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METHOD FOR PRODUCING HYDROXY CYCLAMMONIUM QUATERNARY SALTS

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8 Claims. (Cl. 260—286)

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This invention relates to method for producing hydroxy cyclammonium quaternary salts.

5-, 6-, 7- and 8-hydroxyquinaldine are known and these can be quaternized by heating with an alkyl salt, e. g. dimethyl sulfate. However, in such a process, the product is not pure hydroxyquinaldine methomethylsulfate, owing to some methylation of the hydroxyl group. The same is true of hydroxylepidines and hydroxy-2,3,3-trimethylindolenines.

Kiprianov, Ushenko and Sych, J. Gen. Chem. U. S. S. R. 15, 200–206 (1945), showed that 6-methoxy-2-methylbenzothiazole could be hydrolyzed with concentrated hydrobromic acid or hydrochloric acid to give 6-hydroxy-2-methylbenzothiazole hydrobromide or hydrochloride. They showed that when 6-methoxy-2-methylbenzothiazole ethobromide was hydrolyzed with hydrobromic acid, not only was the methoxyl group hydrolyzed, but splitting out of alkyl halide took place, so that the 6-hydroxy-2-methylbenzothiazole quaternary salt could not be obtained by such method. To obtain the quaternary salt of 6-hydroxy-2-methylbenzothiazole, Kiprianov et al. were forced to resort to treating the hydrochloride of 6-hydroxy-2-methylbenzothiazole with ethyl-p-toluenesulfonate which tends to contaminate the hydroxy quaternary salt owing to methylation of the hydroxyl group.

We have now found that unlike the ethobromide of 6-methoxy-2-methylbenzothiazole, the alkobromides and the alkoiodides of quinaldines and of lepidines containing an alkoxyl group in the 5-, 6-, 7- or 8-position, can be hydrolyzed, in hydrobromic acid, to give the corresponding hydroxyl quaternary salt, without the splitting out of alkyl halide. Thus pure hydroxy quinaldine and lepidine quaternary salts, free from contaminating alkoxyl derivatives, can be obtained. We likewise have been able to obtain pure hydroxy-2,3,3-trimethylindolenine quaternary salts and pure hydroxynaphthothiazole quaternary salts in the same manner. In our process, the alkobromide is obtained as the hydrolysis product and this can be converted to the alkiodide which, in turn, can be converted to the alkochloride.

It is, accordingly, an object of our invention to provide new hydroxy cyclammonium alkohalides. A further object is to provide a process for preparing hydroxy cyclammonium quaternary salts free from contaminating alkoxy cyclammonium quaternary salts. A still further object is to provide new hydroxy dyes free from contaminating alkoxy dyes. Still further objects will become apparent hereinafter.

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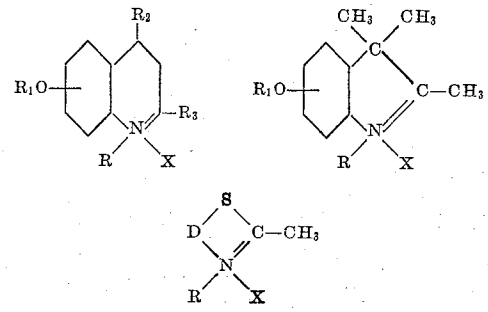
In accordance with our invention, we provide hydroxy cyclammonium quaternary salts which are free from contaminating alkoxy cyclammonium quaternary salts by hydrolyzing, in hydrobromic acid, an alkoxy cyclammonium alkobromide or alkiodide selected from those represented by the following general formulas:



wherein R represents an alkyl group, especially a primary alkyl group, e. g. methyl, ethyl, n-propyl, n-butyl, isobutyl, etc., R_1 represents an alkyl group, e. g. methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, etc., R_2 and R_3 each represents a hydrogen atom or a methyl group, R_2 and R_3 always being different, D represents an alkoxy-o-naphthylene group, and X represents the bromide or the iodide anion.

