Communications to the Editor

Chem. Pharm. Bull.
34(6)2653—2655(1986)

1,3,8,10,11,14-HEXAZAPENTAPHENE-2,4,7,9(14*H*,3*H*,8*H*,11*H*)-TETRAONES (BENT DOUBLE-HEADED 5-DEAZAFLAVINS) WITH STRONG OXIDIZING POWER

Fumio Yoneda,[*,a] Masakazu Koga,[a] Toshiro Ibuka,[a] and Yumihiko Yano[b]
Faculty of Pharmaceutical Sciences, Kyoto University,[a] Sakyo-ku, Kyoto 606, Japan
and Department of Chemistry, Gunma University,[b] Kiryu, Gunma 376, Japan

1,3,8,10,11,14-Hexazapentaphene-2,4,7,9(14*H*,3*H*,8*H*,11*H*)-tetraones (bent double-headed 5-deazaflavins) were prepared by condensing N,N'-dialkyl-*p*-phenylenediamines and 6-chloro-5-formyl-3-methyluracil, and by cyclizing N,N'-dialkyl-N,N'-di(3-methyluracil-6-yl)-*p*-phenylenediamines with Vilsmeier reagent; these bent double-headed 5-deazaflavins oxidized alcohol under neutral condition in light and a remarked autorecycling occurred.

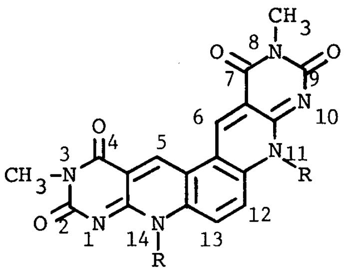
KEYWORDS ——— autorecycling oxidation; alcohol oxidaion; Vilsmeier reagent; epoxidation; *m*-chloroperbenzoic acid; 5-deazaflavin; photosensitizer

Recently the flavin derivatives of extended conjugation, which consist of two flavins or two 5-deazaflavins with a benzo unit in common, have been synthesized.1,2) A Similar mixed system having both flavin and 5-deazaflavin was also synthesized.3) As expected, these derivatives have high oxidizing activities toward alcohols.

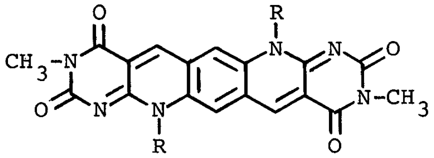
We report here a novel class of extended conjugated compounds, 1,3,8,10,11,14-hexazapentaphene-2,4,7,9(14*H*,3*H*,8*H*,11*H*)-tetraones (**1**), which have a bent type structure and have strong oxidizing power. Compounds **1** were synthesized as follows (Method A). The starting N,N'-dialkyl-*p*-phenylenediamines (**3**) were prepared according to the known procedure.4) Compounds **3** were condensed with two molar amounts of 6-chloro-5-formyl-3-methyluracil (**4**) in N,N'-dimethylformamide (DMF) for 5-9 h under reflux to give the corresponding **1** along with 10-alkyl-7-alkylamino-3-methyl-5-deazaflavins (**5**) (Chart 1).

Compounds **1** were synthesized alternatively as follows (Method B). Compounds **3** were treated with two molar amounts of 6-chloro-3-methyluracil (**6**) to give the corresponding N,N'-dialkyl-N,N'-di(3-methyluracil-6-yl)-*p*-phenylenediamines (**7**) according to the known procedure.2) Treatment of **7** with Vilsmeier reagent (DMF-$POCl_3$) at 90°C for 5-6 h in argon atmosphere gave **1** in better yields than the above method (Chart 1).

In order to determine whether compounds **1** have a linear (**2**) or a bent form, we have carried out the epoxidation reaction of **1**,5) Thus, **1a** was treated with *m*-chloroperbenzoic acid (MCPBA)6) in chloroform for 3 h under reflux to give the corresponding epoxide (**8**)7) in 18% yield, along with the recovered **1a** in 56% yield, after the chloroform solution was washed with aq $Na_2S_2O_3$, aq $NaHCO_3$ and water, dried,



1



2

and then evaporated. As 8 was very unstable and difficult to purify, trifluoroacetic acid (TFA) was added to the chloroform solution and the mixture was heated for 4 h under reflux to give 10-alkyl-7-ethylamino-6-formyl-3-methyl-5-deazaflavin (9) in 49% yield, based on 8. The structures of 8 and 9 were elucidated from their ^{1}H-NMR data. Therefore, the structure of 1a turned out to have a bent form (Chart 2).

