

Studies of some active methylene compounds by thin-layer chromatography

I. Malonates

Malonic acid esters are intermediates in the synthesis of substituted tryptophanes^{1,2}, 4-hydroxycoumarins³ and antispasmodic drugs⁴. Aluminium malonates are employed as condensation accelerators (0.01 % by wt.) for resins⁵. Malonates are employed for the manufacture of high molecular weight, heat-stable polyamides⁶. In addition, as these malonates are active methylene compounds, they could be converted into polynitro esters and form potential intermediates for the synthesis of new explosives.

In view of the importance of malonates, data on their microseparation and identification will be extremely useful. The present paper describes the resolution and identification up to 10 μg of some malonates using a thin-layer chromatography technique.

Experimental

Preparation of malonates. The malonates were prepared by taking the hydroxy compound (2 moles), malonic acid (1 mole) in acetic anhydride or phosphorus oxytrichloride (30 moles) (the latter was only used in the cases of *o*-nitrophenol and benzyl alcohol). The mixture was refluxed for one hour, excess solvent distilled off under vacuum, and the residue poured over crushed ice. In the case of crystalline products, they were filtered, washed with water and crystallized from a suitable solvent. The liquid products were taken up in ether, washed with water, the ether evaporated off and the syrupy liquid distilled under vacuum.

TABLE I

No.	Compound	Silica Gel G			Silica Gel G buffered with 0.5 N oxalic acid			Silica Gel G buffered with 0.5 M borax		
		Ben- zene- xylene (75:25)	Ben- zene- toluene (1:1)	To- luene	Ben- zene- xylene (75:25)	Ben- zene- toluene (1:1)	To- luene	Ben- zene- xylene (75:25)	Ben- zene- toluene (1:1)	To- luene
1	Bis(diphenyl) malonate	0.59	0.70	0.56	0.41	0.38	0.40	0.27	0.32	0.34
2	Di- <i>o</i> -nitrophenyl malonate	0.26	0.28	0.34	0.24	0.22	0.21	0.14	0.15	0.13
3	Di- <i>m</i> -nitrophenyl malonate	0.22	0.18	0.19	0.16	0.15	0.15	0.06	0.09	0.07
4	Di- <i>p</i> -nitrophenyl malonate	0.13	0.09	0.06	0.08	0.06	0.07	0.04	0.06	0.05
5	Di- <i>p</i> -chlorophenyl malonate	0.64	0.50	0.29	0.50	0.56	0.49	0.48	0.54	0.51
6	Di- <i>o</i> -tolyl malonate	0.48	0.55	0.51	0.33	0.50	0.42	0.32	0.40	0.35
7	Di- <i>m</i> -tolyl malonate	0.53	0.56	0.59	0.46	0.52	0.45	0.42	0.52	0.44
8	Di- <i>p</i> -tolyl malonate	0.51	0.75	0.46	0.34	0.38	0.35	0.32	0.36	0.33
9	Dithymyl malonate	0.70	0.83	0.55	0.52	0.60	0.50	0.50	0.52	0.48
10	Diphenyl malonate	0.49	0.56	0.48	0.40	0.39	0.39	0.30	0.38	0.36
11	Dibenzyl malonate	1.00	1.00	0.98	0.93	1.00	0.88	0.97	0.94	0.93
12	Di- α -naphthyl malonate	0.50	0.54	0.58	0.36	0.41	0.31	0.25	0.34	0.29
13	Di- β -naphthyl malonate	0.52	0.62	0.69	0.39	0.43	0.34	0.29	0.37	0.30

The following list gives the malonic ester, the solvent used for its crystallisation (in the case of solids), its melting point/boiling point and its elemental analysis:

