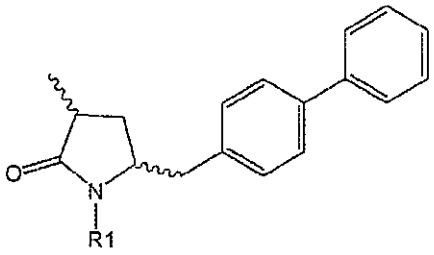
Claims:

1. A process for preparing a compound of formula (3)

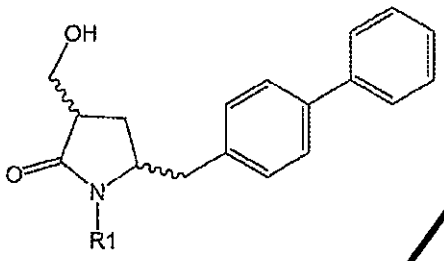


(3)

or salt thereof,

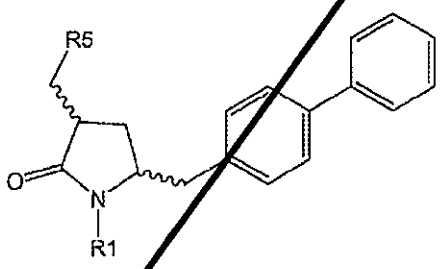
wherein R1 is hydrogen or a nitrogen protecting group, said process comprising

a) converting a compound of formula (5), or salt thereof,



(5)

wherein R1 is hydrogen or a nitrogen protecting group, into a compound of formula (12)

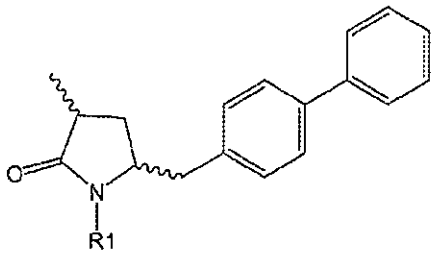


(12)

or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group and R5 is a leaving group; and

b) reacting the compound of formula (12), or salt thereof, with a reducing agent to obtain the compound of formula (3).

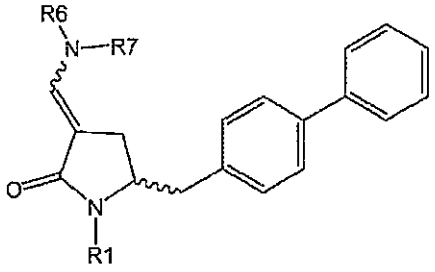
2. A process for preparing a compound of formula (3)



(3)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, said process comprising treating a compound of formula (7),

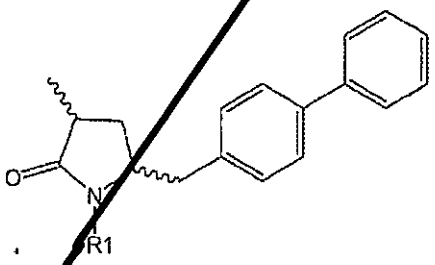


(7)

or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms,

with a reducing agent to obtain the compound of formula (3), or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group.

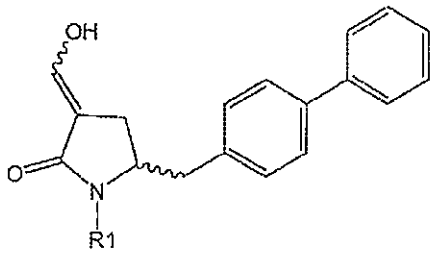
3. A process for preparing a compound of formula (3)



(3)

or salt thereof,

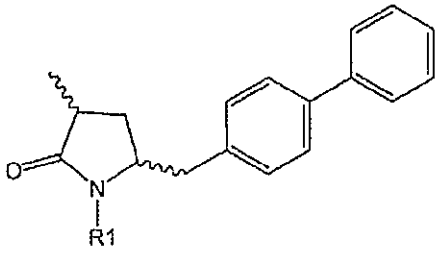
wherein R1 is hydrogen or a nitrogen protecting group, said process comprising treating a compound of formula (6),



(6)

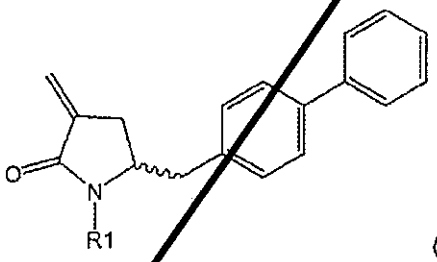
or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group,
with a reducing agent to obtain the compound of formula (3), or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group.

4. A process for preparing a compound according to formula (3),



(3)

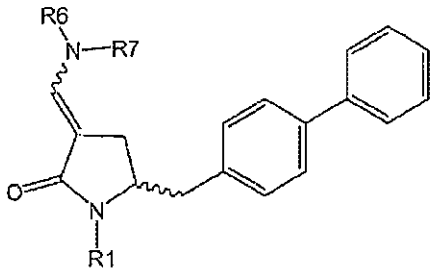
or salt thereof,
wherein R1 is hydrogen or a nitrogen protecting group, comprising reducing a compound according to formula (4),



(4)

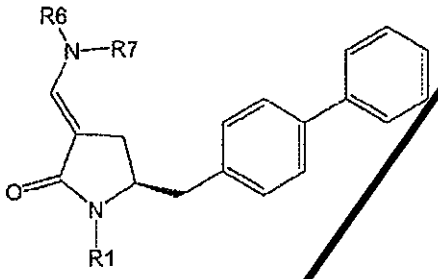
or salt thereof,
wherein R1 is hydrogen or a nitrogen protecting group, to obtain the compound of formula (3).

