Russian Journal of Organic Chemistry, Vol. 40, No. 7, 2004, pp. 976–981. From Zhurnal Organicheskoi Khimii, Vol. 40, No. 7, 2004, pp. 1017–1022.

An Efficient One-Pot Synthesis of Triamides and Amidodiesters*

A. Shaabani[1], M. B. Teimouri[1], and H. R. Bijanzadeh[2]

[1] *Department of Chemistry, Shahid Beheshti University, 1983963113 Tehran, Iran*
fax: +(9821)2403041; e-mail: a-shaabani@cc.sbu.ac.ir

[2] *Department of Chemistry, Tarbiat Modarres University, P.O. Box 14155-4838, Tehran, Iran*

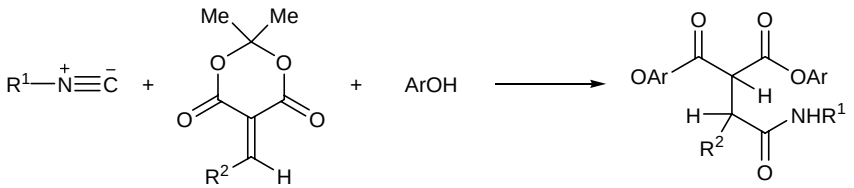
Received April 23, 2003

Abstract—An efficient one-pot procedure has been proposed for the synthesis of compounds containing three carboxamide groups or one carboxamide and two ester groups. The procedure is based on three-component condensation of alkyl isocyanides with 5-alkylidene- or 5-arylmethylene-substituted Meldrum's acids in the presence of such nucleophiles as phenols and amines.

In the recent years, chemistry of 5-alkylidene- and 5-arylmethylene-substituted Meldrum's acid derivatives has attracted much attention owing to their potential synthetic utility and diversity of reactions [1, 2]. These compounds are useful intermediates in cycloaddition reactions not only as good dienophiles but also as good oxy-dienes in hetero-Diels–Alder reactions [3–6]. In continuation of our recent studies on [1+4]-cycloadditions of isocyanides to activated α,β-unsaturated carbonyl compounds which are capable of adopting a cisoid configuration [7–12], the present communication reports on reactions of alkyl isocyanides **I** with 5-methoxymethylene- and 5-(4-nitrobenzylidene)-substituted Meldrum's acids as electron-deficient oxy-dienes in the presence of phenols and amines as nucleophiles. We found that these reactions occur under mild conditions (at room temperature) in the absence of a catalyst to afford highly functionalized triamides and amidodiesters. The products and their derivatives can find application in various fields, such as complex formation with metals [13–17] and pharmaceutical chemistry [18, 19].

Three-component condensation of alkyl isocyanides **I** with compounds **II** in the presence of phenols **III** in methylene chloride at room temperature gave amdodiesters **IV** in fairly high yields (Scheme 1). The formation of compounds **IV** follows from the ^{1}H and ^{13}C NMR spectra of the crude products. No other compounds were detected in the reaction mixtures by NMR spectroscopy. The structure of compounds **IVa**–**IVf** was deduced from their elemental analyses and IR and ^{1}H and ^{13}C NMR spectra. The mass spectra of **IVa**–**IVf** displayed the molecular ion peaks with appropriate *m*/*z* values. The ^{1}H NMR spectrum of **IVa** contained a signal at δ 1.26 ppm from the *tert*-butyl group and signals at δ 4.31 and 4.76 ppm (*AX* system, J_{AX} = 11.3 Hz) from the two CH protons. The NH proton resonates at δ 5.54 ppm, and signals in the δ range from 6.69 to 8.24 ppm belong to the aromatic protons. In the proton-decoupled ^{13}C NMR spectrum

Scheme 1.



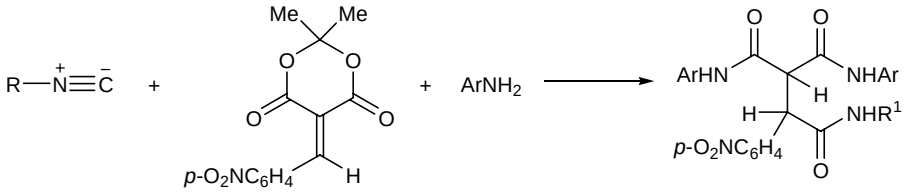
Ia, **Ib** **IIa**, **IIb** **IIIa**, **IIIb** **IVa–IVf**

I, R^1 = *t*-Bu (**a**), cyclohexyl (**b**); **II**, R^2 = 4-$O_2NC_6H_4$ (**a**), MeO (**b**); **III**, Ar = Ph (**a**), 3-$O_2NC_6H_4$ (**b**); **IV**, R^1 = *t*-Bu, R^2 = 4-$O_2NC_6H_4$, Ar = Ph (**a**); R^1 = cyclohexyl, R^2 = 4-$O_2NC_6H_4$, Ar = Ph (**b**); R^1 = *t*-Bu, R^2 = 4-$O_2NC_6H_4$, Ar = 3-$O_2NC_6H_4$ (**c**); R^1 = cyclohexyl, R^2 = 4-$O_2NC_6H_4$, Ar = 3-$O_2NC_6H_4$ (**d**); R^1 = *t*-Bu, R^2 = MeO, Ar = Ph (**e**); R^1 = cyclohexyl, R^2 = MeO, Ar = Ph (**f**).

