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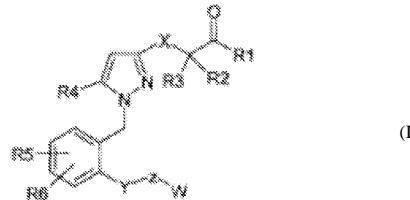
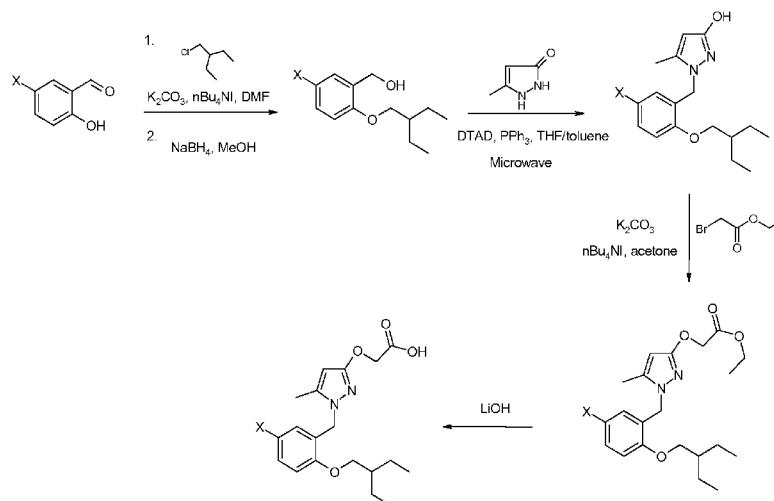
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(54) Title: COMPOUNDS ACTING AT MULTIPLE PROSTAGLANDIN RECEPTORS GIVING A GENERAL ANTI-INFLAMMATORY RESPONSE

(57) Abstract: The present invention provides a compound that is represented by the following general formula (I) wherein R₁, R₂, R₄, R₅, R₆, R₇, X, W, X and Y are as defined in the specification. The compounds may be administered to treat DPI, FP, EP 1, TP and/or EP4 receptor mediated diseases or conditions.



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**COMPOUNDS ACTING AT MULTIPLE PROSTAGLANDIN RECEPTORS GIVING
A GENERAL ANTI-INFLAMMATORY RESPONSE**

BY INVENTORS

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JENNY W. WANG AND DAVID F. WOODWARD**

RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application Serial No. 61/578,456, 10 filed December 21, 2011, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

This invention relates to compounds, to processes for their preparation, to pharmaceutical compositions containing them and to their use in medicine, in particular their use in the 15 treatment of conditions mediated by the action of ligands for the DPi, FP, TP, EPi and EP₄ prostaglandin (PG) receptors. The present compounds have the general structure shown below and act at different prostaglandin receptors to thereby provide a general anti-inflammatory response.

20 **SUMMARY OF THE RELATED ART**

The EPi receptor is a 7-transmembrane receptor and its natural ligand is the prostaglandin PGE₂. PGE₂ also has affinity for the other EP receptors (types EP₂, EP₃ and EP₄). The EPi receptor is associated with smooth muscle contraction, pain (in particular inflammatory, neuropathic and visceral), inflammation, allergic activities, renal regulation and gastric or 25 enteric mucus secretion.

Prostaglandin E₂ (PGE₂) exerts allodynia through the EPi and EP₄ receptor subtypes and hyperalgesia through EP₂, EP₃, and EP₄ receptors. Furthermore, it has been shown that in the EPi knock-out mouse pain-sensitivity responses are reduced by approximately 50%. EPi receptor antagonist (ONO-8711) reduces hyperalgesia and allodynia in a rat model of chronic constriction injury and inhibits mechanical hyperalgesia in a rodent model of post-operative pain. The efficacy of EPi receptor antagonists in the treatment of visceral pain in a human 30 model of hypersensitivity has been demonstrated. Thus, selective prostaglandin ligands,

agonists or antagonists, depending on which prostaglandin E receptor subtype is being considered, have anti-inflammatory, antipyretic and analgesic properties similar to a conventional non-steroidal anti-inflammatory drug, and in addition, inhibit hormone-induced uterine contractions and have anti-cancer effects. These compounds have a diminished 5 ability to induce some of the mechanism-based side effects of NSAIDs which are indiscriminate cyclooxygenase inhibitors. In particular, the compounds have a reduced potential for gastrointestinal toxicity, a reduced potential for renal side effects, a reduced effect on bleeding times and a lessened ability to induce asthma attacks in aspirin-sensitive asthmatic subjects. Moreover, as a result of sparing potentially beneficial prostaglandin 10 pathways, these agents may have enhanced efficacy over NSAIDS and/or COX-2 inhibitors. (See Pub. No. US 2005/0065200 which is hereby incorporated in its entirety for other diseases that may be treated by EP₄ receptor antagonists.)

15 The TP (also known as TXA₂) receptor is a prostanoid receptor subtype stimulated by the endogenous mediator thromboxane. Activation of this receptor results in various physiological actions primarily incurred by its platelet aggregatory and smooth muscle constricting effects, thus opposing those of prostacyclin receptor activation.

20 TP receptors have been identified in human kidneys in the glomerulus and extraglomerular vascular tissue. Activation of TP receptors constricts glomerular capillaries and suppresses glomerular filtration rates indicating that TP receptor antagonists could be useful for renal dysfunction in glomerulonephritis, diabetes mellitus and sepsis.

25 Activation of TP receptors induces bronchoconstriction, an increase in microvascular permeability, formation of mucosal edema and mucus secretion, which are typical characteristic features of bronchial asthma. TP antagonists have been investigated as potential asthma treatments resulting in, for example, orally active Seratrodast (AA-2414). Ramatroban is another TP receptor antagonist currently undergoing phase III clinical trials as an anti-asthmatic compound.

30

Since the DPi receptor may trigger an asthmatic response in certain individuals, compounds that have DPi antagonist properties may be useful as anti-asthmatic drugs. (See Pub. No.

2004/0162323 which is hereby incorporated by reference in its entirety for the disclosure of other diseases and conditions that may be treated with DP antagonists.)

Finally, the FP receptor modulates intraocular pressure and mediates smooth muscle contraction of the sphincter muscles in the gastrointestinal tract and the uterus. Thus, antagonists of the FP receptor are useful for treating reproductive disorders. (See US Patent No. 6,511,999 which is hereby incorporated by reference in its entirety for other diseases and conditions that may be treated with FP receptor antagonists.)

10 As further background for the present invention, see US Published Patent Application 2007/0060596 which is hereby incorporated by reference in its entirety.

Brief Summary of the Invention

15 This invention provides a compound, that is a 1-[(2-{(hydrocarbyl or substituted hydrocarbyl)oxa, thia, sulfmyl, sulfonyl or alkylene}phenyl)methyl]-(5-hydro or alkyl or fluoroalkyl)-1H-pyrazole-3-(oxaacetic acid or azaacetic acid or thiaacetic acid) or an alkyl or aryl ester or sulfonamide thereof, e.g. a 1-[(2-{(hydrocarbyl)oxa}phenyl)methyl]-(5-alkyl)-1H-pyrazole-3-(oxaacetic acid) or an alkyl or aryl ester or sulfonamide thereof.

20

Preferably, said hydrocarbyl is selected from the group consisting of branched chain alkyl and carbocyclic aryl, e.g. phenyl, and more preferably said hydrocarbyl is selected from the group consisting of branched chain alkyl having from 4 to 7 carbons.

25 The invention further relates to pharmaceutical compositions containing the above compounds in combination with a pharmaceutically-acceptable excipient and to their use in medicine, in particular their use in the treatment of conditions mediated by the action of ligands for the DPi, FP, EPi and EP₄ prostaglandin (PG) receptors. The compounds of this invention are also useful for treating conditions mediated by the action of ligands for the 30 thromboxane (TP) receptor.

Some embodiments of the present invention include:

1. A compound, that is a -[(2- {(hydrocarbyl or substituted hydrocarbyl)oxa, thia, sulfmyl, sulfonyl or alkylene}phenyl)methyl]-(5-hydro or alkyl or fluoroalkyl)-IH-pyrazole-3-(oxaacetic acid or azaacetic acid or thiaacetic acid) or an alkyl or aryl ester or sulfonamide thereof. (As will be understood by those of ordinary skill in the art, certain 5 compounds of the invention may be the same but have slightly different names. In one example, the compounds may be designated as a "methylene carboxylic acid" or an "acetic acid." They are the same, despite the different nomenclature.)

2. The compound of paragraph 1, that is a 1-[(2- {(hydrocarbyl)oxa}phenyl)methyl]-(10 5-alkyl)-IH-pyrazole-3 -(oxaacetic acid) or an alkyl or aryl ester or sulfonamide thereof.

3. The compound of paragraph 1 wherein said hydrocarbyl is selected from the group consisting of alkyl and carbocyclic aryl.

15 4. The compound of paragraph 3 wherein said hydrocarbyl is selected from the group consisting of branched chain alkyl and phenyl.

5. The compound of paragraph 4 wherein said hydrocarbyl is selected from the group consisting of branched chain alkyl having from 4 to 7 carbons.

20 6. The compound of paragraph 1 wherein said compound is a IH-pyrazole-3 -oxaacetic acid compound or lower alkyl ester thereof.

7. The compound of paragraph 6 wherein said compound is a 5-alkyl-IH-pyrazole.

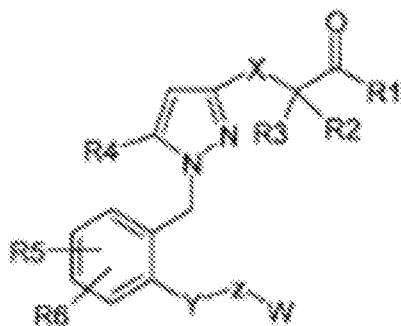
25 8. The compound of paragraph 6 wherein said phenyl is a bromophenyl.

9. The compound of paragraph 1 wherein said compound is a 5-alkyl-IH-pyrazole-3 -oxaacetic acid compound or lower alkyl ester thereof, said hydrocarbyl is selected from the group consisting of branched chain alkyls having from 4 to 7 carbons and said phenyl is a 30 bromophenyl.

10. The compound of paragraph 1, that is selected from the group consisting of

1-[(5-Bromo-2- {2-ethylbutyloxy }phenyl)methyl] -5-methyl- 1H-pyrazole-3-yloxaacetic acid,

11. Compounds having the general formula:



5

wherein X is O, S or NR₇;

Y is (CH₂)_n, wherein n is 0 or an integer of 1 to 3;

10 Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

W is hydrocarbyl or substituted hydrocarbyl:

R_i is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

15

R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

20

R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

25 R₆ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

R₇ is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

12. The compound of paragraph 11 wherein R₇ is selected from the group consisting of
5 carbocyclic aryl and alkyl.

13. The compound of paragraph wherein R_i is OH.

14. The compound of paragraph 11 wherein R₂ and R₃ are H.

10

15. The compound of paragraph 11 wherein R₄ is selected from the group consisting of H, alkyl and fluoro-substituted alkyl.

15

16. The compound of paragraph 11 wherein R₅ is selected from the group consisting of fluoro, chloro, bromo, alkyl, aryl, alkoxy, and fluoro-substituted alkyl and alkoxy. More preferably R₅ is chloro or bromo.

20

17. The compound of paragraph 11 wherein R₆ is selected from the group consisting of is selected from the group consisting of fluoro, chloro, bromo, alkyl, aryl, alkoxy, and fluoro-substituted alkyl and alkoxy.

18. The compound of paragraph 17 wherein R₆ is H.

25

19. The compound of paragraph 11 wherein R₇ is selected from the group consisting of H and alkyl

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20. The compound of paragraph 19 wherein R₇ is H.

21. The compound of paragraph 11 wherein X is O.

22. The compound of paragraph 11 wherein Y is absent, i.e. n is 0.

23. The compound of paragraph 11 wherein Z is O.

24. The compound of paragraph 11 wherein W is selected from the group consisting of alkyl, e.g. branched chain alkyl such as 2-ethylbutyl, 2-methylpropyl, etc. and carbocyclic aryl, e.g. phenyl.

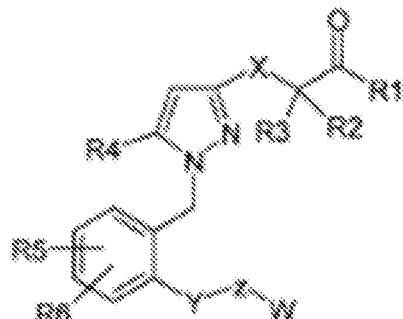
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25. The compound of paragraph 11 wherein said compound is selected from the group consisting of

{1-[5-Chloro-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1*H*-pyrazol-3-yl} -acetic acid,

{1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid,
{1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid, and
{1-(5-Chloro-2-isobutoxy-benzyl)-5 -methyl- 1H-pyrazol-3-yloxy} -acetic acid.

