

Condensation of (E)-5-Aryl-3-Arylmethylene-2-(3H)-Furanones with Different Amines

SHADIA M. ABDALLAH*, HANNA A. SAAD, HALIMA A. HEFNY,
HADIA H. YEHA and MERVAT H. ABDOU
*Chemistry Department, Faculty of Women for Arts, Science and Education
Ain Shams University, Heliopolis, Cairo, Egypt*

Condensation of (E)-2(3H)-furanones (1–8) with different amines gives the corresponding (E)-N-substituted-3-aryl-2-arylmethylene propionamides and 5-substituted amino-5-aryl-3-arylmethylene butyrolactones (9–36). The structures of compounds obtained were assigned in accordance with their elemental analysis, ¹H NMR, MS and FTIR.

Key Words: Condensation, (E)-5-Aryl-3-arylmethylene-2-(3H)-furanones, Amines.

INTRODUCTINO

γ -Butyrolactones (GBL) are used exclusively as chemical intermediates in the production of vitamins and pharmaceuticals as in the production of pesticides and herbicides^{1, 2}. So the aim of our work was to synthesize the derivatives of these important biological compounds.

Condensation of (E)-2(3H)-furanones (1–8) with *n*-butylamine gives the corresponding (E)-N-(*n*-butyl)3-aryl-2-arylmethylene propionamides (9–16), whereas the condensation of (E)-2(3H)-furanones (2–4, 6–8) with methylamine yields mixtures of the corresponding (E)-N-methyl-3-aryl-2-arylmethylene propionamides and 5-methyl-amino-5-aryl-3-arylmethylene-butylolactones [17–22 (a, b)] respectively. The condensation of the furanones with aniline and *p*-toluidine except furanones (7) yields mixtures of the corresponding (E)-N-substituted-3-aryl-2-arylmethylene propionamides and 5-substituted amino-5-aryl-3-arylmethylene-butylolactones [23–36(a,b)] respectively. Many trials for the condensation of furanones (7) with aniline and *p*-toluidine under different conditions were unsuccessful. The results obtained are ascribed to the electronic structure of the furanone and to the steric effect exerted by the alkyl group of the amine. A mechanism is proposed in which propionamides are formed (9–16, 17a–36a). Propionamides (17a–36a) undergo thermal transformation to form the corresponding butylolactones (17b–36b).

EXPERIMENTAL

Condensation of (E)-2(3H)-Furanones with Amines

General Procedure: A mixture of (E)-2(3H)-furanones (1–8)^{3–8} (1 mmol) and amine (2 mmol) in 40 mL of the suitable solvent was refluxed for 4 h. After cooling the reaction mixtures, working out and crystallization from the appropriate solvent, the products (9–36) were obtained. Accomplishment of the reaction was assured by monitoring the products using TLC technique. The structures of the compounds (9–36) are confirmed by their elemental analysis (Table-1), ¹H NMR, MS and FTIR.

TABLE-1
ELEMENTAL ANALYSIS FOR COMPOUNDS 9-36

Compound	m.f. (Colour)	m.p.* (°C)	Yield (%)	Found (Calcd.)		
				C	H	N
9	C ₂₁ H ₂₃ NO ₂ (White)	171	66	78.39 (78.40)	7.09 (7.16)	4.30 (4.36)
10	C ₂₂ H ₂₅ NO ₂ (White)	150	71	77.95 (78.70)	7.39 (7.45)	4.14 (4.17)
11	C ₂₂ H ₂₅ NO ₃ (Yellow)	142	49	75.08 (75.11)	7.05 (7.11)	3.94 (3.98)
12	C ₂₁ H ₂₂ NO ₂ Cl (White)	146	92	70.76 (70.82)	6.09 (6.18)	3.90 (3.93)
13	C ₂₂ H ₂₅ NO ₃ (White)	176	49	74.98 (75.11)	6.90 (7.11)	3.94 (3.98)
14	C ₂₃ H ₂₇ NO ₃ (Yellow)	121	63	75.50 (75.53)	7.34 (7.93)	3.80 (3.83)
15	C ₂₃ H ₂₇ NO ₄ (Pale yellow)	120	51	72.29 (72.36)	7.03 (7.08)	3.61 (3.67)
16	C ₂₂ H ₂₄ NO ₃ Cl (Pale brown)	151	53	68.37 (68.41)	6.19 (6.22)	3.58 (3.63)
17 (a, b)	C ₁₉ H ₁₉ NO ₂ (Pale brown)	129-35	86	77.69 (77.74)	6.42 (6.48)	4.71 (4.77)
18 (a, b)	C ₂₂ H ₂₅ NO ₃ (Brown)	105-10	54	73.66 (73.71)	6.09 (6.14)	4.50 (4.53)
19 (a, b)	C ₁₈ H ₁₆ NO ₂ Cl (Brown)	105-10	90	68.85 (68.89)	5.40 (5.11)	4.41 (4.47)
20 (a, b)	C ₂₀ H ₂₁ NO ₃ (Pale brown)	158-63	78	74.15 (74.23)	6.40 (6.50)	4.29 (4.33)
21 (a, b)	C ₂₀ H ₂₁ NO ₄ (Brown)	112-18	85	70.71 (70.73)	6.15 (6.19)	4.10 (4.15)
22 (a, b)	C ₁₉ H ₁₈ NO ₂ Cl (Brown)	139-44	92	66.11 (66.32)	5.10 (5.24)	4.11 (4.08)
23 (a, b)	C ₂₃ H ₁₉ NO ₂ (Pale yellow)	139-45	59	80.78 (80.84)	5.48 (5.56)	4.08 (4.10)
24 (a, b)	C ₂₄ H ₂₁ NO ₂ (Pale brown)	110-16	70	81.00 (81.03)	5.92 (5.91)	3.90 (3.93)
25 (a, b)	C ₂₄ H ₂₁ NO ₃ (Brown)	110-15	64	77.49 (77.54)	5.60 (5.64)	3.71 (3.76)
26 (a, b)	C ₂₃ H ₁₈ NO ₂ Cl (Brown)	125-30	57	73.39 (73.44)	4.80 (4.79)	3.68 (3.73)
27 (a, b)	C ₂₄ H ₂₁ NO ₃ (Yellow)	162-68	54	77.49 (77.54)	5.60 (5.65)	3.71 (3.76)
28 (a, b)	C ₂₅ H ₂₃ NO ₃ (Pale brown)	150-55	66	77.79 (77.84)	5.91 (5.97)	3.60 (3.63)

