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(73)	Innehaver	Sanofi-Aventis Deutschland GmbH, Brüningstraße 50, 65929 Frankfurt am Main, DE-Tyskland
(72)	Oppfinner	BILLEN, Guenter, c/o Sanofi-Aventis Deutschland GmbH, 65926 Frankfurt am Main, DE-Tyskland FRICK, Wendelin, c/o Sanofi-Aventis Deutschland GmbH, 65926 Frankfurt am Main, DE-Tyskland LARKIN, John, Patrick, 10 Smyth CloseMarket Harborough, Leicestershire LE16 7, GB-Storbritannia LEMAITRE, Guy, 62avenue des Chataigniers, F-77280 Othis, FR-Frankrike BENDETTI, Françoise, c/o Sanofi-Aventis Département Brevets174, avenue de France, F-75013 Paris, FR-Frankrike BOFFELLI, Philippe, c/o Sanofi-Aventis Département Brevets174, avenue de France, F-75013 Paris, FR-Frankrike GODARD, Jean-Yves, c/o Sanofi-Aventis Département Brevets174, avenue de France, F-75013 Paris, FR-Frankrike MASSON, Christian, c/o Sanofi-Aventis Département Brevets174, avenue de France, F-75013 Paris, FR-Frankrike

CROCQ, Véronique, c/o Sanofi-Aventis Département Brevets 174, avenue de France, F-75013 Paris, FR-Frankrike
LAFONT, Sylvaine, c/o Sanofi-Aventis Département Brevets 174, avenue de France, F-75013 Paris, FR-Frankrike
HULSHOF, Jos, c/o Syncom BV Kadijk 3, NL-9747 AT Groningen, NL-Nederland

(74) Fullmektig TANDBERG INNOVATION AS, Postboks 1570 Vika, 0118 OSLO, Norge

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(54) Benevnelse **METHOD FOR THE PRODUCTION OF 1,4-BENZOTHIEPIN-1,1-DIOXIDE DERIVATIVES**

(56) Anførte publikasjoner EP-B1- 2 084 172, US-A1- 2004 147 774, US-A- 5 994 391

Vedlagt foreligger en oversettelse av patentkravene til norsk. I hht patentloven § 66i gjelder patentvernet i Norge bare så langt som det er samsvar mellom oversettelsen og teksten på behandlingsspråket. I saker om gyldighet av patentet skal kun teksten på behandlingsspråket legges til grunn for avgjørelsen. Patentdokument utgitt av EPO er tilgjengelig via Espacenet (http://worldwide.espacenet.com), eller via søkemotoren på vår hjemmeside her: https://search.patentstyret.no/

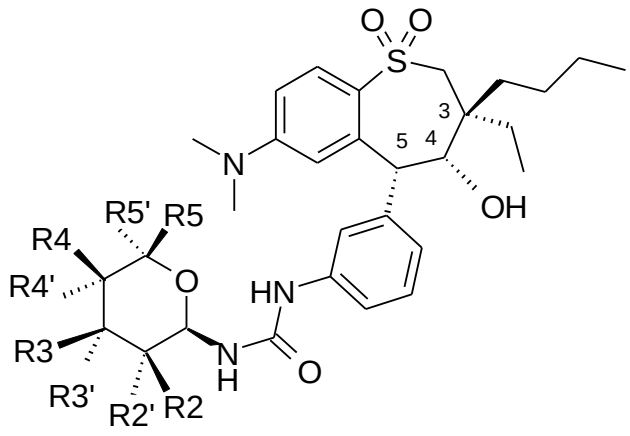
Method for the production of 1,4-benzothiepin-1,1-dioxide derivatives

The invention relates to a method for the production of 1,4-benzothiepin 1,1-dioxide derivatives substituted with benzyl radicals.

1,4-Benzothiepin 1,1-dioxide derivatives have already been described (US 5,994,391). However, the method described in US 5,994,391 leads to racemates. The synthesis of the optically pure compounds (intermediate products or end products) requires complex chromatographic purification steps. See, for example, position 3 of compound I from US 5,994,391 or else the intermediate products LI or XLI from US 5,994,391.

The object of the invention was to provide an improved method for the production of certain enantiomerically pure 1,4-benzothiepin 1,1-dioxide derivatives. In particular, the stereo centers at position 3, 4 and 5 of the thiepin system of the compound of the formula I should be built up and/or obtained in optically pure form.

The invention therefore relates to an improved method for the production of the compounds of the formula I



I

in which

R2, R2', R3, R3', R4, R4', R5, R5', independently of one another, are H, Cl, Br, I, OH, -(CH_2)-OH, CF_3, NO_2, N_3, CN, $S(O)_p$-R6, O-$S(O)_p$-R6, (C_1-C_6)-alkylene-$S(O)_p$-R6, (C_1-C_6)-alkylene-O-$S(O)_p$-R6, COOH, COO(C_1-C_6)alkyl, $CONH_2$,

CONH(C_1-C_6)alkyl, CON[(C_1-C_6)alkyl]$_2$, (C_1-C_6)-alkyl, (C_2-C_6)-alkenyl, (C_2-C_6)-alkynyl, O-(C_1-C_6)-alkyl, where, in the alkyl radicals, one, more, or all hydrogen(s) can be replaced by fluorine;

phenyl, -(CH_2)-phenyl, -(CH_2)$_n$-phenyl, O-phenyl, O-(CH_2)$_m$-phenyl, -(CH_2)-O-(CH_2)$_m$-phenyl, where the phenyl ring may be mono- to trisubstituted with F, Cl, Br, I, OH, CF_3, NO_2, CN, OCF_3, O-(C_1-C_6)-alkyl, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$, SO_2-CH_3, COOH, COO-(C_1-C_6)-alkyl, $CONH_2$;

where always at least one of the radicals R2, R2', R3, R3', R4, R4', R5, R5' has the meaning -O-(CH_2)$_m$-phenyl or -(CH_2)-O-(CH_2)$_m$-phenyl, where the phenyl ring may be mono- to trisubstituted with F, Cl, Br, I, OH, CF_3, NO_2, CN, OCF_3, O-(C_1-C_6)-alkyl, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$, SO_2-CH_3, COOH, COO-(C_1-C_6)-alkyl, $CONH_2$;

R6 is H, OH, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$;

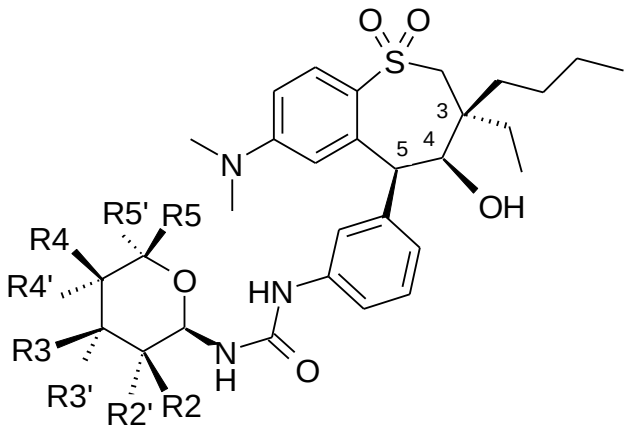
n is 2, 3, 4, 5, 6;

m is 1, 2, 3, 4, 5, 6;

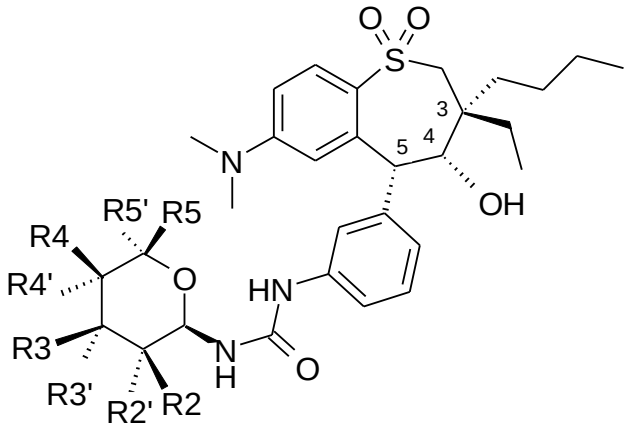
p is 0, 1, 2;

and pharmaceutically compatible salts thereof.

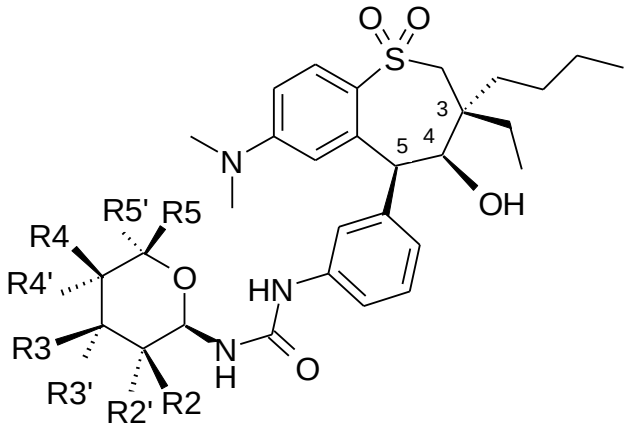
The invention further relates to improved methods for the production of the compounds of the formulae Ia, Ib and Ic



Ia



Ib



Ic

in which

R2, R2', R3, R3', R4, R4', R5, R5', independently of one another, are H, Cl, Br, I, OH, -(CH_2)-OH, CF_3, NO_2, N_3, CN, $S(O)_p$-R6, O-$S(O)_p$-R6, (C_1-C_6)-alkylene-$S(O)_p$-R6, (C_1-C_6)-alkylene-O-$S(O)_p$-R6, COOH, COO(C_1-C_6)alkyl, $CONH_2$, CONH(C_1-C_6)alkyl, CON[(C_1-C_6)alkyl]$_2$, (C_1-C_6)-alkyl, (C_2-C_6)-alkenyl, (C_2-

C_6)-alkynyl, O-(C_1-C_6)-alkyl, where, in the alkyl radicals, one, more, or all hydrogen(s) can be replaced by fluorine;
phenyl, -(CH_2)-phenyl, -(CH_2)$_n$-phenyl, O-phenyl, O-(CH_2)$_m$-phenyl, -(CH_2)-O-(CH_2)$_m$-phenyl, where the phenyl ring may be mono- to trisubstituted with F, Cl, Br, I, OH, CF_3, NO_2, CN, OCF_3, O-(C_1-C_6)-alkyl, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$, SO_2-CH_3, COOH, COO-(C_1-C_6)-alkyl, $CONH_2$;

where always at least one of the radicals R2, R2', R3, R3', R4, R4', R5, R5' has the meaning -O-(CH_2)$_m$-phenyl or -(CH_2)-O-(CH_2)$_m$-phenyl, where the phenyl ring may be mono- to trisubstituted with F, Cl, Br, I, OH, CF_3, NO_2, CN, OCF_3, O-(C_1-C_6)-alkyl, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$, SO_2-CH_3, COOH, COO-(C_1-C_6)-alkyl, $CONH_2$;

R6 is H, OH, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$;

n is 2, 3, 4, 5, 6;

m is 1, 2, 3, 4, 5, 6;

p is 0, 1, 2;

and pharmaceutically compatible salts thereof.

If radicals or substituents can occur several times in the compounds of the formulae I, then they can all, independently of one another, have the stated meaning and be identical or different.

The alkyl, alkenyl, alkynyl, alkylene, alkenylene and alkynylene radicals in the radicals R, R1, R2, R2', R3, R3', R4, R4', R5, R5' and R6 may either be straight-chain or branched.

One embodiment of the invention also further relates to individual reaction steps and also intermediate products of this method for the production of the compounds of the formulae 10 and 10a which has the following steps:

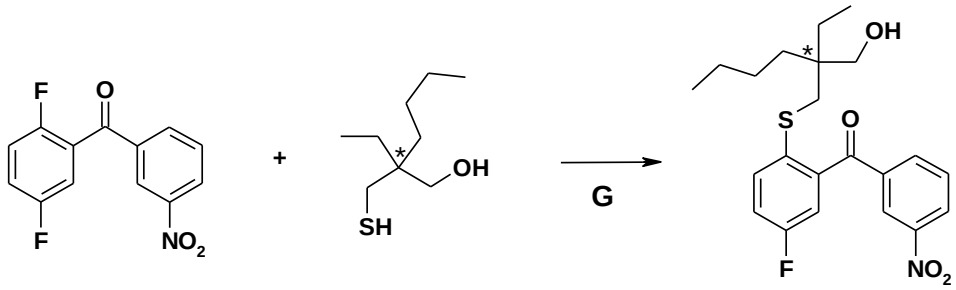
The compound of the formula 10 or 10a can be produced, for example, by reacting the compound of the formula 8 with a thiol of the formula 5 or 5a, in the presence of a

suitable base, such as, for example, sodium carbonate, potassium carbonate or cesium carbonate, in a suitable solvent, such as, for example, toluene, dimethylformamide, dimethyl sulfoxide or N-methylpyrrolidone.

The reaction temperature here is from 20°C to 120°C, preferably from 40°C to 80°C.

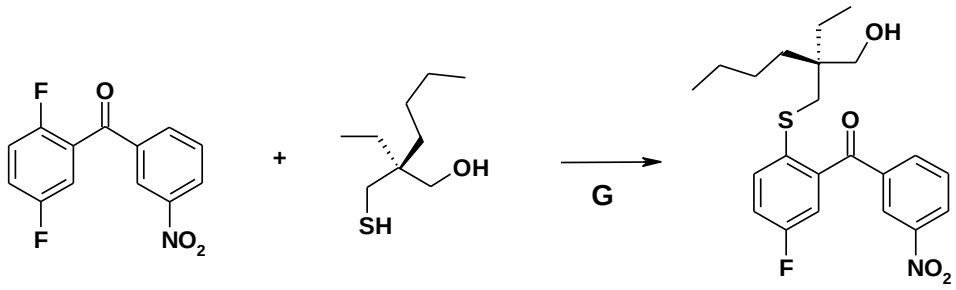
The reaction time is generally 0.5 to 8 hours, depending on the composition of the mixture and the selected temperature range.

The resulting compound of the formula 10 or 10a is then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate or dichloromethane.



8 5/5a 10/10a

The asterisk on one carbon atom in the compound of the formula 10/10a means that the carbon atom in each case is chiral and the compound is present either as R- or S-enantiomer or as a mixture of the two enantiomers.



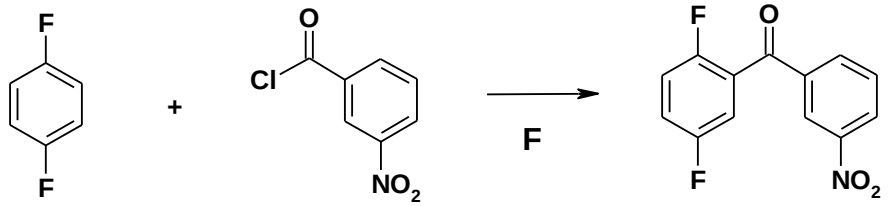
8 5 10

Preferably, the compound 10 or 10a is produced in enantiomerically pure form, for example by reacting the compound of the formula 8 with the compound of the formula 5 under the stated reaction conditions. The compound of the formula 10a is produced analogously by reaction with the compound of the formula 5a.

The compound of the formula 8 can be produced, for example, by reacting the compound of the formula 7 with 3-nitrobenzoyl chloride, in the presence of a suitable catalyst, for example aluminum(III) chloride.

The reaction temperature here is from 40°C to 140°C, preferably from 80°C to 120°C. The reaction time is generally 2 to 24 hours, depending on the composition of the mixture and the selected temperature range.

The resulting compound of the formula 8 is then separated off from the reaction mixture by aqueous work-up and extraction in a suitable solvent, for example ethyl acetate or dichloromethane, and subsequent crystallization.

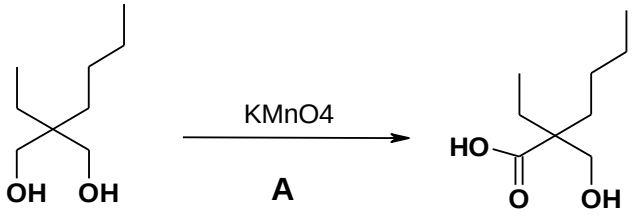


7 8

The compound of the formula 1 can be produced, for example, by reacting 2-butyl-2-ethyl-1,3-propanediol with suitable oxidizing agents, for example potassium permanganate.

The reaction temperature here is from 0°C to 100°C, preferably from 0°C to 40°C. The reaction time is generally 2 to 8 hours, depending on the composition of the mixture and the selected temperature range. The resulting compound of the formula 1 is then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example ethyl acetate or dichloromethane. A purification can be carried out with the help of a vacuum distillation.

Furthermore, the compound of the formula 1 can be obtained by methods known in the literature.

