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(71) Demandeur/Applicant:
MERCK PATENT GESELLSCHAFT MIT BESCHRAENKTER HAFTUNG, DE

(72) Inventeurs/Inventors:
MOINET, GERARD, FR;
MARAIS, DOMINIQUE, FR;
MAIZERAY, PHILIPPE, FR

(74) Agent: FETHERSTONHAUGH & CO.

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(54) Title: USE OF 4-OXOBUTANOIC ACID DERIVATIVES IN THE TREATMENT OF INFLAMMATION

(57) Abrégé/Abstract:
The present invention relates to the use of a 4-oxobutanoic acid derivative for the preparation of a pharmaceutical composition for treating inflammation.

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(71) Applicant *(for all designated States except US)*: **MERCK PATENT GMBH** [DE/DE]; Frankfurter Strasse 250, 64293 Darmstadt (DE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **MOINET, Gérard** [FR/FR]; 15, rue Lamartine, F-91400 Orsay (FR). **MARAIS, Dominique** [FR/FR]; 3, chemin Pouillères, F-78250 Meulan (FR). **MAIZERAY, Philippe** [FR/FR]; 32, rue de la Pommeraie, F-91630 Ledeville (FR).

(74) Common Representative: **MERCK PATENT GMBH**; Frankfurter Strasse 250, 64293 Darmstadt (DE).

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(54) Title: USE OF 4-OXOBUTANOIC ACID DERIVATIVES IN THE TREATMENT OF INFLAMMATION

(57) Abstract: The present invention relates to the use of a 4-oxobutanoic acid derivative for the preparation of a pharmaceutical composition for treating inflammation.

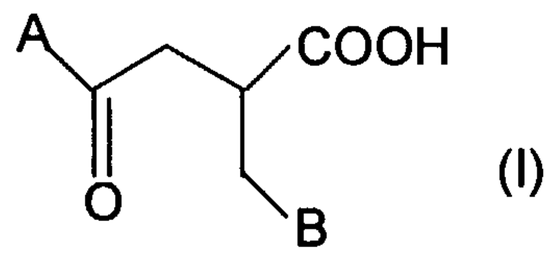
Use of 4-oxobutanoic acid derivatives in the treatment of inflammation

The present invention relates to the use of a 4-oxobutanoic acid derivative for the preparation of a pharmaceutical composition for treating inflammation.

4-Oxobutanoic acid derivatives have already been described in patent application WO 98/07681 as antidiabetic agents and more particularly for treating non-insulin-dependent diabetes.

Thus, the present patent application relates firstly to the use of at least one 4-oxobutanoic acid derivative conforming to the general formula (I) for the preparation of a medicament for treating inflammation.

The compound of the formula (I) is defined as follows:



(I)

in which the groups A and B are chosen, independently of each other, from:

- a mono-, bi- or tricyclic aryl group containing from 6 to 14 carbon atoms;
- a heteroaromatic group chosen from pyridyl, pyrimidyl, pyrrolyl, furyl and thienyl groups;
- an alkyl group containing from 1 to 14 carbon atoms;
- a cycloalkyl group containing from 5 to 8 carbon atoms;
- a saturated heterocyclic group chosen from tetrahydrofuryl, tetrahydropyranyl, piperidyl and pyrrolidinyl groups;

where the groups A and B may carry from 1 to 3 substituents chosen from a C_1-C_6 alkyl group, a C_1-C_6 alkoxy group, a C_6-C_{14} aryl group, a heteroaryl group chosen from pyridyl, pyrimidyl, pyrrolyl, furyl and thienyl, a (C_6-C_{14})aryl(C_1-C_6)alkyl group, a (C_6-C_{14})aryl(C_1-C_6)alkyl(C_6-C_{14})aryl group, a halogen or a trifluoromethyl, trifluoromethoxy, cyano, hydroxyl, nitro, amino, carboxyl, (C_1-C_6)-

alkoxycarbonyl, carbamoyl, (C_1-C_6)alkylsulfonyl, sulfoamino, (C_1-C_6)alkylsulfonylamino, sulfamoyl or (C_1-C_6)alkylcarbonylamino group;

or two of the substituents form a methylenedioxy group, a solvate thereof or a salt of this acid.

In a preferred embodiment of the invention, the 4-oxobutanoic acids are those of the formula (I) in which A and B are chosen from aryl groups.

Examples of aryl groups that may be mentioned include phenyl, α-naphthyl, β-naphthyl and fluorenyl groups.

The C_1-C_6 alkyl groups may be linear or branched. Examples that may be mentioned include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl and pentyl groups.

The C_1-C_6 alkoxy groups may also be linear or branched.

Examples that may be mentioned include methoxy, ethoxy, propoxy, isopropoxy, butoxy and isobutoxy groups.

