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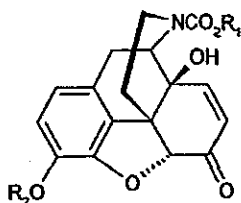
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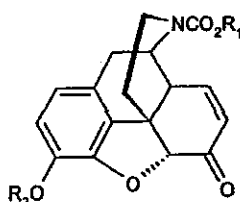
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(54) Title: C-14 OXIDATION OF MORPHINE DERIVATIVES



(IV)



(III)

(57) Abstract: The present invention relates to process for the preparation of a 14-hydroxynormorphinone derivative of formula IV comprising reacting the compound of formula III, with a cobalt (II) oxidant in the presence of a mild base and air or oxygen as the cooxidant; wherein

R_1 is (1C-7C) alkyl optionally substituted with one or more chlorines, butenyl, vinyl, benzyl, phenyl or naphthyl; and R_2 is benzyl or benzyl substituted with one or more (1C-6C) alkoxy group or benzyl substituted with one or more halogen. The process is very suitable in the production of noroxymorphone.

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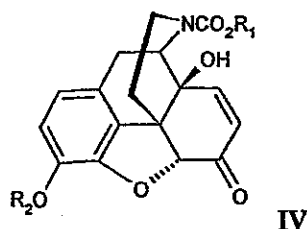
C-14 OXIDATION OF MORPHINE DERIVATIVES

The invention relates to a process for the production of 14-hydroxynormorphinone derivatives, to a new synthetic route for producing noroxymorphone, as well as to new intermediates in said route.

Noroxymorphone is a key intermediate for the production of important medicinal opioids, such as naltrexone and naloxone. The common starting material for the production of these opioids is thebaine from which they are readily synthesized. However, thebaine has only a low natural abundance in poppy heads and opium. As the supply of thebaine is limited and the demand is increasing, many alternative approaches have been made for the preparation of 14-hydroxymorphine derivatives. See for example EP 0,158,476, US 5,922,876, and the references cited therein.

Further, in an attempt to remove the requirement for (the preparation of) thebaine, Coop et al. (Tetrahedron 55 (1999), 11429-11436; WO 00/66588) recently described an oxidative method for the production of 14-hydroxycodeinone in a yield of 51% from codeinone, using $\text{Co}(\text{OAc})_3$ as the metallic oxidant in acetic acid at room temperature. Other oxidative conditions with metallic oxidants, such as $\text{Co}(\text{OAc})_3$ under other conditions, FeCl_3 , $\text{Co}(\text{OAc})_2$ in combination with several cooxidants, RuO_4 , $\text{Mn}(\text{OAc})_3$, $\text{Cu}(\text{OAc})_2$, and others, proved to be not very useful according to Coop.

Surprisingly, and in spite of the findings of Coop, it has now been found that in the production of 14-hydroxynormorphinone derivatives of formula IV from compounds of formula III cobalt (II) salts can be used as efficient oxidants when the reaction is performed in the presence of a mild base and oxygen or air is used as cooxidant. In a first aspect, the invention relates to a process for the preparation of a 14-hydroxynormorphinone derivative of formula IV



comprising reacting the compound of formula III,



with a cobalt (II) oxidant, being a cobalt (II) salt selected from a range, such as CoF_2 , CoCl_2 , CoBr_2 , Co(II)sulfate , Co(II)nitrate , Co(II)acetate , Co(II)propionate , and the like, and mixtures thereof, in the presence of a mild base and air or oxygen as the cooxidant; wherein R_1 is (1-7C)alkyl optionally substituted with one or more chlorines (such as 1,1,1-trichloroethyl), butenyl, vinyl, benzyl, phenyl or naphthyl; and R_2 is benzyl or benzyl substituted with one or more (1-6C)alkoxy group or benzyl substituted with one or more halogen.

The oxidation process can be an efficient process with good yields, which are significantly improved when compared to the process described by Coop et al..