.26. A method comprising administering a compound having the following formula



15

wherein X is O, S or NR₇;

Y is $(CH_2)_n$, wherein n is 0 or an integer of 1 to 3;

20

Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

W is hydrocarbyl or substituted hydrocarbyl:

25 Ri is selected from the group consisting of OR_7 , $N(R_7)_2$, and $N(R_7)SO_2R_7$;

R_2 and R_3 are independently selected from the group consisting of H and alkyl and R_2 and R_3 together may form a cycloalkyl ring;

R_4 is selected from the group consisting of H, alkyl and halogen-substituted alkyl;
 R_5 is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, 5 alkoxy or aryloxy;

R_6 is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

10

R_7 is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

27. The method of paragraph 26 wherein said compound is administered to treat DPI, FP, EP1, TP and/or EP4 receptor mediated diseases or conditions.

15 28. The method of paragraph 27 wherein said condition or disease is related to inflammation.

29. The method of paragraph 27 wherein said DPI, FP, EP1, TP and/or EP4 receptor mediated condition or disease is selected from the group consisting of allergic conditions, 20 asthma, allergic asthma, allergic rhinitis, uveitis and related disorders, atherosclerosis, blood coagulation disorders, bone disorders, cancer, cellular neoplastic transformations, chronic obstructive pulmonary diseases and other forms of lung inflammation, congestive heart failure, diabetic retinopathy, diseases or conditions requiring a treatment of anti-coagulation, diseases requiring control of bone formation and resorption, fertility disorders, gangrene, 25 glaucoma, hyperpyrexia, immune and autoimmune diseases, inflammatory conditions, metastatic tumor growth, migraine, mucus secretion disorders, nasal congestion, nasal inflammation, occlusive vascular diseases, ocular hypertension, ocular hypotension, osteoporosis, rheumatoid arthritis, pain, perennial rhinitis, pulmonary congestion, pulmonary hypotension, Raynaud's disease, rejection in organ transplant and by-pass surgery, respiratory 30 conditions, hirsutism, rhinorrhea, shock, sleep disorders, and sleep-wake cycle disorders.

30. The method of paragraph 27 wherein said compound is administered as a surgical adjunct in ophthalmology for cataract removal and artificial lens insertion, ocular implant procedures, photorefractive radial keratotomy and other ophthalmological laser procedures.

5 31. The method of paragraph 27 wherein said compound is administered as a surgical adjunct in a procedure involving skin incisions, relief of pain and inflammation and scar formation/keloids post-surgery, for treating sports injuries and general aches and pains in muscles and joints.

10 32. The method of paragraph 27 wherein said DPi, FP, EPi, TP, and/or EP₄ receptor mediated condition or disease is an EPi and/or EP₄ receptor mediated condition or disease.

33. The method of paragraph 32 wherein said DPi, FP, EPi, TP and/or EP₄ receptor mediated condition or disease is an allergic condition.

15 34. The method of paragraph 27 wherein said condition is dermatological allergy.

35. The method of paragraph 27 wherein said condition is an ocular allergy.

20 36. The method of paragraph 27 wherein said condition is a respiratory allergy.

37. The method of paragraph 27 wherein said condition or disease is selected from the group consisting of nasal congestion, rhinitis, and asthma.

25 38. The method of paragraph 27 wherein said condition or disease is related to pain.

39. The method of paragraph 27 wherein said condition or disease is selected from the group consisting of arthritis, migraine, and headache.

30 40. The method of paragraph 27 wherein said condition or disease is associated with the gastrointestinal tract.

41. The method of paragraph 27 wherein said condition or disease is selected from the group consisting of peptic ulcer, heartburn, reflux esophagitis, erosive esophagitis, non-ulcer dyspepsia, infection by Helicobacter pylori, alrynitis, and irritable bowel syndrome.

5 42. The method of paragraph 27 wherein said condition or disease is selected from the group consisting of hyperalgesia and allodynia.

43. The method of paragraph 27 wherein said condition or disease is related to mucus secretion.

10

44. The method of paragraph 27 wherein said mucus secretion is gastrointestinal.

45. The method of paragraph 27 wherein said mucus secretion occurs in the nose, sinuses, throat, or lungs.

15

46. The method of paragraph 27 wherein said condition or disease is related to abdominal cramping.

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47. The method of paragraph 27 wherein said condition or disease is irritable bowel syndrome.

48. The method of paragraph 27 wherein said condition or disease is a bleeding disorder.

49. The method of paragraph 27 wherein said condition or disease is a sleep disorder.

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50. The method of paragraph 27 wherein said condition or disease is mastocytosis.

51. The method of paragraph 27 wherein said condition or disease is associated with elevated body temperature.

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52. The method of paragraph 27 wherein said condition or disease is associated with ocular hypertension and glaucoma.

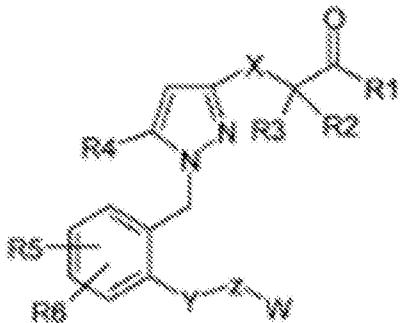
53. The method of paragraph 27 wherein said condition or disease is associated with ocular hypotension.

54. The method of paragraph 27 wherein said condition relates to surgical procure to treat pain, inflammation and other unwanted sequelae wherein said surgical procedure includes incision, laser surgery or implantation.

55. The method of paragraph 27 where said condition is related to pain and inflammation and post-surgical scar and keloid formation.

10

56. A pharmaceutical product comprising a compound having the following formula



wherein X is O, S or NR₇;

15

Y is (CH₂)_n, wherein n is 0 or an integer of 1 to 3;

Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

20 W is hydrocarbyl or substituted hydrocarbyl;

R_i is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R_j;

25 R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

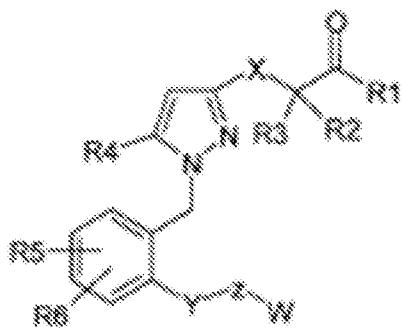
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R₆ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

10 R₇ is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

or a pharmaceutically acceptable salt or a prodrug thereof, wherein said product is packaged and labeled for the treatment or prevention of a disease or condition selected from the group consisting of uveitis , allergic conditions, asthma, allergic asthma, allergic rhinitis, 15 atherosclerosis, blood coagulation disorders, bone disorders, cancer, cellular neoplastic transformations, chronic obstructive pulmonary diseases and other forms of lung inflammation, congestive heart failure, diabetic retinopathy, diseases or conditions requiring a treatment of anti-coagulation, diseases requiring control of bone formation and resorption, fertility disorders, hyperpyrexia , gangrene, glaucoma, hypothermia, immune and 20 autoimmune diseases, inflammatory conditions, metastatic tumor growth, migraine, mucus secretion disorders, nasal congestion, nasal inflammation, occlusive vascular diseases, ocular hypertension, ocular hypotension, osteoporosis, pain, perennial rhinitis, pulmonary congestion, pulmonary hypotension, Raynaud's disease, rejection in organ transplant and by-pass surgery, respiratory conditions, rheumatoid arthritis, rhinorrhea, shock, sleep disorders, 25 sleep-wake cycle disorders, sports injuries , muscle aches and pains , and surgical adjunct for minimizing pain , inflammation and scar/keloid formation.

57. A pharmaceutical composition comprising a compound having the following formula



wherein X is O, S or NR₇;

5 Y is $(CH_2)_n$, wherein n is 0 or an integer of 1 to 3;

Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

W is hydrocarbyl or substituted hydrocarbyl:

10

Ri is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

R_2 and R_3 are independently selected from the group consisting of H and alkyl and R_2 and R_3 together may form a cycloalkyl ring;

15

R_4 is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

R_5 is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

R_6 is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

25

R_7 is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

or a pharmaceutically acceptable salt or a prodrug thereof, and a pharmaceutically acceptable excipient.

Brief Description of the Drawing Figures

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Figures 1 and 2 shows the reaction schemes for the preparation of the compounds of this invention, wherein X in the drawing corresponds to R4 and R5 in the general formula.

Detailed Description of the Invention

10

The following terms are used to define the disclosed invention.

"Hydrocarbyl" refers to a hydrocarbon radical having only carbon and hydrogen atoms. Preferably, the hydrocarbyl radical has from 1 to 20 carbon atoms, more preferably from 1 to 15 12 carbon atoms and most preferably from 1 to 7 carbon atoms.

"Substituted hydrocarbyl" refers to a hydrocarbyl radical wherein one or more, but not all, of the hydrogen and/or the carbon atoms are replaced by a halogen, nitrogen, oxygen, sulfur or phosphorus atom or a radical including a halogen, nitrogen, oxygen, sulfur or phosphorus atom, e.g. fluoro, chloro, cyano, nitro, hydroxyl, phosphate, thiol, etc.

20 "Methylenyl" refers to a -CH₂- linking group.

"Alkylenyl" refers to a -(C(Ry)₂)_p- linking group wherein R₇ is and p is an integer, e.g. an 25 integer varying from 1 to 10, and R₇ is defined below.

"Alkyl" refers to a straight-chain, branched or cyclic saturated aliphatic hydrocarbon. Preferably, the alkyl group has 1 to 12 carbons. More preferably, it is an alkyl of from 4 to 30 10 carbons, most preferably 4 to 8 carbons. Typical alkyl groups include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tertiary butyl, pentyl, hexyl and the like. The alkyl group may be optionally substituted with one or more substituents are selected from the group consisting of hydroxyl, cyano, alkoxy, =O, =S, N0₂, halogen, dimethyl amino, and SH.

"Cycloalkyl" refers to a cyclic saturated aliphatic hydrocarbon group. Preferably, the cycloalkyl group has 3 to 12 carbons. More preferably, it has from 4 to 7 carbons, most preferably 5 or 6 carbons.

5 "Aryl" refers to an aromatic group which has at least one ring having a conjugated pi electron system and includes carbocyclic aryl, heterocyclic aryl and biaryl groups. The aryl group may be optionally substituted with one or more substituents selected from the group consisting of alkyl, hydroxyl, halogen, COOR⁷, N0₂, CF₃, N(R⁷)₂, CON(R⁷)₂, SR⁷, sulfoxyl, sulfone, CN and OR⁷, wherein R⁷ is selected from the group consisting of H, hydrocarbyl and 10 substituted hydrocarbyl, e.g. carbocyclic aryl and alkyl

"Carbocyclic aryl" refers to an aryl group wherein the ring atoms are carbon.

15 "Heteroaryl or heterocyclic aryl" refers to an aryl group having from 1 to 3 heteroatoms as ring atoms, the remainder of the ring atoms being carbon. Heteroatoms include oxygen, sulfur, and nitrogen. Thus, heterocyclic aryl groups include furanyl, thienyl, pyridyl, pyrrolyl, N-lower alkyl pyrrolo, pyrimidyl, pyrazinyl, imidazolyl and the like. Preferably, the heteroaryl group has from 2 to 10 carbons. More preferably, it has from 3 to 10 carbons, most preferably 3 carbons.

20 An "effective amount" is an amount sufficient to accomplish a stated purpose (e.g., achieve the effect for which it is administered, treat a disease, reduce one or more symptoms of a disease or condition). An example of an "effective amount" is an amount sufficient to contribute to the treatment, prevention, or reduction of a symptom or symptoms of a disease, 25 which can be referred to as a "therapeutically effective amount." A "reduction" of a symptom or symptoms (and grammatical equivalents of this phrase) means decreasing of the severity or frequency of the symptom(s), or elimination of the symptom(s). The actual amount effective for a particular application will depend, *inter alia*, on the condition being treated.

