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SYNTHESIS OF FURO[3,2-*c*]PYRIDINE-2,4-DIONE DERIVATIVES BY THE REACTION OF 1-METHYL-4-PHENYL-5,6-DIHYDROPYRIDIN-2(1H)-ONE WITH CARBOXYLIC ACIDS IN THE PRESENCE OF MANGANESE TRIACETATE

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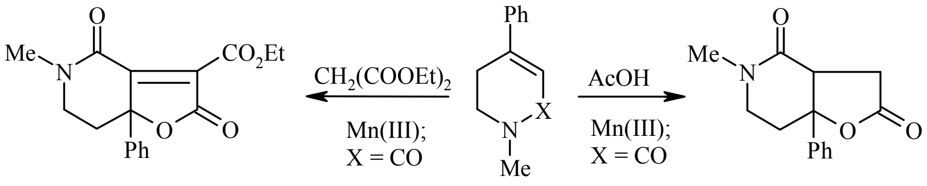
There have been recent major advances in the study of radical reactions of unsaturated compounds with carbonyl compounds induced by manganese triacetate [1, 2]. However, inadequate attention has been given to the behavior of partially reduced heterocyclic systems. In our opinion, this failure may be related to the possible formation of strong complexes of Mn(II) and Mn(III) ions with the reaction products, especially in the case of nitrogen heterocycles. Indeed, in an attempt to carry out the reaction of 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (**1a**) with acetic acid in the presence of manganese triacetate, we were unable to isolate any pure product by chromatography from the reaction mixture, in which the starting tetrahydropyridine was absent after only 40 min heating at reflux. On the other hand, perhydrofuro[3,2-*c*]pyridinedione **2** was obtained in 58% yield from 5,6-dihydropyridin-2(1H)-one **1b**, in which the nitrogen atom is amidic and cannot form strong coordination compounds with manganese diacetate. We also found that carrying out the analogous reaction in the presence of the diethyl ester of malonic acid leads to a partially hydrogenated derivative of furo[3,2-*c*]-pyridinedione **3** in 21% yield.



3 **1a,b** **2**

1 a X = CH_2, **b** X = CO

Thus, we are the first to show that, in principle, it is possible to condense 5,6-dihydropyridin-2(1H)-one with carboxylic acids or esters to give furo[3,2-*c*]pyridine derivatives, whose structure contains both δ-lactam and γ-lactone fragments.

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5-Methyl-7a-phenylperhydrofuro[3,2-*c*]pyridine-2,4-dione (2). A mixture of 1-methyl-4-phenyl-5,6-dihydropyridin-2(1H)-one (**1b**) (0.6 g, 3.2 mmol), acetic acid (7 ml), acetic anhydride (1 ml), and manganese triacetate trihydrate (2.56 g, 9.6 mmol) was stirred and heated at reflux for 40 min until the dark brown color disappeared. The reaction mixture was then cooled, diluted with water until the manganese diacetate precipitate dissolved, and extracted with ether. The residue after evaporation of the ether (0.7 g) was separated on a silica gel column with ether as the eluent to give 0.46 g (58%) furopyridine **2** as a thick oil, R_f 0.52 (acetone). IR spectrum, ν, cm^{-1}: 1640 (N–C=O), 1770 (O=C=O). ^{1}H NMR spectrum, δ, ppm, *J* (Hz): 2.30 (2H, m, 7-CH_2); 2.83 (2H, br. d, *J* = 2.5, $OCOCH_2$); 3.08 (3H, s, N–CH_3); 3.25-3.31 (1H, t, *J* = 2.2, 6-CH_2); 3.44 (1H, t, *J* = 2.5, 3a-H); 3.68 (1H, m, 6-CH_2); 7.35-7.48 (5H, m, Ph). Mass spectrum, *m/z* (I_{rel}, %): 245 (100) $[M]^+$, 244 (12), 217 (5) $[M - CO]^+$, 201 (5) $[M - CO_2]^+$, 187 (17) $[M - CH_2CO_2]^+$, 186 (74), 160 (21), 105 (64) $[PhCO]^+$, 77 (29). Found, %: C 68.31; H 6.34; N 5.43. $C_{14}H_{15}NO_3$. Calculated, %: C 68.57; H 6.12; N 5.71.

3-Ethoxycarbonyl-5-methyl-7a-phenyl-6,7-dihydrofuro[3,2-*c*]pyridine-2(7aH),4(5H)-dione (3) was obtained analogously from a mixture of **1b** (0.6 g, 3.2 mmol), acetic acid (7 ml), acetic anhydride (1 ml), diethyl malonate (0.5 ml, 3.2 mmol), and manganese triacetate (2.56 g, 9.6 mmol), which gave 0.22 g (21%) furopyridine **3** as a light yellow oil, R_f 0.56 (ether). IR spectrum, δ, cm^{-1}: 1770 (O=C–OEt), 1733 (lactone C=O), 1650 (N–C=O). ^{1}H NMR spectrum, δ, ppm, *J* (Hz): 1.37 (3H, t, *J* = 4.4, O–CH_2–$\underline{CH_3}$); 2.37 (1H, m, 7-H); 2.92 (1H, m, 7-H); 2.95 (3H, s, N–CH_3); 3.02 (1H, m, 6-H); 3.37 (1H, m, 6-H); 4.40 (2H, m, O–$\underline{CH_2}$–CH_3); 7.29 (2H, m, Ph); 7.37 (3H, m, Ph). Mass spectrum, *m/z* (*I*, %): 315 (10) $[M]^+$, 271 (8) $[M - CO_2]^+$, 242 (12) $[M - CO_2Et]^+$, 237 (21) $[M - H - Ph]^+$, 210 (90) $[M - PhCO]^+$, 164 (81), 105 (100) $[PhCO]^+$, 77 (43). Found, %: C 64.37; H 5.63; N 4.32. $C_{17}H_{17}NO_5$. Calculated, %: C 64.76; H 5.40; N 4.44.

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