The cobalt (II) oxidant according to the present invention is selected from a range of cobalt (II) salts, such as CoF_2 , CoCl_2 , CoBr_2 , Co(II)sulfate , Co(II)nitrate , Co(II)acetate , Co(II)propionate , and the like, and mixtures thereof. The preferred oxidant in the process is Co(OAc)_2 and the preferred cooxidant is air. The reaction mixture of this oxidation process can be a heterogeneous system; the oxidant can dissolve only in minor amounts in the organic solvent that is used. The amount of cobalt (II) salts used may not be very critical, as long as the system is heterogeneous, and a skilled person will know to choose sufficient amounts thereof. The cooxidant may be introduced into the reaction mixture by bubbling it through the solution, while stirring.

A person skilled in the art is aware what type of base are meant with the term mild bases, however preferred bases are sodium acetate, potassium acetate, sodium phosphate and potassium phosphate. Most preferred is sodium acetate.

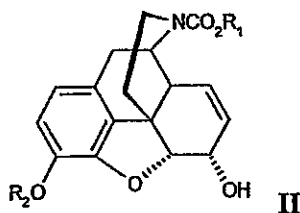
Preferably R_1 is (1-7C)alkyl, and most preferred is ethyl. For R_2 benzyl is most preferred.

The oxidant process can be performed in an organic solvent well-suited for dissolution of this type of compounds, preferably (1-4C)alcohols or mixtures thereof. Preferred is ethanol.

The reaction temperature may usually be higher than room temperature, and may be chosen dependent on the boiling point of the solvent used. However, the temperature may not be higher than about 100 °C in order to keep the oxygen sufficiently in solution.

In the terms (1-7C)alkyl, (1-6C)alkoxy and (1-4C)alcohols the alkyl group may be a branched or unbranched alkyl group having 1 to 7, 1 to 6 or 1 to 4 carbon atoms, respectively, such as methyl, ethyl, isopropyl, t-butyl, heptyl and the like.

The compound of formula **III** may suitably prepared by methods well known in the art. In a second aspect, there is provided a process for the preparation of a compound of formula **III** comprises reactively contacting a morphine derivative of formula **II**



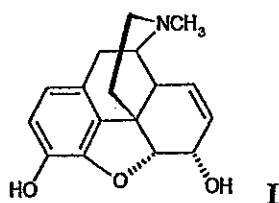
with an oxidizing agent effective for oxidizing allylic hydroxy groups to form keto groups, where a compound of the formula **III** is prepared, R_1 and R_2 being as defined above. Preferably, the oxidizing agent is sodium dichromate. Preferably, R_1 is ethyl. For R_2 benzyl is most preferred.

In a third aspect, there is provided a morphine derivative of formula **II**.

The process may conveniently be used in the production of noroxymorphone. Therefore, in a fourth aspect of this invention, there is provided a process for the production of noroxymorphone, comprising a reaction step wherein a morphinone derivative of formula **III** is oxidized into the 14-hydroxynormorphinone derivative of formula **IV**. In particular preferred is the process further comprising the oxidation of a morphine derivative of formula **II** into the compound of formula **III** as described above.

Especially preferred is a process for the production of noroxymorphone comprising the steps:

(a) converting morphine having the formula **I**



by reaction with a haloformate ester of the formula $X-C(=O)OR_1$, wherein R_1 is as previously defined and X is a halogen (F, Cl, Br or I, preferably Cl),

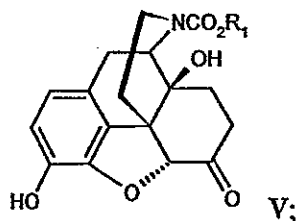
followed by a reaction with R_2-X , wherein X (preferably Cl) and R_2 are as previously defined, to

5 form a morphine derivative of formula II;

