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Review Article

A Critical Review On Analytical Methods Used For Quantification Of Indapamide As Diuretics

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ABSTRACT

Indapamide is a Thiazide- suchlike diuretic medicine used in the treatment of hypertension Since 1977. Class of Thiazide- Suchlike diuretics. It shows great capability to overcome Hypertension as well as Heart failure. Different analytical method used to get to determine a chemical or physical property of a chemical substance, chemical element, or mixture. Even though Indapamide has had the approval for clinical use for more than 30 years now most of the analytical methods for its determination reported in the scientific literature are the ones which utilize different analytical methods. This shows which method and which Solvents are more efficient to determine Indapamide.

INTRODUCTION

History of Drug[1-3]

- Indapamide is a thiazide- suchlike diuretic medicine used in the treatment of hypertension, as well as decompensated heart failure. Combination medications with perindopril (an ACE asset antihypertensive) are available. The thiazide- suchlike diuretics (indapamide and chlorthalidone) reduce threat of major cardiovascular events and heart failure in hypertensive cases compared with hydrochlorothiazide with a similar prevalence of adverse events. It was patented in 1968 and approved for medical use in 1977.It is on the

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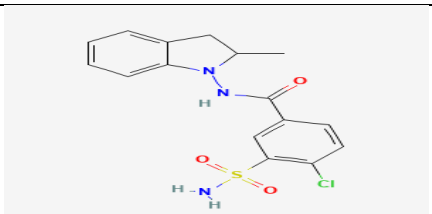
World Health Organization's List of Essential Medicines.

- It's Mainly included hypertension and edema due to congestive heart failure. Indapamide has been shown to reduce stroke rates in people with high blood pressure. Studies have shown that the blood pressure lowering goods of indapamide in combination with perindopril reduce the rate of stroke in high threat cases (those with a history of high blood pressure, stroke or type two diabetes). HYVET study showed that indapamide (sustained release), with or without perindopril as antihypertensive treatment in persons 80 times of age or aged with sustained systolic blood pressure of 160 mmHg or advanced, demonstrated significant reduction in all- cause mortality when treated to a target of 150/80 mmHg, but there was set up to be no significant reduction in threat of death from cardiac causes
- Two methodical reviews linked that indapamide with or without perindopril significantly reduced each- beget mortality in youthful- senior cases with a history of stroke, cardiovascular complaint and type 2 diabetes mellitus, when lesser reductions in mean office blood pressure are achieved, significant cardiovascular benefit was only observed when trials including the >75 times old cohort was included.

Class of Drug [4]

Classified as a sulfonamide diuretic, indapamide is an effective antihypertensive agent and by extension, has shown efficacity in the forestallment of target organ damage. Administration of indapamide produces water and electrolyte loss, with advanced boluses associated with increased diuresis. Drug Profile of Indapamide.

Table 1 Drug Profile of Indapamide

SR NO	NAME	Indapamide
1)	IUPAC	(4-chloro-N-(2-methyl-2,3-dihydroindol-1-yl)-3-sulfamoylbenzamide
2)	Class	sulfonamide diuretic
3)	Category	antihypertensive
4)	CAS No.	26807-65-8
5)	Molecular Formula	C16H16ClN3O3S
6)	Structural Formula	 **Indapamide**
7.)	Molecular Weight	159.23 g/mol
8.)	Appearance	White to off-white crystalline solid
9.)	physical state	Solid
10.)	Solubility	Soluble in Methanol, Acetonitrile
11.)	pKa	8.8
12.)	Melting Point	160-162
13.)	Partition coefficient (log P)	2.2

Current Research on Indapamide-

Current exploration on Indapamide- Indapamide (IND) is a medic action to treat high blood pressure that can reduce oxidative stress and ameliorate the survival of whim-whams cells in laboratory studies. IND is presently approved to treat high blood pressure. IND is available in tablet form and is generally taken formerly a day, the most typical cure is 2.5 mg. It's estimated that a cure of 2.5 mg per day will be sufficient to treat oxidative stress in SPMS. IND is generally well permitted.

