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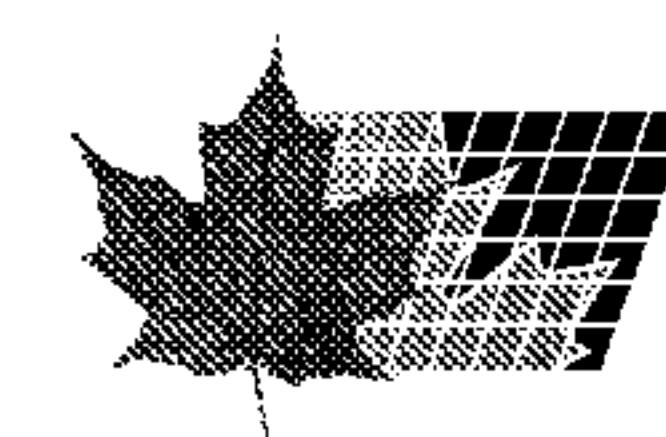
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(54) Titre : COMPOSITIONS PHARMACEUTIQUES COMPRENANT UN ACTIVATEUR DE LA SENSIBILITE A
L'INSULINE ET UN AUTRE ANTIDIABETIQUE

(54) Title: PHARMACEUTICAL COMPOSITIONS COMPRISING INSULIN SENSITIVITY ENHANCER AND ANOTHER
ANTIDIABETIC

(57) Abrégé/Abstract:

Disclosed is a pharmaceutical composition which comprises an insulin sensitivity enhancer in combination with another antidiabetic differing from the enhances in the mechanism of action other than a biguanide and an insulin secretion enhances and which shows a potent depressive effect on diabetic hyperglycemia and is useful for prophylaxis and treatment of diabetes.



24205-1056E

ABSTRACT

Disclosed is a pharmaceutical composition which comprises an insulin sensitivity enhancer in combination with another antidiabetic differing from the enhancer in the 5 mechanism of action other than a biguanide and an insulin secretion enhancer and which shows a potent depressive effect on diabetic hyperglycemia and is useful for prophylaxis and treatment of diabetes.

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PHARMACEUTICAL COMPOSITIONS COMPRISING INSULIN
SENSITIVITY ENHANCER AND ANOTHER ANTIDIABETIC

This is a divisional application of Canadian Patent Application No. 2,179,584 filed June 20, 1996.

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FIELD OF THE INVENTION

The present invention relates to a pharmaceutical composition comprising an insulin sensitivity enhancer in combination with one or more other antidiabetics differing from the enhancer in the mechanism of action.

10 Claimed in this divisional application is a pharmaceutical composition comprising an insulin sensitivity enhancer and another antidiabetic differing from the enhancer in the mechanism of action where the other antidiabetic does not include a biguanide or an insulin
15 secretion enhancer. A pharmaceutical composition comprising the insulin sensitivity enhancer and metformin that is a biguanide, is the subject of the parent application. It should be understood that the expression "present invention" encompasses the subject matters of both this and other
20 divisional application as well as the parent application.

BACKGROUND OF THE INVENTION

Recent years, the pathology of diabetes has become more and more understood and, in parallel, drugs specific for the respective pathologic states have been developed.
25 Accordingly a variety of drugs having new mechanisms of action have appeared one after another.

Insulin sensitivity enhancers are also known as insulin resistance deblockers because they have the action to normalize the impaired insulin receptor function, and are
30 gathering much attention in these years.

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Regarding such insulin sensitivity enhancers, a very useful compound such as pioglitazone has been developed [Fujita et al., Diabetes, 32, 804-810, 1983, JP-A S55(1980)-22636 (EP-A 8203), JP-A S61(1986)-267580 (EP-A 193256)].

- 5 Pioglitazone restores the impaired insulin receptor function to normalize the uneven distribution of glucose transporters in cells, the cardinal enzyme systems associated with glycometabolism, such as glucokinase, and enzyme systems associated with lipid metabolism, such as lipoprotein
- 10 lipase. As the results, insulin resistance is deblocked to improve glucose tolerance, and lower the plasma concentrations of neutral lipids and free fatty acids. Since these actions of pioglitazone are comparatively gradual and the risk of side effect in long-term
- 15 administration is also low, this compound is

useful for obese patients who are presumed to be highly insulin-resistant.

Also, insulin sensitivity enhancers such as CS-045, thiazolidinedione derivatives and substituted thiazolidinedione derivatives are reported to be used in combination with insulin [JP-A H4(1992)-66579, JP-A H4(1992)-69383, JP-A H5(1993)-202042]. However, the pharmaceutical composition having a specific combination of the present invention is unknown.

10 Diabetes is a chronic disease with diverse pathologic manifestations and is accompanied by lipid metabolism disorders and circulatory disorders as well as glycometabolism disorders. As the results, diabetes tends to progress entailing various complications in many cases. Therefore, it is necessary to select the drug of choice for the prevailing disease state in each individual case. However, this selection is often difficult in clinical settings because single use of each individual drug can not bring sufficient effects in some disease states and there are various problems such as side effect which is caused by an increased dose or a long-term administration.

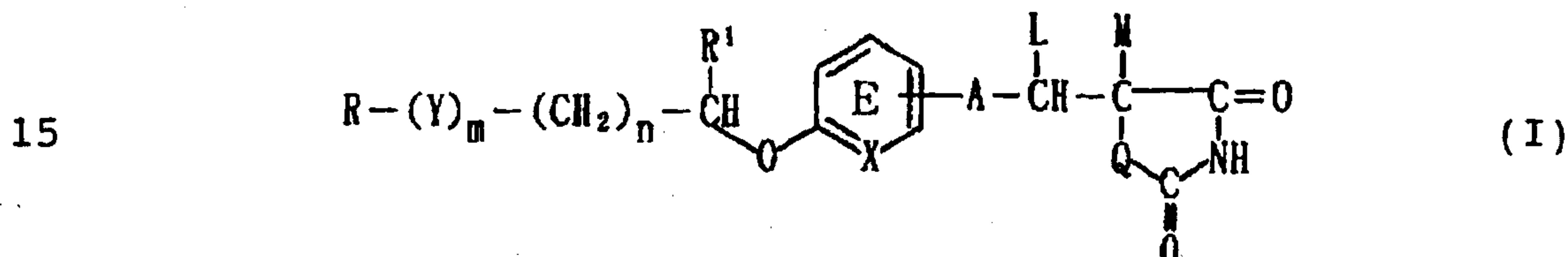
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SUMMARY OF THE INVENTION

30 In view of the above state of the art, the inventors of the present invention did much research to develop antidiabetics which would cause virtually no adverse reactions even on long-term administration and could be effective for a large cohort of the diabetic population. As a consequence, they discovered that the above object can be accomplished by using an insulin sensitivity enhancer, such as the drug described above, in combination with other antidiabetics differing from the enhancer in the mechanism of action, and accordingly have perfected the present invention.

The present invention, therefore, relates to:

- 1) a pharmaceutical composition which comprises an insulin sensitivity enhancer in combination with at least one member of the group consisting of an α -glucosidase inhibitor, an aldose reductase inhibitor, a biguanide, a statin compound, a squalene synthesis inhibitor, a fibrate compound, a LDL catabolism enhancer and an angiotensin converting enzyme inhibitor;
- 2) a pharmaceutical composition according to 1), wherein the insulin sensitivity enhancer is a compound represented by the formula:



wherein R represents an optionally substituted hydrocarbon or heterocyclic group; Y represents a group represented by -CO-, -CH(OH)- or -NR³- (wherein R³ represents an optionally substituted alkyl group); m is 0 or 1; n is 0, 1 or 2; X represents CH or N; A represents a bond or a C₁₋₇ divalent aliphatic hydrocarbon group; Q represents oxygen atom or sulfur atom; R¹ represents hydrogen atom or an alkyl group; ring E may optionally have 1 to 4 substituents, and the substituents may optionally be combined with R¹ to form a ring; L and M each represent hydrogen atom, or L and M may optionally be combined with each other to form a bond; or a pharmacologically acceptable salt thereof;

3) a pharmaceutical composition according to 2), wherein the compound represented by the formula (I) is pioglitazone;

4) a pharmaceutical composition according to 1), which

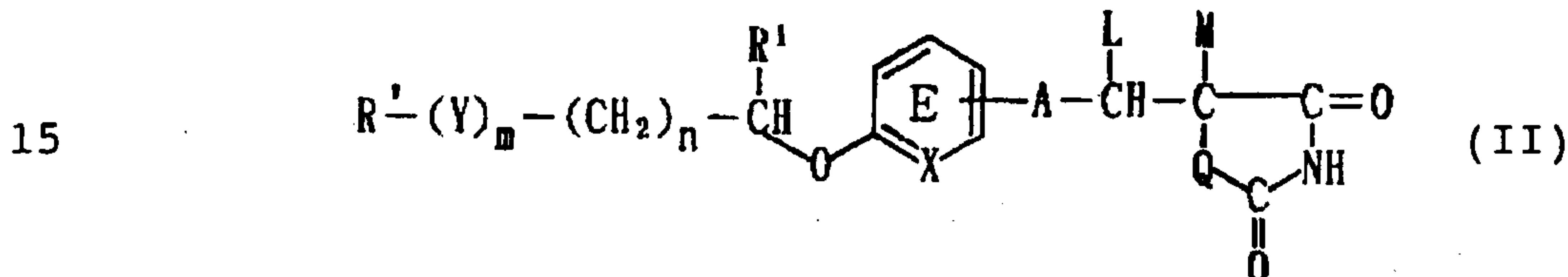
comprises an insulin sensitivity enhancer in combination with an α -glucosidase inhibitor;

5) a pharmaceutical composition according to 4),
wherein the α -glucosidase inhibitor is voglibose;

5 6) a pharmaceutical composition according to 4),
wherein the insulin sensitivity enhancer is
pioglitazone and the α -glucosidase inhibitor is
voglibose;