5. A process for converting a compound of formula (7), or salt thereof,



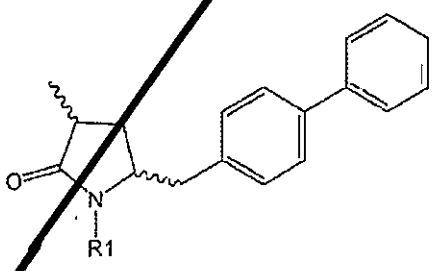
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



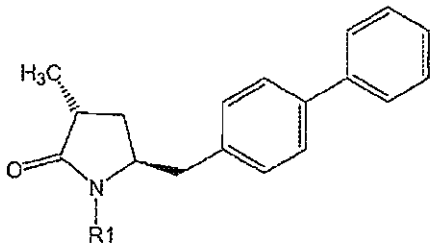
(7-b),

into a compound of formula (3), or salt thereof,



(3)

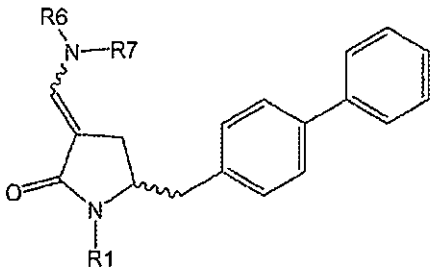
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

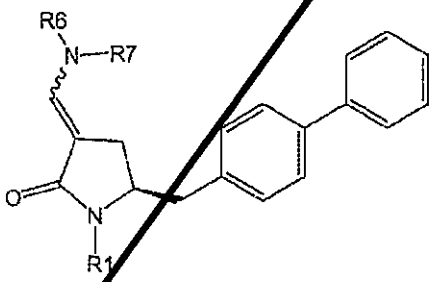
wherein said process comprises

a) converting a compound of formula (7), or salt thereof,



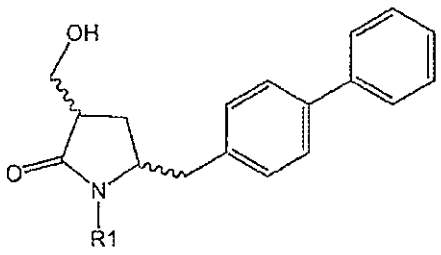
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-a),



(7-a),

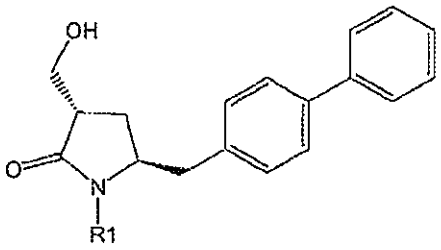
into a compound of formula (5), or salt thereof,



(5),

wherein R1 is hydrogen or a nitrogen protecting group,

preferably having a configuration according to formula (5-b),

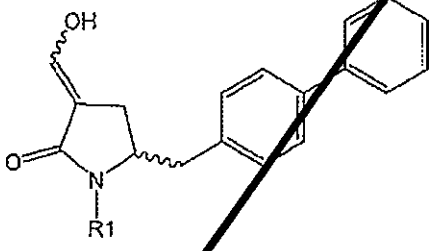


(5-b),

according to any one of methods 1 to 3:

method 1 comprises

a) converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof,



(6)

wherein R1 is hydrogen or a nitrogen protecting group,

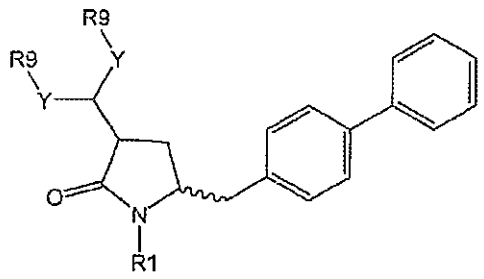
comprising treating a compound of formula (7), or salt thereof, with an acid to obtain the compound of formula (6) or treating a compound of formula (7), or salt thereof with a reducing agent to obtain the compound of formula (6) and

b) converting a compound of formula (6) into the compound of formula (5) comprising treating a compound of formula (6), or salt or a tautomer thereof, with a reducing agent to obtain the compound of formula (5).

method 2 comprises treating a compound of formula (7), or salt thereof, with a reducing agent;

method 3 comprises

a) converting the compound of formula (7) into the compound of formula (16)



(16)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, Y is oxygen and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered acetal ring,

comprising treating a compound of formula (7), or salt thereof, with an acetal forming agent to obtain the compound of formula (16) or

converting a compound of formula (16) or salt thereof wherein R1 is hydrogen or a nitrogen protecting group, Y is sulfur and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered thioacetal ring,

comprising treating a compound of formula (7), or salt thereof, with a thioacetal forming agent to obtain the compound of formula (16);

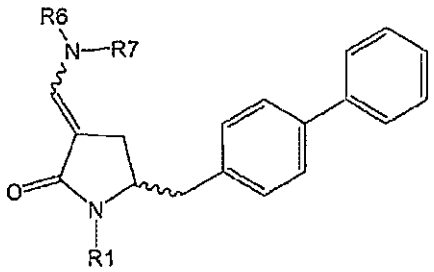
b) converting the compound of formula (16) into the compound of formula (6) comprising removal of the acetal functionality or the thioacetal functionality, respectively, in a compound of formula (16), or salt thereof, to obtain the compound of formula (6) and

c) converting the compound of formula (6) into the compound of formula (5) comprising treating a compound of formula (6), or salt or a tautomer thereof, with a reducing agent to obtain the compound of formula (5);

and

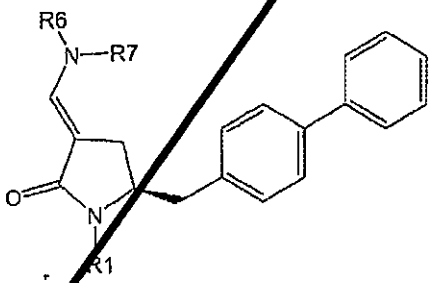
b) converting the compound of formula (5) into the compound of formula (3) according to the process defined in claim 1.

6. A process for converting a compound of formula (7), or salt thereof,



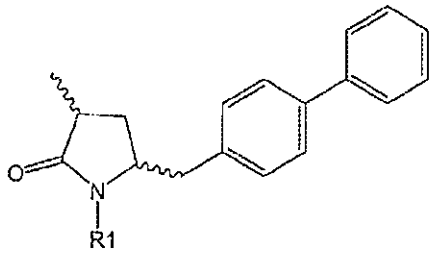
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



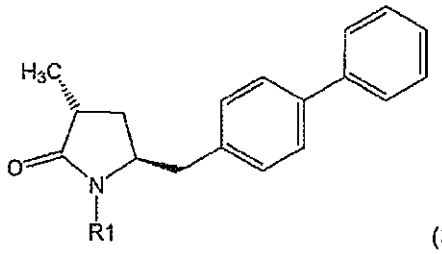
(7-b),

into a compound of formula (3), or salt thereof,



(3)

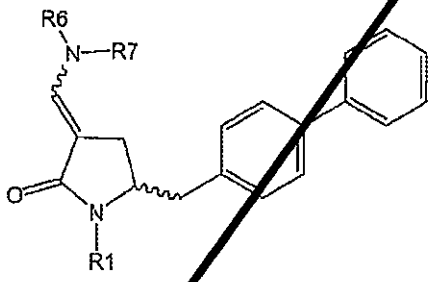
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

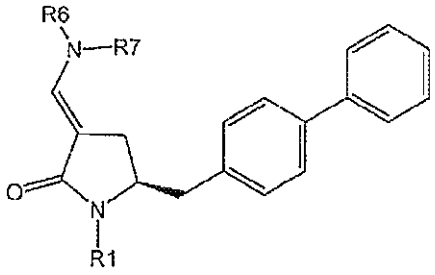
wherein said process comprises converting the compound of formula (7) into the compound of formula (3) according to the process defined in claim 2.

