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(54) Title: BILAYER TABLET FORMULATIONS

(57) Abstract: The present invention relates to bilayer tablet formulations comprising metformin extended release (XR) or reduced mass metformin XR formulation as the first layer, an SGLT2 inhibitor formulation as the second layer, and optionally a film coating. The present invention provides methods of preparing the bilayer tablet formulations and methods of treating diseases or disorders associated with SGLT2 activity employing the bilayer tablet formulations.

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BILAYER TABLET FORMULATIONS

FIELD OF THE INVENTION

The present invention relates to bilayer tablet formulations comprising metformin
5 extended release (XR) formulations or reduced mass metformin XR formulations as the
first layer, sodium dependent glucose transporter inhibitor (SGLT2) formulations as the
second layer, and optionally a film coating. The present invention provides methods of
preparing the bilayer tablet formulations and methods of treating diseases or disorders
associated with SGLT2 activity employing the bilayer tablet formulations.

10

BACKGROUND OF THE INVENTION

Type II diabetes is the most common form of diabetes accounting for 90% of
diabetes cases. Over 100 million people worldwide have type-2 diabetes (nearly 17
million in the U.S.) and the prevalence is increasing dramatically in both the developed
15 and developing worlds. Type-II diabetes is a lifelong illness, which generally starts in
middle age or later part of life, but can start at any age. Patients with type-2 diabetes do
not respond properly to insulin, the hormone that normally allows the body to convert
blood glucose into energy or store it in cells to be used later. The problem in type-2
diabetes is a condition called insulin resistance where the body produces insulin, in
20 normal or even high amounts, but certain mechanisms prevent insulin from moving
glucose into cells. Because the body does not use insulin properly, glucose rises to
unsafe levels in the blood, the condition known as hyperglycemia.

Over time, sustained hyperglycemia leads to glucotoxicity, which worsens insulin
resistance and contributes to dysfunction in the beta cells of the pancreas. The degree of
25 sustained hyperglycemia is directly related to diabetic microvascular complications and
may also contribute to macrovascular complications. In this way, hyperglycemia
perpetuates a cycle of deleterious effects that exacerbate type 2 diabetes control and
complications.

It is now widely accepted that glycemic control makes a difference in type II
30 diabetes patients. The goal of diabetes therapy today is to achieve and maintain as near
normal glycemia as possible to prevent the long-term microvascular and macrovascular

complications associated with elevated glucose in the blood. Oral therapeutic options for the treatment of type II diabetes mellitus include compounds known as: sulfonylureas, biguanides (metformin), thiazolidinediones, and alpha-glucosidase inhibitors. The active agents from each class are generally administered to patients alone. However, once
5 monotherapy becomes inadequate, combination therapy is an attractive and rational course of action for treating hyperglycemia despite the known side effect of weight gain associated with sulfonylurea and thiazolidinone therapies.

Recently, a new class of anti-diabetics was discovered known as sodium-glucose transporter-2 inhibitors (SGLT2). SGLT2 inhibitors prevent the reabsorption of glucose
10 into blood by the kidney. The kidney continuously filters glucose through the glomerulus into the bladder, however, nearly all of this glucose is reabsorbed. SGLT2 is the protein responsible for the majority of glucose reabsorption and helps the body retain glucose for its energy requirements. For patients with diabetes, retention of excess glucose by this pathway contributes to persistent hyperglycemia. Suppressing the activity of SGLT2
15 inhibits renal-glucose reabsorption in the body, thereby leading to the excretion of glucose in the urine.

Accordingly, the present invention provides bilayer tablet formulations that consist of metformin and an SGLT2 inhibitor for oral administration in the treatment of diseases or disorders associated with SGLT2 activity without weight gain associated with
20 other therapies. The first layer of the bilayer tablet is metformin extended release (XR) or metformin XR in a reduced mass formulation. The second layer is an SGLT2 inhibitor formulation. The metformin/SGLT2 bilayer tablet of the present invention provides an antidiabetic therapy to patients that is both convenient and effective for controlling blood glucose levels.

SUMMARY OF THE INVENTION

In a first aspect, the invention provides a bilayer tablet comprising: (1) a first layer wherein the first layer is a metformin extended release formulation; (2) a second layer wherein the second layer is an SGLT2 inhibitor formulation comprising
30 dapagliflozin, dapaglifloxin (S) propylene glycol hydrate, or dapagliflozin (R) propylene

glycol hydrate, and a glidant; and (3) optionally a film coating that covers the first layer and the second layer.

In another aspect, the invention provides a bilayer tablet comprising: (1) a first layer wherein the first layer is a metformin extended release formulation comprising metformin hydrochloride, sodium carboxymethyl cellulose; hydroxypropyl methylcellulose; magnesium stearate; and optionally silicon dioxide or colloidal silicon dioxide; (2) a second layer wherein the second layer is an SGLT2 inhibitor formulation comprising dapagliflozin or dapagliflozin (S) propylene glycol hydrate; two or three fillers selected from lactose anhydrous, microcrystalline cellulose, pregelatinized starch, mannitol, and hydroxypropyl cellulose; a disintegrant that is crospovidone; a glidant that is silicon dioxide; and a lubricant that is magnesium stearate; (3) an optional film coating that covers the first layer and the second layer comprising polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.

In another aspect, the invention provides a method of treating a disorder or disease selected from diabetes (including type I and type II diabetes), impaired glucose tolerance, insulin resistance, nephropathy, retinopathy, neuropathy and cataracts, hyperglycemia, hyperinsulinemia, hypercholesterolemia, dyslipidemia, elevated blood levels of free fatty acids or glycerol, hyperlipidemia, hypertriglyceridemia, obesity, wound healing, tissue ischemia, atherosclerosis and hypertension in a mammal comprising administering to the mammal in need of such treatment a bilayer tablet comprising (1) a first layer wherein the first layer is a metformin extended release formulation; (2) a second layer wherein the second layer is an SGLT2 inhibitor formulation comprising dapagliflozin, dapagliflozin (S) propylene glycol hydrate, or dapagliflozin (R) propylene glycol hydrate, and a glidant; and (3) optionally a film coating that covers the first layer and the second layer.

In a further aspect, the invention provides a coated bilayer tablet that comprises: (1) a bilayer tablet core comprising two layers wherein the first layer comprises metformin; and the second layer comprises an SGLT2 inhibitor; and a glidant, wherein the SGLT2 inhibitor is dapagliflozin, dapagliflozin (S) propylene glycol hydrate, or dapagliflozin (R) propylene glycol hydrate; wherein the second layer is about 300 to about 400 mgs; (2) a first coating that coats the bilayer tablet core and optionally

comprises saxagliptin; (3) a second coating that coats the first coating and optionally comprises saxagliptin; and (4) optionally a third coating that coats the second coating; wherein at least one of the first coating and the second coating comprises saxagliptin.

The invention is as defined above and in the claims. However, the description
5 which follows also refers to additional compositions and methods outside the scope of the present claims. This description is retained for its technical content.

Described herein are bilayer tablets comprising (1) a metformin XR formulation or a reduced mass metformin XR formulation as the first layer, (2) an SGLT2 inhibitor formulation as the second layer, and (3) optionally a film coating that covers both layers.

10 Metformin may be in the form of a pharmaceutically acceptable salt where metformin hydrochloride (HCl) is preferred. A preferred SGLT2 inhibitor is dapagliflozin or a pharmaceutically acceptable salt thereof, dapagliflozin (S) propylene glycol hydrate (1:1:1), or dapagliflozin (R) propylene glycol hydrate (1:1:1). The most preferred SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) propylene glycol hydrate (1:1:1).

15 The SGLT2 inhibitor formulation is an immediate release or an extended release formulation, where an immediate release formulation is preferred.

The metformin XR layer (1000 mg) comprises metformin, a binder, a release modifier, a lubricant, and optionally a glidant. A preferred binder is sodium carboxymethyl cellulose. Hydroxypropyl methylcellulose 2208 is a preferred release
20 modifier. Magnesium stearate is a preferred lubricant and silicon dioxide or colloidal silicon dioxide are preferred glidants. The SGLT2 inhibitor layer comprises an SGLT2 inhibitor, two or three fillers, a disintegrant, a glidant, and a lubricant. The preferred fillers are lactose anhydrous, microcrystalline cellulose 302, pregelatinized starch, and mannitol. A preferred disintegrant is crospovidone. Silicon dioxide is the preferred
25 glidant and magnesium stearate is the preferred lubricant. Hydroxypropyl cellulose EXF is the preferred binder.

The metformin XR layer (500 mg) comprises metformin, a binder, at least one release modifier, a filler, a lubricant, and optionally a glidant. A preferred binder is sodium carboxymethyl cellulose. The preferred release modifiers are hydroxypropyl
30 methylcellulose 2208 in combination with hydroxypropyl methylcellulose 2910. Microcrystalline cellulose is a preferred filler. Magnesium stearate is a preferred

lubricant and silicon dioxide or colloidal silicon dioxide are preferred glidants. The SGLT2 inhibitor layer comprises an SGLT2 inhibitor, two or three fillers, a disintegrant, a glidant, and a lubricant. The preferred fillers are lactose anhydrous, microcrystalline cellulose 302, pregelatinized starch, and mannitol. A preferred disintegrant is

5 crosopvidone. Silicon dioxide is the preferred glidant and magnesium stearate is the preferred lubricant. Hydroxypropyl cellulose EXF is the preferred binder.

Also described herein are methods of treating diseases or disorders associated with SGLT2 activity comprising administering to a mammal in need of such treatment a therapeutically effective amount of a bilayer tablet comprised of metformin XR or

10 reduced mass metformin XR, an SGLT2 inhibitor, and optionally a film coating. The bilayer tablet formulations of the present invention can be administered to mammals, preferably humans, for the treatment of a variety of conditions and disorders associated with SGLT2 activity including, but not limited to, treating or delaying the progression or onset of diabetes (including Type I and Type II diabetes), impaired glucose tolerance,

15 insulin resistance, and diabetic complications, such as nephropathy, retinopathy, neuropathy and cataracts, hyperglycemia, hyperinsulinemia, hypercholesterolemia, dyslipidemia, elevated blood levels of free fatty acids or glycerol, hyperlipidemia, hypertriglyceridemia, obesity, wound healing, tissue ischemia, atherosclerosis and hypertension. The formulations of the present invention can also be utilized to increase

20 the blood levels of high density lipoprotein (HDL). In addition, the conditions, diseases, and maladies collectively referenced to as "Syndrome X" or Metabolic Syndrome as detailed in Johannsson, *J. Clin. Endocrinol. Metab.*, 82, 727-34 (1997), can be treated employing the formulations of the present invention.

Also described herein are methods for preparing a bilayer tablet comprising

25 metformin XR or reduced mass metformin XR, an SGLT2 inhibitor, and optionally a film coating.

DETAILED DESCRIPTION OF THE INVENTION

Preparing bilayer tablets with significantly different weight ratios between the two

30 layers can lead to cracking at the layer interface, separation of the layers, or even cross-contamination of the two layers. The large difference in weight ratio between the

metformin and the SGLT2 inhibitor layers of Examples 4-15 provides challenges with regard to maintaining potency and content uniformity of the lower weight layer, the SGLT2 inhibitor layer. Furthermore it was found that a number of trial formulations showed cracking in the SGLT2 layers at the tablet surface in an area adjacent to but
5 separate from the interface between the layers and parallel to that interface. Formulations of the SGLT2 layer with increased microcrystalline cellulose levels, for example, reduced or eliminated cracking, separation, and cross-contamination of the two layers while maintaining potency and uniformity of the second layer. Further, pregelatinized starch, hydroxypropyl cellulose EXF, or mannitol, can be used as a substitute for a portion of the
10 microcrystalline cellulose. Finally, a total weight of about 300 mgs to about 400 mgs for the second layer contributed to reducing or eliminating cracking, separation, and cross-contamination of the two layers. The preferred weight of the second layer is 300 mgs. Accordingly, the present invention provides bilayer tablet formulations that reduce or eliminate cracking, separation, and cross-contamination of the metformin and SGLT2
15 layers and maintains or improves the SGLT2 layer potency and uniformity.

Described herein is a bilayer tablet comprising metformin XR (1000 mg) formulations, SGLT2 inhibitor (2.5, 5.0, or 10.0 mgs) formulations, and optionally a film coating. The metformin XR formulation comprises metformin hydrochloride (HCl), sodium carboxymethyl cellulose, hydroxypropyl methylcellulose, and magnesium
20 stearate. The SGLT2 inhibitor formulation comprises an SGLT2 inhibitor, lactose anhydrous, microcrystalline cellulose, crospovidone, silicon dioxide, and magnesium stearate. For the second layer, pregelatinized starch, hydroxypropyl cellulose EXF, or mannitol (pearlitol SD 200) can be used to substitute a portion of the microcrystalline cellulose. In addition, the second layer has a total weight of about 300 mgs to about 400
25 mgs. The preferred weight of the second layer is 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin, dapagliflozin (S) PGS, or dapagliflozin (R) PGS.

