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Note

Synthesis of some novel barbituric acid and 1,3-cyclohexanedione based condensed heterocycles

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Synthesis of some novel condensed heterocycles based on peripheral barbituric acid/1,3-cyclohexanedione moieties and central pyran, pyridine and thiin (thiopyran) ring systems has been achieved by the condensation of barbituric acid/1,3-cyclohexanedione with different aromatic aldehydes.

Keywords: Barbituric acid, heterocyclization

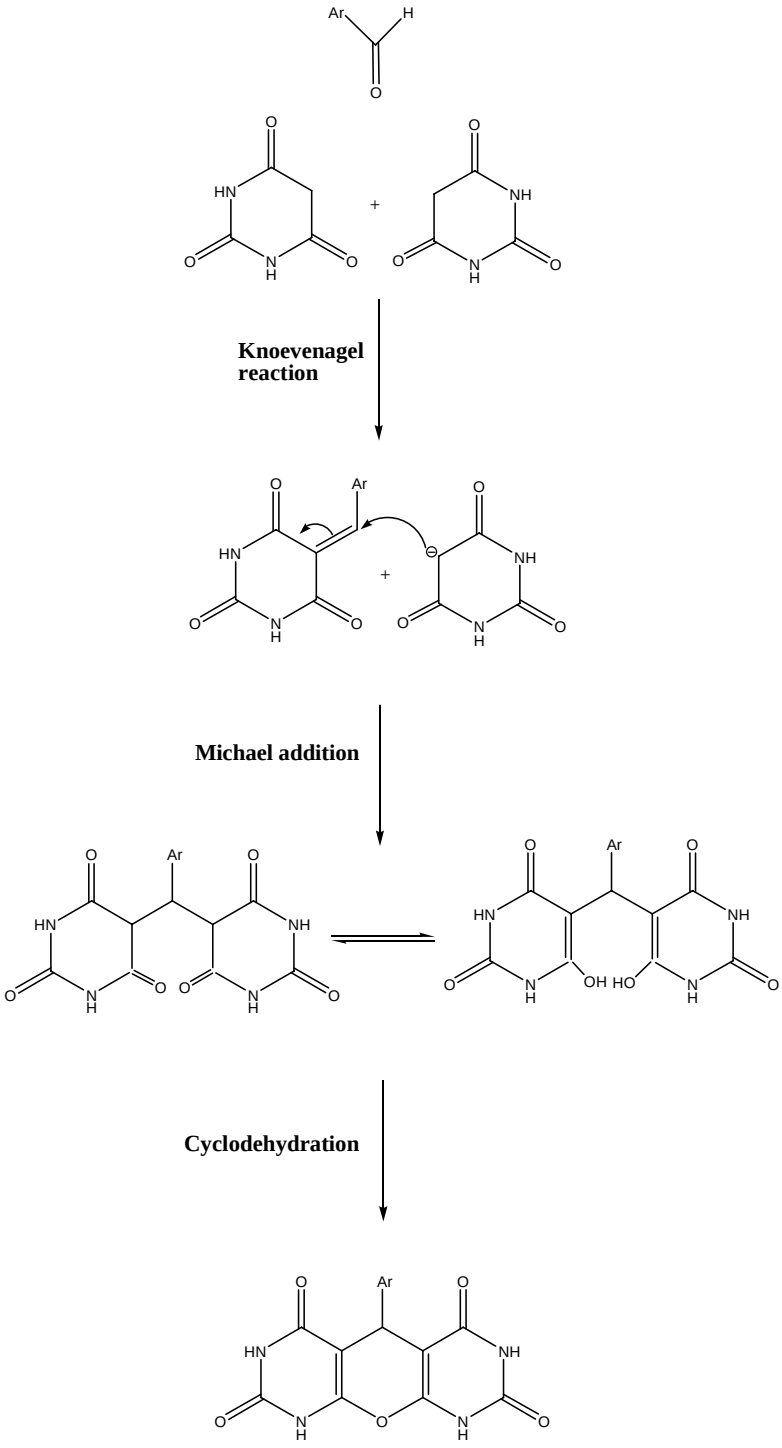
The derivatives of Pyrimidinetriones (barbituric acids) have a special place in pharmaceutical chemistry. The biological activities range from classical applications in medical treatment as hypnotic, sedative and anaesthetic drugs[1] to the more recent reports indicating that they have applications in antitumor[2], anticancer[3] and antiosteoporosis[4] treatments. Literature search reveals that a fair amount of work has been published on the condensation reactions of barbituric acid with carbonyl compounds[5-14]. Keeping in view these findings and because of the long standing interest in this laboratory, in the condensation reactions of active methylene compounds[15], the synthetic activity in the present work is elaborated along these lines. These include the synthesis of some novel barbituric acid based condensed heterocycles *via* the Knoevenagel condensation, Michael addition and cyclodehydration between barbituric acid and an aromatic monoaldehyde and α,β-unsaturated aromatic aldehyde. The initial step of the procedure involves the mixing of an aldehyde with barbituric acid in a minimum amount of acetic acid to dissolve both the reactants. According to the reactivity of the applied aldehydes, the reaction mixture is left to stir at RT for a few hours. The completion of the reaction determines the way in which product is isolated. The reaction proceeds probably *via* the mechanism in which one barbituric acid moiety adds to the aromatic aldehyde by Knoevenagel condensation followed by the addition of second barbituric acid moiety across the double bond by a Michael type addition to give compound **2**. In the final step, the compound **2** is subjected to heterocyclization under different sets of conditions (as detailed in Experimental Section) to give some novel condensed heterocycles. Similar products can also be obtained when the reaction is carried out in ethylene glycol in place of acetic acid. It has been found that in ethylene glycol, Knoevenagel condensation, Michael addition and cyclodehydration take place simultaneously without allowing the intermediate compounds to be isolated to give the similar compounds. This reaction has also been extended to another cyclic active methylene compound, 1,3-cyclohexanedione when xanthene, acridine and thioxenthene derivatives could be obtained in very good yield under similar conditions (**Scheme I**). All the synthesized compounds gave analysis for CHN and S in good agreement with the calculated values and the structures have been elucidated on the basis of spectroscopic data. Comparative yield under two different conditions are given in **Table I**.

