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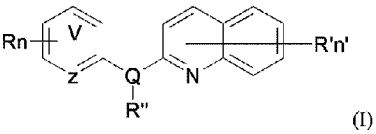
(54) Titre : DERIVES DE QUINOLEINE POUR LE TRAITEMENT DE MALADIES INFLAMMATOIRES
(54) Title: QUINOLINE DERIVATIVES FOR THE TREATMENT OF INFLAMMATORY DISEASES



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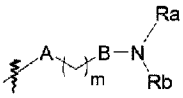

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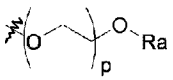

(IIIa)

(57) Abrégé/Abstract:
There is provided an in vitro or ex vivo use of at least one miRNA being miR-124, as a biomarker for screening a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease (see formula I) wherein (see above formula) means an aromatic ring wherein V is C or N and when V is N, V is in ortho, meta or para of Z, i.e. forms respectively a pyridine, a pyridazine, a pyrimidine or a pyrazine group, Q is N or O, provided that R'' does not exist when Q is O, R' independently represent a hydrogen atom or a group chosen among a (C_1-C_3)alkyl group, a halogen atom, a -NO_2 group, a -NR_1R_2 group, a morpholinyl group, a morpholino group, a N-methylpiperazinyl group, a (C_1-C_3)fluoroalkyl group, a -O-P(=O)-(OR_3)(OR_4) group and a -CN group, and can further be a group chosen among: (see formula IIa)(see formula IIIa) or anyone of its pharmaceutically acceptable salt.

(21) 3 166 018

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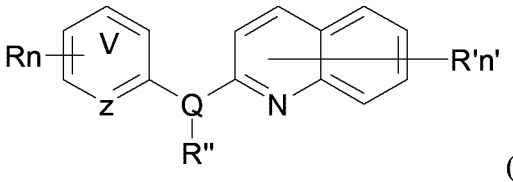
ABSTRACT

There is provided an *in vitro* or *ex vivo* use of at least one miRNA being miR-124, as a biomarker for screening a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease



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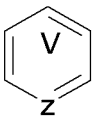
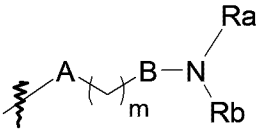
wherein  means an aromatic ring wherein V is C or N and when V is N, V is in ortho, meta or para of Z, i.e. forms respectively a pyridine, a pyridazine, a pyrimidine or a pyrazine group,

Q is N or O, provided that R'' does not exist when Q is O,

R' independently represent a hydrogen atom or a group chosen among a (C_1-C_3)alkyl group, a halogen atom, a $-NO_2$ group, a $-NR_1R_2$ group, a morpholinyl group, a morpholino group, a N-methylpiperazinyl group, a (C_1-C_3)fluoroalkyl group, a -O-P(=O)-(OR_3)(OR_4) group and a –CN group, and can further be a group chosen among:



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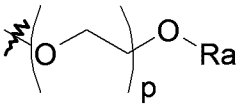


(IIIa)

or anyone of its pharmaceutically acceptable salt.

Date Reçue/Date Received 2022-06-29

QUINOLINE DERIVATIVES FOR THE TREATMENT OF INFLAMMATORY DISEASES

FIELD OF THE INVENTION

The invention relates to the identification of novel quinoline derivatives which are efficient for treating and/or preventing inflammatory diseases, as well as novel therapeutic uses of quinoline derivative towards inflammatory diseases.

The invention also relates to the field of biomarkers in connection with such inflammatory diseases.

BACKGROUND OF THE INVENTION

Inflammation is a protective response by the immune system to tissue damage and infection. However, the inflammatory response, in some circumstances, can damage the body. In the acute phase, inflammation is characterized by pain, heat, redness, swelling and loss of function. There are a wide range of inflammatory conditions which affect millions of people worldwide.

Indeed, inflammatory diseases include a wide range of conditions including, inflammatory disease associated with an autoimmune disease, a central nervous system (CNS) inflammatory disease, a joint inflammation disease, an inflammatory digestive tract disease, and inflammatory skin. Among them, Inflammatory Bowel Disease, Rheumatoid Arthritis and Multiple Sclerosis are of particular interest.

Inflammatory Bowel Disease (IBD) is a complex multifactorial disease (Perše and Cerar, 2012). It commonly refers to ulcerative colitis (UC) and Crohn's disease (CD), the two chronic conditions that involve inflammation of the intestine. IBD is common in developed countries, with up to 1 in 200 of individuals of Northern European region affected by these diseases. Patients with IBD present several clinically challenging problems for physicians. DSS-induced colitis is associated with the upregulation of different proinflammatory cytokines including TNFalpha and IFNgamma. Recently, miR-124 has been shown to be de-regulated specifically in pediatric patients with active UC, leading to increased levels of transducer and activator of transcription 3 (STAT3) expression and the transcriptional activation of its downstream targets among which

Date Reçue/Date Received 2022-06-29

proinflammatory cytokines (Koukos et al.; Gastroenterology; 145(4):842-52: 2013). However, in spite of recent advances, there remains a need for a safe, well-tolerated therapy with a rapid onset, and increased capacity for maintaining long-term remission.

Rheumatoid arthritis (RA) is the most frequent autoimmune disease with a prevalence of about 0.3 to 1 % of the population worldwide and often associated with reduced mobility, increased social dependency and work disability. RA is a systemic inflammatory disease affecting the joint lining tissue called synovium. The rheumatoid synovial tissue is characterized by hyper-proliferation of fibroblast-like synoviocytes (FLS) in the intimal lining layer and infiltration of the sublining by macrophages, T and B cells, and other inflammatory cells that promote inflammation and destruction of bone and cartilage. The intra-articular and systemic expression of pro-inflammatory cytokines, in particular tumor necrosis factor alpha (TNFα), interleukin-1 (IL-1) and -6 (IL-6), which are primarily produced by synovial macrophages, plays a crucial role in the pathogenesis of RA, e.g. by contributing to the hyper-proliferation of RA FLS. RA patients are in general treated with a group of small molecular drugs called disease modifying antirheumatic drugs (DMARDs). DMARDs suppress the body's overactive immune and/or inflammatory systems in some way, thereby slowing down disease progression. RA patients not responding to DMARDs are treated with biological agents such as Tumor Necrosis Factor (TNF) antagonists. However, even though TNF antagonists are effective in about two-thirds of the patients, the responding patients frequently become non-responsive within five years. Therefore, alternative treatments are required. Notably, there is a particular interest for novel therapeutic approaches designed for RA patients at early stages, before the disease becomes chronic.

Multiple sclerosis (MS) is an inflammatory disease autoimmune, demyelinating disease of the central nervous system that destroys myelin, oligodendrocytes, and axons. MS is characterized by multiple foci of inflammation and infiltration of macrophages and encephalitogenic T cells in the central nervous system. Microglia are found throughout the central nervous system and participate in the onset and progression of CNS inflammatory responses. Microglia, when activated, are highly damaging to CNS function through their production of neurotoxins, inflammatory cells (Inflammatory Protein-10, Macrophage Inflammatory Protein-1, Macrophage

Date Reçue/Date Received 2022-06-29

Inflammatory Protein-2, C-C Chemokine Ligand 19, Monocyte Chemoattractant Protein-1, Monocyte Chemoattractant Protein-2) and immune cells that produce antibodies. Microglia direct inflammatory responses that can result in the brain and spinal cord being infiltrated with immune cells against foreign invaders as well as T-cells that destroy myelin proteins. Peripheral macrophages appear in the CNS during inflammation and these cells have a highly activated phenotype, efficiently stimulate expansion of encephalitogenic T cells, and are thought to contribute to neuronal tissue destruction.

MicroRNAs (miRNA), the most comprehensive noncoding group, are a class of about 22 nt noncoding RNAs that inhibit gene expression through binding to the UnTranslated Region (UTR) of target mRNA transcripts (Lai *et al.*, Nature Genetics, vol. 30, no. 4, pp. 363–364, 2002; Bartel *et al.*, Cell, vol. 136, no. 2, pp. 215–233, 2009). miRNA genes represent about 1-2% of the known eukaryotic genomes. Predictions suggest that each miRNA can target more than 200 transcripts and that a single mRNA can be regulated by multiple miRNAs (LINDOW, DNA Cell Biol., vol. 26(5), p. 339-351, 2007). miRNAs are generated from endogenous hairpin-shaped transcripts and act by base pairing with target mRNAs, which leads to mRNA cleavage or translational repression, depending on the degree of base-pairing. Two processing events lead to mature miRNA formation: first, the nascent miRNA transcripts (pri-miRNA) are processed into 70 nucleotides precursors (pre-miRNA) which are exported from the nucleus and are cleaved in the cytoplasm to generate short (about 22 nucleotides long) mature miRNAs (LEE, EMBO J., vol. 21, p; 4663-4670, 2002). miRNAs can be located inter- or intragenically. When intergenic, their expression is coordinated with other miRNAs as a cluster (Altuvia *et al.*, Nucleic Acids Research, vol. 33, no. 8, pp. 2697–2706, 2005, Ozsolak *et al.*, Genes and Development, vol. 22, no. 22, pp. 3172–3183, 2008). When intragenic, namely, positioned within a protein-coding gene (almost exclusively in introns), they are often expressed from the same strand as their host-gene (Liu *et al.*, Cell Research, vol. 18, no. 10, pp. 985–996, 2008, Kim *et al.*, EMBO Journal, vol. 26, no. 3, pp. 775–783, 2007) and at correlated levels (Baskerville *et al.*, RNA, vol. 11, no. 3, pp. 241–247, 2005).

It has now been shown that overexpression of a miRNA, namely miR-124, deactivates inflammatory macrophages and converts them into microglia-like cells. miR-

Date Reçue/Date Received 2022-06-29

124 is believed to inhibit macrophage activation by targeting CEBPα, a transcription factor responsible for the differentiation of myeloid lineage cells. Intravenous injection of liposomes containing miR-124 markedly suppresses clinical EAE symptoms and inhibits the infiltration of encephalitogenic T cells and inflammatory macrophages into the CNS.

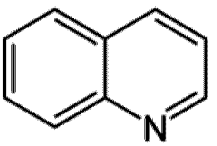
Indeed, **Ponomarev *et al.*** ("microRNA-124 promotes microglia quiescence and suppresses EAE by deactivating macrophages via the C/EBP-α-PU.1 pathway"; Nature Medicine (2011); 17:1: 64-71) suggests that miR-124 could play a role as a key regulator of microglia quiescence and as a modulator of monocyte and macrophage activation. Based on an Experimental Autoimmune Encephalomyelitis (EAE) model, this study suggests that the miR-124 expression pattern is modulated (either up-regulated or down-regulated depending on the cell type) in mice with EAE.

WO2010/151755 also teaches the administration of miR-124 for treating a central nervous system (CNS) inflammatory disease.

Sun *et al.* ("microRNA-124 mediates the cholinergic anti-inflammatory action through inhibiting the production of pro-inflammatory cytokines"; Cell Research (2013); 23:1270-1283) also teaches that miR-124 could mediate a cholinergic anti-inflammatory action through targeting of STAT3 and TACE.

On the other hand, novel compounds, also referred herein as "*quinoline derivatives*" have been identified, but for distinct indications.

For reference, a Quinoline is a heterocyclic aromatic organic compound of formula:



Thus, "*quinoline derivatives*" include substituted Quinolines, such as mono-, or polysubstituted Quinolines.

WO2010/143170 teaches the use of compounds for treating conditions associated with premature aging.

WO2010/143169 and **WO2012/080953** teach the use of compounds for treating AIDS.

Date Reçue/Date Received 2022-06-29

WO2010/143168 teaches the use of compounds for treating a selection of cancers. Those compounds have been shown to be able to correct defects of alternative splicing.

SUMMARY OF THE INVENTION

It has now been found that compounds as defined in formula (I) hereinafter are useful in the treatment and/or prevention of inflammatory diseases.

The present invention therefore relates to compounds of formula (I), as defined below, for use in the treatment and/or prevention of an inflammatory disease.

In particular, the invention relates to compounds of formula (I), as defined below, for use in the treatment and/or prevention of inflammation, and/or inflammation which may occur along with such inflammatory diseases.

The invention also relates to an *in vitro* or *ex vivo* use of at least one miRNA, said at least one miRNA being miR-124, as a biomarker for screening, a quinoline derivative, and in particular a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease.

The invention further relates to a compound of formula (Id) or (Ie) as defined hereinafter as such.

The invention further relates to a pharmaceutical composition comprising at least one compound of formula (Id) or (Ie).

It also relates to a compound as such, selected in a list consisting of:

- (8) 8-chloro-5-(3-(piperidin-1-yl)propoxy)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (9) 8-chloro-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethyl)pyridin-2-yl)quinoline-2,4-diamine
- (10) 8-chloro-N-methyl-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (11) 8-chloro-N^4-(2-morpholinoethyl)-N^2-(4-(trifluoromethyl)pyridin-2-yl)quinoline-2,4-diamine
- (13) 4,8-dichloro-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (14) 8-chloro-N-(3-morpholinopropyl)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

Date Reçue/Date Received 2022-06-29

- (15) 8-chloro-6-(2-morpholinoethoxy)-N-(3-morpholinopropyl)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (16) 8-chloro-5-(2-morpholinoethoxy)-N-(3-morpholinopropyl)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (17) 8-chloro-6-(2-(4-methylpiperazin-1-yl)ethoxy)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (18) 8-chloro-6-(2-(piperidin-1-yl)ethoxy)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (19) 8-chloro-6-(3-(piperidin-1-yl)propoxy)-N-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (20) 8-chloro-N-(3-fluoro-4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (21) N-(5-bromo-4-(trifluoromethyl)pyridin-2-yl)-8-chloroquinolin-2-amine
- (22) N^2-(8-chloroquinolin-2-yl)-N^5-(3-(4-methylpiperazin-1-yl)propyl)-4-(trifluoromethyl)pyridine-2,5-diamine
- (28) 8-chloro-N-methyl-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (29) 8-chloro-5-(3-(piperidin-1-yl)propoxy)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (30) 8-chloro-N-(3-(piperidin-1-yl)propyl)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (31) 8-chloro-N-(2-morpholinoethyl)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (32) 8-chloro-N-(2-(pyrrolidin-1-yl)ethyl)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (33) 8-chloro-N-(4-morpholinobutyl)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (34) 8-chloro-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethoxy)phenyl)quinoline-2,4-diamine
- (35) 4,8-dichloro-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (36) 8-chloro-5-(2-morpholinoethoxy)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (37) N^1-(4,8-dichloroquinolin-2-yl)-4-(trifluoromethoxy)benzene-1,2-diamine

Date Reçue/Date Received 2022-06-29

- (38) 4,8-dichloro-N-(2-morpholinoethyl)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (39) 8-chloro-6-(2-morpholinoethoxy)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (40) 8-chloro-N^2-(2-morpholinoethyl)-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethoxy)phenyl)quinoline-2,4-diamine

- (41) 8-chloro-N-(2-morpholinoethyl)-N-(2-nitro-4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (42) N^1-(8-chloroquinolin-2-yl)-N^1-(2-morpholinoethyl)-4-(trifluoromethoxy)benzene-1,2-diamine

- (43) 8-chloro-5-(2-morpholinoethoxy)-N-(2-morpholinoethyl)-N-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (44) N^1-(8-chloro-5-(2-morpholinoethoxy)quinolin-2-yl)-4-(trifluoromethoxy)benzene-1,2-diamine

- (46) 8-chloro-2-((4-(trifluoromethyl)pyridin-2-yl)oxy)quinoline

- (47) 4-(2-((8-chloro-2-((4-(trifluoromethyl)pyridin-2-yl)oxy)quinolin-6-yl)oxy)ethyl)morpholine

- (48) 8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinoline

- (49) 4-(2-((8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinolin-6-yl)oxy)ethyl)morpholine

- (50) 4-(2-((8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinolin-5-yl)oxy)ethyl)morpholine

- (51) phosphoric acid mono-[8-chloro-2-(4-trifluoromethyl-pyridin-2-ylamino)-quinolin-6-yl] ester

- (52) phosphoric acid mono-[2-(8-chloro-quinolin-2-ylamino)-5-trifluoromethoxy-phenyl] ester

- (53) phosphoric acid mono-[8-chloro-2-(4-trifluoromethoxy-phenylamino)-quinolin-6-yl] ester

- and their pharmaceutically acceptable salts, and more particularly selected from compounds (8), (9); (10); (11); (30); (46); (47) ; (48) ; (49) and (50) as defined above or one of its pharmaceutical salts.

Date Reçue/Date Received 2022-06-29

It also relates to a pharmaceutical composition comprising at least one compound of formula (Id) or (Ie), or one of compounds (8), (9), (10), (11), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22), (28), (29), (30), (31), (32), (33), (34), (35), (36), (37), (38), (39), (40), (41), (42), (43), (44), (46), (47), (48), (49), (50), (51), (52) and (53), and more particularly one of compounds (8), (9), (10), (11), (30), (46), (47), (48), (49) and (50) as defined above.

The invention further relates to an *in vitro* or *ex vivo* method for increasing the expression of miR-124 in an eukaryotic cell, comprising at least a step of:

a) providing an eukaryotic cell,

b) bringing into contact said cell with a quinoline derivative, and in particular a compound of formula (I).

The invention further relates to an *in vitro* or *ex vivo* method for screening a derivative compound, and in particular a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease, comprising at least a step of:

a) providing an eukaryotic cell,

b) bringing into contact said cell with a compound of formula (I),

c) measuring an expression of miR-124 in said cell, and

d) selecting the candidate presumed effective in treating and/or preventing an inflammatory disease when the level of expression of miR-124 measured in step c) is increased relatively to a reference value.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1: Dextran sulphate sodium (DSS-) induced colitis model 1 – Variation of the percentage of weight loss over time (days), on a DSS- mouse model, in the presence of quinoline derivative compound (24) as defined hereinafter. The percentage of weight loss (%) is indicated in the y- axis. DSS treatment occurs on days 3 to 10 (x- axis). Gavage with a quinoline derivative in methylcellulose (MC), or MC only, occurs between days 3 to 29.

Figure 2: Dextran sulphate sodium (DSS-) induced colitis model 2 – Variation of the percentage of weight loss over time (days), on a DSS- mouse model, after a second cyle of DSS in the presence of quinoline derivative compound (24) as

Date Reçue/Date Received 2022-06-29

defined hereineafter. The percentage of weight loss (%) is indicated in the y- axis. DSS treatment started on day 12 for a period of 5 days (x- axis). Gavage with a quinoline derivative in methylcellulose (MC), or MC only, occurs between days 3 to 29.

Figure 3: Dextran sulphate sodium (DSS-) induced colitis model – Colons were removed 2-3 days upon a second DSS treatment (for 5 days) and variation of colon size (cm) was measured.. (ns) marks a non-statistically significant difference. Statistical analysis was performed using Mann-Whitney test, asterisk indicates a significant difference ($p<0.5$), two asterisks indicate a very significant difference ($p<0.05$)

Figure 4: Dextran sulphate sodium (DSS-) induced colitis model – Colons were removed 3 days upon a second DSS treatment and analyzed for lesion numbers**.** The lesions were observed under microscope and measured.

Figure 5: Dextran sulphate sodium (DSS-) induced colitis model – Colons were removed 3 days upon a second DSS treatment **and lesion area (mm^2) was determined.**

Figure 6: Collagen induced arthritis model – Variation of the swelling of joints (mm) over time (weeks) on a mean cohort of 10 individuals. Swelling of joints (mm) is indicated in the y- axis. The variation between untreated vs treated groups is assessed over 12 weeks.

DETAILED DESCRIPTION OF THE INVENTION

There is a need for identifying novel compounds for use in the treatment and/or prevention of an inflammatory disease.

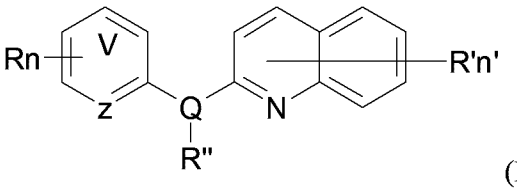
There is also a need for a novel biomarker for assessing the activity of candidate drugs, such as quinoline derivatives towards inflammatory diseases.

The present invention has for purpose to meet these needs.

Quinoline derivatives

According to a first aspect, a subject-matter of the present invention relates to the use of a compound of formula (I):

Date Reçue/Date Received 2022-06-29

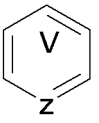


(I)

wherein:

Z is C or N,

V is C or N,



means an aromatic ring wherein V is C or N and when V is N, V is in ortho, meta or para of Z, i.e. forms respectively a pyridine, a pyridazine, a pyrimidine or a pyrazine group,

R independently represent a hydrogen atom, a halogen atom or a group chosen among a –CN group, a hydroxyl group, a $–COOR_1$ group, a $(C_1\text{-}C_3)$fluoroalkyl group, a $(C_1\text{-}C_3)$fluoroalkoxy group, a $(C_3\text{-}C_6)$cycloalkyl group, a $–NO_2$ group, a $–NR_1R_2$ group, a $(C_1\text{-}C_4)$alkoxy group, a phenoxy group, a $\text{-}NR_1\text{-}SO_2\text{-}NR_1R_2$ group, a $–NR_1\text{-}SO_2\text{-}R_1$ group, a $\text{-}NR_1\text{-}C(=O)\text{-}R_1$ group, a $\text{-}NR_1\text{-}C(=O)\text{-}NR_1R_2$ group, a $\text{-}SO_2\text{-}NR_1R_2$ group, a $\text{-}SO_3H$ group, a $\text{-O-}SO_2\text{-}OR_3$ group, a $\text{-O-P(=O)-}(OR_3)(OR_4)$ group, a $\text{-O-}CH_2\text{-}COOR_3$ group and a $(C_1\text{-}C_3)$alkyl group, said alkyl being optionally mono-substituted by a hydroxyl group,

Q is N or O, provided that R'' does not exist when Q is O,

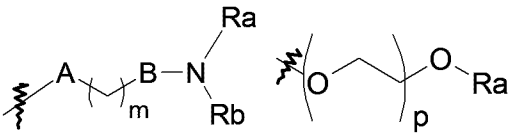
R_1 and R_2 are independently a hydrogen atom or a $(C_1\text{-}C_3)$alkyl group,

R_3 and R_4 independently represent a hydrogen atom, Li^+, Na^+, K^+, $N^+(Ra)_4$ or a benzyl group,

n is 1, 2 or 3,

n' is 1, 2 or 3,

R' independently represent a hydrogen atom or a group chosen among a $(C_1\text{-}C_3)$alkyl group, a halogen atom, a hydroxyl group, a $–COOR_1$ group, a $–NO_2$ group, a $\text{-}NR_1R_2$ group, a morpholinyl or a morpholino group, a N-methylpiperazinyl group, a $(C_1\text{-}C_3)$fluoroalkyl group, a $(C_1\text{-}C_4)$alkoxy group, a $\text{-O-P(=O)-}(OR_3)(OR_4)$ group and a –CN group, and can further be a group chosen among:



(IIa) (IIIa)

A is a covalent bond, an oxygen atom or NH,

B is a covalent bond or NH,

m is 1, 2, 3, 4 or 5,

p is 1, 2 or 3,

Ra and Rb independently represent a hydrogen atom, a (C_1-C_5)alkyl group or a (C_3-C_6)cycloalkyl group,

Ra and Rb can further form together with the nitrogen atom to which they are attached a saturated 5- or 6-membered heterocycle optionally containing a further heteroatom chosen among N, O and S, said heterocycle being optionally substituted by one or more Ra, provided that when R' is a group (IIa) or (IIIa), n' may be 2 or 3 only if other R' groups are different from said group (IIa) or (IIIa),

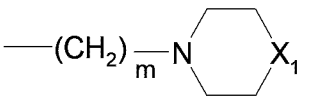
R'' is a hydrogen atom, a (C_1-C_4)alkyl group or is a group (IIa) as defined above, or anyone of its pharmaceutically acceptable salt,

in the treatment and/or prevention of an inflammatory disease.