7) a pharmaceutical composition according to 1), which
10 is for prophylaxis or treatment of diabetes;

8) a pharmaceutical composition which comprises a compound represented by the formula:

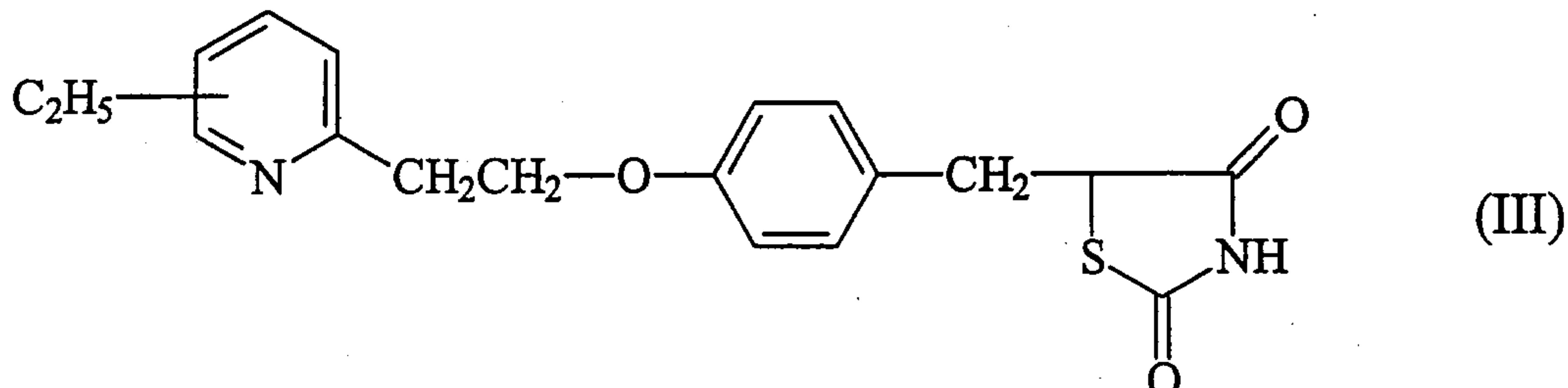


wherein R' represents an optionally substituted hydrocarbon or heterocyclic group; Y represents a group represented by -CO-, -CH(OH)- or -NR³- (wherein R³ represents an optionally substituted alkyl group); m is 0 or 1; n is 0, 1 or 2; X represents CH or N; A represents a bond or a C₁-, divalent aliphatic hydrocarbon group; Q represents oxygen atom or sulfur atom; R¹ represents hydrogen atom or an alkyl group; ring E may optionally have 1 to 4 substituents, and the substituents may optionally be combined with R¹ to form a ring; L and M each represent hydrogen atom, or L and M may optionally be combined with each other to form a bond; with the proviso that R' does not represent benzopyranyl group when m and n are 0, X represents CH, A represents a bond, Q represents sulfur atom, R¹, L and M represent hydrogen atom and ring E does not have further substituents; or a pharmacologically acceptable salt thereof in

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combination with an insulin secretion enhancer and/or an insulin preparation;

9) a pharmaceutical composition according to 8), wherein the compound represented by the formula (II) is the compound
5 represented by the formula:



10) a pharmaceutical composition according to 8), wherein the compound represented by the formula (II) is pioglitazone;

11) a pharmaceutical composition according to 8), wherein
15 the insulin secretion enhancer is glibenclamide;

12) a pharmaceutical composition according to 8), wherein the compound represented by the formula (II) is pioglitazone and the insulin secretion enhancer is glibenclamide; and

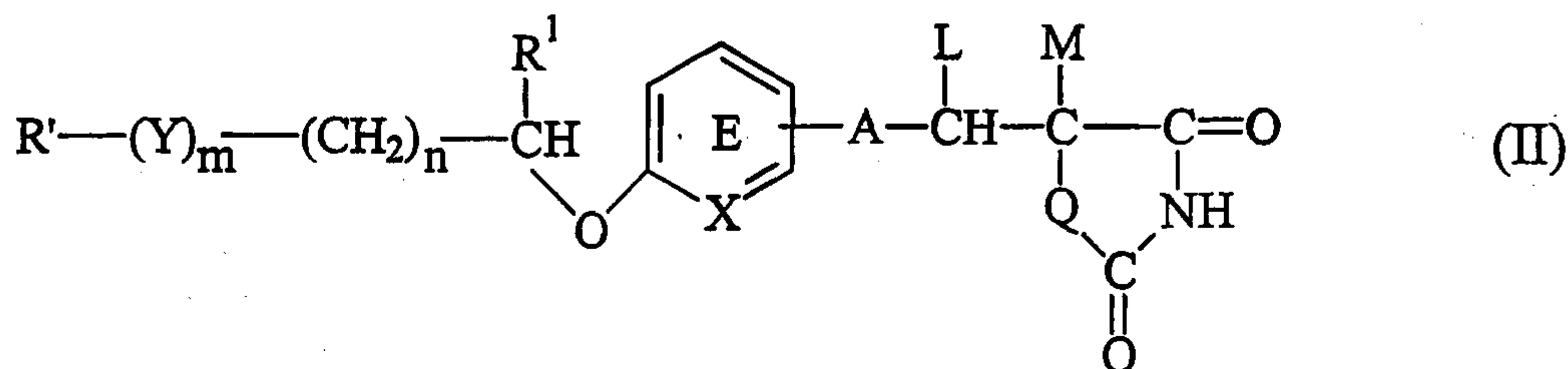
13) a pharmaceutical composition according to 8), which
20 is for prophylaxis or treatment of diabetes.

The invention extends to use of a compound disclosed herein for the manufacture of a medicament, preferably for prophylaxis or treatment of diabetes.

25 The invention further provides use of an insulin sensitivity enhancer for the manufacture of a pharmaceutical for reducing the amount of at least one member which is selected from the group consisting of an α -glucosidase inhibitor, an aldose reductase inhibitor, a biguanide, a statin compound, a squalene syntheses inhibitor, a fibrate compound, a
30 LDL catabolism enhancer and an angiotensin converting enzyme inhibitor and which is formulated for a diabetic patient.

The invention further provides use of a compound represented by the formula:

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wherein R' represents an optionally substituted hydrocarbon or heterocyclic group; Y represents a group represented by -CO-, -CH(OH)- or -NR³- (wherein R³ represents an optionally substituted alkyl group); m is 0 or 1; n is 0, 1 or 2; X represents CH or N; A represents a bond or a C₁₋₇ divalent aliphatic hydrocarbon group; Q represents oxygen atom or sulfur atom; R¹ represents hydrogen atom or an alkyl group; ring E may optionally have further 1 to 4 substituents, and the substituents may optionally be combined with R¹ to form a ring; L and M respectively represent hydrogen atom, or L and M may optionally be combined with each other to form a bond; with a proviso that R' does not represent benzopyranyl group when m and n are 0, X represents CH, A represents a bond, Q represents sulfur atom, R¹, L and M represent hydrogen atom and ring E does not have further substituents; or a pharmaceutically acceptable salt thereof for the manufacture of a pharmaceutical for reducing the amount of an insulin secretion enhancer and/or an insulin preparation administered to a diabetic patient.

25 DETAILED DESCRIPTION OF THE INVENTION

The term "insulin sensitivity enhancer" as used in this specification means any and all drug substances that restore the impaired insulin receptor function to deblock insulin resistance and consequently enhance insulin sensitivity. As examples of the insulin sensitivity enhancer, the compound represented by the formula (I) or a pharmaceutically acceptable salt thereof can be mentioned.

In the formula (I), as the hydrocarbon group in the optionally substituted hydrocarbon group represented by R, mention is made of aliphatic

hydrocarbon groups, alicyclic hydrocarbon groups, alicyclic-aliphatic hydrocarbon groups, aromatic aliphatic hydrocarbon groups and aromatic hydrocarbon groups. Number of carbon atoms in these hydrocarbon groups is preferably 1 to 14.

The aliphatic hydrocarbon groups are preferably those having 1 to 8 carbon atoms. As the aliphatic hydrocarbon groups, mention is made of C₁₋₈ saturated aliphatic hydrocarbon groups (e.g. alkyl group) as exemplified by methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec.-butyl, t.-butyl, pentyl, isopentyl, neopentyl, t.-pentyl, hexyl, isohexyl, heptyl and octyl, and C₂₋₈ unsaturated aliphatic hydrocarbon groups (e.g. alkenyl group, alkadienyl group, alkynyl group, alkadiynyl group) as exemplified by vinyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-methyl-1-propenyl, 1-pentenyl, 2-pentenyl, 3-pentenyl, 4-pentenyl, 3-methyl-2-butenyl, 1-hexenyl, 3-hexenyl, 2,4-hexadienyl, 5-hexenyl, 1-heptenyl, 1-octenyl, ethynyl, 1-propynyl, 2-propynyl, 1-butynyl, 2-butynyl, 3-butynyl, 1-pentynyl, 2-pentynyl, 3-pentynyl, 4-pentynyl, 1-hexynyl, 3-hexynyl, 2,4-hexadiynyl, 5-hexynyl, 1-heptynyl and 1-octynyl.

The alicyclic hydrocarbon groups are preferably those having 3 to 7 carbon atoms. As the alicyclic hydrocarbon groups, mention is made of C₃₋₇ saturated alicyclic hydrocarbon groups (e.g. cycloalkyl group) as exemplified by cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl, and C₅₋₇ unsaturated alicyclic hydrocarbon groups (e.g. cycloalkenyl group, cycloalkadienyl group) as exemplified by 1-cyclopentenyl, 2-cyclopentenyl, 3-cyclopentenyl, 1-cyclohexenyl, 2-cyclohexenyl, 3-cyclohexenyl, 1-cycloheptenyl, 2-cycloheptenyl, 3-cycloheptenyl and 2,4-cycloheptadienyl.

