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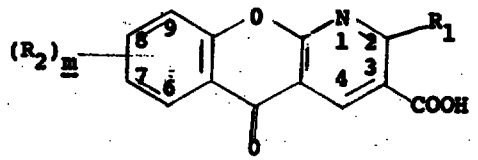
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(54) 1-AZAXANTHONE-3-CARBOXYLIC ACIDS

(71) We, TAKEDA YAKUHIN KOGYO KABUSHIKI KAISHA, also known as TAKEDA CHEMICAL INDUSTRIES LTD., a body corporate organised under the laws of Japan of 27, Doshomachi 2-chome, Higashi-ku, Osaka, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to novel 1-azaxanthone-3-carboxylic acid and its derivatives which have excellent pharmacological activities. More particularly, the present invention provides novel 1-azaxanthone-3-carboxylic acid and its derivatives of the formula (I):

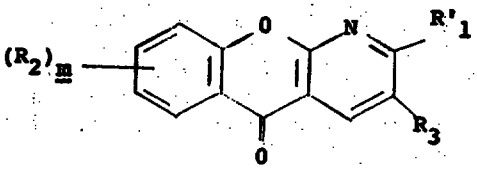


(I)

wherein R_1 is hydrogen, alkyl, phenyl, carboxyl, hydroxyl, alkoxy or amino, which may be unsubstituted or substituted by one alkyl; *m* is 0, 1 or 2; and R_2 is alkyl, alkoxy, halogen, nitro, hydroxy, carboxyl, butadienylene (—CH = CH—CH = CH—) which forms a benzene ring with any adjacent carbon atoms, or amino, which may be unsubstituted or substituted by at least one alkyl,

and their physiologically acceptable salts, which have excellent pharmacological activities such as antiallergic and bronchodilating activities.

The desired compounds of formula (I) may be produced by hydrolysing the compounds of formula (II):



(II)

wherein R'_1 is hydrogen, alkyl, phenyl, alkoxycarbonyl, hydroxyl, alkoxy or amino, which may be unsubstituted or substituted by one alkyl; *m* and R_2 have

the same meaning as defined above; and R_3 is cyano, alkoxycarbonyl or carboxamide, which may be unsubstituted or substituted by at least one alkyl.

Certain compounds within the scope of formula (II) are described and claimed in our copending Application No. 30850/79 divided from the present Application Serial No. 1,597,025.

The substituents designated in each of the above-mentioned formulae may be substituted at an optional position or optional positions of the 6-, 7-, 8- or 9-positions of the azaxanthone ring.

In the formula (I), the alkyl group represented by R_1 and R_2 may be any of straight-chain, branched or cyclic alkyl groups having 1 to 6 carbon atoms. Typical examples of the alkyl group may be methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec.-butyl, tert.-butyl, pentyl, cyclopentyl, hexyl and cyclohexyl. Among them, for practical purposes, lower alkyls having 1 to 3 carbon atoms are preferred.

The alkoxy group represented by R_1 and R_2 may, for example, be that having 1 to 4 carbon atoms in the alkyl moieties, such as, e.g. methoxy, ethoxy, propoxy, isopropoxy or butoxy.

The mono-alkyl substituted amino group represented by R_1 may be that having 1 to 3 carbon atoms in the alkyl moieties, such as methylamino, ethylamino, propylamino is isopropylamino. The halogen represented by R_2 may be chlorine, bromine, iodine or fluorine.

The alkyl-substituted amino group represented by R_2 includes mono- or di-alkyl substituted amino groups whose alkyl moiety is that having 1 to 3 carbon atoms, e.g. methylamino, ethylamino, propylamino, isopropylamino, dimethylamino, diethylamino or dipropylamino.

In the formula (II), the alkyl group represented by R'_1 may be any of straight-chain, branched or cyclic alkyl groups having 1 to 6 carbon atoms. Typical examples of the alkyl group may be methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec.-butyl, tert.-butyl, pentyl, cyclopentyl, hexyl or cyclohexyl. Among them, for practical purposes, lower alkyls having 1 to 3 carbon atoms are preferred.

The alkoxy group represented by R'_1 may, for example be that having 1 to 4 carbon atoms in the alkyl moieties, such as methoxy, ethoxy, propoxy, isopropoxy or butoxy.

The mono-alkyl substituted amino group represented by R'_1 may be that having 1 to 3 carbon atoms in the alkyl moieties, such as methylamino, ethylamino, propylamino or isopropylamino. The alkoxycarbonyl groups R'_1 and R_3 are represented by the formula $-COOR_4$, wherein R_4 is a straight-chain alkyl having 1 to 6 carbon atoms, e.g. methyl, ethyl, *n*-propyl, *n*-butyl or *n*-hexyl.

The alkyl-substituted carboxamide group represented by R_3 includes mono- or di-alkyl substituted carbonamide groups whose alkyl moiety is alkyl having 1 to 3 carbon atoms. Typical examples of these groups are, e.g. N-methyl carboxamide, N,N-dimethyl carboxamide, N-ethyl carboxamide, N,N-diethyl carboxamide and N-propyl carboxamide.

The compounds of the formula (I) according to this invention may be produced by hydrolysing the compounds of the formula (II) above. This hydrolysis reaction can be accomplished under acidic or alkaline conditions, the hydrolysis under acid conditions being preferred. Thus, for the purpose, a mineral acid such as, e.g. hydrochloric acid, sulphuric acid, perchloric acid or phosphoric acid, or an organic acid such as, e.g. trifluoroacetic acid, formic acid or acetic acid may be employed. Generally, this reaction is preferably conducted in the presence of water and in a mixture of an organic acid with a mineral acid. While the temperature, time and other conditions of the reaction are not particularly critical, the reaction is generally carried out at from 50 to 150°C for a time varying from one hour to 2 days.

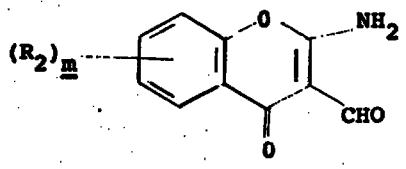
The compound of the general formula (I) wherein R_1 is carboxyl may be converted to a compound wherein R_1 is hydrogen by heating the former compound at a temperature slightly higher than the temperature conducive to decarboxylation, and in the presence or the absence of a solvent.

The compound of the general formula (I) can be converted to the corresponding organic amine salts, alkali metal salts or ammonium salts by reacting the compound (I) in the *per se* conventional manner with an organic amine (e.g. ethanolamine, diethanolamine, dl-methylephedrine, 1-(3,5-dihydroxyphenyl)-L-isopropylaminoethanol, isoproterenol, dextromethorphan, hetrazan (diethylcarbamazine), diethylamine or triethylamine), an alkali metal hydroxide (e.g. sodium hydroxide or potassium hydroxide) or ammonia, for example, by mixing them together and heating in a suitable solvent.

The resulting compounds (I) or salts have antiallergic properties and the particular organic amine salts just mentioned have particularly excellent anti-allergic activity, thus being of value as prophylactic and curative drugs for the treatment of allergic asthma, allergic dermatitis, hay fever and other allergic diseases in mammals including human beings. Further, these alkali metal salts and organic amine salts are soluble in water and the resulting aqueous solutions are stable, thus being suitable for the preparation of such dosage forms as injectable solutions and aqueous solutions.

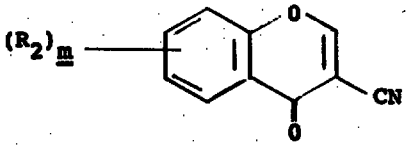
When a compound of the general formula (I) or a salt thereof is used for the prevention or the treatment of said allergic diseases in adult humans, it can be orally administered at the usual dose level of about one to 500 mg/day in such dosage forms as tablets, capsules, powders or solutions, or administered by other routes in such dosage forms as injectable solutions, inhalations or ointments.

The starting compounds of the formula (II) can be produced by the following procedure. Thus, the compound of the formula (III):



(III)

(wherein m and R_2 have the same meaning as defined above), can be produced by reacting a compound of the general formula (IV):



(IV)

(wherein m and R_2 have the same meaning as defined above), which is obtainable by the process described in U.S. Patent No. 3,896,114, with water in the presence of a base. As the base there may be mentioned, e.g. organic amines such as primary amines (e.g. ethylamine, *n*-propylamine, *n*-butylamine, benzylamine or aniline), secondary amines (e.g. dimethylamine, diethylamine, dipropylamine, dibutylamine, piperidine or pyrrolidine), tertiary amines (e.g. triethylamine), heterocyclic bases (e.g. imidazole, 2-methylimidazole or morpholine), and inorganic bases such as aqueous ammonia, ammonium acetate, ammonium carbonate, sodium acetate, sodium carbonate or sodium bicarbonate. The amount of such base is not particularly critical and may range from a catalytic amount to a large excess.

The reaction is generally conducted in a solvent which is miscible with water. As examples of the solvent there may be mentioned dimethylformamide, dimethylsulphoxide, hexamethylphosphoric acid triamide, organic acids (e.g. formic acid, acetic acid or propionic acid) and ethers (e.g. tetrahydrofuran or dioxane). While the temperature, time and other conditions of the reaction are not particularly critical, the reaction is generally carried out at from room temperature to 100°C for a time varying from a few minutes to 3 hours.

A compound of the formula (II) may be produced by reacting a compound of the formula (III) with an active methylene compound, an acetylene-carboxylic acid derivative in an organic solvent, or a cyanoacetyl halide in the presence of a substituted formamide.

