Proc. Indian Acad. Sci., Vol. 82 A, No. 6, 1975, pp. 211–216

Synthesis of some pyronochromanones

J. R. MERCHANT, F.A.Sc. AND (SMT.) S. M. THAKKAR

Department of Chemistry, Institute of Science, Bombay 400032

MS received 23 August 1975

ABSTRACT

The O-cyanoethylation of 7-hydroxy-3, 4-cyclopenteno- and 7-hydroxy-3, 4-cyclohexeno-coumarins followed by hydrolysis and cyclisation of the resulting acids, affords α-pyronochromanones whose structures have been established by spectral data and the formation of 2, 4-DNP derivatives.

INTRODUCTION

IN continuation of our earlier work[1] on the cyanoethylation of benzopyrone derivatives leading to the synthesis of polycyclic compounds we describe here the synthesis of α-pyronochromanones obtained from some 7-hydroxy-3, 4-cyclopenteno and 7-hydroxy-3,4-cyclohexeno derivatives by the application of cyanoethylation. For this purpose 2-methyl- and 4-ethyl-resorcinols were condensed with ethyl cyclopentanone- and ethyl cyclohexanone-2-carboxylates in the presence of sulphuric acid under the conditions of the Pechmann reaction[2] to yield the corresponding coumarin derivatives I–IV (table 1). The coumarins I and III were violet crystalline solids, which dissolved in alkali with a bluish fluorescence and were reprecipitated by addition of acid. Coumarins II and IV were yellow crystalline solids which dissolved in alkali with a pale blue fluorescence.

The cyanoethylation of these coumarins was affected by heating them with acrylonitrile in dioxan solution in the presence of aqueous sodium hydroxide (10%) to yield the corresponding nitriles as crystalline solids. Hydrolysis of the latter with conc. hydrochloric acid gave crystalline propionic acid derivatives, which underwent facile cyclisation with PPA to yield the respectively α-pyronochromanone derivatives in yields ranging from 15 to 20 per cent. The latter formed crystalline 2,4-DNP derivatives and their structures were in full agreement with their spectral data.

It was generally observed that the linear α-pyronochromanones showed λ_{max}^{MeOH} around 255 nm whilst the angular isomers gave λ_{max}^{MeOH} around 260 nm.