As the alicyclic-aliphatic hydrocarbon groups,

mention is made of, among those formed by combination of the above-mentioned alicyclic hydrocarbon groups with aliphatic hydrocarbon groups (e.g. cycloalkyl-alkyl group, cycloalkenyl-alkyl group), ones having 4 to 9 carbon atoms as exemplified by cyclopropylmethyl, cyclopropylethyl, cyclobutylmethyl, cyclopentylmethyl, 2-cyclopentenylmethyl, 3-cyclopentenylmethyl, cyclohexylmethyl, 2-cyclohexenylmethyl, 3-cyclohexenylmethyl, cyclohexylethyl, cyclohexylpropyl, cycloheptylmethyl and cycloheptylethyl.

The aromatic aliphatic hydrocarbon groups are preferably those having 7 to 13 carbon atoms (e.g. aralkyl group). As the aromatic aliphatic hydrocarbon groups, mention is made of C₇₋₉ phenylalkyl as exemplified by benzyl, phenethyl, 1-phenylethyl, 3-phenylpropyl, 2-phenylpropyl and 1-phenylpropyl, and C₁₁₋₁₃ naphthylalkyl as exemplified by α -naphthylmethyl, α -naphthylethyl, β -naphthylmethyl and β -naphthylethyl.

As the aromatic hydrocarbon groups, mention is made of, ones having 6 to 14 carbon atoms as exemplified by phenyl, naphthyl (α -naphthyl, β -naphthyl).

In the formula (I), as the heterocyclic group in the optionally substituted heterocyclic group represented by R, mention is made of, for example, 5- to 7-membered heterocyclic groups containing, as a ring component atom, 1 to 4 hetero atoms selected from oxygen atom, sulfur atom and nitrogen atom, and a condensed ring group. As the condensed ring, mention is made of, for example, these 5- to 7-membered heterocyclic groups condensed with 6-membered ring containing one or two nitrogen atoms, benzene ring or 5-membered ring containing one sulfur atom.

Examples of these heterocyclic groups include 2-pyridyl, 3-pyridyl, 4-pyridyl, 2-pyrimidinyl, 4-pyrimidinyl, 5-pyrimidinyl, 6-pyrimidinyl, 3-

pyridazinyl, 4-pyridazinyl, 2-pyrazinyl, 2-pyrrolyl, 3-pyrrolyl, 2-imidazolyl, 4-imidazolyl, 5-imidazolyl, 3-pyrazolyl, 4-pyrazolyl, isothiazolyl, isoxazolyl, 2-thiazolyl, 4-thiazolyl, 5-thiazolyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, 1,2,4-oxadiazol-5-yl, 1,2,4-triazol-3-yl, 1,2,3-triazol-4-yl, tetrazol-5-yl, benzimidazol-2-yl, indol-3-yl, 1H-indazol-3-yl, 1H-pyrrolo[2,3-b]pyrazin-2-yl, 1H-pyrrolo[2,3-b]pyridin-6-yl, 1H-imidazo[4,5-b]pyridin-2-yl, 1H-imidazo[4,5-c]pyridin-2-yl, 1H-imidazo[4,5-b]pyrazin-2-yl and benzopyranyl. Among them, pyridyl, oxazolyl or thiazolyl group is preferable.

In the formula (I), the hydrocarbon group and heterocyclic group represented by R may optionally have 1 to 5, preferably 1 to 3 substituents at any substitutable positions. Examples of such substituents include aliphatic hydrocarbon group, alicyclic hydrocarbon group, aryl group, aromatic heterocyclic group, non-aromatic heterocyclic group, halogen atom, nitro group, optionally substituted amino group, optionally substituted acyl group, optionally substituted hydroxyl group, optionally substituted thiol group, optionally esterified carboxyl group, amidino group, carbamoyl group, sulfamoyl group, sulfo group, cyano group, azido group and nitroso group.

Examples of the aliphatic hydrocarbon groups include C₁₋₁₅ straight-chain or branched aliphatic hydrocarbon groups as exemplified by alkyl group, alkenyl group, and alkynyl group.

Preferable examples of the alkyl group include C₁₋₁₀ alkyl groups such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec.-butyl, t.-butyl, pentyl, isopentyl, neopentyl, t.-pentyl, 1-ethylpropyl, hexyl, isohexyl, 1,1-dimethylbutyl, 2,2-dimethylbutyl, 3,3-dimethylbutyl, 2-ethylbutyl, hexyl, pentyl, octyl, nonyl and decyl.

Preferable examples of the alkenyl group include C₂₋₁₀ alkenyl groups such as vinyl, allyl, isopropenyl, 1-propenyl, 2-methyl-1-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 2-ethyl-1-butenyl, 3-methyl-2-butenyl, 1-pentenyl, 2-pentenyl, 3-pentenyl, 4-pentenyl, 4-methyl-3-pentenyl, 1-hexenyl, 2-hexenyl, 3-hexenyl, 4-hexenyl and 5-hexenyl.

5 Preferable examples of the alkynyl group include C₂₋₁₀ alkynyl groups such as ethynyl, 1-propynyl, 2-propynyl, 1-butynyl, 2-butynyl, 3-butynyl, 1-pentynyl, 2-pentynyl, 3-pentynyl, 4-pentynyl, 1-hexynyl, 2-hexynyl, 3-hexynyl, 4-hexynyl and 5-hexynyl.

10 As the alicyclic hydrocarbon group, mention is made of C₃₋₁₂ saturated or unsaturated alicyclic hydrocarbon groups as exemplified by cycloalkyl group, cycloalkenyl group and cycloalkadienyl group.

15 Preferable examples of cycloalkyl group include C₃₋₁₀ cycloalkyl groups such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, 20 bicyclo[2.2.1]heptyl, bicyclo[2.2.2]octyl, bicyclo[3.2.1]octyl, bicyclo[3.2.2]nonyl, bicyclo[3.3.1]nonyl, bicyclo[4.2.1]nonyl and bicyclo[4.3.1]decyl.

25 Preferable examples of the cycloalkenyl group include C₃₋₁₀ cycloalkenyl groups such as 2-cyclopenten-1-yl, 3-cyclopenten-1-yl, 2-cyclohexen-1-yl and 3-cyclohexen-1-yl.

30 Preferable examples of the cycloalkadienyl group include C₄₋₁₀ cycloalkadienyl groups such as 2,4-cyclopentadien-1-yl, 2,4-cyclohexadien-1-yl and 2,5-cyclohexadien-1-yl.

35 Preferable examples of the aryl group include C₆₋₁₄ aryl groups such as phenyl, naphthyl (1-naphthyl, 2-naphthyl), anthryl, phenanthryl and acenaphthylene.

Preferable examples of the aromatic heterocyclic group include aromatic monocyclic heterocyclic groups

such as furyl, thienyl, pyrrolyl, oxazolyl, isoxazolyl, thiazolyl, isothiazolyl, imidazolyl, pyrazolyl, 1,2,3-oxadiazolyl, 1,2,4-oxadiazolyl, 1,3,4-oxadiazolyl, furazanyl, 1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,3,4-thiadiazolyl, 1,2,3-triazolyl, 1,2,4-triazolyl, tetrazolyl, pyridyl, pyridazinyl, pyrimidinyl, pyrazinyl and triazinyl; and aromatic condensed heterocyclic groups such as benzofuranyl, isobenzofuranyl, benzo[b]thienyl, indolyl, isoindolyl, 1H-indazolyl, benzimidazolyl, benzoxazolyl, 1,2-benzoisoxazolyl, benzothiazolyl, 1,2-benzoisothiazolyl, 1H-benzotriazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, quinoxalinyl, phthalazinyl, naphthylidinyl, purinyl, pteridinyl, carbazolyl, α -carbolinyl, β -carbolinyl, γ -carbolinyl, acridinyl, phenoxyazinyl, phenothiazinyl, phenazinyl, phenoxythiinyl, thianthrenyl, phenathridinyl, phenathrolinyl, indolizinyl, pyrrolo[1,2-b]pyridazinyl, pyrazolo[1,5-a]pyridyl, imidazo[1,2-a]pyridyl, imidazo[1,5-a]pyridyl, imidazo[1,2-b]pyridazinyl, imidazo[1,2-a]pyrimidinyl, 1,2,4-triazolo[4,3-a]pyridyl and 1,2,4-triazolo[4,3-b]pyridazinyl.

Preferable examples of the non-aromatic heterocyclic group include oxiranyl, azetidinyl, oxetanyl, thietanyl, pyrrolidinyl, tetrahydrofuryl, thiolanyl, piperidyl, tetrahydropyranyl, morpholinyl, thiomorpholinyl, piperazinyl, pyrrolidino, piperidino, morpholino and thiomorpholino.

Examples of the halogen atom include fluorine, chlorine, bromine and iodine.

As the substituted amino group in the optionally substituted amino group, mention is made of, N-monosubstituted amino group and N,N-disubstituted amino group. Examples of the substituted amino groups include amino groups having one or two substituents selected from C₁₋₁₀ alkyl group, C₂₋₁₀ alkenyl group, C₂₋₁₀

alkynyl group, aromatic group, heterocyclic group and C₁₋₁₀ acyl group (e.g. methylamino, dimethylamino, ethylamino, diethylamino, dibutylamino, diallylamino, cyclohexylamino, phenylamino, N-methyl-N-phenyl-amino, 5 acetylamino, propionylamino, benzoylamino and nicotinoylamino).

As the acyl group, mention is made of C₁₋₁₃ acyl groups such as C₁₋₁₀ alkanoyl group, C₃₋₁₀ alkenoyl group, C₄₋₁₀ cycloalkanoyl group, C₄₋₁₀ cycloalkenoyl group and 10 C₆₋₁₂ aromatic carbonyl group.