As examples of the active methylene compound to be employed in the reaction, there may be mentioned methyl acetoacetate, ethyl acetoacetate, methyl cyanoacetate, ethyl cyanoacetate, cyanoacetamide, malononitrile, ethyl oxaloacetate, diethyl malonate, dimethyl malonate, ethyl benzoylacetate and methyl 3-oxo-*n*-caproate. Normally, for practical purposes, from 1 to 10 molar equivalents of the active methylene compound are employed for each molar equivalent of the compound (III).

The above reaction is preferably conducted in the presence of a base which may be an organic amine. The organic amine may be a primary amine such as *n*-

butylamine, benzylamine or aniline; a secondary amine such as diethylamine, dipropylamine, dibutylamine, piperidine or pyrrolidine; a tertiary amine such as 1,8-diazabicyclo-(5,4,0)-7-undecene or triethylamine; or a heterocyclic base such as imidazole, 2-methylimidazole or morpholine. The proportion of the organic base is normally from a catalytic amount to 5 molar equivalents per mole of compound (III).

Generally, the reaction is conducted in an organic solvent. As examples of the solvent there may be mentioned alcohols such as methanol, ethanol, propanol or butanol; aromatic hydrocarbons such as benzene or toluene; and dimethylformamide. Although the reaction temperature, the reaction time and the other conditions are virtually optional, it is generally desirable to conduct the reaction at a temperature somewhere between room temperature and near the boiling point of the solvent used for from one to 24 hours.

The compounds of the invention may also be obtained by the following procedure. Thus, a compound of the general formula (III) is reacted with an acetylene-carboxylic acid derivative. As examples of the acetylene-carboxylic acid derivative, there may be mentioned dimethyl acetylenedicarboxylate, diethyl acetylenedicarboxylate, methyl propiolate, ethyl propiolate and cyanoacetylene. Where a propiolic acid ester is employed, the intermediate aminoacrylate derivative may be isolated or may be further subjected to a cyclisation reaction. The acetylenedicarboxylic acid derivative may be used, normally and in practice, in a proportion of from one to 10 molar equivalents per mole of compound (III).

Generally, the above reaction is conducted in the presence of a base which may be an organic amine. As examples of such organic amine there may be mentioned tertiary amines such as triethylamine, tripropylamine or tributylamine; heterocyclic amines such as pyridine, quinoline, imidazole, 2-methylimidazole or morpholine; and secondary amines such as piperidine, pyrrolidine, diethylamine, dipropylamine or dibutylamine. The organic base is normally employed in a proportion from a catalytic amount to 10 molar equivalents per mole of starting compound (II).

Generally speaking, this reaction is desirably conducted in an organic solvent. As examples of the solvent there may be mentioned alcohols such as methanol, ethanol, propanol or butanol; aromatic hydrocarbons such as benzene, toluene or xylene; dimethylformamide; and so on. While the temperature, the time and the other conditions of the reaction are not particularly critical, the reaction is generally conducted at a temperature somewhere between room temperature and near the boiling point of the solvent employed for a time ranging from one to 24 hours.

The compounds of the general formula (II) according to this invention can be produced by the following process. Thus, the compound (II) may be produced by reacting a compound of the general formula (III) with a cyanoacetyl halide in the presence of a substituted formamide. The cyanoacetyl halide employed in this reaction may, for example, be cyanoacetyl chloride, cyanoacetyl bromide, cyanoacetyl iodide or cyanoacetyl fluoride. The substituted formamide used in this reaction may be an alkyl or aryl-substituted formamide, such as N,N-dimethylformamide, N,N-diethylformamide, N,N-dipropylformamide, N-methyl-N-ethylformamide, N-methyl-N-phenylformamide or N,N-diphenylformamide. This reaction may be conducted in the presence of such a substituted formamide alone, i.e. using it as the reaction solvent, although the reaction may be carried out, if required, in a solvent mixture of said substituted formamide with an extraneous solvent that will not interfere with the reaction. The solvent just mentioned is preferably one of the common organic solvents such as hydrocarbons (e.g. benzene, toluene, xylene or petroleum ether), ethers (e.g. tetrahydrofuran, dioxane, ethyl ether or ethylene glycol dimethylether), halogenated hydrocarbons (e.g. chloroform, dichloromethane, dichloroethane or tetrachloroethane), esters (e.g. ethyl acetate, methyl acetate or butyl acetate), acetonitrile, or dimethylsulfoxide. The proportion of cyanoacetyl halide used in the production of the compound (II) is normally in the range of from 1 to 10 molar equivalents based on the starting compound (III). While the temperature, the time and the other conditions of reaction are not particularly critical, the reaction is normally carried out at from 20°C to 120°C for from 30 minutes to 2 days. The proportion of said substituted formamide is not particularly critical either. It is, however, preferably used in a proportion of 2 or more molar equivalents based on the starting compound (III).

A compound (II) wherein R'_1 is alkoxy may be produced by, for example, reacting a compound (II) wherein R'_1 is hydroxy with diazomethane or an alkyl

halide such as methyl iodide, ethyl iodide, propyl iodide, isopropyl iodide, butyl iodide or isobutyl iodide, in the presence of a base (e.g. potassium carbonate).

This reaction is desirably conducted in an organic solvent such as chloroform, dichloromethane, acetone or methyl ethyl ketone. The above reaction is generally conducted at a temperature between 0°C and near the boiling point of the solvent employed for from several minutes to a few hours.

A compound (II) wherein R'_1 is monoalkylamino may be, for example, produced by the following procedure. Thus, it can be produced by reacting a compound (II) wherein R'_1 is chlorine, which is obtainable by reacting a compound (II) wherein R'_1 is hydroxy with a mixture of phosphoryl trichloride and phosphorus pentachloride at from 100°C to 120°C for a time varying from several hours to a few days, with a monoalkylamine such as methylamine, ethylamine or propylamine. Generally, the reaction is conducted in an organic solvent. As examples of the solvent for dissolving the compound (II) wherein R'_1 is chlorine, there may mentioned chloroform or dichloromethane, and the solvent for dissolving the monoalkylamine is exemplified by methanol, ethanol, propanol or chloroform.

While the temperature, the time and the other conditions of the reaction of a compound (II) wherein R'_1 is chlorine and monoalkylamine are not particularly critical, the reaction is generally carried out at from 0°C to room temperature for from a few minutes to 3 hours.

A compound (II) wherein R'_1 is hydroxy may, for example, be produced by reacting a compound (II) wherein R'_1 is amino with an alkali metal nitrite (e.g. sodium nitrite or potassium nitrite) in an aqueous inorganic or organic acid (e.g. hydrochloric acid or acetic acid).

The invention is further described and illustrated in the following reference examples and examples.

Reference Example 1.

A mixture of 2 ml of morpholine, 3 ml of dimethylformamide and 10 ml of water was heated to 60°C and, under stirring, 1.71 g of finely divided 4-oxo-4H-1-benzopyran-3-carbonitrile was added over a period of 5 minutes. The mixture was heated at that temperature for one hour and the resultant precipitate was recovered by filtration, rinsed with water, recrystallized from acetic acid and washed with chloroform. By the above procedure was obtained 1.32 g crystals of 2-amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde melting at 252—255°C (decomp.).

Nuclear magnetic resonance spectrum (DMSO—d_6) δ:
10.19(1H, s), 9.67(ca 1.5H, br. s), 8.11(1H, dd, J = 2 & 8Hz), 7.97—7.30(3H, m)

Elemental analysis, for $C_{10}H_7NO_3$
Calcd. C, 63.49; H, 3.73; N, 7.41
Found C, 63.59; H, 3.44; N, 7.45

By procedures similar to the above, the following compounds were produced.

Starting compound	Product	m.p. (°C) / Recrys Solvent
6-Methyl-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-methyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	282–284 (decomp.) Acetic acid
6-Ethyl-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	246–249 (decomp.) Acetone
6-Chloro-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde	308–310 (decomp.) Acetic acid
6-Methoxy-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-methoxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	251–254 (decomp.) Chloroform
6,8-Dimethyl-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	259–263 (decomp.) Acetic acid
7-Hydroxy-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-7-hydroxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	297–300 (decomp.) Acetic acid
6-Nitro-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-nitro-4-oxo-4H-1-benzopyran-3-carboxyaldehyde	290–293 (decomp.) Formic acid
6-Isopropyl-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-isopropyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	206–208 Acetic acid
6-n-Butyl-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-n-butyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	220–222 Acetic acid
8-Methoxy-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-8-methoxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	235–238 Chloroform
3-Cyano-benzo[f]-chromone	2-Amino-benzo[f]-chromone-3-carboxaldehyde	258–260 (decomp. with foaming) Acetic acid
6-Dimethylamino-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-dimethyl-amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	276–280 (decomp.) Chloroform-Methanol
6-tert.-Butyl-4-oxo-4H-1-benzopyran-3-carbonitrile	2-Amino-6-tert.-butyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	240–242 Acetic acid

Reference Example 2.

A mixture of 2.17 g. of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 4.0 ml of ethyl acetoacetate, 50 ml of ethanol and 5 ml of piperidine was refluxed under stirring for 2 hours. After cooling, the precipitate was recovered by filtration and recrystallized from ethanol. By this procedure was obtained 1.60 g yellow needles of ethyl 7-ethyl-2-methyl-1-azaxanthone-3-carboxylate melting at 149—151°C.

