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"Overview on Analysis Methods for Telmisartan and Captopril"

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ABSTRACT
Systemic chronic inflammation (SCI) is a basic feature of chronic kidney disease (CKD)/end-stage renal disease (ESRD), especially in those undergoing hemodialysis (HD. SCI is the result of the increased serum levels of proinflammatory cytokines such as interleukin (IL)-6 and tumor necrosis factor (TNF-α) as well as acute phase proteins such as C-reactive protein (CRP) and fibrinogen. Telmisartan, an Angiotensin receptor Blocker (ARB) with partial peroxisome proliferators activated receptor-γ (PPAR-γ) agonist activity works by blocking a substance in the body that causes blood vessels to tighten. Captopril Angiotensin-converting enzyme (ACE) inhibitors are pharmaceutical drugs used primarily for the treatment of hypertension and congestive heart failure. In addition, ACE inhibitors have also been used in chronic kidney diseases. Analytical methods are available of this review article UV, HPLC, RP-HPLC, HPTLC, UHPLC methods.

Keywords: Analytical method, Telmisartan, Captopril, UV, HPLC, RP-HPLC, HPTLC, UHPLC

I. INTRODUCTION

INTRODUCTION OF DISEASE [1-3]

- Inflammation is highly prevalent in patients with end stage kidney disease(ESKD) on dialysis, and has been associated with multiple factors such as malnutrition, overhydration, bioincompatibility of hemodialysis (HD) membranes and dialysate, uremia, dialysis vintage, dialysis dose, and vascular access among others.
- Systemic chronic inflammation SCI is the result of the increased serum levels of proinflammatory cytokines such as interleukin (IL)-6 and tumor necrosis factor (TNF-α) as well as acute phase proteins such as C-reactive protein (CRP) and fibrinogen.
- It has now been well established that CKD/ESRD is a type of SCI.
- Hemodialysis patients are at greater risk of cardiovascular disease. Higher than expected cardiovascular morbidity and mortality in this population has been attribuvrrted to dislipidemia as well as inflammation.
- The causes of inflammation in hemodialysis patients are multifactorial. Several markers were used for the detection of inflammatory reaction in patients with chronic renal disease.
- These markers can be used for the prediction of future cardiovascular events. Among the several parameters of inflammatory markers, serum, CRP is well known and its advantages for the detection of inflammation and its predictor ability has been evaluated in several studies.

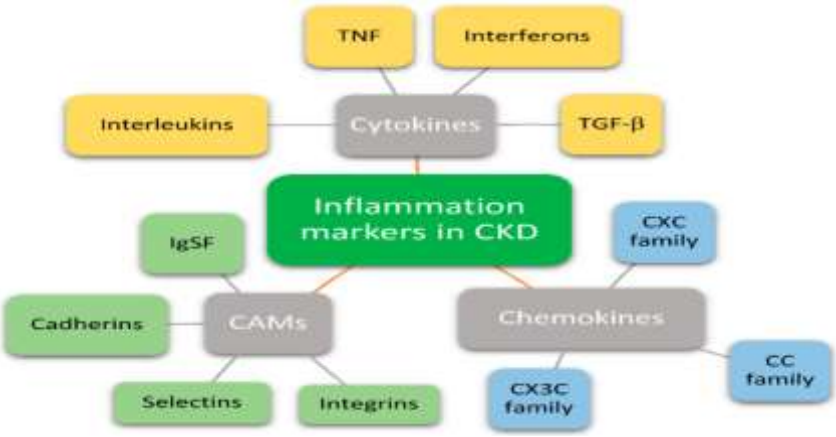

Fig. 1: Inflammation markers in CKD

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INTRODUCTION OF DRUG [4-6]
INTRODUCTION OF TELMISARTAN

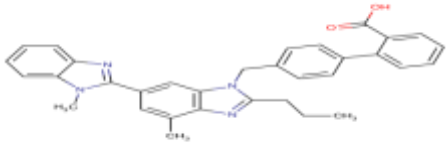

Fig. 2: Chemical Structure of Telmisartan

- Telmisartan, an ARB with partial peroxisome proliferators activated receptor-γ (PPAR-γ) agonist activity works by blocking a substance in the body that causes blood vessels to tighten. As a result, telmisartan relaxes the blood vessels. This lowers blood pressure and increases the supply of blood and oxygen.
- The status of End Stage Renal Disease (ESRD) may be monitored by measuring a blood test called the serum creatinine. The value of the serum creatinine can be used to calculate the estimated glomerular filtration rate (eGFR), which reflects the percentage of glomeruli which are no longer filtering the blood.Treatment with an angiotensin receptor blocker, which dilates the arteriole exiting the glomerulus, thus reducing the blood pressure within the glomerular capillaries, which may slow (but not stop) progression of the disease.

