

PYRIDAZINYL PHENYL HYDRAZONES USEFUL AGAINST CONGESTIVE HEART FAILURE

The present invention relates to pyridazinyl phenyl hydrazone compounds and pharmaceutically acceptable salts and esters thereof. The invention also relates to pharmaceutical compositions comprising such compounds as active ingredients. The compounds of the invention increase the calcium sensitivity of contractile proteins of the cardiac muscle and are thus useful in the treatment of congestive heart failure.

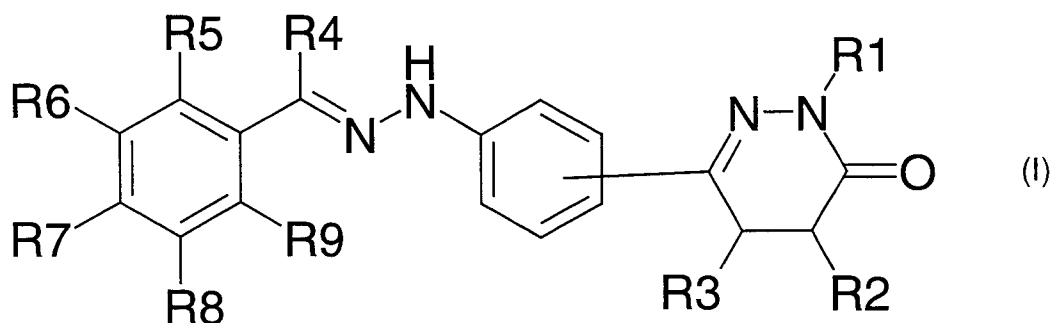
Congestive heart failure is characterized by a decrease in cardiac output and an increase in right and left ventricular filling pressure. These hemodynamic conditions can produce symptoms of dyspnea, fatigue and edema.

The contraction in cardiac muscle is triggered by the binding of calcium to contractile proteins. Series of phosphodiesterase isoenzyme III (PDE III) inhibitors are in clinical trials for the treatment of congestive heart failure. These compounds increase the contractility of the cardiac muscle and produce vasodilatation. However, it is known that the long-term application of those compounds may lead to calcium overload in the cardiac muscle and trigger arrhythmias. It is therefore desired to develop medicaments acting by a mechanism which would increase cardiac contractility without producing calcium overload. The increase of calcium sensitivity of contractile proteins would be such a mechanism.

Pyridazinyl phenyl hydrazone compounds have been described earlier in European patent application EP 383449. The compounds show calcium dependent binding to contractile proteins of the cardiac muscle, as well as PDE III inhibiting activity. In the specific examples one 1-acetyl-1-phenyl methylidene derivative is disclosed (Ex. 16). While the 1-acetyl-1-phenyl methylidene derivative has some effect in cardiac contractility, it does not increase the calcium sensitivity of contractile proteins.

Certain pyridazinyl phenyl hydrazone compounds appear as intermediates in European patent applications EP 223937 and EP 280224. However, the compounds are not specifically characterized. Mertens, A. et al., J. Med. Chem. 1990, 33, 2870-2875, discloses a phenyl, 4-methoxyphenyl and 2-hydroxyphenyl derivatives of pyridazinyl phenyl hydrazone compounds as intermediates.

It has now been found that compounds of formula (I) are potent in increasing the calcium sensitivity of contractile proteins in the cardiac muscle:



5

in which

R_1 to R_4 means hydrogen, alkyl, alkenyl, aryl, arylalkyl, carboxyalkyl, hydroxyalkyl or halogenalkyl, or R_2 and R_3 form a ring of 5-7 carbon atoms,

10 R_5 to R_9 means hydrogen, alkyl, alkenyl, aryl, arylalkyl, acyl, hydroxy, alkoxy, alkoxycarbonyl, amino, acylamino, alkylamino, aryloxy, halogen, cyano, nitro, carboxy, alkylsulfonyl, sulfonamido or trifluoromethyl,

wherein each aryl residue defined above by itself or as a part of another group may be substituted,

15 and pharmaceutically acceptable salts and esters thereof,

provided that a) when R_1 , R_2 , R_3 , R_5 , R_6 , R_8 and R_9 are hydrogen and R_4 is methyl, R_7 is not hydrogen or methoxy and b) when R_1 , R_2 , R_3 , R_5 , R_6 , R_7 and R_8 are hydrogen and R_4 is methyl, R_9 is not hydroxy.

20 The invention also relates to compounds of formula (I) in which R_1 , R_2 , R_3 , R_5 , R_6 , R_8 and R_9 are hydrogen, R_4 is methyl, and R_7 is hydrogen or methoxy, or in which R_1 , R_2 , R_3 , R_5 , R_6 , R_7 and R_8 are hydrogen, R_4 is methyl and R_9 is hydroxy and pharmaceutically acceptable salts and esters thereof, for use as a medicament.

25 In a class of preferred compounds and pharmaceutically acceptable salts and esters are compounds of formula (I) wherein R_5 to R_9 are independently hydrogen, C_{1-6} alkyl, C_{1-6} alkenyl, C_{6-10} aryl, C_{7-12} arylalkyl, C_{1-6} acyl, hydroxy, C_{1-6} alkoxy, C_{1-6} alkoxycarbonyl, amino, C_{1-6} acylamino, C_{1-6} alkylamino, C_{6-10} aryloxy, halogen, cyano, nitro, carboxy, C_{1-6} alkylsulfonyl, sulfonamido or trifluoromethyl. In a subclass of this class of compounds and pharmaceutically acceptable salts thereof are compounds of formula (I) wherein R_5 to R_9 are independently hydrogen, hydroxy, C_{1-6} alkyl, C_{1-6} alkoxy, carboxy, C_{1-6} alkoxycarbonyl or nitro. In a subclass of this class of compounds and pharmaceutically acceptable salts thereof are compounds of

30

formula (I) wherein R₅ is hydroxy, C₁₋₆ alkyl, C₁₋₆ alkoxy, carboxy, C₁₋₆ alkoxycarbonyl or nitro, most preferably hydroxy or nitro.

In another class of preferred compounds and pharmaceutically acceptable salts R₁ to R₄ are independently hydrogen, C₁₋₆ alkyl, C₁₋₆ alkenyl, C₆₋₁₀ aryl, C₇₋₁₂ arylalkyl, C₁₋₆ carboxyalkyl, C₁₋₆ hydroxyalkyl or C₁₋₆ halogenalkyl, or R₂ and R₃ form a phenyl ring. In a subclass of this class of compounds and pharmaceutically acceptable salts thereof are compounds of formula (I) wherein R₁ to R₃ are independently hydrogen or C₁₋₆ alkyl.

10

Each aryl residue in each of these preferred classes of compounds, by itself or as part of another group, may be substituted by 1 to 3, preferably 1 or 2, of fluorine, chlorine, bromine, iodine, hydroxy, nitro, carboxy, trifluoromethyl, amino, C₁₋₄ alkyl, C₁₋₄ alkoxy, C₁₋₆ acyl, C₁₋₆ carboxyalkyl, phenyl, naphthyl, halophenyl, halonaphthyl, benzyl, phenethyl, halobenzyl, halophenethyl, naphthylmethyl, naphthylethyl, C₄₋₇ cycloalkyl, C₁₋₄ alkyl C₄₋₇ cycloalkyl, mono C₁₋₄ alkylamino, di C₁₋₄ alkylamino, C₁₋₆ alkanoylamino, phenylcarbonylamino, naphthylcarbonylamino, cyano, thiol, or C₁₋₆ alkylthio.

20

The compounds of formula (I) may contain one or more asymmetric centers and thus they can exist as enantiomers or diastereomers. The invention includes both mixtures and separate individual isomers.