REVIEW OF LITERATURE

Table 2 UV spectrophotometric method of Indapamide

Sr No.	Title	Description	Ref
1	Development of New Spectrophotometric methods for the determination of Indapamide in Bulk and Pharmaceutical formulations	**Solvent-** phosphate buffer 7.4 **λmax –** Method I-682.0nm Method II-602.0nm **Linearity-** 50-250µg/ml 1-18µg/ml	**5**
2	Development and Validation of UV-Spectrophotometric methods for estimation of Indapamide in bulk and tablet dosage form	**Solvent-** phosphate buffer 7.4 **λmax –** Method I-240 nm Method II-223 nm **Linearity-** 5 –40 µg/ml.(For Both Method)	**6**
3	Solvent effects on UV–Vis and FT-IR spectra of indapamide combined with DFT calculations	**Solvent-** Ethanol, Methanol, THF and DMSO **λmax -** 243 nm. (Ethanol) 246.388nm (Methanol) THF (247nm) DMSO (257.48nm)	**7**
4	Dual wavelength and simultaneous equation Spectrophotometric methods for estimation of atenolol and indapamide in their combined Dosage form	**Solvent-** Methanol **λmax** – For Atenolol-246.4 nm, 254.2nm For Indapamide-266nm,270.2nm **Linearity-** 100 to 350 µg/mL Atenolol 5 to 17.5 µg/mL Indapamide	**8**
5	Development and Validation of a Novel UV Spectrophotometric Method for Simultaneous Analysis of Amlodipine, Indapamide and Perindopril	**Solvent-** Methanol **λmax –** 365 nm for Amlodipine 245 nm for Indapamide 204 nm for Perindopril **Linearity-** 10-60 µg/ml, Amlodipine 5-20	**9**

		µg/ml, Indapamide 10-100 µg/ml, Perindopril	
6	Development and Validation of UV Spectrophoto metric Methods for Simultaneous Analysis of Amlodipine and Indapamide in Combined Dosage forms	**Solvent-** water, Methanol, Ethanol, Acetonitrile, 0.1N hydrochloric acid (0.1N HCl), 0.1N sodium hydroxide (0.1N NaOH) and chloroform. **λmax –** For simultaneous equation – 242 nm and 239nm For Isoabsorptive point- 310 nm **Linearity-** 2- 12µg/mL Amlodipine Besylateand 2-7 µg/mL Indapamide	**10**
7	Development and Validation of Spectrophotometric Method for Simultaneous Estimation of Perindopril and Indapamide in Combined Dosage Form by Absorbance Correction Method.	**Solvent-** Methanol **λmax –** 210.4nm Perindopril and 285.8nm Indapamide **Linearity-** 24 – 56 µg/ml Perindopril 7.5 – 17.5 µg/ml Indapamide	**11**
8	Development and Validation of UV Spectrophotometric Estimation of Perindopril Erbumine and Indapamide in Bulk and Tablet Dosage by using Area Under Curve Method	**Solvent-** Methanol **λmax –** Quantity Determination -208-214 nm Perindopril Erbumine 239-244 nm Indapamide **Linearity-** 1-5 µg/ml	**12**
9	Simultaneous Estimation of Indapamide and Atenolol by Two Different Ultraviolet Spectroscopic Methods	**Solvent-** Distilled water **λmax –** Method I- simultaneous equation 241 nm indapamide 224.4 nm atenolol Method II- Absorbance ratio 233.8 nm indapamide 24.4 nm atenolol **Linearity-** 2-20 µg/ml for indapamide and 10-80 µg/ml for atenolol.	**13**
10	Two Wavelength Method for Estimation of Indapamide and Perindopril Erbumine in Combined Tablet Dosage Form	**Solvent-** Methanol **λmax –** 1st - 220 nm 2nd - 240 nm **Linearity-** Indapamide - 2-20 µg/ml Perindopril Erbumine- 4-40 µg/ml	**14**