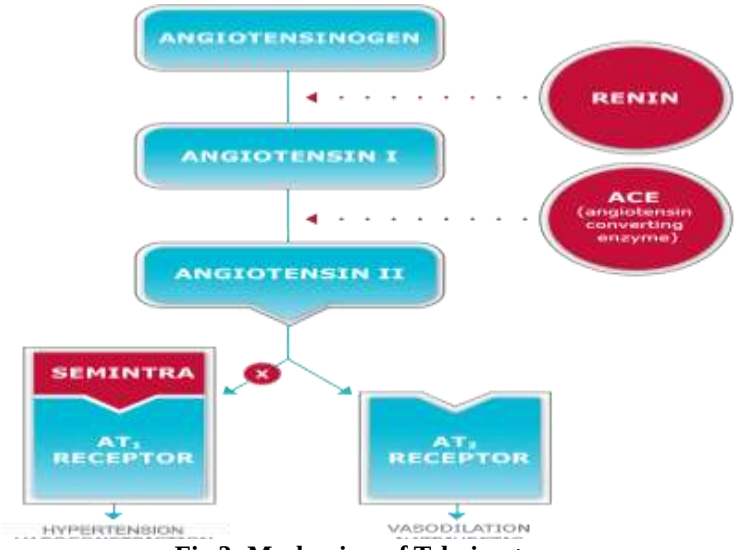

Fig 3: Mechanism of Telmisartan

INTRODUCTION OF CAPTOPRIL

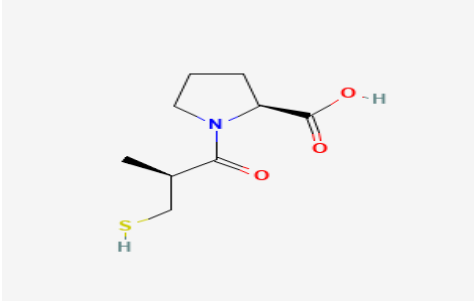

Fig. 4: Chemical Structure of Captopril

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- Captopril is an FDA-approved medication used in the management of hypertension, left ventricular dysfunction after myocardial infarction, and diabetic nephropathy. Off-label indications include acute hypertensive crisis and Raynaud phenomenon.
- Angiotensin-converting enzyme (ACE) inhibitors are pharmaceutical drugs used primarily for the treatment of hypertension and congestive heart failure. In addition, ACE inhibitors have also been used in chronic kidney diseases.Captopril, an ACE inhibitor, has been demonstrated to exhibit protective effect on diabetic and non-diabetic renal injury.
- Hypertension is a global chronic disease, and uncontrolled hypertension usually leads to chronic kidney disease and ultimately kidney failure.
- Hypertension-induced renal damage is a significant cause of morbidity and mortality in hypertensive patients and has become an important public health problem
- The elucidation of mechanisms underlying hypertensive renal injury, as well as the development of new therapies to blunt its progression, are urgently required.

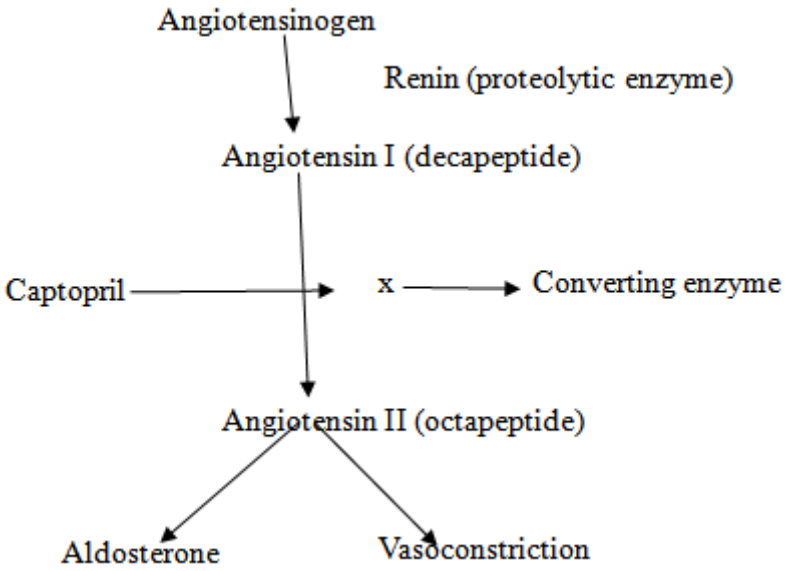

Fig 5: Mechanism of Captopril

ANALYTICAL METHODS

1) Method for determination of Telmisartan and Captopril by high performance Liquid Chromatography (Table 1)

