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(54) SUBSTITUTED 1,3,4-OXADIAZOLES AND A METHOD OF REDUCING TNF-ALPHA LEVELS

SUBSTITUIERTE 1,3,4-OXADIAZOLE UND METHODE ZUR SENKUNG DES TNF-ALPHA-SPIEGELS

1,3,4-OXADIAZOLES SUBSTITUES ET METHODE DE REDUCTION DES TAUX DE TNF-ALPHA

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Description

[0001] The present invention relates to substituted 1,3,4-oxadiazole compounds, the method of reducing levels of tumor necrosis factor α and increasing cAMP levels and treating inflammatory and autoimmune diseases and cancer in a mammal through the administration thereof, and to pharmaceutical compositions of such derivatives.

Background of the Invention

[0002] Tumor necrosis factor-α (TNFα) is a cytokine which is released primarily by cells of immune systems in response to certain immunostimulators. When administered to animals or humans, it causes inflammation, fever, cardiovascular effects, hemorrhage, coagulation, cachexia, and acute phase responses similar to those seen during acute infections, inflammatory diseases, and shock states. Excessive or unregulated TNFα production has been implicated in a number of disease conditions. These include endotoxemia and/or toxic shock syndrome [Tracey, *et al.*, *Nature* 330, 662-664 (1987) and Hinshaw, *et al.*, *Circ. Shock* 30, 279-292 (1990)], rheumatoid arthritis, inflammatory bowel disease, cachexia [Dezube, et *al.*, *Lancet*, 335 (8690), 662 (1990)], and lupus. TNFα concentration in excess of 12,000 pg/mL have been detected in pulmonary aspirates from Adult Respiratory Distress Syndrome (ARDS) patients [Millar, *et al.*, *Lancet* 2(8665), 712-714 (1989)]. Systemic infusion of recombinant TNFα resulted in changes typically seen in ARDS [Ferrai-Baliviera, *et al.*, *Arch. Surg.* 124(12), 1400-1405 (1989)].

[0003] TNFα appears to be involved in a number of bone resorption diseases, including arthritis. When activated, leukocytes will produce bone-resorption. TNFα apparently contributes to this mechanism. [Bertolini, *et al.*, *Nature* 319, 516-518 (1986) and Johnson, *et al.*, *Endocrinology* 124(3), 1424-1427 (1989)]. TNFα also has been shown to stimulate bone resorption and inhibit bone formation *in vitro* and *in vivo* through stimulation of osteoclast formation and activation combined with inhibition of osteoblast functions. Another compelling link with disease is the association between production of TNFα by tumor or host tissues and malignancy associated hypercalcemia [*Calci. Tissue Int. (US)* 46(Suppl.), S3-10 (1990)]. In Graft versus Host Reactions, increased serum TNFα levels have been associated with major complication following acute allogenic bone marrow transplants [Holler, *et al.*, *Blood,* 75(4), 1011-1016 (1990)].

[0004] Validation of TNF-α inhibition as a clinical therapy has been demonstrated by the therapeutic use of TNF-α antibodies and soluble TNF-α receptors. TNFα blockage with monoclonal anti-TNFα antibodies has been shown to be beneficial in rheumatoid arthritis [Elliot, *et al.*, *Int. J. Pharmac.* 1995 17(2), 141-145]. High levels of TNFα are associated with Crohn's disease [von Dullemen, *et al.*, *Gastroenterology*, 1995 109(1), 129-135] treatment with soluble TNFα receptor treatment gave clinical benefits.

[0005] Cerebral malaria is a lethal hyperacute neurological syndrome associated with high blood levels of TNFα and the most severe complication occurring in malaria patients. Elevated levels of serum TNFα correlated directly with the severity of disease and the prognosis in patients with acute malaria attacks [Grau, *et al.*, *N. Engl. J. Med.* 320(24), 1586-1591 (1989)].

[0006] TNFα plays a role in the area of chronic pulmonary inflammatory diseases. The deposition of silica particles leads to silicosis, a disease of progressive respiratory failure caused by a fibrotic reaction. Antibodies to TNFα completely blocked the silica-induced lung fibrosis in mice [Pignet, *et al.*, *Nature,* 344, 245-247 (1990)]. High levels of TNFα production (in the serum and in isolated macrophages) have been demonstrated in animal models of silica and asbestos induced fibrosis [Bissonnette, *et al.*, *Inflammation* 13(3), 329-339 (1989)]. Alveolar macrophages from pulmonary sarcoidosis patients have also been found to spontaneously release massive quantities of TNFα as compared with macrophages from normal donors [Baughman, *et al.*, *J. Lab. Clin. Med.* 115(1), 36-42 (1990)].

[0007] Elevated levels of TNFα are implicated in reperfusion injury, the inflammatory response which follows reperfusion, and is a major cause of tissue damage after blood flow loss [Vedder, *et al.*, *PNAS* 87, 2643-2646 (1990)]. TNFα also alters the properties of endothelial cells and has various pro-coagulant activities, such as producing an increase in tissue factor pro-coagulant activity, suppressing the anticoagulant protein C pathway, and down-regulating the expression of thrombomodulin [Sherry, *et al.*, *J. Cell Biol.* 107, 1269-1277 (1988)]. TNFα has pro-inflammatory activities which together with its early production (during the initial stage of an inflammatory event) make it a likely mediator of tissue injury in several important disorders including but not limited to, myocardial infarction, stroke and circulatory shock. TNFα-induced expression of adhesion molecules, such as intercellular adhesion molecules (ICAM) or endothelial leukocyte adhesion molecules (ELAM) on endothelial cells may be especially important [Munro, *et al.*, *Am. J. Path.* 135(1), 121-132 (1989)].

[0008] It has been reported that TNFα is a potent activator of retrovirus replication including activation of HIV-1. [Duh, *et al.*, *Proc. Nat. Acad. Sci.* 86, 5974-5978 (1989); Poll, *et al.*, *Proc. Nat. Acad. Sci.* 87, 782-785 (1990); Monto, *et al.*, *Blood* 79, 2670 (1990); Clouse, *et al.*, *J. Immunol.* 142, 431-438 (1989); Poll, *et al.*, *AIDS Res. Hum. Retrovirus,* 191-197 (1992)]. At least three types or strains of HIV (*i.e.*, HIV-1, HIV-2 and HIV-3) have been identified. As a consequence of HIV infection, T-cell mediated immunity is impaired and infected individuals manifest severe opportunistic infections and/or unusual neoplasms. HIV entry into the T-lymphocyte requires T-lymphocyte activation. Other viruses, such as

HIV-1, HIV-2 infect T-lymphocytes after T-cell activation. This virus protein expression and/or replication is mediated or maintained by this T-cell activation. Once an activated T-lymphocyte is infected with HIV, the T-lymphocyte must continue to be maintained in an activated state to permit HIV gene expression and/or HIV replication. Cytokines, specifically TNFα, are implicated in activated T-cell mediated HIV protein expression and/or virus replication by playing a role in maintaining T-lymphocyte activation. Therefore, interference with cytokine activity such as prevention or inhibition of cytokine production, notably TNFα, in an HIV-infected individual assists in limiting the maintenance of T-lymphocyte caused by HIV infection.

[0009] Monocytes, macrophages, and related cells, such as kupffer and glial cells, also have been implicated in maintenance of the HIV infection. These cells, like T-cells, are targets for viral replication and the level of viral replication is dependent upon the activation state of the cells. [Rosenberg, *et al.*, *The Immunopathogenesis of HIV Infection*, Advances in Immunology, 57 (1989)]. Cytokines, such as TNFα, have been shown to activate HIV replication in monocytes and/or macrophages [Poli, *et al.*, *Proc. Natl. Acad. Sci.*, 87, 782-784 (1990)], therefore, prevention or inhibition of cytokine production or activity aids in limiting HIV progression for T-cells. Additional studies have identified TNFα as a common factor in the activation of HIV *in vitro* and have provided a clear mechanism of action via a nuclear regulatory protein found in the cytoplasm of cells [Osborn, *et al., PNAS* 86 2336-2340]. This evidence suggests that reducing TNFα synthesis may have an antiviral effect in HIV infections, by reducing transcription and thus virus production.

[0010] AIDS viral replication of latent HIV in T-cell and macrophage lines can be induced by TNFα [Folks, *et al.*, *PNAS* 86, 2365-2368 (1989)]. A molecular mechanism for the virus inducing activity is suggested by TNFα's ability to activate a gene regulatory protein (transcription factor, NFκB) found in the cytoplasm of cells, which promotes HIV replication through binding to a viral regulatory gene sequence (LTR) [Osborn, *et al.*, *PNAS* 86, 2336-2340 (1989)]. TNFα in AIDS associated cachexia is suggested by elevated serum TNFα and high levels of spontaneous TNFα production in peripheral blood monocytes from patients [Wright, *et al.*, *J. Immunol.* 141(1), 99-104 (1988)]. TNFα has been implicated in various roles with other viral infections, such as the cytomegalia virus (CMV), influenza virus, adenovirus, and the herpes family of viruses for similar reasons as those noted.

[0011] The nuclear factor κB (NFκB) is a pleiotropic transcriptional activator (Lenardo, *et al.*, *Cell* 1989, 58, 227-29). NFκB has been implicated as a transcriptional activator in a variety of disease and inflammatory states and is thought to regulate cytokine levels including but not limited to TNFα and active HIV transcription [Dbaibo, *et al.*, *J. Biol. Chem.* 1993, 17762-66; Duh, *et al.*, *Proc. Natl. Acad. Sci.* 1989, 86, 5974-78; Bachelerie, *et al.*, *Nature* 1991, 350, 709-12; Boswas, *et al.*, *J. Acquired Immune Deficiency Syndrome* 1993, 6, 778-786; Suzuki, *et al.*, *Biochem. And Biophys. Res. Comm.* 1993, 193, 277-83; Suzuki, *et al.*, *Biochem. And Biophys. Res Comm.* 1992, 189, 1709-15; Suzuki, *et al.*, *Biochem. Mol. Bio. Int.* 1993, 31(4), 693-700; Shakhov, *et al.*, *Proc. Natl. Acad. Sci. USA* 1990, 171, 35-47; and Staal, *et al.*, *Proc. Natl. Acad. Sci. USA* 1990, 87, 9943-47]. Thus, it would be helpful to inhibit NFκB activation, nuclear translation or binding to regulate transcription of cytokine gene(s) and through this modulation and other mechanisms be useful to inhibit a multitude of disease states.

[0012] Many cellular functions are mediated by levels of adenosine 3',5'-cyclic monophosphate (cAMP). Such cellular functions can contribute to inflammatory conditions and diseases including asthma, inflammation, and other conditions (Lowe and Cheng, *Drugs of the Future,* 17(9), 799-807, 1992). It has been shown that the elevation of cAMP in inflammatory leukocytes inhibits their activation and the subsequent release of inflammatory mediators, including TNFα and NFκB. Increased levels of cAMP also lead to the relaxation of airway smooth muscle.

[0013] The primary cellular mechanism for the inactivation of cAMP is the breakdown of cAMP by a family of isoenzymes referred to as cyclic nucleotide phosphodiesterases (PDE) [Beavo and Reitsnyder, *Trends in Pharm.,* 11, 150-155, 1990]. There are ten known members of the family of PDEs. It is well documented that the inhibition of PDE type IV (PDE 4) enzyme is particularly effective in both the inhibition of inflammatory mediator release and the relaxation of airway smooth muscle [Verghese, et al., *Journal of Pharmacology and Experimental Therapeutics,* 272(3), 1313-1320, 1995].

[0014] Decreasing TNFα levels and/or increasing cAMP levels thus constitutes a valuable therapeutic strategy for the treatment of many inflammatory, infectious, immunological, and malignant diseases. These include but are not restricted to: septic shock, sepsis, endotoxic shock, hemodynamic shock and sepsis syndrome, post ischemic reperfusion injury, malaria, mycobacterial infection, meningitis, psoriasis and other dermal diseases, congestive heart failure, fibrotic disease, cachexia, graft rejection, cancer, tumor growth, undesirable angiogenesis, autoimmune disease, opportunistic infections in AIDS, rheumatoid arthritis, rheumatoid spondylitis, osteoarthritis, other arthritic conditions, inflammatory bowel disease, Crohn's disease, ulcerative colitis, multiple sclerosis, systemic lupus erythrematosis, ENL in leprosy, radiation damage, and hyperoxic alveolar injury. Prior efforts directed to the suppression of the effects of TNFα have ranged from the utilization of steroids such as dexamethasone and prednisolone to the use of both polyclonal and monoclonal antibodies [Beutler, *et al., Science* 234, 470-474 (1985); WO 92/11383].

[0015] Angiogenesis, the process of new blood vessel development and formation, plays an important role in numerous normal and pathological physiological events. Angiogenesis occurs in response to specific signals and involves a complex process characterized by infiltration of the basal lamina by vascular endothelial cells in response to angiogenic growth signal(s), migration of the endothelial cells toward the source of the signal(s), and subsequent proliferation and formation of the capillary tube. Blood flow through the newly formed capillary is initiated after the endothelial cells come into contact and connect with a preexisting capillary. Angiogenesis is required for tumor growth beyond a certain size.

[0016] Inhibitory influences predominate in the naturally occurring balance between endogenous stimulators and inhibitors of angiogenesis [Rastinejad, *et al.*, 1989, *Cell* 56:345-355]. In those rare instances in which neovascularization occurs under normal physiological conditions, such as wound healing, organ regeneration, embryonic development, and female reproductive processes, angiogenesis is stringently regulated and spatially and temporally delimited. Under conditions of pathological angiogenesis such as that characterizing solid tumor growth, these regulatory controls fail.

