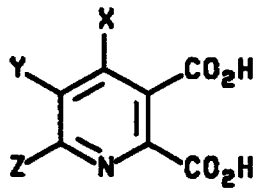
Description

2,3-Pyridinedicarboxylic acids are useful in the preparation of herbicidal 2-(2-imidazolin-2-yl)nicotinic and quinoline-3-carboxylic acids, esters and salts. In the manufacture of these herbicidal compounds, aqueous media containing undesirable 3-(2-imidazolin-2-yl)picolinic acid by-products are obtained.

Heretofore, these 3-(2-imidazolin-2-yl) picolinic acid by-products served no utitity and were disposed of by incineration. Now it has been found that the undesirable 3-(2-imidazolin-2-yl)picolinic acid by-products can be recycled by conversion to 2,3-pyridinedicarboxylic acids, useful starting materials for the manufacture of herbicidal 2-(2-imidazolin-2-yl) nicotinic and quinoline-3-carboxylic acids, esters and salts, thus eliminating the need for disposal and resulting in significant environmental and cost benefits.

The present invention relates to a process for the preparation of 2,3-pyridinedicarboxylic acids of formula I



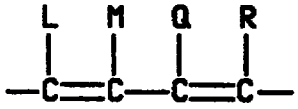
(I)

wherein

X is hydrogen or methyl; and

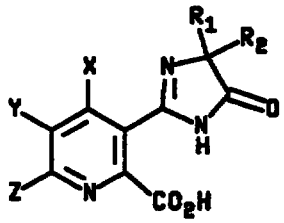
Y and Z are each independently hydrogen, halogen, C_1-C_6 alkoxy, C_1-C_4 alkylthio, C_1-C_6 alkyl optionally substituted with one to three C_1-C_4 alkoxy groups, phenoxy optionally substituted with one C_1-C_4 alkyl or C_1-C_4 alkoxy group, or phenyl optionally substituted with one C_1-C_4 alkyl or C_1-C_4 alkoxy group; and,

when taken together, Y and Z may form a ring in which YZ is represented by the structure: $-(CH_2)_n-$, where n is an integer of 3 or 4, or



where L, M, Q and R are each independently hydrogen, C_1-C_4 alkyl or C_1-C_4 alkoxy.

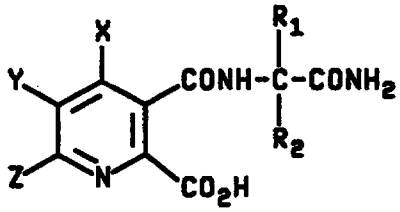
Surprisingly, it has been found that 2,3-pyridinedicarboxylic acids of formula I may be prepared efficiently and effectively in a two step process by reacting an undesirable, by-product 3-(2-imidazolin-2-yl)-picolinic acid of formula II



(II)

wherein X, Y and Z are as described above, R_1 is C_1-C_4 alkyl and R_2 is C_1-C_4 alkyl or C_3-C_6 cycloalkyl, and when R_1 and R_2 are taken together with the carbon atom to which they are attached they may represent C_3-C_6 cycloalkyl optionally substituted with methyl,
with a metal hydroxide in the presence of water to form a 3-[(1-carbamoylpropyl)carbamoyl]picolinic acid of

formula III



(III)