Preferable examples of the C₁₋₁₀ alkanoyl group include formyl acetyl, propionyl, butyryl, isobutyryl, valeryl, isovaleryl, pivaloyl, hexanoyl, heptanoyl and octanoyl. Preferable examples of the C₃₋₁₀ alkenoyl 15 group include acryloyl, methacryloyl, crotonoyl and isocrotonoyl. Preferable examples of C₄₋₁₀ cycloalkanoyl group include cyclobutanecarbonyl, cyclopentanecarbonyl, cyclohexanecarbonyl and cycloheptanecarbonyl. Preferable examples of C₄₋₁₀ cycloalkenoyl group include 2-cyclohexenecarbonyl. 20 Preferable examples of C₆₋₁₂ aromatic carbonyl group include benzoyl, naphthoyl and nicotinoyl.

As the substituent in the substituted acyl group, mention is made of, for example, C₁₋₃ alkyl group, C₁₋₃ alkoxy group, halogen atom (e.g. chlorine, fluorine, bromine, etc.), nitro group, hydroxyl group and amino 25 group.

As the substituted hydroxyl group in the optionally substituted hydroxyl group, mention is made of, for example, alkoxy group, cycloalkyloxy group, alkenyloxy group, cycloalkenyloxy group, aralkyloxy group, acyloxy group and aryloxy group.

Preferable examples of the alkoxy group include C₁₋₁₀ alkoxy groups such as methoxy, ethoxy, propoxy, 35 isopropoxy, butoxy, isobutoxy, sec.-butoxy, t.-butoxy, pentyloxy, isopentyloxy, neopentyloxy, hexyloxy,

heptyloxy and nonyloxy. Preferable examples of the cycloalkyloxy group include C₃₋₁₀ cycloalkyloxy groups such as cyclobutoxy, cyclopentyloxy and cyclohexyloxy. Preferable examples of the alkenyloxy group include C₂₋₁₀ alkenyloxy groups such as allyloxy, crotyloxy, 2-pentenyloxy and 3-hexenyloxy. Preferable examples of the cycloalkenyloxy group include C₃₋₁₀ cycloalkenyloxy groups such as 2-cyclopentyloxy and 2-cyclohexenyloxy. Preferable examples of the aralkyloxy group include C₇₋₁₀ aryloxy groups such as phenyl-C₁₋₄ alkyloxy (e.g. benzyloxy and phenethyloxy). Preferable examples of the acyloxy group include C₂₋₁₃ acyloxy group, more preferably C₂₋₄ alkanoyloxy groups (e.g. acetyloxy, propionyloxy, butyryloxy and isobutyryloxy). Preferable examples of the aryloxy group include C₆₋₁₄ aryloxy groups such as phenoxy and naphthyloxy. The aryloxy group may optionally have one or two substituents such as halogen atom (e.g. chlorine, fluorine, bromine). Examples of the substituted aryloxy group include 4-chlorophenoxy.

As the substituted thiol group in the optionally substituted thiol group, mention is made of, alkylthio group, cycloalkylthio group, alkenylthio group, cycloalkenylthio group, aralkylthio group, acylthio group and arylthio group.

Preferable examples of the alkylthio group include C₁₋₁₀ alkylthio groups such as methylthio, ethylthio, propylthio, isopropylthio, butylthio, isobutylthio, sec.-butylthio, t.-butylthio, pentylthio, isopentylthio, neopentylthio, hexylthio, heptylthio and nonylthio. Preferable examples of the cycloalkylthio group include C₃₋₁₀ cycloalkylthio groups such as cyclobutylthio, cyclopentylthio and cyclohexylthio. Preferable examples of the alkenylthio group include C₂₋₁₀ alkenylthio groups such as allylthio, crotylthio, 2-pentenylthio and 3-hexenylthio. Preferable examples

of the cycloalkenylthio group include C_{3-10} cycloalkenylthio groups such as 2-cyclopentenylthio and 2-cyclohexenylthio. Preferable examples of the aralkylthio include C_{7-10} aralkylthio groups such as 5 phenyl- C_{1-4} alkylthio (e.g. benzylthio and phenethylthio). Preferable examples of the acylthio group include C_{2-13} acylthio group, more preferably C_{2-4} alkanoylthio groups (e.g. acetylthio, propionylthio, butyrylthio and isobutyrylthio).

10 Preferable examples of the arylthio group include C_{6-14} arylthio groups such as phenylthio and naphthylthio. The arylthio group may optionally have one or two substituents such as halogen atom (e.g. chlorine, fluorine, bromine). Examples of the 15 substituted arylthio group include 4-chlorophenylthio.

As the optionally esterified carboxyl group, mention is made of, for example, alkoxycarbonyl group, aralkyloxycarbonyl group and aryloxycarbonyl group.

20 Preferable examples of the alkoxycarbonyl group include C_{2-5} alkoxycarbonyl groups such as methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl and butoxycarbonyl. Preferable examples of the aralkyloxycarbonyl group include C_{8-10} aralkyloxycarbonyl groups such as benzyloxycarbonyl. 25 Preferable examples of the aryloxycarbonyl group include C_{7-15} aryloxycarbonyl groups such as phenoxy carbonyl and p-tolyloxycarbonyl.

30 Among the substituents on the hydrocarbon group and heterocyclic group represented by R, C_{1-10} alkyl groups, aromatic heterocyclic groups and C_{6-14} aryl groups are preferable, and C_{1-3} alkyl, furyl, thieryl, phenyl and naphthyl are especially preferable.

35 In the formula (I), substituents on the hydrocarbon group and heterocyclic group which are represented by R, may, when they are alicyclic hydrocarbon group, aryl group, aromatic heterocyclic

group or non-aromatic heterocyclic group, have one or more, preferably 1 to 3, of suitable substituents respectively. Examples of these substituents include C₁₋₆ alkyl groups, C₂₋₆ alkenyl groups, C₂₋₆ alkynyl groups, C₃₋₇ cycloalkyl groups, C₆₋₁₄ aryl groups, aromatic heterocyclic groups (e.g. thienyl, furyl, pyridyl, oxazolyl and thiazolyl), non-aromatic heterocyclic groups (e.g. tetrahydrofuryl, morpholino, thiomorpholino, piperidino, pyrrolidino and 5 piperazino), C₇₋₉ aralkyl groups, amino group, N-mono-C₁₋₄ alkylamino groups, N,N-di-C₁₋₄ alkylamino groups, C₂₋₈ acylamino groups (e.g. acetylamino, propionylamino and benzoylamino), amidino group, C₂₋₈ acyl group (e.g. C₂₋₈ alkanoyl groups), carbamoyl group, N-mono-C₁₋₄ alkyl 10 carbamoyl groups, N,N-di-C₁₋₄ alkyl carbamoyl groups, sulfamoyl group, N-mono-C₁₋₄ alkyl sulfamoyl groups, 15 N,N-di-C₁₋₄ alkyl sulfamoyl groups, carboxyl group, C₂₋₈ alkoxy carbonyl groups, hydroxyl group, C₁₋₄ alkoxy groups, C₂₋₅ alkenyloxy groups, C₃₋₇ cycloalkyloxy groups, C₇₋₉ aralkyloxy groups, C₆₋₁₄ aryloxy groups, 20 mercapto group, C₁₋₄ alkylthio groups, C₇₋₉ aralkylthio groups C₆₋₁₄ arylthio groups, sulfo group, cyano group, azido group, nitro group, nitroso group and halogen atom. 25

In the formula (I), R is preferably an optionally substituted heterocyclic group. R is more preferably pyridyl, oxazolyl or thiazolyl group which is optionally substituted by 1 to 3 substituents selected from C₁₋₃ alkyl group, furyl group, thienyl group, 30 phenyl group and naphthyl group.

R' in the formula (II) has the same definition as R except that R' does not represent benzopyranyl group when m and n are 0; X represents CH; A represents a bond; Q represents sulfur atom; R¹, L and M represent 35 hydrogen atom; and ring E does not have further

substituents.

In the formulae (I) and (II), Y represents $-CO-$, $-CH(OH)-$ or $-NR^3-$ (wherein R^3 represents an optionally substituted alkyl group), preferably $-CH(OH)-$ or $-NR^3-$.

5 As the alkyl group in the optionally substituted alkyl group represented by R^3 , mention is made of, for example, C_{1-4} alkyl groups such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec.-butyl and t.-butyl. Examples of the substituents include halogen

10 (e.g., fluorine, chlorine, bromine and iodine), C_{1-4} alkoxy groups (e.g. methoxy, ethoxy, propoxy, butoxy, isobutoxy, sec.-butoxy and t.-butoxy), hydroxyl group, nitro group and C_{1-4} acyl groups (e.g. formyl, acetyl and propionyl).

15 The symbol m is 0 or 1, preferably 0.

The symbol n is 0, 1 or 2, preferably 0 or 1.

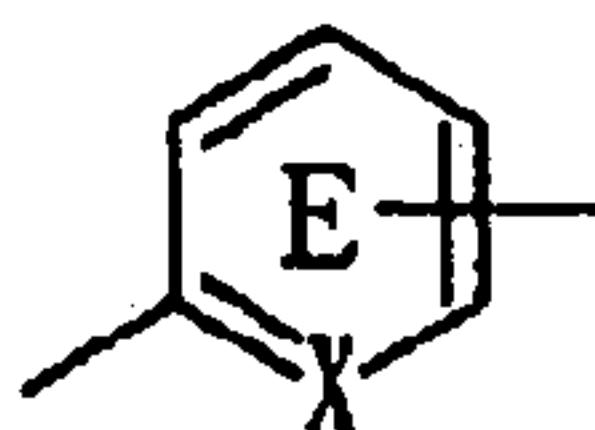
X represents CH or N, preferably CH.

