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REVIEW ARTICLE

High-performance Liquid Chromatography Analytical Techniques for Determining the Various Diabetic Type 2 Medications: A Review Article

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ABSTRACT

A metabolic illness known as diabetes mellitus (DM) is brought on by the body's decreased secretion and/or activity of the hormone insulin. The condition worsens, pathological alterations in the body, such as nephropathy, retinopathy, and cardiovascular problems, become inevitable. Type I and II DM are the two primary subtypes of DM. Oral hypoglycaemics are used to treat type II diabetes, while insulin replacement therapy is typically used to treat type I diabetes. Patients typically receive dual drug treatments. Despite using oral hypoglycemic medications as monotherapy, have not been able to accomplish their therapeutic goals with first-line therapy.

In the current research, compiled the analytical methods reported for the estimation of some drugs diabetes in formulations for medicines. Most extensively used Technique like High-performance liquid chromatography (HPLC) was reported in Table 1, 2, 3, 4 and 5. These Tables show an overview of the reported HPLC methods for drugs of diabetes in combination respectively indicating the HPLC conditions.

Keywords: Diabetes Mellitus (DM), High-Performance Liquid Chromatography (HPLC), Glimepiride (GLM), Metformin (MET), Glipizide (GLP), Acarbose (ACA), Glibenclamide (GLB), Repaglinide (REP)

1. Introduction

Diabetes mellitus is a collection of diseases distinguished by alterations in glucose, protein, and lipid metabolism [1]. Although additional variables might be implicated, the

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primary disruption in diabetes mellitus is an imbalance in insulin synthesis either action or both. This mostly causes increased Postprandial blood glucose levels and fasting. Diabetes mellitus has become a frequent condition that has had a major impact on human health in recent years. Diabetes affects an estimated 150 million people globally, and this estimate is expected to more than multiply by 2030 [2]. Diabetes mellitus is one of the major causes of mortality worldwide, according to "World Health Organization (WHO)" estimations, with those most at risk living in South East Asia and the Western Pacific. As a consequence, the world looks to be under the control of a diabetic epidemic [3]. Approximately 90% of diabetic individuals who have diabetes mellitus (non-insulin-dependent) have type II diabetes [4]. It is particularly important to assure the quality of anti-diabetic medications for type II diabetes, which has a less severe insulin deficit. Anti-diabetic drugs. Sulfonylurea medications (Glipizide (GLP), Glibenclamide (GLB), Gliclazide (GLC), and Glimepiride (GLM)) work by increasing the synthesis of insulin by pancreatic beta cells [5]. This generation of hypoglycemic pharmaceuticals is far more powerful and hence effective at considerably lower doses [6]. Repaglinide (REP) similarly stimulates cell insulin secretion, but it binds to locations other than the binding sites for sulfonylureas [7]. Nateglinide (NGL) enhances the sensitivity of pancreatic cells to ambient glucose without increasing basal insulin production [8, 9].

2. Classification of diabetes medication according their chemical structure

Different pharmacological classes are included in the classification of diabetes medications based on their chemical structures. sulfonylureas, Medication such as glimepiride, glipizide, and glyburide is included in this class. Sulfonylureas function by inhibiting the K ATP channel, which causes pancreatic beta cells to produce more insulin [11, 12]. Metformin is categorized under the biguanides. Metformin increases AMPK signalling in the liver, which lowers gluconeogenesis and insulin resistance. Glucosidase inhibitors alpha: This class of drugs includes acarbose, miglitol, and voglibose. They work by inhibiting carbohydrate digestion in the small intestine by inhibiting enzymes that break down polysaccharides. Thiazolidinediones, Pioglitazone and rosiglitazone are part of this class [13, 14]. Through the activation of PPAR-γ in fat and muscle, they lessen insulin resistance. SGLT2 inhibitors: These medications cause increased glucose excretion in the urine by blocking the kidneys' sodium-glucose transport protein 2 [15–21].

In summary, diabetes medications are classified based on their mechanisms of action and chemical structures into different classes like sulfonylureas, biguanides, alpha-glucosidase inhibitors, thiazolidinediones, and SGLT2 inhibitors. The aim of the review have compiled a list of published methods for the measurement of glimepiride in pharmaceutical formulations, discussed the importance of estimation, and listed important new methods in this regard name methods such as high-performance chromatography (HPLC), and spectrophotometry, which are the most common methods. Glimepirides synthesized with various polymers have also been described.