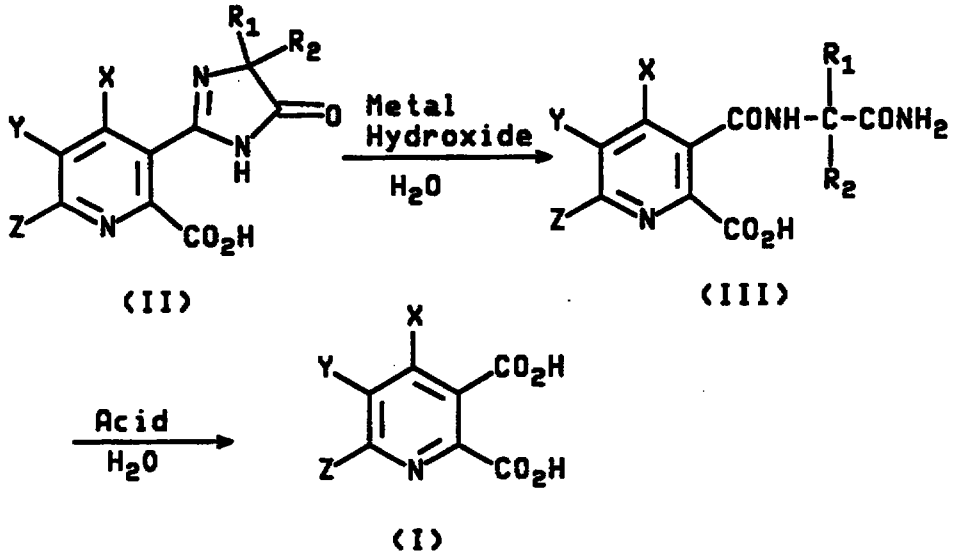
wherein X, Y, Z, R_1 and R_2 are as described above and reacting said formula III compound with an acid in the presence of water to form the desired 2,3-pyridinedicarboxylic acid of formula I.

Advantageously, the present invention provides an efficient and effective process for converting undesirable 3-(2-imidazolin-2-yl)picolinic acids to desirable 2,3-pyridinedicarboxylic acids which are used in the manufacture of herbicidal 2-(2-imidazolin-2-yl)nicotinic and quinoline-3-carboxylic acids, esters and salts. By converting the 3-(2-imidazolin-2-yl)picolinic acids to useful starting materials, the overall product yields of the herbicidal compounds are improved through conversion of undesirable by-products into starting materials.

The present invention provides an efficient and effective two step process for converting an undesirable formula II 3-(2-imidazolin-2-yl)picolinic acid to a desirable formula I 2,3-pyridinedicarboxylic acid. The 2,3-pyridinedicarboxylic acid may be integrated into an existing preparative process for a herbicidal 2-(2-imidazolin-2-yl)nicotinic or quinoline-3-carboxylic acid, ester or salt.

Formula I 2,3-pyridinedicarboxylic acids are efficiently and effectively prepared by reacting a formula II 3-(2-imidazolin-2-yl)picolinic acid with a metal hydroxide in the presence of water to form a formula III 3-[(1-carbamoylpropyl)carbamoyl]picolinic acid and reacting said formula III compound with an acid in the presence of water to form the desired formula I 2,3-pyridinedicarboxylic acid. The above reaction scheme is shown in Flow Diagram I.

FLOW DIAGRAM I



(II) (III) (I)

The process of the present invention preferably comprises reacting a formula II 3-(2-imidazolin-2-yl)-picolinic acid with a metal hydroxide in the presence of water at a pH range of from about pH 8.5 to pH 11.5, preferably from about pH 9.0 to pH 11.0, and at a temperature range of from about 20 °C to 120 °C to form a formula III 3-[(1-carbamoylpropyl)carbamoyl]picolinic acid. Said formula III compound is then reacted with an acid in the presence of water at a pH range of from about pH 1.0 to pH 4.0, preferably from about

pH 1.5 to pH 3.5, and at a temperature range of from about 20 °C to 120 °C to form the desired formula I 2,3-pyridinedicarboxylic acid.

The process of the present invention is especially useful for the preparation of formula I compounds wherein

X is hydrogen; and

Y and Z are each independently hydrogen or C_1-C_6 alkyl optionally substituted with one to three C_1-C_4 alkoxy groups; and, when taken together, Y and Z may form a ring in which YZ is represented by the structure:

-CH = CH-CH = CH-.

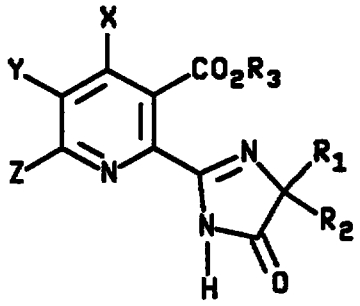
Preferred formula I compounds prepared according to the process of the present invention are 5-ethyl-2,3-pyridinedicarboxylic acid, 2,3-pyridinedicarboxylic acid, 5-methyl-2,3-pyridinedicarboxylic acid, 5-(methoxymethyl)-2,3-pyridinedicarboxylic acid and 2,3-quinolinedicarboxylic acid.