In the formulae (I) and (II), A represents a bond or a C_{1-7} divalent aliphatic hydrocarbon group. The

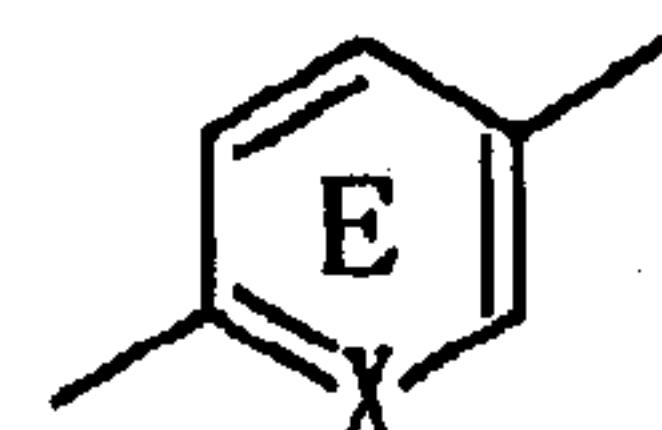
20 aliphatic hydrocarbon group may be straight-chain or branched, and saturated or unsaturated. Specific examples of the aliphatic hydrocarbon group include saturated ones [e.g. $-CH_2-$, $-CH(CH_3)-$, $-(CH_2)_2-$, $-CH(C_2H_5)-$, $-(CH_2)_3-$, $-(CH_2)_4-$, $-(CH_2)_5-$, $-(CH_2)_6-$ and $-(CH_2)_7-$] and unsaturated ones [e.g. $-CH=CH-$, $-C(CH_3)=CH-$, $-CH=CH-CH_2-$, $-C(C_2H_5)=CH-$, $-CH_2-CH=CH-CH_2-$, $-CH_2-CH_2-CH=CH-CH_2-$, $-CH=CH-CH=CH-CH_2-$ and $-CH=CH-CH=CH=CH-CH=CH-$]. A is preferably a bond or C_{1-4} divalent aliphatic hydrocarbon groups, the aliphatic hydrocarbon groups preferably being saturated. A is more preferably a bond or $-(CH_2)_2-$.

As the alkyl group represented by R^1 , substantially the same one as the alkyl group in the above-mentioned R^3 . R^1 is preferably hydrogen atom.

35 In the formulae (I) and (II), the partial formula:



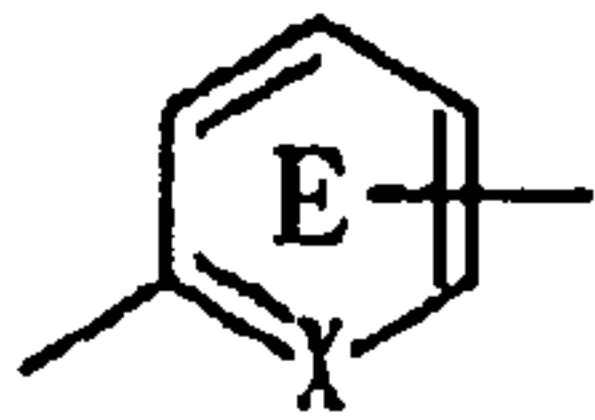
preferably represents
the formula:



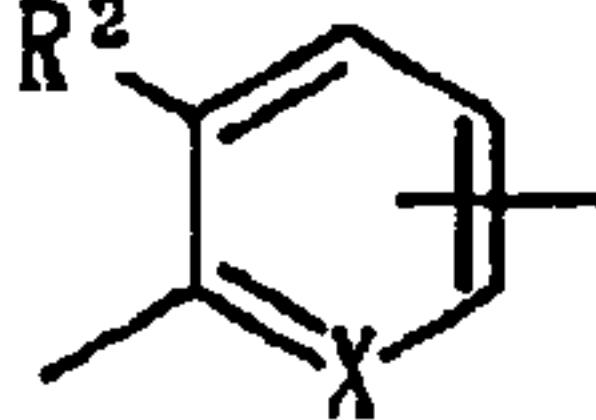
5 Ring E has 1 to 4 substituents at any substitutable positions. Examples of such substituents include alkyl group, optionally substituted hydroxyl group, halogen atom, optionally substituted acyl group and optionally substituted amino group. These
10 substituents have substantially the same meaning as those described as substituents of the hydrocarbon group and heterocyclic group represented by R.

Ring E, namely the partial formula:

15



preferably represents
the formula:



25 wherein R² represents hydrogen atom, an alkyl group, an optionally substituted hydroxyl group, a halogen atom, an optionally substituted acyl group, nitro group or an
30 optionally substituted amino group.

As the alkyl group, optionally substituted hydroxyl group, halogen atom, optionally substituted acyl group and optionally substituted amino group represented by R², mention is made of those described as substituents of the hydrocarbon group and heterocyclic group represented by R. R² is preferably hydrogen atom, optionally substituted hydroxyl group or halogen atom, more preferably hydrogen atom or
35 optionally substituted hydroxyl group, especially preferably hydrogen atom or C₁₋₄ alkoxy groups.

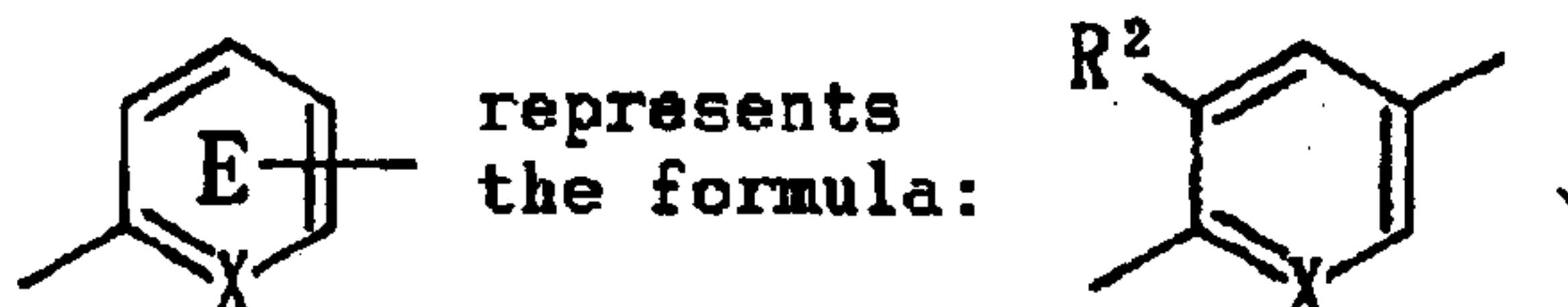
In the formulae (I) and (II), L and M represent hydrogen atom, or they may optionally be combined with each other to form a bond. L and M are preferably hydrogen atom.

In the compounds wherein L and M are combined with

each other to form a bond, there exist (E)- and (Z)- isomers relative to the double bond at the 5-position of the azolidinedione ring.

And, in the compounds wherein L and M respectively represent hydrogen atom, there exist (R)- and (S)- optical isomers due to the asymmetric carbon at the 5-position of the azolidinedione ring. The compounds include these (R)- and (S)- optical isomers and racemic isomers.

Preferable examples of the compounds represented by the formula (I) or (II) includes those in which R is pyridyl, oxazolyl or thiazolyl optionally having 1 to 3 substituents selected from C₁₋₃ alkyl, furyl, thieryl, phenyl and naphthyl; m is 0; n is 0 or 1; X is CH; A is a bond or -(CH₂)₂-; R¹ is hydrogen atom; ring E, namely the partial formula:



and R² is hydrogen atom or C₁₋₄ alkoxy group; and L and M are both hydrogen atom.

Preferable examples of the compound represented by the formula (I) include

(1) the compound represented by the formula (III) such as 5-[4-[2-(3-ethyl-2-pyridyl)ethoxy]benzyl]-2,4-thiazolidinedione; 5-[4-[2-(4-ethyl-2-pyridyl)ethoxy]-benzyl]-2,4-thiazolidinedione; 5-[4-[2-(5-ethyl-2-pyridyl)ethoxy]benzyl]-2,4-thiazolidinedione (generic name: pioglitazone); and 5-[4-[2-(6-ethyl-2-pyridyl)-ethoxy]benzyl]-2,4-thiazolidinedione;

(2) (R)-(+)-5-[3-[4-[2-(2-furyl)-5-methyl-4-oxazolylmethoxy]-3-methoxyphenyl]propyl]-2,4-oxazolidinedione; and

(3) 5-[(4-[(3,4-dihydro-6-hydroxy-2,5,7,8-tetramethyl-2H-1-benzopyran-2-yl)methoxy]phenyl)methyl]-2,4-

thiazolidinedione (generic name: troglitazone/CS-045).

The compound represented by the formula (I) is especially preferably pioglitazone.

The compound represented by the formula (II) is preferably the compound represented by the formula (III) and (R)-(+)-5-[3-[4-[2-(2-furyl)-5-methyl-4-oxazolylmethoxy]-3-methoxyphenyl]propyl]-2,4-oxazolidinedione, more preferably pioglitazone.

10 The pharmacologically acceptable salt of the compound represented by the formula (I) or (II) are exemplified by salts with inorganic bases, salts with organic bases, salts with inorganic acids, salts with organic acids, and salts with basic or acidic amino acids.

Preferable examples of salts with inorganic bases include salts with alkali metals such as sodium, potassium, etc., salts with alkaline earth metals such as calcium, magnesium, etc., and salts with aluminum, ammonium, etc.

20 Preferable examples of salts with organic bases include salts with trimethylamine, triethylamine, pyridine, picoline, ethanolamine, diethanolamine, triethanolamine, dicyclohexylamine, N,N-dibenzylethylenediamine, etc.

Preferable examples of salts with inorganic acids include salts with hydrochloric acid, hydrobromic acid, nitric acid, sulfuric acid, phosphoric acid, etc.

Preferable examples of salts with organic acids include salts with formic acid, acetic acid, trifluoroacetic acid, fumaric acid, oxalic acid, tartaric acid, maleic acid,

citric acid, succinic acid, malic acid, methanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, etc.

Preferable examples of salts with basic amino acids include salts with arginine, lysine, ornithine, etc., and preferable examples of salts with acidic amino acids include salts with aspartic acid, glutamic acid, etc.

5 The pharmacologically acceptable salt of the compound represented by the formula (III) is preferably a salt with an inorganic acid, more preferably a salt with hydrochloric acid. Especially, pioglitazone is preferably used in the form of salt with hydrochloric acid.

