for hydroxyl group. In regard to the formation mechanisms, other possibilities might be considered, and much informations should be necessary to interpret the mechanism of complex formation in solutions.

The authors wish to express their deep gratitude to Prof. Emeritus M. Ishidate of the University of Tokyo for his encouragements and helpful advices.

Summary

Copper complexes of methyl-β-D-glucosaminide (II) and 3,4,6-tri-O-methyl-D-glucosamine (III) were investigated by pH titration method.

The stability constants log K_1 and hydrolysis constants $pK_{LCu(OH)}$ of these two complexes were determined and compared with that of copper complex of D-glucosamine (I).

The magnitude of log K_1 of copper complex of II was the same to that of copper complex of III, but both of them were slightly smaller than that of copper complex of I.

However, the hydrolysis constants of copper complexes of I, II, and III were of the same order in the magnitude.

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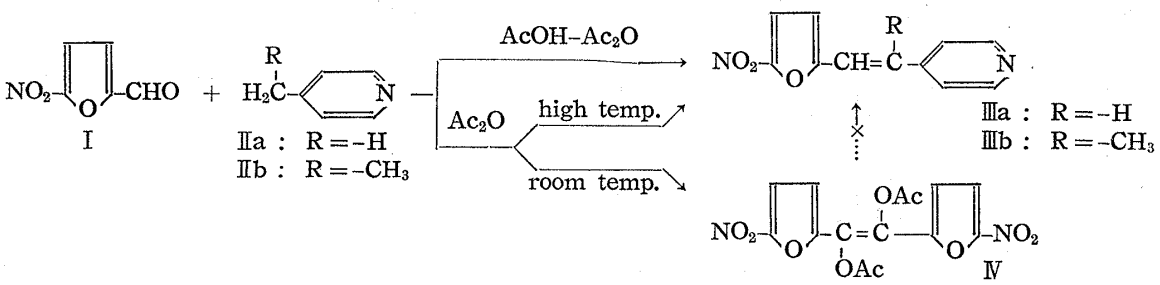
Kinji Harada and Sakae Emoto : Condensation of 5-Nitro-2-furaldehyde with 4-Methyl(or 4-Ethyl)pyridine.

(*The Institute of Physical and Chemical Research*[*1])

A series of condensation of 5-nitro-2-furaldehyde with 2- or 4-alkylpyridines and lutidines was studied to obtain antibacterial substances.

Recently, Boehringer, *et al.*[1] reported on the condensation of 5-nitro-2-furaldehyde (I) with 4-methyl(or 4-ethyl)pyridine (IIa or IIb) by being heated at 100° for 2 hours in acetic anhydride to give 4-[2-(5-nitro-2-furyl)vinyl]pyridine (IIIa) or 4-[1-methyl-2-(5-nitro-2-2-furyl)vinyl]pyridine (IIIb), however our reinvestigation on their experiments found the yield of IIIa or IIIb was unsatisfactory (about 10%) and its purification was very difficult.



Accordingly, in order to improve the yield of aimed products (IIIa or IIIb), aforementioned condensations were examined again under the following conditions. Using of acetic acid

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1) C. F. Boehringer, Soehne G. m. b. H : C. A., 58, 11333 (1963); Berg. Pat., 615319, Sept. 20, 1962.

and acetic anhydride as solvent, the reaction result showed apparent increase of the yield of IIIa or IIIb (23% or 36% respectively) as shown in Table I.

Table I. The Relation between the Yield of IIIa and Various Contents of the Solvent

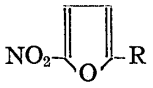
Acetic acid–Acetic anhydride (V/V)	The yield of IIIa (%)
only acetic acid	very poor
1 : 1	20
4 : 1	23 (36% for IIIb)
only acetic acid	10

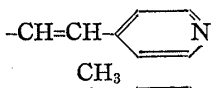
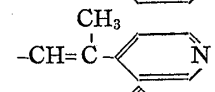
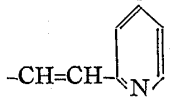
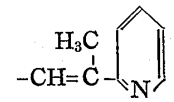
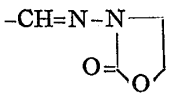
While, treatment of I with IIa or IIb in acetic anhydride alone at lower temperature gave a common unexpected neutral compound which also obtained from 3-methylpyridine under similar condition and it was in contrast to the aforementioned condensation at high temperature to give IIIa or IIIb. The neutral compound was never obtained by treatments of I with 2-alkylpyridines and with lutidines and was not obtained in acetic acid–acetic anhydride mixture.

On the structure of the neutral compound $C_7H_5O_5N$, a chemical fact that it gave the known methyl 5-nitro-2-furoate by treatment of an equivalent of either methanolic potassium hydroxide or sodium methoxide under cooling with cold water and infrared spectrum absorption at 1768 cm^{-1} corresponding a carbonyl group of vinyl ester would be consistent with assignment to the neutral compound as IV.

Independently Fujita, *et al.*[2] obtained under similar condition by using other bases a neutral compound which was assigned to 5,5′-dinitro-2,2′-furoin diacetate (IV) by preparing itself. Our neutral compound was identified with IV both by no depression of the mixed melting point and by reference to the infrared spectral data and our attempt to prepare IIIa on treatment of IIa with IV in acetic anhydride was unsuccessful, which showed that IV was not intermediate for IIIa.