Table 3 HPLC Method of Indapamide

Sr No.	Title	Description	Ref
1	A selective HPLC method for the determination of indapamide in human whole blood: Application to a bioequivalence study in Chinese volunteers	**Mobile Phase-**buffer solution (2 g KH2PO4, 3 ml H3PO4 and 3.5 ml triethylamine in 1 l of H2O), acetonitrile and methanol (55:40:5%v/v) **Stationary phase** - Inertsil ODS-3 column **λmax** - 210 nm **Flow Rate**: 1mL/min **Retention time** 12.3 min, **Linearity** – 10–400 ng/ml	**15**
2	Validated RP-HPLC Method for the Determination of Indapamide in Bulk and Tablet Dosage Form	**Mobile Phase-** Acetonitrile:Methanol:Water in the ratio of 40:50:10 (%v/v/v) **Stationary phase** -C18 column (250X4.6mm i.d.,5µm) **λmax** -242 nm **Flow Rate**: 1mL/min **Retention time-**3.23min **Linearity** – 10-60 µg/ml	**16**
3	Development and Validation of RP-HPLC Method for Quantitative estimation of Indapamide in Bulk and Pharmaceutical dosage forms	**Mobile Phase** o-phosphoric acid (0.05%) buffer of pH 3.0 and Acetonitrile in the ratio of 60:40 (% v/v) **Stationary phase -** o RP C-18 Column (25cm x 4.6 mm i.d.,particle size 5 µm) **λmax** -240 nm **Flow Rate**: 1mL/min **Retention time** 6.76±0.0145 min **Linearity –** 10-100µg/ml	**17**
4	HPLC-UV determination of indapamide in the presence Of its main synthesis and degradation impurities. Method validation	**Mobile Phase-** Aqueous Na2EDTA, Acetonitrile and Methanol **Stationary phase** -X-Terra, C18, 250 mm × 4.6 mm, 5 µm (Waters) column **λmax** -254nm **Flow Rate**: 1mL/min **Retention time-**3.1min **Linearity –** 200-800 µg/ml	**18**
5	Simultaneous Estimation of Amlodipine Besylate and Indapamide in a Pharmaceutical Formulation by a High-Performance Liquid Chromatographic (RP-HPLC) Method	**Mobile Phase-** 0.02 M potassium dihydrogen phosphate– methanol (30:70, %v/v) total pH-adjusted to 3 using o-phosphoric acid was used. **Stationary phase** -Brownlee C-18, 5 µm column **λmax** – 242 nm **Flow Rate**: 1mL/min **Retention time** –Indapamide-3.6 min Amlodipine besylate-5.9 min **Linearity –** AML-0.25-35 µg/ml IND-0.075-10.5 µg/ml	**19**