Results and Discussion

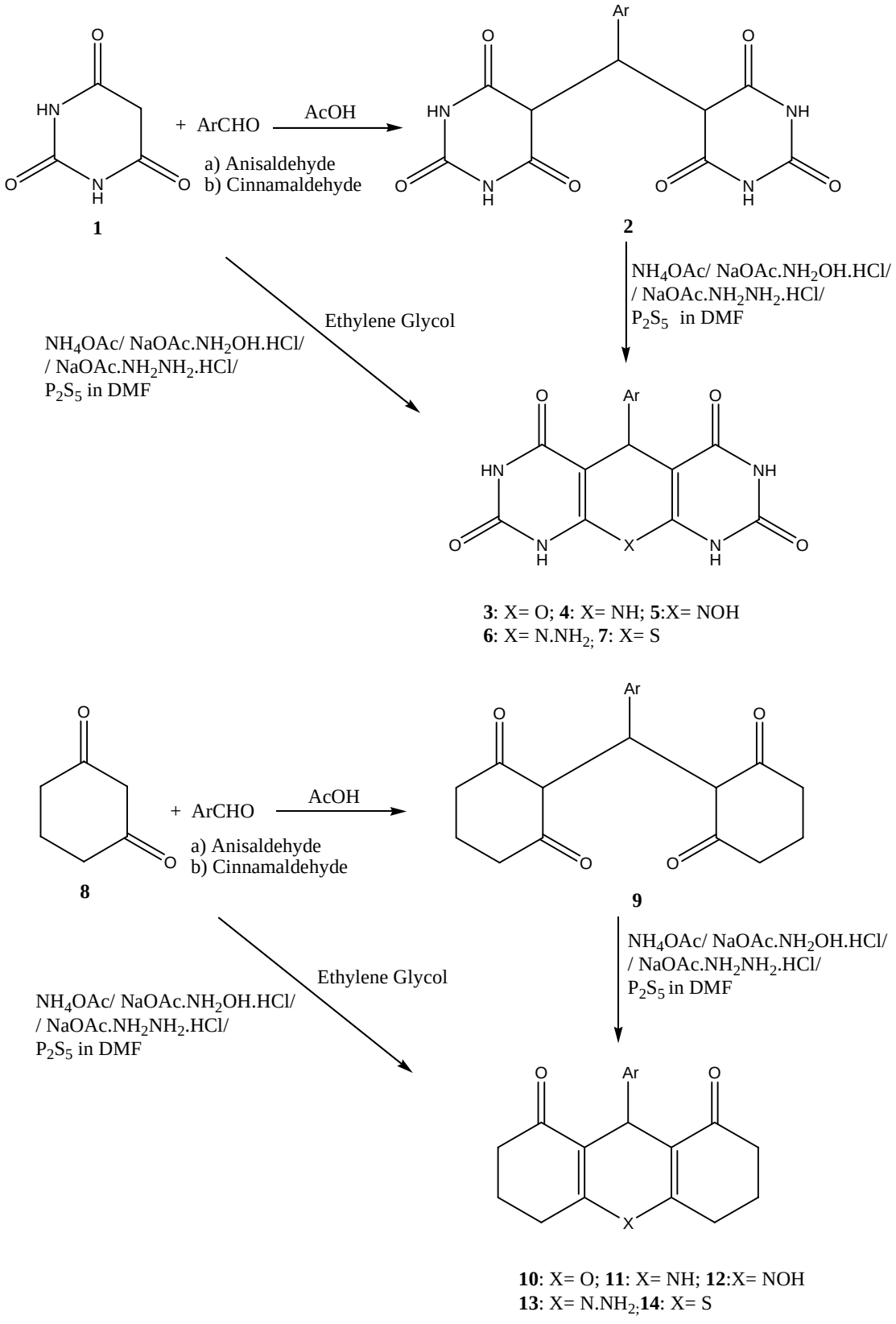
With barbituric acid and aromatic aldehyde under two sets of conditions, in presence of NH_4OAc, NH_2OH. HCl and NaOAc, $NH_2.NH_2$ and NaOAc and P_2S_5 separately the condensed ring assembly compounds **3, 4**, **5**, **6** and **7** were obtained. With 1,3-cyclohexanedione under similar conditions compounds **10**, **11**, **12**, **13**, **14** were generated. Using ethylene glycol as the solvent, the three operations *i.e.* Knoevenagel condensation, Michael addition and cyclodehydration occurred in a single step with excellent yields but the intermediate product of Knoevenagel condensation and Michael addition could not be isolated. Using acetic acid, the yield of the final product was not comparable with that obtained in case of ethylene glycol but the added advantage was the isolation of the intermediate product **2** in a reasonably good yield. The yield slightly falls in conversion of **2** in **3**, **4**, **5**, **6** and **7**.