Table II. Antibacterial Action of 2(or 4)-[2-(5-nitro-2-furyl)vinyl]pyridines



Comp. No.	R	*T. ast.* (γ/ml.)	*C. alb.* (γ/ml.)	*Staph. aur.* 209P (γ/ml.)	*E. coli* (γ/ml.)
IIIa		1.56	6.25	6.25	12.5
IIIb		1.56	6.25	12.5	100
Va		0.78	3.13	6.25	12.5
Vb		1.56	3.13	12.5	200
Control		200	200	6.25	12.5

2) A. Fujita, K. Yamamoto, S. Minami, S. Takamatu : Presented at the Meeting of Kinki Branch of Pharmaceutical Society of Japan, Feb. 15, 1964. A. Fujita, J. Matumoto, S. Minami : Presented at the Meeting of Kinki Branch of Pharmaceutical Society of Japan, May 16, 1964.

Bacteriostatic and fungistatic concentration of these derivatives against the growth of *Trichophyton asteroides*, *Candida albicans* in Sabouraud and against that of *Staphylococcus aureus* 209 P, *Escherichia coli* in glucose-bouillon were shown in Table II respectively.

Experimental*2

4-[2-(5-Nitro-2-furyl)vinyl]pyridine (IIIa)——To a solution of 4.7 g. (0.033 mole) of I and 3.2 g. (0.034 mole) of IIa (dried over KOH for 12 hr.) in 20 ml. of AcOH was added slowly 5 ml. of Ac_2O with stirring at 60~70° during 20 min. After being heated at 108° for 3 hr. with stirring, the reaction mixture was cooled and filtered.

The precipitate was extracted with 600 ml. of hot MeOH, which was treated with charcoal. MeOH was evaporated to dryness under reduced pressure to give crude product of IIIa. On the other hand, the filtrate was evaporated to dryness under reduced pressure.

After cooling, the residue was poured into dil. HCl cooled on ice. The precipitate was washed with saturated $NaHCO_3$ aqueous solution and with H_2O to give crude product of IIIa.

The combined product was 3.5 g. (45%). Recrystalization from MeOH yielded 2.1 g. (23%) of IIIa as yellow needles, m.p. 163~164° (167~168°),[1] UV λ_{max}^{MeOH} mμ (ε): 215, 259 (10120), 288 (9570), 368 (21580). *Anal.* Calcd. for $C_{11}H_8O_3N_2$: C, 61.11; H, 3.73; N, 12.96. Found: C, 61.16; H, 3.49; N, 13.53.

4-[1-Methyl-2-(5-nitro-2-furyl)vinyl]pyridine (IIIb)——To a solution of 2 g. (0.014 mole) of I and 1.52 g. (0.014 mole) of IIa in 8 ml. of AcOH was added slowly 1.4 ml. of Ac_2O with stirring at 70°. After being heated at 110° for 3 hr. with stirring, the reaction mixture was evaporated to dryness under reduced pressure. The residue was extracted with 500 ml. of hot MeOH, and was treated as mentioned above. Recrystalization from MeOH yielded 1.18 g. (36.2%) of yellow needles, m.p. 150~151° (154~156°).[1] UV λ_{max}^{MeOH} mμ (ε): 220, 259 (8750), 285 (7630), 368 (19510). *Anal.* Calcd. for $C_{12}H_{10}O_3N_2$: C, 62.60; H, 4.36; N, 12.17. Found: C, 62.31; H, 4.14; N, 12.19.

On the other hand, 2-[2-(5-nitro-2-furyl)vinyl]pyridine (Va) [m.p. 176~177° (178°),[3] (170~171°),[4] (178~180°).[1] UV λ_{max}^{MeOH} mμ (ε): 213, 254 (10720), 296 (9340), 376 (23000)] or 2-[1-methyl-2-(5-nitro-2-furyl)-vinyl]pyridine (Vb) [m.p. 149~149.5° (151~152°).[1] UV λ_{max}^{MeOH} mμ (ε): 213, 260 (8280), 285 (7040), 376 (16910)] was also prepared in Ac_2O-AcOH mixture under similar condition.

5,5'-Dinitro-2,2'-furoin Diacetate (IV)——To a solution of 1.5 g. (0.0106 mole) of I and 2.0 g. (0.0215 mole) of IIa (dried over KOH for 12 hr.) was added 6 ml. of Ac_2O. Yellow solution changed into dark at once with spontaneous rising of temperature and the precipitate appeared after a few minutes. After the reaction mixture was allowed to stand overnight at room temperature, it was heated at 50~55° for 4 hr., and cooled and filtered off. The residue was washed with 30 ml. of ether. Recrystlization from dimehylformamide yielded 1.05 g. (27%) of IV as yellow needles. m.p. 253~254° (253°).[2] UV $\lambda_{MeOH}^{dioxane}$ mμ (ε): 231, 287 (12300), 379 (15830). *Anal.* Calcd. for $C_{14}H_{10}O_{10}N_2$: C, 45.91; H, 2.75; N, 7.65. Found: C, 45.95, H, 2.70, N, 7.66.

This reaction also proceeded in the presence of either IIb or 3-methylpyridine instead of IIa.

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*2 Melting points are uncorrected.

3) K. Miura, J. Oohashi, S. Matsuda, Y. Igarashi: Yakugaku Zasshi, 83, 771 (1963).
4) CIBA Ltd.: C. A., 58, 1441 (1963); Berg. Pat., 613604, August 7, 1962.