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Advances in Bioresearch

REVIEW ARTICLE

A Review: Analytical Methods for Estimation of Dapagliflozin and Vildagliptin

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ABSTRACT
*Diabetes Mellitus (DM) is a chronic metabolic disorder defined by perpetual hyperglycaemia. It may be due to resistance to peripheral actions of insulin, impaired insulin secretion, or both. According to the International Diabetes Federation (IDF), approximately 537 million adults had diabetes mellitus in 2021. Chronic hyperglycaemia, in combination with other metabolic abnormalities in diabetes mellitus patients and can cause damage to major organs, leading to the development of chronic health complications. The most prevalent of which are microvascular and macrovascular complications, which increase the risk of cardiovascular disease by a factor of two to four. Dapagliflozin (DAPA) belongs to gliflozin class. Dapagliflozin (Forxiga®) is a sodium glucose cotransporter-2 inhibitor that is highly potent, reversible, and selective used to treat diabetes type 2. Vildagliptin (**Galvus)** is an oral antidiabetic drug belonging to dipeptidyl peptidase-4 (DPP-4) inhibitor. These DPP-4 inhibitors are a new class of oral antihyperglycemic medicines used to treat diabetes type 2. This review provides information about different analytical method development like UV spectrophotometry, HPLC and HPTLC methods reported for Dapagliflozin and Vildagliptin for individual and other drug combination. All reported methods were discovered to be simple, accurate, economical, precise, and reproducible.*
Keywords: *Dapagliflozin, Vildagliptin, HPLC, HPTLC, UV Spectroscopy*

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INTRODUCTION

Dapagliflozin is a sodium-glucose co-transporter 2 inhibitor (SGLT2) used to treat hyperglycemia caused by type 2 diabetes. Dapagliflozin inhibits the SGLT2, present in proximal tubule of nephron. Because SGLT2 supports 90% of glucose resorption in the kidneys, inhibiting it permits glucose to be eliminated in the urine. In patients with type 2 diabetes, this excretion improves glycemic control. Dapagliflozin's efficacy is independent of insulin secretion and action. As a result, when used in conjunction with other diabetes medications, dapagliflozin provides complementary therapy due to its unique mode of action.

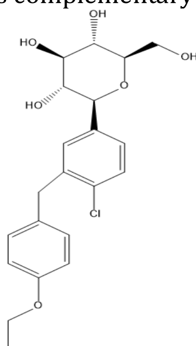

Fig. 1: Dapagliflozin

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Table 1: Drug profile of dapagliflozin

Category	Anti-diabetic
Trade Name	***Edistride, Farxiga, Forxiga, Qtern, Qternmet, Xigduo***
Color/Form	White/ Crystalline Powder
Molecular Formula	$C_{21}H_{25}ClO_6$
Molecular Weight	408 g. mol^{-1}
IUPAC Name	(2S,3R,4R,5S,6R) -2- [4-chloro-3-[(4-ethoxyphenyl) methyl] phenyl]-6-(hydroxymethyl) oxane-3,4,5-triol
Melting Point	59-63°C
Solubility	Soluble in Methanol, Dimethyl sulfoxide and Dimethyl formamide
Log P	2.7
Pharmacology	Dapagliflozin inhibits the sodium-glucose cotransporter 2(SGLT2) which is present in proximal tubule of nephron. SGLT2 assist 90% of glucose resorption in the kidneys and so when inhibted, the filtered glucose is excreted in urine. This helps in getting better glycaemic control and potentially weight loss in patients with type 2 DM.

VILDAGLIPTIN

Vildagliptin (Galvus, Jalra) is an oral Dipeptidyl peptidase (DPP)-4 inhibitor. DPP-4 is an enzyme found in many tissues, including the gut and the endothelial cells of blood arteries. DPP-4 rapidly deactivates the incretin hormones like glucagon-like peptide-1 (GLP-1) and glucose-dependent insulinotropic peptide (GIP), which are produced from the Gastrointestinal wall after food consumption and increases insulin production. DPP-4 inhibition limits the breakdown of GLP-1, therefore there is an increase of GLP-1 levels, it results in better glycemic control.