The product formula I compounds may be isolated by filtration of the formula I product or by extraction of the reaction mixture with a suitable solvent. In the isolation procedure suitable extraction solvents include tetrahydrofuran and water-immiscible alcohols.

Metal hydroxides suitable for use in the process of the present invention include alkali metal hydroxides and alkaline earth metal hydroxides. Preferred alkali metal hydroxides are sodium hydroxide and potassium hydroxide.

Acids suitable for use in the above process of the invention include mineral acids, trifluoroacetic acid, trichloroacetic acid, dichloroacetic acid and the like. Preferred mineral acids are sulfuric acid, hydrochloric acid and hydrobromic acid.

Formula I 2,3-pyridinedicarboxylic acids are useful in the preparation of highly effective herbicidal 2-(2-imidazolin-2-yl)nicotinic and quinoline-3-carboxylic acids, esters and salts of formula IV



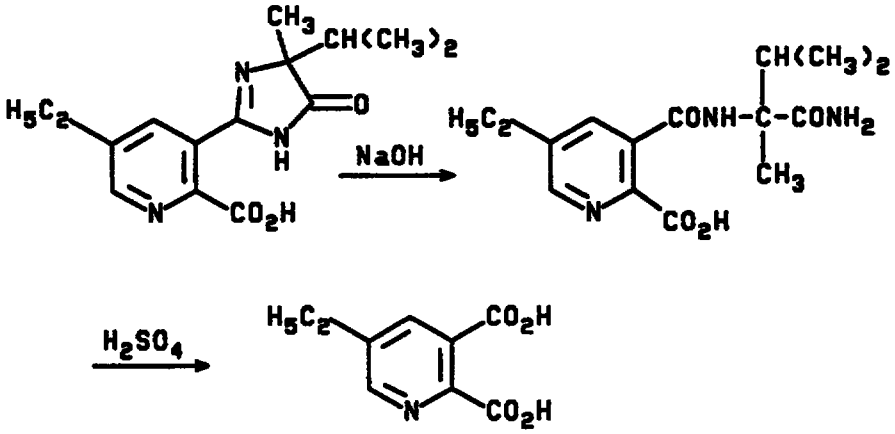
(IV)

wherein R_3 is hydrogen, an ester or a cation; and X, Y, Z, R_1 and R_2 are as described above for formula II.

In order to facilitate a further understanding of the invention, the following examples are presented to illustrate more specific details thereof. The invention is not to be limited thereby except as defined in the claims. All weight/weight percents are determined by high performance liquid chromatography analyses.

EXAMPLE 1

Preparation of 5-Ethyl-2,3-pyridinedicarboxylic acid from an aqueous medium containing 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid



An aqueous medium (300 g) containing 0.51 wt/wt% 5-ethyl-2,3-pyridinedicarboxylic acid, 16.05 wt/wt% 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid, 0.90 wt/wt% 3-[(1-carbamoyl-1,2-dimethylpropyl)carbamoyl]-5-ethylpicolinic acid and 5.37 wt/wt% other by-products is adjusted to pH 9.9 with 50% sodium hydroxide solution (11.2 g, 0.23 mol) and sulfuric acid (3.1 g, 0.03 mol). The reaction mixture is heated at reflux for 90 hours and found to contain 0.67 wt/wt% 5-ethyl-2,3-pyridinedicarboxylic acid, 3.8 wt/wt% 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid, 14.56 wt/wt% 3-[(1-carbamoyl-1,2-dimethylpropyl)carbamoyl]-5-ethylpicolinic acid and 5.51 wt/wt% other by-products. The reaction mixture is then adjusted to pH 2.0 with sulfuric acid (50 g, 0.51 mol), heated at reflux for 7 hours and found to contain 5.55 wt/wt% 5-ethyl-2,3-pyridinedicarboxylic acid, 0.0% wt/wt% 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid, 2.65 wt/wt% 3-[(1-carbamoyl-1,2-dimethylpropyl)carbamoyl]-5-ethylpicolinic acid and 6.79 wt/wt% other by-products.

