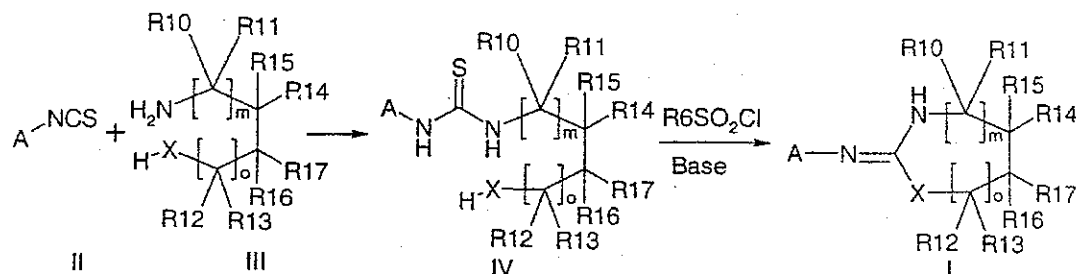


## Method for synthesising heterocyclic compounds

The invention provides the process illustrated in scheme 1 for synthesizing the heterocyclic compounds of the formula I.

5



Scheme 1

- 10 In the process, the isothiocyanate of the formula II is initially reacted with the primary amine of the formula III to give the thiourea of the formula IV. Subsequently, the thiourea of the formula IV is converted to the heterocycle of the formula I using a base and a sulfonyl chloride.
- 15 The construction of basic heterocyclic structures is one of the most important synthetic steps in organic chemistry. The resulting heterocyclic compounds are of great significance, inter alia, as intermediates in the synthesis of active pharmaceutical ingredients and active crop protection ingredients or else directly as such active ingredients. In addition, the rapid
- 20 synthesis, which is particularly important in the preparation of screening substances, of analogs which are sometimes quite diverse in structural terms places high demands on synthesis planning. Central building blocks which allow direct access to a multitude of diverse heterocycles under similar or ideally identical reaction conditions are therefore particularly
- 25 valuable and of great significance, in particular for robot-assisted syntheses.

30 The synthesis of heterocycles starting from thioureas has been known for some time. However, the methods have limitations in the substrate selection or disadvantages in reaction control, workup, by-product removal or in the cost of reagents. For instance, 1-(2-hydroxyethyl)-3-arylthioureas can be cyclized by heavy metal derivatives such as mercury(II) oxide or

lead oxide to give oxazolidin-2-ylidenarylamines (Jen, et al., J. Med. Chem. 1975 (18), 90). Acid catalysis of the same reactants affords the corresponding arylthiazolidin-2-ylidenamines (Jen, et al., J. Med. Chem. 1975 (18), 90). However, the use of heavy metals is disadvantageous, since they are unwanted in the product, even only in traces. The acid-catalyzed conversion to the thiazolidine again proceeds satisfactorily only at elevated temperature and in the presence of high acid concentrations. These drastic conditions are not tolerated by some functionalities such as esters, nitriles or ketals.

Syntheses starting from 1-(2-aminoethyl)-3-arylthioureas to imidazolidin-2-ylidenaryl derivatives succeed in the presence of methyl iodide (Synthesis 1974, 41-42) or carbodiimide derivatives (Synthesis 1977, 864). A disadvantage in the case of methyl iodide is the competing reaction which occurs on other nucleophilic centers in the molecule and its danger potential in the event of unintentional release. In the case of carbodiimide derivatives, the removal of the ureas formed is frequently problematic and time-consuming. More recent carbodiimide derivatives such as EDC (N'-(3-dimethylaminopropyl)-N-ethylcarbodiimide hydrochloride) or solid phase-bound DCC (dicyclohexylcarbodiimide), used in a relatively large amount, are again very expensive.

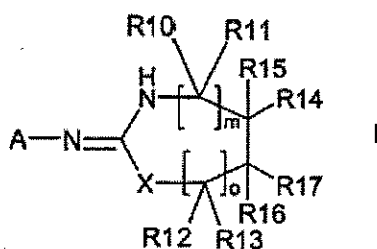
The synthesis method of the present invention leads, starting from isothiocyanates and amino alcohols, amino mercaptans and diamines, via the thioureas formed as intermediates, to the desired heterocycles of variable ring size, by cyclizing the intermediate derivatives in the presence of sulfonyl chloride and of a base. These reagents are inexpensive, easy to handle and require no drastic reaction conditions, and their subsequent products are easy to remove by simple washings, so that this synthetic process is suitable, for example, for reactions on the gram and kilogram scale. However, it can also be employed for parallel and robot syntheses which are usually carried out on the milligram scale, especially owing to the simple reaction control. Of particular interest for these synthetic methods which are generally employed on a relatively small scale is the use of polymer-bound sulfonyl chloride, which enables the isolation of the reaction products by filtration and evaporation steps which are simple from an apparatus point of view.

In the literature, a similar process method is to be found quite specifically

for the reaction of phenyl or methyl isothiocyanates with 2-hydroxyethyl-amines to give oxazolidin- or thiazolidin-2-ylidenamines (Tetrahedron Letters 40 (1999), 8201; Tetrahedron 57 (2001), 7137; Bull. Korean Chem. Soc. 2002 (23), 19).

It has now been possible to show, surprisingly, that under these conditions, not only can five-membered rings such as oxazolidines or thiazolidines be formed, but also that ring size and degree of substitution are much more flexible and the synthesis method is not restricted to the use of 2-hydroxy-10 ethylamines. The restriction to thiourea intermediates which bear at least one aryl substituent on one of the thiourea nitrogens, results in the ring closure proceeding very selectively and affording, with the loss of the thiourea sulfur, generally only one cyclization product.

In a first aspect, there is provided a process for preparing heterocycles of the formula I



where:

X is NR<sub>5</sub>

where R<sub>5</sub> is hydrogen or (C<sub>1</sub>-C<sub>4</sub>)alkyl;

m and o

are each independently zero, 1 or 2;

A is phenyl, naphthyl or heteroaryl, all of which may be substituted by 1, 2, 3, 4 or 5 R<sub>11</sub> radicals

where R<sub>11</sub> is in each case independently selected from the group of (C<sub>1</sub>-C<sub>4</sub>)alkyl, F, Cl, Br, I, CN, NO<sub>2</sub> OH, O(C<sub>1</sub>-C<sub>4</sub>)alkyl, COO(C<sub>1</sub>-C<sub>4</sub>)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms

or

(C1-C4)alkyl, (C2-C5)alkenyl, (C2-C5)alkynyl, (C3-C8)cycloalkyl,  
(C4-C8)cycloalkenyl

5 where these radicals may each independently be substituted by (C1-C4)alkyl or (C3-C6)cycloalkyl, and some or all of the hydrogen atoms of the alkyl, alkenyl, alkynyl, cycloalkyl and cycloalkenyl radicals may be replaced by fluorine atoms,

R14, R15, R16 and R17

are each independently hydrogen, F or (C1-C4)alkyl,  
10 where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

or

R14 and R16

15 together are a bond, and

R15 and R17

with the two carbon atoms to which they are bonded are an aromatic six-membered carbocycle in which one or two carbon atoms may be replaced by nitrogen, or a thiophene ring,

20 where the aromatic six-membered carbocycle and the thiophene ring may be substituted by 1, 2, 3 or 4 R7 radicals, where R7 is in each case independently selected from the group of (C1-C4)alkyl, F, Cl, Br, I, CN, NO<sub>2</sub>, OH, O(C1-C4)-alkyl and COO(C1-C4)alkyl, and some or all of the hydrogen  
25 atoms of the alkyl radicals may be replaced by fluorine atoms;

or

R14 and R16

are each independently hydrogen or (C1-C4)alkyl,  
30 where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

and

R15 and R17

with the two carbon atoms to which they are bonded are a saturated 5-, 6-, 7- or 8-membered carbocycle in which one or two carbon  
35 atoms may each independently be replaced by O, S, NH and N(C1-C4)alkyl and may be substituted by 1, 2, 3, 4, 5 or 6 R8 radicals

where R8 is in each case independently selected from the group of (C1-C4)alkyl, O(C1-C4)alkyl, COO(C1-C4)alkyl, and

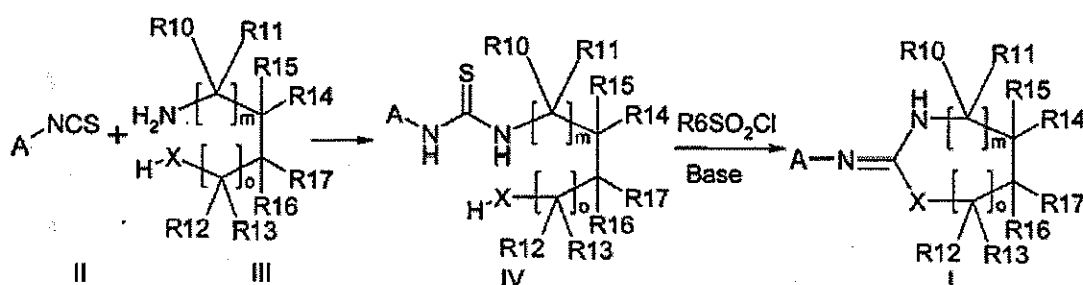
some or all of the hydrogen atoms of the alky radicals may be replaced by fluorine atoms;