[0017] Unregulated angiogenesis becomes pathologic and sustains progression of many neoplastic and non-neoplastic diseases. A number of serious diseases are dominated by abnormal neovascularization including solid tumor growth and metastases, arthritis, some types of eye disorders, and psoriasis [Moses, *et al.*, 1991, *Biotech.* 9:630-634; Folkman, *et al.*, 1995, *N. Engl. J. Med.*, 333:1757-1763; Auerbach, *et al.*, 1985, *J. Microvasc. Res.* 29:401-411; Folkman, 1985, *Advances in Cancer Research,* eds. Klein and Weinhouse, Academic Press, New York, pp. 175-203; Patz, 1982, *Am. J. Opthalmol.* 94:715-743; and Folkman, *et al.*, 1983, *Science* 221:719-725]. In a number of pathological conditions, the process of angiogenesis contributes to the disease state. For example, significant data suggests that the growth of solid tumors is dependent on angiogenesis [Folkman and Klagsbrun, 1987, *Science* 235:442-447].

[0018] The maintenance of the avascularity of the cornea, lens, and trabecular meshwork is crucial for vision as well as for ocular physiology. See, *e.g.,* reviews by Waltman, *et al.*, 1978, *Am. J. Ophthal.* 85:704-710 and Gartner, *et al.*, 1978, *Surv. Ophthal.* 22:291-312. Currently, the treatment of these diseases, especially once neovascularization has occurred, is inadequate and blindness often results.

[0019] An inhibitor of angiogenesis could have an important therapeutic role in limiting the contributions of this process to pathological progression of the underlying disease states as well as providing a valuable means of studying their etiology. For example, agents that inhibit tumor neovascularization could play an important role in inhibiting metastatic and solid tumor growth.

[0020] Several kinds of compounds have been used to prevent angiogenesis. Taylor, *et al.* used protamine to inhibit angiogenesis, [Taylor, *et al.*, *Nature* 297:307 (1982)]. The toxicity of protamine limits its practical use as a therapeutic. Folkman, *et al.* used heparin and steroids to control angiogenesis. [Folkman, *et al.*, *Science* 221:719 (1983) and U.S. Pat. Nos. 5,001,116 and 4,994,443]. Steroids, such as tetrahydrocortisol, which lack gluco and mineral corticoid activity, are angiogenic inhibitors. Interferon β is also a potent inhibitor of angiogenesis induced by allogeneic spleen cells [Sidky, *et al.*, Cancer Research 47:5155-5161 (1987)]. Human recombinant interferon-α was reported to be successfully used in the treatment of pulmonary hemangiomatosis, an angiogenesis-induced disease [White, *et al.*, *New England J. Med.* 320:1197-1200 (1989)].

[0021] Other agents which have been used to inhibit angiogenesis include ascorbic acid ethers and related compounds [Japanese Kokai Tokkyo Koho No. 58-131978]. Sulfated polysaccharide DS 4152 also shows angiogenic inhibition [Japanese Kokai Tokkyo Koho No. 63-119500]. A fungal product, fumagillin, is a potent angiostatic agent *in vitro.* The compound is toxic *in vivo,* but a synthetic derivative, AGM 12470, has been used *in vivo* to treat collagen II arthritis. Fumagillin and o-substituted fumagillin derivatives are disclosed in EPO Publication Nos. 0325199A2 and 0357061A1.

[0022] In U.S. Pat. No. 5,874,081, Parish teaches use of monoclonal antibodies to inhibit angiogenesis. In WO92/12717, Brem, *et al.* teach that some tetracyclines, particularly Minocycline, Chlortetracycline, Demeclocycline and Lymecycline are useful as inhibitors of angiogenesis. Brem, *et al.* teach that Minocycline inhibits angiogenesis to an extent comparable to that of the combination therapy of heparin and cortisone *[Cancer Research,* 51, 672-675, Jan. 15, 1991]. Teicher, *et al.* teach that tumor growth is decreased and the number of metastases is reduced when the anti-angiogenic agent of metastases is reduced when the anti-angiogenic agent Minocycline is used in conjunction with cancer chemotherapy or radiation therapy [*Cancer Research,* 52, 6702-6704, Dec. 1, 1992].

[0023] Macrophage-induced angiogenesis is known to be stimulated by TNFα. Leibovich, *et al.* reported that TNFα induces *in vivo* capillary blood vessel formation in the rat cornea and the developing chick chorioallantoic membranes at very low doses and suggested TNFα is a candidate for inducing angiogenesis in inflammation, wound repair, and tumor growth *[Nature,* 329, 630-632 (1987)].

[0024] All of the various cell types of the body can be transformed into benign or malignant tumor cells. The most frequent tumor site is lung, followed by colorectal, breast, prostate, bladder, pancreas, and then ovary. Other prevalent types of cancer include leukemia, central nervous system cancers, brain cancer, melanoma, lymphoma, erythroleukemia, uterine cancer, bone cancer, and head and neck cancer.

[0025] Cancer is now primarily treated with one or a combination of three types of therapies: surgery, radiation, and chemotherapy. Surgery involves the bulk removal of diseased tissue. While surgery is sometimes effective in removing tumors located at certain sites (e.g., in the breast, colon, and skin) surgery cannot be used in the treatment of tumors located in other areas (e.g., the backbone) nor in the treatment of disseminated neoplastic conditions (e.g., leukemia). Chemotherapy involves the disruption of cell replication or cell metabolism. Chemotherapy is used most often in the treatment of leukemia, as well as breast, lung, and testicular cancer.

[0026] Chemotherapeutic agents are often referred to as antineoplastic agents. The alkylating agents are believed to act by alkylating and cross-linking guanine and possibly other bases in DNA, arresting cell division. Typical alkylating agents include nitrogen mustards, ethyleneimine compounds, alkyl sulfates, cisplatin, and various nitrosoureas. A disadvantage with these compounds is that they not only attack malignant cells, but also other cells which are naturally dividing, such as those of bone marrow, skin, gastro-intestinal mucosa, and fetal tissue. Antimetabolites are typically reversible or irreversible enzyme inhibitors, or compounds that otherwise interfere with the replication, translation or transcription of nucleic acids. Thus, it would be preferable to find less toxic compounds for cancer treatment.

[0027] Matrix metalloproteinase (MMP) inhibition has been associated with several activities including inhibition of TNFα [Mohler, *et al., Nature*, 370, 218-220 (1994)] and inhibition of angiogenesis. MMPs are a family of secreted and membrane-bound zinc endopeptidases that play a key role in both physiological and pathological tissue degradation [Yu, *et al., Drugs & Aging, 1997,* (3):229-244; Wojtowicz-Praga, *et al., Int. New Drugs,* 16:61-75 (1997)]. These enzymes are capable of degrading the components of the extracellular matrix, including fibrillar and non-fibrillar collagens, fibronectin, laminin, and membrane glycoproteins. Ordinarily, there is a delicate balance between cell division, matrix synthesis, matrix degradation (under the control of cytokines), growth factors, and cell matrix interactions. Under pathological conditions, however, this balance can be disrupted. Conditions and diseases associated with undesired MMP levels include, but are not limited to: tumor metastasis invasion and growth, angiogenesis, rheumatoid arthritis, osteoarthritis, osteopenias such as osteoporosis, periodontitis, gingivitis, Crohn's disease, inflammatory bowel disease, and corneal epidermal or gastric ulceration.

[0028] Increased MMP activity has been detected in a wide range of cancers [Denis, *et al., Invest New Drugs*, 15: 175-185 (1987)]. As with TNFα, MMPs are believed to be involved in the invasive processes of angiogenesis and tumor metastasis.

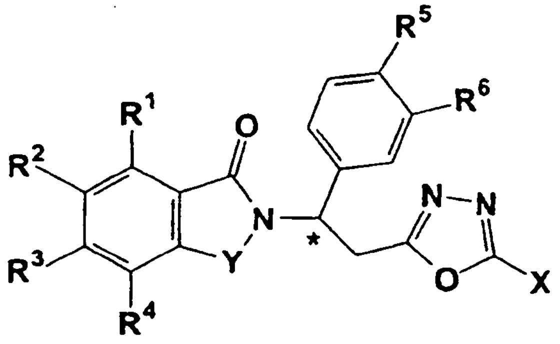
[0029] US5968945 discloses novel amides and imides which are inhibitors of TNFα and phosphodiesterase and can be used to combat cachexia, endotoxic shock, retrovirus replication, asthma and inflammatory conditions.

Detailed Description

[0030] The present invention is based on the discovery that certain classes of non-polypeptide compounds more fully described herein decrease the levels of TNFα, and/or inhibit PDEs particularly PDE 4, and/or inhibit angiogenesis and/or are useful in the treatment of cancer, inflammatory and autoimmune diseases. For example, compounds that selectively inhibit PDE 4 specifically would at least partially inhibit inflammation and relaxation of airway smooth muscle with a minimum of unwanted side effects, such as cardiovascular or anti-platelet effects. The compounds of the present invention are useful in the inhibition of phosphodiesterases, particularly PDE 4, and in the treatment of disease states mediated thereby.

[0031] The compounds described herein can inhibit the action of NFκB in the nucleus and thus are useful in the treatment of a variety of diseases including but not limited to rheumatoid arthritis, rheumatoid spondylitis, osteoarthritis, other arthritic conditions, septic shock, sepsis, endotoxic shock, graft versus host disease, wasting, inflammatory bowel disease Crohn's disease, ulcerative colitis, multiple sclerosis, systemic lupus erythrematosis, ENL in leprosy, HIV, AIDS, and opportunistic infections in AIDS. TNFα and NFκB levels are influenced by a reciprocal feedback loop. As noted above, the compounds of the present invention affect the levels of both TNFα and NFκB.

[0032] In particular, the invention pertains to *(a)* 1,3,4-oxadiazole compounds of Formula I:



Formula I

in which:
the carbon atom designated * constitutes a center of chirality;
Y is C=O, CH_2, SO_2 or CH_2C=O;
X is hydrogen, or alkyl of 1 to 4 carbon atoms;
each of R^1, R^2, R^3, and R^4, independently of the others, is hydrogen, halo, trifluoromethyl, acetyl, alkyl of 1 to 8 carbon atoms, alkoxy of 1 to 4 carbon atoms, nitro, cyano, hydroxy, *tert*-butyl, $-CH_2NR^8R^9$, $-(CH_2)_2NR^8R^9$, or $-NR^8R^9$; or any two of R^1, R^2 , R^3, and R^4 on adjacent carbon atoms, together with the depicted phenylene ring are naphthylidene, quinoline, quinoxaline, benzimidazole, benzodioxole or 2-hydroxybenzimidazole;
each of R^5 and R^6, independently of the other, is hydrogen, alkyl of 1 to 4 carbon atoms, alkoxy of 1 to 6 carbon atoms, cyano, benzocycloalkoxy, cycloalkoxy of up to 18 carbon atoms, bicyloalkoxy of up to 18 carbon atoms, tricylcoalkoxy of up to 18 carbon atoms, or cycloalkylalkoxy of up to 18 carbon atoms;
each of R^8 and R^9 taken independently of the other is hydrogen, straight alkyl of 1 to 8 carbon atoms, branched alkyl of 1 to 8 carbon atoms, phenyl, benzyl, pyridyl, pyridylmethyl, or one of R^8 and R^9 is hydrogen and the other is $-COR^{10}$, or $-SO_2R^{10}$, or

R^8 and R^9 taken together are tetramethylene, pentamethylene, -CHNCHCH-, hexamethylene, or $-CH_2CH_2X^1CH_2CH_2-$

in which X^1 is -O-, -S-, or -NH-;

R^{10} is hydrogen, alkyl of 1 to 8 carbon atoms, cycloalkyl, cycloalkylmethyl of up to 6 carbon atoms, phenyl, pyridyl, benzyl, imidazolylmethyl, pyridylmethyl, $NR^{11}R^{12}$, $CH_2NR^{\bullet}R^0$, or $NR^{11}R^{12}$

wherein $R^{\bullet}$ and R^0, independently of each other, are hydrogen, methyl, ethyl, or propyl, and

wherein R^{11} and R^{12}, independently of each other, are hydrogen, alkyl of 1 to 8 carbon atoms, phenyl, or benzyl;

and
(b) the acid addition salts of said compounds which contain a nitrogen atom susceptible of protonation.

[0033] It will be appreciated that while for convenience the compounds of Formula I are identified as 1,3,4-oxadiazoles. The term alkyl denotes a univalent saturated or unsaturated branched, or straight, cyclic or mixture thereof hydrocarbon chain containing from 1 to 8 carbon atoms. Representative of such alkyl groups are methyl, ethyl, propyl, isopropyl, butyl, isobutyl, *sec*-butyl, *tert*-butyl, cyclopentyl, and cyclopropylmethyl. Alkoxy refers to an alkyl group bound to the remainder of the molecule through an ethereal oxygen atom. Representative of such alkoxy groups are methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, sec-butoxy, *tert*-butoxy, cyclohexylmethoxy, and cyclopentylmethoxy.