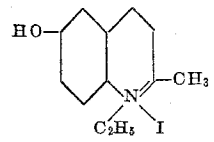
The hydrobromic acid employed advantageously contains from 35 to 48 per cent by weight of hydrogen bromide, the remainder, of course, being water. Constant boiling hydrobromic acid, i. e. the 48 per cent, is most advantageously employed. The hydrolysis is carried out most advantageously by refluxing the mixture of hydrobromic acid and alkoxy cyclammonium alkobromide or alkiodide. However, higher or lower temperatures can be used, e. g. temperatures from 80° to 150° C.

The hydrolysis product is a hydroxy cyclammonium alkobromide and this in some cases is advantageously converted to the cyclammonium alkiodide by treating a solution of the hydrolysis product with an aqueous or alcoholic solution of a water-soluble metal iodide, e. g. an alkali metal iodide, e. g. sodium or potassium iodide. The hydroxy cyclammonium alkiodide can be converted to the hydroxy cyclammonium alkochloride by heating the hydroxy cyclammonium alkiodide with a suspension of silver chloride in methyl alcohol, or with a suspension of silver chloride in a phenol, according to the process described in United States Patent 2,245,249, dated June 10, 1941. The alkobromide can be regenerated from the alkochloride by treating a solution of the

alkochloride with a concentrated aqueous solution of sodium or potassium bromide.

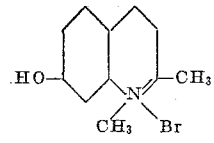
The following examples will serve to illustrate further the manner of practicing our invention.

Example 1.—6-hydroxyquinaldine ethiodide



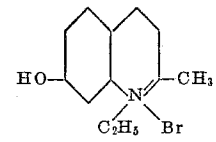
49.4 g. of 6-methoxyquinaldine ethiodide were refluxed for three hours with 75 cc., 48 per cent hydrobromic acid. The brown solution was chilled and the solid which separated was filtered off. It was dissolved in 200 cc. of ethyl alcohol and to the hot solution was added a solution of 33.8 g. sodium iodide in a minimum of ethyl alcohol. The resulting solution was cooled, the solid was filtered off. It was washed with a small amount of cold ethyl alcohol and dried. A yield of 35.2 g., 74 per cent was obtained. Melting point 257–60° C. with decomposition-tan crystals.

Example 2.—7-hydroxyquinaldine methobromide



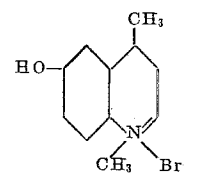
15.75 grams of 7-methoxyquinaldine methiodide and 35 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed for 1½ hours. The reaction mixture was chilled to 0° C. On stirring, it set to a solid mass. It was chilled again to 0° C. and then filtered, washed with acetone and dried. A yield of 9.2 grams of colorless material was obtained.

Example 3.—7-hydroxyquinaldine ethobromide



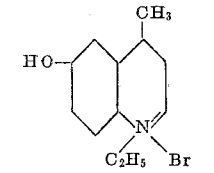
16.5 grams of 7-methoxyquinaldine ethiodide and 30 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 1½ hours. The solution was chilled to 0° C. and diluted with 3 volumes of acetone and chilled for 2 hours at 0° C. The separated solid was filtered off, washed with acetone and dried. A yield of 9.8 grams of colorless material was obtained.

Example 4.—6-hydroxylepidine methobromide



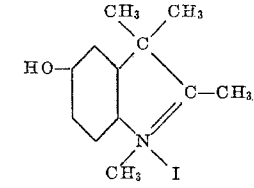
29.5 grams of 6-methoxylepidine methiodide and 50 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 1 hour. The solution was cooled with ice water and stirred until crystals separated. It was chilled an additional hour at 0° C. The separated solid was filtered off, washed with acetone and dried. A yield of 21.4 grams of colorless material was obtained.

Example 5.—6-hydroxylepidine ethobromide



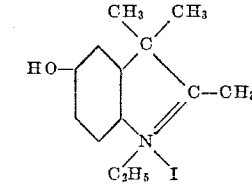
30 grams of 6-methoxylepidine ethiodide and 50 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 1 hour. The reaction mixture was cooled to room temperature and 250 cc. of acetone added and the mixture chilled to 0° C. The separated solid was filtered off, washed with acetone and dried. A yield of 19.3 grams of colorless material was obtained.

