Notes

A department for short papers of immediate interest.

Styryl-Type Dyes

Motoko Ito and Konomu Matsumura

Received March 6, 1957

Recently a convenient method for the preparation of *cis*- and *trans*-styrylquinolinium salts has been developed by Horwitz.[1] Using his method, 5-formyl-8-quinolinol on condensation with quinaldine in acetic anhydride, followed with quaternation of the condensation product (IV) with ethyl iodide gave *cis*-1-ethyl-2-(8-quinolinol-5-ylvinylene)quinolinium iodide (IB)[2] and on condensation with ethylquinaldinium iodide in piperidine–isopropyl alcohol gave its *trans* isomer (IA), in agreement with Horwitz's results.[1]

It was found in the present investigation that the use of acetic anhydride instead of piperidine-isopropylalcohol as a condensing agent in the latter condensation results in the *trans* compound (IA) in satisfactory yield. *Cis-trans* assignment was based on ultraviolet spectra. With vanillin instead of 5-formyl-8-quinolinol, equivalent results were obtained. Recently Horwitz[3] reported the facile conversion of certain *cis*- and *trans*-stilfazolium iodides to an identical compound by 2 hours refluxing in acetic anhydride. When IB was refluxed in acetic anhydride for 5 hours, most of the compound was recovered unaltered and only slight isomerization appeared to have taken place judging from the color reaction of the crude product in dilute alkali. Thus, the possibility of the initial formation of a *cis* compound followed by isomerization to the *trans* form was excluded in the case of our compound under the experimental conditions used. The formation of *trans* compounds on condensation in acetic anhydride must be due to the quaternary nitrogen of 1-ethylquinaldinium iodide.

Assuming the intermediate formation of a six-membered chelate ring, it seems probable that steric hindrance between two quinoline groups due to quaternary nitrogen caused the acetate decomposition in the configuration shown in Fig. 1, giving a *trans* compound as the final product, notwithstanding the difficulty of coplanarity between two quinoline groups and the cyclic structure as a transition state.

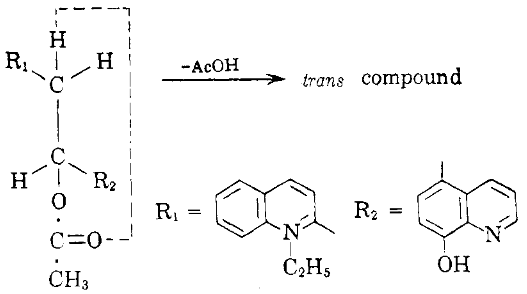


Fig. 1 Probable Step in the Formation of *trans* Compounds.

EXPERIMENTAL[4]

Piperidine-catalyzed condensation of quinaldinium salt with aromatic aldehydes (Method A). 1-Ethyl-2-(8-quinolinol-5-ylvinylene)quinolinium iodide (IA). Piperidine (0.02 ml.) was added with stirring to a hot mixture of 5-formyl-8-quinolinol (0.2 g., 0.0012 mole), 1-ethylquinaldinium iodide (0.36 g., 0.0012 mole), and isopropyl alcohol (2 ml.). The resulting solution was heated at 85–90° for 1 hr. (sealed tube). The product was filtered, washed with cold water, then repeatedly with methanol until the green color disappeared from the washing.[5] The residue (0.48 g., 92%), after two recrystallizations from 90% ethanol, formed deep violet red prisms. It is soluble in water and ethanol with a wine red color.

Condensation of quinaldine with aromatic aldehydes in acetic anhydride and quaternation of the products (Method B). 2-(8-Quinolinol-5-ylvinylene)quinoline (IV). A mixture of 5-formyl-8-quinolinol (0.35 g., 0.002 mole), quinaldine (0.29 g., 0.002 mole), and acetic anhydride (0.2 g., 0.002 mole) was heated at 140° for 6 hr. The crude product was treated with 10% hydrochloric acid and the resulting hydrochloride washed with cold ethanol. The base, set free by treating the hydrochloride with sodium carbonate, crystallized from ethanol (charcoal) as light yellow prisms, yield 0.5 g. (83%).

1-Ethyl-2-(8-quinolinol-5-ylvinylene)quinolinium iodide (IB). A mixture of IV (0.55 g., 0.0018 mole), ethyl iodide (1.5 g., 0.01 mole), and ethanol (1.5 ml.) was heated at 100° for 16 hr. in a sealed tube. The product was washed with ether and recrystallized twice from ethanol to give dark red prismatic needles (0.49 g., 60%). It is fairly difficultly soluble

---

(1) Horwitz, *J. Am. Chem. Soc.*, **77**, 1687 (1955).