[0034] The term cycloalkyl as used herein denotes a univalent cyclic hydrocarbon chain which may be saturated or unsaturated. Unless otherwise stated, such chains can contain up to 18 carbon atoms and include monocycloalkyl, dicycloalkyl, polycycloalkyl, and benzocycloalkyl structures. Monocycloalkyl refers to groups having a single ring group. Polycycloalkyl denotes hydrocarbon systems containing two or more ring systems with one or more ring carbon atoms in common; *i.e.*, a spiro, fused, or bridged structure. Benzocycloalkyl signifies a monocyclic alkyl group fused to a benzo group. Representative of monocycloalkyl groups are cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cycloundecyl, cyclododecyl, cyclotridecyl, cyclotetradecyl, cyclopentadecyl, cyclohexadecyl, cycloheptadecyl, and cyclooctadecyl. Representative of polycycloalkyl include decahydronaphthalene, spiro[4.5]decyl, bicyclo[2.2.1]heptyl, bicyclo[3.2.1]octyl, pinanyl, norbornyl, and bicyclo[2.2.2]octyl. Benzocycloalkyl is typified by tetrahydronaphthyl, indanyl, and 1.2-benzocycloheptanyl. Cycloalkoxy refers to a cycloalkyl group as just described, that is a monocycloalkyl, polycycloalkyl, or benzocycloalkyl structure, bound to the remainder of the molecule through an ethereal oxygen atom.

[0035] A first preferred group of compounds are those of Formula I in which Y is C=O.

[0036] A further preferred group of compounds are those of Formula I in which Y is CH_2.

[0037] A further preferred group of compounds are those of Formula I in which each of R^1, R^2, R^3, and R^4 independently of the others, is hydrogen, halo, methyl, ethyl, methoxy, ethoxy, nitro, cyano, hydroxy, or $-NR^8R^9$ in which each of R^8 and R^9 taken independently of the other is hydrogen or methyl or one of R^8 and R^9 is hydrogen and the other is $-COCH_3$, or COR, where R is alkyl, benzyl, pyridyl, or pyridylmethyl.

[0038] A further preferred group of compounds are those of Formula I in which one of R^1, R^2, R^3 and R^4 is $-NH_2$ or $-CH_3$ and the remaining of R^1, R^2, R^3 and R^4 are hydrogen.

[0039] A further preferred group of compounds are those of Formula I in which one of R^1, R^2, R^3, and R^4 is $-NHCOCH_3$, $NHSO_2R^{10}$, or $NHCOR^{10}$, and the remaining of R^1, R^2, R^3 and R^4 are hydrogen.

[0040] A further preferred group of compounds are those of Formula I in which one of R^1, R^2, R^3, and R^4 is $-N(CH_3)_2$ and the remaining of R^1, R^2, R^3 and R^4 are hydrogen.

[0041] A further preferred group of compounds are those of Formula I in which one of R^1, R^2, R^3, and R^4 is methyl or ethyl and the remaining of R^1, R^2, R^3, and R^4 are hydrogen.

[0042] A further preferred group of compounds are those of Formula I in which each of R^5 and R^6, independently of the other, is methoxy, ethoxy, propoxy, cyclopentoxy, or cyclohexoxy.

[0043] A further preferred group of compounds are those of Formula I in which R^5 is methoxy and R^6 is alkoxy, monocycloalkoxy, polycycloalkoxy, and benzocycloalkoxy.

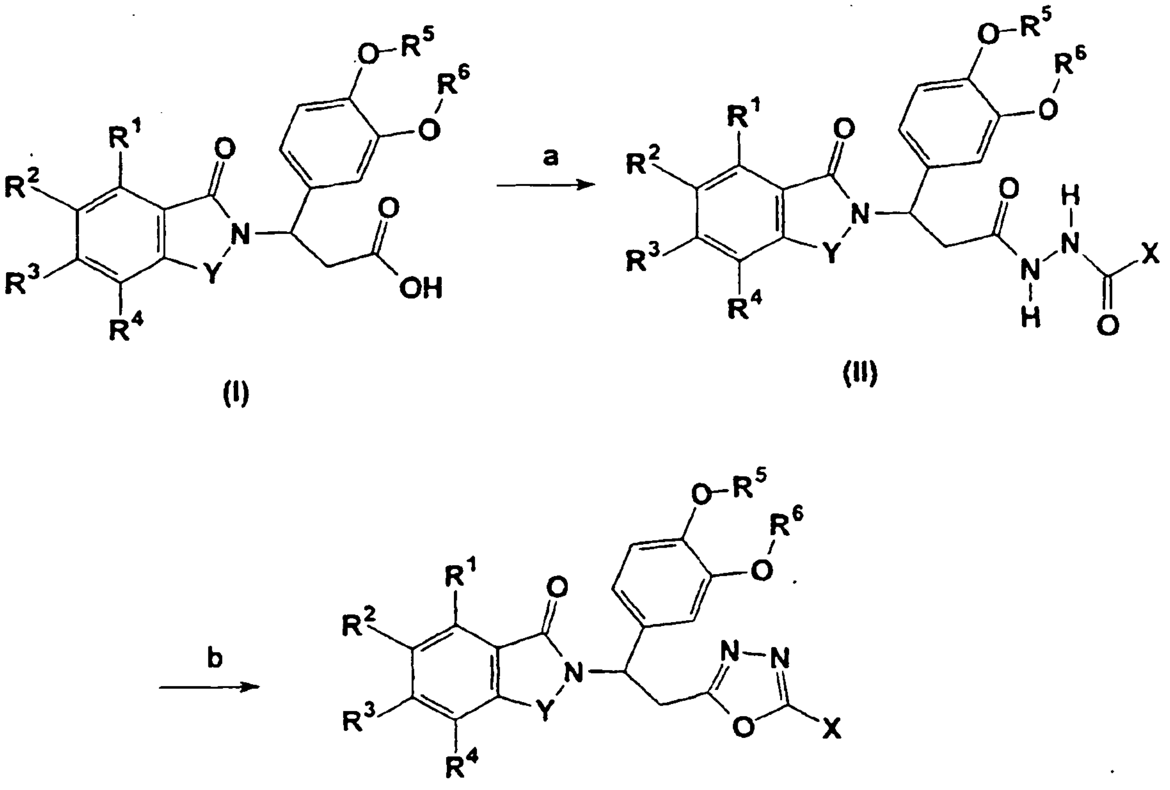
[0044] A further preferred group of compounds are those of Formula I in which R^5 is methoxy and R^6 is ethoxy or cyclopentoxy.

[0045] The compounds of Formula I are used, under the supervision of qualified professionals, to inhibit the undesirable effects of TNFα and PDE 4. The compounds may also be given to treat cancer conditions, undesirable angiogenesis, inflammation, skin conditions, etc. The compounds can be administered orally, rectally, or parenterally, alone or in combination with other therapeutic agents including antibiotics, steroids, etc., to a mammal in need of treatment. Use of the terms PDE IV and PDE 4 are deemed equivalent.

[0046] The compounds can also be used topically in the treatment or prophylaxis of topical disease states including, but not limited to atopic dermatitis, psoriasis, lupus, viral infections, such as those caused by the herpes viruses, or viral conjunctivitis, psoriasis, cancer, *etc.* PDE 4 inhibition is a preferred embodiment, though inhibition of other phosphodiesterases is envisioned.

[0047] The compounds also can be used in the veterinary treatment of mammals other than humans in need of prevention or inhibition of TNFα production or PDE 4 inhibition. TNFα mediated diseases for treatment, therapeutically or prophylactically, in animals which include disease states such as those noted above. Viral infection examples include feline immunodeficiency virus, equine infectious anemia virus, caprine arthritis virus, visna virus, and maedi virus, as well as other lentiviruses.

[0048] Methods of preparation of acids (I) are described in U.S. Patent No. 5,605,914 which is incorporated by reference herein. The preparation of the oxadiazoles (III) can be done in a two-step fashion or in a single-pot fashion. Reaction of acid (I) with carbonyldiimidazole (CDI) or another activating agent, followed by addition of an acyl hydrazide (NH_2NHCXO, wherein X is a hydrogen or alkyl) provides a compound of Formula (II). Preferred solvents for this reaction ("**a**") are aprotic polar solvent that include acetonitrile (CH_3CN) , tetrahydrofuran (THF), and ethyl acetate (EtOAc). Compounds of Formula (II) can be isolated at this point. Alternatively, a compound of Formula (II) can be used in the next reaction "**b**" without isolation (a preferred solvent is then acetonitrile). In reaction "**b**" dehydration of a compound of Formula (II) with dehydrating reagents such as phosphorous oxychloride ($POCl_3$) or phosphorous pentoxide (P_2O_5) provides a compound of Formula (III). Heat may be used in reaction "**b**".



(I) (II) (III)

[0049] When one of R^1, R^2, R^3, and R^4 is to be amino in the final 1,3,4-oxadiazole, it often is desirable to utilize the corresponding nitro compound (I) and then reduce the resulting nitroisoindolinone to an aminoisoindolinone after formation. Alternatively, amino groups and other groups which may react can be converted to an appropriately protected group.

[0050] Protecting groups utilized herein denote groups which generally are not found in the final therapeutic compounds but which are intentionally introduced at some stage of the synthesis in order to protect groups which otherwise might be altered in the course of chemical manipulations. Such protecting groups are removed at a later stage of the synthesis and compounds bearing such protecting groups thus are of importance primarily as chemical intermediates (although some derivatives also exhibit biological activity). Accordingly the precise structure of the protecting group is not critical. Numerous reactions for the formation and removal of such protecting groups are described in a number of standard works including, for example, "Protective Groups in Organic Chemistry", Plenum Press, London and New York, 1973; Greene, Th. W. "Protective Groups in Organic Synthesis", Wiley, New York, 1981; "The Peptides", Vol. 1, Schröder and Lubke, Academic Press, London and New York, 1965; "Methoden der organischen Chemie", Houben-Weyl, 4th Edition, Vol. 15/1, Georg Thieme Verlag, Stuttgart 1974, the disclosures of which are incorporated herein by reference.

[0051] The compounds of Formula I possess a center of chirality and thus can exist as optical isomers. Both the racemates of these isomers and the individual isomers themselves, as well as diastereomers when there are two chiral centers, are within the scope of the present invention. The racemates can be used as such or can be separated into their individual isomers mechanically as by chromatography using a chiral absorbent. Alternatively, the individual isomers can be prepared in chiral form or separated chemically from a mixture by forming salts with a chiral acid or base, or have such as the individual enantiomers of 10-camphorsulfonic acid, camphoric acid, α-bromocamphoric acid, methoxyacetic acid, tartaric acid, diacetyltartaric acid, malic acid, pyrrolidone-5-carboxylic acid, and the like, and then freeing one or both of the resolved bases, optionally repeating the process, so as obtain either or both substantially free of the other; *i.e.*, in a form having an optical purity of >95%.

[0052] Preferred examples include substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, wherein the isomer is 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]benzo[e]isoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, 2-[1-(3-cyclopentyloxy-4-methoxy-phenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione, N-[2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl) ethyl]-1,3-dioxoisoindolin-4-yl]acetamide, N-[2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]-acetamide, 5-(tert-butyl)-2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione, 2-[1-(3,4-dimethoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindolin-1-one, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(5-methyl(1,3,4-oxadiazol-2-yl))ethyl]isoindolin-1-one, and 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-3-pyrrolino[3,4-]quinoline-1,3-dione.

[0053] The present invention also pertains to the physiologically acceptable non-toxic acid addition salts of the compounds of Formula I. Such salts include those derived from organic and inorganic acids such as, without limitation, hydrochloric acid, hydrobromic acid, phosphoric acid, sulfuric acid, methanesulphonic acid, acetic acid, tartaric acid, lactic acid, succinic acid, citric acid, malic acid, maleic acid, sorbic acid, aconitic acid, salicylic acid, phthalic acid, embonic acid, enanthic acid, and the like.

[0054] Oral dosage forms include tablets, capsules, dragees, and similar shaped, compressed pharmaceutical forms containing from 1 to 100 mg of drug per unit dosage. Mixtures containing from 20 to 100 mg/mL can be formulated for parenteral administration which includes intramuscular, intrathecal, intravenous and intra-arterial routes of administration. Rectal administration can be effected through the use of suppositories formulated from conventional carriers such as cocoa butter.

[0055] Pharmaceutical compositions thus comprise one or more compounds of the present invention associated with at least one pharmaceutically acceptable carrier, diluent or excipient. In preparing such compositions, the active ingredients are usually mixed with or diluted by an excipient or enclosed within such a carrier which can be in the form of a capsule or sachet. When the excipient serves as a diluent, it may be a solid, semi-solid, or liquid material which acts as a vehicle, carrier, or medium for the active ingredient. Thus, the compositions can be in the form of tablets, pills, powders, elixirs, suspensions, emulsions, solutions, syrups, soft and hard gelatin capsules, suppositories, sterile injectable solutions and sterile packaged powders. Examples of suitable excipients include lactose, dextrose, sucrose, sorbitol, mannitol, starch, gum acacia, calcium silicate, microcrystalline cellulose, polyvinylpyrrolidinone polyvinylpyrrolidone, cellulose, water, syrup, and methyl cellulose, the formulations can additionally include lubricating agents such as talc, magnesium stearate and mineral oil, wetting agents, emulsifying and suspending agents, preserving agents such as methyl- and propylhydroxybenzoates, sweetening agents or flavoring agents.

[0056] The compositions preferably are formulated in unit dosage form, meaning physically discrete units suitable as a unitary dosage, or a predetermined fraction of a unitary dose to be administered in a single or multiple dosage regimen to human subjects and other mammals, each unit containing a predetermined quantity of active material calculated to produce the desired therapeutic effect in association with a suitable pharmaceutical excipient. The compositions can be formulated so as to provide an immediate, sustained or delayed release of active ingredient after administration to the patient by employing procedures well known in the art.

[0057] The following examples will serve to further typify the nature of this invention but should not be construed as a limitation in the scope thereof, which scope is defined solely by the appended claims.