Also described herein is provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 50-87% metformin hydrochloride (HCl), about
30 1-10% sodium carboxymethyl cellulose, about 10-40% hydroxypropyl methylcellulose, about 0.1-75% magnesium stearate, and about 0-2% silicon dioxide or about 0-1.5%

colloidal silicon dioxide. The SGLT2 inhibitor formulation comprises about 0.1-10% SGLT2 inhibitor, about 5-30% lactose anhydrous, about 40-90% microcrystalline cellulose, about 0-25% pregelatinized starch, about 0-20% hydroxypropyl cellulose, about 0-25% mannitol, about 1-10% crospovidone, about 0.1-5% silicon dioxide, and about 0.1-5% magnesium stearate. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

Also described herein is a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 64-82% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 15-30% hydroxypropyl methylcellulose, about 0.1-75% magnesium stearate, and about 0-2% silicon dioxide or

about 0-1.5% colloidal silicon dioxide. The SGLT2 inhibitor formulation comprises about 0.5-4% SGLT2 inhibitor, about 14-18% lactose anhydrous, about 50-80% microcrystalline cellulose, about 0-20% pregelatinized starch, about 0-15% hydroxypropyl cellulose, about 0-20% mannitol, about 2-6% crospovidone, about 5 0.5-2.5% silicon dioxide, and about 0.49-2% magnesium stearate. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 67-71% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-29% hydroxypropyl methylcellulose 2208, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) PGS, about 14-18% lactose anhydrous, about 72-80% microcrystalline cellulose 302, about 2-6% crospovidone, about 0.5-2.5% silicon dioxide, and about 0.5-1.5% magnesium stearate. 15 The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 67-71% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-29% hydroxypropyl methylcellulose 2208, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose 302; about 10-22% pregelatinized starch; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 25 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 67-71% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-29% hydroxypropyl methylcellulose 2208, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol 30

hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose 302; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about
5 300 mgs.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 67-71% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-29% hydroxypropyl methylcellulose 2208, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor
10 formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose 302; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor
15 formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 57-77% microcrystalline cellulose 302, about 0-19% pegelatinized starch, 0-10% hydroxypropyl cellulose EXF, about 0-15% mannitol, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.
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In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor
25 formulation comprises about 0.8% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 77% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The
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total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 76% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor formulation comprises about 3.4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 74% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 64% microcrystalline cellulose 302; about 13% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor
5 formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 57% microcrystalline cellulose 302; about 19% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film
10 coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor
15 formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 66% microcrystalline cellulose 302; about 10% hydroxypropyl cellulose EXF; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film
20 coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor
25 formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 61% microcrystalline cellulose 302; about 15% mannitol; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be
30 Opadry® II.

In another aspect, the present invention provides a bilayer tablet formulation wherein the metformin XR (1000 mg) formulation comprises about 67-73% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-30% hydroxypropyl methylcellulose 2208, and about 0.08-0.2% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 14-18% lactose anhydrous, about 55-70% microcrystalline cellulose 302, about 10-25% pregelatinized starch, about 3-5% crospovidone, about 0.5-2.5% silicon dioxide, and about 0.5-2% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 56-64% microcrystalline cellulose 302, about 13-19% pregelatinized starch, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet formulation wherein the metformin XR (1000 mg) formulation comprises about 67-73% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-30% hydroxypropyl methylcellulose 2208, and about 0.08-0.2% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 14-18% lactose anhydrous, about 55-70% microcrystalline cellulose 302, about 5-20% hydroxypropyl Cellulose EXF, about 3-5% crospovidone, about 0.5-2.5% silicon dioxide, and about 0.5-2% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride

(HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 66% microcrystalline cellulose 302, about 10% hydroxypropyl cellulose EXF, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 67-73% metformin hydrochloride (HCl), about 3-5% sodium carboxymethyl cellulose, about 25-30% hydroxypropyl methylcellulose 2208, and about 0.08-0.2% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 14-18% lactose anhydrous, about 55-70% microcrystalline cellulose 302, about 5-25% mannitol, about 3-5% crospovidone, about 0.5-2.5% silicon dioxide, and about 0.5-2% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (1000 mg) formulation comprises about 69% metformin hydrochloride (HCl), about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.49% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 61% microcrystalline cellulose 302, about 15% mannitol, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

Also described herein is a bilayer tablet comprising metformin XR (500 mg) formulations, SGLT2 inhibitor (2.5, 5.0, or 10.0 mgs) formulations, and optionally a film coating. The metformin XR formulation comprises metformin hydrochloride (HCl), sodium carboxymethyl cellulose, hydroxypropyl methylcellulose, microcrystalline cellulose, and magnesium stearate. The SGLT2 inhibitor formulation comprises an SGLT2 inhibitor, lactose anhydrous, microcrystalline cellulose, crospovidone, silicon

dioxide, and magnesium stearate. For the second layer, pregelatinized starch, hydroxypropyl cellulose EXF, or mannitol (pearlitol SD 200) can be used to substitute a portion of the microcrystalline cellulose. In addition, the second layer has a total weight of about 300 mgs to about 400 mgs. The preferred weight of the second layer is 300 mgs.

5 The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin, dapagliflozin (S) PGS, or dapagliflozin (R) PGS.

Also described herein is a bilayer tablet wherein the metformin XR (500 mg) formulation comprises about 40-60% metformin hydrochloride (HCl), about 1-10% sodium carboxymethyl cellulose, about 20-45% hydroxypropyl methylcellulose, about 5-10 15% microcrystalline cellulose, about 0.1-0.75% magnesium stearate, and about 0-2% silicon dioxide or about 0-1.5% colloidal silicon dioxide. The SGLT2 inhibitor formulation comprises about 0.1-10% SGLT2 inhibitor, about 5-30% lactose anhydrous, about 40-90% microcrystalline cellulose, about 0-25% pregelatinized starch, about 0-20% hydroxypropyl cellulose, about 0-25% mannitol, about 1-10% crospovidone, 15 about 0.1-5% silicon dioxide, and about 0.1-5% magnesium stearate. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

Also described herein is a bilayer tablet wherein the metformin XR (500 mg) formulation comprises about 42-55% metformin hydrochloride (HCl), about 4-6% 20 sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose, about 5-15% microcrystalline cellulose, about 0.1-0.75% magnesium stearate, and about 0-2% silicon dioxide or about 0-1.5% colloidal silicon dioxide. The SGLT2 inhibitor formulation comprises about 0.5-4% SGLT2 inhibitor, about 14-18% lactose anhydrous, about 65-80% microcrystalline cellulose, about 0-20% pregelatinized starch, about 25 0-15% hydroxypropyl cellulose, about 0-20% mannitol, about 2-6% crospovidone, about 0.5-2.5% silicon dioxide, and about 0.49-2% magnesium stearate. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

In another aspect, the present invention provides a bilayer tablet wherein the 30 metformin XR (500 mg) formulation comprises about 46-50% metformin hydrochloride

(HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, 5-15% microcrystalline cellulose, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) PGS, 5 about 14-18% lactose anhydrous, about 72-80% microcrystalline cellulose 302, about 2-6% crospovidone, about 0.5-2.5% silicon dioxide, and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the 10 metformin XR (500 mg) formulation comprises about 46-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, 0.1-1.5% hydroxypropyl methylcellulose 2910, 5-15% microcrystalline cellulose, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) 15 propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose 302; about 10-22% pregelatinized starch; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs.

In another aspect, the present invention provides a bilayer tablet wherein the 20 metformin XR (500 mg) formulation comprises about 46-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, 0.1-1.5% hydroxypropyl methylcellulose 2910, 5-15% microcrystalline cellulose, and about 0.1-0.75% magnesium stearate. The SGLT2 25 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose 302; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where 30 the preferred weight is about 300 mgs.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mg) formulation comprises about 46-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, 0.1-1.5% hydroxypropyl methylcellulose 2910, 5-15%
5 microcrystalline cellulose, and about 0.1-0.75% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose 302; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of
10 the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mg) formulation comprises about 48-49% metformin hydrochloride (HCl), about 4.5-5% sodium carboxymethyl cellulose, about 34.5-35% hydroxypropyl
15 methylcellulose 2208, 0.8-1.2% hydroxypropyl methylcellulose 2910, about 9.75-10.25% microcrystalline cellulose, and about 0.34% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 72-77% microcrystalline cellulose 302, about 0-19% pegelatinized starch, 0-10% hydroxypropyl cellulose EXF, about 0-15% mannitol, about 4%
20 crospovidone, about 0.5-1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mg) formulation comprises about 48-49% metformin hydrochloride
25 (HCl), about 4.5-5% sodium carboxymethyl cellulose, about 34.5-35% hydroxypropyl methylcellulose 2208, 0.8-1.2% hydroxypropyl methylcellulose 2910, about 9.75-10.25% microcrystalline cellulose, and about 0.34% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 72-77% microcrystalline cellulose 302, about 4% crospovidone, about
30 0.5-1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the

SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

Formulations that reduce the mass of the metformin XR layer, as compared with known or currently available formulations of metformin XR, without affecting the amount of active ingredient are desirable because these formulations provide lower weight differentials between the two layers thereby reducing or eliminating problems associated with the manufacture of a bilayer tablet (cracking, separation, cross-contamination). In addition, the bilayer tablets are rendered smaller and more suitable for oral administration to patients. The present invention provides reduced mass metformin XR formulations that comprise silicon dioxide or colloidal silicon dioxide with reduced amounts of hydroxypropyl methylcellulose. Hydroxypropyl methylcellulose is reduced from about 27% to about 18%. These formulations improve compactability and reduce layer weight ratios from about 4.8:1 to about 4.4:1 while maintaining similar metformin release rates.

Accordingly, described herein are bilayer tablets comprising reduced mass metformin XR (1000 mgs) formulations, SGLT2 inhibitor (2.5, 5.0, 10.0 mgs) formulations, and optionally a film coating. The reduced mass metformin XR formulations comprise metformin HCl, sodium carboxymethyl cellulose, hydroxypropyl methylcellulose, silicon dioxide or colloidal silicon dioxide, and magnesium stearate. The SGLT2 inhibitor formulation comprises the SGLT2 inhibitor, lactose anhydrous, microcrystalline cellulose, crospovidone, silicon dioxide, and magnesium stearate. For the second layer, pregelatinized starch, hydroxypropyl cellulose, or mannitol can be used to substitute a portion of the microcrystalline cellulose. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin, dapagliflozin (S) PGS, or dapagliflozin (R) PGS.

Also described herein is a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 70-85% metformin hydrochloride (HCl), about 2-6% sodium carboxymethyl cellulose, about 15-27% hydroxypropyl methylcellulose 2208, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises

about 0.1-10% SGLT2 inhibitor, about 5-30% lactose anhydrous, about 40-90% microcrystalline cellulose 302, about 0-25% pregelatinized starch, about 0-20% hydroxypropyl cellulose EXF, about 0-25% mannitol (pearlitol SD 200), about 1-10% crospovidone, about 0.1-5% silicon dioxide, and about 0.1-5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

Also described herein is a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.1-10% SGLT2 inhibitor, about 5-30% lactose anhydrous, about 40-90% microcrystalline cellulose 302, about 0-25% pregelatinized starch, about 0-20% hydroxypropyl cellulose EXF, about 0-25% mannitol (pearlitol SD 200), about 1-10% crospovidone, about 0.1-5% silicon dioxide, and about 0.1-5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose 302; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is

about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22%
5 hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70%
10 microcrystalline cellulose 302; about 10-22% pregelatinized starch; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the
15 reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S)
20 propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose 302; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the
25 reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The
30 SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65%

microcrystalline cellulose 302; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

5 In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The
10 SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 56-64% microcrystalline cellulose 302, about 13-19% pregelatinized starch, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be
15 Opadry® II.

 In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about
20 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 66% microcrystalline cellulose 302, about 10% hydroxypropyl cellulose, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400
25 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

 In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 72-82% metformin hydrochloride (HCl); about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about
30 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin (S) PGS, about 16%

lactose anhydrous, about 61% microcrystalline cellulose 302, about 15% mannitol, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

5 In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2
10 inhibitor formulation comprises about 0.8% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 77% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

15 In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2
20 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 76% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

25 In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2
30 inhibitor formulation comprises about 3.4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate, about 16% lactose anhydrous; about 74% microcrystalline cellulose 302;

about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the
5 reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene
10 glycol hydrate; about 16% lactose anhydrous; about 64% microcrystalline cellulose 302; about 13% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the
15 reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene
20 glycol hydrate; about 16% lactose anhydrous; about 57% microcrystalline cellulose 302; about 19% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film
25 coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the
reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about
30 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene

glycol hydrate; about 16% lactose anhydrous; about 66% microcrystalline cellulose 302; about 10% hydroxypropyl cellulose EXF; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs.

5 The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the reduced mass metformin XR (1000 mgs) formulation comprises about 76.6% metformin hydrochloride (HCl); about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about
10 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate. The SGLT2 inhibitor formulation comprises about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 61% microcrystalline cellulose 302; about 15% mannitol; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to
15 about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

Also described herein are bilayer tablets comprising metformin XR (500 mgs) formulations, SGLT2 inhibitor (2.5, 5.0, 10.0 mgs) formulations, and optionally a film coating. The metformin XR 500 mg formulations comprise metformin HCl, sodium
20 carboxymethyl cellulose, hydroxypropyl methylcellulose, microcrystalline cellulose, magnesium stearate, and optionally silicon dioxide or colloidal silicon dioxide. The SGLT2 inhibitor formulation comprises the SGLT2 inhibitor, lactose anhydrous, microcrystalline cellulose, crospovidone, silicon dioxide, and magnesium stearate. For the second layer, pregelatinized starch, hydroxypropyl cellulose, or mannitol can be used
25 to substitute a portion of the microcrystalline cellulose. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin, dapagliflozin (S) PGS, or dapagliflozin (R) PGS.