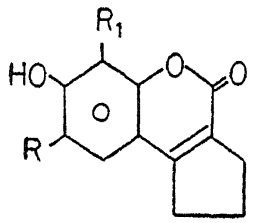
Table 1

Coumarin	Coumarino *o*-propio-nitriles	Coumarino *o*-propionic acid	Pyrono-chromanone	Spectral data of pyronochromanone
1. 7–Hydroxy-3, 4-cyclo-pentenono-8-methyl † (figure I), m.p. 257° Pale blue needles	Pale yellow needles*, m.p. 160–62°.	Colourless needles‡, m.p. 210–12°	Colourless needles*, m.p. 230–32° (figure II)	*UV*: λ_{max}^{MeOH} 220 (log ϵ 4·18) 260 (log ϵ 4·42), 345 (log ϵ 3·96) nm. *IR*: (CH_2Cl_2) bands at 1720 cm^{-1} (coumarin) and 1695 cm^{-1} (chromanone).
Analysis: Found: C, 71·8; H, 5·6%	Analysis: C, 71·8; H, 5·8; N, 5·5%	Analysis: C, 67·0; H, 5·8%	Analysis: C, 70·9; H, 5·4%	
Calcd. for $C_{13}H_{12}O_3$ C, 72·2; H, 5·6%	$C_{16}H_{15}O_3N$ C, 71·4; H, 5·6; N, 5·2%	$C_{16}H_{16}O_5$ C, 66·67; H, 5·6%	$C_{16}H_{14}O_4$ C, 71·1; H, 5·2% 2, 4-DNP, m.p. > 320°. Analysis: Found: N, 12·20%. Calcd. for $C_{22}H_{18}O_7N_4$ N, 12·45%.	*NMR*: ($CDCl_3$): signals at δ 2·29 (5H, *s*, $-CH_3$ at C_8 and CH_2 at C_3''); around δ 2·75–δ 3·0 (6H, b.m., $-CH_2$ at C_3'' and allylic protons at C_2'' and C_1''); δ 4·65 (2H, *t*, $-CH_2$ at C_2, J = 8Hz; δ 7·8 (1H, *s* at C_5)
2. 7-Hydroxy-3, 4-cyclo-hexenono-8-methyl (figure IV). Light yellow needles, m.p.262°**	Cream coloured needles* m.p. 149-51°	Colourless needles* m.p. 218-20°	Colourless needles* m.p. 214–15° (figure V)	*UV*: λ_{max}^{MeOH} 215 (log ϵ 4·21); 260 (log ϵ 4·41); 345 (log ϵ 3·99) nm.
Analysis:	Analysis:	Analysis:	Analysis:	*IR*: (CH_2Cl_2): bands at 1720 cm^{-1} (coumarin) and 1690 cm^{-1} (chromanone).
Found: C, 73·4; H, 6·1%	C, 72·1; H, 6·3; N, 5·3%	C, 67·1; H, 6·0%	C, 72·2; H, 5·7%	*NMR*: ($CDCl_3$): Signals at δ 2·3 (*s*) and δ 2·55–δ 2·9 (*m*) (9H, $-CH_3$ at C_8 and $-CH_2$ at C_3'' C_2'' and C_5''); δ 1·8 (4H, b.s.–CH_2 at C_3'' and C_4'' 8); δ 4·62 (2H, *t*, $-CH_2$ at C_1; δ 7·85 (1H, *s*, at C_5'')
Calcd. for $C_{14}H_{14}O_3$ C, 73·0; H, 6·2%	$C_{17}H_{17}O_3N$ C, 72·07; H, 6·0; N, 4·9%	$C_{17}H_{18}O_5$ C, 67·5; H, 6·0%	$C_{17}H_{16}O_4$ C, 71·8; H, 5·7% 2, 4- DNP m.p. 281–83° Analysis: Found: N, 12·0% Calcd. for $C_{23}H_{20}N_4O_7$ N, 12·0%.	
3. 7-Hydroxy-3, 4-cyclo-	Colourless needles*	Colourless needles*	Colourless needles*	*UV*: λ_{max}^{MeOH} 215 (log ϵ 4·15)

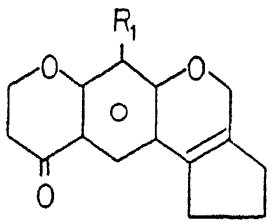
3. 7-Hydroxy-3, 4-cyclo-penteno-6-ethyl[4] (figure I *a*) Violet needles**, m.p. 264–65°	Colourless needles* m.p. 154–56° Analysis: Found: C, 71·6; H, 5·8; N, 5·2% Calcd. for: $C_{17}H_{17}O_3N$; C, 72·1; H, 6·0; N, 4·9%	Colourless needles* m.p. 178–80° Analysis: C, 67·9; H, 6·3% $C_{17}H_{18}O_5$; C, 67·5; H, 6·0%	Colourless needles* m.p. 195–97°. (figure III) Analysis: C, 71·5; H, 5·7% $C_{17}H_{16}O_4$ C, 71·8; H, 5·7% 2, 4-DNP m.p. 295–97°. Analysis: Found: N, 12·2% Calcd. for $C_{23}H_{20}N_4O_7$ N, 12·0%.	*UV*: λ_{max}^{MeOH} 215 (log ϵ 4·18), 270 (log ϵ 3·85); 345 (log ϵ 3·76) nm. *IR*: (KBr): bands at 1725 cm^{-1} (coumarin) and 1695 cm^{-1} (chromanone) *NMR*: ($CDCl_3$) band at δ 1·2 (3H, *t*, $-CH_3$ of C_2H_5 at C_8, J = 8Hz); δ 1·9–δ 3·1 (10 H, *m*, $-CH_2$ of C_2H_5 at C_8 $-CH_2$ at C_3 and $-CH_2$ at C_3'', C_4'', C_2''); δ 4·6 (2H, *t*, $-CH_2$, at C_2, J = 7Hz) δ 7·35 (1H *s*, at C_7) aromatic protons.
4. 7-Hydroxy-3, 4-cyclo-hexeno-6-ethyl.[5] (figure IV *a*) Colourless needles** m.p. 219-20°	Colourless needles* m.p. 133–35 Analysis : Found: C, 72·6; H 6·7; N, 4·4% Calcd. for $C_{18}H_{19}O_3N$ C, 72·7; H, 6·4; N, 4·7%	Colourless needles* m.p. 167-68° Analysis: C, 68·00; H, 6·5% $C_{18}H_{20}O_5$ C, 68·36; H, 6·4%	Colourless needles* m.p. 168–70 (figuer VI) Analysis: C, 72·2; H, 6·3% $C_{18}H_{18}O_4$ C, 72·5; H, 6·1% 2, 4–DNP, m.p. 284–85°. Analysis: Found: N, 11·8% Calcd. for $C_{24}H_{28}N_4O_7$ N, 11·6%.	*UV*: λ_{max}^{MeOH} 215 (log ϵ 4·37); 275 (log ϵ 4·02); 300 (log ϵ 3·95; 3·55 (log ϵ 4·0) nm. *IR*: (KBr) bands at 1725 cm^{-2} (coumarin) and 1645 cm^{-1} (chromanone). *NMR*: ($CDCl_3$) bands at δ 1·18 (3H, *t*, $-CH_3$ of C_2H_5 at C_8); δ 2·65–δ 3·95 (12H, *m*, $-CH_2$ of C_2H_5 $-CH_2$ at C_3 and $-CH_2$, at C_3'', C_1'', C_5'', C_6''); δ 4·6 (2H, *t*, $-CH_2$ at C_2, J = 7Hz) and δ 7·45 (1H, *s*, at C_7) aromatic protons.