R10, R11, R12 and R13

are each independently hydrogen, F or (C1-C4)alkyl,

where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

where either A or the ring formed from R15 and R17 together, where m is zero, is an aromatic ring system, or both are aromatic ring systems;



a) reacting an isothiocyanate of the formula II with a primary amine of the formula III to give a thiourea of the formula IV, and

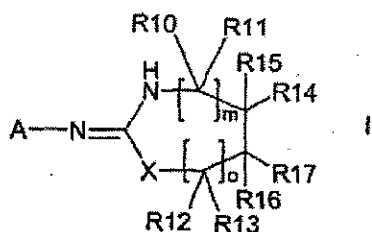
b) converting the thiourea of the formula IV using a sulfonyl chloride R6SO<sub>2</sub>Cl in the presence of a base to the compound of the formula I,

where, in the compounds of the formulae II, III and IV,

A, X, n, m and R10 to R17 are each as defined in formula I and

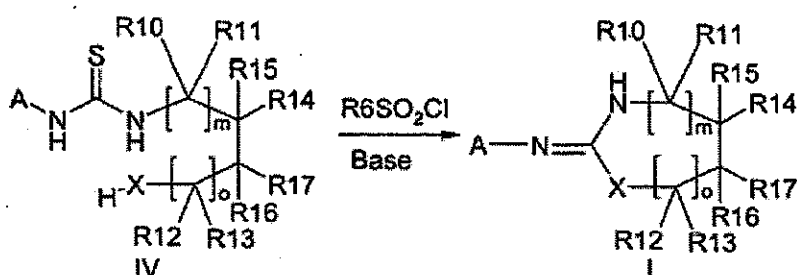
R6 is (C1-C4)alkyl, trifluoromethyl or phenyl which is unsubstituted or substituted by methyl, trifluoromethyl, F, Cl, Br or a polymeric support.

In a second aspect, there is provided a process for preparing a compound of the formula I as defined above

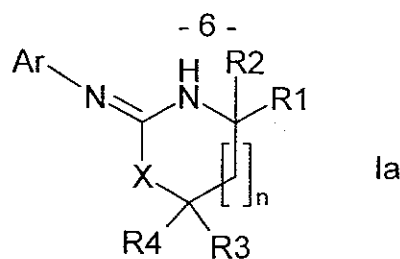


which comprises

converting a thiourea of the formula IV using a sulfonyl chloride  $R_6SO_2Cl$  in the presence of a base to the compound of the formula I



A further embodiment disclosed herein relates to a process for preparing heterocycles of the formula Ia,



where:

X is sulfur, oxygen or NR<sub>5</sub>,

5 where R<sub>5</sub> is hydrogen or (C1-C4)alkyl;

n is zero, 1, 2 or 3;

Ar is phenyl, naphthyl or heteroaryl which may be substituted by 1, 2, 3, 4 or 5 R<sub>11</sub> radicals

10 where R<sub>11</sub> is in each case independently selected from the group of (C1-C4)alkyl, F, Cl, Br, I, CN, NO<sub>2</sub>, OH, O(C1-C4)-alkyl, COO(C1-C4)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub>

15 are each independently hydrogen, F or (C1-C4)alkyl where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

or

R<sub>1</sub> and R<sub>3</sub>

20 together are a bond, and

R<sub>2</sub> and R<sub>4</sub>

25 with the two carbon atoms to which they are bonded are an aromatic six-membered carbocycle in which one or two carbon atoms may be replaced by nitrogen and the aromatic six-membered ring may be substituted by 1, 2, 3 or 4 R<sub>7</sub> radicals;

where R<sub>7</sub> is in each case independently selected from the group of (C1-C4)alkyl, F, Cl, Br, I, CN, NO<sub>2</sub>, OH, O(C1-C4)-alkyl, COO(C1-C4)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms,

30 where n = 0;

or

R<sub>1</sub> and R<sub>3</sub>

are each independently hydrogen or (C1-C4)alkyl

and

35 R<sub>2</sub> and R<sub>4</sub>

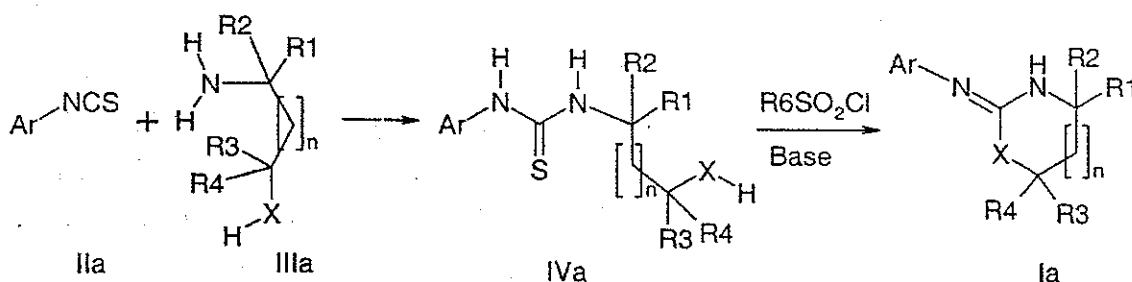
with the two carbon atoms to which they are bonded are a saturated 5-, 6-, 7- or 8-membered carbocycle in which one or two carbon atoms may be replaced by O, S, NH and N(C1-C4)alkyl and may be substituted by 1, 2, 3, 4, 5 or 6 R<sub>8</sub> radicals

5 where R<sub>8</sub> is in each case independently selected from the group of (C1-C4)alkyl, O(C1-C4)alkyl, COO(C1-C4)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms,

where n = 0;

10 excluding compounds in which Ar is unsubstituted phenyl, X is oxygen or sulfur, R<sub>1</sub> and R<sub>2</sub> are each independently hydrogen, (C1-C4)alkyl or benzyl, R<sub>3</sub> and R<sub>4</sub> are each hydrogen and n is zero, and their tautomers and their salts, which comprises, as shown in scheme 2

15



Scheme 2

- 20 a) reacting an aromatic isothiocyanate of the formula IIa with a primary amine of the formula IIIa to give thiourea of the formula IVa, and  
 b) converting the thiourea of the formula IVa using a sulfonyl chloride R<sub>6</sub>SO<sub>2</sub>Cl in the presence of a base to the compound of the formula Ia, where, in the compounds of the formulae IIa, IIIa and IVa,  
 25 Ar, X, n and R<sub>1</sub> to R<sub>4</sub> are each as defined in formula Ia and  
 R<sub>6</sub> is phenyl which is unsubstituted or substituted by methyl, trifluoromethyl, F, Cl or Br.

30 The compounds of the formula Ia are encompassed by the compounds of the formula 1; similarly the compounds of the formulae IIa, IIIa, and IVa are encompassed by the compounds of the formulae II, III, and IV.

Process step a) may be effected continuously or batchwise. The reaction of the isothiocyanate of the formula II with the primary amine of the formula III

may be carried out in the presence of a solvent or diluent, or without the addition of a solvent. Preference is given to carrying it out in the presence of a solvent. It is possible to use various solvents, for example aliphatic or aromatic hydrocarbons, chlorinated hydrocarbons, for example methylene chloride, esters, for example ethyl acetate, alcohols or ethers. Preference is given to using ethers as the solvent, for example tetrahydrofuran, dioxane or ethylene glycol ethers such as ethylene glycol dimethyl ether, especially when the overall reaction is carried out as a one-pot reaction. It is also possible to use mixtures of two or more solvents. The temperature for the reaction in process step a) is preferably from 0°C to the boiling point of the solvent used, more preferably from 20°C to 60°C, for example about room temperature. The isothiocyanate of the formula II and the primary amine of the formula III are used, for example, in a molar ratio of from 1 : 1.1 to 1 : 0.9, preferably in about equimolar amounts. However, it is also possible to use an excess of the amine of the formula III, for example when X is NR<sub>5</sub>, in order to prevent side reactions.