It has been concluded from the above discussion that ethylene glycol is the most suitable solvent for

Probable Mechanism of formation of 3



barbituric acid and 1,3-cyclohexanedione as synthon for the production of final condensed heterocyclic ring assembly systems. $NH_2OH.HCl$ in the synthesis of *N*-hydroxy compounds, $NH_2.NH_2$ in the synthesis of *N*-amino compounds and P_2S_5 in the synthesis of thio compounds should be used exactly quantitatively lest the higher quantities should form the corresponding oximino, hydrazine and thioxo derivatives respectively.


+ ArCHO
AcOH
a) Anisaldehyde
b) Cinnamaldehyde
1
2
NH4OAc/ NaOAc.NH2OH.HCl/
/ NaOAc.NH2NH2.HCl/
P2S5 in DMF
Ethylene Glycol
NH4OAc/ NaOAc.NH2OH.HCl/
/ NaOAc.NH2NH2.HCl/
P2S5 in DMF
3: X= O; 4: X= NH; 5:X= NOH
6: X= N.NH2; 7: X= S
8
9
NH4OAc/ NaOAc.NH2OH.HCl/
/ NaOAc.NH2NH2.HCl/
P2S5 in DMF
Ethylene Glycol
NH4OAc/ NaOAc.NH2OH.HCl/
/ NaOAc.NH2NH2.HCl/
P2S5 in DMF
10: X= O; 11: X= NH; 12:X= NOH
13: X= N.NH2; 14: X= S

Scheme I

Table I — Yield of synthesized compounds in different media

Compd	Yield (%) (ethylene glycol)	Yield (%) (acetic acid and DMF)
2a	….	66
2b	….	64
3a	84	60
4a	90	62
5a	92	62
6a	94	64
7a	88	68
3b	84	64
4b	86	66
5b	86	62
6b	92	60
7b	94	64
9a	….	62
9b	….	68
10a	86	64
11a	88	60
12a	82	66
13a	84	62
14a	84	60
10b	86	64
11b	80	66
12b	84	64
13b	90	62
14b	86	64

Experimental Section

Thin layer chromatography was used to establish the homogeneity of the compounds. Column chromatography was performed over silica gel (60-120 mesh) using ethyl acetate-pet. ether system as eluent. Aldehydes were distilled before use. All other reagents were commercially available and used without further purification. Melting points were determined in a capillary tube and are uncorrected. IR spectra were recorded on Perkin Elmer IR spectrometer using potassium bromide pellets. The ^{1}H and ^{13}C NMR spectra were run on Varian Unity 500 MHz NMR spectrometer using TMS as an internal standard (chemical shift in δ ppm). Elemental analyses were performed on simple CHNS analyzer.

