ISSN: 0975-766X
CODEN: IJPTFI
Available through Online *Review Article*
www.ijptonline.com

A REVIEW ON CHROMATOGRAPHIC AND SPECTROPHOTOMETRIC METHOD FOR ESTIMATION OF DPP-IV INHIBITOR DRUGS IN BULK AND IN DIFFERENT DOSAGE FORMS

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Received on 23-10-2015 *Accepted on 19-11-2015*

Abstract

Dipeptidyl peptidase-4 inhibitors (DPP-4s), also called as gliptins, are a relatively new class of drugs to treat type 2 diabetes. Their mechanism of action is to improve insulin secretion from the Beta-cells of the pancreas as a result of an increase in blood sugar and simultaneously decrease glucagon output from the alpha-cells of the pancreas, which in turn decreased hepatic glucose output. It also opensnew gateways for a personalized medicine in patients with Type 2 diabetes and it alsooffers various merits when compared to other glucose-lowering agents. Despite they have been commercialized since a few years only, available data obtained in randomized controlled trials are of better quality compared to those available with classical glucose-lowering agents, especially in elderly people who have suffering from renal impairment or at high cardiovascular risk and patients at higher risk of hypoglycemia. But, their remaining uncertainties and controversies that should be resolved by further ongoing large prospective controlled trials and increasing clinical experience combined with a careful post-marketing surveillance[3]This article narrate different chromatographic (HPLC, HPTLC, UPLC,LC) & different spectrophotometric method (UV) for Gliptins class single drug as well as combination with other drug.

Key Words:

Dipeptidyl peptidase-4 inhibitors (DPP-4s), UV, HPLC (High Performance Liquid Chromatography), HPTLC (High Performance Thin Layer Chromatography), UPLC (Ultra Performance Liquid Chromatography), LC (Liquid Chromatography)

Introduction

DPP-4 inhibitors work by blocking the action of DPP-4, an enzyme which destroys the hormone incretin which help the body produce more insulin only when it is needed and reduce the amount of glucose being produced by the liver

when it is not needed [1]. The change in glucagon correlates linearly with improvement in glucose tolerance. Since these drugs improve insulin secretion in response to an increase in blood glucose, it seems appropriate to pair them with drugs that have a different mechanism of action, such as insulin sensitizers or Metformin[2].During short-term clinical trials, no increased risk of acute pancreatitis has been observed with Sitagliptin, Vildagliptin, Saxagliptin, Alogliptin, and Linagliptin[3].Linagliptin (Trajenta) is still included in black triangle scheme, while Sitagliptin (Januvia), Saxagliptin (Onglyza) and Vildagliptin (Galvus) were removed from the black triangle list in 2012 [4]. DPPIV inhibitors (Gliptins) include Saxagliptin, Linagliptin, Alogliptin, Sitagliptin, and Vildagliptin. This Review Article offers an overview of various analytical methods for estimation of DPP-IV Inhibitors .Different methods have been developed for estimation of Gliptins like UV-Spectroscopy, Liquid Chromatography, HPTLC and RP-HPLC. Reported methods are categorized depending on the following considerations:

1. Single component DPP-IV Inhibitors analyzed by UV-Spectroscopy methods and Chromatographic method.
2. Analysis of DPP-IV Inhibitors with combination with other class drugs(More preferably Sulfonyl Urea) by UV-Spectroscopy methods and Chromatographic method

Table-1: Analysis of single component DPP-IV Inhibitors by UV-Spectroscopy methods.

Sr. No.	Drug	Method	Description	Ref. No.
1	Validated spectroscopic m ethod for estimationof **Sax agliptin** in pure and from t ablet formulation	Spectroscopic m ethod	**Detection wavelength:** 208 nm in Methanol. **Linearity range:** 5-40 µg/ml. **Co-relation Co-efficient**: 0.999. **LOD and LOQ:** 0.0607 µg/ml and 0.1821 µg/ml respectively.	5
2	Estimation of **Sitagliptin** from bulk and Pharmaceutical formulation.	**UV**- spectro photometric method First order derivative	**λ max in Water & Methanol:**267 **First order derivative λ max:** 275nm **Linearity range:** 10-60 µg/ml **Correlation coefficient:** 0.998 **% Recovery range:** 98.54%– 99.98%. **%RSD:**<2%	6
3	Spectrophotometric Methods Based on Charge Transfer Complexation Reactions for the Determination of **Saxagliptin** in Bulk and	Spectrophotom etric Method: Charge Transfer Complexation	**Charge transfer complexes of Saxagliptin:** 2, 3-dichloro-5, 6-dicyano-1, 4-benzoquinone (DDQ) and 7, 7, 8, 8-tetracyanoquinodimethane (TCNQ). **Linearity ranges:** 50-300 µg/ml and 10-110 µg/ml with DDQ and TCNQ, respectively.	7