Process step b) may be effected continuously or batchwise. In general, the conversion of the thiourea of the formula IV to the compound of the formula I may be carried out in the presence of a solvent or diluent. It is possible to use various solvents, for example esters or ethers, preferably ethers, for example tetrahydrofuran, dioxane or ethylene glycol ethers such as ethylene glycol dimethyl ether. The solvent used may also, for example, be water. It is also possible to use mixtures of two or more solvents, for example mixtures of water and one or more organic solvents, for example mixtures of water and one of the ethers mentioned. The reaction may proceed as a monophasic reaction or as a biphasic reaction. The temperature for the reaction in process step b) is preferably from 0°C to 35°C, more preferably about room temperature. The thiourea of the formula IV and the sulfonyl chloride R<sub>6</sub>SO<sub>2</sub>Cl are used, for example, in a molar ratio of from 1 : 1.4 to 1 : 0.9, preferably in a ratio of from 1 : 1 to 1 : 1.2, for example in the ratio of about 1 : 1.1. When polymer-bound sulfonyl chloride is used, the ratio may be from 1:1 to 1:4, preferably from 1:1.5 to 2.5. The molar ratio of the thiourea of the formula IV to the base in process step b) is, for example, from 1 : 4 to 1 : 1, preferably in a ratio of from 1 : 3 to 1 : 2, for example in the ratio of about 1 : 2.5. The base used in process step b) may be various inorganic or organic compounds, for example basic alkali metal compounds or alkaline earth metal compounds, in particular the metal hydroxides, or amines or ammonium hydroxides. Preference is given

to using basic sodium compounds or potassium compounds as the base, for example sodium hydroxide, potassium hydroxide, sodium carbonate or potassium carbonate. It is advantageous to use an aqueous solution of sodium hydroxide or potassium hydroxide, for example having a hydroxide concentration of the solution of from 0.1 to 10 molar, preferably about 1 molar.

The reaction mixture may be worked up after each of the two process steps a) and b). However, the compounds of the formula I by the process according to the invention may also be synthesized in a one-pot reaction without isolating the thiourea of the formula IV formed in step a), and a workup carried out only after the completion of both process steps. The products are worked up and, if desired, purified by the customary methods such as extraction, filtration, pH separation, chromatography or crystallization and the customary dryings.

The starting compounds of the formulae II and III are commercially available or can be prepared according to, or in a similar manner to, processes which are described in the literature and familiar to those skilled in the art. The starting compounds may also contain functional groups in protected form or in the form of precursors, and these may then be converted to the desired groups in the compounds of the formula I prepared by the process according to the invention. Appropriate protecting group techniques are known to those skilled in the art. For example, in compounds of the formula III in which X is NR<sup>5</sup>, the NHR<sup>5</sup> group may be protected by an acetyl, trifluoroacetyl or trityl group and be deprotected before carrying out process step b).

X is preferably NR<sup>5</sup> or oxygen, more preferably NR<sup>5</sup>, most preferably NH.

The A radicals, when A is aromatic, and Ar are preferably phenyl or a monocyclic heteroaromatic, more preferably phenyl or a five-membered heteroaromatic, for example thiophene or isoxazole, and all of these radicals may be unsubstituted or substituted. Substituents on the aromatic A and Ar radicals are preferably each independently selected from the group of (C1-C4)alkyl, F, Cl, Br and O(C1-C4)alkyl, where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms. Particularly preferred substituents on the Ar and aromatic A radical are in each case independently methyl, Cl or Br.

When A is nonaromatic, it is preferably (C1-C4)alkyl, (C2-C5)alkenyl, (C3-C5)cycloalkyl, (C4-C8)cycloalkenyl, more preferably (C1-C4)alkyl or (C3-C5)cycloalkyl, and some or all of the hydrogen atoms of all radicals  
5 may be replaced by fluorine atoms. A substituent on the nonaromatic A radicals is preferably (C1-C4)alkyl.

n, m and o are preferably in each case independently zero or 1, more preferably zero.

10

R14, R15, R16 and R17 are preferably each independently hydrogen or methyl, more preferably hydrogen, or R14 and R16 together form a bond and R15 and R17 form an aromatic six-membered ring, preferably a  
15 benzene ring, or a thiophene ring, and the aromatic six-membered ring and the thiophene ring may be unsubstituted or substituted by 1, 2, 3 or 4 mutually independent R7 radicals, or R14 and R16 are each independently hydrogen or methyl, and R15 and R17 form a saturated 5- or 6-membered ring, preferably a cyclopentane or cyclohexane ring, and the ring may be substituted by a 1, 2, 3, 4, 5 or 6 mutually independent R8 radicals.

20

In compounds of the formulae I, III or IV, it is always the case that either A is aromatic or m is zero and R15 and R17 together with the two carbon atoms to which they are bonded form an aromatic six-membered carbocycle in which one or two carbon atoms may be replaced by nitrogen,  
25 or a thiophene ring, or both A and R15 and R17 together with the two carbon atoms to which they are bonded each form aromatic ring systems.

R1, R2, R3 and R4 are preferably each independently hydrogen or methyl, more preferably hydrogen, or R1 and R3 together form a bond and R2 and  
30 R4 form an aromatic six-membered ring, preferably a benzene ring, and the aromatic six-membered ring may be unsubstituted or substituted by 1, 2, 3 or 4 mutually independent R7 radicals, or R1 and R3 are each independently hydrogen or methyl and R2 and R4 are a saturated 5- or 6-membered ring, preferably a cyclopentane or cyclohexane ring, and the  
35 ring may be substituted by 1, 2, 3, 4, 5 or 6 mutually independent R8 radicals.

R5 is preferably hydrogen or methyl, more preferably hydrogen.

R7 is preferably in each case independently selected from the group of (C1-C4)alkyl, F, Cl, Br, OH or O(C1-C4)alkyl, where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms; the R7 substituents are more preferably each independently F, Cl, methyl, methoxy, CF<sub>3</sub> or OH.

R8 is preferably in each case independently selected from the group of (C1-C4)alkyl or O(C1-C4)alkyl, where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms.

R10, R11, R12 and R13 are preferably each independently hydrogen, methyl or ethyl, more preferably hydrogen.

The base is preferably an aqueous base, triethylamine or diisopropylethylamine, more preferably an aqueous metal hydroxide solution, in particular a sodium hydroxide or potassium hydroxide solution.

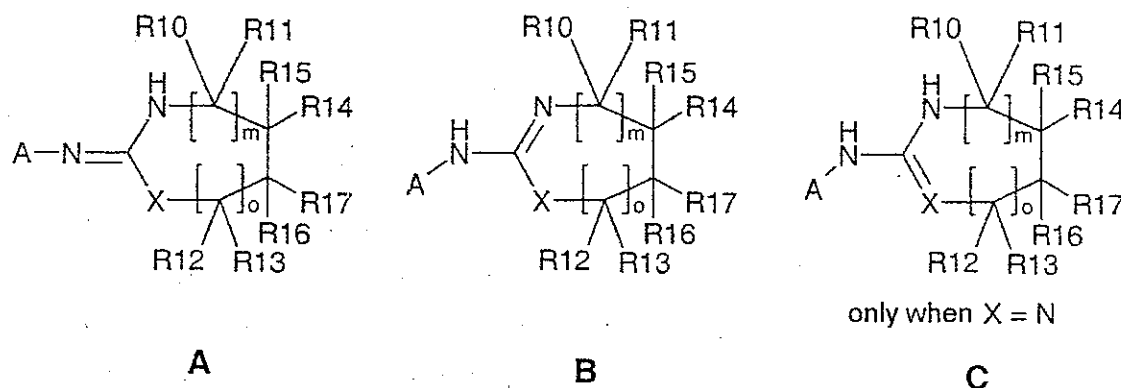
The sulfonyl chloride R<sub>6</sub>SO<sub>2</sub>Cl is an unsubstituted or substituted benzene- or alkylsulfonyl chloride where R<sub>6</sub> is preferably methyl, phenyl, p-tolyl or polymer-bound phenyl.

Polymer-bound sulfonyl chloride is generally an aromatic sulfonyl chloride, for example benzenesulfonyl chloride, which is substituted on the phenyl radical by a polymeric support, for example polystyrene, especially crosslinked polystyrene. For example, sulfonylchloride polystyrene from Novabiochem can be used. In this case, the benzenesulfonic acid is bound to copoly(styrene-1%DVB), 100-200 mesh.

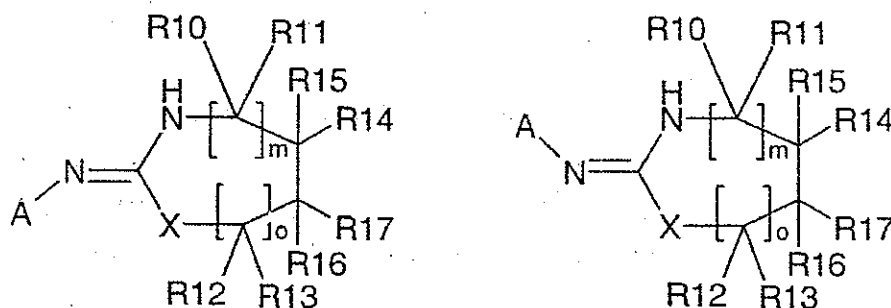
The compounds of the formula I may be isolated in the form of their salts. These are obtained by the customary methods by reacting with acids or bases. Useful acid addition salts include, for example, halides, in particular hydrochlorides or hydrobromides, lactates, sulfates, citrates, tartrates, acetates, phosphates, methylsulfonates, benzenesulfonates, p-toluene-sulfonates, adipates, fumarates, gluconates, glutamates, glycerol-phosphates, maleates, benzoates, oxalates and pamoates and trifluoroacetates; in the case of the preparation of active ingredients, preferably physiologically acceptable salts. When the compounds contain an acid group, they may form salts with bases, for example alkali metal salts, preferably sodium or potassium salts, or ammonium salts, for

example as salts with ammonia or organic amines or amino acids. They may also be present as a zwitterion.