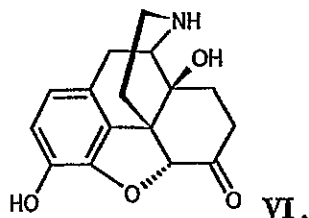
(b) oxidizing the morphine of formula II to form a morphinone derivative of formula III according to the previously described process;

(c) oxidizing the morphinone derivative of formula III to form a 14-hydroxynormorphinone derivative of formula IV according to the previously described process;

10 (d) deprotecting the 3-position and (at the same time) reducing the double bond at the 7,8-position of the 14-hydroxynormorphinone derivative of formula IV to form a 3,14-hydroxynormorphinone derivative of formula V, using methods well known in the art for such type of reaction, e.g. using hydrogen and palladium-carbon as a catalyst,



15 (e) and hydrolyzing the 3,14-hydroxynormorphinone derivative of formula V into noroxymorphone of formula VI, using methods well known in the art for such type of hydrolysis, e.g. using sulfuric acid,



20 In the process for the production of noroxymorphone, there is disclosed novel intermediates of formula II, III and IV. The intermediates of formula II, III

and IV are in particular preferred wherein R₁ is ethyl. Also preferred are intermediates of formula II, III and IV wherein R₂ is benzyl. Most preferred are the intermediates of formula II, III and IV wherein R₁ is ethyl and R₂ is benzyl.

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The invention is further illustrated by the following example.

EXAMPLE 1

The underlined numbers refer to the numbers of the structures of Scheme I. (Bn = benzyl).

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(5 α , 6 α)-3-(benzyloxy)-7,8-didehydro-4,5-epoxy-6-hydroxymorphinan-17-carboxylic acid ethylester (2)

Morphine (1, 8 g) was dissolved in 80 ml of toluene and the solution was dried by azeotropic distillation of water. Sodium carbonate (15 g) and sodium hydrogen carbonate (6 g) were added and the solution was again dried by azeotropic distillation. Ethyl chloroformate (30 g) was slowly and in portions added over a period of approximately 4 h at 78°C. Completion of the reaction was checked with TLC. The excess of reagent and the salts were dissolved by addition of water. The layers were separated and the toluene layer was washed with water. The toluene solution was evaporated to dryness and the residue was dissolved in 70 ml of ethanol. The 3-carboxylic acid ethyl ester group was saponified by 6 g potassium hydroxide (dissolved in 18 ml of ethanol) and 5 g potassium carbonate at 55°C. The pH was checked (in a 1:1 dilution in water) and was >11. To this basic solution 5 g benzylchloride was added and the reaction was performed for 4 h at 75°C. The product was precipitated by the addition of water (70 ml), filtered, washed with water and dried. The yield of product (2) was 10 g. ¹H NMR (600 MHz, CDCl₃) δ 1.29 (m, 3H), 1.92 (m, 2H), 2.52 (s, 1H), 2.72 (m, 2H), 2.85 (m, 1H), 3.01 (m, 1H), 4.01 (m, 1H), 4.17 (m, 3H), 4.87 (d, 1H), 4.89 (d, 1H), 5.09 (d, 1H), 5.18 (d, 1H), 5.29 (t, 1H), 5.72 (t, 1H), 6.53 (d, 1H), 6.75 (d, 1H), 7.37 (m, 5H).

25

(5 α)-3-(benzyloxy)-7,8-didehydro-4,5-epoxy-6-oxomorphinan-17-carboxylic acid ethylester (3)

A solution of Jones reagent was prepared by dissolving 7.5 g sodium dichromate.2H₂O in 22 ml water and 6 ml sulfuric acid. Compound (2) (7.5 g) was dissolved in 60 ml trichloro ethylene and