7. A process for converting a compound of formula (7), or salt thereof,



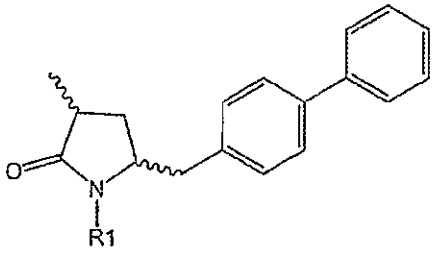
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



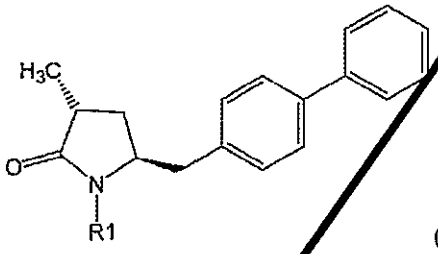
(7-b),

into a compound of formula (3), or salt thereof,



(3)

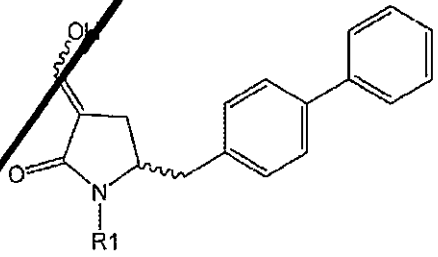
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

wherein said process comprises

a) converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof,



(6)

wherein R1 is hydrogen or a nitrogen protecting group,

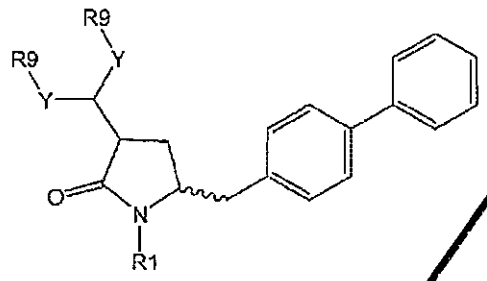
according to any one of methods 1 or 2:

method 1 comprises

converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof, comprising treating a compound of formula (7), or salt thereof, with an acid to obtain the compound of formula (6) or treating a compound of formula (7), or salt thereof with a reducing agent to obtain the compound of formula (6);

method 2 comprises

a) converting the compound of formula (7) into the compound of formula (16)



(16)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, Y is oxygen and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered acetal ring,

comprising treating a compound of formula (7), or salt thereof, with an acetal forming agent to obtain the compound of formula (16) or

converting the compound of formula (7) into the compound of formula (16) wherein R1 is hydrogen or a nitrogen protecting group, Y is sulfur and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered thioacetal ring,

comprising treating a compound of formula (7), or salt thereof, with an thioacetal forming agent to obtain the compound of formula (16);

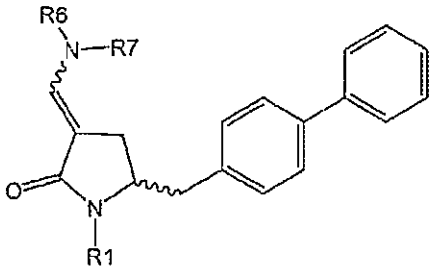
b) converting the compound of formula (16) into the compound of formula (6) comprising removal of the acetal functionality or the thioacetal functionality,

respectively, in a compound of formula (16), or salt thereof, to obtain the compound of formula (6)

and

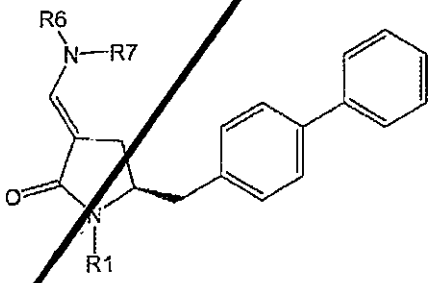
b) converting a compound of formula (6) into the compound of formula (3) or a salt thereof, according to the process defined in claim 3.

8. A process for converting a compound of formula (7), or salt thereof,



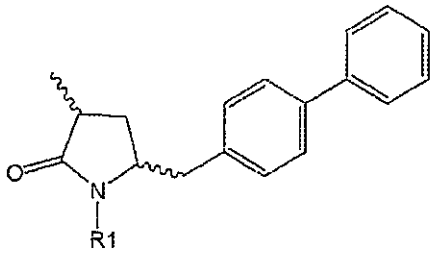
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



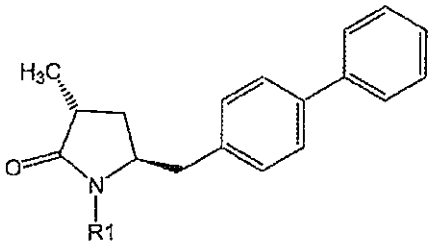
(7-b),

into a compound of formula (3), or salt thereof,



(3)

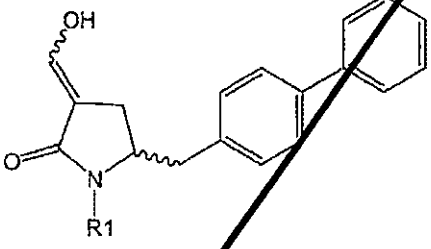
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

wherein said process comprises

a) converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof,



(6)

wherein R1 is hydrogen or a nitrogen protecting group,

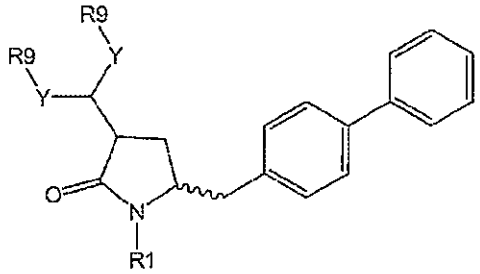
according to any one of methods 1 or 2:

method 1 comprises

converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof, comprising treating a compound of formula (7), or salt thereof, with an acid to obtain the compound of formula (6) or treating a compound of formula (7), or salt thereof with a reducing agent to obtain the compound of formula (6);

method 2 comprises

a) converting the compound of formula (7) into the compound of formula (16)