This example shows that by converting undesirable, by-product 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid to useful 5-ethyl-2,3-pyridinedicarboxylic acid, the amount of 5-ethyl-2,3-pyridinedicarboxylic acid present in the aqueous medium is increased by over a thousand percent.

EXAMPLE 2

Preparation of 2,3-Pyridinedicarboxylic acid compounds

Following essentially the same procedure described in Example 1 and substituting the appropriate aqueous media, the following compounds are prepared: 2,3-pyridinedicarboxylic acid, 5-methyl-2,3-pyridinedicarboxylic acid, 5-(methoxymethyl)-2,3-pyridinedicarboxylic acid, and 2,3-quinolinedicarboxylic acid.

EXAMPLE 3

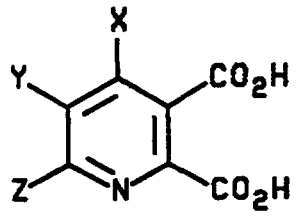
Preparation of 5-Ethyl-2,3-pyridinedicarboxylic acid

A solution of 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid (25.0 g, 92% real, 79.5 mmol) in water (150 g) is adjusted to pH 10.2 with sodium hydroxide, heated at reflux for 6 hours, stirred overnight at room temperature, adjusted to pH 9.7 with sulfuric acid, heated at reflux for 3 hours and found to contain 0.05 wt/wt% 5-ethyl-2,3-pyridinedicarboxylic acid, 12.48 wt/wt% 3-[(1-carbamoyl-1,2-dimethylpropyl)carbamoyl]-5-ethylpicolinic acid and 2.72 wt/wt% 5-ethyl-3-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)picolinic acid. The reaction mixture is then adjusted to pH 2.2 with sulfuric acid, heated at reflux for 8 hours and found to contain 3.29 wt/wt% 5-ethyl-2,3-pyridinedicarboxylic acid, 0.69 wt/wt% 3-[(1-carbamoyl-1,2-dimethylpropyl)carbamoyl]-5-ethylpicolinicacid and 0.0 wt/wt% 5-ethyl-3-(4-isopropyl-4-meth-

yl-5-oxo-2-imidazolin-2-yl)picolinic acid.

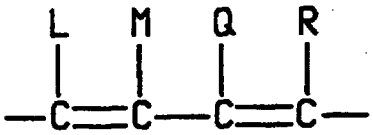
Claims

1. A process for the preparation of a 2,3-pyridinedicarboxylic acid of formula I

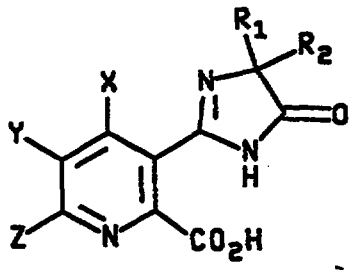


(I)

wherein
X is hydrogen or methyl; and
Y and Z are each independently hydrogen, halogen, C_1-C_6 alkoxy, C_1-C_4 alkylthio, C_1-C_6 alkyl optionally substituted with one to three C_1-C_4 alkoxy groups, phenoxy optionally substituted with one C_1-C_4 alkyl or C_1-C_4 alkoxy group, or phenyl optionally substituted with one C_1-C_4 alkyl or C_1-C_4 alkoxy group; and, when taken together, Y and Z may form a ring in which YZ is represented by the structure: $-(CH_2)_n-$, where n as an integer of 3 or 4, or



where L, M, Q and R are each independently hydrogen, C_1-C_4 alkyl or C_1-C_4 alkoxy, which is characterized by reacting a 3-(2-imidazolin-2-yl)picolinic acid of formula II



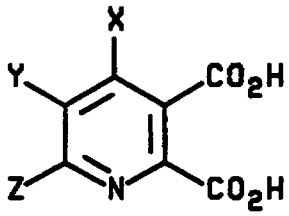
(II)

wherein X, Y and Z are as described above, R_1 is C_1-C_4 alkyl and R_2 is C_1-C_4 alkyl or C_3-C_6 cycloalkyl, and when R_1 and R_2 are taken together with the carbon atom to which they are attached they may represent C_3-C_6 cycloalkyl optionally substituted with methyl,
with a metal hydroxide in the presence of water to form a 3-[(1-carbamoylpropyl)carbamoyl]picolinic acid of formula III

yl-5-oxo-2-imidazolin-2-yl)picolinic acid.