Especially preferred individual compounds of the invention include:

25

(R)- 6-{4-[N'-(4-Hydroxy-3-methoxy-2-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one;

6-{4-[N'-(4-Hydroxy-3-methoxy-2-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one;

30

6-(4-{N'-[1-(2,5-Dihydroxy-phenyl)-ethylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one;

6-(4-{N'-[1-(2,4-Dihydroxy-3-methylphenyl)ethylidene]hydrazino}phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one;

6-(4-{N'-[Bis-(2,4-dihydroxy-phenyl)-methylene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one;

35

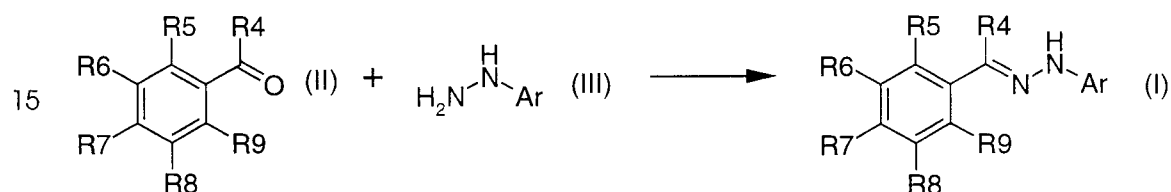
6-(4-{N'-[1-(2,4-Dihydroxy-phenyl)-ethylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one;

2,6-Dihydroxy-3-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazonomethyl}-benzoic acid ethyl ester; and

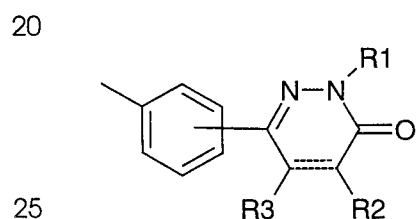
6-{4-[N'-(3-Ethyl-2,4-dihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one.

5 The compounds of the invention can be prepared by the well known condensation reaction between a carbonyl compound and a hydrazine as shown in Scheme 1:

10 Scheme 1. The hydrazones



20 wherein Ar means

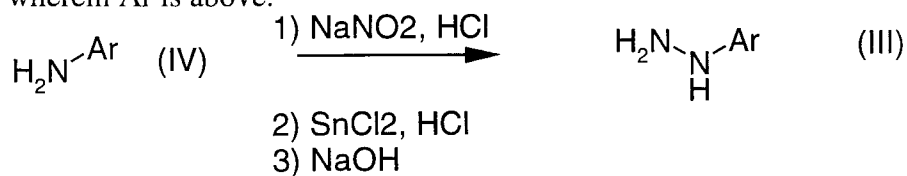


and R₁ to R₉ as defined above.

30 A suitable method for the preparation of hydrazines (III) is the diazotization of an aniline and reduction as a one pot synthesis. Scheme 2 shows this reaction:

Scheme 2. The hydrazines

35 wherein Ar is above.



40

where Ar is as above.

Compounds of formula (II) and (IV) are commercially available or can be prepared using methods known in the literature.

General method 1: In case where R₄ is hydrogen, the reaction of Scheme 1 is generally performed by refluxing a mixture of compounds (II) and (III) in a suitable solvent, such as ethanol, 2-propanol, acetonitrile or acetic acid, for 1-24 hours. The product (I) is filtered.

General method 2: In case where R₄ is not hydrogen, the reaction of Scheme 1 is generally performed by heating a neat mixture of compounds (II) and (III) at 140-170°C under inert atmosphere. The mixture is then triturated with ethyl acetate and the product (I) filtered.

Salts and esters of the compounds, when applicable, may be prepared by known methods. Physiologically acceptable salts are useful as active medicaments, however, preferred are the salts with alkali or alkaline earth metals. Physiologically acceptable esters are also useful as active medicaments. Examples are the esters with aliphatic or aromatic alcohols.

The term "alkyl" as employed herein by itself or as part of another group includes both straight, branched and cyclized chain radicals of up to 18 carbon atoms, preferably 1 to 8 carbon atoms, most preferably 1 to 4 carbon atoms. The term "lower alkyl" as employed herein by itself or as part of another group includes straight, branched and cyclized chain radicals of 1 to 7, preferably 1 to 4, most preferably 1 or 2 carbon atoms. Specific examples for the alkyl and lower alkyl residues, respectively, are methyl, ethyl, propyl, isopropyl, butyl, tert. butyl, pentyl, cyclopentyl, hexyl, cyclohexyl, octyl, decyl and dodecyl including the various branched chain isomers thereof.

The term "acyl" as employed herein by itself or as part of another group refers to an alkylcarbonyl or alkenylcarbonyl group, the alkyl and alkenyl groups being defined above.

The term "aryl" as used herein by itself or as part of another group refers to a monocyclic or bicyclic group containing from 6 to 10 carbon atoms in the ring portion. Specific examples for aryl groups are phenyl, naphthyl and the like. "Aroyl" means in a corresponding way an arylcarbonyl group.

The term "alkoxy" as employed herein by itself or as part of another group includes an alkyl group as defined above linked to an oxygen atom. "Aryloxy" means in a corresponding way an aryl group linked to an oxygen atom.

5 The term "substituted" as used herein in connection with various residues refers to halogen substituents, such as fluorine, chlorine, bromine, iodine or trifluoromethyl group, amino, alkyl, alkoxy, aryl, alkyl-aryl, halogen-aryl, cycloalkyl, alkylcycloalkyl, hydroxy, alkylamino, alkanoylamino, arylcarbonylamino, nitro, cyano, thiol, or alkylthio substituents.

10

The "substituted" groups may contain 1 to 3, preferably 1 or 2 of the above mentioned substituents.

Compounds of the invention may be administered to a patient in
15 therapeutically effective amounts which range usually from about 0.1 to 500 mg per day depending on the age, weight, condition of the patient, administration route and the phospholamban inhibitor used. The compounds of the invention can be formulated into dosage forms using the principles known in the art. It can be given to a patient as such or in combination with suitable pharmaceutical excipients in the
20 form of tablets, dragees, capsules, suppositories, emulsions, suspensions or solutions. Choosing suitable ingredients for the composition is a routine for those of ordinary skill in the art. It is evident that suitable carriers, solvents, gel forming ingredients, dispersion forming ingredients, antioxidants, colours, sweeteners, wetting compounds and other ingredients normally used in this field of technology may be
25 also used. The compositions containing the active compound can be given enterally or parenterally, the oral route being the preferred way. The contents of the active compound in the composition is from about 0.5 to 100 %, preferably from about 0.5 to about 20 %, per weight of the total composition.

30 The usefulness of the compounds of the invention is demonstrated by the following experiments.

Experiment 1. Calcium sensitizing effect in skinned cardiac fiber

Method

5

The heart of a guinea-pig was excised and perfused with ice-cold saponin (125 mg/l) skinning solution consisting of (mM): K^+ -acetate 74.7, EGTA- Na_2 10, $MgSO_4$ 5.4, ATP- Na_2 4, MOPS 20, pH 7.0 (by 1 M KOH). Left ventricular papillary muscle was dissected and sonicated at 10 Watt for 60 s. The distance between
10 ultrasound probe and the papillary muscle was 10 mm. The fibres (< 200 μm in diameter) were dissected from the surface of sonicated papillary muscles in the same solution.

The fibre was glued between platinum wires, one attached to an isometric force transducer (type AE-801, SensoNor, Horten, Norway) and another to a micro
15 manipulator. The fibre was relaxed in a solution consisting of (mM): EGTA- Na_2 10, $MgSO_4$ 5.4, ATP- Na_2 4, MOPS 20. The pH of the solution was adjusted to 7.0 and ionic strength to 0.16 M by the addition of KOH and K^+ -acetate. Creatine kinase and creatine phosphate were not added as an ATP generating system because the developed tension was well sustained for the time required for experiment. The
20 calculations for ionic strength and for free calcium (pCa 7.0-6.2) were performed using a suitable program. The fibres were stretched in relaxing solution until resting tension was just noticeable. When the calcium (pCa 6.0 or 6.2)-induced tension had reached steady state the test compound (final concentrations 0.1, 0.3, 1, 3, and 10 μM) was cumulatively added into the solution at 6 min intervals. All the experiments
25 were carried out with fresh fibres at normal room temperature.

Results

The calcium sensitizing effect of the compounds are shown in Table 1.

30

TABLE 1. Maximum calcium sensitizing effect in skinned fiber (change in force, % change from control). The Reference compound is Ex. 16 of EP 383449.

Compound of Example No.	Change in force / % change from control
2	207.2
6	32.9
21	44.2
23	39.9
24	42.0
33	55.2
34	52.8
35	25.4
37	21.7
38	32.2
40	100.2
43	39.0
49	28.7
Ref. compound	No effect

5

Experiment 2. Effect in left ventricular pressure derivatives in isolated heart

After sacrifice the heart of a guinea-pig was rapidly excised and rinsed in oxygenated perfusion buffer. A cannula was inserted into the aorta and secured with a ligature. Retrograde perfusion began as soon as the heart was placed in a thermostatically controlled moist chamber of the Langendorff apparatus (Hugo Sachs Elektronik, KG). Modified Tyrode solution (37 °C), equilibrated in a thermostatically controlled bulb oxygenator with carbogen (95 % O₂ and 5% CO₂), was used as a perfusion buffer. The composition of the Tyrode solution was (in mM): NaCl 135; MgCl₂ x 6H₂O 1; KCl 5; CaCl₂ x 2H₂O 2; NaHCO₃ 15; Na₂HPO₄ x 2H₂O 1; glucose 10; pH 7.3-7.4. The perfusion buffer was delivered at the top of the oxygenator by a pump and driven automatically by its controller. Subsequently, the buffer was delivered into the bulbs of the oxygenator chamber by a rotating disk. It was dispersed by making a thin fluid film on a large inner oxygenator surface in O₂/CO₂ atmosphere leading to saturation of the perfusate with oxygen (partial pressure 660 mmHg at 37 °C).