According to a preferred embodiment, Q is N.

According to another preferred embodiment, n is 1 or 2.

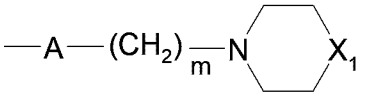
According to another preferred embodiment, n' is 1 or 2.

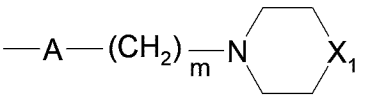
According to another preferred embodiment, R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group 

wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3.

According to another preferred embodiment, R independently represent a hydrogen atom, a methyl group, a methoxy group, a trifluoromethyl group, a

trifluoromethoxy group, an amino group, a halogen atom and a -O-P(=O)-(OR_3)(OR_4) group and more particularly a fluorine or chlorine atom, a trifluoromethoxy group and an amino group.

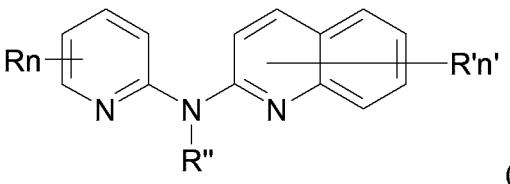
According to another preferred embodiment, R' independently represent a hydrogen atom, a halogen atom and more particularly a fluorine or chlorine atom, an amino group, a methyl group, a -O-P(=O)-(OR_3)(OR_4) group or a group  , wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, the other R' group is different from said group.

According to one aspect of said preferred embodiment, R' alternatively independently represent a hydrogen atom, a halogen atom and more particularly a fluorine or chlorine atom, a methyl group or a group  , wherein A is O or NH, m is 2 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, the other R' group is different from said group.

All the preceding and following particular embodiments may of course be combined together and form part of the invention.

Compounds of formula (I) include compounds of formula (Ia), (Ib), (Ic), (Id) and (Ie), as defined herebelow.

<u>According to a particular embodiment, another subject-matter of the present invention is the use of a compound of formula (Ia)</u>



(Ia)

wherein R, R', R'', n and n' are as defined above,

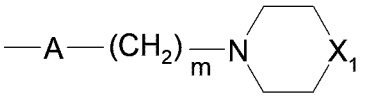
in the treatment and/or prevention of an inflammatory disease.

According to one aspect of said preferred embodiment, n is 1 or 2.

According to one aspect of said preferred embodiment, n' is 1 or 2.

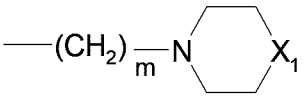
According to one aspect of said preferred embodiment, R independently represent a hydrogen atom, a halogen atom or a group chosen among a hydroxyl group, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3) fluoroalkoxy group, a $-NR_1R_2$ group, a (C_1-C_4)alkoxy group and a (C_1-C_3)alkyl group.

According to one aspect of said preferred embodiment, R' independently represent a hydrogen atom, a halogen atom or a group chosen among a (C_1-C_3)alkyl group, a hydroxyl group, a -O-P(=O)-(OR_3)(OR_4) group, a $-NR_1R_2$ group, or a group



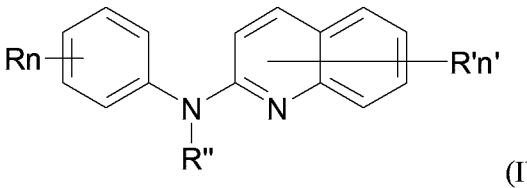
, wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2 and when n' is 2, the other R' group is different from said group.

According to one aspect of said preferred embodiment, R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group



, wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, and preferably R" is a hydrogen atom or a methyl group.

<u>According to a particular embodiment, another subject-matter of the present invention is the use of a compound of formula (Ib)</u>



(Ib)

wherein R, R', R'', n and n' are as defined above,

in the treatment and/or prevention of an inflammatory disease.

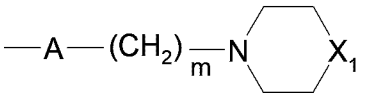
According to one aspect of said preferred embodiment, n is 1 or 2.

According to one aspect of said preferred embodiment, n' is 1, 2 or 3.

According to one aspect of said preferred embodiment, R independently represent a hydrogen atom, a halogen atom or a group chosen among a hydroxyl group, a

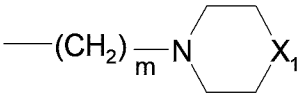
(C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group, a $-NR_1R_2$ group, a (C_1-C_4)alkoxy group, a -O-P(=O)-(OR_3)(OR_4) group and a (C_1-C_3)alkyl group.

According to one aspect of said preferred embodiment, R' independently represent a hydrogen atom, a halogen atom or a group chosen among a (C_1-C_3)alkyl group, a hydroxyl group, a -O-P(=O)-(OR_3)(OR_4) group, a $-NR_1R_2$ group, or a group

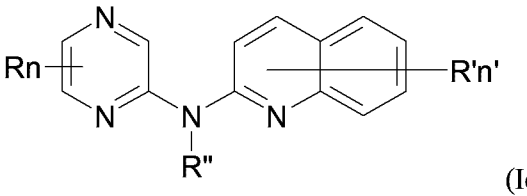


, wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, with the other R' group is different from said group.

According to one aspect of said preferred embodiment, R' alternatively independently represent a hydrogen atom, a halogen atom or a group chosen among a (C_1-C_3)alkyl group, a hydroxyl group or a $-NR_1R_2$ group.

According to one aspect of said preferred embodiment, R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group  , wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, and preferably R" is a hydrogen atom or a methyl group.

<u>According to a particular embodiment, another subject-matter of the present invention is the use of a compound of formula (Ic)</u>



(Ic)

wherein R, R', R'', n and n' are as defined above,

in the treatment and/or prevention of an inflammatory disease.

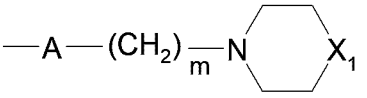
According to one aspect of said preferred embodiment, n is 1.

According to one aspect of said preferred embodiment, n' is 1.

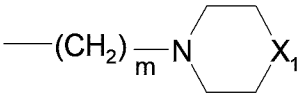
According to one aspect of said preferred embodiment, R independently represent a hydrogen atom, a halogen atom or a group chosen among a hydroxyl group, a

(C_1-C_3) fluoroalkyl group, a (C_1-C_3) fluoroalkoxy group, a –NR_1R_2 group, a (C_1-C_4) alkoxy group and a (C_1-C_3) alkyl group.

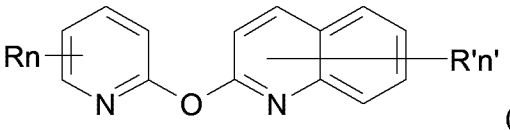
According to one aspect of said preferred embodiment, R alternatively independently represent a hydrogen atom or a halogen atom.

According to one aspect of said preferred embodiment, R' independently represent a hydrogen atom, a halogen atom or a group chosen among a (C_1-C_3) alkyl group, a hydroxyl group, a -NR_1R_2 group, or a group  , wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2 and when n' is 2, the other R' group is different from said group.

According to one aspect of said preferred embodiment, R' alternatively independently represent a hydrogen atom or a halogen atom.

According to one aspect of said preferred embodiment, R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group  , wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, and preferably R" is a hydrogen atom or a methyl group.

<u>According to a particular embodiment, another subject-matter of the present invention is the use of a compound of formula (Id)</u>



(Id)

wherein R, R', n and n' are as defined above,

in the treatment and/or prevention of an inflammatory disease.

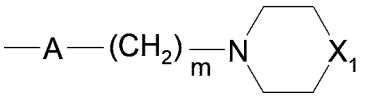
According to one aspect of said preferred embodiment, n is 1.

According to one aspect of said preferred embodiment, n' is 1.

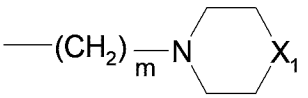
According to one aspect of said preferred embodiment, R independently represent a hydrogen atom, a halogen atom or a group chosen among a hydroxyl group, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group, a –NR_1R_2 group, a (C_1-C_4)alkoxy group and a (C_1-C_3)alkyl group.

Date Reçue/Date Received 2022-06-29

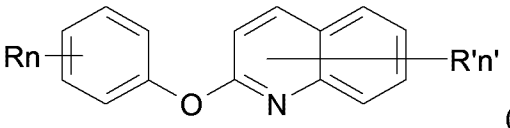
According to one aspect of said preferred embodiment, R alternatively independently represent a hydrogen atom, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group or a halogen atom.

According to one aspect of said preferred embodiment, R' independently represent a hydrogen atom, a halogen atom or a group chosen among a (C_1-C_3)alkyl group, a hydroxyl group, a -NR_1R_2 group, or a group  , wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2 and when n' is 2, the other R' group is different from said group.

According to one aspect of said preferred embodiment, R' alternatively independently represent a hydrogen atom or a halogen atom.

According to one aspect of said preferred embodiment, R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group  , wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, and preferably R" is a hydrogen atom or a methyl group.

<u>According to a particular embodiment, another subject-matter of the present invention is the use of a compound of formula (Ie)</u>



(Ie)

wherein R, R', n and n' are as defined above,

in the treatment and/or prevention of an inflammatory disease.

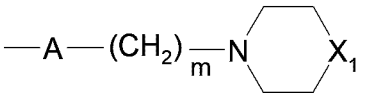
According to one aspect of said preferred embodiment, n is 1.

According to one aspect of said preferred embodiment, n' is 1.

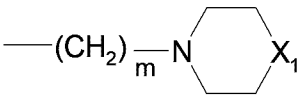
According to one aspect of said preferred embodiment, R independently represent a hydrogen atom, a halogen atom or a group chosen among a hydroxyl group, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group, a –NR_1R_2 group, a (C_1-C_4)alkoxy group and a (C_1-C_3)alkyl group.

Date Reçue/Date Received 2022-06-29

According to one aspect of said preferred embodiment, R alternatively independently represent a hydrogen atom, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group or a halogen atom.

According to one aspect of said preferred embodiment, R' independently represent a hydrogen atom, a halogen atom or a group chosen among a (C_1-C_3)alkyl group, a hydroxyl group, a -NR_1R_2 group, or a group  , wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2 and when n' is 2, the other R' group is different from said group.

According to one aspect of said preferred embodiment, R' alternatively independently represent a hydrogen atom or a halogen atom.

According to one aspect of said preferred embodiment, R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group  , wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, and preferably R" is a hydrogen atom or a methyl group.

According to another particular embodiment, compounds (Id) and (Ie) as defined above, as such, also form part of the present invention.

According to a preferred embodiment of the present invention, some compounds of formula (I) are new, form part of the present invention and are chosen among (with the number to be found in table 1 hereinafter):

- (8) 8-chloro-5-(3-(piperidin-1-yl)propoxy)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (9) 8-chloro-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethyl)pyridin-2-yl)quinoline-2,4-diamine
- (10) 8-chloro-*N*-methyl-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine
- (11) 8-chloro-N^4-(2-morpholinoethyl)-N^2-(4-(trifluoromethyl)pyridin-2-yl)quinoline-2,4-diamine
- (13) 4,8-dichloro-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

Date Reçue/Date Received 2022-06-29

- (14) 8-chloro-*N*-(3-morpholinopropyl)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (15) 8-chloro-6-(2-morpholinoethoxy)-*N*-(3-morpholinopropyl)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (16) 8-chloro-5-(2-morpholinoethoxy)-*N*-(3-morpholinopropyl)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (17) 8-chloro-6-(2-(4-methylpiperazin-1-yl)ethoxy)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (18) 8-chloro-6-(2-(piperidin-1-yl)ethoxy)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (19) 8-chloro-6-(3-(piperidin-1-yl)propoxy)-*N*-(4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (20) 8-chloro-*N*-(3-fluoro-4-(trifluoromethyl)pyridin-2-yl)quinolin-2-amine

- (21) *N*-(5-bromo-4-(trifluoromethyl)pyridin-2-yl)-8-chloroquinolin-2-amine

- (22) N^2-(8-chloroquinolin-2-yl)-N^5-(3-(4-methylpiperazin-1-yl)propyl)-4-(trifluoromethyl)pyridine-2,5-diamine

- (28) 8-chloro-*N*-methyl-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (29) 8-chloro-5-(3-(piperidin-1-yl)propoxy)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (30) 8-chloro-*N*-(3-(piperidin-1-yl)propyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (31) 8-chloro-*N*-(2-morpholinoethyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (32) 8-chloro-*N*-(2-(pyrrolidin-1-yl)ethyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (33) 8-chloro-*N*-(4-morpholinobutyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (34) 8-chloro-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethoxy)phenyl)quinoline-2,4-diamine

- (35) 4,8-dichloro-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

- (36) 8-chloro-5-(2-morpholinoethoxy)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine

Date Reçue/Date Received 2022-06-29

- (37) N^1-(4,8-dichloroquinolin-2-yl)-4-(trifluoromethoxy)benzene-1,2-diamine
- (38) 4,8-dichloro-*N*-(2-morpholinoethyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (39) 8-chloro-6-(2-morpholinoethoxy)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (40) 8-chloro-N^2-(2-morpholinoethyl)-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethoxy)phenyl)quinoline-2,4-diamine
- (41) 8-chloro-*N*-(2-morpholinoethyl)-*N*-(2-nitro-4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (42) N^1-(8-chloroquinolin-2-yl)-N^1-(2-morpholinoethyl)-4-(trifluoromethoxy)benzene-1,2-diamine
- (43) 8-chloro-5-(2-morpholinoethoxy)-*N*-(2-morpholinoethyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine
- (44) N^1-(8-chloro-5-(2-morpholinoethoxy)quinolin-2-yl)-4-(trifluoromethoxy)benzene-1,2-diamine
- (46) 8-chloro-2-((4-(trifluoromethyl)pyridin-2-yl)oxy)quinoline
- (47) 4-(2-((8-chloro-2-((4-(trifluoromethyl)pyridin-2-yl)oxy)quinolin-6-yl)oxy)ethyl)morpholine
- (48) 8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinoline
- (49) 4-(2-((8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinolin-6-yl)oxy)ethyl)morpholine
- (50) 4-(2-((8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinolin-5-yl)oxy)ethyl)morpholine
- (51) phosphoric acid mono-[8-chloro-2-(4-trifluoromethyl-pyridin-2-ylamino)-quinolin-6-yl] ester
- (52) phosphoric acid mono-[2-(8-chloro-quinolin-2-ylamino)-5-trifluoromethoxy-phenyl] ester
- (53) phosphoric acid mono-[8-chloro-2-(4-trifluoromethoxy-phenylamino)-quinolin-6-yl] ester
- and their pharmaceutically acceptable salts.

For the purpose of the present invention, a compound of formula (I) includes any one of compounds of formula (Ia), (Ib), (Ic), (Id) and (Ie), as well as combinations thereof. Compounds of formula (I) include compounds (1) to (53), as defined in Table I, and combinations thereof.

The compounds of the invention may exist in the form of free bases or of addition salts with pharmaceutically acceptable acids.

Suitable physiologically acceptable acid addition salts of compounds of formula (I) include hydrobromide, tartrate, citrate, trifluoroacetate, ascorbate, hydrochloride, tartrate, triflate, maleate, mesylate, formate, acetate and fumarate.

The compounds of formula (I) and or salts thereof may form solvates or hydrates and the invention includes all such solvates and hydrates.

The terms "hydrates" and "solvates" simply mean that the compounds (I) according to the invention can be in the form of a hydrate or solvate, i.e. combined or associated with one or more water or solvent molecules. This is only a chemical characteristic of such compounds, which can be applied for all organic compounds of this type.

The compounds of formula (I) can comprise one or more asymmetric carbon atoms. They can thus exist in the form of enantiomers or of diastereoisomers. These enantiomers, diastereoisomers and their mixtures, including the racemic mixtures, are encompassed within the scope of the present invention.

In the context of the present invention, the term:

- “halogen” is understood to mean chlorine, fluorine, bromine, or iodine, and in particular denotes chlorine, fluorine or bromine,

- “(C_1-C_5)alkyl” as used herein respectively refers to C_1-C_5 normal, secondary or tertiary saturated hydrocarbon. Examples are, but are not limited to, methyl, ethyl, 1-propyl, 2-propyl, butyl, pentyl,

- “(C_3-C_6)cycloalkyl” as used herein respectively refers to cyclic saturated hydrocarbon. Examples are, but are not limited to cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl,

Date Reçue/Date Received 2022-06-29

- "(C_1-C_4)alkoxy" as used herein respectively refers to O-(C_1-C_4)alkyl moiety, wherein alkyl is as defined above. Examples are, but are not limited to, methoxy, ethoxy, 1-propoxy, 2-propoxy, butoxy,

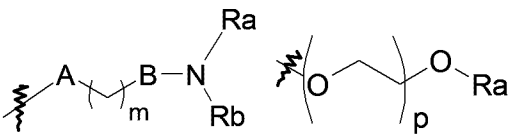
- "fluoroalkyl group" and "fluoroalkoxy group" refers respectively to alkyl group and alkoxy group as above-defined, said groups being substituted by at least one fluorine atom. Examples are perfluoroalkyl groups, such as trifluoromethyl or perfluoropropyl,

- "saturated 5- or 6-membered heterocycle" as used herein respectively refers to a saturated cycle comprising at least one heteroatom. Examples are, but are not limited to, morpholine, piperazine, thiomorpholine, piperidine, pyrrolidine,

- "patient" may extend to humans or mammals, such as cats or dogs.

The compounds of formula (I) which are suitable for the invention may be prepared as described in **WO2010/143170**, **WO2010/143169**, **WO2012/080953** and **WO2010/143168**, and/or as described further here below.

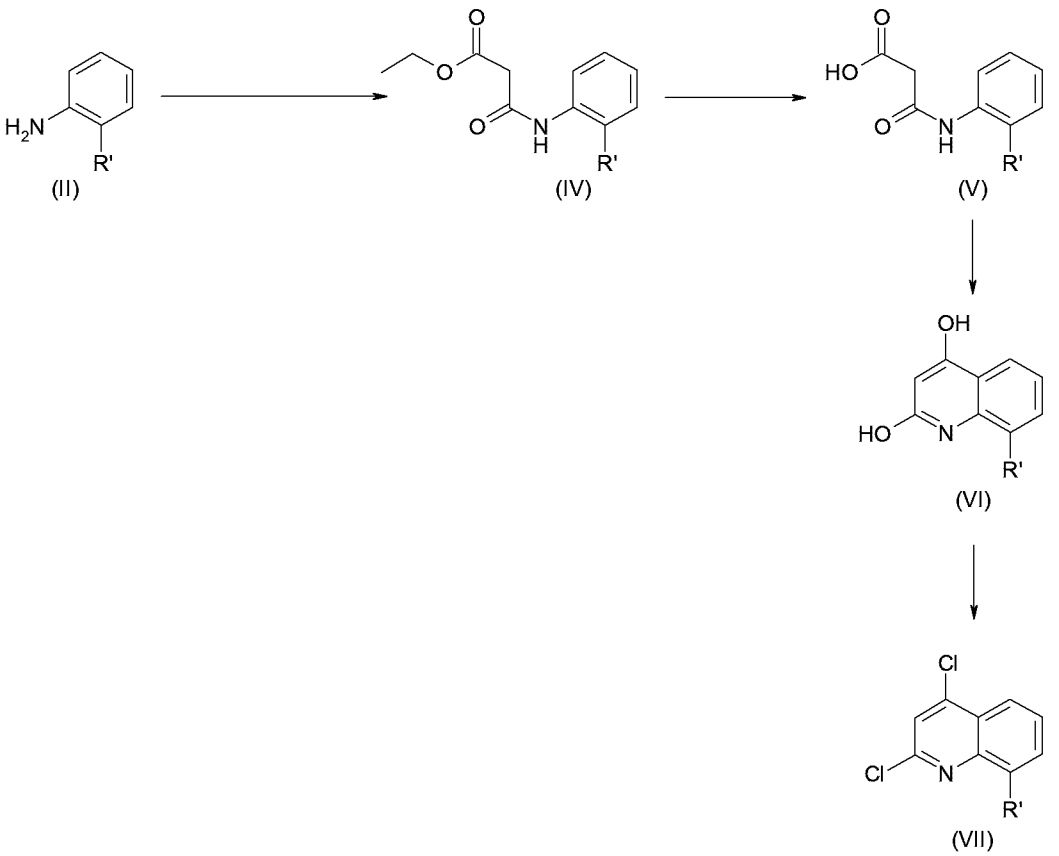
More particularly, compounds of formula (I) wherein R' represents a group chosen among:



(IIa) (IIIa) as defined above, may be prepared according to synthetic routes as described in **WO2012/080953**, more particularly when A is O.

When A is N, the following synthetic route may be implemented. A quinoline derivative of formula (VII) may be synthesized as a building block, before additional cross-coupling reactions.

In order to obtain said compound of formula (VII), the following sequence of reactions may be carried out as shown in Scheme **1** below.



Scheme 1

The compound of formula (II), wherein R' is different from H and is as defined above and may in particular be a Chlorine atom, can be placed in pyridine, the compound of formula (III) can then be added in a molar ratio ranging from 1 to 2, for example 1.5, with respect to the compound of formula (II). The reaction mixture can be stirred at a temperature ranging from 110 to 150°C, for example at 130°C, for a time ranging from 8 hours to 18 hours, for example 14 hours. Upon cooling to room temperature, the reaction mixture can be concentrated under reduced pressure and the resulting residue can be diluted with an organic solvent such as dichloromethane. The organic phase can then be washed with a saturated aqueous solution of an inorganic base such as Na_2CO_3, dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (IV).

The compound of formula (IV) can be placed in a THF/water mixture, sodium hydroxide can then be added in a molar ratio ranging from 1 to 1.5, for example 1.2, with

respect to the compound of formula (IV), and the reaction mixture can be stirred at room temperature for a time ranging from 8 hours to 18 hours, for example 14 hours. Concentrated hydrochloric acid can then be added until reaching pH 2 and the resulting solution can be extracted with an organic solvent such as ethyl acetate. The organic phase can then be dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (V).

The compound of formula (V) can be placed in polyphosphoric acid, added in a molar ratio ranging from 5 to 15, for example 10, with respect to the compound of formula (V), and the reaction mixture can be stirred at a temperature ranging from 110 to 150°C, for example at 130°C, for a time ranging from 8 hours to 18 hours, for example 14 hours. Upon cooling to room temperature, an aqueous solution of sodium hydroxide with a molarity ranging from 1 to 5M, for example 2M, can slowly be added. The resulting precipitate can be filtered, rinsed with water and dried under reduced pressure in a desiccator to give a compound of formula (VI).

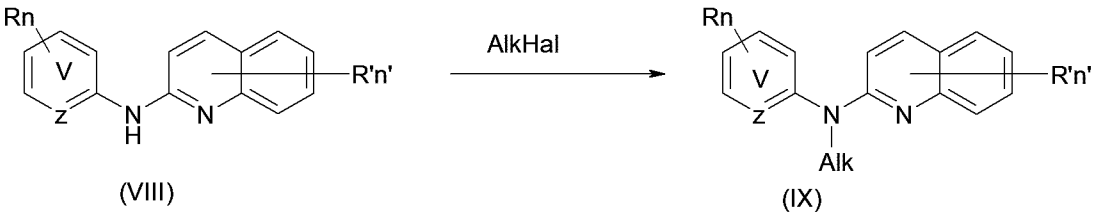
The compound of formula (VI) can be placed in $POCl_3$, added in a molar ratio ranging from 5 to 15, for example 10, with respect to the compound of formula (VI), and the reaction mixture can be stirred at a temperature ranging from 80 to 120°C, for example at 100°C, for a time ranging from 1 hour to 5 hours, for example 2 hours. Upon cooling to room temperature, water can slowly be added. The resulting precipitate can be filtered, rinsed with water and dried under reduced pressure in a desiccator to give a compound of formula (VII).