Infrared absorption spectrum (Nujol)cm^{-1}: 1715, 1665 (Nujol is a Trade Mark)

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.15(1H, s), 8.09(1H, s), 7.37—7.75(2H, m), 4.44(2H, q, J = 7Hz), 2.97(3H, s), 2.81(2H, q, J = 7Hz), 1.45(3H, t, J = 7Hz), 1.33(3H, t, J = 7Hz)

Elemental analysis, for $C_{18}H_{17}NO_4$
Calcd. C, 69.44; H, 5.50; N, 4.50
Found C, 69.58; H, 5.44; N, 4.28

The following compounds were produced by procedures similar to the above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-methyl-1-azaxanthone-3-carboxylate	155—156 Ethanol
2-Amino-6-methoxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 7-methoxy-2-methyl-1-azaxanthone-3-carboxylate	203—205 Ethanol
2-Amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2,7,9-trimethyl-1-azaxanthone-3-carboxylate	165—166 Ethanol
2-Amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 7-chloro-2-methyl-1-azaxanthone-3-carboxylate	175—176 Ethyl acetate
2-Amino-6-nitro-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 7-nitro-2-methyl-1-azaxanthone-3-carboxylate	212-213 Dimethyl-formamide

Reference Example 3

A mixture of 2.17 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 4.0 ml of ethyl cyanoacetate, 50 ml of ethanol and 5.0 ml of piperidine was refluxed for 30 minutes and, after cooling, the crystalline precipitate was recovered by filtration and washed with chloroform. By the above procedure was obtained 2.07 g of colorless needles of ethyl 2-amino-7-ethyl-1-azaxanthone-3-carboxylate, melting at 279—280°C.

Elemental analysis, for $C_{17}H_{16}N_2O_4$
Calcd. C, 65.37; H, 5.16; N, 8.97
Found C, 65.24; H, 5.08; N, 8.86

The following compounds were produced by procedures similar to the above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-1-azaxanthone-3-carboxylate	241–242 Chloroform-ethanol
2-Amino-6-methoxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-7-methoxy-1-azaxanthone-3-carboxylate	285–286 Chloroform-ethanol
2-Amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-7,9-dimethyl-1-azaxanthone-3-carboxylate	299–300 Chloroform-ethanol
2-Amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-7-chloro-1-azaxanthone-3-carboxylate	299–300 Dimethyl-formamide
2-Amino-6-methyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-7-methyl-1-azaxanthone-3-carboxylate	277–279 Chloroform
2-Amino-6-isopropyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-7-isopropyl-1-azaxanthone-3-carboxylate	243–244 Ethanol
2-Amino-8-methoxy-4-oxo-4H-benzopyran-3-carboxaldehyde	Ethyl 2-amino-9-methoxy-1-azaxanthone-3-carboxylate	>300 Dimethyl-formamide
2-Amino-6-n-butyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-7-n-butyl-1-azaxanthone-3-carboxylate	234.5–235 Ethanol
2-Amino-benzo[f]-chromone-3-carboxaldehyde	Ethyl 2-amino-benzo-[h]-1-azaxanthone-3 carboxylate	279–280 Chloroform-ethanol
2-Amino-7-hydroxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 2-amino-8-hydroxy-1-azaxanthone-3-carboxylate	>300 Dimethyl-formamide
2-Amino-6-methoxy-4-oxo-4H-1-benzopyran-3-carboxyaldehyde	Ethyl 2-amino-7-methoxy-1-azaxanthone-3-carboxylate	286–288 Chloroform-ethanol

Reference Example 4

A mixture of 366 mg of 2-amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 500 mg of methyl 3-oxo-n-caproate and 0.6 ml of piperidine in 20 ml of methanol was refluxed for 6 hours. The reaction mixture was concentrated under reduced pressure and the residue was chromatographed on a column of silica gel. Elution was carried out with chloroform and the leading eluate was collected and recrystallized from methanol. By the above procedure was obtained 52 mg yellow crystals of methyl 2-n-propyl-1-azaxanthone-3-carboxylate melting at 105—106°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1725, 1680

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.23(1H, s), 8.35(1H, dd, J = 8 & 2Hz), 7.3—8.0(3H, m), 3.95(3H, s), 3.32(2H, t, J = 7Hz), 1.6—2.3(2H, m), 1.06(3H, t, J = 7Hz)

Elemental analysis, for $C_{17}H_{15}NO_4$
Calcd. C, 68.67; H, 5.08; N, 4.71
Found C, 68.79; H, 5.02; N, 4.62

Reference Example 5.

A mixture of 1.085 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 2.0 ml of ethyl benzoylacetate, 50 ml of ethanol and 1.0 ml of piperidine was refluxed under stirring for 6 hours and, while hot, the small amount of insolubles was filtered off. The filtrate was cooled and the resultant precipitate was recovered by filtration and recrystallized from ethanol. By the above procedure was obtained 635 mg of ethyl 7-ethyl-2-phenyl-1-azaxanthone-3-carboxylate as pale yellow needles melting at 176—177°C.

Infrared absorption spectrum (Nujol) cm^{-1}: 1730, 1675

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.12(1H, s), 8.18(1H, s), 7.30—7.87(7H, m), 4.28(2H, q, J = 7Hz), 2.82(2H, q, J = 7Hz), 1.03—1.53(6H, t + t).

Elemental analysis, for $C_{23}H_{19}NO_4$
Calcd. C, 73.98; H, 5.13; N, 3.75
Found C, 74.10; H, 5.08; N, 3.71

Reference Example 6.

A mixture of 217 mg of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 300 mg of cyanoacetamide, 5 ml of ethanol and 0.5 ml of piperidine was refluxed under stirring for one hour and, after cooling, the sparingly soluble product was collected by filtration and recrystallized from dimethylformamide-acetone. By the above procedure was obtained 180 mg crystals of 2-amino-7-ethyl-1-azaxanthone-3-carboxamide, m.p. >300°C.

Nuclear magnetic resonance spectrum (CF_3COOD) δ:
9.50(1H, s), 8.20(1H, d, J = 2Hz), 7.88(1H, dd), 7.63(1H, d, J = 9Hz), 2.91(2H, q, J = 7Hz), 1.38(3H, t, J = 7Hz)

Elemental analysis, for $C_{18}H_{13}N_3O_3$
Calcd. C, 63.59; H, 4.63; N, 14.83
Found C, 63.40; H, 4.72; N, 14.79

The following compounds were produced by procedures similar to that described above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	2-Amino-1-azaxanthone-3-carboxamide	>300; Dimethylformamide
2-Amino-6-chloro-4H-1-benzopyran-3-carboxaldehyde	2-Amino-7-chloro-1-azaxanthone-3-carboxamide	>300; Dimethylformamide

Reference Example 7.

A mixture of 217 mg of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 300 mg of malononitrile, 5 ml of ethanol and 0.5 ml of piperidine was stirred under reflux for 15 minutes and, after cooling, the sparingly soluble product was collected by filtration and recrystallized from dimethylformamide. By the above procedure was obtained 160 mg of 2-amino-7-ethyl-1-azaxanthone-3-carbonitrile as colorless needles, m.p. >300°C.

Infrared absorption spectrum (Nujol) cm^{-1}:
3325, 3125, 2225, 1660

Nuclear magnetic resonance spectrum (CF_3COOD) δ:
9.07(1H, s), 8.16(1H, d, J = 2Hz), 7.88(1H, dd), 7.63(1H, d, J = 9Hz), 2.92(2H, q, J = 7Hz), 1.39(3H, t, J = 7Hz)

Elemental analysis, for $C_{15}H_{11}N_3O_2$
Calcd. C, 67.91; H, 4.18; N, 15.84
Found C, 67.75; H, 4.01; N, 16.00

The following compounds were produced by procedures similar to that described above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	2-Amino-1-azaxanthone-3-carbonitrile	>300 Dimethylformamide
2-Amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde	2-Amino-7-chloro-1-azaxanthone-3-carbonitrile	>300 Dimethylformamide
2-Amino-6-dimethylamino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	2-Amino-7-dimethylamino-1-azaxanthone-3-carbonitrile	>300 Ethanol
2-Amino-6-isopropyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Isopropyl-2-amino-3-cyano-1-azaxanthone azaxanthone	>300 Dimethylformamide
2-Amino-6-methyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Methyl-2-amino-3-cyano-1-azaxanthone	>300 Dimethylformamide

Reference Example 8.

A mixture of 2.17 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 1.778 g of dimethyl acetylene-dicarboxylate, 50 ml of methanol and 0.5 ml of triethylamine was stirred under reflux for 3 hours and, after cooling, the precipitate was collected by filtration. The precipitate was added to chloroform and, after stirring, the sparingly soluble product was filtered off. The filtrate was concentrated to dryness and dissolved in about 50 ml of n-hexane-chloroform-acetone (10:5:0,5). The solution was run onto a column of silica gel (30 g) and elution was carried out with the same solvent system. The eluate was concentrated and the residue was recrystallized from methanol. By the above procedure was obtained 590 mg of dimethyl 7-ethyl-1-azaxanthone-2,3-dicarboxylate as colorless needles melting at 169—170°C.

Infrared absorption spectrum (Nujol) cm^{-1}: 1745, 1720, 1670

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.20(1H, s), 8.10(1H, d, J = 2Hz), 7.68(1H, dd, J = 2 & 8Hz), 7.52(1H, d, J = 8Hz), 4.05(3H, s), 3.99(3H, s), 2.83(2H, q, J = 7Hz), 1.33(3H, t, J = 7Hz)

Elemental analysis, for $C_{18}H_{15}NO_6$
Calcd. C, 63.34; H, 4.43; N, 4.10
Found C, 63.15; H, 4.30; N, 4.01

Reference Example 9.