20

The experiments were carried out under constant pressure condition (50 mmHg). After a short prestabilization (10 min) a latex balloon (size 4) was carefully placed into the left ventricle through the left pulmonary vein and the left atrium. The latex balloon was attached to a stainless-steel cannula coupled with a pressure transducer. The latex balloon, the cannula and the chamber of the pressure transducer were carefully filled with ethylene glycol / water (1:1) mixture avoiding any air-bubble. The isovolumetric left ventricular pressure was recorded through the pressure transducer. At the beginning of the experiment, the volume of the balloon was adjusted to obtain a diastolic pressure of approximately 5 mmHg. Before starting the experiment the heart was allowed to stabilise further for 30 - 50 min. The systolic and end-diastolic left ventricular pressures were recorded for calculating the maximal positive and negative derivatives of the left ventricular pressure.

Results

The EC_{50} values (μM) of various compounds of the invention on maximal positive derivative of the left ventricular systolic pressure are shown in Table 2.

Compound of Example No.	EC_{50} (μM)
2	0.02
6	0.31
21	3.04
23	2.47
33	0.4
34	0.11
35	0.31
40	0.71
43	1.75
49	0.25

To further illustrate the invention, but not by way of limitation, the following examples are provided. The melting points were determined on a Reichert plate melting point apparatus and were not corrected. NMR-spectra were recorded on using a Bruker ARX 400 spectrometer with internal TMS as the reference (0 ppm).

EXAMPLES

5 Example 1 (intermediate compound).

(R)-6-(4-hydrazino-phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

A slight modification on the procedure described in J.Med.Chem. (1990),
33(10), 2870-2875 was used as follows. A solution of sodium nitrite (1.7 g) in water
10 (12.5 ml) was added slowly at 0-5 °C to a solution of (R)-6-(4-aminophenyl)-5-
methyl-4,5-dihydro-2*H*-pyridazin-3-one (5 g) in 1 M hydrochloric acid (75 ml). The
resulting solution was stirred on ice bath for five minutes and then added slowly to a
solution of tin(II)chloride dihydrate (17 g) in 1 M hydrochloric acid (150 ml) keeping
the reaction temperature below 5 °C. This solution was stirred on ice for forty
15 minutes and then a solution of 50% NaOH (75 ml) was quickly added. The resulting
mixture was stirred on ice bath until the temperature reached zero degrees Celsius.
The crystals were filtered and washed with dilute ammonia. Yield: 5.0 g, 93 %.

HPLC: enantiomerically pure.

20 ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.04 (d, 3H, CH₃), 2.17 (d, 1H, J = 16
Hz), 2.60 (m, 1H), 3.29 (m, 1H), 4.04 (s, 2H, NH₂), 6.77 (d, 2H, J = 8 Hz), 7.09 (b,
1H, NH), 7.54 (d, 2H, J = 8 Hz), 10.66 (s, 1H, NHCO).

25 Example 2.

(R)- 6-{4-[N'-(4-Hydroxy-3-methoxy-2-nitro-benzylidene)-hydrazino]-
phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

A solution of 4-hydroxy-3-methoxy-2-nitro-benzaldehyde (1.6g) in ethanol
30 (15 ml) was added to a suspension of (R)-6-(4-hydrazino-phenyl)-5-methyl-4,5-
dihydro-2*H*-pyridazin-3-one (1.75 g) in ethanol (20 ml) and the resulting mixture
refluxed for two hours. The resulting crystals were filtered at room temperature and
washed with ethanol. Yield 2.37 g. HPLC: purity 99.4 %, optical purity 99.8 %.

35 ¹H NMR (DMSO-*d*₆): δ = 1.06 (d, 3H, CH₃), 2.18-2.22 (m, 1H), 2.64 (m, 1H),
3.34 (m, 1 H), 3.84 (s, 3H, CH₃O), 6.98 (d, 2H), 7.08 (d, 1H), 7.37 (d, 1H), 7.66 (d,
2H), 7.67 (s, 1H), 10.68 (s, 1H, NH), 10.77 (s, 1H, NHCO).

Further examples

The following compounds were synthesized according to the General method 1 (as exemplified in the previous example) or according to the General method 2.

5

General method 1:

Reflux a mixture of a hydrazine derivative (II) and a benzaldehyde derivative (III) in a suitable solvent (ethanol, 2-propanol, acetonitrile or acetic acid) for 1-24 hours. Filter the product.

10

General method 2:

Heat a neat mixture of a hydrazine derivative (II) and a ketone (III) at 140-170°C under inert atmosphere. Triturate with ethyl acetate and filter the product.

15 The following compounds are synthesized according to the general method 1 unless otherwise specified.

Example 3.

20 2,6-Dihydroxy-3-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazonomethyl}-benzoic acid ethyl ester

Yield 73 %, Melting point: 203 –208 °C

¹H NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.20-2.23 (m, 1H), 2.64-2.68 (m, 1H), 3.30-3.33 (m, 1H), 3.83 (s, 3H, COOCH₃), 6.49 (d, 1H), 6.93 (d, 2H), 7.40 (d, 1H), 25 7.69 (d, 2H), 8.09 (s, 1H), 10.40 (s, 1H), 10.57 (s, 1H), 10.76 (s, 1H), 11.54 (s 1H).

Example 4.

6-{4-[N'-(2,4,5-trihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

30

Yield: 82 %, Melting point: 286-290 °C

¹H NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.18-2.22 (m, 1H), 2.61-2.67 (m, 1H), 3.30-3.35 (m, 1H), 6.32 (s 1H), 6.93-6.95 (m, 1H), 7.66 (d, 2H), 8.03 (s, 1H), 8.42 (s, 1H), 9.24 (s, 1H), 9.76 (s, 1H), 10.32 (s, 1H), 10.74 (s, 1H).

35

Example 5.

6-{4-[N'-(2-Hydroxy-5-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield: 89 %, Melting point: 299-300°C

¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.19-2.23 (m, 1H), 2.63-2.68 (m, 1H), 3.31-3.37 (m, 1H), 7.05-7.10 (m, 3H), 7.72 (d, 2H), 8.05-8.08 (m, 1H), 8.21 (s, 1H), 8.55-8.56 (m, 1H), 10.78 (s, 1H), 10.89 (s, 1H), 11.61 (s, 1H).

5

Example 6.

6-{4-[N'-(4-Hydroxy-3-methoxy-2-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

10 Yield: 87 %, Melting point: 235-239 °C

¹H NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.18-2.22 (m, 1H), 2.62-2.68 (m, 1H), 3.31-3.34 (m, 1H), 3.84 (s, 3H, CH₃O), 6.98 (d, 2H), 7.08 (d, 1H), 7.37 (d, 1H), 7.65 (d, 2H), 7.67 (s, 1H), 10.67 (s, 1H), 10.76 (s, 1H).

15 Example 7.

6-{4-[N'-(2,3-Dihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield: 69 %, Melting point: 245-247 °C

20 ¹H-NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.19-2.23 (m, 1H), 2.64-2.68 (m, 1H), 3.33-3.38 (m, 1H), 6.68-6.77 (m, 2H), 6.99-7.03 (m, 3H), 7.70 (d, 2H), 8.17 (s, 1H), 9.2 (b, 1H), 9.95 (s, 1H), 10.63 (s, 1H), 10.77 (s, 1H).

Example 8.

25 6-{4-[N'-(2,5-Dihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield: 89 %, Melting point: 317-320 °C

30 ¹H-NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.18-2.22 (m, 1H), 2.62-2.68 (m, 1H), 3.30-3.36 (m, 1H), 6.59-6.62 (m, 1H), 6.69-7.03 (m, 1H), 7.68 (d, 2H), 8.12 (s, 1H), 8.82 (s, 1H), 9.57 (s, 1H), 10.57 (s, 1H), 10.76 (s, 1H).

Example 9.