Also described herein is a bilayer tablet wherein the metformin XR (500 mgs)
30 formulation comprises about 40-60% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl

methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.1-10% SGLT2 inhibitor, about 5-30% lactose anhydrous, about 40-90% microcrystalline cellulose 302, about 0-25% pregelatinized starch, about 0-20% hydroxypropyl cellulose EXF, about 0-25% mannitol (pearlitol SD 200), about 1-10% crospovidone, about 0.1-5% silicon dioxide, and about 0.1-5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

Also described herein is a bilayer tablet wherein the metformin XR (500 mgs) formulation comprises about 45-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.1-10% SGLT2 inhibitor, about 5-30% lactose anhydrous, about 40-90% microcrystalline cellulose 302, about 0-25% pregelatinized starch, about 0-20% hydroxypropyl cellulose EXF, about 0-25% mannitol (pearlitol SD 200), about 1-10% crospovidone, about 0.1-5% silicon dioxide, and about 0.1-5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The optional film coating can be Opadry® II. In a preferred embodiment, the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) PGS.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mgs) formulation comprises about 45-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor

formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose 302; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mgs) formulation comprises about 45-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose 302; about 10-22% pregelatinized starch; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mgs) formulation comprises about 45-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose 302; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mgs) formulation comprises about 45-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose 302; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

In another aspect, the present invention provides a bilayer tablet wherein the metformin XR (500 mgs) formulation comprises about 45-50% metformin hydrochloride (HCl), about 4-6% sodium carboxymethyl cellulose, about 30-40% hydroxypropyl methylcellulose 2208, about 0.1-1.5% hydroxypropyl methylcellulose 2910, about 5-15% microcrystalline cellulose, about 0.75-1.25% silicon dioxide or about 0.25%-0.75% colloidal silicon dioxide, and about 0.05-5% magnesium stearate. The SGLT2 inhibitor formulation comprises about 0.5-4% dapagliflozin (S) PGS, about 16% lactose anhydrous, about 74-77% microcrystalline cellulose 302, about 4% crospovidone, about 1.5% silicon dioxide, and about 1% magnesium stearate. The total weight of the SGLT2 inhibitor layer is about 300 mgs to about 400 mgs where the preferred weight is about 300 mgs. The film coating can be Opadry® II.

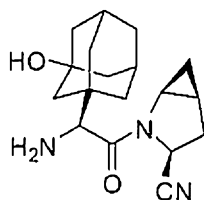
The SGLT2 percentages listed above correspond to the active ingredient. The preferred active ingredient is dapagliflozin or dapagliflozin (S) propylene glycol hydrate. It is to be understood that the above percentages (amount) will be higher for dapagliflozin as the propylene glycol hydrate than as the non-solvate/hydrate.

Different forms of the antidiabetic agent metformin are suitable for use in the formulations of the present invention's bilayer tablets including pharmaceutically acceptable salts thereof such as the hydrochloride, hydrobromide, fumarate, succinate, p-chlorophenoxy acetate or embonate. The fumarate and succinate salts are preferably

metformin (2:1) fumarate, and metformin (2:1) succinate. Metformin hydrochloride is preferred.

Also described herein are coated bilayer tablets wherein the coating comprises saxagliptin or a pharmaceutically acceptable salt thereof. Saxagliptin as the free base, as the monohydrate, or as the hydrochloride is preferred. The coated tablet comprises a tablet core, a first coating, a second coating, and optionally a third coating. The tablet core comprises metformin, preferably metformin hydrochloride. The first and second coating optionally comprises saxagliptin wherein at least one of the first and second coatings comprises saxagliptin. The third coating is an optional outer protective coating.

Saxagliptin, shown below, can be prepared as described in U.S. 6395767, herein incorporated by reference in its entirety for any purpose. The first and second coatings are prepared in a similar manner to the preparation of the inner seal coating layer or the middle (drug) coating layer described in WO 2005/117841, herein incorporated by reference in its entirety for any purpose. The third coating is prepared in a similar manner to the preparation of the outer protective coating layer described in WO 2005/117841.



Saxagliptin

The first coating includes up to 95% of polymer based on the weight of the first coating layer. The formulation will contain at least one coating layer polymer and a coating solvent, preferably the solvent is water used for processing and removed by drying. The first coating layer polymer may be hydroxypropyl methylcellulose, polyvinyl alcohol (PVA), ethyl cellulose, methacrylic polymers or hydroxypropyl cellulose, preferably PVA. The first coating optionally includes saxagliptin within the range from about 0.5 to about 70%, preferably from about 30 to about 50% by weight based on the weight of the second coating layer. The first coating may include: optionally a plasticizer such as triacetin, diethyl phthalate, tributyl sebacate or polyethylene glycol (PEG), preferably PEG; an anti-adherent or glidant such as talc,

fumed silica or magnesium stearate; and an opacifying agent such as titanium dioxide. The coating layer may also include iron oxide based colorants. The coating material is commercially available under the trade name Opadry® HP or Opadry® II white.

The second coating is similar in composition to the first coating and preferably includes saxagliptin.

The third coating is similar in composition to the first coating, only without saxagliptin.

Accordingly, described herein is a coated bilayer tablet that comprises: (1) a bilayer tablet core comprising two layers wherein the first layer comprises metformin; and the second layer comprises an SGLT2 inhibitor; wherein the second layer is about 300 to about 400 mgs; (2) a first coating that coats the bilayer tablet core and optionally comprises saxagliptin; (3) a second coating that coats the first coating and optionally comprises saxagliptin; and (4) optionally a third coating that coats the second coating; wherein at least one of the first coating and the second coating comprises saxagliptin.

Also described herein is a coated bilayer tablet that comprises: (1) a bilayer tablet core wherein the first layer comprises about 64-82% metformin hydrochloride, about 3-5% sodium carboxymethyl cellulose; about 15-30% hydroxypropyl methylcellulose; about 0.1-0.75% magnesium stearate; and about 0-2% silicon dioxide or 0-1.5% colloidal silicon dioxide; and the second layer comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-80% microcrystalline cellulose; about 0-20% pregelatinized starch; about 0-20% mannitol; about 0-15% hydroxypropyl cellulose; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-2% magnesium stearate; wherein the second layer is about 300 to about 400 mgs; (2) the first coating comprises a polyvinyl alcohol based polymer; (3) the second coating comprises saxagliptin and a polyvinyl alcohol based polymer; and (4) the third coating comprises a polyvinyl alcohol based polymer.

In one aspect, the present invention provides a coated bilayer tablet that comprises: (1) a bilayer tablet core wherein the first layer comprises about 67-71% metformin hydrochloride, about 3-5% sodium carboxymethyl cellulose, about 25-29%

hydroxypropyl methylcellulose 2208, and about 0.1-0.75% magnesium stearate; and the second layer comprises:

(A) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose 302; about
5 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(B) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose 302; about 10-22% pregelatinized starch; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide;
10 and about 0.5-1.5% magnesium stearate;

(C) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose 302; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; or

(D) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose 302; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; wherein the second layer is about 300 to about 400 mgs;
15 (2) the first coating comprises Opadry® HP; (3) the second coating comprises saxagliptin and Opadry® HP; and (4) the third coating comprises Opadry® HP.
20

In one aspect, the present invention provides a coated bilayer tablet that comprises: (1) a bilayer tablet core wherein the first layer comprises about 69% metformin hydrochloride, about 3.5% sodium carboxymethyl cellulose, about 27% hydroxypropyl methylcellulose 2208, and about 0.48% magnesium stearate and the
25 second layer comprises:

(A) about 0.8% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 77% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(B) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about
30 16% lactose anhydrous; about 76% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(C) about 3.4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 74% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(D) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate;
5 about 16% lactose anhydrous; about 64% microcrystalline cellulose 302; about 13% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(E) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 57% microcrystalline cellulose 302; about 19%
10 pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(F) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 66% microcrystalline cellulose 302; about 10% hydroxypropyl cellulose EXF; about 4% crospovidone; about 1.5% silicon dioxide; and
15 about 1% magnesium stearate; or

(G) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 61% microcrystalline cellulose 302; about 15% mannitol; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate; wherein the second layer is about 300 to about 400 mgs;

(2) the first coating comprises Opadry® HP; (3) the second coating comprises saxagliptin and Opadry® HP; and (4) the third coating comprises Opadry® HP.
20

In one aspect, the present invention provides a coated bilayer tablet that comprises: (1) a bilayer tablet core wherein the first layer comprises about 72-82% metformin hydrochloride; about 3-5% sodium carboxymethyl cellulose; about 15-22%
25 hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate; the second layer comprises:

(A) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose 302; about
30 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(B) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose 302; about 10-22% pregelatinized starch; about 2-6.00% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

5 (C) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose 302; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; or

(D) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; 10 about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose 302; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; wherein the second layer is about 300 to about 400 mgs;

(2) the first coating comprises Opadry® HP; (3) the second coating comprises saxagliptin and Opadry® HP; and (4) the third coating comprises Opadry® HP.

15 In one aspect, the present invention provides a coated bilayer tablet that comprises: (1) a bilayer tablet core wherein the first layer comprises about 76.6% metformin hydrochloride; about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate; the second 20 layer comprises:

(A) about 0.8% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 77% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(B) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 25 16% lactose anhydrous; about 76% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(C) about 3.4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate, about 16% lactose anhydrous; about 74% microcrystalline cellulose 302; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

30 (D) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 64% microcrystalline cellulose 302; about 13%

pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(E) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 57% microcrystalline cellulose 302; about 19%

5 pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(F) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 66% microcrystalline cellulose 302; about 10%

10 hydroxypropyl cellulose EXF; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate; or

(G) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 61% microcrystalline cellulose 302; about 15% mannitol; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate; wherein the second layer is about 300 to about 400 mgs;

15 (2) the first coating comprises Opadry® HP; (3) the second coating comprises saxagliptin and Opadry® HP; and (4) the third coating comprises Opadry® HP.

Also described herein is a coated tablet that comprises a tablet core coated with a first coating optionally containing saxagliptin, a second coating optionally containing saxagliptin, and an optional third coating. The tablet core comprises metformin where
20 metformin hydrochloride is preferred. At least one of the first and second coatings contains saxagliptin. The first and second coatings are prepared in a similar manner to the preparation of the inner seal coating layer or the middle (drug) coating layer described in WO 2005/117841. The third coating is prepared in a similar manner to the preparation of the outer protective coating layer described in WO 2005/117841.

25 In another aspect, the present invention provides a coated tablet comprising: (1) a tablet core that comprises metformin; (2) a first coating that coats the tablet core and optionally comprises saxagliptin; (3) a second coating that coats the first coating and optionally comprises saxagliptin; and (4) optionally a third coating that coats the second coating; where at least one of the first coating and the second coating comprises
30 saxagliptin.

Also described herein is a coated tablet comprising: (1) a tablet core that comprises about 72-82% metformin hydrochloride; about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate; (2) a first coating that comprises a polyvinyl alcohol based polymer; (3) a second coating that comprises saxagliptin and a polyvinyl alcohol based polymer; and (4) a third coating that comprises a polyvinyl alcohol based polymer.

Also described herein is a coated tablet comprising: (1) a tablet core that comprises about 76.6% metformin hydrochloride; about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate; (2) a first coating that comprises Opadry® HP; (3) a second coating that comprises saxagliptin and Opadry® HP; and (4) a third coating that comprises Opadry® HP.

Also described herein is a coated tablet comprising: (1) a tablet core that comprises about 76.6% metformin hydrochloride; about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 1% silicon dioxide; and about 0.53% magnesium stearate; (2) a first coating that comprises Opadry® HP; (3) a second coating that comprises saxagliptin and Opadry® HP; and (4) a third coating that comprises Opadry® HP.

Also described herein is a coated tablet comprising: (1) a tablet core that comprises about 76.6% metformin hydrochloride; about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 1% silicon dioxide; and about 0.53% magnesium stearate; (2) a first coating that comprises about 2% Opadry® HP; (3) a second coating that comprises about 1.25% saxagliptin and about 10% Opadry® HP; and (4) a third coating that comprises about 2% Opadry® HP.

In another aspect, the present invention provides combination therapies that comprise the bilayer tablet of the present invention in combination with one or more: anti-diabetics; anti-hyperglycemic agents; hypolipidemic/lipid lowering agents; anti-obesity agents; anti-hypertensive agents appetite suppressants; insulin secretagogues, insulin sensitizers, glucokinase activators, glucocorticoid antagonist, fructose 1,6-bis

phosphatase inhibitors, AMP kinase activators, modulators of the incretin pathway such as incretin secretagogues such as GPR119 or GPR40 agonists, incretin mimics such as Byetta, and incretin potentiators, bile acid sequestrants or bile acid receptor agonists such as TGR5 agonists, dopamine receptor agonists such as Cycloset, aldose reductase inhibitors PPAR γ agonists, PPAR α agonists, PPAR δ antagonists or agonists, PPAR α/γ dual agonists, 11- β -HSD-1 inhibitors, dipeptidyl peptidase IV (DPP4) inhibitors other than saxagliptin, SGLT2 inhibitors other than dapagliflozin, glucagon-like peptide-1 (GLP-1), GLP-1 agonists, and PTP-1B inhibitors. Also weight loss agents acting to decreasing food intake such as sibutrimine, CB1 antagonists, 5HT2C agonists, MCHR1 antagonists, and agents which decrease nutrient absorption (such as lipase inhibitors (Orlistat)), and agents which increase energy expenditure such as thyromimetics, or slow GI motility such as amylin mimetics or ghrelin antagonists.