10 The compounds represented by the formula (I) or (II) or a salt thereof can be produced in accordance with, for example, methods described in JPA S55(1980)-22636(EP-A 8203), JPA S60(1985)-208980(EP-A 155845), JPA S61(1986)-286376(EP-A 208420), JPA S61(1986)-85372(EP-A 177353), JPA S61(1986)-267580(EP-A 193256), JPA H5(1993)-86057(WO 92/18501), JPA H7(1995)-82269(EP-A 605228), JPA H7(1995)-101945(EP-A 612743), EP-A 15 643050, EP-A 710659, etc. or methods analogous thereto.

15 Insulin sensitivity enhancers include 5-[(3,4-dihydro-2-(phenylmethyl)-2H-1-benzopyran-6-yl)methyl]-2,4-thiazolidinedione (generic name: englitazone) or its sodium salt;

20 5-[(4-[3-(5-methyl-2-phenyl-4-oxazolyl)-1-oxopropyl]phenyl)methyl]-2,4-thiazolidinedione (generic name: darglitazone/CP-86325) or its sodium salt;

25 5-[2-(5-methyl-2-phenyl-4-oxazolylmethyl)benzofuran-5-ylmethyl]-2,4-oxazolidinedione (CP-92768);

30 5-(2-naphthalenylsulfonyl)-2,4-thiazolidinedione (AY-31637);

35 4-[(2-naphthalenyl)methyl]-3H-1,2,3,5-oxathiadiazol-2-oxide (AY-30711); and

5-[(4-[2-(methyl-2-pyridylamino)ethoxy]phenyl)methyl]-2,4-thiazolidinedione (BRL-49653), etc. in addition to compounds mentioned hereinbefore.

35 In the present invention, examples of the drug which is used in combination with the above-mentioned insulin sensitivity enhancer include an α -glucosidase inhibitor, an aldose reductase inhibitor, a biguanide, a statin compound, a squalene synthesis inhibitor, a

fibrate compound, a LDL catabolism enhancer and an angiotensin converting enzyme inhibitor.

5 α -Glucosidase inhibitors are drugs which inhibit digestive enzymes such as amylase, maltase, α -dextrinase, sucrase, etc. to retard digestion of starch and sugars. Examples of the α -glucosidase inhibitors include acarbose, N-(1,3-dihydroxy-2-propyl)valiolamine (generic name; voglibose), miglitol, etc. with preference given to voglibose.

10 Aldose reductase inhibitors are drugs which inhibit the first-stage rate-limiting enzyme in the polyol pathway to prevent or arrest diabetic complications. In the hyperglycemic state of diabetes, the utilization of glucose in the polyol pathway is increased and the excess sorbitol accumulated intracellularly as a consequence acts as a tissue toxin and hence evokes the onset of complications such as diabetic neuropathy, retinopathy, and nephropathy. Examples of the aldose reductase inhibitors include 15 tolurestat; epalrestat; 3,4-dihydro-2,8-diisopropyl-3-thioxo-2H-1,4-benzoxazine-4-acetic acid; 2,7-difluoro-spiro(9H-fluorene-9,4'-imidazolidine)-2',5'-dione (generic name: imirestat); 3-[(4-bromo-2-fluorophenyl)methyl]-7-chloro-3,4-dihydro-2,4-dioxo-1(2H)-quinazoline acetic acid 20 (generic name: zenarestat); 6-fluoro-2,3-dihydro-2',5'-dioxo-spiro[4H-1-benzopyran-4,4'-imidazolidine]-2-carboxamide (SNK-860); zopolrestat; sorbinil; and 25 1-[(3-bromo-2-benzofuranyl)sulfonyl]-2,4-imidazolidinedione (M-16209), etc.

30 Biguanides are drugs having actions of stimulation of anaerobic glycolysis, increase of the sensitivity to insulin in the peripheral tissues, inhibition of glucose absorption from the intestine, suppression of hepatic gluconeogenesis, and inhibition of fatty acid

oxidation. Examples of the biguanides include phenformin, metformin, buformin, etc.

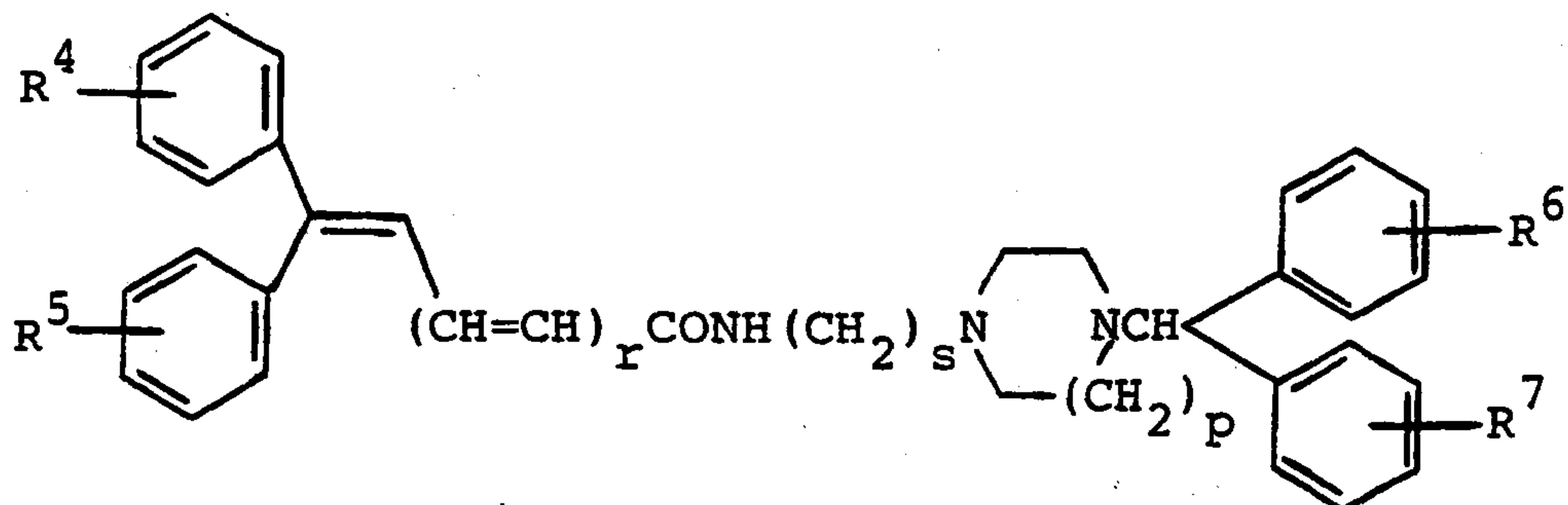
Statin compounds are drugs having actions of lowering blood cholesterol levels by inhibiting hydroxymethylglutaryl CoA (HMG-CoA) reductase. Examples of the statin compounds include pravastatin and its sodium salt, simvastatin, lovastatin, atorvastatin, fluvastatin, etc.

10 Squalene synthesis inhibitors are drugs having actions of lowering blood cholesterol levels by inhibiting synthesis of squalene. Examples of the squalene synthesis inhibitors include (S)- α -[bis[2,2-dimethyl-1-oxopropoxy]-methoxy]phosphinyl]-3-phenoxybenzenesulfonic acid, mono potassium salt (BMS-188494).

20 Fibrate compounds are drugs having actions of lowering blood cholesterol levels by inhibiting synthesis and secretion of triglycerides in liver and activating a lipoprotein lipase. Examples of the fibrate compounds include bezafibrate, beclobrate, binifibrate, ciprofibrate, clinofibrate, clofibrate, clofibratric acid, etofibrate, fenofibrate, gemfibrozil, nicofibrate, pirifibrate, ronifibrate, simfibrate, theofibrate, etc.

LDL catabolism enhancers are drugs having actions of lowering blood cholesterol levels by increasing the number of LDL (low-density lipoprotein) receptors.

Examples of the LDL catabolism enhancers include the compound which is described in JPA H7(1995)-316144 and represented by the formula:



wherein R^4 , R^5 , R^6 and R^7 are the same or different, and represent hydrogen atom, a halogen atom, a lower alkyl group or a lower alkoxy group; r is 0-2; s is 2-4; p is 1-2; or a salt thereof; specifically N-[2-[4-bis(4-fluorophenyl)methyl-1-piperazinyl]ethyl]-7,7-diphenyl-2,4,6-heptatrienic acid amide, etc.

10

The above-mentioned statin compounds, squalene synthesis inhibitors, fibrate compounds and LDL catabolism enhancers can be substituted with other drugs having the property to lower blood cholesterol and triglyceride levels. Examples of these drugs include nicotinic acid derivatives such as nicomol and niceritrol; antioxidants such as probucol; and ion-exchange resins such as colestyramin.

20

Angiotensin converting enzyme inhibitors are drugs having actions of partially lowering blood glucose levels as well as lowering blood pressure by inhibiting angiotensin converting enzymes. Examples of the angiotensin converting enzyme inhibitors include captopril, enalapril, alacepril, delapril, ramipril, lisinopril, imidapril, benazepril, ceronapril, cilazapril, enalaprilat, fosinopril, moveltopril, perindopril, quinapril, spirapril, temocapril, trandolapril, etc.

In the present invention, especially preferred is the pharmaceutical composition which comprises an insulin sensitivity enhancer in combination with an α -glucosidase inhibitor. The insulin sensitivity enhancer is especially preferably pioglitazone, and the α -glucosidase inhibitor is especially preferably voglibose.

In the present invention, examples of the drug which is used in combination with the compound represented by the formula (II) or a pharmacologically acceptable salt thereof include an insulin secretion enhancer and/or an insulin preparation.