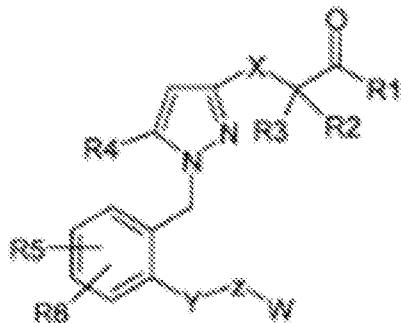
30 The dosage and frequency (single or multiple doses) of compounds administered can vary depending upon a variety of factors, including route of administration; size, age, sex, health, body weight, body mass index, and diet of the recipient; nature and extent of symptoms of the disease being treated (e.g., the disease responsive to an IP receptor

antagonist); presence of other diseases or other health-related problems; kind of concurrent treatment; and complications from any disease or treatment regimen. Other therapeutic regimens or agents can be used in conjunction with the methods and compounds of the invention.

5 For any compound described herein or combination thereof, the therapeutically effective amounts can be initially determined from cell culture assays. Therapeutically effective amounts for use in humans may be determined from animal models. For example, a dose for humans can be formulated to achieve a concentration that has been found to be effective in animals.

10

The present invention provides compounds having the general formula:



15 wherein X is O, S or NR₇;

Y is (CH₂)_n, wherein n is 0 or an integer of 1 to 3;

Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

20

W is hydrocarbyl or substituted hydrocarbyl:

Ri is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

25 R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

R₅ is selected from the group consisting of H, hydroxyl, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl,

5 alkoxy or aryloxy;

R₆ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

10

R₇ is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl, e.g. carbocyclic aryl and alkyl

Preferably, R_i is OH.

Preferably, R₂ and R₃ are H;

15

Preferably, R₄ is selected from the group consisting of H, alkyl and fluoro-substituted alkyl.

Preferably, R₅ is selected from the group consisting of fluoro, chloro, bromo, alkyl, aryl, alkoxy, and fluoro-substituted alkyl and alkoxy. More preferably R₅ is chloro or bromo.

20 Preferably, R₆ is selected from the group consisting of is selected from the group consisting of fluoro, chloro, bromo, alkyl, aryl, alkoxy, and fluoro-substituted alkyl and alkoxy. More preferably R₆ is H.

25 Preferably, R₇ is selected from the group consisting of H and alkyl, e.g. lower alkyl. More preferably, R₇ is H.

Preferably, X is O.

Preferably, Y is absent, i.e. n is 0.

30

Preferably, Z is O.

Preferably, W is selected from the group consisting of alkyl, e.g. branched chain alkyl such as 2-ethylbutyl, 2-methylpropyl, etc. and carbocyclic aryl, e.g. phenyl.

The most preferred compounds of the present invention are selected from the group

5 consisting of

{1-[5-Chloro-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid,
{1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid,
{1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid and
{1-(5-Chloro-2-isobutoxy-benzyl)-5 -methyl- 1H-pyrazol-3-yloxy} -acetic acid

10

1-[(5-Bromo-2- {2-ethylbutyloxy }phenyl)methyl] -5-methyl- 1H-pyrazole-3 -yloxaacetic acid,

The following examples are intended to illustrate the present invention.

15 The reagents and conditions used in the Figure 1, Figure 2 and the Examples may be abbreviated as follows:

Ac is acetyl;

20 DCM is dichloromethane;

RT is room temperature;

Ph is phenyl;

25

DMF is dimethylformamide;

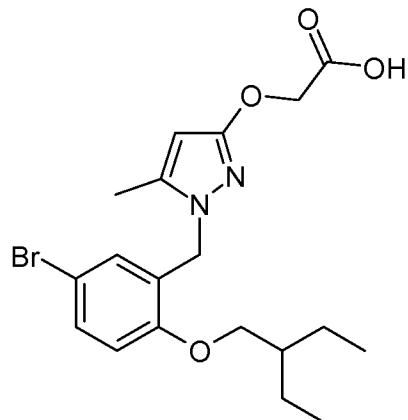
Et is ethyl;

30 THF is tetrahydrofuran;

HEPES is 4- (2-hydroxyethyl)-1-piperazineethanesulfonic acid).

EXAMPLE 1{I-[5-BROMO-2-(2-ETHYL-BUTOXY)-BENZYL]-5-METHYL-1H-PYRAZOL-3-YL}-
OXAACETIC ACID 5

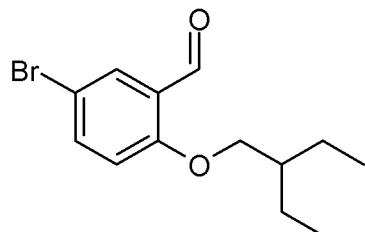
5



Step 1

5-Bromo-2-(2-ethyl-butoxy)-benzaldehyde, 1.

10



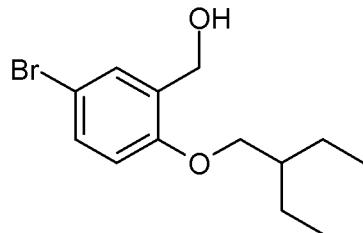
To a solution of 5-chloro-2-hydroxybenzaldehyde, 2.1g (13.4 mmol) DMF (50 mL) under N_2 atmosphere at RT was added 3-(chloromethyl)pentane (1.92g 15.6 mmol), K_2C0_3 (4.5g, 32.6 mmol) and tetrabutylammonium iodide (0.35g, 0.9 mmol). The resulting mixture was stirred 15 at 120 °C for 5 hours. The mixture was partitioned between water (80 ml) and EtOAc (80 ml). The organic layer was washed with water (80 ml) followed by brine (80 ml), dried over (Na_2S0_4) , filtered and the volatiles were removed *in vacuo*. The crude product was purified on silica to yield 2.83g of 5-Chloro-2-(2-ethyl-butoxy)-benzaldehyde, 1.

300 MHz) δ 10.46 (s, 1H, ArCHO₂), 7.80 (d, 1H, ArH₁), 7.49 (dd, 1H, ArH₂), 6.97 (d, 1H, ArH₃), 3.99 (d, 2H, CH₂), 1.75 (m, 1H, CH), 1.52 (m, 4H, CH₂), 0.97 (t, 6H, CH₃). LC-MS: m/z 241 M + H⁺.

Step 2

5

[5-Bromo-2-(2-ethyl-butoxy)-phenyl]-methanol, **2**.



A solution of 5-chloro-2-(2-ethyl-butoxy)-benzaldehyde, **1**, (2.83g 11.8 mmol), MeOH (50 mL) was cooled to 5 °C under N₂ atmosphere and NaBH₄ (0.54g, 14.2 mmol) was added. The mixture was allowed to warm to RT over 2 hours and the volatiles were removed *in vacuo*. The reaction mixture was partitioned between water and CH₂Cl₂. The organic layer was washed with sat. brine, dried (Na₂SO₄) and evaporated to dryness to give 2.61g of 5-chloro-2-(2-ethyl-butoxy)-phenyl]-methanol, **2** as a pale yellow oil.

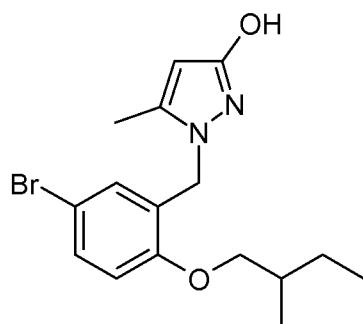
15 1H-NMR(CDCl₃, 300 MHz) δ 7.30 (d, 1H, ArH₁), 7.22 (dd, 1H, ArH₂), 6.82 (d, 1H, ArH₃), 4.68 (d, 2H, CH₂), 3.91 (d, 2H, CH₂), 2.22 (t, 1H, CH₂OH), 1.71 (m, 1H, CH), 1.50 (m, 4H, CH₂), 0.96 (t, 6H, CH₃).

LC-MS: m/z 243 M + H⁺.

20

Step 3

1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-ol, **3**.



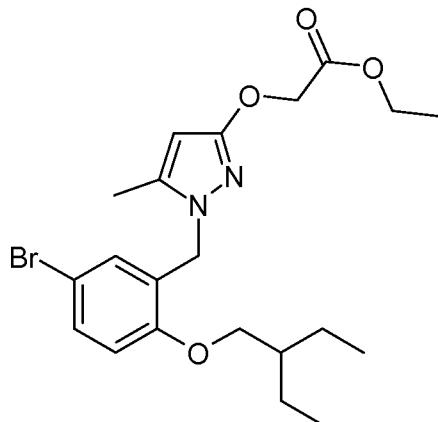
A solution of [5-bromo-2-(2-ethyl-butoxy)-phenyl] -methanol, **2**, (1.2 g 4.2 mmol), triphenylphosphine (1.6g, 6 mmol), di-tert-butylazodicarboxylate (1.4g, 6 mmol) and 3-methylpyrazolyl-5-one (0.75g, 7.7 mmol) in a mixture of THF (5 mL) and toluene (10 ml) was heated at 120 °C in an Emrys microwave reactor for 20 min. The volatiles were removed 5 *in vacuo*. The crude product was purified on silica to yield 1-[5-bromo-2-(2-ethyl-butoxy)-benzyl]-1H-pyrazol-3-ol, **3**.

1H-NMR(CDC1₃, 300 MHz) δ δ 7.32 (dd, 1H, ArH), 6.80 (d, 1H, ArH), 6.74 (d, 1H, ArH), 5.48 (s, 1H, ArH), 5.06 (s, 2H, ArCH₂), 3.88 (d, 2H, CH₂), 2.12 (s, 3H, CH₃), 1.72 (m, 1H, CH), 1.50 (m, 4H, CH₂), 0.96 (t, 6H, CH₃).

10 LC-MS: m/z 368 M + H⁺

Step 4

15 {1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5 -methyl- 1H-pyrazol-3-yloxy} -acetic acid ethyl ester, **4**.

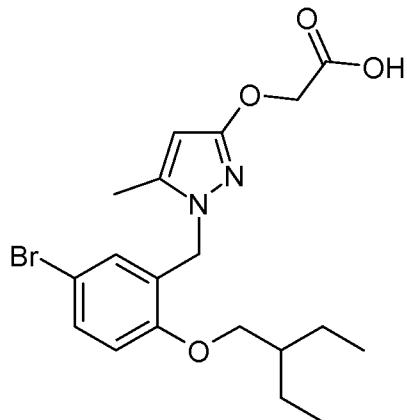


To a solution of 1-[5-bromo-2-(2-ethyl-butoxy)-benzyl]-1H-pyrazol-3-ol, **3**, 0.06 g (0.15 mmol) in acetone (3 mL) was added ethylbromoacetate (24 µL 0.22 mmol), K₂C0₃ (0.03g, 0.22 mmol) and tetrabutylammonium iodide (0.008g, 0.022 mmol). The resulting mixture 20 was heated at 120 °C in an Emrys microwave reactor for 20 min. The volatiles were removed *in vacuo* and the crude product was purified on silica to yield to {1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-1H-pyrazol-3-yloxy}-acetic acid ethyl ester, **4**.

1H-NMR(CDC1₃, 300 MHz) δ δ 7.31 (dd, 1H, ArH), 6.74 (d, 1H, ArH), 6.69 (d, 1H, ArH), 5.62 (s, 1H, ArH), 5.08 (s, 2H, ArCH₂), 4.77 (s, 2H, 0-CH₂), 4.27 (q, 2H, CH₂CH₃), 3.89 (d, 2H, CH₂), 2.14 (s, 3H, CH₃), 1.71 (m, 1H, CH), 1.51 (m, 4H, CH₂), 1.29 (t, 3H, CH₂CH₃), 0.96 (t, 6H, CH₃).

LC-MS: m/z 454 M + H⁺Step 5

5 {1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yl}-oxa-acetic acid 5



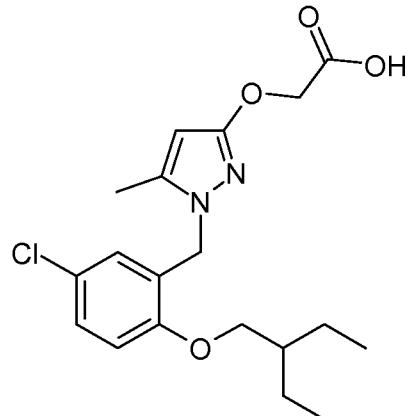
To a solution of {1-[5-bromo-2-(2-ethyl-butoxy)-benzyl]-1H-pyrazol-3-yl}-acetic acid ethyl ester, 4, (0.017g, 0.038 mmol) in a mixture of THF (1 mL) and methanol (0.5 ml) was added a solution of LiOH (0.05g in 1 ml H₂O). The resulting mixture was heated at 100 °C in an Emrys microwave reactor for 15 minutes. The mixture was poured into water (20 mL) and extracted with EtOAc (3 x 15 mL). The organic layers were combined, washed with brine (30 mL), dried (MgSC⁺) and the volatiles were removed *in vacuo*. The crude product was purified on silica to yield 0.016 g of {1-[5-bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yl}-acetic acid, 5 as a white solid.

