SYNTHESIS OF BENZO[g]QUINOLINE DERIVATIVES

VII*. 3-SUBSTITUTED BENZO[g]QUINOLIN-4-ONES

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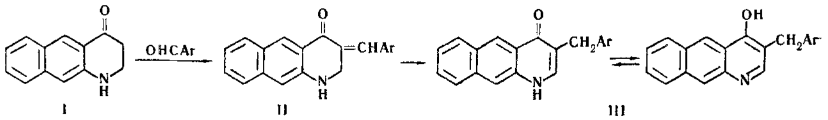
A method for the synthesis of 3-substituted benzo[g]quinolin-4-ones by the condensation of 1,2,3,4-tetrahydrobenzo[g]quinolin-4-one with aromatic aldehydes in an alkaline medium has been developed. It has been found that the first stage of the reaction is the formation of the corresponding benzylidene derivative, which then isomerizes into the more stable benzyl derivative. The structure of the 3-substituted benzo[g]quinolin-4-ones obtained, as existing in the tautomeric oxo form, is confirmed by their IR and UV spectra.

In order to investigate the activity of the methylene group of 1,2,3,4-tetrahydrobenzo[g]quinolin-4-one in position 3, we have studied the aldol-crotonic condensation of I with aromatic aldehydes. This reaction, which takes place in the presence of alkali, leads to various products, depending on the amount of alkali and the time of heating. It was found that in the presence of less than 1 mole of alkali per mole of I the 3-benzylidene derivatives (II), red or violet compounds, are formed.

An increase in the amount of alkali to 1.5 mole per mole of I leads to the corresponding 3-benzyl derivative (III). On being heated in alcoholic alkali, the 3-benzoylidene derivatives IIa-c that were isolated isomerize into the more stable 3-benzyl derivatives (IIIa-c).



The benzylidene derivatives II differ from the benzyl derivatives III in their physical and chemical properties: solubility in alkalis, color, melting point, and UV and IR spectra. Compounds III, unlike compounds II, are soluble in aqueous alcoholic alkali, apparently because of the ease of formation of the enolic structure; they are yellow instead of red; and they have higher melting points, except for compound IIIc (Table 1).

The IR spectra of compounds II and III (Table 2) differ considerably. In the high-frequency region, in the crystals ν_{N-H} for II is ~3360 cm^{-1} and III 3070-3250 cm^{-1}; in solutions these frequencies almost coincide. This difference is obviously connected with the different strengths of the hydrogen bonds in the crystals of compounds II and III. In the 1500-1600 cm^{-1} region of III ($\nu_{C=C}$) there are three (in some cases two) strong absorption bands. For compounds II, absorption in this region is either absent or there is only one band. At 1600-1700 cm^{-1} two bands are found in the spectra of crystals of compounds IIIc-f, the ν_{CO}

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*For Communication VI, see [1].

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TABLE 1. 3-Substituted Benzo[g]quinolin-4-ones

Compound	Ar	Mp, °C (from a mixture of dimethylformamide and ethanol)	Color	Empirical formula	Found, %			Calculated, %			Yield, %
					C	H	N	C	H	N	
IIa	C_6H_5	261—262 (decomp.)	Red	$C_{20}H_{15}NO$	84,3	5,7	5,0	84,1	5,3	4,9	63,1
IIb	C_6H_4Cl-*p*	247—248	Dark red	$C_{20}H_{14}ClNO$*	75,0	4,5	4,4	75,1	4,4	4,4	34,4
IIc	$C_6H_4N(CH_3)_2$-*p*	245—246	Violet	$C_{22}H_{20}N_2O$	80,3	6,2	8,5	80,5	6,1	8,5	74,3
IIIa	C_6H_5	275—276	Yellow	$C_{20}H_{15}NO$	84,1	5,6	4,8	84,1	5,3	4,9	90,0
IIIb	C_6H_4Cl-*p*	279—280	Yellow	$C_{20}H_{14}ClNO$*	75,5	4,5	4,2	75,1	4,4	4,4	85,0
IIIc	$C_6H_4N(CH_3)_2$-*p*	232—233	Greenish yellow	$C_{22}H_{20}N_2O$	80,6	5,9	8,6	80,5	6,1	8,5	85,5
IIId	C_6H_4OH-*p*	274—275	Yellow	$C_{20}H_{15}NO_2$	79,6	5,3	4,7	79,7	5,0	4,6	54,4
IIIe	C_6H_4OH-*o*	306—307	Yellow	$C_{20}H_{15}NO_2$	79,8	5,4	4,9	79,7	5,0	4,6	79,6
IIIf	2-HO-5-Cl-C_6H_3	327—328	Yellow	$C_{20}H_{14}ClNO_2$*	71,8	4,7	4,3	71,5	4,2	4,1	95,8

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*Found, %: Cl IIb 11.0; IIIb 11.0; IIIf 10.0. Calculated, %: Cl IIb 11.1; IIIb 11.1; IIIf 10.6.