35 6-{4-[N'-(3,4-Dihydroxy-2-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield: 70 %, Melting point: 239-241 °C

¹H-NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.18-2.22 (m, 1H), 2.61-2.67 (m, 1H), 3.33-3.38 (m, 1H), 6.94-6.98 (m, 1H), 7.06 (d, 1H), 7.64-7.66 (m, 3H, ArH, CH=N),

9.94 (b, 1H), 10.48 (b, 1H), 10.59 (s, 1H), 10.75 (s, 1H).

Example 10.

2-{[4-(4-Methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-
5 hydrazonomethyl}-benzoic acid

Yield: 61 %, Melting point: 250-251 °C

¹H-NMR (DMSO-*d*₆): δ = 1.12 (d, 3H), 2.25-2.30 (m, 1H), 2.72-2.78 (m, 1H), 3.42-
3.51 (m, 1H), 7.72 (d, 2H), 7.90-7.95 (m, 3H), 7.98-8.05 (m, 2H), 8.34-8.36 (m 1H),
10 8.61 (s, 1H), 11.03 (s, 1H).

Example 11.

6-{4-[N'-(2-trifluoromethyl-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-
15 dihydro-2H-pyridazin-3-one

Yield: 62 %, Melting point: 113-115 °C

¹H-NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.19-2.23 (m, 1H), 2.63-2.69 (m, 1H),
3.33-3.37 (m, 1H), 7.14 (d, 2H), 7.50-7.52 (m, 1H), 7.68-7.75 (m, 4H),
8.19-8.27 (m, 2H), 10.79 (s, 1H), 11.04 (s, 1H).

Example 12.

Acetic acid 2-methoxy-4-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-
yl)-phenyl]-hydrazonomethyl}-3-nitro-phenyl ester

25 Yield: 65 %, Melting point: 220-223 °C.

¹H-NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.18-2.23 (m, 1H), 2.38 (s, 3H, OCOCH₃),
2.62-2.67 (m, 1H), 3.33-3.38 (m, 1H), 3.85 (s, 3H), 7.03 (d, 2H), 7.46 (d, 1H),
7.60 (d, 1H), 7.72 (d, 2H), 7.75 (s, 1H), 10.79 (s, 1H), 10.98 (s, 1H).

Example 13.

6-(4-{N'-[1-(3,5-Dihydroxy-phenyl)-ethylidene]-hydrazino}-phenyl)-5-
30 methyl-4,5-dihydro-2H-pyridazin-3-one

The title compound was prepared according to the general method 2.

35 Yield: 27 %, melting point 162-166 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.07 (d, 3H), 2.17 (s, 3 H), 2.18-2.22 (m, 1H),
2.62-2.68 (m, 1H), 3.35-3.41 (m, 1H), 6.17 (s, 1H), 6.67 (s, 2H), 7.23 (d, 2H),
7.67 (d, 2H), 9.21 (s, 1H), 9.44 (s, 1H), 10.75 (s, 1H).

Example 14.

6-(4-{N'-[1-(2,4-Dihydroxy-phenyl)-3-(3,4-dimethoxy-phenyl)-propylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

5 The title compound was prepared according to the general method 2

Yield: 71 %, melting point 135-140 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.07 (d, 3H), 2.19-2.23 (m 1H), 2.64-2.67 (m, 1H), 2.77 (t, 2H), 3.15 (t, 2H), 3.31-3.33 (m 1H), 3.69 (s, 3H, OCH₃), 3.75 (s, 3H, OCH₃), 6.29-6.35 (m, 2H), 6.83-6.87 (m 2H), 6.93 (d, 1H), 7.03 (d, 2H), 7.36 (d, 10 1H), 7.71 (d, 2H), 9.1 (s, 1H), 9.5 (s, 1H), 10.78 (s, 1H), 12.91 (s, 1H).

Example 15.

4-(4-{N'-[(2,4-Dihydroxy-phenyl)-phenyl-methylene]-hydrazino}-phenyl)-2*H*-phthalazin-1-one

15

The title compound was prepared according to the general method 2.

Yield: 95 %, melting point 160-170 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 6.7 (m, 2 H), 7.3-7.9 (m, 13 H), 8.3 (m, 1 H), 10.1 (s, 1H), 10.7 (s, 1H), 12.1 (s, 1H), 12.7 (s, 1H).

20

Example 16.

4-(4-{N'-[(2,4-Dihydroxy-phenyl)-(4-hydroxy-phenyl)-methylene]-hydrazino}-phenyl)-2*H*-phthalazin-1-one

25 The title compound was prepared according to the general method 2.

Yield: 95 %, melting point 150-160 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 6.3 (m, 2H), 6.8 (m, 2 H), 7.4-7.9 (m, 10H), 8.3 (m, 1H), 10.1 (s, 1H), 10.2 (s, 1H), 10.4 (s, 1H), 12.1 (s, 1H), 12.7 (s, 1H)

30

Example 17.

4-(4-{N'-[Bis-(2,4-dihydroxy-phenyl)-methylene]-hydrazino}-phenyl)-2*H*-phthalazin-1-one

The title compound was prepared according to the general method 2.

35 Yield 60 %, melting point 140-146 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 6.3 (m, 4H), 7.1-8.3 (m, 10H), 10.1 (s, 1H), 10.2 (s, 2H), 11.2 (s, 2H) 12.7 (s, 1H).

Example 18.

4-{4-[N'-(2,4-Dihydroxy-benzylidene)-hydrazino]-phenyl}-2*H*-phthalazin-1-one

5 Yield: 50 %, melting point 278-283 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 6.3(m, 1H), 6.4(m, 1H), 7.4-7.9 (m, 8H), 8.3(m, 1H), 8.9(s, 1H), 10.3 (s, 1H), 12.8 (s, 1H), 13.4 (s, 1H).

Example 19.

10 6-{4-[N'-(4-Methanesulfonylbenzylidene)hydrazino]phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield: 54.3 %, mp 130-137 °C.

15 ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.08 (d, 3H, CH₃), 2.21 (d, 1H, CH), 2.66 (d of d, 1H, CH), 3.22 (s, 3H, CH₃), 3.33 (m, 1H, CH), 7.17 (d, 2H, CH), 7.71 (d, 2H, CH), 7.97 (s, 1H, CH), 10.79 (s, 1H, NH), 10.95 (s, 1H, NH).

Example 20.

20 3-{[4-(4-Methyl-6-oxo-1,4,5,6-tetrahydropyridazin-3-yl)phenyl]-hydrazonomethyl}-benzonitrile

Yield: 60 %, mp 220-224 °C.

25 ¹H NMR (400 MHz, DMSO-*d*₆): δ = 1.08 (d, 3H, CH₃), 2.22 (d, 1H, CH), 2.66 (d of d, 1H, CH), 3.35 (m, 1H, CH), 7.16 (d, 2H, CH), 7.59 (t, 1H, CH), 7.69 (d, 2H, CH), 7.74 (d, 1H, CH), 7.92 (s, 1H, CH), 8.01 (d, 1H, CH), 8.10 (s, 1H, CH), 10.78 (s, 1H, NH), 10.86 (s, 1H, NH).

Example 21.

30 6-{4-[N'-(2,4-Dihydroxybenzylidene)hydrazino]phenyl}-5-methyl-2*H*-pyridazin-3-one

The product was recrystallized from dimethylformamide.

Yield: 55 %, mp 303-310°C.

35 ¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.16 (s, 3H, CH₃), 6.35 (m, 2H, CH), 6.79 (s, 1H, CH), 6.97 (d, 2H, CH), 7.34 (m, 3H, CH), 8.10 (s, 1H, CH), 9.69 (s, 1H, OH), 10.33 (s, 1H, NH), 10.63 (s, 1H, OH), 12.90 (s, 1H, NH).

Example 22.

6-{4-[*N'*-(4-Hydroxy-3-methoxy-2-nitrobenzylidene)hydrazino]phenyl}-5-methyl-2*H*-pyridazin-3-one

5 Yield: 71.0 %, mp 264-268 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.15 (s, 3H, CH₃), 3.85 (s, 3H, OCH₃), 6.79 (s, 1H, CH), 7.01 (d, 2H, CH), 7.09 (d, 1H, CH), 7.33 (d, 2H, CH), 7.38 (d, 1H, CH), 7.68 (s, 1H, CH), 10.62 (s, 1H, NH), 10.65 (s, 1H, OH), 12.91 (s, 1H, NH).