	Pharmaceutical Preparation"			
4	A new UV Method for Determination of **Linagliptin** in bulk and pharmaceutical dosage form	**UV** Method	**Maximum absorption:**241 nm **Mobile Phase:** Methanol and water 50:50. **Linearity range:**10.0-35.0 µg/ml. **R^2:**0.999 **%RSD:**<2%	8

Table-2: Analysis of DPP-IV Inhibitors with combination with other drugs by UV spectroscopy.

Sr. No.	Drug	Method	Description	Ref. No.
6.	Simultaneous estimation of **Sitagliptin** and **Pioglitazone** and study of interference of various excipients on this combination of drugs	**UV**-spectroscopic method	**Absorbance maxima**: 267nm and 269nm for Sitagliptin and Pioglitazone as respectively. **Correlation coefficient**: 0.9999 **Concentration range:** 20-120µg/ml for Sitagliptin and 2.5-25µg/ml for Pioglitazone respectively. **Mean percent recovery:** 101.3±0.88 and 94.5±3.47 for Sitagliptin and Pioglitazone respectively.	9
7.	Simultaneous UV Spectrophotometric Method for Estimation of **Sitagliptin phosphate** and **Metformin hydrochloride** in Bulk and Tablet Dosage Form	**UV** Spectrophotometric Method	**Method A- Absorbance maxima method:** Absorption at maximum wavelength of 266 nm and 232 nm for Sitagliptin phosphate and Metformin hydrochloride respectively. **Method B-Area under curve (AUC):**wavelength range is 244-279 nm for Sitagliptin phosphate and 222-240 nm for Metformin hydrochloride **%RSD:**<2% **Linearity range:** In the concentration range of 25-225 µg/ml for Sitagliptinphosphate and 2-12 µg/ml for Metformin hydrochloride. **%Recovery:**99.64 % and 98.98% for Sitagliptin phosphate and Metformin	10

			hydrochloride	
8.	Simultaneous spectrophotometric estimation of **Vildagliptin** and **Metformin** in bulk and tablet dosage form	Simultaneous estimation	**Linearity range:**30-70 µg/ml for VIDA **Coefficient:**0.999 and 5-25 µg/ml for MET with correlation coefficient of 0.999 **%RSD:**<2%	11
9.	Spectrophotometric &Spectrofluorometric methods for the determination of **Saxagliptin** and **Vildagliptin** in bulk and pharmaceutical preparations	Spectrophotometric &Spectrofluorometric methods	**Absorbance readings:** 3–32 and 5–50 µg mL−1 for the derivative readings of SAX and VDG, respectively. For NBD-Cl reaction, 1.5–25 and 2.5–40 µg mL−1 for the derivative readings of SAX and VDG, respectively. **Linearity range:** 0.02–0.25 and 0.03–0.37 µg mL−1 for SAX and VDG, respectively.	12
10	Sensitive and Selective approaches for real time estimation of **Alogliptin benzoate** and **Metformin** hydrochloride in synthetic mixture	Simultaneous equation (method A) Zero crossing first order derivative (method B) Dual wavelength method (method C).	**Linearity ranges:** For ALO and MET 0.1-0.5 µg/ml and 4-20 µg/ml for all the methods respectively **Method A**: **Limit of detection (LOD):** 0.005517µg/ml, and 0.24018 µg/ml **Limit of quantitation (LOQ):** 0.016717 µg/ml and 0.727823 µg/ml for ALO and MET respectively. **Method B**: **Limit of detection (LOD):**0.021481 µg/ml and 0.120206 µg/ ml for ALO and MET, respectively. **Limit of quantitation (LOQ):**0.065095 µg/ml and 0.364261 µg/ml for ALO and MET, respectively. **Method C:** **Limit of detection (LOD):**0.008013 µg/ml and 1.34055 µg/ml	13