Claims

1. A process for the preparation of a 2,3-pyridinedicarboxylic acid of formula I

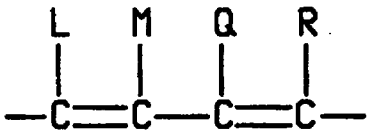


(I)

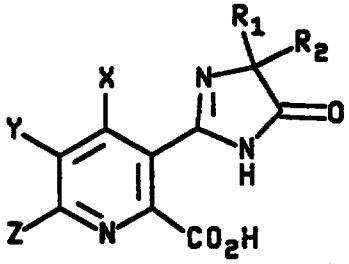
wherein

X is hydrogen or methyl; and

Y and Z are each independently hydrogen, halogen, C_1-C_6 alkoxy, C_1-C_4 alkylthio, C_1-C_6 alkyl optionally substituted with one to three C_1-C_4 alkoxy groups, phenoxy optionally substituted with one C_1-C_4 alkyl or C_1-C_4 alkoxy group, or phenyl optionally substituted with one C_1-C_4 alkyl or C_1-C_4 alkoxy group; and, when taken together, Y and Z may form a ring in which YZ is represented by the structure: $-(CH_2)_n-$, where n as an integer of 3 or 4, or



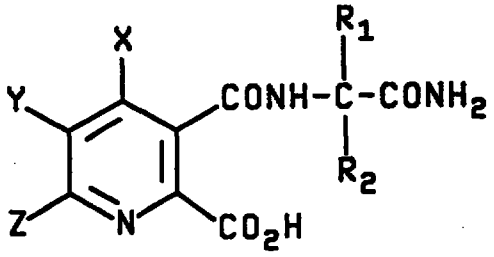
where L, M, Q and R are each independently hydrogen, C_1-C_4 alkyl or C_1-C_4 alkoxy, which is characterized by reacting a 3-(2-imidazolin-2-yl)picolinic acid of formula II



(II)

wherein X, Y and Z are as described above, R_1 is C_1-C_4 alkyl and R_2 is C_1-C_4 alkyl or C_3-C_6 cycloalkyl, and when R_1 and R_2 are taken together with the carbon atom to which they are attached they may represent C_3-C_6 cycloalkyl optionally substituted with methyl, with a metal hydroxide in the presence of water to form a 3-[(1-carbamoylpropyl)carbamoyl]picolinic acid of formula III

* C L M S *



(III)

wherein X, Y, Z, R_1 and R_2 are as described above and reacting said formula III compound with an acid in the presence of water to form the desired formula I 2,3-pyridinedicarboxylic acid.

2. The process according to claim 1 wherein the metal hydroxide is selected from the group consisting of an alkali metal hydroxide and an alkaline earth metal hydroxide; the acid is a mineral acid; the pH of the reaction mixture formed by reacting the formula II compound with the metal hydroxide is from about pH 8.5 to pH 11.5; and the temperature of the reaction mixture formed by reacting the formula II compound with the metal hydroxide is from about 20 °C to 120 °C.

3. The process according to claim 2 wherein the alkali metal hydroxide is selected from the group consisting of sodium hydroxide and potassium hydroxide; and the mineral acid is selected from the group consisting of sulfuric acid, hydrochloric acid and hydrobromic acid.

4. The process according to claim 3 wherein the pH of the reaction mixture formed by reacting the formula II compound with the metal hydroxide is from about pH 9.0 to pH 11.0.

5. The process according to claim 1 wherein the pH of the reaction mixture formed by reacting the formula III compound with the acid is from about pH 1.0 to pH 4.0.

6. The process according to claim 5 wherein the pH is from about pH 1.5 to pH 3.5.

7. The process according to claim 1 wherein the temperature of the reaction mixture formed by reacting the formula III compound with the acid is from about 20 °C to 120 °C.