Example 1

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl] isoindoline-1,3-dione

[0058] A mixture of 3-(1,3-dioxoisoindolin-2-yl)-3-(3-ethoxy-4-methoxyphenyl)propanoic acid (3.0 g, 8.1 mmol) and carbonyldiimidazole (1.45 g, 8.94 mmol) in tetrahydrofuran (15 mL) was stirred at room temperature for 2 hours. To the solution was added formic hydrazide (644 mg, 10.7 mmol). The mixture was stirred for 18 hours. The resulting suspension was filtered and washed with ether. The isolated solid was stirred in a mixture of ethyl acetate (40 mL) and water (10 mL) for 1 hour. The suspension was filtered and washed with water and ether to give crude 3-(1,3-dioxoisoindolin-2-yl)-N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)propanamide (1.3 g, 39% yield). A solution of 3-(1,3-dioxoisoindolin-2-yl)-N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)-propanamide (600 mg, 1.46 mmol) and phosphorus oxychloride ($POCl_3$, 0.54 mL, 5.8 mmol) in acetonitrile (20 mL) was heated to reflux for 2 hours. This solution was poured into water (10 mL). The aqueous layer was extracted with ethyl acetate (2 X 50 mL). The combined organic layers were washed with sodium hydrogen carbonate (50 mL, sat), brine (50 mL) and dried over magnesium sulfate. Removal of solvent and chromatography gave an oil. The oil was slurried in ether (10 mL). The resulting suspension was filtered to yield 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione as a white solid (250 mg, 43% yield): mp, 132.0-134.0 °C; ^1H NMR ($CDCl_3$); δ 1.46 (t, J = 6.9 Hz, 3H, CH_3), 2.82 (dd, J = 6.0, 15.6 Hz, 1H, CHH), 3.84 (s, 3H, CH_3), 4.11 (q, J = 7.0 Hz, 2H, CH_2), 4.37 (dd, J = 10.3, 15.7 Hz, 1 H, CHH), 5.81 (dd, J = 6.0, 10.3 Hz, 1 H, NCH), 6.62 (d, J = 7.9 Hz, 1H, Ar), 7.13-7.17 (m, 2H, Ar), 7.67-7.72 (m, 2H, Ar), 7.75-7.62 (m, 2H, Ar), 8.29 (s, 1H, Ar); ^{13}C NMR ($CDCl_3$) δ 14.69, 27.70, 51.85, 55.90, 64.42, 111.32, 112.51, 120.32, 123.44, 130.14, 13163, 134.13, 148.39, 143.43, 153.03, 163.99, 167.93; Anal Calcd for $C_{21}H_{29}N_3O_5$: C, 64.12; H, 4.87; N, 10.68. Found: C, 63.84; H, 4.90; N, 10.48.

Example 2

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]benzo[e]isoindoline-1,3-dione

[0059] 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]benzo[e]isoindoline-1,3-dione was prepared by the procedure used in Example 1. Thus, reaction of 3-(1,3-dioxobenzo[e]isoindolin-2-yl)-3-(3-ethoxy-4-methoxyphenyl)propanoic acid (1.50 g, 3.58 mmol), carbonyldiimidazole (0.70 g, 4.3 mmol) and formic hydrazide (310 mg, 5.16 mmol) in tetrahydrofuran (20 mL) gave crude 3-(1,3-dioxobenzo[e]isoindolin-2-yl)-N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)propanamide (1.0 g, 2.2 mmol), which was then treated with phosphorus oxychloride ($POCl_3$, 0.4 mL, 4.3 mmol) in acetonitrile (10 mL). The product was obtained as a yellow solid (135 mg, 8% overall yield): mp, 139.0-141.5 °C; ^1H NMR ($CDCl_3$) δ 1.47 (t, *J* = 7.2 Hz, 3H, CH_3), 3.85 (s, 3H, CH_3), 3.87 (dd, *J* = 6.0, 15.6 Hz, 1H, CH*H*), 4.13 (q, *J* = 6.9 Hz, 2H, CH_2), 4.42 (dd, *J* = 10.2, 15.6 Hz, 1H, CH*H*), 5.87 (t, *J* = 5.9, 10.4 Hz, 1 H, NC*H*), 6.84 (d, *J* = 8.7 Hz, 1H, Ar), 7.18-7.27 (m, 2H, Ar), 7.64-7.75 (m, 2H, Ar), 7.81 (d, *J* = 8.3 Hz, 1H, Ar), 7.94 (d, *J* = 7.6 Hz, 1H, Ar), 8.14 (d, *J* = 8.2 Hz, 1 H, Ar), 8.29 (s, 1 H, C*H*), 8.90 (d, *J* = 7.5 Hz, 1H, Ar); ^{13}C NMR ($CDCl_3$) δ 14.63, 27.79, 51.69, 55.84, 64.39, 111.34, 112.53, 118.41, 121.22, 124.83, 126.88, 127.93, 128.62, 128.74, 129.44, 130.31, 130.87, 135.06, 136.59, 148.37, 149.36, 152.95, 164.04, 168.51, 169.07; Anal Calcd for $C_{25}H_{21}N_3O_5$: C, 67.71; H, 4.77; N, 9.48. Found: C, 67.80; H, 4.95; N, 9.20.

Example 3

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione

[0060] 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione was prepared by the procedure of Example 1. Reaction of 3-(3-ethoxy-4-methoxyphenyl)-3-(4-methyl-1,3-dioxoisoindolin-2-yl)propanoic acid (2.03 g, 5.29 mmol), carbonyldiimidazole (1.03 g, 6.35 mmol) and formic hydrazide (420 mg, 6.99 mmol) in tetrahydrofuran (20 mL) gave crude N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)-3-(4-methyl-1,3-dioxoisoindolin-2-yl)propanamide(610 mg, 1.43 mmol), which was then treated with phosphorus oxychloride (0.4 mL, 4.3 mmol) in acetonitrile (6 mL). The product was obtained as a white solid (311 mg, 14% overall yield): mp, 96.0-98.0 °C; ^1H NMR ($CDCl_3$) δ 1.47 (t, *J* = 6.9 Hz, 3H, CH_3), 2.67 (s, 3H, CH_3), 3.81 (dd, *J* = 6.0, 15.7 Hz, 1H, CH*H*), 3.85 (s, 3H, CH_3), 4.12 (q, *J* = 6.9 Hz, 2H, CH_2), 4.37 (dd, *J* = 10.2, 15.6 Hz, 1H, CH*H*), 5.81 (t, *J* = 6.0, 10.3 Hz, 1H, NC*H*), 6.83 (d, *J* = 8.7 Hz, 1H, Ar), 7.14-7.17 (m, 2H, Ar), 7.43 (d, *J* = 7.6 Hz, 1H, Ar), 7.54 (t, *J* = 7.3 Hz, 1H, Ar), 7.63 (d, *J* = 7.1 Hz, 1H, Ar), 8.30 (s, 1H, C*H*); ^{13}C NMR ($CDCl_3$) δ 14.69, 17.52, 27.71, 51.62, 55.92, 64.46, 111.37, 112.63,.120.33, 121.06, 128.31, 130.33, 132.07, 133.59, 136.55, 138.18, 148.39, 149.42, 153.02, 164.08, 168.04, 168.53; Anal Calcd for $C_{22}H_{21}N_3O_5$ + 0.2 H_2O: C, 64.29; H, 5.25; N, 10.22; H_2O, 0.90. Found: C, 64.62; H, 5.30; N, 9.83; H_2O, 0.71.

Example 4

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione

[0061] 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione was prepared by the procedure of Example 1. Reaction of 3-(3-ethoxy-4-methoxyphenyl)-3-(5-methyl-1,3-dioxoisoindolin-2-yl)propanoic acid (1.81 g, 4.72 mmol), carbonyldiimidazole (0.92 g, 5.7 mmol) and formic hydrazide (375 mg, 6.2 mmol) in ethyl acetate (20 mL) gave crude N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)-3-(5-methyl-1,3-dioxoisoindolin-2-yl)propanamide (0.93 g, 2.2 mmol), which was then treated with phosphorus oxychloride (0.4 mL, 4.3 mmol) in acetonitrile (12 mL). The product was obtained as a white solid (371 mg, 19% overall yield): mp, 122.0-124.0 °C; ^1H NMR ($CDCl_3$) δ 1.45 (t, *J* = 6.9 Hz, 3H, CH_3), 2.48 (s, 3H, CH_3), 3.80 (dd, *J* = 6.0, 15.6 Hz; 1 H, CH*H*), 3.84 (s, 3H, CH_3), 4.10 (q, *J* = 6.9 Hz, 2H, CH_2), 4.35 (dd, *J* =10.3, 15.6 Hz, 1 H, CH*H*), 5.79 (dd, *J* = 6.0, 10.2 Hz, 1H, NC*H*), 6.82 (d, *J* = 8.1 Hz, 1 H, Ar), 7.12-7.17 (m, 2H, Ar), 7.47 (d, *J* = 7.5 Hz, 1 H, Ar), 7.59 (s, 1 H, Ar), 7.68 (d, *J* = 7.6 Hz, 1H, Ar), 8.28 (s, 1H, Ar); ^{13}C NMR ($CDCl_3$) δ 14.61, 21.86, 27.67, 51.71, 55.83, 64.36; 111.29, 112.49, 120.22, 123.27, 123.88, 128.97, 130.23, 131.95, 134.58, 145.39, 148.33, 149.34, 152.93, 163.97, 167.91, 168.04; Anal Calcd for $C_{22}H_{21}N_3O_5$: C, 64.86; H, 5.20; N, 10.31. Found: C, 64.77; H, 5.07; N, 10.30.

Example 5

2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyt]-5-methylisoindoline-1,3-dione

[0062] 2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione was prepared by the procedure of Example 1. Reaction of 3-(3-cyclopentyloxy-4-methoxyphenyl)-3-(5-methyl-1,3-dioxoisoindolin-2-yl)propanoic acid (2.33 g, 5.5 mmol), carbonyldiimidazole (1.07 g, 6.59 mmol) and formic hydrazide (436 mg, 7.26 mmol) in ethyl acetate (20 mL) gave crude N-carbonylamino-3-(3-cyclopentyloxy-4-methoxyphenyl)-3-(5-methyl-1,3-dioxoisoindolin-2-yl)propanamide (2.24 g, 4.8 mmol), which was then treated with phosphorus oxychloride (0.9 mL, 9.6 mmol) in acetonitrile (10 mL). The product was obtained as a white solid (728 mg, 32% overall yield): mp, 184.0-186.5 °C; ^1H NMR ($CDCl_3$) δ 1.55-2.00 (m, 8H, C_5H_8), 2.48 (s, 3H, CH_3), 3.81 (s, 3H, CH_3), 3.82 (dd, *J* = 6.1, 15.7 Hz, 1 H, CH*H*), 4.36 (dd, *J* = 10.3, 15.7 Hz, 1H, CH*H*), 4.74-4.81 (m, 1H, OC*H*), 5.79 (dd, *J* = 5.9, 10.3 Hz, 1H, NC*H*), 6.80 (d, *J* = 8.4 Hz, 1H, Ar), 7.10 (dd, J = 2.0, 8.3 Hz, 1 H, Ar), 7.18 (d, *J* = 2.0 Hz, 1H, Ar), 7.47 (d, *J* = 7.5 Hz, 1H, Ar), 7.59 (s, 1 H, Ar), 7.67 (d, *J* = 7.6 Hz, 1H, Ar), 8.28 (s, 1H, C*H*); ^{13}C NMR ($CDCl_3$) δ 21.95, 24.09, 27.75, 32.77, 51.79, 56.00, 80.48, 111.73, 114.51, 120.16, 123.34, 123.95, 129.05, 130.22, 132.03, 134.65, 145.44, 147.75, 150.03, 153.00, 164.08, 167.98, 168.11; Anal Calcd for $C_{25}H_{25}N_3O_5$ + 0.13 Et_2O: C, 67.05; H, 5.80; N, 9.19. Found: C, 66.95; H, 5.88; N, 8.97. (HNMR showed the sample contained 0.13 equiv. of ether).

Example 6

2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione

[0063] 2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione was prepared by the procedure of Example 1. Reaction of 3-(3-cyclopentyloxy-4-methoxyphenyl)-3-(4-methyl-1,3-dioxoisoindalin-2-yl)propanoic acid (2.23 g, 5.27 mmol), carbonyldiimidazole (0.94 g, 5.8 mmol) and formic hydrazide (382 mg, 6.36 mmol) in ethyl acetate (20 mL) gave crude N-carbonylamino-3-(3-cyclopentyloxy-4-methoxyphenyl)-3-(4-methyl-1,3-dioxoisoindolin-2-yl)propanamide (1.71 g, 3.67 mmol), which was then treated with phosphorus oxychloride (0.8 mL, 8.6 mmol) in acetonitrile (10 mL). The product was obtained as a white solid (368 mg, 16% overall yield): mp, 126.0-128.5 °C; ^1H NMR ($CDCl_3$) δ 1.21-1.99 (m, 8H, C_5H_8), 2.66 (s, 3H, CH_3), 3.81 (s, 3H, CH_3), 3.82 (dd, *J* = 6.1, 15.8 Hz, 1H, CH*H*), 4.37 (dd, *J* = 10.3, 15.6 Hz, 1 H, CH*H*), 4.76-4.83 (m, 1 H, OC*H*), 5.80 (dd, *J* = 5.9, 10.3 Hz, 1 H, NC*H*), 6.81 (d, *J* = 8.4 Hz, 1H, Ar), 7.09-7.18 (m, 2H, Ar), 7.43 (d, *J* = 7.6 Hz, 1H, Ar), 7.54 (t, *J* = 7.4 Hz, 1H, Ar), 7.62 (d, *J* = 7.1 Hz, 1H, Ar), 8.29 (s, 1 H, C*H*); ^{13}C NMR ($CDCl_3$) δ 17.45, 24.00, 27.67, 32.68, 51.57, 55.94, 80.44, 111.69, 114.55, 120.13, 120.98, 128.25, 130.22, 132.01, 133.50, 136.44, 138.08, 147.68, 149.99, 152.93, 164.04, 167.95, 168.56; Anal Calcd for $C_{25}H_{25}N_3O_5$: C, 67.10; H, 5.63; N, 9.39. Found: C, 67.14; H, 5.55; N, 9.19.

