STRUCTURE AND PROPERTIES OF 9-AMINOPHENYL- AND 9-ACETAMIDOPHENYLACRIDINES

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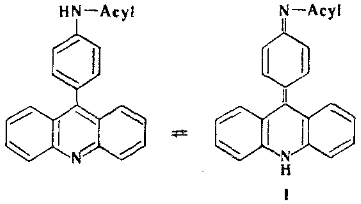
It was established by electronic and IR spectroscopy that 9-aminoarylacridines and their acyl derivatives exist exclusively in the amino form in the crystalline state and in solutions.

As was shown in [1, 2], p-hydroxyphenylacridine exists in the hydroxy form rather than the oxo form; this is due to the energetic favorability of the aromatic system of bonds of the phenolic grouping and the steric hindrance to realization of the planar system of acridonobenzoquinone. The amino form should probably be characteristic for the amino compounds of this series.

The tendency for the existence of p-aminophenylacridine in the amino form can be evaluated by a study of the tautomeric properties of its acylated (at the amino group) derivatives, since this has been done in a number of papers for various heterocyclic amines [3-5]. It might have been expected that the introduction of electronegative substituents ($COCCl_3$, $COCF_3$, RSO_2, etc.) into the amino group would make it possible to shift the amino – imino tautomeric equilibrium to such a degree to favor the imino form (I) that the latter might be detected spectrally. In addition, it can be assumed that the percentage of the imino form, even in the case of derivatives with the most electronegative acyl residues, will be considerably lower than in the previously investigated 9-acylaminoacridines [6], in which the amino group is not separated from the acridine ring by the benzene ring.



In the present study, we have synthesized and investigated (by IR and UV spectroscopy) acylated p-aminophenylacridines with acyl residues with different acidifying capacities (RCO, C_6H_5CO, $ClCH_2CO$, Cl_3CCO, F_3CCO, $ArSO_2$). A study of the IR spectra of 9-(p-aminophenyl)acridine demonstrated that it exists in the amino form in the crystalline state; this is confirmed by the presence in its spectra of bands of the deformation vibration of the amino group at 1626 cm^{-1} and of stretching vibrations at 3395 and 3490 cm^{-1}. All of the p-acylaminophenylacridines have spectra of the same type in the region of the absorption of the stretching vibrations of an amide carbonyl group [7]. The $\nu_{C=O}$ value of the investigated compounds depends only slightly on the nature of the acidifying substituent and lies at 1650-1716 cm^{-1}; this indicates that these compounds have the amide structure in the crystalline state. The increase in $\nu_{C=O}$ to 1690-1716 cm^{-1} in the case of the trichloroacetyl and trifluoroacetyl derivatives is due to the inductive effect of the halogen atoms [8]. Not one of the investigated compounds absorbs at 1616-1640 cm^{-1}, which is the region characteristic for the stretching vibrations of an imide carbonyl group. The

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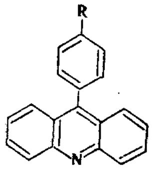
TABLE 1. 9-Arylacridines



R	mp, °C (crystallization solvent)	Empirical formula	Found, %				Calculated, %				$\nu_{C=O}$, cm^{-1}	Yield, %
			C	H	Cl(F)	N	C	H	Cl(F)	N		
$NHCOCH_3$	266 (xylene)	$C_{21}H_{16}N_2O$	81,0	5,3	—	9,2	80,7	5,2	—	9,0	1662	76
$N(CH_3CO)_2$	269—270 (absolute ethanol)	$C_{23}H_{18}N_2O_2$	77,7	4,9	—	7,6	77,9	5,1	—	7,9	1707	91
$NHCOCH_2Cl$	214 (xylene)	$C_{21}H_{15}N_2OCl$	72,8	4,3	10,3	8,0	72,7	4,4	10,2	8,1	1667	78
$NHCOCCl_3$	240 (xylene)	$C_{21}H_{13}N_2OCl_3$	61,0	3,4	26,1	6,8	60,7	3,2	25,6	6,7	1694	61
$NHCOC_6H_5$	262—264 (xylene)	$C_{26}H_{18}N_2O$	83,6	4,9	—	7,0	83,4	4,8	—	7,5	1650	91
$NHCOC_{17}H_{35}$	142 (benzene)	$C_{37}H_{48}N_2O$	82,7	9,1	—	5,4	82,8	9,0	—	5,2	1709	72
$N(CO)_2C_6H_4$*	320—322 (dimethylformamide)	$C_{27}H_{16}N_2O_2$	80,5	4,0	—	7,0	81,0	4,0	—	7,0	1716	81
$NHCOCF_3$	222 (xylene)	$C_{21}H_{13}N_2OF_3$	—	—	(15,2)	7,3	—	—	(15,6)	7,6	1697	82
$NHSO_2C_6H_5$	265 (absolute ethanol)	$C_{25}H_{18}N_2O_2S$	73,5	4,3	—	6,7	73,2	4,4	—	6,8	—	79
$NHSO_2C_6H_4CH_3$	224 (absolute ethanol)	$C_{26}H_{20}N_2O_2S$	73,6	4,8	—	6,5	73,6	4,7	—	6,6	—	82
$NHSO_2C_6H_4NHCOCH_3$	315—317 (isoamyl alcohol)	$C_{27}H_{21}N_3O_3S$	69,2	4,6	—	8,8	69,4	4,5	—	9,0	1672	79