A mixture of 1.83 g of 2-amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 1.6 g of dimethyl acetylenedicarboxylate, 50 ml of ethanol and 1 drop of triethylamine was stirred under reflux for 2 hours. The reaction mixture was concentrated under reduced pressure and ether was added to the residue. The crystalline product was collected by filtration, washed with ether and recrystallized from methanol. By the above procedure was obtained 2.06 g of dimethyl 1-azaxanthone-2,3-dicarboxylate as colorless needles melting at 149—151°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1750, 1730, 1675

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.28(1H, s), 8.20(1H, dd, J = 2 & 8 Hz), 7.4—8.0(3H, m), 4.06(3H, s), 4.02(3H, s)

Elemental analysis, for $C_{16}H_{11}NO_6$
Calcd. C, 55.34; H, 2.90; N, 4.03
Found C, 55.25; H, 2.74; N, 3.94

Reference Example 10.

A mixture of 2.17 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 2.55 g of diethyl acetylenedicarboxylate, 50 ml of ethanol and 0.5 ml of triethylamine was refluxed for 2 hours and, while hot, the small amount of sparingly soluble product was filtered off. The filtrate was cooled and the resultant crystals were collected by filtration and recrystallized from ethanol. By the above procedure was obtained 3.2 g of diethyl 7-ethyl-1-azaxanthone-2,3-dicarboxylate as colorless crystals melting at 112—113°C.

Infrared absorption spectrum (Nujol) cm^{-1}: 1745, 1718, 1665

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.28(1H, s), 8.13(1H, s), 7.43—7.83(2H, m), 4.27—4.77(4H, q + q), 2.82(2H, q, J = 7Hz), 1.17—1.62(9H)

Elemental analysis, for $C_{20}H_{18}NO_6$
Calcd. C, 65.03; H, 5.19; N, 3.79
Found C, 65.26; H, 5.02; N, 3.87

Reference Example 11.

A mixture of 217 mg of 2-amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 255 mg of diethyl acetylenedicarboxylate, 10 ml of ethanol and 0.05 ml of triethylamine was refluxed for 3 hours, followed by addition of 150 mg of diethyl acetylenedicarboxylate, 1 ml of ethanol and 2 drops of triethylamine. The mixture was further refluxed for 2 hours. After cooling, the precipitate was collected by filtration and recrystallized twice from ethanol. By the above procedure was obtained 260 mg of diethyl 7,9-dimethyl-1-azaxanthone-2,3-dicarboxylate as yellow crystals melting at 156—159°C.

Infrared absorption spectrum (Nujol) cm^{-1}: 1740, 1725, 1675

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.22(1H, s), 7.90(1H, s), 7.45(1H, s), 4.57(2H, q, J = 7Hz), 4.45(2H, q, J = 7Hz), 2.58(3H, s), 2.43(3H, s), 1.47(6H, t, J = 7Hz)

Reference Example 12.

By a procedure similar to that described in Reference Example 9, dimethyl 7-chloro-1-azaxanthone-2,3-dicarboxylate was produced from 2-amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde. Light-yellow needles (recrys. solvent: ethyl acetate), m.p. 220—223°C.

Elemental analysis, for $C_{16}H_{10}NO_6Cl$
Calcd. C, 55.34; H, 2.90; N, 4.03
Found C, 55.25; H, 2.74; N, 3.94

Reference Example 13.

A mixture of 5.5 g of 2-amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 5 g of ethyl propiolate, 25 ml of dimethylformamide and 0.1 ml of triethylamine was heated under stirring at 90°C for one hour. The reaction mixture was concentrated under reduced pressure and the residue was recrystallized from methanol. By the above procedure was obtained 3.5 g of ethyl 3-N-(3-formyl-4-oxo-4H-1-benzopyran-2-yl)aminoacrylate as colorless needles melting at 201—203°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1700, 1680

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
10.47(1H, s), 8.23(1H, dd, J = 2 & 8Hz), 7.68(1H, d, J = 9Hz), 7.3—7.8(3H, m), 5.45(1H, d, J = 9Hz), 4.38(2H, q, J = 6Hz), 3.66(3H, t, J = 6Hz)

Elemental analysis, for $C_{15}H_{13}NO_5$
Calcd. C, 62.71; H, 4.56; N, 4.88
Found C, 62.47; H, 4.40; N, 4.81

Then, a mixture consisting of 3.5 g of the above ethyl 3-N-(3-formyl-4-oxo-4H-1-benzopyran-2-yl)aminoacrylate, 5 ml of triethylamine and 20 ml of toluene was refluxed for 24 hours. The reaction mixture was concentrated under reduced pressure and the residue was recrystallized from methanol. By the above procedure was obtained 1.42 g of ethyl 1-azaxanthone-3-carboxylate as light-yellow crystals melting at 139—140°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1715, 1670, 1615

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.2—9.4(2H, m), 8.35(1H, dd, J = 2 & 7Hz), 7.2—8.0(3H, m), 4.50(2H, q, J = 8Hz), 1.34(3H, t, J = 8Hz)

Elemental analysis, for $C_{15}H_{11}NO_4$
Calcd. C, 66.91; H, 4.12; N, 5.20
Found C, 66.71; H, 4.00; N, 5.11

Reference Example 14.

A mixture of 2.23 g of 2-amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 5 g of ethyl propiolate, 30 ml of dimethylformamide and 0.1 ml of triethylamine was stirred at 90°C for one hour and, after cooling, filtered to recover the precipitate. The precipitate was washed with methanol, whereby 1.6 g of ethyl 3-N-(3-formyl-6-chloro-4-oxo-4H-1-benzopyran-2-yl)aminoacrylate was obtained as crude crystals. The crystals were stirred with 15 ml of dimethylformamide and 5 ml of triethylamine under heating at 130—140°C for 2 hours. The reaction mixture was concentrated under reduced pressure and the residue was recrystallized from ethanol. By the above procedure was obtained 650 mg of ethyl 7-chloro-1-azaxanthone-3-carboxylate as light-yellow needles melting at 176—177°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1725, 1675

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.37(1H, d, J = 2Hz), 9.27(1H, d, J = 2Hz), 8.30(1H, d, J = 2Hz), 7.80(1H, dd, J = 2 & 8Hz), 7.60(1H, d, J = 8Hz), 4.84(2H, q, J = 7Hz), 1.43(3H, t, J = 7Hz)

Elemental analysis, for $C_{15}H_{10}NO_4Cl$
Calcd. C, 59.32; H, 3.32; N, 4.61
Found C, 59.40; H, 3.18; N, 4.44

Reference Example 15.

By a procedure similar to that described in Reference Example 9, ethyl 7-nitro-1-azaxanthone-3-carboxylate was produced from 2-amino-6-nitro-4-oxo-4H-1-benzopyran-3-carboxaldehyde. Light-yellow platelets (as recrystallized from dimethylformamide), m.p. 228—229°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1720, 1675

Nuclear magnetic resonance spectrum (CF_3CO_2D) δ:
9.1—9.3(2H, br. s.), 8.92(1H, d, J = 2Hz), 8.42(1H, dd, J = 2 & 9Hz), 7.48(1H, d, J = 9Hz), 4.22(2H, q, J = 7Hz), 1.10(3H, t, J = 7Hz)

Elemental analysis, for $C_{15}H_{10}N_2O_6$
Calcd. C, 57.33; H, 3.21; N, 8.92
Found C, 56.96; H, 3.09; N, 8.76

Reference Example 16.

A mixture consisting of 3.17 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 8 g of diethyl malonate, 15 ml of pyridine, 1 ml of 1,8-diazabicyclo[5,4,0]-7-undecene and 50 ml of ethanol was stirred under reflux for 15 hours. The reaction mixture was concentrated under reduced pressure and the residue was made acidic by the addition of dilute hydrochloric acid. The precipitate was recovered by filtration, rinsed with water and recrystallized from ethanol. By the above procedure was obtained 1.23 g of ethyl 7-ethyl-2-hydroxy-1-azaxanthone-3-carboxylate as light-yellow needles melting at 200—204°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1675, 1610

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
1.35(3H, t, J = 7Hz), 1.53(3H, t, J = 7Hz), 2.87(2H, q, J = 7Hz), 4.58(2H, q, J = 7Hz), 7.4—7.8(2H), 8.23(1H, q, J = 2Hz), 9.30(1H, s)

By procedures similar to the above, the following compounds were produced.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-6-methyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 7-methyl-2-hydroxy-1-azaxanthone-3-carboxylate	221—222 : Ethanol
2-Amino-6-methoxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 7-methoxy-2-hydroxy-1-azaxanthone-3-carboxylate	269—270 Chloroform-ethanol
2-Amino-6-n-butyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 7-n-butyl-2-hydroxy-1-azaxanthone-3-carboxylate	142—144 Ethanol
2-Amino-8-methoxy-4-oxo-4H-1-benzopyran-3-carboxaldehyde	Ethyl 9-methoxy-2-hydroxy-1-azaxanthone-3-carboxylate	252—254 Dimethyl-formamide

Reference Example 17.

A mixture consisting of 326 mg of 2-amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, 7.5 ml of ethanol, 2.0 ml of pyridine, 2.0 ml of diethyl

malonate and 0.1 ml of 1,8-diazabicyclo[5,4,0]-7-undecene was refluxed for 4 hours, at the end of which the solvent was distilled off. To the residue was added 1N-hydrochloric acid and the sparingly soluble product was collected by filtration and dissolved in chloroform. The chloroform solution was chromatographed on silica gel and elution was carried out with chloroform-acetone-formic acid (9:1:0.1). The purified product was further recrystallized from ethanol to obtain 20 mg pale yellow crystals of ethyl 2-hydroxy-7,9-dimethyl-1-azaxanthone-3-carboxylate, m.p. 251—253°C.