General method for the synthesis of (2a,b / 9a,b)

A mixture of barbituric acid/1,3-cyclohexanedione (0.02 mole) and an aldehyde (0.01 mole) were dissolved in glacial acetic acid (50 mL) and the reaction mixture was stirred at RT until TLC showed the disappearance of starting material. Thereafter, solvent was removed under reduced pressure. The residue was purified by passing through a short column of silica gel to get the final product and then final purification was accomplished by recrystallization from 95% EtOH.

General method for the synthesis of (3-7, 10-14)

Compound **2/9** (0.01 mole) was taken in a round bottom flask and reaction mixture was stirred at 80°C in DMF for 30 min (for **4**/**11**: 3 mmole NH_4OAc; for **5**/**12**: 2 mmole $NH_2OH.HCl$ and 2 mmole NaOAc; for **6**/**13**: 2 mmole $NH_2NH_2.HCl$ and 2 mmole NaOAc and for **7**/**14**: 2 mmole P_2S_5 was added), the reaction-mixture was cooled to RT. Then the reaction-mixture was poured into 100 mL water. The solid was filtered and washed with water. The crude solid was purified by recrystallization from EtOH to give final product.

General procedure for the synthesis of (3-7, 10-14)

Barbituric acid/1,3-cyclohexanedione (4 mmoles) and an aldehyde (2 mmoles) was refluxed in ethylene glycol (1 mL) for 8-10 min (for **4**/**11**: 3 mmole NH_4OAc; for **5**/**12**: 2 mmole $NH_2OH.HCl$ and 2 mmole NaOAc; for **6**/**13**: 2 mmole $NH_2.NH_2.HCl$ and 2 mmole NaOAc and for **7**/**14**: 2 mmole P_2S_5 was added). The reaction-mixture was allowed to cool to RT, then poured into 50 mL water. The solid was filtered and washed with water. The crude solid was purified by recrystallization from EtOH.

5-[(4-Methoxyphenyl)(2,4,6-trioxo-1,2,3,4,5,6-hexahydropyrimidin-5-yl)-methyl]pyrimidine-2,4,6 (1*H*, 3*H*, 5*H*)-trione, 2a

m.p. 272-76°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 3.78 (3H ,s , -OCH_3), 7.0 - 7.2 (4H, m, ArHs), 8.44 (1H, t, CH), 8.72 (2H, d, J = 8.5 Hz), 11.22 (2H, s, NH); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 42.0 (barbituric acid C-5 carbon), 61.7 (methoxyl carbon), 86.4 (benzyl carbon), 129.9, 130.3, 135.5, 138.7, 147.3, 148.6 (six carbons of benzene ring), 162.5, 166.1, 169.4 (three different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{16}H_{14}N_4O_7$: C, 51.34; H, 3.77; N,14.96. Found: C, 51.28; H, 3.71; N, 14.92%.

5-[(α-Styryl)(2,4,6-trioxo-1,2,3,4,5,6-hexahydropyrimidin-5-yl)methyl]pyrimidine-2,4,6(1*H*,3*H*,5*H*)-trione, 2b

m.p. 274-78°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 5.25 (1H, d, J = 16 Hz), 5.35 (1H, d, J = 16 Hz), 7.0 -

7.2 (5H, m, ArHs), 8.45 (1H, t, CH), 8.74 (2H, d, J = 8.5 Hz), 11.22 (2H, s, NH); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 42.0 (barbituric acid C-5 carbon), 61.7, 62.3 (styryl carbons), 86.4 (benzyl carbon), 129.9, 130.3, 135.5, 138.7, 147.3, 148.6 (six carbons of benzene ring), 162.2, 166.4, 169.2 (three different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{17}H_{14}N_4O_6$: C, 55.13; H, 3.81; N,15.12. Found: C, 55.08; H, 3.76; N, 15.07%.