- From the above literature review, all spectroscopic methods for telmisartan and captopril done by using Methanol as a common solvent. Wavelength for telmisartan and captopril found to be 240nm and 220nm respectively. From the literature review, all chromatographic method done for telmisartan by using mobile phase as potassium dihydrogen phosphate, sodium pentane sulphonate monohydrate, Methanol, Acetonitrile and orthophosphoric acid with pH 3.0 adjust in different proportion by using C18 analytical column as a stationary phase. For captopril all chromatographic method was done using mobile phase as orthophosphoric acid, water, methanol with adjust pH 2.3 by using C18 analytical column.

2) Method for determination of Telmisartan and Captopril by UV Spectroscopic Method

- Spectroscopy is the branch of science that deals with the study of interaction of electromagnetic radiation with matter.Instrument used to measure the absorbance in UV (200- 400nm) or visible (400-800nm) region is called UV- visible spectrophotometer.

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Table No. 1: Methods for determination of Telmisartan and Captopril by UV Spectroscopy, Chromatography and Other Technique

Sr.no.	Method	Description	Ref. no.
1	Analytical Method Development and Validation for Determination of Telmisartan in Bulk and Pharmaceutical Formulation by QbD Approach	**Solvent**: Methanol **Wavelength**: 292nm	13
2	Validation of Telmisartan by UV Spectrophotometry Method	**Solvent:** Sodium hydroxide, Distilled Water **Wavelength:** 295.0 nm	14
3	UV-spectrophotometric analytical method development and validation for determination of telmisartan in pharmaceutical drug and drug product (tablet dosage form)	**Solvent**: Sodium Hydroxide, Acetic acid, Water and Methanol **Wavelength:** 296.5 nm	15
4	Development and validation of UV-visible spectrophotometric method for estimation of cilnidipine and telmisartan in bulk and dosage form	**Solvent:** 0.1N HCl and pH 6.8 Phosphate buffer were prepared in double distilled water **Wavelength:** 236 nm	16
5	Development of UV spectrophotometric method for estimation and validation of Telmisartan as a pure API	**Solvent:** 60% Ethanol (95%) and 40% of 0.1 N $NaHCO_3$ **Wavelength:** 240 nm	17
6	Method development and validation of telmisartan in bulk and pharmaceutical dosage forms by UV spectrophotometric method	**Solvent**: Methanol: Water (90:10 %v/v) **Wavelength**: 298 nm	18
7	Analytical Method Development and Validation of Ondansetron and Telmisartan in Tablet Dosage Form by RP-UHPLC Method	**Column:** C18 (50×2.1mm and1.7µm) **Mobile phase:** Acetonitrile: Water (50:50 %v/v) **Wavelength:** 214 nm **Flow rate:** 1ml/min	19
8	Analytical Method Development and Validation of Azelnidipine and Telmisartan by RP HPLC Method	**Column:** C18 (4.6 x 150 mm, 5 µm) **Mobile phase:** Buffer 0.01 N KH_2PO: Acetonitrile (45:55% v/v) **Wavelength:** 290 nm **Flow rate:** 1 ml/min	20
9	Analytical method for simultaneous estimation of Efonidipine Hydrochloride Ethanolate and Telmisartan by validated RP-HPLC method	**Column:** C18 Column (150 mm × 4.6 mm, 5 µm) **Mobile phase:** Potassium Dihydrogen Orthophosphate: Acetonitrile (30:70 %v/v) **Wavelength:** 254 nm **Flow rate:** 0.8 ml/min	21
10	Development and validation of Telmisartan in tablet dosage form by RP-HPLC assay technology	**Column: (**Hypersil BDS C-8 12.5 cm X 4.00 mm, 5µm) **Mobile phase:** Buffer Solution and Solution A (Methanol and Acetonitrile (1:1%v/v) in the gradient ratio. **Wavelength:** 298 nm **Flow rate:** 1.2ml/min	22

