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Palladium-Catalyzed Allylation of Pyrimidine-2,4-diones (Uracils) and of 6-Membered Heterocyclic Ambident Sulfur Nucleophiles

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Abstract.- Pd(0)-Catalyzed allylation of six-membered ambident heterocycles bearing NH-CO, NH-CS and CH_2-CO moieties obey the regioselectivity rules C>O, N>O, S>N, NH-CO>NH-CS Uracil and 5-methyluracil (thymine) do not show regioselectivity (N-1 = N-3) whereas 6-methyluracil is regioselectively allylated at N-3 (N-3>N-1)

INTRODUCTION

The Pd(0)-catalyzed allylation of heterocyclic systems bearing ambident nucleophiles is a topic of increasing interest Thus, regioselective N-9 allylation of purines, at the imidazole part of the molecule, is a key step in the preparation of carbanucleosides [1-7] Ambident heterocyclic 6-membered rings possessing a tautomeric or mesomeric aromatic structure that have been allylated under Pd(0) catalysis include 2-pyridones (N-allylation under Pt(0) catalysis),[8] pyrimidin-2-ones (N-allylation under thermodynamic control),[1,9,10] pyridine-2,6-diones (C-allylation),[11] pyrimidine-2,4-dione (uracil) (N-1 allylation),[12,13] and its 5-methylderivative (thymine) (N-1 allylation),[13] 4-hydroxy-6-methyl-2-pyrone (triacetic acid lactone) (C-allylation under thermodynamic control),[14,15] and barbituric acid [16] However, a very recent paper[7] reports the regioselective Pd(0)-catalyzed allylation of citosine and 5-methylcitosine to occur at N-1 but the allylation of thymine with cyclopentadiene monoepoxide to be non selective, both products from allylation at N-1 and N-3 being produced

On the other hand, sulfur nucleophiles are not popular in Pd(0)-catalyzed allylation chemistry, possibly due to the belief that the pronounced thiophilicity of palladium could poison the catalytic systems However, Trost and Scanlan have described a Pd(0)-catalyzed synthesis of allyl sulfides[17] and also two scattered examples of allylations at sulfur under Pd[18] and Ni[19] catalysis have been reported

RESULTS

We have studied the Pd-catalyzed allylation of several 6-membered heterocyclic ambident systems bearing a nucleophilic sulfur atom, i e 2-thiopyridone, **3**, 2-mercaptopyrimidine, **4**, 6-methyl-2-thiouracil, **6**, and 2-thiobarbituric acid, **7** Some oxo analogues such as 2-pyridone, **2**, 6-methyluracil, **5**, thymine, **8**, and uracil, **9** were also included Cinnamyl ethyl carbonate, **1a**, was chosen as allylic reagent for its high regioselectivity [16]

Our results are collected in the table and the scheme Pyridone, **2**, affords the N-cinnamyl derivatives **10** (runs 1 and 2), thus pointing out to a preferential attack at the nitrogen atom of the amide (N>O) as previously observed under Pt catalysis [8] However, the thioanalogue **3** behaves differently to give sulfides **11** (runs 3 and 4) Thus, the conjugate base of the thioamide (or its tautomer) exhibits preferential attack by the sulfur nucleophilic center (S>N) Clearly the sulfur atom is compatible with the initial presence of a Pd(II) species Also, 2-mercaptopyrimidine, **4**, was allylated at the sulfur atom giving **12** (run 5)

Next, we studied compounds **5** and **6**. 6-Methyluracil, **5**, affords N-cinnamyl derivative **13** (N>O, N-3 > N-1) (run 6) Further reaction of **13** produced the dicinnamyl derivative **14** (run 8) However, the sulfur counterpart **6** produces **15** as the only clearly identified isomer (run 9) Compound **15** was converted into **13** by oxidation with hydrogen peroxide, thus giving an additional evidence that both compounds have the cinnamyl group at the same position.