The halogens may be chosen from fluorine, chlorine, bromine and iodine.

The present invention also includes the tautomeric forms of the compounds of the general formula (I), the enantiomers, diastereoisomers and epimers of these compounds, and also the solvates thereof.

Examples of salts of the compounds of the general formula (I) include pharmacologically acceptable salts, such as the sodium salts, potassium salts, magnesium salts, calcium salts, amine salts and other salts of the same type (aluminium, iron, bismuth, etc.).

In a preferred embodiment, the 4-oxobutanoic acids are chosen from:

- 2-benzyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid
- 2-cyclohexylmethyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-phenyl-4-oxobutanoic acid
- 2-(β-naphthylmethyl)-4-phenyl-4-oxobutanoic acid
- 2-benzyl-4-(β-naphthyl)-4-oxobutanoic acid
- 2-[(4-chlorophenyl)methyl]-4-(4-methoxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-(4-methylphenyl)-4-oxobutanoic acid
- 4-(4-fluorophenyl)-2-[(4-methoxyphenyl)methyl]-4-oxobutanoic acid

- 2-benzyl-4-(3,4-methylenedioxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-cyclohexyl-4-oxobutanoic acid
- 4-phenyl-2-[(tetrahydrofur-2-yl)methyl]-4-oxobutanoic acid,
- the solvates, enantiomers and salts of these acids.

Advantageously, the 4-oxobutanoic acid derivative is chosen from:

- (-)-2-benzyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- (+)-2-benzyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- (-)-2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid
- (+)-2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid,
- the solvates and salts of these acids.

The compound that is most particularly preferred is 2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid, its solvates, its enantiomers and its salts.

The compounds of the formula (I) were subjected to biological tests designed to reveal their anti-inflammatory activity. The *in vivo* activity of the compounds of the formula (I) was studied in an experimental model of inflammation in rats. Inflammatory oedema of the rat paw is induced by intradermal injection of carrageenan (1% V/V) into the hind paw of the rat. This oedema is measured by plethysmometry according to the method of Winter C.A. et al. (Proc. Soc. Exp. Biol. Med.; (1962); 111; 544-547). The substances with an anti-inflammatory effect bring about a reduction in the oedema thus created. Indomethacin is used as anti-inflammatory reference in the test.

The results show that the compounds of the formula (I) have anti-inflammatory properties *in vivo*. The treatment of inflammation may be performed preventively or curatively.

They may thus be used in this respect in the symptomatic treatment of painful conditions of mild to moderate intensity and/or febrile conditions, more particularly in diabetic neuropathy, polyarthritis, arthrosis, lumbago, traumatological pain and ORL inflammations.

The inflammation treated according to the invention may be associated with pathologies of insulin-resistant metabolic syndrome, with pathologies resulting from diabetes, for instance retinopathy, nephropathy, neuropathy, micro- and macro-angiopathy, hypertension or atherosclerosis. Specifically, diabetic patients with poor glycaemic control are liable to develop

atherosclerotic plaque infections associated with an inflammatory process [Endocr.; 2000, 6(3), 272-276]. This inflammation may also be associated with pathologies of central origin, for instance neurodegenerative diseases such as, especially, Alzheimer's disease or Parkinson's disease [Lancet; 2001, Aug 11, 358 (9280), 436 – J. Neuropathol. Exp. Neurol. 2001; Oct; 60 (10); 923].

The compounds of the invention may be presented, in combination with any suitable excipient, in any form that is suitable for enteral (more particularly oral) or parenteral administration, for example in the form of tablets, gel capsules, powders, sugar-coated tablets, or drinkable or injectable solutions. These suitable forms and suitable excipients are as defined in patent application WO 98/7681 filed by the Applicant.

The compounds of the formula (I) may be administered in daily doses of between about 1 and 400 mg to adults orally, or between 0.1 and 200 mg parenterally.

The examples below illustrate the present invention without, however, limiting it.

EXAMPLES

•Experimental data:

Animal model: Rat of Wistar type

Anti-inflammatory reference: indomethacin from the company Sigma

Control: 0.5 % methylcellulose hydrogel.

After fasting for one day, the volume of the right hind paw is measured [V paw]. The test compounds, the reference and the control are administered orally in a volume of 10 ml/kg. One hour after administration, oedema is induced by an intraplantar injection of 50 microlitres of carrageenan (1%, V/V) hydrogel into the right hind paw. The volume of this paw is measured three hours after inducing the oedema. The intensity of the oedema [V oedema] is evaluated by the difference in the volume of the paw, before and three hours after the injection of carrageenan.