Said intermediate compound of formula (VII) may be used to form a compound of formula (I) by cross-coupling it with an aniline derivative, an aminopyridine derivative, a pyrimidine derivative, a hydroxypyridine derivative, a phenol derivative or a hydroxypyrimidine derivative, as described in WO2010/143170, WO2010/143169, WO2012/080953 and WO2010/143168 and/or as described further here below.

Chlorine in position 4 of the intermediate compound of formula (VII) may thereafter be substituted by an amine to form a quinoline derivative bearing a group of formula (IIa) with A = NH.

When Q = N and R'' is different from H, the following routes, illustrated by schemes **2** and **3**, may be implemented.

In order to obtain compounds of formula (IX), the following reaction may be carried out as shown in Scheme **2** below.

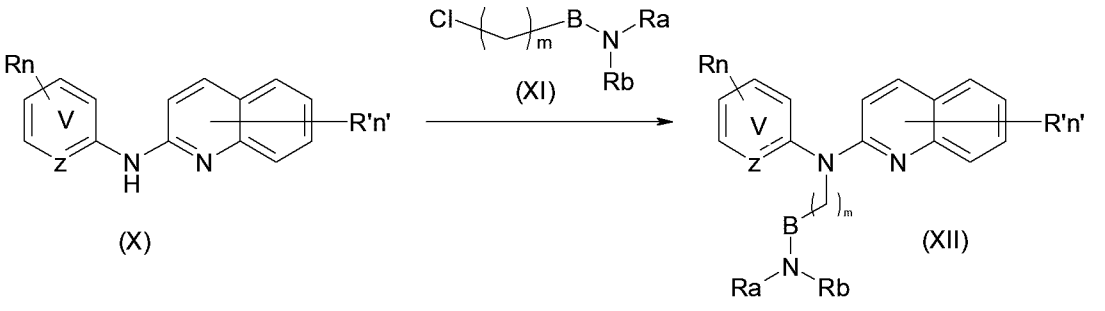


(VIII) (IX)

Scheme 2

The compound of formula (VIII), wherein Z, V, n, n', R and R' are as defined above, can be placed in an anhydrous polar solvent such as anhydrous *N,N*-dimethylformamide in the presence of AklHal, wherein Alk represents a (C_1-C_4)alkyle group and Hal represents a halogen atom, in a molar ratio ranging from 1 to 2, for example 1.1, and in the presence of an inorganic base such as potassium *tert*-butoxide in a molar ratio ranging from 1 to 2, for example 1.1, with respect to the compound of formula (VIII). The reaction mixture can be stirred at room temperature for a time ranging from 7 hours to 24 hours, for example 16 hours. The reaction mixture can be partitioned between water and an organic solvent such as ethyl acetate. The organic phases can then be gathered, washed with a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (IX).

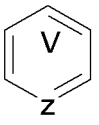
In order to obtain compounds of formula (XII), the following reaction may be carried out as shown in Scheme **3** below.

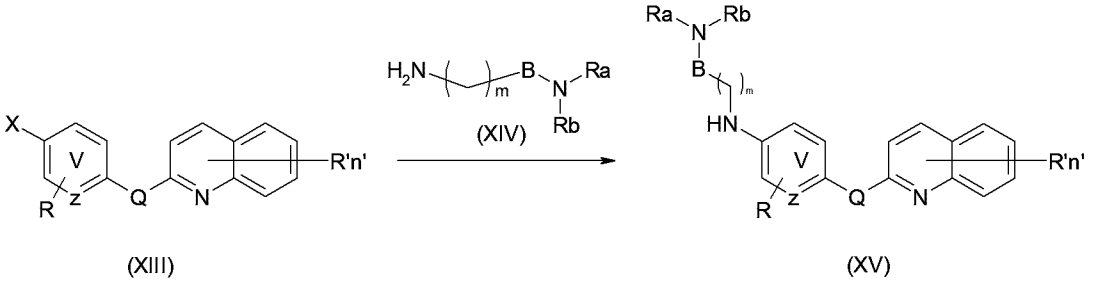


(X) (XII)

Scheme 3

The compound of formula (X), wherein Z, V, n, n', R and R' are as defined above, can be placed in an anhydrous polar solvent such as anhydrous *N,N*-dimethylformamide in the presence of NaH in a molar ratio ranging from 2 to 5, for example 3, and the reaction mixture can be stirred at room temperature for a time ranging from 10 minutes to 50 minutes, for example 30 minutes. The compound of formula (XI), wherein m, B, Ra and Rb are as defined above, can then be placed, in a molar ratio ranging from 1 to 2, for example 1, in an anhydrous polar solvent such as anhydrous *N,N*-dimethylformamide in the presence of KI in a molar ratio ranging from 1 to 2, for example 1, and in the presence of an organic base such as Et_3N in a molar ratio ranging from 1 to 2, for example 1, with respect to the compound of formula (X), and the reaction mixture can be stirred at room temperature for a time ranging from 10 minutes to 50 minutes, for example 30 minutes, under an inert atmosphere of gas, for example argon. The activated compound (X) can then added to compound (XI) and the resulting reaction mixture can be stirred at a temperature ranging from 70 to 110°C, for example at 90°C, for a time ranging from 2 hours to 10 hours, for example 4 hours. Upon cooling to room temperature, the reaction mixture can be concentrated under reduced pressure and the resulting residue can be diluted with an organic solvent such as ethyl acetate. The organic phase can then be washed with a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (XII).

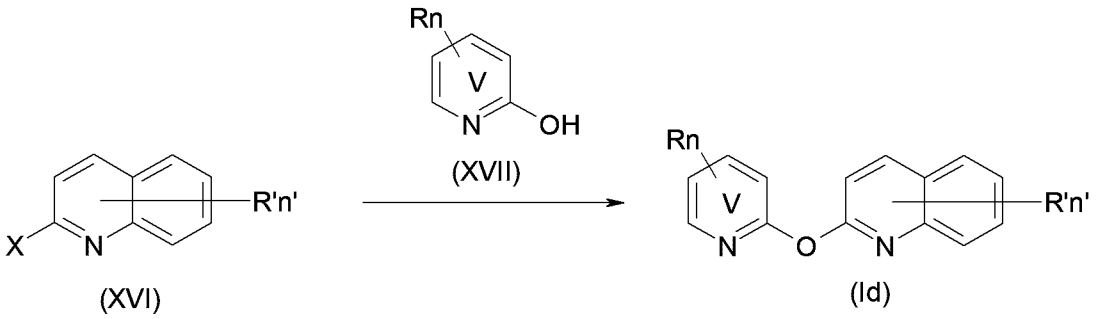
When  bears a substitution being an amino group of formula (IIa), wherein A is NH, the following route may be implemented, as in Scheme **4**.



Scheme 4

The compound of formula (XIII), wherein Z, V, n', R and R' are as defined above and X is a halogen atom such as Br, can be placed in a polar solvent mixture such as a dioxane / *N,N*-dimethylformamide mixture. A compound of formula (XIV), wherein B, R_a, and R_b are as defined above, is then added in a molar ratio ranging from 1 to 2, for example 1.5, with respect to the compound of formula (XIII), in the presence of a non-nucleophilic organic base, such as sodium *tert*-butoxide or potassium *tert*-butoxide, in a molar ratio ranging from 2 to 5, for example 3, in the presence of a diphosphine, such as Xantphos (4,5-Bis(diphenylphosphino)-9,9-dimethylxanthene) or X-Phos (2-Dicyclohexylphosphino-2',4',6'-triisopropylbiphenyl) in an amount ranging from 5 mol% to 40 mol% relative to the total amount of compound of formula (XIII), and in the presence of a catalyst, such as $Pd(OAc)_2$ or $Pd_2(dba)_3$ in an amount ranging from 2 mol% to 15 mol% relative to the total amount of compound of formula (XIII). The reaction mixture can be heated in a microwave reactor at a temperature ranging from 90 to 150°C, for example at 120°C, for a time ranging from 30 minutes to 100 minutes, for example 70 minutes. The reaction mixture can be concentrated under reduced pressure and the residue can be diluted with an organic solvent such as ethyl acetate. The organic phase can be washed with water, decanted, dried over magnesium sulphate, filtered and concentrated under reduced pressure to give a compound of formula (XV).

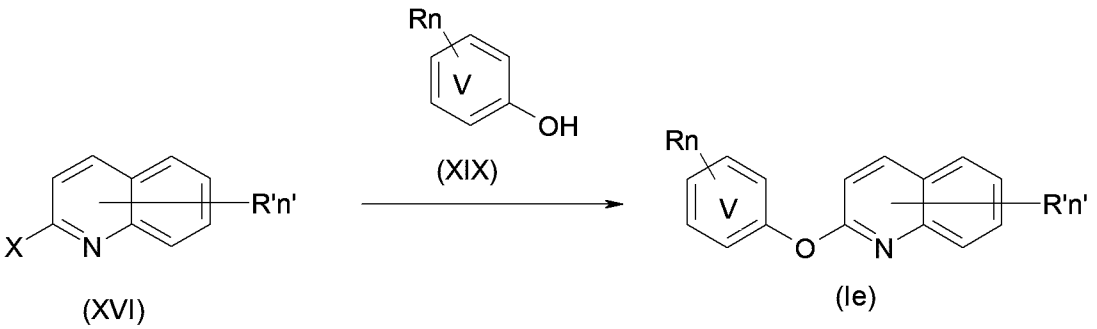
The compounds of general formula (Id) as defined above can be prepared according to Scheme **5** below.



Scheme 5

The compound of formula (XVI), wherein n'and R' are as defined above and X is a halogen atom such as Cl, can be placed in a polar solvent such as *N,N*-dimethylformamide in the presence of an inorganic base such as Cs_2CO_3 in a molar ratio ranging from 2 to 5, for example 3, and in the presence of CuI in a molar ratio ranging from 1 to 2, for example 1. The compound of formula (XVII), wherein R, V and n are as defined above, can then be added in a molar ratio ranging from 1 to 2, for example 1, with respect to the compound of formula (XVI). The reaction mixture can be heated in a microwave reactor at a temperature ranging from 130 to 170°C, for example at 150°C, for a time ranging from 30 minutes to 100 minutes, for example 50 minutes. Upon cooling to room temperature, water can be added to the reaction mixture, the undissolved solids can be filtered through celite and the resulting filtrate can be extracted with an organic solvent such as ethyl acetate. The organic phase can then be washed with water and a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (Id).

The compounds of general formula (Ie) as defined above can be prepared according to Scheme **6** below.



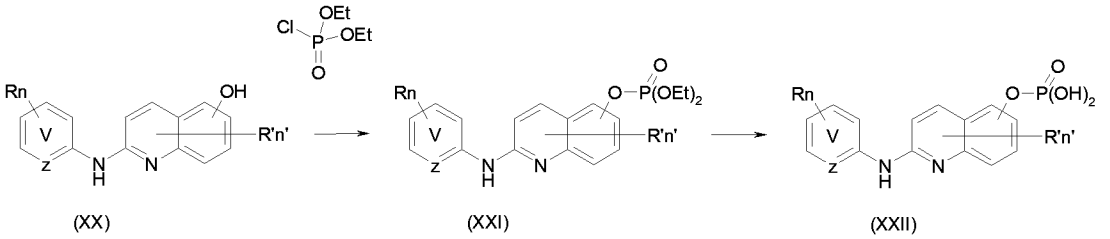
Scheme 6

The compound of formula (XVI), wherein n' and R' are as defined above and X is a halogen atom such as Cl, can be placed in a polar solvent such as *N,N*-dimethylformamide in the presence of an inorganic base such as Cs_2CO_3 in a molar ratio ranging from 2 to 5, for example 3, and in the presence of CuI in a molar ratio ranging from 1 to 2, for example 1. The compound of formula (XIX), wherein R, V and n are as defined above, can then be added in a molar ratio ranging from 1 to 2, for example 1,

Date Reçue/Date Received 2022-06-29

with respect to the compound of formula (XVI). The reaction mixture can be heated in a microwave reactor at a temperature ranging from 130 to 170°C, for example at 150°C, for a time ranging from 30 minutes to 100 minutes, for example 50 minutes. Upon cooling to room temperature, water can be added to the reaction mixture, the undissolved solids can be filtered through celite and the resulting filtrate can be extracted with an organic solvent such as ethyl acetate. The organic phase can then be washed with water and a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (Ie).

More particularly, compounds of formula (I) wherein R' represents a -O-P(=O)-(OR_3)(OR_4) group may be prepared starting from a compound of formula (XX) having a R' group being a OH group, through the following route:



Scheme 7

The compound of formula (XX), wherein Z, V, n, n', R and R' are as defined above, can be placed in an anhydrous chloroalkane solvent such as anhydrous dichloromethane, at 0°C under an inert atmosphere of gas, for example argon, in the presence of diethylchlorophosphate in a molar ratio of 1, and in the presence of an organic base such as triethylamine in a molar ratio ranging from 1 to 2, for example 1.2, with respect to the compound of formula (XX). The reaction mixture can be stirred at room temperature for a time ranging from 7 hours to 24 hours, for example 14 hours. The reaction mixture can then be concentrated under reduced pressure and the resulting residue can be partitioned between an aqueous solution of hydrochloric acid with a molarity ranging from 1 to 2 M, for example 1M, and an organic solvent such as ethyl acetate. The organic phases can then be gathered, washed with a saturated aqueous solution of an inorganic base such as Na_2CO_3, dried over $MgSO_4$, filtered and concentrated under reduced pressure to give a compound of formula (XXI).

Date Reçue/Date Received 2022-06-29

The compound of formula (XXI) can be placed in a polar aprotic solvent such as acetonitrile, in the presence of trimethylsilylbromide in a molar ratio ranging from 1 to 5, for example 4, with respect to the compound of formula (XXI). The reaction mixture can be stirred under microwave irradiation at a temperature ranging from 50 to 70°C, for example at 60°C, for a time ranging from 15 hours to 60 minutes, for example 30 minutes. Upon cooling to room temperature, a MeOH/water (95/5) mixture can slowly be added. The resulting precipitate can be filtered, rinsed with water and dried under reduced pressure in a desiccator to give a compound of formula (XXII).

The same procedure may be applied for obtaining compounds of formula (I) wherein R represents a -O-P(=O)-(OR_3)(OR_4) group, starting from a compound of formula (I) having a R group being a OH group.

Inflammatory diseases

Thus, the invention also relates to a compound of formula (Ia), (Ib), (Ic), (Id) and (Ie), for use in the treatment and/or prevention of an inflammatory disease.

Surprisingly, the inventors were able to show that compounds of formula (I) led to a dramatic improvement of the signs associated with inflammatory diseases such as Inflammatory bowel disease (IBD) and Rheumatoid Arthritis (RA), based on two *in vivo* mouse models.

The inflammation modulating capacity of compounds of formula (I) has now been assessed in two established mouse models for two inflammatory diseases: Inflammatory bowel disease (IBD) and Rheumatoid Arthritis (RA). The Dextran Sulphate Sodium (DSS-) induced colitis mouse model has been used for studying Inflammatory Bowel Disease (see Perše & Cerar; "Dextran Sodium Sulphate Colitis Mouse Model: Traps and Tricks"; Journal of Biomedicine and Biotechnology (2012); 718617). The collagen-induced arthritis model has been used for studying Rheumatoid Arthritis, as shown in Brand *et al.* ("Collagen-induced arthritis"; Nature Protocols; (2007); 2(5):1269-75).

Indeed, the inventors have shown that the administration of a compound belonging to formula (I) led *in vivo* to an improvement of the length of the colon and a decrease of alterations in lymphoid organs such as Peyer's Patches, on (DSS-) induced colitis mouse models. The inventors have further shown that the administration of a

compound of formula (I) led to a significant decreased swelling and lowered signs of inflammation based on a collagen-induced arthritis mouse model.

According to the invention, an « *inflammation* » is characterized by pain, heat, redness and swelling, and can result from infection, irritation, or injury.

Thus, an « *inflammatory disease* » refers to a group of diseases and/or disorders that are caused by an excessive or dysregulated inflammation.

According to the invention, « *treating and/or preventing an inflammatory disease* » may either refer to the treatment and/or prevention of an inflammatory disease, or to inflammation itself, which may occur along with said inflammatory disease in an individual.

Thus, a treatment and/or prevention of an inflammatory disease also includes a treatment and/or prevention of inflammation as such.

According to the invention, « *treating and/or preventing* » an inflammatory disease includes treating, reducing the likelihood of developing, or delaying the occurrence of said inflammatory disease.

According to the invention, an "*individual*" may relate to a human or non-human mammal, and preferably to a human.

In a non-limitative manner, inflammatory diseases include: an inflammatory disease associated with an autoimmune disease, a central nervous system (CNS) inflammatory disease, a joint inflammation disease, an inflammatory digestive tract disease, inflammatory skin and other inflammatory diseases related to epithelial cells such as bronchitis, inflammation associated with cancer, such as colon carcinoma, inflammation associated with irritation, and inflammation associated with injury.

Thus, an inflammatory disease can be selected in the list consisting of: an inflammatory disease associated with an autoimmune disease, a central nervous system (CNS) inflammatory disease, a joint inflammation disease, an inflammatory digestive tract disease, inflammatory skin and other inflammatory diseases related to epithelial cells, inflammation associated with cancer, inflammation associated with irritation, and inflammation associated with injury.

In particular, an inflammatory disease is selected in the list consisting of: Inflammatory Bowel Disease, Rheumatoid Arthritis, Crohn's disease, Ulcerative Colitis, Multiple Sclerosis, Alzheimer's disease, Parkinson, osteoarthritis, atherosclerosis,

Date Reçue/Date Received 2022-06-29

ankylosing spondylitis, psoriasis, dermatitis, Sjogren's syndrom, bronchitis, asthma and inflammation associated with colon carcinoma.

More particularly, an inflammatory disease is selected in the list consisting of: Inflammatory Bowel Disease, Rheumatoid Arthritis, Crohn's disease, Ulcerative Colitis, Multiple Sclerosis, osteoarthritis, ankylosing spondylitis, psoriasis, Sjogren's syndrom, bronchitis, and inflammation associated with colon carcinoma.

More particularly, an inflammatory disease is selected in the list consisting of: Inflammatory Bowel Disease, Rheumatoid Arthritis, Crohn's disease, Ulcerative Colitis, Multiple Sclerosis, osteoarthritis, ankylosing spondylitis, and psoriasis.

Preferably, an inflammatory disease according to the invention includes: Inflammatory Bowel Disease, Crohn's disease, Ulcerative Colitis, Rheumatoid Arthritis and Multiple Sclerosis.

Even more preferably, an inflammatory disease according to the invention includes: Inflammatory Bowel Disease, Rheumatoid Arthritis and Multiple Sclerosis.

An inflammatory disease may also encompass Alzheimer's disease, Parkinson, asthma, atherosclerosis and dermatitis.

As dermatitis, eczema may be cited.

In view of the above, the invention relates to a compound of formula (I) for use in the treatment and/or prevention of an inflammatory disease, which encompasses inflammation as such, and inflammation associated with an inflammatory disease.

Thus, the invention also relates to the use of a compound of formula (I) for treating and/or preventing an inflammatory disease, which encompasses inflammation as such, and inflammation associated with an inflammatory disease.

According to another aspect, a subject-matter of the present invention relates to a compound (Ie), (Id), (8), (9), (10), (11), (44), (46), (47), (48), (49), (50), (51), (52), (53) or its pharmaceutically acceptable salts, either alone or in combination, for use as a medicament.

According to another of its objects, the invention relates to a pharmaceutical composition comprising a compound (Ie), (Id), (8), (9), (10), (11), (44), (46), (47), (48), (49), (50), (51), (52), (53) or its pharmaceutically acceptable salts, either alone or in combination.

Date Reçue/Date Received 2022-06-29

The invention also relates to the use of a compound of formula (I) for the preparation of a composition, such as a medicament, for treating and/or preventing inflammation, which encompasses inflammation as such, and inflammation associated with an inflammatory disease.

The invention also relates to a method for treating and/or preventing an inflammatory disease, which includes inflammation as such, and inflammation associated with said inflammatory disease, and which comprises a step of administering a compound of formula (I) to a patient in need thereof.

miRNA-124

MicroRNAs (miRNAs) are small, single-stranded non-coding RNAs that can act in the cytoplasm of a cell to cause a decrease in the expression of their cognate target messenger RNAs or translation of the mRNA's protein product. Mature miRNAs are typically about 19-23 nucleotides in length. This ability of miRNAs to inhibit the production of their target proteins results in the regulation of many types of cellular activities, such as cell-fate determination, apoptosis, differentiation, and oncogenesis.

miR-124 was initially cloned in mouse. Human miR-124 precursor (or miRN-124 or miRNA-124 or micro RNA 124) was cloned from embryonic stem cells. 9 haplotypes of miR-124 precursors have been identified so far (Guo *et al.*, PLoS ONE, 2009, 4(11):e7944), from which 3 are present in the Human, hsa-miR-124-1, hsa-miR-124-2 and hsa-miR-124-3. (Respectively **SEQ ID NO:1, SEQ ID NO:2** and **SEQ ID NO:3**).

The miR-124 microRNA precursor is a small non-coding RNA molecule. The mature ~21 nucleotide microRNAs are processed from hairpin precursor sequences by the Dicer enzyme. The mature sequences are **SEQ ID NO: 4** for miR-124-3p and **SEQ ID NO: 5** for miR-124-5p.

According to the invention, measuring the level of expression of miR-124 encompasses both measuring the level expression of a precursor or of a mature miR-124.

The invention also relates to a compound of formula (I) for increasing the expression of miR-124 in a biological sample.

Thus, according to another of its objects, the invention relates to an *in vitro* or *ex vivo* method for increasing the expression of miR-124 in an eukaryotic cell, comprising at least a step of:

Date Reçue/Date Received 2022-06-29

a) providing an eukaryotic cell,

b) bringing into contact said cell with a derivative compound, and in particular a compound of formula (I).

Methods or screening of candidate compounds.

One key factor for the success of development of a given drug or vaccine is the possibility to assess efficiently and rapidly its efficacy. It is therefore critical to have proper tools, such as specific biomarkers, to rely upon for assessing the efficacy of a drug or vaccine.

Surprisingly, it has been found that, during inflammation, miR-124 plays an important role. Indeed, the inventors have shown that compounds of formula (I) are able to modulate the expression of miR-124. In particular, the inventors have shown that compounds of the invention could up-regulate (up to 100-fold increase) the expression of miR-124 on Peripheral blood mononuclear cells (PBMCs) from donors, isolated by centrifugation on a FICOLL™ gradient.

Because the inventors have now established that compounds of formula (I) are able to modulate the expression of miR-124, the invention also relates to an *in vitro* or *ex vivo* method for screening a quinoline derivative, and in particular a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease.

Thus, according to another of its objects, the invention relates to an *in vitro* or *ex vivo* use of at least one miRNA, said at least one miRNA being miR-124, as a biomarker for screening a quinoline derivative, and in particular a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease.

Thus, the invention also relates to an *in vitro* or *ex vivo* method for screening a quinoline derivative, and in particular a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease, comprising at least a step of:

a) providing an eukaryotic cell,

b) bringing into contact said cell with a compound of formula (I),

c) measuring an expression of miR-124 in said cell, and

Date Reçue/Date Received 2022-06-29

d) selecting the candidate presumed effective in treating and/or preventing an inflammatory disease when the level of expression of miR-124 measured in step c) is modulated relatively to a reference value.

According to the invention, the "*modulation*" of a level of expression, includes both the up-regulation and the down-regulation of a level of expression. In the sense of the invention, the "*modulation*" of a level of expression of miR-124 refers preferably to an up-regulation.