6	A Validated HPLC Method for Simultaneous Determination of Perindopril Arginine, Amlodipine, and Indapamide: Application in Bulk and in Different Pharmaceutical Dosage Forms	**Mobile Phase–**0.05 M potassium dihydrogen phosphate buffer (pH 2.6)–methanol (50: 50, %v/v) **Stationary phase:** BDS Hypersil® C18 column (100 × 3 mm, 5 µm) **λmax –** 215 nm **Flow Rate**: 0.6 mL/min **Retention time-** 3.457 min PER arginine 6.097 min AML 2.007 min IND **Linearity –** 5–80 µg/mL PER, 2.5–80 µg/mL AML, 0.5–20 µg/mL IND	**20**
7	A Validated RP-HPLC Method for Simultaneous Estimation of Atenolol and Indapamide in Pharmaceutical Formulations	**Mobile Phase-** Methanol and water (adjusted to pH 2.7 with 1% orthophosphoric acid) in the ratio of (80:20%v/v) **Stationary phase –** C18 column (250×4.6 mm, 5 µ particle size) **λmax** -230 nm **Flow Rate**: 1.0mL/min **Retention time** – Atenolol -1.766 min Indapamide-3.407 min **Linearity –** 12.5-150 µg/mL atenolol 0.625-7.5 µg/mL indapamide	**21**
8	HPLC Determination and Pharmacokinetic Study of Indapamide in Human Whole Blood	**Mobile Phase-** Acetonitrile – 2-propanol −0.1 triethylamine in water (adjusting to pH 3.75 with 85% phosphoric acid) (35:5:60, % v/v/v) **Stationary phase** – YMC® ODS-A reverse column (5 µm particle size, 4.6×150 mm i.d.) **λmax –** 241 **Flow Rate**: 1mL/min **Linearity –** 5.0–500 mL/min	**22**
9	Validated stability indicating reverse phase HPLC method for The simultaneous estimation of perindopril and indapamide in Pharmaceutical dosage forms	**Mobile Phase-** Phosphate buffer pH 3.5±0.05 and methanol in the ratio of (65:35 %v/v) **Stationary phase –** Hypersil BDS C18 column (250 mm x 4.6 mm, 5µm) **λmax** -235nm **Flow Rate**: 1mL/min **Retention time** – Perindopril-3.53min Indapamide -4.09 min **Linearity –**	**23**

		Perindopril -160 to 480 µg/mL Indapamide – 50 -150 µg/mL	
10	Stability indicating isocratic RP-HPLC method development and validation for indapamide and perindopril erbumine in pure and its combined tablet dosage form	**Mobile Phase-** Potassium dihydrogen phosphate buffer of pH 2.5 and acetonitrile(60:40 %v/v) **Stationary phase –** YMC Column (150 x 4.6mm, 3µ particle size) **λmax** -230 nm **Flow Rate**: 1mL/min **Retention time** – Perindopril- 4.18 min Indapamide - 2.5 min **Linearity –** Indapamide -15-35 µg/ml Perindopril-48-112µg/ml	**24**
11	Stability-indicating HPLC method for simultaneous determination of Captopril, indapamide, and them Related compounds	**Mobile Phase-** 26 mM pentane-1-sulfonic acid sodium salt in 30 mM potassium dihydrogen phosphate (pH 2.8, adjusted by phosphoricacid):methanol:acetonitril (%60:20:20v/v/v) **Stationary phase –** a 250 x 4.6 mm Xterra RP8 column, 5 lm particle size **λmax** -210 nm **Flow Rate**: 1mL/min **Retention time** – CSBA-2.5, min CPD- 3.2 min MN- 6.0 min IND-12.3 min **Linearity –** CP-0.25-150 µg/ml IND-0.2– µg/ml	**25**

Table 4 HPTLC Method of Indapamide

Sr no.	Title	Description	Ref
1	Development and validation of HPTLC method for simultaneous estimation of telmisartan and indapamide in pharmaceutical solid dosage form	**Mobile Phase**- Hexane: ethyl acetate: methanol: glacial acetic acid (14:6:2:1 %v/v/v/v) **Stationary phase**: silica gel HPTLC F254 **λmax** – 249 nm **Concentration range-** Telmisartan-2000-7000 ng/spot Indapamide -75-262.5 ng/spot	**26**
2	High Performance Thin Layer Chromatographic Estimation of Atenolol and Indapamide from Pharmaceutical Dosage Form	**Mobile Phase**- Toluene: Ethanol: Acetone: Acetic acid (7:2.5:3:0.3 %v/v/v/v) **Stationary phase**: silica gel HPTLC F_{254}λ	**27**