(16)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, Y is oxygen and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered acetal ring,

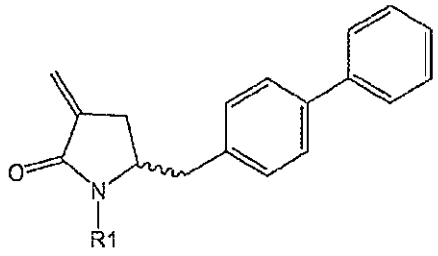
comprising treating a compound of formula (7), or salt thereof, with an acetal forming agent to obtain the compound of formula (16) or

converting the compound of formula (7) into the compound of formula (16) wherein R1 is hydrogen or a nitrogen protecting group, Y is sulfur and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered thioacetal ring,

comprising treating a compound of formula (7), or salt thereof, with an thioacetal forming agent to obtain the compound of formula (16);

b) converting the compound of formula (16) into the compound of formula (6) comprising removal of the acetal functionality or the thioacetal functionality, respectively, in a compound of formula (16), or salt thereof, to obtain the compound of formula (6);

b) converting a compound of formula (6) into the compound of formula (4)



(4)

or a salt thereof,

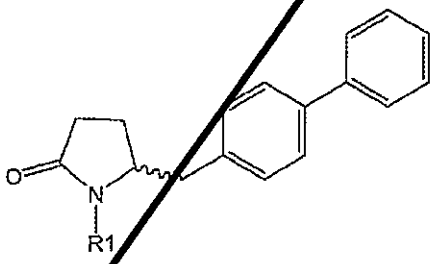
wherein R1 is hydrogen or a nitrogen protecting group,

comprising treating a compound of formula (6), or salt or a tautomer thereof, with a reducing agent preferably in the form of an aldehyde to obtain the compound of formula (4)

and

c) converting a compound of formula (4) into the compound of formula (3) or a salt thereof, according to the process defined in claim 4.

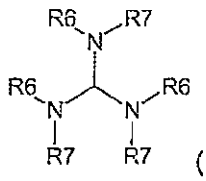
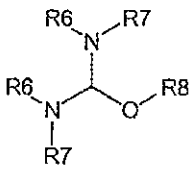
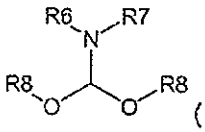
9. A process according to any of claims 3 or 5 to 8, wherein the compound of formula (7) is prepared by a process comprising reacting a compound of formula (8), or salt thereof,



(8)

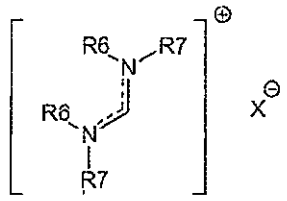
wherein R1 is hydrogen or a nitrogen protecting group,

- with an amine of formula (13), (14) or (15)


(13),

(14),

(15)

and optionally a salt, such as an alkali metal salt, an alkali earth meatl salt, an ammonium salt or an ionic liquid;

- or with a compound prepared by mixing a compound of formula (18),


(18)

with an alcoholate of the formula M-O-R8 and optionally treating said compound with a salt M1X';

- or with mixtures thereof;

wherein

each R6 and each R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, and each R8 is, independently, an alkyl group, an aryl group or an arylalkyl group;

X and X' are, independently, an anion, for example, a halide, an anion of a sulphonic acid, an anion of an alkylsulfate, a tetrahalometalate, such as a tetrachlorometalate, hexafluorophosphate, hexafluoroantimonate, tetrafluoroborate, perchlorate, alkoxide R8-O$^-$ wherein R8 is defined as before, carboxylate, or tribromide;

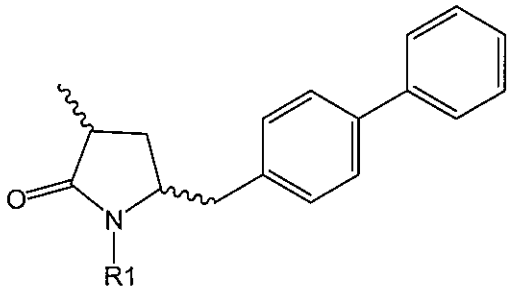
M is an alkali metal or an alkaline earth metal; and

M1 is an alkali metal, an alkaline earth metal or ammonium;

to obtain the compound of formula (7).

Claims:

1. A process for preparing a compound of formula (3)

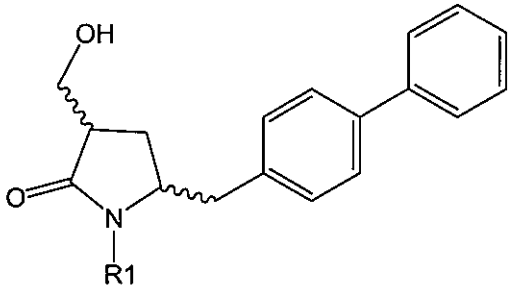


(3)

or salt thereof,

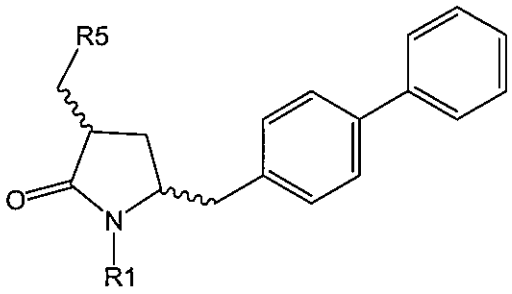
wherein R1 is hydrogen or a nitrogen protecting group, said process comprising

a) converting a compound of formula (5), or salt thereof,



(5)

wherein R1 is hydrogen or a nitrogen protecting group, into a compound of formula (12)

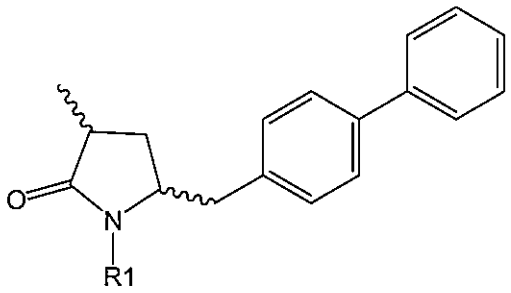


(12)

or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group and R5 is a leaving group; and

b) reacting the compound of formula (12), or salt thereof, with a reducing agent to obtain the compound of formula (3).