* The original article was submitted in English.

1070-4280/04/4007-0976 © 2004 MAIK "Nauka/Interperiodica"

Scheme 2.



Ia, **Ib** **IIa** **IIIc–IIIf** **Va–Vh**

I, R = *t*-Bu (**a**), cyclohexyl (**b**); **III**, Ar = Ph (**c**), 4-$O_2NC_6H_4$ (**d**), 4-MeC_6H_4 (**e**), 1-naphthyl (**f**); **V**, R = *t*-Bu, Ar = Ph (**a**); R = cyclohexyl, Ar = Ph (**b**); R = *t*-Bu, Ar = 4-$O_2NC_6H_4$ (**c**); R = cyclohexyl, Ar = 4-$O_2NC_6H_4$ (**d**); R = *t*-Bu, Ar = 4-MeC_6H_4 (**e**); R= cyclohexyl, Ar = 4-MeC_6H_4 (**f**); R = *t*-Bu, Ar = 1-naphthyl (**g**); R = cyclohexyl, Ar = 1-naphthyl (**h**).

of **IVa** we observed 19 distinct signals in agreement with the assumed structure. The ^{1}H and ^{13}C NMR spectra of compounds **IVb**–**IVf** were similar to those obtained for **IVa**, except for signals from the alkylamino group (R), ester groups, and R' which exhibited characteristic signals with appropriate chemical shifts.

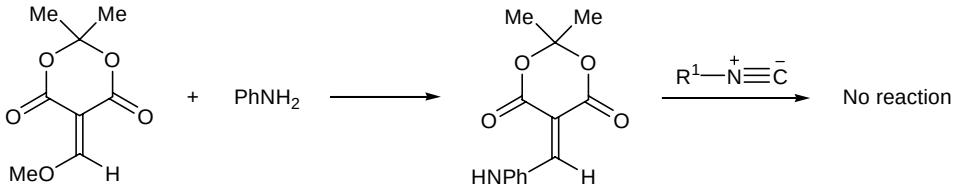
Treatment of alkyl isocyanides **I** with 5-(4-nitrobenzylidene)-substituted Meldrum's acid **IIa** in the presence of amines at room temperature gave N^2-alkyl-2-(4-nitrophenyl)-N^1,N^1-diaryl-1,1,2-ethanetricarboxamides **V** in high yields (Scheme 2). The ^{1}H NMR spectrum of **Va** contained a narrow singlet at δ 1.28 ppm, which was readily recognized as arising from the *tert*-butyl group and an *AX* pattern (J_{AX} = 8.1 Hz) from the two methine protons at δ 4.42 and 4.79 ppm. A broadened singlet (δ 7.96 ppm) was observed for the NH group attached to *t*-Bu, and protons of the phenyl ring appeared as multiplets in the aromatic region (δ 7.03–7.78 ppm). Two PhNH protons gave a broad singlet at δ 9.98 ppm. The ^{13}C NMR spectrum of **Va** (recorded with decoupling from protons) consists of 18 distinct signals, in agreement with the assigned structure. The ^{1}H and ^{13}C NMR spectra of compounds **Vb**–**Ve**, **Vg**, and **Vh** were similar to those obtained for **Va**, except for signals from the alkyl and aryl groups on the nitrogen atoms. We failed to record ^{1}H and ^{13}C NMR spectra of compound **Vf** because of its poor solubility.

Under analogous conditions, the reaction of 5-methoxymethylene-2,2-dimethyl-1,3-dioxane-4,6-dione (**IIb**) with alkyl isocyanides **I** in the presence of aniline afforded the corresponding 5-phenylaminomethylene derivative **IIc** (R' = PhNH) (Scheme 3). This result may be interpreted in terms of highly electron-rich nature of the oxy-diene system in **IIc**, which hampers its subsequent reaction at the electron-rich carbon atom of isocyanide.

Scheme 4 shows a possible mechanism of the above reactions. Taking into account that compound **IIc**, being an electron-rich heterodiene, failed to react with isocyanides, the first step of the process may be [1+4]-cycloaddition of alkyl isocyanide to electron-deficient heterodiene **II** with formation of iminolactone intermediate **VI**. The subsequent reaction of **VI** with nucleophile according to pathway *a* or *b* results in formation of the same product **IV** or **V**.

