

Description

Novel thiophene glycoside derivatives, methods for production thereof, medicaments comprising said compounds and use thereof

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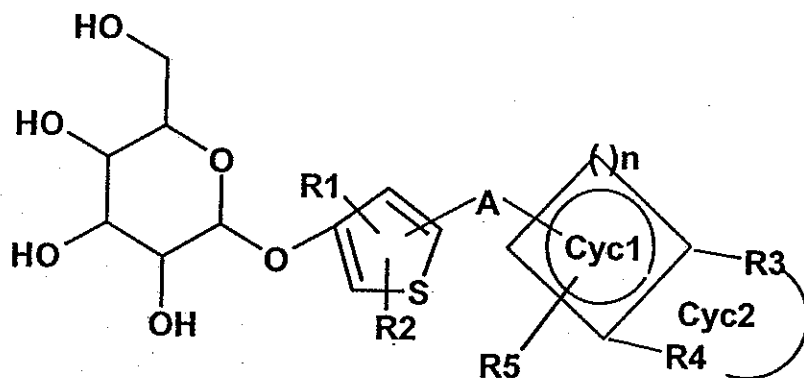
The invention relates to substituted thiophene glycoside derivatives, to the physiologically tolerated salts thereof and to physiologically functional derivatives.

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The antirheumatic tenidap (β -D-glucopyranoside uronic acid, 5-[(Z)-[1-(amino-carbonyl)-5-chloro-1,2-dihydro-2-oxo-3H-indol-3-ylidenehydroxymethyl-3-thienyl] (H.G. Fouda et al., CA: 1997:165448) is known, as are 3-amino-2-benzoyl-5-glucopyranosylaminothiophene compounds (J. Fuentes et al, Tetrahedron Asymmetry, 1998, 9, 2517-2532).

Compounds possible to prevent and treat type 1 and type 2 diabetes are disclosed.

A first aspect of the present invention provides a compound of the formula I



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in which

R1, R2 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, CO(C₁-C₆)-alkyl, COO(C₁-C₆)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₆)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₆)-alkoxy, HO-(C₁-C₈)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, phenyl, benzyl,

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(C₁-C₄)-alkylcarbonyl, where one, more than one or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;

SO₂-NH₂, SO₂NH(C₁-C₆)-alkyl, SO₂N[(C₁-C₆)-alkyl]₂, S-(C₁-C₆)-alkyl, S-(CH₂)_o-phenyl, SO-(C₁-C₆)-alkyl, SO-(CH₂)_o-phenyl, SO₂-(C₁-C₆)-alkyl, SO₂-(CH₂)_o-phenyl, where o may be 0-6 and the phenyl radical may be substituted up to twice by F, Cl, Br, OH, CF₃, NO₂, CN, OCF₃, (C₁-C₆)-alkoxy, (C₁-C₆)-alkyl, NH₂;

NH₂, NH-(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, NH(C₁-C₇)-acyl, phenyl, O-(CH₂)_o-phenyl, where o may be 0-6 and where the phenyl ring may be substituted one to 3 times by F, Cl, Br, I, OH, CF₃, NO₂, CN, OCF₃, (C₁-C₆)-alkoxy, (C₁-C₆)-alkyl, NH₂, NH(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, SO₂-CH₃, COOH, COO-(C₁-C₆)-alkyl, CONH₂;

A is (C₀-C₁₅)-alkanediyl, where one or more carbon atoms in the alkanediyl radical may be replaced independently of one another by -O-, -(C=O)-, -CH=CH-, -C≡C-, -S-, -CH(OH)-, -CHF-, -CF₂-, -(S=O)-, -(SO₂)-, -N((C₁-C₆)-alkyl)-, -N((C₁-C₆)-alkylphenyl)- or -NH-;

n is a number from 0 to 4;

Cyc1 is a 3- to 7-membered, saturated, partially saturated or unsaturated ring, where 1 carbon atom may be replaced by O or S;

R3, R4, R5 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, COO(C₁-C₆)-alkyl, CO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₈)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₁₂)-alkoxy, HO-(C₁-C₆)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, where one, more than one

or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;

SO₂-NH₂, SO₂NH(C₁-C₆)-alkyl, SO₂N[(C₁-C₆)-alkyl]₂, S-(C₁-C₆)-alkyl, S-(CH₂)_o-phenyl, SO-(C₁-C₆)-alkyl, SO-(CH₂)_o-phenyl, SO₂-(C₁-C₆)-alkyl, SO₂-(CH₂)_o-phenyl, where o may be 0-6 and the phenyl radical may be substituted up to twice by F, Cl, Br, OH, CF₃, NO₂, CN, OCF₃, (C₁-C₆)-alkoxy, (C₁-C₆)-alkyl, NH₂;

NH₂, NH-(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, NH(C₁-C₇)-acyl, phenyl, (CH₂)_o-phenyl, O-(CH₂)_o-phenyl, where o may be 0-6 and where the phenyl ring may be substituted one to 3 times by F, Cl, Br, I, OH, CF₃, NO₂, CN, OCF₃, (C₁-C₈)-alkoxy, (C₁-C₆)-alkyl, NH₂, NH(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, SO₂-CH₃, COOH, COO-(C₁-C₆)-alkyl, CONH₂;

or

R3 and R4 together with the carbon atoms carrying them are a 5- to 7-membered, saturated, partially or completely unsaturated ring Cyc2, where 1 or 2 carbon atom(s) in the ring may also be replaced by N, O or S, and Cyc2 may optionally be substituted by (C₁-C₆)-alkyl, (C₂-C₅)-alkenyl, (C₂-C₅)-alkynyl, where in each case one CH₂ group may be replaced by O, or substituted by H, F, Cl, OH, CF₃, NO₂, CN, COO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₄)-alkyl, OCF₃; and

R5 is hydrogen;

and the pharmaceutically acceptable salts thereof.

A second aspect of the present invention provides a medicament comprising one or more of the compounds of formula I as defined above.

A third aspect of the present invention provides a medicament comprising one or more of the compounds of formula I as defined above and one or more blood glucose-lowering active ingredients.

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A fourth aspect of the present invention provides the use of the compounds of formula I as defined above for producing a medicament for the treatment of type 1 and type 2 diabetes.

A fifth aspect of the present invention provides the use of the compounds of formula I as defined above for producing a medicament for lowering blood glucose.

A sixth aspect of the present invention provides the use of the compounds of formula I as defined above in combination with at least one other blood glucose-lowering active ingredient for producing a medicament for the treatment of type 1 and type 2 diabetes.

A seventh aspect of the present invention provides the use of the compounds of formula I as defined above in combination with at least one other blood glucose-lowering active ingredient for producing a medicament for lowering blood glucose.

An eighth aspect of the present invention provides a process for producing a medicament comprising one or more of the compounds of formula I as defined above which comprises mixing the active ingredient with a pharmaceutically suitable carrier and converting this mixture into a form suitable for administration.

- 25 Compounds of the formula I in which A is linked to the thienyl ring in position 2 are preferred.

Preference is further given to compounds of formula I in which

R1, R2 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, CO(C₁-C₆)-alkyl, COO(C₁-C₆)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₈)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₆)-alkoxy, HO-(C₁-C₆)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, phenyl, benzyl, (C₁-C₄)-alkylcarbonyl, SO-(C₁-C₆)-alkyl, where one, more than one or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;

A is (C₀-C₁₅)-alkanediyl, where one or more carbon atom(s) in the alkanediyl radical may be replaced independently of one another by -O-, -(C=O)-, -CH=CH-, -C≡C-, -S-, -CH(OH)-, -CHF-, -CF₂-, -(S=O)-, -(SO₂)-, -N((C₁-C₆)-alkyl)-, -N((C₁-C₆)-alkylphenyl)- or -NH-;

n is a number 2 or 3;

Cyc1 is a 5- to 6-membered, saturated, partially saturated or unsaturated ring, where 1 carbon atom may be replaced by O or S;

R3, R4, R5 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, COO(C₁-C₆)-alkyl, CO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₈)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₁₂)-alkoxy, HO-(C₁-C₆)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, (C₁-C₄)-alkylphenyl, (C₁-C₄)-alkoxyphenyl, S-(C₁-C₆)-alkyl, SO-(C₁-C₆)-alkyl, where one, more than one or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;

or

R3 and R4 together with the carbon atoms carrying them are a 5- to 7-membered, saturated, partially or completely unsaturated ring Cyc2, where 1 or 2 carbon atom(s) in the ring may also be replaced by N, O or S, and Cyc2 may optionally be substituted by (C₁-C₆)-alkyl, (C₂-C₅)-alkenyl,

(C₂-C₅)-alkynyl, where in each case one CH₂ group may be replaced by O, or substituted by H, F, Cl, OH, CF₃, NO₂, CN, COO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₄)-alkyl, OCF₃, and

R₅ is hydrogen.

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Particular preference is given to compounds of the formula I in which

R₁, R₂ are hydrogen, (C₁-C₆)-alkyl, (C₁-C₄)-alkoxy, HO-(C₁-C₄)-alkyl, (C₁-C₄)-alkoxy-(C₁-C₄)-alkyl, F, Cl, CF₃, OCF₃, OCH₂CF₃ (C₁-C₄)-alkyl-CF₂-, phenyl, benzyl, (C₁-C₄)-alkylcarbonyl, (C₂-C₄)-alkenyl, (C₂-C₄)-alkynyl, COO(C₁-C₄)-alkyl;

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A is -CH=CH-CH₂- or (C₁-C₄)-alkanediyl, where one or two CH₂ groups may also be replaced by -(C=O)-, -CH=CH-, -CH(OH)-, -NH-, -CHF-, -CF₂-, -O-;

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n is a number 2 or 3;

Cyc1 is unsaturated ring, where 1 carbon atom may be replaced by O or S;

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R₃, R₄, R₅ are hydrogen, F, Cl, Br, I, NO₂, OH, CN, (C₁-C₆)-alkyl, (C₁-C₈)-alkoxy, OCF₃, OCH₂CF₃, S-(C₁-C₄)-alkyl, COOH, HO-(C₁-C₄)-alkyl, (C₁-C₄)-alkoxy-(C₁-C₄)-alkyl, (C₁-C₂)-alkylphenyl, (C₁-C₂)-alkoxyphenyl, or

25 R₃ and R₄ together are -CH=CH-O-, -CH=CH-S-, -O-(CH₂)_p-O-, with p = 1 or 2, -O-CF₂-O-, -CH=CH-CH=CH-, and

R₅ is hydrogen.

Compounds of the formula I in which R2 is hydrogen are further particularly preferred.

Very particular preference is given to compounds of the formula I in which

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R1 is hydrogen, CF₃, (C₁-C₄)-alkyl, phenyl,

R2 is hydrogen,

10 A is -CH₂-, -C₂H₄-, -C₃H₆-, -CH(OH)-, -(C=O)-, -CH=CH-, -CH=CH-CH₂-,
-CO-CH₂-CH₂- or -CO-NH-CH₂-;

n is a number 2 or 3;

15 Cyc1 is unsaturated ring, where 1 carbon atom may be replaced by S;

R3, R4, R5 are hydrogen, F, Cl, I, NO₂, OH, CN, (C₁-C₆)-alkyl, (C₁-C₈)-alkoxy,
O-CH₂-phenyl, OCF₃, S-CH₃, COOH or

20 R3 and R4 together are -CH=CH-O-, -O-(CH₂)_p-O-, with p = 1 or 2, -O-CF₂-O-,
-CH=CH-CH=CH-, and

R5 is hydrogen.

25 Particular preference is further given to compounds of the formula I in which

A is -CH₂- or -CH₂-CH₂-, or

Cyc1 is phenyl, or

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Cyc1 is thienyl.

Mention may further be made in particular of compounds of the formula I in which

- Cyc1 is monosubstituted, or
- Cyc1 is para-substituted, or
- 5 Cyc1 is meta-substituted.

Compounds of the formula I in the form of their racemates, racemic mixtures and pure enantiomers, and to their diastereomers and mixtures thereof are further disclosed.

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The alkyl radicals, including alkoxy, alkenyl and alkynyl, in the substituents R1, R2, R3, R4 and R5 may be either straight-chain or branched.

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The sugar residues in the compounds of the formula I are either L- or D-sugars in their alpha (α) and beta (β) form, such as, for example, allose, altrose, glucose, mannose, gulose, idose, galactose, talose. Those which may be mentioned as preferred are: β -glucose, β -galactose, β -allose and α -mannose, particularly preferably β -glucose, β -allose and α -mannose, very particularly preferably β -glucose.

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Pharmaceutically acceptable salts are particularly suitable for medical applications because of their greater solubility in water compared with the starting or base compounds. These salts must have a pharmaceutically acceptable anion or cation. Suitable pharmaceutically acceptable acid addition salts of the compounds of the invention are salts of inorganic acids such as hydrochloric acid, hydrobromic,

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phosphoric, metaphosphoric, nitric and sulfuric acids, and of organic acids such as, for example, acetic acid, benzenesulfonic, benzoic, citric, ethanesulfonic, fumaric, gluconic, glycolic, isethionic, lactic, lactobionic, maleic, malic, methanesulfonic, succinic, p-toluenesulfonic and tartaric acids. Suitable pharmaceutically acceptable basic salts are ammonium salts, alkali metal salts (such as sodium and potassium

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salts) and alkaline earth metal salts (such as magnesium and calcium salts), and salts of trometamol (2-amino-2-hydroxymethyl-1,3-propanediol), diethanolamine, lysine or ethylenediamine.

Salts with a pharmaceutically unacceptable anion such as, for example, trifluoroacetate likewise belong within the scope of the invention as useful intermediates for the preparation or purification of pharmaceutically acceptable salts and/or for use in nontherapeutic, for example in vitro, applications.

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The term "physiologically functional derivative" used herein refers to any physiologically tolerated derivative of a compound of the formula I of the invention, for example an ester which is able, on administration to a mammal such as, for example, to a human, to form (directly or indirectly) a compound of the formula I or an active metabolite thereof.

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Physiologically functional derivatives also include prodrugs of the compounds of the invention, as described, for example, in H. Okada et al., Chem. Pharm. Bull. 1994, 42, 57-61. Such prodrugs can be metabolized in vivo to a compound of the invention.

15 These prodrugs may themselves have activity or not.

The compounds of the invention may also exist in various polymorphous forms, for example as amorphous and crystalline polymorphous forms. All polymorphous forms of the compounds of the invention belong within the scope of the invention and are a further aspect of the invention.

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All references hereinafter to "compound(s) of formula I" refer to compound(s) of the formula I as described above, and to the salts, solvates and physiologically functional derivatives thereof as described herein.

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The amount of a compound of formula I necessary to achieve the desired biological effect depends on a number of factors, for example the specific compound chosen, the intended use, the mode of administration and the clinical condition of the patient. The daily dose is generally in the range from 0.3 mg to 100 mg (typically from 3 mg to 50 mg) per day and per kilogram of bodyweight, for example 3-10 mg/kg/day. An intravenous dose may be, for example, in the range from 0.3 mg to 1.0 mg/kg, which can suitably be administered as infusion of 10 ng to 100 ng per kilogram and per minute. Suitable infusion solutions for these purposes may contain, for example, from 0.1 ng to 10 mg, typically from 1 ng to 10 mg, per milliliter. Single doses may contain,

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for example, from 1 mg to 10 g of the active ingredient. Thus, ampoules for injections may contain, for example, from 1 mg to 100 mg, and single-dose formulations which can be administered orally, such as, for example, tablets or capsules, may contain, for example, from 1.0 to 1000 mg, typically from 10 to 600 mg. For the therapy of the

5 abovementioned conditions, the compounds of formula I may be used as the compound itself, but they are preferably in the form of a pharmaceutical composition with an acceptable carrier. The carrier must, of course, be acceptable in the sense that it is compatible with the other ingredients of the composition and is not harmful for the patient's health. The carrier may be a solid or a liquid or both and is preferably

10 formulated with the compound as a single dose, for example as a tablet, which may contain from 0.05% to 95% by weight of the active ingredient. Other pharmaceutically active substances may likewise be present, including other compounds of formula I. The pharmaceutical compositions of the invention can be produced by one of the known pharmaceutical methods, which essentially consist of mixing the ingredients

15 with pharmacologically acceptable carriers and/or excipients.

Pharmaceutical compositions of the invention are those suitable for oral, rectal, topical, peroral (for example sublingual) and parenteral (for example subcutaneous, intramuscular, intradermal or intravenous) administration, although the most suitable

20 mode of administration depends in each individual case on the nature and severity of the condition to be treated and on the nature of the compound of formula I used in each case. Coated formulations and coated slow-release formulations also belong within the framework of the invention. Preference is given to acid- and gastric juice-resistant formulations. Suitable coatings resistant to gastric juice comprise cellulose

25 acetate phthalate, polyvinyl acetate phthalate, hydroxypropylmethylcellulose phthalate and anionic polymers of methacrylic acid and methyl methacrylate.

Suitable pharmaceutical compounds for oral administration may be in the form of separate units such as, for example, capsules, wafers, suckable tablets or tablets,

30 each of which contain a defined amount of the compound of formula I; as powders or granules, as solution or suspension in an aqueous or nonaqueous liquid; or as an oil-in-water or water-in-oil emulsion. These compositions may, as already mentioned, be prepared by any suitable pharmaceutical method which includes a step in which the active ingredient and the carrier (which may consist of one or more additional

ingredients) are brought into contact. The compositions are generally produced by uniform and homogeneous mixing of the active ingredient with a liquid and/or finely divided solid carrier, after which the product is shaped if necessary. Thus, for example, a tablet can be produced by compressing or molding a powder or granules of the compound, where appropriate with one or more additional ingredients.

Compressed tablets can be produced by tableting the compound in free-flowing form such as, for example, a powder or granules, where appropriate mixed with a binder, glidant, inert diluent and/or one or more surface-active/dispersing agent(s) in a suitable machine. Molded tablets can be produced by molding the compound which is in powder form and is moistened with an inert liquid diluent in a suitable machine.

Pharmaceutical compositions which are suitable for peroral (sublingual) administration comprise suckable tablets which contain a compound of formula I with a flavoring, normally sucrose and gum arabic or tragacanth, and pastilles which comprise the compound in an inert base such as gelatin and glycerol or sucrose and gum arabic.

Pharmaceutical compositions suitable for parenteral administration comprise preferably sterile aqueous preparations of a compound of formula I, which are preferably isotonic with the blood of the intended recipient. These preparations are preferably administered intravenously, although administration may also take place by subcutaneous, intramuscular or intradermal injection. These preparations can preferably be produced by mixing the compound with water and making the resulting solution sterile and isotonic with blood. Injectable compositions of the invention generally contain from 0.1 to 5% by weight of the active compound.