- 5 The compounds of the formula I may also be present as tautomers or as a mixture of tautomeric structures, for example as the following tautomers:



- 10 When the compounds of the formula I are present in the tautomeric form A, they may be present as double bond isomers or as a mixture of double bond-isomeric structures.



- 15 When the compounds of the formula I contain one or more centers of asymmetry, these may each independently have either S or R configuration. The compounds may be present as optical isomers, as diastereomers, as cis/trans isomers, as racemates or as mixtures thereof in any ratios.

- 20 When m, n or o = 0, there is a direct bond between the two adjacent atoms in each case.

- 25 Alkyl radicals may be straight-chain or branched. This is also true when they bear substituents or occur as substituents of other radicals, for example in fluoroalkyl radicals or alkoxy radicals. Examples of alkyl radicals

are methyl, ethyl, n-propyl, isopropyl (= 1-methylethyl), n-butyl, isobutyl (= 2-methylpropyl), sec-butyl (= 1-methylpropyl) and tert-butyl (= 1,1-dimethylethyl). Preferred alkyl radicals are methyl, ethyl and isopropyl. In alkyl radicals, one or more, for example 1, 2, 3, 4, 5, 6, 7, 8 or 9, hydrogen atoms may be substituted by fluorine atoms. Examples of such fluoroalkyl radicals are trifluoromethyl, 2,2,2-trifluoroethyl, pentafluoroethyl, heptafluoroisopropyl. Substituted alkyl radicals may be substituted in any positions, for example by fluorine, by alkyl, for example methyl, ethyl, propyl, butyl, or by cycloalkyl, for example cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl.

Alkenyl radicals may be straight-chain or branched. This is also true when they bear substituents, for example in fluoroalkenyl radicals. The alkenyl radicals may be unsaturated and also polyunsaturated in different positions. Examples of alkenyl radicals are ethenyl, n-prop-1-enyl, n-prop-2-enyl, isoprop-1-enyl (= 1-methylethenyl), n-but-1-enyl, n-but-2-enyl, n-but-3-enyl, n-buta-1,3-dienyl, isobut-1-enyl (= 2-methylprop-1-enyl), isobut-2-enyl (= 2-methylprop-2-enyl), sec-but-1-enyl (= 1-methylprop-1-enyl) and pentenyl. Preferred alkenyl radicals are ethenyl, n-prop-1-enyl, n-prop-2-enyl, n-but-1-enyl, n-but-2-enyl, n-pentenyl, n-pentadienyl, isopentenyl, tert-pentenyl and neopentenyl. In alkenyl radicals, one or more, for example 1, 2, 3, 4, 5, 6, 7, 8 or 9, hydrogen atoms may be substituted by fluorine atoms. Substituted alkenyl radicals may be substituted in any positions, for example by fluorine, by alkyl, for example methyl, ethyl, propyl, butyl, or by cycloalkyl, for example cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl.

Alkynyl radicals may be straight-chain or branched. This is also true when they bear substituents, for example in fluoroalkynyl radicals. The alkynyl radicals may be unsaturated and also polyunsaturated in different positions. Examples of alkynyl radicals are ethynyl, n-prop-1-ynyl, n-prop-2-ynyl, n-but-1-ynyl, n-but-2-ynyl, n-but-3-ynyl, n-buta-1,3-diynyl, sec-but-2-ynyl (= 1-methylprop-2-ynyl), n-pentynyl, n-pentadiynyl, isopentynyl, tert-pentynyl and neopentynyl. Preferred alkynyl radicals are n-prop-1-ynyl, n-prop-2-ynyl, n-but-1-ynyl and n-but-2-ynyl. In alkynyl radicals, one or more, for example 1, 2, 3, 4, 5, 6 or 7, hydrogen atoms may be substituted by fluorine atoms. Substituted alkynyl radicals may be substituted in any positions, for example by fluorine, by alkyl, for example methyl, ethyl,

propyl, butyl, or by cycloalkyl, for example cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl.

5 Examples of cycloalkyl radicals are cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl or cyclooctyl. Preferred cycloalkyl radicals are cyclopropyl, cyclopentyl and cyclohexyl. In cycloalkyl radicals, one or more, for example 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15, hydrogen atoms may be substituted by fluorine atoms. Substituted cycloalkyl radicals may be substituted in any positions, for example by fluorine, by alkyl, for  
10 example methyl, ethyl, propyl, butyl, or by cycloalkyl, for example cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl.

The cycloalkenyl radicals may be unsaturated in different positions and also polyunsaturated. Examples of cycloalkenyl radicals are cyclobut-1-  
15 enyl, cyclobut-2-enyl, cyclopentenyl, cyclopentadienyl, cyclohexenyl, cyclohexadienyl, cycloheptenyl and cyclooctenyl. Preferred cycloalkylene radicals are cyclopentenyl, cyclopentadienyl, cyclohexenyl and cyclohexadienyl. In cycloalkenyl radicals, one or more, for example 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 or 13, hydrogen atoms may be substituted by  
20 fluorine atoms. Substituted cycloalkenyl radicals may be substituted in any positions, for example by fluorine, by alkyl, for example methyl, ethyl, propyl, butyl, or by cycloalkyl, for example cyclopropyl, cyclobutyl, cyclopentyl or cyclohexyl.

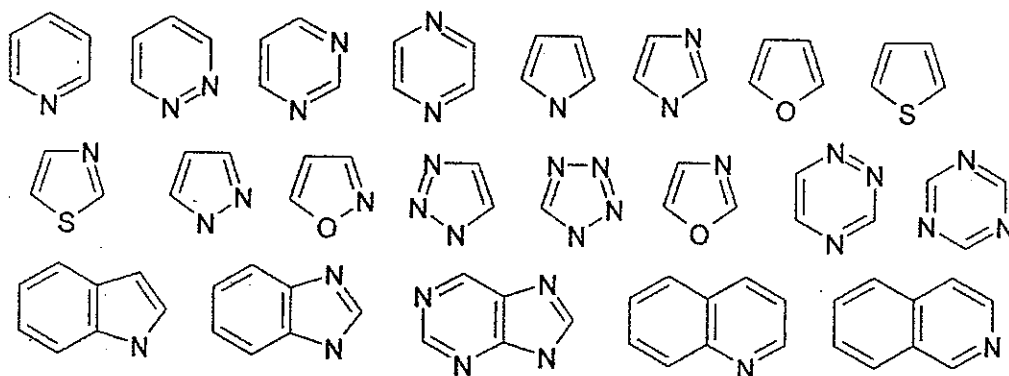
25 Aromatic ring systems are phenyl, naphthyl and heteroaryl radicals, and also aromatic six-membered carbocycles in which one or two carbon atoms may be replaced by nitrogen, or thiophene rings.

Phenyl radicals may be unsubstituted or mono- or polysubstituted, for  
30 example mono-, di-, tri-, tetra- or pentasubstituted, by identical or different radicals. When a phenyl radical is substituted, it preferably bears one or two identical or different substituents. In monosubstituted phenyl radicals, the substituent may be in the 2-position, the 3-position or the 4-position. Disubstituted phenyl may be substituted in the 2,3-position, 2,4-position, 2,5-position, 2,6-position, 3,4-position or 3,5-position. In trisubstituted  
35 phenyl radicals, the substituents may be in the 2,3,4-position, 2,3,5-position, 2,4,5-position, 2,4,6-position, 2,3,6-position or 3,4,5-position. Naphthyl radicals may be joined via all positions, for example via the 1-

position or 2-position. Naphthyl radicals may likewise be unsubstituted or mono- or polysubstituted, for example mono-, di-, tri-, tetra- or pentasubstituted, by identical or different radicals. Where a naphthyl radical is substituted, it preferably bears one or two identical or different substituents.

Heteroaryl radicals are aromatic ring compounds in which 1, 2, 3 or 4 ring atoms are oxygen atoms, sulfur atoms or nitrogen atoms, for example 1, 2 or 3 nitrogen atoms, 1 or 2 oxygen atoms, 1 or 2 sulfur atoms or a combination of different hetero atoms. The heteroaryl radicals may be mono- or bicyclic. The heteroaryl radicals may be bonded via all positions, for example via the 1-position, 2-position, 3-position, 4-position, 5-position, 6-position, 7-position or 8-position. Heteroaryl radicals may be unsubstituted or mono- or polysubstituted, for example mono-, di- or trisubstituted, by identical or different radicals.

Useful heteroaryl radicals include, for example:

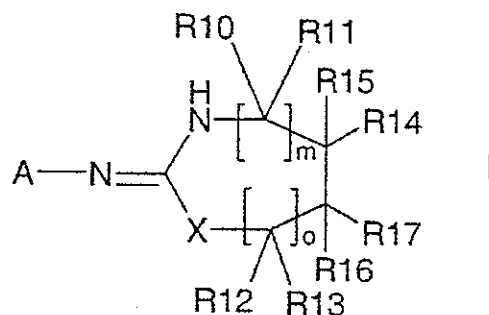


Preferred heteroaryl radicals are monocyclic aromatic ring compounds; particular preference is given to five-membered heteroaryl radicals, for example thiophene and isoxazole.