In particular, the invention relates to an *in vitro* or *ex vivo* method for screening a quinoline derivative, and in particular a compound of formula (I), presumed effective in treating and/or preventing an inflammatory disease, comprising at least a step of:

a) providing an eukaryotic cell,

b) bringing into contact said cell with a compound of formula (I),

c) measuring an expression of miR-124 in said cell, and

d) selecting the candidate presumed effective in treating and/or preventing an inflammatory disease when the level of expression of miR-124 measured in step c) is increased relatively to a reference value.

According to one embodiment, a presence or a level of expression of miR-124 is measured from an eukaryotic cell from a biological sample, and is compared to a control reference value.

In particular, a "*biological sample*" suitable for the invention may be a biological fluid, such as a blood, a plasma, or a serum, a saliva, an interstitial fluid, or an urine sample; a cell sample, such as a cell culture, a cell line, a stem cell line, or a Peripheral blood mononuclear cells (PBMC) containing sample, a tissue biopsy, such as an oral tissue, a gastrointestinal tissue, a skin, an oral mucosa sample, or a plurality of samples from a clinical trial. The sample can be a crude sample, or can be purified to various degrees prior to storage, processing, or measurement.

In particular, a biological sample suitable for the invention is a Peripheral blood mononuclear cell (PBMC) or a PBMC containing sample. Thus, a biological sample of the invention may be processed from peripheral whole blood using common techniques

Date Reçue/Date Received 2022-06-29

in the Art, such as density gradient centrifugation, and more particularly FICOLL™ gradient.

PBMC samples, especially the ones which have been processed using a FICOLL™ gradient, are susceptible to include lymphocytes (T cells, B cells, and NK cells), monocytes and dendritic cells. In humans, the frequencies of these populations vary across individuals.

Thus, and in a non-limitative manner, an eukaryotic cell includes any one of cell types as defined above, such as lymphocytes (T cells, B cells, and NK cells), monocytes and dendritic cells.

The step of collecting biological samples for the uses and methods of the invention is performed before carrying out the invention and is not a step of a use or a method in accordance with the invention.

Samples for miRNA assessment can be taken during any desired intervals. For example, samples can be taken hourly, twice per day, daily, weekly, monthly, every other month, yearly, or the like. The sample can be tested immediately, or can be stored for later testing.

The samples can be purified prior to testing. In some embodiments, the miR-124 can be isolated from the remaining cell contents prior to testing. Further, the miR-124 molecules can be separated from the rest of the mRNA in the sample, if desired. For example, the miR-124 can be separated from the mRNA based on size differences prior to testing.

Control reference value to be used for comparing the measured level of expression of miR-124 in a tested biological sample is obtained from a control sample.

Control samples can be taken from various sources. In some embodiments, control samples are taken from the patient prior to treatment or prior to the presence of the disease (such as an archival blood sample). In other embodiments, the control samples are taken from a set of normal, non-diseased members of a population. In another embodiment, a cell assay can be performed on a control cell culture, for example, that has not been treated with the test compound or has been treated with a reference compound, such as DMSO, methylcellulose (MC) or water.

Date Reçue/Date Received 2022-06-29

According to one embodiment, for the determination or monitoring of an inflammatory disease in a patient, a control reference value may be obtained from an isolated biological sample obtained on an individual or group of individuals known to not suffer from such condition.

According to another embodiment, for the determination or monitoring of an efficacy of a treatment of an inflammatory disease in a patient, a control reference value may be obtained from an isolated biological sample obtained from an individual or group of individuals known to not suffer from such condition(s), and/or not receiving the treatment the efficacy of which is to be determined or monitored. Alternatively, a control reference value may be obtained from an isolated biological sample obtained from a patient suffering from an inflammatory disease and receiving a treatment the efficacy of which being to be determined or monitored, the isolated biological sample being taken from the patient before administration of the treatment.

Numerous methods are available to the skilled man to measure a presence or level of expression of the miR-124 biomarker.

For example, nucleic acid assays or arrays can be used to assess the presence and/or expression level of miR-124 in a sample.

The sequence of the miR-124 may be used to prepare a corresponding nucleotide acting as complementary probe or primer to be used in different nucleic acid assays for detecting the expression or presence of the miR-124 biomarker in the sample, such as, but not limited to, Northern blots and PCR-based methods (e.g., Real-Time Reverse Transcription-PCR or qRT- PCR). Methods such as qRT-PCR may be used to accurately quantitate the amount of the miRNA in a sample.

Sense and anti-sense probes or primers according to the invention may be obtained using every process known to the man skilled in the art, in particular those that are described in Sambrook et al. (Molecular Cloning: A Laboratory Manual, 3rd ED., 2001, Cold Spring Harbour, N. Y.).

Methods related to the detection and quantification of RNA or DNA are well known in the art. The man skilled in the art may for instance refer to Wang et al. (1989, Proc Natl Acad Sci USA, Vol. 86 : 917-921), de Wong et al. (2005, Bio Techniques, Vol. 39 (1): 75-85), de Nolan et al. (2006, Nat Protoc, Vol. 1(3) : 1559-1582) et de Klinck et al.

Date Reçue/Date Received 2022-06-29

(2008, Cancer Research, Vol. 68 : 657-663), or also to a general review published by Bustin (2000, Journal of Molecular Endocrinology, Vol. 25 : 169-193).

An isolated nucleic acid probe suitable for measuring a presence or level expression of miR-124 is a nucleic acid probe able to specifically hybridize to a miR-124, such as a precursor or a mature miR-124.

Such a nucleic acid probe may comprise from 18 to 30 nucleotides, in particular from 20 to 27, preferably from 20 to 25, preferably from 20, 22, or 25, and more preferably about 25 nucleotides. As previously indicated, such nucleic acid probes may be prepared according to any known methods in the art.

Methods and formulas are well known in the art to predict the optimal hybridization temperature for a given probe and a given target.

Thus, the man skilled in the art may easily calculate an optimal hybridization temperature based on a set of probes, on a given target sequence, and with particular conditions of hybridization.

Advantageously, the optimal hybridization temperature of said probes is between 40ºC and 60°C, and more particularly between 45°C and 55°C, and preferably is about 48ºC.

As examples of buffers useful for hybridizing a nucleic acid probe of the invention to a biomarker of the invention, one may mention, as an hybridization buffer, a buffer comprising 100mM MES, 1M [Na+], 20mM EDTA, 0.01% Tween-20™, as a non-stringent washing buffer a buffer comprising 6X SSPE, 0.01% Tween-20™, and as a stringent washing buffer a buffer comprising 100mM MES, 0.1M [Na+], 0.01% Tween-20™.

In one embodiment, a method for the detection and quantification of nucleic acids may be a fluorescent-dye-based method, wherein nucleic acid concentration is assessed by measuring the fluorescence intensity of ligands, such as dyes, that bind to said nucleic acids. Fluorescent dyes are well known in the art.

Alternatively, said nucleic acid may be quantified using spectrophotometry.

In another embodiment, a method for the detection and quantification of nucleic acids may be a hybridation-based method. Said hybridation-based methods may include PCR and quantitative-PCR (qRT-PCR or q-PCR) techniques or reverse transcriptase / polymerase based techniques. Advantageously, said method may comprise, or be further combined, with a sequencing step.

Date Reçue/Date Received 2022-06-29

Those methods may comprise (i) a step of extraction of cellular mRNAs, (ii) a step of reverse transcription of mRNA to DNA using a reverse transcriptase and (iii) a step of DNA amplification from DNA obtained on the previous step. Usually, starting from the same sample, the following nucleic acids are amplified : (a) DNA obtained after a reverse transcription step of the target mRNA and (b) a DNA or a plurality of DNAs obtained after reverse transcription of mRNAs which are constitutively and constantly expressed by cells (« housekeeping genes »), such as RNAs coded by genes *MRPL19, PUM1* and *GADPH*.

The amplified DNA can be quantified, after separation by electrophoresis, and measure of DNA bands. Results related to the target mRNA(s) are expressed as relative units in comparison to mRNAs coded by « housekeeping » genes. In some embodiments, the step of separation of amplified DNAs is achieved after agarose gel electrophoresis, and then coloration of DNA bands with ethidium bromide, before quantification of DNA contained in those migration bands with densitometry. In other embodiments, one may use a micro-channel device in which amplified DNA is separated by capillar electrophoresis, before quantification of the emitted signal using a laser beam. Such a device may be a LabChip® device, for instance from the « GX » series, commercialized by the company Caliper LifeSciences (Hopkinton, MA, USA).

Quantitative results obtained by qRT-PCR can sometimes be more informative than qualitative data, and can simplify assay standardization and quality management. Thus, in some embodiments, qRT-PCR-based assays can be useful to measure miRNA levels during cell-based assays. The qRT-PCR method may be also useful in monitoring patient therapy. Commercially available qRT-PCR based methods (e.g., TaqmanR Array™)

Any suitable assay platform can be used to determine the expression or presence of the miRNA in a sample. For example, an assay may be in the form of a dipstick, a membrane, a chip, a disk, a test strip, a filter, a microsphere, a slide, a multiwell plate, or an optical fiber. An assay system may have a solid support on which an oligonucleotide corresponding to the miRNA is attached. The solid support may comprise, for example, a plastic, silicon, a metal, a resin, glass, a membrane, a particle, a precipitate, a gel, a polymer, a sheet, a sphere, a polysaccharide, a capillary, a film a plate, or a slide. The assay components can be prepared and packaged together as a kit for detecting an miRNA.

In some embodiments, an oligonucleotide array for testing for quinoline derivative or drug candidate activity in a biological sample can be prepared or purchased.

Date Reçue/Date Received 2022-06-29

An array typically contains a solid support and at least one oligonucleotide contacting the support, where the oligonucleotide corresponds to at least a portion of the miR-124 biomarker. In some embodiments, the portion of the miR-124 biomarker comprises at least 5, 10, 15, 20 or more bases.

According to one embodiment, the presence or expression of miR-124 may be assayed in combination with others miRNA also used as biomarkers. In such an embodiment, an array can be used to assess the expression or presence of multiple miRNAs in a sample, including miRNA-124. In general, the method comprises the following steps: a) contacting the sample with an array comprising a probe set under conditions sufficient for specific binding to occur; and b) examining the array to detect the presence of any detectable label, thereby evaluating the amount of the respective target miRNAs in the sample. The use of an expression array allows obtaining a miRNA expression profile for a given sample.

Methods of preparing assays or arrays for assaying miRNAs are well known in the art and are not needed to be further detailed here.

Nucleic acid arrays can be used to detect presence or differential expression of miRNAs in biological samples. Polynucleotide arrays (such as DNA or RNA arrays) typically include regions of usually different sequence polynucleotides ("capture agents") arranged in a predetermined configuration on a support. The arrays are "addressable" in that these regions (sometimes referenced as "array features") have different predetermined locations ("addresses") on the support of array. The region (i.e., a "feature" or "spot" of the array) at a particular predetermined location (i.e., an "address") on the array will detect a particular miRNA target. The polynucleotide arrays typically are fabricated on planar supports either by depositing previously obtained polynucleotides onto the support in a site specific fashion or by site specific in situ synthesis of the polynucleotides upon the support. Arrays to detect miRNA expression can be fabricated by depositing (e.g., by contact- or jet-based methods or photolithography) either precursor units (such as nucleotide or amino acid monomers) or pre-synthesized capture agent. After depositing the polynucleotide capture agents onto the support, the support is typically processed (e.g., washed and blocked for example) and stored prior to use.

An array to detect miRNA expression has at least two, three, four, or five different subject probes. However, in certain embodiments, a subject array may include a

Date Reçue/Date Received 2022-06-29

probe set having at least 10, at least 20, at least 50, at least 100, at least 200, at least 500, or at least 1,000 or more probes that can detect a corresponding number of miRNAs. In some embodiments, the subject arrays may include probes for detecting at least a portion or all of the identified miRNAs of an organism, or may include orthologous probes from multiple organisms.

A nucleic acid array may be contacted with a sample or labeled sample containing miRNA analytes under conditions that promote specific binding of the miRNA in the sample to one or more of the capture agents present on the array to exhibit an observed binding pattern. This binding pattern can be detected upon interrogating the array. For example, the target miRNAs in the sample can be labeled with a suitable label (such as a fluorescent compound), and the label then can be accurately observed (such as by observing the fluorescence pattern) on the array after exposure of the array to the sample. The observed binding pattern can be indicative of the presence and/or concentration of one or more miRNA components of the sample.

The labeling of miRNAs may be carried using methods well known in the art, such as using DNA ligase, terminal transferase, or by labeling the RNA backbone, etc. In some embodiments, the miRNAs may be labeled with fluorescent label. Exemplary fluorescent dyes include but are not limited to xanthene dyes, fluorescein dyes, rhodamine dyes, fluorescein isothiocyanate (FITC), 6 carboxyfluorescein (FAM), 6 carboxy-2 l ,4 l ,7',4,7-hexachlorofluorescein (HEX), 6 carboxy 4', 5' dichloro 2', 7' dimethoxyfluorescein (JOE or J), N,N,N',N' tetramethyl 6 carboxyrhodamine (TAMRA or T), 6 carboxy X rhodamine (ROX or R), 5 carboxyrhodamine 6G (R6G5 or G5), 6 carboxyrhodamine 6G (R6G6 or G6), and rhodamine 110; cyanine dyes, e.g. Cy3, Cy5 and Cy7 dyes; Alexa dyes, e.g. Alexa-fluor-555; coumarin, Diethylaminocoumarin, umbelliferone; benzimide dyes, e.g. Hoechst 33258; phenanthridine dyes, e.g. Texas Red; ethidium dyes; acridine dyes; carbazole dyes; phenoxazine dyes; porphyrin dyes; polymethine dyes, BODIPY dyes, quinoline dyes, Pyrene, Fluorescein Chlorotriazinyl, Rl 10, Eosin, JOE, R6G, Tetramethylrhodamine, Lissamine, ROX, Naptho fluorescein, and the like.

In some embodiments, an oligonucleotide array for assessing immunomodulatory activity can be prepared or purchased, for example from Affymetrix. The array may contain a solid support and a plurality of oligonucleotides contacting the support. The oligonucleotides may be present in specific, addressable locations on the solid

Date Reçue/Date Received 2022-06-29

support; each corresponding to at least a portion of miRNA sequences which may be differentially expressed upon treatment of a quinoline derivative or a drug candidate in a cell or a patient. The miRNA sequences comprise at least one miR-124 sequence.

When an array is used to assess miRNAs, a typical method can contain the steps of 1) obtaining the array containing surface-bound subject probes; 2) hybridization of a population of miRNAs to the surface-bound probes under conditions sufficient to provide for specific binding (3) post-hybridization washes to remove nucleic acids not bound in the hybridization; and (4) detection of the hybridized miRNAs. The reagents used in each of these steps and their conditions for use may vary depending on the particular application.

Hybridization can be carried out under suitable hybridization conditions, which may vary in stringency as desired. Typical conditions are sufficient to produce probe/target complexes on an array surface between complementary binding members, i.e., between surface-bound subject probes and complementary miRNAs in a sample. In certain embodiments, stringent hybridization conditions may be employed. Hybridization is typically performed under stringent hybridization conditions. Standard hybridization techniques which are well-known in the art (e.g. under conditions sufficient to provide for specific binding of target miRNAs in the sample to the probes on the array) are used to hybridize a sample to a nucleic acid array. Selection of appropriate conditions, including temperature, salt concentration, polynucleotide concentration, hybridization time, stringency of washing conditions, and the like will depend on experimental design, including source of sample, identity of capture agents, degree of complementarity expected, etc., and may be determined as a matter of routine experimentation for those of ordinary skill in the art. In general, a "stringent hybridization" and "stringent hybridization wash conditions" in the context of nucleic acid hybridization are typically sequence dependent, and are different under different experimental conditions. Hybridization may be done over a period of about 12 to about 24 hours. The stringency of the wash conditions can affect the degree to which miRNA sequences are specifically hybridized to complementary capture agents. Those of ordinary skill will readily recognize that alternative but comparable hybridization and wash conditions can be utilized to provide conditions of similar stringency.

Date Reçue/Date Received 2022-06-29

As an illustration, in one embodiment, the miRNA expression profiling experiments may be conducted using the Affymetrix Genechip miRNA Array 2.0 and following the protocols described in the instruction manual.

In one particular embodiment, said hybridization can be performed using the GeneChip® Hybridization, Wash, and Stain Kit (Affymetrix Ref. #900720). Advantageously, said hybridization is performed by following the protocols of the manufacturer.

After the miRNA hybridization procedure, the array-surface bound polynucleotides are typically washed to remove unbound nucleic acids. Washing may be performed using any convenient washing protocol, where the washing conditions are typically stringent, as described above. For instance, a washing step may be performed using washing buffers sold by the company Affymetrix (Ref. #900721 and #900722). The hybridization of the target miRNAs to the probes is then detected using standard techniques of reading the array. Reading the resultant hybridized array may be accomplished, for example, by illuminating the array and reading the location and intensity of resulting fluorescence at each feature of the array to detect miRNA/probe binding complexes.

A modulation of the presence or level of expression of miR-124 relatively to the control reference, such as a control reference value from a healthy donor, may be indicative of an inflammatory disease. In particular a reduced or suppressed presence, or a decreased level of expression, of said miRNA relative to a control reference value (i.e., a control reference value from a healthy donor) may be indicative of an inflammatory disease.

Thus, in one embodiment, a use of the invention may comprise obtaining or measuring a level of expression of miR-124 into an isolated biological sample and comparing said measured level of expression to a control reference value. An observation of a modulation of said measured level relatively to said control reference value may be indicative of an inflammatory disease, or of the treatment of said inflammatory disease.

An increased or up-regulated level of expression of miR-124 in the presence of a drug candidate, relatively to a control reference value (i.e., without the treatment by the drug candidate, such as a quinoline derivative) is indicative of a drug candidate presumed effective in treating and/or preventing an inflammatory disease.

Date Reçue/Date Received 2022-06-29

Accordingly, when miR-124 from a sample is "*increased*" or "*up-regulated*" in a biological sample, as compared to a control reference value, this increase can be of about 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 90%, 100%, 200%, 300%, 500%, 1,000%, 5,000% or more of the comparative control reference value (i.e., without the treatment by the quinoline derivative).

In particular, the measured level expression of miR-124 may be at least a two-fold, preferably at least a four-fold, preferably at least a six-fold, preferably at least an eight-fold, and more preferably at least a ten-fold increase relatively to said control reference value.

According to a preferred embodiment, the measured level expression of miR-124 may be at least a 100-fold increase relatively to said control reference value.

According to one embodiment, a use or a method according to the invention may be implemented for optimizing the dosing regimen of a patient. Patients may respond differently to a given quinoline derivative, in particular a compound of formula (I), depending on such factors as age, health, genetic background, presence of other complications, disease progression, and the co-administration of other drugs. It may be useful to utilize the miR-124 biomarker to assess and optimize the dosage regimen, such as the dose amount and/or the dose schedule, of a quinoline derivative in a patient. In this regard, miR-124-based biomarker can also be used to track and adjust individual patient treatment effectiveness over time. The biomarker can be used to gather information needed to make adjustments in a patient's treatment, increasing or decreasing the dose of an agent as needed. For example, a patient receiving a quinoline derivative can be tested using the miR-124 -based biomarker to see if the dosage is becoming effective, or if a more aggressive treatment plan needs to be put into place. The amount of administered drug, the timing of administration, the administration frequency, the duration of the administration may be then adjusted depending on the miR-124 biomarker measurement.

The miR-124 biomarker may also be used to track patient compliance during individual treatment regimes, or during clinical trials. This can be followed at set intervals to ensure that the patients included in the trial are taking the drugs as instructed. Furthermore, a patient receiving a quinoline derivative can be tested using the miR-124 biomarker to determine whether the patient complies with the dosing regimen of the

Date Reçue/Date Received 2022-06-29

treatment plan. An increased expression level of the biomarker compared to that of an untreated control sample is indicative of compliance with the protocol.

Thus, and without departing from the scope of the invention, a control reference value may be obtained from an eukaryotic cell that is derived from: a biological sample from an healthy donor, and/or a donor that was not previously treated with a given candidate drug, such as a given quinoline derivative.

A biomarker of the invention may be implemented to assess and follow the efficacy of quinoline derivatives, in particular compounds of formula (I). Accordingly, a presence or level of expression of miR-124 may be measured into an isolated biological sample obtained from a patient previously treated with a quinoline derivative, such as a compound of formula (I).

Then, the measured presence or level expression of miR-124 into an isolated biological sample can be compared to a control reference value.

When an increase of the measured level expression of miR-124 relatively to the control reference value is observed, then the measure is indicative of an activity of quinoline derivatives, and in particular compounds of formula (I).

In another embodiment, when an increase of the measured level of expression of miR-124 relatively to the control reference value is observed, then the measure may be indicative of a responsiveness of a patient to a treatment with said quinoline derivatives, in particular said compounds of formula (I).

In another embodiment, when an increase of the measured level relatively to the control reference value is observed, then the measure is indicative of an effectiveness of a treatment with said quinoline derivatives, in particular said compounds of formula (I).

In another embodiment, when an increase of the measured level of expression of miR-124 relatively to the control reference value is observed, then the measure is indicative a therapeutic efficacy of said quinoline derivatives, in particular said compounds of formula (I), as a therapeutic agent for preventing and/or treating an inflammatory disease.

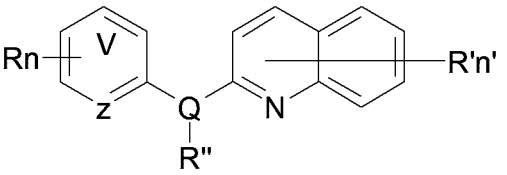
In another embodiment, when an increase of the measured level of expression of miR-124 relatively to the control reference value is observed, then the measure is indicative a therapeutic efficacy of a particular dosage regimen of said quinoline derivatives, in particular said compounds of formula (I) as a therapeutic agent for preventing and/or

Date Reçue/Date Received 2022-06-29

treating an inflammatory disease, if the control reference value is measured from a biological sample that is derived from a patient treated with anoter dosage regimen.

The chemical structures and spectroscopic data of some compounds of formula (I) of the invention are illustrated respectively in Table I herebelow and Table II (see examples).