Examples of suitable anti-diabetic agents for use in combination with the formulations of the present invention include, but are not limited to, alpha glucosidase inhibitors (acarbose or miglitol), insulins (including insulin secretagogues or insulin sensitizers), meglitinides (repaglinide), sulfonylureas (glimepiride, glyburide, gliclazide, chlorpropamide and glipizide), biguanide/glyburide combinations (Glucovance[®]), thiazolidinediones (e.g., troglitazone, rosiglitazone and pioglitazone), PPAR-alpha agonists, PPAR-gamma agonists, PPAR alpha/gamma dual agonists, glycogen phosphorylase inhibitors, inhibitors of fatty acid binding protein (aP2), GPR-119 modulators, GPR 40 modulators, glucokinase inhibitors, glucagon-like peptide-1 (GLP-1) and other agonists of the GLP-1 receptor, SGLT2 inhibitors other than dapagliflozin, and dipeptidyl peptidase IV (DPP4) inhibitors other than saxagliptin.

Other suitable thiazolidinediones include, but are not limited to, MCC-555 (disclosed in U.S. Patent No. 5,594,016, Mitsubishi), faraglitazar (GI-262570, Glaxo-Wellcome), englitazone (CP-68722, Pfizer) or darglitazone (CP-86325, Pfizer; isaglitazone, MIT/Johnson & Johnson), reglitazar (JTT-501, (JPNT/Pharmacia & Upjohn), rivoglitazone (R-119702, Sankyo/WL), liraglutide (NN-2344, Dr. Reddy/NN), and (Z)-1,4-bis-4-[(3,5-dioxo-1,2,4-oxadiazolidin-2-yl-methyl)]phenoxybut-2-ene (YM-440, Yamanouchi).

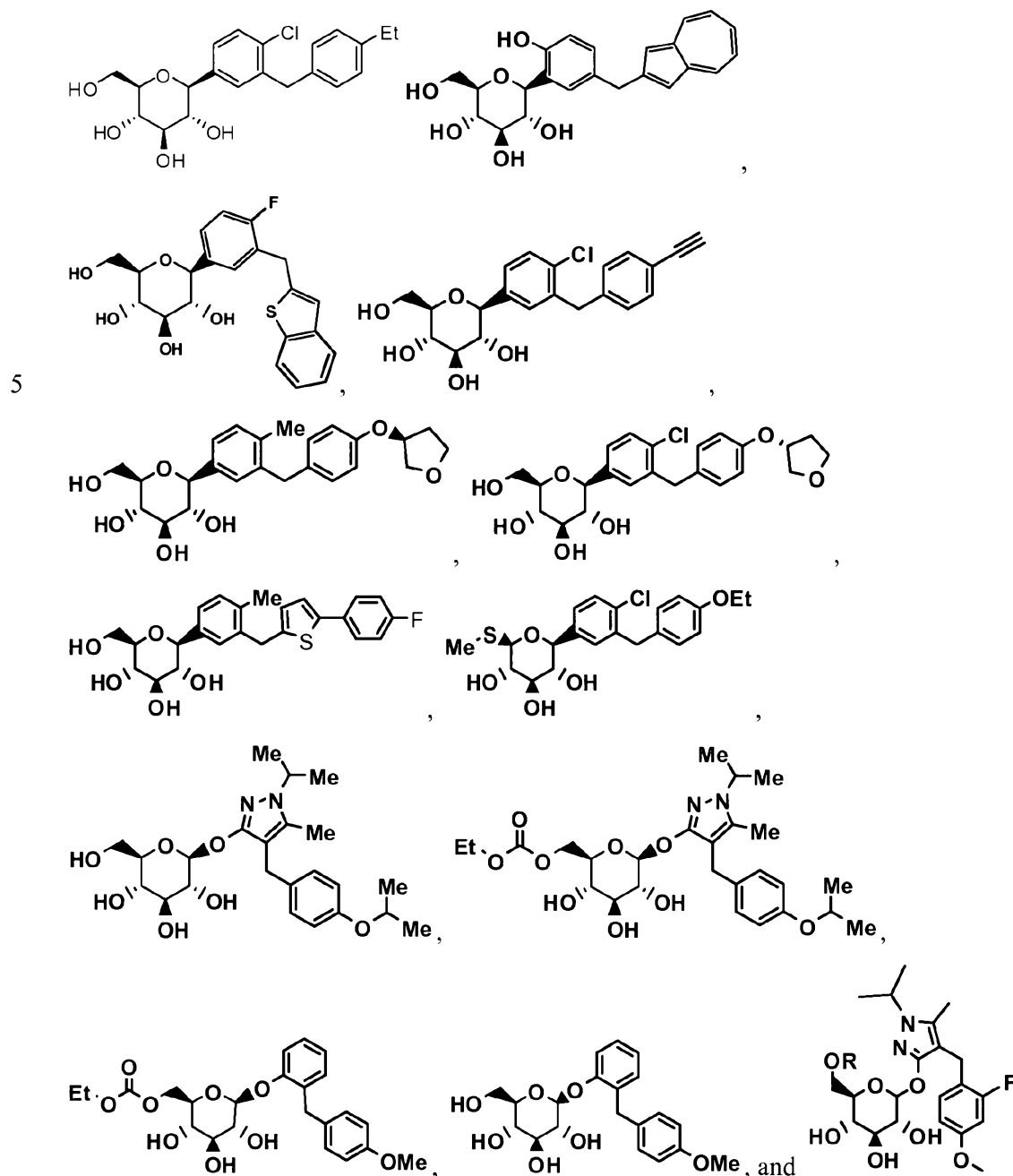
Examples of PPAR-alpha agonists, PPAR-gamma agonists and PPAR alpha/gamma dual agonists include, but are not limited to, muraglitazar, peliglitazar, tesaglitazar AR-HO39242 (Astra/Zeneca), GW-501516 (Glaxo-Wellcome), KRP297 (Kyorin Merck), as well as those disclosed by Murakami et al, "A Novel Insulin Sensitizer Acts As a Coligand for Peroxisome Proliferation – Activated Receptor Alpha (PPAR alpha) and PPAR gamma. Effect on PPAR alpha Activation on Abnormal Lipid Metabolism in Liver of Zucker Fatty Rats", Diabetes 47, 1841-1847 (1998); WO 01/21602 and in U.S. Patent No. 6,414,002 and U.S. Patent No. 6,653,314, the disclosures of which are incorporated herein by reference in their entireties, employing dosages as set out therein. In one embodiment, the compounds designated as preferred in the cited references are preferred for use herein.

Suitable aP2 inhibitors include, but are not limited to, those disclosed in U.S. application Serial No. 09/391,053, filed September 7, 1999, and in U.S. Patent No. 6,548,529, the disclosures of which are incorporated herein by reference in their entireties, employing dosages as set out therein.

Suitable DPP4 inhibitors include, but are not limited to, sitagliptin and vildagliptin, as well as those disclosed in WO99/38501, WO99/46272, WO99/67279 (PROBIODRUG), WO99/67278 (PROBIODRUG), WO99/61431 (PROBIODRUG), NVP-DPP728A (1-[[[2-[(5-cyanopyridin-2-yl)amino]ethyl]amino]acetyl]-2-cyano-(S)-pyrrolidine) (Novartis) as disclosed by Hughes et al, Biochemistry, 38(36), 11597-11603, 1999, TSL-225 (tryptophyl-1,2,3,4-tetrahydroisoquinoline-3-carboxylic acid (disclosed by Yamada et al, Bioorg. & Med. Chem. Lett. 8 (1998) 1537-1540), 2-cyanopyrrolidides and 4- cyanopyrrolidides, as disclosed by Ashworth et al, Bioorg. & Med. Chem. Lett., Vol. 6, No. 22, pp 1163-1166 and 2745-2748 (1996), the compounds disclosed in U.S. application Serial No. 10/899,641, all of which are incorporated herein by reference in their entireties, employing dosages as set out in the above references.

Suitable SGLT2 inhibitors contemplated by the present invention's bilayer coated tablet and combination therapy with the present invention's bilayer tablet include sergliflozin, remogliflozin, remogliflozin etabonate, canagliflozin, BI-10773 and BI-44847, ASP-1941, R-7201, LX-4211, YM-543, AVE 2268, TS-033 or SGL-0100, and the compounds disclosed in US 7,589,193, WO2007007628, EP2009010,

WO200903596, US2009030198, US 7,288,528 and US 2007/0197623, herein incorporated by reference in their entirety for any purpose. The following SGLT2 inhibitors are preferred



Suitable meglitinides include nateglinide (Novartis) or KAD1229 (PF/Kissei).

Examples of suitable anti-hyperglycemic agents for use in combination with the formulations of the present invention include, but are not limited to, glucagon-like

peptide-1 (GLP-1) such as GLP-1(1-36) amide, GLP-1(7-36) amide, GLP-1(7-37) (as disclosed in U.S. Patent No. 5,614,492, incorporated herein by reference in its entirety), as well as exenatide (Amylin/Lilly), LY-315902 (Lilly), MK-0431 (Merck), liraglutide (NovoNordisk), ZP-10 (Zealand Pharmaceuticals A/S), CJC-1131 (Conjuchem Inc), and
5 the compounds disclosed in WO 03/033671, incorporated herein by reference in its entirety.

Examples of suitable hypolipidemic/lipid lowering agents for use in combination with the formulations of the present invention include one or more MTP inhibitors, HMG CoA reductase inhibitors, squalene synthetase inhibitors, fibric acid derivatives, ACAT
10 inhibitors, lipoxygenase inhibitors, cholesterol absorption inhibitors, ileal Na⁺/bile acid co-transporter inhibitors, up-regulators of LDL receptor activity, bile acid sequestrants, cholesterol ester transfer protein (e.g., CETP inhibitors, such as torcetrapib (CP-529414, Pfizer) and JTT-705 (Akros Pharma)), PPAR agonists (as described above) and/or nicotinic acid and derivatives thereof. The hypolipidemic agent can be an up-regulator of
15 LDL2 receptor activity, such as 1(3H)-isobenzofuranone,3-(13-hydroxy-10-oxotetradecyl)-5,7-dimethoxy- (MD-700, Taisho Pharmaceutical Co. Ltd) and cholestan-3-ol,4-(2-propenyl)-(3a,4a,5a)- (LY295427, Eli Lilly). Preferred hypolipidemic agents include pravastatin, lovastatin, simvastatin, atorvastatin, fluvastatin, cerivastatin, atavastatin and rosuvastatin (ZD-4522), for example.

20 Examples of MTP inhibitors that can be employed as described above include, but are not limited to, those disclosed in U.S. Patent No. 5,595,872, U.S. Patent No. 5,739,135, U.S. Patent No. 5,712,279, U.S. Patent No. 5,760,246, U.S. Patent No. 5,827,875, U.S. Patent No. 5,885,983 and U.S. Patent No. 5,962,440, all of which are incorporated herein by reference in their entireties.

25 Examples of HMG CoA reductase inhibitors that can be employed in combination with the formulations of the invention include, but are not limited to, mevastatin and related compounds, as disclosed in U.S. Patent No. 3,983,140, lovastatin (mevinolin) and related compounds, as disclosed in U.S. Patent No. 4,231,938, pravastatin and related compounds, such as disclosed in U.S. Patent No. 4,346,227, simvastatin and related
30 compounds, as disclosed in U.S. Patent Nos. 4,448,784 and 4,450,171. Other suitable HMG CoA reductase inhibitors that can be employed herein include, but are not limited

to, fluvastatin, disclosed in U.S. Patent No. 5,354,772, cerivastatin, as disclosed in U.S. Patent Nos. 5,006,530 and 5,177,080, atorvastatin, as disclosed in U.S. Patent Nos. 4,681,893, 5,273,995, 5,385,929 and 5,686,104, atavastatin (Nissan/Sankyo's nisvastatin (NK-104)), as disclosed in U.S. Patent No. 5,011,930, rosuvastatin (Shionogi-
5 Astra/Zeneca (ZD-4522)), as disclosed in U.S. Patent No. 5,260,440, and related statin compounds disclosed in U.S. Patent No. 5,753,675, pyrazole analogs of mevalonolactone derivatives, as disclosed in U.S. Patent No. 4,613,610, indene analogs of mevalonolactone derivatives, as disclosed in PCT application WO 86/03488, 6-[2-(substituted-pyrrol-1-yl)-alkyl]pyran-2-ones and derivatives thereof, as disclosed in U.S.
10 Patent No. 4,647,576, Searle's SC-45355 (a 3-substituted pentanedioic acid derivative) dichloroacetate, imidazole analogs of mevalonolactone, as disclosed in PCT application WO 86/07054, 3-carboxy-2-hydroxy-propane-phosphonic acid derivatives, as disclosed in French Patent No. 2,596,393, 2,3-disubstituted pyrrole, furan and thiophene derivatives, as disclosed in European Patent Application No. 0221025, naphthyl analogs
15 of mevalonolactone, as disclosed in U.S. Patent No. 4,686,237, octahydronaphthalenes, such as disclosed in U.S. Patent No. 4,499,289, keto analogs of mevinolin (lovastatin), as disclosed in European Patent Application No.0142146 A2, and quinoline and pyridine derivatives, as disclosed in U.S. Patent No. 5,506,219 and 5,691,322. All of the cited references are incorporated herein by reference in their entireties. In addition, phosphinic
20 acid compounds useful in inhibiting HMG CoA reductase, such as those disclosed in GB 2205837, are suitable for use in combination with the formulations of the present invention.