15 ¹H-NMR(CDC₃, 300 MHz) δ 7.33 (dd, 1H, ArH), 6.75 (d, 1H, ArH), 6.74 (d, 1H, ArH), 5.63 (s, 1H, ArH), 5.09 (s, 2H, ArCH₂), 4.80 (s, 2H, O-CH₂), 3.89 (d, 2H, CH₂), 2.16 (s, 3H, CH₃), 1.71 (m, 1H, CH), 1.50 (m, 4H, CH₂), 0.96 (t, 6H, CH₃).

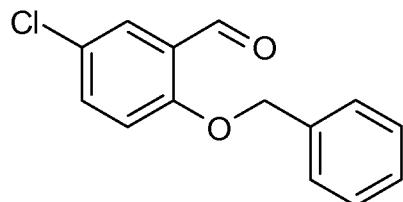
LC-MS: m/z 426 M + H⁺

EXAMPLE 2

{I-[5-CHLORO-2-(2-ETHYL-BUTOXY)-BENZYL]-5-METHYL-IH-PYRAZOL-3-YLOXYj-ACETIC ACID, 11.



5

Step 12-Benzyl-5-chloro-benzaldehyde, **6**.

10

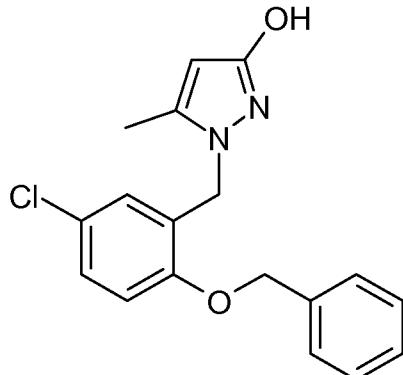
The title compound was prepared following the method in Example 1, Step 1.

1H-NMR(CDC1₃, 300 MHz) δ 10.50 (s, 1H, ArCHO,), 7.83 (d, 1H, ArH,), 7.50-7.33 (m, 15 5H, ArH), 7.49 (dd, 1H, ArH), 7.02 (d, 1H, ArH), 5.02 (s, 2H, OCH₂Ph).
LC-MS: m/z 247 M + H⁺.

20

Step 2

1-(2-Benzyl-5-chloro-phenyl)-5 -methyl- 1H-pyrazol-3-ol, 7.



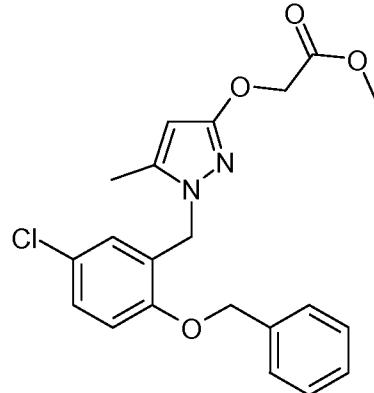
5

Ethyl crotonate (4.08 mL, 35 mmol) was added dropwise to a solution of hydrazine hydrate (1.8 mL, 37.1 mmol) in abs. EtOH (42 mL). The solution was stirred at RT for 2 hours and then refluxed for 3 hours. The volatiles were removed *in vacuo* to yield 5-methyl-pyrazolidin-3-one as a viscous yellow oil. This oil was dissolved in MeOH (20 mL), cooled to 0 °C under a N₂ atmosphere and sodium methoxide in MeOH (2 ml of 4.4M) was added. After 10 minutes 2-Benzyl-5-chloro-phenylaldehyde, **6**, (7.66g, 31mmol) in MeOH (100 mL) was added and the mixture was stirred at RT for 1 hour. Sodium methoxide in MeOH (7 ml of 4.4M) was added and the mixture was refluxed for 16 hours. The volatiles were removed *in vacuo* and the residue was portioned between EtOAc and HCl (aq., 2M). A yellow solid was collected and triturated with diethyl ether to yield a cream coloured solid which was dried under vacuum to yield 9.2g of 1-(2-benzyl-5-chloro-phenyl)-5 -methyl- 1H-pyrazol-3-ol, 7. 1H-NMR(CDCI₃, 300 MHz) δ δ 7.47-7.29 (m, 5H, ArH), 7.18 (dd, 1H, ArH), 6.85 (d, 1H, ArH), 6.77 (d, 1H, ArH), 5.45 (s, 1H, ArH), 5.09 (s, 2H, ArCH₂), 5.07 (s, 2H, ArCH₂), 4.48 (broad s, 1H, -OH), 2.06 (s, 3H, CH₃).
20 LC-MS : m/z 329 M + H⁺

25

Step 3

[1-(2-Benzyl-5-chloro-benzyl)-5-methyl-1H-pyrazol-3-yloxy]-acetic acid methyl ester, **8**.



5

The title compound was prepared following the method in Example 1, Step 4.

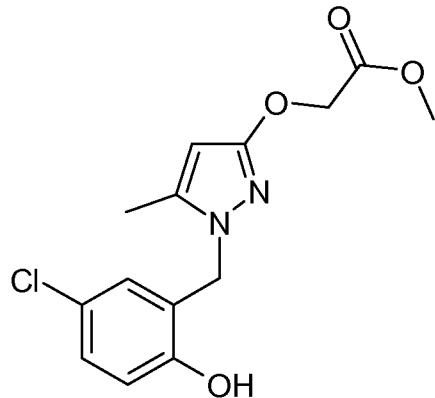
1H-NMR(CDC₃, 300 MHz) δ 7.44-7.22 (m, 5H, ArH), 7.11 (dd, 1H, ArH), 6.81 (d, 1H, ArH), 6.60 (d, 1H, ArH), 5.54 (s, 1H, ArH), 5.05 (s, 2H, ArCH₂), 5.02 (s, 2H, ArCH₂), 4.70 (s, 2H, -OCH₂), 3.70 (s, 3H, CH₃). 2.03 (s, 3H, CH₃).

LC-MS: m/z 401 M + H⁺

Step 4

15

[1-(5-Chloro-2-hydroxy-benzyl)-5-methyl-1H-pyrazol-3-yloxy]-acetic acid methyl ester, **9**.



A solution of [l-(2-benzyloxy-5-chloro-benzyl)-5 -methyl- lH-pyrazol-3-yloxy] -acetic acid methyl ester, **8**, (1.19g, 2.97 mmol), PtO₂ (0.17g) and cone. HCl (2 ml) in MeOH was stirred under a H₂ atmosphere for 3 hours. The catalyst was removed by filtration, the volatiles were removed *in vacuo* and the crude product was purified on silica to yield [l-(5-chloro-2-hydroxy-benzyl)-5 -methyl- lH-pyrazol-3-yloxy] -acetic acid methyl ester, **9**.

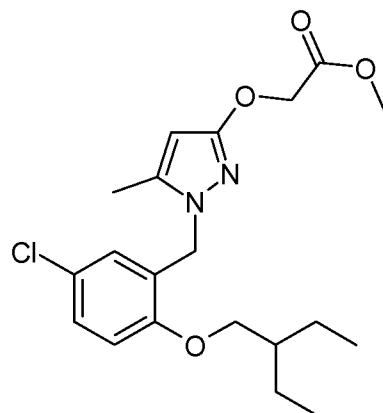
1H-NMR(CDCl₃, 300 MHz) δ 9.76 (s, 1H, ArOH), 7.20 (dd, 1H, ArH), 7.11 (d, 1H, ArH), 6.91 (d, 1H, ArH), 5.54 (s, 1H, ArH), 4.95 (s, 2H, ArCH₂), 4.73 (s, 2H, O-CH₂), 3.83 (s, 3H, CH₃). 2.31 (s, 3H, CH₃).

LC-MS: m/z 311 M + H⁺

10

Step 5

{l-[5-Chloro-2-(2-ethyl-butoxy)-benzyl]-5-methyl-lH-pyrazol-3-yloxy} -acetic acid methyl ester, **10**.



15

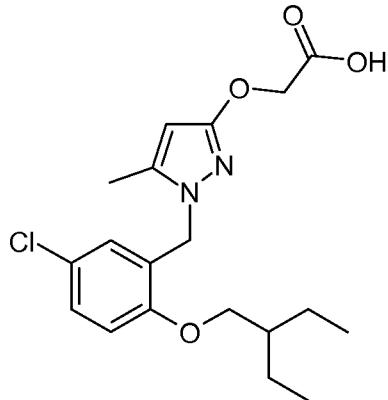
The title compound was prepared following the method in Example 1, Step 3.

1H-NMR(CDCl₃, 300 MHz) δ 7.16 (dd, 1H, ArH), 6.79 (d, 1H, ArH), 6.53 (d, 1H, ArH), 5.63 (s, 1H, ArH), 5.08 (s, 2H, ArCH₂), 4.78 (s, 2H, O-CH₂), 3.89 (d, 2H, CH₂), 3.79 (s, 3H, CH₃), 2.15 (s, 3H, CH₃), 1.71 (m, 1H, CH), 1.52 (m, 4H, CH₂), 0.96 (t, 6H, CH₃).

LC-MS: m/z 395 M + H⁺

Step 6

{1-[5-Chloro-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy}-acetic acid, **11**.



5 The title compound was prepared following the method in Example 1, Step 5.

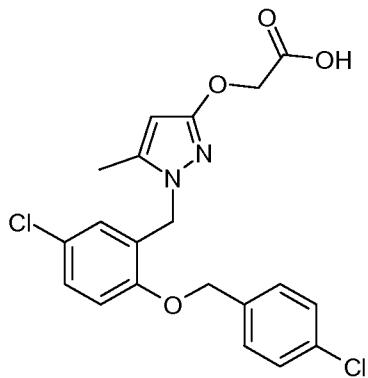
1H-NMR(CDC1₃, 300 MHz) δ 7.15 (dd, 1H, ArH), 6.77 (d, 1H, ArH), 6.58 (d, 1H, ArH), 5.63 (s, 1H, ArH), 5.06 (s, 2H, ArCH₂), 4.70 (s, 2H, O-CH₂), 3.88 (d, 2H, CH₂), 3.79 (s, 3H, CH₃), 2.12 (s, 3H, CH₃), 1.70 (m, 1H, CH), 1.49 (m, 4H, CH₂), 0.95 (t, 6H, CH₃).

10 LC-MS: m/z 381 M + H⁺

EXAMPLE 3

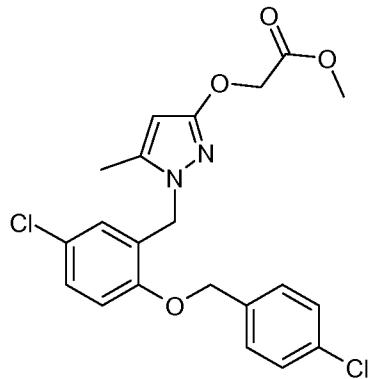
{1-[5-CHLORO-2-(4-CHLORO-BENZYLOXY)-BENZYL]-5-METHYL-1H-PYRAZOL-3-YLOXY}-ACETIC ACID 13.

15



Step 1

{1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid methyl ester, **12**.

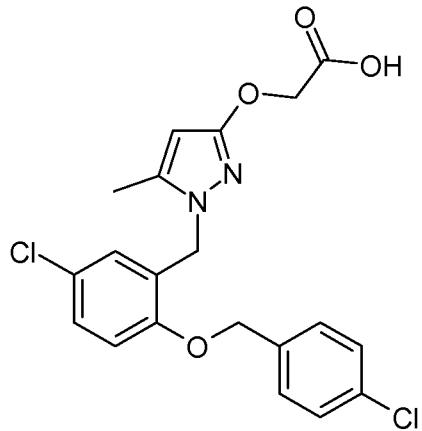


5

The title compound was prepared following the method in Example 1, Step 3.

1H-NMR(CDC₃, 300 MHz) δ 7.43-7.24 (m, 4H, ArH), 7.18 (dd, 1H, ArH), 6.82 (d, 1H, ArH), 6.64 (d, 1H, ArH), 5.60 (s, 1H, ArH), 5.08 (s, 2H, ArCH₂), 5.05 (s, 2H, ArCH₂), 4.76
10 (s, 2H, -OCH₂), 3.77 (s, 3H, CH₃). 2.10 (s, 3H, CH₃).

LC-MS: m/z 436 M + H⁺

Step 2{1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid **13**.

5

The title compound was prepared following the method in Example 1, Step 5.