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11	Stability-indicating RP-HPLC method development and validation for simultaneous estimation of telmisartan and rosuvastatin calcium in bulk and in tablet dosage form	**Column**: Oyster ODS3 (5 µm, 4.6×150 mm) column **Mobile phase:** 10 mM Phosphate buffer with 1.1 g octane-1-sulfonic acid sodium salt having pH 2.5 (adjusted with 5% OPA) and Acetonitrile, with a proportion of 500:500, %v/v **Wavelength:** 242.0 nm **Flow rate:** 1.0 ml/min	23
12	Novel RP-HPLC Method for Simultaneous Analysis of Chlorthalidone and Telmisartan from Combined Dosage Form	**Column:** (4.6 mm I.D × 250 mm, 5µm) C18 **Mobile phase:** Acetonitrile and Potassium phosphate buffer (pH 2.5) (45:55 %v/v) **Wavelength:** 235 nm **Flow rate:** 0.7 ml/min	24
13	QbD based development of HPLC method for simultaneous quantification of Telmisartan and Hydrochlorothiazide impurities in tablets dosage form	**Column:** ODS-3V, 150 × 4.6 mm, 3.5 µm **Mobile phase A:** 0.02 M Potassium dihydrogen phosphate (pH of 3.5) **Mobile phase B:** Water and Acetonitrile (100: 900 v/v) **Wavelength:** 230 nm **Flow rate:** 1.0 ml/min	25
14	Method development and validation for the simultaneous estimation of Telmisartan and Azelnidipine in bulk and tablet dosage form by using HPLC	**Column:** (4.6×250mm, 5µm) **Mobile phase:** Phosphate buffer and Acetonitrile (70:30 %v/v) **Wavelength:** 225 nm **Flow rate:** 1ml/min	26
15	Simultaneous Estimation of Telmisartan and Cilnidipine In Combined Tablet Dosage Form By RP-HPLC	**Column:** C18 column (150 × 4.6 mm, 5 µm) **Mobile phase:** Methanol: Sodium dihydrogen phosphate buffer (pH 7) (70:30%v/v) **Wavelength:** 273 nm **Flow rate:** 1 ml/min	27
16	RP-HPLC method development and validation for simultaneous estimation of cilnidipine and telmisartan in combined pharmaceutical dosage form	**Column:** C18 (250 x 4.6 mm, 5µm) **Mobile phase:** Acetonitrile: 0.05% Ortho phosphoric acid (60: 40 %v/v) **Wavelength:** 236 nm **Flow rate:** 0.7 ml/min	28
17	Simple and stability indicating RP-HPLC assay method development and validation of telmisartan in bulk and dosage form	**Column:** ZorabaxSBC18 (150x4.6 MM, 5µm) **Mobile phase:** Acetonitrile and (0.1ml Phosphoric acid and 0.2ml Try Ethyl Amine in10 0mlof Triple distilled Milli-Q-water) Buffer (35:65 %v/v) **Wavelength:** 234 nm **Flow rate:** 1.2 ml/min	29
18	Analytical Method Development and Validation and Force Degradation Studies for Simultaneous Estimation of Amlodipine Besylate and Telmisartan in Tablet Dosage Form by using RP-HPLC	**Column:** C18 column (250×4.6mm, 5µm particle size) **Mobile phase:** Methanol and Phosphate buffer (pH 4) 70:30 %v/v **Wavelength:** 240 nm **Flow rate:** 1 ml/min	30