Examples of squalene synthetase inhibitors suitable for use herein include, but are not limited to, α -phosphono-sulfonates disclosed in U.S. Patent No. 5,712,396, those
25 disclosed by Biller et al., J. Med. Chem., 1988, Vol. 31, No. 10, pp. 1869-1871, including isoprenoid (phosphinyl-methyl)phosphonates, as well as other known squalene synthetase inhibitors, for example, as disclosed in U.S. Patent No. 4,871,721 and 4,924,024 and in Biller, S.A., Neucenschwander, K., Ponpipom, M.M., and Poulter, C.D., Current
Pharmaceutical Design, 2, 1-40 (1996). Other squalene synthetase inhibitors suitable for
30 use herein include the terpenoid pyrophosphates disclosed by P. Ortiz de Montellano et al, J. Med. Chem., 1977, 20, 243-249; the farnesyl diphosphate analog A and presqualene

pyrophosphate (PSQ-PP) analogs as disclosed by Corey and Volante, *J. Am. Chem. Soc.*, 1976, 98, 1291-1293; phosphinylphosphonates reported by McClard, R.W. et al, *J.A.C.S.*, 1987, 109, 5544; and cyclopropanes reported by Capson, T.L., PhD dissertation, June, 1987, Dept. Med. Chem. U of Utah, Abstract, Table of Contents, pp
5 16, 17, 40-43, 48-51, Summary. All of the cited references are incorporated herein by reference in their entirety.

Examples of fibric acid derivatives that can be employed in combination the formulations of the invention include, but are not limited to, fenofibrate, gemfibrozil, clofibrate, bezafibrate, ciprofibrate, clinofibrate and the like, probucol, and related
10 compounds, as disclosed in U.S. Patent No. 3,674,836, bile acid sequestrants, such as cholestyramine, colestipol and DEAE-Sephadex (Secholix[®], Policexide[®]), as well as lipostabil (Rhone-Poulenc), Eisai E-5050 (an N-substituted ethanolamine derivative), imanixil (HOE-402), tetrahydrolipstatin (THL), istigmastanylphosphorylcholine (SPC, Roche), aminocyclodextrin (Tanabe Seiyoku), Ajinomoto AJ-814 (azulene derivative),
15 melinamide (Sumitomo), Sandoz 58-035, American Cyanamid CL-277,082 and CL-283,546 (disubstituted urea derivatives), nicotinic acid, acipimox, acifran, neomycin, p-aminosalicylic acid, aspirin, poly(diallylmethylamine) derivatives, such as disclosed in U.S. Patent No. 4,759,923, quaternary amine poly(diallyldimethylammonium chloride) and ionenes, such as disclosed in U.S. Patent No. 4,027,009, and other known serum
20 cholesterol lowering agents. In one embodiment, the fibric acid derivative is probucol or gemfibrozil. All of the cited references are incorporated herein by reference in their entirety.

Examples of ACAT inhibitors that can be employed in combination with the formulations of the invention include, but are not limited to, those disclosed in *Drugs of the Future* 24, 9-15 (1999), (Avasimibe); "The ACAT inhibitor, CI-1011 is effective in the prevention and regression of aortic fatty streak area in hamsters", Nicolosi et al, *Atherosclerosis* (Shannon, Ireland). (1998), 137(1), 77-85; "The pharmacological profile of FCE 27677: a novel ACAT inhibitor with potent hypolipidemic activity mediated by selective suppression of the hepatic secretion of ApoB100-containing lipoprotein",
30 Ghiselli, Giancarlo, *Cardiovasc. Drug Rev.* (1998), 16(1), 16-30; "RP 73163: a bioavailable alkylsulfanyl-diphenylimidazole ACAT inhibitor", Smith, C., et al, *Bioorg.*

Med. Chem. Lett. (1996), 6(1), 47-50; "ACAT inhibitors: physiologic mechanisms for hypolipidemic and anti-atherosclerotic activities in experimental animals", Krause et al, Editor(s): Ruffolo, Robert R., Jr.; Hollinger, Manfred A., Inflammation: Mediators Pathways (1995), 173-98, Publisher: CRC, Boca Raton, Fla.; "ACAT inhibitors: potential
5 anti-atherosclerotic agents", Sliskovic et al, Curr. Med. Chem. (1994), 1(3), 204-25; "Inhibitors of acyl-CoA:cholesterol O-acyl transferase (ACAT) as hypocholesterolemic agents. The first water-soluble ACAT inhibitor with lipid-regulating activity. Inhibitors of acyl-CoA:cholesterol acyltransferase (ACAT). Development of a series of substituted N-phenyl-N'-(1-phenylcyclopentyl)methyl]ureas with enhanced hypocholesterolemic
10 activity", Stout et al, Chemtracts: Org. Chem. (1995), 8(6), 359-62, or TS-962 (Taisho Pharmaceutical Co. Ltd). All of the cited references are incorporated herein by reference in their entireties.

Examples of suitable cholesterol absorption inhibitors for use in combination with the formulations of the invention include, but are not limited to, SCH48461 (Schering-
15 Plough), as well as those disclosed in Atherosclerosis 115, 45-63 (1995) and J. Med. Chem. 41, 973 (1998), incorporated herein by reference in its entirety.

Examples of suitable ileal Na⁺/bile acid co-transporter inhibitors for use in combination with the formulations of the invention include, but are not limited to, compounds as disclosed in Drugs of the Future, 24, 425-430 (1999), incorporated herein
20 by reference in its entirety.

Examples of lipoxygenase inhibitors that can be employed in combination with the formulations of the invention include, but are not limited to, 15-lipoxygenase (15-LO) inhibitors, such as benzimidazole derivatives, as disclosed in WO 97/12615, 15-LO inhibitors, as disclosed in WO 97/12613, isothiazolones, as disclosed in WO 96/38144,
25 and 15-LO inhibitors, as disclosed by Sendobry et al "Attenuation of diet-induced atherosclerosis in rabbits with a highly selective 15-lipoxygenase inhibitor lacking significant antioxidant properties", Brit. J. Pharmacology (1997) 120, 1199-1206, and Cornicelli et al., "15-Lipoxygenase and its Inhibition: A Novel Therapeutic Target for Vascular Disease", Current Pharmaceutical Design, 1999, 5, 11-20. All of the cited
30 references are incorporated herein by reference in their entireties.

Examples of suitable anti-hypertensive agents for use in combination with the formulations of the present invention include, but are not limited to, beta adrenergic blockers, calcium channel blockers (L-type and T-type; e.g. diltiazem, verapamil, nifedipine, amlodipine and mybefradil), diuretics (e.g., chlorothiazide, hydrochlorothiazide, flumethiazide, hydroflumethiazide, bendroflumethiazide, methylchlorothiazide, trichloromethiazide, polythiazide, benzthiazide, ethacrynic acid, triacrynafen, chlorthalidone, furosemide, musolimine, bumetanide, triamtrenene, amiloride, spironolactone), renin inhibitors, ACE inhibitors (e.g., captopril, zofenopril, fosinopril, enalapril, ceranopril, cilazopril, delapril, pentopril, quinapril, ramipril, lisinopril), AT-1 receptor antagonists (e.g., losartan, irbesartan, valsartan), ET receptor antagonists (e.g., sitaxsentan, atrsentan and compounds disclosed in U.S. Patent Nos. 5,612,359 and 6,043,265), Dual ET/AII antagonist (e.g., compounds disclosed in WO 00/01389), neutral endopeptidase (NEP) inhibitors, vasopepsidase inhibitors (dual NEP-ACE inhibitors) (e.g., omapatrilat and gemopatrilat), and nitrates. All of the cited references are incorporated herein by reference in their entireties.

Examples of suitable anti-obesity agents for use in combination with the formulations of the present invention include, but are not limited to, beta 3 adrenergic agonists, lipase inhibitors, serotonin (and dopamine) reuptake inhibitors, thyroid receptor beta drugs, 5HT2C agonists, (such as Arena APD-356); MCHR1 antagonists, such as Synaptic SNAP-7941 and Takeda T-226926, melanocortin receptor (MC4R) agonists, melanin-concentrating hormone receptor (MCHR) antagonists (such as Synaptic SNAP-7941 and Takeda T-226926), galanin receptor modulators, orexin antagonists, CCK agonists, NPY1 or NPY5 antagonist, NPY2 and NPY4 modulators, corticotropin releasing factor agonists, histamine receptor-3 (H3) modulators, 11-beta-HSD-1 inhibitors, adinopectin receptor modulators, monoamine reuptake inhibitors or releasing agents, ciliary neurotrophic factors (CNTF, such as AXOKINE[®] by Regeneron), BDNF (brain-derived neurotrophic factor), leptin and leptin receptor modulators, cannabinoid-1 receptor antagonists (such as SR-141716 (Sanofi) or SLV-319 (Solvay)), and anorectic agents.

Beta 3 adrenergic agonists that can be optionally employed in combination with formulations of the present invention include, but are not limited to, AJ9677

(Takeda/Dainippon), L750355 (Merck), CP331648 (Pfizer,) or other known beta 3 agonists, as disclosed in U.S. Patent Nos. 5,541,204, 5,770,615, 5,491,134, 5,776,983 and 5,488,064, all of which are incorporated herein by reference in their entireties.

5 Examples of lipase inhibitors that can be employed in combination with formulations of the present invention include, but are not limited to, orlistat and ATL-962 (Alizyme).

10 Serotonin (and dopamine) reuptake inhibitors (or serotonin receptor agonists) that can be employed in combination with the formulations of the present invention include, but are not limited to, BVT-933 (Biovitrum), sibutramine, topiramate (Johnson & Johnson) and axokine (Regeneron).

15 Examples of thyroid receptor beta compounds that can be employed in combination with formulations of the present invention include, but are not limited to, thyroid receptor ligands, such as those disclosed in WO 97/21993 (U. Cal SF), WO 99/00353 (KaroBio) and WO 00/039077 (KaroBio), incorporated herein by reference in their entireties.

20 Examples of monoamine reuptake inhibitors that can be employed in combination with the formulations of the present invention include, but are not limited to, fenfluramine, dexfenfluramine, fluvoxamine, fluoxetine, paroxetine, sertraline, chlorphentermine, cloforex, clortermine, picilorex, sibutramine, dexamphetamine, phentermine, phenylpropanolamine and mazindol.

Anorectic agents that can be employed in combination with the formulations of the present invention include, but are not limited to, topiramate (Johnson & Johnson), dexamphetamine, phentermine, phenylpropanolamine and mazindol.

25 The aforementioned patents and patent applications are incorporated herein by reference.

30 Where any of the formulations of the invention are used in combination with other therapeutic agent(s), the other therapeutic agent(s) can be used, for example, in the amounts indicated in the Physician's Desk Reference, as in the cited patents and patent applications set out above, or as otherwise known and used by one of ordinary skill in the art.

Also described herein is a bilayer tablet that comprises (1) a reduced mass metformin formulation; (2) a formulation with canagliflozin; and (3) optionally a coating. Accordingly, in one aspect, the present invention provides a bilayer tablet wherein (1) the first layer comprises about 72-82% metformin hydrochloride; about 3-5% sodium carboxymethyl cellulose; about 15-22% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate; (2) the second layer comprises canagliflozin; and (3) the optional coating comprises Opadry® II.

Also described herein is a bilayer tablet wherein (1) the first layer comprises about 76.6% metformin hydrochloride; about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate; (2) the second layer comprises canagliflozin; and (3) the optional coating comprises Opadry® II.

Also described herein is a bilayer tablet wherein (1) the first layer comprises about 76.6% metformin hydrochloride; about 3.84% sodium carboxymethyl cellulose; about 18% hydroxypropyl methylcellulose 2208; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.53% magnesium stearate; (2) the second layer comprises canagliflozin; and (3) the optional coating comprises Opadry® II.

Examples of bulking agents or fillers suitable for use herein include, but are not limited to, cellulose derivatives, such as microcrystalline cellulose or wood cellulose (including microcrystalline cellulose 302), lactose, lactose anhydrous, sucrose, starch, pregelatinized starch, dextrose, mannitol (including mannitol Pearlitol SD 200), fructose, xylitol, sorbitol, corn starch, modified corn starch, inorganic salts such as calcium carbonate, calcium phosphate, dicalcium phosphate, calcium sulfate, dextrin/dextrates, maltodextrin, compressible sugars, and other known bulking agents or fillers, and/or mixtures of two or more thereof. Several types of microcrystalline cellulose are suitable for use in the formulations described herein, for example, microcrystalline cellulose selected from the group consisting of Avicel® types: PH101, PH102, PH103, PH105, PH 112, PH113, PH200, PH301, and other types of microcrystalline cellulose, such as

silicified microcrystalline cellulose. Several types of lactose are suitable for use in the formulations described herein, for example, lactose selected from the group consisting of anhydrous lactose, lactose monohydrate, lactose fast flo, directly compressible anhydrous lactose, and modified lactose monohydrate.

5 Examples of binders suitable for use herein include, but are not limited to, carboxymethyl cellulose (including sodium carboxymethyl cellulose), hydroxypropyl cellulose (including hydroxypropyl cellulose EXF), corn starch, pregelatinized starch, modified corn starch, polyvinyl pyrrolidone (PVP), hydroxypropyl methylcellulose (HPMC) (including hydroxypropyl methylcellulose 2208), lactose, gum acacia, ethyl
10 cellulose, cellulose acetate, as well as a wax binder such as carnauba wax, paraffin, spermaceti, polyethylenes or microcrystalline wax, as well as other conventional binding agents and/or mixtures of two or more thereof.

 Examples of disintegrants suitable for use herein include, but are not limited to, croscarmellose sodium, crospovidone, starch, potato starch, pregelatinized starch, corn
15 starch, sodium starch glycolate, microcrystalline cellulose, low substituted hydroxypropyl cellulose and other known disintegrants. Several specific types of disintegrant are suitable for use in the formulations described herein. For example, any grade of crospovidone can be used, including for example crospovidone XL-10, and includes members selected from the group consisting of Kollidon CL[®], Polyplasdone XL[®],
20 Kollidon CL-M[®], Polyplasdone XL-10[®], and Polyplasdone INF-10[®]. In one embodiment, the disintegrant, if present, of the stock granulation is sodium starch glycolate, croscarmellose sodium and/or crospovidone.