TABLE 2. Frequencies in the IR Spectra of Compounds II and III in the Crystalline Form and in Solutions*

Compound	$\nu_{C=O}$		$\nu_{C=C}$ (and δ_{N-H})		ν_{NH} (and ν_{OH})†	
	crystals	$CHCl_3$	crystals	$CHCl_3$	crystals	$CHCl_3$
IIa	1667 s	1675 m	1636 s 1606 s 1494 m	1633 s 1608 s	3360	3437
IIb	1666 s	1672 m	1636 s 1600 m 1560 w 1494 s	1633 s 1610 s	3365	3439
IIc	1640 s	1664 m	1621 s 1607 s 1526 s broad 1498 m	1627 s 1605 s	3355	3439
IIIa	1640 s	1646 s	1613 s 1578 m 1560 s 1535 s 1497 s	1621 s 1600 s	3070—3250	3444
IIIb	1640 m	1648 s	1614 s 1585 s 1538 v.s 1496 s	1624 s 1604 s	3070; 3180	3440
IIIc	1640 m	1646 s	1614 s 1579 m 1562 m 1526 v.s 1494 s	1617 s 1600 s	3070; 3170; 3220	3443
IIId	1645 m		1617 s 1583 m 1577 s 1538—1518 s 1500 s		3600; 3250; 3110	
IIIe	1640 m		1610 s 1584 s 1526 v.s 1494 s		3250; 3100—2670	
IIIf	1640 m		1605 s 1584 m 1550 w 1527 v.s 1490 v.s		3100—3220	

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*Similar spectral characteristics were found in pyridine and dioxane; because of the poor solubility of the substances, the assignment of only some of the bands in the spectra of the solutions was made.

† ν_{OH} is observed only for compounds IIId-f.

band at 1645-1648 cm^{-1} being weaker than is generally found for carbonyl groups, which is in harmony with the situation for quinolin-4-ol and its derivatives [2-4], which exist in the tautomeric oxo form. In this region, three fairly strong bands are found for the benzylidene analogs, and the ν_{CO} frequencies are higher (1640-1667 cm^{-1}) which is in harmony with literature information for 3,5-dibenzylidenepiperidin-4-one [5]. The bands at 1621-1636 cm^{-1} (in the spectra of compounds IIa-c) are apparently due to the stretching vibrations of an exocyclic double bond.

The UV spectra also confirm the difference in the structures of compounds of type II and III (Fig. 1). The presence of several strong maxima in the 240-340-mm region and of long-wave absorption at 495 nm are characteristic for the benzylidene derivatives II. In the spectra of the benzyl derivatives III, however, the latter long-wave maximum is absent, there is extremely strong absorption at 260 nm, and there are three characteristic maxima in the 376-410-nm region. The UV spectra of III are similar to those of

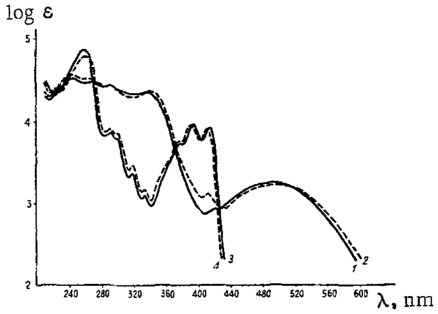

Fig. 1. UV spectra in ethanol of 3-substituted benzo[g]quinolin-4-ones: 1) IIa; 2) IIb; 3) IIIa; 4) IIIb.

quinolin-4-one and 1-methylquinolin-4-one, which have the quinoid structure, and differ from the spectrum of 4-methoxyquinoline [6, 7].

The spectroscopic features observed for the benzo[g]quinoline derivatives studied show that compounds III, like quinolin-4-one and other hydroxyheterocycles [8, 9], exist predominantly in the tautomeric oxo form, both as crystals and in solutions.

EXPERIMENTAL

The IR spectra of the compounds studied were obtained on a UR-10 spectrophotometer as crystals in the form of mulls in paraffin oil and in solutions in $CHCl_3$, pyridine, and dioxane.

The UV spectra were obtained on an EPS-3 recording ultraviolet spectrophotometer in ethanol.

3-Benzylidene-1,2,3,4-tetrahydrobenzo[g]quinolin-4-ones (II). A mixture of 0.05 mole of I, 0.05 mole of the aldehyde, 0.038 mole of caustic soda, and 80 ml of ethanol was heated at the boil for 5 h. Then it was cooled, and the precipitate that had deposited was filtered off and washed with hot water. The compounds obtained are sparingly soluble in the majority of organic solvents and in aqueous alcoholic alkali and are insoluble in water. The results of the experiments are given in Table 1.

3-Benzylbenzo[g]quinolin-4-ones (III). a) A mixture of 0.05 mole of I, 0.05 mole of the aldehyde, 0.075 mole of caustic soda, and 80 ml of ethanol was heated at the boil for 5 h. Then it was cooled, treated with activated carbon, and filtered, and the filtrate was diluted with water and neutralized; the precipitate that deposited was filtered off and washed with water. Compounds III consist of small yellow crystals soluble in aqueous ethanolic alkali, moderately soluble in the majority of organic solvents, and insoluble in water. The results of the experiments are given in Table 1.

b) A mixture of 0.2 g of II, 0.5 ml of 10% caustic soda, and 5 ml of ethanol was heated at the boil for 5 h. Then the reaction mixture was filtered, the filtrate was treated with water and neutralized, and the precipitate that deposited was filtered off and washed with water. The compounds IIIa-c obtained in this way gave no depression of the melting points in mixtures with the corresponding compounds obtained by method (a).

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