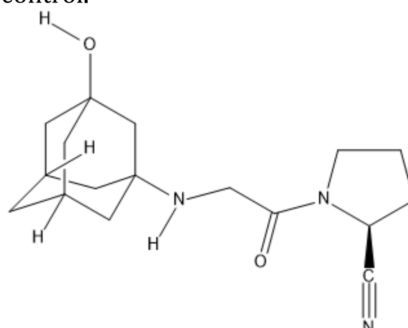

Fig. 2: VILDAGLIPTIN

Table 2: Drug profile of vildagliptin

Category	Anti-diabetic
Trade Name	***Galvus, Jalra, Xiliarx***
Color/Form	White/ Crystalline Powder
Mol. Formula	$C_{17}H_{25}N_3O_2$
Molecular Weight	303 g. mol^{-1}
IUPAC Name	(2S)-1-[2-[(3-hydroxy-1adamantyl) amino] acetyl] pyrrolidine-2-carbonitrile
Melting Point	149-155°C
Solubility	Soluble in Ethanol, Dimethyl sulfoxide, dimethyl formamide (DMF)
Log P	1.12
Pharmacology	Incretin hormones such as glucagon-like peptide-1 (GLP-1) and glucose-dependent insulinotropic peptide (GIP) control blood glucose levels and maintain glucose homeostasis. They increase insulin secretion through G-protein-coupled GIP and GLP-1 receptor. Vildagliptin works by inhibiting DPP-4, an enzyme that inactivates GLP-1 and GIP after they are released from intestinal cells. DPP-4 splits the oligopeptides after the second amino acid from the N-terminus. DPP-4 inhibition increases the half-life of GLP-1 and GIP, increasing the amount of active circulating incretin hormones. The duration of vildagliptin's suppression of DPP-4 is dosage dependent. Vildagliptin reduces fasting and postprandial glucose levels, as well as HbA1c levels. It stimulates glucose-dependent insulin secretion and improves alpha- and beta-cell glucose sensitivity.

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LITERATURE REVIEW

Table 3: Reported Methods for Estimation of Dapagliflozin

Sr. No.	Title	Method	Description	Ref. No.
1.	Stability indicating stress degradation studies of DAPA	RP- HPLC	**Stationary Phase:** ZORBAX C_{18} column (4.6 x 250 mm, 5µ) **Mobile phase:** Methanol: ACN: Phosphate Buffer (05:40:55, %v/v/v) **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 225 nm **t_R:** 2.12 min **Range:** 10-120 µg. ml^{-1}	1
2	Stability indicating Dapagliflozin propanediol monohydrate and MET HCl	HPTLC	**Stationary Phase:** Silica gel 60 F_{254} **Mobile Phase:** Ammonium Acetate: Ethyl Acetate: Methanol (0.1:4:6, v/v) **λ_{max}:** 220 nm **Retention Factor:** **DAPA:** 0.79 **MET:** 0.31 **Range:** **DAPA:** 0.02-0.1 µg. ml^{-1} **MET:** 0.5-2.5 µg. ml^{-1}	2
3	Stability indicating - DAPA and SAXA	RP-HPLC	**Stationary Phase:** BDS C_{18} column (4.6 x 150 mm, 5µ) **Mobile phase:** ACN: Ammonium Acetate Buffer (60:40, %v/v) **Detector:** DAD **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 220nm **t_R: DAPA:** 2.207 min **SAXA:** 2.889 min **Range:** **DAPA:** 0- 15 µg. ml^{-1} **SAXA:** 0- 8 µg. ml^{-1}	3
4	DAPA and SAXA	RP-HPLC	**Stationary Phase:** SPOLAR C_{18} column (4.6 x 250 mm, 5µ) **Mobile Phase:** Buffer, pH 5.8: ACN (74:26, %v/v) **Detector:** UV **Rate of Flow:** 0.96 ml. min^{-1} **λ_{max}:** 236 nm **t_R: DAPA:** 3.5 min **SAXA:** 5 min **Range:** **DAPA:** 0.2- 300 µg. ml^{-1} **SAXA:** 0.1- 150 µg. ml^{-1}	4
5	Stability indicating - DAPA and MET HCl	RP-HPLC	**Stationary Phase:** C_{18} column **Mobile Phase:** ACN: Water (35:65, %v/v) of pH 6.8 (0.1 % OPA) **Detector:** UV **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 240 nm **t_R: DAPA:** 5.41 min **MET:** 2.13 min **Range:** **DAPA:** 1 - 6 µg. ml^{-1} **MET:** 100 - 600 µg. ml^{-1}	5
6	DAPA	RP-HPLC	**Stationary Phase:** C_{18} column (4.6 x 250mm, 5µ) **Mobile Phase:** Water: ACN (60:40, %v/v) **Detector:** UV-Visible Detector **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 277 nm **t_R:** 7.029 min **Range:** 1-16 µg. ml^{-1}	6