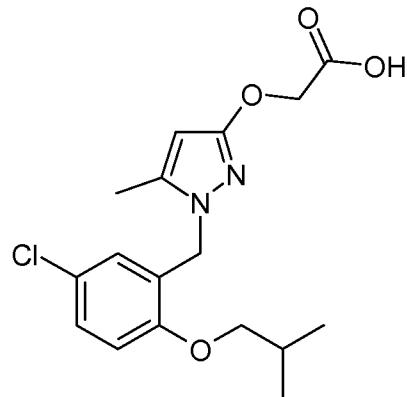
1H-NMR(CDC1₃, 300 MHz) δ 7.48-7.35 (m, 4H, ArH), 7.23 (dd, 1H, ArH), 7.03 (d, 1H, ArH), 6.64 (d, 1H, ArH), 5.61 (s, 1H, ArH), 5.13 (s, 2H, ArCH₂), 5.11 (s, 2H, ArCH₂), 4.53 10 (s, 2H, -OCH₂), 3.77 (s, 3H, CH₃). 2.11 (s, 3H, CH₃).

LC-MS: m/z 422 M + H⁺

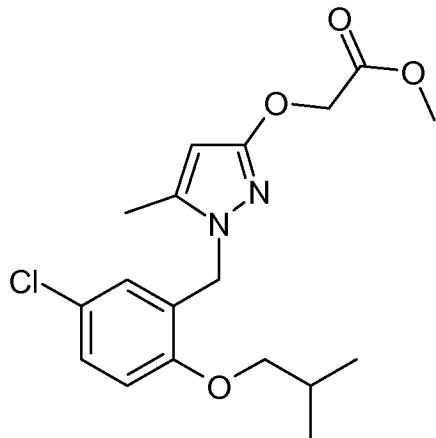
EXAMPLE 4

[1-(5-CHLORO-2-ISOBUTOXY-BENZYL)-5-METHYL-1H-PYRAZOL-3-YLOXY]-
ACETIC ACID 15.

5

Step 1

[1-(5-Chloro-2-isobutoxy-benzyl)-5 -methyl- 1H-pyrazol-3-yloxy] -acetic acid methyl ester 12.



10

The title compound was prepared following the method in Example 1, Step 3.

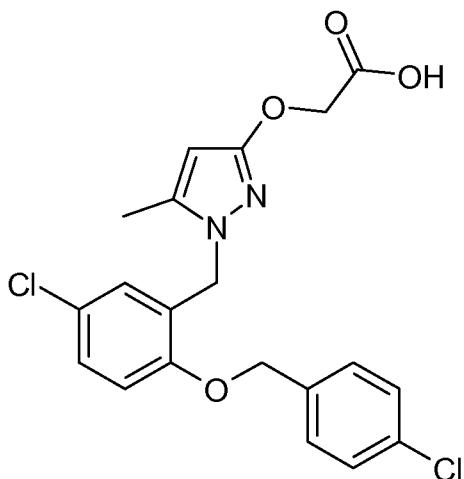
1H-NMR(CDC1₃, 300 MHz) δ 7.16 (dd, 1H, ArH), 6.77 (d, 1H, ArH), 6.55 (d, 1H, ArH), 5.62 (s, 1H, ArH), 5.09 (s, 2H, ArCH₂), 4.78 (s, 2H, -OCH₂), 3.78 (s, 3H, CH₃), 3.75 (s, 2H, CH₂), 2.15 (s, 3H, CH₃), 1.28 (m, 1H, CH), 1.07 (d, 6H, CH₃).

LC-MS: m/z 367 M + H⁺

5

Step 2

{1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy} -acetic acid **13**.



10 The title compound was prepared following the method in Example 1, Step 5.

1H-NMR(CDC1₃, 300 MHz) δ 7.48-7.35 (m, 4H, ArH), 7.23 (dd, 1H, ArH), 7.03 (d, 1H, ArH), 6.64 (d, 1H, ArH), 5.61 (s, 1H, ArH), 5.13 (s, 2H, ArCH₂), 5.11 (s, 2H, ArCH₂), 4.53 (s, 2H, -OCH₂), 3.77 (s, 3H, CH₃), 2.11 (s, 3H, CH₃).

15 LC-MS: m/z 353 M + H⁺

The above compounds were tested for PG antagonist activity as follows using human recombinant prostanoid receptor (DPi, EPi₋₄, FP, IP and TP) stable cell lines:

20 In order to measure the response of G_s and G_i coupled prostanoid receptors as a Ca²⁺ signal, chimeric G protein cDNAs were used. Stable cell lines over-expressing human prostanoid DPi, EPi₋₄, FP, IP, and TP receptors were established as follows:

Briefly, human prostanoid DP_i, EP₂, and EP₄ receptor cDNAs were co-transfected with chimeric G_{qs} cDNA containing a haemagglutinin (HA) epitope; human prostanoid EP₃ receptors were co-transfected with chimeric G_{qi}-HA; human EPi, FP, IP, and TP receptor cDNAs were expressed with no exogenous G-proteins. G_{qs} and G_{qi} chimeric cDNAs (Molecular Devices, Sunnyvale, CA, U.S.A.), as well as cDNAs of prostanoid receptors, were cloned into a pCEP₄ vector with a hygromycin B selection marker. Transfection into HEK-293 EBNA (Epstein-Barr virus nuclear antigen) cells was achieved by the FuGENE 6 transfection Reagent (Roche Applied Science, Indianapolis, IN, USA). Stable transfectants were selected according to hygromycin resistance. Because G_{qs} and G_{qi} contained an HA epitope, G-protein expression was detected by Western blotting analysis using anti-mouse HA monoclonal antibody and horseradish peroxidase (HRP)-conjugated secondary antibody, while functional expression of prostanoid receptors was detected by FLIPR screening (Matias *et al.*, 2004). These stable cell lines were validated using previously published antagonists at 10 μM against serial dilutions of standard agonists by FLIPR functional assays for Ca²⁺ Signaling (as described below).

Ca²⁺ signaling studies were performed using a FLIPR TETRA system (Molecular Devices, Sunnyvale, CA, USA) in the 384-format. This is a high-throughput instrument for cell-based assays to monitor Ca²⁺ signaling associated with GPCRs and ion channels. Cells were seeded at a density of 5 x 10⁴ cells/well in BioCoat poly-D-lysine coated, black wall, clear bottom 384-well plates (BD Biosciences, Franklin lakes, NJ, USA) and allowed to attach overnight in an incubator at 37°C. The cells were then washed twice with HBSS-HEPES buffer (Hanks' balanced salt solution without bicarbonate and phenol red, 20mM HEPES, pH 7.4) using an ELx405 Select CW Microplate Washer (BioTek, Winooski, VT, USA). After 60 min of dye-loading in the dark using the Ca²⁺-sensitive dye Fluo-4AM (Invitrogen, Carlsbad, CA, USA), at a final concentration of 2 x 10⁻⁶M, the plates were washed 4 times with HBSS-HEPES buffer to remove excess dye and leaving 50 μl of buffer in each well. The plates were then placed in the FLIPR TETRA instrument and allowed to equilibrate at 37°C. Compounds were added in a 25 μl volume to each well to give final concentrations of 0.1 μM, 0.3 μM, 1 μM, 3 μM, 10 μM, and 30 μM; or 0.067 μM, 0.1 μM, 0.2 μM, 0.3 μM, 0.67 μM, and 1 μM for cells over-expressing TP receptors. After 4.5 minutes, a 7-point serial dilution of the standard agonist for the corresponding receptor, in a 25 μl volume was injected at the final

concentrations from 10^{-11} M to 10^{-5} M in 10-fold serial dilution increments for cells expressing human recombinant DP_i, EP_i, EP₂, EP₃, EP₄, FP, and IP receptors. The dose range for the standard agonist for human recombinant TP receptors was from 10^{-12} M to 10^{-6} M. HBSS-HEPES buffer was used as the negative control for the standard agonists. Cells were excited
5 with LED (light emitting diode) excitation at 470-495nm and emission was measured through an emission filter at 515-575nm. Assay plates were read for 3.5 minutes using the FLIPR^{TETRA}. The peak increase in fluorescence intensity was recorded for each well. On each plate, negative controls, dose response of positive controls, and co-treatments of antagonist-agonist for each dose were in triplicates. Standard agonists were as follows: DP_i =BW 245C,
10 EP_i-EP₄ =PGE₂, FP =17-phenyl-PGF_{2α}, IP =Cicaprost, and TP =U-46619. The peak fluorescence change in each well containing drug was expressed relative to vehicle controls with the standard agonist at 10^{-6} M (the positive control). To obtain concentration-response curves, compounds were tested in triplicate in each plate over the desired concentration range.

15

Ca²⁺ Signal Studies on Human Recombinant Prostanoid Receptor DP₂

FLIPR functional assays were conducted at Millipore to monitor the activity anti-asthmatic against human DP₂ receptors stably expressed in the Chem-5 proprietary host cell line
20 generated by Millipore. Prior to standard agonist addition, the compounds were spotted at 10μM along with vehicle control (1% Ethanol in HBSS-HEPES buffer) across the assay wells. The assay plate was incubated at room temperature for 10 minutes in the dark. Then an 8-point serial dilution dose response from 10^{-12} M to 10^{-5} M of the standard agonist PGD₂ was performed. Assay plates were read for 90 seconds using the FLIPR^{TETRA}. The fluorescence
25 measurements were collected to calculate IC₅₀ values. The assays were done at least 3 times to give n=3.

Data Processing

All plates were subjected to appropriate baseline corrections. Maximum fluorescence values
30 were exported. The raw data of n=1 was first processed by Activity Base using nonlinear regression curve fit to calculate the percentage activity of each data point relative to the positive control (= 10^{-6} M of the standard agonist). Then n=3 of this data were exported to GraphPad Prism 4 to calculate the average EC₅₀ of the standard agonist, and the IC₅₀ (the

concentration of the antagonist required to inhibit half the standard agonist activity) were calculated using nonlinear regression curve fit, with constraints of bottom constant equal to 0 and top constant equal to 100. Calculation of $K_b = [\text{Antagonist Concentration}] / (IC_{50}/EC_{50} - 1)$. When no antagonism was detected or when $K_b > 10,000\text{nM}$, the antagonist is defined as not active (NA).

The results of the above testing are reported in TABLE 1, below.

TABLE 1

10

| Example | FP | DP ₁ | EP ₁ | EP ₂ | EP ₃ | EP ₄ | IP | TP |
|---------|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|
| 1 | 250 | 640 | 40 | NA | NA | 130 | 220 | 2 |
| 2 | 980 | 500 | 75 | NA | NA | 350 | 600 | PAg |
| 3 | 220 | 1000 | 9 | 340 | 3700 | NA | 500 | 1 |
| 4 | 1700 | PAg | 110 | NA | NA | NA | NA | 15 |

As shown in TABLE 1, the above compound of Example 1 of this invention is a pan antagonists having activity at the FP, DP₁, EP₁, EP₄ and TP receptors, but are inactive or less active at the EP₂ and EP₃ receptors and the IP receptor, respectively. Thus, these compounds 15 have a biological selectivity profile making them useful in treating diseases and conditions which are mediated by the EP₂, EP₃ and/or DP receptors, without the side effects mediated by the FP, EP₁, EP₄ and TP receptors.

For example, said condition or disease may be related to inflammation, or said DP₁, FP, EP₁, 20 TP and/or EP₄ receptor mediated condition or disease may be selected from the group consisting of allergic conditions, asthma, allergic asthma, allergic rhinitis, uveitis and related disorders, atherosclerosis, blood coagulation disorders, bone disorders, cancer, cellular neoplastic transformations, chronic obstructive pulmonary diseases and other forms of lung inflammation, congestive heart failure, diabetic retinopathy, diseases or conditions requiring 25 a treatment of anti-coagulation, diseases requiring control of bone formation and resorption, fertility disorders, gangrene, glaucoma, hyperpyrexia, immune and autoimmune diseases, inflammatory conditions, metastatic tumor growth, migraine, mucus secretion disorders, nasal congestion, nasal inflammation, occlusive vascular diseases, ocular hypertension, ocular

hypotension, osteoporosis, rheumatoid arthritis , pain, perennial rhinitis, pulmonary congestion, pulmonary hypotension, Raynaud's disease, rejection in organ transplant and bypass surgery, respiratory conditions, hirsutism , rhinorrhea, shock, sleep disorders, and sleep-wake cycle disorders.

5

Said compound may be administered as a surgical adjunct in ophthalmology for cataract removal and artificial lens insertion , ocular implant procedures, photorefractive radial keratotomy and other ophthalmological laser procedures or as a surgical adjunct in a procedure involving skin incisions, relief of pain and inflammation and scar formation/keloids post-surgery, for treating sports injuries and general aches and pains in muscles and joints.