8. The process according to claim 1 wherein
X is hydrogen;
Y and Z are each independently hydrogen or C_1-C_6 alkyl optionally substituted with one to three C_1-C_4 alkoxy groups; and, when taken together, Y and Z
may form a ring in which YZ is represented by the structure:

-CH=CH-CH=CH-;

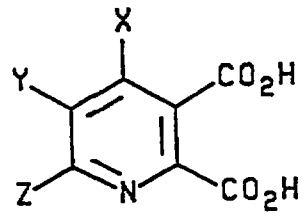
and
R_1 and R_2 are each independently C_1-C_4 alkyl.

9. The process according to claim 8 wherein the formula I compound is selected from the group consisting of 5-ethyl-2,3-pyridinedicarboxylic acid; 2,3-pyridinedicarboxylic acid; 5-methyl-2,3-pyridinedicarboxylic acid; 5-(methoxymethyl)-2,3-pyridinedicarboxylic acid; and 2,3-quinolinedicarboxylic acid.

* C L M S *

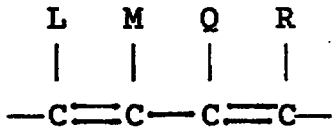
Patentansprüche

1. Verfahren zur Herstellung einer 2,3-Pyridindicarbonsäure der Formel I

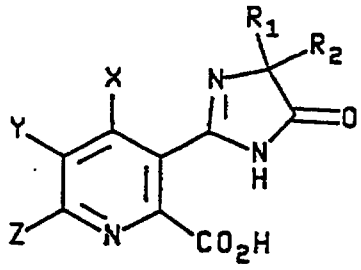


(I)

wobei
X Wasserstoff oder Methyl ist; und
Y und Z jeweils unabhängig Wasserstoff, Halogen, C_1-C_6-Alkoxy, C_1-C_4-Alkylthio, C_1-C_6-Alkyl, gegebenenfalls substituiert mit einer bis drei C_1-C_4-Alkoxygruppen, Phenoxy, gegebenenfalls substituiert mit einer C_1-C_4-Alkyl- oder C_1-C_4-Alkoxygruppe, oder Phenyl, gegebenenfalls substituiert mit einer C_1-C_4-Alkyl- oder C_1-C_4-Alkoxygruppe, ist, und
Y und Z können zusammen einen Ring bilden, in dem YZ dargestellt wird durch die Struktur: $-(CH_2)_n-$, wobei n eine ganze Zahl 3 oder 4 ist, oder



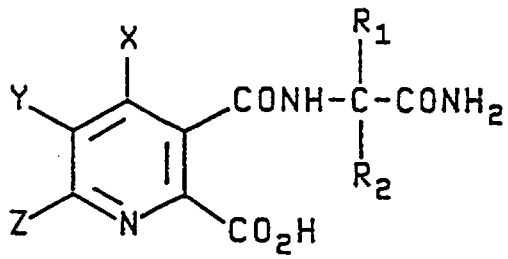
wobei L, M, Q und R jeweils unabhängig Wasserstoff, C_1-C_4-Alkyl oder C_1-C_4-Alkoxy ist,
das gekennzeichnet ist durch die Umsetzung einer 3-(2-Imidazolin-2-yl)picolinsäure der Formel II



(II)

wobei X, Y und Z wie oben beschrieben sind, R_1 C_1-C_4-Alkyl ist, und R_2 C_1-C_4-Alkyl oder C_3-C_6-Cycloalkyl ist, und wenn R_1 und R_2 zusammen mit dem Kohlenstoffatom, an das sie gebunden sind, genommen werden, können sie C_3-C_6-Cycloalkyl, gegebenenfalls substituiert mit Methyl, darstellen, mit einem Metallhydroxid in Gegenwart von Wasser, um eine 3-[(1-Carbamoylpropyl)carbamoyl]-picolinsäure der allgemeinen Formel III zu bilden

* C L M S *



(III)

wobei X, Y, Z, R_1 und R_2 wie oben beschrieben sind, und Umsetzung der Verbindung der Formel III mit einer Säure in Gegenwart von Wasser, um die gewünschte 2,3-Pyridindicarbonsäure der Formel I zu bilden.