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7	QbD bioanalytical method for DAPA: Forced degradation	RP-HPLC	**Stationary Phase:** C_{18} column (4.6 x 250mm, 5μ) **Mobile Phase:** Water: ACN (50:50, %v/v) **Detector:** UV-Visible Detector **Rate of Flow:** 0.5 ml. min^{-1} **λ_{max}:** 235 nm **t_R:** 4.11 min **Range:** 10-1200 ng. ml^{-1}	7
8	DAPA and SAXA	UV Spectroscopy	**UV- Spectrophotometer:** Lab India model-3000+ series **λ_{max}: DAPA:** 276 nm **SAXA:** 222 nm **Solvent:** Buffer pH 6.8 **Range:** 5-25 μg. ml^{-1}	8
9	DAPA and SAXA	HPTLC-densitometric analysis	**Stationary Phase:** Silica gel 60 F_{254} **Mobile Phase:** Ethyl Acetate: Hexane: Methanol (4:4:2, v/v/v) **λ_{max}: DAPA:** 225 nm **SAXA:** 210 nm **Retention Factor:** **DAPA:** 0.6 **SAXA:** 0.18 **Linearity:** 50-550 ng. $spot^{-1}$	9
10	DAPA, SAXA, MET	HPLC-DAD	**Stationary Phase:** Agilent C_{18} column (4.6 x 250 mm, 5μ) **Mobile Phase:** acidified aqueous phase: acetonitrile (90:10, %v/v) - 3 min, acidified aqueous phase: acetonitrile (10:90, %v/v) - 1 min and acidified aqueous phase: acetonitrile (90:10, %v/v) - 6 min Run time: 10 min **Detector:** DAD **Rate of Flow:** 0.8 ml. min^{-1} for 3 min then increased to 1.0 ml. min^{-1} **λ_{max}:** 230 nm **t_R: DAPA:** 7.17 min **SAXA:** 3.78 min **MET:** 2.83 min **Linearity:** **DAPA:** 20-160 μg. ml^{-1} **SAXA:** 80-300 μg. ml^{-1} **MET:** 10-120 μg. ml^{-1}	10
11	DAPA, SAXA, MET	HPTLC	**Stationary Phase:** Silica gel plates **Mobile Phase:** Acetic Acid: Water: Methanol: Chloroform (0.01:0.5:2.6:7.4, v/v) **λ_{max}:** 224 nm **Retention Factor:** **DAPA:** 0.66 **SAXA:** 0.50 **MET:** 0.14 **Linearity:** **DAPA:**250-3000 ng. $spot^{-1}$ **SAXA:**700-7500 ng. $spot^{-1}$ **MET:**150-1750 ng. $spot^{-1}$	10
12	Bioanalytical method - DAPA and MET	UV- Spectroscopy	**UV- Spectrophotometer:** ELICO Double beam SL 210 UV-Visible spectrometer with 0.5 cm quartz cells **Method:** Q absorption ratio method **λ_{max}: DAPA:** 232 nm **MET:** 222 nm **Solvent:** Water **Range:** **DAPA:** 2-32 μg. ml^{-1} **MET:** 1-20 μg. ml^{-1}	11
13	Stability indicating - DAPA, MET, SAXA	RP-UPLC	**Stationary Phase:** BEH C_{18} column (2.1 x 50 mm, 1.7 μm) **Mobile Phase:** Methanol: Water (30:70, %v/v) **Rate of Flow:** 0.3 ml. min^{-1} **λ_{max}:** 222 nm	12