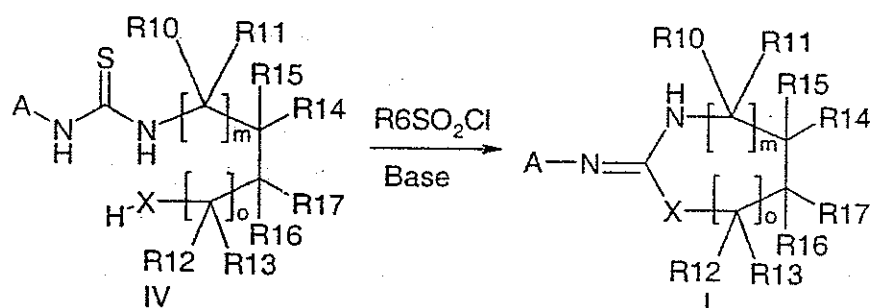
When groups, substituents or variables can be present more than once in the compounds of the formula I, Ia, II, IIa, III, IIIa, IV or IVa, they may all each independently be as defined above and may each be identical or different.

The present invention further provides a process for preparing a compound of the formula I

- 16 -



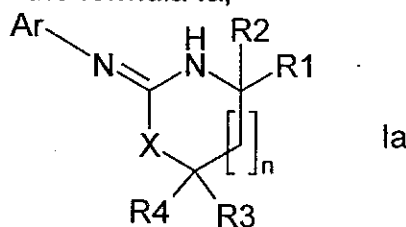
which comprises  
 converting a thiourea of the formula IV using a sulfonyl chloride  $R_6SO_2Cl$  in  
 5 the presence of a base to the compound of the formula I



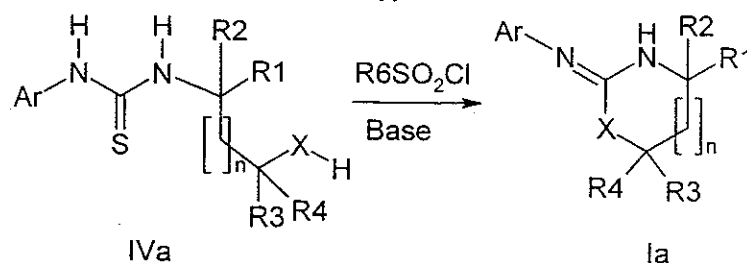
where  
 10 A, X, o, m,  $R_6$  and  $R_{10}$  to  $R_{17}$  are each as specified for the above process.

All definitions and illustrations for the above-described process apply correspondingly to this process.

15 In a further embodiment, the present invention provides a process for preparing compounds of the formula Ia,



which comprises  
 converting a thiourea of the formula IVa using a sulfonyl chloride  $R_6SO_2Cl$   
 20 in the presence of a base to the compound of the formula Ia



where

Ar, X, n, R1 to R4 and R6 are each as defined above.

- 5 All definitions and illustrations of the above-described process apply correspondingly for this process.

The compounds of the formula I obtainable by the process according to the invention are valuable intermediates, for example for the preparation of active pharmaceutical ingredients such as clonidine and its analogs, or are themselves active pharmaceutical ingredients. For example, the applications WO 03101984 and WO 03053434 describe compounds which may be prepared by means of the process described here, and which are suitable as NHE inhibitors, in particular NHE3 inhibitors, for example for treating respiratory disorders and snoring, and also for improving the respiratory drive, or for treating acute or chronic disorders which are induced by ischemic and/or reperfusion events or by proliferative or by fibrotic events.

## 20 Experimental descriptions and examples:

### Abbreviations:

|       |                         |
|-------|-------------------------|
| abs.  | absolute                |
| ESI   | electrospray ionization |
| 25 rt | retention time          |
| THF   | tetrahydrofuran         |
| TFA   | trifluoroacetic acid    |

The retention times (rt) reported below relate to LC-MS measurements with the following parameters:

### Analytical methods:

#### Method A:

stationary phase: Merck Purospher 5 $\mu$  2  $\times$  55 mm

mobile phase: 95% H<sub>2</sub>O (0.05% TFA) → 95% acetonitrile,  
3 min; → 95% acetonitrile, 1.5 min; 0.5 ml/min.

Method B:

5 stationary phase: Merck Purospher 3 $\mu$  2 x 55 mm  
mobile phase: 95% H<sub>2</sub>O (0.08% HCOOH) → 95% acetonitrile  
(0.1% HCOOH), 5 min; → 95% acetonitrile  
(0.1% HCOOH), 2 min; → 95% H<sub>2</sub>O (0.1%  
HCOOH), 1 min; 0.45 ml/min.

10

Method C:

stationary phase: YMC J'sphere H80, 4 $\mu$ , 2.1 x 20 mm  
mobile phase: 96% H<sub>2</sub>O (0.05% TFA) → 95% acetonitrile,  
2 min; → 95% acetonitrile, 0.4 min; 1 ml/min.

15

Method D:

stationary phase YMC J'sphere H80, 4 $\mu$ , 2.1 x 20 mm  
mobile phase: 95% H<sub>2</sub>O (0.05% TFA) → 95% acetonitrile,  
2.3 min; → 95% acetonitrile, 1 min; 1 ml/min.

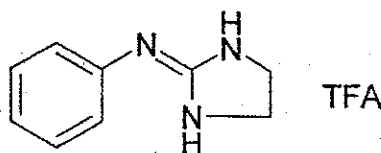
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The preparative HPLC was carried out under the following conditions:

stationary phase: Merck Purospher RP18 (10 $\mu$ m) 250 x 25 mm  
mobile phase: 90% H<sub>2</sub>O (0.05% TFA) → 90% acetonitrile,  
40 min; 25 ml/min

25

Example 1: Imidazolidin-2-ylidenephénylamine, trifluoroacetic acid salt



30 a) 1-(2-Aminoethyl)-3-phenylthiourea

A solution of phenyl isothiocyanate (500 mg) in abs. THF (6 ml) was added dropwise over 20 minutes under argon to a solution of ethylenediamine (5.56 g) in abs. THF (6 ml). Afterwards, the reaction mixture was added to water, acidified with 10% HCl and extracted with ethyl acetate. The aqueous phase was then basified with potassium carbonate and extracted three times with ethyl acetate. The combined organic phases were dried over magnesium sulfate, filtered and concentrated. Subsequently,

35

coevaporation with toluene was effected twice. 650 mg of the desired product remained.

LC-MS rt (A): 1.96 min

MS (ESI+): 196.2

5

b) Imidazolidin-2-ylidenephénylamine, trifluoroacetic acid salt

1-(2-Aminoethyl)-3-phenylthiourea (50 mg) was dissolved in THF (1.5 ml) under argon and admixed with a solution of sodium hydroxide (25.6 mg) in water (0.6 ml), and a solution of p-toluenesulfonyl chloride (53.7 mg) in THF was added dropwise within five minutes. After a half hour of stirring, the reaction mixture was added to water and extraction was effected with ether six times. Subsequently, the combined organic phases were dried over magnesium sulfate, filtered and concentrated. The residue was purified by means of preparative chromatography, and the product-containing fractions were combined, freed of acetonitrile and freeze-dried. After freeze-drying, 20 mg of the desired product were obtained.

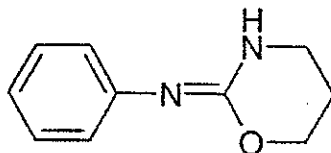
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15

LC-MS rt (A): 1.72 min

MS (ESI+): 162.2

20 Example 2: [1,3]Oxazinan-2-ylidenephénylamine



a) 1-(3-Hydroxypropyl)-3-phenylthiourea

25 A solution of phenyl isothiocyanate (200 mg) in abs. THF (2 ml) was added dropwise under argon and with stirring to a solution of 3-amino-1-propanol (114.5 mg) in abs. THF (2 ml). The reaction mixture was stirred at room temperature for two hours. After removing the solvent, the residue was dissolved in aqueous HCl and washed with ether. Subsequently, the aqueous phase was basified with potassium carbonate and extracted three times with ether. The combined organic phases were dried over magnesium sulfate, filtered and concentrated. The residue was purified by means of preparative chromatography, and the product-containing fractions were combined, freed of acetonitrile, basified and extracted three times with ethyl acetate. The organic phases were combined, dried (MgSO<sub>4</sub>) and

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35

filtered. After removing the solvent, 114 mg of the desired product were obtained.