Example 6.—5 - hydroxy - 2,3,3 - trimethylindolenine methiodide



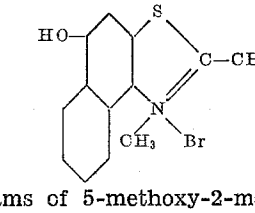
33.1 grams of 5-methoxy-2,3,3-trimethylindolenine methiodide and 60 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 1½ hours. The reaction mixture was chilled to 0° C. and the separated solid was filtered as dry as possible. The wet material is dissolved in ethyl alcohol and treated with a hot solution of 15 grams of sodium iodide in ethyl alcohol. The mixture was chilled to 0° C. and the separated solid was filtered off and dried. A yield of 16.5 grams of colorless solid was obtained of melting point 271–272° C. with decomposition.

Example 7.—5-hydroxy-2,3,3-trimethylindolenine ethiodide



34.5 grams of 5-methoxy-2,3,3-trimethylindolenine ethiodide and 60 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 1½ hours. The solution was chilled to 0° C. and stirred to prevent supercooling. The separated solid was filtered as dry as possible. The crude material was dissolved in 200 cc. ethyl alcohol in the hot and treated with 15 grams of sodium iodide. Some solid separated immediately and was filtered off. The filtrate was chilled to 0° C. The solid which separated was filtered off and dried. A yield of 17.5 grams of colorless solid of melting point 210–213° C. with decomposition was obtained.

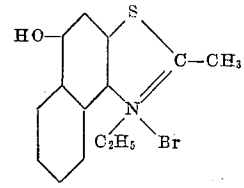
Example 8.—5-hydroxy-2-methylnaphtho[1,2]-thiazole methobromide



17.5 grams of 5-methoxy-2-methyl naphtha-[1,2]thiazole methiodide and 30 cc. of 48 per

cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 1¼ hours. The reaction mixture was chilled and the solid which separated was filtered off and washed with acetone and dried. A yield of 15 grams of colorless material was obtained.

Example 9.—5-hydroxy-2-methylnaphtho[1,2]-thiazole ethobromide



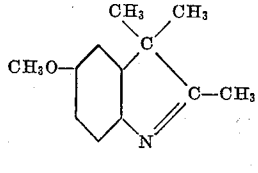
14.2 grams of 5-methoxy-2-methyl naphtha-[1,2]thiazole ethiodide and 30 cc. of 48 per cent hydrobromic acid were mixed in a 200 cc. flask and refluxed 2 hours. The reaction mixture was chilled to 0° C. and the separated solid was filtered off, washed lightly with water and dried. A yield of 12 grams of colorless solid was obtained.

In a manner similar to that illustrated in Example 1, 5-hydroxyquinaldine ethiodide can be prepared by replacing the 6-methoxyquinaldine ethiodide with a molecularly equivalent amount of 5-ethoxyquinaldine ethiodide, 6-hydroxyquinaldine n-propiodide can be prepared by replacing the 6-methoxyquinaldine ethiodide with the n-propiodide, 6-hydroxyquinaldine n-butiodide can be prepared by replacing the 6-methoxyquinaldine ethiodide with the n-butobromide, etc.

The alkoxy cyclammonium quaternary salts which we employ in our process can be prepared by heating the corresponding alkoxy heterocyclic nitrogen bases with an alkyl bromide or alkyl iodide, e. g. methyl iodide, ethyl iodide, n-propyl iodide, n-butyl bromide, n-propyl bromide, isobutyl bromide, n-butyl iodide, etc., using a closed tube where higher temperatures are desired or the volatility of the reactants demands.

The alkoxy heterocyclic nitrogen bases are known in several instances. The alkoxyquinaldines can be prepared by the interaction of an alkoxyaniline with paraldehyde (or aldol), nitrobenzene and sulfuric acid, according to the process given by Doebner and Miller, Ber. 16, 2465 (1886). Thus p-methoxyaniline (p-anisidine gives 6-methoxyquinaldine. See also Braunholtz, J. Chem. Soc. 121, 169 (1922). The alkoxylepidines can be prepared by heating an alkoxyaniline with methyl vinyl ketone, Campbell et al., J. Am. Chem. Soc. 67, 86 (1945). 5-alkoxy-2-methylnaphtho[1,2]thiazoles are described in British Patent 593,025, complete accepted October 7, 1947. 8-alkoxyl-2-methylnaphtho[1,2]thiazoles are described in British Patent 411,479, accepted June 5, 1934. Alkoxy-2,3,3-trimethylindolenines can be prepared by heating an alkoxyphenylhydrazine with methyl isopropyl ketone and refluxing the resulting mixture with glacial acetic acid. The following example will serve to illustrate further the preparation of the alkoxy-2,3,3-trimethylindolenines.