Infrared absorption spectrum (Nujol) cm^{-1}: 1700, 1675, 1650

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
12.30(1H, br.), 9.22(1H, s), 7.93(1H, s), 7.45(1H, s), 4.55(2H, q, J = 7Hz), 2.57(3H, s), 2.43(3H, s), 1.50(3H, t)

Reference Example 18.

In 40 ml of dimethylformamide was dissolved 1.82 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde, followed by the addition of 3.5 g of cyanoacetyl chloride. The mixture was reacted at 60°C for 3 hours, with constant stirring. The solvent was then distilled off under reduced pressure and the residue was chromatographed on silica gel. The desired product was recovered from the chloroform eluate and recrystallized from acetonitrile. By the above procedure was obtained 1.03 g of 7-ethyl-3-cyano-1-azaxanthone, m.p. 183—185°C.

The following compounds were produced in the same manner as above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-6-methyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Methyl-3-cyano-1-azaxanthone	240–242 Ethanol
2-Amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde	3-Cyano-1-azaxanthone	220–226 Ethanol
2-Amino-6-isopropyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Isopropyl-3-cyano-1-azaxanthone	203–205 Ethanol
2-Amino-6-chloro-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Chloro-3-cyano-1-azaxanthone	286–288 Dimethyl-formamide
2-Amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7,9-Dimethyl-3-cyano-1-azaxanthone	254–257 Acetonitrile
2-Amino-6-tert-butyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-tert.-Butyl-3-cyano-1-azaxanthone	247–249 Acetonitrile

Reference Example 19.

In 20 ml of chloroform was dissolved in 1.0 g of ethyl 7-ethyl-2-hydroxy-1-azaxanthone-3-carboxylate, and to the solution was added dropwise an excess amount of diazomethane dissolved in ether over a period of 15 minutes under stirring at room temperature.

The reaction mixture was further stirred for 45 minutes at room temperature and, then, to the mixture was added small amount of acetic acid to decompose the

excess amount of diazomethane. The solvent was distilled off and, then, the residue was chromatographed on a column packed with 100 g of silica gel, and eluted with chloroformacetone-formic acid (20:1:0.1). The first fraction was recrystallized from acetone to obtain 615 mg of ethyl 7-ethyl-2-methoxy-1-azaxanthone-3-carboxylate as colorless needles, melting point: 145—146°C.

Elemental analysis, for $C_{18}H_{17}NO_5$
Calcd. C, 66.05; H, 5.42; N, 4.28
Found C, 66.12; H, 5.23; N, 4.21

Infrared absorption spectrum (Nujol) cm^{-1}:
1730, 1670, 1605, 1590, 1310, 1240, 1220, 815, 790

Nuclear magnetic resonance ($CDCl_3$) δ:
9.17(1H, s), 8.13)1H, b.s.), 7.55(2H, m), 4.43(2H, q, J = 7Hz), 4.20(3H, s), 2.82(2H, q, J = 7Hz), 1.43(3H, t, J = 7Hz), 1.32(3H, t, J = 7Hz)

Reference Example 20.

To a mixture of 25 ml of phosphoryl trichloride and 3 g of phosphorus pentachloride was added 974 mg of ethyl 7-ethyl-2-hydroxyl-1-azaxanthone-3-carboxylate under stirring at 120°C for 12 hours and then, phosphoryl trichloride was distilled off under reduced pressure. To the residue, ethanol was added gradually under ice-cooling to dissolve the residue. The solvent was then distilled off and the residue was chromatographed on silica gel. The desired product was eluted with benzene and recrystallized from isopropylether, whereby was obtained 658 mg of ethyl 7-ethyl-2-chloro-1-azaxanthone-3-carboxylate as colorless crystals, melting pont: 160—161°C.

Elemental analysis, for $C_{17}H_{14}NO_4Cl$
Calcd. C, 61.54; H, 4.25; N, 4.22
Found C, 61.46; H, 3.98; N, 4.27

Infrared absorption spectrum (Nujol) cm^{-1}:
1720, 1658, 1585, 1265, 1210, 1130

Nuclear magnetic resonance ($CDCl_3$) δ:
1.30(3H, t, J=7Hz), 1.43(3H, t, J=7Hz), 2.73(2H, q, J=7Hz), 4.46(2H, q, J=7Hz), 7.43(1H, d, J=8Hz), 7.63(1H, dd, J=2 & 8Hz), 8.03(1H, d, J=2Hz), 9.06(1H, s)

Reference Example 21.

In 20 ml of chloroform was dissolved 884 mg of ethyl 7-ethyl-2-chloro-1-azaxanthone-3-carboxylate and to the resultant solution was added 3 ml of 30% methylamine-ethanol solution. The mixture was stirred at room temperature for 2 hours and then the solvent was distilled off. Water was added to the residue and the resultant precipitate was collected by filtration and recrystallized from dimethylformamide. By the above procedure was obtained 730 mg of ethyl 7-ethyl-2-methylamino-1-azaxanthone-3-carboxylate as colorless crystals, melting at 205—207°C.

Elemental analysis, for $C_{18}H_{18}N_2O_4$:
Calcd. C, 66.24; H 5.56; N, 8.58
Found C, 66.22; H, 5.47; N, 8.74

Infrared absorption spectrum (Nujol) cm^{-1}:
3250, 1660, 1610, 1582, 1280, 1240

Nuclear magnetic resonance (CF_3COOD) δ:
1.36(3H, t, J=7Hz), 1.53(3H, t, J=7Hz), 2.90(2H, q, J=7Hz), 3.50(3H, s), 4.60(2H, q, J=7Hz), 7.60(1H, d, J=8Hz), 7.90(1H, dd, J=2 & 8Hz), 8.20(1H, d, J=2Hz), 9.43(1H, s)

Reference Example 22.

A mixture consisting of 2.17 g of 2-amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxyaldehyde, 25 ml of dimethylformamide, 5 g of ethyl propiolate and 0.1 ml of

triethylamine was stirred at 90°C for one hour and then the mixture was allowed to stand at room temperature. The resulting crystals were collected by filtration and recrystallized from acetone to obtain 1.65 g of ethyl 3-(6-ethyl-3-formyl-4-oxo-4H-1-benzopyran-2-yl)aminoacrylate as colorless needles melting at 201—203°C.

Infrared absorption spectrum (KBr) cm^{-1}:
3070, 1700, 1665, 1635

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
13.50(1H, d, J=12Hz), 10.36(1H, s), 8.02(1H, d, J=2Hz), 7.17—7.73(3H, m), 5.42(1H, d, J=9Hz), 4.34(2H, q, J=7Hz), 2.75(2H, q, J=7Hz), 1.35(3H, t, J=7Hz), 1.28(3H, t, J=7Hz)

Elemental analysis, for $C_{17}H_{17}NO_5$
Calcd. C, 64.75; H, 5.43; N, 4.44
Found C, 64.72; H, 5.40; N, 4.33

By a procedure similar to that described above, ethyl 3-(2-formyl-benzo[f]-chromon-2-yl)aminoacrylate was obtained from 2-aminobenzo[f]chromone-3-carboxaldehyde, m.p. 228—230°C(decomp.) (recrys. solvent: chloroform-petroleum benzine).

Reference Example 23.

A mixture consisting of 1.58 g of ethyl 3-(6-ethyl-3-formyl-4-oxo-4H-1-benzopyran-2-yl)aminoacrylate obtained in Reference Example 22, 15 ml of dimethylformamide and 5 ml of triethylamine was refluxed at 130°C for 2.5 hours. The reaction mixture was concentrated and to the residue was added about 50 ml of ethanol. The ethanol solution was cooled and the precipitated crystals were collected by filtration and recrystallized from ethanol to obtain 920 mg of ethyl 7-ethyl-1-azaxanthone-3-carboxylate as light-yellow needles, m.p. 140—142°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1725, 1670

Nuclear magnetic resonance spectrum ($CDCl_3$) δ:
9.27(2H, m), 8.11(1H, near s), 7.42—7.82(2H, m), 4.51(2H, q, J=7Hz), 2.83(2H, q, J=8Hz), 1.48 & 1.38(3H×2, t & t)

Elemental analysis, for $C_{17}H_{15}NO_4$
Calcd. C, 68.67; H, 5.08; N, 4.71
Found C, 68.86; H, 4.80; N, 4.85

By a procedure similar to that described above, ethyl benzo[h]-1-azaxanthone-3-carboxylate melting at 186—188°C (recrys. solvent: acetone) was obtained from ethyl 3-(3-formyl-benzo[f]chromon-2-yl)aminoacrylate.

Reference Example 24.

To 70 ml of dimethylformamide was added 2.2 g of 2-amino-4-oxo-4H-1-benzopyran-3-carboxaldehyde, followed by the addition of 2.5 g of cyanoacetylene. The mixture was heated under stirring at 140°C for 15 hours and the solvent was then distilled off under reduced pressure. The residue was chromatographed on silica gel and eluted with chloroform and recrystallized from acetonitrile to give 0.83 g of 3-cyano-1-azaxanthone as crystals, m.p. 220—226°C.

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
7.4—8.4(4H, m), 9.10(1H, d, J=2Hz), 9.30(1H, d, J=2Hz).