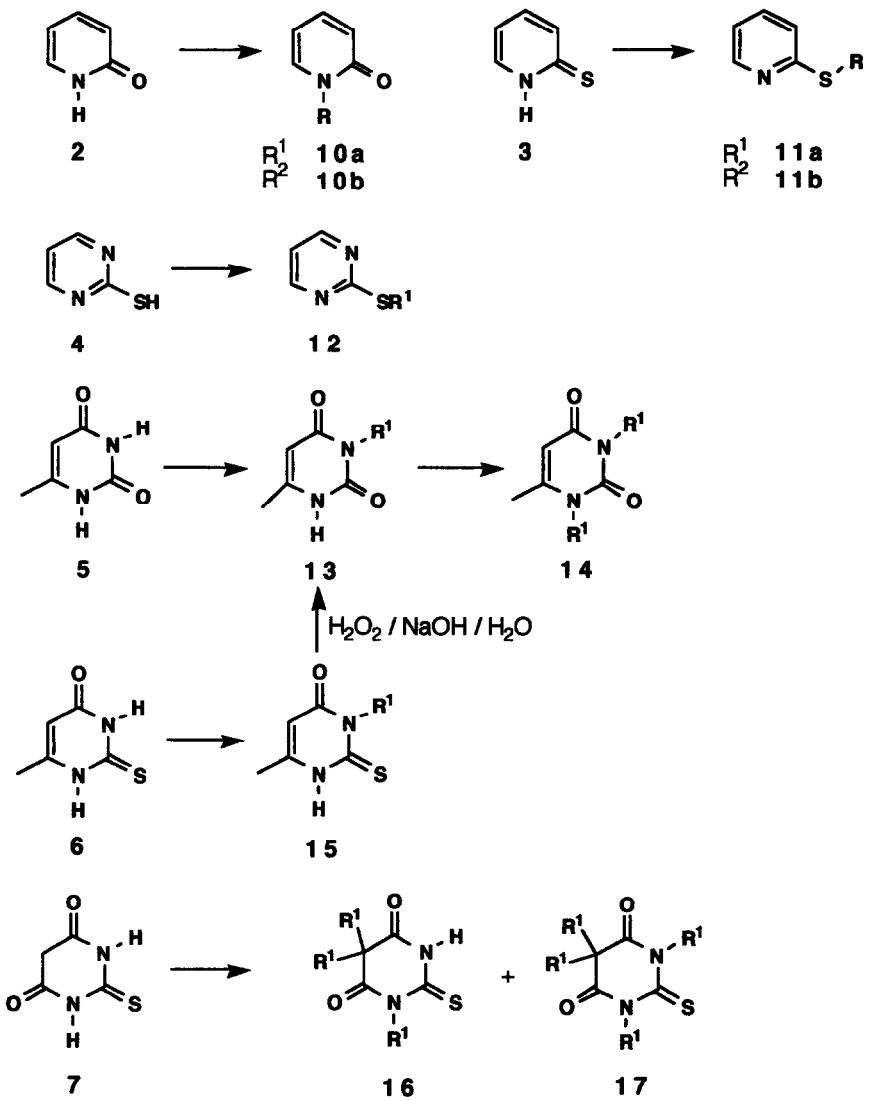
2-Thiobarbituric acid, **7**, bears a nucleophilic carbon atom and, as already observed for barbituric acid,[16] the active methylene group is the preferred point for reaction followed by the nitrogen atoms (C>O, N>O, CH_2-CO > NH-CO, NH-CO > NH-CS) as pointed out by the isolation of **16** and **17** (run 10)