30

28 ml water was added. The pH was adjusted to 5 with sulfuric acid. The mixture was heated under reflux and the Jones reagents was slowly added over a period of 1 h. The oxidation was continued for another 1,5 h under reflux. The excess of oxidant was destroyed with 6 ml 2-propanol. The layers were separated and the organic layer was washed with 10% sodium hydrogen carbonate solution and water and dried with sodium sulfate. The solution was evaporated to dryness and the residue was dissolved in ethanol. Yield: ~ 9 g product (3). ¹H NMR (200 MHz, CDCl₃) δ 1.28 (m, 3H), 1.92 (m, 2H), 2.8 (m, 2H), 2.9 (m, 1H), 3.05 (m, 1H), 4.02 (m, 1H), 4.19 (m, 2H), 4.72 (s, 1H), 5.03 (m, 1H), 5.18 (s, 2H), 6.12 (dd, 1H), 6.57 (d, 1H), 6.64 (m, 1H), 6.74 (d, 1H), 7.34 (m, 5H).

(5α)-3-(benzyloxy)-7,8-didehydro-4,5-epoxy-14-hydroxy-6-oxomorphinan-17-carboxylic acid ethylester (4)

The solution of product (3) in ethanol (9 g in 135 ml) was heated to 60°C, 2,6 g cobalt (II) acetate and 0,5 g sodium acetate were added and air was bubbled through the solution under vigorous stirring. The reaction was followed with TLC. After completion of the reaction the solution was treated with charcoal (0,3 g) and filtered. The solution was distilled to volume and this concentrated solution (6,3 g (4) in 53 ml of ethanol) was transferred to the next step. ¹H NMR of 4 (360 MHz, CH₃OH-d₄) δ 1.28 (m, 3H), 1.55 (m, 1H), 2.52 (m, 1H), 2.74 (m, 1H), 2.92 (m, 2H), 4.05 (m, 1H), 4.15 (m, 2H), 4.64 (m, 1H), 4.72 (s, 1H), 4.85 (m, 1H), 5.1 (s, 2H), 6.05 (d, 1H), 6.6 (d, 1H), 6.76 (d, 1H), 6.91 (m, 1H), 7.3 (m, 5H).

(5α)-4,5-epoxy-3,14-dihydroxy-6-oxomorphinan-17-carboxylic acid ethylester (5)

To the solution of the previous step 6 ml of acetic acid was added. The product (4) was reduced with hydrogen and palladium-carbon (5%) as a catalyst (0,9 g) at 20°C and normal pressure. After filtration and evaporation of ethanol 5,4 g of crude product (5) was obtained. The product was recrystallized from 2 parts (w/v) of ethyl acetate to obtain 4,7 g product (5).

(5α)-4,5-epoxy-3,14-dihydroxymorphinan-6-one (noroxymorphone) (6)

Product (5) (4,7 g) was dissolved in 28 ml of water and 5,6 ml of sulfuric acid and refluxed for approx. 24 h. The product was precipitated at pH = 9 by dilution with water and 4,6 g of crude product (6) was obtained after filtration and drying. The product was purified by dissolution in