			Limit of quantitation (LOQ): 0.024283 µg/ml and 4.062272 µg/ml for ALO and MET. **%RSD:** Less than 2% R.S.D. for all three methods.	
11	First order derivative and Dual wavelength spectrophotometry methods development and validation for simultaneous estimation of **Alogliptin** and **Pioglitazone** in bulk and dosage form	First order derivative and Dual wavelength spectrophotometry	**Solvent:** Methanol **Linearity range:**5-30 µg/ml **ZCP:** Alogliptin was found 275.60 nm and Pioglitazone was found 268.20 nm. **Dual wavelength method**: Two wavelengths 270.20 nm and 265 were selected as λ1 and λ2 for the estimation of Alogliptin. Pioglitazone shows the same absorbance at these wavelengths. Similarly, wavelengths 280 nm and 271 nm were selected as λ3 and λ4 for estimation of Pioglitazone. Alogliptin shows the same absorbance at these wavelengths **%Recovery:** 100.8% for Alogliptin&100.33% for Pioglitazone. **%RSD:**<2%	14
12.	Simultaneous estimation of **Alogliptin** and **Metformin** from its tablet dosage form by area under curve &multicomponent UV spectrophotometric method	Area under curve & multicomponent **UV** spectrophotometric method	**Method A- Area under Curve Spectrophotometry: wavelength range for Quantitation:** 215 – 240nm for Alogliptin and 265 - 293nm for Metformin **%Purity:** 99.90 ± 0.151 for ALO and 99.62 ± 0.220 for MET **Method B - Multicomponent UV spectrophotometric method:** **Wavelength forQuantitation**:For MET and ALO 284nm (λ max of MET) and 274 (λ max of ALO) for the analysis. **Linearity range:** 10-50 microgram/ml for MET and ALO respectively. **%Purity:** 99.73 ± 0.306 for ALO and 99.30 ± 0.224 for MET.	15

13	Development and validation of UV spectrophotometric method for simultaneous estimation of **Metformin hydrochloride** and **Alogliptin benzoate** in bulk drugs and combined dosage forms	**UV** spectrophotometric method	**Method A- Simultaneous equation method (Vierodt's Method): Detection wavelength:** 277nm and 232nm i.e. λmax of Alogliptin benzoate and Metformin hydrochloride respectively. **Method B-Absorbance ratio (Q- analysis method):** **Detection wavelength:** 250nm and 277nm i.e. iso-absorptive point of Alogliptin benzoate and Metformin hydrochloride and λmax of Alogliptin benzoate respectively. **Linearity range:** 5-25 µg/ml for Alogliptinbenzoate and 1-10 µg/ml for Metformin hydrochloride. **%RSD:**<2% **%Recovery:** 98-102% for both Alogliptin benzoate and Metformin hydrochloride.	16

Table-3: Analysis of single component DPP-IV inhibitors by chromatographic method.

Sr. No.	Drug	Method	Description	Ref. No.
14	Bioanalytical method development and validation of **Sitagliptin phosphate** by RP-HPLC and its application to pharmacokinetic study	**RP-HPLC**	**Column**: Reverse phase Phenomenex C 18 (250 × 4.6mm, 5µ) A **Mobile phase**: mixture of 0.5% v/v of Triethylamine solution and acetonitrile (77:23 v/v) **Flow rate**: 1.0 ml/min **Detection of SP:** At 267 nm by an UV detector. **The retention time of Sitagliptin phosphate and internal standard**:6.1& 7.7 min, respectively. **Linearity range:**10-1000ng/ml. **LOD and LOQ** :1 ng/ml and 10 ng/ml.	17
15	Development and validation of RP-HPLC method for	**RP-HPLC**	**Flow rate:**1.0 ml/min **Detection**:At 210nm. **Retention time**: 6.3 min. **Linearity range:** 5- 200 µg/ml	18