Bis(diphenyl) malonate, acetone, 203° (Found: C, 79.22; H, 4.85; C₂₇H₂₀O₄ requires: C, 79.41; H, 4.90 %); di-*o*-nitrophenyl malonate, acetone, 124° (Found: C, 51.93; H, 2.88; C₁₅H₁₀N₂O₈ requires: C, 52.02; H, 2.89 %); di-*m*-nitrophenyl malonate, acetone, 128° (Found: C, 52.00; H, 2.81; C₁₅H₁₀N₂O₈ requires: C, 52.02; H, 2.89 %); di-*p*-nitrophenyl malonate, acetic acid, 203° (203³, 202–203° dec.⁷) (Found: C, 51.82; H, 2.80; C₁₅H₁₀N₂O₈ requires: C, 52.02; H, 2.89 %); di-*p*-chlorophenyl malonate, ethanol, 116° (Found: C, 55.12; H, 3.01; C₁₅H₁₀O₄Cl₂ requires: C, 55.36; H, 3.07 %); di-*o*-tolyl malonate, 180–183°/1–1.5 mm (178–180°/1 mm⁸) (Found: C, 71.81; H, 5.54; C₁₇H₁₆O₄ requires: C, 71.83; H, 5.63 %); di-*m*-tolyl malonate, ethanol, 73.5° (73^{9B}), (Found: C, 71.62; H, 5.60; C₁₇H₁₆O₄ requires: C, 71.83; H, 5.63 %); di-*p*-tolyl malonate, ethanol, 68–69° (69^{9B}, 69^{9C}, 71^{9B}) (Found: C, 71.78; H, 5.59; C₁₇H₁₆O₄ requires: C, 71.83; H, 5.63 %); dithymyl malonate, 210–212°/2–2.5 mm (Found: C, 74.98; H, 7.51; C₂₃H₂₈O₄ requires: C, 75.00; H, 7.60 %); diphenyl malonate, ethanol, 49–50° (49^{9B}) (Found: C, 70.23; H, 4.67; C₁₅H₁₂O₄ requires: C, 70.31; H, 4.68 %); dibenzyl malonate, 200–202°/1.5–2 mm (197–200°/1.5 mm¹; 187°/1.5–2 mm⁷) (Found: C, 71.81; H, 5.62; C₁₇H₁₆O₄ requires: C, 71.83; H, 5.63 %); di- α -naphthyl malonate, acetic acid, 126° (126–127¹⁰) (Found: C, 77.49; H, 4.47; C₂₃H₁₆O₄ requires: C, 77.52; H, 4.49 %); di- β -naphthyl malonate, acetic acid, 146° (146–147¹⁰) (Found: C, 77.47; H, 4.45; C₂₃H₁₆O₄ requires: C, 77.52; H, 4.49 %).

Preparation, spotting and irrigation of plates. Kodak photographic glass plates, 22 × 22 cm, were used. The plates were coated by making a slurry of the adsorbent (30 g) in ethanol–water (1:1; 60 cc) or buffer (60 cc), pouring it on the plates and tilting them from side to side. The plates were dried overnight at room temperature and

Neutral alumina (M. Woelm)			Acidic alumina (M. Woelm)			Basic alumina (M. Woelm)			Kieselguhr G + Silica Gel G (1:1)		
Chloro- form- xylene (4:1)	To- luene	Ben- zene	Chloro- form- xylene (4:1)	To- luene	Ben- zene	Chloro- form- xylene (4:1)	To- luene	Ben- zene	Xy- lene	To- luene	To- luene- xylene (1:1)
0.34	0.23	0.17	0.40	0.34	0.50	0.29	0.13	0.19	0.48	0.58	0.53
0.21	0.07	0.12	0.18	0.18	0.58	0.12	0.07	0.09	0.77	0.83	0.80
0.06	0.03	0.08	0.14	0.09	0.08	0.05	0.03	0.04	0.21	0.25	0.20
0.04	0.02	0.04	0.11	0.05	0.06	0.03	0.02	0.03	0.11	0.14	0.12
0.24	0.18	0.19	0.37	0.36	0.58	0.26	0.14	0.21	0.64	0.78	0.71
0.59	0.49	0.65	0.75	0.55	0.79	0.54	0.45	0.57	0.59	0.74	0.62
0.47	0.48	0.58	0.65	0.49	0.62	0.46	0.43	0.52	0.54	0.72	0.60
0.27	0.13	0.36	0.52	0.43	0.55	0.34	0.31	0.28	0.52	0.68	0.58
0.82	0.81	0.70	0.80	0.75	0.90	0.77	0.63	0.82	0.67	0.81	0.74
0.33	0.31	0.26	0.62	0.47	0.56	0.38	0.30	0.34	0.51	0.69	0.61
0.88	0.94	0.96	0.89	0.97	0.99	0.92	0.96	0.99	0.98	0.99	0.98
0.22	0.11	0.12	0.43	0.35	0.59	0.39	0.24	0.24	0.40	0.67	0.51
0.15	0.06	0.10	0.38	0.22	0.61	0.32	0.17	0.17	0.48	0.64	0.50

activated at 110° for 1 h. They were weighed and the average coating of the adsorbent noted. The coatings in the cases of silica gel, alumina and Kieselguhr G-Silica Gel G (1:1) were: 3.72, 9.12 and 4.86 mg/cm², respectively.