Elemental analysis, for $C_{13}H_8N_2O_2$
Calcd. C, 70.27; H, 2.72; N, 12.61
Found C, 70.12; H, 2.55; N, 12.50

The following compounds were produced by procedures similar to the above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
2-Amino-6-methyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Methyl-3-cyano-1-azaxanthone	240–242 Ethyl acetate
2-Amino-6-ethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Ethyl-3-cyano-1-azaxanthone	183–185 Acetonitrile
2-Amino-6-isopropyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7-Isopropyl-3-cyano-1-azaxanthone	203–205 Ethanol
2-Amino-6,8-dimethyl-4-oxo-4H-1-benzopyran-3-carboxaldehyde	7,9-dimethyl-3-cyano-1-azaxanthone	254–257 Acetonitrile

Reference Example 25.

To a solution of 0.5 g of 7-isopropyl-2-amino-3-cyano-1-azaxanthone in 80 ml of acetic acid was added gradually 1.0 g of sodium nitrate at 70°C. After one hour period, 3 ml of water was added to the mixture which was heated at 70°C for a further one hour. The solvent was distilled off under reduced pressure and then, to the residue, water was added. The yellow precipitate was collected by filtration, rinsed with water and recrystallized from ethanol to give 7-isopropyl-2-hydroxy-3-cyano-1-azaxanthone as yellow crystals, m.p. >300°C.

Elemental analysis, for $C_{16}H_{12}N_2O_3$
Calcd. C, 68.56; H, 4.32; N, 10.00
Found C, 68.28; H, 4.34; N, 9.70

Example 1.

To 5 ml of 55% sulfuric acid was added 933 mg of ethyl 7-ethyl-2-methyl-1-azaxanthone-3-carboxylate and the mixture was stirred at 130°C for one hour. After cooling, 100 ml of ice-water was added to the reaction mixture and the precipitate was recovered by filtration and crystallized from ethyl acetate and acetone in the order mentioned. By the above procedure was obtained 510 mg crystals of 7-ethyl-2-methyl-1-azaxanthone-3-carboxylic acid melting at 243—245°C.

Elemental analysis, for $C_{16}H_{13}NO_3$
Calcd. C, 67.84; H, 4.63; N, 4.95
Found C, 67.75; H, 4.43; N, 4.89

The following compounds were produced by procedures similar to that described above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
Ethyl 2-methyl-1-azaxanthone-3-carboxylate	2-Methyl-1-azaxanthone-3-carboxylic acid	>300 80% Dimethylformamide
Ethyl 7-methoxy-2-methyl-1-azaxanthone-3-carboxylate	7-Methoxy-2-methyl-1-azaxanthone-3-carboxylic acid	294–295 Dimethylformamide
Ethyl 2,7,9-trimethyl-1-azaxanthone-3-carboxylate	2,7,9-trimethyl-1-azaxanthone-3-carboxylic acid	>300 Acetic acid
Ethyl 7-chloro-2-methyl-1-azaxanthone-3-carboxylate	7-Chloro-2-methyl-1-azaxanthone-3-carboxylic acid	292–294 Ethanol
Ethyl 7-nitro-2-methyl-1-azaxanthone-3-carboxylate	7-Nitro-2-methyl-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Methyl 2-n-propyl-1-azaxanthone-3-carboxylate	2-n-Propyl-1-azaxanthone-3-carboxylic acid	217–218 Ethanol
Ethyl 7-ethyl-2-phenyl-1-azaxanthone-3-carboxylate	7-Ethyl-2-phenyl-1-azaxanthone-3-carboxylic acid	268–269 Ethyl acetate

Example 2.

A mixture of 1.56 g of ethyl 2-amino-7-ethyl-1-azaxanthone-3-carboxylate, 10 ml of acetic acid and 10 ml of 55% sulfuric acid was stirred at 130°C for 4 hours and, after water was added, the precipitate was collected by filtration and recrystallized from acetic acid-water. By the above procedure was obtained 1.28 g colorless needles of 2-amino-7-ethyl-1-azaxanthone-3-carboxylic acid, m.p. 313—314°C(decomp.).

Elemental analysis, for $C_{16}H_{12}N_2O_4$

Calcd. C, 63.38; H, 4.26; N, 9.86
Found C, 63.24; H, 4.56; N, 9.70

The following compounds were produced by procedures similar to that described above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
Ethyl 2-amino-1-azaxanthone-3-carboxylate	2-Amino-1-azaxanthone-3-carboxylic acid	>330 Dimethylformamide-water.
Ethyl 2-amino-7-methoxy-1-azaxanthone 3-carboxylate	2-Amino-7-methoxy-1-azaxanthone-3-carboxylate acid	337–339 (decomp.) Dimethylformamide
Ethyl 2-amino-7,9-dimethyl-1-azaxanthone-3-carboxylate	2-Amino-7,9-dimethyl-1-azaxanthone-3-carboxylic acid	>330 Dimethylformamide-water
Ethyl 2-amino-7-chloro-1-azaxanthone-3-carboxylate	2-Amino-7-chloro-1-azaxanthone-3-carboxylic acid	320–322 (decomp.) Dimethylformamide
Ethyl 2-amino-7-methyl-1-azaxanthone-3-carboxylate	2-Amino-7-methyl-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 2-amino-7-isopropyl-1-azaxanthone-3-carboxylate	2-Amino-7-isopropyl-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 2-amino-9-methoxy-1-azaxanthone-3-carboxylate	2-Amino-9-methoxy-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 2-amino-7-n-butyl-1-azaxanthone-3-carboxylate	2-Amino-7-n-butyl-1-azaxanthone-3-carboxylic acid	303–304 Dimethylformamide
Ethyl 2-amino-benzo[h]-1-azaxanthone-3-carboxylate	2-Amino-benzo[h]-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 2-amino-8-hydroxy-1-azaxanthone-3-carboxylate	2-Amino-8-hydroxy-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide

Example 3.

A mixture of 1.0 g of ethyl 1-azaxanthone-3-carboxylate, 8 ml of glacial acetic acid and 8 ml of 55% sulfuric acid was stirred under reflux at 130°C for 4 hours. After cooling, the precipitate was recovered by filtration, rinsed with water and recrystallized from 70% dimethylformamide. By the above procedure was obtained 822 mg of 1-azaxanthone-3-carboxylic acid as colorless needles, m.p. 272°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1700, 1670, 1615, 1605

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
9.28(1H, d, J=2Hz), 8.97(1H, d, J=2Hz), 8.17(1H, dd, J=2 & 8 Hz), 7.3—8.0(3H, m)

Elemental analysis, for $C_{13}H_7NO_4$
Calcd. C, 64.73; H, 2.93; N, 5.81
Found C, 64.51; H, 2.77; N, 5.63

The following compounds were produced by procedures similar to that described above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
Ethyl 7-chloro-1-azaxanthone-3-carboxylate	7-Chloro-1-azaxanthone-3-carboxylic acid	300–301 70%. 70% Dimethylformamide
Ethyl 7-nitro-1-azaxanthone-3-carboxylate	7-Nitro-1-azaxanthone-3-carboxylic acid	>300, 70% Dimethylformamide
Ethyl 7-ethyl-1-azaxanthone-3-carboxylate	7-Ethyl-1-azaxanthone-3-carboxylic acid	238–239 Acetone
Ethyl benzo[h]-1-azaxanthone-3-carboxylate	Benzo[h]-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide

Example 4.

A mixture consisting of 341 mg of dimethyl 7-ethyl-1-azaxanthone-2,3-dicarboxylate, 2 ml of acetic acid and 2 ml of 55% sulfuric acid was stirred at 130°C four 4 hours. After cooling, water was added and the precipitate was collected by filtration and heated carefully in a round bottomed flask over a direct fire, whereupon it was fused with foaming. After the foaming had subsided, the fused mass was cooled and recrystallized from acetone. By the above procedure was obtained 124 mg of 7-ethyl-1-azaxanthone-2,3-dicarboxylic acid as colorless needles, m.p. 238—239°C.

Infrared absorption spectrum (Nujol) cm^{-1}: 1690, 1675

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
9.08(1H, d, J=2Hz), 8.81(1H, d, J=2Hz), 7.80(1H, s), 7.69(1H, dd, J=2 & 8 Hz), 7.49(1H, d, J=8Hz), 2.75(2H, q, J=7Hz), 1.24(3H, t, J=7Hz)

Elemental analysis, for $C_{15}H_{11}NO_4$
Calcd. C, 66.91; H, 4.12; N, 5.20
Found C, 66.71; H, 3.94; N, 5.10

Example 5.

A mixture consisting of 1.5 g of dimethyl 7-chloro-1-azaxanthone-2,3-dicarboxylate, 10 ml of 55% sulfuric acid and 10 ml of glacial acetic acid was stirred at 130°C for 6 hours. After cooling, the precipitate was collected by filtration, rinsed with water and crystallized from 70% dimethylformamide. By the above

procedure was obtained 723 mg of 7-chloro-1-azaxanthone-2,3-dicarboxylic acid as colorless needles, m.p. 266—269°C(decomp.).

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
7.9—8.1(2H, m), 8.20(1H, d, J=2Hz), 9.03(1H, s)

Example 6.

A mixture consisting of 170 mg of diethyl 7-ethyl-1-azaxanthone-2,3-dicarboxylate, 1 ml of acetic acid and 1 ml of 55% sulfuric acid was heated at 130°C for 3 hours and the precipitate was collected by filtration and recrystallized from acetic acid. By this procedure was obtained 30 mg of 7-ethyl-1-azaxanthone-2,3-dicarboxylic acid as crystals melting at 210—211°C(decomp.).