Example 10.—5-methoxy-2,3,3-trimethylindolenine



33.8 grams of p-methoxyphenylhydrazine and 23.3 grams of methylisopropyl ketone were mixed in a 200 cc. flask and warmed on a steam bath until water was formed as shown by the appearance of water droplets. 70 cc. of glacial acetic acid was then added and the solution was refluxed 3 hours. The solvent was removed under reduced pressure on a steam bath and the residue taken up in dilute hydrochloric acid (240 cc. of about 6 per cent hydrochloric acid). The solution was filtered and the filtrate was made alkaline with sodium carbonate solution. The oil was extracted with diethyl ether, the ether solution dried with potassium carbonate and the ether removed on a steam bath. The residue was distilled under reduced pressure. Boiling point 140–145°/mm. A yield of 20.6 grams was obtained which was 40 per cent of the theoretical.

The hydroxy cyclammonium alkohalides of our invention can be employed to prepare cyanine, styryl and merocyanine dyes. Thus, the hydroxy cyclammonium alkohalides can be condensed with cyclammonium alkyl quaternary salts containing an iodine atom or a thioether group in a reactive position (i. e. the α- or γ-position) to give monomethine cyanine dyes containing a hydroxyl group. The condensations are advantageously effected in the presence of a basic condensing agent, e. g. a tertiary amine, e. g. a trialkylamine, such as triethylamine, tri-n-propylamine, triisoamylamine, N-methylpiperidine, N-ethylpiperidine, etc. Typical cyclammonium alkyl quaternary salts containing an iodine atom or thioether group are: 2-iodoquinoline ethiodide, 2-iodoquinoline n-butiodide, 2 - methylmercaptobenzothiazole metho - p-toluenesulfonate, 2 - methylbenzoxazole etho - p-toluenesulfonate, 2-methylmercapto-β-naphthothiazole etho-p-toluenesulfonate, etc.

The hydroxy cyclammonium alkohalides can be condensed with alkyl orthocarboxylates, e. g. ethyl orthoformate, ethyl orthoacetate, ethyl orthoproprionate methyl orthoformate, etc., in pyridine, to give symmetrical carbocyanine dyes.

The hydroxy cyclammonium alkohalides can be condensed with cyclammonium quaternary salts containing, in a reactive position, a β-arylaminovinyl or a β-acylated arylaminovinyl group to give unsymmetrical carbocyanine dyes. The condensations are advantageously effected in the presence of a basic condensing agent, e. g. the tertiary amines set forth above. Typical cyclammonium quaternary salts containing a β-arylaminovinyl or β-acylated arylaminovinyl group are: β - acetanilidovinylbenzoxazole ethiodide, β-anilinovinylthiazoline methiodide, β-acetanilidovinylbenzothiazole ethiodide, 4 - (β - anilinovinyl) quinoline n-butiodide, 2 - [2 - (N - methylanilino) vinyl]benzothiazole ethiodide, 2 - β - acetanilidovinyl-4-methylthiazole ethiodide, etc.

The hydroxycyclammonium alkohalides can be condensed with β-anilinoacrolein anil hydrochloride or with glutaconic dianilide hydrochloride, in the presence of a basic condensing agent, e. g. a tertiary amine, e. g. those set forth above, to give di- and tricarbocyanine dyes.

