STUDY OF 5-NO_2-2-FURALDEHYDE DERIVATIVES, III*. SCHIFF BASES FORMED WITH UREA AND SEMICARBAZIDE DERIVATIVES

By

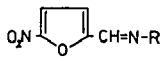
J. CSÁSZÁR

Institute of General and Physical Chemistry, Attila József University, Szeged

(Received 20th October, 1983)

The Schiff base derivatives of 5-NO_2-2-furaldehyde with urea, thiourea, their derivatives, and semi- and thiosemicarbazide were prepared and their u.v. and visible spectral properties were studied. The equilibrium of semi- and thiosemicarbazide derivatives in alkaline solution is discussed.

In previous papers we have described the synthesis of several 5-NO_2-2-furaldehyde (**NFA**) derivatives, obtained in reactions with aniline derivatives [1] and sulphonamides [2], and discussed their spectral behaviour and the antibacterial activity of the latter compounds. The pharmacological activity of thiourea [3—5] and thiosemicarbazide [6] derivatives has been reported in the literature. The semicarbazide derivative, Nitrofurazon, is widely used in therapy for local injury treatment and as an antiseptic agent against skin and mucous inflammation. We have prepared ten derivatives of **NFA**, with structures analogous to that of Nitrofurazon and discussed their u.v. and visible spectral characteristics. The Schiff bases studied are as follows.



1	R = OH	**6**	R = $NH.C(S)NH_2$
2	= NH_2	**7**	= $C(O)NH.CHCHCH_3$
3	= $C(O)NH_2$	**8**	= $C(S)NH.CHCHCH_3$
4	= $C(S)NH_2$	**9**	= $C(O)NH.C_6H_5$
5	= $NH.C(O)NH_2$	**10**	= $C(S)NH.C_6H_5$

* Part II: Császár, J., J. Morvay, O. Herczeg: J. Pharm. Hung., in press.

Experimental

The Schiff bases were prepared by the reaction of **NFA** and the corresponding amine components in 1:1 mole ratio in methanol solution. The products separated out after heating of the solutions at about 310—315 K, and were recrystallized from an ethanol/benzene mixture. The analytical data are given in Table I.

Table I

Analytical data on NFA derivatives

No.	R	C%		H%	
		Calcd.	Found	Calcd.	Found
1	OH	38.47	38.40	2.58	2.65
2	NH_2	38.68	38.61	3.25	3.21
3	$C(O)NH_2$	39.35	39.28	2.75	2.70
4	$C(S)NH_2$	36.18	36.14	2.53	2.47
5	$NH.C(O)NH_2$	36.34	36.19	3.05	3.11
6	$NH.C(S)NH_2$	33.61	33.54	2.82	2.75
7	$C(O)NH.CHCHCH_3$	48.43	48.30	4.06	4.01
8	$C(S)NH.CHCHCH_3$	45.20	45.08	3.79	3.66
9	$C(O)NH.C_6H_5$	55.60	55.51	3.50	3.51
10	$C(S)NH.C_6H_5$	52.36	52.19	3.30	3.26

The u.v. and visible spectra were recorded on a SPECORD UV—VIS spectrophotometer at room temperature, with purified solvents. The equilibrium measurements were performed at 298 ± 0.5 K in $NaOH/CH_3OH$ solution; the NaOH concentration varied in the range $2.10^{-3}-150.10^{-3}$ mol dm^{-3}. The Schiff base concentration was $5.5.10^{-4}$ mol dm^{-3}; $d = 1.0$ cm, and the spectral changes were monitored between 300 and 700 nm.

Results and discussion

The u.v. and visible spectral data on the Schiff bases in methanol and in acidic and basic solutions are presented in Table II; the spectra of the semi- and thiosemicarbazide derivatives are shown in Figs. 1 and 2.

The spectral structures of the compounds studied are similar to one another; characteristic bands appear at around 202—206, 228—250, 260—290 and 310—340 nm, while at 400—450 nm there is a low-intensity inflexion, too. These spectra are similar to those of a methanolic solution of **NFA**, where two high-intensity bands can be found, at 225 and 303 nm; the absorbance of the amine components exerts only a small effect. The unambiguous assignment of the bands is difficult, because at least six chromophores are present and the measured spectra result from the complicated superposition of individual absorbances. Theoretical calculations to determine the possible electronic transitions are in progress.

No marked change can be observed in acidic solution; the general tendency is for the intensities of the bands to increase, but the energies of the transitions remain

almost unchanged. A totally different picture is obtained in alkaline medium. New bands appear between 370 and 450 nm, and the whole spectrum shows a bathochromic shift, except in the case of the semi- and thiosemicarbazide derivatives.