Example 7

N-[2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamide

[0064] N-[2-(1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamide was prepared by the procedure of Example 1. Reaction of 3-[4-(acetylamino)-1,3-dioxoisoindolin-2-yl]-3-(3-cyclopentyloxy-4-methoxyphenyl)-propanoic acid (2.0 g, 4.3 mmol), carbonyldiimidazole (0.77 g, 4.8 mmol) and formic hydrazide (314 mg, 4.7 mmol) in ethyl acetate (20 mL) gave crude 3-[4-(acetylamino)-1,3-dioxoisoindolin-2-yl]-N-carbonylamino-3-(3-cyclopentyloxy-4-methoxyphenyl)-propanamide, which was then reacted with phosphorus oxychloride (1.0 mL, 10.7 mmol) in acetonitrile (15 mL). The product was isolated as a yellow solid (555 mg, 28% overall yield): mp, 115.0-117.0 °C; ^1H NMR ($CDCl_3$) δ 1.62-1.97 (m, 8H, C_5H_8), 2.27 (s, 3H, CH_3), 3.76 (dd, *J* = 5.6, 15.9 Hz, 1H, CH*H*), 3.83 (s, 3H, CH_3), 4.40 (dd, *J* = 10.7, 15.8 Hz, 1H, CH*H*), 4.76-4.82 (m, 1 H, OC*H*), 5.78 (dd, *J* = 5.5, 10.7 Hz, 1H, NC*H*), 6.84 (d, *J* = 8.1 Hz, 1H, Ar), 7.09-7.15 (m, 2H, Ar), 7.47 (d, *J* = 7.2 Hz, 1H, Ar), 7.65 (t, *J* = 7.5 Hz, 1H, Ar), 8.32 (s, 1 H, C*H*), 8.76 (d, *J* = 8.4 Hz, 1H, Ar), 9.48 (s, 1 H, N*H*); ^{13}C NMR ($CDCl_3$) δ 23.99, 24.85, 27.58, 32.68, 51.71, 55.95, 80.53, 111.75, 114.46, 115.10, 118.03, 119.88, 124.82, 129.77, 130.95, 135.94, 137.48, 147.77, 150.21, 152.99, 163.85, 167.36, 169.07, 167.71; Anal Calcd for $C_{26}H_{26}N_4O_6$ + 0.1 hexane: C, 64.01; H, 5.53; N, 11.22. Found: C, 64.01; H, 5.58; N, 10.97. (HNMR showed the product contained 10% of hexane).

Example 8

N-[2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamide

[0065] A mixture of 3-[4-(acetylamino)-1,3-dioxoisoindolin-2-yl]-3-(3-ethoxy-4-methoxyphenyl)propanoic acid (1.69

g, 3.96 mmol) and carbonyldiimidazole (0.71 g, 4.4 mmol) in acetonitrile (20 mL) was stirred at room temperature for 2 hours. To the solution was added formic hydrazide (289 mg, 4.81 mmol). The mixture was then stirred for 18 hours. To the resulting solution was added phosphorus oxychloride (1.0 mL, 10.7 mmol), and this mixture was heated at reflux for 2 hours. The solution was poured to water (10 mL). The aqueous layer was extracted with ethyl acetate (2 X 50 mL). The combined organic layers were washed with aqueous sodium hydrogen carbonate (50 mL, sat), brine (50 mL) and then dried over magnesium sulfate. Chromatography followed by removal of solvent yielded an oil. The oil was stirred in ether (10 mL) to give a suspension. This suspension was filtered to yield N-[2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamide as a white solid (478 mg, 27% yield): mp, 141.0-143.0 °C; ^{1}H NMR (CDCl$_3$) δ 1.47 (t, J = 6.9 Hz, 3H, CH_3), 2.26 (s, 3H, CH_3), 3.74 (dd, J = 5.8, 15.8 Hz, 1H, CHH), 3.85 (s, 3H, CH_3), 4.11 (q, J = 7.1 Hz, 2H, CH_2), 4.38 (dd, J = 10.6, 15.8 Hz, 1H, CHH), 5.78 (dd, J = 5.6, 10.6 Hz, 1 H, NCH), 6.83 (d, J = 8.9 Hz, 1 H, Ar), 7.11-7.14 (m, 2H, Ar), 7.45 (d, J = 7.2 Hz, 1H, Ar), 7.64 (d, J = 7.5 Hz, 1H, Ar), 8.31 (s, 1H, Ar), 8.75 (d, J = 8.4 Hz, 1H, Ar), 9.46 (br s, 1H, NH); ^{13}C NMR (CDCl$_3$) δ 14,70, 24.92, 27.60, 51.74, 55.92, 64.50, 111.40, 112.47, 115.15, 118.11, 120.15, 124.91, 129.87, 130.99, 136.01, 137.55, 148.49, 149.59, 153.07, 163.88, 167.44, 169.14, 169.75; Anal Calcd for $C_{23}H_{22}N_4O_6$: C, 61.33; H, 4.92; N, 12.44. Found: C, 61.37; H, 4.88; N, 12.11.

Example 9

5-(tert-Butyl)-2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione

[0066] 5-(t-Butyl)-2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione was prepared as described for Example 8 from 3-[5-(tert-butyl)-1,3- dioxoisoindolin-2-yl]-3-(3-ethoxy-4-methoxyphenyl)propanoic acid (2.0 g, 4.7 mmol) , carbonyldiimidazole (0.81 g, 5.0 mmol), formic hydrazide (0.35 g, 5.8 mmol), and phosphorus oxychloride (1.0 mL, 10.7 mmol) in acetonitrile (20 mL). The product was isolated as a white solid (800 mg, 38% yield): mp, 136.0-138.5 °C; ^{1}H NMR (CDCl$_3$) δ 1.35 (s, 9H, CH_3), 1.44 (t, J = 6.9 Hz, 3H, CH_3), 3.79 (dd, J = 5.9, 16.1 Hz, 1 H, CHH), 3.84 (s, 3H, CH_3), 4.11 (q, J = 7.1 Hz, 2H, CH_2), 4.38 (dd, J = 10.3, 15.8 Hz, 1H, CHH), 5.80 (dd, J = 5.9, 10.4 Hz, 1H, NCH), 6.82 (d, J = 8.2 Hz, 1 H, Ar), 7.11-7.17 (m, 2H, Ar), 7.70 (br s, 2H, Ar), 7.82 (br s, 1H, Ar), 8.29 (s, 1H, Ar); ^{13}C NMR (CDCl$_3$) δ 14.71, 27.73, 31.08, 35.72, 51.78, 55.92, 64.44, 111.36, 112.58, 120.31, 120.63, 123.26, 128.94, 130.33, 131.14, 131.84, 148.41, 149.42, 153.02, 158.82, 164.07, 168.25, 168.39; Anal Calcd for $C_{25}H_{27}N_3O_5$ + 0.11 H_2O: C, 66.51; H, 6.08; N, 9.31; H_2O, 0.43. Found: C, 66.42; H, 5.83; N, 9,18; H_2O, 0.43.

Example 10

2-[1-(3,4-Dimethoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione

[0067] 2-[1-(3,4-Dimethoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione was prepared by the procedure of Example 8 from 3-(3,4-dimethoxyphenyl)-3-(1,3-dioxoisoindolin-2-yl)propanoic acid (2.0 g, 3.6 mmol) , carbonyldiimidazole (1.0 g, 6.2 mmol), formic hydrazide (0.41 g, 6.8 mmol), and phosphorus oxychloride (1.3 mL, 14 mmol) in acetonitrile (20 mL). The product was obtained as a white solid (730 mg, 34% yield): mp, 83.0-85.0 °C; ^{1}H NMR (CDCl$_3$) δ 3.82 (dd, J = 6.0, 16.0 Hz, 1H, CHH), 3.85 (s, 3H, CH_3), 3.90 (s, 3H, CH_3), 4.39 (dd, J = 10.3, 15.7 Hz, 1H, CHH), 5.84 (dd, J = 6.0, 10.3 Hz, 1H, NCH), 6.81-6.85 (m, 1H, Ar), 7.16-7.19 (m, 2H, Ar), 7.68-7.73 (m, 2H, Ar), 7.77-7.83 (m, 2H, Ar), 8.30 (s, 1H, CH); ^{13}C NMR (CDCl$_3$) δ 27.66, 51.76, 55.79, 55.89, 111.00, 111.07, 120.29, 123.3,8, 130.16, 131.55, 134.07, 149.03, 149.11, 152.96, 163.90, 167.86; Anal Calcd for $C_{20}H_{17}N_3O_6$ + 0.3 Et_2O: C, 63.22; H, 5.20; N, 10.32. Found: C, 63.40; H, 5.02; N, 10.46. (^{1}H NMR showed that the sample contained 30% of ether).

Example 11

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindolin-1-one

[0068] 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindolin-1-one was prepared as described in Example 1. Reaction of 3-(3-ethoxy-4-methoxyphenyl)-3-(1-oxoisoindolin-2-yl)propanoic acid (1.50 g, 4.22 mmol), carbonyldiimidazole (0.80 g, 4.9 mmol) and formic hydrazide (310 mg, 5.16 mmol) in tetrahydrofuran (10 mL) yielded crude N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)-3-(1-oxoisoindolin-2-yl)-propanamide (1.0 g, 2.2 mmol), which was then reacted with phosphorus pentoxide (2.32 g, 16.3 mmol) in chloroform (30 mL) at room temperature for 18 hours. The product was obtained as a white solid (250 mg, 16% overall yield): mp, 143.5-144.5 °C; ^{1}H NMR (CDCl$_3$); δ 1,43 (t, J = 7.0 Hz, 3H, CH_3), 3.65 (dd, J = 6.1, 15.1 Hz, 1H, CHH), 3.85 (s, 3H, CH_3), 3.87 (dd, J = 9.9,15.0 Hz, 1H, CHH), 4.01-4.12 (m, 3H, NCHH, CH_2), 4.46 (d, J = 16.6 Hz, 1H, NCHH), 5.99 (dd, J = 6.1, 10.1 Hz, 1H, NCH), 6.83-6.87 (m, 1H, Ar), 6.94-7.01 (m, 2H, Ar), 7.34-7.52 (m, 3H, Ar), 7.78 (d, J = 7.1 Hz, 1H, Ar), 8.34 (s, 1H, NCH); ^{13}C NMR (CDCl$_3$) δ 14.60, 27.84, 46.19, 52.13, 55.86, 64.45, 111.32, 112.45, 118.98, 122.78, 123.72, 127.95, 129.95, 131.49, 131.98, 141.09, 148.66, 149.35, 153.31, 163.86, 168.25; Anal Calcd for $C_{21}H_{21}N_3O_4$ + 0.06 CH_2Cl_2: C, 65.79; H, 5.54; N, 10.93. Found: C, 65.87; H, 5.67; N, 10.89.

Example 12

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(5-methyl(1,3,4-oxadiazol-2-yl))ethyl]isoindolin-1-one

[0069] 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(5-methyl(1,3,4-oxadiazol-2-yl))ethyl]isoindolin-1-one was prepared by the procedure of Example 1. Reaction 3-(3-ethoxy-4-methoxyphenyl)-3-(1-oxoisoindolin-2-yl)propanoic acid (1.50 g, 4.22 mmol), carbonyldiimidazole (0.76 g, 4.7 mmol) and acetic hydrazide (381 mg, 5.16 mmol) in tetrahydrofuran (15 mL) gave crude N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)-3-(1-oxoisoindolin-2-yl)propanamide (1.22 g, 3.06 mmol), which (650 mg, 1.47 mmol) was then reacted with phosphorus pentoxide (2.0 g, 14 mmol) in chloroform (30 mL) at room temperature for 18 hours The product was obtained as a white solid (250 mg, 32% overall yield): mp, 125.5-128.0 °C; ^{1}H NMR ($CDCl_3$); δ 1.43 (t, *J* = 7.0 Hz, 3H, C*H*$_3$), 2.46 (s, 3H, C*H*$_3$), 3.56 (dd, *J* = 6.3, 15.1 Hz, 1H, CH*H*), 3.76 (dd, *J* = 10.0, 15.0 Hz, 1H, CH*H*), 3.86 (s, 3H, C*H*$_3$), 4.02-4.11 (m, 3H, NCH*H*, C*H*$_2$), 4.46 (d, *J* = 16.6 Hz, 1H, NCH*H*), 5.97 (dd, *J* = 6.3, 9.9 Hz, 1 H, NC*H*), 6.83-6.87 (m, 1H, Ar), 6.95-7.01 (m, 2H, Ar), 7.35-7.53 (m, 3H, Ar), 7.77-7.81 (m, 1H, Ar); ^{13}C NMR ($CDCl_3$) δ 10.89, 14.64, 28.04, 46.18, 52.08, 55.89, 64.47, 111.32, 112.51, 119.03, 122.81, 123.74, 127.95, 130.13, 131.48, 132.11, 141.17, 148.64, 149.31, 163.86, 164.23, 168.30; Anal Calcd for $C_{22}H_{23}N_3O_4$ + 0.28 EtOAc: C, 66.42; H, 6.08; N, 10.05. Found: C, 66.47; H, 5.98; N, 10.04. (^{1}H NMR showed that the sample contained 28% of ethyl acetate).