 Examples of lubricants suitable for use herein include, but are not limited to, magnesium stearate, zinc stearate, calcium stearate, talc, carnauba wax, stearic acid,
25 palmitic acid, sodium stearyl fumarate sodium laurel sulfate, glyceryl palmitostearate, palmitic acid, myristic acid and hydrogenated vegetable oils and fats, as well as other known lubricants, and/or mixtures of two or more thereof.

 Examples of glidants and/or anti-adherents suitable for use herein include but are not limited to, silicon dioxide, colloidal silicon dioxide, magnesium silicate, magnesium
30 trisilicate, talc, and other forms of silicon dioxide, such as aggregated silicates and hydrated silica.

Examples of suitable release modifiers include, but are not limited to, hydroxypropyl methylcellulose, polyvinyl alcohol (PVA), ethyl cellulose, methacrylic polymers, hydroxypropyl cellulose, starches, gums, cellulose ethers, protein derived materials, nylon, acrylic resins, polylactic acid, polyvinylchloride, polyvinylpyrrolidones, and cellulose acetate phthalate.

Described herein are methods of treating diseases or disorders associated with SGLT2 activity comprising administering to a mammal, preferably a human, in need of such treatment a therapeutically effective amount of a bilayer tablet comprising a metformin XR formulation or a reduced mass metformin XR formulation, an SGLT2 inhibitor formulation, and optionally a film coating. The bilayer tablets of the present invention, as described herein, can be administered to mammals, preferably humans, for treating diabetes (including type I and type II diabetes), impaired glucose tolerance, insulin resistance, and diabetic complications, such as nephropathy, retinopathy, neuropathy and cataracts, hyperglycemia, hyperinsulinemia, hypercholesterolemia, dyslipidemia, elevated blood levels of free fatty acids or glycerol, hyperlipidemia, hypertriglyceridemia, obesity, wound healing, tissue ischemia, atherosclerosis and hypertension. In a preferred embodiment, the bilayer tablet formulations of the present invention are administered to humans for treating type II diabetes.

Also described herein is a use of a bilayer tablet comprising a metformin XR formulation or a reduced mass metformin XR formulation, an SGLT2 inhibitor formulation, and optionally a film coating for preparing, or for the manufacture of, a medicament for treating diabetes (including type I and type II diabetes), impaired glucose tolerance, insulin resistance, and diabetic complications, such as nephropathy, retinopathy, neuropathy and cataracts, hyperglycemia, hyperinsulinemia, hypercholesterolemia, dyslipidemia, elevated blood levels of free fatty acids or glycerol, hyperlipidemia, hypertriglyceridemia, obesity, wound healing, tissue ischemia, atherosclerosis and hypertension.

Definitions

The term "about" as used herein means a deviation within 10%, more preferably within 5%, and even more preferably, within 2% of the numbers reported.

The term "dapagliflozin" as used herein means the compound of Example 1 and includes pharmaceutically acceptable salts thereof.

5 The term "dapagliflozin (S) PGS" as used herein means the compound of Example 2 dapagliflozin (S) propylene glycol hydrate (1:1:1).

The term "dapagliflozin (R) PGS" as used herein means the compound of Example 3 dapagliflozin (R) propylene glycol hydrate (1:1:1).

10 The term "metformin extended release" or "metformin XR" as used herein, refers to an amount of metformin HCl that is present in a dosage form that allows for oral controlled release delivery that functions by releasing the payload of drug (metformin HCl) over an extended period of time following administration, while maintaining the desired plasma levels of drug.

15 The term "Opadry® II" as used here means a film coating for a tablet, including a bilayer tablet, that comprises polyvinyl alcohol, titanium dioxide, polyethylene glycol (PEG), and talc. Opadry® II white 85F18422 is comprised of polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc. Opadry® II Yellow 85F92582 is comprised of polyvinyl alcohol, titanium dioxide, polyethylene glycol, talc, and yellow iron dioxide.

20 The term "Opadry® HP " as used here means a film coating for a tablet that comprises 40% polyvinyl alcohol, 20% polyethylene glycol, 15% talc, and 25% titanium dioxide.

Human Studies

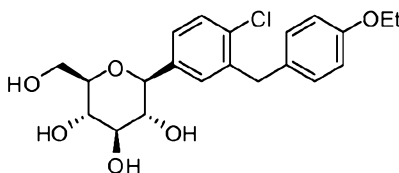
25 In a 24-week phase 3 clinical study, the combination of metformin and dapagliflozin, an SGLT2 inhibitor, reduced glycosylated hemoglobin levels (HbA1c) and fasting plasma glucose (FPG) levels in type II diabetic patients. Glycosylated hemoglobin and fasting plasma glucose levels were inadequately controlled with metformin alone, as compared to placebo plus metformin. The study also showed that
30 individuals receiving dapagliflozin had statistically greater mean reductions in body weight compared to individuals taking placebo.

The study was designed to assess the efficacy and safety of dapagliflozin as an add-on to metformin over 24 weeks in patients with inadequately controlled type 2 diabetes. The data represent findings from a randomized, double-blind, placebo-controlled study of 546 individuals with type 2 diabetes whose HbA1c was greater than or equal to 7.0 percent and less than or equal to 10 percent at baseline. After a two-week lead-in phase, individuals were randomized to one of four separate treatment arms: dapagliflozin 2.5 mg (n= 137), dapagliflozin 5 mg (n= 137), dapagliflozin 10 mg (n= 135), or placebo (n= 137). Patients in all arms also received metformin (greater than or equal to 1500 mg/d). The primary endpoint of the study compared mean HbA1c change from baseline for each dapagliflozin treatment arm compared to placebo after 24 weeks. Secondary endpoints included change from baseline in FPG and body weight at week 24 as compared to placebo, and adjusted percentage of individuals treated with dapagliflozin who achieved HbA1c of less than 7 percent at 24 weeks. Exploratory endpoints included body weight decrease of greater than or equal to 5 percent or greater than or equal to 10 percent as well as body weight percent change from baseline.

After 24 weeks, individuals receiving dapagliflozin 2.5 mg, 5 mg and 10 mg plus metformin demonstrated a statistically significant adjusted mean change in HbA1c from baseline of -0.67 percent, -0.70 percent and -0.84 percent, respectively, compared to -0.30 percent for placebo. Individuals treated with dapagliflozin demonstrated a statistically significant adjusted mean change in FPG, a secondary endpoint, from baseline at Week 24: -17.8 mg/dL for dapagliflozin 2.5 mg -21.5 mg/dL for dapagliflozin 5 mg and -23.5 mg/dL /dl for dapagliflozin 10 mg, compared to -6.0 mg/dL for placebo.

The study also evaluated the potential impact of dapagliflozin on weight loss. These findings included data measuring changes in total body weight over the 24-week study period. At 24 weeks, the change in total body weight in kg, a secondary endpoint, was -2.21 kg for dapagliflozin 2.5 mg, -3.04 kg for dapagliflozin 5 mg and -2.86 kg for dapagliflozin 10 mg, compared to -0.89 kg for placebo. Overall, more patients taking dapagliflozin achieved weight losses greater than or equal to 5 percent compared to placebo, an exploratory endpoint.

These results indicate that the combination of an SGLT2 inhibitor, in particular dapagliflozin or dapagliflozin (S) propylene glycol hydrate, with metformin effectively treats hyperglycemia in type II diabetic patients without inducing weight gain.



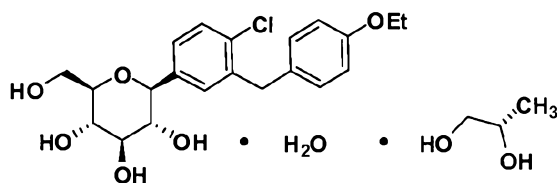
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Example 1

Dapagliflozin - (2S,3R,4R,5S,6R)-2-(4-chloro-3-(4-ethoxybenzyl)phenyl)-6-(hydroxymethyl)tetrahydro-2H-pyran-3,4,5-triol

Dapagliflozin can be prepared using similar procedures as described in U.S.

10 Patent No. 6,515,117 or international published applications no. WO 03/099836 and WO 2008/116179, the disclosures of which are herein incorporated by reference in their entirety for any purpose. SGLT2 EC_{50} = 1.1 nM.

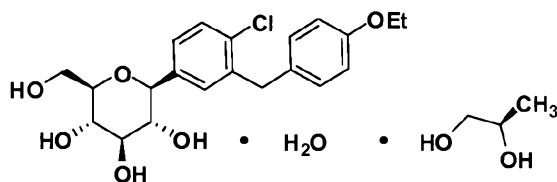


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Example 2

Dapagliflozin (S) PGS - (2S,3R,4R,5S,6R)-2-(4-chloro-3-(4-ethoxybenzyl)phenyl)-6-(hydroxymethyl)tetrahydro-2H-pyran-3,4,5-triol (S)-propane-1,2-diol hydrate (1:1:1)

20 Dapagliflozin (S) propylene glycol hydrate (1:1:1) can be prepared using similar procedures as described in published applications WO 08/002824 and WO 2008/116179, the disclosures of which are herein incorporated by reference in their entirety for any purpose. SGLT2 EC_{50} = 1.1 nM.



Example 3

Dapagliflozin (R) PGS -(2S,3R,4R,5S,6R)-2-(4-chloro-3-(4-ethoxybenzyl)phenyl)-6-(hydroxymethyl)tetrahydro-2H-pyran-3,4,5-triol
(R)-propane-1,2-diol hydrate (1:1:1)

Dapagliflozin (R) propylene glycol hydrate (1:1:1) can be prepared using similar procedures as described in WO 08/002824 and WO 2008/116179, the disclosures of which are herein incorporated by reference in their entirety for any purpose. SGLT2 $EC_{50} = 1.1$ nM.

Example 4

Bilayer tablets containing metformin (1000 mgs) extended release formulation and dapagliflozin (S) PGS (5.00 mgs) immediate release formulation were prepared as described below.

	<u>First Layer</u>	<u>% w/w</u>	<u>amount (mg)</u>
	Metformin HCl	68.97	1000
	Sodium Carboxymethyl Cellulose	3.45	50.01
	Purified water or water for injection	-	q.s. ^(a)
	Hydroxypropyl Methylcellulose 2208	27.10	393
	Magnesium Stearate	0.48	7.00
	Total Metformin XR	100	1450
	<u>Second Layer</u>		
	Dapagliflozin	1.67	5.00
	Lactose Anhydrous	16.00	48.00
	Microcrystalline Cellulose 302	75.83	227.5
	Crospovidone	4.00	12.00
	Silicon Dioxide	1.50	4.50
	Magnesium Stearate	1.00	3.00
	Total Dapagliflozin IR	100	300
	Total Core Bilayer		1750

Film Coat

Opadry® II (2.5% weight gain)	43.75
Total Film Coated Tablet	1793.75

5 Metformin Granulation (1000 mgs)

Metformin HCl, 0.5% magnesium stearate, and sodium carboxymethyl cellulose were combined and mixed into a high shear granulator for one minute. Purified water, using a nozzle, was added with stirring for one minute. The wet granulated material was passed through a mill and then dried until the moisture content was 1.0% or less. The dried material containing metformin HCl, 0.5% magnesium stearate, and sodium carboxymethyl cellulose was passed through a mill and discharge into polyethylene-lined drums to provide milled metformin 1g bulk granulation.

Hydroxypropyl methylcellulose 2208 USP (100,000 centipoise) (methocel K100M Premium) was added to a bin blender and mixed for 60 revolutions. The material was passed through a mill and discharge to provide milled hydroxypropyl methylcellulose 2208 USP.

Metformin (milled 1g bulk granulation), hydroxypropyl methylcellulose 2208 USP (milled), hydroxypropyl methylcellulose 2208 USP (unmilled), and magnesium stearate were added to a bin blender and mixed for 60 revolutions. The mixed material was discharge into polyethylene-lined drums to provide metformin extended release 1g bulk granulation.

Dapagliflozin Granulation (2.5, 5.0, 10.0 mgs)

Dapagliflozin (S) PGS was blended with microcrystalline cellulose, anhydrous lactose, a portion of crospovidone, and a portion of silicon dioxide in a suitable tumble mixer and passed through a suitable conical mill. A portion of magnesium stearate (screened) was blended into the mixture and then compacted using an appropriate roller compactor. The compacted mixture was reduced to form granules. The granules were blended with the remaining amount of crospovidone and silicon dioxide in a suitable tumble mixer. The granules were then blended with the remaining amount of magnesium stearate in a suitable tumble mixer.

Bilayer compression

A bilayer tablet press was with either the metformin XR formulation or the reduced mass metformin XR formulation in the first hopper and the SGLT2 inhibitor formulation that is dapagliflozin (S) PGS granulation (2.5 mg, 5 mg or 10 mg strength) in the second hopper. The tablet press was set to obtain the target weight for the first layer (metformin XR or reduced mass metformin XR). The second hopper was opened and the tablet press was adjusted to obtain the target tablet weight of dapagliflozin and metformin XR or dapagliflozin and reduced mass metformin XR bilayer tablets. Once the target weight was obtained the press was adjusted to obtain the target hardness. Once the hardness was obtained, the manufactured tablets were periodically monitored regarding the weight of the first layer, and the weight, hardness, gauge and friability of the whole tablet. The collect bilayer tablets were film coated with Opadry® II PVA (polyvinyl alcohol).

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Example 5

Bilayer tablets containing metformin (1000 mgs) extended release formulation and dapagliflozin (S) PGS (2.5 mgs) immediate release formulation were prepared in a similar manner as described in Example 4.