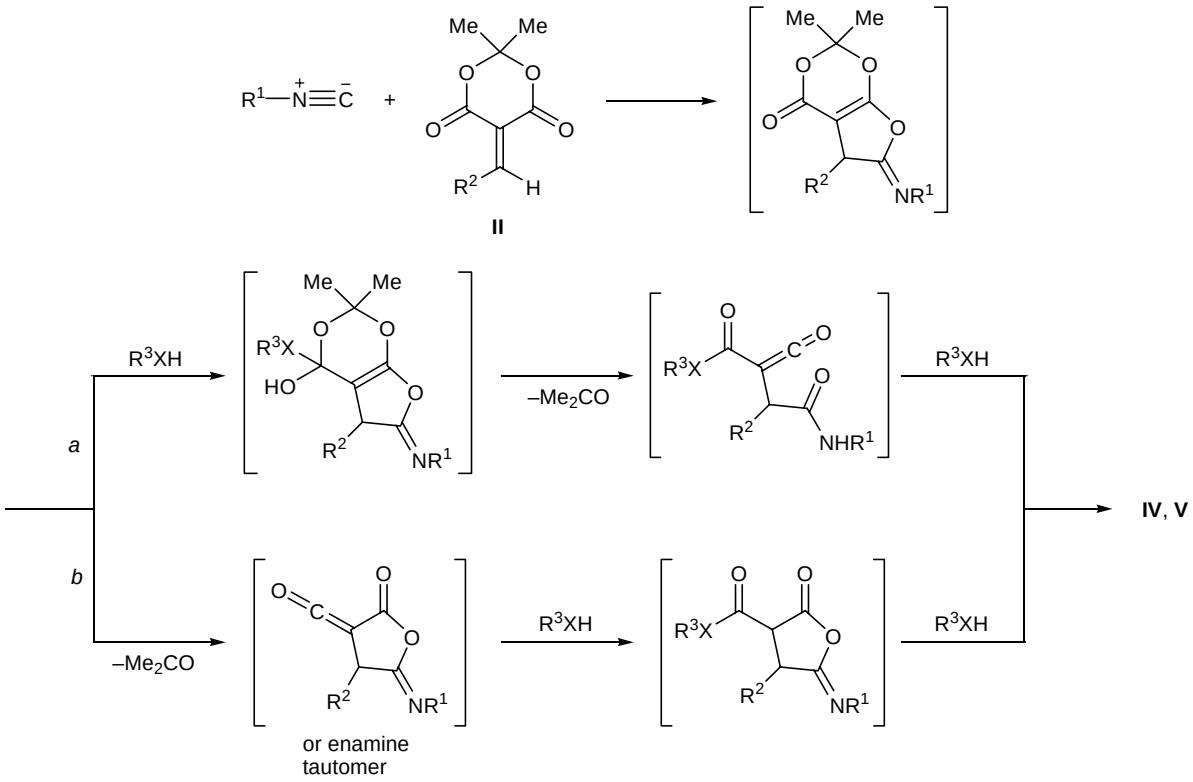
In summary, the reactions of 5-arylmethylene- and 5-methoxymethylene-substituted Meldrum's acids with alkyl isocyanides in the presence of phenols and amines smoothly occur under mild conditions in the absence of a catalyst to afford the corresponding 1,1,2-ethanetricarboxamides and diaryl carbamoylmethylmalonates in high yields. The proposed procedure offers a convenient alternative to multistep approaches [20]. The products attract interest as potential polyfunctional ligands for organometallic chemistry.

Scheme 3.



IIb **IIc**

Scheme 4.



EXPERIMENTAL

The melting points were determined on an Electrothermal 9100 apparatus and are uncorrected. The elemental analyses were obtained using a Heraeus CHN-O-Rapid analyzer. The mass spectra (70 eV) were recorded on a Finnigan MAT-8430 mass spectrometer. The IR spectra were obtained on a Shimadzu IR-470 spectrometer. The ^{1}H and ^{13}C NMR spectra were measured on a Bruker DRX-500 Avance instrument at 500.13 and 125.77 MHz, respectively, using $CDCl_3$ or DMSO-d_6 as solvent. The chemicals used in this work were purchased from Fluka (Buchs, Switzerland). 2,2-Dimethyl-5-(4-nitrobenzylidene)-1,3-dioxane-4,6-dione (**IIa**) and 5-methoxymethylene-2,2-dimethyl-1,3-dioxane-4,6-dione (**IIb**) were synthesized by the procedures described in [21, 22].