Example 13

2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-3-pyrrolino[3,4]quinoline-1,3-dione

[0070] 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-3-pyrrolino[3,4-h]-quinoline-1,3-dione was prepared by the procedure of Example 1. Reaction of 3-(1,3-dioxo(3-pyrrolino[3,4-h]quinolin-2-yl))-3-(3-ethoxy-4-methoxyphenyl)propanoic acid (1.0 g, 2.4 mmol), CDI (0.46 g, 2.8 mmol) and formic hydrazide (0.20 g, 3.4 mmol) in THF (10 mL) gave crude 3-(1,3-dioxo(3-pyrrolino[3,4-h]quinolin-2-yl))-N-carbonylamino-3-(3-ethoxy-4-methoxyphenyl)propanamide (1.12 g), which was then reacted with phosphorus oxychloride (0.8 mL, 8.6 mmol) in acetonitrile (30 mL). The product was obtained as a white solid (350 mg, 33% overall yield): mp, 166-168 °C; ^{1}H NMR ($CDCl_3$) δ 1.47 (t, *J* = 6.8 Hz, 3H, C*H*$_3$), 3.85 (dd, *J* = 5.9, 15.8 Hz, 1H, CH*H*), 3.85 (s, 3H, C*H*$_3$), 4.13 (q, *J* = 6.9 Hz, 2H, C*H*$_2$), 4.48 (dd, *J* = 10.4, 15.8 Hz, 1H, CH*H*), 5.91 (dd, *J* = 5.8, 10.4 Hz, 1 H, NC*H*), 6.82-6.85 (m, 1H, Ar), 7.21-7.25 (m, 2H, Ar), 7.58 (dd, *J* = 4.2, 8.4 Hz, 1H, Ar), 7.94 (d, *J* = 8.0 Hz, 1H, Ar), 8.19 (d, *J* = 8.2 Hz, 1H, Ar), 8.27 (dd, *J* = 1.7, 8.4 Hz, 1H, Ar), 8.28 (s, 1 H, C*H*), 9.24 (dd, *J* = 1.7, 4.2 Hz, 1 H); ^{13}C NMR ($CDCl_3$) δ 14.63, 27.60, 51.83, 55.85, 64.39, 111.29, 112.58, 119.52, 120.43, 123.16, 126.81, 130.08, 132.14, 134.44, 135.57, 136.68, 142.77, 148.34, 149.36, 152.97, 154.27, 163.99, 167.07, 167.80, Anal Calcd for $C_{24}H_{20}N_4O_5$ + 0.05 CH_2Cl_2: C, 64.38; H, 4.52; N, 12.49. Found: C, 64.33; H, 4.58; N, 12.12. (H NMR showed the sample contained ~5% of CH_2Cl_2).

Example 14

[0071] Tablets, each containing 50 mg of 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione are prepared in the following manner:

Constituents (for 1000 tablets)	
2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione	50.0 g
lactose	50.7 g
wheat starch	7.5 g
polyethylene glycol 6000	5.0 g
talc	5.0 g
magnesium stearate	1.8 g
demineralized water	q.s.

The solid ingredients are first forced through a sieve of 0.6 mm mesh width. The active ingredient, lactose, talc, magnesium stearate and half of the starch then are mixed. The other half of the starch is suspended in 40 mL of water and this suspension is added to a boiling solution of the polyethylene glycol in 100 mL of water. The resulting paste is added to the pulverulent substances and the mixture is granulated, if necessary with the addition of water. The granulate is dried overnight at 35°C, forced through a sieve of 1.2 mm mesh width and compressed to form tablets of approximately 6 mm diameter which are concave on both sides.

Example 15

[0072] Tablets, each containing 100 mg of 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, can be prepared in the following manner:

éConstituents (for 1000 tablets)	
2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione	100.0 g
lactose	100.0 g
wheat starch	47.0 g
magnesium stearate	3.0 g

All the solid ingredients are first forced through a sieve of 0.6 mm mesh width. The active ingredient, lactose, magnesium stearate and half of the starch then are mixed. The other half of the starch is suspended in 40 mL of water and this suspension is added to 100 mL of boiling water. The resulting paste is added to the pulverulent substances and the mixture is granulated, if necessary with the addition of water. The granulate is dried overnight at 35°C, forced through a sieve of 1.2 mm mesh width and compressed to form tablets of approximately 6 mm diameter which are concave on both sides.

Example 16

[0073] Tablets for chewing, each containing 75 mg of 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, can be prepared in the following manner:

Composition (for 1000 tablets)	
2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione	75.0 g
mannitol	230.0 g
lactose	150.0 g
talc	21.0 g
glycine	12.5 g
stearic acid	10.0 g
saccharin	1.5 g
5% gelatin solution	q.s.

[0074] All the solid ingredients are first forced through a sieve of 0.25 mm mesh width. The mannitol and the lactose are mixed, granulated with the addition of gelatin solution, forced through a sieve of 2 mm mesh width, dried at 50°C and again forced through a sieve of 1.7 mm mesh width. 2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, the glycine and the saccharin are carefully mixed, the mannitol, the lactose granulate, the stearic acid and the talc are added and the whole is mixed thoroughly and compressed to form tablets of approximately 10 mm diameter which are concave on both sides and have a breaking groove on the upper side.

Example 17

[0075] Tablets, each containing 10 mg 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, can be prepared in the following manner:

Composition (for 1000 tablets)	
2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione	10.0 g
lactose	328.5 g
corn starch	17.5 g
polyethylene glycol 6000	5.0 g

(continued)

Composition (for 1000 tablets)	
talc	25.0 g
magnesium stearate	4.0 g
demineralized water	q.s.

The solid ingredients are first forced through a sieve of 0.6 mm mesh width. Then the active imide ingredient, lactose, talc, magnesium stearate and half of the starch are intimately mixed. The other half of the starch is suspended in 65 mL of water and this suspension is added to a boiling solution of the polyethylene glycol in 260 mL of water. The resulting paste is added to the pulverulent substances, and the whole is mixed and granulated, if necessary with the addition of water. The granulate is dried overnight at 35°C, forced through a sieve of 1.2 mm mesh width and compressed to form tablets of approximately 10 mm diameter which are concave on both sides and have a breaking notch on the upper side.

Example 18

[0076] Gelatin dry-filled capsules, each containing 100 mg of 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, can be prepared in the following manner:

Composition (for 1000 capsules)	
2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione	100.0 g
microcrystalline cellulose	30.0 g
sodium lauryl sulfate	2.0 g
magnesium stearate	8.0 g

The sodium lauryl sulfate is sieved into the 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazo(-2-yl)ethyl]-5-methylisoindoline-1,3-dione through a sieve of 0.2 mm mesh width and the two components are intimately mixed for 10 minutes. The microcrystalline cellulose is then added through a sieve of 0.9 mm mesh width and the whole is again intimately mixed for 10 minutes. Finally, the magnesium stearate is added through a sieve of 0.8 mm width and, after mixing for a further 3 minutes, the mixture is introduced in portions of 140 mg each into size 0 (elongated) gelatin dry-fill capsules.

Example 19

[0077] Gelatin dry-filled capsules, each containing 100 mg of 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, can be prepared in the following manner:

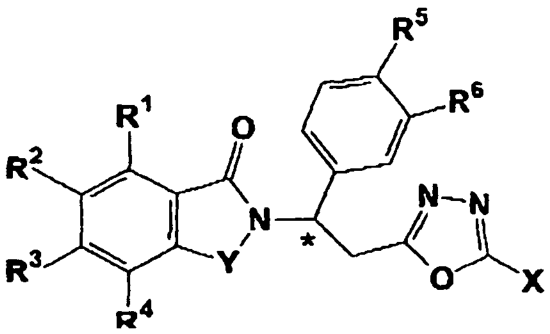
Composition (for 1000 capsules)	
2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione	5.0 g
microcrystalline cellulose	30.0 g
sodium lauryl sulfate	2.0 g
magnesium stearate	8.0 g

The sodium lauryl sulfate is sieved into the 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione through a sieve of 0.2 mm mesh width and the two components are intimately mixed for 10 minutes. The microcrystalline cellulose is then added through a sieve of 0.9 mm mesh width and the whole is again intimately mixed for 10 minutes. Finally, the magnesium stearate is added through a sieve of 0.8 mm width and, after mixing for a further 3 minutes, the mixture is introduced in portions of 140 mg each into size 0 (elongated) gelatin dry-fill capsules.

Claims

1. A **substantially chirally pure (R)- or a substantially chirally pure (S)-, or mixture of (R)- and (S)-**1,3,4-oxadi-

azole compound of formula



selected from the group consisting of

(a) a compound:
in which:

the carbon atom designated * constitutes a center of chirality;
Y is C=O, CH_2, SO_2 or CH_2C=O;
X is hydrogen, or alkyl of 1 to 4 carbon atoms;
each of R^1, R^2, R^3, and R^4, independently of the others, is hydrogen, halo, trifluoromethyl, acetyl, alkyl of 1 to 8 carbon atoms, alkoxy of 1 to 4 carbon atoms, nitro, cyano, hydroxy, *tert*-butyl, $-CH_2NR^8R^9$, $-(CH_2)_2NR^8R^9$, or $-NR^8R^9$; or any two of R^1, R^2, R^3, and R^4 on adjacent carbon atoms together with the depicted phenylene ring are naphthylidene, quinoline, quinoxaline, benzimidazole, benzodioxole or 2-hydroxybenzimidazole;
each of R^5 and R^6, independently of the other, is hydrogen, alkyl of 1 to 4 carbon atoms, alkoxy of 1 to 6 carbon atoms, cyano, benzocycloalkoxy, cycloalkoxy of up to 18 carbon atoms, bicyloalkoxy of up to 18 carbon atoms, tricylcoalkoxy of up to 18 carbon atoms, or cycloalkylalkoxy of up to 18 carbon atoms;
each of R^8 and R^9 taken independently of the other is hydrogen, straight alkyl of 1 to 8 carbon atoms, branched alkyl of 1 to 8 carbon atoms, phenyl, benzyl, pyridyl, pyridylmethyl, or one of R^8 and R^9 is hydrogen and the other is $-COR^{10}$, or $-SO_2R^{10}$, or
R^8 and R^9 taken together are tetramethylene, pentamethylene, -CHNCHCH-, hexamethylene, or $-CH_2CH_2X^1CH_2CH_2-$ in which X^1 is -O-, -S-, or -NH-;
R^{10} is hydrogen, alkyl of 1 to 8 carbon atoms, cycloalkyl, cycloalkylmethyl of up to 6 carbon atoms, phenyl, pyridyl, benzyl, imidazolylmethyl, pyridylmethyl, $NR^{11}R^{12}$, $CH_2NR^{*}R^0$, or $NR^{11}R^{12}$ wherein R^* and R^0, independently of each other, are hydrogen, methyl, ethyl, or propyl, and

wherein R^{11} and R^{12}, independently of each other, are hydrogen, alkyl of 1 to 8 carbon atoms, phenyl, or benzyl; and
(b) the acid addition salts of said compounds which contain a nitrogen atom susceptible of protonation.

2. A 1,3,4-oxadiazole compound according to claim 1, wherein Y is C=O.

3. A 1,3,4-oxadiazole compound according to claim 1, wherein Y is CH_2.

4. A 1,3,4-oxadiazole compound or a salt thereof according to claim 1, wherein each of R^1, R^2, R^3, and R^4, independently of the others, is hydrogen, halo, methyl, ethyl, methoxy, ethoxy, nitro, cyano, hydroxy, or $-NR^8R^9$, in which

(i) each of R^8 and R^9 taken independently of the other is hydrogen, methyl or alkyl of 1 to 4 carbon atoms, or
(ii) one of R^8 and R^9 is hydrogen and the other is $-COCH_3$, or
(iii) one of R^8 and R^9 is hydrogen and the other is $-CONH_2$, or
(iv) one of R^8 and R^9 is hydrogen and the other is $-COCH_2NH_2$ or $-COCH_2N(CH_3)_2$.

5. A 1,3,4-oxadiazole compound according to claim 1, wherein one of R^1, R^2, R^3, and R^4 is $-NH_2$ and the remaining of R^1, R^2, R^3 and R^4 are hydrogen.

6. A 1,3,4-oxadiazole compound according to claim 1, wherein one of R^1, R^2, R^3, and R^4 is $-NHCOCH_3$, $NHSO_2R^{10}$, or $NHCOR^{10}$ and the remaining of R^1, R^2, R^3, and R^4 are hydrogen.

7. A 1,3,4-oxadiazole compound according to claim 1, wherein one of R^1, R^2, R^3, and R^4 is methyl or ethyl and the remaining of R^1, R^2, R^3, and R^4 are hydrogen.

8. A 1,3,4-oxadiazole compound according to claim 1, wherein one of R^1, R^2, R^3, and R^4 is $-N(CH_3)_2$ or hydroxy and the remaining of R^1, R^2, R^3, and R^4 are hydrogen.

9. A 1,3,4-oxadiazole compound according to claim 1, wherein Y is C=O, X is hydrogen, and R^3 and R^4, taken together, are benzo.

10. A 1,3,4-oxadiazole compound according to claim 1, wherein Y is C=O, X is hydrogen, and R^3 and R^4, taken together, are methylenedioxy.

11. A 1,3,4-oxadiazole compound according to claim 1, wherein each of R^5 and R^6, independently of the other, is methoxy, ethoxy, propoxy, isopropoxy, cyclopentoxy, cyclohexoxy, or bicycloalkoxy.

12. A 1,3,4-oxadiazole compound according to claim 1, wherein R^5 is alkoxy and R^6 is alkoxy, cycloalkoxy, or bicycloalkoxy.

13. A 1,3,4-oxadiazole compound according to claim 1, wherein R^5 is methoxy and R^6 is methoxy, ethoxy, or cyclopentoxy.