*Phthaloyl.

monotypic character of the spectra of the p-acylaminophenylacridines and of the spectra of 9-(p-aminophenyl)acridine derivatives, which have a fixed amide structure (p-phthaloyl- and p-diacetamidophenylacridines, Table 1), also indicates an amide structure for them.

In a number of papers [4, 5, 9], the criterion for the selection of the structure for various heterocyclic sulfonamide derivatives was the presence in their IR spectra of a band at 940-990 cm^{-1}, which is systematically observed for compounds with an imide structure, and of bands at 850-890 cm^{-1}, which are present in the spectra of compounds of amide character. However, in the case of acridine derivatives the corresponding bands are of low intensity and cannot serve practically for the characterization of the structures of the phenylsulfonyl, tolylsulfonyl, and acetamidophenylsulfonyl derivatives of p-aminophenylacridine. The conclusion regarding the structure of these compounds was drawn on the basis of an investigation of their UV spectra.

The UV spectra of all of the synthesized p-acylaminophenylacridines are identical. All of them have three absorption maxima at 385, 355, and 250 nm. The position of the maxima and the shape of the curves are close to those for fixed forms that have an amide structure. The character of the absorption does not change when the polarity of the solvent is changed. All of this provides a basis for asserting that all of the investigated p-acylaminophenylacridines in solutions and in the crystalline state have an amide structure.

The quantum-mechanical calculation of the electronic spectra of both forms may serve as a confirmation of the existence of the compounds in the amino form. The calculation was made by the MO LCAO method within the Hückel approximation with the Pullman parameters.

The β_{spect} value (−56.85 kcal/mole) was found by solution of the inverse spectral problem; this value was obtained in the assignment of the 380-nm band of acridine to a $\pi_2 \rightarrow \pi^*_1$ transition. This value was used to calculate the electronic spectrum of the amino form. The following wavelengths were obtained for this form: 383 nm for $\pi_3 \rightarrow \pi^*_1$, 349 nm for $\pi_1 \rightarrow \pi^*_3$, and 252 nm for $\pi_3 \rightarrow \pi^*_2$. The satisfactory agreement between the calculated spectrum and the experimental spectrum of the investigated compound ($\lambda_{\max}$ 385, 355, and 250 nm) confirms the amino structure of this compound. To check this, we calculated the imino form. In this case, β_{spect} (−57.94 kcal/mole) was determined from a calculation of the spectrum of acridone, which is structurally similar to the imino form. In conformity with the calculation, a resolved $\pi_2 \rightarrow \pi^*_1$ transition at 564 nm should be observed in the spectrum of the imino form; this is in agreement with the data in [11]. The absence in the electronic spectrum of p-aminophenylacridine and its acylated derivatives of this band or even a band close to it makes it possible to assume the complete absence of the imino form.

EXPERIMENTAL

The IR spectra were recorded with IKS-14 and UR-20 spectrophotometers. Pastes of the substances in mineral oil or in a perfluorocarbon were used to obtain spectra of the crystalline substances. The UV spectra were obtained with an SF-4 spectrophotometer. The UV spectra were obtained with dioxane, absolute ethanol, and 75% ethanol solutions of the substances.

The starting 9-(p-aminophenyl)acridine was obtained by the method described in [10].

The p-acylaminophenylacridines were synthesized by reaction of the corresponding acid chlorides with the starting amine in pyridine or xylene. The diacetyl and trifluoroacetyl derivatives were obtained by reaction of 9-(p-aminophenyl)acridine with the anhydride of the appropriate acid in xylene and pyridine (Table 1).

The secular determinants were solved with a Ural-2 computer in the computer center of the Ural Polytechnic Institute.

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