Compound	m.f. (Colour)	m.p.* (°C)	Yield (%)	Found (Calcd.)		
				C	H	N
29 (a, b)	C ₂₄ H ₂₀ NO ₃ Cl (Brown)	106–11	77	70.90 (70.95)	4.88 (4.88)	3.41 (3.45)
30 (a, b)	C ₂₄ H ₂₁ NO ₂ (Yellow)	178–83	56	80.91 (81.02)	5.86 (5.91)	3.90 (3.94)
31 (a, b)	C ₂₅ H ₂₃ NO ₂ (Brown)	80–85	80	81.18 (81.20)	6.19 (6.23)	3.74 (3.79)
32 (a, b)	C ₂₅ H ₂₃ NO ₃ (Brown)	105–10	75	77.82 (77.80)	5.91 (5.97)	3.60 (3.63)
33 (a, b)	C ₂₄ H ₂₀ NO ₂ Cl (Pale brown)	138–42	69	73.50 (73.87)	5.07 (5.13)	3.51 (3.59)
34 (a, b)	C ₂₅ H ₂₃ NO ₃ (Brown)	160–65	77	77.72 (77.80)	5.91 (5.97)	3.60 (3.63)
35 (a, b)	C ₂₆ H ₂₅ NO ₃ (Orange)	130–35	56	77.95 (78.11)	6.15 (6.26)	3.45 (3.50)
36 (a, b)	C ₂₅ H ₂₂ NO ₃ Cl (Pale brown)	130–35	76	71.50 (71.45)	5.46 (5.24)	3.30 (3.33)

*From benzene-petroleum ether (b.p. 40–60).

RESULTS AND DISCUSSION

Condensation of (E)-2(3H)-Furanones (1–8) with Aliphatic Amines

(a) Condensation of the furanones (1–8) with *n*-butylamine

N-(2-Butyl)-3-benzoyl-2-phenylmethylene propionamide (9): FTIR (KBr): 3346 ν (NH), 1668 ν (benzoyl, C=O) and 1638 cm^{-1} ν (amide, C=O). ¹H NMR (DMSO-*d*₆): δ = 7.30–7.38 (5H, m; H-1), 7.28 (1H, s; H-2), 3.3 (2H, d; H-3), 7.40–7.53, (5H, m; H-4), 6.702 (1H, s; H-5), 2.70–2.90 (2H, m; H-6), 1.20–1.40 (2H, m; H-7), 1.10–1.20 (2H, six; H-8) and 0.756 (3H, t; H-9). MS: m/z = 321 (M^+ , 22%, C₂₁H₂₃NO₂), 303 (22, C₂₁H₂₁NO), 261 (9, C₁₈H₁₅NO), 249 (26, C₁₇H₁₅NO), 202 (18, C₁₃H₁₆NO), 116 (100, C₉H₈), and 105 (17, C₇H₅O).

N-(*n*-Butyl)-3-(4-methylbenzoyl)-2-phenylmethylene propionamide (10): FTIR (KBr): 3257 ν (NH), 1680 ν (aroyl, C=O) and 1643 cm^{-1} ν (amide, C=O). ¹H NMR (DMSO-*d*₆): δ = 7.24–7.40 [(5H, m; H-1) and (1H, imp; H-2)], 3.27–3.35 (2H, d; H-3), 7.50–7.52, (2H, d; H-4), 7.16–7.18 (2H, d; H-5), 2.28 (3H, s; H-6), 6.63 (1H, s; H-7), 2.70–2.85 (2H, m; H-8), 1.20–1.52 (2H, m; H-9), 1.14 (2H, six; H-10) and 0.75–0.79 (3H, t; H-11). MS: m/z = 335 (M^+ , 9%, C₂₂H₂₅NO₂), 317 (6, C₂₂H₂₃NO), 275 (3, C₁₉H₁₇NO), 262 (2.5, C₁₈H₁₃O₂), 119 (100, C₈H₇O), 116 (19, C₉H₈) and 91 (24, C₇H₇).

N-(*n*-Butyl)-3-(4-methoxybenzoyl)-2-phenylmethylene propionamide (11): FTIR (KBr): 3327 ν (NH), 1668 ν (aroyl, C=O) and 1638 cm^{-1} ν (amide, C=O). ¹H NMR (DMSO-*d*₆): δ = 7.27–7.36 [(5H, m; H-1), 7.36–7.38 (1H, imp; H-2), 3.28–3.33, (2H, d; H-3), 7.50–7.53 (2H, d; H-4), 6.90–6.93 (2H, d; H-5), 3.74 (3H, s; H-6), 6.60 (1H, s; H-7), 2.70–2.90 (2H, m; H-8), 1.20–1.40 (2H, m;

H-9), 1.14–1.17 (2H, 6; H-10) and 0.75–0.80 (3H, t; H-11). MS: $m/z = 351$ (M^+ , 8.6%, $C_{22}H_{25}NO_3$), 333 (10, $C_{22}H_{23}NO_2$), 278 (4.5, $C_{18}H_{14}O_3$), 202 (2, $C_{13}H_{10}NO$), 135 (100, $C_8H_7O_2$), 116 (10, C_9H_8) and 107 (6, C_7H_7O).

N-(*n*-Butyl)-3-(4-chlorobenzoyl)-2-phenylmethylene propionamide (12): FTIR (KBr): 3266 ν (NH), 1681 ν (aroyl, C=O) and 1645 cm^{-1} ν (amide, C=O). 1H NMR (DMSO- d_6): $\delta = 7.28$ – 7.36 (5H, m; H-1), 7.40–7.42 (1H, s; H-2), 3.26–3.40 (2H, imp; H-3), 7.51–7.53 (2H, d; H-4), 7.80–7.85 (2H, d; H-5), 7.25 (1H, s; H-6), 2.75–2.85 (2H, m; H-7), 1.20–1.45 (2H, 6; H-9) and 0.75–0.79 (3H, t; H-10), MS: $m/z = 355.8$ (M^+ , 79%, $C_{21}H_{22}NO_2Cl$), 337 (51, $C_{21}H_{20}NOCl$), 295 (28, $C_{18}H_{14}NOCl$), 282 (26, $C_{17}H_{11}O_2Cl$), 202 (25, $C_{13}H_{16}NO$), 153 (5.6, C_8H_6OCl) and 116 (100, C_9H_8).