Diphenyl 2-[2-*tert*-butylamino-1-(4-nitrophenyl)-2-oxoethyl]malonate (IVa). A solution of 0.084 g (1 mmol) of *tert*-butyl isocyanide (**Ia**) in 2 ml of methylene chloride was added dropwise over a period of 10 min to a solution of 0.280 g (1 mmol) of 2,2-dimethyl-5-(4-nitrobenzylidene)-1,3-dioxane-4,6-dione (**IIa**) and 0.197 g (2.1 mmol) of phenol (**IIIa**) in 15 ml of methylene chloride under stirring (with a magnetic stirrer) at 0°C. The mixture was allowed to warm up to room temperature and was stirred for 5 h. The solution was concentrated, and the colorless crystalline product was filtered off and recrystallized from methylene chloride–hexane, 1:1. Yield 0.420 g (85%), mp 163–164°C. IR spectrum (KBr), ν, cm^{-1}: 3380 (NH); 1759, 1730, 1672 (C=O); 1519, 1340 (NO_2). ^{1}H NMR spectrum ($CDCl_3$, Me_4Si), δ, ppm: 1.26 s (9H, CMe_3), 4.31 d and 4.76 d (2H, CH, $^3J_{HH}$ = 11.25 Hz), 5.54 s (1H, NH), 6.69–7.42 m (10H, C_6H_5), 7.69 d and 8.24 d (4H, $C_6H_4NO_2$, $^3J_{HH}$ = 6.95 Hz). ^{13}C NMR spectrum ($CDCl_3$, Me_4Si), δ_C, ppm: 28.49 (C**Me**$_3$); 52.02 (**C**Me_3); 52.53, 55.27 (CH); 120.80, 121.20, 124.18, 126.47, 126.52, 129.45, 129.60, 129.63, 143.29, 147.85, 149.86, 150.41 (C_{arom}); 165.87, 166.26, 168.45 (CO). Mass spectrum, *m*/*z*, (I_{rel}, %): 588 M^+ (10), 345 (43), 221 (35), 176 (40), 144 (100), 57 (64). Found, %: C 65.98; H 5.31; N 5.60. $C_{27}H_{26}N_2O_7$. Calculated, %: C 66.10; H 5.34; N 5.71. *M* 490.55.

Compounds **IVb**–**IVf** were synthesized in a similar way.

Diphenyl 2-[2-cyclohexylamino-1-(4-nitrophenyl)-2-oxoethyl]malonate (IVb). Colorless crystals. Yield 0.440 g (85%), mp 168–169°C. IR spectrum (KBr), ν, cm^{-1}: 3315 (NH); 1750, 1637 (CO); 1506,

1338 (NO_2). ^{1}H NMR spectrum ($CDCl_3$, Me_4Si), δ, ppm: 1.05–1.69 m (10H, CH_2), 3.70 m (1H, NCH), 4.35 d and 4.81 d (2H, CH, $^3J_{HH}$ = 11.2 Hz), 5.55 d (1H, NH, $^3J_{HH}$ = 8.00 Hz), 6.68–7.42 m (10H, C_6H_5), 7.69 d and 8.24 d (4H, $C_6H_4NO_2$, $^3J_{HH}$ = 8.50 Hz). ^{13}C NMR spectrum ($CDCl_3$, Me_4Si), δ, ppm: 24.64, 24.69, 25.32, 32.54, 32.70 (CH_2); 49.08 (NCH); 52.00, 55.16 (CH); 120.78, 121.20, 124.16, 126.48, 126.53, 129.61, 129.63, 143.09, 147.87, 149.85, 150.37 (C_{arom}); 165.81, 166.21, 168.32 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 517 $[M + H]^+$ (3), 424 (27), 329 (13), 247 (18), 176 (22), 94 (100). Found, %: C 66.75; H 5.56; N 5.45. $C_{29}H_{28}N_2O_7$. Calculated, %: C 67.42; H 5.46; N.42. *M* 516.59.

Bis(3-nitrophenyl) 2-[2-*tert*-butylamino-1-(4-nitrophenyl)-2-oxoethyl]malonate (IVc). Yellow crystals. Yield 0.468 g (80%), mp 175–176°C. IR spectrum (KBr), ν, cm^{-1}: 3310 (NH); 1749, 1674 (CO); 1532, 1351 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.18 s (9H, CMe_3), 4.66 d and 4.86 d (2H, CH, $^3J_{HH}$ = 10.5Hz), 7.37 d (1H, NH, $^3J_{HH}$ = 8.17 Hz), 7.53–8.29 m (12H, H_{arom}). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 28.60 (C**Me**$_3$); 51.11 (**C**Me_3); 51.55, 54.68 (CH); 117.01, 117.34, 122.02, 124.06, 124.23, 128.69, 124.84, 129.33, 130.14, 131.66, 131.74, 144.76, 147.05, 147.98, 148.68, 148.84, 150.08, 150.64 (C_{arom}); 165.81, 165.97, 168.75 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 580 M^+ (2), 479 (8), 442 (10), 303 (15), 277 (35), 221 (50), 176 (25), 139 (90), 57 (100). Found, %: C 56.03; H 4.27; N 9.81. $C_{27}H_{24}N_4O_{11}$. Calculated, %: C 55.85; H 4.16; N 9.65. *M* 580.57.

