (Figure 15).

$A = 0.0476X + 0.0435r = 0.9998$

Where*A*is the relative area under the peak, *X is* the concentration in µgmL^{-1} and *r is* the regression coefficient.

Method validation

By applying the proposed HPLC method, it was possible to determine terazosinhydrochloride in its pure powder form. The mean accuracy was found as shown in (TABLES 1).

The selectivity and specificity of the proposed methods were verified by determination of terazosin in laboratory prepared mixture containing different ratios of the drug and its degradation product. The

TABLE 3 : Determination of terazosin in Itrin® tablets by the proposed procedures

Itrin® tablet	Fourth Derivativemethod Recovery % ±S.D.[(a)]	Derivative ratio method Recovery % ±S.D.[(a)]	Densitometric method	HPLC method
Dosage form BN: 76664/3J	100.75 ± 0.747	100.93 ± 0.610	100.91± 0.630	100.91± 0.630

[(a)] Average of seven determinations

TABLE 4 : Results of application of standard addition to the determination of terazosin in Itrin® tablets by the proposed methods

Itrin® tablet	Fourth Derivative (Claimed taken: Standard added) (Recovery %) (µgmL^{-1})	Derivative ratio (Claimed taken: Standard added) (Recovery %) (µgmL^{-1})	Densitometry (Claimed taken: Standard added) (Recovery %) (µg spot^{-1})	HPLC (Claimed taken: Standard added) (Recovery %) (µgmL^{-1})
Dosage form BN: 76664/3J	(2.00: 2.00) 100.33	(2.00: 2.00) 101.03	(0.50: 0.50) 100.76	(5.00: 5.00) 101.16
	(2.00: 4.00) 101.68	(2.00: 4.00) 101.67	(0.50: 1.00) 99.69	(5.00: 10.00) 99.21
	(2.00: 6.00) 99.38	(2.00: 6.00) 99.75	(0.50: 2.00) 100.57	(5.00: 20.00) 101.70
	(2.00: 8.00) 100.94	(2.00: 8.00) 100.29	(0.50: 3.00) 99.60	(5.00: 30.00) 99.75
	(2.00: 10.00) 100.42	(2.00: 10.00) 101.24	(0.50: 4.00) 99.55	(5.00: 40.00) 100.52
	(2.00: 12.00) 101.92	(2.00: 12.00) 99.67	(0.50: 5.00) 100.20	(5.00: 50.00) 100.97
	(2.00: 14.00) 99.04	(2.00: 14.00) 100.39	(0.50: 6.00) 100.64	(5.00: 60.00) 101.28
	(2.00: 16.00) 99.51	(2.00: 16.00) 100.08	(0.50: 7.00) 99.48	(5.00: 70.00) 100.51
	(2.00: 18.00) 100.19	(2.00: 18.00) 99.93		
Mean ± S.D.	100.37 ± 0.997	100.45 ± 0.705	100.72 ± 0.508	100.64 ± 0.825

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TABLE 5 : Assay parameters and validation sheet

Parameter	Fourth Derivative method	Derivative ratio method	Densitometric method	HPLC method
n	11	10	9	9
Range ($\mu g\ mL^{?1}$)	2.00 – 22.00	2.00 – 20.00	0.50 – 8.00	5.00 – 80.00
Slope	0.0397	0.0896	0.2913	0.0476
Intercept	0.0821	0.0047	0.0381	0.0435
Mean	100.38	100.39	99.93	99.99
S.D.	0.682	0.965	0.465	0.755
Variance	0.465	0.931	0.216	0.570
Coefficient of variation	0.679	0.961	0.466	0.755
Correlation Coefficient (*r*)	0.9997	0.9998	0.9999	0.9998
RSD (%)[a]	0.675	0.960	0.463	0.752
RSD (%)[b]	0.677	0.963	0.464	0.762

TABLE 6 : Statistical comparison for the results obtained by the proposed methods and the reported method for the analysis of terazosin in bulk powder

	Fourth Derivative method	Derivative ratio method	Densitometry	HPLC	Reported method[22]
Mean	100.38	100.39	99.93	99.99	99.75
S.D.	0.682	0.965	0.465	0.755	0.671
Variance	0.465	0.931	0.216	0.570	0.450
N	11	10	9	9	6
F-test	1.03 (4.74)*	2.06 (4.77)*	2.08 (3.69)*	1.26 (4.82)*	
Student's *t*-test	1.829 (2.131)*	1.422 (2.145)*	0.617 (2.160)*	0.629 (2.160)*	

***The figures in parenthesis are the corresponding tabulated values at P = 0.05 (Remington)**

analysis was valid up to 90% of the degradation product for the (^{4}D), (^{1}DD) method, densitometry and liquid chromatography, respectively (TABLES 2).

To ascertain the accuracy of the proposed procedures, they were successfully applied for the determination of terazosin in Itrin® tablets as presented in TABLE 3.

The validity of the proposed procedures was further assessed by application of the standard addition technique. The small relative standard deviations indicate that the methods were accurate (TABLE 4).

The precision of the suggested methods was also expressed in terms of relative standard deviation of the inter-day and intra-day analysis. The individual methods were also checked for its robustness by minor changes in assay conditions, the methods proved robust. The obtained assay parameters and a validation sheet are presented in (TABLE 5).

The results obtained by the proposed methods for determination of terazosin in bulk powder were statistically compared with those obtained by applying the reported method[22], and it revealed insignificant difference (TABLE 6).

CONCLUSION

The proposed procedures are simple, sensitive, selectiveand stability indicating. The methods can be used for the routine analysis of terazosin either in bulk powder or inpharmaceutical dosage forms. The proposed methods can be applied in laboratories lacking sophisticated instruments such as GC–MS or LC–MS. The suggested methods can be simply applied to kinetic studies and accelerated stability experiments to predict expiry dates of pharmaceuticals.

ABBREVIATION

^{1}D ……..First derivative.
^{2}D ……..Second derivative.
^{3}D ……..Third derivative.
^{4}D ……..Forth derivative.
^{1}DD …...First derivative ratio.
HPLC ….High performance liquid chromatography.
HPTLC…High performance thin layer chromatography.
TR ……..Terazosin.
TLC ……Thin layer chromatography.

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