N-(*n*-Butyl)-3-benzoyl-2-(4-methoxyphenylmethylene)propionamide (13): FTIR (KBr): 3284 ν (NH), 1674 ν (benzoyl, C=O) and 1636 cm^{-1} ν (amide, C=O). 1H NMR (DMSO- d_6): $\delta = 3.77$ (3H, s; H-1), 6.95–6.98 (2H, d; H-2), 7.46–7.49, (2H, d; H-3), 7.23 (1H, s; H-4), 3.33 (2H, d; H-5), 7.37–7.38 (5H, m; H-6), 6.63 (1H, s; H-7), 2.70–2.80 (2H, m; H-8), 1.20–1.40 (2H, m; H-9), 1.13–1.15 (2H, 6; H-10) and 0.73–0.78 (3H, t; H-11). MS: $m/z = 351.4$ (M^+ , 24%, $C_{22}H_{25}NO_3$), 333 (27, $C_{22}H_{23}NO_2$), 291 (6.5, $C_{19}H_{17}NO_2$), 277 (5.3, $C_{18}H_{15}NO_2$), 232 (2, $C_{14}H_{18}NO_2$), 146 (100, $C_{10}H_{10}O$), 119 (3, C_8H_7O) and 105 (82, C_7H_5O).

N-(*n*-Butyl)-3-(4-methylbenzoyl)-2-(4-methoxyphenylmethylene)propionamide (14): FTIR (KBr): 3292 ν (NH), 1677 ν (aroyl, C=O) and 1642 cm^{-1} ν (amide, C=O). 1H NMR (DMSO- d_6): $\delta = 3.77$ (3H, s; H-1), 6.94–6.97 (2H, d; H-2), 7.24–7.27, (2H, d; H-3), 7.22 (1H, s; H-4), 3.29–3.31 (2H, d; H-5), 7.44–7.47 (2H, d; H-6), 7.15–7.18 (2H, d; H-7), 2.28 (3H, s; H-8), 6.58 (1H, s; H-9), 2.70–2.90 (2H, m; H-10) 1.20–1.40 (2H, m; H-11), 1.15–1.20 (2H, 6; H-12) and 0.74–0.79 (3H, t; H-13). MS: $m/z = 365.4$ (M^+ , 7%, $C_{23}H_{27}NO_3$), 347 (17, $C_{23}H_{25}NO_2$), 305 (3.4, $C_{20}H_{19}NO_2$), 292 (5, $C_{19}H_{16}O_3$), 232 (2.2, $C_{14}H_{18}NO_2$), 146 (22, $C_{10}H_{10}O$) 119 (100, C_8H_7O) and 91 (18, C_7H_7).

N-(*n*-Butyl)-3-(4-methoxybenzoyl)-2-(4-methoxyphenylmethylene)propionamide (15): FTIR (KBr): 3450 ν (NH), 1685 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O). 1H NMR (DMSO- d_6): $\delta = 7.75$ (3H, s; H-1), 6.91–6.94 (2H, d; H-2)], 7.29–7.31, (2H, d; H-3), 7.22 (1H, s; H-4), 3.30–3.35 (2H, imp; H-5), 7.46–7.48 (2H, d; H-6), 6.96–6.99 (2H, d; H-7), 3.783 (3H, s; H-8), 6.85 (1H, imp; H-9), 2.70–2.90 (2H, m; H-10) 1.20–1.40 (2H, m; H-11), 1.12–1.17 (2H, 6; H-12) and 0.76–0.80 (3H, t; H-13). MS: $m/z = 381$ (M^+ , 0%, $C_{23}H_{27}NO_4$), 363 (11, $C_{23}H_{25}NO_3$), 202 (2.3, $C_{13}H_{16}NO$), 149 (20, $C_9H_9O_2$), 135 (58, $C_8H_7O_2$), 107 (12, C_7H_7O) and 55 (100, C_3H_5O).

N-(*n*-Butyl)-3-(4-chlorobenzoyl)-2-(4-methoxyphenylmethylene)propionamide (16): FTIR (KBr): 3270 ν (NH), 1678 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O). 1H NMR (DMSO- d_6): $\delta = 3.773$ (3H, s; H-1), 6.93–6.98 (2H, d; H-2), 7.40–7.42, [(2H, d; H-3) and (2H, d; H-6)], 7.23 (1H, s; H-4), 3.27–3.32 (2H, d; H-5), 7.46–7.49 (2H, d; H-7), 6.78 (1H, d; H-8), 2.70–2.90 (2H, m; H-9), 1.20–1.40 (2H, m; H-10), 1.10–1.20 (2H, 6; H-11) and 0.74–0.79 (3H, t; H-12), MS: $m/z = 386$ (M^+ , 24%, $C_{22}H_{24}NO_3Cl$), 367 (100, $C_{22}H_{22}NO_2Cl$), 325 (17,

C₁₉H₁₆NO₂Cl), 312 (25, C₁₈H₁₃O₃Cl), 202 (10, C₁₃H₁₆NO), 154 (3.4, C₈H₇OCl) and 146 (90, C₁₀H₁₀O).

(b) Condensation of (E)-2(3H)-furanones (2–4 and 6–8) with methylamine

N-Methyl-3-(4-methylbenzoyl)-2-phenylmethylene propionamide (17a) and 5-methylamino-5-(4-methylphenyl)-3-phenylmethylene butyrolactone (17b): FTIR (KBr): 3400–3250 v(NH), 1750 v(butyrolactone, C=O), 1682 cm⁻¹ v(aroyl, C=O). and 1650 cm⁻¹ v(amide, C=O) ¹H NMR (DMSO-d₆): δ = 7.19–7.61 (5H, m; H-1a and H-1b), 7.26–7.28 (1H, s; H-2a and H-2b), 3.40 (2H, imp; H-3a and H-3b), 7.71–7.83 (2H, d; H-4a and H-4b), 6.88–7.18 (2H, d; H-5a and H-5b), 2.29–2.34 (3H, s; H-6a and H-6b), 6.43 (1H, s; H-7a), 7.2–7.8 (1H, imp; H-7b) and 2.78–2.80 (3H, s; H-8a and H-8b). MS: m/z = 293 (M⁺, 4.5%, C₁₉H₁₉NO₂), 275 (46, C₁₉H₁₇NO), 203 (8, C₁₂H₁₃NO₂), 133 (15, C₉H₉O), 126 (7, C₆H₈NO₂), 119 (97, C₈H₇O), 116 (13, C₉H₈) and 91 (100 C₇H₇).