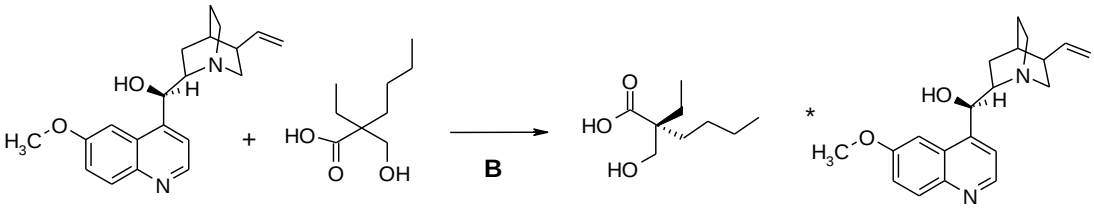


1

Boehm, Andreas; Petersen, Hermann; Stohrer, Juergen. Regioselective hydroxymethylation process for the preparation of α ,α -dialkyl-α -hydroxymethylcarboxylic acid derivatives. EP 1,666,447 A1

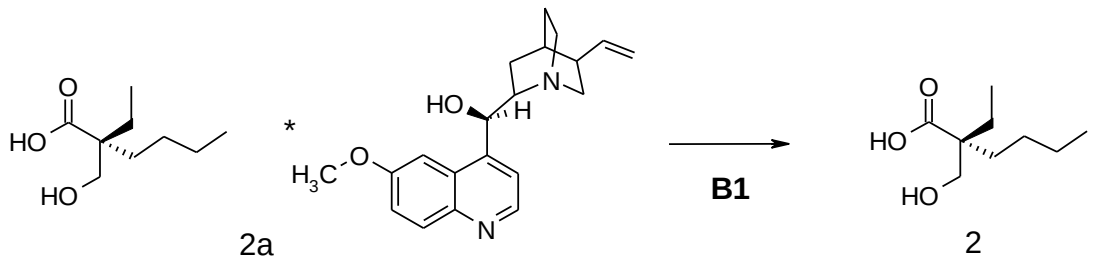
Nishii, Sadao. Preparation of 2-ethyl-2-(hydroxymethyl)hexanoic acid. Jpn. Kokai Tokkyo Koho (1989), JP 01139544

The compound of the formula 2a can be produced, for example, by reacting racemic 2-butyl-2-ethyl-1,3-propanediol with chiral bases, for example quinine, in a suitable solvent or solvent mixture, for example toluene, n-butyl acetate or acetone/water. The reaction temperature of the racemate resolution here is 0°C to 100°C, preferably from 20°C to 60°C. The reaction time is generally 2 to 24 hours, depending on the composition of the mixture and the selected temperature range. The achieved enantiomer excesses (ee) are between 20 and 80% ee depending on the selected conditions. Higher ee values can be achieved if the resulting compound of the formula 2a is then recrystallized in a suitable solvent or solvent mixture, for example toluene, n-butyl acetate/heptane or acetone/water. The achieved enantiomer excesses (ee) are between 80 and 99% ee depending on the selected conditions.



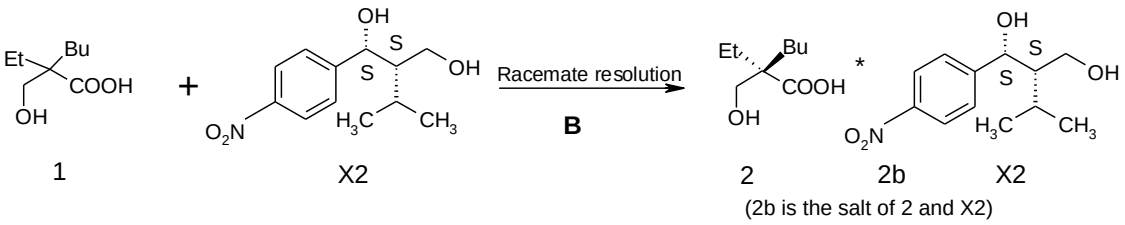
X1 1 2a

The compound of the formula 2 is then obtained from the compound of the formula 2a by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate or dichloromethane.



2a 2

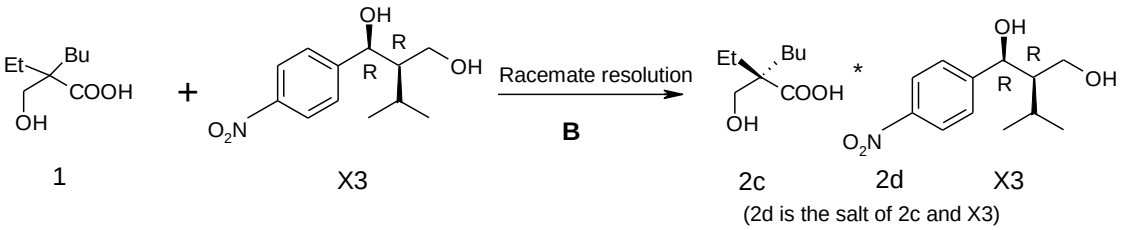
Alternatively, the compound 2 can be produced by racemate resolution with the compound of the formula X2. The compound of the formula 2 is then obtained from the compound of the formula 2b by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate or dichloromethane.



1 X2 2 2b X2

(2b is the salt of 2 and X2)

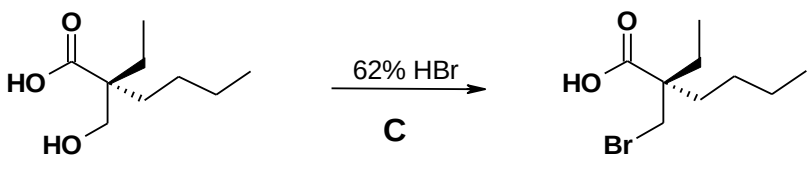
The enantiomer (formula 2c) of the compound 2 can be produced by racemate resolution with the antipode (formula X3) of the compound X2.



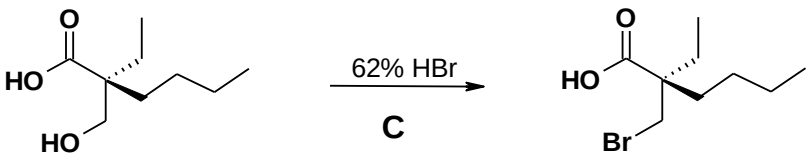
1 X3 2c 2d X3

(2d is the salt of 2c and X3)

The compounds of the formula 3 and 3a can be produced for example by reacting the compound of the formula 2 or 2c e.g. with hydrobromic acid with or without a suitable solvent or solvent mixture, for example toluene. The reaction temperature of the here is 40°C to 120°C, preferably from 60°C to 100°C. The reaction time is generally 2 to 24 hours, depending on the composition of the mixture and the selected temperature range. The yields achieved are between 60 and 90% depending on the selected conditions.



2 3

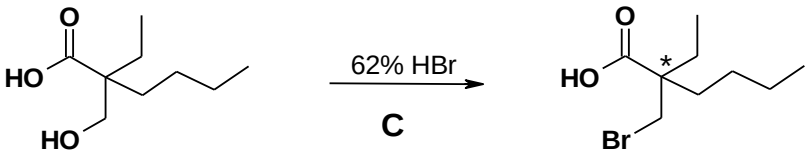


2c 3a

The racemate is produced analogously by reacting the compound of the formula 1 e.g. with hydrobromic acid analogously to the conditions stated above.

The resulting compounds of the formula 3 and 3a or a mixture thereof are then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example ethyl acetate or dichloromethane. A purification can be carried out with the help of a vacuum distillation.

Furthermore, the compounds of the formula 3 and 3a or mixtures thereof can be obtained by methods known in the literature.

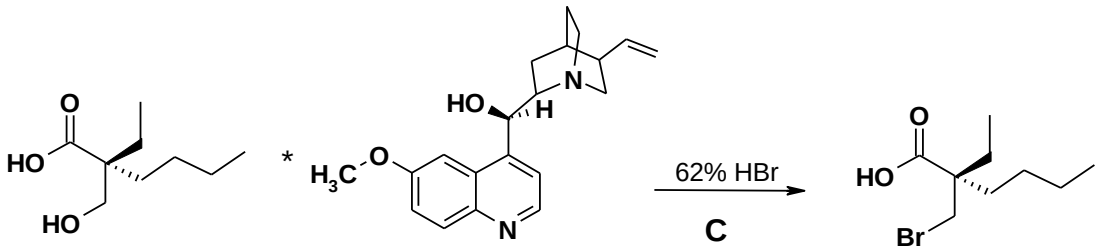


1 3/3a

Mitsuda, Masaru; Oguro, Kazumi; Watabe, Kazuhiko; Hayano, Tetsuji. Preparation of 2-substituted-2-(hydroxymethyl)carboxylic acids (esters) and their intermediates.; Jpn. Kokai Tokkyo Koho (2006), JP 2006219404

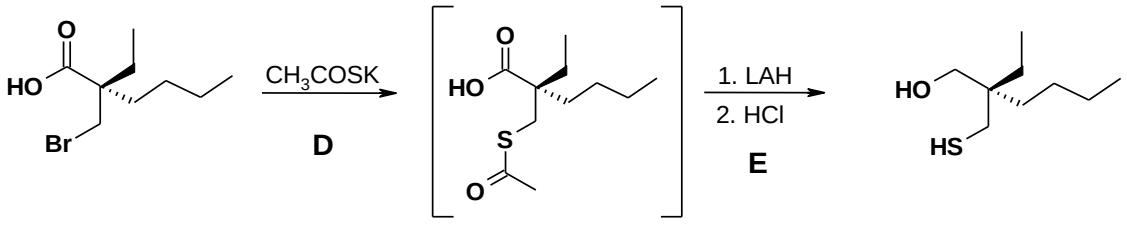
Crocq, Veronique; Roussel, Patrick. Process for preparation of new chiral compounds derived from esters of hexanoic acid, and their use in the synthesis of the chiral 2-(bromomethyl)-2-ethylhexanoic acid.; FR 2849024

Alternatively, the compound of the formula 3 or 3a can be obtained directly from the salts, e.g. 2a, 2b and 2d, analogously to the described conditions.



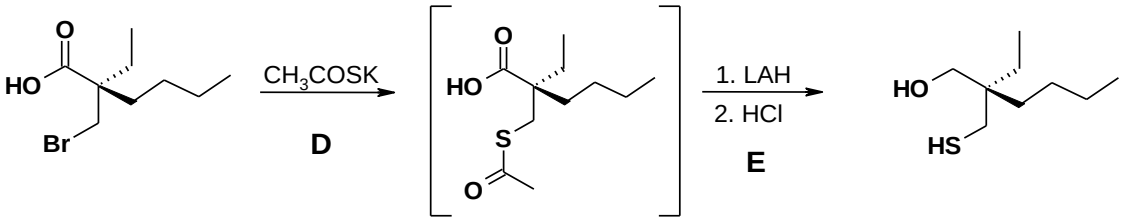
2a 3

The compound of the formula 5 can be produced, for example, by reacting the bromide of the compound of the formula 3 e.g. with potassium thioacetate in a suitable solvent or solvent mixture, for example toluene or acetone. The reaction temperature here is 0°C to 100°C, preferably from 20°C to 40°C. The reaction time is generally 2 to 24 hours, depending on the composition of the mixture and the selected temperature range. The resulting compounds of the formula 4 are then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example ethyl acetate or dichloromethane. Preferably, the reaction product is not isolated, but reduced directly in a suitable solvent or solvent mixture, such as e.g. THF/toluene, using a reducing agent such as e.g. lithium aluminum hydride (LAH) to give the compound of the formula 5. The reaction temperature here is 0°C to 100°C, preferably 0°C to 40°C. Following aqueous work-up and extraction with a suitable solvent, for example ethyl acetate, toluene or dichloromethane, the product is separated off from the reaction mixture. A purification can be carried out with the help of a vacuum distillation.



3 4 5

The compound of the formula 5a is synthesized analogously.



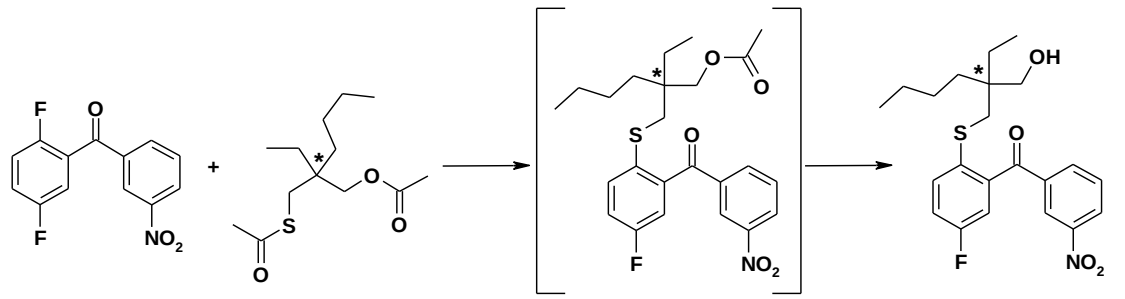
3a 4a 5a

One embodiment of the invention further also relates to individual reaction steps and also intermediate products of this method for the production of the compound of the formula 10 which has the following steps:

The compound of the formula 10 can be produced, for example, by reacting the compound of the formula 8 with a thiol of the formula 35 in the presence of a suitable, aqueous base, such as for example sodium carbonate, potassium carbonate, cesium carbonate.

The reaction temperature here is from 40°C to 140°C, preferably from 60°C to 120°C. The reaction time is generally 3 to 24 hours, depending on the composition of the mixture and the selected temperature range.

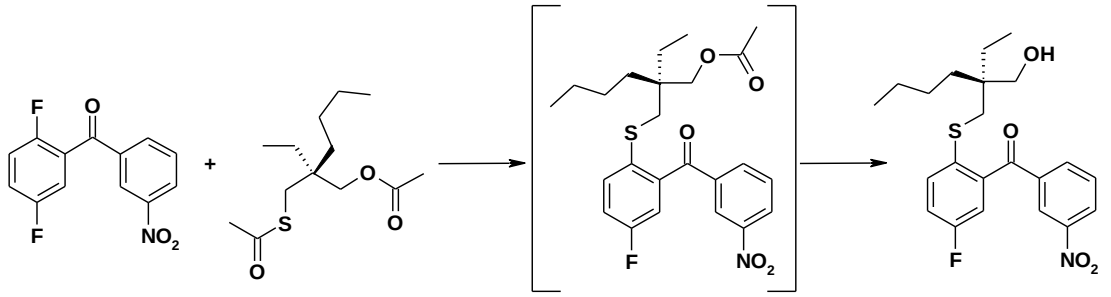
The resulting mixture of the compounds of the formula 30/30a and 10/10a is completely converted to the compound of the formula 10/10a by alkaline hydrolysis of the compound of the formula 30/30a, e.g. with sodium methylate in methanol or methanolic potassium hydroxide solution, and is then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate or dichloromethane.



8 35/35a (where R is CH_3) 30/30a 10/10a

The asterisk on one carbon atom in the compound of the formula 10 means that the carbon atom in each case is chiral and the compound is present either as R- or S-

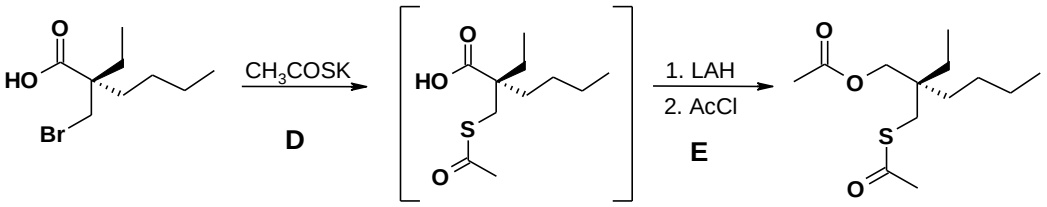
enantiomer or as a mixture of the two enantiomers.



8 35 (where R is CH_3) 30 10

Preferably, the compound 10 or 10a is produced in enantiomerically pure form, for example by reacting the compound of the formula 8 with the compound of the formula 35 under the stated reaction conditions. The compound of the formula 10a is produced analogously by reaction with the compound of the formula 5a.

The compound of the formula 35 can be produced, for example, by reacting the bromide of the compound of the formula 3 e.g. with potassium thioacetate in a suitable solvent or solvent mixture, such as for example toluene or acetone. The reaction temperature of the here is 0°C to 100°C, preferably from 20°C to 40°C. The reaction time is generally 2 to 24 hours, depending on the composition of the mixture and the selected temperature range. The resulting compounds of the formula 4 are then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example ethyl acetate or dichloromethane. Preferably, the reaction product is not isolated, but reduced directly to the compound of the formula 5 in a suitable solvent or solvent mixture, such as e.g. THF/toluene, using a reducing agent such as e.g. lithium aluminum hydride. The reaction temperature here is 0°C to 100°C, preferably 0°C to 40°C. Following aqueous work-up and extraction with a suitable solvent, for example ethyl acetate, toluene or dichloromethane, the product is reacted with an acid chloride or acid anhydride under conditions known in the literature. Preferably, after reduction has taken place, the reaction mixture is hydrolyzed directly with an acid halide or carboxylic anhydride, such as e.g. acetyl chloride or acetanhydride, and then subjected to aqueous work-up. A purification can be carried out with the help of a vacuum distillation.



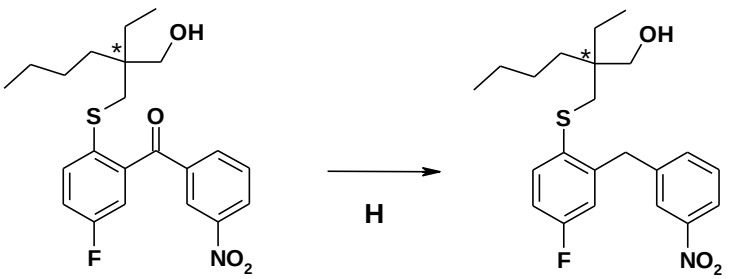
3 4 35 (where R is CH_3)

The compound of the formula 35a or of the mixture of 35/35a is produced analogously to the conditions specified for the compound of the formula 35.

One embodiment of the invention further also relates to individual reaction steps and also intermediate products of this method for the production of the compounds of the formula 15, 15a, 15b and 15c which has the following steps:

The compound of the formula 11/11a can be produced, for example, by reacting the compound of the formula 10/10a with a suitable reducing agent, such as for example hydrophosphorous acid/iodine, sodium borohydride/aluminum(III) chloride, triethylsilane/trifluoroacetic acid, isobutylaluminum dichloride, butylsilane/boron trifluoride, polyhydroxymethylsilane (PHMS) or triethylsilane/boron trifluoride without or in a suitable solvent, such as e.g. toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is 20°C to 120°C, preferably from 40°C to 80°C.