The results are collated in the table below:

TEST OF CARRAGEENAN-INDUCED INFLAMMATORY OEDEMA

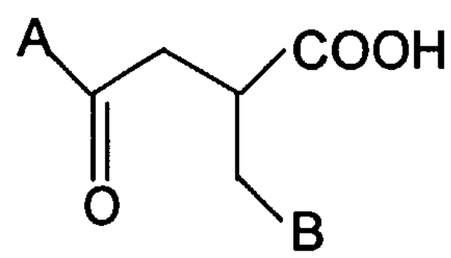
	V paw (ml)	V oedema (ml)	Reduction in oedema (%)
Controls	1.65	0.62	--
Indomethacin	1.65	0.20	- 67
P (30 mg)	1.57	0.42	- 32
P (100 mg)	1.67	0.11	- 83
P (300 mg)	1.71	0.17	- 73

P corresponds to (-)-2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid.

The experimental results show the anti-inflammatory effect of the compounds corresponding to the general formula (I).

CLAIMS

1. Use of at least one 4-oxobutanoic acid derivative of the formula (I) for the preparation of a medicament for treating inflammation, formula (I) being defined as follows:



(I)

in which the groups A and B are chosen, independently of each other, from:

- a mono-, bi- or tricyclic aryl group containing from 6 to 14 carbon atoms;
- a heteroaromatic group chosen from pyridyl, pyrimidyl, pyrrolyl, furyl and thienyl groups;
- an alkyl group containing from 1 to 14 carbon atoms;
- a cycloalkyl group containing from 5 to 8 carbon atoms;
- a saturated heterocyclic group chosen from tetrahydrofuryl, tetrahydropyranyl, piperidyl and pyrrolidinyl groups;

where the groups A and B may carry from 1 to 3 substituents chosen from a C_1-C_6 alkyl group, a C_1-C_6 alkoxy group, a C_6-C_{14} aryl group, a heteroaryl group chosen from pyridyl, pyrimidyl, pyrrolyl, furyl and thienyl, a (C_6-C_{14})aryl(C_1-C_6)alkyl group, a (C_6-C_{14})aryl(C_1-C_6)alkyl(C_6-C_{14})aryl group, a halogen or a trifluoromethyl, trifluoromethoxy, cyano, hydroxyl, nitro, amino, carboxyl, (C_1-C_6)-alkoxycarbonyl, carbamoyl, (C_1-C_6)alkylsulfonyl, sulfoamino, (C_1-C_6)alkylsulfonyl-amino, sulfamoyl or (C_1-C_6)alkylcarbonylamino group;

or two of the substituents form a methylenedioxy group, a solvate thereof or a salt of this acid.

2. Use according to Claim 1, characterised in that the 4-oxobutanoic acid derivative is chosen from:

- 2-benzyl-4-(4-methoxyphenyl)-4-oxobutanoic acid

- 2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid
- 2-cyclohexylmethyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-phenyl-4-oxobutanoic acid
- 2-(β-naphthylmethyl)-4-phenyl-4-oxobutanoic acid
- 2-benzyl-4-(β-naphthyl)-4-oxobutanoic acid
- 2-[(4-chlorophenyl)methyl]-4-(4-methoxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-(4-methylphenyl)-4-oxobutanoic acid
- 4-(4-fluorophenyl)-2-[(4-methoxyphenyl)methyl]-4-oxobutanoic acid
- 2-benzyl-4-(3,4-methylenedioxyphenyl)-4-oxobutanoic acid
- 2-benzyl-4-cyclohexyl-4-oxobutanoic acid
- 4-phenyl-2-[(tetrahydrofur-2-yl)methyl]-4-oxobutanoic acid,
- the solvates, enantiomers and salts of these acids.

3. Use according to Claim 1 or 2, characterised in that the compound of the formula (I) is chosen from:

- (-)-2-benzyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- (+)-2-benzyl-4-(4-methoxyphenyl)-4-oxobutanoic acid
- (-)-2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid
- (+)-2-benzyl-4-(4-fluorophenyl)-4-oxobutanoic acid,
- the solvates and salts of these acids.

4. Use according to one of the preceding claims, characterised in that the medicament is intended for the symptomatic treatment of painful conditions of mild to moderate intensity and/or febrile conditions.

5. Use according to one of Claims 1 to 3, characterised in that the medicament is intended for treating diabetic neuropathy, polyarthritis, arthrosis, lumbago, traumatological pain or ORL inflammations.

6. Use according to one of Claims 1 to 3, characterised in that the medicament is intended for treating inflammation associated with pathologies of insulin-resistant metabolic syndrome.

7. Use according to any one of Claims 1 to 3, characterised in that the medicament is intended for treating inflammation associated with pathologies resulting from diabetes, more particularly chosen from retinopathy, nephropathy, neuropathy, micro- or macro-angiopathy, hypertension and atherosclerosis.

8. Use according to any one of Claims 1 to 3, characterised in that the medicament is intended for treating inflammation associated with pathologies of central origin, more particularly chosen from neurodegenerative diseases.