Bis(3-nitrophenyl) 2-[2-cyclohexylamino-1-(4-nitrophenyl)-2-oxoethyl]malonate (IVd). Yellow crystals. Yield 0.496 g (81%), mp 151–152°C. IR spectrum (KBr), ν, cm^{-1}: 3285 (NH); 1771, 1750, 1672 (C=O); 1527, 1349 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.05–1.73 m (10H, CH_2), 3.85 m (1H, NCH), 4.63 d and 4.91 d (2H, CH, $^3J_{HH}$ = 1.1 Hz), 7.20 d (1H, NH, $^3J_{HH}$ = 8.15 Hz), 7.42–8.21 m (12H, H_{arom}). ^{13}C NMR spectrum (DMSO-d_6), δ, ppm: 24.81, 24.89, 25.34, 32.52, 32.76 (CH_2); 45.39 (NCH); 48.31 and 51.59 (CH); 110.04, 114.27, 117.48, 121.38, 122.87, 124.09, 124.22, 129.12, 129.41, 129.93, 131.09, 131.45, 146.24, 147.11, 147.26, 147.76, 148.73, 149.16 (C_{arom}); 169.80, 170.09, 176.30 (C=O). Mass spectrum, *m*/*z* (I_{rel}, %): 606 M^+ (3), 506 (5), 303 (37), 221 (854), 166 (25), 150 (51), 55 (100). Found, %: C 58.46; H 5.00; N 9.20. $C_{29}H_{26}N_4O_{11}$. Calculated, %: C 57.42; H 4.32; N 9.23. *M* 606.61.

Diphenyl 2-[2-*tert*-butylamino-1-methoxy-2-oxoethyl]malonate (IVe). Red oily substance. Yield 0.295 g (74%). IR spectrum (KBr), ν, cm^{-1}: 3370 (NH); 1750, 1691 (C=O). ^{1}H NMR spectrum ($CDCl_3$, Me_4Si), δ, ppm: 1.36 s (9H, CMe_3), 3.52 s (3H, OCH_3), 4.47 m (2H, CH, *AB* system, $^3J_{HH}$ = 4.4 Hz), 6.49 s (1H, NH), 6.83–7.42 m (10H, H_{arom}). ^{13}C NMR spectrum ($CDCl_3$, Me_4Si), δ_C, ppm: 28.60 (C**Me**$_3$); 50.90 (**C**Me_3); 55.12 (OCH_3); 59.96 (CH); 78.71 (OCH); 114.69, 120.11, 121.37, 121.40, 126.88, 126.95, 127.13, 129.33, 130.04, 151.26, 151.73, 155.10 (C_{arom}); 165.22, 165.93, 169.20 (C=O). Mass spectrum, *m*/*z* (I_{rel}, %): 400 M^+ (10), 368 (31), 338 (17), 275 (22), 247 (15), 217 (28), 124 (33), 94 (100), 57 (95). Found, %: C 66.33; H 6.21; N 3.61. $C_{22}H_{25}NO_6$. Calculated, %: C 66.14; H 6.30; N 3.50. *M* 399.48.

Diphenyl 2-[2-cyclohexylamino-1-methoxy-2-oxoethyl]malonate (IVf). Red oily substance. Yield 0.303 g (71%). IR spectrum (KBr), ν, cm^{-1}: 3355 (NH), 1748, 1695 (C=O). ^{1}H NMR spectrum ($CDCl_3$, Me_4Si), δ, ppm: 1.10–1.89 m (10H, CH_2), 3.61 s (3H, OCH_3), 3.81 m (1H, NCH), 4.52 m (2H, CH, *AB* system, $^3J_{HH}$ = 4.25 Hz), 6.25 d (1H, NH, $^3J_{HH}$ = 8.50 Hz), 6.82–7.37 m (10H, H_{arom}). ^{13}C NMR spectrum ($CDCl_3$, Me_4Si), δ, ppm: 24.64, 24.77, 25.38, 32.75, 32.94 (CH_2); 48.23 (NCH); 54.55 (OCH_3); 60.10 (CH); 79.68 (OCH); 115.47, 119.86, 121.35, 121.37, 126.28, 126.30, 129.42, 129.52, 150.42, 150.48, 156.54 (C_{arom}); 164.91, 165.76, 168.39 (CO). Mass spectrum, *m*/*z* (I_{rel},%): 426 M^+ (7), 364 (24), 332 (33), 300 (25), 270 (42), 238 (35), 156 (60), 117 (29), 94 (100), 83 (41). Found, %: C 67.03; H 6.11; N 3.49. $C_{24}H_{27}NO_6$. Calculated, %: C 67.74; H 6.39; N 3.29. *M* 425.52.