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			t_R: MET: 1.06 min **DAPA:** 1.50 min **SAXA:** 2.17 min **Range:** **MET:** 250-1500 μg. ml^{-1} **DAPA:** 2.5-15 μg. ml^{-1} **SAXA:** 1.25-37.5 μg. ml^{-1}	
14	Stability indicating-DAPA	HPTLC	**Stationary Phase:** Silica gel 60 F_{254} **Mobile Phase:** Ammonium Acetate: Toluene: Methanol (0.1:3:6.9, v/v/v) **λ_{max}:** 250 nm **Retention Factor:** 0.29 ± 0.05 **Range:** 100-1000 ng. $band^{-1}$	13
15	DAPA	HPTLC	**Stationary Phase:** Silica gel 60F_{254} (10 x10 cm) **Mobile Phase:** Methanol: Chloroform (1:9, v/v) **λ_{max}:** 223 nm **Retention Factor:** 0.21 ± 0.004 **Range:** 400-1200 ng. $band^{-1}$	14
16	DAPA and MET	RP-HPLC	**Stationary Phase:** Cosmosil C_{18} column (4.6 x 250 mm, 5μ) **Mobile Phase:** Potassium dihydrogen phosphate buffer with pH 3.0: Methanol (20:80, %v/v) **Detector:** UV Detector **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 228nm **t_R: DAPA:** 5.2 min **MET:** 3.6 min **Range:** **DAPA:** 1-5 μg. ml^{-1} **MET:** 100-500 μg. ml^{-1}	15
17	DAPA and MET	LC–MS/MS	**Stationary Phase:** RP- ACE 5CN (4.6 x 150 mm, 5μ) column **Mobile Phase:** 15 mM Ammonium Acetate, pH 4.5: ACN (30:70, %v/v) **Range:** **DAPA:** 0.10-200 ng. ml^{-1} **MET:** 1.00-2000 ng. ml^{-1}	16
18	DAPA and SAXA	UV spectroscopy	**UV- Spectrophotometer**: UV-spectrophotometric method, Lab India model-3000+ series **λ_{max}: DAPA:** 276 nm **SAXA:** 222 nm **Solvent:** Buffer pH 6.8 **Range:** 5-25 μg. ml^{-1}	17
19	QbD DAPA and SAXA	RP-HPLC	**Stationary Phase:** Discovery C_{18} column (4.6 x 250 mm, 5μ) **Mobile Phase:** OPA(0.1%): ACN (50:50, %v/v) **Rate of Flow:** 0.98 ml. min^{-1} **λ_{max}:** 210 nm **t_R: DAPA:** 3.49 min **SAXA:** 2.81 min **Range:** **DAPA:** 25-150 μg. ml^{-1} **SAXA:** 12.5-75 μg. ml^{-1}	18
20	DAPA and SAXA	HPLC	**Stationary Phase:** Eclipse XDB C_{18} (4.6 x 150 mm, 5μ) **Mobile Phase:** ACN: 0.1% OPA (50:50, %v/v) with pH adjusted to 5.0 **Detector:** UV **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 254 nm **t_R: DAPA:** 5.17 min **SAXA:** 2.74 min **Range:** **DAPA:** 0.05-2 μg. ml^{-1} **SAXA:** 0.01-0.5 μg. ml^{-1}	19

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21	EMPA, DAPA, CANA Three gliflozins	HPLC/DAD	**Stationary Phase:** Agilent Zorbax RX-C_8 column (4.6 mm x 150 mm, 5µ) **Mobile Phase:** Aqueous 0.1% trifluoroacetic acid pH 2.5: CAN (60:40, %v/v) **Detector:** DAD **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 210 nm **t_R: EMPA:** 2.047 min **DAPA:** 2.819 min **CANA:** 4.889 min **Range:** **EMPA:** 2-2500 ng. ml^{-1} **DAPA:** 3.5-2500 ng. ml^{-1} **CANA:** 1.1-2500 ng. ml^{-1}	20
22	MET, SAXA, LINA, TENELI, EMPA, PIO, DAPA, GLI	HPLC-PDA	**Stationary Phase:** Waters Reliant™ HPLC Columns (4.6 x 250 mm, 5µ) **Mobile Phase:** Water: ACN (4:6, %v/v) **Detector:** DAD **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 230 nm **t_R:MET:** 1.31 min **SAXA:** 6.44 min **LINA:** 4.96 min **TENELI:** 1.96 min **EMPA:** 3.42 min **PIO:** 2.71 min **DAPA:** 8.41 min **GLI:** 7.49 min **Range:** **MET:** 10-70 µg. ml^{-1} **GLI, PIO, SAXA, TENELI:** 50-350 µg. ml^{-1} **LINA:** 10-70 µg. ml^{-1} **EMPA**: 30-210 µg. ml^{-1} **DAPA:** 30-210 µg. ml^{-1}	21
23	DAPA and MET	UHPLC	**Stationary Phase:** Symmetry Acclaim RSLC 120 C_{18} column (2.1 x 100 mm, 2.2 µm) **Mobile Phase:** ACN: Buffer, pH (3.5) (50:50, %v/v) **Detector:** UV **Rate of Flow:** 0.4 ml. min^{-1} **λ_{max}:** 225 nm **t_R: DAPA:** 1.5 min **MET:** 0.9min **Range:** **DAPA:** 1-50 µg. ml^{-1} **MET:** 0.5-100 µg. ml^{-1}	22
24	Stability indicating - DAPA	RP-HPLC	**Stationary Phase:** Zorbax Eclips XDB C_{18} (4.6 x 150mm, 5µ) **Mobile Phase:** Methanol: ACN: Buffer (03:37:60, %v/v/v) **Detector:** PDA **Rate of Flow:**1.0 ml. min^{-1} **λ_{max}:** 220 nm **t_R:** 1.63 min **Range:** 12–36 µg. ml^{-1}	23
25	DAPA	RP-HPLC	**Stationary Phase:** Princeton C_{18} column **Mobile Phase:** Triethylamine: Acetonitrile (50:50, %v/v) **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 224 nm **t_R:** 5.16 min **Range:** 10-70 µl. ml^{-1}	24