LC-MS rt (B): 1.99 min

MS (ESI+): 211.20

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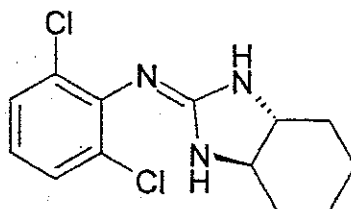
b) [1,3]Oxazinan-2-ylidenephénylamine

A solution of sodium hydroxide (23.8 mg) and water (0.6 ml) was added under argon and with stirring to a solution of 1-(3-hydroxypropyl)-3-phenylthiourea (50 mg) and THF (1.5 ml). Subsequently, a solution of p-toluenesulfonyl chloride (49.9 mg) and THF (0.5 ml) was added dropwise over fifteen minutes. After stirring for 30 minutes, the reaction mixture was added to water and extraction was effected three times with ether. The combined organic phases were dried over magnesium sulfate, filtered and concentrated. Chromatography using silica gel (initially 50:1 methylene chloride/methanol, at the end 100:1 methanol/saturated ammonia solution) afforded 27.4 mg of the desired product.

10

NMR (400 MHz, CDCl<sub>3</sub>): 7.35-7.18 (4H, m), 6.9-7.0 (1H, m), 4.29 (2H, t), 3.43 (2H, t), 1.96 (2H, q)

20 Example 3: (2,6-Dichlorophenyl)(octahydrobenzimidazol-2-yliden)amine



a) 1-(2-Aminocyclohexyl)-3-(2,6-dichlorophenyl)thiourea

25 A solution of 1,3-dichloro-2-isothiocyanatobenzene (100 mg) and abs. THF (3 ml) was added dropwise slowly over a half hour to a solution of trans-1,2-diaminocyclohexane (139.9 mg) and abs. THF (3 ml). The solution was stirred at room temperature for a further 90 minutes. The reaction mixture was subsequently added to water, acidified with hydrochloric acid and extracted once with ethyl acetate. Afterwards, the mixture was basified using potassium carbonate and extracted three times with ethyl acetate. The combined organic phases were dried over magnesium sulfate, filtered and concentrated. 128 mg of the desired product were obtained.

30

LC-MS rt (B): 1.88 min

35 MS (ESI+): 318.20

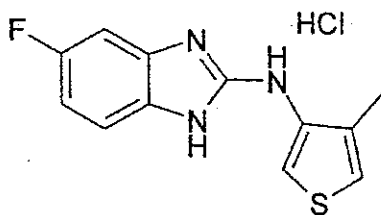
b): (2,6-Dichlorophenyl)(octahydrobenzoimidazol-2-yliden)amine

A solution of sodium hydroxide (15.7 mg) and water (0.6 ml) was added under argon to a solution of 1-(2-aminocyclohexyl)-3-(2,6-dichlorophenyl)-thiourea (50 mg) and THF (1.5 ml). Subsequently, a solution of p-toluenesulfonyl chloride (32.9 mg) and THF (0.5 ml) was added dropwise over fifteen minutes. After stirring for 60 minutes, the reaction mixture was added to water and extracted three times with ether. The combined organic phases were dried over magnesium sulfate, filtered and concentrated. 44 mg of the desired product were obtained.

LC-MS rt (B): 1.95 min

MS (ESI+): 284.20

Example 4: (5-Fluoro-1H-benzoimidazol-2-yl)(4-methylthiophen-3-yl)amine hydrochloride



a) 1-(2-Amino-5-fluorophenyl)-3-(4-methylthiophen-3-yl)thiourea and 1-(2-amino-4-fluorophenyl)-3-(4-methylthiophen-3-yl)thiourea

4-Fluoro-o-phenylenediamine (1.5 g) was dissolved in abs. THF (25 ml) and added dropwise with stirring to 3-isothiocyanato-4-methylthiophene (1.8 g) dissolved in abs. THF (25 ml). On completion of addition, the mixture was stirred at room temperature for 3 h, then a little more 3-isothiocyanato-4-methylthiophene was added and stirring was continued for a further hour. After leaving to stand overnight, the THF was removed, the residue was dissolved in ethanol, carbon was added, and the mixture was heated to boiling and hot-filtered. After cooling, 1.8 g of the desired product were precipitated out of the filtrate with ether.

b) (5-Fluoro-1H-benzoimidazol-2-yl)-(4-methylthiophen-3-yl)amine hydrochloride

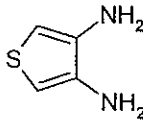
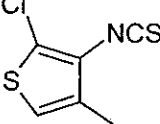
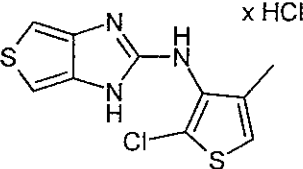
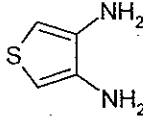
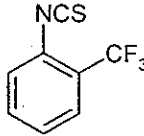
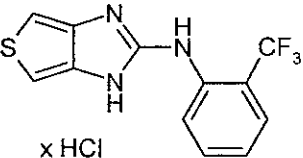
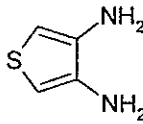
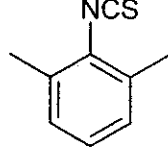
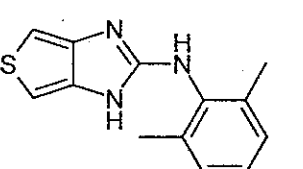
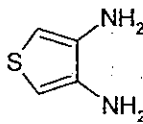
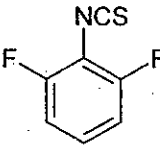
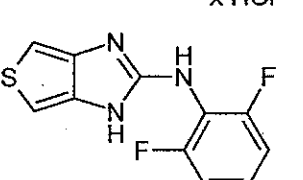
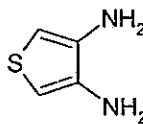
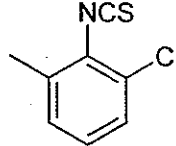
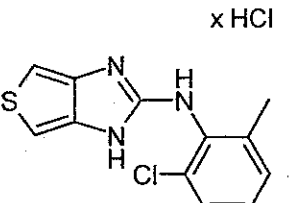
The mixture of 1-(2-amino-5-fluorophenyl)-3-(4-methylthiophen-3-yl)-thiourea and 1-(2-amino-4-fluorophenyl)-3-(4-methylthiophen-3-yl)thiourea (1.75 g) was dissolved in THF (50 ml) and admixed with a solution of sodium hydroxide (0.622 g) and water (15 ml). Within 5 min, a solution of p-toluenesulfonyl chloride (1.304 g) and THF (10 ml) was added dropwise.

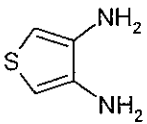
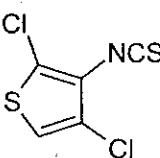
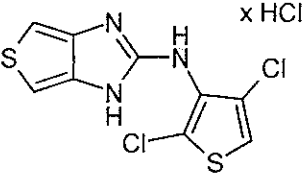
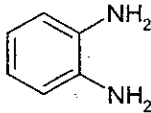
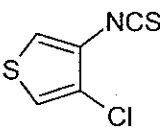
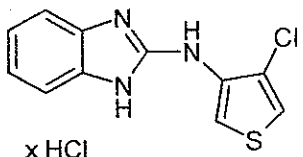
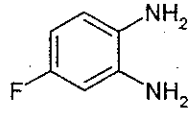
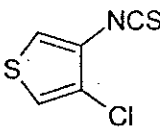
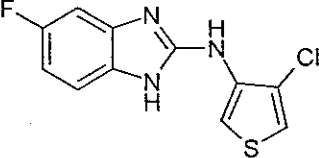
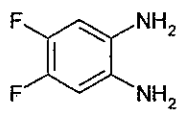
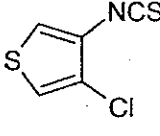
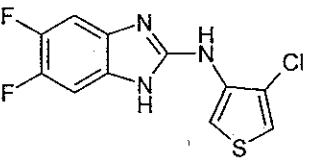
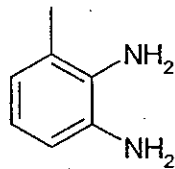
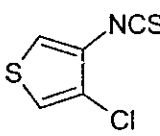
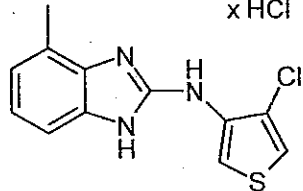
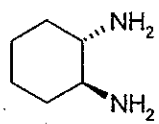
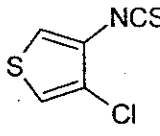
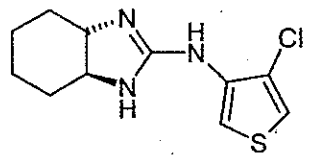
On completion of addition, the mixture was stirred at room temperature for a half hour. The reaction mixture was poured onto water and the aqueous phase was extracted three times. The combined ether phases were dried with magnesium sulfate, filtered and concentrated. The crude product was  
5 dissolved in ethyl acetate and adjusted to pH 2 using ethereal HCl. It was precipitated by adding ether. After drying, 750 mg of the desired product were obtained.