* Crystallised from benzene-petroleum ether 40–60°.
** Crystallised from ethyl alcohol.
† Crystallised from acetic acid.
‡ Crystallised from chloroform petroleum ether.

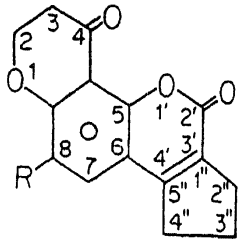
The cyanoethylation of 5,7-dihydroxy-4-methylcoumarin[3] afforded small amounts of the dinitrile together with the unreacted coumarin. No mono-cyanoethylated derivative could be isolated. The dinitrile with conc. HCl was hydrolysed to the corresponding dicarboxylic acid but all attempts to bring about its cyclisation were unsuccessful.



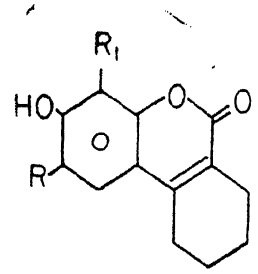
I



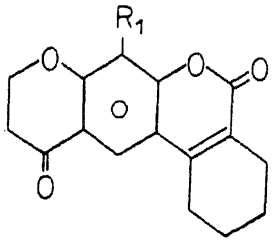
II



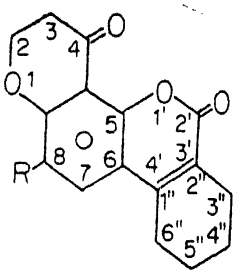
III



IV



V



VI

I, R=H, R_1=CH_3 Ia, R=C_2H_5, R_1=H

IV, R=H, R_1=CH_3 IVa, R=C_2H_5, R_1=H

EXPERIMENTAL

Preparation of 7-hydroxy-3, 4-cyclopenteno-8-methyl- and 7-hydroxy-3, 4-cyclohexeno-8-methylcoumarin

2-Methylresorcinol (5 g) was mixed with ethyl cyclopentanone-2-carboxylate (or ethyl cyclohexanone-2-carboxylate) (5 ml) and to that sulphuric acid (15 ml, 80%) was added and the whole kept in an ice-bath for 6 hr. The mixture was decomposed with ice and the solid filtered and washed with water. It was crystallised from either acetic acid or ethyl alcohol in either pale blue or pale yellow needles. Yield 4·5 g.