The hydroxy cyclammonium alkohalides can be condensed with heterocyclic compounds containing a ketomethylene group (—CH_2—CO—) and alkyl orthocarboxylates, e. g. ethyl orthoformate, ethyl orthoacetate, ethyl orthopropionate, etc., in the presence of pyridine, to give mercarbocyanine dyes. Typical ketomethylene compounds include rhodanine, 3-ethylrhodanine, 3-β-hydroxyethylrhodanine, 3-phenylrhodanine,

3 - ethyl - 2,4(3,5) - oxazoledione, 1 - methyl-3 - phenyl - 5 - pyrazolone, 3 - β - carboxyethyl-rhodanine, 3 - p - carboxyphenylrhodanine, 3 - carboxymethyl - 2,4(3,5) - orazoledione, 1 - methyl - 3 - p - sulfophenyl - 5 - pyrazolone, 1,3 - diphenyl - 2 - thiohydantoin, 1 - ethyl - 3-phenyl - 2 - thiohydantoin, 1 - carboxymethyl-3 - phenyl - 2 - thiohydantoin, 3 - β - sulfoethyl-rhodanine, etc.

The hydroxy cyclammonium alkohalides can be condensed with heterocyclic compounds containing, substituted on the methylene group, an acylated arylaminomethylene group, e. g. 5-acetanilidomethylenerhodanines, 5 - acetanilidomethylene - 2 - thiohydantoins, 5 - acetanilidomethylene - 2 - thio - 2,4(3,5) - oxazolediones, etc., in the presence of a basic condensing agent, e. g. the tertiary amines set forth above.

The hydroxy cyclammonium alkohalides can be condensed with dialkylaminobenzaldehydes, e. g. p-dimethylaminobenzaldehyde, p-diethylaminobenzaldehyde, etc. to give styryl dyes. The condensations are advantageously carried out in the presence of a secondary amine, e. g. piperidine, methylpiperidines, etc.

The hydroxy cyclammonium alkohalides can be condensed with pyrrole carboxaldehydes to give pyrrolocarbocyanine dyes. The condensations are advantageously carried out in a solvent, e. g. methyl, ethyl, n-propyl, isopropyl, isobutyl or n-butyl alcohol. Pyrrole carboxaldehydes can be prepared by the method of Nenitzescu and Isacescu, Bull. soc. chim. Romania 11, 135 (1929). See also Brooker and Sprague, J. Am. Chem. Soc. 67, 1869 (1945).

The hereindescribed cyanine, merocyanine and styryl dyes sensitize photographic silver halide emulsions, especially the customarily employed gelatino-silver-chloride, chlorobromide, chlorobromoiodide, bromide and bromoiodide emulsions, when incorporated therein, e. g. in a concentration of from 10 to 40 mg. per liter of emulsion. The dyes can be added to the emulsions from their solutions in methyl alcohol. The pyrrolocyanine dyes described herein can be employed for the preparation of overcoating layers, filter layers and anti-halation layers for photographic elements.

Among the dyes that have been prepared from the hereindescribed hydroxycyclammonium salts are:

6,6' - dihydroxy - 3,3' - dimethyl - 4,5,4',5' - dibenzothiacarbocyanine bromide, fine dark crystals, M. P. greater than 300° C.

3,3' - diethyl - 6,6' - dihydroxy - 4,5,4',5' - dibenzothiacarbocyanine bromide, very fine dark crystals, melting with slow decomposition from 285° C.

6,6' - dihydroxy - 3,3' - dimethyl - 9 - ethyl - 4,5,4',5'-dibenzothiacarbocyanine bromide, fine dark crystals, melting from 275° C. with slow decomposition.

5,5' - dihydroxy - 1,3,3,1',3',3' - hexamethylindocarbocyanine iodide, stout green needles with bright reflex, M. P. greater than 325° C.

4 - [(5 - hydroxy - 1,3,3 - trimethylindolylidene) - ethylidene] - 3 - methyl - 1 - phenyl - 4(5) - pyrazolone, orange crystals with bright reflex, M. P. 321–322° C. with decomposition.

7,7' - dihydroxy - 1,1' - dimethyl - 2,2' - carbocyanine iodide, very dark green crystals, M. P. 323–324° C. with decomposition.

1,1' - diethyl - 7,7' - dihydroxy - 2,2' - carbocyanine iodide, fine blue-green powder, M. P. 315–316° C. with decomposition.

1,1' - diethyl - 7 - hydroxy - 2,2' - cyanine iodide, fine dark red cubes, M. P. 277 to 280° C. with decomposition.