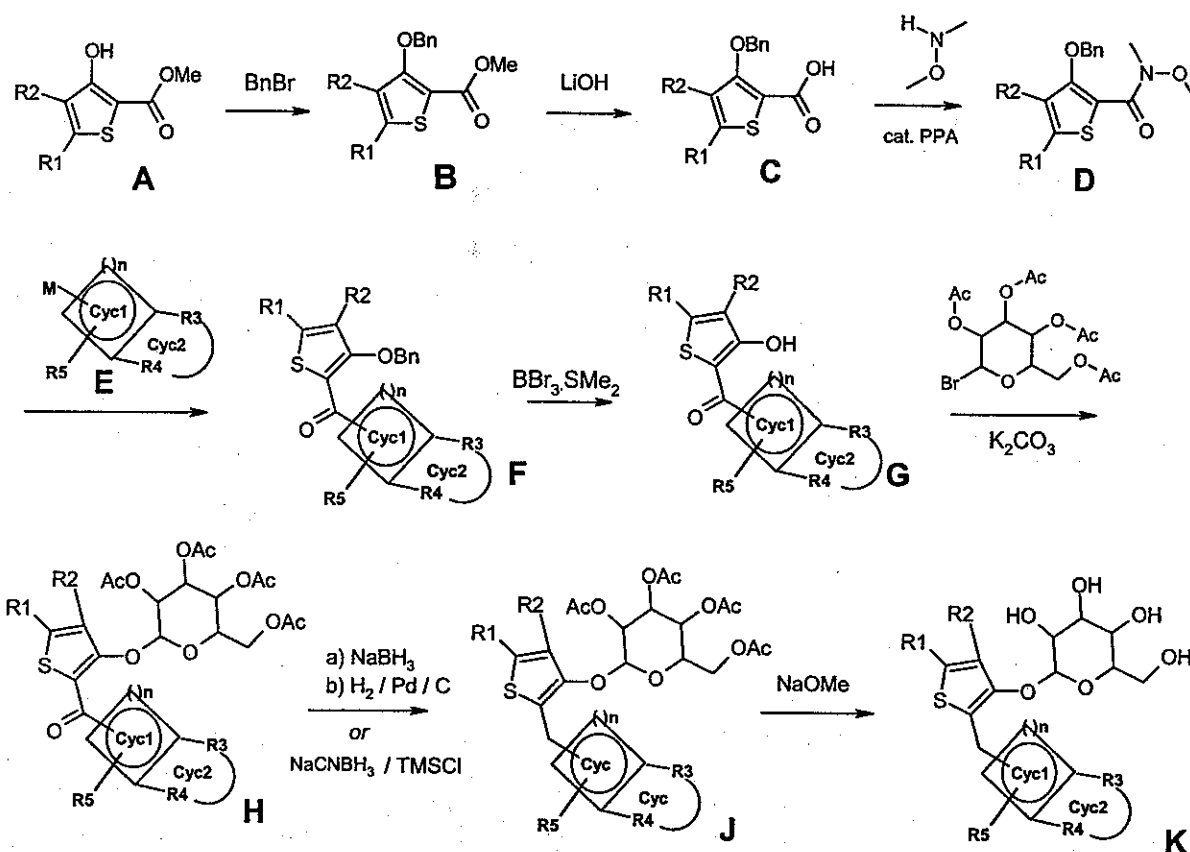
Pharmaceutical compositions suitable for rectal administration are preferably in the form of single-dose suppositories. These can be produced by mixing a compound of the formula I with one or more conventional solid carriers, for example cocoa butter, and shaping the resulting mixture.

Pharmaceutical compositions suitable for topical use on the skin are preferably in the form of ointment, crème, lotion, paste, spray, aerosol or oil. Carriers which can be used are petrolatum, lanolin, polyethylene glycols, alcohols and combinations of two

or more of these substances. The active ingredient is generally present in a concentration of from 0.1 to 15% by weight of the composition, for example from 0.5 to 2%.

- 5 Transdermal administration is also possible. Pharmaceutical compositions suitable for transdermal uses can be in the form of single plasters which are suitable for long-term close contact with the patient's epidermis. Such plasters suitably contain the active ingredient in an aqueous solution which is buffered where appropriate, dissolved and/or dispersed in an adhesive or dispersed in a polymer. A suitable active ingredient concentration is about 1% to 35%, preferably about 3% to 15%. A particular possibility is for the active ingredient to be released by electrotransport or iontophoresis as described, for example, in *Pharmaceutical Research*, 2(6): 318 (1986).
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- 15 The invention further relates to processes for preparing the compounds of the formula I which can be obtained in accordance with the following reaction schemes A, B, C, D and E:

Process A:



The compound of the formula A where R1 and R2 have the meanings described above is deprotonated with CsCO_3 or another suitable base in DMF and then reacted with benzyl bromide, resulting in a compound of the formula B.

- 5 The compound B is dissolved in a mixture of methanol, tetrahydrofuran and water and converted into the compound of the formula C by reaction with lithium hydroxide.

The compound C is converted with N,O-dimethylhydroxylamine using propanephosphonic anhydride or another suitable activating reagent for forming amide linkages into the compound of the formula D.

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- The compound D is dissolved with an organometallic compound of the formula E where M is Li, MgCl, MgBr, and Cyc1, Cyc2, n, R3, R4, R5 have the meanings described above in tetrahydrofuran and, while cooling in ice, a Lewis acid (LA), preferably tin tetrachloride or aluminum trichloride, is added to convert into the compound of the formula F.
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To eliminate the benzyl ether, either compound F is dissolved in methylene chloride and reacted with BBr_3 -dimethyl sulfide complex, or compound F is dissolved in methanol and stirred under a hydrogen atmosphere with palladium on carbon, and the compound of the formula G is obtained.

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The compound G is converted with 4,5-diacetoxy-6-acetoxymethyl-2-bromo-tetrahydropyran-3-yl acetate and potassium carbonate in a mixture of methylene chloride and water into the compound of the formula H.

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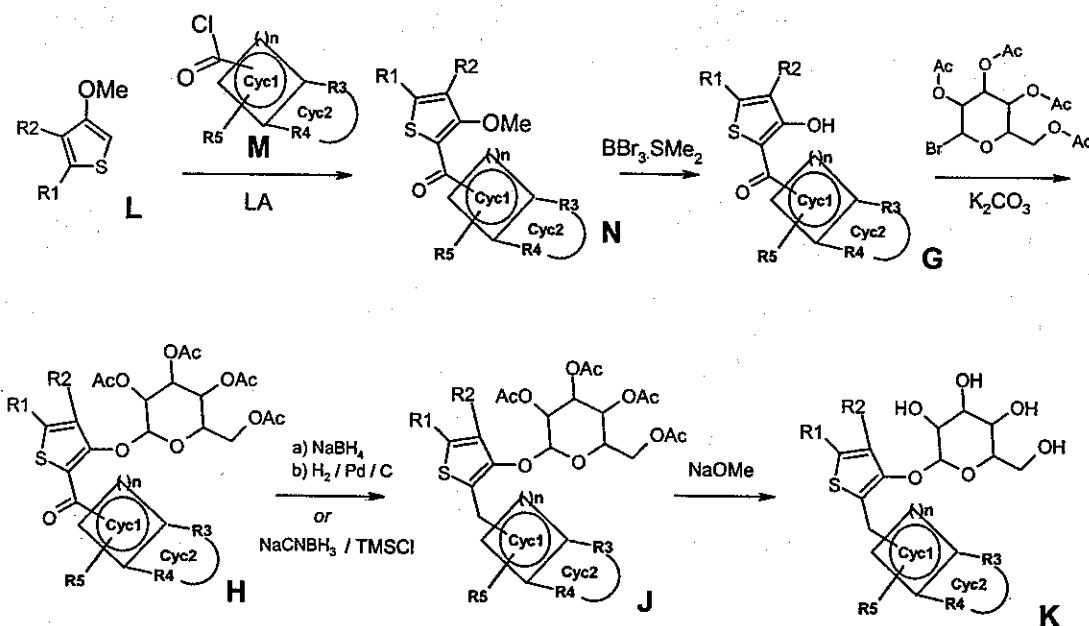
Either compound H is first reacted with sodium borohydride in a mixture of methanol and tetrahydrofuran and then converted in ethanol under a hydrogen atmosphere in the presence of palladium on carbon into the compound of the formula J, or compound H is dissolved in acetonitrile and converted directly to the compound of the formula J in a mixture of sodium cyanoborohydride and chlorotrimethylsilane.

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The compound J is dissolved in methanol and reacted with sodium methanolate, resulting in the compound of the formula K.

The compounds of examples 51 to 54 are synthesized using this process.

Process B:



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The compound of the formula L where R1 and R2 have the meanings described above is dissolved in methylene chloride and, while cooling in ice, reacted with a compound of the formula M, where Cyc1, Cyc2, n, R3, R4, R5 have the meanings described above, to give the compound of the formula N.

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The compound N is dissolved in methylene chloride and reacted with BBr_3 -dimethyl sulfide complex, and the compound of the formula G is obtained in this way.

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The compound G is converted with 4,5-diacetoxy-6-acetoxymethyl-2-bromo-tetrahydropyran-3-yl acetate and potassium carbonate in a mixture of methylene chloride and water into the compound of the formula H.

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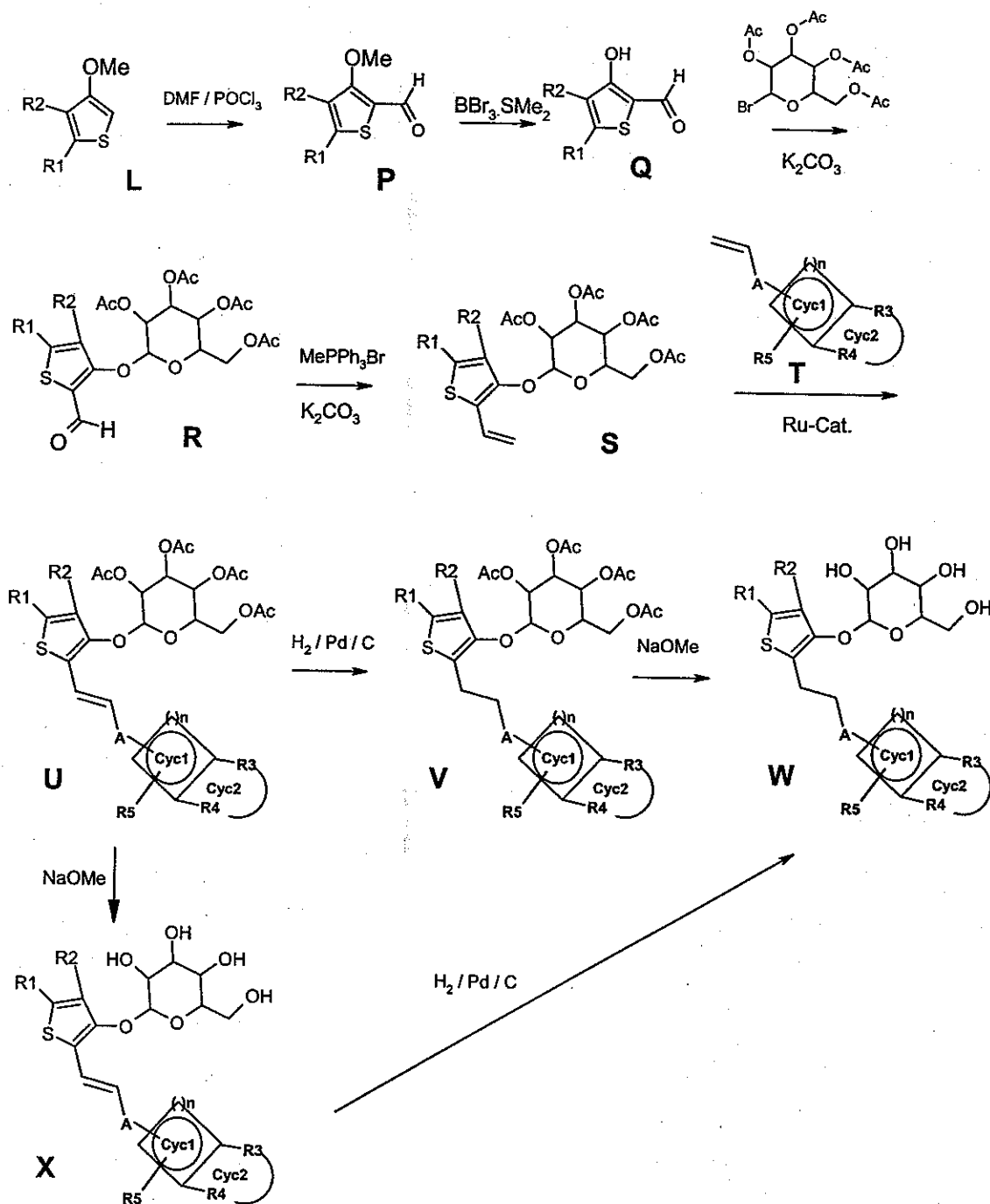
Either compound H is first reacted with sodium borohydride in a mixture of methanol and tetrahydrofuran and then converted in ethanol under a hydrogen atmosphere in the presence of palladium on carbon into the compound of the formula J, or compound H is dissolved in acetonitrile and converted directly to the compound of the formula J in a mixture of sodium cyanoborohydride and chlorotrimethylsilane.

The compound J is dissolved in methanol and reacted with sodium methanolate, resulting in the compound of the formula K.

The compounds of examples 7 to 34 are synthesized using this process.

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Process C:



The compound of the formula L where R1 and R2 have the meanings described above is dissolved in DMF, and phosphoryl chloride is added, resulting in a compound of the formula P.

- 5 The compound P is dissolved in methylene chloride and reacted with BBr₃-dimethyl sulfide complex, and the compound of the formula Q is obtained in this way.

10 The compound Q is converted with 4,5-diacetoxy-6-acetoxymethyl-2-bromo-tetrahydropyran-3-yl acetate and potassium carbonate in a mixture of methylene chloride and water into the compound of the formula R.

○ The compound R is dissolved in dioxane and converted with methyltriphenylphosphonium bromide and potassium carbonate into the compound of the formula S.

- 15 The compound S is converted in the presence of the ruthenium catalyst tricyclohexylphosphine-[1,3-bis(2,4,6-trimethylphenyl)-4,5-dihydroimidazol-2-ylidene][benzylidene]ruthenium(IV) dichloride in dichloromethane with the compound of the formula T, where A, Cyc1, Cyc2, n, R3, R4, R5 have the meanings described above, into the compound of the formula U.

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○ The compound U is dissolved in methanol and reacted with sodium methanolate, resulting in the compound of the formula X.

- 25 Alternatively, the compound U can be converted in methanol under a hydrogen atmosphere in the presence of palladium on carbon into the compound of the formula V.

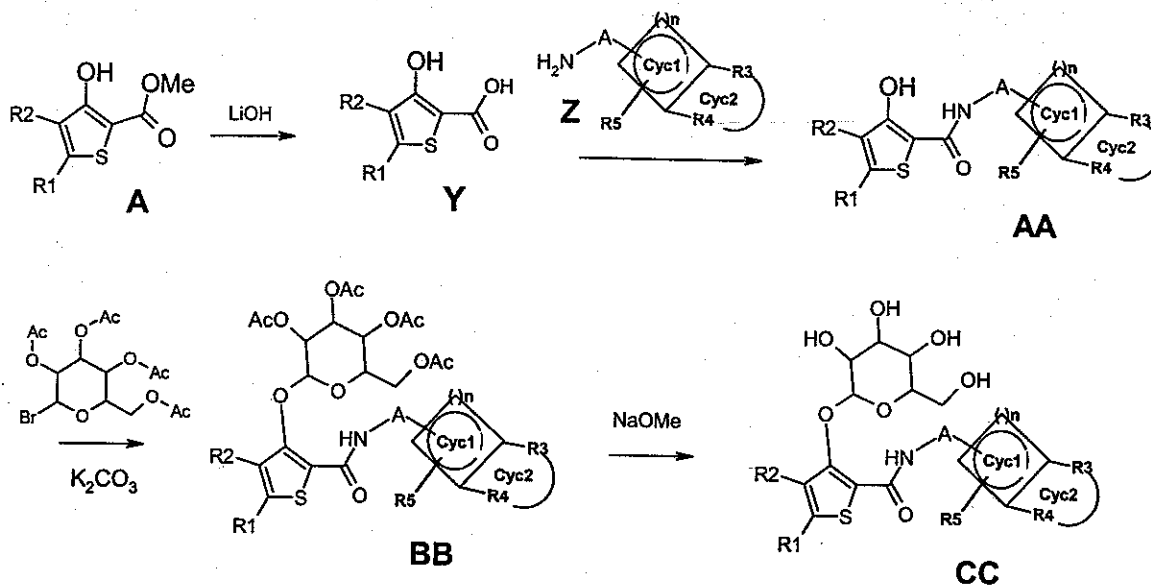
The compound V is dissolved in methanol and reacted with sodium methanolate, resulting in the compound of the formula W.

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Alternatively, W can also be obtained by hydrogenolysis of X. This is done by treating X in methanol and in the presence of palladium on carbon under a hydrogen atmosphere.

The compounds of examples 36 to 50 are synthesized using this process.

Process D:



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The compound of the formula A where R_1 and R_2 have the meanings described above is dissolved in a mixture of methanol, tetrahydrofuran and water and converted by reaction with lithium hydroxide into the compound of the formula Y.

- 10 The compound Y is dissolved with a compound of the formula Z where A, Cyc1, Cyc2, n, R_3 , R_4 , R_5 have the meanings described above in tetrahydrofuran and, while cooling in ice, the compound is converted using propanephosphonic anhydride or another suitable activating reagent for forming amide linkages into the compound of the formula AA.

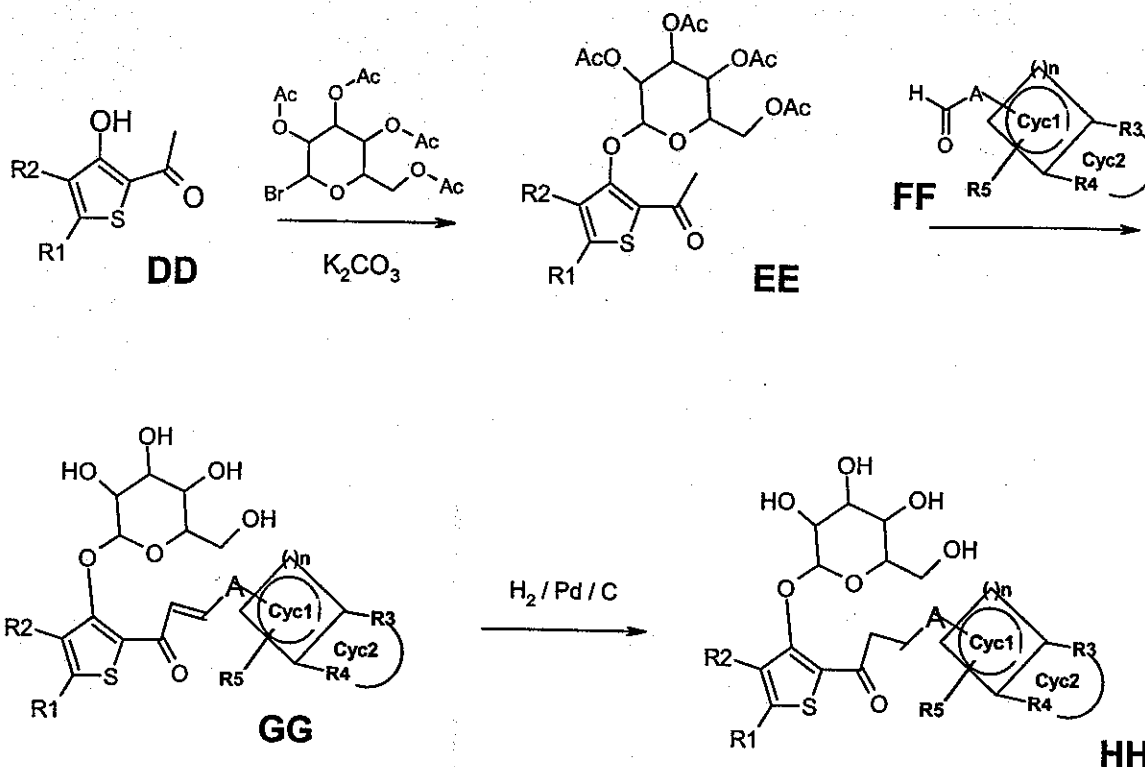
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The compound AA is converted with 4,5-diacetoxy-6-acetoxymethyl-2-bromo-tetrahydropyran-3-yl acetate and potassium carbonate in a mixture of methylene chloride and water into the compound of the formula BB.

- 20 The compound BB is dissolved in methanol and reacted with sodium methanolate, resulting in the compound of the formula K.

The compounds of examples 55 to 58 were synthesized using this process.

Process E:



- 5 The compound DD is converted with 4,5-diacetoxy-6-acetoxymethyl-2-bromo-tetrahydropyran-3-yl acetate and potassium carbonate in a mixture of methylene chloride and water into the compound of the formula EE.

- 10 The compound EE is dissolved in methanol, and sodium methanolate in methanol is added. A compound of the formula FF where A, Cyc1, Cyc2, n, R₃, R₄, R₅ have the meanings described above is added, and a compound of the formula GG is obtained.

The compound GG is converted in methanol under a hydrogen atmosphere in the presence of palladium on carbon into the compound of formula HH.

- 15 The compounds of examples 1 to 6 are synthesized using this process.

Other compounds of the formula I can be prepared correspondingly or by known processes.

- 20 The compound(s) of the formula (I) can also be administered in combination with further active ingredients.