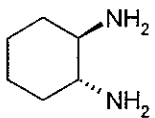
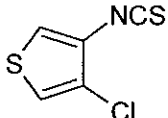
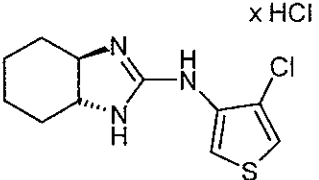
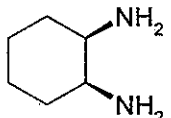
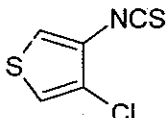
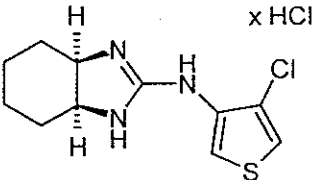
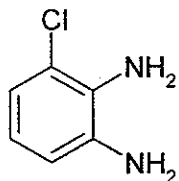
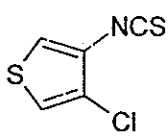
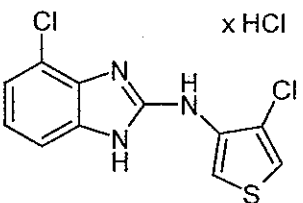
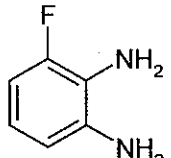
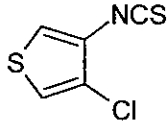
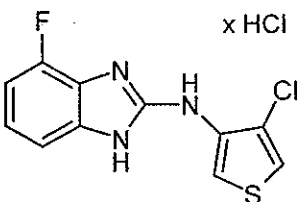
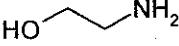
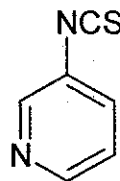
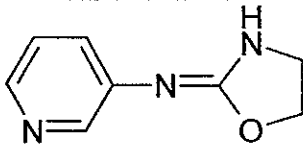
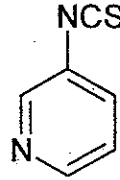
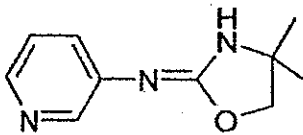
LC-MS rt (B): 1.48 min

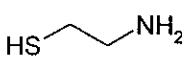
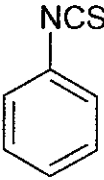
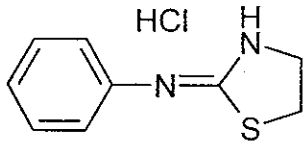
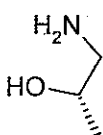
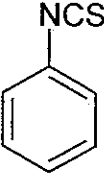
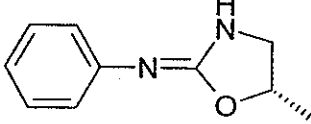
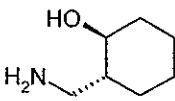
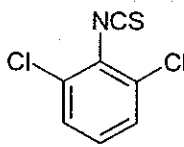
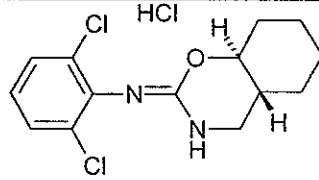
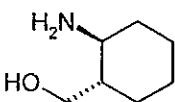
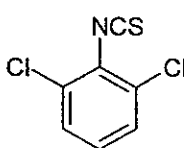
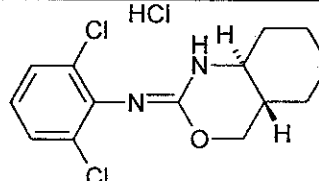
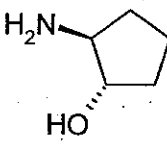
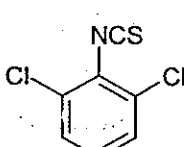
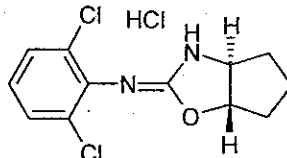
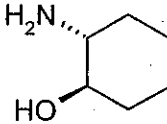
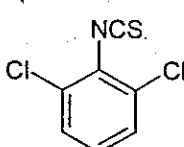
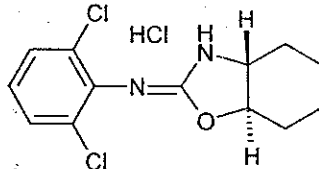
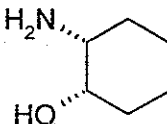
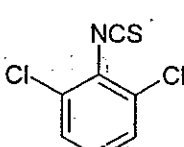
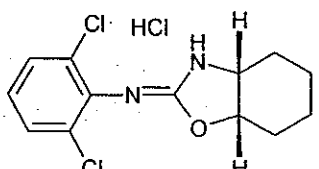
MS (ESI+): 248.11

Starting from commercially available or known starting materials, the following compounds were prepared in a similar manner to the above examples:

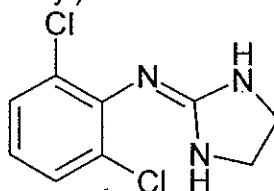
| Exa-<br>mple | Amine                                                                               | Isothio-<br>cyanate                                                                 | Product                                                                              | M.p.<br>[°C] | LC-<br>MS<br>rt<br>[min] | MS<br>(ESI <sup>+</sup> ,<br>M+H <sup>+</sup> ) |
|--------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------|--------------------------|-------------------------------------------------|
| 5            |    |    |    | >300         |                          |                                                 |
| 6            |   |   |   | 194-<br>196  |                          |                                                 |
| 7            |  |  |  | >310         |                          |                                                 |
| 8            |  |  |  | 296          |                          |                                                 |
| 9            |  |  |  | >310         |                          |                                                 |

| Exa-<br>mple | Amine                                                                               | Isothio-<br>cyanate                                                                 | Product                                                                              | M.p.<br>[°C] | LC-<br>MS<br>rt<br>[min] | MS<br>(ESI <sup>+</sup> ,<br>M+H <sup>+</sup> ) |
|--------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------|--------------------------|-------------------------------------------------|
| 10           |    |    |    | >300         |                          |                                                 |
| 11           |    |    |    | 256-<br>260  |                          |                                                 |
| 12           |   |   |   |              | 0.90<br>(C)              | 268.0                                           |
| 13           |  |  |  |              | 0.95<br>(C)              | 286.0                                           |
| 14           |  |  |  | 325-<br>327  |                          |                                                 |
| 15           |  |  |  | 196-<br>200  |                          |                                                 |

| Exa-<br>mple | Amine                                                                               | Isothio-<br>cyanate                                                                 | Product                                                                                       | M.p.<br>[°C] | LC-<br>MS<br>rt<br>[min] | MS<br>(ESI <sup>+</sup> ,<br>M+H <sup>+</sup> ) |
|--------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------|--------------------------|-------------------------------------------------|
| 16           |    |    | <br>x HCl   | 240-<br>244  |                          |                                                 |
| 17           |    |    | <br>x HCl   | 228-<br>231  |                          |                                                 |
| 18           |   |   | <br>x HCl  | 276-<br>280  |                          |                                                 |
| 19           |  |  | <br>x HCl |              | 0.89<br>(C)              | 268.0                                           |
| 20           |  |  |           |              | 0.14<br>(C)              | 164.1                                           |
| 21           |  |  |           |              | 0.20<br>(C)              | 192.1                                           |

| Exa-<br>mple | Amine                                                                               | Isothio-<br>cyanate                                                                 | Product                                                                              | M.p.<br>[°C] | LC-<br>MS<br>rt<br>[min] | MS<br>(ESI <sup>+</sup> ,<br>M+H <sup>+</sup> ) |
|--------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------|--------------------------|-------------------------------------------------|
| 22           |    |    |    |              | 0.64<br>(C)              | 179.1                                           |
| 23           |    |    |    |              | 0.71<br>(C)              | 177.1                                           |
| 24           |    |   |   |              | 1.07<br>(C)              | 299.4                                           |
| 25           |  |  |  |              | 1.04<br>(C)              | 299.3                                           |
| 26           |  |  |  |              | 1.83<br>(D)              | 271.3                                           |
| 27           |  |  |  |              | 1.83<br>(D)              | 285.3                                           |
| 28           |  |  |  |              | 1.76<br>(D)              | 285.3                                           |

Example 29: (2,6-Dichlorophenyl)imidazolidin-2-ylidene amine



a) 1-(2-Aminoethyl)-3-(2,6-dichlorophenyl)thiourea

- 5 A solution of 2,6-dichlorophenyl isothiocyanate (500 mg) and THF (5 ml) was added dropwise under argon within 20 minutes to a solution of ethylenediamine (3.68 g) and abs. THF (4 ml). After stirring for a further 30 min, the mixture was added to water, acidified with 10% HCl and extracted three times with ethyl acetate. The aqueous phase was made
- 10 basic using saturated potassium carbonate solution and extracted three times with ethyl acetate. The combined organic phases were dried over magnesium sulfate, the solvent was removed under reduced pressure and the residue was coevaporated twice with toluene. After drying in high vacuum, the desired product was obtained as a white solid (532 mg).