5-(4-Methoxyphenyl)-1,3,7,9-tetrahydro-5*H*-pyrimidino[5′,4′-5,6]pyrano[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 3a

m.p. 288-92°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 3.78 (3H, s, -OCH_3), 6.90 - 7.20 (4H, m, ArHs), 8.68 (1H, s, CH), 11.12 (2H, s, NH's), 11.26 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.4 (barbituric acid C-5 carbon), 61.7 (methoxyl carbon), 86.1 (benzyl carbon), 136.6, 137.2, 138.8, 141.4, 142.3, 147.1 (six carbons of benzene ring), 162.3, 169.4 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{16}H_{12}N_4O_6$: C, 53.93; H, 3.39; N,15.72. Found: C, 53.87; H, 3.33; N, 15.67%.

5-(4-Methoxyphenyl)-1,3,5,7,9,10-hexahydropyrimidino[5′,4′-5,6]pyridino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 4a

m.p.>300°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 3.74 (3H, s, -OCH_3), 6.90 - 7.20 (4H, m, ArHs), 8.67 (1H, s, CH), 9.26 (1H, s, NH), 11.12 (2H, s, NH's), 11.26 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.4 (barbituric acid C-5 carbon), 61.7 (methoxyl carbon), 86.1 (benzyl carbon), 136.6, 137.2, 139.8, 141.4, 142.3, 147.1 (six carbons of benzene ring), 162.3, 169.2 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{16}H_{13}N_5O_5$: C, 54.08; H, 3.68; N,19.71. Found: C, 54.03; H, 3.63; N, 19.68%.

10-Hydroxy-5-(4-methoxyphenyl)-1,3,5,7,9,10-hexahydropyrimidino[5′,4′-5,6]pyridino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 5a

m.p.288-90°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 3.78 (3H, s, -OCH_3), 6.90 - 7.20 (4H, m, ArHs), 8.68 (1H, s, CH), 10.73 (1H, s, OH), 11.12 (2H, s, NH's), 11.24 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.4 (barbituric acid C-5 carbon), 61.2 (methoxyl carbon), 86.1 (benzyl carbon), 136.6, 137.2, 139.8, 141.1, 143.3, 147.1 (six carbons of benzene ring), 162.4, 169.6 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{16}H_{13}N_5O_6$: C, 51.75; H, 3.52; N,18.86. Found: C, 52.71; H, 3.57; N, 18.81%.

10-Amino-5-(4-methoxyphenyl)-1,3,5,7,9,10-hexahydropyrimidino[5′,4′-5,6]pyridino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 6a

m.p. >300°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 3.78 (3H, s, -OCH_3), 6.90-7.20 (4H, m, ArHs), 8.68 (1H, s, CH), 8.75 (2H, d, NH_2), 11.12 (2H, s, NH's), 11.26 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.4 (barbituric acid C-5 carbon), 61.4 (methoxyl carbon), 86.4 (benzyl carbon), 135.6, 138.2, 139.4, 141.1, 144.3, 147.2 (six carbons of benzene ring), 163.3, 169.2 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{16}H_{14}N_6O_5$: C, 51.89; H, 3.81; N, 22.69. Found: C, 51.84; H, 3.78; N, 22.63%.

5-(4-Methoxyphenyl)-1,3,7,9-tetrahydro-5*H*-hydropyrimidino[5′,4′-5,6]thiino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 7a

m.p. 286-90°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 3.78 (3H, s, -OCH_3), 6.90 - 7.20 (4H, m, ArHs), 8.68 (1H, s, CH), 11.12 (2H, s, NH's), 11.26 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.4 (barbituric acid C-5 carbon), 61.7 (methoxyl carbon), 86.1 (benzyl carbon), 136.6, 137.2, 139.8, 141.1, 142.3, 147.1 (six carbons of benzene ring), 163.3, 169.2 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{16}H_{12}N_4O_5S$: C, 51.61; H, 3.24; N, 15.04. Found: C, 51.56; H, 3.19; N, 15.01%.

5-(α-Styryl)-1,3,7,9-tetrahydro-5*H*-pyrimidino[5′,4′-5,6]pyrano[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 3b

m.p. >300°C. ^{1}H NMR (DMSO-d_6, 500 MHz): 5.24 (1H, d, J = 14 Hz), 5.35 (1H, d, J = 14 Hz), 6.90 - 7.20 (5H, m, ArHs), 8.46 (1H, s, CH), 11.10 (2H, s, NH's), 11.24 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.6 (barbituric acid C-5 carbon), 86.8 (benzyl carbon), 139.9, 141.1, 143.3, 144.4, 146.1, 148.6 (six carbons of benzene ring), 165.3, 166.1 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{17}H_{12}N_4O_5$: C, 57.95; H, 3.43; N,15.90. Found: C, 57.89; H, 3.37; N, 15.84%.