Further active ingredients suitable for combination products are:

all antidiabetics mentioned in chapter 12 of the Rote Liste 2001. They may be combined with the compounds of the formula I of the invention in particular for synergistic improvement of the effect. Administration of the active ingredient

5 combination may take place either by separate administration of the active ingredients to the patients or in the form of combination products in which a plurality of active ingredients are present in one pharmaceutical preparation. Most of the active ingredients listed below are disclosed in USP Dictionary of USAN and International Drug Names, US Pharmacopeia, Rockville 2001.

10 Antidiabetics include insulin and insulin derivatives such as, for example, Lantus[®] (see www.lantus.com) or HMR 1964, fast-acting insulins (see US 6,221,633), GLP-1 derivatives such as, for example, those disclosed in WO 98/08871 of Novo Nordisk A/S, and orally active hypoglycemic active ingredients.

The orally active hypoglycemic active ingredients include, preferably, sulfonylureas,
15 biguanides, meglitinides, oxadiazolidinediones, thiazolidinediones, glucosidase inhibitors, glucagon antagonists, GLP-1 agonists, potassium channel openers such as, for example, those disclosed in WO 97/26265 and WO 99/03861 of Novo Nordisk A/S, insulin sensitizers, inhibitors of liver enzymes involved in the stimulation of gluconeogenesis and/or glycogenolysis, modulators of glucose uptake, compounds
20 which alter lipid metabolism, such as antihyperlipidemic active ingredients and antilipidemic active ingredients, compounds which reduce food intake, PPAR and PXR agonists and active ingredients which act on the ATP-dependent potassium channel of the beta cells.

25 In one embodiment of the invention, the compounds of the formula I are administered in combination with an HMG-CoA reductase inhibitor such as simvastatin, fluvastatin, pravastatin, lovastatin, atorvastatin, cerivastatin, rosuvastatin.

In one embodiment of the invention, the compounds of the formula I are administered
30 in combination with a cholesterol absorption inhibitor such as, for example, ezetimibe, tiqueside, pamaqueside.

In one embodiment of the invention, the compounds of the formula I are administered in combination with a PPAR gamma agonist such as, for example, rosiglitazone, pioglitazone, JTT-501, GI 262570.

- 5 In one embodiment of the invention, the compounds of the formula I are administered in combination with PPAR alpha agonist such as, for example, GW 9578, GW 7647.

- In one embodiment of the invention, the compounds of the formula I are administered in combination with a mixed PPAR alpha/gamma agonist such as, for example, GW
10 1536, AVE 8042, AVE 8134, AVE 0847, or as described in WO 00/64888, WO 00/64876, DE 10142734.4.

- In one embodiment of the invention, the compounds of the formula I are administered in combination with a fibrate such as, for example, fenofibrate, clofibrate, bezafibrate.
15

In one embodiment of the invention, the compounds of the formula I are administered in combination with an MTP inhibitor such as, for example, implitapide, BMS-201038, R-103757.

- 20 In one embodiment of the invention, the compounds of the formula I are administered in combination with bile acid adsorption inhibitor (see e.g. US 6,245,744 or US 6,221,897), such as, for example, HMR 1741.

- In one embodiment of the invention, the compounds of the formula I are administered
25 in combination with a CETP inhibitor such as, for example, JTT-705.

In one embodiment of the invention, the compounds of the formula I are administered in combination with a polymeric bile acid adsorbent such as, for example, cholestyramine, colestesvelam.

30

In one embodiment of the invention, the compounds of the formula I are administered in combination with an LDL receptor inducer (see US 6,342,512) such as, for example, HMR1171, HMR1586.

In one embodiment of the invention, the compounds of the formula I are administered in combination with an ACAT inhibitor such as, for example, avasimibe.

5 In one embodiment of the invention, the compounds of the formula I are administered in combination with an antioxidant such as, for example, OPC-14117.

In one embodiment of the invention, the compounds of the formula I are administered in combination with a lipoprotein lipase inhibitor such as, for example, NO-1886.

10 In one embodiment of the invention, the compounds of the formula I are administered in combination with an ATP citrate lyase inhibitor such as, for example, SB-204990.

15 In one embodiment of the invention, the compounds of the formula I are administered in combination with a squalene synthetase inhibitor such as, for example, BMS-188494.

20 In one embodiment of the invention, the compounds of the formula I are administered in combination with a lipoprotein(a) antagonist such as, for example, CI-1027 or nicotinic acid.

In one embodiment of the invention, the compounds of the formula I are administered in combination with a lipase inhibitor such as, for example, orlistat.

25 In one embodiment of the invention, the compounds of the formula I are administered in combination with insulin.

In one embodiment, the compounds of the formula I are administered in combination with a sulfonylurea such as, for example, tolbutamide, glibenclamide, glipizide or glimepiride.

30 In one embodiment, the compounds of the formula I are administered in combination with a biguanide such as, for example, metformin.

In another embodiment, the compounds of the formula I are administered in combination with a meglitinide such as, for example, repaglinide.

In one embodiment, the compounds of the formula I are administered in combination with a thiazolidinedione such as, for example, troglitazone, ciglitazone, pioglitazone, rosiglitazone or the compounds disclosed in WO 97/41097 of Dr. Reddy's Research Foundation, in particular 5-[[4-[(3,4-dihydro-3-methyl-4-oxo-2-quinazolinylmethoxy)-phenyl]methyl]-2,4-thiazolidinedione.

In one embodiment, the compounds of the formula I are administered in combination with an α -glucosidase inhibitor such as, for example, miglitol or acarbose.

In one embodiment, the compounds of the formula I are administered in combination with an active ingredient which acts on the ATP-dependent potassium channel of the beta cells, such as, for example, tolbutamide, glibenclamide, glipizide, glimepiride or repaglinide.

In one embodiment, the compounds of the formula I are administered in combination with more than one of the aforementioned compounds, for example in combination with a sulfonylurea and metformin, a sulfonylurea and acarbose, repaglinide and metformin, insulin and a sulfonylurea, insulin and metformin, insulin and troglitazone, insulin and lovastatin, etc.

In a further embodiment, the compounds of the formula I are administered in combination with CART modulators (see "Cocaine-amphetamine-regulated transcript influences energy metabolism, anxiety and gastric emptying in mice" Asakawa, A, et al., *M.:Hormone and Metabolic Research* (2001), 33(9), 554-558), NPY antagonists e.g. naphthalene-1-sulfonic acid {4-[(4-amino-quinazolin-2-ylamino)-methyl]-cyclohexylmethyl}-amide; hydrochloride (CGP 71683A)), MC4 agonists (e.g. 1-amino-1,2,3,4-tetrahydro-naphthalene-2-carboxylic acid [2-(3a-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(4-chloro-phenyl)-2-oxo-ethyl]-amide; (WO 01/91752)), orexin antagonists (e.g. 1-(2-methyl-benzoxazol-6-yl)-3-[1,5]naphthyridin-4-yl-urea; hydrochloride (SB-334867-A)), H3 agonists (3-cyclohexyl-1-(4,4-dimethyl-1,4,6,7-tetrahydro-imidazo[4,5-c]pyridin-5-yl)-propan-1-one oxalic acid salt (WO 00/63208)); TNF agonists, CRF antagonists (e.g. [2-methyl-9-(2,4,6-trimethyl-phenyl)-9H-1,3,9-triaza-fluoren-4-yl]-dipropyl-amine (WO 00/66585)), CRF BP antagonists (e.g. urocortin), urocortin agonists, β 3 agonists (e.g. 1-(4-chloro-3-methanesulfonylmethyl-phenyl)-2-[2-(2,3-dimethyl-1H-indol-6-yloxy)-ethylamino]-ethanol; hydrochloride (WO 01/83451)), MSH (melanocyte-stimulating hormone) agonists, CCK-A agonists (e.g. {2-[4-(4-chloro-2,5-dimethoxy-

phenyl)-5-(2-cyclohexyl-ethyl)-thiazol-2-ylcarbamoyl]-5,7-dimethyl-indol-1-yl}-acetic acid trifluoroacetic acid salt (WO 99/15525)); serotonin-reuptake inhibitors (e.g. dexfenfluramine), mixed serotoninergic and noradrenergic compounds (e.g. WO 00/71549), 5HT agonists e.g. 1-(3-ethyl-benzofuran-7-yl)-piperazine oxalic acid salt (WO 01/09111), bombesin agonists, galanin antagonists, growth hormone (e.g. human growth hormone), growth hormone-releasing compounds (6-benzyloxy-1-(2-diisopropylamino-ethylcarbamoyl)-3,4-dihydro-1H-isoquinoline-2-carboxylic acid tert-butyl ester (WO 01/85695)), TRH agonists (see e.g. EP 0 462 884), uncoupling protein 2 or 3 modulators, leptin agonists (see e.g. Lee, Daniel W.; Leinung, Matthew C.; Rozhavskaya-Arena, Marina; Grasso, Patricia. Leptin agonists as a potential approach to the treatment of obesity. *Drugs of the Future* (2001), 26(9), 873-881), DA agonists (bromocriptine, doprexin), lipase/amylase inhibitors (e.g. WO 00/40569), PPAR modulators (e.g. WO 00/78312), RXR modulators or TR- β agonists.

15

In one embodiment of the invention, the other active ingredient is leptin; see e.g. "Perspectives in the therapeutic use of leptin", Salvador, Javier; Gomez-Ambrosi, Javier; Fruhbeck, Gema, *Expert Opinion on Pharmacotherapy* (2001), 2(10), 1615-1622.

20

In one embodiment, the other active ingredient is dexamphetamine or amphetamine.
In one embodiment, the other active ingredient is fenfluramine or dexfenfluramine.
In a further embodiment, the other active ingredient is sibutramine.
In one embodiment, the other active ingredient is orlistat.

25

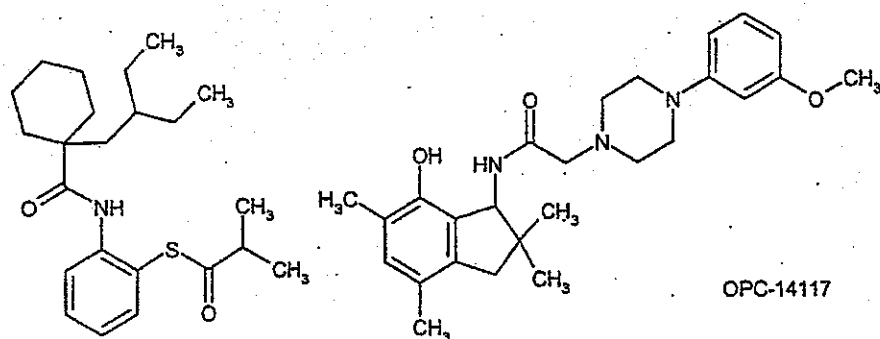
In one embodiment, the other active ingredient is mazindol or phentermine.

30

In one embodiment, the compounds of the formula I are administered in combination with dietary fiber materials, preferably insoluble dietary fiber materials (see e.g. Carob/Caromax[®] (Zunft H J; et al., Carob pulp preparation for treatment of hypercholesterolemia, *ADVANCES IN THERAPY* (2001 Sep-Oct), 18(5), 230-6.) Caromax is a carob-containing product from Nutrinova, Nutrition Specialties & Food Ingredients GmbH, Industriepark Höchst, 65926 Frankfurt/Main)). Combination with Caromax[®] is possible in one preparation or by separate administration of compounds of the formula I and Caromax[®]. Caromax[®] can moreover be

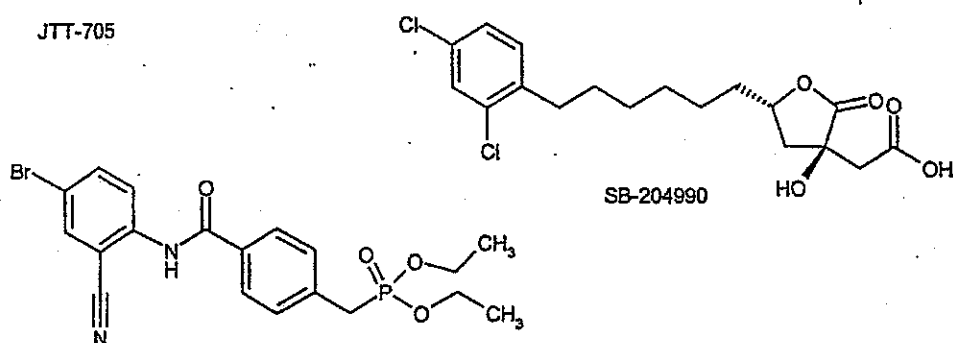
administered in the form of foodstuffs such as, for example, in bakery products or muesli bars.

5 It is self-evident that any suitable combination of the compounds of the invention with one or more of the aforementioned compounds and optionally one or more other pharmacologically active substances is regarded as falling within the protection conferred by the present invention.



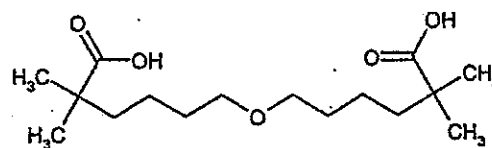
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JTT-705

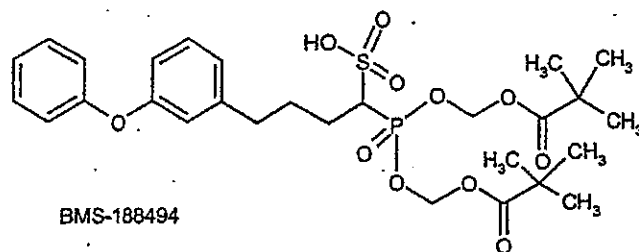


SB-204990

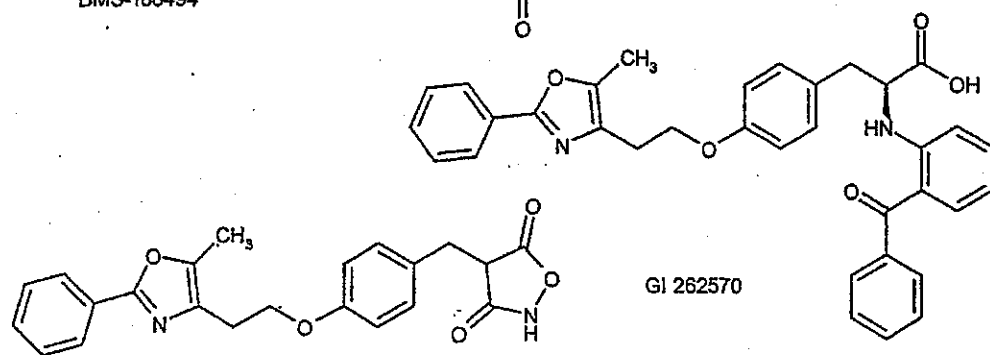
NO-1886



CI-1027



BMS-188494

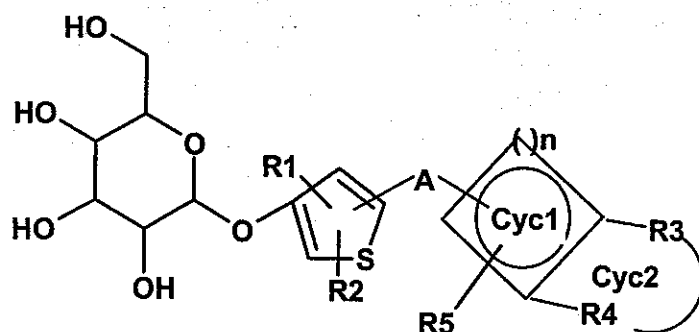


GI 262570

JTT-501

The examples detailed below serve to illustrate the invention without, however, restricting it.

Table 1: Compounds of the formula I



Ex.	R1, R2	A (linkage in thienyl 2 position)	Cyc1	R3, R4, R5	MS*
1	H, H	-CO-CH ₂ -CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
2	H, H	-CO-CH ₂ -CH ₂ -	Ph	3-O-(CH ₂) ₂ -O-4, H	ok
3	H, H	-CO-CH ₂ -CH ₂ -	Ph	3-O-CH ₂ -O-4, H	ok
4	H, H	-CO-CH ₂ -CH ₂ -	Ph	3-CH=CH-O-4, H	ok
5	H, H	-CO-CH ₂ -CH ₂ -	3-thiophene	H, H, H	ok
6	H, H	-CO-CH ₂ -CH ₂ -	2-thiophene	H, H, H	ok
7	H, H	-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
8	H, H	-CO-	Ph	4-O-CH ₃ , H, H	ok
9	H, H	-CH ₂ -	Ph	H, H, H	ok
10	H, H	-CH(OH)-	Ph	H, H, H	ok
11	H, H	-CH ₂ -	Ph	4-O-C ₂ H ₅ , H, H	ok
12	H, H	-CH ₂ -	Ph	3-O-CH ₃ , 4-O-CH ₃ , H	ok
13	H, H	-CH ₂ -	Ph	4-O-C ₇ H ₁₀ , H, H	ok
14	H, H	-CH ₂ -	Ph	4-F, H, H	ok
15	H, H	-CH ₂ -	Ph	4-I, H, H	ok
16	H, H	-CH ₂ -	Ph	4-NO ₂ , H, H	ok
17	H, H	-CH ₂ -	Ph	4-CH ₃ , H, H	ok
18	H, H	-CH ₂ -	Ph	3-CH ₃ , H, H	ok
19	H, H	-CH ₂ -	Ph	2-CH ₃ , H, H	ok
20	H, H	-CH ₂ -	Ph	4-C ₂ H ₅ , H, H	ok
21	H, H	-CH ₂ -	Ph	3-CH ₃ , 4-O-CH ₃ , 5-CH ₃	ok
22	H, H	-CH ₂ -	Ph	3-O-CF ₂ -O-4, H	ok
23	H, H	-CH ₂ -	Ph	4-C ₃ H ₇ , H, H	ok
24	H, H	-CH ₂ -	Ph	4-C(CH ₃) ₃ , H, H	ok
25	H, H	-CH ₂ -	Ph	4-OH, H, H	ok
26	H, H	-CH ₂ -	Ph	4-O-CH ₂ -Ph, H, H	ok
27	H, H	-CH ₂ -	3-thiophene	H, H, H	ok
28	H, H	-CH ₂ -	2-thiophene	4-CH=CH-CH=CH-5, H	ok

29	H, H	-CH ₂ -	Ph	3-O-CH ₃ , H, H	ok
30	H, H	-CH ₂ -	Ph	4-CN, H, H	ok
31	H, H	-CH ₂ -	Ph	3-O-CH ₂ -O-4, H, H	ok
32	H, H	-CH ₂ -	Ph	4-S-CH ₃ , H, H	ok
33	H, H	-CH ₂ -	Ph	4-O-C ₄ H ₉ , H, H	ok
34	H, H	-CH ₂ -	Ph	4-OCF ₃ , H, H	ok
35	H, H	-CH ₂ -	Ph	4-COOH, H, H	ok
36	H, H	-CH ₂ -CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
37	H, H	-CH=CH-	Ph	4-O-CH ₃ , H, H	ok
38	H, H	-CH=CH-	Ph	4-F, H, H	ok
39	H, H	-CH=CH-	Ph	4-Cl, H, H	ok
40	H, H	-CH=CH-	Ph	4-O-C ₂ H ₅ , H, H	ok
41	H, H	-CH=CH-	Ph	4-CH ₃ , H, H	ok
42	H, H	-CH=CH-	Ph	4-OH, H, H	ok
43	H, H	-CH ₂ -CH ₂ -	Ph	4-F, H, H	ok
44	H, H	-CH ₂ -CH ₂ -	Ph	4-Cl, H, H	ok
45	H, H	-CH ₂ -CH ₂ -	Ph	4-O-C ₂ H ₅ , H, H	ok
46	H, H	-CH ₂ -CH ₂ -	Ph	4-CH ₃ , H, H	ok
47	H, H	-CH ₂ -CH ₂ -	Ph	4-OH, H, H	ok
48	H, H	-CH=CH-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
49	H, H	-CH ₂ -CH ₂ -CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
50	H, H	-CH=CH-CH ₂ -	Ph	3-O-CH ₂ -O-4, H	ok
51	5-CH(CH ₃) ₂ , H	-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
52	5-Ph, H	-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
53	5-CH ₃ , H	-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
54	5-CF ₃ , H	-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
55	H, H	-CO-NH-CH ₂ -	Ph	H, H, H	ok
56	H, H	-CO-NH-CH ₂ -	Ph	4-O-CH ₃ , H, H	ok
57	H, H	-CO-NH-CH ₂ -	Ph	3-O-CH ₂ -O-4, H	ok
58	H, H	-CO-NH-CH ₂ -	Ph	4-O-CF ₃ , H, H	ok

5 * The indication "MS is ok" means that a mass spectrum or HPLC/MS was recorded and the molecular peak M+1 (MH⁺) and/or M+18 (MNH₄⁺) and/or M+23 (MNa⁺) was detected therein

The compounds of the formula I are distinguished by beneficial effects on glucose metabolism; in particular, they lower the blood glucose level and are suitable for the treatment of type 1 and type 2 diabetes. The compounds can therefore be employed alone or in combination with other blood glucose-lowering active ingredients

5 (antidiabetics).