2. A process for preparing a compound of formula (3)

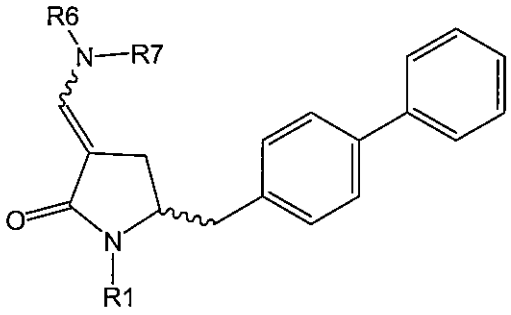


(3)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group,

said process comprising treating a compound of formula (7),



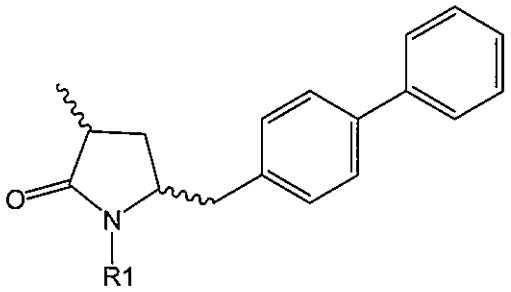
(7)

or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms,

with a reducing agent to obtain the compound of formula (3), or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group.

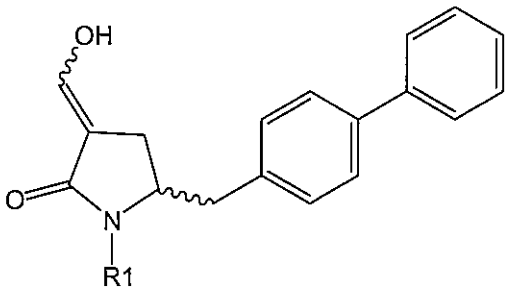
3. A process for preparing a compound of formula (3)



(3)

or salt thereof,

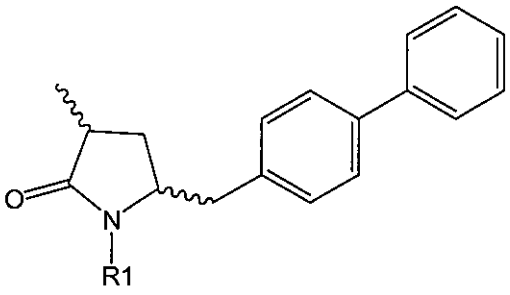
wherein R1 is hydrogen or a nitrogen protecting group, said process comprising treating a compound of formula (6),



(6)

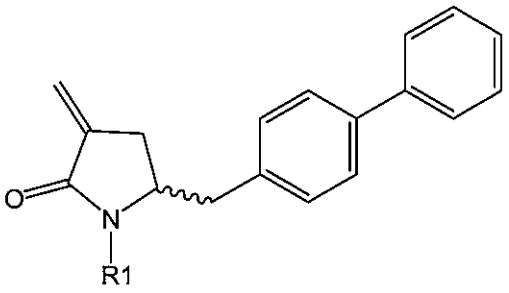
or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group,
with a reducing agent to obtain the compound of formula (3), or salt thereof, wherein R1 is hydrogen or a nitrogen protecting group.

4. A process for preparing a compound according to formula (3),



(3)

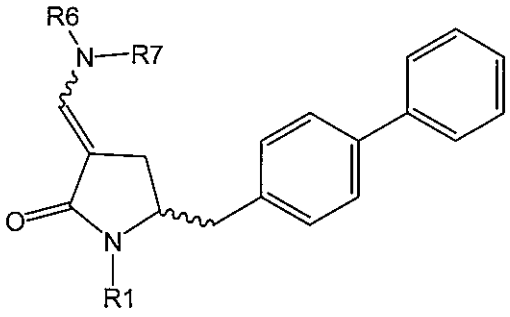
or salt thereof,
wherein R1 is hydrogen or a nitrogen protecting group, comprising reducing a compound according to formula (4),



(4)

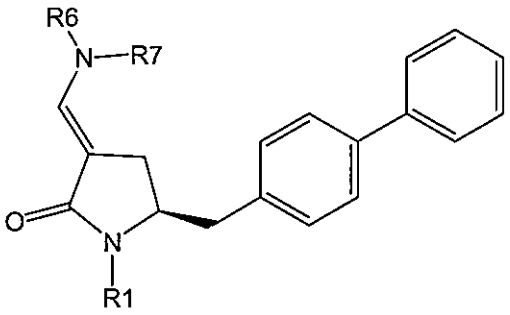
or salt thereof,
wherein R1 is hydrogen or a nitrogen protecting group, to obtain the compound of formula (3).

5. A process for converting a compound of formula (7), or salt thereof,



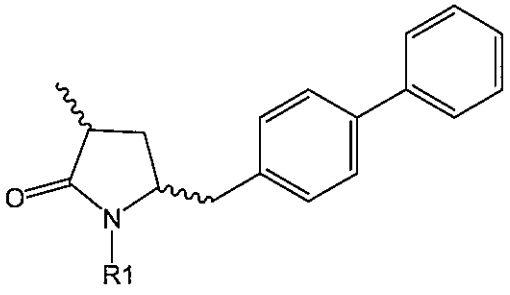
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



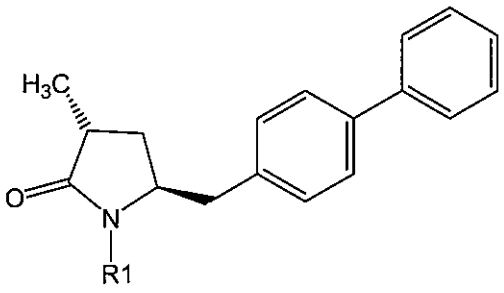
(7-b),

into a compound of formula (3), or salt thereof,



(3)

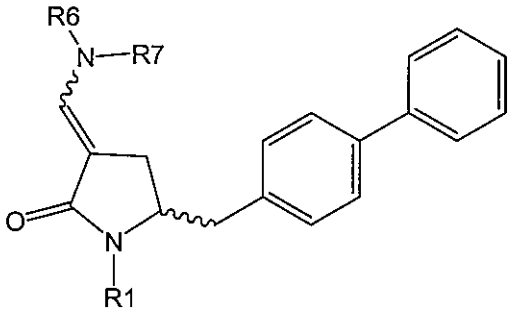
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