***N*^{2}-*tert*-Butyl-2-(4-nitrophenyl)-*N*^{1},*N*^{1}-diphenyl-1,1,2-ethanetricarboxamide (Va).** A solution of 0.084 g (1 mmol) of *tert*-butyl isocyanide **Ia** in 2 ml of methylene chloride was added dropwise over a period of 10 min to a solution of 0.280 g (1 mmol) of 2,2-dimethyl-5-(4-nitrobenzylidene)-1,3-dioxane-4,6-dione (**IIa**) and 2 ml of aniline (**IIIc**) in 15 ml of methylene chloride under stirring (magnetic stirrer) at 0°C. The mixture was allowed to warm up to room temperature and was stirred for 5 h. The solution was concentrated, and the colorless crystalline product was filtered off and washed with diethyl ether. Yield 0.440 g (90%), mp 300–301°C (decomp.). IR spectrum (KBr), ν, cm^{-1}: 3305 (NH); 1672, 1632, 1603 (C=O); 1510, 1349 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.21 s (9H, CMe_3), 4.42 d and 4.79 d (2H, CH, $^3J_{HH}$ = 8.13 Hz), 7.96 br.s (1H, *t*-BuN**H**), 7.03–8.20 (14H, H_{arom}), 9.98 s (2H PhN**H**). ^{13}C NMR

spectrum (DMSO-d_6), δ_C, ppm: 28.23 (C**Me**$_3$); 50.21 (**C**Me$_3$); 50.60 and 58.04 (CH); 119.21, 123.08, 123.47, 123.63, 128.50, 128.63, 129.33, 138.24, 138.69, 146.34, 146.51 (C_{arom}); 164.71, 165.30, 169.63 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 488 M^+ (3), 396 (15), 340 (10), 323 (13), 295 (20), 269 (53), 176 (17), 130 (15), 93 (100), 77 (25), 57 (64). Found, %: C 66.06; H. 5.49; N. 11.31. $C_{27}H_{28}N_4O_5$. Calculated, %: C 66.37; H.77; N 11.46. *M* 488.57.

***N*^{2}-Cyclohexyl-2-(4-nitrophenyl)-*N*^{1},*N*^{1}-diphenyl-1,1,2-ethanetricarboxamide (Vb).** Colorless crystals. Yield 0.476 g (92%), mp 304–305°C (decomp.). IR spectrum (KBr), ν, cm^{-1}: 3270 (NH); 1668, 1660, 1627 (C=O); 1514, 1345 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 0.93–1.62 m (10H, CH_2), 3.35 m (1H, NCH), 4.37 d and 4.65 d (2H, CH, $^3J_{HH}$ = 9.2 Hz), 6.98–8.16 m (14H, H_{arom}), 8.21 s (1H, CyN**H**), 9.83 s and 9.92 s (2H, PhN**H**). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 24.73, 24.80, 25.58, 32.37, 32.63 (CH_2); 48.15 (NCH); 50.52, 58.23 (CH); 119.63, 119.69, 123.81, 124.17, 124.33, 129.25, 129.93, 138.61, 139.06, 146.52, 147.05 (C_{arom}); 165.15, 65.73, 169.68 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 515 $[M + H]^+$ (3), 410 (5), 346 (2), 283 (30), 107 (100), 93 (44). Found, %: C 67.29; H 5.89; N 10.82. $C_{29}H_{30}N_4O_5$. Calculated, %: C 67.68; H 5.87; N 10.88. *M* 514.61.

***N*^{2}-(*tert*-Butyl)-*N*^{1},*N*^{1},2-tris(4-nitrophenyl)-1,1,2-ethanetricarboxamide (Vc).** Colorless crystals. Yield 0.468 g (81%), mp 267–268°C (decomp.). IR spectrum (KBr), ν, cm^{-1}: 3292 (NH); 1687, 1630 (C=O); 1508, 1348 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.10 s (9H, CMe$_3$), 4.39 d and 4.68 d (2H, CH, $^3J_{HH}$ = 11.25 Hz), 7.61 t.d and 8.24 t.d (12H, H_{arom}, $^3J_{HH}$ = 9 Hz), 8.02 s (1H, *t*-BuN**H**), 10.43 s and 10.59 s (2H, NH). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 28.64 (C**Me**$_3$); 50.74 (**C**Me$_3$); 51.23, 58.81 (CH); 119.73, 123.86, 125.33, 125.51, 129.93, 143.10, 143.18, 144.45, 145.05, 146.02, 147.12 (C_{arom}); 165.93, 166.35, 169.77 (C=O). Mass spectrum, *m*/*z* (I_{rel}, %): 579 $[M + H]^+$ (2), 384 (27), 277 (17), 220 (48), 176 (50), 138 (99), 57 (100). Found, %: C.73; H 4.55; N 14.23. $C_{27}H_{26}N_6O_9$. Calculated, %: C 56.04; H 4.52; N 14.52. *M*578.59.