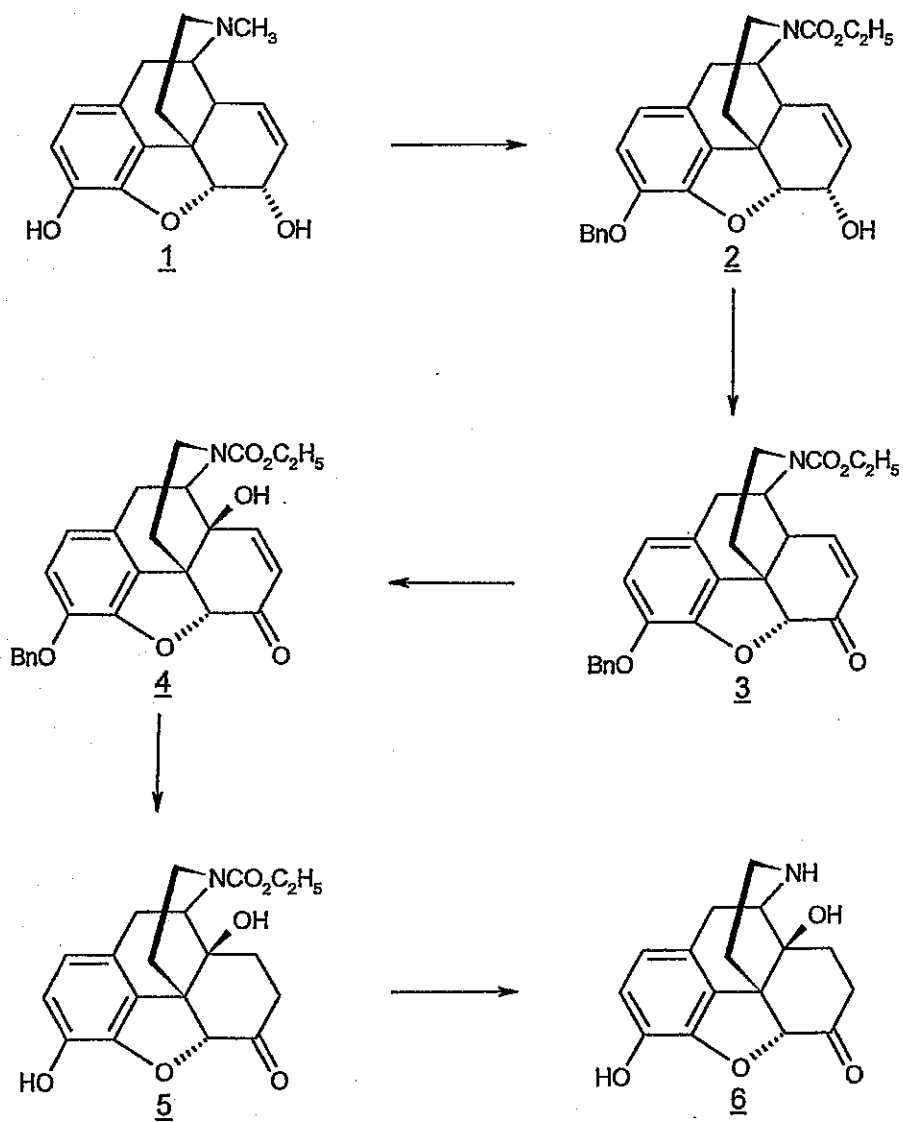
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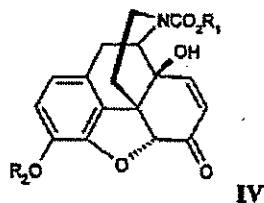
ethanol, precipitation from this solvent at pH = 2, dissolution in water, charcoal treatment and precipitation at pH = 9. ^1H NMR (400 MHz, DMSO- d_6) δ 1.17 (m, 1H), 1.41 (m, 1H), 1.72 (m, 1H), 2.07 (m, 1H), 2.29 (m, 1H), 2.36 (m, 1H), 2.62 (m, 1H), 3.9 (m, 4H), 4.68 (s, 1H), 6.52 (d, 1H), 6.56 (d, 1H).

SCHEME 1

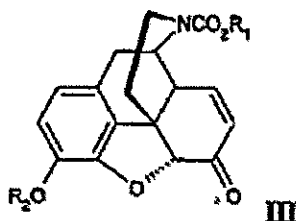


CLAIMS

1. A process for the preparation of a 14-hydroxynormorphinone derivative of formula IV



comprising reacting the compound of formula III,



with a cobalt (II) oxidant, being a cobalt (II) salt selected from a range, such as CoF_2 , CoCl_2 , Co(II)sulfate , Co(II)nitrate , Co(II)acetate , Co(II)propionate , and the like, and mixtures thereof,

in the presence of a mild base and air or oxygen as the cooxidant;

wherein R_1 is (1C-7C)alkyl optionally substituted with one or more chlorines, butenyl, vinyl, benzyl, phenyl or naphthyl;

and R_2 is benzyl or benzyl substituted with one or more (1C-6C)alkoxy group or benzyl substituted with one or more halogen.