The greatest change occurs upon alkali addition to a solution of **5** or **6** (see Figs. 1 and 2). In response to alkali, both compounds give a very intense brickred colour and high bands appear at 372, 452 and 451 nm in the spectra. For the semicarbazide derivative the 364 nm band shifts to 372 nm and a new band appears at 452 nm, while the 382 nm band of the thiosemicarbazide shifts to 451 nm. For both compounds the spectral change depends on the alkali concentration; the set of curves measured unambiguously indicate an equilibrium system (Fig. 3). Isosbestic points are

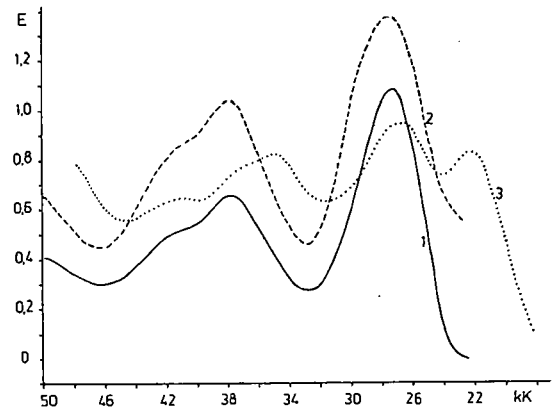


Fig. 1. Spectra of $O_2N.C_4H_2O.CHNNHC(O)NH_2$; 1: in methanol, $c=2.0\cdot10^{-4}$; 2: in 0.1 mol dm^{-3} H_2SO_4/CH_3OH, $c=1.06\cdot10^{-3}$; 3: in 0.1 mol dm^{-3} $NaOH/CH_3OH$, $c=9.59\cdot10^{-4}$ mol dm^{-3}; d=0.1 cm

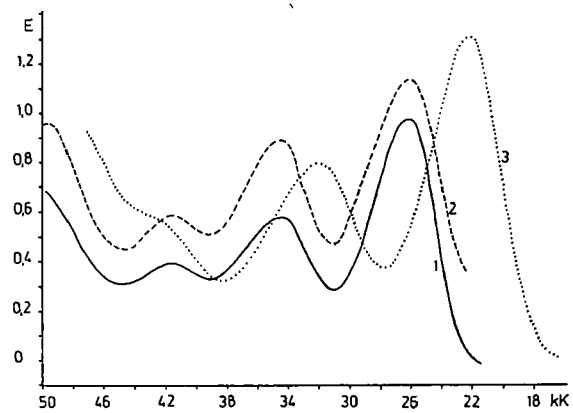


Fig. 2. Spectra of $O_2N.C_4H_2O.CHNNHC(S)NH_2$; 1: in methanol, $c=5.0\cdot10^{-4}$; 2: in 0.1 mol dm^{-3} H_2SO_4/CH_3OH, $c=9.34\cdot10^{-4}$; 3: in 0.1 mol dm^{-3} $NaOH/CH_3OH$, $c=7.0\cdot10^{-4}$ mol dm^{-3}; d=0.1 cm

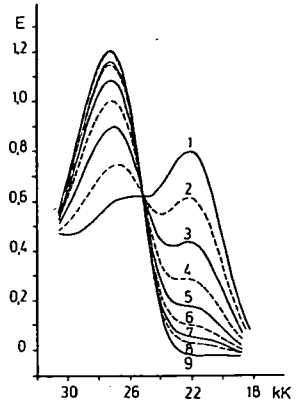


Fig. 3. Changes in the spectrum of $O_2N.C_4H_2O.CHNNHC(O)NH_2$ with the NaOH concentration: $c_{Schiff b.} = 6.7 \cdot 10^{-4}$ mol dm^{-3}, c_{NaOH} = 1: $150 \cdot 10^{-3}$; 2: $90 \cdot 10^{-3}$; 3: $54 \cdot 10^{-3}$; 4: $32.4.10^{-3}$; 5: $19.4 \cdot 10^{-3}$; 6: $11.7 \cdot 10^{-3}$; 7: $7.0 \cdot 10^{-3}$; 8: $4.2 \cdot 10^{-3}$ mol dm^{-3}; 9: in methanol; d = 0.1 cm

Table II

U. v. spectral data on the Schiff bases

No.	Solvent*	U.v. band maxima (nm and ε)				
	CH_3OH	234 (8 910)	~256		337(12 880)	
1	Acid	233(11 750)	~256		337(21 380)	
	Base	~238	267 (7 240)		392(12 880)	
	CH_3OH	233 (4 470)	~290		373(16 600)	
2	Acid	235 (4 570)	~286		370(12 590)	
	Base	~241	~286		370 (6 760)	
	CH_3OH	203(21 380) 228(13 180)		313(33 110)		
3	Acid	~228		309 (8 710)		
	Base		273 (7 760)	313 (7 760)	~385	
	CH_3OH	203(18 650) 243(15 150)		311 (7 120)	~380	
4	Acid	203(13 810) 242(11 480)		~303	~385	
	Base	243(40 740)		~303	~385	
	CH_3OH	~238	264(14 450)		364(22 910)	
5	Acid	~244	264 (9 770)		365(16 220)	
	Base	~244	286 (8 510)		372(10 000)	452 (8 790)
	CH_3OH	240 (7 940)	288(11 480)		382(19 500)	
6	Acid	202(10 470) 240 (6 310)	291 (9 550)		382(16 980)	
	Base	~233	313(11 480)			451(18 620)
	CH_3OH	205 (8 130) ~228		317 (8 910)		
7	Acid	~228		311 (8 510)		
	Base	~230	282(11 480)	~323	~385	
	CH_3OH	204(12 020) 251 (8 130)		311 (7 080)	~400	
8	Acid	202(12 020) ~244		311 (6 170)	~390	
	Base	~244		317 (6 920)	~385	
	CH_3OH	204(38 020) 240(33 880)		313(11 750)		
9	Acid	203(41 690) 238(26 300)		311 (8 910)		
	Base	238(14 450)	~270.		385 (2 820)	
	CH_3OH	204(41 690) ~240	266(32 360)			
10	Acid	203(42 660) ~238	265(25 180)			
	Base	~241	265(42 660)			

