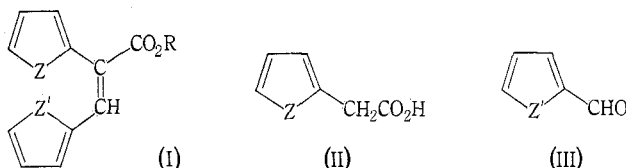


# PREPARATION OF METHYL *cis*- $\alpha,\beta$ -DI(2-PYRROLYL)ACRYLATE\*

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Several methyl *cis*- $\alpha,\beta$ -diarylacrylates, (I; R = Me, Z = Z' = S), (I; R = Me, Z = Z' = O), and (I; R = Me, Z = S, Z' = O), have been employed as precursors of key intermediates in the synthesis of internally bridged derivatives of [18]annulene.<sup>1-5</sup> Some attention has now been given to the preparation of methyl *cis*- $\alpha,\beta$ -di(2-pyrrolyl)acrylate (I; R = Me, Z = Z' = NH) as a possible intermediate for the synthesis of [18]annulenes containing epimino groups.



In the synthesis so far reported<sup>1-5</sup> the required  $\alpha,\beta$ -diarylacrylic esters were prepared from the corresponding acids (I; R = H), each acid having been obtained in the first place through a Perkin condensation of the appropriate arylacetic acid (II; Z = O or S) with either furfural (III; Z' = O) or thiophen-2-aldehyde (III; Z' = S). Condensation led in every case to formation of a mixture consisting mainly of the *cis* acid (I; R = H) and a small amount of the corresponding *trans* isomer. Treatment of the *cis* acid with methanolic hydrogen chloride then afforded the *cis* ester (I; R = Me) in sufficient overall yield (37–50%) for the purpose of the synthesis in hand.

Application of this method to the preparation of methyl *cis*- $\alpha,\beta$ -di(2-pyrrolyl)-acrylate has proved far less successful. The condensation of pyrrole-2-acetic acid (II; Z = NH) with pyrrole-2-aldehyde (III; Z' = NH) gave a deep red polymer as the major product; and the desired  $\alpha,\beta$ -di(2-pyrrolyl)acrylic acid (I; R = H, Z = Z' = NH) could not be isolated. Nevertheless, methyl *cis*- $\alpha,\beta$ -di(2-pyrrolyl)-acrylate (I; R = Me, Z = Z' = NH) was eventually obtained in poor yield (5%) following treatment of the crude condensation-mixture with methanolic hydrogen chloride and subsequent chromatography of the esterified material.

\* Manuscript received July 10, 1967.

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<sup>1</sup> Badger, G. M., Elix, J. A., and Lewis, G. E., *Aust. J. Chem.*, 1965, **18**, 70.

<sup>2</sup> Badger, G. M., Lewis, G. E., and Singh, U. P., *Aust. J. Chem.*, 1966, **19**, 257.

<sup>3</sup> Badger, G. M., Elix, J. A., and Lewis, G. E., *Aust. J. Chem.*, 1966, **19**, 1221.

<sup>4</sup> Badger, G. M., Lewis, G. E., and Singh, U. P., *Aust. J. Chem.*, 1966, **19**, 1461.

<sup>5</sup> Badger, G. M., Lewis, G. E., and Singh, U. P., *Aust. J. Chem.*, 1967, **20**, 1635.

The molecular formula of the isolated ester was established by microanalysis and determination of molecular weight; and the structural formula (I; R = Me, Z = Z' = NH) was confirmed by n.m.r., infrared, and ultraviolet spectral data.

TABLE 1  
N.M.R. SPECTRUM OF METHYL *cis*- $\alpha,\beta$ -DI(2-PYRROLYL)-  
ACRYLATE  
(I; R = Me, Z = Z' = NH) IN CDCl<sub>3</sub>

$\tau$ (p.p.m.)	Proton Count	Assignment
6.25	3	ester-group protons
3.83, 3.78	4	aromatic C-H protons
3.68, 3.62		
3.57, 3.50		
3.37, 3.32		
3.17, 3.12	2	
2.35	1	olefinic proton
1.40	2	imino protons
(broad singlet)		

The integrated n.m.r. spectrum (Table 1) accounted for all the hydrogen atoms in the molecule, including the two imino protons; and the low-field resonance ( $\tau$  2.35) of the olefinic proton indicated that the two pyrrolyl groups were in the *cis* relationship. As shown by Jackman and Wiley,<sup>6</sup> the olefinic protons of *cis* isomers of the type