General Procedure for cyanoethylation

A mixture of the 7-hydroxycoumarin derivative (0·005 mole) dioxane (3 ml), acrylonitrile (1·5 ml) and aqueous sodium hydroxide (10%, 7–8 ml) was refluxed for 15 hr. The reaction mixture was then cooled and extracted with chloroform. The solvent layer was washed with aqueous sodium hydro-

xide (10%) and with water and dried with anhydrous sodium sulphate. Removal of the solvent gave a solid which was crystallised from benzene-petrol ether (40–60°) mixture in colourless needles.

Hydrolysis of the propionitriles

The above nitriles (100 mg) were refluxed with concentrated hydrochloric acid (10 ml) for 1 hr. The solution was then cooled and extracted with chloroform. On removal of chloroform a solid separated which was dissolved in sodium bicarbonate solution and filtered. The filtrate was acidified to yield a solid, which was crystallised from benzene-petrol ether (40–60°) in colourless needles.

Cyclisation of the propionic acid

The acids (300 mg) were added to a mixture of phosphorus pentoxide (10 g) and phosphoric acid (4 ml) preheated at 100° for 0·5 hr and heating continued for 2 hr more. The mixture was cooled, decomposed with water and extracted with chloroform. The solvent layer was washed with sodium bicarbonate solution, water and dried. A solid was obtained, which was crystallised from benzene-petrol ether (40–60°) in colourless needles.

The 2, 4-DNPs of the above α-pyronochromanones were crystallised from acetic acid.

Cyanoethylation of 5, 7-dihydroxy-4-methylcoumarin[3] *: Formation of 5, 7-dicyanoethoxy-4-methylcoumarin*

A mixture of 5, 7-dihydroxy-4-methylcoumarin (2 g) acrylonitrile (3 ml) dioxan (5·0 ml) and aqueous sodium hydroxide (1·2 ml, 10%) was refluxed for 15 hr. The reaction mixture was extracted with chloroform and the solvent layer washed thoroughly with aqueous sodium hydroxide (10%), water and dried. Removal of the solvent gave a solid (100 mg), which was crystallised from ethyl acetate-petroleum ether (40–60°) in colourless needles, m.p. 154–56°.

Analysis

Found : C, 64·5; H, 4·9; N, 9·2%

Calcd. for $C_{16}H_{16}O_4N_2$: C, 64·4; H, 4·7; N, 9·4%

The alkali layer was acidified and the solid obtained was filtered and again extracted with ether. Removal of ether gave a solid which was crystallised from alcohol in colourless prisms, m.p. 282°. It was identified as the original coumarin (m.m.p.).

Hydrolysis of 5,7-dicyano-ethoxy-4-methylcoumarin: Formation of 5, 7-dicarboxyethoxy-4-methylcoumarin

The above dinitrile (250 mg) was refluxed with concentrated hydrochloric acid (30 ml) for 1 hr. The mixture was cooled and the solid which separated was dissolved in sodium bicarbonate solution and filtered. The filtrate was acidified to give a solid (150 mg) which was crystallised from ethyl acetate in colourless clusters of needles, m.p. 180°.

Analysis

Found : C, 57·2; H, 4·5%
Calcd. for $C_{16}H_{16}O_8$: C, 57·1; H, 4·8%.

REFERENCES

1. Merchant, J. R. and Patell, J. R., *Curr. Sci.* 37 404 (1968).
2. Merchant, J. R. and Patell, J. R., *J. Chem. Soc.* (C) 1544 (1969).
3. Merchant, J. R. and Patell, J. R., *Tetrahedron Lett.* 8 555 (1970).
4. Merchant, J. R., Patell, J. R. and (Smt.) Thakkar, S. M., *Curr. Sci.* 40 353 (1971).
5. Merchant, J. R., Patell, J. R. and (Smt.) Barve, N. V., *J. Indian Chem. Soc.* 48 241 (1971),
6. Sethna, S. and Phadke, R., Pechmann reaction in R. Adams Ed., *Organic Reactions* Vol. VII, John Wiley and Sons, Inc., New York, N.Y., p. 14 (1953).
7. Von Pechmann, H. and Cohen, J. B., *Ber.* 17 2189 (1884).
8. Ahmed, S. Z. and Desai, R. D., *Proc. Indian Acad. Sci.* 5 276 (1937).
9. Ahmed, S. Z. and Desai, R. D., *J. Bombay Uni.* (6) (2) 89 (1937–38).