N-Methyl-3-(4-methoxybenzoyl)-2-phenylmethylene propionamide (18a) and 5-methylamino-5-(4-methoxyphenyl)-3-phenylmethylene butyrolactone (18b): FTIR (KBr): 3300–3180 v(NH), 1750 v(butyrolactone, C=O), 1698 v(aroyl, C=O) and 1650 cm⁻¹ v(amide, C=O). ¹H NMR (DMSO-d₆): δ = 7.24–7.42 (5H, m; H-1a and H-1b), 7.24–7.35 (1H, s; H-2a and H-2b), 3.22–3.23 (2H, s; H-3a and H-3b), 7.48–7.60 (2H, d; H-4a and H-4b), 6.94–6.97 (2H, d; H-5a and H-5b), 3.77 (3H, s; H-6a and H-6b), 6.66 (1H, s; H-7a), 7.24–7.60 (1H, imp; H-7b) and 2.58–2.59 (3H, s; H-8a and H-8b). MS: m/z = 309 (M⁺, 9%, C₁₉H₁₉NO₃), 292 (13, C₁₉H₁₈NO₂), 202 (11, C₁₂H₁₂NO₂), 149 (11, C₉H₉O₂), 135 (40, C₈H₇O₂), 119 (13, C₈H₇O), 115 (31, C₉H₇) and 107 (12 C₇H₇O).

N-Methyl-3-(4-chlorobenzoyl)-2-phenylmethylene propionamide (19a) and 5-methylamino-5-(4-chlorophenyl)-3-phenylmethylene butyrolactone (19b): FTIR (KBr): 3370–3250 v(broad NH), 1750 v(butyrolactone, C=O), 1697 v(aroyl, C=O) and 1650 cm⁻¹ v(amide, C=O). ¹H NMR (DMSO-d₆): δ = 7.40–7.69 (5H, m; H-1a and H-1b), 7.54 (1H, s; H-2a and H-2b), 3.40 (2H, imp; H-3a and H-3b), 7.45–7.51 (2H, d; H-4a and H-4b), 7.95–7.99 (2H, d; H-5a and H-5b), 6.56 (1H, broad; H-6a), 7.95 (1H, broad; H-6b) and 2.80 (3H, s; H-7a and H-7b). MS: m/z = 313 (M⁺, 6%, C₁₈H₁₆NO₂Cl), 296 (50, C₁₈H₁₅NO), 284 (82, C₁₇H₁₃O₂Cl), 255 (39, C₁₆H₁₂OCl), 236 (26, C₁₂H₁₁NO₂Cl), 173 (37, C₁₁H₉O₂), 139 (100, C₇H₄OCl) and 116 (6, C₉H₈).

N-Methyl-3-(4-methylbenzoyl)-2-(4-methoxyphenylmethylene) propionamide (20a) and 5-methylamino-5-(4-methylphenyl)-3-(4-methoxyphenylmethylene) butyrolactone (20b): FTIR (KBr): 3313 v(NH), 1750 v(butyrolactone, C=O), 1680 v(aroyl, C=O) and 1643 cm⁻¹ v(amide, C=O). ¹H NMR (DMSO-d₆): δ = 3.75–3.77 (3H, s; H-1a and H-1b), 6.94–6.97 (2H, d; H-2a and H-2b), 7.31–7.34 (2H, d; H-3a and H-3b), 7.10–7.22 (1H, s; H-4a and H-4b), 3.30 (2H, imp; H-5a and H-5b), 7.44–7.47 (2H, d; H-6a and H-6b), 7.71–7.20 (2H, d; H-7a and H-7b), 2.29 (3H, s; H-8), 6.60 (1H, s; H-9a), 7.15–7.25 (1H, imp; H-9b) and 2.57 (3H, s; H-10a and H-10b). MS: m/z = 323 (M⁺, 2.6%, C₂₀H₂₁NO₃), 305 (100, C₂₀H₁₉NO₂), 292 (3.3, C₁₉H₁₆O₃), 290 (40, C₁₉H₁₆NO₂), 233 (2, C₁₃H₁₅NO₂), 145 (10, C₁₀H₉O), 119 (22, C₈H₇O) and 107 (1.1, C₇H₇O).

N-Methyl-3-(4-methylbenzoyl)-2-(4-methoxyphenylmethylene propionamide (21a) and 5-methylamino-5-(4-methylphenyl)-3-(4-methoxyphenylmethylene)-butyrolactone (21b): FTIR (KBr): 3293 ν (NH), 1750 ν (butyrolactone, C=O), 1680 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.76–3.84 (3H, s; H-1a and H-1b), 6.90–7.20 (2H, d; H-2a and H-2b), 7.20–7.40 [(2H, d; H-3a and H-3b) and (1H, s; H-4a and H-4b)], 3.25–3.36 (2H, s; H-5a and H-5b), 7.50–7.70 (2H, d; H-6a and H-6b), 6.90–7.20 (2H, d; H-7a and H-7b), 3.79–3.88 (1H, s; H-8a and H-8b), 6.60 (1H, s; H-9a), 7.80 (1H, s; H-9b) and 2.59 (3H, s; H-10a and H-10b). MS: m/z = 339 (M^+ , 0%, $\text{C}_{20}\text{H}_{21}\text{NO}_4$), 321 (100, $\text{C}_{20}\text{H}_{19}\text{NO}_3$), 307 (47, $\text{C}_{19}\text{H}_{19}\text{NO}_3$), 290 (8, $\text{C}_{19}\text{H}_{17}\text{NO}_2$), 233 (30, $\text{C}_{13}\text{H}_{15}\text{O}_3$), 184 (12, $\text{C}_{12}\text{H}_{10}\text{NO}$), 149 (16, $\text{C}_9\text{H}_9\text{O}_2$) and 107 (6 $\text{C}_7\text{H}_7\text{O}$).

N-Methyl-3-(4-chlorobenzoyl)-2-(4-methoxyphenylmethylene propionamide (22a) and 5-methylamino-5-(4-chlorophenyl)-3-(4-methoxyphenylmethylene)-butyrolactone (22b): FTIR (KBr): 3400–3200 ν (broad NH), 1753 ν (butyrolactone, C=O), 1680 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.73–3.82 (3H, s; H-1a and H-1b), 6.95–7.03 (3H, d; H-2a and H-2b), 7.43–7.51 (2H, d; H-3a and H-3b), 7.54–7.58 (1H, imp; H-4a and H-4b), 3.11 (2H, s; H-5a and H-5b), 7.67–7.70 (2H, d; H-6a and H-6b), 7.77–7.91 (2H, d; H-7a and H-7b), 6.55 (1H, s; H-8a), 7.30 (1H, s; H-8b), and 2.80 (3H, s; H-9b and H-9b). MS: m/z = 343.8 (M^+ , 0%, $\text{C}_{19}\text{H}_{18}\text{O}_3\text{NCl}$), 231 (1.4, $\text{C}_{13}\text{H}_{13}\text{NO}_3$), 190 (1.1, $\text{C}_{11}\text{H}_{12}\text{NO}_2$), 153 (1.6, $\text{C}_8\text{H}_6\text{OCl}$), 145 (1.7, $\text{C}_{10}\text{H}_9\text{O}$), 139 (7, $\text{C}_7\text{H}_4\text{OCl}$), 111 (10, $\text{C}_6\text{H}_4\text{Cl}$) and 69 (100, $\text{C}_3\text{H}_3\text{NO}$).