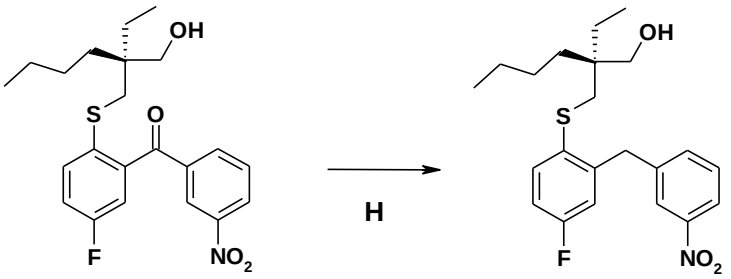
The reaction time is generally 2 to 12 hours, depending on the composition of the mixture and the selected temperature range. The resulting compounds of the formula 11/11a is then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate, methyl tert-butyl ether or dichloromethane.



10/10a 11/11a

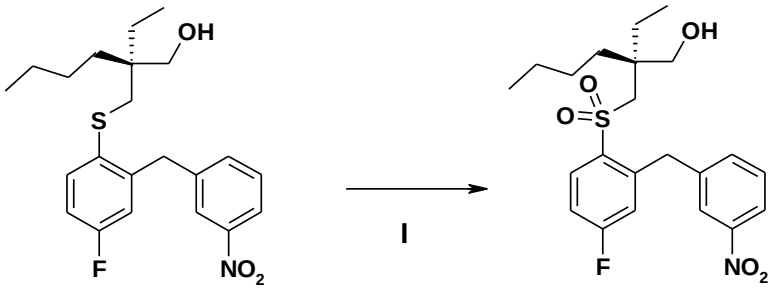
The asterisk on one carbon atom in the compounds of the formula 10/10a and 11/11a means that the carbon atom in question is chiral and the compounds are present either as R- or S-enantiomer or as a mixture of the two enantiomers.

The compound of the formula 11 is produced analogously to the conditions specified for the compounds of the formula 11/11a.



10 11

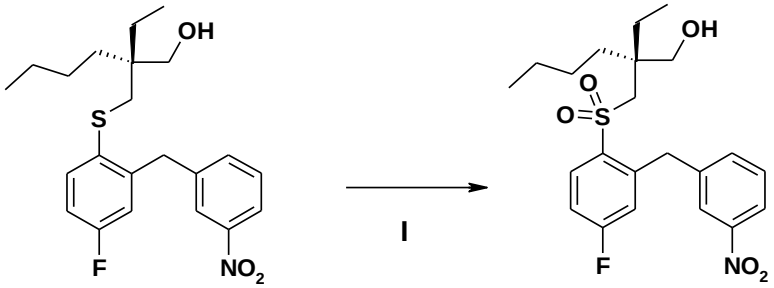
The compound of the formula 12 can be produced, for example, by reacting the compound of the formula 11 with a suitable oxidizing agent, such as for example sodium perborate, hydrogen peroxide/sodium tungstate, hydrogen peroxide/molybdenum(IV) oxide dichloride, ozones or hydrogen peroxide/acetonitrile/ethanol in a suitable solvent, such as e.g. toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is 0°C to 120°C, preferably from 20°C to 80°C.



11 12

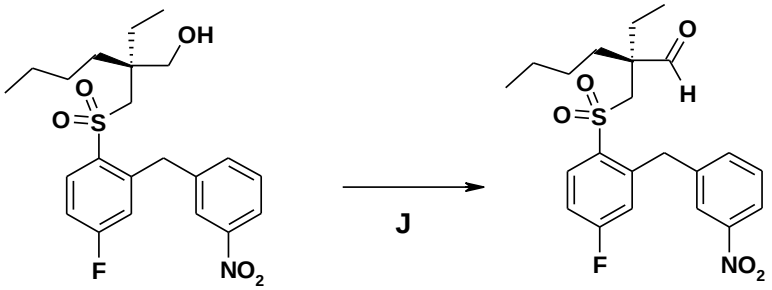
The reaction time is generally 2 to 12 hours, depending on the composition of the mixture and the selected temperature range. The resulting compound of the formula 12 is then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate, methyl tert-butyl ether or dichloromethane, and crystallized.

The compound of the formula 12a is produced analogously to the conditions specified for the compound of the formula 12.



11a 12a

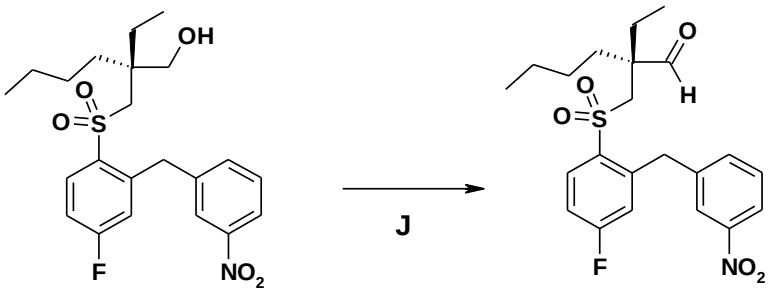
The compound of the formula 13 can be produced, for example, by reacting the compound of the formula 12 with a suitable oxidizing agent, such as for example oxayl chloride/DMSO, sulfur trioxide-pyridine complex/DMSO, pyridinium dichromate, periodane or sodium hypochloride/TEMPO in the suitable solvent or solvent mixture, such as e.g. toluene, THF, methyl-THF, water or dimethoxyethane. The reaction temperature here is 0°C to 100°C, preferably from 0°C to 40°C.



12 13

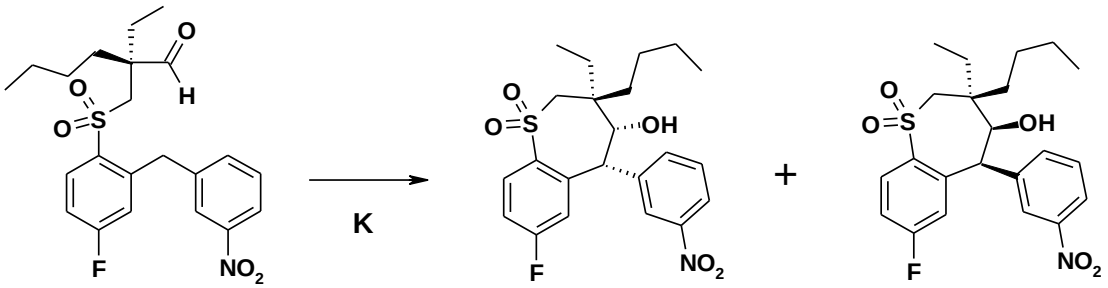
The reaction time is generally 1 to 4 hours, depending on the composition of the mixture and the selected temperature range. The resulting compound of the formula 13 is then separated off from the reaction mixture by aqueous work-up and extraction with a suitable solvent, for example toluene, ethyl acetate, methyl tert-butyl ether or dichloromethane, and crystallized.

The compound of the formula 13a is produced analogously to the conditions specified for the compound of the formula 13.



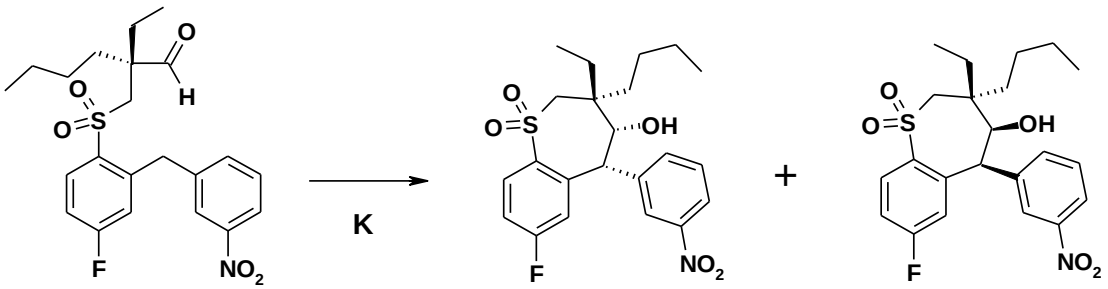
12a 13a

The compound of the formula 15 can be produced, for example, by reacting the compound of the formula 13 with a suitable base, such as for example potassium carbonate, cesium carbonate, DBU, sodium or potassium ethylate or sodium or potassium tert-butylate, a suitable solvent such as e.g. 2-propanol, toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is -70°C to 80°C, preferably from -20°C to 25°C. The resulting isomer mixture can then be separated by means of chromatographic methods, such as e.g. chromatography on silica gel and toluene/ethyl acetate as mobile phase, or fractional crystallization.



13 15 15a

The compounds of the formula 15b and 15c are produced analogously to the conditions specified for the compound of the formula 15 and 15a.



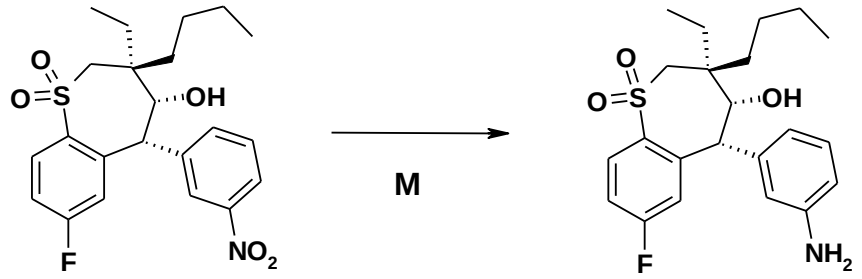
13a 15b 15c

One embodiment of the invention further also relates to individual reaction steps and

also intermediate products of the method for the production of the compounds of the formulae 17, 17a, 17b and 17c.

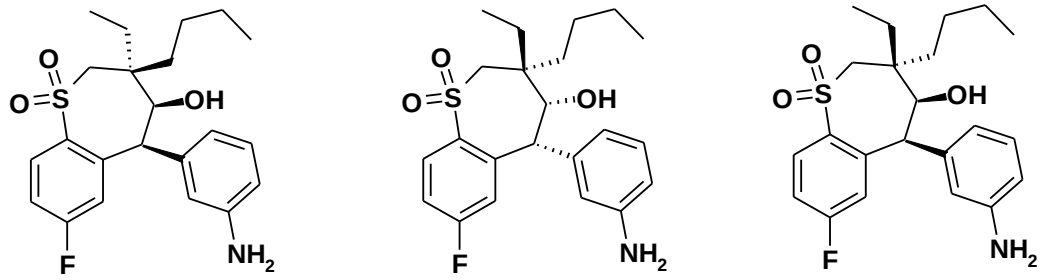
The compound of the formula 16 can be produced, for example, by reacting the compound of the formula 15 with a suitable reducing agent, such as for example hydrogen/palladium on activated carbon in a suitable solvent, such as e.g. methanol, ethanol, 2-propanol, dichloromethane, toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is 0°C to 80°C, preferably from 20°C to 50°C.

The reaction time is generally 2 to 12 hours, depending on the composition of the mixture and the selected temperature range.



15 16

The compounds of the formula 16a, 16b and 16c and mixtures thereof are produced analogously to the conditions specified for the compound of the formula 16.

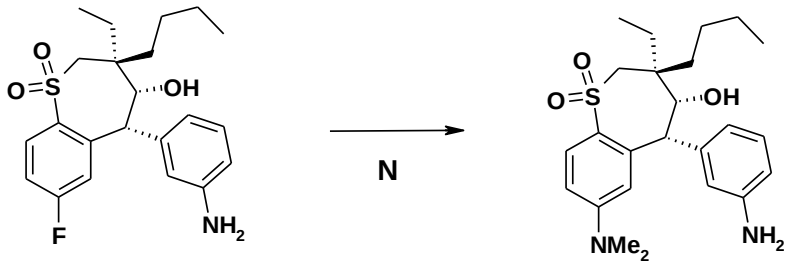


16a 16b 16c

The compound of the formula 17 (not part of the invention) can be produced, for example, by reacting the compound of the formula 16 with dimethylamine in a suitable solvent, such as e.g. methanol, ethanol, 2-propanol, toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is 60°C to 140°C, preferably from 80°C to 120°C.

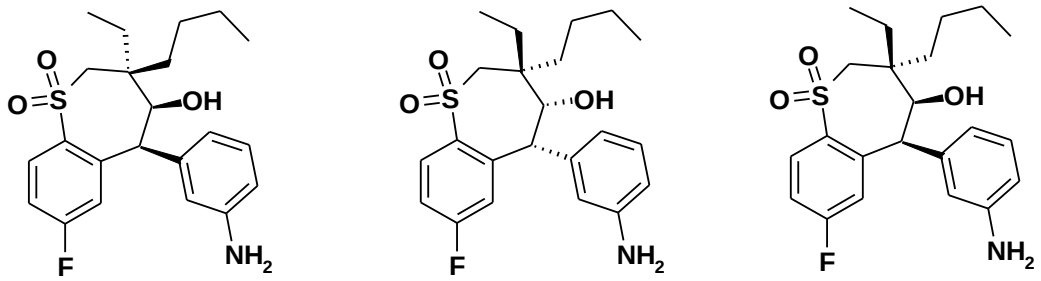
The reaction time is generally 4 to 24 hours, depending on the composition of the mixture and the selected temperature range. The resulting compound of the formula 17 is then crystallized from the reaction mixture using a suitable solvent or solvent mixture,

for example methanol, ethanol, 2-propanol, methyl tert-butyl ether or diisopropyl ether.



16 17

The compounds of the formula 17a, 17b and 17c or mixtures thereof are produced analogously to the conditions specified for the compound of the formula 17.

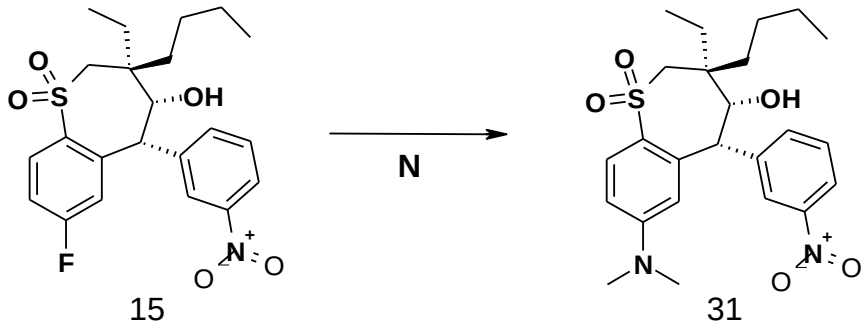


17a 17b 17c

Alternatively, the method for compound 17 or 17a/17b and 17c can be carried out as follows:

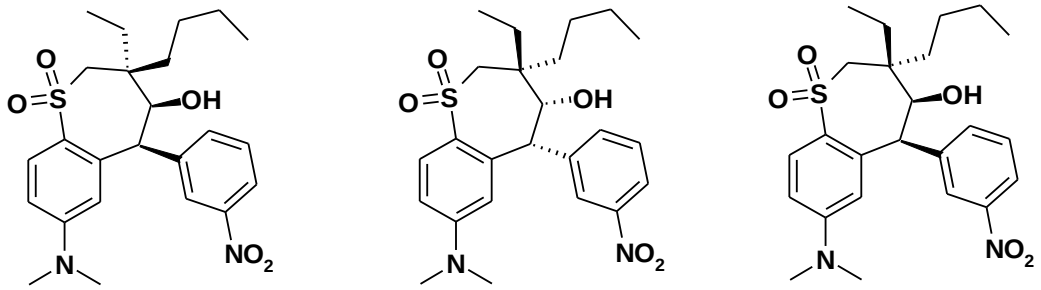
The compound of the formula 31 can be produced for example by reacting the compound of the formula 15 with dimethylamine in a suitable solvent, such as e.g. methanol, ethanol, 2-propanol, toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is 60°C to 140°C, preferably from 80°C to 120°C.

The reaction time is generally 4 to 24 hours, depending on the composition of the mixture and the selected temperature range. The resulting compound of the formula 31 is then crystallized from the reaction mixture using a suitable solvent or solvent mixture, for example methanol, ethanol, 2-propanol, methyl tert-butyl ether or diisopropyl ether, or further reacted without purification.



15 31

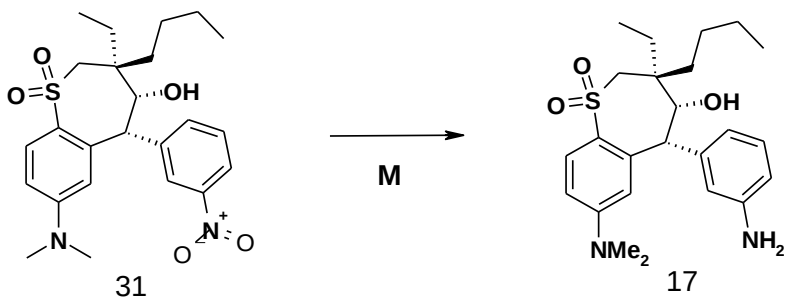
The compounds of the formula 31a, 31b and 31c or mixtures thereof are produced analogously to the conditions specified for the compound of the formula 31.