	<u>First Layer</u>	<u>% w/w</u>	<u>amount (mg)</u>
20	Metformin HCl	68.97	1000
	Sodium Carboxymethyl Cellulose	3.45	5001
	Purified water or water for injection	-	q.s. ^(a)
	Hydroxypropyl Methylcellulose 2208	27.10	393
	Magnesium Stearate	0.48	7
25	Total Metformin XR	100	1450
	<u>Second Layer</u>		
	Dapagliflozin	0.83	2.50
	Lactose Anhydrous	16.00	48.00
30	Microcrystalline Cellulose 302	76.67	230.00
	Crospovidone	4.00	12.00
	Silicon Dioxide	1.50	4.50
	Magnesium Stearate	1.00	3.00
	Total Dapagliflozin IR	100	300
35	Total Core Bilayer		1750

Example 6

Bilayer tablets containing metformin (1000 mgs) extended release formulation and dapagliflozin (S) PGS (10.00 mgs) immediate release formulation were prepared in a similar manner as described in Example 4.

	<u>First Layer</u>	<u>% w/w</u>	<u>amount (mg)</u>
	Metformin HCl	68.97	1000
	Sodium Carboxymethyl Cellulose	3.45	50.01
	Purified water or water for injection	-	q.s. ^(a)
10	Hydroxypropyl Methylcellulose 2208	27.10	393
	Magnesium Stearate	0.48	7
	Total Metformin XR	100	1450
	<u>Second Layer</u>		
15	Dapagliflozin	3.33	10.00
	Lactose Anhydrous	16.00	48.00
	Microcrystalline Cellulose 302	74.17	222.50
	Crospovidone	4.00	12.00
	Silicon Dioxide	1.50	4.50
20	Magnesium Stearate	1.00	3.00
	Total Dapagliflozin IR	100	300
	Total Core Bilayer		1750

25 **Example 7**

Bilayer tablets containing reduced mass metformin (1000 mgs) extended release formulation and dapagliflozin (S) PGS (5.00 mgs) immediate release formulation were prepared as described below.

	<u>First Layer</u>	<u>% w/w</u>	<u>amount (mg)</u>
30	Metformin HCl	76.62	1000
	Sodium Carboxymethyl Cellulose	3.84	50.01
	Purified water or water for injection	-	q.s. ^(a)
	Hydroxypropyl Methylcellulose 2208	18.01 ^(b)	235
	Silicon Dioxide	1.00 ^(c)	13
35	Magnesium Stearate	0.53	7
	Total Metformin XR	100	1305

Second Layer

	Dapagliflozin	1.67	5
	Lactose Anhydrous	16	48
	Microcrystalline Cellulose 302	75.83	227.5
5	Croscopvidone	4	12
	Silicon Dioxide	1.5	4.5
	Magnesium Stearate	1	3
	Total Dapagliflozin IR	100	300
	Total Core Bilayer		1605
10	<u>Film Coat</u>		
	Opadry® II (2.5% weight gain)		40.13
	Total Film Coated Tablet		1645.13

(a) refers to the quantity sufficient to make the granulation composition 100% w/w

(b) The range is 15% - 27%

15 (c) The range is 0.75% - 1.25%

Metformin HCl, 0.5% magnesium stearate, and sodium carboxymethyl cellulose were combined and mixed into a high shear granulator for one minute. Purified water, using a nozzle, was added with stirring for one minute. The wet granulated material was passed through a mill and then dried until the moisture content was 1.0% or less. The dried material containing metformin HCl, 0.5% magnesium stearate, and sodium carboxymethyl cellulose was passed through a mill and discharge into polyethylene-lined drums to provide milled metformin 1g bulk granulation.

Metformin (milled 1g bulk granulation), hydroxypropyl methylcellulose 2208 USP (100,000 centipoise) (methocel K100M Premium), and silicon dioxide were added to a bin blender and mixed for 120 revolutions. Magnesium stearate was added, and after 60 revolutions, the material was discharge into polyethylene-lined drums to provide reduced mass metformin extended release 1g bulk granulation.

The dapagliflozin (S) PGS granulation and the bilayer compression procedures were conducted as described in Example 4.

Example 8

Bilayer tablets containing a reduced mass metformin (1000 mg) extended release formulation and dapagliflozin (S) PGS (2.5 mg) immediate release formulation were prepared in a similar manner as described in Example 7.

	<u>First Layer</u>	<u>% w/w</u>	<u>amount (mg)</u>
	Metformin HCl	76.62	1000
	Sodium Carboxymethyl Cellulose	3.84	50.01
	Purified water or water for injection	-	q.s. ^(a)
5	Hydroxypropyl Methylcellulose 2208	18.01 ^(b)	235
	Silicon Dioxide	1.00 ^(c)	13
	Magnesium Stearate	0.53	7
	Total Metformin XR	100	1305
10	<u>Second Layer</u>		
	Dapagliflozin	0.83	2.50
	Lactose Anhydrous	16.00	48.00
	Microcrystalline Cellulose 302	76.67	230.00
	Crospovidone	4.00	12.00
15	Silicon Dioxide	1.50	4.50
	Magnesium Stearate	1.00	3.00
	Total Dapagliflozin IR	100	300
	Total Core Bilayer		1605

20 Example 9

Bilayer tablets containing a reduced mass metformin (1000 mgs) extended release formulation and dapagliflozin (S) PGS (10.00 mgs) immediate release formulation were prepared in a similar manner as described in Example 7.

	<u>First Layer</u>	<u>% w/w</u>	<u>amount (mg)</u>
25	Metformin HCl	76.62	1000
	Sodium Carboxymethyl Cellulose	3.84	50.01
	Purified water or water for injection	-	q.s. ^(a)
	Hydroxypropyl Methylcellulose 2208	18.01 ^(b)	235
	Silicon Dioxide	1.00 ^(c)	13
30	Magnesium Stearate	0.53	7
	Total Metformin XR	100	1305
	<u>Second Layer</u>		
	Dapagliflozin	0.83	2.50
35	Lactose Anhydrous	16.00	48.00
	Microcrystalline Cellulose 302	76.67	230.00
	Crospovidone	4.00	12.00
	Silicon Dioxide	1.50	4.50
	Magnesium Stearate	1.00	3.00
40	Total Dapagliflozin IR	100	300

Total Core Bilayer**1605**

Other SGLT2 inhibitor IR formulations, described in Table 2, can be used to prepare bilayer tablets of the present invention. The Table 2 formulations are compatible with the metformin XR formulations or reduced mass metformin XR formulations described herein. The bilayer tablets prepared from the SGLT2 inhibitor IR formulations of Table 2 reduced or eliminated cracking, separation, and/or cross-contamination with the metformin XR layer and with the reduced mass metformin XR layer.

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Table 2

	% w/w	% w/w	% w/w	% w/w	% w/w
Dapagliflozin (S) PGS	1.66	1.66	1.66	1.66	1.66
Microcrystalline Cellulose 302	59.83	63.83	56.83	65.83	60.83
Lactose Anhydrous	16.00	16.00	16.00	16.00	16.00
Pregelatinized Starch	16.00	13.00	19.00	-	-
Hydroxypropyl Cellulose EXF	-	-	-	10.00	-
Mannitol	-	-	-	-	15.00
Crospovidone	4.00	4.00	4.00	4.00	4.00
Silicon Dioxide	1.50	1.50	1.50	1.50	1.50
Magnesium stearate	1.00	1.00	1.00	1.00	1.00

Example 10

Bilayer tablets containing metformin (500 mgs) extended release formulation and dapagliflozin (S) PGS (5.00 mgs) immediate release formulation were prepared in a similar manner as described in Example 13 except that silicon dioxide was not added to the metformin layer.

Component	Function	% w/w per layer	Amount per layer (mg)
Metformin HCl XR Layer (1st Layer)			
Metformin hydrochloride	Active	48.85	500.00
Sodium carboxymethyl cellulose	Binder	4.89	50.03

Purified water or water for injection	Granulating fluid	-	q.s. ⁽¹⁾
Hydroxypropyl methylcellulose 2208	Release modifier	34.98	357.98
Hydroxypropyl methylcellulose 2910	Release modifier	0.97	9.92
Microcrystalline cellulose	Filler	9.97	102.03
Magnesium stearate	Lubricant	0.34	3.53
Total metformin HCl XR Layer		100.00	1023.49
Dapagliflozin Layer (2nd Layer)			
Dapagliflozin	Active	1.67	5.00
Lactose anhydrous	Filler	16.00	48.00
Microcrystalline cellulose 302	Filler	75.83	227.50
Crospovidone	Disintegrant	4.00	12.00
Silicon dioxide	Glidant	1.50 ²	4.50
Magnesium stearate	Lubricant	1.00	3.00
Total dapagliflozin Layer	-	100.00	300.00
Total core bilayer	-	-	1323.49
Film coat component Opadry® II (2.5% weight gain)	Coating material	-	33.09
Total film coated tablet	-	-	1356.58

¹ Purified water is used only for processing and is removed during drying

² The range is 0.5% - 1.5%

Example 11

- 5 Bilayer tablets containing metformin (500 mgs) extended release formulation and dapagliflozin (S) PGS (10.0 mgs) immediate release formulation were prepared in a similar manner as described in Example 13 except that silicon dioxide was not added to the metformin layer.

Component	Function	% w/w per layer	Amount per layer (mg)
Metformin XR Layer (1st Layer)			
Metformin hydrochloride	Active	48.85	500.00

Sodium carboxymethyl cellulose	Binder	4.89	50.03
Purified water or water for injection	Granulating fluid	-	q.s. ⁽¹⁾
Hydroxypropyl methylcellulose 2208	Release modifier	34.98	357.98
Hydroxypropyl methylcellulose 2910	Release modifier	0.97	9.92
Microcrystalline cellulose	Filler	9.97	102.03
Magnesium stearate	Lubricant	0.34	3.53
Total metformin XR Layer		100.00	1023.49
Dapagliflozin Layer (2nd Layer)			
Dapagliflozin	Active	3.33	10.00
Lactose anhydrous	Filler	16.00	48.00
Microcrystalline cellulose 302	Filler	74.17	222.50
Crospovidone	Disintegrant	4.00	12.00
Silicon dioxide	Glidant	1.50 ⁽²⁾	4.50
Magnesium stearate	Lubricant	1.00	3.00
Total dapagliflozin Layer	-	100.00	300.00
Total core bilayer	-	-	1323.49
Film coat component Opadry® II (2.5% weight gain)	Coating material	-	33.09
Total film coated tablet	-	-	1356.58

¹ Purified water is used only for processing and is removed during drying

² The range is 0.5% - 1.5%

Example 12

5 Bilayer tablets containing metformin (500 mgs) extended release formulation and dapagliflozin (S) PGS (2.50 mgs) immediate release formulation were prepared in a similar manner as described in Example 13 except that silicon dioxide was not added to the metformin layer.

Component	Function	% w/w per layer	Amount per layer (mg)
Metformin XR Layer (1st Layer)			

Metformin hydrochloride	Active	48.85	500.00
Sodium carboxymethyl cellulose	Binder	4.89	50.03
Purified water or water for injection	Granulating fluid	-	q.s. ⁽¹⁾
Hydroxypropyl methylcellulose 2208	Release modifier	34.98	357.98
Hydroxypropyl methylcellulose 2910	Release modifier	0.97	9.92
Microcrystalline cellulose	Filler	9.97	102.03
Magnesium stearate	Lubricant	0.34	3.53
Total metformin XR Layer		100.00	1023.49
Dapagliflozin Layer (2nd Layer)			
Dapagliflozin	Active	0.83	2.50
Lactose anhydrous	Filler	16.00	48.00
Microcrystalline cellulose 302	Filler	76.67	230.00
Crospovidone	Disintegrant	4.00	12.00
Silicon dioxide	Glidant	1.50 ⁽²⁾	4.50
Magnesium stearate	Lubricant	1.00	3.00
Total dapagliflozin Layer	-	100.00	300.00
Total core bilayer	-	-	1323.49
Film coat component Opadry® II (2.5% weight gain)	Coating material	-	33.09
Total film coated tablet	-	-	1356.58

¹ Purified water is used only for processing and is removed during drying

² The range is 0.5% - 1.5%

Example 13

- 5 Bilayer tablets containing metformin (500 mgs) extended release formulation and dapagliflozin (S) PGS (5.0 mgs) immediate release formulation were prepared as described below.

Component	Function	% w/w per layer	Amount per layer (mg)
Metformin XR Layer (1st Layer)			

Metformin hydrochloride	Active	48.37	500.00
Sodium carboxymethyl cellulose	Binder	4.84	50.03
Purified water or water for injection	Granulating fluid	-	q.s. ⁽¹⁾
Hydroxypropyl methylcellulose 2208	Release modifier	34.63	357.98
Hydroxypropyl methylcellulose 2910	Release modifier	0.96	9.92
Microcrystalline cellulose	Filler	9.87	102.03
Silicon dioxide	Compression aid	0.99	10.24
Magnesium stearate	Lubricant	0.34	3.53
Total metformin XR Layer		100.00	1033.73
Dapagliflozin Layer (2nd Layer)			
Dapagliflozin	Active	1.67	5.00
Lactose anhydrous	Filler	16.00	48.00
Microcrystalline cellulose 302	Filler	75.83	227.50
Crospovidone	Disintegrant	4.00	12.00
Silicon dioxide	Glidant	1.50 ²	4.50
Magnesium stearate	Lubricant	1.00	3.00
Total dapagliflozin Layer	-	100.00	300.00
Total core bilayer	-	-	1333.73
Film coat component Opadry® II (2.5% weight gain)	Coating material	-	33.34
Total film coated tablet	-	-	1367.07

¹ Purified water is used only for processing and is removed during drying

² The range is 0.5% - 1.5%

Metformin HCl, 0.5% magnesium stearate, and sodium carboxymethyl cellulose were combined and mixed in a high shear granulator for one minute. Purified water, using a nozzle, was added with stirring for one minute. The wet granulated material was passed through a mill and then dried until the moisture content was 1.0% or less. The dried material containing metformin HCl, 0.5% magnesium stearate, and sodium

carboxymethyl cellulose was passed through a mill and discharge into polyethylene lined drums to provide milled metformin 500 mg bulk granulation.