Table I



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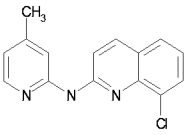
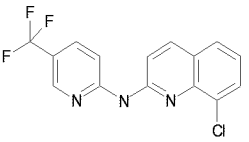
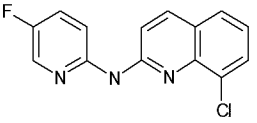
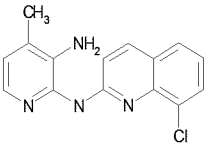
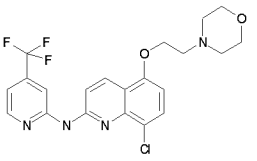
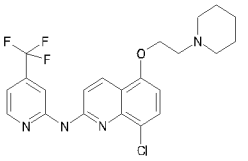
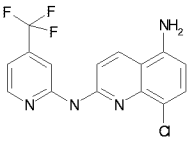
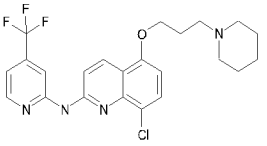
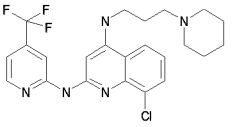
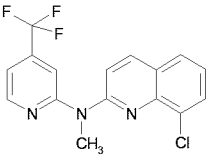
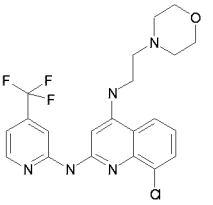
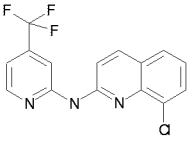
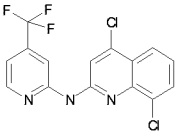
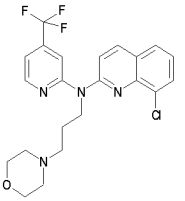
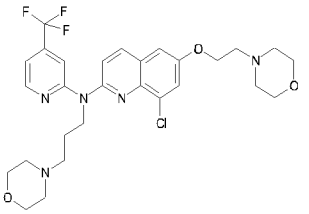
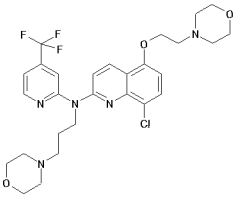
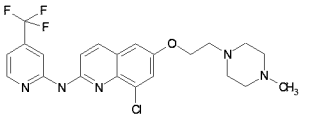
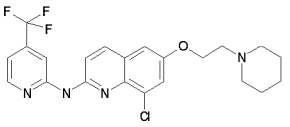
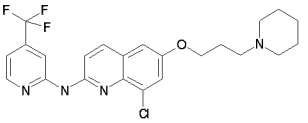
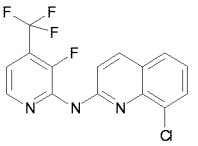
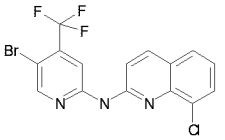
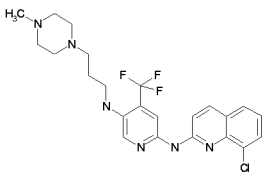
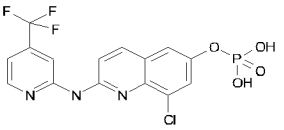
1	
2	
3	
4	
5	

6	
7	
8	
9	
10	
11	
12	
13	

14	
15	
16	
17	
18	
19	
20	
21	

Date Reçue/Date Received 2022-06-29

22	
51	
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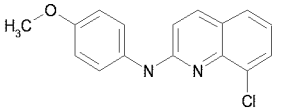
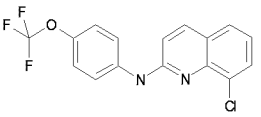
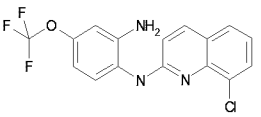
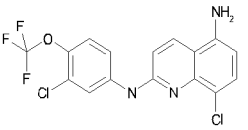
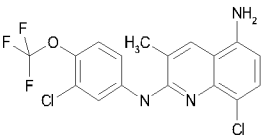
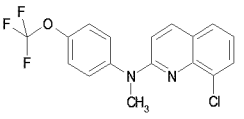
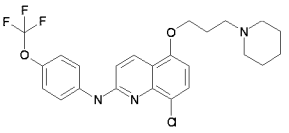
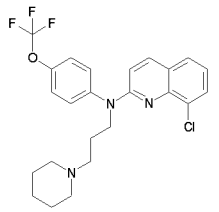
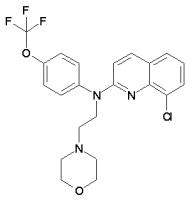
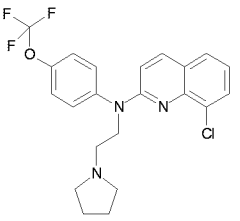
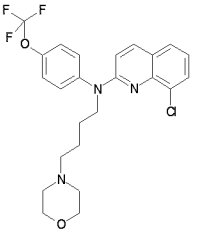
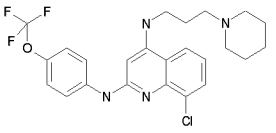
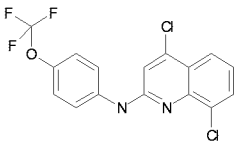
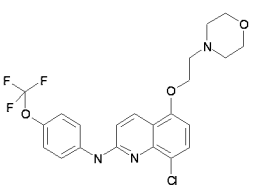
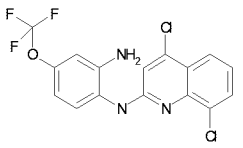
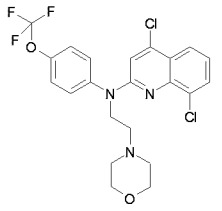
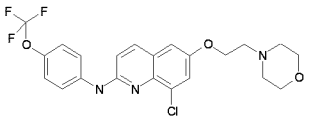
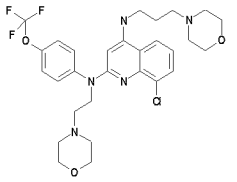
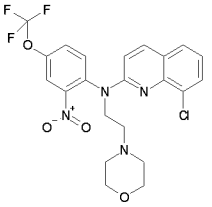
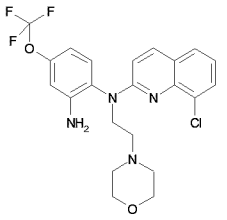
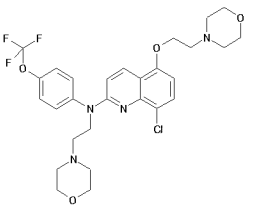
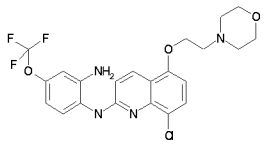
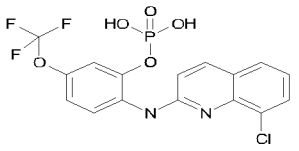
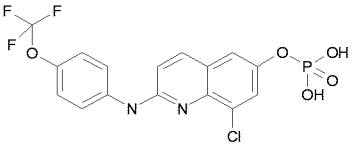
23	
24	
25	
26	
27	
28	
29	

30	
31	
32	
33	
34	
35	
36	

37	
38	
39	
40	
41	
42	
43	

44	
52	
53	
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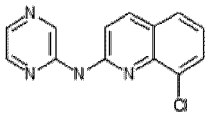
45	
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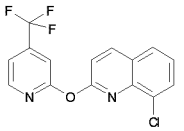
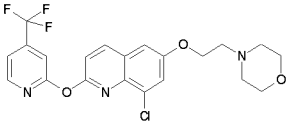
46	
47	
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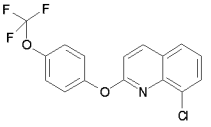
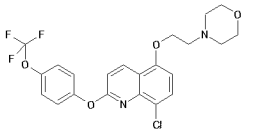
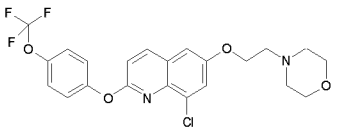
48	
49	

50	

The examples provided herein are intended to be merely exemplary, and those skilled in the art will recognize, or will be able to ascertain using no more than routine experimentation, numerous equivalents of specific compounds, materials, and procedures. All such equivalents are considered to be within the scope of the invention and are encompassed by the appended claims.

EXAMPLES

Example 1: 8-chloro-N^4-(3-(piperidin-1-yl)propyl)-N^2-(4-(trifluoromethyl)pyridin-2-yl)quinoline-2,4-diamine ; compound **(9)**

o-Chloroaniline (5.3 mL, 50 mmoles, 1 eq.) was placed in pyridine (8 mL). Diethyl malonate (11.4 mL, 75 mmoles, 1.5 eq.) was then added and the reaction mixture was stirred at 130°C for 14 hours. Upon cooling to room temperature, the reaction mixture was concentrated under reduced pressure and the resulting residue was diluted with dichloromethane. The organic phase was then washed with a saturated aqueous solution of Na_2CO_3, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to afford ethyl 2-[(2-chlorophenyl)carbamoyl]acetate (2.7 g, 22%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 9.74 (br s, 1H), 8.38 (dd, J = 8.1, 1.5 Hz, 1H), 7.40 (dd, J = 8.1, 1.5 Hz, 1H), 7.28 (td, J = 8.1, 1.5 Hz, 1H), 7.07 (td, J = 8.1, 1.5 Hz, 1H), 4.30 (q, J = 7.1 Hz, 2H), 3.54 (s, 2H), 1.34 (t, J = 7.1 Hz, 3H).

Ethyl 2-[(2-chlorophenyl)carbamoyl]acetate (2.4 g, 9.93 mmoles, 1 eq.) was placed in a THF (9.9 mL) / water (3.8 mL) mix. Sodium hydroxide (477 mg, 11.92 mmoles, 1.2 eq.) was then added and the reaction mixture was stirred for 14 hours at room temperature. Concentrated hydrochloric acid was then added until reaching pH 2 and the resulting solution was extracted with ethyl acetate. The organic phase was then dried over $MgSO_4$, filtered and concentrated under reduced pressure to afford 2-[(2-chlorophenyl)carbamoyl]acetic acid (2 g, 94%).

Date Reçue/Date Received 2022-06-29

^{1}H NMR (300 MHz, MeOD) δ 7.98 (dd, J = 8.1, 1.5 Hz, 1H), 7.45 (dd, J = 8.1, 1.5 Hz, 1H), 7.30 (td, J = 8.1, 1.5 Hz, 1H), 7.16 (td, J = 8.1, 1.5 Hz, 1H), 3.54 (s, 2H).

A reaction mixture of 2-[(2-chlorophenyl)carbamoyl]acetic acid (3.7 g, 17.32 mmoles, 1 eq.) in polyphosphoric acid (17 g, 173.2 mmoles, 10 eq.) was stirred at 130°C for 14 hours. The reaction mixture was cooled to room temperature then a 2M aqueous solution of sodium hydroxide was slowly added. The resulting precipitate was filtered, rinsed with water and dried under reduced pressure in a desiccator to afford 8-chloroquinoline-2,4-diol (3 g, 89%).

^{1}H NMR (300 MHz, DMSO) δ 11.66 (br s, 1H), 10.40 (br s, 1H), 7.78 (d, J = 7.8 Hz, 1H), 7.66 (d, J = 7.8 Hz, 1H), 7.17 (t, J = 7.8 Hz, 1H), 5.81 (s, 1H).

MS (ESI) $[M-H]^-$ = 194.1

A reaction mixture of 8-chloroquinoline-2,4-diol (1.5 g, 7.67 mmoles, 1 eq.) in $POCl_3$ (7.1 mL, 76.7 mmoles, 10 eq.) was stirred at 100°C for 2 hours. The reaction mixture was cooled to room temperature then water was slowly added. The resulting precipitate was filtered, rinsed with water and dried under reduced pressure in a desiccator to afford 2,4,8-trichloroquinoline (1.6 g, 90%).

^{1}H NMR (300 MHz, DMSO) δ 8.21 (d, J = 8.4 Hz, 1H), 8.14 (d, J = 8.4 Hz, 1H), 8.11 (s, 1H), 7.78 (t, J = 8.4 Hz, 1H).

A reaction mixture of 2,4,8-trichloroquinoline (1 g, 4.30 mmoles, 1 eq.), 2-amino-4-trifluoromethylpyridine (768 mg, 4.73 mmoles, 1.1 eq.), $Pd(OAc)_2$ (19 mg, 0.09 mmol, 2 mol%), XantPhos (50 mg, 0.09 mmol, 2 mol%) and Cs_2CO_3 (3.9 g, 12.04 mmoles, 2.8 eq.) in *t*-BuOH (17.2 mL) was heated at 90°C for 2 days. Upon cooling to room temperature, the reaction mixture was concentrated under reduced pressure and the resulting residue was diluted with ethyl acetate. The organic phase was then washed with water, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to afford (4,8-dichloro-quinolin-2-yl)-(4-trifluoromethyl-pyridin-2-yl)-amine **(13)** (588 mg, 38%).

Date Reçue/Date Received 2022-06-29

^{1}H NMR (300 MHz, $CDCl_3$) δ 9.40 (s, 1H), 8.46 (d, J = 5.4 Hz, 1H), 8.06 (dd, J = 8.1, 1.5 Hz, 1H), 7.86 (dd, J = 8.1, 1.5 Hz, 1H), 7.81 (s, 1H), 7.40 (t, J = 8.1 Hz, 1H), 7.25 (s, 1H), 7.22 (d, J = 5.4 Hz, 1H).

MS (ESI) $[M+H]^+$ = 358.1

A reaction mixture of (4,8-dichloro-quinolin-2-yl)-(4-trifluoromethyl-pyridin-2-yl)-amine (200 mg, 0.54 mmole, 1 eq.), 3-(piperidin-1-yl)propan-1-amine (94 μL, 0.59 mmole, 1.1 eq.), CuI (10 mg, 0.05 mmol, 0.1 eq), L-proline (9 mg, 0.11 mmole, 0.2 eq.), potassium carbonate (148 mg, 1.01 mmole, 2 eq.) in DMSO (1.4 mL) was stirred at 90°C for 24 hours under an inert atmosphere of argon. The reaction mixture was then partitioned between ethyl acetate and water. Upon decantation, the aqueous phase was further extracted with dichloromethane. The organic phases were gathered, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to give 8-chloro-N^4-(3-piperidin-1-yl-propyl)-N^2-(4-trifluoromethyl-pyridin-2-yl)-quinoline-2,4-diamine (**9**) (48 mg, 7%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 9.55 (s, 1H), 8.40 (d, J = 4.8 Hz, 1H), 7.85 (s, 1H), 7.77 (d, J = 7.8 Hz, 1H), 7.72 (d, J = 7.8 Hz, 1H), 7.62 (s, 1H), 7.18 (t, J = 7.8 Hz, 1H), 7.10 (d, J = 4.8 Hz, 1H), 5.88 (s, 1H), 3.41 – 3.31 (m, 2H), 2.59 (t, J = 5.4 Hz, 2H), 2.57 – 2.43 (m, 4H), 2.01 – 1.92 (m, 2H), 1.79 – 1.70 (m, 4H), 1.65 – 1.54 (m, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 154.9, 154.0, 152.3, 148.5, 144.2, 132.2, 129.7, 121.7, 119.7, 118.4, 112.4, 109.8, 88.0, 59.6, 55.1, 44.9, 26.1, 24.4, 23.4.

MS (ESI) $[M+H]^+$ = 464.2

Example 2: 2-*N*-(8-chloroquinolin-2-yl)-5-*N*-[3-(4-methylpiperazin-1-yl)propyl]-4-(trifluoromethyl)pyridine-2,5-diamine; compound **(22)**

A reaction mixture of 2,8-dichloroquinoline (198 mg, 1.0 mmol, 1 eq.), 5-bromo-4-(trifluoromethyl)pyridin-2-amine (241 mg, 1.0 mmol, 1 eq.), $Pd(OAc)_2$ (4.5 mg, 0.02 mmol, 2 mol%), XantPhos (11.6 mg, 0.02 mmol, 2 mol%) and Cs_2CO_3 (782 mg, 2.4 mmoles, 2.4 eq.) in *t*-BuOH (4 mL) was heated in a microwave reactor at 120°C for 70 minutes. Upon cooling to room temperature, the reaction mixture was concentrated under reduced pressure and the resulting residue was diluted with ethyl acetate. The organic phase was then washed with water, dried over $MgSO_4$, filtered and concentrated under reduced

Date Reçue/Date Received 2022-06-29

pressure. The resulting residue was purified by column chromatography on silica gel to afford *N*-[5-bromo-4-(trifluoromethyl)pyridin-2-yl]-8-chloroquinolin-2-amine (**21**) (300 mg, 75%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 9.71 (s, 1H), 8.51 (s, 1H), 8.06 (d, J = 9.0 Hz, 1H), 7.81 (m, 2H), 7.65 (d, J = 7.8 Hz, 1H), 7.33 (t, J = 7.8 Hz, 1H), 7.00 (d, J = 9.0 Hz, 1H).

MS (ESI) $[M+H]^+$ = 403.7

A reaction mixture of *N*-[5-bromo-4-(trifluoromethyl)pyridin-2-yl]-8-chloroquinolin-2-amine (101 mg, 0.250 mmol, 1 eq.), 3-(4-methylpiperazin-1-yl)propan-1-amine (64 µL, 0.375 mmol, 1.5 eq.), $Pd_2(dba)_3$ (28 mg, 0.030 mmol, 12 mol%), XantPhos (43.4 mg, 0.075 mmol, 30 mol%) and sodium *tert*-butoxide (72 mg, 0.75 mmol, 3 eq.) in a dioxane (1 mL) / DMF (0.1 mL) mixture was heated in a microwave reactor at 120°C for 70 minutes. Upon cooling to room temperature, the reaction mixture was concentrated under reduced pressure and the resulting residue was diluted with ethyl acetate. The organic phase was then washed with water, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to afford 2-*N*-(8-chloroquinolin-2-yl)-5-*N*-[3-(4-methylpiperazin-1-yl)propyl]-4-(trifluoromethyl)pyridine-2,5-diamine (**22**) (52 mg, 43%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 9.39 (s, 1H), 7.97 – 7.86 (m, 2H), 7.82 (br s, 1H), 7.73 (d, J = 7.5 Hz, 1H), 7.56 (d, J = 7.5 Hz, 1H), 7.23 (t, J = 7.5 Hz, 1H), 6.94 (d, J = 9.0 Hz, 2H), 3.34 – 3.22 (m, 2H), 2.80 – 2.44 (m, 10H), 2.37 (s, 3H), 1.87 (t, J = 6.0 Hz, 2H).

MS (ESI) $[M+H]^+$ = 479.0

Example 3: 8-chloro-*N*-methyl-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine ; compound **(28)**

8-chloro-*N*-[4-(trifluoromethoxy)phenyl]quinolin-2-amine, *i.e.* compound **(24)**, was synthesised as in WO2010/143169, in example 5.

A reaction mixture of 8-chloro-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine (**24**) (340 mg, 1.0 mmole, 1 eq.), potassium *tert*-butoxide (124 mg, 1.1 mmole, 1.1 eq.), and iodomethane (69 µL, 1.1 mmole, 1.1 eq.), in DMF (2 mL) was stirred at room temperature for 4 hours. The reaction mixture was then partitioned between ethyl acetate

Date Reçue/Date Received 2022-06-29

and water. The organic phases were gathered, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to give 8-chloro-*N*-methyl-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine (**28**) (247 mg, 70%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.69 (d, J = 9.0 Hz, 2H), 7.49 (d, J = 7.8 Hz, 1H), 7.36 – 7.25 (m, 4H), 7.14 (t, J = 7.8 Hz, 1H), 6.75 (d, J = 9.0 Hz, 1H), 3.69 (s, 3H).

MS (ESI) $[M+H]^+$ = 353.1

Example 4: 8-chloro-*N*-(3-(piperidin-1-yl)propyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine ; compound **(30)**

8-chloro-*N*-[4-(trifluoromethoxy)phenyl]quinolin-2-amine, *i.e.* compound **(24)**, was synthesised as in WO2010/143169, in example 5.

A reaction mixture of 8-chloro-*N*-[4-(trifluoromethoxy)phenyl]quinolin-2-amine (**24**) (500 mg, 1.47 mmole, 1 eq.) and NaH (177 mg, 4.43 mmoles, 3 eq.) in anhydrous DMF (2 mL) was stirred at room temperature for 30 minutes. A reaction mixture of 1-(3-chloropropyl)piperidine hydrochloride (292 mg, 1.47 mmole, 1 eq.), KI (245 mg, 1.47 mmole, 1 eq.) and Et_3N (205 µL, 1.47 mmole, 1 eq.) in anhydrous DMF (5 mL) was stirred at room temperature for 30 minutes under an inert atmosphere of argon. The activated quinoline was then added to the piperidine chain and the resulting reaction mixture was stirred at 90°C for 4 hours. The reaction mixture was then concentrated under reduced pressure and the resulting residue was diluted with ethyl acetate. The organic phase was washed with a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to afford 8-chloro-*N*-(3-(piperidin-1-yl)propyl)-*N*-(4-(trifluoromethoxy)phenyl)quinolin-2-amine (**30**) (472 mg, 69%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.73 – 7.63 (m, 2H), 7.48 (d, J = 7.9 Hz, 1H), 7.39 – 7.26 (m, 4H), 7.13 (t, J = 7.9 Hz, 1H), 6.67 (d, J = 9.1 Hz, 1H), 4.26 – 4.14 (m, 2H), 2.52 – 2.33 (m, 6H), 2.11 – 1.97 (m, 2H), 1.64 – 1.52 (m, 4H), 1.45 (s, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 156.5, 147.3, 144.1, 143.5, 137.1, 130.8, 129.7, 129.1, 126.4, 124.7, 122.7, 122.4, 118.9 (t, J = 222 Hz), 112.5, 56.9, 54.5, 49.6, 25.6, 24.6, 24.3.

MS (ESI) $[M+H]^+$ = 464.4

Date Reçue/Date Received 2022-06-29

Example 5: 8-chloro-2-((4-(trifluoromethyl)pyridin-2-yl)oxy)quinoline ; compound **(46)**

A reaction mixture of 2,8-dichloroquinoline (79 mg, 0.4 mmol, 1 eq.), 2-hydroxy-4-(trifluoromethyl)pyridine (65 mg, 0.4 mmol, 1 eq.), CuI (76 mg, 0.4 mmol, 1 eq.) and Cs_2CO_3 (391 mg, 1.2 mmol, 3 eq.) in DMF (6 mL) was heated in a microwave reactor at 150°C for 50 minutes. Upon cooling to room temperature, water was added to the reaction mixture. The undissolved solids were filtered through celite and the resulting filtrate was twice extracted with ethyl acetate. The organic phase was washed with water and a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to afford 8-chloro-2-{[4-(trifluoromethyl)pyridin-2-yl]oxy}quinoline (**46**) (68 mg, 52%).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.40 (d, J = 7.2 Hz, 1H), 8.34 (d, J = 8.8 Hz, 1H), 8.18 (d, J = 8.8 Hz, 1H), 7.90 (d, J = 7.2 Hz, 1H), 7.85 (d, J = 7.9 Hz, 1H), 7.56 (t, J = 7.9 Hz, 1H), 6.98 (s, 1H), 6.53 (d, J = 7.9 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 161.6, 151.2, 143.4, 142.3, 138.7, 138.2, 137.4, 133.4, 130.6, 129.1, 127.6, 126.7, 120.2, 119.7, 102.3.

MS (ESI) $[M+H]^+$ = 325.1

Example 6: 8-chloro-2-(4-(trifluoromethoxy)phenoxy)quinoline ; compound **(48)**

A reaction mixture of 2,8-dichloroquinoline (2x 79 mg, 2x 0.4 mmol, 1 eq.), 4-(trifluoromethoxy)phenol (2x 52 μL, 2x 0.4 mmol, 1 eq.), CuI (2x 76 mg, 2x 0.4 mmol, 1 eq.) and Cs_2CO_3 (2x 391 mg, 2x 1.2 mmol, 3 eq.) in DMF (2x 6 mL) was heated in a microwave reactor at 150°C for 50 minutes. Upon cooling to room temperature, water was added to the reaction mixture. The undissolved solids were filtered through celite and the resulting filtrate was twice extracted with ethyl acetate. The organic phase was washed with water and a saturated aqueous solution of brine, dried over $MgSO_4$, filtered and concentrated under reduced pressure. The resulting residue was purified by column chromatography on silica gel to afford 8-chloro-2-[4-(trifluoromethoxy)phenoxy]quinoline **48** (212 mg, 78%).

Date Reçue/Date Received 2022-06-29

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.12 (d, J = 8.8 Hz, 1H), 7.73 (d, J = 8.1 Hz, 1H), 7.66 (d, J = 8.1 Hz, 1H), 7.46 (d, J = 9.1 Hz, 2H), 7.38 – 7.22 (m, 3H), 7.12 (d, J = 8.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 161.5, 151.9, 145.9, 142.7, 140.5, 132.0, 130.3, 127.0, 126.4, 125.1, 122.8, 122.2, 119.0 (t, J = 255 Hz), 113.6.

MS (ESI) $[M+H]^+$ = 340.1

The structures of other compounds of the invention have been confirmed by NMR spectra.