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Table 4: Reported Methods for Estimation of Vildagliptin

Sr. No.	Title	Method	Description	Ref. No.
1	Multicomponent antidiabetic formulation REMO, VLG, MET	HILIC Method	**Stationary Phase:** Acclaim mixed-mode HILIC-1 column (4.6 x 150mm, 5μ, 120 A∘) **Mobile Phase:** 20 mM phosphate buffer, pH 6 adjusted using Orthophosphoric acid): Acetonitrile (35: 65% v/v) **Detector:** PDA **Rate of Flow:** 1.4 ml. min^{-1} **λ_{max}:** 210 nm **t_R: REMO:** 1.51 ± 0.021 min **VLG:** 2.35 ± 0.029 min **MET:** 3.54 ± 0.065 min **Range:** **REMO:** 20-150μg. ml^{-1} **VLG:** 10-75μg. ml^{-1} **MET:** 50-750μg. ml^{-1}	25
2	VLG and REMO	RP HPLC	**Stationary Phase:** Zorbax C_{18} HPLC column (4.6 x 100 mm, 5μ) **Mobile Phase:** Buffer (pH 5): ACN(45:55, %v/v) **Detector:** DAD **Rate of Flow:** 1.2 ml. min^{-1} **λ_{max}:** 210 nm **t_R: VLG:** 1.265±0.02 **REMO:** 2.813±0.04 **Range:** **VLG:** 10-60μg. ml^{-1} **REMO:** 10-100μg. ml^{-1}	26
3	Stability indicating - VLG	LC-UV	**Stationary Phase:** Purospher RP_{18} endcapped column (4.0 x 125 mm, 5μ) **Mobile Phase:**ACN: 2 mM Ammonium Acetate (20:80, %v/v) **Detector:** UV **Rate of Flow:** 1.2 ml. ml^{-1} **λ_{max}:** 210 nm **t_R:** 1.95 min **Range:** 40-190μg. ml^{-1}	27
4	VLG and MET	UHPLC DAD	**Stationary Phase:** C_{18} column (4.6 x 150 mm, 5μ) **Mobile Phase:** ACN: 1.36 g Phosphate buffer (pH 4.2) set to phosphoric acid (20:80, %v/v) **Detector:** DAD **Rate of Flow:** 0.6 ml. min^{-1} **λ_{max}:** 207 nm **t_R: VLG:** 3.67 min **MET:** 2.5 min **Range:**20-200 μg. ml^{-1}	28
5	Stability indicating - VLG	HPTLC	**Stationary Phase:** Silica gel 60 F_{254} **Mobile Phase:** n-Butanol: Methanol: Chloroform (2:3:5, v/v/v) **λ_{max}:** 227nm **Retention Factor:**0.62 ± 1.92 **Range:** 2000-20000 ng. ml^{-1}	29
6	VLG	UV spectroscopy	**UV-Spectrophotometer:** UV Visible double beam spectrophotometer **λ_{max}:** 210 nm **SOLVENT:** 0.1N HCl **Linearity:** 5-60 μg. ml^{-1}	30
7	Stability indicating- VLG and MET	RP-HPLC	**Stationary Phase:** C_{18} column (4.6 x 250mm, 5μ) **Mobile Phase:** Buffer (pH 3.5): ACN: Methanol (65:30:5, %v/v/v) **Detector:** UV **Rate of Flow:** 0.8 ml. min^{-1} **λ_{max}:** 212 nm **t_R: VLG:** 5.41 min **MET:** 3.36 min	31