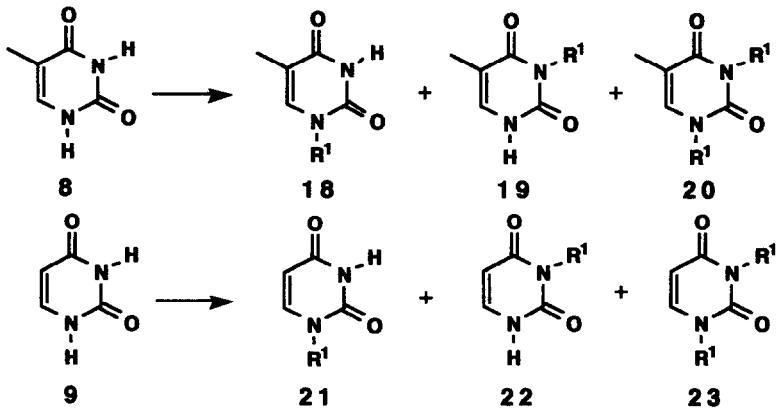
Table - Allylation of Compounds **2-9** and **13**

Run	**2-9,13** (mmole)	**1** (mmole)	Pd[a] (mmole)	Solvent (mL)	temp	time	Products (%)	Allylation
1	**2**(10 0)	**1a**(12 0)	A(0.5)	THF(20)	rt	16h	**10a**(88)	N > O
2	**2**(7 0)	**1b**(8.4)	A(0.35)	THF(15)	rt	16h	**10b**(70)	N > O
3	**3**(7 0)	**1a**(8 4)	A(0 35)	THF(20)	rt	64h	**11a**(96)	S > N
4	**3**(10 0)	**1b**(10 0)	B(0 5)	THF(20)	rt	64h	**11b**(80)	S > N
5	**4**(8.0)	**1a**(8.0)	B(0.4)	DMSO(20)	rt	2 5h	**12**(55)	S > N
6	**5**(8 0)	**1a**(9 6)	A(0 4)	Diox (20)	Reflux	24h	**13**(52)	N > O, N-3 > N-1
7	**5**(8.0)	**1a**(8 0)	B(0.4)	DMSO(25)	105C	14h	**13**(49), **14**(5)	N > O, N-3 > N-1
8	**13**(0 8)	**1a**(1 0)	A (0 04)	THF (20)	Reflux	3h	**14**(90)	N > O
9	**6**(8 0)	**1a**(9.6)	A(0.4)	Diox.(20)	Reflux	6d	**15**(30)	N > O NHCO > NHCS
10	**7**(4.0)	**1a**(13 0)	B(0 4)	THF(20)	rt	16h	**16**(20), **17**(32)	C > N, N > O, NHCO > NHCS
11	**8**(4 0)	**1a**(4 0)	B(0 2)	DMSO(20)	108C	45h	**18**(30), **19**(14), **20**(7)	N-1 = N-3
12	**9**(9 0)	**1a**(9 0)	B(0 4)	DMSO(20)	105C	5 5h	**21**(38), **22**(7), **23**(9)	N-1 = N-3

[a] A $Pd(acac)_2/PPh_3$ (1 4), B $Pd(PPh_3)_4$

1a **PhCH=CH-CH$_2$OCOOEt** R^1 = cinnamyl
1b **CH$_2$=CH-CH$_2$OCOOEt** R^2 = allyl





Scheme For experimental conditions see table

The reaction of **5** at N-3 (run 6) was surprising in view of the literature precedents dealing with uracil and thymine as indicated above [12,13] Therefore, we decided to perform some experiments on thymine, **8**, and uracil, **9** Indeed, reactions of both **8** and **9** with **1a** (runs 11 and 12) showed poor regioselectivity, reactions at N-1 being only slightly predominant and allylation at N-3 being significant A very recent paper by a Hoechst AG group reports similar results.[7] Our reactions with **8** and **9** were performed in DMSO for solubility reasons and therefore we performed a second experiment with **5** in the same solvent (run 7) Again, the result was a remarkable regioselectivity favouring N-3 Possibly the steric hindrance introduced by the methyl group at C-6 is responsible for the observed results. In any case the conclusion is that extreme caution in structure determinations is required in this field