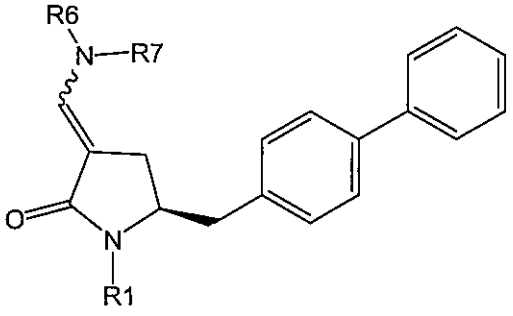
wherein said process comprises

a) converting a compound of formula (7), or salt thereof,



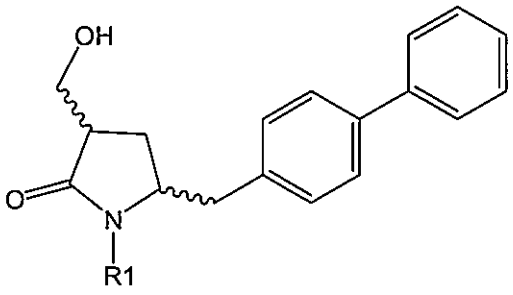
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-a),



(7-a),

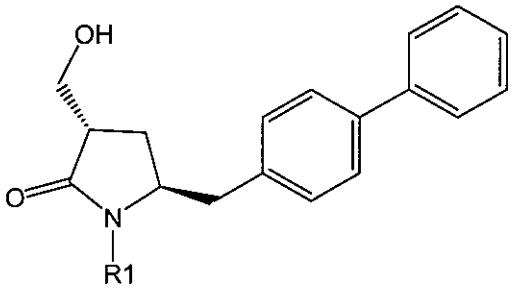
into a compound of formula (5), or salt thereof,



(5),

wherein R1 is hydrogen or a nitrogen protecting group,

preferably having a configuration according to formula (5-b),

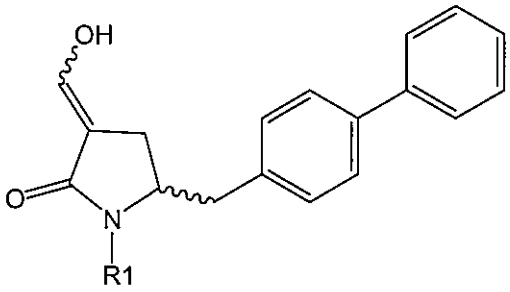


(5-b),

according to any one of methods 1 to 3:

method 1 comprises

a) converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof,



(6)

wherein R1 is hydrogen or a nitrogen protecting group,

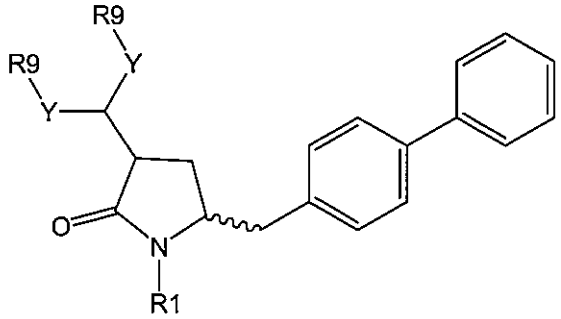
comprising treating a compound of formula (7), or salt thereof, with an acid to obtain the compound of formula (6) or treating a compound of formula (7), or salt thereof with a reducing agent to obtain the compound of formula (6) and

b) converting a compound of formula (6) into the compound of formula (5) comprising treating a compound of formula (6), or salt or a tautomer thereof, with a reducing agent to obtain the compound of formula (5).

method 2 comprises treating a compound of formula (7), or salt thereof, with a reducing agent;

method 3 comprises

a) converting the compound of formula (7) into the compound of formula (16)



(16)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, Y is oxygen and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered acetal ring,

comprising treating a compound of formula (7), or salt thereof, with an acetal forming agent to obtain the compound of formula (16) or treating a compound of formula (7), or salt thereof, with a thioacetal forming agent to obtain the compound of formula (16);

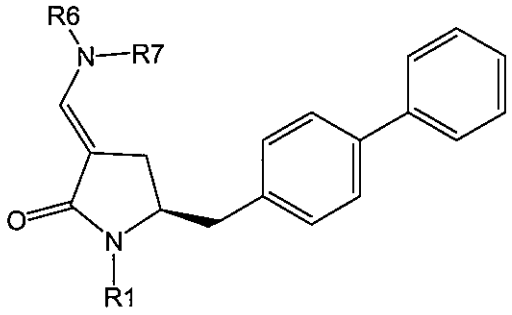
b) converting the compound of formula (16) into the compound of formula (6) comprising removal of the acetal functionality or the thioacetal functionality in a compound of formula (16), or salt thereof, to obtain the compound of formula (6) and

c) converting the compound of formula (6) into the compound of formula (5) comprising treating a compound of formula (6), or salt or a tautomer thereof, with a reducing agent to obtain the compound of formula (5);

and

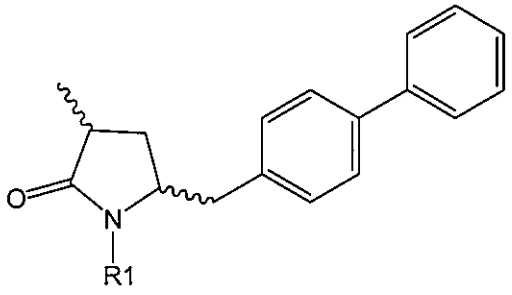
b) converting the compound of formula (5) into the compound of formula (3) according to the process defined in claim 1.

6. A process according to claim 2, wherein the compound of formula (7), or salt thereof, has a configuration according to formula (7-b),



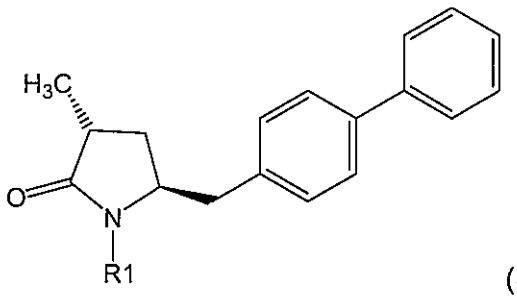
(7-b),

and the compound of formula (3), or salt thereof,



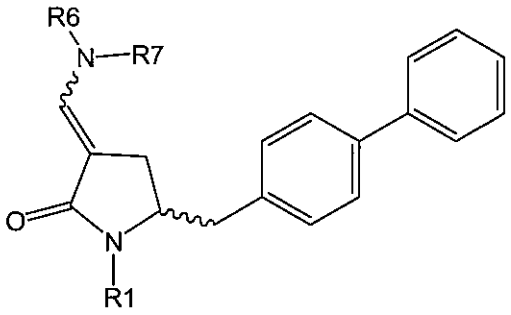
(3)

has a configuration according to formula (3-a),



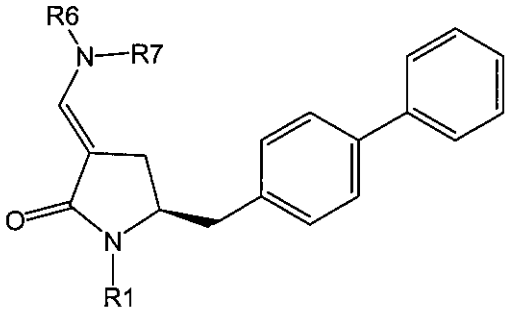
(3-a)

