

The Synthesis of 6-Aryl-2,4-dioxoperhydro-1,3,5-triazines

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The synthesis of a series of 6-aryl-2,4-dioxoperhydro-1,3,5-triazines by the condensation of biuret with aromatic aldehydes in trifluoroacetic acid, is described.

Introduction

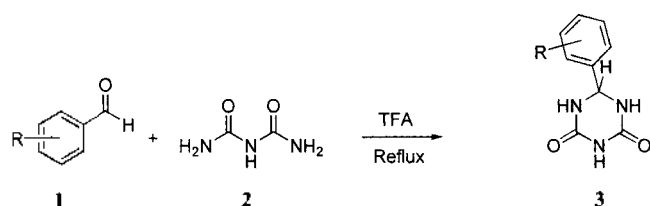
2,4-Dioxoperhydro-1,3,5-triazine and its derivatives exhibit antiviral activity against plant virus *e.g.*, potato plant virus and tobacco plant virus.¹⁻⁵ They are also found to be good activator for sodium perborate laundry bleach,² moreover these bleaching agents are found to be physiologically, and ecologically harmless.⁶

Syntheses of 2,4-dioxoperhydrotriazines have been reported to a limited extent.^{1,2,6-9} Biginelli⁷ has reported that 6-phenyl-2,4-dioxoperhydro-1,3,5-triazine (**3a**) can be prepared by simply heating the benzaldehyde with biuret. Ostrogovich⁸ prepared the same compound from biuret and benzaldehyde in the presence of sulfuric acid. Etienne and Bonte⁹ have prepared a series of 6-substituted 2,4-dioxoperhydro-1,3,5-triazines and their *N*-substituted derivatives by the condensation of biuret and its *N*-substituted derivatives with ketones and aldehydes.

Results and Discussion

In the present work a series of 6-aryl-2,4-dioxoperhydro-1,3,5-triazines (**3a-3o**) (Scheme 1) have been prepared from aromatic aldehydes and biuret. A mixture of appropriate aldehyde and biuret in trifluoroacetic acid on refluxing afforded the triazine. All the reactions proceeded smoothly and generally gave moderate to excellent yields (45-90%) (Table 1).

The condensation of an aldehyde with biuret (1 : 1) can possibly yield either an open chain *N*-arylidenebiuret (**4**) or the cyclized product, 6-aryl-2,4-dioxoperhydro-1,3,5-triazine (**3**). Chemical and Spectroscopic evidences provided conclusive proof for the cyclic structure (**3**) of the product. The open chain structure (**4**) was excluded on the basis that the products of the aromatic aldehydes with biuret remain unchanged, when reacted with excess of the aldehydes. Had



Scheme 1. R = (a) H; (b) 2-NO₂; (c) 3-NO₂; (d) 4-NO₂; (e) 2-Br; (f) 3-Br; (g) 4-Br; (h) 2-Cl; (i) 3-Cl; (j) 2-OH; (k) 3-OH; (l) 4-OH; (m) 2-OMe; (n) 3-OMe; (o) 4-OMe.

Table 1.

Product	Melting point (°C)	Yield (%)	Reflux time (hour)
3a (colourless)	268-270 (272-273) ⁷	80	5.5
3b (dark brown)	262-264	30	3.0
3c (yellow)	198-200	84	3.0
3d (yellow)	237-240	55	3.0
3e (yellow)	240-242	70	5.5
3f (yellow)	250-251	46	5.5
3g (yellow)	278-280	72	5.5
3h (colourless)	228-230	78	5.5
3i (colourless)	264-266	44	5.5
3j (pink)	>360	92	5.5
3k (pink)	>360	91	5.5
3l (pink)	>360	63	5.5
3m (pink)	220-221	72	5.5
3n (brown)	>360	86	5.5
3o (orange)	280-281	45	5.5

the products been *N*-arylidenebiurets, it would have resulted in the formation *N,N'*-diarylidenebiurets (**6**). The proton NMR spectra (Table 2) of the products were almost similar. However a slight shifting of methine proton peak, upfield or downfield due to the effect of substituent in the aromatic ring, has been observed. The methine proton peak in all the spectra appeared as singlet in the range of δ 5.5 to δ 7.0. The absence of coupling with NH proton is probably due to the rapid exchange of NH proton with solvent (TFA). The NH protons peaks generally appeared along with aromatic protons. The IR spectra showed absorption band within the ranges of 3210-3412 cm⁻¹, 1674-1726 cm⁻¹ and 1507-1623 cm⁻¹ corresponding to NH, -CO and -C=C-, respectively. However the presence of tautomeric forms *i.e.* **3'** could not be excluded.