2. Verfahren gemäß Anspruch 1, wobei das Metallhydroxid ausgewählt wird aus der Gruppe, bestehend aus einem Alkalimetallhydroxid und einem Erdalkalimetallhydroxid; die Säure eine Mineralsäure ist; der pH des Reaktionsgemisches, gebildet durch Umsetzung der Verbindung der Formel II mit dem Metallhydroxid, ungefähr 8,5 bis pH 11,5 ist, die Temperatur des Reaktionsgemisches, gebildet durch Umsetzung der Verbindungen der Formel II mit dem Metallhydroxid, ungefähr von 20 °C bis 120 °C ist.

3. Verfahren gemäß Anspruch 2, wobei das Alkalimetallhydroxid ausgewählt wird aus der Gruppe, bestehend aus Natriumhydroxid und Kaliumhydroxid; und die Mineralsäure ausgewählt wird aus der Gruppe, bestehend aus Schwefelsäure, Chlorwasserstoffsäure und Bromwasserstoffsäure.

4. Verfahren gemäß Anspruch 3, wobei der pH des Reaktionsgemisches, gebildet durch Umsetzung der Verbindung der Formel II mit dem Metallhydroxid, ungefähr pH 9,0 bis pH 11,0 ist.

5. Verfahren gemäß Anspruch 1, wobei der pH des Reaktionsgemisches, gebildet durch Umsetzung der Verbindung der Formel III mit der Säure, ungefähr pH 1,0 bis pH 4,0 ist.

6. Verfahren gemäß Anspruch 5, wobei der pH ungefähr 1,5 bis pH 3,5 ist.

7. Verfahren gemäß Anspruch 1, wobei die Temperatur des Reaktionsgemisches, gebildet durch Umsetzung der Verbindung der Formel III mit der Säure, ungefähr 20 °C bis 120 °C ist.

8. Verfahren gemäß Anspruch 1, wobei
X Wasserstoff ist;
Y und Z jeweils unabhängig Wasserstoff oder C_1-C_6-Alkyl, gegebenenfalls substituiert mit einer bis drei C_1-C_4-Alkoxygruppen ist; und Y und Z zusammen einen Ring bilden können, in dem YZ dargestellt wird durch die Struktur:

-CH = CH-CH = CH-;

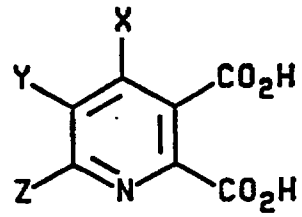
und
R_1 und R_2 jeweils unabhängig C_1-C_4-Alkyl ist.

9. Verfahren gemäß Anspruch 8, wobei die Verbindung der Formel I ausgewählt wird aus der Gruppe, bestehend aus 5-Ethyl-2,3-pyridindicarbonsäure; 2,3-Pyridindicarbonsäure; 5-Methyl-2,3-pyridindicarbonsäure; 5-(Methoxymethyl)-2,3-pyridindicarbonsäure; und 2,3-Chinolindicarbonsäure.

* C L M S *

Revendications

1. Procédé pour la préparation d'un acide pyridine-2,3-dicarboxylique de formule I



(I)

où

X est l'hydrogène ou le groupe méthyle ; et

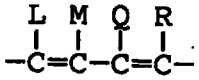
Y et Z sont chacun indépendamment l'hydrogène, un halogène, un groupe alcoxy en C_1-C_6, un groupe alkylthio en C_1-C_4,

un groupe alkyle en C_1-C_6 facultativement substitué par un à trois groupes alcoxy en C_1-C_4,

un groupe phénoxy facultativement substitué par un groupe alkyle en C_1-C_4 ou alcoxy en C_1-C_4, ou

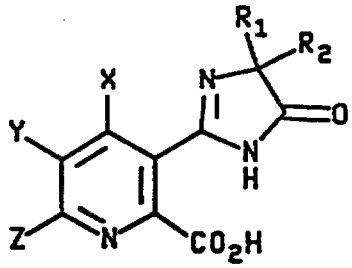
un groupe phényle facultativement substitué par un groupe alkyle en C_1-C_4 ou alcoxy en C_1-C_4 ; et,

s'ils sont pris ensemble, Y et Z peuvent former un cycle dans lequel YZ est représenté par la structure : $-(CH_2)_n-$, où n est le nombre entier 3 ou 4, ou



où L, M, Q et R sont chacun indépendamment l'hydrogène, un groupe alkyle en C_1-C_4 ou un groupe alcoxy en C_1-C_4,

qui est caractérisé en ce qu'on fait réagir un acide 3-(2-imidazoline-2-yl)picolinique de formule II