3. Assay methods for HPLC

Technique High-performance Liquid Chromatography for estimating some drugs for diabetes mellitus by using HPLC [21] that documented in literature, which is for determining drug DM. The literature review's illustrated in Tables 1 to 5 display an efficient, simple, and sensitive HPLC approach for the validation and development of a singles pharmaceutical,

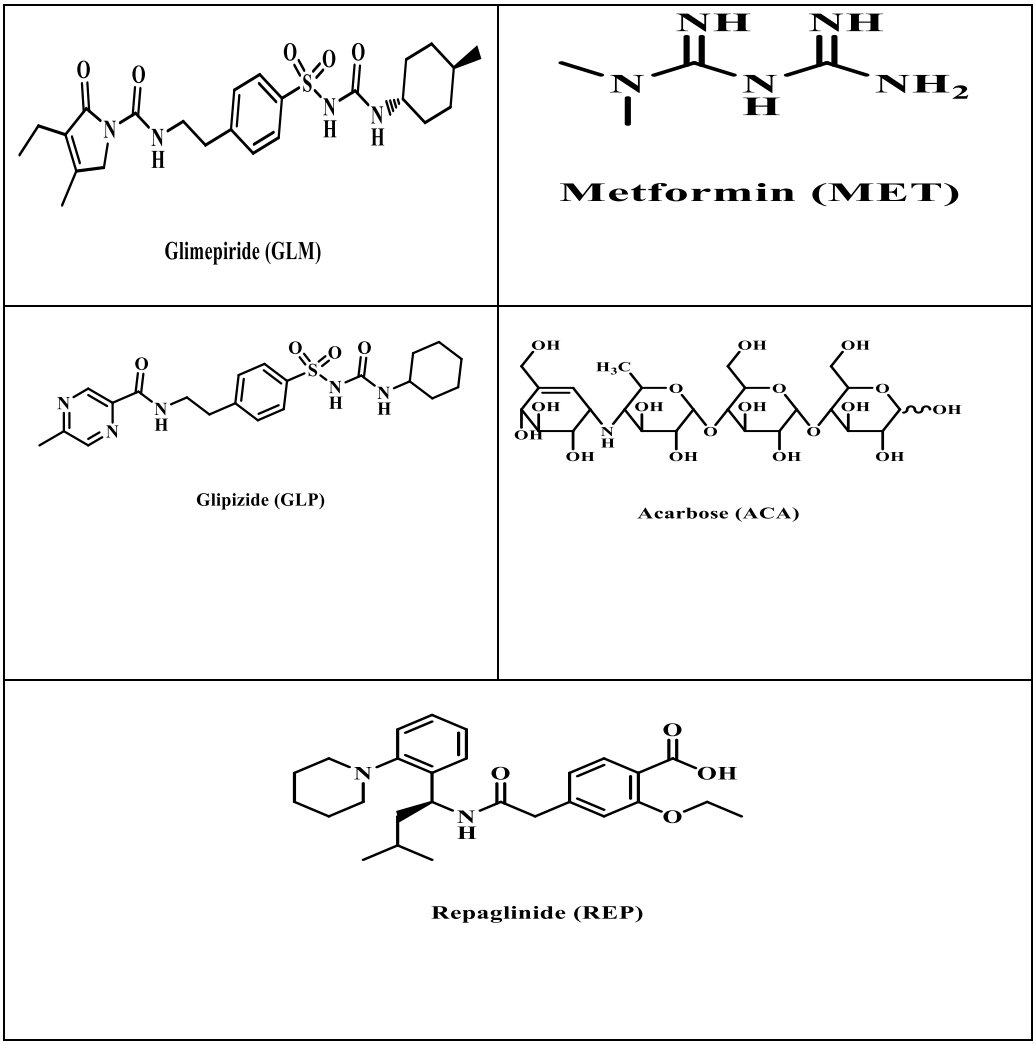

Fig. 1. Structural representation of Glimepiride (GLM). Metformin (MET), Glipizide (GLP), acarbose (ACA), Glibenclamide (GLB), and, Repaglinide (REP).

in addition to information on the stationary phase as well as the mobile phase, utilized, as well as their retention duration and flow rate with UV detection.

4. Conclusion

This article presents a literature review on five medications Glimepiride, Acarbose, Repaglinide, Glipizide and Metformin. It is particularly relevant in HPLC, as demonstrated in Tables 1 to 5. The study highlights the importance of determining diabetes drugs such as glimepiride, acarbose, repaglinide, glipizide, and metformin using high-performance liquid chromatography (HPLC). The study demonstrated the great effectiveness of this technology in analyzing these medications accurately and reliably, which contributes to improving the management of drug treatment for diabetes patients. The results also show the importance

Table 1. HPLC methods for assay of glimepiride.

No.	Stationary phase	Mobile phase	Detection	FR (mL/min)	RT (min)	Detection limit	Ref.
1.	3 mm × 15 cm column containing 5 μm packing L20	Isopropyl alcohol: Hexane: glacial acetic acid (10:90:0.1)	UV detection at 228 nm	0.5	NA	NA	[22]
2.	C18 (250 mm × 4.6 mm, 5 μ)	"Sodium hexanesulfonate buffer adjusted to pH 2.5 with ortho-phosphoric acid and acetonitrile (45:55 v/v)"	UV detection At 229 nm	1.0	3.55 and 5.82	150–750 and 0.75–4.5 ppm	[23]
3.	C18 Hybrid) UPLC (100 mm × 2.1 mm, 1.8 μm)	"0.1% ortho phosphoric acid buffer (the pH was adjusted to 3.4 with 0.1 N NaOH) and methanol in the ratio 40:60% v/v"	UV detection at 254 nm	0.25 ml/min			[24]
4.	C8	Methanol, KH_2PO_4 adjusted to pH 3.2 utilizing ortho-phosphoric acid (70: 30, v/v)	UV detection at 235 nm	1.0	3.06, 4.33 and 6.00	0.05, 1.21 and 0.11 ppm	[25]
5.	C18 column (4.6 mm × 100 mm; 2.5 μm)	methanol: phosphate buffer (pH corrected to 3.2 with 80% ortho phosphoric acid) in the ratio of 60:40 v/v	UV detection at 254 nm	1.0			[26]

Table 2. HPLC methods for assay of metformin.