The yields of the products (Table 1) are found to be dependent upon the position and nature of the substituents in aromatic ring. Generally electron withdrawing substituents

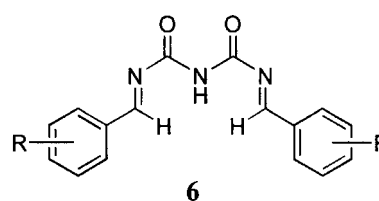


Table 2. Analytical and Spectral Data of the Products

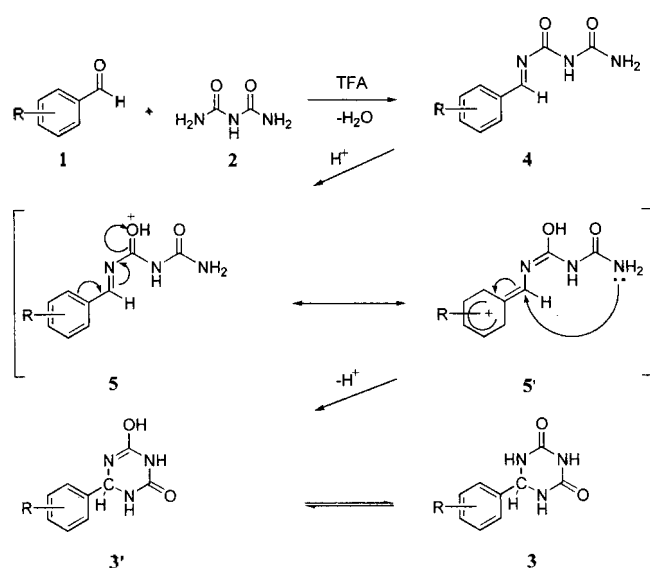
Product	Found (%)	Calculated (%)	¹ H NMR δ (TFA)	IR (cm ⁻¹)
3a	C, 56.50 H, 4.64 N, 22.01	C, 56.54 H, 4.74 N, 21.98	5.6 (1H, s, 6-H), 7.0 (5H, m)	3376, 3220 (NH), 1713, 1674 (CO), 1587, 1516 (Ar)
3b	C, 45.72 H, 3.49 N, 23.69	C, 45.77 H, 3.41 N, 23.72	7.1 (1H, s, 6-H), 8.6-9.3 (7H, m, 4 Ar-H, 3 NH)	3397, 3200 (NH), 1710 (CO), 1608, 1540 (Ar), 1350, 1328 (NO ₂)
3c	C, 45.68 H, 3.42 N, 23.77	C, 45.77 H, 3.41 N, 23.72	6.5 (1H, s, 6-H), 8.5-10.0 (7H, m, 4 Ar-H, 3 NH)	3390, 3200 (NH), 1711 (CO), 1601, 1533 (Ar), 1340, 1321 (NO ₂)
3d	C, 45.71 H, 3.44 N, 23.71	C, 45.77 H, 3.41 N, 23.72	7.0 (1H, s, 6-H), 8.6 (3H, bs, 3NH) 9.0-9.5 (4H, m, 4 Ar-H),	3406, 3220 (NH), 1713 (CO), 1611, 1533 (Ar), 1347, 1329 (NO ₂)
3e	C, 40.10 H, 3.11 N, 15.61	C, 40.02 H, 2.99 N, 15.56	6.2 (1H, s, 6-H), 7.0-7.5 (7H, m, 4 Ar-H, 3 NH)	3400, 3200 (NH), 1720 (CO), 1619, 1590, 1580 (Ar)
3f	C, 40.01 H, 2.98 N, 15.56	C, 40.02 H, 2.99 N, 15.56	6.0 (1H, s, 6-H), 7.7-8.4 (7H, m, 4 Ar-H, 3 NH)	3375, 3200 (NH), 1720 (CO), 1608, 1590 (Ar)
3g	C, 39.98 H, 2.94 N, 15.64	C, 40.02 H, 2.99 N, 15.56	5.9 (1H, s, 6-H), 7.2-7.5 (7H, m, 4 Ar-H, 3 NH)	3375, 3200 (NH), 1717 (CO), 1600, 1580 (Ar)
3h	C, 47.86 H, 3.57 N, 18.58	C, 47.91 H, 3.57 N, 18.62	6.4 (1H, s, 6-H), 7.5-8.0 (7H, m, 4 Ar-H, 3 NH)	3400, 3300 (NH), 1710 (CO), 1608, 1585 (Ar)
3i	C, 47.93 H, 3.55 N, 18.61	C, 47.91 H, 3.57 N, 18.62	6.3 (1H, s, 6-H), 7.0-8.0 (7H, m, 4 Ar-H, 3 NH)	3400, 3333 (NH), 1708 (CO), 1601, 1580 (Ar)
3j	C, 52.17 H, 4.48 N, 20.21	C, 52.17 H, 4.38 N, 20.28	5.5 (1H, s, 6-H) 6.8-7.2 (4H, m, Ar-H), 7.5 (3H, bs, 3 NH), 8.7 (1H, s, Ar-OH)	3412 (NH, OH), 1716 (CO), 1623 (Ar)
3k	C, 52.21 H, 4.41 N, 20.35	C, 52.17 H, 4.38 N, 20.28	5.4 (1H, s, 6-H) 7.0-7.3 (4H, m, Ar-H), 7.6 (3H, bs, 3 NH), 8.5 (1H, s, Ar-OH)	3410 (OH), 3350, 3270 (NH), 1701 (CO), 1615, 1570 (Ar)
3l	C, 52.22 H, 4.50 N, 20.31	C, 52.17 H, 4.38 N, 20.28	5.8 (1H, s, 6-H), 6.5-6.9 (4H, m, 4 Ar-H), 7.2 (4H, 1 OH, 3 NH)	3288 (NH, OH), 1699 (CO), 1600, 1567 (Ar)
3m	C, 54.31 H, 4.98 N, 19.10	C, 54.29 H, 5.01 N, 19.00	4.2 (3H, s, OMe), 6.7 (1H, s, 6-H), 7.0-7.8 (4H, m, Ar-H), 8.5 (3H, bs, 3 NH)	3330, 3260 (NH), 1710 (CO), 1599, 1570 (Ar)
3n	C, 54.24 H, 5.14 N, 18.98	C, 54.29 H, 5.01 N, 19.00	4.0 (3H, s, OMe), 6.5 (1H, s, 6-H), 7.2-7.8 (7H, m, 4 Ar-H, 3 NH)	3340, 3270 (NH), 1711 (CO), 1600, 1580 (Ar)
3o	C, 54.31 H, 5.11 N, 19.15	C, 54.29 H, 5.01 N, 19.00	4.0 (3H, s, OMe), 6.0 (1H, s, 6-H), 7.0-7.5 (7H, m, 4 Ar-H, 3 NH)	3340, 3260 (NH), 1703 (CO), 1602, 1591 (Ar)