10 Example 23.

6-{4-{*N'*-[1-(2,4-Dihydroxyphenyl)ethylidene]hydrazino}phenyl}-5-methyl-2*H*-pyridazin-3-one

The title compound was prepared according to the general method 2. The product
15 was refluxed in propionitrile with acetic acid as a catalyst.

Yield: 32 %, mp 299-303 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.16 (d, 3H, CH₃), 2.35 (s, 3H, CH₃), 6.28 (d, 1H, CH), 6.33 (d of d, 1H, CH), 6.79 (d, 1H, CH), 7.07 (d, 2H, CH), 7.38 (d, 1H, CH), 7.39 (d, 2H, CH), 9.50 (s, 1H, NH), 9.69 (s, 1H, OH), 12.92 (s, 1H, OH), 12.97
20 (s, 1H, NH).

Example 24.

6-{4-[*N'*-(2,4-Dihydroxybenzylidene)hydrazino]phenyl}-2,5-dimethyl-2*H*-pyridazin-3-one

25

Yield: 82 %, mp 266-269 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 2.16 (d, 3H, CH₃), 3.66 (s, 3H, CH₃), 6.32 (d, 1H, CH), 6.34 (d of d, 1H, CH), 6.84 (d, 1H, CH), 6.97 (d, 2H, CH), 7.32 (d, 1H, CH), 7.36 (d, 2H, CH), 8.10 (s, 1H, CH), 9.69 (s, 1H), 10.36 (s, 1H), 10.61 (s, 1H).

30

Example 25.

6-{4-[*N'*-(2,4-Dihydroxybenzylidene)hydrazino]phenyl}-2-methyl-2*H*-pyridazin-3-one

35 Yield: 82.4 %, mp 304-306 °C.

¹H NMR (400 MHz, DMSO-*d*₆): δ = 3.72 (s, 3H, CH₃), 6.36 (m, 2H, CH), 6.99 (m, 3H, CH), 7.36 (d, 1H, CH), 7.76 (d, 2H, CH), 7.96 (d, 1H, CH), 8.12 (s, 1H, CH), 9.72 (s, 1H), 10.44 (s, 1H), 10.57 (s, 1H).

Example 26.

6-{4-{*N'*-[1-(2,4-dihydroxyphenyl)ethylidene]hydrazino}phenyl}-2-methyl-2*H*-pyridazin-3-one

5 A solution of 6-(4-hydrazinophenyl)-2-methyl-2*H*-pyridazin-3-one (0.78 g) and 2,4-dihydroxy-acetophenone (0.55 g) in acetonitrile (20.0 ml) was heated under reflux for 5 hrs. Chrystals formed at room temperature were filtered away. On cooling the filtrate overnight the product chrystallized out. This was filtered, washed with warm ethanol and dried under reduced pressure. Yield: 5.6 %, mp 263-268 °C.

10

¹H NMR (400 MHz, DMSO-d₆): δ = 2.35 (s, 3H, CH₃), 3.72 (s, 3H, CH₃), 6.30 (s, 1H, CH), 6.34 (d, 1H, CH), 6.99 (d, 1H, CH), 7.09 (d, 2H, CH), 7.39 (d, 1H, CH), 7.82 (d, 2H, CH), 7.99 (d, 1H, CH), 9.58 (s, 1H, NH), 9.71 (s, 1H, OH), 12.90 (s, 1H, OH).

15

Example 27.

6-{4-{*N'*-[1-(2,4-Dihydroxyphenyl)propylidene]hydrazino}phenyl}-2-methyl-2*H*-pyridazin-3-one

20 The title compound was prepared according to the general method 2.
Yield: 29 %, mp 225-233 °C.

¹H NMR (400 MHz, DMSO-d₆): δ = 1.15 (t, 3H, CH₃), 2.87 (q, 2H, CH₂), 3.73 (s, 3H, CH₃), 6.33 (d, 1H, CH), 6.37 (d of d, 1H, CH), 6.99 (d, 1H, CH) 7.13 (d, 2H, CH), 7.37 (d, 1H, CH), 7.82 (d, 1H, CH), 7.99 (d, 1H, CH), 9.67 (s, 1H), 9.73 (s, 1H), 12.98 (s, 1H).

25

Example 28.

6-{4-[*N'*-(2,4-Dihydroxy-3-ethylbenzylidene)hydrazino]phenyl}-2-methyl-2*H*-pyridazin-3-one

30

Yield: 37 %, mp 262-266 °C.

¹H NMR (400 MHz, DMSO-d₆): δ = 1.08 (t, 3H, CH₃), 2.61 (q, 2H, CH₂), 3.71 (s, 3H, CH₃), 6.43 (d, 1H, CH), 6.96 (d, 2H, CH), 6.99 (d, 1H, CH), 7.01 (d, 1H, CH), 7.79 (d, 2H, CH), 7.96 (d, 1H, CH), 8.05 (s, 1H, CH), 9.67 (s, 1H), 10.49 (s, 1H), 11.30 (s, 1H).

35

Example 29.

4-(2,4-Dihydroxyphenyl)-4-{[4-(1-methyl-6-oxo-1,6-dihydropyridazin-3-yl)phenyl]hydrazono}butyric acid

5 The title compound was prepared according to the general method 2.

Yield: 15.9 %, mp 138-141 °C.

¹H NMR (400 MHz, DMSO-d₆): δ = 2.51 (t, 2H, CH₂), 3.06 (t, 2H, CH₂), 3.72 (s, 3H, CH₃), 6.30 (s, 1H, CH), 6.34 (d, 1H, CH), 7.01 (d, 1H, CH), 7.10 (d, 2H, CH), 7.32 (d, 1H, CH), 7.83 (d, 2H, CH), 7.01 (d, 1H, CH), 9.72 (s, 1H), 9.78 (s, 1H),
10 12.31 (s, 1H), 12.74 (s, 1H).

Example 30 (intermediate).

6-(4-hydrazinophenyl)-5-methyl-2*H*-pyridazin-3-one

15 The title compound was prepared from 6-(4-aminophenyl)-5-methyl-2*H*-pyridazin-3-one similarly as 6-(4-hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one.

¹H NMR (400 MHz, DMSO-d₆): δ = 2.13 (s, 3H, CH₃), 4.11 (s, 2H, NH₂), 6.75 (s, 1H, CH), 6.81 (d, 2H, CH), 6.95 (s, 1H, NH), 7.21 (d, 2H, CH), 12.82 (s, 1H, NH).
20

Example 31 (intermediate).

6-(4-hydrazinophenyl)-2,5-dimethyl-2*H*-pyridazin-3-one

The title compound was prepared from 6-(4-aminophenyl)-2,5-dimethyl-2*H*-pyridazin-3-one similarly as 6-(4-hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one.
25

¹H NMR (400 MHz, DMSO-d₆): δ = 2.14 (d, 3H, CH₃), 3.63 (s, 3H, CH₃), 4.12 (s, 2H, NH₂), 6.81 (d, 2H, CH), 6.82 (d, 1H, CH), 6.98 (s, 1H, NH), 7.22 (d, 2H, CH).

30 Example 32 (intermediate).

6-(4-hydrazinophenyl)-2-methyl-2*H*-pyridazin-3-one

The title compound was prepared from 6-(4-aminophenyl)-2-methyl-2*H*-pyridazin-3-one similarly as 6-(4-hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one.
35

¹H NMR (400 MHz, DMSO-d₆): δ = 3.69 (s, 3H, CH₃), 4.18 (s, 2H, NH₂), 6.83 (d, 2H, CH), 6.94 (d, 1H, CH), 7.11 (s, 1H, NH), 7.65 (d, 2H, CH), 7.93 (d, 1H, CH).

Example 33.

6-(4-{N'-[1-(2,4-Dihydroxy-phenyl)-ethylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2H-pyridazin-3-one

5 The title compound was prepared according to the general method 2.

Yield 74 %, Melting point: 259 –261 °C

¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.21 (d, 1H), 2.35(s, 3H), 2.63-2.68 (m, 1H), 3.30-3.36 (m, 1H), 6.28 (d, 1H), 6.34 (q, 1H), 7.03 (d, 2H), 7.37 (d, 1H), 7.71 (d, 2H), 9.57 (s, 1H), 9.70 (s, 1H), 10.78 (s, 1H), 12.91 (s 1H).

10

Example 34.