No.	Stationary phase	Mobile phase	Detection	FR (mL/min)	RT (min)	Detection limit	Ref.
1.	3 mm × 15 cm column containing 5 μm packing L20	Isopropyl alcohol: Hexane: glacial acetic acid (10:90:0.1)	UV detection at 228 nm	0.5			[22]
2.	Column C18 250 × 4.6 mm, 5 μm	TEA buffer (50:50 v/v)	272 nm	1.0	3.6 min		[27]
3.	CN 250 mm × 4.6 mm × 5 μ	ammonium formate buffer (pH 3.5) and acetonitrile at a ratio of (45:55, v/v)	227 nm	1.0			[28]
4.	C18 (250 mm × 4.6 mm, 5 μ)	acetonitrile: phosphate buffer (pH 6.0): water (65: 20:15v/v/v)	UV detection at 239 nm	1.0	3.55 and 5.82	0.0040 ppm and 0.025 ppm	[29]
5.	C18 column (150 mm × 4.6 mm, 5 μm)	0.1% ortho-phosphoric acid buffer (pH 2.7): acetonitrile (65:35% v/v)	224 nm	1.0	2.170	0.025 ppm	[30]

Table 3. HPLC methods for assay of glipizide.

No.	Stationary phase	Mobile phase	Detection	FR (mL/min)	RT (min)	Detection limit	Ref.
1.	3 mm × 15 cm column containing 5 μm packing L20	Isopropyl alcohol: Hexane: glacial acetic acid (10:90:0.1)	UV detection at 228 nm	0.5			[22]
2.	Grace Smart Altima C-8 column	acetonitrile : phosphate buffer (60: 40 (v/v), pH 3.0)	235 nm		1.0	2.57 min, 7.06 min, and 9.39 min	[31]
3.	C18 (250 mmL × 4.6 mm I.D × 5 μ)	acetonitrile: phosphate buffer (pH 6.0): water (65: 20:15v/v/v)	UV detection at 239 nm	1.0	3.55 and 5.82	0.0040 ppm and 0.025 ppm	[32]
4.	y C18 column (75*4.6 mm, 3.5 m	ning Brij-35 (12.05 mM) and SDS (76.25 mM) at pH 3	225 nm 210 nm and	1.0	2.7 min	0.4 μg/Ml	[33]

Table 4. HPLC methods for assay of acarbose.

No.	Stationary phase	Mobile phase	Detection	FR (mL/min)	RT (min)	Detection limit	Ref.
1.	3 mm × 15 cm column containing 5 μm packing L20	Isopropyl alcohol: Hexane: glacial acetic acid (10:90:0.1)	UV detection at 228 nm	0.5			[22]
2.	Column Lichrospher −100–NH2, 5 μm, 250 × 4.6 mm	acetonitrile–phosphate buffer	210	2			[34]
3.	An Alltima C18 column (4.6 mm × 250 mm, 5 μm)	acetonitrile-10 mmol·L-1 ammonium dihydrogen phosphate (containing 0.04% sodium 1-octanesulfonate, adjusted pH to 3.3 with H^3PO^4) (15:85	200 nm	0.8			[35]
4.	through thermo BDS (250 mm 4.6 mm, 5μ).	Buffer and Acetonitrile in the ratio of 35:65A	215 nm	1.0	4.1	1.3 ppm	[36]

of determining the limits of detection (LOD) for these drugs, as this contributes to ensuring the delivery of accurate and safe doses, which enhances the effectiveness of treatment and reduces the potential risks of over- or under-doses.

Table 5. HPLC methods for assay of repaglinide.

No.	Stationary phase	Mobile phase	Detection	FR (mL/min)	RT (min)	Detection limit	Ref.
1.	3 mm × 15 cm column containing 5 μm packing L20	Isopropyl alcohol: Hexane: glacial acetic acid (10:90:0.1)	UV detection at 228 nm	0.5			[22]
2.	Shim-pack, RP-C18 column	methanol: 0.1% v/v triethylamine (pH adjusted to 7 with orthophosphoric acid)	UV detection at 235 nm	NA	3.40	NA	[37]
3.	STAR C-18 analytical column (4.8 mm × 150 mm; 5 _m particle size).	The mobile phase composed of acetonitrile–ammonium formate (pH 2.7; 0.01 M) (60:40, v/v)		1.0	6.2	3.90 to 6.67%.	[38]
4.	μ-bondapack C18 column	acetonitrile- methanol-potassium dihydrogen phosphate	244	1.5	4.0	NA	[39]

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