SYNTHESIS OF FURANO-BENZOPYRONES*

Part VIII. Synthesis of 8-Methoxyfuranoisoflavones

A. S. R. ANJANEYULU, L. RAMACHANDRA ROW, C. SRI KRISHNA AND C. SRINIVASULU
Department of Chemistry, Andhra University, Waltair

DURING a programme of synthesis of rotenone analogues, the synthesis of 8-methoxyfuranoisoflavones was undertaken. This programme was also encouraged by the recent discoveries of furanoisoflavones, furanopterocarpans and related compounds from *Pachyrrhizus*[1–5] and *Neorautanenia*[5–7] species and more recently from *Swartzia madagascariensis*.[8]

6 : 7-Dihydroxy coumaran (I), not being sufficiently reactive in Nencki's reaction, its dimethyl ether (II) was condensed with substituted phenacyl chlorides in presence of aluminium chloride to yield the corresponding deoxybenzoins (Table I). This reaction was studied at 0° and also at 40° in ether medium. The latter produced yields of deoxybenzoins of the order of 40–50%. The I.R. spectra of these three deoxybenzoins (III, IV and V) showed significantly negligible absorption in hydroxyl region while the corresponding 6-hydroxy deoxybenzoins[9,10] (7-methoxyl absent) exhibited broad trough between 3560–3460 cm.$^{-1}$, although of a low intensity. This seems to suggest the sandwiched character of this hydroxyl between 7–OCH_3 and 5–CO in these compounds (III, IV and V) which exhibited brown ferric reaction.

Substituted phenylacetic acids can be prepared by several methods. In the present synthesis, these were prepared by the following sequence :

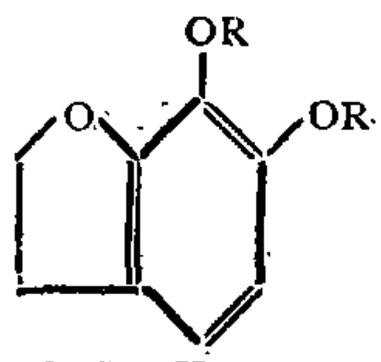
$$R-CHO \xrightarrow{HCHO} R-CH_2OH \xrightarrow{SOCl_2}$$

$$R-CH_2Cl \xrightarrow{KCN} R-CH_2CN \xrightarrow{KOH} R-CH_2COOH.$$

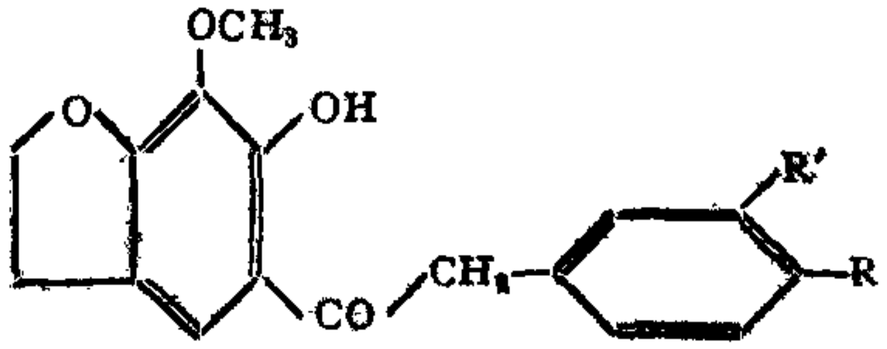
The reduction of the aldehyde to benzyl alcohol was quickly and efficiently carried out by crossed Cannizaro reaction using formaiin.[11] Thus anisaldehyde yielded ansyl alcohol and veratraldehyde, veratryl alcohol in good yields (70–80%). The product could be used directly without much purification. Reduction with Raney Ni/H_2 at 900 lbs./sq. inch gave varying results ; with anisaldehyde, *p*-methoxy toluene was the major product while with veratraldehyde the major product was the veratryl alcohol. The conversion of the benzyl alcohols to the phenylacetic acids by the scheme given above yielded consistent results. The azlactone synthesis, Willgerodt or Arndt-Eistert reaction

TABLE I

S. No.	6-OH-7-OCH_3-Coumaran	Yield	M.P.	Mol. formula	Required C	Required H	Found C	Found H
1	5-(ω-phenyl) acetyl (III)	40%	98°	$C_{17}H_{18}O_4$	71·8	5·7	71·6	5·8
2	5-(ω-*p*-methoxyphenyl) acetyl (IV)	50%	129°	$C_{18}H_{18}O_5$	68·8	5·8	69·1	6·1
3	5 (ω-3 : 4-dimethoxyphenyl) acetyl (V)	10%	169–70°	$C_{19}H_{20}O_6$	66·3	5·8	66·0	6·1



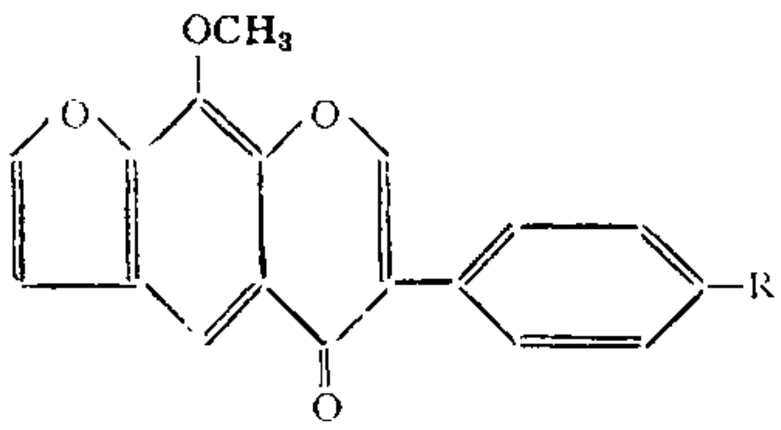
I R=H
II R=CH_3



III R=R'=H ($\nu_{max.}^{CHCl_3}$ 1633 cm.$^{-1}$)
IV R=OCH_3; R'=H ($\nu_{max.}^{CHCl_3}$ 1630 cm.$^{-1}$)
V R=R'=OCH_3 ($\nu_{max.}^{CHCl_3}$ 1630 cm.$^{-1}$)