15 LC-MS rt (C): 0.719 min

MS (ESI+): 264.0

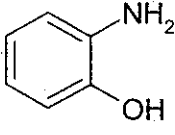
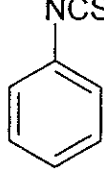
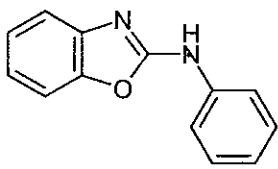
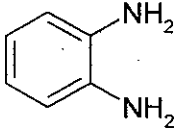
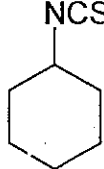
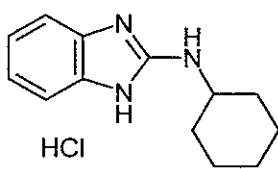
b) (2,6-Dichlorophenyl)imidazolidin-2-ylidene amine

- 1-(2-Aminoethyl)-3-(2,6-dichlorophenyl)thiourea (200 mg) was dissolved
- 20 under argon in THF (4 ml), admixed with a solution of sodium hydroxide (102 mg) in water (2 ml) and then a slurry of polystyrene-bound toluenesulfonyl chloride (457 mg, 2.9 mmol/g) in THF (4 ml) was added dropwise within five minutes. After stirring at room temperature for 2 h, further polystyrene-bound toluenesulfonyl chloride (65 mg in 2 ml of THF)
- 25 was added, followed after a further hour by further acid chloride (124 mg in 2 ml of THF). After standing overnight, the reaction mixture was filtered, the resin was slurried twice in dichloromethane and the combined phases were concentrated to dryness. The residue was taken up in water/dichloromethane, the phases were separated and the aqueous
- 30 phase was extracted three times with dichloromethane. The combined organic phases were dried over magnesium sulfate, and the solvent was removed under reduced pressure and subsequently dried under high vacuum. 104 mg of the title compound were obtained.

LC-MS rt (C): 0.65 min

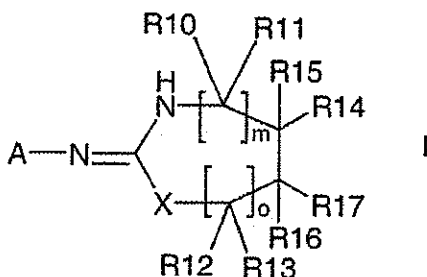
35 MS (ESI+): 230.1

In a similar manner to example 29, the following compounds were obtained:

| Exa-<br>mple | Amine                                                                             | Isothio-<br>cyanate                                                               | Product                                                                                   | LC-MS<br>rt [min] | MS<br>(ES <sup>+</sup> ,<br>M+H <sup>+</sup> ) |
|--------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-------------------|------------------------------------------------|
| 30           |  |  |         | 1.42<br>(C)       | 211.1                                          |
| 31           |  |  | <br>HCl | 0.95<br>(C)       | 216.1                                          |

What is claimed is:

1. A process for preparing heterocycles of the formula I



where:

X is NR<sub>5</sub>

where R<sub>5</sub> is hydrogen or (C1-C4)alkyl;

m and o

are each independently zero, 1 or 2;

A is phenyl, naphthyl or heteroaryl, all of which may be substituted by 1, 2, 3, 4 or 5 R<sub>11</sub> radicals

where R<sub>11</sub> is in each case independently selected from the group of (C1-C4)alkyl, F, Cl, Br, I, CN, NO<sub>2</sub>, OH, O(C1-C4)alkyl, COO(C1-C4)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

or

(C1-C4)alkyl, (C2-C5)alkenyl, (C2-C5)alkynyl, (C3-C8)cycloalkyl, (C4-C8)cycloalkenyl, where these radicals may each independently be substituted by (C1-C4)alkyl or (C3-C6)cycloalkyl, and some or all of the hydrogen atoms of the alkyl, alkenyl, alkynyl, cycloalkyl and cycloalkenyl radicals may be replaced by fluorine atoms, R<sub>14</sub>, R<sub>15</sub>, R<sub>16</sub> and R<sub>17</sub>

are each independently hydrogen, F or (C1-C4)alkyl,

where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

or

R<sub>14</sub> and R<sub>16</sub>

together are a bond,

and

R15 and R17

with the two carbon atoms to which they are bonded are an aromatic six-membered carbocycle in which one or two carbon atoms may be replaced by nitrogen, or a thiophene ring,

where the aromatic six-membered carbocycle and the thiophene ring may be substituted by 1, 2, 3 or 4 R7 radicals, where R7 is in each case independently selected from the group of (C1-C4)alkyl, F, Cl, Br, I, CN, NO<sub>2</sub>, OH, O(C1-C4)alkyl and COO(C1-C4)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

or

R14 and R16

are each independently hydrogen or (C1-C4)alkyl,

where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

and

R15 and R17

with the two carbon atoms to which they are bonded are a saturated 5-, 6-, 7- or 8-membered carbocycle in which one or two carbon atoms may be replaced in each case independently by O, S, NH and N(C1-C4)alkyl and may be substituted by 1, 2, 3, 4, 5 or 6 R8 radicals

where R8 is in each case independently selected from the group of (C1-C4)alkyl, O(C1-C4)alkyl, COO(C1-C4)alkyl, and some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

R10, R11, R12 and R13

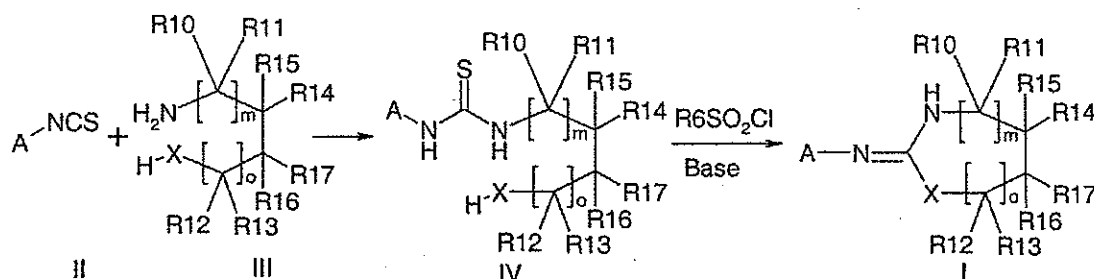
are each independently hydrogen, F or (C1-C4)alkyl,

where some or all of the hydrogen atoms of the alkyl radicals may be replaced by fluorine atoms;

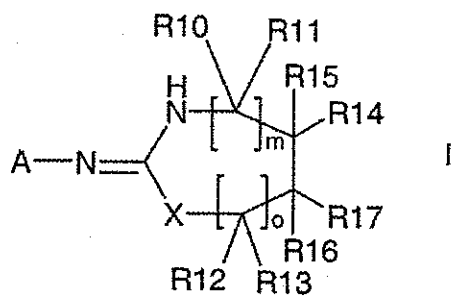
where either A or the ring formed from R15 and R17 together, where m is zero, is an aromatic ring system, or both are aromatic ring systems;

and their tautomers and their salts,

which comprises,

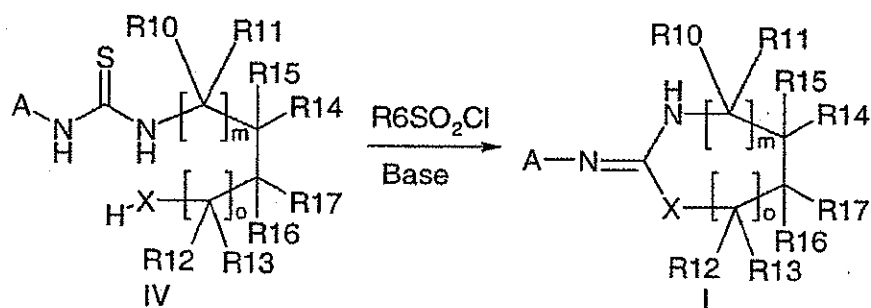


- a) reacting an isothiocyanate of the formula II with a primary amine of the formula III to give a thiourea of the formula IV, and
  - b) converting the thiourea of the formula IV using a sulfonyl chloride R6SO<sub>2</sub>Cl in the presence of a base to the compound of the formula I,
- where, in the compounds of the formulae II, III and IV,
- A, X, n, m and R10 to R17 are each as defined in formula I and
- R6 is (C1-C4)alkyl, trifluoromethyl or phenyl which is unsubstituted or substituted by methyl, trifluoromethyl, F, Cl, Br or, or a polymeric support.
2. The process of claim 1, in which the reaction is carried out as a one-pot reaction.
  3. The process of claim 1 and/or 2, wherein steps a) and b) are each independently conducted continuously or batchwise.
  4. The process of one or more of claims 1 to 3, wherein A is phenyl, thienyl or isoxazolyl, each of which may be substituted as specified in claim 1.
  5. The process of one or more of claims 1 to 4, wherein R6 is phenyl or p-methylphenyl.
  6. The process of one or more of claims 1 to 5, wherein the base used in step b) is sodium hydroxide or potassium hydroxide.
  7. A process for preparing a compound of the formula I as defined in claim 1



which comprises

converting a thiourea of the formula IV using a sulfonyl chloride  $R_6SO_2Cl$  in the presence of a base to the compound of the formula I



where

A, X, o, m, R<sub>6</sub> and R<sub>10</sub> to R<sub>17</sub> are each as defined in claim 1.