Condensation of (E)-2(3H)-Furanones (1–6, 8) with Aromatic Amines

(a) Condensation of (E)-2(3H) furanones (1–6, 8) with aniline

N-Phenyl-3-benzoyl-2-phenylmethylene propionamide (23a) and 5-phenylamino-5-phenyl-3-phenylmethylene-butylolactone (23b): FTIR (KBr): 3340–3320 ν (NH), 1768 ν (butyrolactone, C=O), 1691 ν (benzoyl, C=O) and 1649 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 6.97–7.19 (5H, m; H-1a and H-1b), 7.49 (1H, imp; H-2a and H-2b), 3.46–3.47 (2H, s; H-3a and H-3b), 7.22–7.36 (5H, m; H-4a and H-4b), 6.82 (1H, s; H-5a), 7.79 (1H, imp; H-5b), and 7.36–7.60 (5H, m; H-6a and H-6b). MS: m/z = 341 (M^+ , 3.4%, $\text{C}_{23}\text{H}_{19}\text{NO}_2$), 264 (22, $\text{C}_{17}\text{H}_{14}\text{NO}_2$), 249 (29, $\text{C}_{17}\text{H}_{13}\text{O}_2$), 249 (21, $\text{C}_{17}\text{H}_{12}\text{O}_2$), 115 (17, C_9H_7), 105 (100, $\text{C}_7\text{H}_5\text{O}$) and 102 (48, C_8H_6).

N-Phenyl-3-(4-methylbenzoyl)-2-phenylmethylene propionamide (24a) and 5-phenylamino-5-(4-methylphenyl)-3-phenylmethylene-butylolactone (24b): FTIR (KBr): 3296 ν (NH), 1765 ν (butyrolactone, C=O), 1681 ν (aroyl, C=O) and 1644 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.17–7.28 (5H, m; H-1a and H-1b), 7.32–7.34 (1H, s; H-2a and H-2b), 3.3–3.5 (2H, imp; H-3a and H-3b), 7.56–7.60 (2H, d; H-4a and H-4b), 7.49–7.72 (2H, d; H-5a and H-5b), 2.22–2.27 (3H, s; H-6a and H-6b), 6.77 (1H, s; H-7a), 7.6–8.0 (1H, imp; H-7b) and 7.37–7.50 (5H, m; H-8a and H-8b). MS: m/z = 355 (M^+ , 5%, $\text{C}_{24}\text{H}_{21}\text{NO}_2$), 263 (5, $\text{C}_{17}\text{H}_{13}\text{NO}_2$), 235 (5, $\text{C}_{17}\text{H}_{15}\text{O}$), 222 (2.3, $\text{C}_{15}\text{H}_{12}\text{NO}$), 120 (6, $\text{C}_7\text{H}_6\text{NO}$), 119 (18, $\text{C}_8\text{H}_7\text{O}$), 93 (100, $\text{C}_6\text{H}_7\text{N}$) and 91 (21, C_7H_7).

N-Phenyl-3-(4-methylbenzoyl)-2-phenylmethylene propionamide (25a)

and **5-phenylamino-5-(4-methylphenyl)-3-phenylmethylene-butyrolactone (25b)**: FTIR (KBr): 3293 ν (NH), 1757 ν (butyrolactone, C=O), 1676 ν (aroyl, C=O) and 1641 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.02–7.18 (5H, m; H-1a and H-1b), 7.23–7.27 (1H, t; H-2a and H-2b), 3.46 (2H, s; H-3a and H-3b), 7.59–7.62 [(2H, d; H-4a and H-4b) and (1H, imp; H-7b)], 6.80–6.85 [(2H, d; H-5a and H-5b) and (1H, s; H-7a)], 3.70–3.76 (3H, s; H-6a and H-6b) and 7.36–7.48 (5H, m; H-8a and H-8b). MS: m/z = 371 (M^+ , 23%, $\text{C}_{24}\text{H}_{21}\text{NO}_3$), 278 (31, $\text{C}_{18}\text{H}_{14}\text{O}_3$), 263 (31, $\text{C}_{17}\text{H}_{13}\text{NO}_2$), 222 (15, $\text{C}_{15}\text{H}_{12}\text{NO}$), 119 (32, $\text{C}_8\text{H}_7\text{O}_2$), 105 (10, $\text{C}_7\text{H}_5\text{O}$) and 76 (100, C_6H_4).

N-Phenyl-3-(4-chlorobenzoyl)-2-phenylmethylene propionamide (26a) and 5-phenylamino-5-(4-chlorophenyl)-3-phenylmethylene-butyrolactone (26b): FTIR (KBr): 3350–3200 ν (NH), 1760 ν (butyrolactone, C=O), 1680 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.25–7.40 (5H, m; H-1a and H-1b), 7.47–7.61 (1H, imp; H-2a and H-2b), 3.4–3.45 (2H, imp; H-3a and H-3b), 7.71–7.74 (2H, d; H-4a and H-4b), 7.91–7.94 (2H, d, H-5a and H-5b), 6.88 (1H, broad; H-6a), 7.91–7.94 (1H, imp; H-6b) and 7.44–7.61 (5H, m; H-7a and H-7b). MS: m/z = 375 (M^+ , 0%, $\text{C}_{23}\text{H}_{18}\text{NO}_2\text{Cl}$), 357 (7, $\text{C}_{23}\text{H}_{16}\text{NOCl}$), 283 (36, $\text{C}_{17}\text{H}_{12}\text{O}_2\text{Cl}$), 264 (2, $\text{C}_{17}\text{H}_{14}\text{NO}_2$), 139 (100, $\text{C}_7\text{H}_4\text{OCl}$), 115 (9, C_9H_7) and 111 (42, $\text{C}_6\text{H}_4\text{Cl}$).