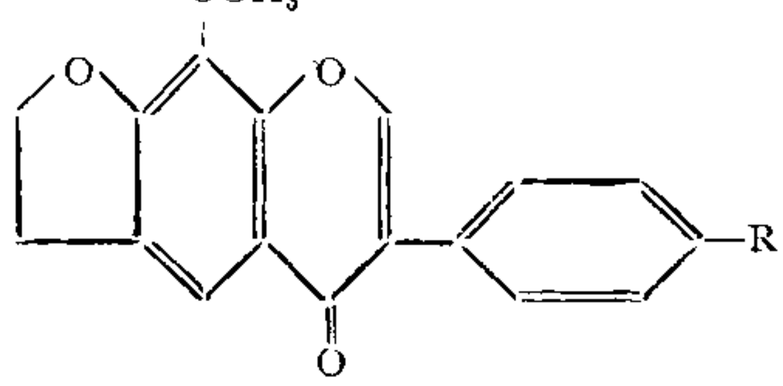
TABLE II

S. No.	Compound	M.P.	Mol. formula	Required		Found	
				C	H	C	H
1	8-OMe-(4′ : 5′)-dihydrofurano (3′ : 2′ : 6 : 7)-isoflavone	134°	$C_{18}H_{14}O_4$	73·5	4·8	73·6	5·1
2	8-OMe furano-(3′ : 2′ : 6 : 7)-isoflavone ..	166°	$C_{18}H_{12}O_4$	74·0	4·1	73·7	4·5
3	8, 4″-$(OMe)_2$-(4′ : 5′)-dihydrofurano (3′ : 2′ : 6 : 7)-isoflavone	147–48°	$C_{19}H_{16}O_5$	70·0	5·0	70·0	5·4
4	8, 4″-$(OMe)_2$-furano-(3′ : 2′ : 6 : 7)-isoflavone	153–54°	$C_{19}H_{14}O_5$	70·8	4·4	70·5	4·6



VIII R=H ($\nu_{max.}^{Nujol}$ 1645 and 1618 cm.$^{-1}$)

IX R=OCH_3 ($\nu_{max.}^{Nujol}$ 1638 and 1613 cm.$^{-1}$)



VI R=H ($\nu_{max.}^{CHCl_3}$ 1650 and 1620 cm.$^{-1}$)

VII R=OCH_3 ($\nu_{max.}^{CHCl_3}$ 1650 and 1620 cm.$^{-1}$)

involve costly reagents. Although, these have been followed extensively, the above conversion appears to be commendable for the synthesis of substituted phenylactonitriles or phenylacetic acids.

Cyclisation of the deoxybenzoins (III and IV), using ethyl formate and metallic sodium afforded the corresponding dihydrofuranoisoflavones (VI and VII). These exhibited feeble greenish-yellow fluorescence in conc. H_2SO_4. The yields (35–40%) of these isoflavones were poor compared to those secured with deoxybenzoins[9,10] without 7-methoxyls (50–60%).

The final stage of dehydrogenation was effected with Pd-C (30%) by refluxing in diphenyl ether for four hours. 8-Methoxy and 8 : 4″-dimethoxyfuranoisoflavones (VIII and IX) were secured in excellent yields (70–75%). These furanoisoflavones (VIII and IX) were colourless crystalline compounds exhibiting light green fluorescence in conc. H_2SO_4.

Finally, during the course of this synthesis, it appears that 7-methoxyl in 6 : 7-dimethoxy coumaran (II) exercises deleterious influence in the synthesis of deoxybenzoin and its cyclisation reactions. Dehydrogenation was, however, facile and afforded better yields.

* Part VII, *Ind. J. Chem.* (in press).

1. Norton, L. B. and Hansberry, R., *J. Amer. Chem. Soc.*, 1945, **67**, 1609.
2. Simonitsch, E., Frei, H. and Schmid, H., *Monatsh.*, 1957, **88**, 541.
3. Eisenbeiss, J. and Schmid, H., *Helv. Chim. Acta*, 1959, **42**, 61.
4. Bickel, H. and Schmid, H., *Ibid.*, 1953, **36**, 664.
5. Crombie, L. and Whitting, D. A., *J. Chem. Soc.*, 1963, 1569.
6. Brink, C. V. N., Dekker, J. J., Hanekom, E. C., Meiring, D. H. and Rall, G. J. H., *J. S. African Chem. Inst.*, 1965, **18** (1), **21**.
7. —, Nel, W., Rall, G. J. H., Weitz, J. C. and Pachler, K. G. R., *Ibid.*, 1966, **19** (1), **24**.
8. Harper, S. H., Kemp, A. D. and Underwood, W. G. E., *Chem. Commn.*, 1965, **14**, 309.
9. Pavanaram, S. K. and Row, L. R., *J. Sci. Industr. Res.*, 1956, **15 B**, 495; 1958, **17 B**, 272.
10. Anjaneyulu, A. S. R., Sri Krishna, C. and Row, L. R., *Tetrahedron*, 1965, **21**, 2677.
11. *Organic Synthesis*, 1943, Col. Vol. **2**, 590.