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			Range: **VLG:** 1-14µg. ml^{-1} **MET:** 10-140µg. ml^{-1}	
8	VLG	UV spectroscopy	**UV- SPECTROPHOTOMETER:** UV- VIS spectrophotometer (Shimadzu model 18001) **λ_{max}:** 202.5 nm **Solvent:** 0.5 M HCl **Range:** 10-35 µg. ml^{-1}	32
9	VLG	Second-order derivative UV spectrophotometric	**UV- Spectrophotometer:** UV-Vis UV-1800 double-beam spectrophotometer with 1 cm quartz cells **λ_{max}:** 220 nm **Scaling Factor:** 20 **Range:** 25-125 µg. ml^{-1}	33
10	VLG	RP-HPLC	**Stationary Phase:** Zorbax Eclipse Plus RP-C_8 (4.6 x 150 mm, 5µ) **Mobile Phase:** ACN: 50 mM potassium phosphate buffer (15:85, %v/v) pH was adjusted to 7.0 using phosphoric acid **Detector:** PDA **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 207 nm **Range:** 10-90 µg. ml^{-1}	33
11	VLG and MET HCl	RP-HPLC	**Stationary Phase:** Xterra C_{18} column (4.6 x 250mm, 5µ) **Mobile Phase:** Water: Buffer (pH 6.0): CAN (15:20:65%v/v/v) **Detector:** UV **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 239nm **t_R: VLG:** 2.28 min **MET:** 4.27 min **Range:** **VLG:** 4-34 µg. ml^{-1} **MET:** 8-54 µg. ml^{-1}	34
12	Stability indicating - VLG and MET HCl	HPTLC	**Stationary Phase:** Silica gel 60 F_{254} **Mobile Phase:** Glacial Acetic Acid: ACN: Methanol: Hexane (0.2:2.5:3.5:2 v/v/v/v) **λ_{max}:** 245nm **Retention Factor** **VLG:** 0.73±0.02 **MET:** 0.22±0.01 **Range:** **VLG:** 10-150 ng. $band^{-1}$ **MET:** 50-500 ng. $band^{-1}$	35
13	QbD -VLG	RP-UPLC	**Stationary Phase:** X-bridge C_{18} column **Mobile Phase:** ACN: Buffer (pH 6.8) (33:67, %v/v) **Detector:** PDA **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 239 nm **t_R:** 2.75 min **Range:** 10-50 µg. ml^{-1}	36
14	Stability indicating - VLG and MET	RP-HPLC	**Stationary Phase:** C18 column (4.5 x 250 mm, 5µ) **Mobile Phase:** ACN: 0.05 mmol potassium dihydrogen phosphate buffer (20:80%v/v), pH adjusted to 3.5 using OPA **Detector:** PDA Detector **Rate of Flow:** 0.9 ml. min^{-1} **λ_{max}:** 263 nm **t_R: VLG:** 2.600 min **MET:** 2.215 min **Range:** **VLG:** 5-17.5µg. ml^{-1} **MET:**50-175µg. ml^{-1}	37