The compounds of the formula I are further suitable for the prevention and treatment of late damage from diabetes, such as, for example, nephropathy, retinopathy, neuropathy and syndrome X, obesity, myocardial infarction, peripheral arterial occlusive diseases, thromboses, arteriosclerosis, inflammations, immune diseases, autoimmune diseases such as, for example, AIDS, asthma, osteoporosis, cancer, psoriasis, Alzheimer's, schizophrenia and infectious diseases, with preference for the treatment of type 1 and type 2 diabetes and the prevention and treatment of late damage from diabetes, syndrome X and obesity.

15 The activity of the compounds was tested as follows:

Preparation of brush border membrane vesicles from the small intestine of rabbits, rats and pigs

20 Preparation of brush border membrane vesicles from the intestinal cells of the small intestine was carried out by the so-called Mg^{2+} precipitation method. The mucosa of the small intestine was scraped off and suspended in 60 ml of ice-cold Tris/HCl buffer (pH 7.1)/300 mM mannitol, 5 mM EGTA. Dilution to 300 ml with ice-cold distilled water was followed by homogenization with an Ultraturrax (18 shaft, IKA Werk

25 Staufen, FRG) at 75% of the max. power for 2×1 minute, while cooling in ice. After addition of 3 ml of 1M $MgCl_2$ solution (final concentration 10 mM), the mixture is left to stand at 0°C for exactly 15 minutes. Addition of Mg^{2+} causes the cell membranes to aggregate and precipitate with the exception of the brush border membranes. After centrifugation at $3\,000 \times g$ (5 000 rpm, SS-34 rotor) for 15 minutes, the precipitate is

30 discarded and the supernatant, which contains the brush border membranes, is centrifuged at $26\,700 \times g$ (15 000 rpm, SS-34 rotor) for 30 minutes. The supernatant is discarded, and the precipitate is rehomogenized in 60 ml of 12 mM Tris/HCl buffer (pH 7.1)/60 mM mannitol, 5 mM EGTA using a Potter Elvehjem homogenizer (Braun, Melsungen, 900 rpm, 10 strokes). Addition of 0.1 ml of 1M $MgCl_2$ solution and

incubation at 0°C for 15 minutes is followed by centrifugation again at $3\,000 \times g$ for 15 minutes. The supernatant is then centrifuged again at $46\,000 \times g$ (20 000 rpm, SS-34 rotor) for 30 minutes. The precipitate is taken up in 30 ml of 20 mM Tris/Hepes buffer (pH 7.4)/280 mM mannitol and homogeneously resuspended by 20 strokes in
5 a Potter Elvehjem homogenizer at 1 000 rpm. After centrifugation at $48\,000 \times g$ (20 000 rpm, SS-34 rotor) for 30 minutes, the precipitate was taken up in 0.5 to 2 ml of Tris/Hepes buffer (pH 7.4)/280 mM mannitol (final concentration 20 mg/ml) and resuspended using a tuberculin syringe with a 27 gauge needle.

The vesicles were either used directly after preparation for labeling or transport
10 studies or were stored at -196°C in 4 mg portions in liquid nitrogen.

To prepare brush border membrane vesicles from rat small intestine, 6 to 10 male
Wistar rats (bred at Kastengrund, Aventis Pharma) were sacrificed by cervical
dislocation, and the small intestines were removed and rinsed with cold isotonic
saline. The intestines were cut up and the mucosa was scraped off. The processing
15 to isolate brush border membranes took place as described above. To remove
cytoskeletal fractions, the brush border membrane vesicles from rat small intestine
were treated with KSCN as chaotropic ion.

To prepare brush border membranes from rabbit small intestine, rabbits were
20 sacrificed by intravenous injection of 0.5 ml of an aqueous solution of 2.5 mg of
tetracaine HCl, 100 mg of m-butramide and 25 mg of mebezonium iodide. The small
intestines were removed, rinsed with ice-cold physiological saline and frozen in
plastic bags under nitrogen at -80°C and stored for 4 to 12 weeks. For preparation of
the membrane vesicles, the frozen intestines were thawed at 30°C in a water bath
25 and then the mucosa was scraped off. Processing to give membrane vesicles took
place as described above.

To prepare brush border membrane vesicles from pig intestine, jejunum segments
from a freshly slaughtered pig were rinsed with ice-cold isotonic saline and frozen in
30 plastic bags under nitrogen at -80°C. Preparation of the membrane vesicles took
place as described above.

Preparation of brush border membrane vesicles from the renal cortex of the rat
kidney

Brush border membrane vesicles were prepared from the cortex of the rat kidney by the method of Biber et al. The kidneys from 6 to 8 rats (200 to 250 g) were removed and the cortex was cut off each kidney as a layer about 1 mm thick. The kidneys were taken up in 30 ml of ice-cold 12 mM Tris/HCl buffer (pH 7.4)/300 mM mannitol and homogenized with an Ultraturrax shaft (level 180 V) for 4×30 seconds while cooling in ice. Addition of 42 ml of ice-cold distilled water was followed by addition of 850 μ l of a 1M $MgCl_2$ solution. Incubation at 0°C for 15 minutes was followed by centrifugation at 4 500 rpm (Sorvall SS-34 rotor) for 15 minutes. The precipitate was discarded, and the supernatant was centrifuged at 16 000 rpm for 30 minutes. Resuspension of the precipitate in 60 ml of 6 mM Tris/HCl buffer (pH 7.4)/150 mM mannitol/2.5 mM EGTA by 10 strokes in a Potter-Elvehjem homogenizer (900 rpm) and addition of 720 μ l of 1 mM $MgCl_2$ solution was followed by incubation at 0°C for 15 minutes. The supernatant resulting after centrifugation at 4 500 rpm (SS-34 rotor) for 15 minutes was centrifuged at 16 000 rpm for 30 minutes. The supernatant was homogenized by 10 strokes in 60 ml of 20 mM Tris/Hepes buffer (pH 7.4)/280 mM mannitol, and the resulting suspension was then centrifuged at 20 000 rpm for 30 minutes. The precipitate was resuspended in 20 mM Tris/HCl buffer (pH 7.4)/280 mM mannitol using a tuberculin syringe with a 27 gauge needle and was adjusted to a protein concentration of 20 mg/ml.

Measurement of the glucose uptake by brush border membrane vesicles

The uptake of [^{14}C]-labeled glucose into brush border membrane vesicles was measured by the membrane filtration method. 10 μ l of the brush border membrane vesicle suspension in 10 mM Tris/Hepes buffer (pH 7.4)/300 mM mannitol were added at 30°C to 90 μ l of a solution of 10 pM [^{14}C]D glucose and the appropriate concentrations of the relevant inhibitors (5-200 μ M) in 10 mM Tris/Hepes buffer (pH 7.4)/100 mM NaCl/100 mM. After incubation for 15 seconds, the transport process was stopped by adding 1 ml of ice-cold stop solution (10 mM Tris/Hepes buffer (pH 7.4)/150 mM KCl) and the vesicle suspension was immediately filtered with suction through a cellulose nitrate membrane filter (0.45 μ m, 25 mm diameter, Schleicher & Schüll) under a vacuum of

from 25 to 35 mbar. The filter was washed with 5 ml of ice-cold stop solution. Each measurement was carried out as duplicate or triplicate determination. To measure the uptake of radiolabeled substrates, the membrane filter was dissolved in 4 ml of an appropriate scintillator (Quickszint 361, Zinsser Analytik GmbH, Frankfurt am

5 Main), and the radioactivity was determined by liquid scintillation measurement. The measured values were obtained as dpm (disintegrations per minute) after calibration of the instrument using standard samples and after correction for any chemiluminescence present.

10 The active ingredients are compared for activity on the basis of IC₂₅ data obtained in the transport assay on rabbit renal cortex brush border membrane vesicles for selected substances. (The absolute values may be species- and experiment-dependent)

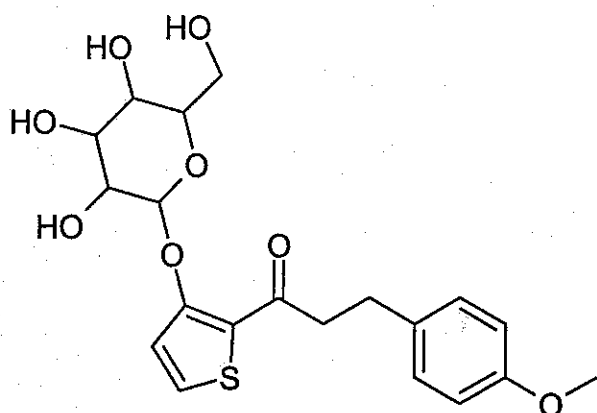
15	Example No.	IC ₂₅ [μM]
	5*	13.9
	6*	9.9
	7*	1.1
	9*	1.4
20	11*	1.3
	13*	3.5
	34*	1.0
	43*	2.2
	44*	0.9
25	45*	2.9
	47*	1.6
	50*	4.7
	54*	1.4
	56*	2.8
30	* β-D-glucoside form	

The preparation of various examples is described in detail hereinafter, and the other compounds of the formula I were obtained analogously:

Experimental part:

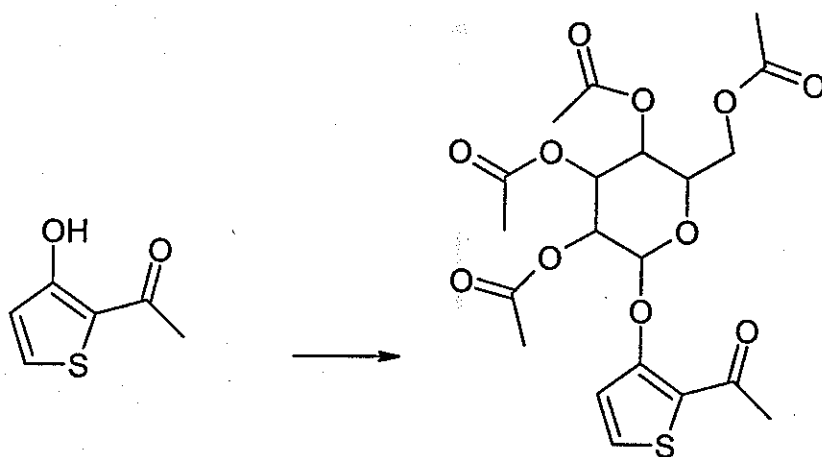
Example 1:

5



3-(4-Methoxy-phenyl)-1-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-propan-1-one

10



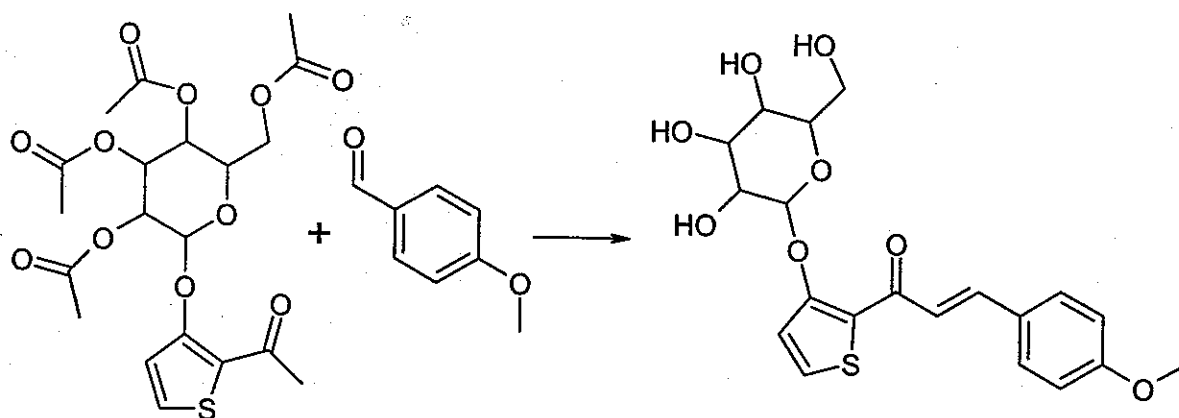
a) 4,5-Diacetoxy-6-acetoxymethyl-2-(2-acetyl-thiophen-3-yloxy)-tetrahydro-pyran-3-yl acetate

15

2 g of 1-(3-hydroxy-thiophen-2-yl)-ethanone are dissolved in 120 ml of dichloromethane and stirred with 6.4 g of 4,5-diacetoxy-6-acetoxymethyl-2-bromotetrahydropyran-3-yl acetate, 1.4 g of benzyltributylammonium chloride, 6.4 g

of potassium carbonate and 1.2 ml of water at 22°C for 20 h. Insoluble constituents are removed by filtration, the filtrate is concentrated and the crude product mixture is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:1). The product with the molecular weight of 472.5 (C₂₀H₂₄O₁₁S), MS (CI): 473 (M+H⁺) is

5 obtained.

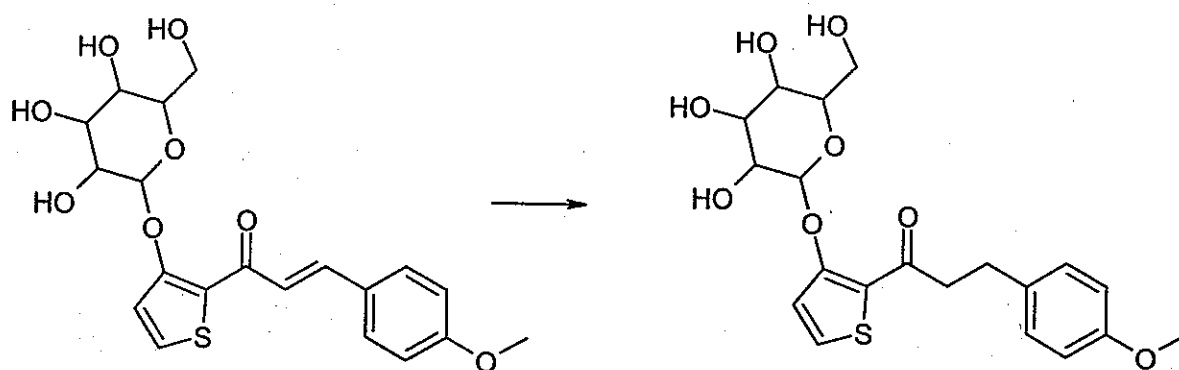


b) 3-(4-Methoxy-phenyl)-1-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-propenone

472 mg of 4,5-diacetoxy-6-acetoxymethyl-2-(2-acetylthiophen-3-yloxy)-tetrahydro-

10 pyran-3-yl acetate are dissolved in 20 ml of methanol, and 5 ml of 1N NaOCH₃ solution in methanol are added. 410 mg of 4-methoxy-benzaldehyde are added thereto, and the mixture is stirred at 22°C for 20 h. The mixture is neutralized with a little dilute methanolic hydrochloric acid and concentrated, and the residue is purified by chromatography on a silica gel column (dichloromethane/methanol = 6:1). The

15 product with the molecular weight of 422.5 (C₂₀H₂₂O₈S), MS (ESI): 423 (M+H⁺) is obtained.



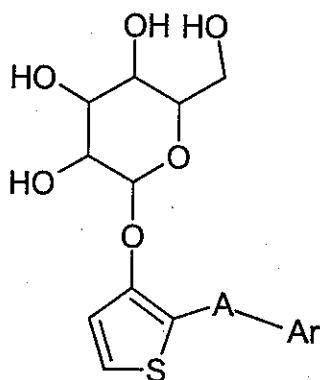
c) 3-(4-Methoxy-phenyl)-1-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-propan-1-one

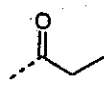
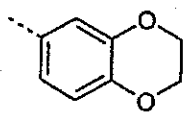
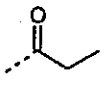
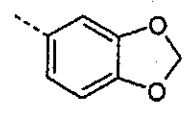
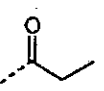
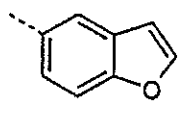
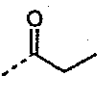
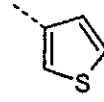
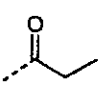
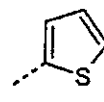
100 mg of 3-(4-methoxy-phenyl)-1-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-propenone are hydrogenated dissolved in 10 ml of ethanol with about 20 mg of 5% palladium on carbon in a shaking apparatus under slightly elevated pressure (about 4 h, TLC check). The catalyst is filtered off, the filtrate is concentrated, and the residue is purified by column filtration (SiO_2 , dichloromethane/methanol = 6:1). The product with the molecular weight of 424.5 ($\text{C}_{20}\text{H}_{24}\text{O}_8\text{S}$), MS (ESI): 447 ($\text{M}+\text{Na}^+$) is obtained.

α -D-Acetobromoglucose was used as 4,5-diacetoxy-6-acetoxymethyl-

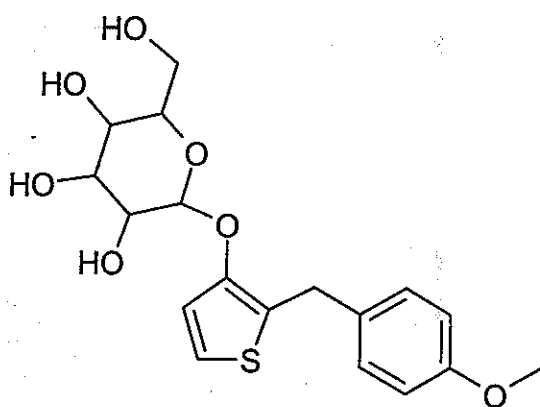
2-bromotetrahydropyran-3-yl acetate in the synthetic sequence described above. The glycoside of example 1 was thus obtained in β -D-gluco form. This also applies for all examples described below. If, however, α -D-acetobromogalactose is used, then the glycoside is obtained in the β -D-galacto form, if α -D-acetobromoallose is used, then the glycoside is obtained in the β -D-allo form or if α -D-acetobromomannose is used, then the glycoside is obtained in α -D-manno form.

