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AUTORECYCLING OXIDATION OF ALCOHOL CATALYZED BY 1,3,7,9,11,12,14-HEPTAZAPENTACENE-2,4,8,10(14H,3H,9H,12H)-TETRAONES (MIXED FLAVINS)

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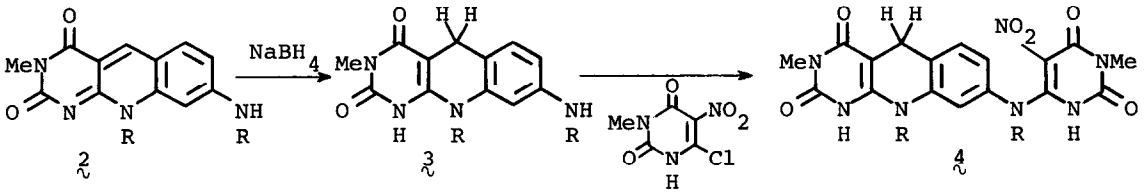
1,3,7,9,11,12,14-Heptazapentacene-2,4,8,10(14H,3H,9H,12H)-tetraones (mixed flavins) were prepared by the cyclization of 1,5-dihydro-8-[N-alkyl-N-(5-nitrouracil-6-yl)-amino-5-deazaflavins with Vilsmeier reagent. The mixed flavins oxidized alcohol under neutral condition in sunlight and a remarkable autorecycling was observed.

Recently it was shown that 5-deazaflavins which are regarded as NAD^+ in flavin clothing are able to oxidize alcohols[1] and amines[2] nonenzymatically and exhibit some autorecycling in the oxidation. However, the reoxidation of the reduced 5-deazaflavins formed initially by molecular oxygen was so slow that these NAD^+ analogs could not serve efficiently as a turnover oxidation catalyst. To overcome the shortcoming, Shinkai et al,[3] considered that flavins may madiate in the above reoxidation step and constructed an efficient autorecycling system for the oxidation of banzylamine to benzaldehyde using 5-deazaflavin and FMN; by this system the yield of benzaldehyde reached 3500% as against 170% by 5-deazaflavin alone. It occurred to us that such a co-operation of 5-deazaflavin and flavin involving intermolecular hydrogen transfer may be expected to take place intramolecularly (or intermolecularly) in the "mixed flavins" which contain both 5-deazaflavin and flavin moieties in the molecules. First, we have planned to prepare 1,3,7,9,11,12,14-heptazapentacene-2,4,8,10(14H,3H,9H,12H)-tetraones (1) as "mixed flavins". In 1, the intramolecular (or intermolecular) hydrogen transfer might occur from the initially formed 1,5-dihydro derivatives to 7,11-dihydro derivatives in the oxidation process (Scheme 2). Furthermore, the long conjugation of 1 would highten the redox potentials compared with either monomeric 5-deazaflavins or flavins, and considerable oxidizing ability would be expected for 1. We now report that this type of mixed flavins facilitate the autorecycling oxidation of alcohol in sunlight.

The mixed flavins (1) were synthesized as follows. The starting 1,5-dihydro-8-alkylamino-5-deazaflavins (3) were prepared by the $NaBH_4$ reduction of 8-alkylamino-5-deazaflavins (2) according to the known procedure.[4] As compounds 3 were extremely unstable in air, an equimolar amount of 6-chloro-3-methyl-5-nitrouracil[5] was immediately added to the chloroform solution of 3, and the mixture was heated under reflux for 10 h in argon atmosphere to give the corresponding 1,5-dihydro-8-[N-alkyl-N-(5-nitrouracil-6-yl)]-amino-5-deazaflavins (4). Compounds 4 are also unstable in air and so we used them for next step without



	R	mp(°C)	$\delta(CDCl_3)$ C_5-H	C_6-H	C_{13}-H
1a	n-C_8H_{17}	>330	8.93	8.81	7.47
1b	n-$C_{12}H_{25}$	>330	8.93	8.81	7.47
1c	n-$C_{18}H_{37}$	>330	8.92	8.81	7.46

Scheme 1

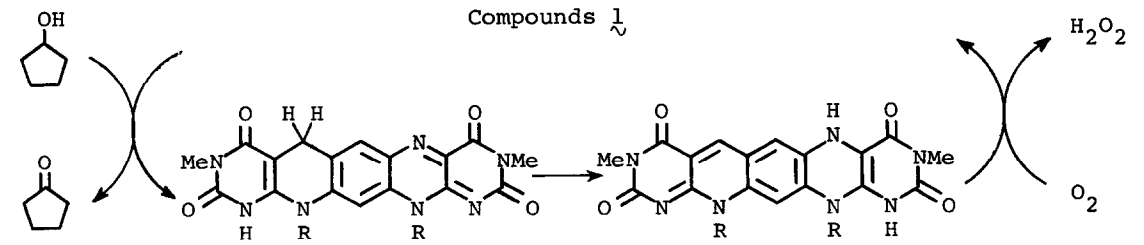
purification. Treatment of 4 with Vilsmeier reagent at 90°C for 30 min in argon atmosphere gave the mixed flavins (1) (ca. 3% yield based on 2) along with double-headed 5-deazaflavins (5)[4] (ca. 2% yield). Other products are not yet identified.

The mixed flavins (1) thus obtained oxidized cyclopentanol to give cyclopentanone under neutral condition at 80°C (oil bath) in sunlight and a remarkable autorecycling in the oxidation was observed as shown in Table 1.

Table 1. Autorecycling Oxidation of Cyclopentanol (1.5 ml) by 1 (0.5 mg) at 80°C (oil bath) for 25 h in Sunlight (Kyoto, February, Cloudless Sky)

Compd.	Yield of Cyclopentanone[a]	
1a	83600[b]	2.5[c]
1b	119300	5.5
1c	28500	1.1

a) Isolated as the 2,4-dinitrophenylhydrazone. b) Based on 1. c) Based on substrate.



Scheme 2

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