14. A 1,3,4-oxadiazole compound according to claim 1, wherein R^5 is methoxy and R^6 is bicycloalkoxy or benzoalkoxy.

15. A 1,3,4-oxadiazole compound according to claim 1, wherein said compound is selected from the group consisting of a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, wherein the isomer is 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]benzo[e]isoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindoline-1,3-dione, 2-[1-(3-cyclopentyloxy-4-methoxy-phenyl)-2-(1,3,4-oxadiazol-2-yl) ethyl]-5-methylisoindoline-1,3-dione, 2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindoline-1,3-dione, N-[2-[1-(3-cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamide, N-[2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamide, 5-(tert-butyl)-2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione, 2-[1-(3,4-dimethoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindoline-1,3-dione, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindolin-1-one, 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(5-methyl (1,3,4-oxadiazol-2-yl))ethyl]isoindolin-1-one, and 2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-3-pyrrolino[3,4-]quinoline-1,3-dione.

16. A 1,3,4-oxadiazole compound according to claim 1, wherein two of R^1, R^2, R^3, and R^4 are hydrogen and the other two of R^1, R^2, R^3, and R^4 are not hydrogen.

17. A 1,3,4-oxadiazole compound according to claim 15, wherein two of R^1, R^2, R^3, and R^4, independent of each other, are alkyl of 1 to 8 carbon atoms, or alkoxy of 1 to 8 carbon atoms.

18. Use of a 1,3,4-oxadiazole compound according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, in the preparation of a medicament for reducing or inhibiting undesirable levels of TNFα in a mammal.

19. A pharmaceutical composition comprising a quantity of a 1,3,4-oxadiazole compound according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, sufficient upon administration in a single or multiple dose regimen to reduce or inhibit levels of TNFα in a mammal in combination with a carrier.

20. Use of a 1,3,4-oxadiazole compound according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, in the preparation of a medicament for inhibiting

phosphodiesterase type 4 in a mammal.

21. Use of a compound according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, in the preparation of a medicament for the treatment in a mammal of a disease selected from the group consisting of inflammatory diseases and, autoimmune diseases, selected from the group consisting of arthritis, rheumatoid arthritis, inflammatory bowel disease, Crohn's disease, aphthous ulcers, cachexia, multiple sclerosis, graft versus host disease, asthma, adult respiratory distress syndrome, and acquired immune deficiency syndrome.

22. Use of a compound according to claim 1 or a combination of compounds according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, in the preparation of a medicament for the treatment of cancer in a mammal.

23. Use of a compound according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, in the preparation of a medicament for the treatment of undesirable angiogenesis in a mammal.

24. The compound according to claim 1, which is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof.

25. A pharmaceutical composition comprising a quantity of a 1,3,4-oxadiazole compound according to claim 1, which compound is a substantially chirally pure (R)-isomer, a substantially chirally pure (S)-isomer, or a mixture thereof, sufficient upon administration in a single or multiple dose regimen to reduce or inhibit undesirable levels of TNFα or matrix metalloproteinases in a mammal in combination with a carrier.

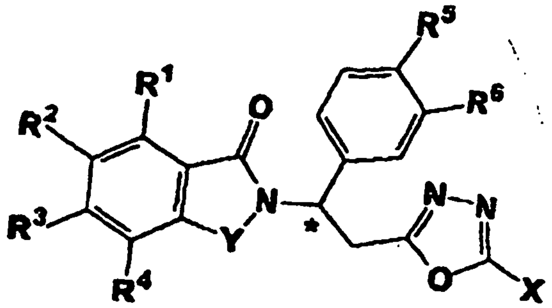
26. A 1,3,4-oxadiazole compound or a salt thereof according to claim 1, wherein:

Y is C = O or CH_2;
each of R^1, R^2, R^3, and R^4 independently of the other, is hydrogen, halo, trifluoromethyl, acetyl, alkyl of 1 to 8 carbon atoms, alkoxy of 1 to 4 carbon atoms, nitro, cyano, hydroxy, *tert*-butyl, or $-NR^8R^9$; and
any two R^1, R^2, R^3, and R^4 on adjacent carbon atoms, together with the depicted phenylene ring are quinoline, quioxaline,
2-R^{13}-benzimidazole, benzodioxole or 2-hydroxybenzimidazole,

wherein R^{13} is alkyl of 1 to 10 carbon atoms, $-NH_2$, or hydrogen.

Patentansprüche

1. Eine im Wesentlichen chiral reine (R)- oder eine im Wesentlichen chiral reine (S)- oder ein Gemisch einer (R)-und (S)-1,3,4-Oxadiazolverbindung der Formel



ausgewählt aus:

(a) einer Verbindung:

in welcher:

das mit * bezeichnete Kohlenstoffatom ein chirales Zentrum darstellt;
Y C=O, CH_2, SO_2 oder CH_2C=O ist;
X Wasserstoff oder Alkyl der Länge 1 bis 4 Kohlenstoffatome ist;
jeder der Reste R^1, R^2, R^3 und R^4 unabhängig voneinander Wasserstoff, Halogen, Trifluormethyl, Acetyl, Alkyl der Länge 1 bis 8 Kohlenstoffatome, Alkoxy der Länge 1 bis 4 Kohlenstoffatome, Nitro, Cyan, Hydroxy, *tert*-Butyl, $-CH_2NR^8R^9$, $-(CH_2)_2NR^8R^9$ oder $-NR^8R^9$ ist; oder wobei zwei beliebige Reste von R^1, R^2, R^3 und R^4 an benachbarten Kohlenstoffatomen zusammen mit dem dargestellten Phenylenring Naphthyliden, Chinolin, Chinoxalin, Benzimidazol, Benzodioxol oder 2-Hydroxybenzimidazol sind;
die Reste R^5 und R^6 unabhängig voneinander Wasserstoff, Alkyl der Länge 1 bis 4 Kohlenstoffatome, Alkoxy der Länge 1 bis 6 Kohlenstoffatome, Cyan, Benzocycloalkoxy, Cycloalkoxy der Länge bis zu 18 Kohlenstoffatome, Bicycloalkoxy der Länge bis zu 18 Kohlenstoffatome, Tricycloalkoxy der Länge bis zu 18 Kohlenstoffatome oder Cycloalkylalkoxy der Länge bis zu 18 Kohlenstoffatome ist;
die Reste R^8 und R^9 unabhängig voneinander Wasserstoff, gerades Alkyl der Länge 1 bis 8 Kohlenstoffatome, verzweigtes Alkyl der Länge 1 bis 8 Kohlenstoffatome, Phenyl, Benzyl, Pyridyl, Pyridylmethyl sind oder einer der Reste R^8 und R^9 Wasserstoff ist und der andere COR^{10} oder $-SO_2R^{10}$ ist, oder
die Reste R^8 und R^9 zusammen genommen Tetramethylen, Pentamethylen, -CHNCHCH-, Hexamethylen oder $-CH_2CH_2X^1CH_2CH_2$sind, in welchem X^1 -O-, -S- oder -NH- ist; R^{10} Wasserstoff, Alkyl der Länge 1 bis 8 Kohlenstoffatome, Cycloalkyl, Cycloalkylmethyl der Länge bis zu 6 Kohlenstoffatome, Phenyl, Pyridyl, Benzyl, Imidazolylmethyl, Pyridylmethyl, $NR^{11}R^{12}$, $CH_2NR^{\bullet}$ R^0 oder $NR^{11}R^{12}$, in dem die Reste $R^{\bullet}$ und R^0 unabhängig voneinander Wasserstoff, Methyl, Ethyl oder Propyl sind, und

wobei die Reste R^{11} und R^{12} unabhängig voneinander Wasserstoff, Alkyl der Länge 1 bis 8 Kohlenstoffatome, Phenyl oder Benzyl sind; und
(b) den Säureadditionssalzen der Verbindungen, die ein Stickstoffatom besitzen, das für eine Protonierung empfänglich ist.

2. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei Y C=O ist.

3. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei Y CH_2 ist.

4. 1,3,4-Oxadiazolverbindung oder ein Salz davon gemäß Anspruch 1, wobei jeder der Reste R^1, R^2, R^3 und R^4 unabhängig voneinander Wasserstoff, Halogen, Methyl, Ethyl, Methoxy, Ethoxy, Nitro, Cyan, Hydroxy oder $-NR^8R^9$ sind, in dem

   (i) jeder der Reste R^8 und R^9 unabhängig voneinander Wasserstoff, Methyl oder Alkyl der Länge 1 bis 4 Kohlenstoffatome ist, oder
   (ii) einer der Reste R^8 und R^9 Wasserstoff ist und der andere $-COCH_3$ ist, oder
   (iii) einer der Reste R^8 und R^9 Wasserstoff ist und der andere $-CONH_2$ ist, oder
   (iv) einer der Reste R^8 und R^9 Wasserstoff ist und der andere $-COCH_2NH_2$ oder $-COCH_2N(CH_3)_2$ ist.

5. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei einer der Reste R^1, R^2, R^3 und R^4 $-NH_2$ ist und die verbleibenden Reste von R^1, R^2, R^3 und R^4 Wasserstoff sind.

6. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei einer der Reste R^1, R^2, R^3 und R^4 $-NHCOCH_3$, $NHSO_2R^{10}$ oder $NHCOR^{10}$ ist und die verbleibenden Reste von R^1, R^2, R^3 und R^4 Wasserstoff sind.

7. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei einer der Reste R^1, R^2, R^3 und R^4 Methyl oder Ethyl ist und die verbleibenden Reste von R^1, R^2, R^3 und R^4 Wasserstoff sind.

8. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei einer der Reste R^1, R^2, R^3 und R^4 $-N(CH_3)_2$ oder Hydroxy ist und die verbleibenden Reste von R^1, R^2, R^3 und R^4 Wasserstoff sind.

9. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei Y C=O, X Wasserstoff ist und die Reste R^3 und R^4 zusammen genommen Benzo sind.

10. 1,3,4-Oxadiazol gemäß Anspruch 1, wobei Y C=O, X Wasserstoff ist und die Reste R^3 und R^4 zusammen genom-

men Methylendioxy sind.

11. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei jeder der Reste R^5 und R^6 unabhängig voneinander Methoxy, Ethoxy, Propoxy, Isopropoxy, Cyclopentoxy, Cyclohexoxy oder Bicycloalkoxy ist.

12. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei R^5 Alkoxy und R^6 Alkoxy, Cycloalkoxy oder Bicycloalkoxy ist.

13. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei R^5 Methoxy und R^6 Methoxy, Ethoxy oder Cyclopentoxy ist.

14. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei R^5 Methoxy und R^6 Bicycloalkoxy oder Benzoalkoxy ist.

15. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei die Verbindung ausgewählt wird aus einem im Wesentlichen chiral reinen (R)-Isomer, einem im Wesentlichen chiral reinen (S)-Isomer oder aus einem Gemisch davon, wobei das Isomer 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)-ethyl]isoindolin-1,3-dion, 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]benzo[e]isoindolin-1,3-dion, 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindolin-1,3-dion, 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindolin-1,3-dion, 2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-5-methylisoindolin-1,3-dion, 2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-4-methylisoindolin-1,3-dion, N-[2-[1-(3-Cyclopentyloxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamid, N-[2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-1,3-dioxoisoindolin-4-yl]acetamid, 5-(*tert*-Butyl)-2-[1-(3-ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-isoindolin-1,3-dion, 2-[1-(3,4-Dimethoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindolin-1,3-dion, 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]isoindolin-1-on, 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(5-methyl-(1,3,4-oxadiazol-2-yl))ethyl]isoindolin-1-on und 2-[1-(3-Ethoxy-4-methoxyphenyl)-2-(1,3,4-oxadiazol-2-yl)ethyl]-3-pyrrolin[3,4-]chinolin-1,3-dion ist.

16. 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, wobei zwei der Reste R^1, R^2, R^3 und R^4 Wasserstoff sind und die anderen beiden Reste von R^1, R^2, R^3 und R^4 nicht Wasserstoff sind.

17. 1,3,4-Oxadiazolverbindung gemäß Anspruch 16, wobei zwei der Reste R^1, R^2, R^3 und R^4 unabhängig voneinander Alkyl der Länge 1 bis 8 Kohlenstoffatome oder Alkoxy der Länge 1 bis 8 Kohlenstoffatome sind.

18. Verwendung einer 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, die ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, für die Zubereitung eines Medikaments zur Reduktion oder Inhibition unerwünschter Konzentrationen von TNFα in einem Säuger.

19. Pharmazeutische Zusammensetzung, umfassend eine Menge einer 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, die ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, wobei die Menge ausreicht, um nach einer Verabreichung einer einzelnen oder von mehrfachen Dosen in Kombination mit einem Träger die Konzentrationen von TNFα in einem Säuger zu reduzieren oder zu inhibieren.

20. Verwendung einer 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, die ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, für die Zubereitung eines Medikaments für die Inhibition der Phosphodiesterase Typ 4 in einem Säuger.

21. Verwendung einer Verbindung gemäß Anspruch 1, die ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, für die Zubereitung eines Medikaments für die Behandlung einer Erkrankung in einem Säuger, wobei die Erkrankung ausgewählt wird aus Entzündungs- und Autoimmunerkrankungen, insbesondere Arthritis, rheumatoide Arthritis, entzündliche Darmerkrankung, Morbus Crohn, aphtöse Geschwüre, Cachexie, multiple Sklerose, Transplantat-Wirt-Reaktion (*graft versus host disease*), Asthma, posttraumatische Lungeninsuffizienz (Schocklunge) und erworbenes Immunschwächesyndrom.