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15	QbD VLG	RP-HPLC	**Stationary Phase:** Jasco CrestPack RP C_{18} (4.6 x 250 mm, 5μ) **Mobile Phase:** ACN: Methanol: Buffer (pH 6) (10:20:70, %v/v) **Detector:** PDA **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 210 nm **t_R:** 7.21 min **Range:** 5-15 μg. ml^{-1}	38
16	Stability indicating - VLG	HPTLC	**Stationary Phase:** Silica gel 60 F_{254} **Mobile Phase:** Methanol: Ethyl acetate (1.5:8.5, v/v) **λ_{max}:** 217 nm **Linearity:** 200-1000 ng. $band^{-1}$ **Retention Factor:** 0.37 ± 0.003	39
17	VLG	RP- HPLC	**Stationary Phase:** RP C_{18} column (4.6 x 150 mm, 5μ) **Mobile Phase:** ACN: 10 mM Phosphate Buffer (pH 4.6) (15:85, %v/v) **Detector:** PDA **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 210 nm **t_R:** 3.38 min **Range:** 10-100 μg. ml^{-1}	40
18	VLG and LINAs	UV spectroscopy	**Spectrophotometer:** UV-Visible (Shimadzu UV-1800) spectrophotometer **λ_{max}: VLG:** 197 nm **LINA:** 294 nm **Solvent:** **VLG:** Distilled water **LINA:** Methanol **Range:** **VLG:** 8-32μg. ml^{-1} **LINA:** 5-25μg. ml^{-1}	41
19	VLG	UV spectroscopy	**UV- Spectrophotometer:** UV visible 1601 Shimadzu double beam spectrophotometer **λ_{max}:** 244 nm **Solvent:** Water **Range:** 12.5-200 μg. ml^{-1}	42
20	VLG and MET	RP-HPLC	**Stationary Phase:** Hypercil BDS C_{18} column **Mobile Phase :** ACN: 0.1 M Phosphate buffer (pH 4.8) (40:60, %v/v) **Detector:** PDA **Rate of Flow:** 0.9 ml. min^{-1} **λ_{max}:** 210nm **t_R: VLG:** 4.697 min **MET:** 3.273 min **Linearity** **VLG:** 1.25-7.5 μg. ml^{-1} **MET:** 12.5-75 μg. ml^{-1}	43
21	VLG and MET HCl	HPTLC	**Stationary Phase:** Silica Gel 60G F_{254} **Mobile Phase:** Toluene: Ammonium Acetate in Methanol (1% w/v) (0.5:10, v/v) **Detector:** UV **λ_{max}:** 214 nm **Retention Factor** **VLG:** 0.55 **MET:** 0.44 **Range:** **VLG:** 500-2000 ng. $spot^{-1}$ **MET:** 1000-5000 ng. $spot^{-1}$	44

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22	VLG and MET HCl	RP-HPLC	**Stationary Phase:** HiQsil C_{18}HS (4.6 x 250 mm, 5µ) **Mobile Phase:** ACN: Methanol: Phosphate buffer (pH set to 6 using 3M KOH) (20:30:50, %v/v/v) **Detector:** UV Detector **Rate of Flow:** 0.8 ml. min^{-1} **λ_{max}:** 220 nm **t_R: VLG:** 4.8 min **MET:** 3.7 min **Linearity** **VLG:** 10-60 µg. ml^{-1} **MET:** 10-60 µg. ml^{-1}	44
23	VLG	RP-HPLC	**Stationary Phase:** C_{18} column **Mobile Phase:** Methanol: ACN: Buffer (70:480:450, %v/v/v) **Rate of Flow:** 0.5 ml. min^{-1} **λ_{max}:** 254 nm **t_R:** 3.9 ± 0.1 min **Range:** 50-90 µg. ml^{-1}	45
24	Stability indicating - VLG	RP-HPLC	**Stationary Phase:** C_{18} column (4.6 x 250mm, 5µ) **Mobile Phase:** ACN: Buffer (50:50, %v/v) **Detector:** UV **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 220 nm **t_R:** 5.017 min **Range:** 10-60 µg. ml^{-1}	46
25	VLG and MET	RP-HPLC	**Stationary Phase:** Lichrocart C_{18} column (4.6 x 250 mm, 5µ) **Mobile Phase:** Acetonitrile: 0.05 M KH_2PO_4 (30:70, %v/v) pH 3.5 using OPA **Detector:** UV Detector **Rate of Flow:** 1.0 ml. min^{-1} **λ_{max}:** 215 nm **t_R: VLG:** 6.64 min **MET:** 5.18 min **Range:** **VLG:** 5-25 µg. ml^{-1} **MET:**10-50 µg. ml^{-1}	47

CONCLUSION

A review of the available data showed that no methodology for the fixed-dose combination of dapagliflozin and vildagliptin has been documented. Various analytical techniques, include UV, HPLC, UPLC, Stability indicating RP-HPLC, and HPTLC approaches, have been reported for dapagliflozin and vildagliptin individual as well with other combinations, according to the review of literature. There is hence an opportunity to create various analytical techniques for the combination of dapagliflozin and vildagliptin. This review provides a summary of the most recent, cutting-edge analytical techniques for determining dapagliflozin and vildagliptin, which will be useful for future studies on this combination. After reading the review, knowing the important solvents and their available set of instruments in the analytical laboratory will be beneficial.

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