	estimation of **Vildagliptin** from tablet dosage form		**Limit of detection(LOD):**1.47 µg/mL **Limit of quantization(LOQ)**:4.90 µg/mL **% Recovery:** 99.11-100.62%.	
16	Development and Validation of a Liquid Chromatographic Method for Estimation of **Saxagliptin** in Tablet Dosage form	Liquid Chromatographic Method	**Mobile phase:** Acetonitrile: Buffer in proportion of 30:70v/v **Flow rate:** 1.0ml/min **UV detection**: 220nm wavelengths. **Retention time:** SAX was 3.487 min. **Linearity range:**50µg/ml to 150µg/ml **Co-relation Co-efficient:** 0.9999.	19
17	Stability indicating Isocratic Reverse phase HPLC method with PDA detector for the Estimation of **Saxagliptin** in bulk drugs and in its Formulation"	Isocratic Reverse phase **HPLC** method	**Flow rate:** 1.0mL/min. **UV detection:**213 nm **Retention time:** 3.8 minutes. **Linearity Range:**25 µg/mL to 150 µg/mL **%RSD:**<1.0 **% Recoveries:** 99.2% to 100.2%.	20
18	A new RP-HPLC method for the estimation of **Linagliptin** in tablet dosage forms"	**RP-HPLC**	**Mobile phase:** Mixture of phosphate buffer (pH 3.4) and acetonitrile (70:30 v/v) **Flow rate:** 1.0ml/min. **UV detection:**240 nm **Retention time:** 2.791 min **Linearity range:** 25-150 µg/mL	21
19	Method development and validation of new RP-	**RP-HPLC**	**Mobile phase:** 0.01M phosphate buffer (pH 5.3) and acetonitrile (30:70% v/v). **Flow rate:**1 ml/min **Detector wavelength:**210nm	22

	HPLC method for the estimation of **Vildagliptin** in bulk and tablet dosage form		**Tailing factor**: 1.86.	
20	A validated chiral HPLC method for the enantiomeric purity of **Alogliptinbenzoate**	Chiral **HPLC**	**Column:** Lux cellulose 2 (250×4.6mm, 5µm) **Mobile phase:** Ethanol and diethyl amine **UV detection:** At 230 nm. **LOQ:** 1.5 µg/mL of (S)-isomer. **Mean recovery of (S)-isomer range:** 100–102%.	23
21	Development and validation of HPLC method for the estimation of **Vildagliptin** in pharmaceutical dosage form	**HPLC** method	**Mobile phase:** Dilute orthophosphoric acid solution pH 2.6±0.5 as buffer and acetonitrile (72:28 v/v) **Flow rate:**1.0 ml/min **Retention time:** 3.25 min. **LOD:**0.06 µg/ml **LOQ:**0.21 µg/ml **%Recovery:** 99.73%.	24

Table-4: Analysis of DPP-IV Inhibitors with combination with other drugs by Chromatographic methods.

Sr. No.	Drug	Method	Description	Ref. No.
22	Validated RP-HPLC Method for **Metformin hydrochloride** and **Sitagliptin phosphate** in bulk drug and pharmaceutical formulation	**RP-HPLC**	**Column**: Xterra Symmetry C-8 analytical 100×4.6 mm I.D., 5 µm particle size). **Mobilephase**: methanol:acetonitrile:phosphate buffer in the ratio of 20:35:45 v/v/v (Phosphate buffer pH 8 was adjusted with sodium hydroxide) was selected as a mobile phase **Flow rate**:1.0 ml/min **UV detection**: At 254 nm. **Retention time:** 3.69& 4.90 min for Metformin Hydrochloride and Sitagliptin Phosphate respectively.	25

			Linearity range: 100-300 µg/ml for Metformin Hydrochloride and 10-30 µg/ml Sitagliptin Phosphate. **Mean percent recovery:**101% for Metformin Hydrochloride and 102% for Sitagliptin Phosphate.	
23	A Validated RP–HPLC method for Simultaneous estimation of **Metformin** and **Saxagliptin** in tablets	**RP–HPLC** method	**Mobile phase:**Phosphate buffer (pH 5.0),Acetonitrile and Methanol in the ratio 75:15: 10 respectively **Flow rate:**1.5mL/min. **Detection wavelength**: For Metformin and Saxagliptin at 225 nm **Retention time:**For Metformin and Saxagliptin 5.65 and 6.20 min, respectively.	26
24.	Development and Validation of HPTLC method for the estimation of **Sitagliptin Phosphate** and **Simvastatin** in bulk and Marketed Formulation	**HPTLC**	**Stationary phase:** silica gel 60 F254 (0.2 mm thickness) **Mobile phase:**chloroform: methanol in the ratio of 8:2 v/v **Detection wavelength**:217 nm **Linearity range:**2000ng/spot - 7000 ng/spot & 250ng/spot -50 ng/spot for Sitagliptin phosphate & Simvastatin respectively. **Average Recovery:**92.80 % and 98.01 % for Sitagliptin phosphate and Simvastatin respectively **LOD:**660 ng/spot for Sitagliptinphosphate&50ng/spot for Simvastatin **%RSD**:<2% **LOQ:**2000 ng/spot for Sitagliptinphosphate &150ng/spot for Simvastatin	27
25	Validated HPTLC method for simultaneous estimation of **Metformin hydrochloride** and	**HPTLC**	**Stationary phase**: Aluminum plates precoated with silica gel 60 F 254 **Mobile Phase**: acetone:methanol:toluene:formic acid (4:3:2:1 v/v/v/v) **Densitometry evaluation:**220 nm **R f values and drug content of metformin**	28