		max – 266 nm **Concentration range-** Atenolol-3.8-10.9 ng/spot Indapamide0.2-0.6 ng/spot	
3	Development and validation of stability-indicating HPTLC method for the Estimation of perindopril and indapamide	**Mobile Phase**- Dichloromethane: Methanol: Glacial acetic acid (9.5:0.5:0.1 %v/v/v) **Stationary phase**: silica gel HPTLC F_{254} **λmax** – 215 nm **Concentration range-** 1000–5000 ng/band	**28**
4	Development and validation of stability indicating HPTLC method for determination of indapamide and amlodipine besylate	**Mobile Phase**- Chloroform: Glacial acetic acid: Methanol (8.5: 1: 0.5 %v/v/v) **Stationary phase**: silica gel HPTLC F_{254} **λmax** – 241 nm **Concentration range-** Indapamide -100–1000 ng/band Amlodipine Besylate-500-3000ng/band	**29**
5	HPTLC Method for the Simultaneous Estimation of Amlodipine Besylate and Indapamide in Tablet Formulation	**Mobile Phase**- Dichloromethane: methanol: ammonia (8.5: 1.5: 0.1 %v/v/v) **Stationary phase**: silica gel HPTLC F_{254} **λmax** – 241 nm **Concentration range-** Indapamide -99.2 -102.01ng/band Amlodipine Besylate-98.49 - 102.05ng/band	**30**

Table 5 LC-MS method of indapamide

Sr no.	Title	Description	Ref
1	An improved LC-MS/MS method for quantitation of indapamide in whole	**Stationary phase** Synergi Polar RP-column (50 × 4.6 mm i.d.; 4 μm) **Mobile Phase:** methanol and 5 mM aqueous ammonium acetate containing 1 mM formic acid (60:40%v/v) **Mass spectrometric detection** – ion source in negative ionization mode, using the transitions m/z 364.0→m/z 188.9 and m/z 367.0→m/z 188.9 **Flow rate: 1** mL/min **Linearity-** 0.25-50 ng/mL	**31**

	blood: application for a bioequivalence study		

Different pie Chart Acoording to Methods and solvents .