(2) On treating IV with an excess of ethyl iodide only a monoethyl iodide compound was isolated, and no special efforts were made to determine which of the two tertiary nitrogens in the molecule was quaternated. It is probable, however, that quaternation took place in the quinaldinylidene moiety in view of the fact that on treating with methanolic sodium hydroxide, the ethyl iodide compound (IB) gave a stable phenolbetaine. Moreover, according to our unpublished experience, 5-α-hydroxy-β-trichloroethyl- and 5-formyl-8-quinolinol defied quaternation with ethyl iodide on long heating at 100°.

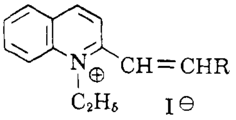
(3) Horwitz, *J. Org. Chem.*, **21**, 1039 (1956).

(4) Ultraviolet spectra are on $10^{-5}M$ solutions in methanol.

(5) When more piperidine was used, isocyanine [m.p. 193° (dec.)] was isolated from the combined filtrate and washings.

TABLE I[a]

PROPERTIES OF 2-SUBSTITUTED QUINOLINIUM SALTS



Compound	R	M.P.,[b] °C.	Formula	Nitrogen Calcd.	Nitrogen Found	λ mμ	ε
IA	[c]	254	$C_{22}H_{19}IN_2O \cdot 0.5H_2O$	6.05[d]	5.90	243 468 560	31,920 23,910 31,720
IB	[c]	315–317	$C_{22}H_{19}IN_2O \cdot 0.5H_2O$	6.05[e]	6.32	244 371	35,070 23,070
IIA[f]	[g]	235	$C_{22}H_{22}INO_3$	2.95	2.85	385	19,930
IIB[h]	[g]	265	$C_{22}H_{22}INO_3$	2.95	2.81	361	32,650
IIIA[i]	[j]	258	$C_{20}H_{20}INO_2$	3.23[k]	3.16	440	39,360
IIIB[l]	[j]	256	$C_{22}H_{20}INO_2$	3.23[m]	3.46	362	27,070

[a] A compounds are from the piperidine-catalyzed condensation of quinaldinium iodide with aromatic aldehydes (Method A). B compounds are from the quaternation of 2-styryl-type-quinolines obtained by acetic anhydride condensation (Method B). [b] All melting points were with dec. [c] 8-Quinolinol-5-yl. [d] Calcd.: C, 57.02; H, 4.32. Found: C, 56.57; H, 4.48. [e] Calcd.: C, 57.02; H, 4.32. Found: C, 56.30; H, 3.34. [f] Made by heating a mixture of IIIA (0.1 g.) and acetic anhydride (0.5 g.) at 140° for 6 hr. [g] 3-Methoxy-4-acetoxyphenyl. [h] Made by quaternation of VI in a similar manner as that for IB; yield 90%. It formed orange yellow prisms. [i] Made by a procedure analogous to that described by Horwitz;[1] yield 88%. It formed brown red elongated plates. [j] 3-Methoxy-4-hydroxyphenyl. [k] Calcd.: C, 55.42; H, 4.62; I, 29.32. Found: C, 55.08; H, 4.94; I, 29.01. [l] Made by quaternation of VII; yield 96%. It formed orange prismatic needles. [m] Calcd.: I, 29.32. Found: I, 29.24.

in water and moderately soluble in ethanol with a light wine color.

Condensation of quinaldinium salts with aromatic aldehydes in acetic anhydride (Method C). trans-1-Ethyl-2-(8-quinolinol-5-ylvinylene)quinolinium iodide (IA). A mixture of 5-formyl-8-quinolinol (0.09 g., 0.0005 mole), 1-ethylquinaldinium iodide (0.15 g., 0.0005 mole), and acetic anhydride (0.2 ml.) was heated (bath temperature 130–140°) for 5 hr., and after cooling treated with water. After standing overnight, the product was filtered and washed with water; yield 0.2 g. (83%). Crystallized from methanol, it formed brown red prisms, m.p. 250° (dec.). Mixed melting point with a sample of the piperidine-catalyzed condensation product (IA) (m.p. 254° dec.) was 254° (dec.), whereas with a sample of IB [m.p. 315–317° (dec.)] the mixed m.p. was 239–240°.

trans-1-Ethyl-2-(3-methoxy-4-acetoxystyryl)quinolinium iodide (IIA). A solution of 1-ethylquinaldinium iodide (0.9 g., 0.003 mole) and vanillin (0.45 g., 0.003 mole) in acetic anhydride (0.6 g., 0.006 mole) was heated at 150° for 8 hr. The product, when crystallized from ethanol, formed orange prismatic needles, m.p. 230°; mixed melting point with a sample of acetylated piperidine catalyzed condensation product (IIA) (m.p. 235°) was 235°; yield 50%.

trans-1-Ethyl-2-(3-methoxy-4-hydroxystyryl)quinolinium iodide (IIIA). A solution of the above compound (0.1 g.) in a mixture of methanol (2 ml.) and 50% freshly prepared hydroiodic acid (0.1 ml.) was heated at 100° for 6 hr. in a sealed tube.