10

Preferably, said DPi, FP, EPi, TP , and/or EP₄ receptor mediated condition or disease is an EPi and/or EP₄ receptor mediated condition or disease.

15

Preferably, said DPi, FP, EPi , TP and/or EP₄ receptor mediated condition or disease is an allergic condition, e.g. an dermatological allergy, or an ocular allergy, or a respiratory allergy, e.g. nasal congestion, rhinitis, and asthma.

Said condition or disease may be related to pain.

20

Said condition or disease may be selected from the group consisting of arthritis, migraine, and headache.

25

Said condition or disease may be associated with the gastrointestinal tract, wherein said condition or disease may be peptic ulcer, heartburn, reflux esophagitis, erosive esophagitis, non-ulcer dyspepsia, infection by Helicobacter pylori, alrynitis, and irritable bowel syndrome.

30

Said condition or disease may be selected from the group consisting of hyperalgesia and allodynia, or said condition or disease may be related to mucus secretion, wherein said mucus secretion is gastrointestinal, or occurs in the nose, sinuses, throat, or lungs.

Said condition or disease is related to abdominal cramping, e.g. said condition or disease may be irritable bowel syndrome.

Said condition or disease may be a bleeding disorder, or a sleep disorder, or mastocytosis.

Said condition or disease may be associated with elevated body temperature, or ocular hypertension and glaucoma, or ocular hypotension.

5

Said condition may relate to surgical procedures to treat pain, inflammation and other unwanted sequelae wherein said surgical procedure includes incision, laser surgery or implantation.

10 The present invention also relates to a method of treating inflammation resulting from inflammatory diseases characterized by monocytic infiltration caused by the secretion of cytokines and/or chemokines by administration, to a patient in need of said treatment, of a pharmaceutical composition comprising a compound of the present invention

15 The current finding that the compounds of this invention are effective in attenuating the production of TNF family cytokines (TNFa), and the classical interleukin-1 (IL-1) family cytokines is especially important. These cytokines exert a broad spectrum of biological and pathological effects. They play key roles in inflammation and RA pathogenesis by stimulating the release of multiple proinflammatory cytokines, including themselves, through the NFKB signaling pathway. Although alleviating the symptoms of RA in 50-65% of 20 patients, a TNFa antibody is very expensive to use compared to chemically synthesized small molecules, inconvenient to administer usually requiring injections, and has been linked to tuberculosis, lymphoma, and other adverse effects. Unlike a TNFa antibody that totally eliminates all circulating TNFa in the system; the compounds of this invention only attenuate the production of TNFa by inhibiting proinflammatory PG receptors. Therefore the adverse 25 effects associated with a TNFa antibody in elevating infectious and cancerous tendency is less likely.

30 Proinflammatory elements TNF, RANTES, and MCP-1 are involved in the cascade of events in the early and late stages of atherosclerosis. Plasma MCP-1 levels have been linked to cardiovascular disease risk factors in clinical studies. Platelet activation leads to the release of MIP-1 α , RANTES, and IL-8, which attract leukocytes and further activate other platelets. These evidences provide a direct linkage between homeostasis, infection, and inflammation

and the development of atherosclerosis. The compounds of this invention are able to target multiple biomarkers of inflammation, thrombosis, and atherothrombosis simultaneously, which may confer pharmaceutical potential on the compounds of this invention in treating atherosclerosis and atherothrombosis. As a result, the compounds of this invention are 5 unlikely to be associated with cardiovascular liability as in the case of the COXIBs, conversely it may even have a beneficial effect on cardiovascular function.

In summary, because of their ability to suppress the synthesis of some key proinflammatory cytokines/chemokines IL-8, MCP-1, MDC, RANTES, and TNFa,, the compounds of the 10 present invention are believed to be, not only at least as effective as COXIBs and NSAIDs in RA treatment, but also are a safer therapy in RA treatment. They are also a potential therapy for cardiovascular diseases.

The compounds of this invention are believed to treat or prevent inflammation at least in part 15 by the decreasing the amount of the secretion of certain cytokines and/ or chemokines that result from the exposure of the patient to a stimulant.

In particular, the secretion of VEGF, MIP-1 β , IL-8, MCP-1, MDC and RANTES may be reduced in those instances where said secretions are triggered by lipopolysaccharides (LPS) 20 and or TNFa.

Interleukin-8 (IL-8): functions as a potent chemoattractants and activator of neutrophils, IL-8 is produced in response to stimulation with either IL-1 or TNFa. IL-8 not only accounts for a significant proportion of the chemotactic activity for neutrophils in rheumatoid arthritis (RA) 25 synovial fluids, but also is a potent angiogenic factor in the RA synovium.

Monocyte chemoattractant protein- 1 (MCP-1, or CCL-2): is not only believed to play a role in inflammatory diseases characterized by monocytic infiltration, such as RA rheumatoid 30 arthritis, psoriasis, and atherosclerosis, but is also implicated in other diseases, such as atopic dermatitis, renal disease, pleurisy, allergy and asthma, colitis, endometriosis, polymyositis and dermatomyositis, uveitis, restenosis, brain inflammation and obesity. MCP-1 also controls leukocyte trafficking in vascular cells involved in diabetes and diabetes-induced

atherosclerosis. MCP-1 antibodies are potential therapeutic agents for treating MCP-1/CCR2-mediated multiple inflammatory diseases.

Tumor necrosis factor a (TNFa): mainly secreted by macrophages and recognized for its 5 importance in activating the cytokine cascade. TNFa stimulates the production of proinflammatory cytokines/chemokines, collagenases, metalloproteinases, and other inflammatory mediators; activates endothelial cells and neutrophils; promotes T- and B-cell growth, as well as stimulating bone resorption. The TNFa antibody infliximab not only decreases the production of local and systemic proinflammatory cytokines/chemokines, but 10 also reduces serum MMP-3 production, nitric oxide synthase activity, VEGF release, and angiogenesis in inflamed joints.

Macrophage-derived chemokine (MDC) induces chemotaxis for monocyte-derived dendritic cells, activated T cells and natural killer (NK) cells (Ho *et al.*, 2003). Highly expressed by 15 the three major cell types involved in allergic inflammation: eosinophils, basophils, and Th2 lymphocytes (Garcia *et al.*, 2005), as well as highly expressed in atopic dermatitis (Pivarcsi *et al.*, 2005), MDC plays a role in inflammatory diseases such as allergic asthma and atopic dermatitis (Ho *et al.*, 2003). Significantly enhanced in keratinocytes of patients with atopic dermatitis, MDC could be a candidate therapeutic target for inflammatory skin disease such 20 as atopic dermatitis (Qi *et al.*, 2009). MDC is also implicated in disease activity of RA. After combination treatment with the disease-modifying anti-rheumatic drugs leflunomide and methotrexate in RA patients, plasma MCP-1 and MDC concentrations were significantly lower, and so was the recruitment of inflammatory cells into the sites of inflammation (Ho *et al.*, 2003). Moreover, MDC also amplify platelet activation and has been associated with the 25 pathogenesis of atherosclerotic disease including thrombosis (Gleissner *et al.*, 2008).

Regulated on Activation, Normal T Cell Expressed and Secreted (RANTES) is a chemoattractant for blood monocytes, memory T-helper cells and eosinophils, and plays an active role in recruiting leukocytes into inflammatory sites. It also stimulates the release of 30 histamine from basophils, activates eosinophils and causes hypodense eosinophils, which is associated with diseases such as asthma and allergic rhinitis. RANTES receptor CCR5 is also expressed on cells involved in atherosclerosis (e.g. monocytes/macrophages, T lymphocytes, or Th1-type cells), and is specialized in mediating RANTES-triggered

atherosclerotic plaque formation (Zernecke *et al.*, 2008). Like MCP-1, stimulation with RANTES enhances production of IL-6 and IL-8 in RA fibroblast-like synovial cells; elevated MMP-3 production by chondrocytes, and inhibited proteoglycan synthesis and enhanced proteoglycan release from the chondrocytes (Iwamoto *et al.*, 2008). Both MCP-1 and 5 RANTES were found to play an important role in allergic lung inflammation, lung leukocyte infiltration, bronchial hyper-responsiveness, and the recruitment of eosinophils in the pathogenesis of asthma (Conti *et al.*, 2001). Similar to MCP-1, RANTES also enhances the inflammatory response within the nervous system, which plays an apparent role in the pathogenesis of multiple sclerosis (Conti *et al.*, 2001). Inhibitors for RANTES may provide 10 clinical benefits in treating inflammation, CNS disorders, parasitic disease, cancer, autoimmune and heart diseases (Castellani *et al.*, 2007).

While the use of the compounds of this invention are believed to decrease the secretion of the above cytokines, it is also believed that the compounds of this invention are effective to 15 decrease the secretion of ENA-7, PAI-1, CD-10, G-CSF, GM-CSF, IL-1 α and IL-18, as well.

The compounds of this invention may be also tested for efficacy in treating uveitis as described below.

20 **Arachidonate Induced Uveitis**

The rational for this protocol is to use arachidonate to directly produce ocular anterior segment uveitis, as opposed to using lipopolysaccharide (LPS) to indirectly release arachidonic acid.

25 *Induction of uveitis:*

Conscious male or female Dutch-belted pigmented rabbits weighing 2.5 - 3 kg are used for all in vivo slit lamp studies. Four animals are employed per test group. The right eye of each animal receiving 35 μ l of topically administered test and the contralateral left eye of each animal receiving 35 μ l of topically administered vehicle (t = 0 minutes), followed 30 minutes 30 later by treatment with 35 μ l of 0.5% sodium arachidonate onto the surface of both eyes (t = 30 minutes). Both eyes are examined by slit lamp 60 minutes following sodium arachdionate challenge (t = 90 minutes) at 16x magnification under both white light and blue light illumination at an approximate angle of 45° through 1 mm and 5 mm slit widths.

Measurement of anterior chamber leukocyte infiltration:

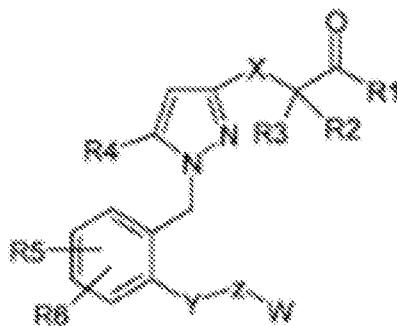
Anterior chamber leukocyte infiltration is measured using a numerical scoring system to estimate cell number per field defined by a 5 mm slit width: 0 = no cells per field (no response); 1 = 1 - 10 cells per field (mild); 2 = 11 - 20 cells per field (moderate); 3 = 26 - 50 cells per field (severe); 4 = >50 cells per field (florid). Results are reported as the mean score value \pm S.E.M.

The compounds of this invention may be tested according to the method described in
10 "Characterization of Receptor Subtypes Involved in Prostanoid-Induced Conjunctival
Pruritis and Their Role in Mediating Conjunctival Itching", Vol. 279, No.1,(JPET)279, 137-
142' 1996 for their efficacy in alleviating itch. The results show a significantly lower number
of itch-scratch episodes with the use of the compounds of this invention to thereby indicate
that the compounds of this invention are useful in treating allergic conjunctivitis..

15

Finally, said condition that may be treated with the compounds of this invention may be related to pain and inflammation and post-surgical scar and keloid formation.

In view of the various diseases and conditions that may be treated with the compositions of this invention there is provided a pharmaceutical product comprising a compound having the
20 following formula



wherein X is O, S or NR₇;

Y is (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

25

Z is selected from the group consisting of O, S, SO, SO₂ and (CH₂)_p, wherein p is 0 or an integer of from 1 to 3;

W is hydrocarbyl or substituted hydrocarbyl:

Ri is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

5 R₂ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

10

R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

15 R₆ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

R₇ is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl, e.g.

20 carbocyclic aryl and alkyl

or a pharmaceutically acceptable salt or a prodrug thereof, wherein said product is packaged and labeled for the treatment or prevention of a disease or condition selected from the group consisting of uveitis, allergic conditions, asthma, allergic asthma, allergic rhinitis, atherosclerosis, blood coagulation disorders, bone disorders, cancer, cellular neoplastic

25 transformations, chronic obstructive pulmonary diseases and other forms of lung inflammation, congestive heart failure, diabetic retinopathy, diseases or conditions requiring a treatment of anti-coagulation, diseases requiring control of bone formation and resorption, fertility disorders, hyperpyrexia, gangrene, glaucoma, hypothermia, immune and autoimmune diseases, inflammatory conditions, metastatic tumor growth, migraine, mucus

30 secretion disorders, nasal congestion, nasal inflammation, occlusive vascular diseases, ocular hypertension, ocular hypotension, osteoporosis, pain, perennial rhinitis, pulmonary congestion, pulmonary hypotension, Raynaud's disease, rejection in organ transplant and bypass surgery, respiratory conditions, rheumatoid arthritis, rhinorrhea, shock, sleep disorders,

sleep-wake cycle disorders, sports injuries, muscle aches and pains, and surgical adjunct for minimizing pain, inflammation and scar/keloid formation.