* Acid: 0.1 mol dm^{-3} H_2SO_4/CH_3OH; Base: 0.1 mol dm^{-3} $NaOH/CH_3OH$.

present at 398 and 408 nm. The changes in absorbance at two different wavelengths are shown in Fig. 4.

It was possible to calculate the equilibrium constants *via* the following equation:

$$K = \frac{E_i - E}{E - E_f} \frac{1}{[\mathrm{NaOH}]_{eq}}$$

where E_i, E and E_f are the absorbances of the solution without NaOH, at different NaOH concentrations and at a high NaOH concentration where no further spectral change can be obtained. $[\mathrm{NaOH}]_{eq}$ is obtained from the equation

$$[\mathrm{NaOH}]_{eq} = [\mathrm{NaOH}]_{total} - \frac{E_i - E}{E - E_f} c_{SB}$$

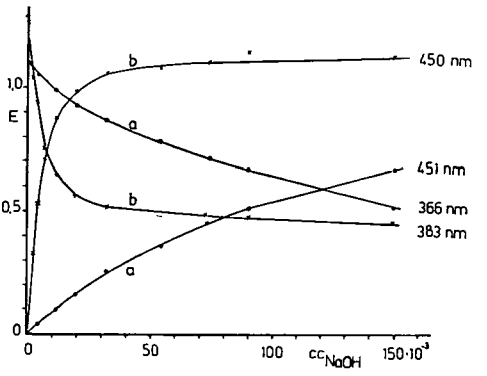
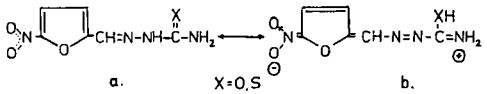


Fig. 4. Changes in the absorbance of semicarbazide (a) and thiosemicarbazide derivatives (b) with the NaOH concentration, at two different nm values

As regards the spectral change, there is a marked difference between the structurally analogous compounds. Two species of identical absorbance are present in the equilibrium systems of semi- and thiosemicarbazide derivatives at 120.10^{-3} and $7.5.10^{-3}$ mol dm^{-3} NaOH concentration, respectively. The equilibrium constants computed for the two compounds are 8.2 ± 0.4 and 226 ± 1.5, respectively.

The interpretation of the equilibrium systems is difficult. We presume that, on the action of NaOH, the Schiff base molecule (a) undergoes an electronic rearrangement to give the conjugated system (b).



This supposition is supported by the preliminary NMR investigations, but an unambiguous interpretation of the equilibrium systems requires still further theoretical and experimental investigations.

References

[1] *Császár, J.:* Acta Phys. et Chem. Szeged, **30,** 71 (1984).
[2] *Császár, J., J. Morvay:* Acta Pharm. Hung. **53,** 121 (1983).
[3] *Astwood, E. B.:* J. Pharmacol. **78,** 79 (1943).
[4] *Astwood, E. B., A. Bissell, A. M. Hughes:* Endocrinology **37,** 456 (1945).
[5] *May, J. D., J. L. McNaughton:* Poult. Sci. **59,** 893 (1980).
[6] *Mostafa, M. M., A. M. Shallaby, A. A. El-Asmy:* Trans. Metal. Chem. **6,** 303 (1981); J. Inorg. Nucl. Chem. **43,** 2998 (1981).

ИССЛЕДОВАНИЕ ПРОИЗВОДНЫХ 5-NO_2-2-ФУРАЛЬДЕГИДА, III. ОСНОВАНИЯ ШИФА, ОБРАЗУЮЩИЕСЯ С МОЧЕВИНОЙ И ПРОИЗВОДНЫМИ СЕМИКАРБАЗИДА

Й. Часар

Синтезированы основания Шифа производные 5-NO_2-2-фуралъдегида и мочевины, тиомочевины и их производных, а также семи- и тиосемикарбазидов. Изучены ультрафиолетовые и видимые спектры полученных соединений. Обсуждены состояния равновесия производных семи- и тиосемикарбазидов в щелочных растворах.