31a 31b 31c

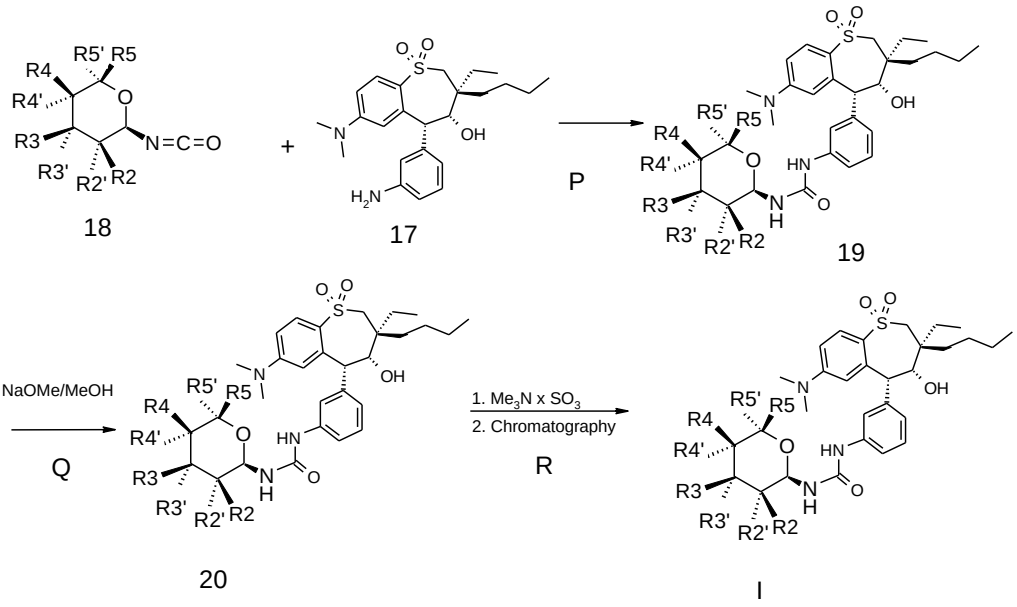
The compound of the formula 17 can be produced, for example, by reacting the compound of the formula 31 with a suitable reducing agent, such as to the hydrogen/palladium on activated carbon in a suitable solvent, such as e.g. methanol, ethanol, 2-propanol, dichloromethane, toluene, THF, methyl-THF or dimethoxyethane. The reaction temperature here is 0°C to 80°C, preferably from 20°C to 50°C.

The reaction time is generally 2 to 12 hours, depending on the composition of the mixture and the selected temperature range. The resulting compound of the formula 17 is then crystallized from the reaction mixture using a suitable solvent or solvent mixture, for example methanol, ethanol, 2-propanol, methyl tert-butyl ether or diisopropyl ether.

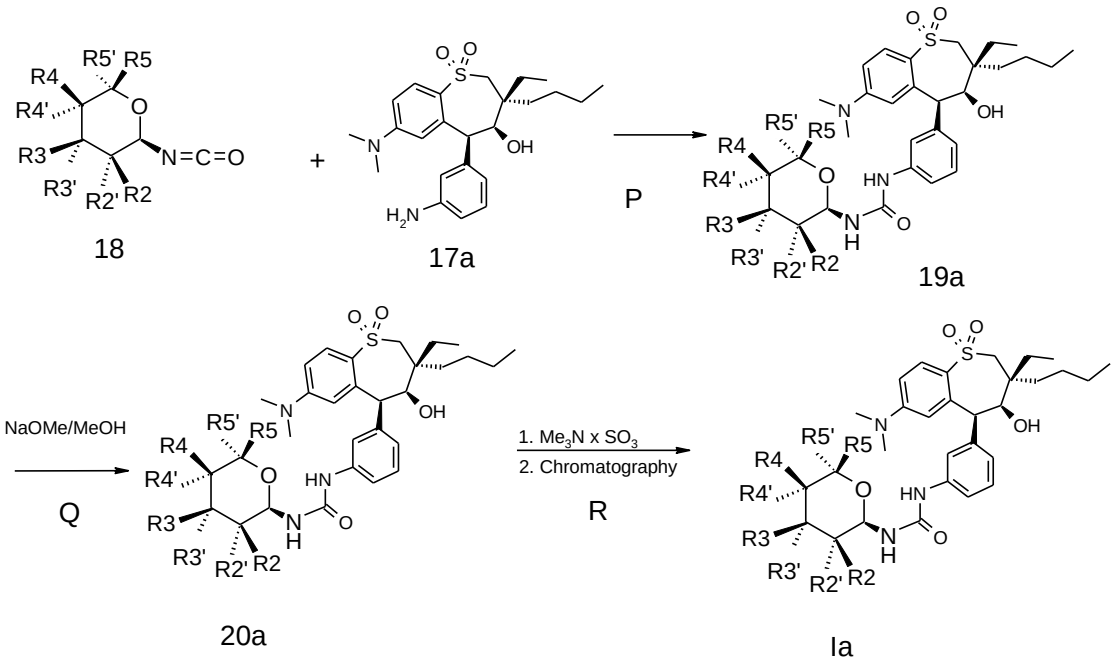


31 17

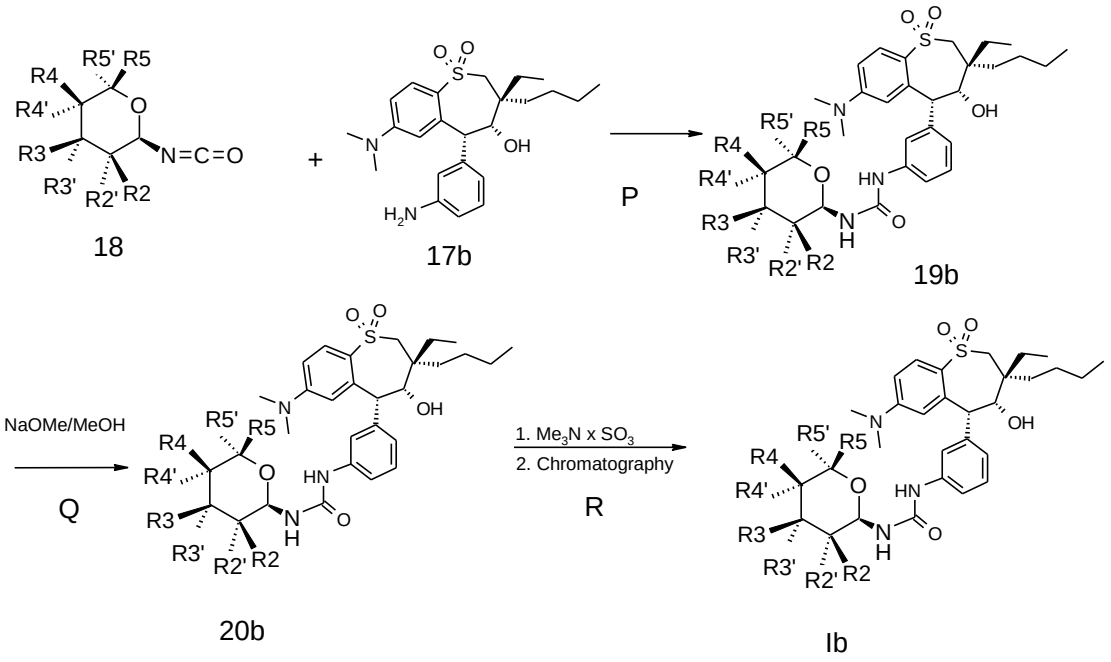
Compound 17 can be used further as follows for the production of the compounds of the formula I.



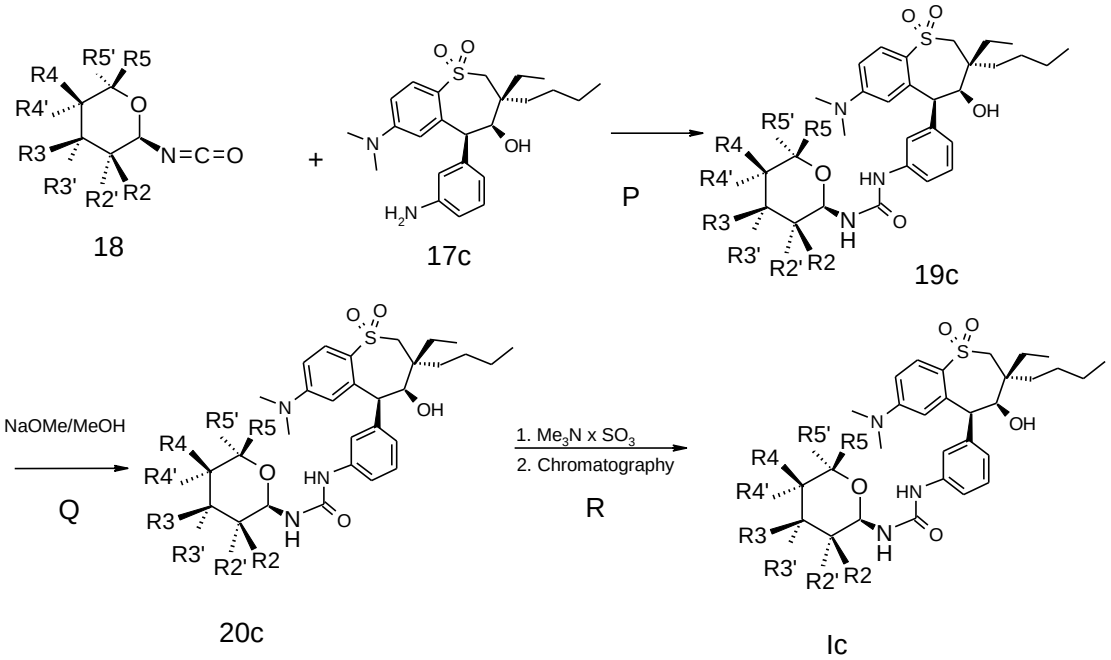
Compound 17a can further be used as follows for the production of the compound of the formula Ia.



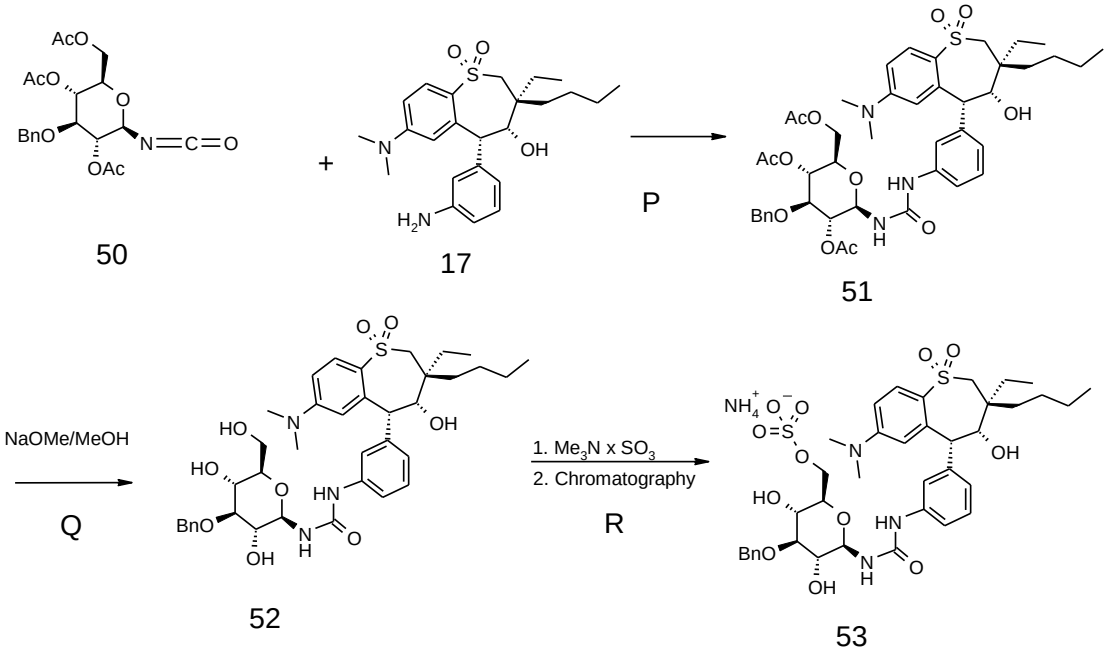
Compound 17b can further be used as follows for the production of the compound of the formula Ib.



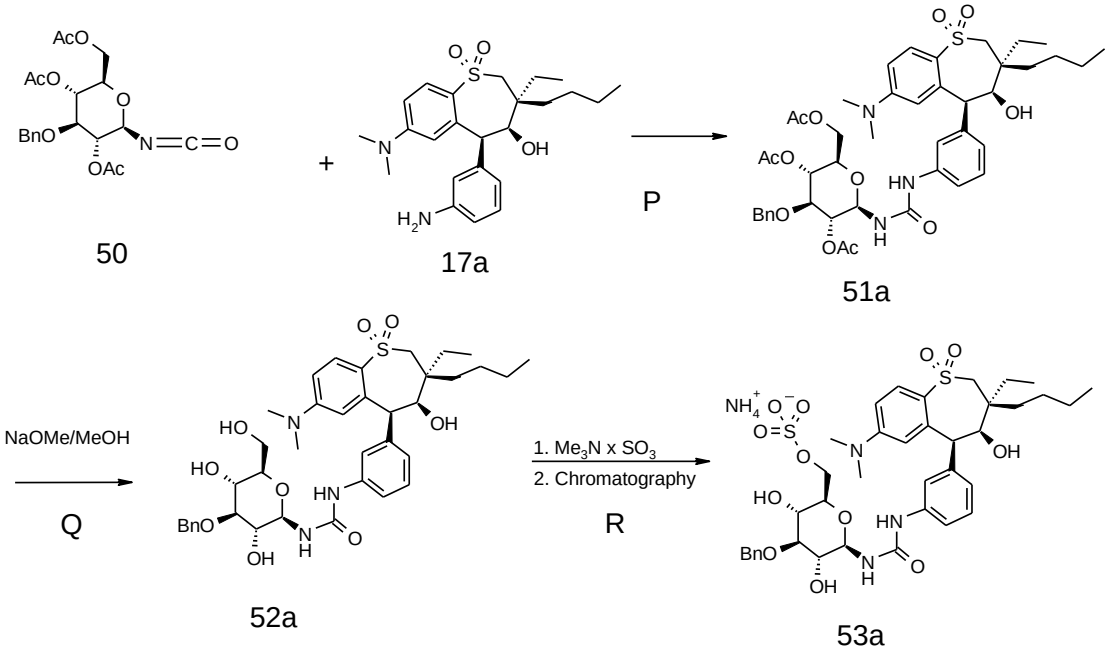
Compound 17c can further be used as follows for the production of the compound of the formula Ic.



In a preferred embodiment, compound 17 is used for the production of the compound 53.



The compound 53a is produced e.g. in an analogous manner:



The examples listed below serve to illustrate the invention without, however, limiting it. The compounds given in the table can be produced by the above method.

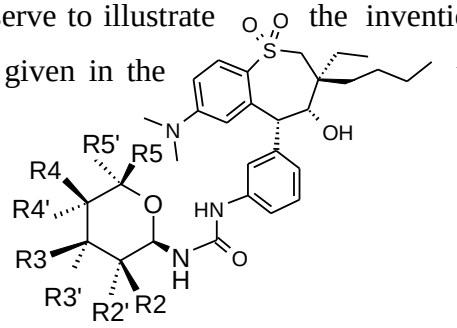


Table 1:

I

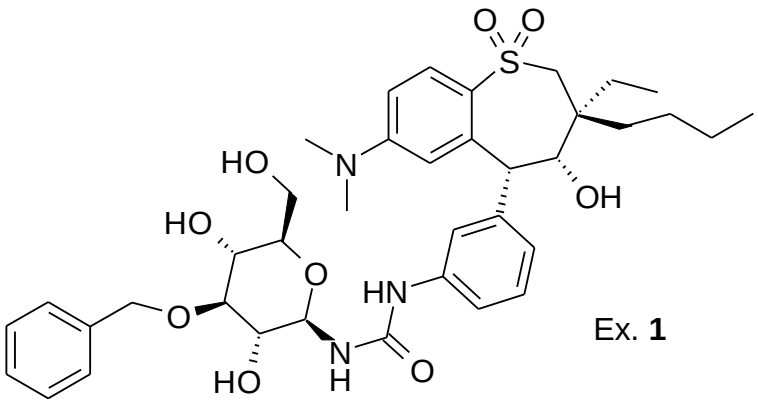
Ex.	**R2, R2'**	**R3, R3'**	**R4, R4'**	**R5, R5'**
1	OH, H	OBn, H	OH, H	CH_2OH, H
2	OH, H	OBn, H	OH, H	CH_2OH, H
3	OH, H	OBn,H	OH, H	CH_2OBn, H
4	OH, H	OBn, H	OH, H	CH_2OSO_2OH, H
5	OH, H	OBn, H	OSO_2OH, H	CH_2OSO_2OH, H
6	OH, H	OBn, H	OH, H	CH_2OSO_2OH, H

Et = Ethyl, Bu = n-Butyl, Bn = Benzyl

The production of a number of examples is described in detail below; the other compounds of the formula I, Ia, Ib and Ic were obtained analogously:

Experimental section:

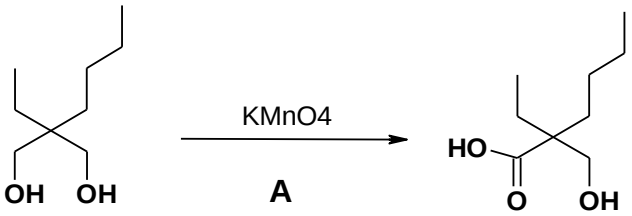
Example 1 (formula 52)



Ex. **1**

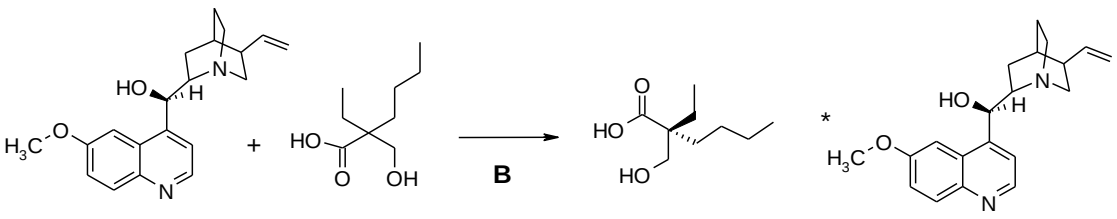
Synthesis of example 1:

Process step A



1

Process step B



X1 1 2a

35.5 g (204 mmol) of the carboxylic acid of the formula 1 and 63 g (194 mmol; 0.95 eq.) of quinine are suspended in 440 ml of n-butyl acetate and 220 ml of n-heptane. The mixture is heated to 90°C and stirred at this temperature for 15 minutes. The mixture is then cooled to 55°C, then to room temperature over the course of 12 hours and 2a is filtered off from the crystallized quinine salt of the formula 1.