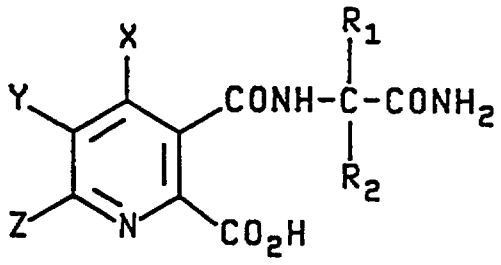


(II)

où X, Y et Z sont tels que définis ci-dessus, R_1 est un groupe alkyle en C_1-C_4 et R_2 est un groupe alkyle en C_1-C_4 ou cycloalkyle en C_3-C_6, et, si R_1 et R_2 sont pris ensemble avec l'atome de carbone auquel ils sont fixés, ils peuvent représenter un groupe cycloalkyle en C_3-C_6 facultativement substitué par un groupe méthyle,

avec un hydroxyde métallique en présence d'eau pour former un acide 3-[(1-carbamoylpropyl)-carbamoyl]picolinique de formule III

* C L M S *



(III)

où X, Y, Z, R_1 et R_2 sont tels que définis ci-dessus,
et on fait réagir ledit composé de formule III avec un acide en présence d'eau pour former l'acide pyridine-2,3-dicarboxylique désiré de formule I.

2. Procédé selon la revendication 1, dans lequel l'hydroxyde métallique est choisi dans le groupe formé par un hydroxyde de métal alcalin et un hydroxyde de métal alcalino-terreux ; l'acide est un acide minéral ; le pH du mélange réactionnel formé en faisant réagir le composé de formule II avec l'hydroxyde métallique est d'environ pH 8,5 à pH 11,5 ; et la température du mélange réactionnel formé en faisant réagir le composé de formule II avec l'hydroxyde métallique est d'environ 20 °C à 120 °C.

3. Procédé selon la revendication 2, dans lequel l'hydroxyde de métal alcalin est choisi dans le groupe formé par l'hydroxyde de sodium et l'hydroxyde de potassium ; et l'acide minéral est choisi dans le groupe formé par l'acide sulfurique, l'acide chlorhydrique et l'acide bromhydrique.

4. Procédé selon la revendication 3, dans lequel le pH du mélange réactionnel formé en faisant réagir le composé de formule II avec l'hydroxyde métallique est d'environ pH 9,0 à pH 11,0.

5. Procédé selon la revendication 1, dans lequel le pH du mélange réactionnel formé en faisant réagir le composé de formule III avec l'acide est d'environ pH 1,0 à pH 4,0.

6. Procédé selon la revendication 5, dans lequel le pH est d'environ pH 1,5 à pH 3,5.

7. Procédé selon la revendication 1, dans lequel la température du mélange réactionnel formé en faisant réagir le composé de formule III avec l'acide est d'environ 20 °C à 120 °C.

8. Procédé selon la revendication 1, dans lequel
X est l'hydrogène ;
Y et Z sont chacun indépendamment l'hydrogène ou un groupe alkyle en C_1-C_6 facultativement substitué par un à trois groupes alcoxy en C_1-C_4 ; et, s'ils sont pris ensemble, Y et Z peuvent former un cycle dans lequel YZ est représenté par la structure :

-CH = CH-CH = CH- ;

et R_1 et R_2 sont chacun indépendamment un groupe alkyle en C_1-C_4.

9. Procédé selon la revendication 8, dans lequel le composé de formule I est choisi dans le groupe formé par l'acide 5-éthylpyridine-2,3-dicarboxylique ; l'acide pyridine-2,3-dicarboxylique ; l'acide 5-méthylpyridine-2,3-dicarboxylique ; l'acide 5-(méthoxyméthyl)pyridine-2,3-dicarboxylique ; et l'acide quinoléine-2,3-dicarboxylique.

* C L M S *