All N-cinnamyl derivatives present a doublet at d 4 4-5 2, whereas S-cinnamyl derivatives exhibit the doublet at 3 9-4 1. Furthermore, the signals for the S-$\underline{C}H_2$ appear in 13C-NMR at 32 7-33.0 whereas those for N-$\underline{C}H_2$ appear above 40 Assignments of structure to monoallylated products were made on the basis of the 13C-NMR spectra with the program Selective Distorsionless Enhancement by Polarization Transfer (SDEPT) developed by Sánchez-Ferrando and coworkers in our Department [20] As an example, by selective pulsing of the methylene protons of compound **13** only the coupled carbonyl carbon atoms (apart from the cinnamyl olefinic carbon atoms) at C-2 and C-4 showed signals enhanced by polarization transfer (SDEPT effect) Should the isomeric structure (cinnamyl group at N-1) have been the real one, SDEPT effect for signals due to C-2 and C-6 would have been observed A similar technique (Selective INEPT) has been recently reported [21]

FINAL REMARCK

When this work was already finished Prof Denis Sinou (Lyon) announced us that he and his coworkers had obtained results similar to those here described We are indebted to him for this communication [27]

EXPERIMENTAL

N-Cinnamyl-2-pyridone, **10a** (Run 1) (General procedure) A degassed solution of $Pd(acac)_2$ (0 152 g, 0.5 mmole), triphenylphosphine (0.525 g, 2 0 mmole) and cinnamyl ethyl carbonate (2 475 g, 12 0 mmole) in anhydrous THF (15 mL) was added over a degassed solution of 2-pyridone (0.951 g, 10.0 mmole) in anhydrous THF (5 mL) The stirred mixture was kept 16 h under argon at room temperature The formed yellow solid (a palladium complex) was filtered off The filtrate was evaporated and the residue was chromatographed through a column of silica-gel to afford **10a** (1 863 g, 88%), b p 225C/4 5 mmHg, IR(film). 1658 cm^{-1}, 1H-NMR ($CDCl_3$) 4 75 (d, J = 5 7 Hz, 2H), 6 22 (dt, J = 8 2 and 1 9 Hz, 1H), 6.31 (dt, J =

15 0 and 5 7 Hz, 1H), 6.59 (dd, J = 8 2 and 1.9 Hz, 1H), 6 66 (d, J = 15.0 Hz, 1H), 7 22-7 87 (m, 7H), 13C-NMR ($CDCl_3$) 50 4, 105.9, 120 7, 123 0, 126.3, 127 8, 128 3, 133 8, 135 8, 136 8, 139 2, 162 2, MS (m/e) 212(M+1, 7), 211(M, 43), 120(33), 117(85), 116(53), 115(100), 96(41), 91(32). Anal Calcd for $C_{14}H_{13}NO$ C, 79 59, H, 6 20; N, 6 63 Found C, 79 67; H, 6 26; N, 6 39

All other compounds were prepared as for **10a** under the particular conditions described in the table

N-Allyl-2-pyridone, **10b** (Run 2) The final oil was not distilled but converted into the picrate m p 105-6C (Lit [22] m p 104 5-105 5C)

Free **10b**· IR(film). 1657 cm^{-1}, 1H-NMR ($CDCl_3$) 4 51 (d, J = 4 8 Hz, 2H), 4 90-5 20 (m, 2H), 5 47-6 00 (m, 1H), 6 12 (dt, J = 7 4 and 1 8 Hz, 1H), 6 51 (d, J = 7 8 Hz, 1H), 7 11-7 42 (m, 2H), 13C-NMR ($CDCl_3$) 50 0, 105 2, 117 3, 119 8, 131 8, 136 7, 138 7, 161 4, MS(m/e) 135(M, 69), 134(100), 120(82), 79(37), 41(41)