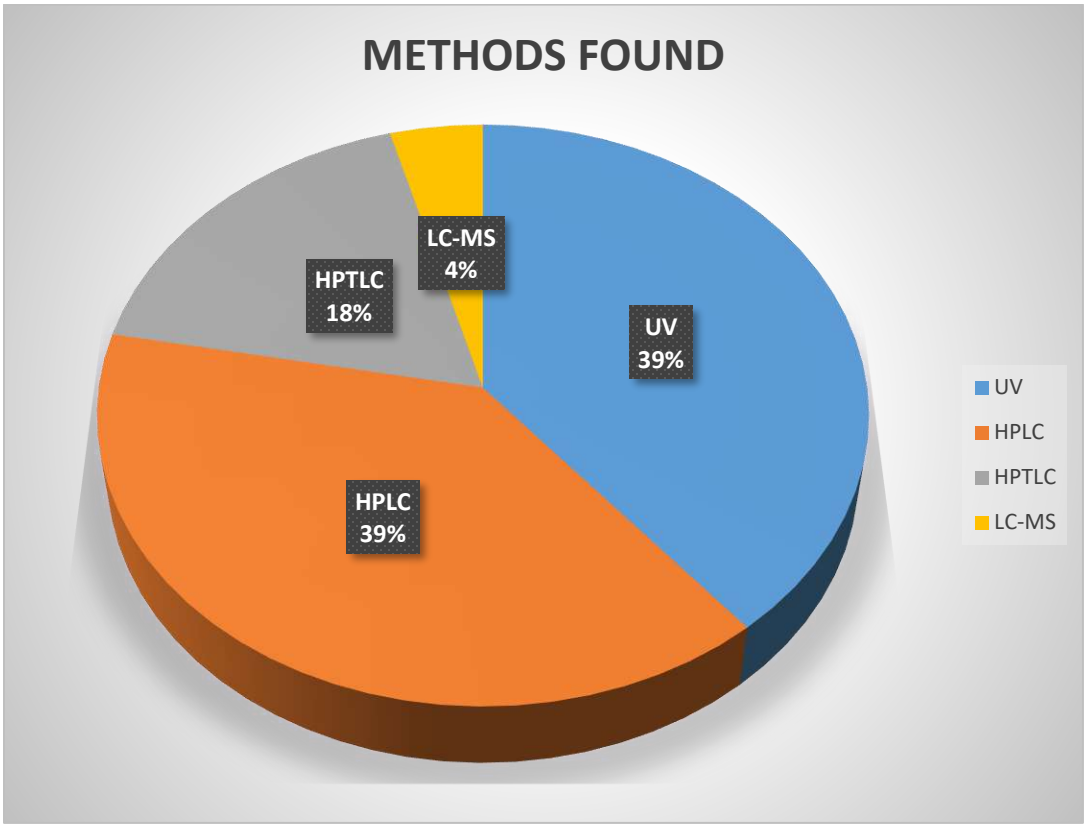


Fig-1 Methos Found for Indapamide

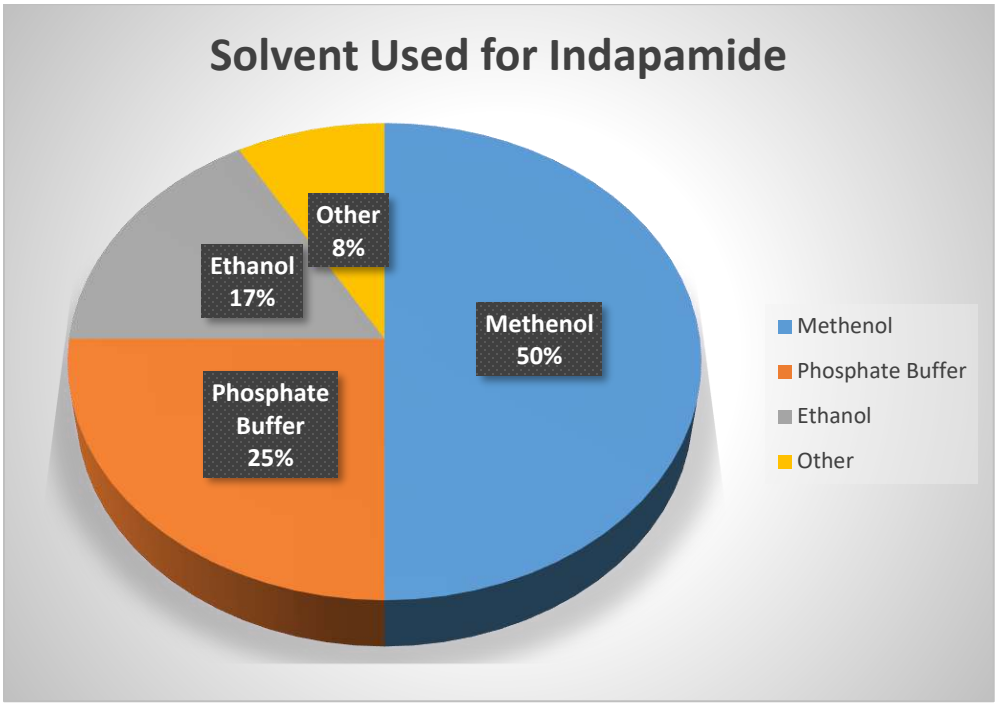


Fig 2- Solvent Used for Indapamide

CONCLUSION

Indapamide is one of the most important Thiazides and even though it received approval for clinical use in the year 1977, just a few analogs of Indapamide have been able to reach the stages of clinical development. The HPLC-based methods coupled with UV are the major analytical techniques available in the literature for the determination of Indapamide in pharmaceuticals as well as in the Development Stages. Most of the methods included in the present review have used HPLC systems coupled with UV detectors. The analytical methods that use mass spectrometers as detectors have emerged in recent years as well as high amount. After the Literature review, we found most of the methods used Methanol and Phosphate Buffer in different ranges.

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