N-Phenyl-3-benzoyl-2-(4-methoxyphenylmethylene) propionamide (27a) and 5-phenylamino-5-phenyl-3-(4-methoxyphenylmethylene)-butyrolactone (27b): FTIR (KBr): 3350–3200 ν (broad NH), 1768 ν (butyrolactone, C=O), 1691 ν (benzoyl, C=O) and 1625 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.84–3.86 (3H, s; H-1a and H-1b), 6.98–7.13 (2H, d; H-2a and H-2b), 7.47–7.583 (2H, d; H-3a and H-3b), 7.27–7.29 (1H, s; H-4a and H-4b), 3.32–3.43 (2H, imp; H-5a and H-5b), 7.34–7.42 (5H, m; H-6a and H-6b), 6.80 (1H, s; H-7a), 7.62 (1H, s; H-7b) and 7.85–7.97 (5H, m; H-8a and H-8b). MS: m/z = 371.4 (M^+ , 0%, $\text{C}_{24}\text{H}_{21}\text{NO}_3$), 293 (3, $\text{C}_{18}\text{H}_{15}\text{NO}_3$), 279 (3, $\text{C}_{18}\text{H}_{15}\text{O}_3$), 278 (41, $\text{C}_{18}\text{H}_{14}\text{O}_3$), 145 (7, $\text{C}_{10}\text{H}_9\text{O}$), 107 (4, $\text{C}_7\text{H}_7\text{O}$), 105 (33, $\text{C}_7\text{H}_6\text{O}$), 93 (13, $\text{C}_6\text{H}_7\text{N}$) and 77 (100, C_6H_5).

N-Phenyl-3-(4-methylbenzoyl)-2-(4-methoxyphenylmethylene) propionamide (28a) and 5-phenylamino-5-(4-methylphenyl)-3-(4-methoxyphenylmethylene)-butyrolactone (28b): FTIR (KBr): 3350–3250 ν (broad NH), 1768 ν (butyrolactone, C=O), 1691 ν (aroyl C=O) and 1625 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.81–3.83 (3H, s; H-1a and H-1b), 6.51–6.75 (2H, d; H-2a and H-2b), 7.36–7.41 (2H, d; H-3a and H-3b), 7.20–7.29 (1H, s; H-4a and H-4b), 3.32–3.45 (2H, imp; H-5a and H-5b), 7.84–7.90 (2H, d; H-6a and H-6b), 7.32–7.36 (2H, d; H-7a and H-7b), 2.26–2.37 (3H, s; H-8a and H-8b), 6.71 (1H, s; H-9a), 7.84–7.86 (1H, imp; H-9b), 7.70–7.80 (5H, m; H-10a and H-10b). MS: m/z = 385.4 (M^+ , 7%, $\text{C}_{25}\text{H}_{23}\text{NO}_3$), 292 (7, $\text{C}_{19}\text{H}_{16}\text{O}_3$), 263 (6, $\text{C}_{17}\text{H}_{13}\text{NO}_2$), 145 (8, $\text{C}_{10}\text{H}_9\text{O}$), 133 (8, $\text{C}_9\text{H}_9\text{O}$), 119 (21, $\text{C}_8\text{H}_7\text{O}$), 107 (12, $\text{C}_7\text{H}_7\text{O}$), 91 (46, C_7H_7) and 65 (100, C_5H_5).

N-Phenyl-3-(4-chlorobenzoyl)-2-(4-methoxyphenylmethylene) propionamide (29a) and 5-phenylamino-5-(4-chlorophenyl)-3-(4-methoxyphenylmethylene)-butyrolactone (29b): FTIR (KBr): 3450–3300 ν (broad NH), 1770 ν (butyrolactone, C=O), 1680 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O).

^1H NMR (DMSO- d_6): δ = 3.82–3.85 (3H, s; H-1a and H-1b), 6.97–7.13 (2H, d; H-2a and H-2b), 7.42–7.50 (2H, d; H-3a and H-3b), 7.33–7.39 (1H, s; H-4a and H-4b), 3.30–3.40 (2H, imp; H-5a and H-5b), 7.55–7.72 (2H, d; H-6a and H-6b), 7.93–8.10 (2H, d; H-7a and H-7b), 6.86 (1H, s; H-8a), 7.93–8.00 (1H, imp; H-8b) and 7.72–7.90 (5H, m; H-9a and H-9b). MS: m/z = 406 (M^+ , 8%, $\text{C}_{24}\text{H}_{20}\text{NO}_3\text{Cl}$), 375 (8, $\text{C}_{23}\text{H}_{18}\text{NO}_2\text{Cl}$), 282 (6, $\text{C}_{17}\text{H}_{12}\text{O}_2\text{Cl}$), 253 (7, $\text{C}_{16}\text{H}_{14}\text{NO}_2$), 153 (9, $\text{C}_8\text{H}_6\text{OCl}$), 145 (9, $\text{C}_{10}\text{H}_9\text{O}$), 139 (20, $\text{C}_7\text{H}_4\text{OCl}$), 111 (29, $\text{C}_6\text{H}_5\text{Cl}$) and 65 (100, C_5H_5).

(b) Condensation of (E)-2(3H)-furanones (1–6, 8) with *p*-toluidine

N-(4-Methylphenyl)-3-benzoyl-2-phenylmethylene propionamide (30a) and 5-(4-methylphenylamino)-5-phenyl-3-phenylmethylene butyrolactone (30b): FTIR (KBr): 3300 ν (NH), 1760 ν (butyrolactone, C=O), 1680 ν (benzoyl, C=O) and 1640 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.17–7.27 (5H, m; H-1a and H-1b), 7.25–7.30 (1H, s; H-2a and H-2b), 3.46 (2H, s; H-3a and H-3b), 7.39–7.45 (5H, m; H-4a and H-4b), 7.02–7.03 [(1H, imp, H-5a) and (2H, d; H-7a and H-7b)], 7.58–7.60 [(1H, imp; H-5b), and (2H, d; H-6a and H-6b)] and 2.21 (3H, s; H-8a and H-8b). MS: m/z = 355 (M^+ , 3%, $\text{C}_{24}\text{H}_{21}\text{NO}_2$), 337 (65, $\text{C}_{24}\text{H}_{19}\text{NO}$), 277 (15, $\text{C}_{18}\text{H}_{15}\text{NO}_2$), 249 (20, $\text{C}_{17}\text{H}_{13}\text{O}_2$), 116 (17, C_9H_8), 105 (100, $\text{C}_7\text{H}_5\text{O}$), 91 (62, C_7H_7) and 65 (44, C_5H_5).