6-(4-{N'-[Bis-(2,4-dihydroxy-phenyl)-methylene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2H-pyridazin-3-one

15 The title compound was prepared according to the general method 2.

Yield 13 %, Melting point: 150->175 °C

¹H NMR (DMSO-*d*₆): δ = 1.06 (d, 3H), 2.19 (d, 1H), 2.61-2.67 (m, 1H), 3.30-3.36 (m, 1H), 6.16 - 6.19 (q, 1H), 6.03 (d, 1H), 6.37 - 6.39 (q, 1H), 6.47 (d, 1H), 6.55 (d, 1H), 6.84 (d, 1H), 7.02 (d, 2H), 7.66 (d, 2H), 8.93 (broad, 1H), 9.72 (broad, 3H), 10.76 (s, 1H), 12.71 (s 1H).

20

Example 35.

6-(4-{N'-[1-(2,5-Dihydroxy-phenyl)-ethylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2H-pyridazin-3-one

25

The title compound was prepared according to the general method 2.

Yield 73 %, Melting point: 279 –284 °C

¹H NMR (DMSO-*d*₆): δ = 1.08 (d, 3H), 2.21 (d, 1H), 2.34 (s, 3H), 2.63-2.69 (m, 1H), 3.32-3.38 (m, 1H), 6.66-6.73 (m, 2H), 6.93 (s, 1H), 7.09 (d, 2H), 7.73 (d, 2H), 8.85 (s, 1H), 9.73 (s, 1H), 10.80 (s, 1H), 11.85 (s, 1H).

30

Example 36.

6-{4-[N'-(2,4-Dihydroxy-benzylidene)-hydrazino]-phenyl}-5-ethyl-4,5-dihydro-2H-pyridazin-3-one

35

Yield 29 %, Melting point: 270 –275 °C

¹H NMR (DMSO-*d*₆): δ = 0.87 (t, 3H), 1.38-1.54 (m, 2H), 2.36 (d, 1H), 2.56-2.62 (q, 1H), 3.12-3.38 (m, 1H), 6.32 (m, 2H), 6.93 (d, 2H), 7.33 (d, 1H), 7.67 (d, 2H), 8.08 (s, 1H), 9.68 (s, 1H), 10.34 (s, 1H), 10.55 (s 1H), 10.71 (s, 1H).

Example 37.

N-[4-(1-{[4-(4-Methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazono}-ethyl)-phenyl]-acetamide

5

The title compound was prepared according to the general method 2.

Yield 41 %, Melting point: 145-155 °C

¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.05 (s, 3H), 2.23 (d, 1H), 2.24 (s, 3H), 2.61-2.68 (m, 1H), 3.30-3.36 (m, 1H), 7.24 (d, 2H), 7.60 (d, 2H), 7.67 (d, 2H), 7.74 (d, 2H), 9.45 (s, 1H), 10.01 (s, 1H), 10.75 (s, 1H).

10

Example 38.

6-(4-{N'-[1-(2,4-Dihydroxy-3-methyl-phenyl)-ethylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2H-pyridazin-3-one

15

Yield 47 %, Melting point: 244 –248 °C

¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.03 (s, 3H), 2.20 (d, 1H), 2.63-2.68 (m, 1H), 3.30-3.36 (m, 1H), 6.43 (d, 1H), 6.91 (d, 2H), 7.01 (d, 1H), 7.70 (d, 2H), 8.05 (s, 1H), 9.69 (s, 1H), 10.46 (s, 1H), 10.76 (s, 1H), 11.31 (s, 1H)

20

Example 39.

6-{4-[N'-(3-Acetyl-2,4-dihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

25 Yield 72 %, Melting point: 268 –270 °C

¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.20 (d, 1H), 2.61-2.66 (m, 1H), 2.69 (s, 3H), 3.30-3.36 (m, 1H), 6.53 (d, 1H), 6.98 (d, 2H), 7.70 (m, 3H), 8.15 (s, 1H), 10.56 (s, 1H), 10.76 (s, 1H), 11.89 (s, 1H), 13.91 (s, 1H)

30

Example 40.

6-{4-[N'-(3-Ethyl-2,4-dihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield 36 %, Melting point: 238 –240 °C

¹H NMR (DMSO-*d*₆): δ = 1.05-1.09 (m, 3H, 3H), 2.21 (d, 1H), 2.60-2.64 (m, 3H), 3.30-3.36 (m, 1H), 6.42 (d, 1H), 6.90 (d, 2H), 7.00 (d, 1H), 7.71 (d, 2H), 8.04 (s, 1H), 9.65 (s, 1H), 10.46 (s, 1H), 10.76 (s, 1H), 11.31 (s, 1H).

35

Example 41.

N-(3-Hydroxy-4-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazonomethyl}-phenyl)-acetamide

5 Yield 39 %, Melting point: 269 –275 °C

¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.03 (s, 3H), 2.20 (d, 1H), 2.61-2.67 (m, 1H), 3.28-3.34 (m, 1H), 6.97-7.01 (m, 3H), 7.36 (d, 1H), 7.49 (d, 1H), 7.68 (d, 2H), 8.12 (s, 1H), 9.96 (s, 1H), 10.42 (s, 1H), 10.52 (s, 1H), 10.75 (s, 1H).

10 Example 42.

6-{4-[N'-(2,4-Dichloro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield 53 %, Melting point: 252 –254 °C

15 ¹H NMR (DMSO-*d*₆): δ = 1.07 (d, 3H), 2.21 (d, 1H), 2.63-2.68 (m, 1H), 3.28-3.37 (m, 1H), 7.13 (d, 2H), 7.45 (q, 1H), 7.64 (d, 1H), 7.70 (d, 2H), 8.04 (d, 1H), 8.19 (s, 1H), 10.78 (s, 1H), 11.02 (s, 1H)

Example 43.

20 6-{4-[N'-(2,4-Dihydroxy-3-propyl-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield 61 %, Melting point: 160 –170 °C

25 ¹H NMR (DMSO-*d*₆): δ = 0.92 (t, 3H), 1.07 (d, 3H), 1.48-1.53 (m, 2H), 2.21 (d, 1H), 2.55-2.58 (m, 2H), 2.62-2.68 (m, 1H), 3.30-3.35 (m, 1H), 6.42 (d, 1H), 6.91 (d, 2H), 7.00 (d, 1H), 7.70 (d, 2H), 8.04 (s, 1H), 9.25 (s, 1H), 10.45 (s, 1H), 10.76 (s, 1H), 11.29 (s, 1H)

Example 44.

30 6-{4-[N'-(3-Butyl-2,4-dihydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield 74 %, Melting point: 218 °C

35 ¹H NMR (DMSO-*d*₆): δ = 0.91 (t, 3H), 1.07 (d, 3H), 1.29-1.38 (m, 2H), 1.45-1.51 (m, 2H), 2.21 (d, 1H), 2.57-2.68 (m, 2H, 1H), 3.29-3.36 (m, 1H), 6.42 (d, 1H), 6.91 (d, 2H), 6.99 (d, 1H), 7.71 (d, 2H), 8.04 (s, 1H), 9.62 (s, 1H), 10.46 (s, 1H), 10.76 (s, 1H), 11.28 (s, 1H).

Example 45 (intermediate).

6-(3-Hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

The title compound was prepared using method of example 1 starting from
5 1.5 g of 6-(3-aminophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one (J. Med.
Chem. 1974 17(3)). The product was isolated (after addition of sodium hydroxide
solution) by extraction to tetrahydrofuran. Crystallisation from acetonitrile yielded
1.0 g of the title compound.

1-HNMR (DMSO-d₆, 400 MHz): 1.06 (d, 3H), 2.22 (d, 1H), 2.66 (dd, 1H), 3.30 (m,
10 1H), 3.97 (s, 2H), 6.78 (s, 1H), 6.81 (m, 1H), 6.98 (m, 1H), 7.14 (t, 1H), 7.23 (t, 1H),
10.86 (s, 1H).

Example 46.

6-(3-{*N*-[Bis(2,4-dihydroxy-phenyl)methylene]hydrazino}phenyl)-5-methyl-
15 4,5-dihydro-2*H*-pyridazin-3-one

A mixture of 6-(3-Hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-
one (0.38 g), 2,2',4,4'-tetrahydroxybenzophenone (0.51 g), acetic acid (0.4 ml), and
acetonitrile (7.0 ml) was refluxed for 20 h. Solvents were removed *in vacuo* and the
20 product was separated using column chromatography (silicagel; toluene, ethyl
acetate, acetic acid 8:3:3). Crystallisation from a mixture of ethyl acetate and
dichloromethane gave 290 mg of product, mp 195-205 °C.