7. A process for converting a compound of formula (7), or salt thereof,



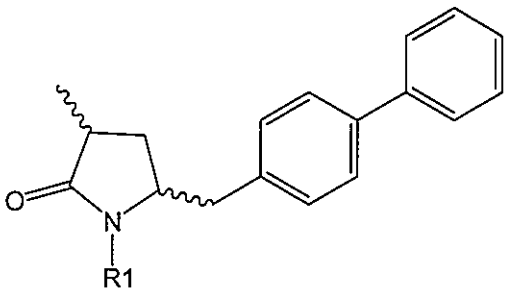
(7)

wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



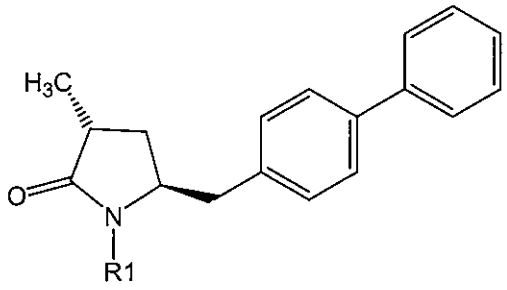
(7-b),

into a compound of formula (3), or salt thereof,



(3)

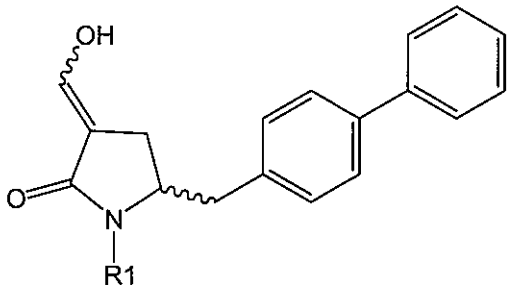
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

wherein said process comprises

a) converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof,



(6)

wherein R1 is hydrogen or a nitrogen protecting group,

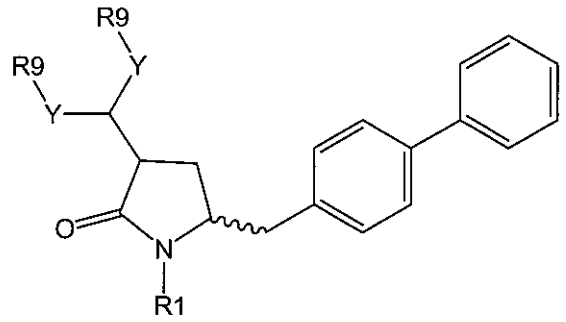
according to any one of methods 1 or 2:

method 1 comprises

converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof, comprising treating a compound of formula (7), or salt thereof, with an acid to obtain the compound of formula (6) or treating a compound of formula (7), or salt thereof with a reducing agent to obtain the compound of formula (6);

method 2 comprises

a) converting the compound of formula (7) into the compound of formula (16)



(16)

or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, Y is oxygen and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered acetal ring,

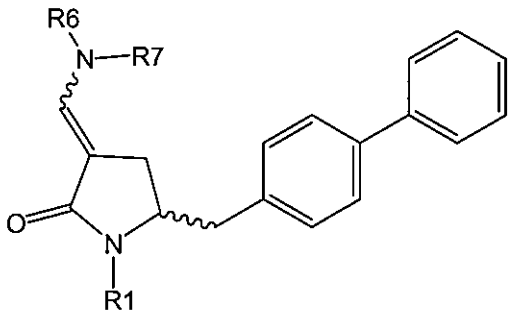
comprising treating a compound of formula (7), or salt thereof, with an acetal forming agent to obtain the compound of formula (16) or treating a compound of formula (7), or salt thereof, with a thioacetal forming agent to obtain the compound of formula (16);

b) converting the compound of formula (16) into the compound of formula (6) comprising removal of the acetal functionality or the thioacetal functionality in a compound of formula (16), or salt thereof, to obtain the compound of formula (6)

and

b) converting a compound of formula (6) into the compound of formula (3) or a salt thereof, according to the process defined in claim 3.

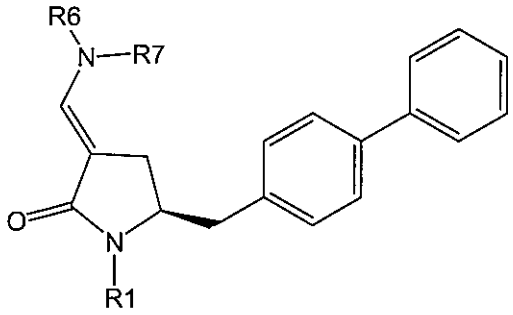
8. A process for converting a compound of formula (7), or salt thereof,



(7)

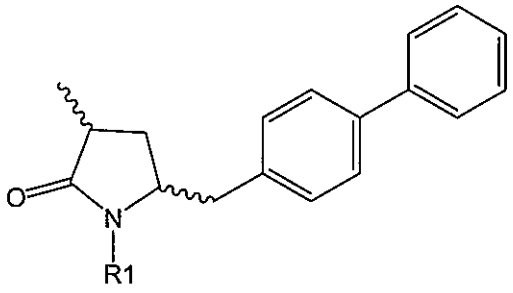
wherein R1 is hydrogen or a nitrogen protecting group and, R6 and R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7

form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, preferably having a configuration according to formula (7-b),



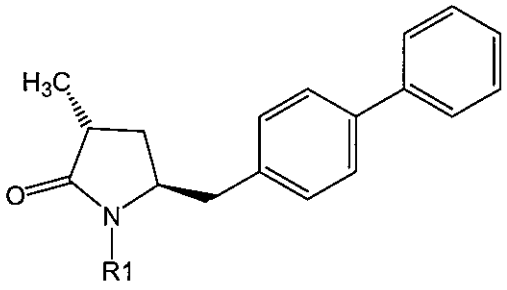
(7-b),

into a compound of formula (3), or salt thereof,



(3)