2-(Cinnamylthio)pyridine, **11a** (Run 3) The filtrated Pd complex was bis(pyridine-2-thiolate)bis(triphenylphosphine)palladium, m p 181-2C (Lit [23] m p 185-6C) The filtrate was evaporated and the residue was distilled to give 1 533 g (96%) of **11a**, b p 150C/0 05 mmHg, m p 41-2C (Lit [24] m p 42-42 5C), 1H-NMR ($CDCl_3$) 4 08 (d, J = 6 1 Hz, 2H), 6 32 (dt, J = 16 0 and 6 1 Hz, 1H), 6 68 (d, J = 16 0 Hz, 1H), 6 89-7 68 (m, 8H), 8 48 (d, J = 5 0 Hz, 1H), 13C-NMR ($CDCl_3$) 32 7, 119 4, 122 4, 125 4, 126 3, 127 4, 128 4, 132 7, 135.9, 136 9, 149 3, 158 6, MS (m/e) 227(M, 61), 194(95), 136(29), 117(89), 115(100), 91(33)

2-(Allylthio)pyridine, **11b** (Run 4) Isolated as an oil. Its spectroscopic data were in agreement with those already described [25,26] 1H-NMR ($CDCl_3$) 3 82 (d, J = 6 9 Hz, 2H), 5 09 (d, J = 9 8 Hz, 1H), 5 27 (dd, J = 17 2 and 2 2 Hz, 1H), 5 95 (ddt, J = 17 2, 9 8 and 6 9 Hz, 1H), 6 94-6 99 (m, 1H), 7 16 (d, J = 8 0 Hz, 1H), 7 47 (dt, J = 2 0 and 8.0 Hz, 1H), 8 38 (d, J = 6 4 Hz, 1H), 13C-NMR ($CDCl_3$) 32 8, 117 3, 119 3, 122 1, 128 1, 135 7, 149 2, 158 4, MS(m/e) 151(M, 25), 136(100), 118(32), 79(51)

2-(Cinnamylthio)pyrimidine, **12** (Run 5) The filtrated palladium complex was bis(pyrimidine-2-thiolate)bis(triphenylphosphine)palladium (13%), m p 177-8C, 1H-NMR (d_6-DMSO) 6 91 (d, J = 4 9 Hz, 2H), 7 3-7 5 (m, 30H), 8 21 (d, J = 4 9 Hz, 4H) Anal Calcd for $C_{44}H_{36}N_4P_2PdS_2$ = $(C_4H_3N_2S)_2Pd(PPh_3)_2$) C, 61 94, H, 4 25, N, 6 57, S, 7 52 Found C, 62 02, H, 4 22, N, 6 53, S, 7 30

The filtrate was evaporated and the residue was distilled to afford **12** p 100-125C/0 2 mmHg, m p 32-3C, 1H-NMR ($CDCl_3$) 3 95 (d, J = 6 2 Hz, 2H), 6 31 (dt, J = 15 5 and 6 2 Hz, 1H), 6 66 (d, J = 15 5 Hz, 1H), 6 92 (t, J = 4 5 Hz, 1H), 7 30 (m, 5H), 8 50 (d, J = 4 5 Hz, 2H), 13C-NMR ($CDCl_3$) 33 0, 116 2, 124 5, 126 0, 127 2, 128 2, 132 6, 136 4 156 8, 171 6, MS(m/e) 228(M, 16), 195(100), 117(50), 115(52) Anal Calcd for $C_{13}H_{12}N_2S$ C, 68 39, H, 5 30, N, 12 27, S, 14 04 Found C, 67 80, H, 5 24, N, 11 82, S, 13 28

3-Cinnamyl-6-methyluracyl, **13** (Run 6) No Pd complex was isolated in this reaction Product **13** precipitated when the reaction mixture was reaching room temperature It was filtrated off and the filtrate was evaporated to afford a mixture of **13** and the starting material **5** Compound **13** has m p 233-4C (from ethanol), IR(KBr) 1735, 1644, 1609 cm^{-1}, 1H-NMR (d_6-DMSO) 2 03 (s, 3H), 4 49 (d, J = 6 0 Hz, 2H), 5 48 (s, 1H), 6 23 (dt, J = 15 5 and 6 0 Hz, 1H), 6 46 (d, J = 15 5 Hz, 1H), 7 22-7 38 (m, 5H), 13C-NMR (d_6-DMSO) 17 9, 40 7, 98.2, 124 2, 126 0, 127 4, 128 4, 131 5, 136 2, 151 1, 151 2, 162 4, MS(m/e) 242(M, 25), 151(100), 127(28), 115(29) Anal Calcd for $C_{14}H_{14}N_2O_2$ C, 69 40, H, 5 82, N, 11 56 Found C, 69 50, H, 5 73, N, 11 53