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19	Validated RP-HPLC Method for Simultaneous Determination of Telmisartan and Hydrochlorothiazide in Pharmaceutical Formulation	**Column:** 250 x 4.6 mm 5- µm packing L11 column **Mobile phase:** Acetonitrile and Methanol (50:50 %v/v) **Wavelength:** 298 nm **Flow rate:** 1.2 ml/min	31
20	Development and Validation of RP-HPLC Method for the Simultaneous Estimation of Telmisartan and Hydrochlorothiazide in Bulk and Pharmaceutical Dosage Form	**Column:** ACE 5 C18 (150 mm × 4.6 mm, 5µm) **Mobile phase:** Mobile phase A: Water: Acetonitrile: Ortho phosphoric acid (95:5:1 %v/v/v) Mobile phase B: Water: Acetonitrile: Ortho phosphoric acid (5:95:1 %v/v/v) **Wavelength:** 280 nm **Flow rate:** 1.5 ml/min	32
21	Development and validation of RP-HPLC method for the estimation of telmisartan in bulk drug using internal standard	**Column:** C-18 column (250 X 4.6 mm, particle size 5µm) **Mobile phase:** 10mM Potassium di hydrogen phosphate buffer: Methanol (20: 80 %v/v) **Wavelength:** 296 nm **Flow rate:** 0.8 ml/min	33
22	RP-HPLC method development and validation for estimation of Telmisartan in bulk and tablet dosage form	**Column:** RP 18 column (250×4.6mm, 5 µm) **Mobile phase:** 0.025M Potassium dihydrogen phosphate: Acetonitrile: Methanol (45:50:5 %v/v/v) **Wavelength:** 216 nm **Flow rate:** 1ml/min	34
23	Development and Validation of Stability Indicating HPTLC and HPLC Methods for Simultaneous Determination of Telmisartan and Atorvastatin in Their Formulations	**RP-HPLC method:** **Column:** Luna C_{18} **Mobile phase:** Acetonitrile: 0.025 M ammonium acetate (38 : 52 %v/v), (pH 3.8) **Wavelength:** 281 nm **Flow rate**: 1.0 mL/min **HPTLC Method:** **Column:** silica gel 60 F_{254} **Mobile phase:** Toluene: Methanol: Ethyl acetate-acetic acid (5: 1: 1: 0.3 %v/v) **Wavelength:** 279 nm **R_f value:** TLM and ATV (0.37 ± 0.02 and 0.63 ± 0.01)	35
24	Stability- indicating HPTLC determination of Telmisartan in bulk and tablets	**Column:** TLC Aluminium plates precoated with silica gel 60F-254 (20×20cm, 25) **Mobile phase:** Ethyl acetate: dichloroethane: methanol (6:2:1 %v/v). **Wavelength:** 295 nm **R_f value:** 0.68 ± 0.03	36
25	Development and validation of HPTLC method for determination of Telmisartan in API and pharmaceutical dosage form	**Column:** Silica Gel 60 F254 (20×20cm, 25) **Mobile phase:** Toluene: Methanol (7:3 % v/v/v)	37

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		Wavelength: 299 nm **R_f value:** 0.46	
26	Development and validation of a HPTLC method for the simultaneous estimation of telmisartan and hydrochlorothiazide in tablet dosage form	**Column:** precoated silica gel 60F254 (20×20cm, 25) **Mobile phase:** Chloroform: methanol: toluene (2:5:5 v/v/v) **Wavelength:** 272 nm **R_f value:** 0.53±0.04	38
27	Method development and validation of captopril in pure and solid dosage form by UV spectrophotometry	**Solvent**: 1N Sodium hydroxide (NaOH) **Wavelength**: 265 nm	39
28	Novel Spectrophotometric Method for the Assay of Captopril in Dosage Forms using 2,6-Dichloroquinone-4-Chlorimide	**Solvent:** Distilledwater (100ml) Wavelength: 443 nm	40
29	Quantification of Captopril using Ultra High Performance Liquid Chromatography	**Column:** H C18 1.7 µm (2.1 mm × 50 mm) **Mobile phase:** Methanol, Milli-Q water and Trifluoroacetic acid (55:45:0.05 % v/v/v) **Wavelength:** 220nm **Flow rate:** 0.1ml/min	41
30	Ultra-high-performance Liquid Chromatography as an Assay Method for the Investigation of Conditions of Captopril Extraction by Organic Solvents	**Column:** C18 column (4.6 ×150 mm, 5 µm) **Mobile phase:** Methanol and 0.1% Trifluoroacetic acid (40/60, %v/v) **Wavelength:** 220 nm **Flow rate:** 1.2 ml/min	42
31	Development and validation of reversed phase high performance liquid chromatography (RP-HPLC) for quantification of captopril in rabbit plasma	**Column:**C18 column (250 mm 3 4.6 mm with 5 µm particle size) **Mobile phase:**Water: Acetonitrile (60:40 %v/v) **Wavelength:**203 nm **Flow rate:** 1ml/min	43
32	Validation of a high-performance liquid chromatographic method for the assay and dissolution of captopril in mucoadhesive tablet formulation	**Column:** 100 RP-8 (250 × 4.6 mm, 5 µm) **Mobile phase:** Methanol and Water containing 0.001% of phosphoric acid pH 2.3 (1:1 %v/v) **Wavelength:** 220 nm **Flow rate:** 1.0 ml/min	44
33	Development and validation of a stability indicating RP-HPLC method using quality by design for estimating captopril	**Column:** Luna C18 (150×4.6 mm,5µm) **Mobile phase:** Acetonitrile and Water (30:70 % v/v) **Wavelength:** 210 nm **Flow rate:** 1.0 ml/min	45
34	Validation of the RP-HPLC method for analysis of captopril in pharmaceutical tablets	**Column:** LC1(C18) column (250 × 4.6mm; 5µm) **Mobile phase:** Methanol and Water (55:45 %v/v) **Wavelength:** 220 nm **Flow rate:** 1.0 ml/min	46
35	Stability-indicating HPLC method for simultaneous determination of	**Column:** 250 × 4.6 mm Xterra RP8 column, 5 µm	47