Infrared absorption spectrum (Nujol) cm^{-1}: 1728, 1695, 1675

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
8.93(1H, s), 7.97(1H, d, J=2Hz), 7.80(1H, dd, J=2 & 9Hz), 7.62(1H, d, J=9Hz), 2.78(2H, q, J=7Hz), 1.27(3H, t, J=7Hz)

Example 7.

A mixture consisting of 185 mg of diethyl 7,9-dimethyl-1-azaxanthone-2,3-dicarboxylate, 1 ml of acetic acid and 1 ml of 55% sulfuric acid was heated at 130°C for 2 hours and the sparingly soluble product was recovered by filtration. It was dissolved in a saturated aqueous solution of sodium hydrogen carbonate and the small amount of sparingly soluble product was filtered off. The filtrate was made acidic and the precipitate was collected by filtration and recrystallized from acetic acid-water. By the above procedure was obtained 20 mg of 7,9-dimethyl-1-azaxanthone-2,3-dicarboxylic acid as pale yellow needles, m.p. 175—177°C (depolarization point).

Infrared absorption spectrum (Nujol) cm^{-1}: 1725—1710, 1670

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
9.17(1H, s), 7.85(1H, d J=2Hz), 7.65(1H, d, J=2Hz), 2.53(3H, s), 2.45(3H, s)

Example 8.

A mixture consisting of 700 mg of ethyl 7-ethyl-2-hydroxy-1-azaxanthone-3-carboxylate, 20 ml of glacial acetic acid and 10 ml of 55% sulfuric acid was stirred under reflux at 130°C for 5 hours. After cooling, the precipitate was collected by filtration, rinsed with water and recrystallized from dimethylformamide. By the above procedure was obtained 492 mg of 7-ethyl-2-hydroxy-1-azaxanthone-3-carboxylic acid as colorless platelets melting at 292—296°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1740, 1675, 1610

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
1.25(3H, t, J=7Hz), 2.75(2H, q, J=7Hz), 7.45(1H, d, J=9Hz), 7.70(1H, dd, J=9 & 2Hz), 7.83(1H, d, J=2Hz), 8.74(1H, s)

Example 9.

A mixture consisting of 600 mg of ethyl 2-hydroxy-1-azaxanthone-3-carboxylate, 10 ml of glacial acetic acid and 5 ml of 55% sulfuric acid was stirred under reflux at 130°C for 4 hours. After cooling, the precipitate was collected by filtraton, rinsed with water and recrystallized from dimethylformamide. By the above procedure was obtained 418 mg of 2-hydroxy-1-azaxanthone-3-carboxylic acid as white crystals, m.p. higher than 300°C.

Infrared absorption spectrum (KBr) cm^{-1}: 1745, 1660, 1620

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
7.6—8.1(3H, m), 8.17(1H, dd, J=8 & 2Hz), 8.82(1H, s).

The following compounds were produced in the same manner as above.

Starting compound	Product	m.p. (°C) / Recrys. solvent
Ethyl 7-methyl-2-hydroxy-1-azaxanthone-3-carboxylate	7-Methyl-2-hydroxy-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 7-methoxy-2-hydroxy-1-azaxanthone-3-carboxylate	7-Methoxy-2-hydroxy-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 9-methoxy-2-hydroxy-1-azaxanthone-3-carboxylate	9-Methoxy-2-hydroxy-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 2-hydroxy-7,9-dimethyl-1-azaxanthone 3-carboxylate	2-Hydroxy-7,9-dimethyl-1-azaxanthone-3-carboxylic acid	>300 Dimethylformamide
Ethyl 7-n-butyl-2-hydroxy-1-azaxanthone-3-carboxylate	7-n-Butyl-2-hydroxy-1-azaxanthone-3-carboxylic acid	304–305 Dimethylformamide Ethanol

Example 10.

A mixture of 500 mg of ethyl 7-ethyl-2-methoxy-1-azaxanthone-3-carboxylate, 10 ml of acetic acid and 5 ml of 55% sulfuric acid was stirred at 80°C for 2 hours, followed by the addition of 20 ml of water and further stirred at that temperature for 10 minutes. After cooling, the resultant precipitate was collected by filtration, rinsed with water, dried and dissolved in 3 ml of dimethylformamide. To the resultant solution was added 3 g of silica gel and stirred well, and then the dimethylformamide was distilled off. The residue was layered on a column of 50 g of silica gel and eluted with a solution of chloroform-acetone-formic acid (9:1:0.1) to obtain about 390 mg of crystals, which was recrystallized from dimethylformamide-ethanol to obtain 358 mg of 7-ethyl-2-methoxy-1-azaxanthone-3-carboxylic acid as colorless needles, m.p. 226—228°C.

Elemental analysis, for $C_{16}H_{13}NO_5$:
Calcd. C, 64.21; H, 4.38; N, 4.68
Found C, 64.10; H, 4.24; N, 4.71

Infrared absorption spectrum (Nujol) cm^{-1}:
1690, 1660, 1600, 1590, 1290, 825, 790

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
8.70(1H, s) 7.80(1H, m), 7.40—7.63(2H, m), 4.05(3H, s), 2.73(2H, q, J=7.5Hz), 1.23(3H, t, J=7.5Hz)

Example 11.

In 3.5 ml of 50% sulfuric acid-acetic acid (1:1) was dissolved 681 mg of ethyl 7-ethyl-2-methylamino-1-azaxanthone-3-carboxylate. The solution was heated at 100°C for 6 hours and then adjusted to pH 5 with 10% sodium hydroxide. The resultant precipitate was collected by filtration, rinsed with water and recrystallized from dimethylformamide-ethanol to obtain 488 mg of 7-ethyl-2-methylamino-1-azaxanthone-3-carboxylic acid as crystals, m.p. >300°C.

Elemental analysis, for $C_{16}H_{14}N_2O_4$:
Calcd. C, 64.42; H, 4.73; N, 9.39
Found C, 64.24; H, 4.50; N, 9.19

Infrared absorption spectrum (Nujol) cm^{-1}:
3270, 1690, 1605, 1570, 1300, 1127

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
1.25(3H, t, J=7.5Hz), 2.73(2H, q, J=7.5Hz), 3.03(3H, d, J=4Hz), 7.2—7.8(2H, m), 7.80(1H, d, J=2Hz), 8.70(1H, s)

Example 12.

In a mixture of 10 ml of 50% aqueous sulfuric acid and 10 ml of acetic acid, 0.875 g of 7-isopropyl-3-cyano-1-azaxanthone was stirred at 120°C for 2 hours. After completion of the reaction, water was added to the reaction mixture and the resultant precipitate was collected by filtration, rinsed with water, dried and recrystallized from ethanol. By the above procedure was obtained 0.623 g of 7-isopropyl-1-azaxanthone-3-carboxylic acid, m.p. 259—261°C.

The following compounds were produced in the same manner.

Starting product	Product	m.p. (°C) / Recrys. solvent
1-Azaxanthone-3-carbonitrile	1-Azaxanthone-3-carboxylic acid	267—269 Ethyl acetate
7-Ethyl-1-azaxanthone-3-carbonitrile	7-Ethyl-1-azaxanthone-3-carboxylic acid	238—239 Dimethyl-formamide
2-Amino-7-dimethyl-amino-1-azaxanthone-3-carbonitrile	2-Amino-7-dimethyl-amino-1-azaxanthone-3-carboxylic acid.$2H_2SO_4$	258—260 (Decomp.) Acetic acid
7-tert.-Butyl-1-azaxanthone-3-carbonitrile	7-tert.-Butyl-1-azaxanthone-3-carboxylic acid	225—228 Ethanol

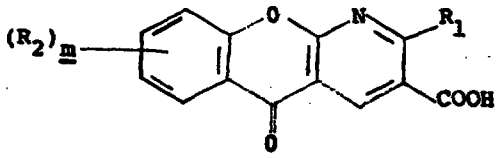
Example 13.

A mixture of 27 mg of 7-ethyl-1-azaxanthone-3-carboxylic acid, 12 mg of diethanolamine and 10 ml of ethanol was dissolved under heating. The solution was concentrated and, after cooling, the precipitated crystals were collected by filtration. By the above procedure was obtained 25 mg of 7-ethyl-1-azaxanthone-3-carboxylic acid diethanolamine salt as colorless crystals melting at 162—164°C.

Elemental analysis, for $C_{19}H_{22}N_2O_6$
Calcd. C, 60.95; H, 5.92; N, 7.48
Found C, 60.70; H, 5.87; N, 7.49

WHAT WE CLAIM IS:—

1. A compound of the formula (I):



(I)

wherein R_1 is hydrogen, alkyl, phenyl, carboxyl, hydroxyl, alkoxy or amino, which may be unsubstituted or substituted by one alkyl; *m* is 0, 1 or 2; and R_2 is alkyl, alkoxy, halogen, nitro, hydroxy, carboxyl, butadienylene

Infrared absorption spectrum (Nujol) cm^{-1}:
3270, 1690, 1605, 1570, 1300, 1127

Nuclear magnetic resonance spectrum (DMSO-d_6) δ:
1.25(3H, t, J=7.5Hz), 2.73(2H, q, J=7.5Hz), 3.03(3H, d, J=4Hz), 7.2—7.8(2H, m), 7.80(1H, d, J=2Hz), 8.70(1H, s)

Example 12.