Milled metformin 500 mg bulk granulation, hydroxypropyl methyl cellulose 2208, hydroxypropyl methyl cellulose 2910, microcrystalline cellulose and silicon dioxide were added to a bin blender and mixed for 240 revolutions. Magnesium stearate was added, and after 60 revolutions, the material was discharge into polyethylene lined drums to provide metformin extended release 500 mg bulk granulation.

The dapagliflozin (S) PGS granulation and the bilayer compression procedures were conducted in a similar manner as described in Example 4.

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Example 14

Bilayer tablets containing metformin (500 mgs) extended release formulation and dapagliflozin (S) PGS (10.0 mgs) immediate release formulation were prepared in a similar manner as described in Example 13.

Component	Function	% w/w per layer	Amount per layer (mg)
Metformin XR Layer (1st Layer)			
Metformin hydrochloride	Active	48.37	500.00
Sodium carboxymethyl cellulose	Binder	4.84	50.03
Purified water or water for injection	Granulating fluid	-	q.s. ⁽¹⁾
Hydroxypropyl methylcellulose 2208	Release modifier	34.63	357.98
Hydroxypropyl methylcellulose 2910	Release modifier	0.96	9.92
Microcrystalline cellulose	Filler	9.87	102.03
Silicon dioxide	Compression aid	0.99	10.24
Magnesium stearate	Lubricant	0.34	3.53
Total metformin XR Layer		100.00	1033.73
Dapagliflozin Layer (2nd Layer)			
Dapagliflozin	Active	3.33	10.00

Lactose anhydrous	Filler	16.00	48.00
Microcrystalline cellulose 302	Filler	74.17	222.50
Crospovidone	Disintegrant	4.00	12.00
Silicon dioxide	Glidant	1.50 ⁽²⁾	4.50
Magnesium stearate	Lubricant	1.00	3.00
Total dapagliflozin Layer	-	100.00	300.00
Total core bilayer	-	-	1333.73
Film coat component Opadry® II (2.5% weight gain)	Coating material	-	33.34
Total film coated tablet	-	-	1367.07

¹ Purified water is used only for processing and is removed during drying

² The range is 0.5% - 1.5%

Example 15

5 Bilayer tablets containing metformin (500 mgs) extended release formulation and dapagliflozin (S) PGS (2.50 mgs) immediate release formulation were prepared in a similar manner as described in Example 13.

Component	Function	% w/w per layer	Amount per layer (mg)
Metformin XR Layer (1st Layer)			
Metformin hydrochloride	Active	48.37	500.00
Sodium carboxymethyl cellulose	Binder	4.84	50.03
Purified water or water for injection	Granulating fluid	-	q.s. ⁽¹⁾
Hydroxypropyl methylcellulose 2208	Release modifier	34.63	357.98
Hydroxypropyl methylcellulose 2910	Release modifier	0.96	9.92
Microcrystalline cellulose	Filler	9.87	102.03
Silicon dioxide	Compression aid	0.99	10.24
Magnesium stearate	Lubricant	0.34	3.53
Total metformin XR Layer		100.00	1033.73

Dapagliflozin Layer (2nd Layer)			
Dapagliflozin	Active	0.83	2.50
Lactose anhydrous	Filler	16.00	48.00
Microcrystalline cellulose 302	Filler	76.67	230.00
Crospovidone	Disintegrant	4.00	12.00
Silicon dioxide	Glidant	1.50 ⁽²⁾	4.50
Magnesium stearate	Lubricant	1.00	3.00
Total dapagliflozin Layer	-	100.00	300.00
Total core bilayer	-	-	1333.73
Film coat component Opadry® II (2.5% weight gain)	Coating material	-	33.34
Total film coated tablet	-	-	1367.07

¹ Purified water is used only for processing and is removed during drying

² The range is 0.5% - 1.5%

5 The term "comprising" as used in this specification and claims means "consisting at least in part of". When interpreting statements in this specification and claims which include "comprising", other features besides the features prefaced by this term in each statement can also be present. Related terms such as "comprise" and "comprised" are to be interpreted in similar manner.

10 In this specification where reference has been made to patent specifications, other external documents, or other sources of information, this is generally for the purpose of providing a context for discussing the features of the invention. Unless specifically stated otherwise, reference to such external documents is not to be construed as an admission
15 form any part of the common general knowledge in the art.

WE CLAIM:

1. A bilayer tablet comprising: (1) a first layer wherein the first layer is a metformin extended release formulation; (2) a second layer wherein the second layer is an SGLT2 inhibitor formulation comprising dapagliflozin, dapagliflozin (S) propylene glycol hydrate, or dapagliflozin (R) propylene glycol hydrate, and a glidant; and (3) optionally a film coating that covers the first layer and the second layer.
2. The bilayer tablet according to claim 1 wherein the total weight of the second layer is about 300 mgs to about 400 mgs.
3. The bilayer tablet according to claim 1 wherein the (1) first layer comprises metformin, a binder, a release modifier, a lubricant, and optionally a glidant; and (2) the second layer comprises dapagliflozin or dapagliflozin (S) propylene glycol hydrate, two or three fillers, a disintegrant, a glidant, and a lubricant.
4. A bilayer tablet comprising: (1) a first layer wherein the first layer is a metformin extended release formulation comprising metformin hydrochloride, sodium carboxymethyl cellulose; hydroxypropyl methylcellulose; magnesium stearate; and optionally silicon dioxide or colloidal silicon dioxide; (2) a second layer wherein the second layer is an SGLT2 inhibitor formulation comprising dapagliflozin or dapagliflozin (S) propylene glycol hydrate; two or three fillers selected from lactose anhydrous, microcrystalline cellulose, pregelatinized starch, mannitol, and hydroxypropyl cellulose; a disintegrant that is crospovidone; a glidant that is silicon dioxide; and a lubricant that is magnesium stearate; (3) an optional film coating that covers the first layer and the second layer comprising polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.
5. The bilayer tablet according to claim 4 wherein (1) the first layer comprises about 40-82% metformin hydrochloride, about 3-5% sodium carboxymethyl cellulose; about 15-40% hydroxypropyl methylcellulose; about 0.1-0.75% magnesium stearate; and about 0-2% silicon dioxide or 0-1.5% colloidal silicon dioxide; (2) the second layer comprises

about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-80% microcrystalline cellulose; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-2% magnesium stearate; (3) the optional film coating comprises polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.

6. The bilayer tablet according to claim 4 wherein (1) the first layer comprises about 40-87% metformin hydrochloride, about 1-10% sodium carboxymethyl cellulose, about 10-40% hydroxypropyl methylcellulose, and about 0.1-0.75% magnesium stearate; and (2) the second layer is about 300 mgs to about 400 mgs.

7. The bilayer tablet according to claim 6 wherein the second layer comprises:

(A) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(B) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose; about 10-22% pregelatinized starch; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(C) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; or

(D) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate.

8. The bilayer tablet according to claim 7 wherein there is a film coating and the film coating comprises polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.

9. The bilayer tablet according to claim 4 wherein (1) the first layer comprises about 42-82% metformin hydrochloride; about 3-5% sodium carboxymethyl cellulose; about 15-40% hydroxypropyl methylcellulose; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.75% magnesium stearate; and (2) the second layer is about 300 mgs to about 400 mgs.

10. The bilayer tablet according to claim 9 wherein the second layer comprises:

(A) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(B) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose; about 10-22% pregelatinized starch; about 2-6.00% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(C) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose; about 5-15% hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; or

(D) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate.

11. The bilayer tablet according to claim 10 wherein there is a film coating and the film coating comprises polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.

12. A method of treating a disorder or disease selected from diabetes (including type I and type II diabetes), impaired glucose tolerance, insulin resistance, nephropathy, retinopathy, neuropathy and cataracts, hyperglycemia, hyperinsulinemia, hypercholesterolemia, dyslipidemia, elevated blood levels of free fatty acids or glycerol, hyperlipidemia, hypertriglyceridemia, obesity, wound healing, tissue ischemia,

atherosclerosis and hypertension in a mammal comprising administering to the mammal in need of such treatment a bilayer tablet comprising (1) a first layer wherein the first layer is a metformin extended release formulation; (2) a second layer wherein the second layer is an SGLT2 inhibitor formulation comprising dapagliflozin, dapagliflozin (S) propylene glycol hydrate, or dapagliflozin (R) propylene glycol hydrate, and a glidant; and (3) optionally a film coating that covers the first layer and the second layer.

13. The method according to claim 12 wherein the disorder is type II diabetes and the mammal is a human.

14. The method according to claim 13 wherein the (1) first layer comprises metformin, a binder, a release modifier, a lubricant, and optionally a glidant; and (2) the second layer comprises dapagliflozin or dapagliflozin (S) propylene glycol hydrate, two or three fillers, a disintegrant, a glidant, and a lubricant.

15. The method according to claim 14 wherein (1) the metformin is metformin hydrochloride, the binder is sodium carboxymethyl cellulose; the release modifier is hydroxypropyl methylcellulose; the lubricant is magnesium stearate; and optionally the glidant is silicon dioxide or colloidal silicon dioxide; (2) the SGLT2 inhibitor is dapagliflozin or dapagliflozin (S) propylene glycol hydrate; the two or three fillers are selected from lactose anhydrous, microcrystalline cellulose, pregelatinized starch, mannitol, and hydroxypropyl cellulose; the disintegrant is crospovidone; the glidant is silicon dioxide; and the lubricant is magnesium stearate; (3) the optional film coating comprises polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.

16. The method according to claim 15 wherein the (1) first layer comprises about 40-87% metformin hydrochloride; about 1-10% sodium carboxymethyl cellulose; about 10-40% hydroxypropyl methylcellulose; and about 0.1-0.75% magnesium stearate; (2) the second layer is about 300 to about 400 mgs and comprises

(A) about 0.8% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 77% microcrystalline cellulose; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(B) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 76% microcrystalline cellulose; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(C) about 3.4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 74% microcrystalline cellulose; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(D) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 64% microcrystalline cellulose; about 13% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(E) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 57% microcrystalline cellulose; about 19% pregelatinized starch; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate;

(F) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 66% microcrystalline cellulose; about 10% hydroxypropyl cellulose EXF; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate; or

(G) about 1.7% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 16% lactose anhydrous; about 61% microcrystalline cellulose; about 15% mannitol; about 4% crospovidone; about 1.5% silicon dioxide; and about 1% magnesium stearate; and (3) there is a coating and the coating comprises polyvinyl alcohol, titanium dioxide, polyethylene glycol, and talc.

17. A coated bilayer tablet that comprises: (1) a bilayer tablet core comprising two layers wherein the first layer comprises metformin; and the second layer comprises an SGLT2 inhibitor; and a glidant, wherein the SGLT2 inhibitor is dapagliflozin, dapagliflozin (S) propylene glycol hydrate, or dapagliflozin (R) propylene glycol hydrate;

wherein the second layer is about 300 to about 400 mgs; (2) a first coating that coats the bilayer tablet core and optionally comprises saxagliptin; (3) a second coating that coats the first coating and optionally comprises saxagliptin; and (4) optionally a third coating that coats the second coating; wherein at least one of the first coating and the second coating comprises saxagliptin.

18. The coated bilayer tablet according to claim 17 wherein (1) the first layer comprises about 48-82% metformin hydrochloride, about 3-5% sodium carboxymethyl cellulose; about 15-50% hydroxypropyl methylcellulose; about 0.1-0.75% magnesium stearate; and about 0-2% silicon dioxide or 0-1.5% colloidal silicon dioxide; and the second layer comprises about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-80% microcrystalline cellulose; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-2% magnesium stearate; (2) the first coating comprises a polyvinyl alcohol based polymer; (3) the second coating comprises saxagliptin and a polyvinyl alcohol based polymer; and (4) the third coating comprises a polyvinyl alcohol based polymer.

19. The coated bilayer tablet according to claim 17 wherein (1) the first layer comprises about 48-82% metformin hydrochloride; about 3-5% sodium carboxymethyl cellulose; about 15-35% hydroxypropyl methylcellulose; about 0.75-1.25% silicon dioxide or about 0.25-0.75% colloidal silicon dioxide; and about 0.1-0.6% magnesium stearate; the second layer comprises:

(A) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 72-80% microcrystalline cellulose; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(B) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 50-70% microcrystalline cellulose; about 10-22% pregelatinized starch; about 2-6.00% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(C) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 60-70% microcrystalline cellulose; about 5-15%

hydroxypropyl cellulose EXF; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate; or

(D) about 0.5-4% dapagliflozin or dapagliflozin (S) propylene glycol hydrate; about 14-18% lactose anhydrous; about 55-65% microcrystalline cellulose; about 10-20% mannitol; about 2-6% crospovidone; about 0.5-2.5% silicon dioxide; and about 0.5-1.5% magnesium stearate;

(2) the first coating comprises 40% polyvinyl alcohol, 20% polyethylene glycol, 15% talc, and 25% titanium dioxide; (3) the second coating comprises saxagliptin and 40% polyvinyl alcohol, 20% polyethylene glycol, 15% talc, and 25% titanium dioxide; and (4) the third coating comprises 40% polyvinyl alcohol, 20% polyethylene glycol, 15% talc, and 25% titanium dioxide.