Yield: 62 g (52%)

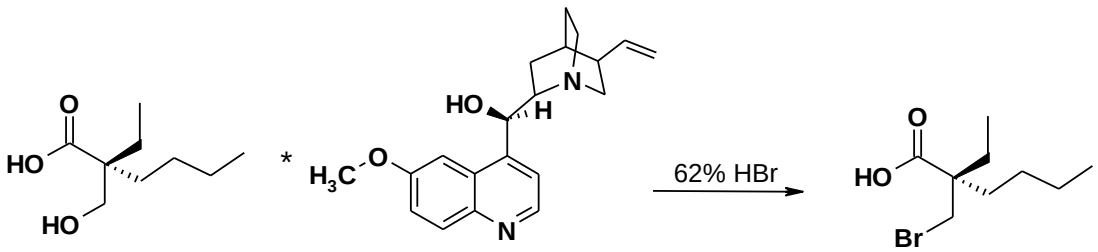
ee: 58% (RT: 6 minutes; Chiralpak AD 250 x 4.6; n-heptane/ethanol 25:1; 30°C)

62 g of the quinine salt of the formula 2a are dissolved in 400 ml of n-butyl acetate and 400 ml of n-heptane at 100 to 110°C and slowly cooled to room temperature overnight. It is drawn off from the precipitated solid of the formula 2a with suction and dried in vacuo.

Yield: 43 g (70%)

ee: 94% (RT: 6 minutes; Chiralpak AD 250 x 4.6; n-heptane/ethanol 25:1; 30°C)

Process step C:



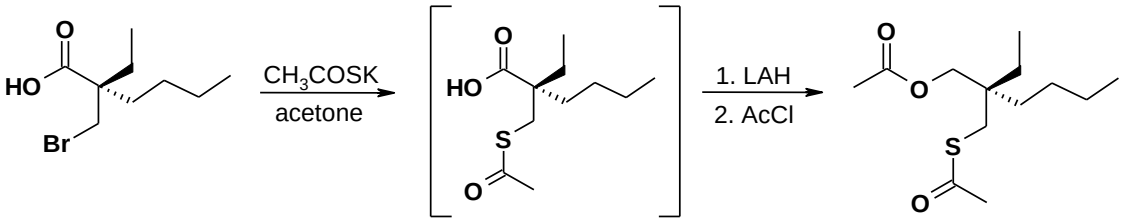
2a 3

26 g of the quinine salt of the formula 2a are stirred in 110 ml of 62% strength HBr for 12 hours at 100°C. Afterwards, the conversion is complete (TLC ethyl acetate/n-heptane 1:1). The solution is cooled and admixed with 100 ml of water and 100 ml of toluene. The aqueous phase is separated off and the toluene phase is dried and distilled off in vacuo. The carboxylic acid of the formula 3 is purified by means of a short-path distillation at 2 mbar and jacket temperature of 140°C.

Yield: 11.1 g (90%)

^{1}H-NMR ($CDCl_3$): 3.83 (s, 2H); 2.98 (s, 2H); 2.32 (s, 3H); 2.15 (s, 3H); 1.6 – 1.8 (m, 4H); 1.1 – 1.4 (m, 4H); 0.85 (t, 3H); 0.8 (t, 3H)

Alternative process step to give compound 35a where R is methyl.



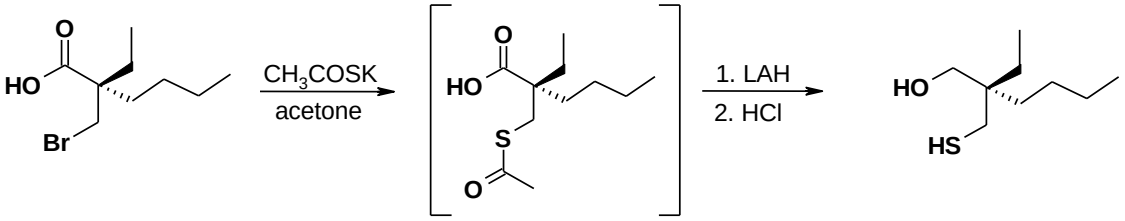
3 4 35a

64 g (0.56 mol; 1.12 eq.) of potassium thioacetate are suspended in 400 ml of acetone. 118.57 g (0.5 mol) of the bromide of the formula 3, dissolved in 100 ml of acetone, are added and the solution is stirred at room temperature for 4 hours. The suspension is diluted with 1500 ml of toluene and filtered over 100 g of silica gel. The filtrate is concentrated by evaporation in vacuo to a volume of 1000 ml, cooled to 0°C and slowly admixed with 750 ml (0.75 mol) of a 1M LAH solution in THF. The solution is stirred for 1-2 hours at 0°C and overnight at RT. The solution is cooled to 10°C and slowly admixed with 225 ml of acetyl chloride. The mixture is after-stirred for 1 hour and then admixed with 250 ml of toluene and 500 ml of water. The phases are separated and the aqueous phase is extracted again with 200 ml of toluene. The combined toluene phases are dried over sodium sulfate and the solvent is distilled off in vacuo. This gave the compound of the formula 35a (R is methyl).

Yield: 123 g (90%)

^{1}H-NMR ($CDCl_3$): 3.83 (s, 2H); 2.98 (s, 2H); 2.32 (s, 3H); 2.15 (s, 3H); 1.6 – 1.8 (m, 4H); 1.1 – 1.4 (m, 4H); 0.85 (t, 3H); 0.8 (t, 3H)

Process steps D and E:



3 4 5

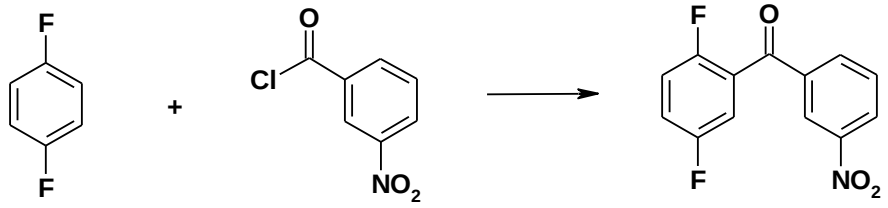
64 g (0.56 mol; 1.12 eq.) of potassium thioacetate are suspended in 400 ml of acetone. 118.57 g (0.5 mol) of the bromide of the formula 3, dissolved in 100 ml of acetone, were

added and the solution was stirred for 4 hours at room temperature. The suspension is diluted with 1500 ml of toluene and filtered over 100 g of silica gel. The filtrate is concentrated by evaporation in vacuo to a volume of 1000 ml, cooled to 0°C and slowly admixed with 750 ml (0.75 mol) of a 1M LAH solution in THF. The solution is stirred for 1-2 hours at 0°C and overnight at RT. The solution is cooled to 10°C and slowly admixed with 700 ml of 2N hydrochloric acid. The mixture is after-stirred for 1 hour and then diluted with 250 ml of toluene. The phases are separated and the aqueous phase is extracted again with 200 ml of toluene. The combined toluene phases are dried over sodium sulfate and the solvent is distilled off in vacuo. This gave the compound of the formula 5.

Yield: 103 g (90%)

^{1}H-NMR ($CDCl_3$): 3.83 (s, 2H); 2.98 (s, 2H); 1.6 – 1.8 (m, 4H); 1.1 – 1.4 (m, 4H); 0.85 (t, 3H); 0.8 (t, 3H)

Process step F:



7 8

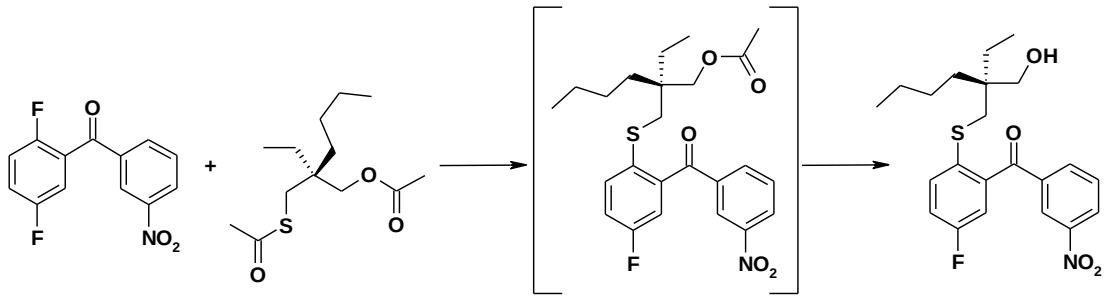
Over the course of 30 minutes at an internal temperature of 20°C, 38.4 g of anhydrous aluminum chloride are added to a mixture of 20 g of 3-nitrobenzoyl chloride and 54 ml of 1,4 –difluorobenzene, during which the temperature increases to 30°C. The reaction mixture is heated under reflux for 16 hours. Afterwards, the reaction is complete (TLC control with toluene/AcOEt/CH3CO2H 95:5:3).

The reaction mixture is cooled to 50°C in the and admixed with 40 ml of ethyl acetate. The suspension is poured onto a mixture of 180 ml of water and 30 ml of 2N hydrochloric acid. The phases are separated and the aqueous phase is after-extracted with ethyl acetate. The combined organic phases are dried over sodium sulfate and the solvent is evaporated in vacuo. The 2,4-difluoro-3'-nitrobenzophenone of the formula 8 is crystallized from the remaining residue using 2-propanol.

Yield: 24.6 g (86.6%)

^{1}H-NMR (CDCl3): 8.63 (s, 1H); 8.49 (d, 1H); 8.15 (d, 1H); 7.71 (t, 1H); 7.15 – 7.45 (m, 3H)

Alternative process step with compound 35a (R is methyl)



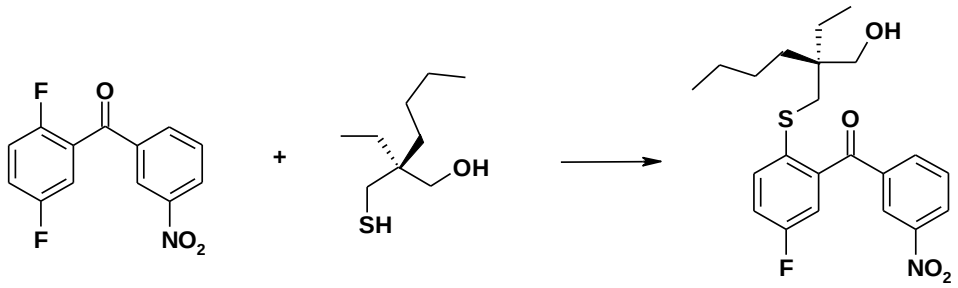
8 35a 30 10

14.4 g (1.15 eq.) of the compound of the formula 8 and 1.9 g of tetrabutylammonium bromide are dissolved in 80 ml of toluene and 70 ml of a 2M K_2CO_3 solution. The mixture is heated under reflux and, over the course of 24 hours, admixed with 14.5 g of the compound of the formula 35a, dissolved in 30 ml of toluene. The reaction mixture is heated for a further 12 hours. The mixture is then cooled to RT, the phases are separated and the organic phase is briefly distilled in order to remove residual amounts of water. 10 ml of methanol and 2.5 ml of 30% strength sodium methylate solution are added and the mixture is stirred for 1.5 hours. The solution is then concentrated and the product is purified by chromatography (eluent: dichloromethane). This gave the compound of the formula 10.

Yield: 10.1 g (57% based on compound 35a)

^{1}H-NMR ($CDCl_3$): 8.53 (s, 1H); 8.49 (d, 1H); 8.15 (d, 1H); 7.71 (t, 1H); 7.60 -7.68 (m, 1H); 3.45 (d, 2H); 2.83 (s, 2H); 1.05 – 1.35 (m, 8H); 0.85 (t, 3H); 0.75 (t, 3H)

Process step G:



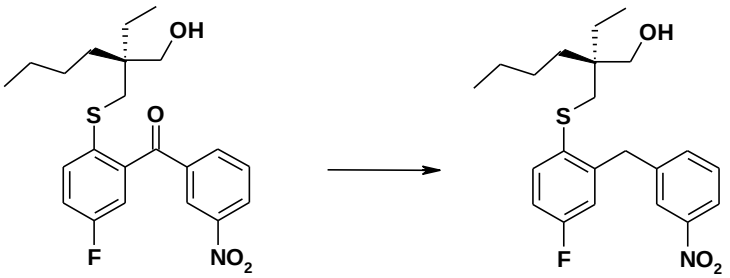
8 5 10

12.2 g (1.15 eq.) of the compound of the formula 8, 1.6 g of tetrabutylammonium bromide and 2 g of K_2CO_3 are heated under reflux in 120 ml of toluene for 8 hours. The mixture is then cooled to RT, the phases are separated, the solution is concentrated and the product is purified by chromatography (eluent: dichloromethane). This gave the compound of the formula 10.

Yield: 6.9 g (46% based on compound 35a, pale yellow oil)

^{1}H-NMR ($CDCl_3$): 8.53 (s, 1H); 8.49 (d, 1H); 8.15 (d, 1H); 7.71 (t, 1H); 7.60 - 7.68 (m, 1H); 3.45 (d, 2H); 2.83 (s, 2H); 1.05 – 1.35 (m, 8H); 0.85 (t, 3H); 0.75 (t, 3H)

Process step H:



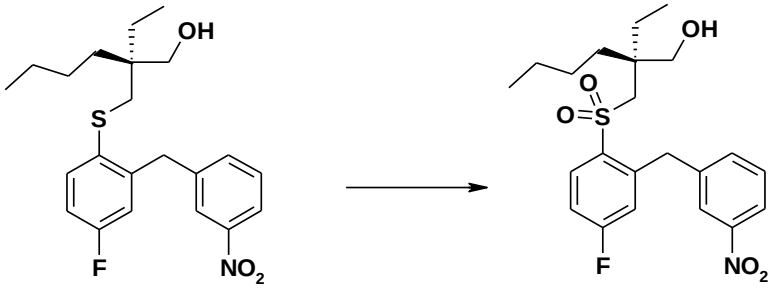
10 11

11 g of the compound of the formula 11, 20 g of triethylsilane and 25 g of boron trifluoride diethyl ether complex are stirred for 8 hours at an internal temperature of 65°C. Afterwards, the reduction is complete (TLC: toluene/ethyl acetate 10:1). The reaction solution is cooled to RT and slowly admixed with 50 ml of a 2M sodium carbonate solution. 100 ml of ethyl acetate are then added, the organic phase is concentrated by evaporation in vacuo and the product, the compound of the formula 11, is purified by chromatography (eluent: toluene/ethyl acetate 10:1).

Yield: 9.6 g (90.5%, pale yellow oil)

Rf = 0.4. $C_{22}H_{28}FNO_3S$ (405.54). MS (M + H)+ = 406.54

Process step I:



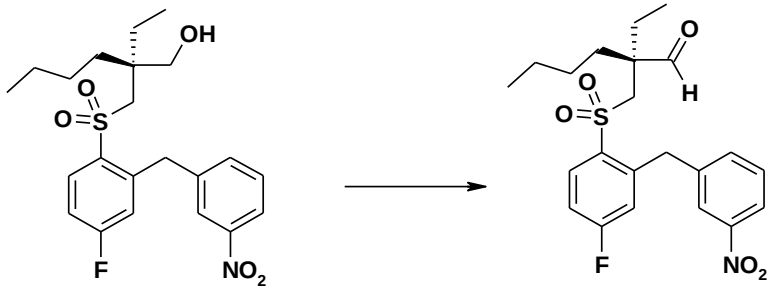
11 12

4 g of potassium carbonate and 12 g of the compound of the formula 11 are dissolved in 80 ml of ethanol, 20 ml of acetonitrile and 20 ml of water. The solution is cooled to 5°C and admixed with 24 ml of 30% strength H_2O_2 over the course of 1 hour. The solution is stirred overnight and admixed with 100 ml of water to precipitate the crude product. The crude product is filtered off, washed with water and crystallized from diisopropyl ether. This gave the compound of the formula 12.

Yield: 11.65 g (90%)

^{1}H-NMR (CDCl3): 8.05 – 8.15 (m, 3H); 7.55 -7.65 (m, 2H); 7.08 - 7.15 (m, 1H); 6.90 - 7.00 (m, 1H); 4.60 (s, 2H); 3.60 – 3.75 (m, 2H); 2.95 (s, 2H); 1.05 – 1.45 (m, 8H); 0.85 (t, 3H); 0.75 (t, 3H)

Process step J:



12 13

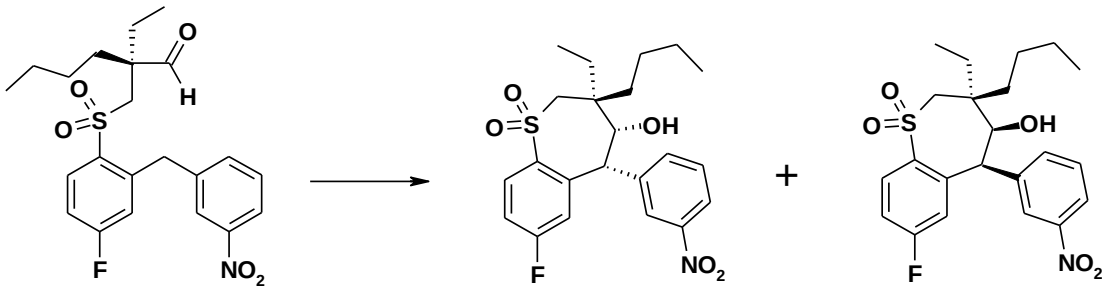
11.75 g (27 mmol) of the compound of the formula 12 and 0.128 g (0.022 eq.) of 4-acetamido-TEMPO (4-acetamido-2,2,6,6-tetramethylpiperidin-1-oxyl) are dissolved in 160 ml of dichloromethane. 1.5 g of NaBr (0.54 eq.), dissolved in 25 ml of water, and 4.45 kg (2 eq.) of $NaHCO_3$, dissolved in 100 ml of water, are added. 20.1 g (1.32 eq.) of a 12.9% strength NaOCl are metered in continuously over the course of 2 hours. The reaction mixture is after-stirred for a further 15 minutes and the complete conversion is monitored via TLC (heptane/ethyl acetate 2:1). Following aqueous work-up, the

aldehyde of the formula 13 is crystallized with diisopropyl ether.