2. The process of claim 1, wherein the oxidant is Co(OAc)_2 .

- 15 3. The process of claim 1 or 2, wherein the cooxidant is oxygen.

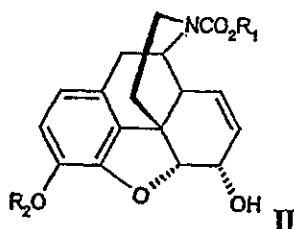
4. The process of any one of claims 1-3, wherein the mild base is sodium acetate, potassium acetate, sodium phosphate or potassium phosphate.

- 20 5. The process of claim 4, wherein the mild base is sodium acetate.

6. The process of any one of claims 1-5, wherein R_1 is (1-7C)alkyl.

7. The process of claim 6, wherein R_1 is ethyl.

8. The process of any one of claims 1-7, wherein R_2 is benzyl.
9. A morphinone derivative of the formula **III** as set out in claim 1.
10. The morphinone derivative of claim 9, wherein R_1 is ethyl.
11. The morphinone derivative of claim 9 or 10, wherein R_2 is benzyl.
12. A process for the preparation of a compound of formula **III**, comprising reactively



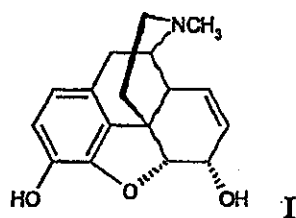
- contacting a morphine derivative of formula **II** with an oxidizing agent effective for oxidizing allylic hydroxy groups to form keto groups, where a compound of formula **III** as set out in claim 1 is prepared, R_1 and R_2 being as defined in claim 1.
13. The process of claim 12, wherein the oxidizing agent is sodium dichromate.
 14. The process of claim 12 or 13, wherein R_1 is ethyl and R_2 is benzyl.
 15. A morphine derivative of formula **II** as set out in claim 12.
 16. The morphine derivative of claim 15, wherein R_1 is ethyl.

17. The morphine derivative of claim 15 or 16, wherein R_2 is benzyl.

18. A process for the production of noroxymorphone, comprising a reaction step wherein a morphinone derivative of formula III is oxidized into a 14-hydroxynormorphinone derivative of formula IV as set out in claim 1.

19. The process of claim 18, further comprising the oxidation of a compound of formula II as defined in claim 12 to form a morphinone derivative of formula as defined in claim 1.

20. The process of claim 18, wherein morphine is converted into noroxymorphone comprising (a) converting morphine having the formula I



by reaction with a haloformate ester of the formula $X-C(=O)OR_1$, wherein R_1 is as previously defined and X is a halogen,

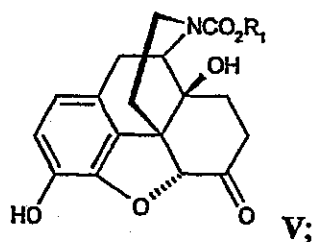
followed by a reaction with R_2-X , wherein X and R_2 are as previously defined, to form a morphine derivative of formula II as defined in claim 15;

(b) oxidizing the morphine of formula II to form a morphinone derivative of formula III according to the process set out in claim 15;

(c) oxidizing the morphinone derivative of formula III to form a 14-

hydroxynormorphinone derivative of formula IV according to process set out in claim 1;

(d) deprotecting the 3-position and reducing the double bond at the 7,8-position of the 14-hydroxynormorphinone derivative of formula IV to form a 3,14-hydroxynormorphinone derivative of formula V,



(e) and hydrolyzing the 3,14-hydroxynormorphinone derivative of formula V into noroxymorphone of formula VI,