N-(4-Methylphenyl)-3-(4-methylbenzoyl)-2-phenylmethylene propionamide (31a) and 5-(4-methylphenylamino)-5-(4-methylphenyl)-3-phenylmethylene-butyrolactone (31b): FTIR (KBr): 3360–3250 ν (broad NH), 1762 ν (butyrolactone, C=O), 1685 ν (aroyl, C=O) and 1640 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.19–7.36 [(5H, m; H-1a and H-1b) and (1H, imp; H-2a and H-2b)], 3.31 (2H, imp; H-3a and H-3b), 7.44–7.53 (2H, d; H-4a and H-4b), 6.46–6.83 (2H, d; H-5a and H-5b), 2.2–2.27 (3H, s, H-6a and H-6b), 7.83–7.94 [(1H, imp; H-7b) and (2H, d; H-8a and H-8b)], 6.74 (1H, s; H-7a), 6.99–7.19 (2H, d; H-9a and H-9b) and 2.28–2.31 (1H, s; H-10a and H-10b). MS: m/z = 369.5 (M^+ , 0%, $\text{C}_{25}\text{H}_{18}\text{NO}_2$), 262 (3.5, $\text{C}_{18}\text{H}_{14}\text{O}_2$), 200 (12, $\text{C}_{12}\text{H}_{10}\text{NO}_2$), 143 (14, $\text{C}_{10}\text{H}_7\text{O}$), 134 (12, $\text{C}_8\text{H}_8\text{NO}$), 115 (6, C_9H_7), 91 (44, C_7H_7), 77 (100, C_6H_5) and 65 (4, C_5H_5).

N-(4-Methylphenyl)-3-(4-methoxybenzoyl)-2-phenylmethylene propionamide (32a) and 5-(4-methylphenylamino)-5-(4-methylphenyl)-3-phenylmethylene-butyrolactone (32b): FTIR (KBr): 3250–3300 ν (broad NH), 1760 ν (butyrolactone, C=O), 1675 ν (aroyl, C=O) and 1643 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.34–7.48 [(5H, m; H-1a and H-1b) and (1H, imp; H-2a and H-2b)], 3.45 (2H, s; H-3a and H-3b), 7.20–7.30 (2H, d; H-4a and H-4b), 6.82–6.90 (2H, d; H-5a and H-5b), 3.70–3.75 (3H, s, H-6a and H-6b), 6.75 (1H, s; H-7a), 8.00–8.10 (1H, m; H-7b), 7.58–7.90 (2H, d; H-8a and H-8b), 7.03–7.12 (2H, d; H-9a and H-9b) and 2.22 (3H, s; H-10a and H-10b). MS: m/z = 385.5 (M^+ , 0%, $\text{C}_{25}\text{H}_{23}\text{NO}_3$), 294 (3.3, $\text{C}_{18}\text{H}_{16}\text{NO}_3$), 277 (12, $\text{C}_{18}\text{H}_{15}\text{NO}_2$), 187 (4, $\text{C}_{11}\text{H}_9\text{NO}_2$), 149 (46, $\text{C}_9\text{H}_9\text{O}_2$), 135 (100, $\text{C}_8\text{H}_8\text{NO}$), 100 (19, $\text{C}_5\text{H}_4\text{NO}_2$), 91 (50, C_7H_7) and 65 (13, C_5H_5).

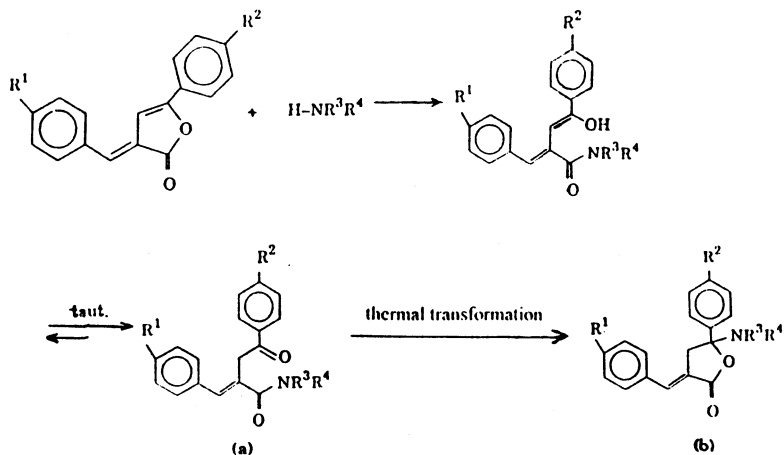
N-(4-Methylphenyl)-3-(4-chlorobenzoyl)-2-phenylmethylene propionamide (33a) and 5-(4-methylphenylamino)-5-(4-chlorophenyl)-3-phenylmethyl-

ene-butyrolactone (33b): FTIR (KBr): 3300–3250 ν (broad NH), 1765 ν (butyrolactone, C=O), 1682 ν (aroyl, C=O) and 1646 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 7.36–7.50 [(5H, m; H-1a and H-1b) and (1H, imp; H-2a and H-2b)], 3.64–3.57 (2H, s; H-3a and H-3b), 7.28–7.36 (2H, d; H-4a and H-4b), 7.62–7.64 (2H, d; H-5a and H-5b), 6.79–6.8 (1H, m, H-6a), 7.93–7.95 (1H, m; H-6b), 7.55–7.78 (2H, d; H-7a and H-7b), 7.02–7.09 (2H, d; H-8a and H-8b) and 2.21–2.26 (3H, s; H-9a and H-9b). MS: m/z = 389.8 (M^+ , 5%, $\text{C}_{24}\text{H}_{20}\text{NO}_2\text{Cl}$), 372 (5, $\text{C}_{24}\text{H}_{18}\text{NOCl}$), 282 (11, $\text{C}_{17}\text{H}_{11}\text{O}_2\text{Cl}$), 277 (11, $\text{C}_{18}\text{H}_{15}\text{NO}_2$), 153 (7, $\text{C}_8\text{H}_6\text{OCl}$), 139 (83, $\text{C}_7\text{H}_4\text{OCl}$), 134 (15, $\text{C}_8\text{H}_8\text{NO}$), 116 (7, C_9H_8), 111 (11, $\text{C}_6\text{H}_4\text{Cl}$), 91 (74, C_7H_7), 78 (100, C_6H_6) and 65 (32, C_5H_5).

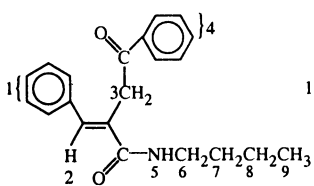
N-(4-Methylphenyl)-3-benzoyl-2-(4-methoxyphenylmethylene) propionamide (34a) and 5-(4-methylphenylamino)-5-phenyl-3-(4-methoxyphenylmethylene)butyrolactone (34b): FTIR (KBr): 3250–3400 ν (NH broad), 1750 ν (butyrolactone, C=O), 1670 ν (benzoyl, C=O) and 1625 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.79–3.86 (3H, s; H-1a and H-1b), 7.00–7.09 (2H, d; H-2a and H-2b), 7.24–7.29 (2H, d; H-3a and H-3b), 7.38–7.62 (1H, imp; H-4a and H-4b), 3.34–3.41 (2H, s; H-5a and H-5b), 7.29–7.55 (5H, m, H-6a and H-6b), 6.98 (1H, s; H-7a), 7.62 (1H, s; H-7b), 7.88–7.91 (2H, d; H-8a and H-8b), 7.19–7.27 (2H, d; H-9a and H-9b) and 2.19 (3H, s; H-10a and H-10b). MS: m/z = 385.5 (M^+ , 0%, $\text{C}_{25}\text{H}_{23}\text{NO}_3$), 367 (100, $\text{C}_{25}\text{H}_{21}\text{NO}_2$), 308 (3, $\text{C}_{19}\text{H}_{18}\text{NO}_3$), 279 (4.4, $\text{C}_{18}\text{H}_{15}\text{O}_3$), 278 (5.5, $\text{C}_{18}\text{H}_{14}\text{O}_3$), 247 (5.3, $\text{C}_{17}\text{H}_{13}\text{NO}$), 135 (4, $\text{C}_8\text{H}_9\text{NO}$), 105 (10, $\text{C}_7\text{H}_5\text{O}$), 102 (4, C_8H_6), 91 (33, C_7H_7) and 65 (23, C_5H_5).