Yield: 10.5 g (90%)

^{1}H-NMR (400MHz, CDCl3): 9.45 (s, 1H); 8.05 – 8.15 (m, 3H); 7.55 - 7.65 (m, 2H); 7.08 - 7.15 (m, 1H); 6.90 - 7.00 (m, 1H); 4.60 (s, 2H); 3.20 (s, 2H); 1.55 – 2.05 (m, 4H); 1.05 – 1.35 (m, 4H); 0.85 (t, 3H); 0.75 (t, 3H)

Process step K and L:



13 15 15A

A solution of 9.3 g (21.4 mmol) of the aldehyde of the formula 13 in 80 ml of THF is admixed at 0°C with 4.1 ml (0.18 eq.) of a 1M KOtBu in THF and after-stirred for 1 hour at this temperature. The reaction solution is neutralized with 0.25 g of acetic acid (4.1 mmol, 0.18 eq.) and concentrated by evaporation in vacuo. The two isomers (the compounds of the formulae 15 and 15A) are separated by chromatography over silica gel (eluent: toluene/ethyl acetate 5:1).

Yield of compound of the formula 15: 4.1 g (45%, pale yellow solid)

Rf = 0.38. $C_{22}H_{26}FNO_5S$ (435.52). MS (M + H)+ = 436.52

Yield of compound of the formula 15A: 3.8 g (41%, pale yellow solid)

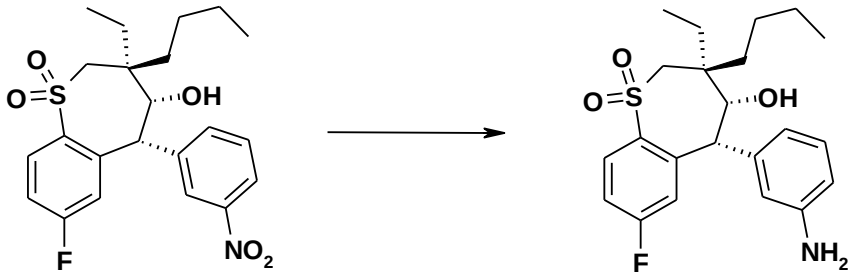
Rf = 0.49. $C_{22}H_{26}FNO_5S$ (435.52). MS (M + H)+ = 436.52

Compounds of the formulae 17 and 17A (not part of the invention)

Method A:

Process step M:

Production of the compound of the formula 16:



15 16

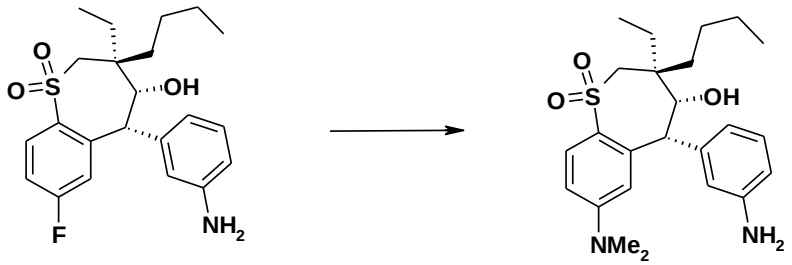
4 g of the compound of the formula 15 are dissolved in 40 ml of dichloromethane/ethanol 1:1, admixed with 400 mg of Pd/C 5% and hydrogenated until the end of the hydrogen absorption (3 - 4 hours) at 3 bar (TLC control: ethyl acetate/n-heptane 2:1). The catalyst is filtered off and the solvent is distilled off in vacuo. This gave the compound of the formula 16.

Yield: 3.7 g (98%)

Rf = 0.48. $C_{22}H_{26}FNO_3S$ (405.54). MS (M + H)+ = 406.54

Process step N:

Production of the compound of the formula 17:



16 17

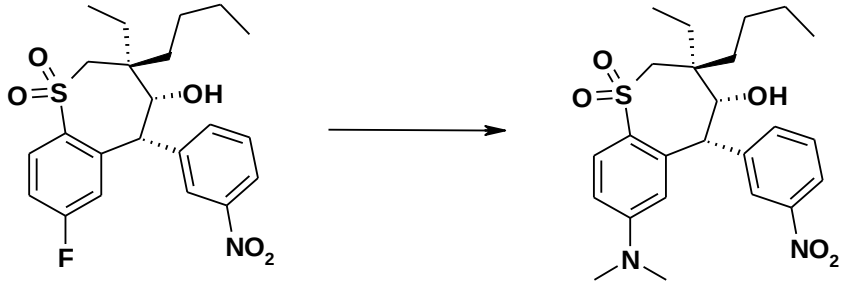
8 g of the compound 16 are introduced as initial charge in a pressurized container and admixed with 50 ml of a 33% strength solution of dimethylamine in ethanol. The pressurized container is sealed gas-tight and the solution is heated at 120°C for at least 8 hours. The solution is cooled and slowly admixed with water (10 ml) for crystallization. Once crystallization has taken place, a further 50 ml of water is added for complete precipitation and the suspension is stirred for 1 hour. The aniline (compound 17) is filtered off, washed thoroughly with water and dried in vacuo.

Yield: 7.8 g (91%, colorless solid)

^{1}H-NMR (400MHz, $CDCl_3$): 7.90 (d, 1H); 7.18 (t, 1H); 6.92 (d, 1H, b); 6.80 (s, 1H, b); 6.63 – 6.67 (m, 1H); 6.45 – 6.53 (m, 1H); 6.10 (s, 1H, b); 5.43 (s, 1H); 4.13 (s, 1H); 3.12 (d, 1H); 2.98 (d, 1H); 2.82 (s, 6H); 2.15 – 2.25 (m, 1H); 1.10 – 1.65 (m, 8H); 0.90 (t, 3H); 0.85 (t, 3H)

$C_{24}H_{34}N_2O_3S$ (437.54). MS (M + H)+ = 438.54

Method B:

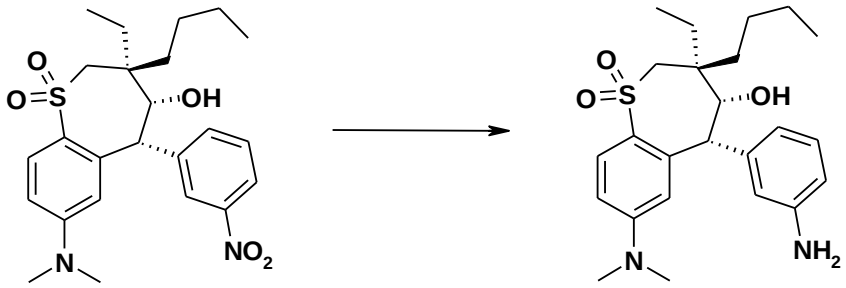


15 21

5 g of the compound 15 are introduced as initial charge in a pressurized container and admixed with 50 ml of a 33% strength solution of dimethylamine in ethanol. The pressurized container is sealed gas-tight and the solution is heated at 120°C for at least 8 hours. The solvents are evaporated off and the residue is chromatographed over silica gel (eluent: ethyl acetate/n-heptane 2:1).

Yield: 4.76 g (90%)

$C_{24}H_{32}N_2O_5S$ (460.6). MS (M + H)+ = 461.6



21 17

4 g of the compound 21 are dissolved in 40 ml of ethanol, admixed with 400 mg of Pd/C

5% and hydrogenated until the end of the hydrogen absorption (3 - 4 hours) at 3 bar (TLC control: ethyl acetate/n-heptane 2:1). The catalyst is filtered off and the filtrate is admixed in portions with water until the onset of crystallization. The mixture is after-stirred for a further 30 minutes and a further 40 ml of water are then added. The colorless solid is filtered off and dried in vacuo.

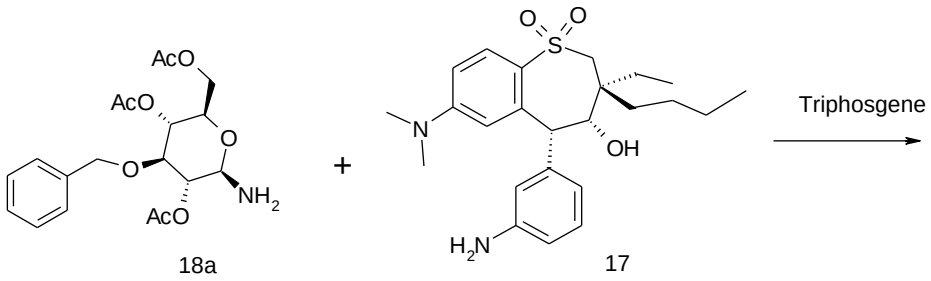
Yield of the compound 17: 3.8 g (91%, colorless solid)

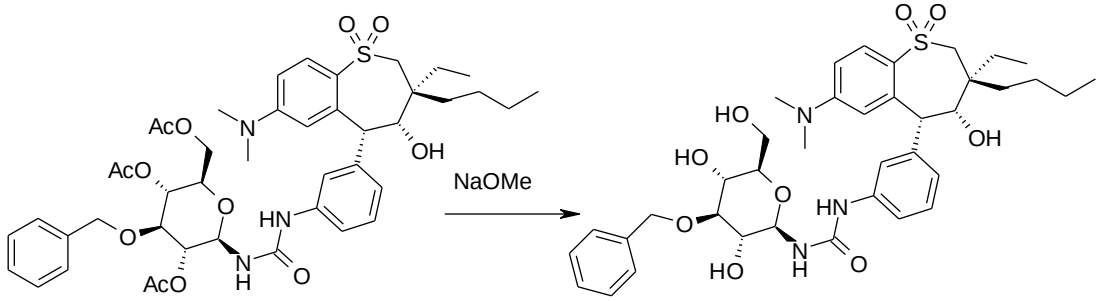
^{1}H-NMR (400 MHz, $CDCl_3$): 7.90 (d, 1H); 7.18 (t, 1H); 6.92 (d, 1H, b); 6.80 (s, 1H, b); 6.63 – 6.67 (m, 1H); 6.45 – 6.53 (m, 1H); 6.10 (s, 1H, b); 5.43 (s, 1H); 4.13 (s, 1H); 3.12 (d, 1H); 2.98 (d, 1H); 2.82 (s, 6H); 2.15 – 2.25 (m, 1H); 1.10 – 1.65 (m, 8H); 0.90 (t, 3H); 0.85 (t, 3H)

$C_{24}H_{34}N_2O_3S$ (437.54). MS (M + H)+ = 438.54

Process step P:

Production of the compounds of the formulae 51 and 52:

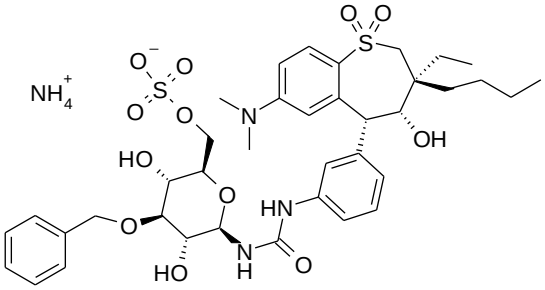




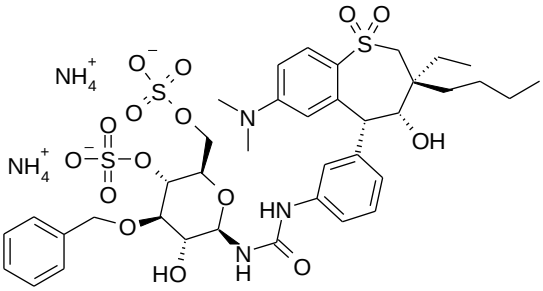
900 mg of triphosgene are dissolved in 10 ml of methylene chloride. Over the course of 20 minutes, a solution of 3.0 g (7.6 mmol) of amine of the formula 18a and 3 ml of N-ethylmorpholine in 20 ml of methylene chloride is added dropwise at room temperature to this solution. The mixture is then stirred for a further 1 hour and then a solution of 3.0 g (7.0 mmol) of aniline of the formula 17 (US 5,994,391), dissolved in 20 ml of methylene chloride, is slowly added dropwise. After a further 30 minutes, the reaction

is complete (TLC control). Washing is carried out twice with saturated sodium chloride solution, followed by filtration over silica gel and concentration by evaporation, giving 7 g of crude product of the formula 51. This is dissolved in 50 ml of methanol and admixed with 2 ml of 1 M sodium methanolate/methanol solution. After 30 minutes, the reaction solution is neutralized with 4 ml of 0.5 M HCL/methanol solution and concentrated by evaporation. The residue is purified using flash chromatography. Yield 4.72 g (93%) of the compound of the formula 52 as colorless solid. TLC (methylene chloride/methanol/conc. ammonia 30/5/1). R_f = 0.7. $C_{38}H_{51}N_3O_9S$ (725.91). MS $(M + H)^+$ = 726.38.

Example 2 and 3



53



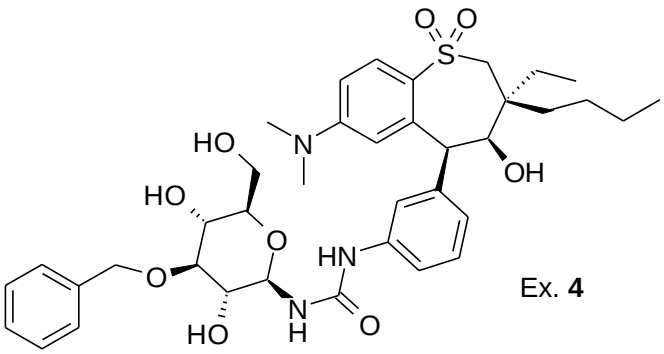
23

50.0 g (68.9 mmol) of example 52 are dissolved in 500 ml of pyridine and, after adding 17 g of pyridine-sulfur trioxide complex, the mixture is stirred for 30 minutes at 60°C. After adding 400 ml of methanol, the mixture is concentrated by evaporation on a rotary evaporator. The residue is again evaporated with 300 ml of methanol and then purified by means of flash chromatography. Yield 38.4 g (68%) of the compound of the formula Ia as ammonium salt. TLC (methylene chloride/methanol/conc. ammonia 30/5/1). R_f = 0.4. $C_{38}H_{51}N_3O_{12}S_2$ x NH_3 (823.00). MS $(M + H)^+$ = 804.21.

As by-product, 4.0 g (7%) of the disulfate of the formula 23 are obtained as double ammonium salt. TLC (methylene chloride/methanol/conc. ammonia 30/5/1). R_f = 0.1. $C_{38}H_{51}N_3O_{15}S_3$ x $2NH_3$ (920.09). MS $(M + H)^+$ = 886.45.

This disulfate can also be obtained as main product if twice the amount of sulfur trioxide complex is used.

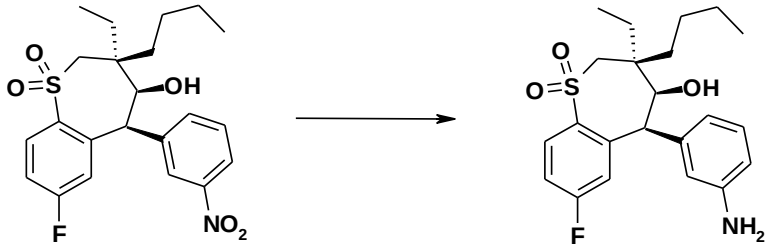
Example 4 (formula 52a)



Ex. **4**

Process step M:

Production of the compound of the formula 16A:



15A 16A

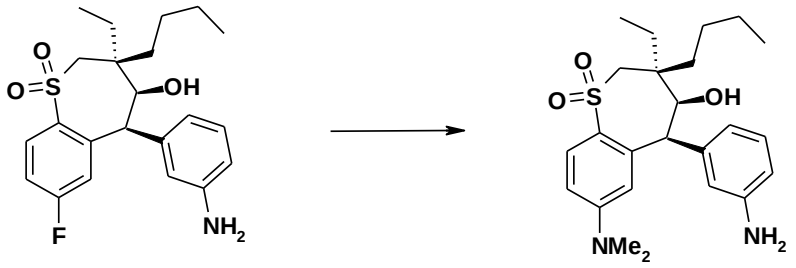
The compound 16A was produced analogously to compound 16.

Yield: 3.7 g (98%)

^{1}H-NMR (400 MHz, DMSO): 7.95 (m, 1H); 7.25 (t, 1H); 7.10 (t, 1H); 6.72 (d, 1H, b); 6.50 – 6.58 (m, 3H); 5.22 (d, 1H); 5.05 – 5.10 (m, 3H); 3.98 (d, 1H); 3.18 (d, 1H); 3.08 (d, 1H); 2.08 – 2.15 (m, 1H); 1.60 – 1.65 (m, 1H); 1.05- 1.40 (m, 6H); 0.84 (t, 3H); 0.82 (t, 3H)

Process step N:

Production of the compound of the formula 17A:



16A 17A

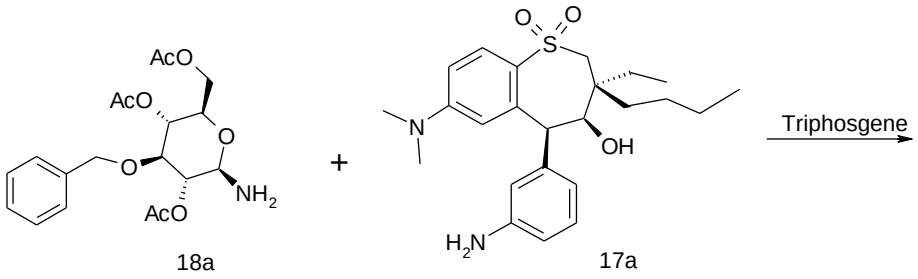
The compound 17A was produced analogously to compound 17.