The following exemplary substances 2 to 6 are prepared by the same synthetic route as described above in example 1:



Example	A	Ar	MS or LC/MS
2			OK
3			OK
4			OK
5			OK
6			OK

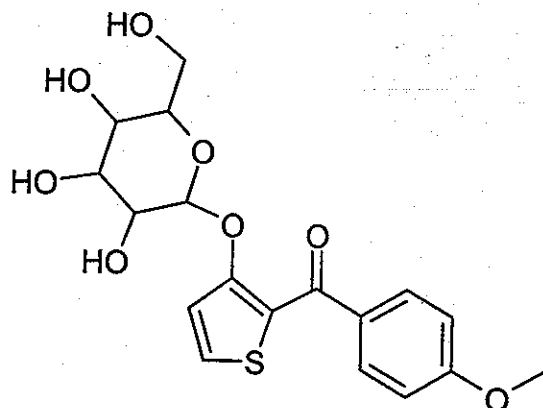
Example 7:



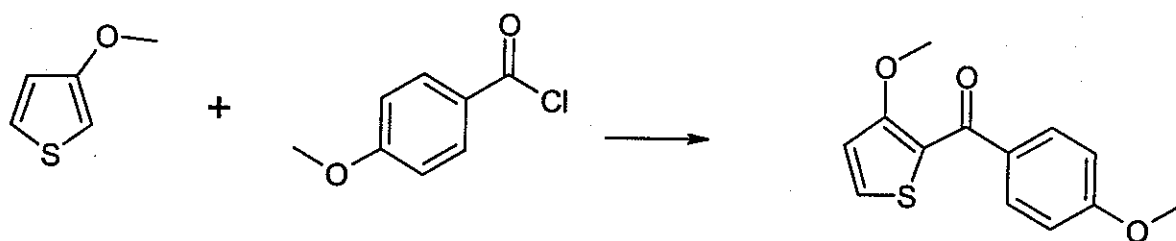
5

2-Hydroxymethyl-6-[2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydro-pyran-3,4,5-triol

Example 8:



(4-Methoxy-phenyl)-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-methanone

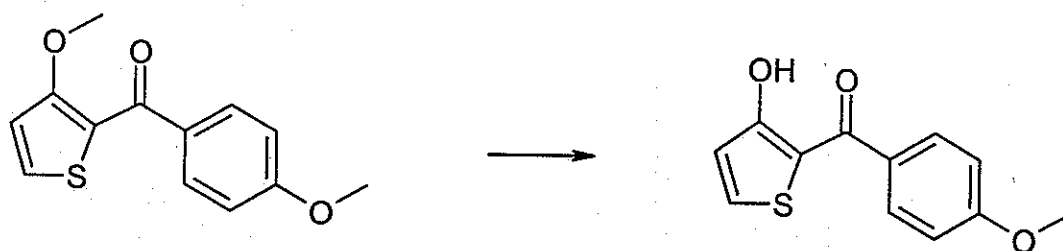


a) (4-Methoxy-phenyl)-(3-methoxy-thiophen-2-yl)-methanone

2.7 ml of tin tetrachloride are added to a solution of 2.3 g of 3-methoxy-thiophene and 3.4 g of 4-methoxybenzoyl chloride in 50 ml of dichloromethane while cooling in ice.

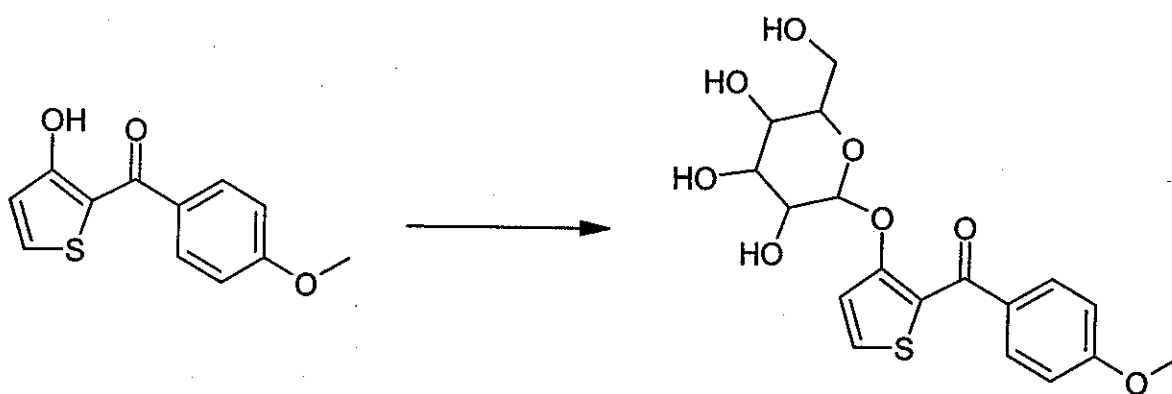
The mixture is stirred at room temp. overnight. For workup, 75 ml of 2N hydrochloric acid are added and the mixture is extracted three times with dichloromethane. The combined organic phases are washed twice with each of 2N sodium carbonate solution and water, and then the solvent is removed in vacuo, and the crude product

is purified by column filtration (SiO_2 , ethyl acetate/n-heptane = 1:2). The product with the molecular weight of 248.3 ($\text{C}_{13}\text{H}_{12}\text{O}_3\text{S}$), MS (CI): 249 ($\text{M}+\text{H}^+$) is obtained.



b) (3-Hydroxy-thiophen-2-yl)-(4-methoxy-phenyl)-methanone

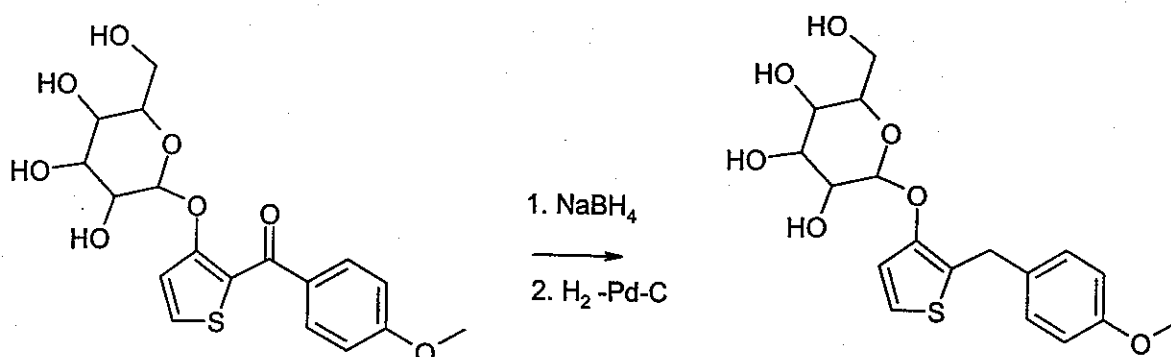
993 mg of (4-methoxy-phenyl)-(3-methoxy-thiophen-2-yl)-methanone are dissolved in 20 ml of dry dichloromethane, and 7 ml of boron tribromide/dimethyl sulfide complex are added. The mixture is stirred at room temp. until the reaction is complete (TLC check). It is then poured into water and extracted several times with dichloromethane. The organic phase is dried and concentrated, and the residue is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:4). The product with the molecular weight of 234.3 (C₁₂H₁₀O₃S), MS (CI): 235 (M+H⁺) is obtained.



c) (4-Methoxy-phenyl)-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-methanone = Example 8

2.8 g of (3-hydroxythiophen-2-yl)-(4-methoxy-phenyl)-methanone are dissolved in 350 ml of dichloromethane, and 12.64 g of 3,4,5-triacetoxy-6-bromo-tetrahydropyran-2-ylmethyl acetate, 15.4 g of potassium carbonate, 3.6 g of benzyltributylammonium chloride and finally 3 ml of water are added. The mixture is vigorously stirred at room temp. for 20 h. After the reaction is complete, the residue after filtration and concentration is filtered through SiO₂ with ethyl acetate/heptane = 1:2. The solvent is removed and the residue is taken up in about 300 ml of methanol and, after addition of 35 ml of 1N NaOCH₃ solution in methanol, stirred at room temp. for 1 h. This is followed by neutralization with 7% methanolic hydrochloric acid (about 35 ml), addition of about 100 ml of dichloromethane/methanol/conc. ammonia = 30:5:0.1 mobile phase mixture and stirring for 5 min. This is followed by concentration, taking up the residue with the same mobile phase mixture and removing insoluble salt from

the solution. Chromatography on silica gel results in the product with the molecular weight of 396.42 ($C_{18}H_{20}O_8S$), MS (ESI): 397 ($M+H^+$), 235 ($M+H^+-gluc$).



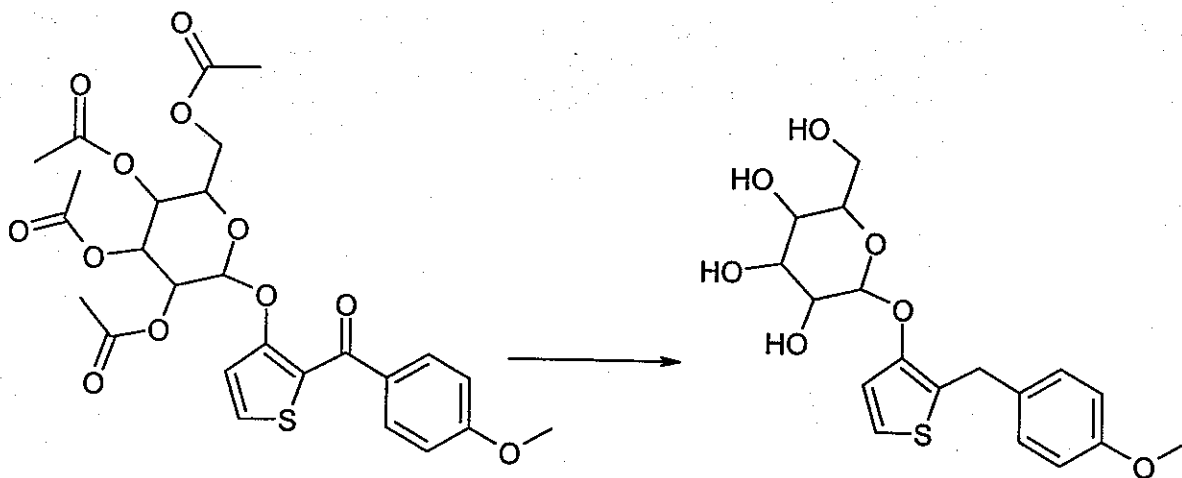
5

d) 2-Hydroxymethyl-6-[2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydro-pyran-3,4,5-triol = Example 7

4.1 g of (4-methoxy-phenyl)-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-yl]-methanone are dissolved in 200 ml of tetrahydrofuran + 20 ml of methanol, and 500 mg of sodium borohydride are added. After the reaction is complete (TLC check, dichloromethane/methanol/conc. ammonia = 30:5:1; about 30-60 min), water is added and the mixture is extracted three times with ethyl acetate. The combined organic phases are dried over magnesium sulfate and concentrated. 2-[2-[Hydroxy-(4-methoxy-phenyl)-methyl]-thiophen-3-yloxy]-6-hydroxymethyl-tetrahydro-pyran-3,4,5-triol is obtained as crude product which is purified by filtration through silica gel.

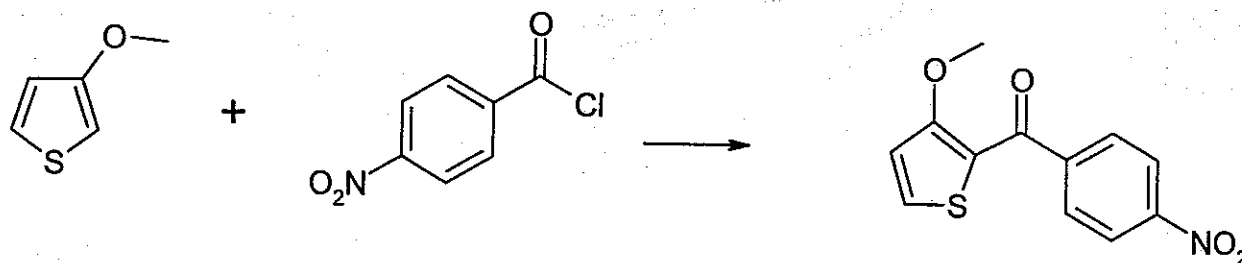
The entire amount is dissolved in about 800 ml of dry ethanol, and the solution is saturated with argon in a shaking apparatus. Then dry palladium on carbon is added as catalyst, and the mixture is hydrogenated while shaking vigorously at 22°C. and atmospheric pressure for 6-7 h. After the reaction is complete, the mixture is filtered with suction through a clarifying layer, and the solvent is removed in vacuo. The residue is purified by column chromatography (SiO_2 , dichloromethane/methanol = 9:1). (TLC plates developed with 10% sulfuric acid). The product with the molecular weight of 382.44 ($C_{18}H_{22}O_7S$), MS (ESI): 383 ($M+H^+$), 221 ($M+H^+-gluc$) is obtained.

Alternatively, this compound can also be prepared in the following way:



- 226 mg of 3,4,5-triacetoxy-6-[2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydro-
 5 pyran-2-yl-methyl acetate are dissolved in 4 ml of acetonitrile and cooled to 0°C in
 an ice bath. 0.3 ml of trimethylchlorosilane and 151 mg of sodium cyanoborohydride
 are added, the ice bath is removed, and the reaction is stirred for 2 h. The reaction
 mixture is diluted with 30 ml of dichloromethane and filtered through Celite, and the
 organic phase is washed with 20 ml of saturated sodium bicarbonate solution and
 10 20 ml of sodium chloride solution. The residue is purified by column chromatography
 (SiO₂, ethyl acetate/n-heptane = 1:2). The crude product is taken up in methanol,
 and 1 ml of sodium methanolate solution (10 mg/ml in methanol) is added. The
 solution is stirred at 22°C for 18 h and, after addition of Amberlyst 15 (H⁺ form),
 diluted with 10 ml of methanol and filtered. The residue is washed with 20 ml of
 15 methanol, the organic phase is concentrated and the residue chromatographed on
 silica gel. 120 mg of the product with the molecular weight of 382.44 (C₁₈H₂₂O₇S),
 MS (ESI): 400 (M+NH₄⁺) are obtained.

Preparation of (3-methoxy-thiophen-2-yl)-(4-nitro-phenyl)-methanone:



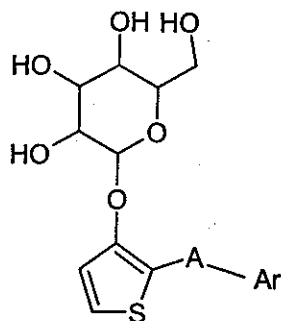
- 5 0.5 ml of 3-methoxythiophene is dissolved in 50 ml of dichloromethane. 968 mg of 4-nitrobenzoyl chloride are added, and the reaction mixture is cooled to 0°C in an ice bath. Then 696 mg of aluminum trichloride are added and the reaction is stirred at 0°C for 4 h. The reaction mixture is added to 100 ml of ice-water and stirred for 15 min, and 100 ml of dichloromethane are added. The organic phase is separated off, washed with 50 ml of 0.5 molar sodium hydroxide solution and 50 ml of saturated sodium chloride solution, dried over sodium sulfate and concentrated. The resulting mixture is then purified by column chromatography (SiO₂, ethyl acetate/n-heptane).

The product with the molecular weight of 263.27 (C₁₂H₉NO₄S); MS (CI): 264.25 (M+H⁺) is obtained.

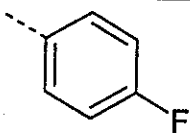
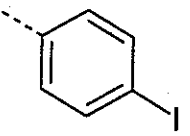
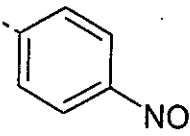
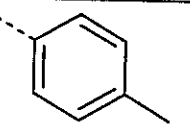
- 15 (3-Methoxy-thiophen-2-yl)-(4-nitro-phenyl)-methanone is then converted as described by way of example for example 7 into exemplary substance 16.

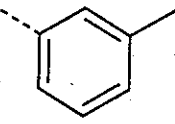
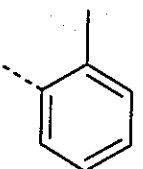
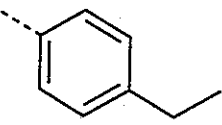
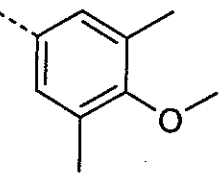
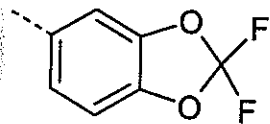
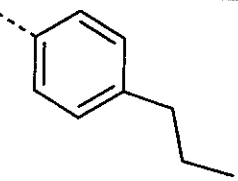
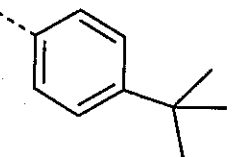
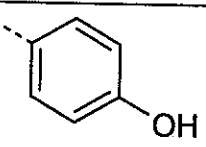
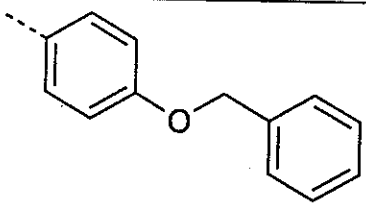
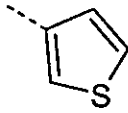
The following exemplary substances 9 to 34 are prepared by the same synthetic route:

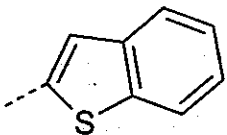
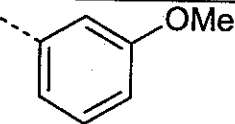
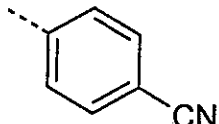
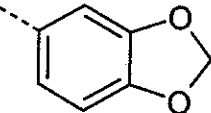
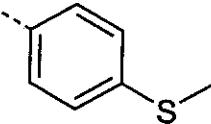
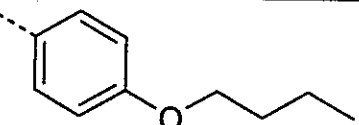
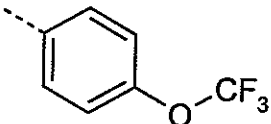
20



Example	A	Ar	MS or LC/MS
9	CH ₂	x	OK
10	CHOH		OK
11	CH ₂		OK
12	CH ₂		OK
13	CH ₂		OK

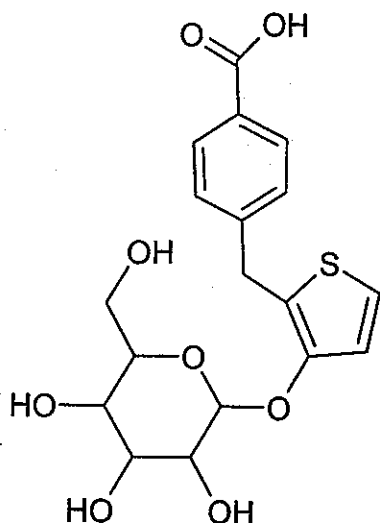
Example	A	Ar	MS or LC/MS
14	CH ₂		OK
15	CH ₂		OK
16	CH ₂		OK
17	CH ₂		OK

16	CH ₂		OK
19	CH ₂		OK
20	CH ₂		OK
21	CH ₂		OK
22	CH ₂		OK
23	CH ₂		OK
24	CH ₂		OK
25	CH ₂		OK
26	CH ₂		OK
27	CH ₂		OK

28	CH ₂		OK
29	CH ₂		OK
30	CH ₂		OK
31	CH ₂		OK
32	CH ₂		OK
33	CH ₂		OK
34	CH ₂		OK

The indication MS/LCMS is OK means that the molecular peak of the indicated compound was obtained as $M+1$ (MH^+) and/or as $M+18$ (MNH_4^+) and/or $M + 23$ (MNa^+).

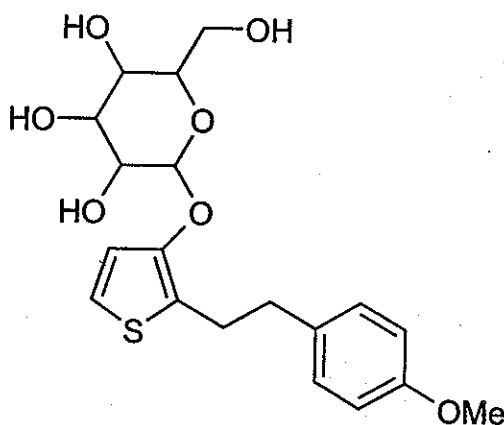
Example 35:



- 5 4-[3-(3,4,5-Trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-ylmethyl]-benzoic acid

- 46 mg of 4-[3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophen-2-ylmethyl]-benzonitrile are dissolved in a mixture of 5 ml of methanol and 2 ml of
 10 25% strength potassium hydroxide solution and heated at 70° for 3 h. The solution is diluted with 10 ml of water and neutralized with 2N HCl. The resulting solution is freeze dried. The crude product is then purified by column chromatography (SiO₂, dichloromethane/methanol/acetic acid/water = 8:2:0.1:0.1). 45 mg of the product with the molecular weight of 396.42 (C₁₈H₂₀O₈S), MS (ESI): 414.45 (M+NH₄⁺) are
 15 obtained.