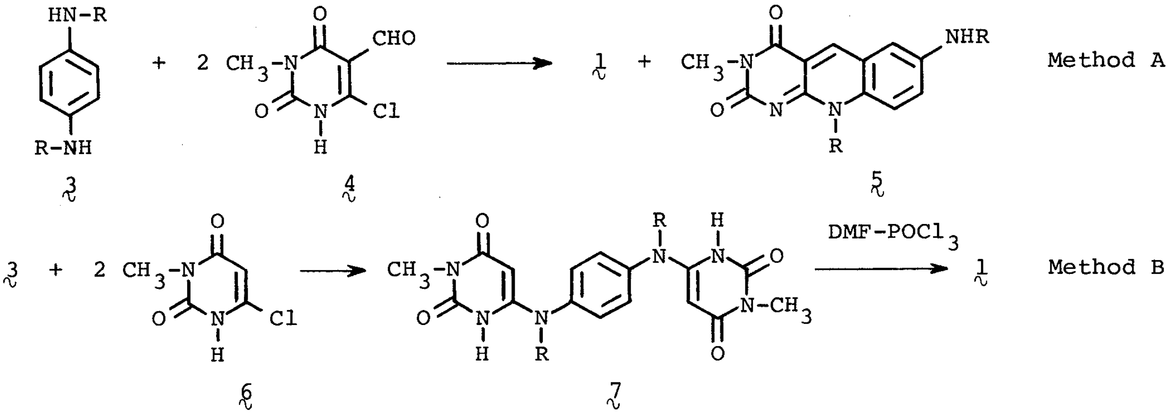
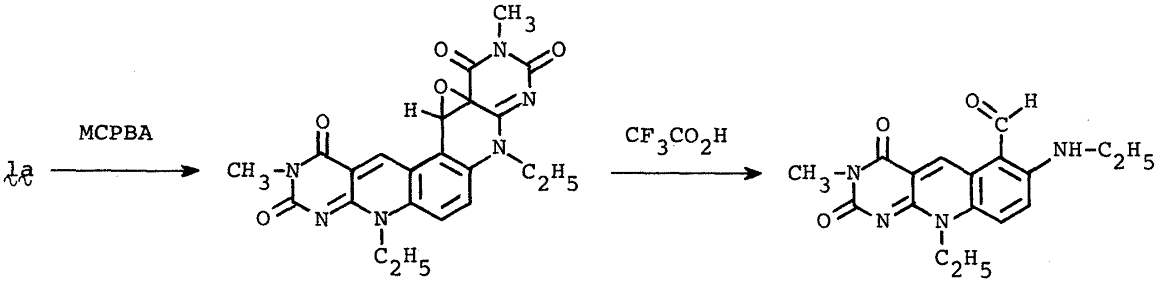


Chart 1

Table I. Bent Double-Headed 5-Deazaflavins (1) and 7-Alkylamino-5-deazaflavins (5)

Compd.	R	Yield (%) Method A	Yield (%) Method B	mp (°C)	δ (CDCl$_3$:CF$_3$CO$_2$D=1:1)
					C$_{5,6}$-H
1a	C_2H_5	31	34	>330	10,70
1b	n-C_8H_{17}	6	36	240	10.70
1c	n-$C_{12}H_{25}$	2	35	190	10.70
					C$_5$-H
5a	C_2H_5	6		318	9.84
5b	n-C_8H_{17}	8		215	9.84
5c	n-$C_{12}H_{25}$	4		188	9.84

The redox potentials (20°C, DMF-LiClO$_4$) for the first one-electron transfer of the bent double-headed 5-deazaflavins (1) were ca. -560 mV *vs*. Ag/AgCl electrode. These potentials are about 30 mV more positive than those of the linear double-headed 5-deazaflavins$^{1)}$ (ca. -590 mV *vs*. Ag/AgCl electrode), suggesting that 1



8 **9**

Chart 2

should have strong oxidizing abilities. In fact, compounds **1** oxidized cyclopentanol to give cyclopentanone under neutral condition at 80°C in light and a remarked autorecycling occurred in the oxidation (Table II). During the reactions compounds **1** were gradually decomposed, and the decomposition products exhibited no further catalytic activity for the alcohol oxidation.

As reference compounds, photosensitizers such as methylene blue and Rose bengal, and also monomeric 5-deazaflavin, 3,10-dimethyl-5-deazaflavin,[8)] were used for comparison with **1**. The photosensitizers did not catalyze the above alcohol oxidation at all under the same conditions. The 5-deazaflavin exhibited some oxidizing ability, although it was less effective than **1** (Table II).

Table II. Autorecycling Oxidation of cyclopentanol (1.5 ml) by **1** (0.5 mg) at 80°C for 25 h in Light (Sun Lamp DR 250/T Ⓛ, Toshiba; 10 cm Distance)

Compd.	Yield of cyclopentanone (%)[a)]	
1a	98,000[b)]	6.8[c)]
1b	120,000	6.2
1c	212,000	9.4
Methylene blue	0	0
Rose bengal	0	0
2,10-Dimethyl-5-deazaflavin	13,000	1.9

a) Isolated as the 2,4-dinitrophenylhydrazone.
b) Based on the catalysts.
c) Based on the starting cyclopentanol.

REFERENCES AND NOTES

1) F. Yoneda, K. Kuroda, M. Koga, and T. Ibuka, J. Chem. Soc., Chem. Commun., **1984**, 872.
2) Y. Yano, M. Nakazato, and R. E. Vasques, J. Chem. Soc., Chem. Commun., **1985**, 226.
3) F. Yoneda, M. Koga, and T. Ibuka, Tetrahedron Lett., **25**, 5345 (1984).
4) P. Vouros and D. Biemann, Org. Mass. Spectrom., **2**, 375 (1969).
5) The structures of **1** could not be determined by direct NMR examinations because of their symmetricity.
6) F. Yoneda and Y. Sakuma, Tetrahedron Lett., **22**, 3977 (1981).
7) The equivalent signals of C_{12}-H and C_{13}-H of **1a** at δ 8.21 ppm (in $CDCl_3$) in the ^1H-NMR spectrum were split into δ 7.84 ppm (d, J=10 Hz) and δ 7.19 ppm (d, J=10 Hz) in the epoxide (**8**), because of disappearance of the symmetry of **1a**.
8) F. Yoneda, Y. Sakuma, S. Mizumoto, and R. Ito, J. Chem. Soc., Perkin Trans. 1, **1976**, 1805.

(Received March 31, 1986)