When crystallized from ethanol, the product formed red prismatic needles, m.p. 249° (dec.); mixed melting point with a *trans* sample (IIIA) (m.p. 258°) was 249° (dec.), whereas with a *cis* sample (IIIB) (m.p. 256°) the mixed m.p. was 230–238° (dec.).

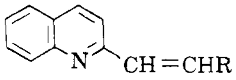
Treatment of IB *with acetic anhydride.* A mixture of IB (0.1 g.) and acetic anhydride (0.2 ml.) was heated at 140° for 5 hr. until a homogeneous gel resulted and mixed with water after cooling. The separated solid (0.07 g.) was filtered and washed with ethanol. After two recrystallizations from ethanol, it formed dark red prisms, m.p. 307–312° (dec.).

When mixed with a sample of IB (m.p. 315–317°), it melted at 313–317° and when mixed with IA (m.p. 254°) melted at 241–244°.

IA dissolves easily in water with a Bordeaux red color and the solution, on addition of a drop of 10% sodium hydroxide, turns to deep reddish violet solution and separates thoroughly as well defined blue needles on standing overnight. IB dissolves in water fairly difficultly and on addition of sodium hydroxide a dark greenish solid of unexact form separates.

TABLE II

2-STYRYL-TYPE-QUINOLINES OBTAINED BY METHOD B



Compound	R	M.P., °C.	Formula	Nitrogen Calcd.	Nitrogen Found
IV[d]	[a]	191–192	$C_{20}H_{14}N_2O$	9.40	9.55
V[e]	[a]	293–298	$C_{20}H_{14}N_2O \cdot 2HCl \cdot H_2O$	7.20	6.95
VI[f]	[b]	192	$C_{20}H_{17}NO_3$	4.39	4.27
VII[g]	[c]	187[h]	$C_{18}H_{15}NO_2$	5.05	4.60

[a] 8-Quinolinol-5-yl. [b] 3-Methoxy-4-acetoxyphenyl. [c] 3-Methoxy-4-hydroxyphenyl. [d] Anal. Calcd. for $C_{20}H_{14}N_2O$: C, 80.54; H, 4.70. Found: C, 80.29; H, 4.37. It forms light yellow prisms. [e] IV-Hydrochloride. It crystallized from 5% hydrochloric acid as orange needles and is soluble in water with a slight hydrolysis. [f] Prepared by a procedure analogous to that described by Horwitz[1] except that 2 moles of acetic anhydride was used; yield 60%. It crystallized from ethanol as colorless prismatic needles. [g] Obtained by refluxing a solution of VI (0.8 g.) in a methanol (25 ml.) 5% hydrochloric acid (25 ml.) mixture for 5 hr., concentrating until hydrochloride began to separate and setting the base (0.75 g.) free by treating the hydrochloride with sodium carbonate. It crystallized from ethanol as light yellow prisms. [h] Mixed m.p. with VI (m.p. 192°) was 168–170°. Nencki[6] records m.p. 182°.

---

(6) Nencki, *Ber.*, 27, 1974 (1894).

TABLE III[a]

PHENOLBETAINES OBTAINED BY TREATING *cis*- AND *trans*-STYRYL-TYPE DYES WITH SODIUM OR AMMONIUM HYDROXIDE

Phenol-betaine	Yield, %	M.P., °C.	Formula	Carbon Calcd.	Carbon Found	Hydrogen Calcd.	Hydrogen Found	Nitrogen Calcd.	Nitrogen Found	λ mμ	ε
From IA	95	240–275 (dec.)	$C_{22}H_{18}N_2O$	80.98	81.19	5.52	5.54	8.59	8.27	245	28,620
										462	18,940
										560	26,480
Dihydrochloride		262 (dec.)	$C_{22}H_{18}N_2O \cdot 2HCl$					7.02	6.61		
From IB[b]	80	189–190	$C_{22}H_{18}N_2O$	80.98	80.70	5.52	4.42	8.59	9.09	250	33,760
										372	27,680
Dihydrochloride		299 (dec.)	$C_{22}H_{18}N_2O \cdot 2HCl$					7.02	6.98		
From IIIB[c]	70	182–183	$C_{20}H_{19}NO_2$	78.69	78.91	6.22	5.36	4.59	4.82	362	24,900
Dihydrochloride		259 (dec.)	$C_{20}H_{19}NO_2 \cdot HCl$					3.98	4.21		

[a] All hydrochlorides crystallized from dilute hydrochloric acid as orange yellow needles. [b] Made by subjecting IB (0.2 g.) to Method A except that methanol (10 ml.) was used instead of water. It crystallized from ethanol as light yellow prisms. [c] Made by similar treatment of IIIB (0.2 g.) as that used for IB or subjecting it to Method B except that methanol was used instead of water.