1-HNMR (DMSO-d₆, 400 MHz): 1.08 (d, 3H), 2.23 (d, 1H), 2.68 (dd, 1H), 3.31 (m,
25 1H), 6.17 (dd, 1H), 6.30 (d, 1H), 6.36 (dd, 1H), 6.46 (d 1H), 6.57 (d, 1H), 6.83 (d,
1H), 7.01 (m, 1H), 7.19 (m, 1H), 7.28 (t, 1H), 7.45 (t, 1H), 10.92 (s, 1H), 8-14 (broad
singlets, 5H).

30 Example 47.

6-{4-[*N*-(2,4-Dihydroxy-5-nitrobenzylidene)hydrazino]phenyl}-5-methyl-
4,5-dihydro-2*H*-pyridazin-3-one

6-(4-Hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one (1.10 g),
35 2,4-dihydroxy-5-nitrobenzaldehyde (0.92 g) and acetic acid (20 ml) were combined
and the resulting mixture was refluxed for 20 min. The mixture was cooled to room
temperature and the product filtered, yield 1.95 g, solvated crystals with 1 mol of
acetic acid, mp about 290 °C with decomposition.

1-HNMR (DMSO-d₆, 400 MHz): 1.08 (d, 3H), 1.91(s, 3H), 2.22 (d, 1H), 2.66 (dd, 1H), 3.36 (m, 1H), 6.58 (s, 1H), 7.03 (d, 2H), 7.70 (d, 2H), 8.11 (s, 1H), 8.34 (s, 1H), 10.69 (s, 1H), 10.76 (s, 1H), 13.04 (s, 1H), 13.58 (s, 1H), 13.95 (s, 1H).

5 Example 48

6-{4-{*N*-[4-(Dimethylamino)benzylidene]hydrazino}phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

6-(4-Hydrazinophenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one (1.1 g), 4-(dimethylamino)benzaldehyde (0.83 g), acetic acid (0,60 ml) and acetonitrile (15 ml) were combined and the resulting mixture was heated to boil, cooled to room temperature and the product was filtered and washed with acetonitrile, yield 1.50g, mp 225-232 °C.

1-HNMR (DMSO-d₆, 400 MHz): 1.07 (d, 3H), 2.21 (d, 1H), 2.64 (dd, 1H), 2.94 (s, 6H), 3.34 (m, 1H), 6.73 (d, 2H), 7.04 (d, 2H), 7.49 (d, 2H), 7.65 (d, 2H), 7.81 (s, 1H), 10.24 (s, 1H), 10.73 (s, 1H).

Example 49.

6-(4-{*N*-[1-(2,4-Dihydroxy-3-methylphenyl)ethylidene]hydrazino}phenyl)-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

The title compound was prepared according to the general method 2.

Yield 41 %, m.p. 268-271 °C.

1-HNMR (DMSO-d₆, 400 MHz): 1.07 (d, 3H), 2.20 (d, 1H), 2.65 (dd, 1H), 3.35 (m, 1H), 6.40 (d, 1H), 7.05 (d, 2H), 7.24 (d, 1H), 7.73 (d, 2H), 9.55 (s, 1H), 9.57 (s, 1H), 10.77 (s, 1H), 13.25 (s, 1H).

Example 50.

6-{4-[*N*-(2,4-Dimethoxybenzylidene)hydrazino]phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield 90 %, m.p. 215-218 °C.

1-HNMR (DMSO-d₆, 400 MHz): 1.07 (d, 3H), 2.17 (d, 1H), 2.63 (dd, 1H), 3.31 (m, 1H), 3.80 (s, 3H), 3.84 (s, 3H), 6.58-6.61 (m, 2H), 7.03 (d, 2H), 7.65 (d, 2H), 7.78 (d, 1H), 8.16 (s, 1H), 10.43 (s, 1H), 10.73 (s, 1H).

Example 51.

6-{4-[*N*-(2-Hydroxy-4-methoxybenzylidene)hydrazino]phenyl}-5-methyl-4,5-dihydro-2*H*-pyridazin-3-one

Yield 93 %, m.p. 214-216 °C.

1-HNMR (DMSO-d₆, 400 MHz): 1.07 (d, 3H), 2.20 (d, 1H), 2.64 (dd, 1H), 3.34 (m, 1H), 3.75 (s, 3H), 6.46-6.51 (m, 2H), 6.96 (d, 2H), 7.47 (d, 1H), 7.68 (d, 2H), 8.12 (s, 1H), 10.48 (s, 1H), 10.66 (s, 1H), 10.75 (s, 1H).

Example 52.

6-{4-[N'-(4-nitrobenzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

10

Yield: 80 %, mp 216-217°C

¹H NMR (400 MHz, DMSO-d₆): δ = 1.08(d,3H), 2.21(d,1H), 2.63-2.66(m,1H), 3.29-3.31(m,1H), 7.19(d,2H), 7.72(d,2H), 7.72 (d,2H), 7.92(s,1H), 7.99(s,1H), 8.24(d,2H), 10.80(s,1H), 10.10(s,1H)

15

Example 53.

6-{4-[N'-(2-Methoxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

20 Yield: 78 %, mp 180 -183°C

¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.20(d,1H), 2.62-2.67(m,1H), 3.32-3.34(m,1H), 3.85(s,3H), 6.97-7.00(m,1H), 7.06(d,2H), 7.29-7.32(m, 1H), 7.66 (d,2H), 7.87(d,1H), 8.25(s,1H), 10.61(s,1H), 10.75(s,1H)

25

Example 54.

6-{4-[N'-(2-Hydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield: 90 %, mp 265 - 268°C

30 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.20(d,1H), 2.62-2.68(m,1H), 3.32-3.36(m,1H), 6.86-6.90(m,1H), 7.01(d,2H), 7.16-7.20(m, 1H), 7.60 (d,2H), 7.69(d,1H), 8.20(s,1H), 10.37(s,1H), 10.64(s,1H), 10.76(s,1H)

Example 55.

35 6-{4-[N'-(4-Methoxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield: 82 %, mp 172 - 174°C

¹H NMR (400 MHz, DMSO-d₆): δ = 1.08(d,3H), 2.19(d,1H), 2.61-2.67(m,1H), 3.29-3.31(m,1H), 3.79(s,3H), 6.98(d,2H), 7.07(d,2H), 7.61 (d,2H), 7.66(s,2H), 7.87(s,1H), 10.43(s,1H), 10.75(s,1H)

5 Example 56.

2,6-Dihydroxy-3-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazonomethyl}-benzoic acid

Yield: 51 %, mp 215 -218°C

10 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.06(d,3H), 2.20(d,1H), 2.61-2.67(m,1H), 3.30-3.36(m,1H), 6.24(d,1H), 6.99(d,2H), 7.63(d,2H), 7.65(d,1H), 8.16(s,1H), 10.00(s,1H), 10.71(s,1H), 10.90(s,1H)

Example 57.

15 6-{4-[N'-(2-Hydroxy-3-methoxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield: 93 %, mp 210 -213°C

20 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.08(d,3H), 2.20(d,1H), 2.62-2.67(m,1H), 3.35-3.39(m,1H), 3.81(s,1H) 6.82(t,1H), 6.93(d,1H), 7.02(d,2H), 7.22(d,1H), 7.69(d,2H), 8.21(s,1H), 9.88(s,1H), 10.64(s,1H), 10.77(s,1H)

Example 58.

25 6-{4-[N'-(2-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield: 77 %, mp 250 -253°C

30 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.20(d,1H), 2.63-2.70(m,1H), 3.29-3.36(m,1H), 7.14(d,2H), 7.50-7.54(m,1H), 7.70(d, 2H), 7.71-7.75(m,1H), 7.99(d,1H), 8.17(s,1H), 8.30(s,1H), 10.79(s,1H), 11.11(s,1H)

Example 59.

35 6-{4-[N'-(2,6-Dinitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield: 20 %, mp 216-218°C

¹H NMR (400 MHz, DMSO-d₆): δ = 1.06(d,3H), 2.20(d,1H), 2.63-2.70(m,1H), 3.29-3.36(m,1H), 6.96(d,2H), 7.68-7.74(m,3H), 8.11(s,1H), 8.22(d,2H), 10.81(s,1H), 11.29(s,1H)

Example 60.

4-{{4-(4-Methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl}-
hydrazonomethyl}-benzonitrile

5

Yield: 85 %, mp 246 -248°C

¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.21(d,1H), 2.63-2.67(m,1H),
3.30-3.35(m,1H), 7.16(d,2H), 7.70(d,2H), 7.82 (d,2H), 7.84(d,2H), 7.93(d,2H),
10.79(s,1H), 10.97(s,1H)

10

Example 61.