	Sitagliptinphosph ate in bulk drug and formulation		**hydrochloride and Sitagliptin phosphate**: 0.36±0.02, 0.63±0.02100.1%, 99.84% respectively. **Linearity range**:2000-5000 ng per band for metformin hydrochloride, 200-500 ng per band for Sitagliptin phosphate **Regression coefficient(r2):**>0.99 **LOD:** Metformin hydrochloride and Sitagliptin phosphate was 45 and 27 ng per band respectively **LOQ**:For metformin hydrochloride and Sitagliptin phosphate 150 and 87 ng per band respectively.	
26	Analytical method development and validation of **Alogliptin** and **metformin hydrochloride** tablet dosage form by RP-HPLC method	**RP-HPLC** METHOD	**Buffer :**0.2% TEA pH adjusted with OPA to 6.0 **Mobile phase:**By adjusting the ratio of buffer and Methanol as 30:70 v/v + 0.2% Triethylamine **Flow rate:**1.0 ml/min **Detection wavelength:**254 nm **Run time**:10 minutes **Column:**Agilent C18 with dimension 250 mm length, 4.6 mm i.d., 5µ particle size. **Linearity range:**25-150 µg/ml for Alogliptin and Metformin Hydrochloride respectively **Correlation coefficient**:ForAlogliptin and Metformin Hydrochloride were 0.9995 and 0.9996. **% Recovery:** 99.96% and 99.83% for Alogliptin and Metformin Hydrochloride respectively.	29
27	Development and Validation of RP-HPLC Method for Simultaneous Estimation of **Vildagliptin** and **Metformin**	**RP-HPLC**	**Column :**Lichrocart C18 (250 x 4.60 x 5 µm) **Mobile phase:** 0.05 M KH 2PO 4: Acetonitrile (70:30 v/v pH 3.5 with Ortho Phosphoric Acid). **Flow rate:**1.0ml/min **UV detection:** 215 nm. **Retention time:** VIDA and MET 6.64 and 5.18 minutes respectively. **Linearity range:** 5-25 µg/ml, 10-50 µg/ml for	30

			VIDA and MET respectively. **Regression equation and correlation of coefficient:** For VIDA and MET were found to be (y = 1014x + 54.43, R2 = 0.999) and (y = 307.8x + 146.0, R2 = 0.999) respectively.	
28	A revised RP-HPLC method for simultaneous determination of **Vildagliptin** and **Pioglitazone Hcl** – application to commercially available drug products	**RP-HPLC**	**Column:** ACE 3 150mm*4.6mm, 3.5µm with gradient flow. **Mobile phase:**10mM sodium hexane sulphonate monohydrate and 10mM Potassium dihydrogen phosphate buffer with acetonitrile and methanol in gradient ratio **Flow rate:**1.5 mL min−1 **UV detection:** 210 nm.	31
29	Development and Validation of Stability indicating RP-HPLC Method for the Simultaneous Estimation of **Linagliptin** and **Metformin** in pure and pharmaceutical dosage form	**RP-HPLC**	**Mobile phase:** Acetonitrile: Water: Methanol (25:50:25 (v/v/v) to pH 4.1 with 0.1% orthophosphoric acid **Detection Wavelength:**243 nm **Detector:** Diode array detector **Linearity range:** 5-30µg/ and 10-100 µg /ml for Linagliptin and Metformin respectively.	32
30	Development and Validation of Simultaneously Estimation of **Vildagliptin&Metformin Hydrochloride** by RP-HPLC in Bulk and Oral Dosage	**RP-HPLC**	**Mobile phase:** Disodium hydrogen phosphate buffer (pH 3.5): methanol in the ratio 73.5:26.5 v/v. **Flow rate:**1.0 ml/min **UV detection:** 200 nm. **Retention times:** 2.490&4.243 for Metformin Hcl and Vildagliptin respectively. **Linearity range**: 75-175µg/ml for Metformin Hcl and 7.5-17.5µg/ml for Vildagliptin.	33