5-(α-Styryl)-1,3,5,7,9,10-hexahydropyrimidino[5′, 4′-5,6]pyridino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 4b

m.p. 290-92°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 5.25 (1H, d, *J* = 16 Hz), 5.35 (1H, d, *J* = 16 Hz), 6.90 - 7.20 (5H, m, ArHs), 8.46 (1H, s, CH), 9.24 (1H, s, NH), 11.10 (2H, s, NH's), 11.24 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.6 (barbituric acid C-5 carbon), 86.8 (benzyl carbon), 139.9, 142.1, 143.3, 144.4, 146.4, 148.8 (six carbons of benzene ring), 165.4, 166.1 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{17}H_{13}N_5O_4$: C, 58.12; H, 3.73; N, 19.93. Found: C, 58.07; H, 3.68; N, 19.87%.

10-Hydroxy-5-(α-styryl)-1,3,5,7,9,10-hexahydropyrimidino[5′,4′-5,6]pyridino[2,3-*d*]pyrimidine-2,4,6, 8-tetraone, 5b

m.p.288-92°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 5.24 (1H, d, *J* = 14 Hz), 5.35 (1H, d, *J* = 14 Hz), 6.90 - 7.20 (5H, m, ArHs), 8.46 (1H, s, CH), 10.73 (1H, s, OH), 11.10 (2H, s, NH's), 11.24 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.6 (barbituric acid C-5 carbon), 86.8 (benzyl carbon), 138.8, 141.1, 143.3, 144.2, 147.1, 148.7 (six carbons of benzene ring), 165.4, 166.1 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{17}H_{13}N_5O_5$: C, 55.58; H, 3.56; N, 19.06. Found: C, 55.51; H, 3.51; N, 19.02%.

10-Amino-5-(α-styryl)-1,3,5,7,9,10-hexahydropyrimidino[5′,4′-5,6]pyridino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 6b

m.p. >300°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 5.25 (1H, d, *J* = 15 Hz), 5.35 (1H, d, *J* = 15 Hz), 6.90-7.20 (5H, m, ArHs), 8.46 (1H, s, CH), 9.24 (2H, s, NH_2), 11.10 (2H, s, NH's), 11.24 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.6 (barbituric acid C-5 carbon), 86.8 (benzyl carbon), 138.8, 141.2, 142.1, 143.3, 144.4, 146.6 (six carbons of benzene ring), 165.3, 166.1 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{17}H_{14}N_6O_4$: C, 55.73; H, 3.85; N, 22.94. Found: C, 55.67; H, 3.81; N, 22.87%.

5-(α-Styryl)-1,3,7,9-tetrahydro-5*H*-hydropyrimidino[5′,4′-5,6]thiino[2,3-*d*]pyrimidine-2,4,6,8-tetraone, 7b

m.p. 292-94°C. ^{1}H NMR (DMSO-d_6, 500 MHz): δ 5.25 (1H, d, *J* = 16 Hz), 5.35 (1H, d, *J* = 16 Hz), 6.90 - 7.20 (5H, m, ArHs), 8.46 (1H, s, CH), 11.10 (2H, s, NH's), 11.24 (2H, s, NH's); ^{13}C NMR (DMSO-d_6, 500 MHz): δ 41.6 (barbituric acid C-5 carbon), 86.8 (benzyl carbon), 137.4, 139.9, 142.1, 144.3, 147.1, 148.8 (six carbons of benzene ring), 165.5, 166.4 (two different carbonyl carbons for the barbituric acid moieties). Anal. Calcd for $C_{17}H_{12}N_4O_4S$: C, 55.43; H, 3.28; N, 15.20. Found: C, 55.38; H, 3.24; N, 15.14%.

2-[(2,6-Dioxocyclohexyl)(4-methoxyphenyl)methyl]-cyclohexane-1,3-dione, 9a

m.p. 266-68°C. IR (KBr): 2860, 2660, 1499, 1514, 1440, 1374, 1204, 1168, 1140, 1046, 851, 810, 733, 663, 592, 503 cm^{-1}; ^{1}H NMR (DMSO-d_6, 500 MHz): δ 2.0-2.70 (12H, m, 6×CH_2), 3.84 (3H, s, -OCH_3), 5.72 (2H, d, *J* = 8.0 Hz), 5.84 (1H, s, CH), 6.86 - 7.21 (4H, m, ArHs). Anal. Calcd for $C_{20}H_{22}O_5$: C, 70.16; H, 6.47. Found: C, 70.11; H, 6.42%.