exert retarding effect while electron donating substituents accelerate the reaction probably due to the facile formation of the intermediate (5) (Scheme 2), which looks necessary to push the reaction in the forward direction in case of electron donating groups.

The reaction is found to be simple and can be conveniently used for the synthesis of 2,4-dioxoperhydro-1,3,5-triazines with moderate to excellent yields as compare to the method reported in the literature.⁹

Experimental Section

Biuret and all aldehydes used were of analytical grade. Melting point were determined on Gallenkamp Melting Point Apparatus and were uncorrected. IR spectra were taken on a Hitachi 273-30 Infrared Spectrophotometer. Samples were taken as nujol mulls on sodium chloride plates. Proton NMR were recorded on a Hitachi, 60 MHz NMR Spectrophotometer, model R 24-B using tetramethylilane



(TMS) as internal standard and were reported in ppm (δ) relative to TMS. Microanalyses for carbon, nitrogen and hydrogen were performed on Perkin-Elmer 240 Elemental Analyzer.

Synthesis of 6-Aryl-2,4-dioxoperhydro-1,3,5-triazines

General Method. A mixture of biuret (10 mmol) and an aromatic aldehyde (10 mmol) in trifluoroacetic acid (5 mL)

was heated under reflux for 3 to 5.5 hours. The reaction mixture was then poured with constant stirring in cold water. After filtration, the crude products were recrystallized from 50% acetic acid (Table 1).

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