Those skilled in the art will readily understand that for administration the compounds disclosed herein can be admixed with pharmaceutically acceptable excipients which, per se, are well known in the art. Specifically, a drug to be administered systemically, it may be formulated as a powder, pill, tablet or the like, or as a solution, emulsion, suspension, aerosol, syrup or elixir suitable for oral or parenteral administration or inhalation.

For solid dosage forms, non-toxic solid carriers include, but are not limited to, pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharin, the polyalkylene glycols, talcum, cellulose, glucose, sucrose and magnesium carbonate. The solid dosage forms may be uncoated or they may be coated by known techniques to delay disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. For example, a time delay material such as glyceryl monostearate or glyceryl distcarate may be employed. They may also be coated by the technique described in the U.S. Pat. Nos. 4,256,108; 4,166,452; and 4,265,874 (which are incorporated by reference in their entireties) to form osmotic therapeutic tablets for control release. Liquid pharmaceutically administrable dosage forms can, for example, comprise a solution or suspension of one or more of the compounds of the present invention and optional pharmaceutical adjutants in a carrier, such as for example, water, saline, aqueous dextrose, glycerol, ethanol and the like, to thereby form a solution or suspension. If desired, the pharmaceutical composition to be administered may also contain minor amounts of nontoxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like. Typical examples of such auxiliary agents are sodium acetate, sorbitan monolaurate, triethanolamine, sodium acetate, triethanolamine oleate, etc. Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art; for example, see Remington's Pharmaceutical Sciences, Mack Publishing Company, Easton, Pa., 16th Edition, 1980. The composition of the formulation to be administered, in any event, contains a quantity of one or more of the presently useful compounds in an amount effective to provide the desired therapeutic effect.

Parenteral administration is generally characterized by injection, either subcutaneously, intramuscularly or intravenously. Injectable formulations can be prepared in conventional

forms, either as liquid solutions or suspensions, solid forms suitable for solution or suspension in liquid prior to injection, or as emulsions. Suitable excipients are, for example, water, saline, dextrose, glycerol, ethanol and the like. In addition, if desired, the injectable pharmaceutical compositions to be administered may also contain minor amounts of non-toxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like.

The amount of the presently useful compound or compounds of the present invention administered is, of course, dependent on the therapeutic effect or effects desired, on the specific mammal being treated, on the severity and nature of the mammal's condition, on the manner of administration, on the potency and pharmacodynamics of the particular compound or compounds employed, and on the judgment of the prescribing physician. The therapeutically effective dosage of the presently useful compound or compounds is preferably in the range of about 0.5 ng/kg/day or about 1 ng/kg/day to about 100 mg/kg/day.

For ophthalmic application, solutions are often prepared using a physiological saline solution as a major vehicle. Ophthalmic solutions should preferably be maintained at a comfortable pH with an appropriate buffer system. The formulations may also contain conventional, pharmaceutically acceptable preservatives, stabilizers and surfactants.

Preservatives that may be used in the pharmaceutical compositions of the present invention include, but are not limited to, benzalkonium chloride, chlorobutanol, thimerosal, phenylmercuric acetate and phenylmercuric nitrate. A useful surfactant is, for example, Tween 80. Likewise, various useful vehicles may be used in the ophthalmic preparations of the present invention. These vehicles include, but are not limited to, polyvinyl alcohol, povidone, hydroxypropyl methyl cellulose, poloxamers, carboxymethyl cellulose, hydroxyethyl cellulose and purified water.

Tonicity adjustors may be added as needed or convenient. They include, but are not limited to, salts, particularly sodium chloride, potassium chloride, mannitol and glycerin, or any other suitable ophthalmically acceptable tonicity adjustor.

Various buffers and means for adjusting pH may be used so long as the resulting preparation is ophthalmically acceptable. Accordingly, buffers include acetate buffers, citrate buffers,

phosphate buffers and borate buffers. Acids or bases may be used to adjust the pH of these formulations as needed.

Similarly, an ophthalmically acceptable antioxidant for use in the present invention includes, 5 but is not limited to, sodium metabisulfite, sodium thiosulfate, acetylcysteine, butylated hydroxyanisole and butylated hydroxytoluene.

Other excipient components which may be included in the ophthalmic preparations are chelating agents. A useful chelating agent is edentate disodium, although other chelating 10 agents may also be used in place or in conjunction with it.

For topical use, creams, ointments, gels, solutions or suspensions, etc., containing the compound of the present invention are employed. Topical formulations may generally be comprised of a pharmaceutical carrier, cosolvent, emulsifier, penetration enhancer, 15 preservative system, and emollient.

The actual dose of the compounds of the present invention depends on the specific compound, and on the condition to be treated; the selection of the appropriate dose is well within the knowledge of the skilled artisan.

20

The present invention is not to be limited in scope by the exemplified embodiments, which are only intended as illustrations of specific aspects of the invention. Various modifications of the invention, in addition to those disclosed herein, will be apparent to those skilled in the art by a careful reading of the specification, including the claims, as originally filed. For 25 example, while the examples disclose the preparation and testing of oxaacetic acids, by analogous methods the corresponding azaacetic acids and thiaacetic acids may be prepared and there activity in treating the various diseases and conditions mediated by the above described prostaglandin receptors may be determined by the test procedures described above. It is intended that all such modifications will fall within the scope of the appended claims

30

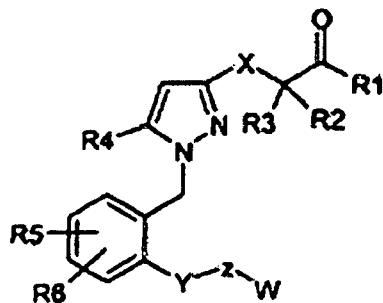
We claim:

1. A compound, that is a -[(2-{(hydrocarbyl or substituted hydrocarbyl)oxa, thia, sulfinyl, sulfonyl or alkylene}phenyl)methyl]-(5-hydro or alkyl or fluoroalkyl)- 1H-pyrazole-3-(oxaacetic acid or azaacetic acid or thiaacetic acid) or an alkyl or aryl ester or sulfonamide thereof.
- 5
2. The compound of claim 1, that is a 1-[(2-{(hydrocarbyl)oxa}phenyl)methyl]-(5-alkyl)-1H-pyrazole-3-(oxaacetic acid) or an alkyl or aryl ester or sulfonamide thereof.
- 10
3. The compound of claim 1 wherein said hydrocarbyl is selected from the group consisting of alkyl and carbocyclic aryl.
- 15
4. The compound of claim 3 wherein said hydrocarbyl is selected from the group consisting of branched chain alkyl and phenyl.
5. The compound of claim 4 wherein said hydrocarbyl is selected from the group consisting of branched chain alkyl having from 4 to 7 carbons.
- 20
6. The compound of claim 1 wherein said compound is a 1H-pyrazole-3-oxaacetic acid compound or lower alkyl ester thereof.
7. The compound of claim 6 wherein said compound is a 5-alkyl-1H-pyrazole.
- 25
8. The compound of claim 6 wherein said phenyl is a bromophenyl.
9. The compound of claim 1 wherein said compound is a 5-alkyl-1H-pyrazole-3-oxaacetic acid compound or lower alkyl ester thereof, said hydrocarbyl is selected from the group consisting of branched chain alkyls having from 4 to 7 carbons and said phenyl is a
- 30
- bromophenyl.
10. The compound of claim 1, that is selected from the group consisting of {1-[5-Chloro-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy}-acetic acid,

{1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy}-acetic acid,
 {1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl- 1H-pyrazol-3-yloxy }-acetic acid, and,
 {1-(5-Chloro-2-isobutoxy-benzyl)-5-methyl-1H-pyrazol-3-yloxy}-acetic acid.

5

11. Compounds having the general formula:



wherein X is O, S or NR₇;

10 Y is (CH₂)_n, wherein n is 0 or an integer of 1 to 3;

Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

W is hydrocarbyl or substituted hydrocarbyl;

15

R₁ is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

20

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl,

25 alkoxy or aryloxy;

R_6 is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

5 R_7 is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

12. The compound of claim 11 wherein R_7 is selected from the group consisting of carbocyclic aryl and alkyl.

10 13. The compound of claim wherein R_1 is OH.

14. The compound of claim 11 wherein R_2 and R_3 are H.

15. The compound of claim 11 wherein R_4 is selected from the group consisting of H, alkyl and fluoro-substituted alkyl.

16. The compound of claim 11 wherein R_5 is selected from the group consisting of fluoro, chloro, bromo, alkyl, aryl, alkoxy, and fluoro-substituted alkyl and alkoxy.

20 17. The compound of claim 11 wherein R_6 is selected from the group consisting of fluoro, chloro, bromo, alkyl, aryl, alkoxy, and fluoro-substituted alkyl and alkoxy.

18. The compound of claim 17 wherein R_6 is H.

25 19. The compound of claim 11 wherein R_7 is selected from the group consisting of H and alkyl

20. The compound of claim 19 wherein R_7 is H.

30 21. The compound of claim 11 wherein X is O.

22. The compound of claim 11 wherein Y is absent.

23. The compound of claim 11 wherein Z is O.

24. The compound of claim 11 wherein W is selected from the group consisting of branched chain alkyl and carbocyclic aryl.

5

25. The compound of claim 11 wherein said compound is selected from the group consisting of

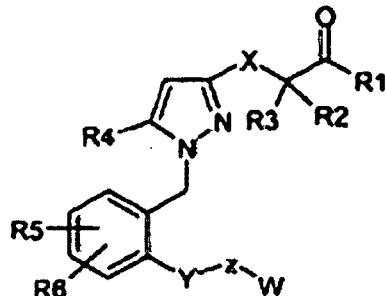
(1-[5-Chloro-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy)-acetic acid,

10 {1-[5-Chloro-2-(4-chloro-benzyloxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy}-acetic acid,

{1-[5-Bromo-2-(2-ethyl-butoxy)-benzyl]-5-methyl-1H-pyrazol-3-yloxy}-acetic acid and

{1-(5-Chloro-2-isobutoxy-benzyl)-5-methyl-1H-pyrazol-3-yloxy}-acetic acid.

26. A method comprising administering a compound having the following formula



15

wherein X is O, S or NR₇;

Y is (CH₂)_n, wherein n is 0 or an integer of 1 to 3;

20 Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;

W is hydrocarbyl or substituted hydrocarbyl;

R₁ is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

25 R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

5

R₆ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

10 R₇ is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

27. The method of claim 26 wherein said compound is administered to treat DPI, FP, EP1, TP and/or EP4 receptor mediated diseases or conditions.

15 28. The method of claim 27 wherein said condition or disease is related to inflammation.

29. The method of claim 27 wherein said DPI, FP, EP1, TP and/or EP4 receptor mediated condition or disease is selected from the group consisting of allergic conditions, asthma, allergic asthma, allergic rhinitis, uveitis and related disorders, atherosclerosis, blood 20 coagulation disorders, bone disorders, cancer, cellular neoplastic transformations, chronic obstructive pulmonary diseases and other forms of lung inflammation, congestive heart failure, diabetic retinopathy, diseases or conditions requiring a treatment of anti-coagulation, diseases requiring control of bone formation and resorption, fertility disorders, gangrene, glaucoma, hyperpyrexia, immune and autoimmune diseases, inflammatory conditions, 25 metastatic tumor growth, migraine, mucus secretion disorders, nasal congestion, nasal inflammation, occlusive vascular diseases, ocular hypertension, ocular hypotension, osteoporosis, rheumatoid arthritis, pain, perennial rhinitis, pulmonary congestion, pulmonary hypotension, Raynaud's disease, rejection in organ transplant and by-pass surgery, respiratory conditions, hirsutism, rhinorrhea, shock, sleep disorders, and sleep-wake cycle disorders.

30

30. The method of claim 27 wherein said compound is administered as a surgical adjunct in ophthalmology for cataract removal and artificial lens insertion, ocular implant procedures, photorefractive radial keratotomy and other ophthalmological laser procedures.

31. The method of claim 27 wherein said compound is administered as a surgical adjunct in a procedure involving skin incisions, relief of pain and inflammation and scar formation/keloids post-surgery, for treating sports injuries and general aches and pains in
5 muscles and joints.