10 μ g of each compound was spotted with a standard microcapillary and the plates irrigated at $20 \pm 1^{\circ}$ with suitable solvents using an ascending system. The spots could be detected either as such under an ultra-violet "chromatolite" lamp, emitting short-wave (2537 Å) radiation, or after spraying with 0.1% fluorescein solution. A typical chromatoplate is shown in Fig. 1 and the R_F values are recorded in Table I.

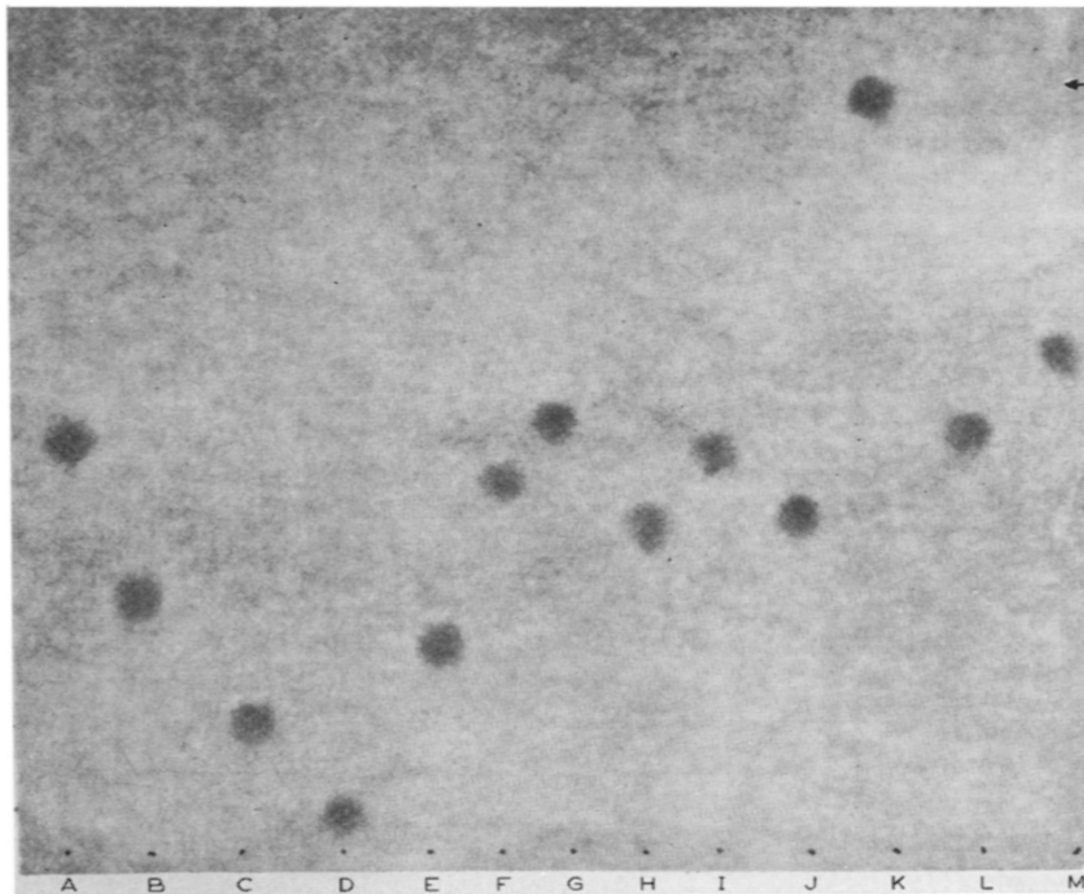


Fig. 1. Thin-layer chromatogram showing the separation of some malonates. A = Bis(diphenyl) malonate; B = di-*o*-nitrophenyl malonate; C = di-*m*-nitrophenyl malonate; D = di-*p*-nitrophenyl malonate; E = di-*p*-chlorophenyl malonate; F = di-*o*-tolyl malonate; G = di-*m*-tolyl malonate; H = di-*p*-tolyl malonate; I = dithymyl malonate; J = diphenyl malonate; K = dibenzyl malonate; L = di- α -naphthyl malonate; M = di- β -naphthyl malonate. Photograph taken under ultra-violet light. Adsorbent: Silica Gel G; solvent: toluene; system: ascending.

Discussion and results

Silica Gel G and alumina at different pH's were found to be excellent adsorbants for malonates. In the case of Kieselguhr G all the compounds migrated to the solvent front with the various solvent systems tried. In general the R_F values on Silica Gel G, buffered with 0.05 *M* borax, were lower than on acidic plates. Silica Gel G buffered with 0.5 *N* oxalic acid had a lowering effect on the resolution of the compounds com-

pared to neutral Silica Gel G. Basic alumina exerted a powerful binding effect on the molecules. The introduction of more alkyl groups in the aromatic solvent gradually decreased the R_F values of the esters.

Acknowledgements

Thanks are due to Dr. KARTAR SINGH, Director, Defence Science Laboratory, Delhi, for his encouragement.

Defence Science Laboratory, Metcalfe House, Delhi-6 (India)

D. B. PARIHAR
S. P. SHARMA
K. K. VERMA

- 1 H. M. KISSMAN AND B. WITKOP, *J. Am. Chem. Soc.*, 75 (1953) 1967.
- 2 C. PASINI, V. COLO AND S. CODA, *Gazz. Chim. Ital.*, 93, No. 8/9 (1963) 1066.
- 3 E. ZIEGLER AND H. JUNEK, *Monatsh.*, 86 (1955) 29.