Treatment of styryl-type dyes with sodium or ammonium hydroxide. Phenolbetaine from IA (Method A). To a mixture of IA (0.2 g.) and water (4 ml.) 5% sodium hydroxide (4 ml.) was added dropwise with stirring, the resulting solution heated at around 80° for 20 min. until a thick paste of fine blue crystals formed, water added, carbon dioxide introduced until a color reaction to phenolphthalein disappeared, the separated crystals filtered, washed with water, and crystallized from ethanol to yield fine violet blue needles. It showed an ill-defined melting point, softened or foamed at about 140°, melted at 240–270° (dec.). After drying at room temperature over potassium hydroxide it retained 3 moles of water of crystallization.

Anal. Calcd. for $C_{22}H_{18}N_2O \cdot 3H_2O$: C, 69.47; H, 6.32; N, 7.37. Found: C, 68.89; H, 7.04; N, 7.53.

(Method B.) To a mixture of IA (0.2 g.) and water (10 ml.), 14% ammonium hydroxide (2 g.) was added dropwise with stirring. The resulting deep blue violet solution separated blue crystals on standing. After standing overnight, the excess ammonia was removed on a water bath, the crystals filtered, washed with water, and recrystallized from ethanol.

On treating IIIA with methanolic ammonium hydroxide, the initial material was recovered, melting point and mixed melting point with a sample of IIIA 258° (dec.). Treatment with sodium hydroxide or silver oxide in methanol also failed to produce the desired phenolbetaine.

CHEMICAL LABORATORY
KITASATO INSTITUTE
TOKYO, JAPAN

N-Aroxyacetyl-*N*-arylglycines

AKIRA TAKEDA

Received April 29, 1957

Since the discovery of the usefulness of some aroxyacetic acids as plant growth substances, a large number of their amides have been synthesized[1] and tested for such activity. As the appropriate *N*-arylglycines themselves exhibit the activity,[2] it also seems of significance to test *N*-aroxyacetyl-*N*-arylglycine, an *N*-aryl substituted aroxyacetamide, for the study of structure-activity relationship of plant growth substances. The present report describes the preparations of eighteen new compounds with the above-mentioned structure by Schotten-Baumann reaction.

In Table I, the melting points and the analyses of these compounds are summarized. Wood and Fontaine[3] have used this method successfully in the synthesis of halogenated phenoxyacetyl derivatives of several amino acids. We also obtained the aroxyacetyl derivatives of *N*-(*p*-tolyl)glycine as well as those of *N*-(3-chloro-*p*-tolyl)glycine in good yields; however, the aroxyacetylations of other glycines gave lower ones.

None of these compounds had auxin properties in the Went pea test or in the Aduki test,[4] while in the *Avena* cylinder test, as shown in Table I, the 2,4-dichloro and 4-chlorophenoxyacetyl derivatives of six *N*-arylglycines exhibited the activity which seemed to be related both to the activity of the parent aroxyacetic acid and to that of the corresponding glycine although they were less active. The details of the biological test will be reported elsewhere.

EXPERIMENTAL

Six *N*-arylglycines used in this work were prepared in our laboratory by saponifying the corresponding nitriles with a 5% aqueous sodium hydroxide solution. Three acid chlorides were prepared by treating one mole of each acid with three moles of thionyl chloride according to the

---

(1) (a) M. S. Newman, W. Fones, and M. Renoll, *J. Am. Chem. Soc.*, **69**, 718 (1947); (b) A. G. Norman, *Botan. Gaz.*, **107**, 476 (1946).

(2) A. Takeda and J. Senda, *Ber. Ohara Inst. landw. Biol.*, **11**, 1 (1957).

(3) J. W. Wood and T. D. Fontaine, *J. Org. Chem.*, **17**, 891 (1952).

(4) The test using a large bean variety of *Phaseolus angularis* W. F. Wight (Aduki beans) called "Dainagon" as test materials, A. Takeda and J. Senda, *loc. cit.* These results have been rather unexpected ones, because it is well-known that the amides whose parent acids possess the activity are active likewise.