In a mixture of 10 ml of 50% aqueous sulfuric acid and 10 ml of acetic acid, 0.875 g of 7-isopropyl-3-cyano-1-azaxanthone was stirred at 120°C for 2 hours. After completion of the reaction, water was added to the reaction mixture and the resultant precipitate was collected by filtration, rinsed with water, dried and recrystallized from ethanol. By the above procedure was obtained 0.623 g of 7-isopropyl-1-azaxanthone-3-carboxylic acid, m.p. 259—261°C.

The following compounds were produced in the same manner.

Starting product	Product	m.p. (°C) / Recrys. solvent
1-Azaxanthone-3-carbonitrile	1-Azaxanthone-3-carboxylic acid	267—269 Ethyl acetate
7-Ethyl-1-azaxanthone-3-carbonitrile	7-Ethyl-1-azaxanthone-3-carboxylic acid	238—239 Dimethylformamide
2-Amino-7-dimethylamino-1-azaxanthone-3-carbonitrile	2-Amino-7-dimethylamino-1-azaxanthone-3-carboxylic acid.$2H_2SO_4$	258—260 (Decomp.) Acetic acid
7-tert.-Butyl-1-azaxanthone-3-carbonitrile	7-tert.-Butyl-1-azaxanthone-3-carboxylic acid	225—228 Ethanol

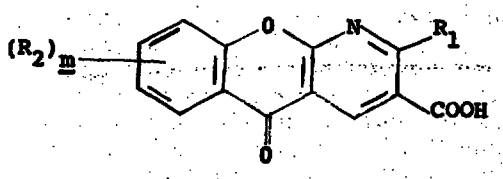
Example 13.

A mixture of 27 mg of 7-ethyl-1-azaxanthone-3-carboxylic acid, 12 mg of diethanolamine and 10 ml of ethanol was dissolved under heating. The solution was concentrated and, after cooling, the precipitated crystals were collected by filtration. By the above procedure was obtained 25 mg of 7-ethyl-1-azaxanthone-3-carboxylic acid diethanolamine salt as colorless crystals melting at 162—164°C.

Elemental analysis, for $C_{19}H_{22}N_2O_6$
Calcd. C, 60.95; H, 5.92; N, 7.48
Found C, 60.70; H, 5.87; N, 7.49

WHAT WE CLAIM IS:—

1. A compound of the formula (I):



(I)

wherein R_1 is hydrogen, alkyl, phenyl, carboxyl, hydroxyl, alkoxy or amino, which may be unsubstituted or substituted by one alkyl; *m* is 0, 1 or 2; and R_2 is alkyl, alkoxy, halogen, nitro, hydroxy, carboxyl, butadienylene

(—CH=CH—CH=CH—), which forms a benzene ring with any adjacent carbon atoms, or amino, which may be unsubstituted or substituted by at least one alkyl,

or a physiologically acceptable salt thereof.

2. A compound as claimed in claim 1, wherein *m* is 0.

3. A compound as claimed in claim 1, wherein *m* is 1.

4. A compound as claimed in claim 1, wherein *m* is 2.

5. A compound as claimed in claim 1, wherein R_1 is alkyl having 1 to 6 carbon atoms.

6. A compound as claimed in claim 1, wherein R_1 is amino.

7. A compound as claimed in claim 1, wherein R_1 is amino which is substituted by one alkyl having 1 to 3 carbon atoms.

8. A compound as claimed in claim 1, wherein R_1 is carboxyl.

9. A compound as claimed in claim 1, wherein R_1 is hydroxyl.

10. A compound as claimed in claim 1, wherein R_1 is alkoxy having 1 to 4 carbon atoms in the alkyl moieties.

11. A compound as claimed in claim 1, wherein R_2 is alkyl having 1 to 6 carbon atoms.

12. A compound as claimed in claim 1, wherein R_2 is alkoxy having 1 to 4 carbon atoms in the alkyl.

13. A compound as claimed in claim 1, wherein R_2 is halogen.

14. A compound as claimed in claim 1, wherein R_2 is nitro.

15. A compound as claimed in claim 1, wherein R_2 is amino which may be unsubstituted or substituted by at least one alkyl having 1 to 3 carbon atoms.

16. A compound as claimed in claim 1, wherein R_2 is hydroxy.

17. A compound as claimed in claim 1, wherein R_2 is carboxyl.

18. A compound as claimed in claim 1, wherein R_2 is butadienylene which forms a benzene ring with any adjacent carbon atoms.

19. 7-Ethyl-2-methyl-1-azaxanthone-3-carboxylic acid.

20. 2-Methyl-1-azaxanthone-3-carboxylic acid.

21. 7-Methoxy-2-methyl-1-azaxanthone-3-carboxylic acid.

22. 2,7,9-Trimethyl-1-azaxanthone-3-carboxylic acid.

23. 7-Chloro-2-methyl-1-azaxanthone-3-carboxylic acid.

24. 7-Nitro-2-methyl-1-azaxanthone-3-carboxylic acid.

25. 2-*n*-Propyl-1-azaxanthone-3-carboxylic acid.

26. 7-Ethyl-2-phenyl-1-azaxanthone-3-carboxylic acid.

27. 2-Amino-7-ethyl-1-azaxanthone-3-carboxylic acid.

28. 2-Amino-1-azaxanthone-3-carboxylic acid.

29. 2-Amino-7-methoxy-1-azaxanthone-3-carboxylic acid.

30. 2-Amino-7,9-dimethyl-1-azaxanthone-3-carboxylic acid.

31. 2-Amino-7-chloro-1-azaxanthone-3-carboxylic acid.

32. 1-Azaxanthone-3-carboxylic acid.

33. 7-Chloro-1-azaxanthone-3-carboxylic acid.

34. 7-Nitro-1-azaxanthone-3-carboxylic acid.

35. 7-Ethyl-1-azaxanthone-3-carboxylic acid.

36. 7-Chloro-1-azaxanthone-2,3-dicarboxylic acid.

37. 7-Ethyl-1-azaxanthone-2,3-dicarboxylic acid.

38. 7,9-Dimethyl-1-azaxanthone-2,3-dicarboxylic acid.

39. 7-Ethyl-2-hydroxy-1-azaxanthone-3-carboxylic acid.

40. 2-Hydroxy-1-azaxanthone-3-carboxylic acid.

41. 7-Ethyl-2-methoxy-1-azaxanthone-3-carboxylic acid.

42. 7-Ethyl-2-methylamino-1-azaxanthone-3-carboxylic acid.

43. 2-Amino-7-methyl-1-azaxanthone-3-carboxylic acid.

44. 2-Amino-7-isopropyl-1-azaxanthone-3-carboxylic acid.

45. 2-Amino-9-methoxy-1-azaxanthone-3-carboxylic acid.

46. 2-Amino-7-*n*-butyl-1-azaxanthone-3-carboxylic acid.

47. 2-Amino-benzo[h]-1-azaxanthone-3-carboxylic acid.

48. 2-Amino-8-hydroxy-1-azaxanthone-3-carboxylic acid.

49. 7-Methyl-2-hydroxy-1-azaxanthone-3-carboxylic acid.

50. 7-Methoxy-2-hydroxy-1-azaxanthone-3-carboxylic acid.

51. 2-Hydroxy-7,9-dimethyl-1-azaxanthone-3-carboxylic acid.

52. 7-*n*-Butyl-2-hydroxy-1-azaxanthone-3-carboxylic acid.

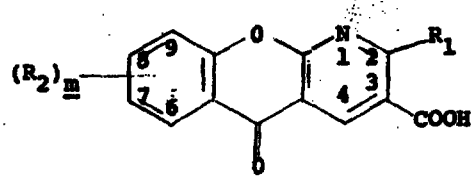
53. 7-Ethyl-1-azaxanthone-3-carboxylic acid.

54. Benzo[h]-1-azaxanthone-3-carboxylic acid.

55. 7-Isopropyl-1-azaxanthone-3-carboxylic acid.

56. 2-Amino-7-dimethylamino-1-azaxanthone-3-carboxylic acid.

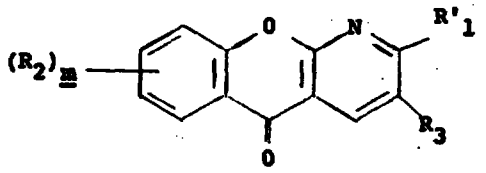
57. A method for the production of a compound of the formula (I):



(I)

wherein R_1 is hydrogen, alkyl, phenyl, carboxyl, hydroxyl, alkoxy or amino, which may be unsubstituted or substituted by one alkyl; *m* is 0, 1, or 2; R_2 is alkyl, alkoxy, halogen, nitro, hydroxy, carboxyl, butadienylene (—CH=CH—CH=CH—), which forms a benzene ring with any adjacent carbon atoms, or amino which may be unsubstituted or substituted by at least one alkyl,

or a physiologically acceptable salt thereof, which method comprises hydrolysing a compound of the formula (II):



(II)

wherein R'_1 is hydrogen, alkyl, phenyl, alkoxycarbonyl, hydroxyl, alkoxy or amino, which may be unsubstituted or substituted by one alkyl; *m* and R_2 have the same meaning as defined above; and R_3 is cyano, alkoxycarbonyl or carboxamide, which may be unsubstituted or substituted by at least one alkyl.

58. A method according to claim 57, substantially as herein described with reference to any of the specific examples.

59. Compound (I) as defined in claim 1, when made by a method as claimed in claim 57 or 58.

60. Compound (I) as claimed in claim 1, substantially as herein defined with reference to any of the specific examples.

61. A pharmaceutical composition comprising a compound (I) as claimed in any of claims 1 to 56, 59 and 60, together with a non-toxic, pharmaceutically acceptable carrier or diluent therefor.

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