32. The method of claim 27 wherein said DP₁, FP, EP₁, TP, and/or EP₄ receptor mediated condition or disease is an EP₁ and/or EP₄ receptor mediated condition or disease.

10 33. The method of claim 32 wherein said DP₁, FP, EP₁, TP and/or EP₄ receptor mediated condition or disease is an allergic condition.

34. The method of claim 27 wherein said condition is dermatological allergy.

15 35. The method of claim 27 wherein said condition is an ocular allergy.

36. The method of claim 27 wherein said condition is a respiratory allergy.

37. The method of claim 27 wherein said condition or disease is selected from the group
20 consisting of nasal congestion, rhinitis, and asthma.

38. The method of claim 27 wherein said condition or disease is related to pain.

39. The method of claim 27 wherein said condition or disease is selected from the group consisting of arthritis, migraine, and headache.

25 40. The method of claim 27 wherein said condition or disease is associated with the gastrointestinal tract.

41. The method of claim 27 wherein said condition or disease is selected from the group
30 consisting of peptic ulcer, heartburn, reflux esophagitis, erosive esophagitis, non-ulcer dyspepsia, infection by Helicobacter pylori, alrynitis, and irritable bowel syndrome.

42. The method of claim 27 wherein said condition or disease is selected from the group consisting of hyperalgesia and allodynia.

43. The method of claim 27 wherein said condition or disease is related to mucus
5 secretion.

44. The method of claim 27 wherein said mucus secretion is gastrointestinal.

45. The method of claim 27 wherein said mucus secretion occurs in the nose, sinuses,
10 throat, or lungs.

46. The method of claim 27 wherein said condition or disease is related to abdominal
cramping.

15 47. The method of claim 27 wherein said condition or disease is irritable bowel
syndrome.

48. The method of claim 27 wherein said condition or disease is a bleeding disorder.

20 49. The method of claim 27 wherein said condition or disease is a sleep disorder.

50. The method of claim 27 wherein said condition or disease is mastocytosis.

25 51. The method of claim 27 wherein said condition or disease is associated with elevated
body temperature.

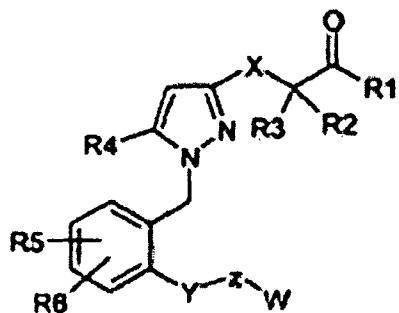
52. The method of claim 27 wherein said condition or disease is associated with ocular
hypertension and glaucoma.

30 53. The method of claim 27 wherein said condition or disease is associated with ocular
hypotension.

54. The method of claim 27 wherein said condition relates to surgical procure to treat pain, inflammation and other unwanted sequelae wherein said surgical procedure includes incision, laser surgery or implantation.

5 55. The method of claim 27 where said condition is related to pain and inflammation and post-surgical scar and keloid formation.

56. A pharmaceutical product comprising a compound having the following formula



10

wherein X is O, S or NR₇;

Y is (CH₂)_n, wherein n is 0 or an integer of 1 to 3;

15 Z is O, S, SO, SO₂ or (CH₂)_m, wherein m is 0 or an integer of from 1 to 3;
W is hydrocarbyl or substituted hydrocarbyl:

R₁ is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

20 R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

25 R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

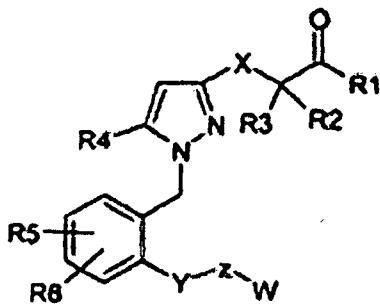
R6 is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

5

R7 is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

or a pharmaceutically acceptable salt or a prodrug thereof, wherein said product is packaged and labeled for the treatment or prevention of a disease or condition selected from the group 10 consisting of uveitis, allergic conditions, asthma, allergic asthma, allergic rhinitis, atherosclerosis, blood coagulation disorders, bone disorders, cancer, cellular neoplastic transformations, chronic obstructive pulmonary diseases and other forms of lung inflammation, congestive heart failure, diabetic retinopathy, diseases or conditions requiring a treatment of anti-coagulation, diseases requiring control of bone formation and resorption, 15 fertility disorders, hyperpyrexia, gangrene, glaucoma, hypothermia, immune and autoimmune diseases, inflammatory conditions, metastatic tumor growth, migraine, mucus secretion disorders, nasal congestion, nasal inflammation, occlusive vascular diseases, ocular hypertension, ocular hypotension, osteoporosis, pain, perennial rhinitis, pulmonary congestion, pulmonary hypotension, Raynaud's disease, rejection in organ transplant and bypass surgery, respiratory conditions, rheumatoid arthritis, rhinorrhea, shock, sleep disorders, 20 sleep-wake cycle disorders, sports injuries, muscle aches and pains, and surgical adjunct for minimizing pain, inflammation and scar/keloid formation.

57. A pharmaceutical composition comprising a compound having the following formula



25

wherein X is O, S or NR₇;

Y is $(CH_2)_n$, wherein n is 0 or an integer of 1 to 3;

Z is O, S, SO, SO₂ or $(CH_2)_m$, wherein m is 0 or an integer of from 1 to 3;

5

W is hydrocarbyl or substituted hydrocarbyl:

R₁ is selected from the group consisting of OR₇, N(R₇)₂, and N(R₇)SO₂R₇;

10 R₂ and R₃ are independently selected from the group consisting of H and alkyl and R₂ and R₃ together may form a cycloalkyl ring;

R₄ is selected from the group consisting of H, alkyl and halogen-substituted alkyl;

15 R₅ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy;

20 R₆ is selected from the group consisting of H, hydroxy, alkyl, aryl, alkoxy, aryloxy, halogen, nitro, amino, cyano and hydroxy, halogen, nitro, amino and cyano-substituted alkyl, aryl, alkoxy or aryloxy; and

R₇ is selected from the group consisting of H, hydrocarbyl and substituted hydrocarbyl.

25 or a pharmaceutically acceptable salt or a prodrug thereof, and a pharmaceutically acceptable excipient.

FIGURE 1

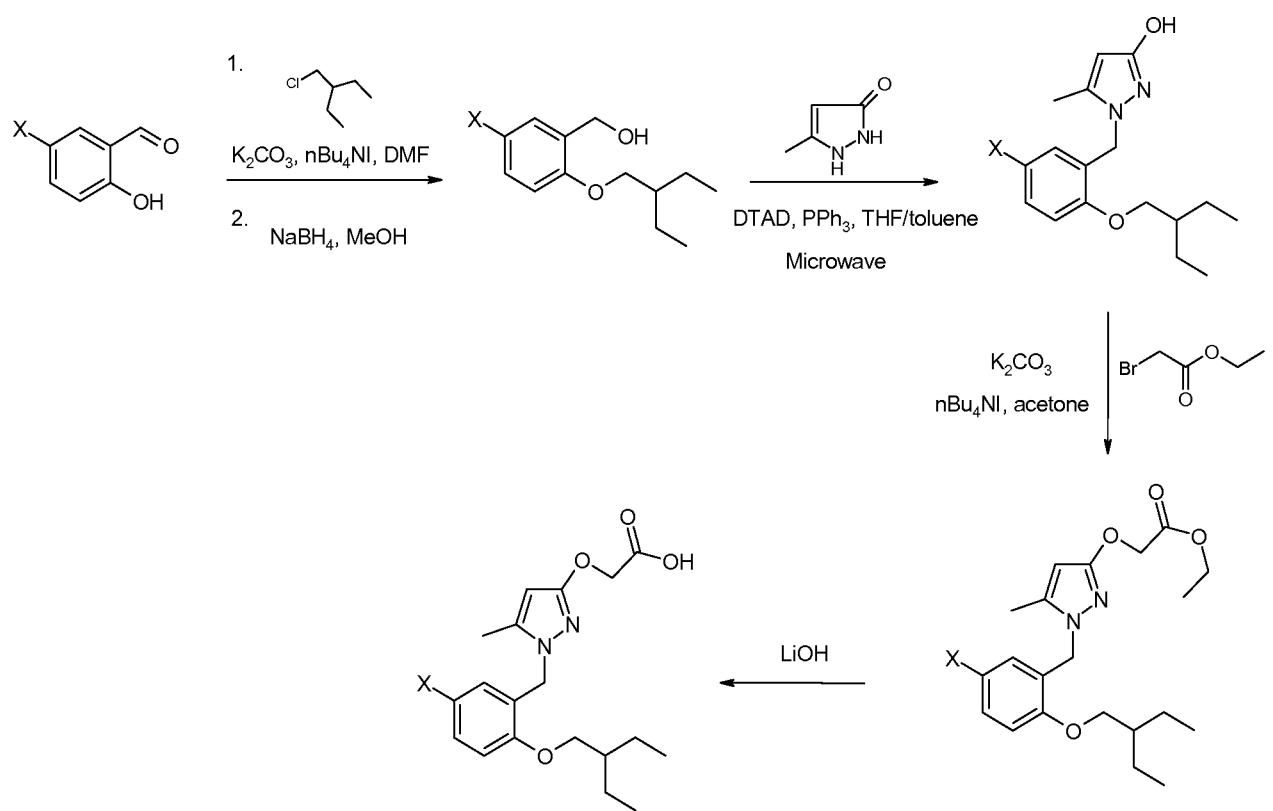
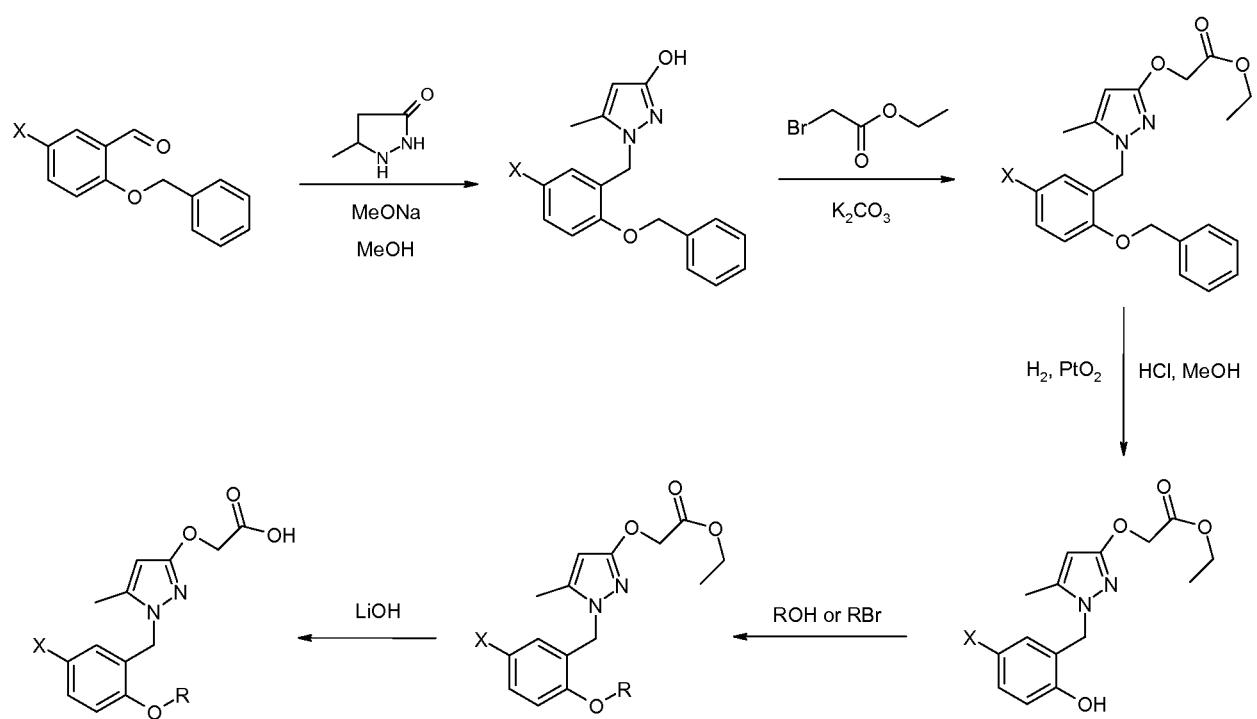


FIGURE 2



INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/07071O

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C07D231/20 A61K31/415 A61P11/00
 ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 C07D A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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| | | |

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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| Date of the actual completion of the international search | Date of mailing of the international search report |
| 8 March 2013 | 19/03/2013 |
| Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016 | Authorized officer Duval, Eric |

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/07Q7 10

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