TABLE 2  
SPECTRAL COMPARISON OF METHYL  $\alpha,\beta$ -DIARYLACRYLATES

Compound	N.M.R. (p.p.m.)		U.V. $\lambda_{\max}$ (m $\mu$ )	I.R. $\nu_{\max}$ (cm <sup>-1</sup> )
	Olefinic Protons	Ester-Group Protons		
Methyl <i>cis</i> - $\alpha,\beta$ -di(2-thienyl)acrylate <sup>1</sup>	1.96, 1.97	6.28	322	1700
Methyl <i>cis</i> - $\alpha$ -(2-thienyl)- $\beta$ -(2-furyl)acrylate <sup>2</sup>	2.27	6.25	323	1690
Methyl <i>cis</i> - $\alpha,\beta$ -di(2-furyl)acrylate <sup>3</sup>	2.43	6.23	—	—
Methyl <i>cis</i> - $\alpha,\beta$ -di(2-pyrrolyl)acrylate	2.35	6.25	320	1695
Methyl <i>trans</i> - $\alpha,\beta$ -di(2-thienyl)acrylate <sup>1</sup>	2.86, 2.87	6.09	341	1730
Methyl <i>trans</i> - $\alpha$ -(2-thienyl)- $\beta$ -(2-furyl)acrylate <sup>2</sup>	3.33	6.14	341	1725
Methyl <i>trans</i> - $\alpha,\beta$ -di(2-furyl)acrylate <sup>3</sup>	3.07	6.16	—	—

RCH=CR'COOR" resonate at lower fields than those of the corresponding *trans* isomers. The position of the olefinic resonance of the present compound, in relation to the corresponding resonance values for other methyl  $\alpha,\beta$ -diarylacrylates of known configuration (see Table 2), shows clearly that the compound has the *cis* configuration. This conclusion is further supported by the relative  $\tau$  values for the ester-group

<sup>6</sup> Jackman, L. M., and Wiley, R. H., *Proc. chem. Soc.*, 1958, 196.

protons and the relative positions of the ultraviolet and infrared (C=O) absorption maxima of the compounds listed in Table 2.

The poor yield of  $\alpha,\beta$ -di(2-pyrrolyl)acrylic acid and predominance of polymeric product in the currently reported condensation might appear to be due to instability of one or both of the reactants under the experimental conditions employed. It may be noted, however, that pyrrole-2-aldehyde undergoes satisfactory Perkin reactions with hydantoin,<sup>7</sup> with rhodanine,<sup>8</sup> and with hippuric acid.<sup>9</sup> The compound also gives normal aldol-type reactions with various ketones.<sup>10</sup> Pyrrole-2-acetic acid, on the other hand, shows some thermal instability and undergoes decarboxylation quite readily.<sup>11</sup>

### Experimental

#### Condensation

A mixture of pyrrole-2-aldehyde<sup>12</sup> (1.9 g), pyrrole-2-acetic acid<sup>11</sup> (2.5 g), triethylamine (20 ml), and acetic anhydride (20 ml) was heated at 100° for 30 min. The reaction mixture was then cooled, treated dropwise with 10% aqueous acetic acid (50 ml), warmed for 5 min, and finally poured onto ice (100 g). A red precipitate (4.5 g) was formed in the process; and this was collected, washed with water, and dried.

#### Esterification and Chromatography

The above red precipitate (4.5 g) was dissolved in 3% (w : v) hydrogen chloride-methanol (250 ml), and the solution was refluxed for 1 hr. A large quantity of water was added to the reaction mixture after it had been cooled, and the esterified material was extracted with chloroform. The chloroform extract was then dried (MgSO<sub>4</sub>), and the solvent was distilled off in order to remove any traces of methanol. The residue was redissolved in chloroform-cyclohexane (1 : 2) and chromatographed on a column of alumina. Elution was carried out with the same solvent, and the first (yellow) band was collected. Removal of the solvent yielded a yellow solid which was further purified by recrystallization from n-hexane (charcoal). *Methyl cis- $\alpha,\beta$ -di(2-pyrrolyl)acrylate* (0.2 g; 5%) was thereby obtained as yellow prisms, m.p. 130° (Found: C, 66.8; H, 6.1; O, 15.0; mol.wt. (mass spectrum), 216. C<sub>12</sub>H<sub>12</sub>N<sub>2</sub>O<sub>2</sub> requires C, 66.65; H, 6.0; O, 14.8%; mol.wt., 216). The ultraviolet absorption maximum (ethanol) at 320 m $\mu$  had  $\epsilon$  10000. The infrared spectrum (CHCl<sub>3</sub>) showed peaks at 3400 (NH), 1695 (ester C=O), and 1600 cm<sup>-1</sup> (C=C).

#### Acknowledgments

This work was supported by a grant from the Petroleum Research Fund administered by the American Chemical Society. Grateful acknowledgment is hereby made to the donors of the said fund. We are indebted to Drs J. H. Bowie and T. M. Spotswood for mass spectral and n.m.r. measurements respectively. Microanalyses were carried out by the Australian Microanalytical Service, Melbourne.

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<sup>12</sup> Fischer, H., and Orth, H., "Die Chemie des Pyrrols." Vol. 1. (Akademische Verlagsgesellschaft: Leipzig 1934.)