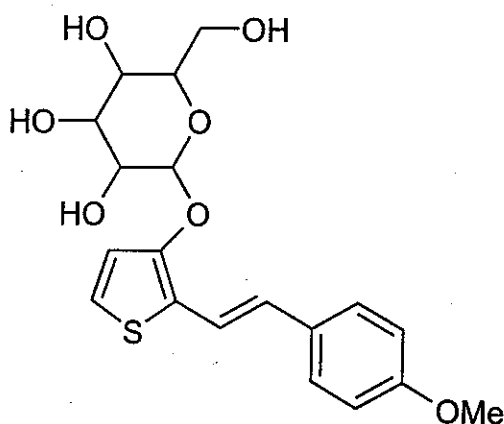
Example 36:



2-Hydroxymethyl-6-{2-[2-(4-methoxy-phenyl)-ethyl]-thiophen-3-yloxy}-tetrahydro-pyran-3,4,5-triol

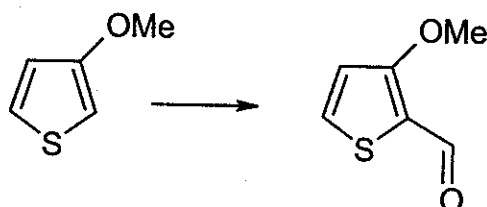
Example 37:

5



2-Hydroxymethyl-6-{2-[2-(4-methoxy-phenyl)-vinyl]-thiophen-3-yloxy}-tetrahydro-pyran-3,4,5-triol

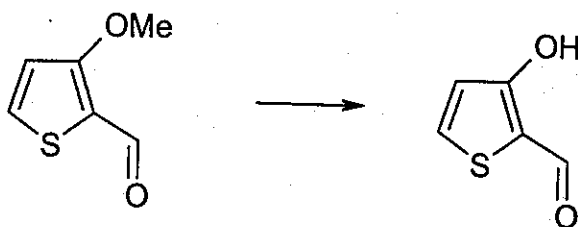
10



a) 3-Methoxy-thiophene-2-carbaldehyde

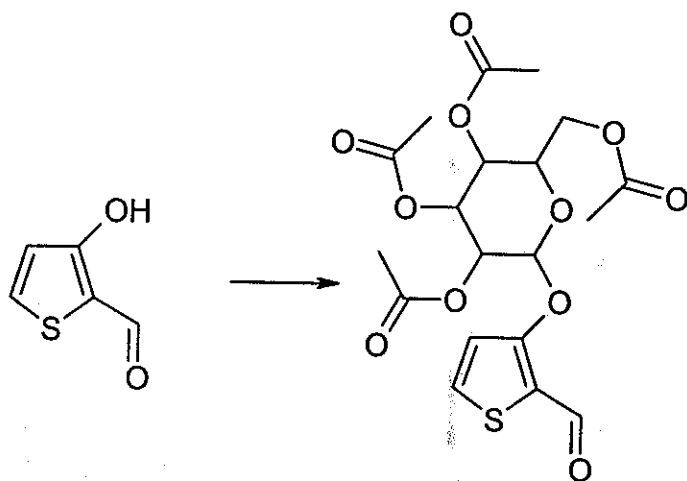
15 1.03 ml of 3-methoxythiophene are dissolved in 2.3 ml of dimethylformamide. While cooling in ice, 1.06 ml of phosphoryl chloride are added. After 1 h, the reaction solution is added to ice, and the solution is neutralized with 5 molar sodium hydroxide solution. The aqueous phase is extracted 3 times with 25 ml of diethyl ether each time, and the combined organic phases are then washed with 50 ml of saturated sodium chloride solution, dried over sodium sulfate and concentrated. 840 mg of the

20 product with the molecular mass of 142.18 ($C_6H_7O_2S$) are obtained. MS (ESI): 143.0 ($M+H^+$).



b) 3-Hydroxy-thiophene-2-carbaldehyde

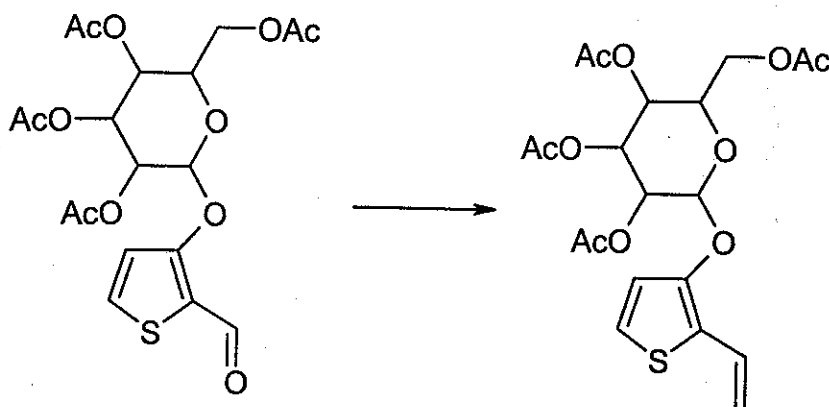
200 mg of 3-methoxy-thiophene-2-carbaldehyde are dissolved in 5 ml of dichloromethane. 880 mg of boron tribromide-dimethyl sulfide complex are dissolved in 5 ml of dichloromethane and added to the reaction solution. The solution is stirred for 18 h. The reaction mixture is poured into 30 ml of water, and the mixture is extracted 4 times with 20 ml of dichloromethane each time. The combined organic phases are washed with 30 ml of saturated sodium chloride solution, dried over sodium sulfate and concentrated. 140 mg of 3-hydroxy-thiophene-2-carbaldehyde with the molecular weight of 128.15 ($C_5H_4O_2S$) are obtained. MS (ESI): 129.0 ($M+H^+$).



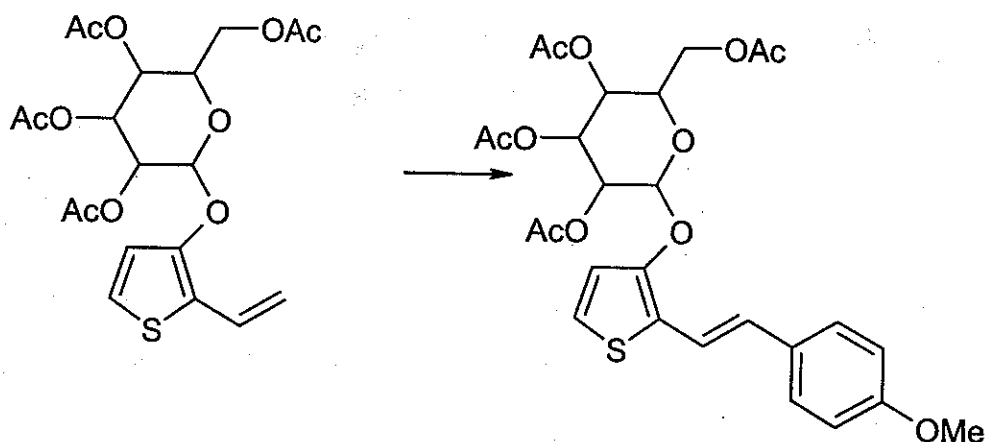
c) 4,5-Diacetoxy-6-acetoxymethyl-2-(2-formyl-thiophen-3-yloxy)-tetrahydropyran-3-yl acetate

3.81 g of 3-hydroxy-thiophene-2-carbaldehyde, 30.5 g of (4,5-diacetoxy-6-acetoxymethyl-2-[5-isopropyl-2-(4-methoxy-benzoyl)-thiophen-3-yloxy]-tetrahydropyran-3-yl) acetate, 37.0 g of potassium carbonate and 9.2 g of benzyltributylammonium chloride are dissolved in 850 ml of dichloromethane. 7.5 ml of water are added, and the reaction mixture is stirred for 60 h. The solution is extracted with water and saturated sodium chloride solution, and the organic phase is dried over sodium sulfate and evaporated. 60 ml of ethanol:water (9:1) are added to the

resulting brownish foam, and the resulting fine precipitate is filtered off with suction. The product with the molecular weight: 458.44 ($C_{19}H_{22}O_{11}S$), MS (ESI): 476 ($M+NH_4^+$) is obtained.



d) 3,4,5-Triacetoxy-6-(2-vinyl-thiophen-3-yloxy)-tetrahydropyran-2-ylmethyl acetate
3.30 g of 3,4,5-triacetoxy-6-(2-formyl-thiophen-3-yloxy)-tetrahydropyran-2-ylmethyl acetate are dissolved in 60 ml of dioxane. 6.43 g of methyltriphenylphosphonium bromide, 5.37 g of potassium carbonate and 0.25 ml of water are added, and the solution is refluxed for 4 h. The solution is concentrated and purified by column filtration. 2.89 g of the product with the molecular weight: 456.47 ($C_{20}H_{24}O_{10}S$), MS (ESI): 479.10 ($M+Na^+$); 474.10 ($M+NH_4^+$) are obtained.

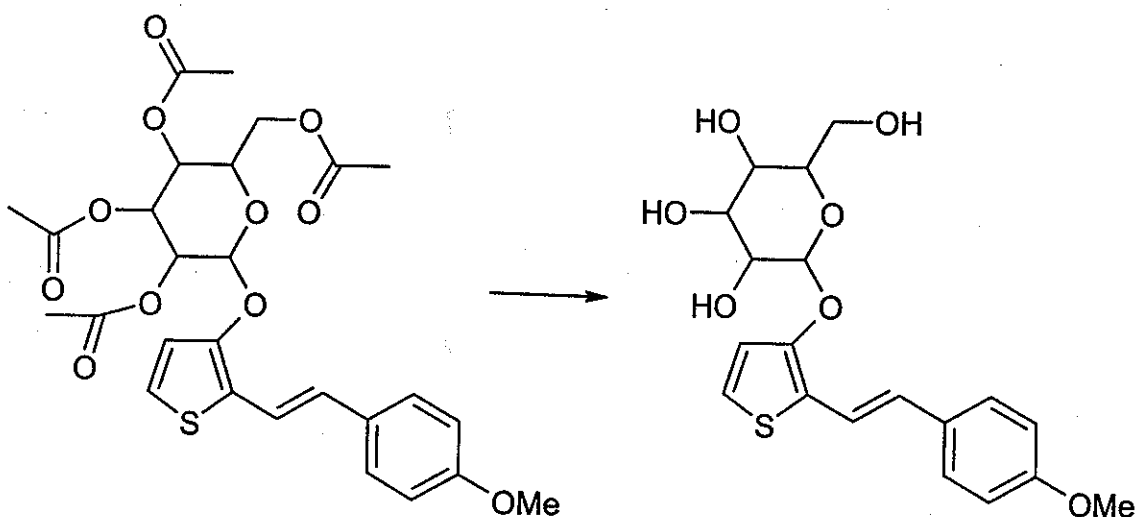


e) 3,4,5-Triacetoxy-6-{2-[2-(4-methoxy-phenyl)-vinyl]-thiophen-3-yloxy}-tetrahydropyran-2-ylmethyl acetate

148 mg of 3,4,5-triacetoxy-6-(2-vinyl-thiophen-3-yloxy)-tetrahydropyran-2-ylmethyl acetate are dissolved in 2 ml of dichloromethane under argon.

Tricyclohexylphosphine-[1,3-bis(2,4,6-trimethylphenyl)-4,5-dihydroimidazol-2-ylidene][benzylidene]ruthenium(IV) dichloride (23 mg, dissolved in 2 ml of dichloromethane) is added, and the solution is heated under reflux for 8 h. The reaction solution is concentrated and purified by column chromatography (SiO₂,

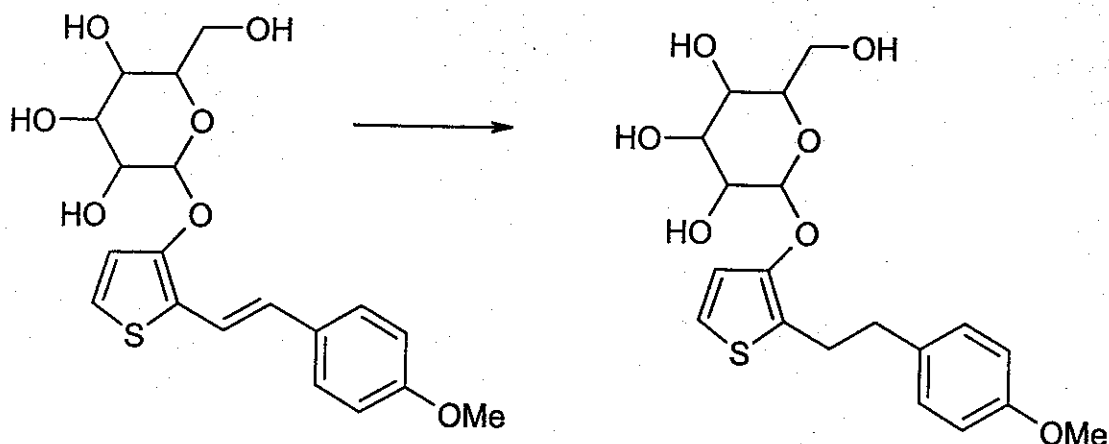
heptane/ethyl acetate 2:1). 132 mg of the product with the molecular mass of 562.60 (C₂₇H₃₀O₁₁S) are obtained. MS(ESI): 575.20 (M+Na⁺).



f) 2-Hydroxymethyl-6-{2-[2-(4-methoxy-phenyl)-vinyl]-thiophen-3-yloxy}-tetrahydro-3,4,5-triol = Example 37

150 mg of 3,4,5-triacetoxy-6-{2-[2-(4-methoxy-phenyl)-vinyl]-thiophen-3-yloxy}-tetrahydropyran-2-ylmethyl acetate are suspended in 10 ml of dry methanol. 1.0 ml of a methanolic NaOMe solution (10 mg/ml) is added. The solution is stirred at 22°C for 18 h. Amberlyst 15 (H⁺ form) is added and the solution is diluted with 10 ml of MeOH and filtered, and the residue is washed with 20 ml of methanol. The organic phase is concentrated, and the residue is purified by chromatography on silica gel. 100 mg of the product with the molecular weight: 394.45 (C₁₉H₂₂O₇S), MS (ESI): 417 (M+Na⁺);

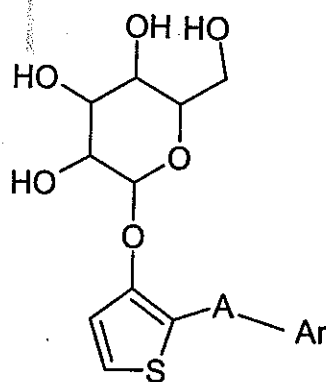
412 (M+NH₄⁺) are obtained.

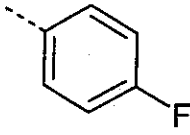
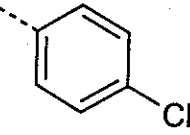
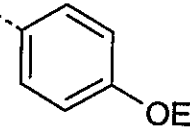
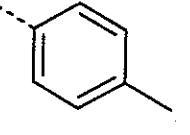
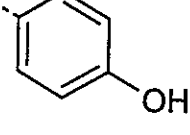
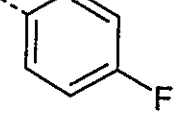
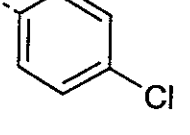
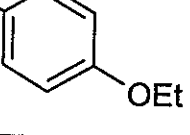
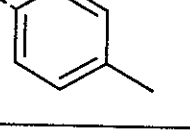
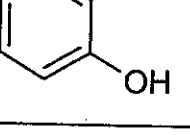


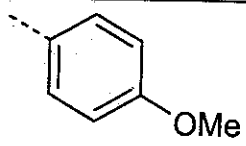
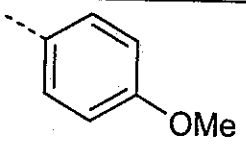
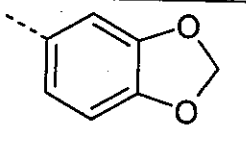
g) 2-Hydroxymethyl-6-{2-[2-(4-methoxy-phenyl)-ethyl]-thiophen-3-yloxy}-tetrahydro-pyran-3,4,5-triol = Example 36

50 mg of 2-hydroxymethyl-6-{2-[2-(4-methoxy-phenyl)-vinyl]-thiophen-3-yloxy}-tetrahydro-pyran-3,4,5-triol are dissolved in 10 ml of methanol. 20 mg of palladium on activated carbon are added and the solution is stirred under a hydrogen atmosphere for 18 h. The catalyst is filtered off and washed with 60 ml of methanol, and the organic phase is concentrated. The residue is chromatographed on silica gel (ethyl acetate). 18 mg of the product with the molecular weight of 396.46 ($C_{19}H_{24}O_7S$); MS (ESI): 419.05 ($M+Na^+$), 414.10 ($M+NH_4^+$).

The following exemplary substances 38 to 50 are prepared by the same synthetic route.



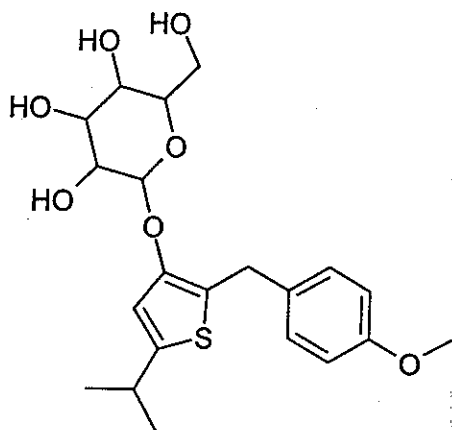
Example	A	Ar	MS or LC/MS
38	-CH=CH-		OK
39	-CH=CH-		OK
40	-CH=CH-		OK
41	-CH=CH-		OK
42	-CH=CH-		OK
43	-CH2-CH2-		OK
44	-CH2-CH2-		OK
45	-CH2-CH2-		OK
46	-CH2-CH2-		OK
47	-CH2-CH2-		OK

48	-CH=CH-CH ₂ -		OK
49	-CH ₂ -CH ₂ - CH ₂ -		OK
50	-CH=CH-CH ₂ -		OK

The indication MS/LCMS is OK means that the molecular peak of the indicated compound was obtained as $M+1$ (MH^+) and/or as $M+18$ (MNH_4^+) and/or $M+23$ (MNa^+).

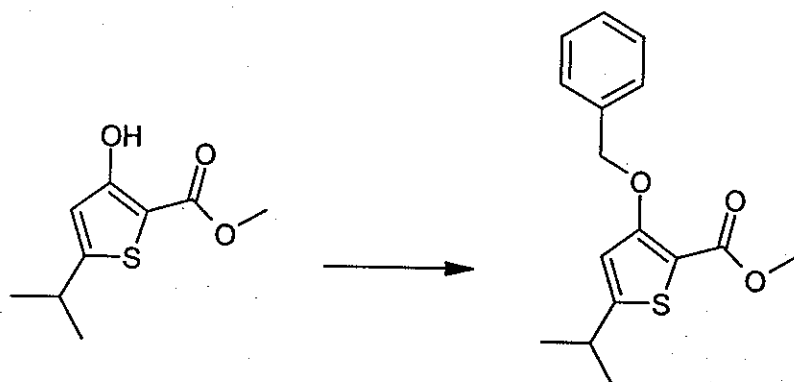
5

Example 51:



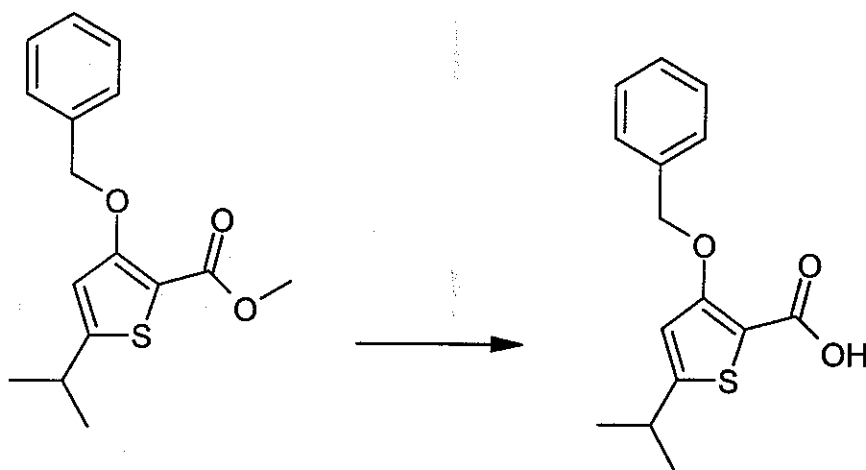
2-Hydroxymethyl-6-[5-isopropyl-2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydropyran-3,4,5-triol

10



a) 3-Benzyloxy-5-isopropyl-thiophene-2-carboxylate

1.16 g of methyl 3-hydroxy-5-isopropyl-thiophene-2-carboxylate, which were synthesized by a process known from the literature [H. Fiesselmann, F. Thoma, Chem. Ber. 1956, 89, 1907], are dissolved in 25 ml of dimethylformamide (DMF), and 2.83 g of cesium carbonate and 1.72 ml of benzyl bromide are added. The reaction mixture is stirred at 22°C for 72 h. Then 10 ml of methanol are added and, after 30 min, 100 ml of saturated sodium bicarbonate solution and 50 ml of water are added. The mixture is extracted 3 times with 70 ml of diethyl ether each time. The combined organic phases are dried over sodium sulfate and concentrated. The crude product is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:4). The product with the molecular weight of 290.4 (C₁₆H₁₈O₃S), MS (ESI): 291 (M+H⁺) is obtained.