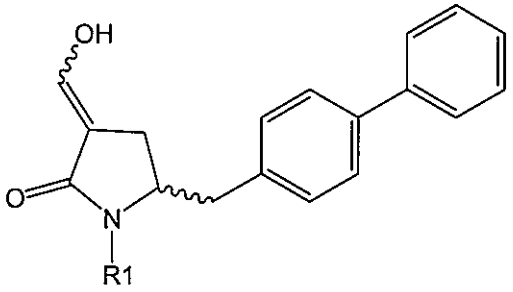
wherein R1 is hydrogen or a nitrogen protecting group, preferably having a configuration according to formula (3-a),



(3-a)

wherein said process comprises

a) converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof,



(6)

wherein R1 is hydrogen or a nitrogen protecting group,

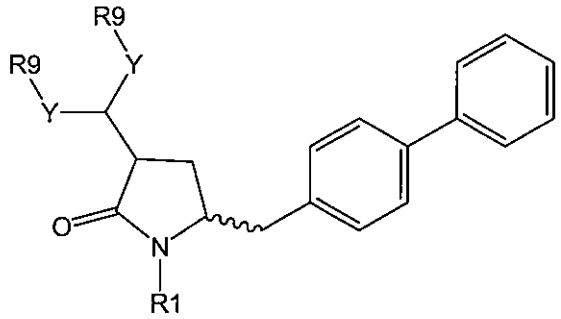
according to any one of methods 1 or 2:

method 1 comprises

converting a compound of formula (7) into the compound of formula (6) or a tautomer thereof, or salt thereof, comprising treating a compound of formula (7), or salt thereof, with an acid to obtain the compound of formula (6) or treating a compound of formula (7), or salt thereof with a reducing agent to obtain the compound of formula (6);

method 2 comprises

a) converting the compound of formula (7) into the compound of formula (16)



(16)

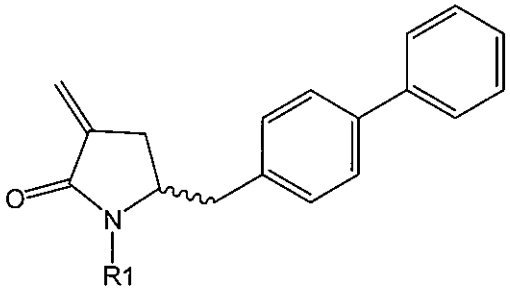
or salt thereof,

wherein R1 is hydrogen or a nitrogen protecting group, Y is oxygen and each R9, is, independently, alkyl, aryl, arylalkyl (eg benzyl) or acetyl or both R9 form together a 4 to 7, preferably a 5 to 6 membered acetal ring,

comprising treating a compound of formula (7), or salt thereof, with an acetal forming agent to obtain the compound of formula (16) or treating a compound of formula (7), or salt thereof, with a thioacetal forming agent to obtain the compound of formula (16);

b) converting the compound of formula (16) into the compound of formula (6) comprising removal of the acetal functionality or the thioacetal functionality in a compound of formula (16), or salt thereof, to obtain the compound of formula (6);

b) converting a compound of formula (6) into the compound of formula (4)



(4)

or a salt thereof,

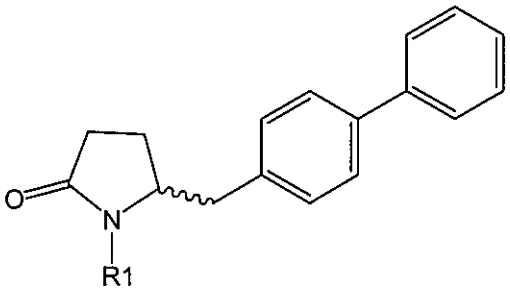
wherein R1 is hydrogen or a nitrogen protecting group,

comprising treating a compound of formula (6), or salt or a tautomer thereof, with a reducing agent, preferably in the form of an aldehyde to obtain the compound of formula (4)

and

c) converting a compound of formula (4) into the compound of formula (3) or a salt thereof, according to the process defined in claim 4.

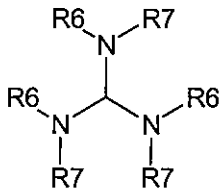
9. A process according to any of claims 2 or 5 to 8, wherein the compound of formula (7) is prepared by a process comprising reacting a compound of formula (8), or salt thereof,



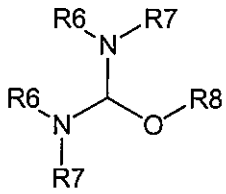
(8)

wherein R1 is hydrogen or a nitrogen protecting group,

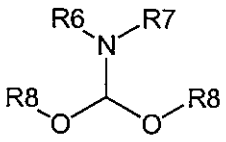
- with an amine of formula (13), (14) or (15)



(13),



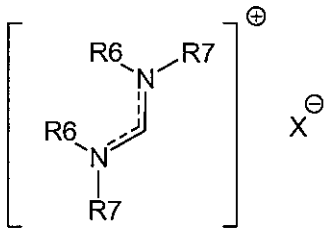
(14),



(15)

and optionally a salt, such as an alkali metal salt, an alkali earth meatl salt, an ammonium salt or an ionic liquid;

- or with a compound prepared by mixing a compound of formula (18),



(18)

with an alcoholate of the formula M-O-R8 and optionally treating said compound with a salt M1X';

- or with mixtures thereof;

wherein

each R6 and each R7 are, independently, an alkyl group, an aryl group, an arylalkyl group, a cycloalkyl group or together R6 and R7 form a cycle, together with the nitrogen to which they are attached, which cycle may be saturated or unsaturated and may optionally contain one or more heteroatoms, such a nitrogen, oxygen or sulphur, whereby the cycle contains 3 to 8, such as 4 to 7 ring atoms, and each R8 is, independently, an alkyl group, an aryl group or an arylalkyl group;

X and X' are, independently, an anion, for example, a halide, an anion of a sulphonic acid, an anion of an alkylsulfate, a tetrahalometalate, such as a tetrachlorometalate, hexafluorophosphate, hexafluoroantimonate, tetrafluoroborate, perchlorate, alkoxide $R8\text{-}O^-$ wherein R8 is defined as before, carboxylate, or tribromide;

M is an alkali metal or an alkaline earth metal; and

M1 is an alkali metal, an alkaline earth metal or ammonium;

to obtain the compound of formula (7).