Table II

Ex	Characterizations
8	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.57 (s, 1H), 8.45 (d, J = 9.0 Hz, 1H), 8.43 (d, J = 5.1 Hz, 1H), 7.90 (br s, 1H), 7.66 (d, J = 8.4 Hz, 1H), 7.18 (d, J = 5.1 Hz, 1H), 6.99 (d, J = 9.0 Hz, 1H), 6.68 (d, J = 8.4 Hz, 1H), 4.17 (t, J = 6.3 Hz, 2H), 2.56 (t, J = 7.8 Hz, 2H), 2.50 – 2.39 (m, 4H), 2.17 – 2.04 (m, 2H), 1.66 – 1.59 (m, 4H), 1.51 – 1.43 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 154.1, 153.8, 152.5, 148.7, 143.8, 133.5, 129.8, 122.9, 117.5, 113.2, 112.5, 109.9, 103.9, 67.2, 56.2, 54.8, 26.9, 26.1, 24.5. MS (ESI) $[M+H]^+$ = 465.4
9	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.55 (s, 1H), 8.40 (d, J = 4.8 Hz, 1H), 7.85 (s, 1H), 7.77 (d, J = 7.8 Hz, 1H), 7.72 (d, J = 7.8 Hz, 1H), 7.62 (s, 1H), 7.18 (t, J = 7.8 Hz, 1H), 7.10 (d, J = 4.8 Hz, 1H), 5.88 (s, 1H), 3.41 – 3.31 (m, 2H), 2.59 (t, J = 5.4 Hz, 2H), 2.57 – 2.43 (m, 4H), 2.01 – 1.92 (m, 2H), 1.79 – 1.70 (m, 4H), 1.65 – 1.54 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 154.9, 154.0, 152.3, 148.5, 144.2, 132.2, 129.7, 121.7, 119.7, 118.4, 112.4, 109.8, 88.0, 59.6, 55.1, 44.9, 26.1, 24.4, 23.4. MS (ESI) $[M+H]^+$ = 464.2
10	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.53 (d, J = 4.8 Hz, 1H), 8.10 (s, 1H), 8.04 (d, J = 9.0 Hz, 1H), 7.76 (dd, J = 7.5, 1.2 Hz, 1H), 7.64 (dd, J = 7.5, 1.2 Hz, 1H), 7.43 (d, J = 9.0 Hz, 1H), 7.30 (t, J = 7.5 Hz, 1H), 7.15 (d, J = 4.8 Hz, 1H), 3.87 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 157.6, 155.8, 149.0, 143.4, 138.0, 131.9, 130.0, 126.3, 126.1, 124.4, 115.0, 113.1, 113.0, 111.6, 111.5, 36.3. MS (ESI) $[M+H]^+$ = 338.1
11	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.50 (s, 1H), 8.41 (br s, 1H), 8.14 (br s, 1H), 7.72 (d, J = 7.8 Hz, 1H), 7.53 (d, J = 7.8 Hz, 1H), 7.21 (t, J = 7.8 Hz, 1H), 7.11 (s, 1H), 5.96 (s, 1H), 5.88 (s, 1H), 3.77 (s, 4H), 3.25 (s, 2H), 2.77 (s, 2H), 2.54 (s, 4H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 154.8, 153.7, 151.1, 148.5, 144.2, 132.4, 129.9, 122.4, 118.2, 118.0, 112.5, 109.9, 89.2, 67.2, 56.0, 53.2, 38.9. MS (ESI) $[M+H]^+$ = 452.1
13	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.40 (s, 1H), 8.46 (d, J = 5.4 Hz, 1H), 8.06 (dd, J = 7.8, 1.5 Hz, 1H), 7.86 (dd, J = 7.8, 1.5 Hz, 1H), 7.81 (s, 1H), 7.40 (t, J = 7.8 Hz, 1H), 7.25 (s, 1H), 7.22 (d, J = 5.4 Hz, 1H). MS (ESI) $[M+H]^+$ = 358.1
14	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.51 (d, J = 4.8 Hz, 1H), 7.99 (d, J = 9.0 Hz, 1H), 7.79 (s, 1H), 7.75 (d, J = 7.5 Hz, 1H), 7.63 (d, J = 7.5 Hz, 1H), 7.39 (d, J = 9.0 Hz, 1H), 7.29 (t, J = 7.5 Hz, 1H), 7.14 (d, J = 4.8 Hz, 1H), 4.48 (t, J = 7.2 Hz, 2H), 3.77 – 3.59 (m, 4H), 2.57 – 2.33 (m, 6H), 2.13 – 1.97 (m, 2H). MS (ESI) $[M+H]^+$ = 451.2

Ex	Characterizations
15	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.47 (d, *J* = 4.8 Hz, 1H), 7.89 (d, *J* = 9.0 Hz, 1H), 7.68 (s, 1H), 7.49 (d, *J* = 2.7 Hz, 1H), 7.38 (d, *J* = 9.0 Hz, 1H), 7.08 (d, *J* = 4.8 Hz, 1H), 6.99 (d, *J* = 2.7 Hz, 1H), 4.45 (t, *J* = 6.9 Hz, 2H), 4.21 (t, *J* = 5.4 Hz, 2H), 3.83 – 3.64 (m, 8H), 2.87 (t, *J* = 5.4 Hz, 2H), 2.70 – 2.56 (m, 4H), 2.56 – 2.36 (m, 6H), 2.12 – 1.96 (t, *J* = 6.9 Hz, 2H). MS (ESI) $[M+H]^+$ = 580.4
16	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.50 (d, *J* = 4.8 Hz, 1H), 8.37 (d, *J* = 9.0 Hz, 1H), 7.80 (s, 1H), 7.61 (d, *J* = 8.4 Hz, 1H), 7.34 (d, *J* = 9.0 Hz, 1H), 7.13 (d, *J* = 4.8 Hz, 1H), 6.65 (d, *J* = 8.4 Hz, 1H), 4.47 (t, *J* = 6.9 Hz, 2H), 4.26 (t, *J* = 5.4 Hz, 2H), 3.78 – 3.64 (m, 8H), 2.92 (t, *J* = 5.4 Hz, 2H), 2.69 – 2.56 (m, 4H), 2.55 – 2.38 (m, 6H), 2.05 (t, *J* = 6.9 Hz, 2H). MS (ESI) $[M+H]^+$ = 580.2
17	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.47 (s, 1H), 8.41 (d, *J* = 5.1 Hz, 1H), 8.24 (br s, 1H), 7.88 (d, *J* = 8.7 Hz, 1H), 7.49 (d, *J* = 2.7 Hz, 1H), 7.14 (d, *J* = 5.1 Hz, 1H), 6.99 (d, *J* = 8.7 Hz, 1H), 6.94 (d, *J* = 2.7 Hz, 1H), 4.17 (t, *J* = 5.7 Hz, 2H), 2.87 (t, *J* = 5.7 Hz, 2H), 2.75 – 2.61 (m, 4H), 2.57 – 2.45 (m, 4H), 2.31 (s, 3H). MS (ESI) $[M+H]^+$ = 233.6
18	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.48 (s, 1H), 8.42 (d, *J* = 4.8 Hz, 1H), 7.94 (d, *J* = 8.7 Hz, 1H), 7.78 (br s, 1H), 7.53 (d, *J* = 2.4 Hz, 1H), 7.16 (d, *J* = 4.8 Hz, 1H), 7.06 – 6.98 (m, 2H), 4.20 (t, *J* = 6.0 Hz, 2H), 2.84 (t, *J* = 6.0 Hz, 2H), 2.61 – 2.50 (m, 4H), 1.69 – 1.59 (m, 4H), 1.52 – 1.42 (m, 2H). MS (ESI) $[M+H]^+$ = 450.9
19	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.48 (s, 1H), 8.41 (d, *J* = 4.5 Hz, 1H), 8.34 (s, 1H), 7.87 (d, *J* = 8.7 Hz, 1H), 7.46 (s, 1H), 7.14 (d, *J* = 4.5 Hz, 1H), 7.01 – 6.89 (m, 2H), 4.08 (t, *J* = 5.7 Hz, 2H), 2.66 – 2.41 (m, 6H), 2.13 – 1.99 (m, 2H), 1.72 – 1.59 (m, 4H), 1.55 – 1.41 (m, 2H). MS (ESI) $[M+H]^+$ = 465.0
20	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.70 (d, *J* = 9.0 Hz, 1H), 8.24 (d, *J* = 4.8 Hz, 1H), 8.19 (d, *J* = 9.0 Hz, 1H), 8.11 (s, 1H), 7.79 (d, *J* = 7.8 Hz, 1H), 7.71 (d, *J* = 7.8 Hz, 1H), 7.34 (t, *J* = 7.8 Hz, 1H), 7.08 (t, *J* = 4.8 Hz, 1H). MS (ESI) $[M+H]^+$ = 341.9
21	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.71 (s, 1H), 8.51 (s, 1H), 8.06 (d, *J* = 9.0 Hz, 1H), 7.81 (m, 2H), 7.65 (d, *J* = 7.8 Hz, 1H), 7.33 (t, *J* = 7.8 Hz, 1H), 7.00 (d, *J* = 9.0 Hz, 1H). MS (ESI) $[M+H]^+$ = 403.7
22	^{1}H NMR (300 MHz, $CDCl_3$) δ 9.39 (s, 1H), 7.97 – 7.86 (m, 2H), 7.82 (br s, 1H), 7.73 (d, *J* = 7.5 Hz, 1H), 7.56 (d, *J* = 7.5 Hz, 1H), 7.23 (t, *J* = 7.5 Hz, 1H), 6.94 (d, *J* = 9.0 Hz, 2H), 3.34 – 3.22 (m, 2H), 2.80 – 2.44 (m, 10H), 2.37 (s, 3H), 1.87 (t, *J* = 6.0 Hz, 2H). MS (ESI) $[M+H]^+$ = 479.0
28	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.69 (d, *J* = 9.0 Hz, 2H), 7.49 (d, *J* = 7.8 Hz, 1H), 7.36 – 7.25 (m, 4H), 7.14 (t, *J* = 7.8 Hz, 1H), 6.75 (d, *J* = 9.0 Hz, 1H), 3.69 (s, 3H). MS (ESI) $[M+H]^+$ = 353.1
29	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.26 (d, *J* = 9.0 Hz, 1H), 7.93 (d, *J* = 9.0 Hz, 2H), 7.54 (d, *J* = 8.4 Hz, 1H), 7.21 (d, *J* = 9.0 Hz, 3H), 6.83 (d, *J* = 9.0 Hz, 1H), 6.53 (d, *J* = 8.4 Hz, 1H), 4.06 (t, *J* = 6.0 Hz, 2H), 2.56 (t, *J* = 7.5 Hz, 2H), 2.52 – 2.40 (m, 4H), 2.14 – 2.01 (m, 2H), 1.69 – 1.58 (m, 4H), 1.50 – 1.41 (m, 2H). MS (ESI) $[M+H]^+$ = 480.3
30	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.73 – 7.63 (m, 2H), 7.48 (d, *J* = 7.9 Hz, 1H), 7.39 – 7.26 (m, 4H), 7.13 (t, *J* = 7.9 Hz, 1H), 6.67 (d, *J* = 9.1 Hz, 1H), 4.26 – 4.14 (m, 2H), 2.52 – 2.33 (m, 6H), 2.11 – 1.97 (m, 2H), 1.64 – 1.52 (m, 4H), 1.45 (s, 2H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 156.5, 147.3, 144.1, 143.5, 137.1, 130.8, 129.7, 129.1, 126.4, 124.7, 122.7, 122.4, 121.8, 118.9, 112.5, 56.9, 54.5, 49.6, 25.6, 24.6, 24.3. MS (ESI) $[M+H]^+$ = 464.4

Date Reçue/Date Received 2022-06-29

Ex	Characterizations
31	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.74 – 7.65 (m, 2H), 7.50 (d, *J* = 7.8 Hz, 1H), 7.42 – 7.28 (m, 4H), 7.14 (t, *J* = 7.8 Hz, 1H), 6.63 (d, *J* = 9.0 Hz, 1H), 4.34 (t, *J* = 6.9 Hz, 2H), 3.66 (t, *J* = 4.5 Hz, 4H), 2.78 (t, *J* = 6.9 Hz, 2H), 2.59 (t, *J* = 4.5 Hz, 4H). MS (ESI) $[M+H]^+$ = 452.3
32	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.70 (d, *J* = 9.0 Hz, 1H), 7.69 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.50 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.38 – 7.26 (m, 4H), 7.15 (t, *J* = 7.8 Hz,1H), 6.66 (d, *J* = 9.0 Hz, 1H), 4.35 (t, *J* = 7.5 Hz, 2H), 2.91 (t, *J* = 7.5 Hz, 2H), 2.70 – 2.60 (m, 4H), 1.83 – 1.74 (m, 4H). MS (ESI) $[M+H]^+$ = 436.1
33	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.66 (d, *J* = 9.3 Hz, 1H), 7.64 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.46 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.29 – 7.22 (m, 4H), 7.10 (t, *J* = 7.8 Hz, 1H), 6.59 (d, *J* = 9.3 Hz, 1H), 4.16 (t, *J* = 7.5 Hz, 2H), 3.66 (t, *J* = 4.8 Hz, 4H), 2.46 – 2.36 (m, 6H), 1.78 (dt, *J* = 15.0, 7.2 Hz, 2H), 1.59 (dt, *J* = 15.0, 7.2 Hz, 2H). MS (ESI) $[M+H]^+$ = 480.1
34	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.80 (d, *J* = 9.0 Hz, 2H), 7.75 (d, *J* = 8.4 Hz, 1H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.58 (br s, 1H), 7.19 (d, *J* = 9.0 Hz, 2H), 7.11 (t, *J* = 8.4 Hz, 1H), 5.83 (s, 1H), 3.24 (t, *J* = 5.4 Hz, 2H), 2.61 – 2.46 (m, 6H), 1.91 (t, *J* = 5.4 Hz, 2H), 1.78 – 1.68 (m, 4H), 1.62 – 1.52 (m, 2H). MS (ESI) $[M+H]^+$ = 479.3
35	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.00 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.87 (d, *J* = 9.0 Hz, 2H), 7.80 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.32 (t, *J* = 7.8 Hz, 1H), 7.27 (d, *J* = 9.0 Hz, 2H), 7.05 (s, 1H), 6.84 (br s, 1H).
36	^{1}H NMR (300 MHz, MeOD) δ 8.37 (d, *J* = 9.0 Hz, 1H), 8.26 (d, *J* = 9.3 Hz, 2H), 7.60 (d, *J* = 8.4 Hz, 1H), 7.22 (d, *J* = 9.3 Hz, 2H), 7.00 (d, *J* = 9.0 Hz, 1H), 6.75 (d, *J* = 8.4 Hz, 1H), 4.29 (t, *J* = 5.4 Hz, 2H), 3.73 (t, *J* = 4.8 Hz, 4H), 2.94 (t, *J* = 5.4 Hz, 2H), 2.66 (t, *J* = 4.8 Hz, 4H). MS (ESI) $[M+H]^+$ = 468.1
37	^{1}H NMR (300 MHz, MeOD) δ 7.92 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.71 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.63 (d, *J* = 8.7 Hz, 1H), 7.24 (t, *J* = 7.8 Hz, 1H), 7.05 (s, 1H), 6.83 – 6.79 (m, 1H), 6.64 – 6.58 (m, 1H). MS (ESI) $[M+H]^+$ = 388.0
38	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.8 Hz, 1H), 7.70 (d, *J* = 7.8 Hz, 1H), 7.37 (d, *J* = 9.0 Hz, 2H), 7.32 (d, *J* = 9.0 Hz, 2H), 7.17 (t, *J* = 7.8 Hz, 1H), 6.69 (s, 1H), 4.29 (t, *J* = 6.9 Hz, 2H), 3.63 (t, *J* = 4.5 Hz, 4H), 2.73 (t, *J* = 6.9 Hz, 2H), 2.55 (t, *J* = 4.5 Hz, 4H). MS (ESI) $[M+H]^+$ = 486.1
39	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.87 (d, *J* = 9.0 Hz, 2H), 7.78 (d, *J* = 8.7 Hz, 1H), 7.44 (d, *J* = 2.7 Hz, 1H), 7.21 (d, *J* = 9.0 Hz, 2H), 6.95 (br s, 1H), 6.91 (d, *J* = 2.7 Hz, 1H), 6.84 (d, *J* = 8.7 Hz, 1H), 4.16 (t, *J* = 5.4 Hz, 2H), 3.76 (t, *J* = 4.5 Hz, 4H), 2.84 (t, *J* = 5.4 Hz, 2H), 2.61 (t, *J* = 4.5 Hz, 4H). MS (ESI) $[M+H]^+$ = 468.1
40	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.67 – 7.59 (m, 2H), 7.39 (d, *J* = 9.0 Hz, 2H), 7.26 (d, *J* = 9.0 Hz, 2H), 7.07 (t, *J* = 7.8 Hz, 1H), 6.79 (s, 1H), 4.34 (t, *J* = 6.9 Hz, 2H), 3.82 (t, *J* = 4.5 Hz, 4H), 3.69 (t, *J* = 4.5 Hz, 4H), 3.05 (t, *J* = 5.4 Hz, 2H), 2.78 (t, *J* = 6.9 Hz, 2H), 2.66 – 2.60 (m, 4H), 2.57 – 2.48 (m, 6H), 1.82 (t, *J* = 5.4 Hz, 2H). MS (ESI) $[M+H]^+$ = 594.4
41	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.95 (d, *J* = 2.7 Hz, 1H), 7.81 (d, *J* = 9.0 Hz, 1H), 7.70 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.66 (d, *J* = 9.0 Hz, 1H), 7.61 – 7.56 (m, 1H), 7.54 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.19 (t, *J* = 7.8 Hz, 1H), 6.49 (d, *J* = 9.0 Hz, 1H), 4.32 – 4.21 (m, 2H), 3.60 (t, *J* = 4.5 Hz, 4H), 2.81 (t, *J* = 6.3 Hz, 2H), 2.49 (t, *J* = 4.5 Hz, 4H). MS (ESI) $[M+H]^+$ = 497.1

Date Reçue/Date Received 2022-06-29

Ex	Characterizations
42	^{1}H NMR (300 MHz, $CDCl_3$) δ 7.91 (d, *J* = 9.0 Hz, 1H), 7.73 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.58 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.52 (br s, 1H), 7.22 (t, *J* = 7.8 Hz, 1H), 7.05 (d, *J* = 8.7 Hz, 1H), 6.82 (d, *J* = 8.7 Hz, 1H), 6.73 (d, *J* = 9.0 Hz, 1H), 3.54 (t, *J* = 4.5 Hz, 4H), 3.21 (t, *J* = 6.0 Hz, 2H), 2.60 (t, *J* = 6.0 Hz, 2H), 2.40 (t, *J* = 4.5 Hz, 4H). MS (ESI) $[M+H]^+$ = 467.2
43	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.11 (d, *J* = 9.3 Hz, 1H), 7.56 (d, *J* = 8.4 Hz, 1H), 7.36 (d, *J* = 9.0 Hz, 2H), 7.30 (d, *J* = 9.0 Hz, 2H), 6.59 (d, *J* = 9.3 Hz, 1H), 6.53 (d, *J* = 8.4 Hz, 1H), 4.34 (t, *J* = 6.9 Hz, 2H), 4.22 (t, *J* = 5.7 Hz, 2H), 3.72 (t, *J* = 4.5 Hz, 4H), 3.65 (t, *J* = 4.5 Hz, 4H), 2.88 (t, *J* = 5.7 Hz, 2H), 2.76 (t, *J* = 6.9 Hz, 2H), 2.63 – 2.55 (m, 8H). MS (ESI) $[M+H]^+$ = 581.2
44	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.25 (d, *J* = 9.3 Hz, 1H), 7.53 (d, *J* = 8.4 Hz, 1H), 7.24 (d, *J* = 8.7 Hz, 1H), 6.64 (d, *J* = 9.3 Hz, 2H), 6.59 (d, *J* = 8.7 Hz, 1H), 6.52 (d, *J* = 8.4 Hz, 1H), 4.21 (t, *J* = 5.4 Hz, 2H), 3.72 (t, *J* = 4.5 Hz, 4H), 2.88 (t, *J* = 5.4 Hz, 2H), 2.61 (t, *J* = 4.5 Hz, 4H).
46	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.40 (d, *J* = 7.2 Hz, 1H), 8.34 (d, *J* = 8.8 Hz, 1H), 8.18 (d, *J* = 8.8 Hz, 1H), 7.90 (d, *J* = 7.2 Hz, 1H), 7.85 (d, *J* = 7.9 Hz, 1H), 7.56 (t, *J* = 7.9 Hz, 1H), 6.98 (s, 1H), 6.53 (d, *J* = 7.9 Hz, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 161.6, 151.2, 143.4, 142.3, 138.7, 138.2, 137.4, 133.4, 130.6, 129.1, 127.6, 126.7, 120.2, 119.7, 102.3. MS (ESI) $[M+H]^+$ = 325.1
47	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.33 (d, *J* = 7.5 Hz, 1H), 8.18 (d, *J* = 8.7 Hz, 1H), 8.08 (d, *J* = 8.7 Hz, 1H), 7.60 (d, *J* = 2.4 Hz, 1H), 7.10 (d, *J* = 2.4 Hz, 1H), 6.96 (s, 1H), 6.50 (dd, *J* = 7.5, 1.8 Hz, 1H), 4.25 (t, *J* = 5.5 Hz, 2H), 3.86 – 3.69 (m, 4H), 2.89 (t, *J* = 5.5 Hz, 2H), 2.73 – 2.54 (m, 4H). MS (ESI) $[M+H]^+$ = 454.2
48	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.12 (d, *J* = 8.8 Hz, 1H), 7.73 (d, *J* = 8.1 Hz, 1H), 7.66 (d, *J* = 8.1 Hz, 1H), 7.46 (d, *J* = 9.1 Hz, 2H), 7.38 – 7.22 (m, 3H), 7.12 (d, *J* = 8.8 Hz, 1H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 161.5, 151.9, 145.9, 142.7, 140.5, 132.0, 130.3, 127.0, 126.4, 125.1, 122.8, 122.2, 119.0 (t, *J* = 255 Hz), 113.6. MS (ESI) $[M+H]^+$ = 340.1
49	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.03 (d, *J* = 8.7 Hz, 1H), 7.48 (d, *J* = 2.7 Hz, 1H), 7.44 (d, *J* = 9.0 Hz, 2H), 7.27 (d, *J* = 9.0 Hz, 2H), 7.10 (d, *J* = 8.7 Hz, 1H), 7.02 (d, *J* = 2.7 Hz, 1H), 4.19 (t, *J* = 5.7 Hz, 2H), 3.75 (t, *J* = 4.5 Hz, 4H), 2.85 (t, *J* = 5.7 Hz, 2H), 2.61 (t, *J* = 4.5 Hz, 4H). MS (ESI) $[M+H]^+$ = 469.1
50	^{1}H NMR (300 MHz, $CDCl_3$) δ 8.52 (d, *J* = 8.7 Hz, 1H), 7.59 (d, *J* = 8.4 Hz, 1H), 7.45 (d, *J* = 9.0 Hz, 2H), 7.27 (d, *J* = 9.0 Hz, 2H), 7.07 (d, *J* = 8.7 Hz, 1H), 6.67 (d, *J* = 8.4 Hz, 1H), 4.29 – 4.20 (m, 2H), 3.79 – 3.70 (m, 4H), 2.98 – 2.88 (m, 2H), 2.71 – 2.56 (m, 4H). MS (ESI) $[M+H]^+$ = 469.1
51	^{1}H NMR (300 MHz, DMSO) δ 10.84 (s, 1H), 9.57 (s, 1H), 8.58 (d, *J* = 5.1 Hz, 1H), 8.31 (d, *J* = 8.8 Hz, 1H), 7.78 (s, 1H), 7.70 (s, 1H), 7.49 (d, *J* = 8.8 Hz, 1H), 7.36 (d, *J* = 5.1 Hz, 1H). MS (ESI) $[M+H]^+$ = 420.1
52	^{1}H NMR (300 MHz, DMSO) δ 9.23 (d, *J* = 9.1 Hz, 1H), 8.21 (d, *J* = 9.1 Hz, 1H), 7.79 (t, *J* = 7.5 Hz, 2H), 7.46 – 7.18 (m, 5H). MS (ESI) $[M+H]^+$ = 435.0
53	^{1}H NMR (300 MHz, DMSO) δ 9.92 (s, 1H), 8.27 (d, *J* = 8.7 Hz, 2H), 8.15 (d, *J* = 9.0 Hz, 1H), 7.65 (s, 1H), 7.54 (s, 1H), 7.35 (d, *J* = 8.7 Hz, 2H), 7.17 (d, *J* = 9.0 Hz, 1H). MS (ESI) $[M+H]^+$ = 435.0

Date Reçue/Date Received 2022-06-29

Pharmacological data

The compounds of the invention have been the subject of pharmacological tests which have demonstrated their relevance as active substances in therapy and in particular for preventing inflammatory disease.