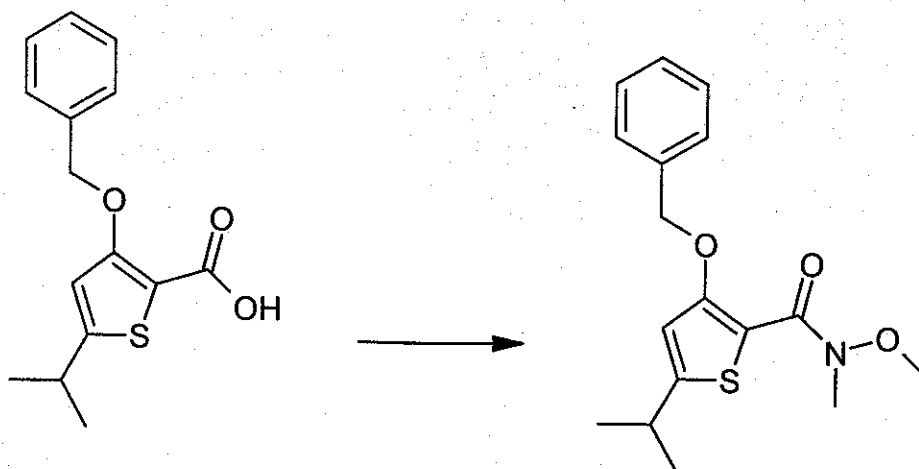


b) 3-Benzyloxy-5-isopropyl-thiophene-2-carboxylic acid

1.16 g of methyl 3-benzyloxy-5-isopropyl-thiophene-2-carboxylate are dissolved in 10 ml of tetrahydrofuran (THF) and 10 ml of methanol, and a solution of 1.7 g of lithium hydroxide in 10 ml of water is added. The reaction mixture is stirred at 22°C for 72 h. Methanol and THF are stripped off in the rotary evaporator. While cooling in ice, the reaction mixture is adjusted to pH = 4 with 2 molar hydrochloric acid and extracted twice with 50 ml of ethyl acetate each time. The combined organic phases are dried over sodium sulfate and concentrated.

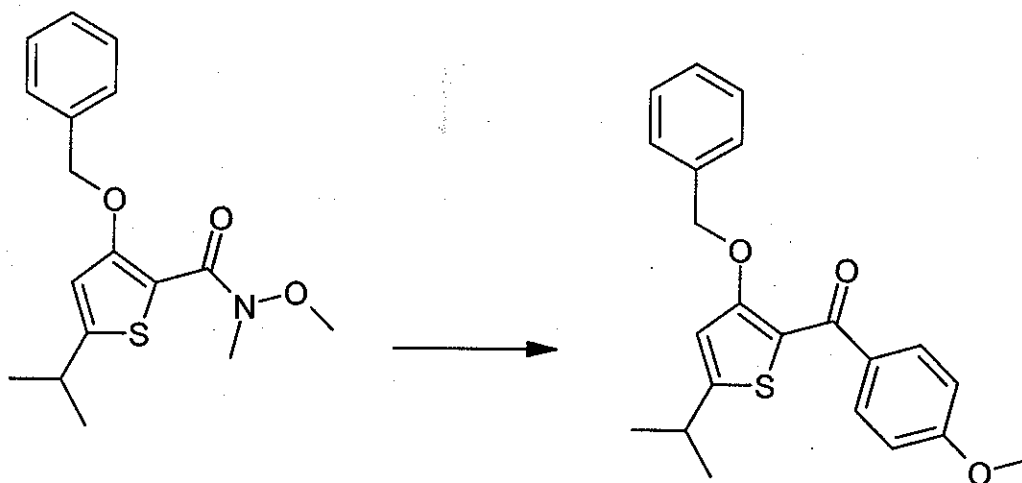
The product with the molecular weight of 276.4 (C₁₅H₁₈O₃S), MS (ESI): 294

(M+Na⁺) is obtained.



c) 3-Benzyloxy-5-isopropyl-N-methoxy-N-methylthiophene-2-carboxamide

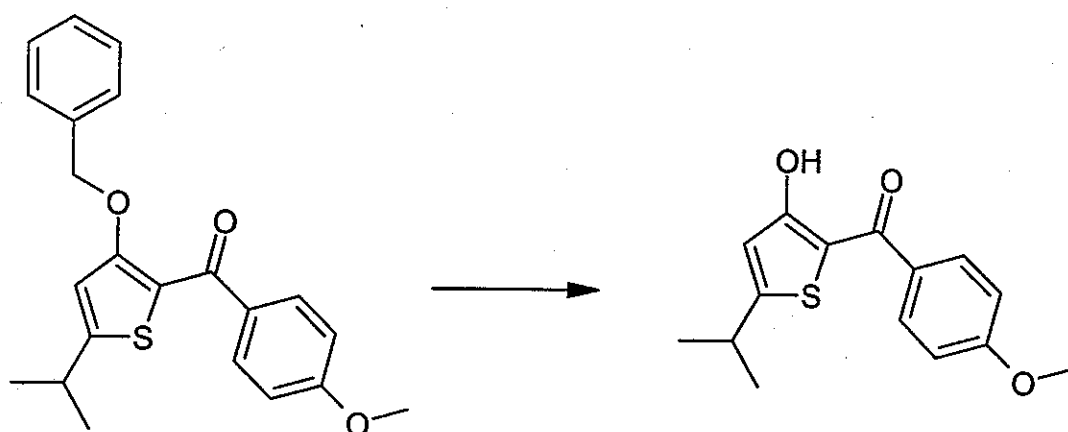
- 5 860 mg of 3-benzyloxy-5-isopropylthiophene-2-carboxylic acid are dissolved in 30 ml of dichloromethane, and 560 mg of N,O-dimethylhydroxylamine hydrochloride and 2.3 ml of triethylamine are added. After 15 min at 22°C, 2.3 ml of a 50% strength 1-propanephosphonic anhydride solution in acetic acid are added, and the mixture is stirred at 22°C for a further 18 h. The reaction mixture is washed twice with 70 ml of water each time and once with 70 ml of saturated sodium chloride solution. The
- 10 organic phase is dried over sodium sulfate and concentrated.
- The product with the molecular weight of 319.4 ($C_{17}H_{21}NO_3S$), MS (ESI): 320 ($M+H^+$) is obtained.



- 15 d) (3-Benzyloxy-5-isopropylthiophen-2-yl)-(4-methoxyphenyl)-methanone
- 860 mg of 3-benzyloxy-5-isopropyl-N-methoxy-N-methylthiophene-2-carboxamide are dissolved in 50 ml of tetrahydrofuran (THF) and cooled to 0°C in an ice bath, and 31.3 ml of a 0.5 molar 4-methoxyphenylmagnesium bromide solution in

tetrahydrofuran are added. After 30 min, the ice bath is removed and the reaction mixture is warmed to 22°C. After one hour, 70 ml of saturated sodium bicarbonate solution are added to the reaction mixture, and it is extracted twice with 100 ml of methyl acetate each time. The combined organic phases are washed with 70 ml of saturated sodium chloride solution, dried over sodium sulfate and concentrated. The crude product is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:3).

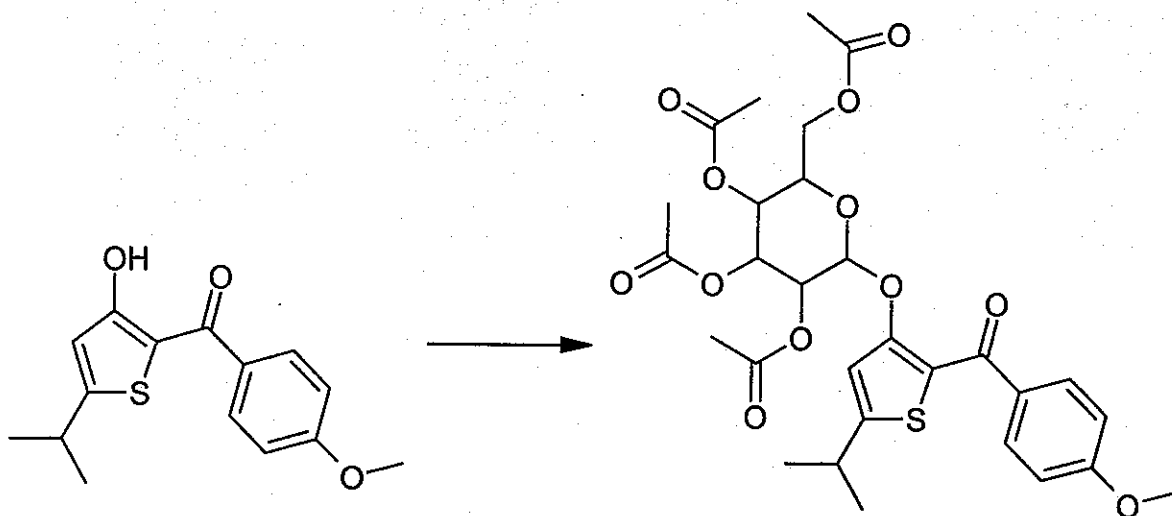
The product with the molecular weight of 366.5 (C₂₂H₂₂O₃S), MS (ESI): 367 (M+H⁺) is obtained.



e) (3-Hydroxy-5-isopropyl-thiophen-2-yl)-(4-methoxy-phenyl)-methanone

1.00 g of (3-benzyloxy-5-isopropyl-thiophen-2-yl)-(4-methoxy-phenyl)-methanone is dissolved in 20 ml of dichloromethane. 2.73 ml of a 1 molar solution of boron tribromide-dimethyl sulfide complex in dichloromethane are added to the reaction solution. The solution is stirred at 22°C for 1.5 h. The reaction mixture is poured into 50 ml of water, and the mixture is extracted twice with 30 ml of dichloromethane each time. The combined organic phase is extracted twice with 30 ml of saturated sodium bicarbonate solution each time and washed once with 50 ml of saturated sodium chloride solution, dried over sodium sulfate and concentrated. The crude product is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:4).

The product with the molecular weight of 276.4 (C₁₅H₁₆O₃S), MS (ESI): 299 (M+Na⁺) is obtained.

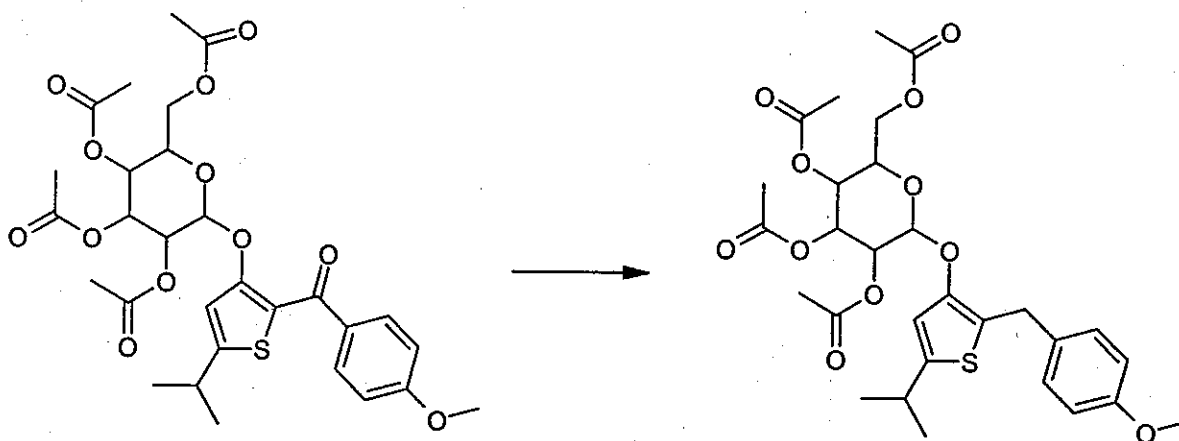


f) (4,5-Diacetoxy-6-acetoxymethyl-2-[5-isopropyl-2-(4-methoxy-benzoyl)-thiophen-3-yloxy]-tetrahydro-pyran-3-yl) acetate

- 5 380 mg of (3-hydroxy-5-isopropyl-thiophen-2-yl)-(4-methoxy-phenyl)-methanone, 848 mg of 4,5-diacetoxy-6-acetoxymethyl-2-bromo-tetrahydro-pyran-3-yl acetate, 1.43 g of potassium carbonate and 71.1 mg of benzyltributylammonium chloride are dissolved in 20 ml of dichloromethane, and 1.20 ml of water are added. The reaction mixture is stirred at 22°C for 40 h. 50 ml of water are added to the reaction mixture,
- 10 which is extracted twice with 50 ml of dichloromethane each time. The combined organic phases are washed with 50 ml of saturated sodium chloride solution, dried over sodium sulfate and concentrated. The crude product is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:1).

The product with the molecular weight of 606.7 (C₂₉H₃₄O₁₂S), MS (ESI): 607 (M+H⁺)

- 15 is obtained.

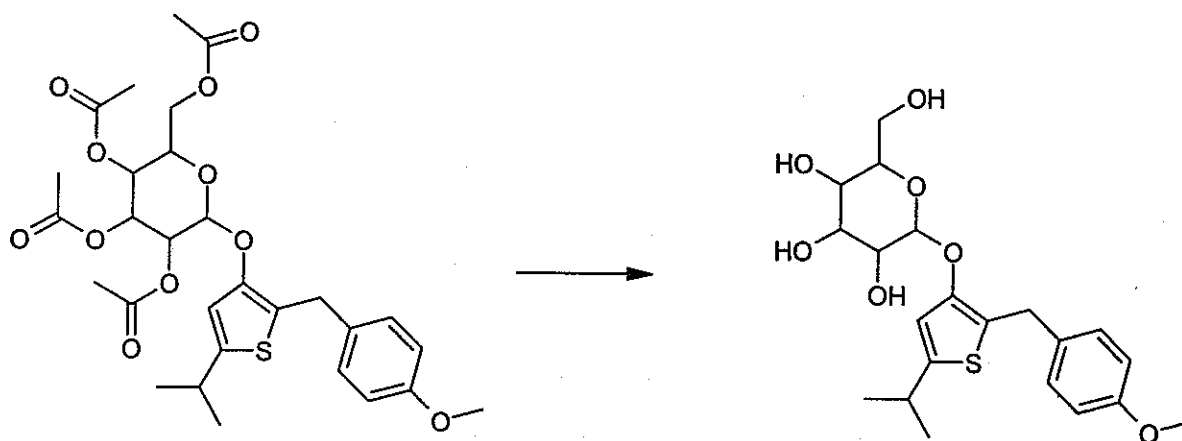


g) (4,5-Diacetoxy-6-acetoxymethyl-2-[5-isopropyl-2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydro-pyran-3-yl) acetate

630 mg of (4,5-diacetoxy-6-acetoxymethyl-2-[5-isopropyl-2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydro-pyran-3-yl) acetate are dissolved in 30 ml of acetonitrile

- 5 and cooled to 0°C in an ice bath. 1.31 ml of trimethylchlorosilane and 652 mg of sodium cyanoborohydride are added, the ice bath is removed and the reaction is stirred for 2 h. 100 ml of water are added to the reaction mixture, which is extracted twice with 70 ml of dichloromethane each time. The combined organic phases are washed with 50 ml of saturated sodium chloride solution, dried over sodium sulfate
- 10 and concentrated. The crude product is purified by column chromatography (SiO₂, ethyl acetate/n-heptane = 1:1).

The product with the molecular weight of 592.7 (C₂₉H₃₆O₁₁S), MS (ESI): 593 (M+H⁺) is obtained.



h) 2-Hydroxymethyl-6-[5-isopropyl-2-(4-methoxy-benzyl)-thiophen-3-yloxy]-tetrahydro-pyran-3,4,5-triol

450 mg of (4,5-diacetoxy-6-acetoxymethyl-2-[5-isopropyl-2-(4-methoxy-benzyl)-

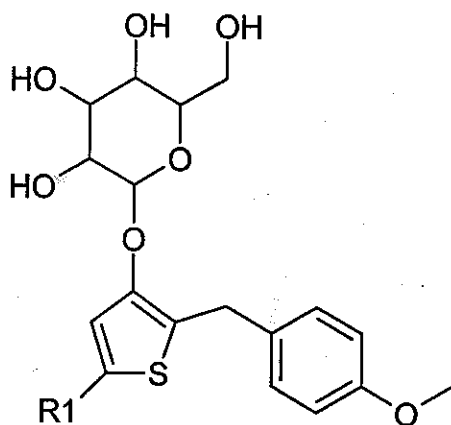
- 20 thiophen-3-yloxy]-tetrahydro-pyran-3-yl) acetate are dissolved in 20 ml of methanol, and 0.41 ml of a 30% strength methanolic sodium methanolate solution is added. The reaction mixture is stirred at 22°C for 1 h and, after addition of Amberlyst 15 (H⁺ form), filtered and washed with 30 ml of methanol. The solution is concentrated.

The product with the molecular weight of 424.5 (C₂₁H₂₈O₇S), MS (ESI): 447

- 25 (M+Na⁺) is obtained.