2-[(2,6-Dioxocyclohexyl)(α-styryl)methyl]cyclohexane-1,3-dione, 9b

m.p. 272-74°C. IR (KBr): 3234, 3068, 2957, 2869, 2397, 1645, 1476, 1368, 1290, 1249, 1215, 1169, 1143, 1017, 979, 942, 890, 864, 746, 707, 631, 599, 556, 527 cm^{-1}; ^{1}H NMR (DMSO-d_6, 500 MHz): δ 1.90-2.70 (12H, m, 6×CH_2), 5.25 (1H, d, *J* = 14 Hz), 5.35 (1H, d, *J* = 14 Hz), 4.83 (1H, s, CH), 4.72 (2H, d, *J* = 8.0 Hz), 6.89 - 7.20 (5H, m, ArHs). Anal. Calcd for $C_{21}H_{22}O_4$: C, 74.53; H, 6.55. Found: C, 74.48; H, 6.49%.

9-(4-Methoxyphenyl)-1,2,3,4,5,6,7,8-octahydroxenthene-1,8-dione, 10a

m.p. 280-82°C. IR (KBr): 2960, 2870, 2660, 1599, 1511, 1450, 1373, 1304, 1255,1168, 1148, 1045, 851, 810, 733, 663, 592,503 cm^{-1}; ^{1}H NMR (DMSO-d_6, 500 MHz): δ 2.0-2.73 (12H, m, 6×CH_2), 3.84 (3H, s, -OCH_3), 5.84 (1H, s, CH), 6.86-7.21 (4H, m, ArHs). Anal. Calcd for $C_{20}H_{20}O_4$: C, 74.05; H, 6.21. Found: C, 74.01; H, 6.16%.

9-(4-Methoxyphenyl)-1,2,3,4,5,6,7,8,9,10-decahydroacridine-1,8-dione, 11a

m.p. >300°C. IR (KBr): 3234, 3068, 2957, 2869, 2397, 1645, 1476, 1368, 1290, 1249, 1215, 1169, 1143, 1017, 979, 942, 890, 864, 746,707, 631, 599, 556, 527 cm^{-1}; ^{1}H NMR (DMSO-d_6, 500 MHz): δ 1.90-2.70 (12H, m, 6×CH_2), 3.86 (3H, s, -OCH_3), 4.73

(1H, s, CH), 6.89-7.20, (4H, m, ArHs), 9.22 (1H, s, NH). Anal. Calcd for $C_{20}H_{21}NO_3$: C, 74.28; H, 6.54; N, 4.33. Found: C, 74.22; H, 6.49; N, 4.27%.

10-Hydroxy-9-(4-methoxyphenyl)-1,2,3,4,5,6,7,8,9, 10-decahydroacridine-1,8-dione, 12a

m.p. >300°C. IR (KBr): 3225, 1954, 1871, 1667, 1660, 1504, 1462, 1504, 1362, 1369, 1229, 1154, 1010, 808, 661, 582 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.00-2.65 (12H, m, 6×CH_2), 3.82 (3H, s, -OCH_3), 4.47 (1H, s, CH), 6.95-7.26 (4H, m, ArHs), 10.73 (1H, s, OH). Anal. Calcd for $C_{20}H_{21}NO_4$: C, 70.78; H, 6.23; N, 4.12. Found: C, 70.72; H, 6.17; N, 4.07%.

10-Amino-9-(4-methoxyphenyl)-1,2,3,4,5,6,7,8,9,10-decahydroacridine-1,8-dione, 13a

m.p. >300°C. IR (KBr): 3240, 2860, 2810, 1640, 1420, 1360, 1200, 1160, 1140, 980, 704, 580 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.03-2.61 (12H, m, 6×CH_2), 3.82 (3H, s, -OCH_3), 4.46 (1H, s, CH), 6.98-7.30, (4H, s, ArHs), 8.25 (2H, d, NH_2). Anal. Calcd for $C_{20}H_{22}NO_3$: C, 70.98; H, 6.55; N, 8.27. Found: C, 70.92; H, 6.51; N, 8.21%.