***N*^{2}-Cyclohexyl-*N*^{1},*N*^{1},2-tris(4-nitrophenyl)-1,1,2-ethanetricarboxamide (Vd).** Colorless crystals. Yield 0.492 g (82%), mp 270–272°C (decomp.). IR spectrum (KBr), ν, cm^{-1}: 3345 (NH); 1688, 1661 (C=O); 1505, 1343 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 0.91–1.63 m (10H, CH_2), 3.39 m (1H, NCH), 4.45 d and 4.66 d (2H, CH, $^3J_{HH}$ = 11.2 Hz), 7.60–8.24 6 d (12H, H_{arom}, $^3J_{HH}$ = 8.9 Hz), 8.11 d (1H, CyN**H**, $^3J_{HH}$ = 8.8 Hz), 10.39 s and 10.62 s (2H, NH). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 24.71, 24.78, 25.55, 32.32, 32.59 (CH_2); 48.25 (NCH); 50.72, 58.63 (CH); 119.74, 123.89, 125.34, 125.52, 130.01, 143.13, 143.22, 144.40, 144.99, 145.77, 147.17 (C_{arom}); 165.86, 166.30, 169.37 (C=O). Mass spectrum, *m*/*z* (I_{rel}, %): 604 M^+ (2), 466 (21), 346 (21), 302 (54), 221 (55), 176 (41), 138 (100), 108 (97). Found, %: C 57.75; H 4.81; N 14.02. $C_{29}H_{28}N_6O_9$. Calculated, %: C 57.60; H 4.66; N 13.89. *M* 604.63.

***N*^{2}-*tert*-Butyl-*N*^{1},*N*^{1}-bis(4-methylphenyl)-2-(4-nitrophenyl)-1,1,2-ethanetricarboxamide (Ve).** Colorless crystals. Yield 0.440 g (85%), mp 316–317°C. IR spectrum (KBr), ν, cm^{-1}: 3260 (NH); 1688, 1672, 1637 (C=O); 1511, 1348 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.10 s (9H, CMe$_3$), 1.92 s and 2.01 s (6H, 2CH$_3$), 4.21 and 4.63 d (2H, CH, $^3J_{HH}$ = 8.2 Hz), 7.00–8.15 m (12H, H_{arom}), 7.95 s (1H, *t*-BuN**H**), 9.77 s (2H, NH). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 15.64, 20.91 (CH_3); 28.70 (C**Me**$_3$); 50.21 (**C**Me$_3$); 51.08, 58.42 (CH); 119.71, 123.75, 128.46, 128.51, 129.16, 129.55, 129.70, 129.88, 133.01, 133.21, 133.40, 133.46, 136.25, 136.67, 146.80, 147.07 (C_{arom}); 165.25, 165.67, 170.10 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 516 M^+ (15), 410 (19), 337 (23), 283 (88), 176 (24), 107 (100), 57 (79). Found, %: C 67.60; H 6.31; N 10.96. $C_{29}H_{32}N_4O_5$. Calculated, %: C 67.42; H 6.24; N 10.84. *M* 516.63.

***N*^{2}-Cyclohexyl-*N*^{1},*N*^{1}-bis(4-methylphenyl)-2-(4-nitrophenyl)-1,1,2-ethanetricarboxamide (Vf).** Colorless crystals. Yield 0.472 g (87%), mp 319–320°C (decomp.). IR spectrum (KBr), ν, cm^{-1}: 3420, 3255 (NH); 1686, 1664, 1642 (C=O); 1508, 1344 (NO_2). Mass spectrum, *m*/*z* (I_{rel}, %): 542 M^+ (15), 436 (39), 329 (55), 283 (20), 107 (100). Found, %: C 68.71; H 6.34; N 10.34. $C_{31}H_{34}N_4O_5$. Calculated, %: C.61; H 6.31; N 10.32. *M* 542.66. We failed to record ^{1}H and ^{13}C NMR spectra of **Vf** because of its poor solubility.

***N*^{2}-(*tert*-Butyl)-*N*^{1},*N*^{1}-bis(1-naphthyl)-2-(4-nitrophenyl)-1,1,2-ethanetricarboxamide (Vg)**. Pink crystals. Yield 0.488 g (83%), mp 290–291°C. IR spectrum (KBr), ν, cm^{-1}: 3270 (NH); 1674, 1658, 1634 (C=O); 1514, 1344 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.19 s (9H, CMe$_3$), 4.78 m (2H, CH, *AB* system, $^3J_{HH}$ = 11.45 Hz), 7.29–8.33 m (18H, H_{arom}), 8.05 s (1H, *t*-BuN**H**), 10.01 s and 10.06 s (2H, NH). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 28.80 (C**Me**$_3$); 50.73 (**C**Me$_3$); 51.52 and 57.64 (CH); 122.41,

122.52, 122.58, 123.18, 126.01, 126.14, 126.52, 126.59, 126.68, 128.29, 128.65, 128.71, 130.24, 133.13, 133.72, 134.08, 134.27, 146.93, 147.20 (C_{arom}); 166.65, 166.93, 170.22 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 588 M^+ (10), 345 (43), 221 (35), 176 (40), 144 (100), 57 (64). Found, %: C 71.13; H 5.36; N 9.43. $C_{35}H_{32}N_4O_5$. Calculated, %: C 71.40; H 5.47; N 9.51%. *M* 588.69.