Yield: 7.6 g (88%, colorless solid)

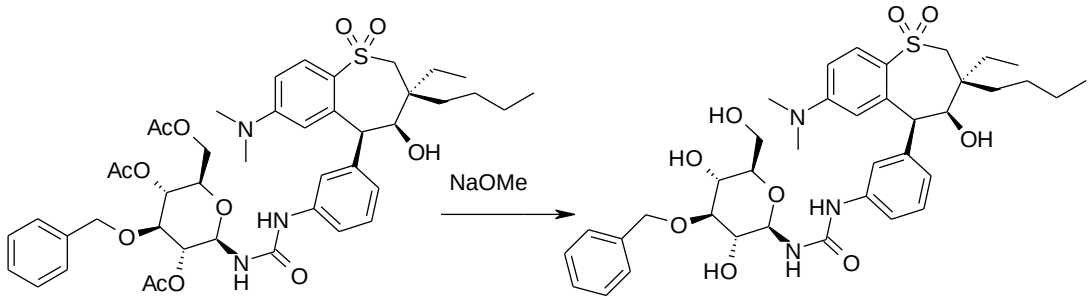
^{1}H-NMR (400MHz, DMSO): 7.62 (d, 1H); 7.18 (t, 1H); 6.73 (d, 1H, b); 6.50 – 6.58 (m, 2H); 6.48 (d, 1H, b); 6.10 (s, 1H, b); 5.00 – 5.05 (m, 3H); 4.85 (d, 1H); 3.92 (d, 1H); 3.40 -3.50 (m, 1H); 3.00 (d, 1H); 3.03 (d, 1H); 2.75 (s, 6H); 2.05 - 2.15 (m, 1H); 1.60 – 1.68 (m, 1H); 1.32 – 1.40 (m, 1H); 1.00 – 1.25 (m, 6H); 0.85 (t, 3H); 0.80 (t, 3H)

Process step P:

Production of the compound of the formula 52a:



18a 17a

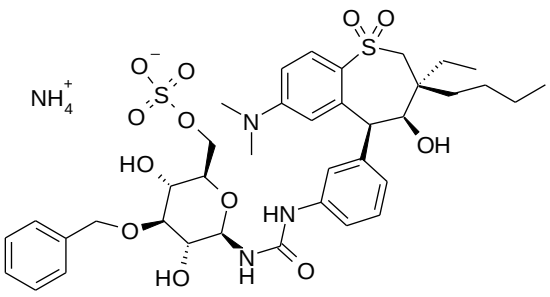


51a 52a

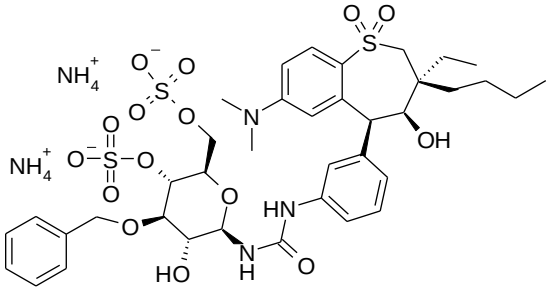
2.7 g of triphosgene are dissolved in 30 ml of methylene chloride. Over the course of 20 minutes, a solution of 9.0 g (22.8 mmol) of amine of the formula 18a and 9 ml of N-

ethylmorpholine in 60 ml of methylene chloride is added dropwise at room temperature to this solution. The mixture is then stirred for a further 1 hour and then a solution of 9.0 g (21.0 mmol) of aniline of the formula 17a, dissolved in 50 ml of methylene chloride, is slowly added dropwise. After a further 30 minutes, the reaction is complete (TLC control). Washing is carried out twice with saturated sodium chloride solution, followed by filtration over silica gel and concentration by evaporation, giving 21 g of crude product of the formula 51a. This is dissolved in 100 ml of methanol and admixed with 5 ml of 1 M sodium methanolate/methanol solution. After 30 minutes, the reaction solution is neutralized with 10 ml of 0.5 M HCL/methanol solution and concentrated by evaporation. The residue is purified by means of flash chromatography. Yield 14 g (92%) of the compound of the formula 52a as colorless solid. TLC (methylene chloride/methanol/conc. ammonia 30/5/1). R_f = 0.65. $C_{38}H_{51}N_3O_9S$ (725.91). MS $(M + H)^+$ = 726.38.

Example 5 and 6



53a



23a

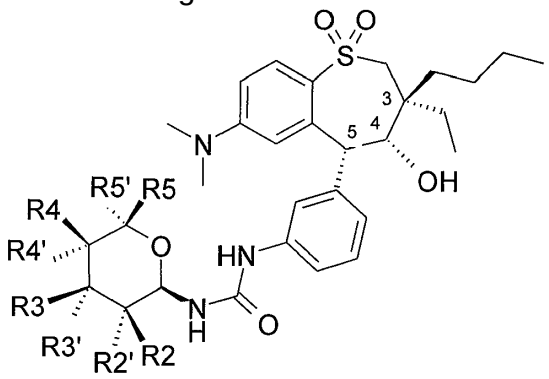
10.0 g (13.8 mmol) of example 52a are dissolved in 100 ml of pyridine and, after adding 3.5 g of pyridine-sulfur trioxide complex, the mixture is stirred for 30 minutes at 60°C. After adding 100 ml of methanol, the mixture is concentrated by evaporation on a rotary evaporator. The residue is evaporated again with 100 ml of methanol and then purified using flash chromatography. Yield 7 g (64%) of the compound of the formula 53a as ammonium salt. TLC (methylene chloride/methanol/conc. ammonia 30/5/1). R_f = 0.35. $C_{38}H_{51}N_3O_{12}S_2 \times NH_3$ (823.00). MS $(M + H)^+$ = 804.21.

As by-product, 0.8 g (7%) of the disulfate of the formula 23a is obtained as double ammonium salt. TLC (methylene chloride/methanol/conc. ammonia 30/5/1). R_f = 0.1. $C_{38}H_{51}N_3O_{15}S_3 \times 2NH_3$ (920.09). MS $(M + H)^+$ = 886.45.

This disulfate can also be obtained as main product if twice the amount of sulfur trioxide complex is used.

Patentkrav

1. Fremgangsmåte for fremstilling av forbindelsen med formel I



I

der

R2, R2', R3, R3', R4, R4', R5, R5', uavhengig av hverandre er H, Cl, Br, I, OH, -(CH_2)-OH, CF_3, NO_2, N_3, CN, S(O)$_p$-R6, O-S(O)$_p$-R6, (C_1-C_6)-alkylen-S(O)$_p$-R6, (C_1-C_6)-alkylen-O-S(O)$_p$-R6, COOH, COO(C_1-C_6)alkyl, $CONH_2$, CONH(C_1-C_6)alkyl, CON[(C_1-C_6)alkyl]$_2$, (C_1-C_6)-alkyl, (C_2-C_6)-alkenyl, (C_2-C_6)-alkynyl, O-(C_1-C_6)-alkyl, der, i alkylradikalene, ett eller flere hydrogen(er) kan erstattes av fluor;
fenyl, -(CH_2)-fenyl, -(CH_2)$_n$-fenyl, O-fenyl, O-(CH_2)$_m$-fenyl, -(CH_2)-O-(CH_2)$_m$-fenyl, der fenylringen kan være mono- til trisubstituert med F, Cl, Br, I, OH, CF_3, NO_2, CN, OCF_3, O-(C_1-C_6)-alkyl, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$, SO_2-CH_3, COOH, COO-(C_1-C_6)-alkyl, $CONH_2$;

der alltid minst ett av radikalene R2, R2', R3, R3', R4, R4', R5, R5' har betydningen -O-(CH_2)$_m$-fenyl eller -(CH_2)-O-(CH_2)$_m$-fenyl, der fenylringen kan være mono- til trisubstituert med F, Cl, Br, I, OH, CF_3, NO_2, CN, OCF_3, O-(C_1-C_6)-alkyl, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$, SO_2-CH_3, COOH, COO-(C_1-C_6)-alkyl, $CONH_2$;

R6 er H, OH, (C_1-C_6)-alkyl, NH_2, NH(C_1-C_6)-alkyl, N((C_1-C_6)-alkyl)$_2$;

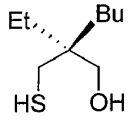
n er 2, 3, 4, 5, 6;

m er 1, 2, 3, 4, 5, 6;

p er 0, 1, 2;

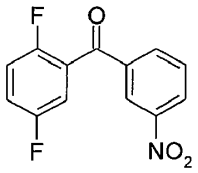
som omfatter

G) å omsette forbindelsen med formel 5



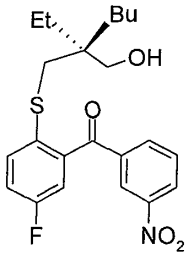
5

med en forbindelse med formel 8



8

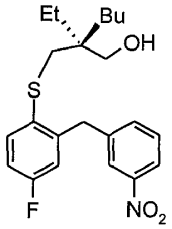
for å gi forbindelsen med formel 10



10

og deretter i et ytterligere prosesstrinn

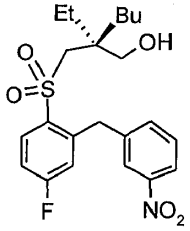
H) å omsette forbindelsen med formel 10 i nærvær av BF_3 og Et_3SiH for å gi en forbindelse med formel 11



11

og deretter i et ytterligere prosesstrinn

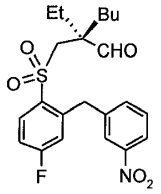
I) å omsette forbindelsen med formel 11 i nærvær av H_2O_2 for å gi forbindelse 12



12

og deretter i et ytterligere prosesstrinn

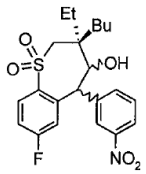
J) å omsette forbindelsen med formel 12 i nærvær av TEMPO (2,2,6,6-tetrametylpiperidinyloksyl) for å gi forbindelse 13



13

og deretter i et ytterligere prosesstrinn

K) å omsette forbindelsen med formel 13 i nærvær av tBuOK i THF for å gi forbindelse 15/15A



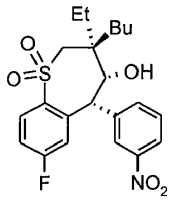
15/15A

2-diastereoisomerer

50:50

og deretter i et ytterligere prosesstrinn

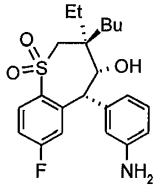
L) å isolere forbindelsen med formel 15



15

og deretter i et ytterligere prosesstrinn

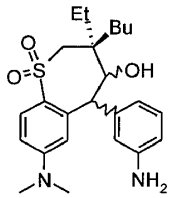
M) å omsette forbindelsen med formel 15 ved hjelp av H_2/Pd-C for å gi en forbindelse med formel 16



16

og deretter i et ytterligere prosesstrinn

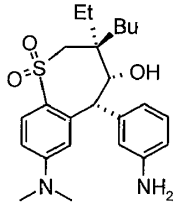
N) å omsette forbindelsen med formel 16 i nærvær av $HNMe_2$ for å gi en forbindelse med formel 17/17A



17/17A

og deretter i et ytterligere prosesstrinn

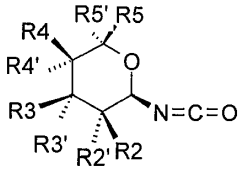
O) å isolere forbindelsen med formel 17



17

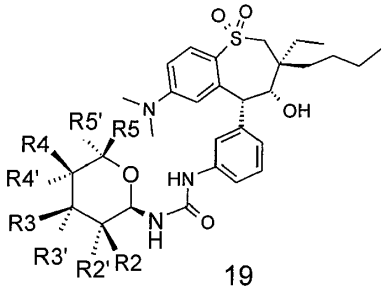
og deretter i et ytterligere prosesstrinn

P) å omsette forbindelsen 17 med forbindelsen 18, der radikalene har de ovenfor angitte betydningene



18

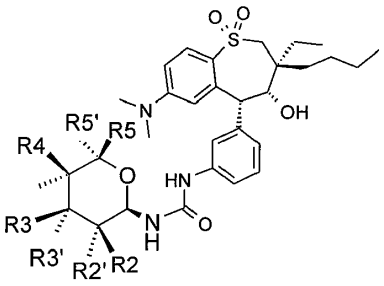
for å gi en forbindelse med formel 19



19

og deretter eventuelt i et ytterligere prosesstrinn

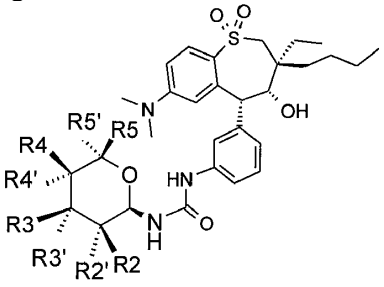
Q) å omsette forbindelsen med formel 19, der radikalene har de ovenfor angitte betydningene, for å gi en forbindelse med formel 20, der radikalene har de ovenfor angitte betydningene,



20

der eventuelle beskyttende grupper til stede spaltes bort, og deretter eventuelt i et ytterligere prosesstrinn

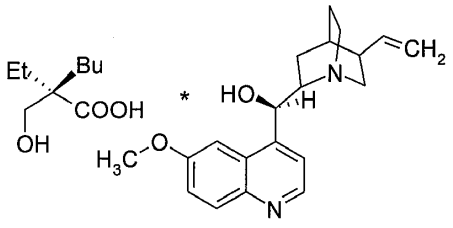
R) å omsette forbindelsen med formel 20, der radikalene har de ovenfor angitte betydningene, for å gi en forbindelse med formel Ia, der radikalene har de ovenfor angitte betydningene,



Ia

som et resultat av hvilke kan substituentene R2, R2', R3, R3', R4, R4', R5, R5' fra formel 20 utveksles.

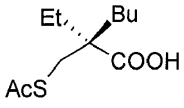
2. Forbindelse med formel 2a



2a

.

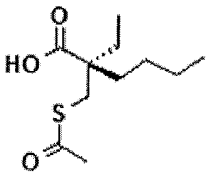
3. Forbindelse med formel 4



4

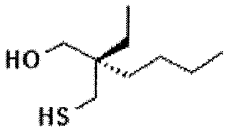
.

4. Forbindelse med formel 4a



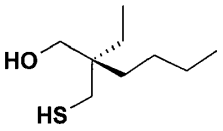
4a

5. Forbindelse med formel 5



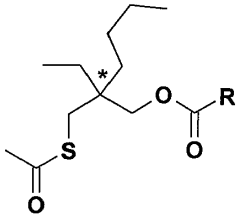
5

6. Forbindelse med formel 5a



5a

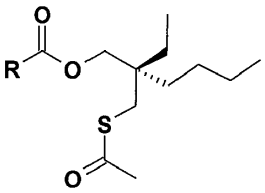
7. Racemat av forbindelsene med formel 35/35a



35/35a

der
R er (C_1-C_6)-alkyl.

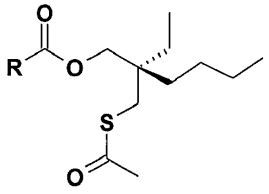
8. Forbindelse med formel 35



35

der
R er (C_1-C_6)-alkyl.

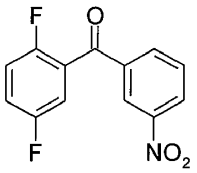
9. Forbindelse med formel 35a



35a

der
R er (C_1-C_6)-alkyl.

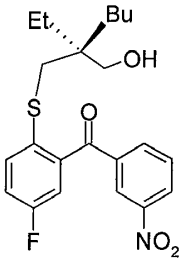
10. Forbindelse med formel 8



8

.

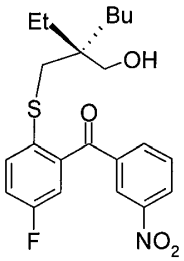
11. Forbindelse med formel 10



10

.

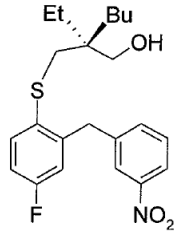
12. Forbindelse med formel 10a



10a

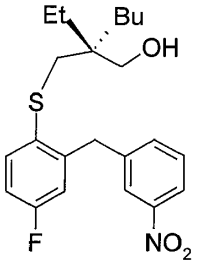
.