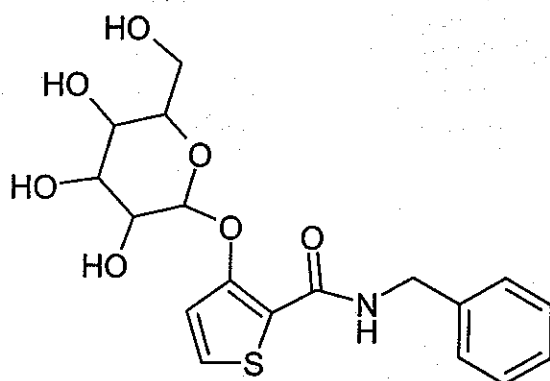
Examples 52 to 54 below are prepared by the same synthetic route starting from 3-hydroxy-thiophene-2-carboxylic acids known from the literature [H. Fiesselmann, F. Thoma, Chem. Ber. 1956, 89, 1907-1913; M.D. Mullican et al., J. Med. Chem. 1991, 34, 2186-2194; G.M. Karp et al., Synthesis 2000, 1078-1080.]:

5

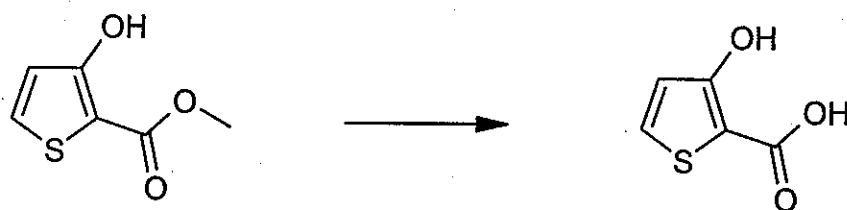


Example	R ₁	MS or LC/MS
52		OK
53		OK
54		OK

Example 55:



- 5 3-(3,4,5-Trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-N-benzylthiophene-2-carboxamide

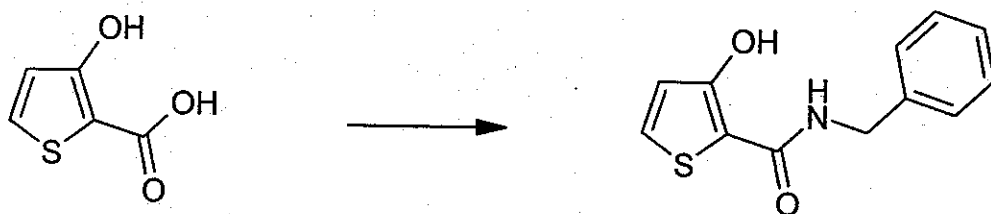


10

a) 3-Hydroxy-thiophene-2-carboxylic acid

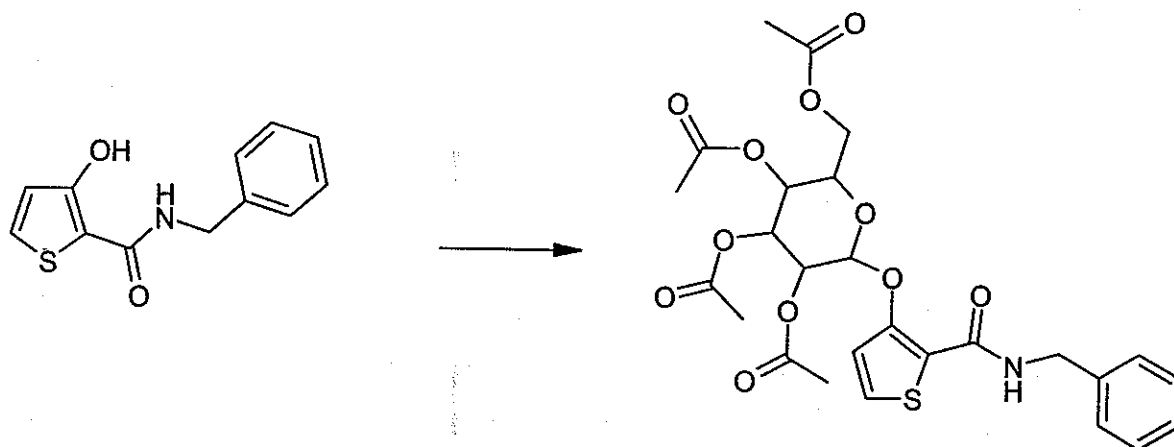
- 10.0 g of methyl 3-hydroxy-thiophene-2-carboxylate are dissolved in a mixture of 90 ml of tetrahydrofuran (THF) and 90 ml of methanol, and a solution of 25.2 g of lithium hydroxide in 25 ml of water is added. The reaction mixture is stirred at 22°C for 18 h and then heated at 55°C for 6 h. The reaction mixture is concentrated to 50 ml in a rotary evaporator, acidified to pH = 1 with 2 molar hydrochloric acid and extracted 3 times with 50 ml of t-butyl methyl ether each time. The combined organic phases are dried over magnesium sulfate and concentrated.

20 The product with the molecular weight of 144.2 (C₅H₄O₃S), MS (ESI): 145 (M+H⁺) is obtained.



b) N-Benzyl-3-hydroxy-thiophene-2-carboxamide

1.44 g of 3-hydroxy-thiophene-2-carboxylic acid are dissolved in 100 ml of
 5 dichloromethane, and 2.18 ml of benzylamine and 5.00 ml of a 50% strength
 1-propanephosphonic anhydride solution in acetic acid are added. The reaction
 mixture is stirred at 22°C for 2 h and, after addition of 100 ml of saturated sodium
 bicarbonate solution, extracted twice with 100 ml of dichloromethane each time. The
 combined organic phases are washed with 100 ml of saturated sodium chloride
 10 solution, dried over magnesium sulfate and concentrated. The product with the
 molecular weight of 233.3 ($C_{12}H_{11}NO_2S$), MS (ESI): 234 ($M+H^+$) is obtained.



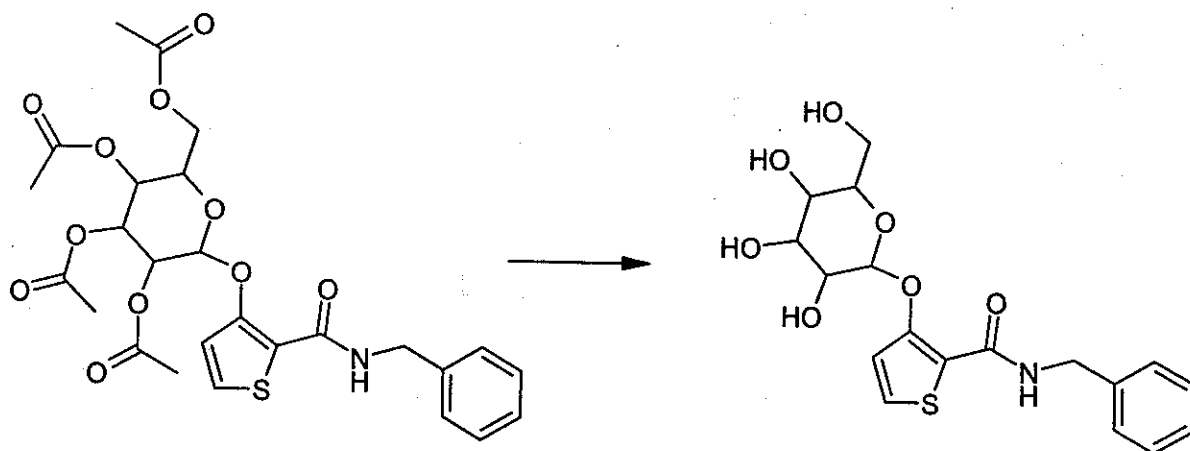
c) 3,4,5-Triacetoxy-6-(2-benzylcarbamoyl-thiophen-3-yloxy)-tetrahydro-pyran-
 2-ylmethyl acetate

1.12 g of N-benzyl-3-hydroxy-thiophene-2-carboxamide, 3.16 g of 4,5-diacetoxy-
 6-acetoxymethyl-2-bromo-tetrahydro-pyran-3-yl acetate, 3.30 g of potassium
 carbonate and 235 mg of benzyltributylammonium chloride are dissolved in 25 ml of
 dichloromethane, and 2.00 ml of water are added. The reaction mixture is stirred at
 20 22°C for 40 h. 50 ml of saturated sodium bicarbonate solution are added to the
 reaction mixture, which is extracted twice with 50 ml of dichloromethane each time.
 The combined organic phases are dried over magnesium sulfate and concentrated.

The crude product is purified by column chromatography (SiO_2 , ethyl acetate/n-heptane = 1:1).

The product with the molecular weight of 563.6 ($\text{C}_{26}\text{H}_{29}\text{NO}_{11}\text{S}$), MS (ESI): 564 ($\text{M}+\text{H}^+$) is obtained.

5



d) N-Benzyl-3-(3,4,5-trihydroxy-6-hydroxymethyl-tetrahydro-pyran-2-yloxy)-thiophene-2-carboxamide

- 10 600 mg of 3,4,5-triacetoxy-6-(2-benzylcarbamoyl-thiophen-3-yloxy)-tetrahydro-pyran-2-ylmethyl acetate are dissolved in 40 ml of methanol, and 1.40 ml of a 30% strength methanolic sodium methanolate solution are added. The reaction mixture is stirred at 22°C for 2 h, neutralized with 0.5 molar methanolic HCl solution and concentrated.

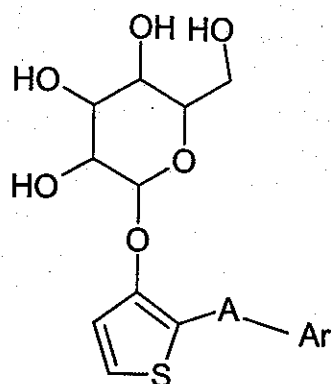
The crude product is purified by column chromatography (SiO_2 , ethyl acetate/methanol = 10:1).

15

The product with the molecular weight of 395.4 ($\text{C}_{18}\text{H}_{21}\text{NO}_7\text{S}$), MS (ESI): 396 ($\text{M}+\text{H}^+$) is obtained.

Examples 56 to 58 below are prepared by the same synthetic route:

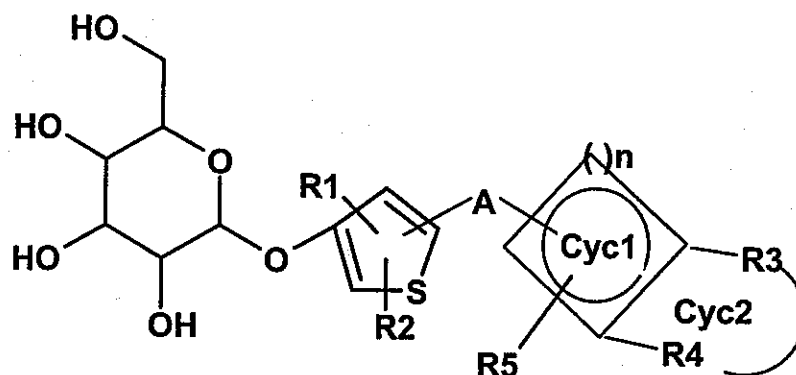
60



Example	A	Ar	MS/LCMS
56	-CO-NH-CH ₂ -		OK
57	-CO-NH-CH ₂ -		OK
58	-CO-NH-CH ₂ -		OK

Patent claims:

1. A compound of the formula I



in which

- 10 R1, R2 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, CO(C₁-C₆)-alkyl, COO(C₁-C₆)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₆)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₆)-alkoxy, HO-(C₁-C₈)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, phenyl, benzyl, (C₁-C₄)-alkylcarbonyl, where one, more than one or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;
- 15 SO₂-NH₂, SO₂NH(C₁-C₆)-alkyl, SO₂N[(C₁-C₆)-alkyl]₂, S-(C₁-C₆)-alkyl, S-(CH₂)_o-phenyl, SO-(C₁-C₆)-alkyl, SO-(CH₂)_o-phenyl, SO₂-(C₁-C₆)-alkyl, SO₂-(CH₂)_o-phenyl, where o may be 0-6 and the phenyl radical may be substituted up to twice by F, Cl, Br, OH, CF₃, NO₂, CN, OCF₃, (C₁-C₆)-alkoxy, (C₁-C₆)-alkyl, NH₂;
- 20 NH₂, NH-(C₁-C₆)-alkyl, N[(C₁-C₆)-alkyl]₂, NH(C₁-C₇)-acyl, phenyl, O-(CH₂)_o-phenyl, where o may be 0-6 and where the phenyl ring may be substituted one to 3 times by F, Cl, Br, I, OH, CF₃, NO₂, CN, OCF₃.

(C₁-C₆)-alkoxy, (C₁-C₆)-alkyl, NH₂, NH(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, SO₂-CH₃, COOH, COO-(C₁-C₆)-alkyl, CONH₂;

A is (C₀-C₁₅)-alkanediyl, where one or more carbon atoms in the
 5 alkanediyl radical may be replaced independently of one another by
 -O-, -(C=O)-, -CH=CH-, -C≡C-, -S-, -CH(OH)-, -CHF-, -CF₂-, -(S=O)-,
 -(SO₂)-, -N((C₁-C₆)-alkyl)-, -N((C₁-C₆)-alkylphenyl)- or -NH-;

n is a number from 0 to 4;

10 Cyc1 is a 3- to 7-membered, saturated, partially saturated or unsaturated
 ring, where 1 carbon atom may be replaced by O or S;

R₃, R₄, R₅ are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, COO(C₁-C₆)-alkyl,
 15 CO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂,
 (C₁-C₈)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₁₂)-alkoxy, HO-
 (C₁-C₆)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, where one, more than one
 or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by
 fluorine;

20 SO₂-NH₂, SO₂NH(C₁-C₆)-alkyl, SO₂N[(C₁-C₆)-alkyl]₂, S-(C₁-C₆)-alkyl,
 S-(CH₂)_o-phenyl, SO-(C₁-C₆)-alkyl, SO-(CH₂)_o-phenyl, SO₂-(C₁-C₆)-
 alkyl, SO₂-(CH₂)_o-phenyl, where o may be 0-6 and the phenyl radical
 may be substituted up to twice by F, Cl, Br, OH, CF₃, NO₂, CN, OCF₃,
 (C₁-C₆)-alkoxy, (C₁-C₆)-alkyl, NH₂;

25 NH₂, NH-(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, NH(C₁-C₇)-acyl, phenyl,
 (CH₂)_o-phenyl, O-(CH₂)_o-phenyl, where o may be 0-6 and where the
 phenyl ring may be substituted one to 3 times by F, Cl, Br, I, OH, CF₃,

NO₂, CN, OCF₃, (C₁-C₈)-alkoxy, (C₁-C₆)-alkyl, NH₂, NH(C₁-C₆)-alkyl, N((C₁-C₆)-alkyl)₂, SO₂-CH₃, COOH, COO-(C₁-C₆)-alkyl, CONH₂;
or

R3 and R4 together with the carbon atoms carrying them are a 5- to 7-membered, saturated, partially or completely unsaturated ring Cyc2, where 1 or 2 carbon atom(s) in the ring may also be replaced by N, O or S, and Cyc2 may optionally be substituted by (C₁-C₆)-alkyl, (C₂-C₅)-alkenyl, (C₂-C₅)-alkynyl, where in each case one CH₂ group may be replaced by O, or substituted by H, F, Cl, OH, CF₃, NO₂, CN, COO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₄)-alkyl, OCF₃, and

R5 is hydrogen;

and the pharmaceutically acceptable salts thereof.

2. A compound of the formula I as claimed in claim 1, in which A is linked to the thienyl ring in position 2.

3. A compound of the formula I as claimed in claim 1 or 2, in which

R1, R2 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, CO(C₁-C₆)-alkyl, COO(C₁-C₆)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₈)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₆)-alkoxy, HO-(C₁-C₆)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, phenyl, benzyl, (C₁-C₄)-alkylcarbonyl, SO-(C₁-C₆)-alkyl, where one, more than one or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;

A is (C₀-C₁₅)-alkanediyl, where one or more carbon atom(s) in the alkanediyl radical may be replaced independently of one another by

-O-, -(C=O)-, -CH=CH-, -C≡C-, -S-, -CH(OH)-, -CHF-, -CF₂-, -(S=O)-, -(SO₂)-, -N((C₁-C₆)-alkyl)-, -N((C₁-C₆)-alkylphenyl)- or -NH-;

n is a number 2 or 3;

Cyc1 is a 5- to 6-membered, saturated, partially saturated or unsaturated ring, where 1 carbon atom may be replaced by O or S;

R3, R4, R5 are hydrogen, F, Cl, Br, I, OH, NO₂, CN, COOH, COO(C₁-C₆)-alkyl, CO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₆)-alkyl, CON[(C₁-C₆)-alkyl]₂, (C₁-C₈)-alkyl, (C₂-C₆)-alkenyl, (C₂-C₆)-alkynyl, (C₁-C₁₂)-alkoxy, HO-(C₁-C₆)-alkyl, (C₁-C₆)-alkoxy-(C₁-C₆)-alkyl, (C₁-C₄)-alkylphenyl, (C₁-C₄)-alkoxyphenyl, S-(C₁-C₆)-alkyl, SO-(C₁-C₆)-alkyl, where one, more than one or all hydrogen(s) in the alkyl and alkoxy radicals may be replaced by fluorine;

or

R3 and R4 together with the carbon atoms carrying them are a 5- to 7-membered, saturated, partially or completely unsaturated ring Cyc2, where 1 or 2 carbon atom(s) in the ring may also be replaced by N, O or S, and Cyc2 may optionally be substituted by (C₁-C₆)-alkyl, (C₂-C₅)-alkenyl, (C₂-C₅)-alkynyl, where in each case one CH₂ group may be replaced by O, or substituted by H, F, Cl, OH, CF₃, NO₂, CN, COO(C₁-C₄)-alkyl, CONH₂, CONH(C₁-C₄)-alkyl, OCF₃, and

R5 is hydrogen.

4. A compound of the formula I as claimed in claims 1 to 3, in which

R1, R2 are hydrogen, (C₁-C₆)-alkyl, (C₁-C₄)-alkoxy, HO-(C₁-C₄)-alkyl, (C₁-C₄)-alkoxy-(C₁-C₄)-alkyl, F, Cl, CF₃, OCF₃, OCH₂CF₃ (C₁-C₄)-alkyl-CF₂-,

phenyl, benzyl, (C₁-C₄)-alkylcarbonyl, (C₂-C₄)-alkenyl, (C₂-C₄)-alkynyl, COO(C₁-C₄)-alkyl;

A is -CH=CH-CH₂- or (C₁-C₄)-alkanediyl, where one or two CH₂ groups may also be replaced by -(C=O)-, -CH=CH-, -CH(OH)-, -NH-, -CHF-, -CF₂-, -O-;

n is a number 2 or 3;

10 Cyc1 is unsaturated ring, where 1 carbon atom may be replaced by O or S;

R₃, R₄, R₅ are hydrogen, F, Cl, Br, I, NO₂, OH, CN, (C₁-C₆)-alkyl, (C₁-C₈)-alkoxy, OCF₃, OCH₂CF₃, S-(C₁-C₄)-alkyl, COOH, HO-(C₁-C₄)-alkyl, (C₁-C₄)-alkoxy-(C₁-C₄)-alkyl, (C₁-C₂)-alkylphenyl, (C₁-C₂)-alkoxyphenyl, or

15 R₃ and R₄ together are -CH=CH-O-, -CH=CH-S-, -O-(CH₂)_p-O-, with p = 1 or 2, -O-CF₂-O-, -CH=CH-CH=CH-, and

R₅ is hydrogen.

20 5. A compound of the formula I as claimed in claims 1 to 4, in which R₂ is hydrogen.

6. A compound of the formula I as claimed in claims 1 to 5, in which

25 R₁ is hydrogen, CF₃, (C₁-C₄)-alkyl, phenyl,

R₂ is hydrogen,

A is -CH₂-, -C₂H₄-, -C₃H₆-, -CH(OH)-, -(C=O)-, -CH=CH-,
-CH=CH-CH₂-, -CO-CH₂-CH₂- or -CO-NH-CH₂-;

n is a number 2 or 3;

5

Cyc1 is unsaturated ring, where 1 carbon atom may be replaced by S;

R₃, R₄, R₅ are hydrogen, F, Cl, I, NO₂, OH, CN, (C₁-C₆)-alkyl, (C₁-C₈)-alkoxy,
O-CH₂-phenyl, OCF₃, S-CH₃, COOH or

10

R₃ and R₄ together are -CH=CH-O-, -O-(CH₂)_p-O-, with p = 1 or 2, -O-CF₂-O-,
-CH=CH-CH=CH-, and

R₅ is hydrogen.

15

7. A compound of the formula I as claimed in claims 1 to 6, in which

A is -CH₂- or -CH₂-CH₂-.

8. A compound of the formula I as claimed in claims 1 to 7, in which

20 Cyc1 is phenyl.

9. A compound of the formula I as claimed in claims 1 to 7, in which

Cyc1 is thienyl.

25 10. A compound of the formula I as claimed in claims 1 to 8, in which

Cyc1 is monosubstituted.

11. A medicament comprising one or more of the compounds as claimed in one or
more of claims 1 to 10.

30

12. A medicament comprising one or more of the compounds as claimed in one or
more of claims 1 to 10 and one or more blood glucose-lowering active ingredients.

13. The use of the compounds as claimed in one or more of claims 1 to 10 for producing a medicament for the treatment of type 1 and type 2 diabetes.
- 5 14. The use of the compounds as claimed in one or more of claims 1 to 10 for producing a medicament for lowering blood glucose.
- 10 15. The use of the compounds as claimed in one or more of claims 1 to 10 in combination with at least one other blood glucose-lowering active ingredient for producing a medicament for the treatment of type 1 and type 2 diabetes.
- 15 16. The use of the compounds as claimed in one or more of claims 1 to 10 in combination with at least one other blood glucose-lowering active ingredient for producing a medicament for lowering blood glucose.
17. A process for producing a medicament comprising one or more of the compounds as claimed in one or more of claims 1 to 10, which comprises mixing the active ingredient with a pharmaceutically suitable carrier and converting this mixture into a form suitable for administration.