***N*^{2}-Cyclohexyl-*N*^{1},*N*^{1}-bis(1-naphthyl)-2-(4-nitrophenyl)-1,1,2-ethanetricarboxamide (Vh).** Pink crystals. Yield 0.512 g (83%), mp 289–290°C. IR spectrum (KBr), ν, cm^{-1}: 3385, 3255 (NH); 1666, 1627 (C=O); 1514, 1345 (NO_2). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 0.97–1.74 m (10H, CH_2), 3.49 m (1H, NCH), 4.73 d and 4.89 d (2H, CH, $^3J_{HH}$ = 11.17 Hz), 7.40–8.29 m (18H, H_{arom}), 8.13 d (1H, CyN**H**, $^3J_{HH}$ = 7.6 Hz), 10.02 s and 10.09 s (2H, PhN**H**). ^{13}C NMR spectrum (DMSO-d_6), δ_C, ppm: 24.76, 24.83, 25.63, 32.43, 32.73 (CH_2); 48.27 (NCH); 51.09, 57.41 (CH); 122.30, 122.39, 122.56, 123.04, 123.96, 124.35, 125.99, 126.14, 126.47, 126.58, 126.67, 128.21, 128.47, 128.65, 128.75, 130.27, 133.65, 134.07, 134.26, 146.69, 147.22 (C_{arom}); 166.59, 166.86, 169.82 (CO). Mass spectrum, *m*/*z* (I_{rel}, %): 614 M^+ (5), 515 (3), 471 (17), 303 (20), 221 (25), 143 (100). Found, %: C 71.45; H 5.44; N 8.93. $C_{37}H_{34}N_4O_5$. Calculated, %: C 72.29; H 5.57; N 9.11. *M* 614.73.

The authors gratefully acknowledge financial support from the Research Council and Medicinal Plant Research Institute of the Shahid Beheshti University.

REFERENCES

1. Chen, B.-C., *Heterocycles*, 1991, vol. 32, p. 529.
2. McNab, H., *Chem. Soc. Rev.*, 1978, vol. 7, p. 345.
3. Stevenson, R. and Weber, J.V., *Heterocycles*, 1988, vol. 27, p. 1929.
4. Bitter, J., Leitich, J., Partale, H., Polansky, O.E., Riemer, W., Ritter-Thomas, U., Schlamann, B., and Stilkerieg, B., *Chem. Ber.*, 1980, vol. 113, p. 1020.
5. Tietze, L.F. and Kiedrowski, G.V., *Tetrahedron Lett.*, 1981, vol. 22, p. 219.
6. Takano, S., Satoh, S., and Ogasawara, K., *Heterocycles*, 1985, vol. 23, p. 41.
7. Shaabani, A. and Farrokhzad, F., *J. Chem. Res., Synop.*, 1997, p. 344.
8. Yavari, I., Shaabani, A., and Maghsoodlou, M.T., *Monatsh. Chem.*, 1997, vol. 128, p. 697.
9. Yavari, I., Shaabani, A., Asghari, S., Olmsted, M., and Safari, N., *J. Fluorine Chem.*, 1997, vol. 86, p. 77.
10. Shaabani, A., Ajabi, S., Farrokhzad, F., and Bijanzadeh, H.M., *J. Chem. Res., Synop.*, 1999, p. 582.
11. Shaabani, A., Yavari, I., Teimouri, M.B., Bazgir, A., and Bijanzadeh, H.M., *Tetrahedron*, 2001, vol. 57, p. 1375.
12. Shaabani, A. and Teimouri, M.B., *J. Chem. Res., Synop.*, 2002, p. 433.
13. Hiratani, K., US Patent no. 5071989, 1991.
14. Mohapatara, P.K., Sriram, S., and Badheka, L.P., *Sep. Sci. Technol.*, 2000, vol. 35, p. 39.
15. Chan Gabriel, Y.S., Drew, M.G.B., and Madic, C., *J. Chem. Soc., Dalton Trans.*, 1997, p. 649.
16. Iveson, P.B., Drew, M.G.B., and Madic, C., *J. Chem. Soc., Dalton Trans.*, 1999, p. 3605.
17. Hiratani, K. and Taguchi, K., *Chem. Lett.*, 1989, p. 2073.
18. Darling, C.M., US Patent no. 4537781, 1985.
19. Jursic, B.S., *Tetrahedron Lett.*, 2000, vol. 41, p. 5325.
20. Beckwith, A.L.J., *The Chemistry of Amides*, Zabicky, J., Ed., London: Intersci., 1970, p. 74.
21. Hedge, J.A., Kruse, C.W., and Snyder, H.R., *J. Org. Chem.*, 1961, vol. 26, p. 3166.
22. Bihlmayer, G.A., Derflinger, G., Derkosch, J., and Polansky, O.E., *Monatsh. Chem.*, 1967, vol. 98, p. 564.