9-(4-Methoxyphenyl)-1,2,3,4,5,6,7,8-octahydro-10*H*-dibenzo[1,2-b;1,2-e]thiin-1,9-dione, 14a

m.p. 280-82°C. IR (KBr): 2960, 2870, 2660, 1599, 1511, 1450, 1373, 1304, 1255, 1168, 1148, 1045, 851, 810, 733, 663, 592, 503 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.0-2.73 (12H, m, 6×CH_2), 3.84 (3H, s, -OCH_3), 5.84 (1H, s, CH), 6.86-7.16 (4H, m, ArHs). Anal. Calcd for $C_{22}H_{20}O_3S$: C, 70.56; H,5.92; S, 9.41. Found: C, 70.52; H, 5.88; S, 9.37%.

9-(α-Styryl)-1,2,3,4,5,6,7,8-octahydroxenthene-1,8-dione, 10b

m.p. 284-88°C. IR (KBr): 2960, 2870, 2660, 1590, 1515, 1455, 1378, 1384, 1256,1166, 1148, 1055, 861, 810, 732, 653, 594,503 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.0-2.76 (12H, m, 6×CH_2), 5.24 (1H, d, *J* = 14 Hz), 5.36 (1H, d, *J* = 14 Hz), 5.84 (1H, s, CH), 6.86-7.10 (5H, m, ArHs). Anal. Calcd for $C_{21}H_{20}O_3$: C, 78.72; H, 6.29. Found: C, 78.66; H, 6.24%.

9-(α-Styryl)-1,2,3,4,5,6,7,8,9,10-decahydroacridine-1,8-dione, 11b

m.p. >300°C. IR (KBr): 3236, 3066, 2857, 2397, 1655, 1476, 1368, 1290, 1249, 1215, 1169, 1143, 1017, 979, 942, 894, 865, 726, 708, 632, 569, 546, 525 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 1.92-2.72 (12H, m, 6×CH_2), 4.73 (1H, s, CH), 5.24 (1H, d, *J* = 14 Hz), 5.35 (1H,d,*J* =14 Hz), 6.89-7.19 (5H, m, ArHs), 9.22 (1H, s, NH). Anal. Calcd for $C_{21}H_{21}NO_2$: C, 78.97; H, 6.62; N, 4.38. Found: C, 78.92; H, 6.57; N, 4.34%.

10-Hydroxy-9-(α-styryl)-1,2,3,4,5,6,7,8,9,10-decahydroacridine-1,8-dione, 12b

m.p. >300°C. IR (KBr): 3226, 1954, 1861, 1655, 1640, 1564, 1466, 1524, 1362, 1366, 1222, 1144, 1010, 802, 651, 582 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.00-2.65 (12H, m, 6×CH_2), 4.47 (1H, s, CH), 5.25 (1H, d, *J* = 14 Hz), 5.35 (1H, d, *J* = 14 Hz), 6.95 - 7.15 (5H, m, ArHs), 10.73 (1H, s, OH). Anal. Calcd for $C_{21}H_{21}NO_3$: C, 75.20; H, 6.31; N, 4.17. Found: C, 75.14; H, 6.27; N, 4.11%.

10-Amino-9-(α-styryl)-1,2,3,4,5,6,7,8,9,10-decahydroacridine-1,8-dione, 13b

m.p. >300°C. IR (KBr): 3240, 2860, 2810, 1640, 1420, 1360, 1200, 1160, 1140, 980, 704, 580 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.03-2.62 (12H, m, 6×CH_2), 4.46 (1H, s, CH), 5.25 (1H, d, *J* = 16 Hz), 5.35 (1H, d, *J* = 16 Hz), 6.98 - 7.30 (5H, m, ArHs), 8.25 (2H, d, NH_2). Anal. Calcd for $C_{21}H_{22}N_2O_2$: C, 75.42; H, 6.63; N, 8.37. Found: C, 75.37; H, 6.59; N, 8.32%.

9-(α-Styryl)1,2,3,4,5,6,7,8-octahydro-10*H*-dibenzo-[1,2-b;1,2-e]thiin-1,9-dione, 14b

m.p. 278-82°C. IR (KBr): 2964, 2870, 2660, 1599, 1511, 1450, 1373, 1304, 1255, 1168, 1148, 1044, 851, 810, 743, 663, 592, 503 cm^{-1}; ^1H NMR (DMSO-d_6, 500 MHz): δ 2.0-2.73 (12H, m, 6×CH_2), 5.24 (1H, d, *J* = 16 Hz), 5.34 (1H, d, *J* = 16 Hz), 5.84 (1H, s, CH), 6.86-7.16 (5H, m, ArHs). Anal. Calcd for $C_{21}H_{20}O_2S$: C, 74.96; H, 5.99; S, 9.53. Found: C, 74.92; H, 5.94; S, 9.58%.

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