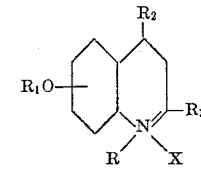
3 - ethyl - 5 - [(3 - ethyl - 5 - hydroxyquinolylidene) - ethylidene]rhodanine, purple crystals, M. P. 312–313° C. with decomposition.

6,6' - dihydroxy - 1,1' - dimethyl - 4,4' - carbocyanine bromide, very fine dark powder, M. P. 275–276° C. with decomposition.

1,1' - diethyl - 6,6' - dihydroxy - 4,4' - carbocyanine bromide, very fine green powder, M. P. 267–268° C., with decomposition.

What we claim as our invention and desire to be secured by Letters Patent of the United States is:

1. A process for preparing a hydroxy cyclammonium quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of hydrobromic acid, an alkoxy cyclammonium salt selected from the group consisting of those represented by the following general formula:



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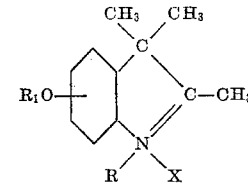

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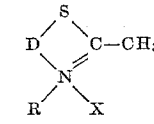
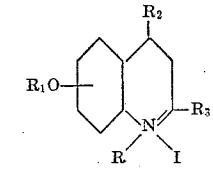


wherein R represents an alkyl group, R_1 represents an alkyl group, R_2 and R_3 each represents a member selected from the group consisting of a hydrogen atom and a methyl group, R_2 and R_3 always being different, D represents an alkoxy-o-naphthylene group, and X represents a number selected from the group consisting of the bromide and the iodide anion.

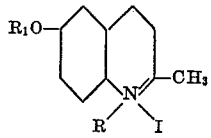
2. A process for preparing a hydroxy cyclammonium quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of hydrobromic acid, an alkoxy cyclammonium salt selected from the group consisting of those represented by the following general formula:



wherein R representsd a primary alkyl group of the formula C_nH_{2n+1} wherein n represents a positive integer of from 1 to 4, R_1 represents an alkyl group of the formula C_nH_{2n+1} wherein n presents a positive integer of from 1 to 2, and R_2 and R_3 each represents a member selected from the group

consisting of a hydrogen atom and a methyl group, R_2 and R_3 always being different.

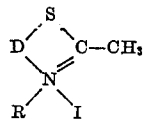
3. A process for preparing a hydroxy cyclammonium quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of hydrobromic acid, an alkoxy cyclammonium quaternary salt selected from the group consisting of those represented by the following general formula:



wherein R represents a primary alkyl group of the formula C_nH_{2n+1} wherein n represents a positive integer of from 1 to 4, and R_1 represents a positive integer of the formula C_nH_{2n+1} wherein n represents a positive integer of from 1 to 2.

4. A process for preparing a hydroxyquinaldine quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of constant boiling hydrobromic acid, 6-methoxyquinaldine ethiodide.

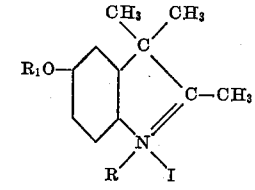
5. A process for preparing a hydroxy cyclammonium quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of hydrobromic acid, an alkoxy cyclammonium quaternary salt selected from the group consisting of those represented by the following general formula:



wherein D represents an alkoxy-o-naphthylene group, and R represents a primary alkyl group of the formula C_nH_{2n+1} wherein n represents a positive integer of from 1 to 4.

6. A process for preparing a hydroxynaphthothiazole quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of constant boiling hydrobromic acid, 5-methoxy-2-methylnaphtha[1,2]thiazole ethiodide.

7. A process for preparing hydroxy cyclammonium quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of hydrobromic acid, an alkoxy cyclammonium quarternary salt selected from the group consisting of those represented by the following general formula:



wherein R represents a primary alkyl group of the formula C_nH_{2n+1} wherein n represents a positive integer of from 1 to 4 and R_1 represents an alky group of the formula C_nH_{2n+1} wherein n represents a positive integer of from 1 to 2.

8. A process for preparing a hydroxy-2,3,3-trimethylindolenine quaternary salt comprising hydrolyzing at a temperature of from 80° to 150° C., in the presence of constant boiling hydrobromic acid, 5-methoxy-2,3,3-trimethylindolenine ethiodide.

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