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	captopril, indapamide, and their related compounds	**Mobile phase:** 26 mM Pentane-1-sulfonic acid sodium salt in 30 mM potassium dihydrogen phosphate (pH 2.8, adjusted by phosphoric acid): Methanol: Acetonitrile (6:2:2) %v/v/v **Wavelength:** 210 nm **Flow rate:** 1.0 ml/min	
36	Rapid RP-HPLC method for estimation of captopril From tablet dosage form	**Column:** RP-18 (10 µm, 250x 4 mm) **Mobile phase:** Methanol: Water (60: 40% v/v) **Wavelength:** 220 nm **Flow rate:** 2 ml/min	48
37	Method for the Determination of Captopril in Bulk, Pharmaceutical Formulations and Serum by HPLC using two different System	**Column:** C18 (250cm x 4.6mm, 5µm) **Mobile phase:** Methanol: Water 50:50(%v/v) **Wavelength:** 225 nm **Flow rate:** 1ml/min	49
38	RP-HPLC Method for the Simultaneous Determination of Captopril and H2-Receptor Antagonist: Application to Interaction Studies	**Column:** C18 (5 µm, 25×0.46 cm) **Mobile phase:** Methanol: Water (60:40 %v/v) **Wavelength:** 225 nm **Flow rate:** 0.8 ml/min	50
39	Development and validation of stability indicating RP-HPLC method for simultaneous determination of Telmisartan and Hydrochlorothiazide from their combination drug product	**Column:** Hypersil GOLD (250 mm x 4.6 mm, 5 µm particle size C18 column **Mobile phase:** Acetonitrile: aqueous 0.01M potassium dihydrogen o-phosphate buffer (pH 3 adjusted with 2% v/v o-phosphoric acid) (40:60 %v/v) **Wavelength:** 254 nm **Flow rate:** 1.0 ml/min	51
40	Development and validation of a stability indicating HPLC method for the simultaneous determination of captopril and indapamide	**Column:**Zorbax C18 column 5 µm particle size, (25 cm × 4.6 mm) **Mobile phase:** Methanol: Water: Triethylamine (42.5:57.5:0.028,% v/v/v), **Wavelength:** 220nm **Flow rate:** 2 ml/min	52
41	A Stability Indicating Assay Method for Captopril Tablets by High Performance Liquid Chromatography For Stability Studies	**Column:** Luna C8, 5µm packing, 4.6 mm x 250 mm **Mobile phase:** Water: Acetonitrile: Tetrahydrofuran: Methane sulfonic acid (80:10:10:0.1 %v/v/v/v) **Wavelength:** 220 nm **Flow rate:** 1.0 ml/min	53
42	A stability-indicating HPTLC method for estimation of Captopril in pharmaceutical dosage form	**Column:** Precoated silica gel 60 F254 plate (20×20cm, 25) **Mobile phase:** Methanol: ethyl acetate: glacial acetic acid (5: 5: 0.5 v/v/v) **Wavelength:** 241 nm **R_f value:** 0.9970	54
43	Development of HPTLC method for simultaneous estimation of captopril and hydrochlorothiazide in combined dosage form	**Column:** performed on silica gel 60 GF254 TLC plates (20×20cm, 25) **Mobile phase:** Methanol: toluene: ethyl acetate: glacial acetic acid (1:6:3:0.5 %	55

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v/v)
Wavelength: 219 nm
R_f value: 0.57±0.38

II. CONCLUSION:

This review describes the reported spectroscopic and Chromatographic methods developed telmisartan and captopril. As per this review it was concluded that for telmisartan and captopril, different spectroscopic and Chromatographic are available for single-single drugs and another drug combination. it was observed that still, any combination method of Telmisartan and captopril is not available. Thus, all methods were simple, accurate, precise and reproducible. All analytical methods were of RP-HPLC and UV absorbance detection because these methods provided with best available reliability, repeatability, analysis time. And sensitivity.

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