1,3-Dicinnamyl-6-methyluracil, **14** (Run 8) No Pd complex was isolated in this reaction Compound **14** was isolated by solvent evaporation and column chromatography through silica-gel Compound **14** has m p 125-6C (ethanol), IR(KBr) 1693, 1651, 1623 cm^{-1}, 1H-NMR ($CDCl_3$) 2 35 (s, 3H), 4 74 (d, J = 5 Hz, 2H), 4 84 (d, J = 5 Hz, 2H), 5 72 (s, 1H), 6 06-6 50 (m, 2H), 6 61 (d, J = 15 Hz, 1H), 6 79 (J = 15 Hz, 1H), 7 35 (m, 10H), 13C-NMR ($CDCl_3$) 19 5, 42 9, 46 6, 101 9, 123 1, 126 5, 127 6, 128 1, 128 4, 128 6, 133 0, 134 0, 135 9, 136 7, 151 4, 151 9, 161 8, MS(m/e) 358(M, 20), 241(20), 132(23), 117(40),

115(100), 110(32), 91(19) Anal Calcd for $C_{23}H_{22}N_2O_2$ C, 77 07, H, 6 19, N, 7 81 Found C, 77 10, H, 6 17, N, 7 81

3-Cinnamyl-6-methyl-2-thiouracil, **15** (Run 9) No Pd complex was isolated Product **15** was separated by digestion with diethyl ether The residue crystallized from ethanol to afford **15**, m p 201-2C, IR(KBr) 1668, 1664, 1623 cm^{-1}, 1H-NMR (d_6-DMSO) 2 13 (s, 3H), 5 03 (d, J = 5 3 Hz, 2H), 5 83 (s, 1H), 6 23 (dt, J = 16 7 and 5 3 Hz, 1H), 6 57 (d, J = 16 7 Hz, 1H), 7 13-7 50 (m, 5H), 13C-NMR (d_6-DMSO) 17 8, 46 6, 102 7, 122 9, 126 0, 127.4, 128 4, 132 4, 136 1, 151 6, 159 8, 176 3, MS(m/e) 258(M, 36), 225(100), 149(21), 117(66), 115(95) Anal Calcd for $C_{14}H_{14}N_2OS$ C, 65 09, H, 5 46, N, 10 84, S, 12 41 Found C, 65 02, H, 5 47; N 10 82, S, 12 33

Preparation of **13** by oxidation of **15** 36% Hydrogen peroxide (0.300 g, 3 30 mmole) was dropwise added under stirring at room temperature upon a mixture of **15** (0.200 g, 0 08 mmole) and 20% aqueous sodium hydroxide (20 mL) After 3 h some starting material still remained and more 36% hydrogen peroxide (2 mL) was added The mixture was stirred for 24 h and partitioned with dichloromethane The organic layer was washed with aqueous sodium bisulfite, with aqueous HCl and with water, then it was dried and evaporated to afford a residue that upon digestion with diethyl ether gave **13** (0 105 g, 53%), m p 233-4 C

1,5,5-Tricinnamyl-2-thiobarbituric acid, **16**, and 1,3,5,5,-tetracinnamyl-2-thiobarbituric acid, **17** (Run 10) After solvent evaporation the residue was digested with ether to afford an insoluble Pd complex of m p 135-6 C (from acetone) The ether solution was evaporated to give an oil that was chromatographed through a column of silica-gel The following products were eluted by increasing the solvent polarity