6-{4-[N'-(4-Hydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-
dihydro-2H-pyridazin-3-one

15 Yield: 86 %, mp 258-261°C

¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.19(d,1H), 2.61-2.67(m,1H),
3.30-3.35(m,1H), 6.79(d,2H), 7.04(d,2H), 7.48 (d,2H), 7.65(d,2H), 7.82(s,1H), 9.66(
s,1H), 10.33(s,1H), 10.73(s,1H)

20

Example 62.

6-{4-[N'-(3-Hydroxy-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-
dihydro-2H-pyridazin-3-one

Yield: 80 %, mp 267 -270°C

25 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.20(d,1H), 2.61-2.67(m,1H),
3.33-3.36(m,1H), 6.71-6.73(dd,1H), 7.04-7.12(m,4H), 7.18-7.21(m,1H), 7.68(d,2H),
7.82(s,1H), 9.46(s,1H), 10.54(s,1H), 10.76(s,1H)

Example 63.

30 6-{4-[N'-(4-Hydroxy-3-nitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-
dihydro-2H-pyridazin-3-one

Yield: 21 %, mp 230 - 233°C

35 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.19(d,1H), 2.62-2.69(m,1H),
3.31-3.36(m,1H), 7.09(d,2H), 7.16(d,1H), 7.67(d,2H), 7.88(s,1H), 7.89-7.91(dd,1H),
8.11(d,1H), 10.64(s,1H), 10.76(s,1H), 11.00(s,1H)

Example 64.

4-(2,4-Dihydroxy-phenyl)-4-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazono}-butyric acid

Yield: 26 %, mp 299 -302°C

- 5 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.19(d,1H), 2.49-2.51(t,2H), 2.64-2.67(m,1H), 3.03-3.05(t,2H), 3.28-3.31(m,1H), 6.29(d,1H), 6.33-6.35(dd,1H), 7.04(d,2H), 7.32(d,1H), 7.72(d,2H), 9.71(s,1H), 9.79(s,1H), 10.78(s,1H), 12.00(s,1H), 12.77(s,1H)

- 10 Example 65.

6-{4-[N'-(2,4-Dinitro-benzylidene)-hydrazino]-phenyl}-5-methyl-4,5-dihydro-2H-pyridazin-3-one

Yield: 50 %, mp 278 -280°C

- 15 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.07(d,3H), 2.21(d,1H), 2.64-2.70(m,1H), 3.37-3.40(m,1H), 7.22(d,2H), 7.75(d,2H), 8.37(s,1H), 8.43(d,1H), 8.44(d,1H), 8.74(d,1H), 10.84(s,1H), 11.62(s,1H)

Example 66.

- 20 5-(2,4-Dihydroxy-phenyl)-5-{[4-(4-methyl-6-oxo-1,4,5,6-tetrahydro-pyridazin-3-yl)-phenyl]-hydrazono}-pentanoic acid

Yield: 39 %, mp 235 - 240°C

- 25 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.04-1.08(m,5H), 1.72-1.74(m,2H), 2.22(d,1H), 2.64-2.67(m,1H), 2.80-2.82(m,2H), 3.30-3.36(m,1H), 6.29(d,1H), 6.32-6.35(dd,1H), 7.04(d,2H), 7.41(d,1H), 7.72(d,2H), 9.77(s,1H), 9.71(s,1H), 10.78(s,1H), 12.00(s,1H), 12.88(s,1H)

Example 67.

- 30 6-(4-{N'-[1-(4-Hydroxy-3-methoxy-2-nitro-phenyl)-ethylidene]-hydrazino}-phenyl)-5-methyl-4,5-dihydro-2H-pyridazin-3-one

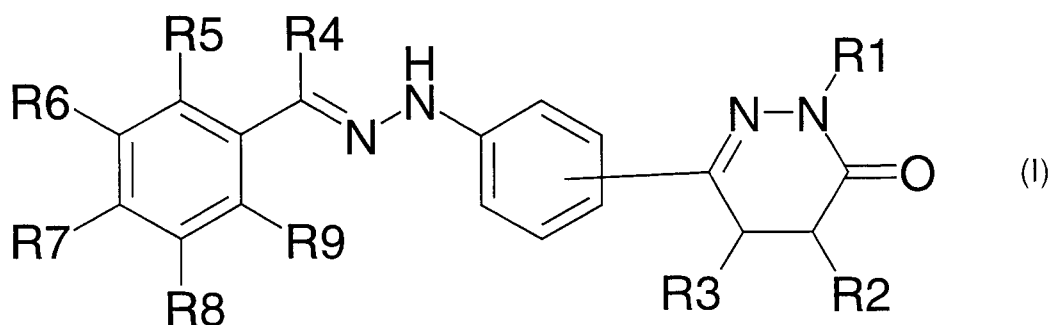
Yield: 46 %, mp 251 -254°C

- 35 ¹H NMR (400 MHz, DMSO-d₆): δ = 1.06(d,3H), 2.19(d,1H), 2.21(s,3H), 2.61-2.65(m,1H), 3.30-3.36(m,1H), 3.83(s,3H), 7.06(d,2H), 7.08(d,2H), 7.28(d,2H), 7.63(d,1H), 9.49(s,1H), 10.55(s,1H), 10.75(s,1H)

Claims

Compounds of formula (I):

5



in which

- 10 R_1 to R_4 means hydrogen, alkyl, alkenyl, aryl, arylalkyl, carboxyalkyl, hydroxyalkyl or halogenalkyl, or R_2 and R_3 form a ring of 5-7 carbon atoms, R_5 to R_9 means hydrogen, alkyl, alkenyl, aryl, arylalkyl, acyl, hydroxy, alkoxy, alkoxy carbonyl, amino, acylamino, alkylamino, aryloxy, halogen, cyano, nitro, carboxy, alkylsulfonyl, sulfonamido or trifluoromethyl,
- 15 wherein each aryl residue defined above by itself or as a part of another group may be substituted, and pharmaceutically acceptable salts and esters thereof, provided that a) when R_1 , R_2 , R_3 , R_5 , R_6 , R_8 and R_9 are hydrogen and R_4 is methyl, R_7 is not hydrogen or methoxy and b) when R_1 , R_2 , R_3 , R_5 , R_6 , R_7 and R_8 are
- 20 hydrogen and R_4 is methyl, R_9 is not hydroxy.

2. Compound of claim 1 wherein R_5 to R_9 are independently hydrogen, C_{1-6} alkyl, C_{1-6} alkenyl, C_{6-10} aryl, C_{7-12} arylalkyl, C_{1-6} acyl, hydroxy, C_{1-6} alkoxy, C_{1-6} alkoxy carbonyl, amino, C_{1-6} acylamino, C_{1-6} alkylamino, C_{6-10} aryloxy, halogen,
- 25 cyano, nitro, carboxy, C_{1-6} alkylsulfonyl, sulfonamido or trifluoromethyl.

3. Compound of claim 2 wherein R_5 to R_9 are independently hydrogen, hydroxy, C_{1-6} alkyl, C_{1-6} alkoxy, carboxy, C_{1-6} alkoxy carbonyl or nitro.

- 30 4. Compound of claim 3 wherein R_5 is hydroxy, C_{1-6} alkyl, C_{1-6} alkoxy, carboxy, C_{1-6} alkoxy carbonyl or nitro.

5. Compound of claim 4 wherein R_5 is hydroxy or nitro.

6. Compound of any of claims 1-5 wherein R₁ to R₄ are independently hydrogen, C₁₋₆ alkyl, C₁₋₆ alkenyl, C₆₋₁₀ aryl, C₇₋₁₂ arylalkyl, C₁₋₆ carboxyalkyl, C₁₋₆ hydroxyalkyl or C₁₋₆ halogenalkyl, or R₂ and R₃ form a phenyl ring.

5

7. Compound of any of claims 1-6 wherein R₁ to R₃ are independently hydrogen or C₁₋₆ alkyl.

8. Compounds of formula (I) in which R₁, R₂, R₃, R₅, R₆, R₈ and R₉ are hydrogen, R₄ is methyl, and R₇ is hydrogen or methoxy, or in which R₁, R₂, R₃, R₅, R₆, R₇ and R₈ are hydrogen, R₄ is methyl and R₉ is hydroxy and pharmaceutically acceptable salts and esters thereof, for use as a medicament.

9. Pharmaceutical composition comprising a compound of claim 1 as an active ingredient together with a pharmaceutically acceptable carrier.

10. Method for the treatment of congestive heart failure comprising administering to a subject in need thereof a therapeutically effective amount of a compound of claim 1.

20