13. Forbindelse med formel 11



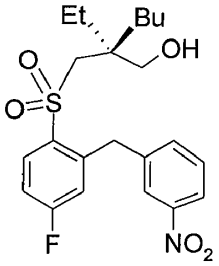
11

14. Forbindelse med formel 11a



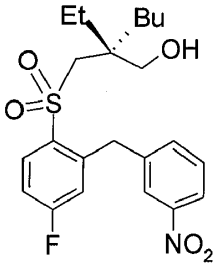
11a

15. Forbindelse med formel 12



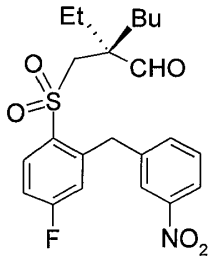
12

16. Forbindelse med formel 12a



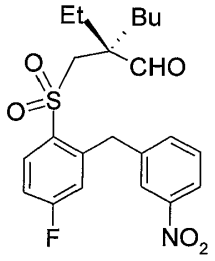
12a

17. Forbindelse med formel 13



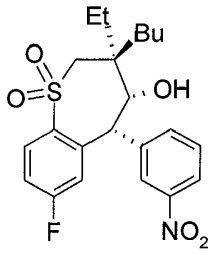
13

18. Forbindelse med formel 13a



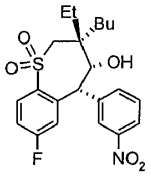
13a

19. Forbindelse med formel 15



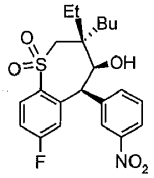
15

20. Forbindelse med formel 15B



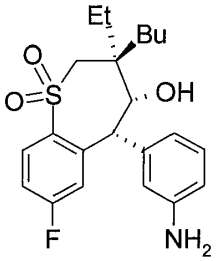
15B

21. Forbindelse med formel 15C



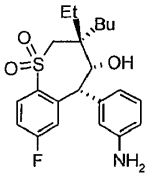
15C

22. Forbindelse med formel 16



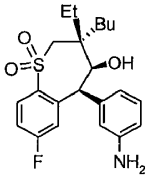
16

23. Forbindelse med formel 16B



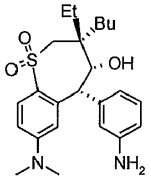
16B

24. Forbindelse med formel 16C



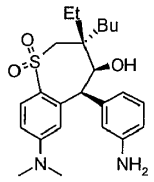
16C

25. Forbindelse med formel 17B



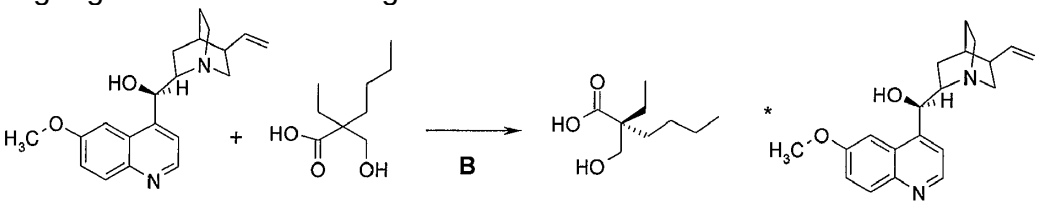
17B

26. Forbindelse med formel 17C



17C

27. Fremgangsmåte for fremstilling av forbindelsen med formel 2a

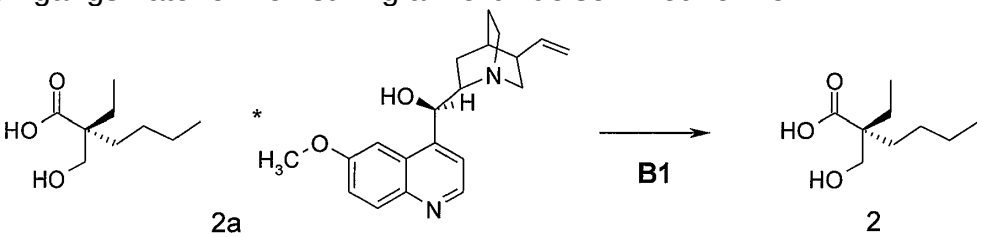


X1 1 2a

som omfatter å fremstille forbindelsen fra forbindelsen med formel X1 og forbindelsen med formel 1 og deretter, om hensiktsmessig, å omkrystallisere forbindelsen i et egnet løsningsmiddel eller løsningsmiddelblanding, som for eksempel toluen, n-butylacetat/heptan eller aceton/vann.

28. Fremgangsmåten for fremstilling av forbindelsen med formel 2a ifølge krav 27, hvori løsningsmidlet eller løsningsmiddelblandingen anvendt for omkrystalliseringen er toluen, n-butylacetat/heptan eller aceton/vann.

29. Fremgangsmåte for fremstilling av forbindelsen med formel 2

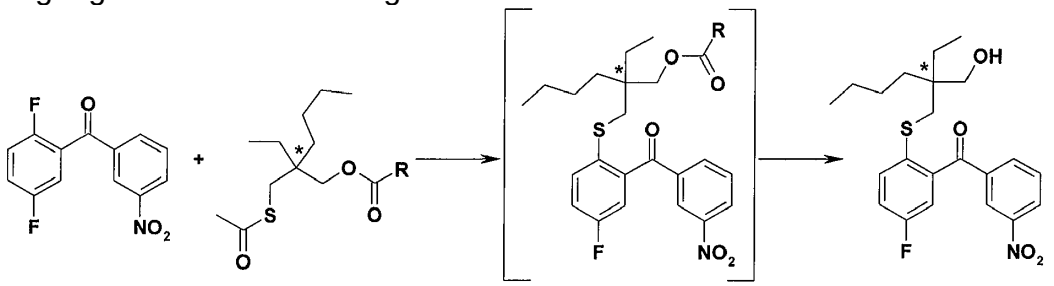


2a 2

som omfatter å dem fra forbindelsen med formel 2a ved vandig opparbeidelse og ekstraksjon med et egnet løsningsmiddel.

30. Fremgangsmåten for fremstilling av forbindelsen med formel 2 ifølge krav 29, hvori det hensiktsmessige løsningsmidlet er toluen, etylacetat eller diklormetan.

31. Fremgangsmåte for fremstilling av forbindelsen med formel 10

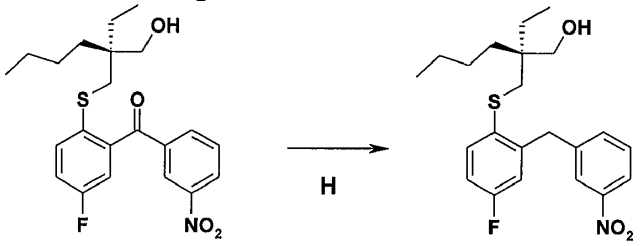


8 35 30 10

der R i forbindelsene med formel 35 og 30 har betydningen (C_1-C_6)-alkyl, som omfatter, i et første trinn,
å omsette forbindelsen med formel 8 med forbindelsen med formel 35a i nærvær av en vandig base og deretter, i et andre trinn,
fullstendig å omdanne den resulterende blandingen som består av forbindelsen med formel 30 og forbindelsen med formel 10 til forbindelsen med formel 10 ved alkalisk hydrolyse.

32. Fremgangsmåten for fremstilling av forbindelsen med formel 10 ifølge krav 31, hvori den vandige basen som anvendes er natriumkarbonat, kaliumkarbonat eller cesiumkarbonat.

33. Fremgangsmåte for fremstilling av forbindelsen med formel 11

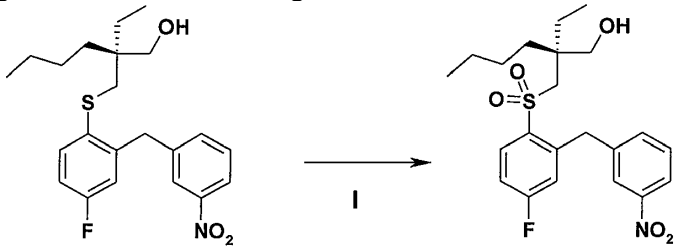


10 11

som omfatter å omsette forbindelsen med formel 10 med et egnet reduksjonsmiddel for å gi forbindelsen med formel 11.

34. Fremgangsmåten for fremstilling av forbindelsen med formel 11 ifølge krav 33, hvori hydrofosforsyre/jod, natriumborhydrid/aluminium(III)-klorid, trietylsilan/trifluoreddiksyre, isobutylaluminiumdiklorid, butylsilan/bortrifluorid, polyhydroksymetylsilan (PHMS) eller trietylsilan/bortrifluorid anvendes som et egnet reduksjonsmiddel.

35. Fremgangsmåte for fremstilling av forbindelsen med formel 12



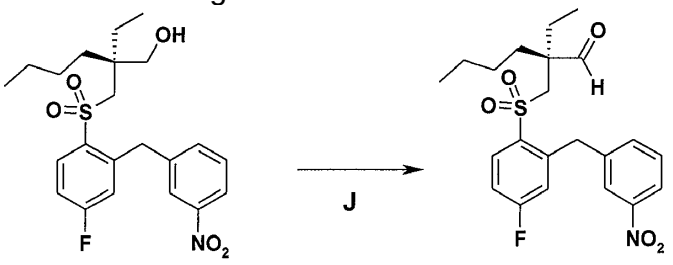
11 12

som omfatter å omsette forbindelsen med formel 11 med et egnet oksidasjonsmiddel

for å gi forbindelsen med formel 12.

36. Fremgangsmåten for fremstilling av forbindelsen med formel 12 ifølge krav 35, hvori natriumperborat, hydrogenperoksid/natriumwolframid, hydrogenperoksid/molybden(IV)-oksiddiklorid, oksoner eller hydrogenperoksid/acetonitril/etanol anvendes som egnet oksidasjonsmiddel.

37. Fremgangsmåten for fremstilling av forbindelsen med formel 13

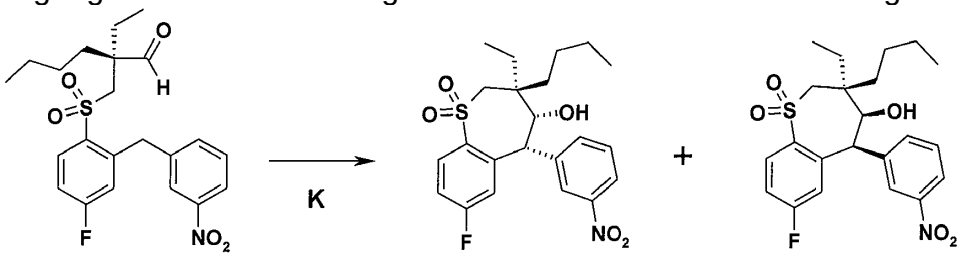


12 13

dom omfatter å omsette forbindelsen med formel 12 med et egnet oksidasjonsmiddel for å gi forbindelsen med formel 12.

38. Fremgangsmåten for fremstilling av forbindelsen med formel 13 ifølge krav 37, hvori oksaylklorid/DMSO, svoveltrioksid-pyridinkompleks/DMSO, pyridiniumdikromat, periodan eller natriumhypoklorid/TEMPO anvendes som oksidasjonsmiddel.

39. Fremgangsmåte for fremstilling av forbindelsene med formel 15 og 15A

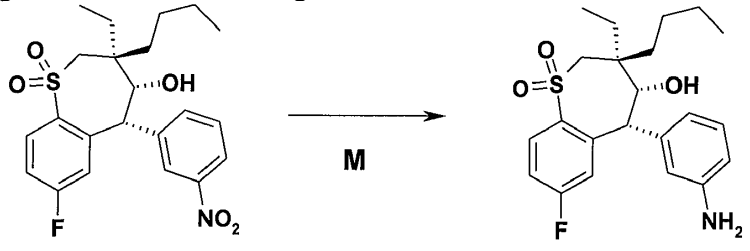


13 15 15A

som omfatter å omsette forbindelsen med formel 13 med en egnet base for å gi forbindelsene med formel 15 og 15A.

40. Fremgangsmåten for fremstilling av forbindelsene med formel 15 og 15A ifølge krav 39, hvori natriumkarbonat, kaliumkarbonat, cesiumkarbonat, natriummetylat, kaliummetylat, natriumetylat, kaliumetylat, natrium-tert-butylat eller kalium-tert-butylat anvendes som egnet base.

41. Fremgangsmåte for fremstilling av forbindelsen med formel 16



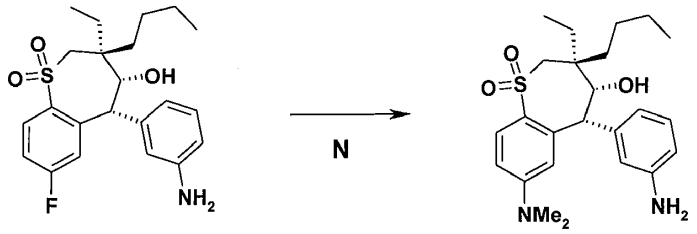
15 16

som omfatter å omsette forbindelsen med formel 15 med et egnet reduksjonsmiddel

for å gi forbindelsen med formel 16.

42. Fremgangsmåten for fremstilling av forbindelsen med formel 16 ifølge krav 41, hvori hydrogen/palladium på aktivert karbon anvendes som egnet reduksjonsmiddel.

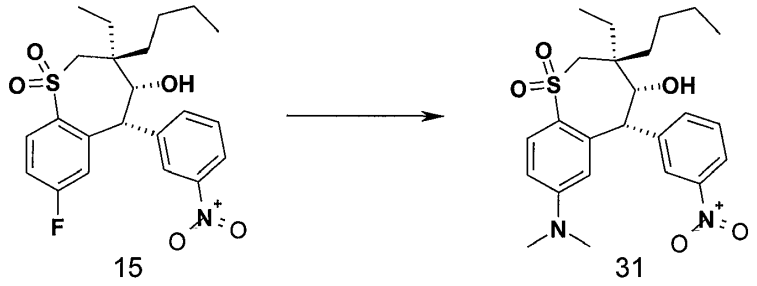
43. Fremgangsmåte for fremstilling av forbindelsen med formel 17



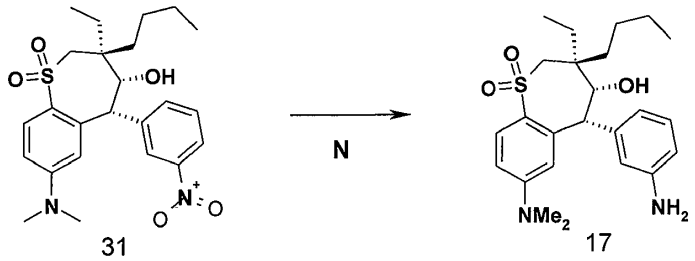
16 17

som omfatter å omsette forbindelsen med formel 16 med dimetylamin for å gi forbindelsen med formel 17.

44. Fremgangsmåte for fremstilling av forbindelsen med formel 17



15 31



31 17

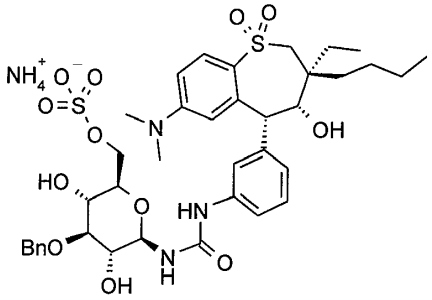
som omfatter å omsette forbindelsen med formel 15 i et første trinn med dimetylamin for å gi forbindelsen med formel 31 og deretter omsette den resulterende forbindelsen 31 i et ytterligere trinn med hydrogen/palladium på aktivert karbon for å gi forbindelsen med formel 17.

45. Fremgangsmåten for fremstilling av forbindelsen med formel I ifølge krav 1, hvori R2, R2' R3, R3', R4, R4', R5, R5', uavhengig av hverandre er H, OH, -(CH_2)-OH, (C_1-C_6)-alkylen-S(O)$_p$-R6, (C_1-C_6)-alkylen-O-S(O)$_p$-R6, -O-$(CH_2)_m$-fenyl, -(CH_2)-O-$(CH_2)_m$-fenyl,
der alltid minst ett av radikalene R2, R2', R3, R3', R4, R4', R5, R5' har betydningen -O-$(CH_2)_m$-fenyl eller -(CH_2)-O-$(CH_2)_m$-fenyl;
R6 er H, OH;
n er 2, 3, 4, 5, 6;
m er 1, 2, 3, 4, 5, 6;

p er 0, 1, 2.

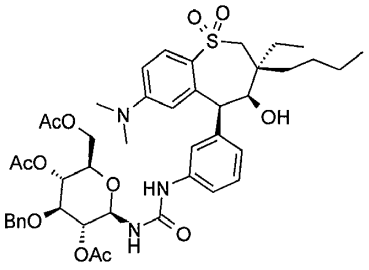
46. Fremgangsmåten for fremstilling av forbindelsen med formel I ifølge krav 1 eller 45, hvori
R2 er H;
R2' er OH;
R3 er -O-CH_2-fenyl;
R3' er H;
R4 er H;
R4' er OH;
R5 er -SO_3H, -$SO_3^-NH_4^+$,
R5' er H;

47. Fremgangsmåte for fremstilling av forbindelsen med formel I ifølge krav 1, 45 eller 46, hvori forbindelsen med formel I har strukturen 53.

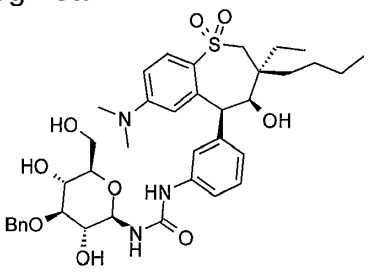


53

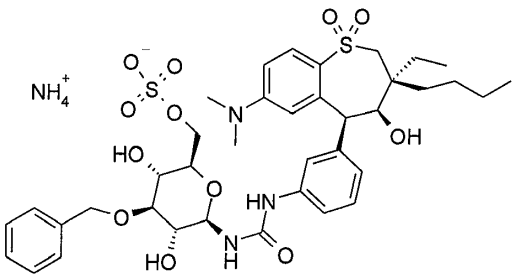
48. Forbindelsen med formel 51a, 52a, 53a og 23a



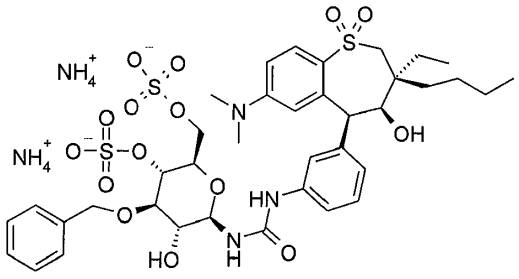
51a



52a



53a



23a