17, m p 61-2C (diethyl ether), IR(KBr) 1693 cm^{-1}, 1H-NMR ($CDCl_3$) 2 97 (d, J = 7 7 Hz, 4H), 5 17 (d, J = 6 3 Hz, 4H), 5 8-6 9 (m, 8H), 7 16 and 7 24 (two s, 20H), 13C-NMR ($CDCl_3$) 42 5, 49 3, 58.1, 121 4, 121 9, 126 2, 126 4, 127 6, 128 3, 134 9, 135 6, 136 2, 168 9, 178 8, MS(m/e) 91(100) Anal Calcd for $C_{40}H_{36}N_2O_2S$ C, 78 92, H, 5 96, N, 4 60, S, 5 27 Found C, 78 60, H, 6 03, N, 4 61, S, 4.80

16, m p 48-9C, IR(KBr) 1725, 1689 cm^{-1}; 1H-NMR ($CDCl_3$) 2 97 (d, J = 7 7 Hz, 4H), 5 05 (d, J = 6.3 Hz, 2H), 5 8-6 9 (m, 6H), 7 21 (s, 15 H), 9 05 (s, 1H), 13C-NMR ($CDCl_3$) 41.8, 47 9, 58 2, 121 1, 121 2, 126 2, 126 4, 127 6, 128 3, 135 3, 135 8, 136 0, 136 2, 168 1, 169 5, 177 3, MS(m/e). 227(41), 212(24), 194(67), 149(23), 136(25), 117(91), 115(100), 91(60) Anal Calcd for $C_{31}H_{28}N_2O_2S$ C, 75 58, H, 5 73, N, 5.69, S, 6 51 Found C, 75 57, H, 5 76, N, 5 64, S, 6 40

1-Cinnamyl-5-methyluracil, **18**, 3-cinnamyl-5-methyluracil, **19**, and 1,3-dicinnamyl-5-methyluracil, **20** (Run 11) After solvent evaporation at water pump pressure, the residue was partitioned between dichloromethane and water The organic layer was dried and evaporated The residue was digested with diethyl ether to afford **18**, m p 210-1C (from ethanol), IR(KBr) 1695, 1676 cm^{-1}, 1H-NMR (d_6- DMSO) 1 72 (s, 3H), 4 39 (d, J = 6 1 Hz, 2H), 6.31 (dt, J = 15 9 and 6 1 Hz, 1H), 6 53 (d, J = 15 9 Hz, 1H), 7 24-7 42 (m, 5H), 11 25 (s, 1H), 13C-NMR (d_6-DMSO) 12 5, 48 5, 108 9, 124 6, 126 7, 127 9, 128 7, 132 5, 135 8, 140 9, 150 8, 164 3, MS(m/e) 242(M, 23), 117(100), 115(36) Anal Calcd for $C_{14}H_{14}N_2O_2$ C, 69.40, H, 5 82, N, 11 56 Found C, 69 39, H, 5 90, N, 11 42

The ether solution was evaporated and the residue chromatographed through a column of silica-gel to afford

20 m p 162-3C (from diethylether-dichloromethane), IR(KBr) 1694, 1668, 1642 cm^{-1}, 1H-NMR ($CDCl_3$) 1 93 (s, 3H), 4 51 (d, J = 6 7 Hz, 2H), 4 74 (d, J = 6 7 Hz, 2H), 6 22 (dt, J = 15 9 and 6 7 Hz, 1H), 6 32 (dt, J = 15 9 and 6 7 Hz, 1H), 6 62 (d, J = 15 9 Hz, 1H), 6 72 (d, J = 15 9 Hz, 1H), 7 02 (s, 1H), 7 20-7 30 (m, 10H), 13C-NMR ($CDCl_3$) 12 9, 42 9, 50 3, 109 9, 122 6, 122 8, 126 3, 126 4, 127 5, 128 1, 128 3, 128 5, 134 4, 135 5, 136 4, 137 6, 151 0, 163 2 Anal Calcd for $C_{23}H_{22}N_2O_2$ C, 77 07, H, 6 19, N, 7 81 Found C, 76 17, H, 6 17, N, 7 53