22. Verwendung einer Verbindung gemäß Anspruch 1 oder einer Kombination von Verbindungen gemäß Anspruch 1, wobei die Verbindung ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, für die Zubereitung eines Medikaments für die Behandlung von Krebs in einem Säuger.

23. Verwendung einer Verbindung gemäß Anspruch 1 oder einer Kombination von Verbindungen gemäß Anspruch 1, wobei die Verbindung ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, für die Zubereitung eines Medikaments für die Behandlung einer unerwünschten Angiogenese in einem Säuger.

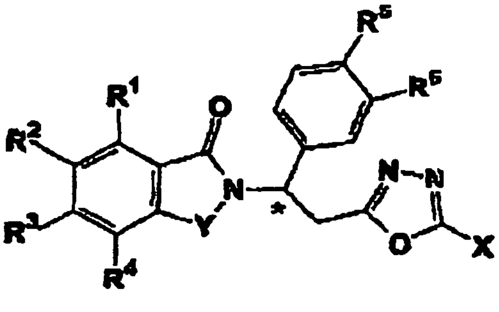
24. Verbindung gemäß Anspruch 1, die ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist.

25. Pharmazeutische Zusammensetzung, umfassend eine Menge einer 1,3,4-Oxadiazolverbindung gemäß Anspruch 1, die ein im Wesentlichen chiral reines (R)-Isomer, ein im Wesentlichen chiral reines (S)-Isomer oder ein Gemisch davon ist, wobei die Menge ausreicht, um nach einer Verabreichung einer einzelnen oder von mehrfachen Dosen in Kombination mit einem Träger unerwünschte Konzentrationen von TNFα oder Matrixmetalloproteinasen in einem Säuger zu reduzieren oder zu inhibieren.

26. 1,3,4-Oxadiazolverbindung oder ein Salz davon gemäß Anspruch 1, wobei
Y C=O oder CH_2 ist;
jeder Rest von R^1, R^2, R^3 und R^4 unabhängig voneinander Wasserstoff, Halogen, Trifluormethyl, Acetyl, Alkyl der Länge 1 bis 8 Kohlenstoffatome, Alkoxy der Länge 1 bis 4 Kohlenstoffatome, Nitro, Cyano, Hydroxy, *tert*-Butyl oder $-NR^8R^9$ ist; und
jeweils zwei beliebige Reste von R^1, R^2, R^3 und R^4 an benachbarten Kohlenstoffatomen zusammen mit dem dargestellten Phenylenring Chinolin, Chinoxalin, 2-R^{13}-Benzimidazol, Benzodioxol oder 2-Hydroxybenzimidazol sind,
wobei R^{13} Alkyl der Länge 1 bis 10 Kohlenstoffatome, $-NH_2$ oder Wasserstoff ist.

Revendications

1. Composé fondamentalement chiralement pur de (R)-1,3,4-oxadiazole ou composé fondamentalement chiralement pur de (S)-1,3,4-oxadiazole, ou mélange de (R)- et (S)-1,3,4-oxadiazole de formule



sélectionné dans le groupe consistant en

(a) un composé dans lequel :

l'atome de carbone désigné * constitue un centre de chiralité ;
Y est C=O, CH_2, SO_2 ou $CH_2C{=}O$;
X est un hydrogène, ou un alkyle ayant 1 à 4 atomes de carbone ;
chacun de R^1, R^2, R^3 et R^4, indépendamment des autres, est un hydrogène, un radical halo, un trifluorométhyle, un acétyle, un alkyle ayant 1 à 8 atomes de carbone, un alcoxy ayant 1 à 4 atomes de carbone, un radical nitro, cyano, hydroxy, tert-butyle, $-CH_2NR^8R^9$, $-(CH_2)_2NR^8R^9$, ou NR^8R^9 ; ou chaque couple de R^1, R^2, R^3, et R^4 sur des atomes de carbone adjacents conjointement avec le cycle phénylène représenté sont le naphtylidène, la quinoléine, la quinoxaline, le benzimidazole, le benzodioxole ou le 2-hydroxybenzimidazole ;
chacun de R^5 et R^6, indépendamment l'un de l'autre, est un hydrogène, un alkyle ayant 1 à 4 atomes de carbone, un alcoxy ayant 1 à 6 atomes de carbone, un radical cyano, un benzocycloalcoxy, un cycloalcoxy

ayant jusqu'à 18 atomes de carbone, un bicycloalcoxy ayant jusqu'à 18 atomes de carbone, un tricycloalcoxy ayant jusqu'à 18 atomes de carbone, ou un cycloalkylalcoxy ayant jusqu'à 18 atomes de carbone ;
chacun de R^8 et R^9, pris indépendamment l'un de l'autre, est un hydrogène, un alkyle linéaire ayant 1 à 8 atomes de carbone, un alkyle ramifié ayant 1 à 8 atomes de carbone, un phényle, un benzyle, un pyridyle, un pyridylméthyle, ou un des R^8 et R^9 est un hydrogène et l'autre est $-COR^{10}$, ou $-SO_2R^{10}$, ou
R^8 et R^9 pris ensemble sont le tétraméthylène, le pentaméthylène, -CHNCHCH-, l'hexaméthylène, ou $-CH_2CH_2X^1CH_2CH_2-$ dans laquelle X^1 est -O-, -S-, ou -NH ;
R^{10} est un hydrogène, un alkyle ayant 1 à 8 atomes de carbone, un cycloalkyle, un cycloalkylméthyle ayant jusqu'à 6 atomes de carbone, un phényle, un pyridyle, un benzyle, un imidazolylméthyle, un pyridylméthyle, $NR^{11}R^{12}$, $CH_2NR^{\cdot}R^0$, ou $NR^{11}R^{12}$, dans laquelle $R^{\cdot}$ et R^0, indépendamment l'un de l'autre, sont un hydrogène, un méthyle, un éthyle, ou un propyle, et
dans laquelle R^{11} et R^{12}, indépendamment l'un de l'autre, sont un hydrogène, un alkyle ayant 1 à 8 atomes de carbone, un phényle, ou un benzyle ; et

(b) les sels d'addition acides desdits composés qui contiennent un atome d'azote susceptible d'être protoné.

2. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel Y est C=O.

3. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel Y est CH_2.

4. Composé d'1,3,4-oxadiazole ou sel de celui-ci selon la revendication 1, dans lequel chacun de R^1, R^2, R^3 et R^4, indépendamment des autres, est un hydrogène, un radical halo, un méthyle, un éthyle, un méthoxy, un éthoxy, un radical nitro, cyano, hydroxy, ou $-NR^8R^9$, dans lequel

   (i) chacun de R^8 et R^9, pris indépendamment l'un de l'autre, est un hydrogène, un méthyle ou un alkyle ayant 1 à 4 atomes de carbone, ou
   (ii) un de R^8 et R^9 est un hydrogène et l'autre est $-COCH_3$, ou
   (iii) un de R^8 et R^9 est un hydrogène et l'autre est $-CONH_2$, ou
   (iv) un de R^8 et R^9 est un hydrogène et l'autre est $-COCH_2NH_2$, ou $-COCH_2N(CH_3)_2$.

5. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel un des R^1, R^2, R^3, et R^4 est $-NH_2$ et les R^1, R^2, R^3 et R^4 restants sont un hydrogène.

6. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel un des R^1, R^2, R^3, et R^4 est $-NHCOCH_3$, $-NHSO_2R^{10}$, ou $-NHCOR^{10}$ et les R^1, R^2, R^3 et R^4 restants sont un hydrogène.

7. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel un des R^1, R^2, R^3, et R^4 est un méthyle ou un éthyle et les R^1, R^2, R^3 et R^4 restants sont un hydrogène.

8. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel un des R^1, R^2, R^3, et R^4 est $-N(CH_3)_2$, ou un hydroxy et les R^1, R^2, R^3 et R^4 restants sont un hydrogène.

9. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel Y est C=O, X est un hydrogène et R^3 et R^4, pris ensemble, sont des radicaux benzoïques.

10. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel Y est C=O, X est un hydrogène et R^3 et R^4, pris ensemble, sont des radicaux méthylènedioxy.

11. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel chacun de R^5 et R^6, indépendamment de l'autre, est un méthoxy, un éthoxy, un propoxy, un isopropoxy, un cyclopentoxy, un cyclohexoxy, ou un bicycloalcoxy.

12. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel R^5 est un alcoxy et R^6 est un alcoxy, un cycloalcoxy, ou un bicycloalcoxy.

13. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel R^5 est un méthoxy et R^6 est un méthoxy, un éthoxy, ou un cyclopentoxy.

14. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel R^5 est un méthoxy et R^6 est un bicycloalcoxy

ou un benzoalcoxy.

15. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel ledit composé est sélectionné dans le groupe consistant en un isomère (R) essentiellement chiralement pur, en un isomère (S) essentiellement chiralement pur, ou un mélange de ceux-ci, dans lequel l'isomère est la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-isoindoline-1,3-dione, la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-benzo[e]-isoindoline-1,3-dione, la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-4-méthyl-isoindoline-1,3-dione, la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-5-méthylisoindoline-1,3-dione, la 2-[1-(3-cyclopentyloxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-5-méthylisoindoline-1,3-dione, la 2-[1-(3-cyclopentyloxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-4-méthylisoindoline-1,3-dione, le N-[2-[1-(3-cyclopentyloxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-1,3-dioxoisoindolin-4-yl]-acétamide, le N-[2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-1,3-dioxoisoindolin-4-yl]-acétamide, la 5-(tert.-butyl)-2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-isoindoline-1,3-dione, la 2-[1-(3,4-diméthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-isoindoline-1,3-dione, la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-isoindoline-1-one, la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(5-méthyl-(1,3,4-oxadiazol-2-yl))-éthyl]-isoindoline-1-one, et la 2-[1-(3-éthoxy-4-méthoxyphényl)-2-(1,3,4-oxadiazol-2-yl)-éthyl]-3-pyrrolino-[3,4]-quinoline-1,3-dione.

16. Composé d'1,3,4-oxadiazole selon la revendication 1, dans lequel deux des R^1, R^2, R^3, et R^4 sont un hydrogène et les deux autres des R^1, R^2, R^3 et R^4 ne sont pas un hydrogène.

17. Composé d'1,3,4-oxadiazole selon la revendication 15, dans lequel deux des R^1, R^2, R^3, et R^4, indépendamment les uns des autres, sont un alkyle ayant 1 à 8 atomes de carbone, ou un alcoxy ayant 1 à 8 atomes de carbone.

18. Utilisation d'un composé de 1,3,4-oxadiazole selon la revendication 1, lequel composé est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, dans la préparation d'un médicament pour réduire ou inhiber les niveaux indésirables de TNFα dans un mammifère.

19. Composition pharmaceutique comprenant une quantité de composé de 1,3,4-oxadiazole selon la revendication 1, lequel composé est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, suffisant par administration en régime de dose simple ou multiple pour réduire ou inhiber les niveaux de TNFα dans un mammifère en combinaison avec un porteur.

20. Utilisation d'un composé de 1,3,4-oxadiazole selon la revendication 1, lequel composé est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, dans la préparation d'un médicament pour réduire ou inhiber la phosphodiestérase de type 4 dans un mammifère.

21. Utilisation d'un composé selon la revendication 1, lequel composé est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, dans la préparation d'un médicament pour le traitement dans un mammifère d'une maladie sélectionnée dans le groupe consistant en des maladies inflammatoires et, des maladies auto-immunes, sélectionnées dans le groupe consistant en l'arthrite, l'arthrite rhumatoïde, la maladie intestinale inflammatoire, la maladie de Crohn, les ulcères aphteux, la cachexie, la sclérose en plaques, la maladie du greffon contre l'hôte, l'asthme, le syndrome de détresse respiratoire de l'adulte, et le syndrome d'immunodéficience acquise.

22. Utilisation d'un composé selon la revendication 1 ou d'une combinaison de composés selon la revendication 1, lequel composé est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, dans la préparation d'un médicament pour le traitement du cancer dans un mammifère.

23. Utilisation d'un composé selon la revendication 1, lequel composé est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, dans la préparation d'un médicament pour le traitement d'angiogénèse indésirable dans un mammifère.

24. Composé selon la revendication 1, qui est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci.

25. Composition pharmaceutique comprenant une quantité d'un composé de 1,3,4-oxadiazole selon la revendication

1, qui est un isomère (R) fondamentalement chiralement pur, un isomère (S) fondamentalement chiralement pur, ou un mélange de ceux-ci, suffisant par administration en régime de dose simple ou multiple pour réduire ou inhiber les niveaux indésirables de TNFα ou de métalloprotéases de matrice dans un mammifère en combinaison avec un porteur.

26. Composé de 1,3,4-oxadiazole ou sel de celui-ci selon la revendication 1, dans lequel :

Y est C=O ou CH_2 ;
chacun de R^1, R^2, R^3 et R^4, indépendamment des autres, est un hydrogène, un radical halo, un trifluorométhyle, un acétyle, un alkyle ayant 1 à 8 atomes de carbone, un alcoxy ayant 1 à 4 atomes de carbone, un radical nitro, cyano, hydroxy, tert-butyle, ou NR^8R^9 ; et chaque couple de R^1, R^2, R^3, et R^4 sur des atomes de carbone adjacents conjointement avec le cycle phénylène représenté sont la quinoléine, la quinoxaline, le 2-R^{13}-benzimidazole, le benzodioxole ou le 2-hydroxybenzimidazole, dans laquelle R^{13} est un alkyle ayant 1 à 10 atomes de carbone, $-NH_2$, ou un hydrogène.

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Title SUBSTITUTED 1,3,4-OXADIAZOLES AND A METHOD OF REDUCING TNF-ALPHA LEVELS

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