10 Insulin secretion enhancers are drugs having the property to promote secretion of insulin from pancreatic β cells. Examples of the insulin secretion enhancers include sulfonylureas (SU). The sulfonylureas (SU) are drugs which promote secretion of insulin from pancreatic β cells by transmitting signals of insulin secretion via SU receptors in the cell membranes. Examples of the SU include tolbutamide; chlorpropamide; tolazamide; acetohexamide; 4-chloro-N-[(1-pyrolidinylamino)carbonyl]benzenesulfonamide (generic name: 20 glycopyramide) or its ammonium salt; glibenclamide (glyburide); gliclazide; 1-butyl-3-metanilylurea; carbutamide, glibonuride; glipizide; gliquidone; glisoxepid; glybuthiazole; glibuzole; glyhexamide; glymidine, glypinamide; phenbutamide; tolycyclamide, etc.

Insulin secretion enhancers include N-[(4-(1-methylethyl)cyclohexyl)carbonyl]-D-phenylalanine (AY-4166);

calcium (2S)-2-benzyl-3-(cis-hexahydro-2-isoindolinylcarbonyl)-
propionate dihydrate (KAD-1229); and glimepiride (Hoe 490),
etc. in addition to

compounds mentioned hereinbefore. The insulin secretion enhancer is especially preferably glibenclamide.

Examples of the insulin preparations include 5 animal insulin preparations typically extracted from bovine or porcine pancreas and human insulin preparations synthesized by genetic engineering techniques typically using Escherichia coli or yeasts. While insulin preparations are available in a variety 10 of types, e.g. immediate-acting, bimodal-acting, intermediate-acting, and long-acting, these types of preparations can be selectively administered according to the patient's condition.

In the present invention, especially preferred is 15 the pharmaceutical composition which comprises the compound represented by the formula (II) or a pharmacologically acceptable salt thereof in combination with an insulin secretion enhancer. The compound represented by the formula (II) or a 20 pharmacologically acceptable salt thereof is especially preferably pioglitazone, and the insulin secretion enhancer is especially preferably glibenclamide.

The pharmaceutical composition comprising an 25 insulin sensitivity enhancer in combination with at least one member selected from the group consisting of an α -glucosidase inhibitor, an aldose reductase inhibitor, a biguanide, a statin compound, a squalene synthesis inhibitor, a fibrate compound, a LDL catabolism enhancer and an angiotensin converting 30 enzyme inhibitor; and the pharmaceutical composition comprising the compound represented by the formula (II) or a pharmacologically acceptable salt thereof in combination with an insulin secretion enhancer and/or an insulin preparation, both provided in accordance 35 with the present invention, can be respectively put to use by mixing the respective active components either

all together or independently with a physiologically acceptable carrier, excipient, binder, diluent, etc. and administering the mixture or mixtures either orally or non-orally as a pharmaceutical composition. When 5 the active components are formulated independently, the respective formulations can be extemporaneously admixed using a diluent or the like and administered or can be administered independently of each other, either concurrently or at staggered times to the same subject.

10 The dosage form for said pharmaceutical composition includes such oral dosage forms as granules, powders, tablets, capsules, syrups, emulsions, suspensions, etc. and such non-oral dosage forms as injections (e.g. subcutaneous, intravenous, 15 intramuscular and intraperitoneal injections), drip infusions, external application forms (e.g. nasal spray preparations, transdermal preparations, ointments, etc.), and suppositories (e.g. rectal and vaginal suppositories).

20 These dosage forms can be manufactured by the per se known technique conventionally used in pharmaceutical procedures. The specific manufacturing procedures are as follows.

To manufacture an oral dosage form, an excipient 25 (e.g. lactose, sucrose, starch, mannitol, etc.), a disintegrator (e.g. calcium carbonate, carboxymethylcellulose calcium, etc.), a binder (e.g. α -starch, gum arabic, carboxymethylcellulose, polyvinylpyrrolidone, hydroxypropylcellulose, etc.), and a lubricant (e.g. talc, magnesium stearate, 30 polyethylene glycol 6000, etc.), for instance, are added to the active component or components and the resulting composition is compressed. Where necessary, the compressed product is coated, by the per se known 35 technique, for masking the taste or for enteric dissolution or sustained release. The coating material

that can be used includes, for instance, ethyl-cellulose, hydroxymethylcellulose, polyoxyethylene glycol, cellulose acetate phthalate, hydroxypropylmethylcellulose phthalate, and Eudragit^{*} (Rohm & Haas, Germany, methacrylic-acrylic copolymer).

Injections can be manufactured typically by the following procedure. The active component or components are dissolved, suspended or emulsified in an aqueous vehicle (e.g. distilled water, physiological saline, Ringer's solution, etc.) or an oily vehicle (e.g. vegetable oil such as olive oil, sesame oil, cottonseed oil, corn oil, etc. or propylene glycol) together with a dispersant (e.g. Tween^{*} 80 (Atlas Powder, U.S.A.), HCO 60^{*} (Nikko Chemicals), polyethylene glycol, carboxymethylcellulose, sodium alginate, etc.), a preservative (e.g. methyl p-hydroxybenzoate, propyl p-hydroxybenzoate, benzyl alcohol, chlorobutanol, phenol, etc.), an isotonizing agent (e.g. sodium chloride, glycerol, sorbitol, glucose, inverted sugar, etc.) and other additives. If desired, a solubilizer (e.g. sodium salicylate, sodium acetate, etc.), a stabilizer (e.g. human serum albumin), a soothing agent (e.g. benzalkonium chloride, procaine hydrochloride, etc.) and other additives can also be added.

A dosage form for external application can be manufactured by processing the active component or components into a solid, semi-solid or liquid composition. To manufacture a solid composition, for instance, the active component or components, either as they are or in admixture with an excipient (e.g. lactose, mannitol, starch, microcrystalline cellulose, sucrose, etc.), a thickener (e.g. natural gums, cellulose derivatives, acrylic polymers, etc.), etc., are processed into powders. The liquid composition can be manufactured in substantially the same manner as the injections mentioned above. The semi-solid composition is

* Trade-mark

preferably provided in a hydrous or oily gel form or an ointment form. These compositions may optionally contain a pH control agent (e.g. carbonic acid, phosphoric acid, citric acid, hydrochloric acid, sodium hydroxide, etc.), and a preservative (e.g. p-hydroxybenzoic acid esters, chlorobutanol, benzalkonium chloride, etc.), among other additives.

Suppositories can be manufactured by processing the active component or components into an oily or aqueous composition, whether solid, semi-solid or liquid. The oleaginous base that can be used includes, for instance, higher fatty acid glycerides [e.g. cacao butter, Witepsols* (Dinamit-Nobel), etc.], medium-chain fatty acids [e.g. Migriols* (Dinamit-Nobel), etc.], vegetable oils (e.g. sesame oil, soybean oil, cotton-seed oil, etc.), etc. The water-soluble base includes, for instance, polyethylene glycols, propylene glycol, etc. The hydrophilic base includes, for instance, natural gums, cellulose derivatives, vinyl polymers, and acrylic polymers, etc.

The pharmaceutical composition of the present invention is low in toxicity and can be safely used in mammals (e.g. humans, mice, rats, rabbits, dogs, cats, bovines, horses, swines, monkeys).

The dosage of the pharmaceutical composition of the present invention may be appropriately determined with reference to the dosages recommended for the respective active components and can be selected appropriately according to the recipient, the recipient's age and body weight, current clinical status, administration time, dosage form, method of administration, and combination of the active components, among other factors. For example, the dosage of the insulin sensitivity enhancer for an adult can be selected from the clinical oral dose range of 0.01 to 10 mg/kg body weight (preferably 0.05 to 10

*Trade-mark

mg/kg body weight, more preferably 0.05 to 5 mg/kg body weight) or the clinical parenteral dose range of 0.005 to 10 mg/kg body weight (preferably 0.01 to 10 mg/kg body weight, more preferably 0.01 to 1 mg/kg body weight). The other active component or components having different modes of action for use in combination can also be used in dose ranges selected by referring to the respective recommended clinical dose ranges. The preferred frequency of administration is 1 to 3 times a day.

10 The proportions of the active components in the pharmaceutical composition of the present invention can be appropriately selected according to the recipient, the recipient's age and body weight, current clinical status, administration time, dosage form, method of administration, and combination of active components, among other factors. When, for example, the compound represented by the formula (I) or a pharmacologically acceptable salt thereof (e.g. pioglitazone) which is the insulin sensitivity enhancer and an α -glucosidase inhibitor (such as voglibose) are to be administered in combination to a human subject, the α -glucosidase inhibitor is used in a proportion of usually about 0.0001 to 0.2 weight part and preferably about 0.001 to 0.02 weight part relative to 1 weight part of the compound or a salt thereof. When, for example, the compound represented by the formula (II) or a pharmacologically acceptable salt thereof and an insulin secretion enhancer (such as glibenclamide) are to be administered in combination to a human subject, the

20

insulin secretion enhancer is used in a proportion of usually about 0.002 to 5 weight parts and preferably about 0.025 to 0.5 weight part, relative to 1 weight part of the compound or a pharmacologically acceptable salt thereof.

The pharmaceutical composition of the present invention shows a marked synergistic effect compared

with administration of either active component alone. For example, compared with cases in which each of these active components was administered to diabetic Wistar fatty rats with genetical obesity, administration of 5 these active components in combination resulted in marked improvements in both hyperglycemia and reduced glucose tolerance. Thus, the pharmaceutical composition of the present invention lowers blood glucose in diabetics more effectively than it is the 10 case with administration of each component drug alone and, therefore, can be used advantageously for the prophylaxis and treatment of diabetic complications.

Furthermore, since the pharmaceutical composition of the present invention develops sufficient efficacy 15 with reduced doses as compared with the administration of any one of the active components alone, the side effects of the respective components (e.g. gastrointestinal disorders such as diarrhea, etc.) can be reduced.

20 The following working examples and experimental examples are merely intended to illustrate the present invention in further detail but should by no means be construed as defining the scope of the invention.