19 m p 168-9C (from diethyl ether), IR(KBr) 1713, 1641 cm^{-1}, 1H-NMR ($CDCl_3$) 1 95 (s, 3H), 4 69 (d, J = 6 7 Hz, 2H), 6 27 (dt, J = 15 8 and 6 7 Hz, 1H), 6 66 (d, J = 15 8 Hz, 1H), 7 04 (d, J = 6 1 Hz, 1H), 7 18-7 39 (m, 5H), 10 42 (N-H, 1H), 13C-NMR ($CDCl_3$) 13 8, 42 3, 110 1, 122 7, 126 4, 127 7, 128 4, 133 8, 134 7, 136 4, 153 1, 163 7 Anal Calcd for $C_{14}H_{14}N_2O_2$ C, 69 40, H, 5 82, N, 11 56 Found C, 68 92, H, 5 86, N, 11 43

1-Cinnamyluracil, **21**, 3-cinnamyluracil, **22**, and 1,3-dicinnamyluracil, **23** (Run 12) This experiment was performed as for compounds **18-20**. Compounds **21-23** were separated by the same procedure.
21 m p 199-200C, IR(KBr) 1714, 1672 cm^{-1}, 1H-NMR (d_6-DMSO) 4.43 (d, J = 6 1 Hz, 2H), 5 59 (d, J = 7 9 Hz, 1H), 6 32 (dt, J = 15 9 and 6 1 Hz, 1H), 6 55 (d, J = 15 9 Hz, 1H), 7 24-7 43 (m, 5H), 7 64 (d, J = 7 9 Hz, 1H), 11 28 (s, 1H), 13C-NMR (d_6-DMSO) 48 9, 101 4, 124 4, 126 6, 128 0, 128 8, 132 6, 136 1, 145 4, 151 0, 163 9; MS(m/e) 228(M, 34), 117(100), 115(49), 91(18) Anal Calcd for $C_{13}H_{12}N_2O_2$ C, 68 41, H, 5 30, N, 12 27 Found C, 68 43, H, 5 31, N, 12 20
23 m p 101-2C, IR(KBr) 1701, 1668, 1647 cm^{-1}, 1H-NMR (d_6-DMSO) 4 52 (d, J = 6 1 Hz, 2H), 4 57 (d, J = 4 9 Hz, 2H), 5 77 (d, J = 7 3 Hz, 1H), 6 26 (dt, J = 15 9 and 6 1 Hz, 1H), 6 35 (d, J = 15 9 and 6 1 Hz, 1H), 6 49 (d, J = 15 9 Hz, 1H), 6 58 (d, J = 15 9 Hz, 1H), 7 19-7 44 (m, 10H), 7 73 (d, J = 7 3 Hz, 1H), 13C-NMR (d_6-DMSO) 42 2, 50 2, 100 7, 124 1, 124 2, 126 4, 126 6, 127 8, 128 1, 128 7, 128 8, 132 0, 132 8, 136 1, 136 3, 144 1, 150 9, 162 4 Anal Calcd for $C_{22}H_{20}N_2O_2$ C, 76 72, H, 5 85, N, 8 13 Found C, 76 80, H, 5 86, N, 8 16
22 m p 160-1C, IR(KBr) 1739, 1634, 1608 cm^{-1}, 1H-NMR (d_6-DMSO) 4 50 (d, J = 6 1 Hz, 2H), 5 61 (d, J = 8 6 Hz, 1H), 6 24 (dt, J = 15 8 and 6 1 Hz, 1H), 6 47 (d, J = 15 8 Hz, 1H), 7 19-7 50 (m, 6H), 11 14 (s, 1H), 13C-NMR (d_6-DMSO) 41 2, 103 9, 124.3, 126 4, 127 8, 128 8, 131 8, 136 4, 140 9, 151 4, 163 0 Anal Calcd for $C_{13}H_{12}N_2O_2$ C, 68 41, H, 5 30 Found C, 68 10, H, 5 36

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