Example 7: Modulation of miR-124 expression by quinoline derivatives on an inflammatory bowel disease in vivo model

A. Material & Methods

Ex vivo studies

Extraction of PBMC using a FICOLL™ gradient

For that purpose, Peripheral blood mononuclear cells (PBMCs) of healthy donors have been isolated by centrifugation on a FICOLL™ gradient according to standard protocols.

Briefly, 60-70 mL of buffy-coat are poured in a flask of 175 cm^2, and the volume is adjusted to 300 mL using PBS in order to obtain a dilution of about 5-fold of the buffy coat. 38 mL of diluted Buffy are then added to Falcon™ tubes of 50 mL comprising 12 mL of FICOLL™ (Histopack-1077) at ambient temperature. The preparation is centrifugated for 30 minutes at 515 rcf at ambient temperature. The lymphocyte ring is recovered from the Falcon™ tube with a transfer pipette (Pastette®) and then washed with PBS using centrifugation for 10 minutes at 290 rcf and at ambient temperature until the supernatant becomes clear.

The cells are then resuspended at 37°C to a density of $1,5x10^6$ cells/mL in RPMI Glutamax medium (Life Technologies Ref 61870-010) supplemented with 10% fetal calf serum (FCS) (Thermo Fischer Ref SV30160.03) and without activation. Cells are incubated for 48 hours at 37°C under 5% CO_2.

Treatment of cells with screened molecules

Six-well plates are used for the screening. Within each well comprising 3.10^6cell/4 ml RPMI supplemented with 10% fetal calf serum and 40 U/mL IL-2 (Peprotech Ref 200-02) are added screened molecules. 100% DMSO (4 µL) is added to the well and tested as a negative control.

Date Reçue/Date Received 2022-06-29

Each tested condition is set up as described here below and the final corresponding volume is adjusted accordingly in the well:

1) Quinoline derivatives in 100% DMSO – (5 µM and final volume 4µL)

2) Antiretroviral drugs : Maraviroc, Efavirenz, Darunavir, AZT (10 µM for all - final volume 4µL).

The wells are incubated for three days at 37°C under 5% CO_2. Medium is changed (Day 3) according to standard protocols. Briefly, plates are centrifugated at 290 rcf for 5 minutes and 3 mL of supernatant is removed. 3 mL of RPMI supplemented with 10% fetal calf serum and 40 U/mL IL-2 is then added with 3 µL of a stock solution of screened molecule at 5 mM in 100% DMSO or 3 µL of 100% DMSO as a negative control.

Extraction of miRNAs (Day 6)

Cells are recovered within Falcon™ tubes of 15 mL, centrifugated at 290 rcf for 5 minutes, and then washed in 10 mL PBS and further centrifugated at 290 rcf for 5 minutes. Cells are then resuspended in 1 mL PBS and counted.

$6x10^6$ cells are recovered and centrifugated at 290 rcf for 5 minutes. The cell pellet is lysed in 300 µL of ML lysis buffer from the Macherey Nagel Nucleospin® miRNA extraction kit ***(Macherey Nagel Ref 740971)***, and further stored at -20°C.

5 µL of $2x10^8$ copies /µL of spike-in control (Ce_miR-39 from QIAGEN© – reference 219610 of **SEQ ID N°6**) are added for each sample. The miRNA extraction is achieved using the protocol from Macherey Nagel Nucleospin® miRNA extraction kit using an elution volume for RNAs of 50 µL and miRNAs of 30 µL, and further stored at -20°C.

Reverse transcription of miRNAs (Day 6)

The reverse transcription step is followed for 12 µL of miRNA using the miScript RT II reverse transcription (RT) kit from QIAGEN© using the miScript HiSpec buffer, and further stored at -20°C.

Quantitative PCR of miRNAs (Day 6)

The quantitative PCR step is achieved using the QIAGEN© miScript SYBR® Green PCR kit and miScript Primer Assays according to the manufacturer's protocol.

Composition of the miScript reaction mix for 384-well plates:

Mix	µL/reaction
2X SYBR® Green mix	5
10X Universal Primer	1
10X Primer Assay	1
H_20	2
Total Mix volume:	**9**
Template cDNA in H_2O (*)	**1**
Final volume:	**10**

(*) cDNA prepared using the miScript II RT kit

The reaction is repeated in triplicates in a 384-well plate according to the manufacturer's protocol on a LightCycler® 380 Roche Real-Time PCR system. Cycling conditions are also set up according to the manufacter's protocol:

Step	Time	Temperature
Initial activation step	15 min	95°C
3-step cycling:		
Denaturation	15 s	94°C
Annealing	30 s	55°C
Extension	30 s	70°C
Cycle number	40 cycles	

Relative quantification of qPCR is known in the Art and is further detailed below.

Relative quantification

From a dilution to the $1/10^{th}$ in H_2O for the miR-124 qPCR (Hs_miR-124a) or to the $1/100^{th}$ for reference/housekeeping gene qPCR (Hs_miR-26a and Hs_miR-191, using miScript Primer Assays (Hs_miR-124a, Hs_miR-26a and Hs_miR-191 or QIAGEN© – references ms00006622, ms00029239 and ms00003682).

Date Reçue/Date Received 2022-06-29

The analysis is achieved using relative quantification models without efficiency correction ($2^{-\Delta\Delta Cp}$) using the average of crossing points (Cp) values from triplicates of miR-124 and the average of the average of triplicates of miR-26a and miR-191.

B. Results

One set of donors (1 to 7 donors tested for each compound) have been evaluated in the presence of different compounds of formula (I).

Using the protocol described above the mean fold change (in comparison to DMSO) in miR-124 expression was assessed with different donors (either 1 to 7) by relative quantification and is presented in the Table III herebelow:

Table III

Molecule	Fold-change compared to DMSO treated cells (Relative quantification)		Number of donors tested
	Mean	SD	
1	31.96	7.25	3
23	45.09	7.44	3
45	34.21	6.22	3
2	66.68	13.86	2
3	48.52	12.71	3
24	32.48	21.76	7
12	16.33	15.12	4
4	24.37	-	1
25	14.28	6.50	2
5	26.76	8.45	3
6	30.94	12.28	3
26	6.13	1.18	2
27	1.42	0.19	3
7	7.54	-	1
28	22.20	8.25	3
8	7.97	2.66	3
30	9.88	8.75	4
9	111.77	75.69	2
10	21.08	13.46	3
48	23.98	11.01	4
46	6.23	4.38	6
11	17.42	-	1
Maraviroc	0.73	0.56	4

Date Reçue/Date Received 2022-06-29

Effavirenz	0.46	0.27	4
Darunavir	1.08	0.89	4
AZT	0.90	0.55	4

Thus, experimental evidence shows that the above-mentioned quinoline derivatives of formula (I) up-regulate the expression levels of miR-124 in PBMCs, when compared to a reference value established on untreated PBMCs.

In contrast none of the known antiretroviral (Maraviroc, Effavirenz, Darunavir or AZT) has any significant effect on the overexpression of miR-124 in PBMCs from four donors.

Example 8: Effect of quinoline derivatives on the (DSS-) induced colitis model

A. Material & Methods

Mouse models

DSS model

A commonly used mouse model of inflammatory bowel disease is the Dextran Sulphate Sodium (DSS-) induced colitis model. Typical histological changes of acute DSS-colitis are mucin depletion, epithelial degeneration and the eventual destruction of the mucosal barrier which leads to inflammation and colitis.

Three groups of 6-week-old C57BL/6 mice (8 mice each) received DSS administration in the drinking water (2.5%) for 9 days (**Figures 1-2**). Weight loss and water consumption was measured every day. The latter was determined by measuring the volume loss of the drinking water in the respective devices. The mice were treated by gavage with 200 ul of 0.5 MC alone (DSS+ MC group) or together with 40 mg/kg of compound 24 (DSS + MC + 24 group). At the point when control mice have loosed up to 20% of their weight (DSS), the treatment with DSS is stopped and replaced with drinking water. The other treatments were continued for 21 days.

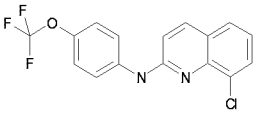
Three groups of 16-week-old C57BL/6 mice (7 mice each) received 2.5% DSS in drinking water (**Figure 3**). The mice were treated by gavage with 200 ul of 0.5 MC alone (DSS+ MC group) or together with 40 mg/kg of compound 24 (DSS + MC + 24 group). The mice were treated with DSS for 6 days and at the point when control mice have loosed up to 15% of their weight (DSS), all the mice were euthanized and colon were taken for further analyses.

Date Reçue/Date Received 2022-06-29

Colons were measured using a ruler and for histological analysis the entire colon was prepared according to the Swiss roll procedure (Whittem *et al.*; "Murine Colitis Modeling using Dextran Sulfate Sodium (DSS)", J Vis Exp 2010 (35) 1652) fixed with formaldehyde and embedded in paraffin. 4 µm sections were de-paraffinized and stained with hematoxylin and eosin and analyzed for lesion size and other alterations (**Figures 4-6**). We compared untreated and treated mice during the DSS-cycle with quinoline derivatives suspended in methylcellulose or methylcellulose (MC) only. Statistical analysis was performed using Mann-Whitney test, asterisk indicates a significant difference ($p<0.5$), two asterisks indicate a very significant difference ($p<0.05$)

B. Results

Results which are presented have been established using the quinoline derivative compound (24), for which the structure is represented herebelow for reference:



(24).

After 5 days of DSS-administration mice treated with the quinoline derivative manifested a weight loss of less then 1% in average in contrast to MC or untreated mice displayed a weight loss between 10 % and 20% (**Figures 1 and 2**).

Notably, we noticed a higher water consumption of drug treated mice mirroring the disease dampening effect of quinoline derivatives. Quinoline derivative treatment did also significantly control weight loss in mice during the second administration of DSS indicating that mice do not become unresponsive and that quinoline derivatives are suitable for repetitive administration. After one cycle of DSS the length of the colon in quinoline derivatives treated mice (6.4 cm +/-0.6 cm) was significantly larger when compared to MC only treated (5.9 cm +/-0.8 cm) and untreated (5.8cm +/-0.8cm) mice (**Figure 3**). This difference was even more pronounced in mice that received two cycles of DSS the length of the colon in quinoline derivatives treated mice (5.7 cm +/-0.9 cm) was significantly larger when compared to MC only treated (4.3 cm +/- 0.5 cm) and untreated (4.4 cm +/-0.4 cm) mice (**Figure 3**). The mice of the different cohorts developed comparable number of lesions (**Figure 4**), but the average size of the lesion area was strikingly lower in quinoline-derivative treated mice, i.e. 2.1 mm^2 versus 8.4 mm^2 in MC only treated mice (**Figure 5**). This difference was maintained in mice exposed to two DSS-cycles (3.8 mm^2 vs 12.2 mm^2).

Date Reçue/Date Received 2022-06-29

Finally, we observed a decrease of alterations in lymphoid organs such as Peyer's Patches after two DSS-cycles suggesting that quinoline derivative treatment modulates immune responses.

Example 9: Effect of quinoline derivatives on the collagen induced arthritis model

A. Material & Methods

Mouse models

Collagen induced Arthritis model:

Groups of 9 to -10-week-old DBA/1 mice were immunized intradermally with bovine collagen type II emulsified in a 1:1 proportion with complete Freund's adjuvant. Mice were challenged 21 days after the first immunization and the phenotypic appearance of arthritis was evaluated by monitoring every second day the thickness of each hind paw *ankle joint* thickness was measured using a dial caliper (0- to 10-mm) test *gauge* using a thickness gage. Mice were treated daily for two weeks with quinoline derivatives candidates suspended in methylcellulose or methylcellulose (MC) only and the development of the disease was then monitored. Statistical analysis was performed using Mann-Whitney test, asterisk indicates a significant difference ($p<0.5$).

B. Results

Only one out of ten mice treated with the tested quinoline derivative compound (24), displayed signs of inflammation (in comparison, 8 out of 10 MC treated mice developed disease). Mice treated with quinoline derivatives displayed a significant decreased swelling in comparison to MC only treated mice (1.9 mm versus about 2.2 mm) (**Figure 6**)

Therefore, the result of the tests carried out on the compounds disclosed in the present invention show that said compounds may be useful to treat and/or prevent inflammatory diseases as described further above.

For this purpose an effective amount of a said compound may be administered to an individual suffering from inflammatory diseases.

Date Reçue/Date Received 2022-06-29

Thus, a compound according to the present invention may be implemented within pharmaceutical composition that may contain an effective amount of said compound, and one or more pharmaceutical excipients.

The aforementioned excipients are selected according to the dosage form and the desired mode of administration.

In this context they can be present in any pharmaceutical form which is suitable for enteral or parenteral administration, in association with appropriate excipients, for example in the form of plain or coated tablets, hard gelatine, soft shell capsules and other capsules, suppositories, or drinkable, such as suspensions, syrups, or injectable solutions or suspensions, in doses which enable the daily administration of from 0.1 to 1000 mg of active substance.

Any route of administration may be used. For example, a compound of formula (I) can be administered by oral, parenteral, intravenous, transdermal, intramuscular, rectal, sublingual, mucosal, nasal, or other means. In addition, a compound of formula (I) can be administered in a form of pharmaceutical composition and/or unit dosage form.

In particular, pharmaceutical compositions of the invention may be administered orally and/or parenterally.

Suitable dosage forms include, but are not limited to, capsules, tablets (including rapid dissolving and delayed release tablets), powder, syrups, oral suspensions and solutions for parenteral administration.

The pharmaceutical composition may also contain another anti-inflammatory agent, well known to the man skilled in the art, in combination with a compound according to the present invention.

Date Reçue/Date Received 2022-06-29

SEQUENCE LISTING

SEQ ID N°1

AGGCCUCUCUCUCCGUGUUCACAGCGGACCUUGAUUUAAAUGUCCAUACAA
UUAAGGCACGCGGUGAAUGCCAAGAAUGGGGCUG

SEQ ID N°2

AUCAAGAUUAGAGGCUCUGCUCUCCGUGUUCACAGCGGACCUUGAUUUAAU
GUCAUACAAUUAAGGCACGCGGUGAAUGCCAAGAGCGGAGCCUACGGCUGC
ACUUGAA

SEQ ID N°3

UGAGGGCCCCUCUGCGUGUUCACAGCGGACCUUGAUUUAAUGUCUAUACAA
UUAAGGCACGCGGUGAAUGCCAAGAGAGGCGCCUCC

SEQ ID N°4

UAAGGCACGCGGUGAAUGCC

SEQ ID N°5

CGUGUUCACAGCGGACCUUGAU

SEQ ID N°6

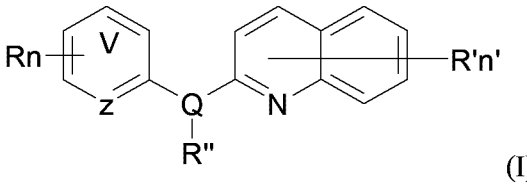
UCACCGGGUGUAAAUCAGCUUG

***

In some aspects, embodiments of the present invention as described herein include the following items:

1. An *in vitro* or *ex vivo* use of at least one miRNA, said at least one miRNA being miR-124, as a biomarker for screening a compound of formula (I) as defined herein after, presumed effective in treating and/or preventing an inflammatory disease

Date Reçue/Date Received 2022-06-29

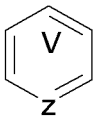


(I)

wherein:

Z is C or N,

V is C or N,



means an aromatic ring wherein V is C or N and when V is N, V is in ortho, meta or para of Z, i.e. forms respectively a pyridine, a pyridazine, a pyrimidine or a pyrazine group,

R independently represent a hydrogen atom, a halogen atom or a group chosen among a –CN group, a hydroxyl group, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group, a (C_3-C_6)cycloalkyl group, a $–NO_2$ group, a $–NR_1R_2$ group, a (C_1-C_4)alkoxy group, a phenoxy group, a $-NR_1$-SO_2-NR_1R_2 group, a $–NR_1$-SO_2-R_1 group, a $-NR_1$-C(=O)-R_1 group, a $-NR_1$-C(=O)-NR_1R_2 group, a $-SO_2$-NR_1R_2 group, a $-SO_3H$ group, a -O-SO_2-OR_3 group, a -O-P(=O)-(OR_3)(OR_4) group, a -O-CH_2-$COOR_3$ group and a (C_1-C_3)alkyl group, said alkyl being optionally mono-substituted by a hydroxyl group,

Q is N or O, provided that R'' does not exist when Q is O,

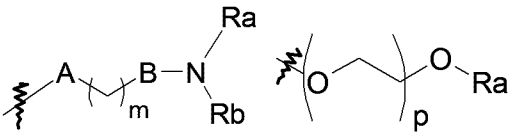
R_1 and R_2 are independently a hydrogen atom or a (C_1-C_3)alkyl group,

R_3 and R_4 independently represent a hydrogen atom, Li^+, Na^+, K^+, $N^+(Ra)_4$ or a benzyl group,

n is 1, 2 or 3,

n' is 1, 2 or 3,

R' independently represent a hydrogen atom or a group chosen among a (C_1-C_3)alkyl group, a halogen atom, a $–NO_2$ group, a $-NR_1R_2$ group, a morpholinyl group, a morpholino group, a N-methylpiperazinyl group, a (C_1-C_3)fluoroalkyl group, a -O-P(=O)-(OR_3)(OR_4) group and a –CN group, and can further be a group chosen among:



(IIa) (IIIa)

A is a covalent bond, an oxygen atom or NH,

B is a covalent bond or NH,

m is 1, 2, 3, 4 or 5,

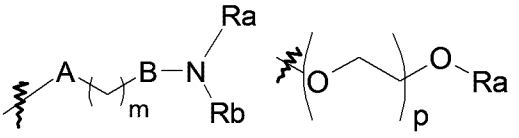
p is 1, 2 or 3,

Ra and Rb independently represent a hydrogen atom, a (C_1-C_5)alkyl group or a (C_3-C_6)cycloalkyl group,

Ra and Rb can further form together with the nitrogen atom to which they are attached a saturated 5- or 6-membered heterocycle optionally containing a further heteroatom chosen among N, O and S, said heterocycle being optionally substituted by one or more Ra, provided that when R' is a group (IIa) or (IIIa), n' may be 2 or 3 only if other R' groups are different from said group (IIa) or (IIIa),

R'' is a hydrogen atom, a (C_1-C_4)alkyl group or is a group (IIa) as defined above, or anyone of its pharmaceutically acceptable salt.

2. The use according to item 1, wherein R' represents a hydrogen atom or a group chosen among a (C_1-C_3)alkyl group, a halogen atom, a $-NO_2$ group, a morpholinyl group, a morpholino group, a N-methylpiperazinyl group, a (C_1-C_3)fluoroalkyl group, a -O-P(=O)-(OR_3)(OR_4) group and a –CN group, and can further be a group chosen among:



(IIa) (IIIa)

A is a covalent bond, an oxygen atom or NH,

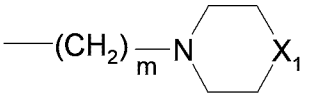
B is a covalent bond or NH,

m is 1, 2, 3, 4 or 5,

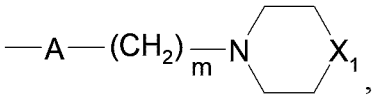
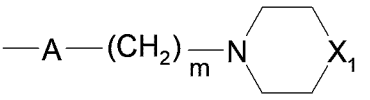
p is 1, 2 or 3,

Ra and Rb independently represent a hydrogen atom, a (C_1-C_5)alkyl group or a (C_3-C_6)cycloalkyl group,

Ra and Rb can further form together with the nitrogen atom to which they are attached a saturated 5- or 6-membered heterocycle optionally containing a further heteroatom chosen among N, O and S, said heterocycle being optionally substituted by one or more Ra, provided that when R' is a group (IIa) or (IIIa), n' may be 2 or 3 only if other R' groups are different from said group (IIa) or (IIIa).

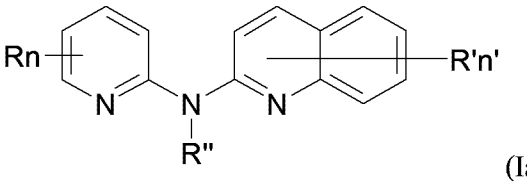
3. The use according to item 1, wherein R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group  wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3.

4. The use according to any one of items 1 to 3, wherein R independently represent a hydrogen atom, a methyl group, a methoxy group, a trifluoromethyl group, a trifluoromethoxy group, an amino group, a halogen atom or a -O-P(=O)-(OR_3)(OR_4) group.

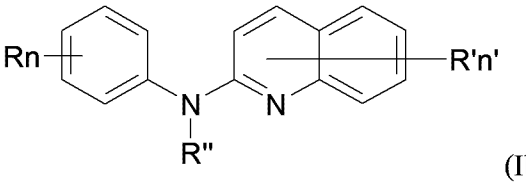
5. The use according to any one of items 1 to 4, wherein R' independently represent a hydrogen atom, a halogen atom, a methyl group, a -O-P(=O)-(OR_3)(OR_4) group or a group  , wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, the other R' group is different from said group or alternatively R' independently represent a hydrogen atom, a halogen atom, a methyl group or a group  , wherein A is O or NH, m is 2 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, the other R' group is different from said group.

6. The use according to any one of items 1 to 5, wherein Q is N.

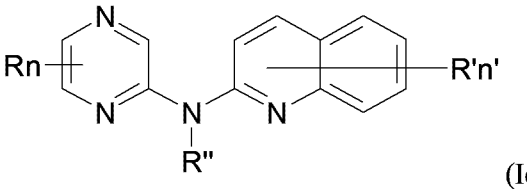
7. The use according to any one of items 1 to 6, wherein the compound is selected from



(Ia),



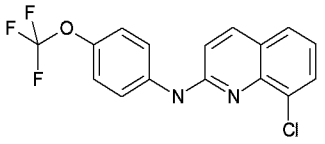
(Ib), and



(Ic)

wherein R, R', R'', n and n' are as defined in anyone of items 1 to 4.

8. The use according to item 7, wherein the compound is of formula (Ib).

9. The use according to item 1, wherein the compound of formula (I) is the compound (24) of formula 

or any one of its pharmaceutically acceptable salt.

10. An *in vitro* or *ex vivo* method for screening a compound of formula (I) as defined in any one of items 1 to 9, presumed effective in treating and/or preventing an inflammatory disease, comprising at least a step of:

a) providing an eukaryotic cell,

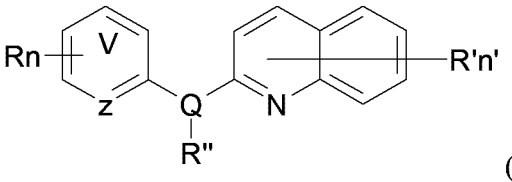
b) bringing into contact said cell with a compound of formula (I),

c) measuring an expression of miR-124 in said cell, and

d) selecting the candidate presumed effective in treating and/or preventing the inflammatory disease when the level of expression of miR-124 measured in step c) is increased relatively to a reference value.