- 4 M. PROTIVA AND Z. J. VEJDĚLEK, *Collection Czech. Chem. Commun.*, 15 (1950) 541.
- 5 A. WACKER G.m.b.H., *Ger. Pat.*, 875,980, May 7th, 1953.
- 6 S. B. SPECK, *J. Am. Chem. Soc.*, 74 (1952) 2876.
- 7 H. J. BACKER AND J. LOKEMA, *Rec. Trav. Chim.*, 57 (1938) 1234.
- 8 I. O. SELISKO, *Ernährungsforschung*, 2 (1957) 362.
- 9 G. URBAIN AND C. MENTZER, *Bull. Soc. Chim. France*, 11 (1944) 171.
- 10 M. CIVERA AND L. BENEDETTI, *Gazz. Chim. Ital.*, 83 (1953) 32.

Received October 3rd, 1966

J. Chromatog., 27 (1967) 276-279

Low temperature fluorescence detection of organic compounds on thin layer chromatograms

Low temperature detection of certain compounds by their fluorescence or phosphorescence was first considered by SZENT-GYÖRGYI¹. He found that many compounds which did not fluoresce at room temperature, would fluoresce at liquid nitrogen temperature. This phenomenon has been employed for the detection of some organic compounds on paper chromatograms¹⁻⁴. WEISS⁵ stated that intense fluorescence may be expected of compounds which are symmetrically conjugated or which do not yield stronger ionic structures. According to TOMASCHEK⁶, intensification of fluorescence is usually due to —OH, —OCH₃, =CH₂, —NH₂ and —CN groups, whereas its weakening is due to the —COOH radical. RADLEY AND GRANT⁷ found that although there may be weakening of fluorescence due to the presence of certain groups, the position of the main bands remained unaltered. Also, the presence of unsaturated groups in the side chain tends to intensify fluorescence.

Many workers have investigated the effect of chemical structure on fluorescence but no complete set of theoretical rules has so far been devised. The successful adaptation of the technique to thin layer chromatographic detections is now reported.

The separatory technique as such need not be altered, of course, but the soft glass plates generally distributed as thin layer supports shatter readily when subjected to liquid nitrogen. A pyrex support plate proved satisfactory at the low temperature

J. Chromatog., 27 (1967) 279-281