25 The pharmaceutical composition of the present invention can be prepared according to the following formulations.

Working Example 1

Capsules

	(1) Pioglitazone hydrochloride	30 mg
30	(2) Voglibose	0.2 mg
	(3) Lactose	60 mg
	(4) Microcrystalline cellulose	79.8 mg
	(5) Magnesium stearate	10 mg
35		Total 180 mg

The whole amounts of (1), (2), (3) and (4) and half the amount of (5) are mixed well and granulated in

the conventional manner. Then, the balance of (5) is added and, after mixing, the whole composition is filled in a gelatin hard capsule shell.

Working Example 2

5 Tablets

	(1) Pioglitazone hydrochloride	10 mg
	(2) Glibenclamide	1.25 mg
	(3) Lactose	86.25 mg
	(4) Corn starch	20 mg
10	(5) Polyethylene glycol	2.5 mg
	(6) Hydroxypropylcellulose	4 mg
	(7) Carmellose calcium	5.5 mg
	(8) Magnesium stearate	0.5 mg

15

 130 mg (per tablet)

The whole amounts of (1), (2), (3), (4), and (5), 2/3 amounts of (6) and (7), and 1/2 amount of (8) are mixed well and granulated in the conventional manner.

20 Then, the balances of (6), (7) and (8) are added to the granules, which is mixed well and the whole composition is compressed with a tablet machine. The adult dosage is 3 tablets/day, to be taken in 1 to 3 divided doses.

25 Working Example 3

Capsules

	(1) Pioglitazone hydrochloride	10 mg
	(2) Epalrestat	50 mg
	(3) Lactose	55 mg
30	(4) Microcrystalline cellulose	55 mg
	(5) Magnesium stearate	10 mg

 Total 180 mg

35 The whole amounts of (1), (2), (3) and (4) and 1/2 amount of (5) are mixed well and granulated in the conventional manner. Then, the balance of (5) is added and the whole composition is filled in gelatin capsule shell. The adult dosage is 3 capsules/day, to be taken

in 1 to 3 divided doses.

Experimental Example 1

Effect of pioglitazone hydrochloride in combination with α -glucosidase inhibitor in genetically 5 obese and diabetic Wistar fatty rats

Male Wistar fatty rats aged 14-19 weeks were divided into 4 groups of 5-6, and pioglitazone hydrochloride (1 mg/kg body wt./day, p.o.) and/or voglibose (an α -glucosidase inhibitor) (0.31 mg/kg body 10 wt./day; administered by mixing in commercial diet at a rate of 5 ppm) was administered for 14 days. The blood was then collected from the tail vein and the plasma glucose and hemoglobin A₁ were determined by the enzymatic method (Encore Chemical System, Baker) and 15 using a commercial kit (NC-ROPET*, Nippon Chemiphar Co.), respectively. The results were expressed in mean \pm standard deviation for each group (n=5-6) and analyzed by Dunnett's test, which are shown in Table 1. The 1% level of significance was used.

20 [Table 1]

	Group	Plasma glucose (mg/dl)	Hemoglobin A ₁ (%)
25	Control	345 \pm 29	5.7 \pm 0.4
	Pioglitazone	215 \pm 50*	5.2 \pm 0.3
30	Voglibose	326 \pm 46	6.0 \pm 0.6
	Pioglitazone + voglibose	114 \pm 23*	4.5 \pm 0.4*

*: P<0.01 vs. control group

35 It is apparent from Table 1 that both the blood glucose and hemoglobin A₁ levels were remarkably lowered by combined administration of pioglitazone and voglibose as compared with the administration of either drug alone.

40 **Experimental Example 2**

Effect of pioglitazone hydrochloride in
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combination with an insulin secretion enhancer in genetically obese and diabetic Wistar fatty rats.

Male Wistar fatty rats aged 13-14 weeks were divided into 4 groups of 5, and pioglitazone hydrochloride (3 mg/kg/day, p.o.) and/or glibenclamide (an insulin secretion enhancer) (3 mg/kg/day, p.o.) was administered for 7 days. Following an overnight fast, the oral glucose loading test (2 g glucose/kg/5 ml, p.o.) was carried out. Prior to glucose loading and 120 and 240 minutes after the loading, blood was collected from the tail vein and the plasma glucose was assayed by the enzymatic method (Encore Chemical System, Baker). The results were expressed in mean \pm SD for each group (n=5) and analyzed by Dunnett's test, which are shown in Table 2.

[Table 2]

Group	Plasma glucose (mg/dl)		
	0 min.	120 min.	240 min.
Control	119 \pm 9	241 \pm 58	137 \pm 10
Pioglitazone	102 \pm 12	136 \pm 17*	102 \pm 9*
Glibenclamide	118 \pm 12	222 \pm 61	106 \pm 24*
Pioglitazone + glibenclamide	108 \pm 3	86 \pm 10*	60 \pm 5*

30 *: P<0.01 vs. control group

It is apparent from Table 2 that the increase of blood sugar following glucose loading was remarkably inhibited by the combined administration of pioglitazone and glibenclamide as compared with the administration of either drug alone.

The pharmaceutical composition of the present invention shows a potent depressive effect on diabetic hyperglycemia and is useful for prophylaxis and treatment of diabetes. Moreover, this pharmaceutical composition is useful for prophylaxis and treatment of

diabetic complications such as diabetic neuropathy, nephropathy, retinopathy, macroangiopathy, and osteopenia. In addition, by appropriately selecting the kinds of component drugs, administration route, 5 dosage, etc. according to clinical status, stable hypoglycemic efficacy in long-term therapy can be expected with an extremely low risk of side effect.

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CLAIMS:

1. A pharmaceutical composition which comprises the following components:

5 (A) pioglitazone, or a pharmacologically acceptable salt thereof, and

(B) voglibose.

2. The pharmaceutical composition of claim 1, wherein the pharmacologically acceptable salt of pioglitazone is pioglitazone HCl.

10 3. The pharmaceutical composition according to claim 1 or 2, which is for use in the prophylaxis or treatment of diabetes.

4. The pharmaceutical composition according to claim 1 or 2, which is for use in the prophylaxis or treatment 15 of a diabetic complication.

5. The pharmaceutical composition according to claim 1 or 2, which is for use in the prophylaxis or treatment of a glycometabolism disorder.

6. A pharmaceutical composition for use in the prophylaxis or treatment of diabetes or a diabetic complication 20 of a human, which comprises the following components:

(A) pioglitazone or a pharmacologically acceptable salt thereof, and

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(B) voglibose, wherein the component (B) is contained in an amount of 0.0001 to 0.2 weight part per weight part of the component (A).

7. The pharmaceutical composition of claim 6, wherein
5 the pharmacologically acceptable salt of pioglitazone is
pioglitazone HCl.

8. The pharmaceutical composition according to
claim 6 or 7, wherein the component (B) is contained in an
amount of 0.001 to 0.02 weight part per weight part of the
10 component (A); and the composition further comprises at least
one pharmacologically acceptable member selected from the group
consisting of a carrier, an excipient, a binder and a diluent.

9. Use of a combination of (A) pioglitazone or a
pharmacologically acceptable salt thereof with (B) voglibose,
15 for the manufacture of a medicament.

10. The use according to claim 9, wherein the
pharmacologically acceptable salt of pioglitazone is
pioglitazone HCl.

11. The use according to claim 9 or 10, wherein the
20 medicament is for use in the prophylaxis or treatment of
diabetes.

12. The use according to claim 9 or 10, wherein the
medicament is for use in the prophylaxis or treatment of a
diabetic complication.

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13. The use according to claim 9 or 10, wherein the medicament is for use in the prophylaxis or treatment of a glycometabolism disorder.

14. Use of (A) pioglitazone for the manufacture of a
5 medicament comprising:

(A) pioglitazone, and

(B) voglibose, wherein the medicament is for use in the prophylaxis or treatment of diabetes, a diabetic complication or a glycometabolism disorder.

10 15. The use according to claim 14, wherein the pioglitazone is in the form of a pharmacologically acceptable salt.

16. The use according to claim 15, wherein the pharmacologically acceptable salt is pioglitazone HCl.

15 17. The use according to any one of claims 14 to 16, wherein the medicament is for use in the prophylaxis or treatment of diabetes.

18. The use according to any one of claims 14 to 16, wherein the medicament is for use in the prophylaxis or
20 treatment of a diabetic complication.

19. The use according to any one of claims 14 to 16, wherein the medicament is for use in the prophylaxis or treatment of a glycometabolism disorder.

20. Use of (B) voglibose, for the manufacture of a
25 medicament comprising:

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(A) pioglitazone, and

(B) voglibose, wherein the medicament is for use in the prophylaxis or treatment of diabetes, a diabetic complication or a glycometabolism disorder.

5 21. The use according to claim 20, wherein the pioglitazone is in the form of a pharmacologically acceptable salt.

22. The use according to claim 21, wherein the pharmacologically acceptable salt is pioglitazone HCl.

10 23. The use according to any one of claims 20 to 22, wherein the medicament is for use in the prophylaxis or treatment of diabetes.

24. The use according to any one of claims 20 to 22, wherein the medicament is for use in the prophylaxis or 15 treatment of a diabetic complication.

25. The use according to any one of claims 20 to 22, wherein the medicament is for use in the prophylaxis or treatment of a glycometabolism disorder.

26. Use of a combination of (A) pioglitazone, or a 20 pharmacologically acceptable salt thereof, and (B) voglibose, in the prophylaxis or treatment of diabetes, a diabetic complication, or a glycometabolism disorder.

27. The use according to claim 26, wherein the pharmacologically acceptable salt of pioglitazone is 25 pioglitazone HCl.

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28. The use according to claim 26 or 27 for the prophylaxis or treatment of diabetes.

29. The use according to claim 26 or 27 for the prophylaxis or treatment of a diabetic complication.

5 30. The use according to claim 26 or 27 for the prophylaxis or treatment of a glycometabolism disorder.

31. The use according to any one of claims 26 to 30, wherein (A) and (B) are present in a single formulation.

32. The use according to any one of claims 26 to 30,
10 which is a concurrent use of (A) and (B).

33. The use according to any one of claims 26 to 30, which is a staggered use at different times of (A) and (B).