	Form		**Mean percent recovery:** 98.88% for Metformin Hcl and 99.85% for Vildagliptin.	
31	Development and validation of HPTLC method for simultaneous estimation and stability indicating study of **Metformin Hcl**and **Linagliptin** in pharmaceutical formulation	**HPTLC**	**Mobile phase:** Acetone-methanol- toluene-formic acid 4:3:2:1 (v/v/v/v) **Detection Wavelength**:259 nm between 400-2000 (ng/spot) **Rf Value:** 0.61 and 0.82 for Metformin hydrochloride and Linagliptin respectively. **Linearity Range:** 20-100 (ng/spot) for Metformin hydrochloride and Linagliptin respectively. **Limits of detection and quantification**:20 (ng/spot) and 10 (ng/spot) for Metformin hydrochloride and Linagliptin respectively	34
32	Development of validated stability indicating assay method for simultaneous estimation of **Metformin hydrochloride** and **Vildagliptin** by RP-HPLC	**RP-HPLC**	**UV detection:**207 nm **Linearity range:** 25-125µg/mL for MET and 50-250µg/mL for VLG respectively. **Limit of detection and limit of quantification**: For MET were 0.36µg/mL and 1.22µg/mL, and for VLG were 0.75µg/mL and 2.51µg/mL respectively.	35
33	RP-HPLC and HPTLC Methods for Simultaneous Estimation of **Metformin Hydrochloride** and **Vildagliptin** from Bulk and Marketed Formulation: Development and Validation	**RP-HPLC** and **HPTLC** Methods	**RP-HPLC** **Mobile phase:** Phosphate buffer (pH adjusted to 6 using 3M KOH): methanol: acetonitrile in the ratio of 50:30:20 v/v/v. **Flow rate:**0.8ml/min **Linearity range:**10-60µg/mL for MET and VLD respectively **LOD:**For MET and VLD were 1.09µg/ml and 1.70µg/ml respectively **LOQ:**For MET and VLD were 3.32µg/ml and 5.15µg/ml respectively. **HPTLC**	36

			Linearity range: 1000-5000ng/spot and 500-2000ng/spot for MET and VLD respectively. **LOD**:MET and VLD were 17.22ng/spot and 34.60ng/spot respectively **LOQ:** MET and VLD were 52.20ng/spot and 104.85ng/spot respectively.	
34	A Validated High Performance Liquid Chromatography Method for the Determination of **Saxagliptin** and **Metformin** in Bulk, a Stability Indicating Study	**HPLC**	**Mobile phase:** Mixture of Methanol-50 mm phosphate buffer (pH 2.7) in a gradient elution mode **Flow rate:** 1.0 ml min-1. **Detection Wavelength:**225 nm **Total run time:** 7 min. **Linearity range:** 5.00-125.00 µg ml-1 for Saxagliptin and 2.50-62.50 µg ml-1 for Metformin.	37
35	RP-UPLC method development and validation for simultaneous estimation of **Vildagliptin** with **Metformin hydrochloride** and **Ciprofloxacin hydrochloride** with Dexamethasone sodium phosphate	**RP-UPLC** method	**Flow rate:**1 mL/min **Detection wavelength:**220 or 254 nm for the two mixtures **Linearity range:** 0.5-5 µg/mL for Vildagliptin & 5-50 µg/mL for Metformin hydrochloride while ranges from 2-20 µg/mL for both ciprofloxacin hydrochloride and Dexamethasone sodium phosphate.	38

Conclusion

This review depicts the reported Spectrophotometric and Chromatographic methods; developed and validated for estimation of DPP-IVinhibitors. According to this review it was concluded that for DPP-IV inhibitor (Sitagliptin, Saxagliptin, Linagliptin, Vildagliptin, and Alogliptin) different Spectroscopic &Chromatographic methods are available for Single component as well as for combination and also it was found that the Mobile phase

containingPhosphate buffer, Methanol and Acetonitrile were common for most of the chromatographic method to provide more resolution.It was observed that most common combination of DPP-IV inhibitors were with Metformin.For chromatographic method flow rate is observed in the range of 0.8-1.5 ml/min to get good retention time. For most of the Spectroscopic methods common solvent is Methanol. Hence this all methods found to be simple, accurate, economic, precise, and reproducible in nature. Most of Methods were of RP-HPLC and UV absorbance detection because these methods provided with best available reliability, repeatability, analysis time and sensitivity.

Acknowledgement

The authors are thankful to Dr. K. Pundarikakshudu, Director of L. J. Institute of Pharmacy, Ahmedabad, India for providing all the facilities and encouragement to carry out the research work.

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