CLAIMS

1. An *in vitro* or *ex vivo* use of at least one miRNA, said at least one miRNA being miR-124, as a biomarker for screening a compound of formula (I) as defined herein after, presumed effective in treating and/or preventing an inflammatory disease

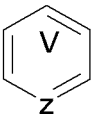


(I)

wherein:

Z is C or N,

V is C or N,



means an aromatic ring wherein V is C or N and when V is N, V is in ortho, meta or para of Z, i.e. forms respectively a pyridine, a pyridazine, a pyrimidine or a pyrazine group,

R independently represent a hydrogen atom, a halogen atom or a group chosen among a –CN group, a hydroxyl group, a (C_1-C_3)fluoroalkyl group, a (C_1-C_3)fluoroalkoxy group, a (C_3-C_6)cycloalkyl group, a $–NO_2$ group, a $–NR_1R_2$ group, a (C_1-C_4)alkoxy group, a phenoxy group, a $-NR_1$-SO_2-NR_1R_2 group, a $–NR_1$-SO_2-R_1 group, a $-NR_1$-C(=O)-R_1 group, a $-NR_1$-C(=O)-NR_1R_2 group, a $-SO_2$-NR_1R_2 group, a $-SO_3H$ group, a -O-SO_2-OR_3 group, a -O-P(=O)-(OR_3)(OR_4) group, a -O-CH_2-$COOR_3$ group and a (C_1-C_3)alkyl group, said alkyl being optionally mono-substituted by a hydroxyl group,

Q is N or O, provided that R'' does not exist when Q is O,

R_1 and R_2 are independently a hydrogen atom or a (C_1-C_3)alkyl group,

R_3 and R_4 independently represent a hydrogen atom, Li^+, Na^+, K^+, $N^+(Ra)_4$ or a benzyl group,

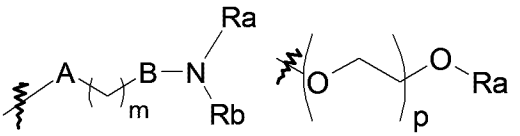
n is 1, 2 or 3,

n' is 1, 2 or 3,

R' independently represent a hydrogen atom or a group chosen among a (C_1-C_3)alkyl group, a halogen atom, a $–NO_2$ group, a $-NR_1R_2$ group, a morpholinyl group, a

Date Reçue/Date Received 2022-06-29

morpholino group, a N-methylpiperazinyl group, a (C_1-C_3)fluoroalkyl group, a -O-P(=O)-(OR_3)(OR_4) group and a –CN group, and can further be a group chosen among:



(IIa) (IIIa)

A is a covalent bond, an oxygen atom or NH,

B is a covalent bond or NH,

m is 1, 2, 3, 4 or 5,

p is 1, 2 or 3,

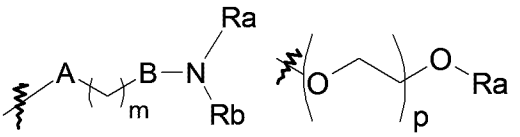
Ra and Rb independently represent a hydrogen atom, a (C_1-C_5)alkyl group or a (C_3-C_6)cycloalkyl group,

Ra and Rb can further form together with the nitrogen atom to which they are attached a saturated 5- or 6-membered heterocycle optionally containing a further heteroatom chosen among N, O and S, said heterocycle being optionally substituted by one or more Ra, provided that when R' is a group (IIa) or (IIIa), n' may be 2 or 3 only if other R' groups are different from said group (IIa) or (IIIa),

R'' is a hydrogen atom, a (C_1-C_4)alkyl group or is a group (IIa) as defined above,

or anyone of its pharmaceutically acceptable salt.

2. The use according to claim 1, wherein R' represents a hydrogen atom or a group chosen among a (C_1-C_3)alkyl group, a halogen atom, a –NO_2 group, a morpholinyl group, a morpholino group, a N-methylpiperazinyl group, a (C_1-C_3)fluoroalkyl group, a -O-P(=O)-(OR_3)(OR_4) group and a –CN group, and can further be a group chosen among:



(IIa) (IIIa)

A is a covalent bond, an oxygen atom or NH,

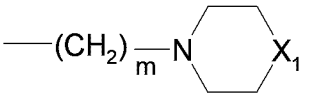
B is a covalent bond or NH,

m is 1, 2, 3, 4 or 5,

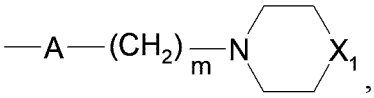
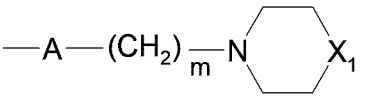
p is 1, 2 or 3,

Ra and Rb independently represent a hydrogen atom, a (C_1-C_5)alkyl group or a (C_3-C_6)cycloalkyl group,

Ra and Rb can further form together with the nitrogen atom to which they are attached a saturated 5- or 6-membered heterocycle optionally containing a further heteroatom chosen among N, O and S, said heterocycle being optionally substituted by one or more Ra, provided that when R' is a group (IIa) or (IIIa), n' may be 2 or 3 only if other R' groups are different from said group (IIa) or (IIIa).

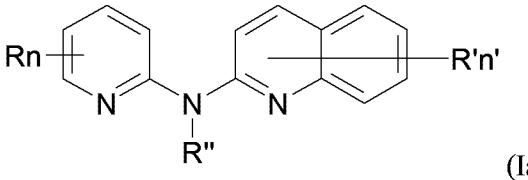
3. The use according to claim 1, wherein R'' is a hydrogen atom, a (C_1-C_4)alkyl group or a group  wherein m is 2 or 3 and X_1 is O, CH_2 or N-CH_3.

4. The use according to any one of claims 1 to 3, wherein R independently represent a hydrogen atom, a methyl group, a methoxy group, a trifluoromethyl group, a trifluoromethoxy group, an amino group, a halogen atom or a -O-P(=O)-(OR_3)(OR_4) group.

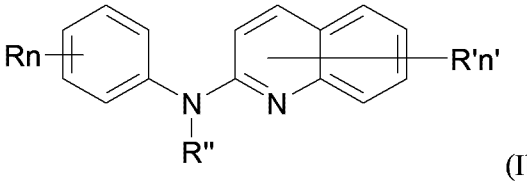
5. The use according to any one of claims 1 to 4, wherein R' independently represent a hydrogen atom, a halogen atom, a methyl group, a -O-P(=O)-(OR_3)(OR_4) group or a group  , wherein A is O or NH, m is 2 or 3 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, the other R' group is different from said group or alternatively R' independently represent a hydrogen atom, a halogen atom, a methyl group or a group  , wherein A is O or NH, m is 2 and X_1 is O, CH_2 or N-CH_3, provided that when R' is such a group, n' is 1 or 2, and when n' is 2, the other R' group is different from said group.

6. The use according to any one of claims 1 to 5, wherein Q is N.

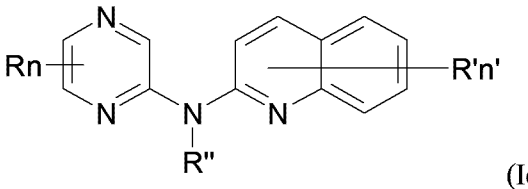
7. The use according to any one of claims 1 to 6, wherein the compound is selected from



(Ia),



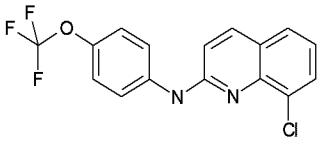
(Ib), and



(Ic)

wherein R, R', R'', n and n' are as defined in anyone of claims 1 to 4.

8. The use according to claim 7, wherein the compound is of formula (Ib).

9. The use according to claim 1, wherein the compound of formula (I) is the compound (24) of formula 

or any one of its pharmaceutically acceptable salt.

10. An *in vitro* or *ex vivo* method for screening a compound of formula (I) as defined in any one of claims 1 to 9, presumed effective in treating and/or preventing an inflammatory disease, comprising at least a step of:

a) providing an eukaryotic cell,

b) bringing into contact said cell with a compound of formula (I),

c) measuring an expression of miR-124 in said cell, and

Date Reçue/Date Received 2022-06-29

d) selecting the candidate presumed effective in treating and/or preventing the inflammatory disease when the level of expression of miR-124 measured in step c) is increased relatively to a reference value.

Date Reçue/Date Received 2022-06-29

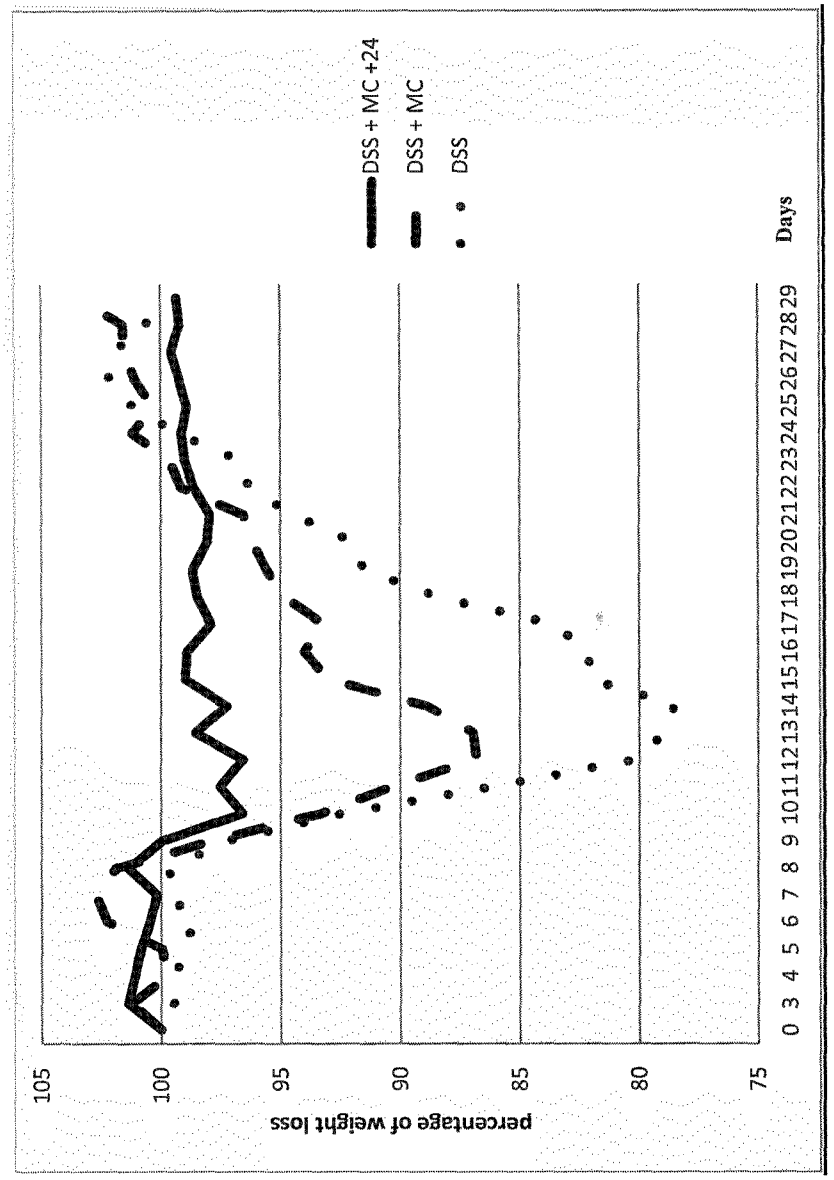


Figure 1

Date Reçue/Date Received 2022-06-29

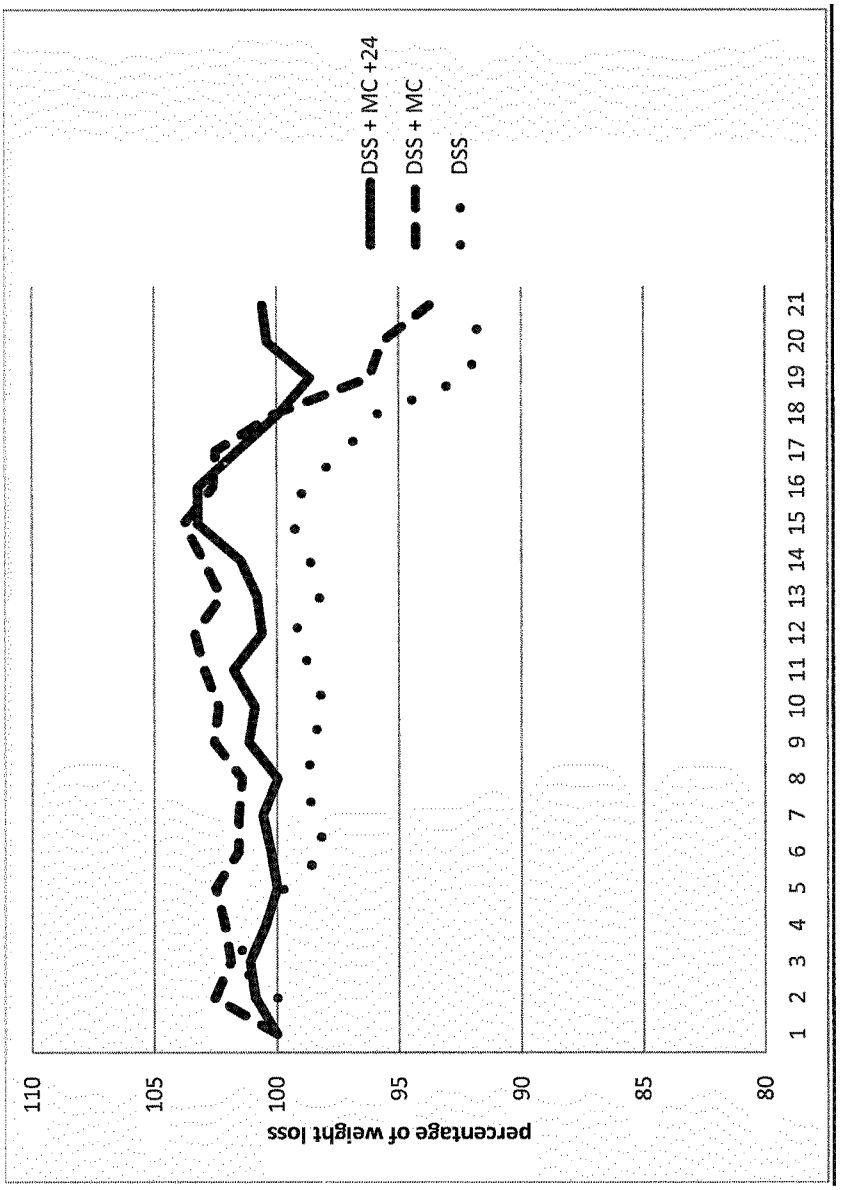


Figure 2

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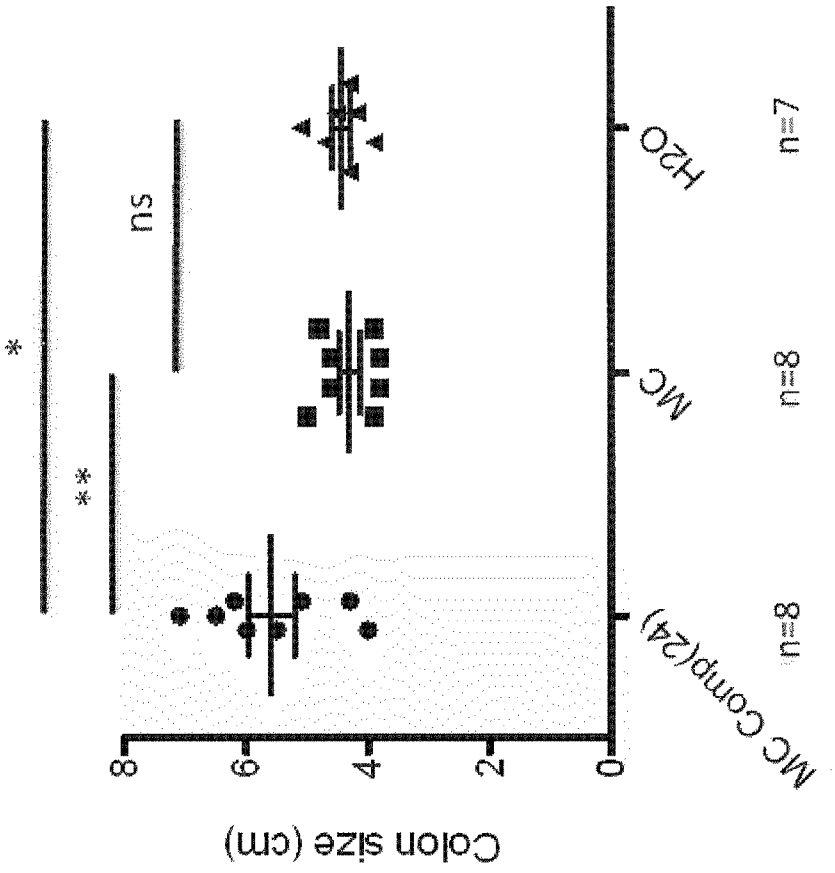

Figure 3

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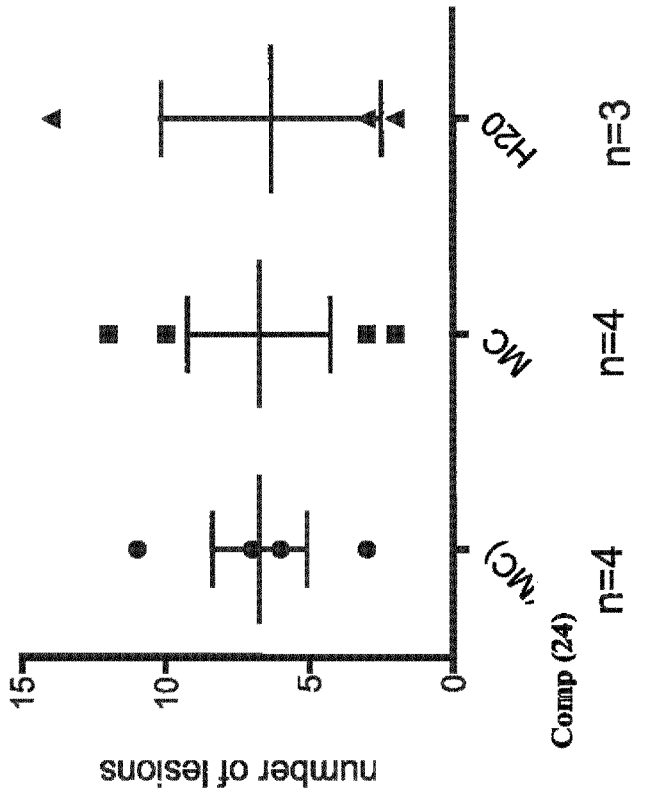

Figure 4

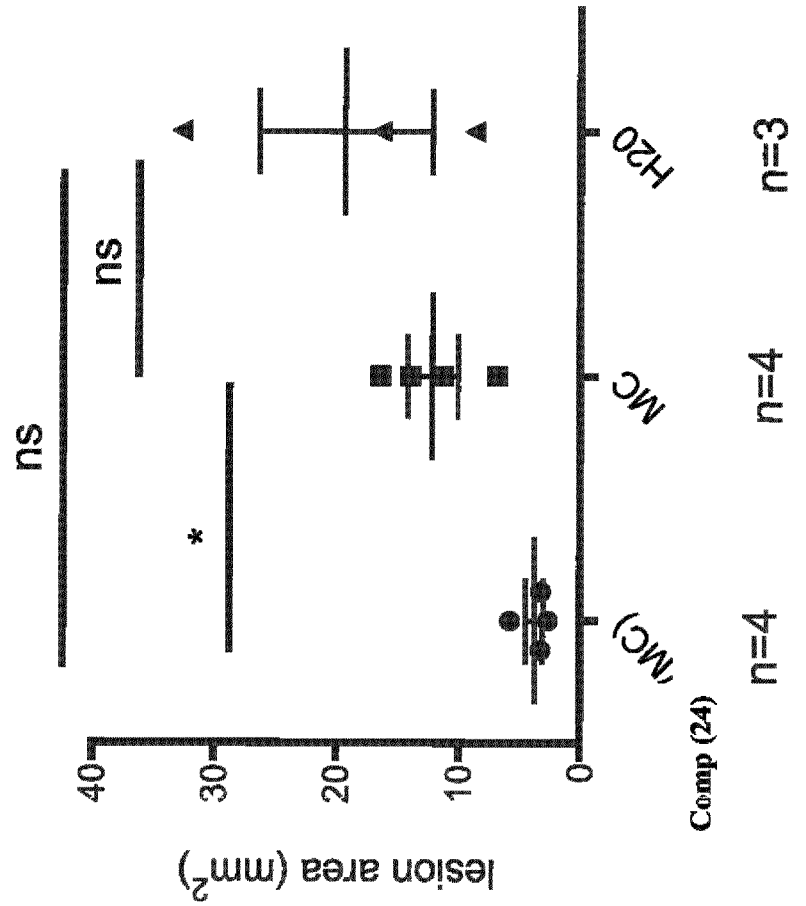

Figure 5

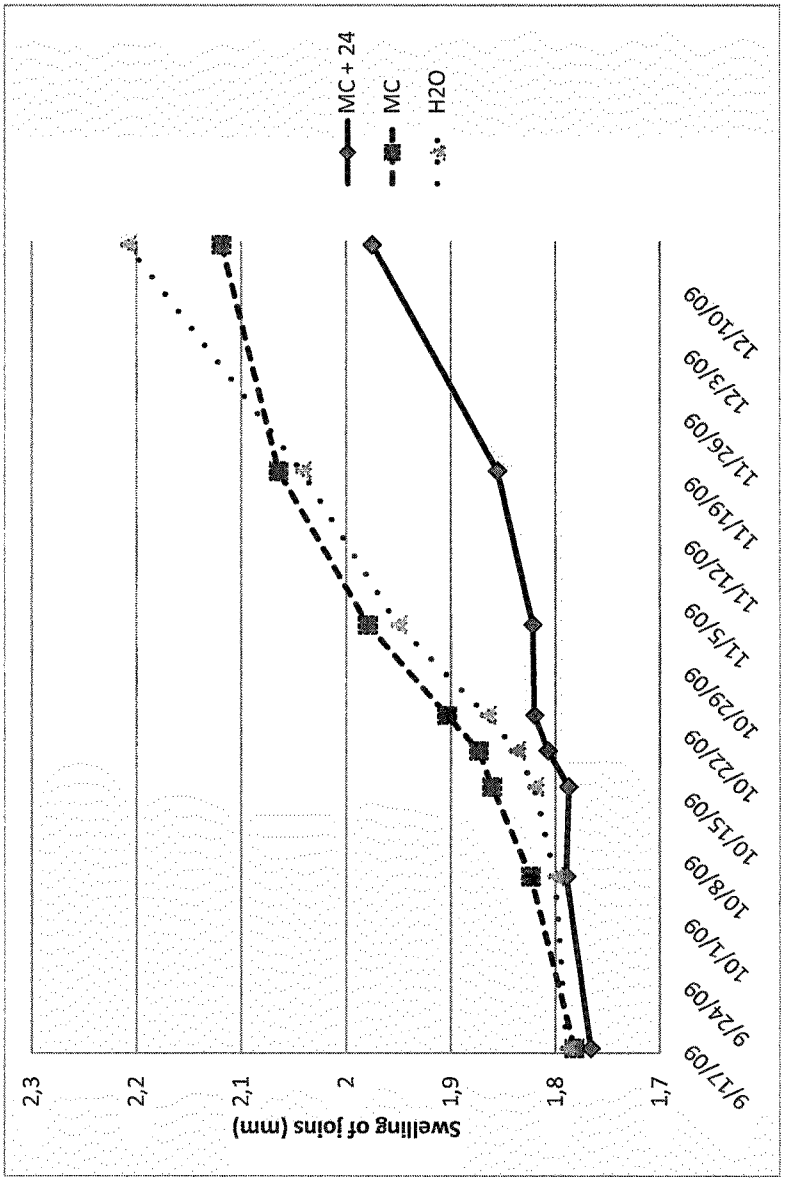

Figure 6

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