N-(4-Methylphenyl)-3-(4-methylbenzoyl)-2-(4-methoxyphenylmethylene) propionamide (35a) and 5-(4-methylphenylamino)-5-(4-methylphenyl)-3-(4-methoxyphenylmethylene)-butyrolactone (35b): FTIR (KBr): 3250–3350 ν (broad NH), 1768 ν (butyrolactone, C=O), 1691 ν (aroyl, C=O) and 1625 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.74–3.83 (3H, s; H-1a and H-1b), 6.46–6.72 (2H, d; H-2a and H-2b), 7.17–7.19 (2H, d; H-3a and H-3b), 7.29–7.34 (1H, s; H-4a and H-4b), 3.31–3.50 (2H, imp; H-5a and H-5b), 7.38–7.48 (2H, d, H-6a and H-6b), 6.80–6.89 (2H, d; H-7a and H-7b), 2.12–2.26 (3H, s; H-8a and H-8b), 6.98 (1H, s; H-9a), 7.83–8.00 [(1H, imp; H-9b) and (2H, d; H-10a and H-10b)], 7.00–7.19 (2H, d; H-11a and H-11b), 2.27–2.30 (3H, s; H-12a and H-12b) MS: m/z = 399 (M^+ , 2%, $\text{C}_{26}\text{H}_{25}\text{NO}_3$), 381 (100, $\text{C}_{26}\text{H}_{23}\text{NO}_2$), 308 (4, $\text{C}_{19}\text{H}_{18}\text{O}_3\text{N}$), 293 (9, $\text{C}_{19}\text{H}_{17}\text{O}_3$), 292 (7, $\text{C}_{19}\text{H}_{16}\text{O}_3$), 135 (3, $\text{C}_8\text{H}_9\text{NO}$), 119 (21, $\text{C}_8\text{H}_7\text{O}$), 107 (4, $\text{C}_7\text{H}_7\text{O}$), 91 (40, C_7H_7) and 65 (29, C_5H_5).

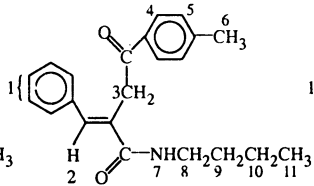
N-(4-Methylphenyl)-3-(4-chlorobenzoyl)-2-(4-methoxyphenylmethylene) propionamide (36a) and 5-(4-methylphenylamino)-5-(4-chlorophenyl)-3-(4-methoxyphenylmethylene)-butyrolactone (36b): FTIR (KBr): 3400–3300 ν (broad NH), 1760 ν (butyrolactone, C=O), 1690 ν (aroyl, C=O) and 1625 cm^{-1} ν (amide, C=O). ^1H NMR (DMSO- d_6): δ = 3.82–3.84 (3H, s; H-1a and H-1b), 6.45–6.82 (2H, d; H-2a and H-2b), 7.06–7.20 (2H, d; H-3a and H-3b), 7.28–7.39 (1H, imp; H-4a and H-4b), 3.31 (2H, imp; H-5a and H-5b), 7.28–7.39 (2H, d, H-6a and H-6b), 7.85–7.95 [(2H, d; H-7a and H-7b) and (1H, imp; H-8b)], 6.98 (1H, s; H-8a), 7.43–7.61 (2H, d; H-9a and H-9b), 7.01–7.09 (2H, d; H-10a and H-10b) and 2.20–2.23 (3H, s; H-11a and H-11b). MS: m/z = 419 (M^+ , 0%, $\text{C}_{25}\text{H}_{22}\text{NO}_3\text{Cl}$), 401 (100, $\text{C}_{25}\text{H}_{20}\text{NO}_2\text{Cl}$), 374 (10, $\text{C}_{23}\text{H}_{17}\text{NO}_2\text{Cl}$), 311 (7, $\text{C}_{18}\text{H}_{14}\text{NO}_2\text{Cl}$), 139 (34, $\text{C}_7\text{H}_4\text{OCl}$), 135 (13, $\text{C}_8\text{H}_9\text{NO}$), 111 (4, $\text{C}_6\text{H}_4\text{Cl}$), 91 (89, C_7H_7) and 65 (56, C_5H_5).



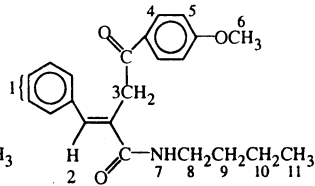
Comp.	R ¹	R ²	R ³	R ⁴	Comp.	R ¹	R ²	R ³	R ⁴
1.	H	H	—	—	19.	H	Cl	H	CH ₃
2.	H	CH ₃	—	—	20.	OCH ₃	CH ₃	H	CH ₃
3.	H	OCH ₃	—	—	21.	OCH ₃	OCH ₃	H	CH ₃
4.	H	Cl	—	—	22.	OCH ₃	Cl	H	CH ₃
5.	OCH ₃	H	—	—	23.	H	H	H	C ₆ H ₅
6.	OCH ₃	CH ₃	—	—	24.	H	CH ₃	H	C ₆ H ₅
7.	OCH ₃	OCH ₃	—	—	25.	H	OCH ₃	H	C ₆ H ₅
8.	OCH ₃	Cl	—	—	26.	H	Cl	H	C ₆ H ₅
9.	H	H	H	NH(CH ₂) ₃ CH ₃	27.	OCH ₃	H	H	C ₆ H ₅
10.	H	CH ₃	H	NH(CH ₂) ₃ CH ₃	28.	OCH ₃	CH ₃	H	C ₆ H ₅
11.	H	OCH ₃	H	NH(CH ₂) ₃ CH ₃	29.	OCH ₃	Cl	H	C ₆ H ₅
12.	H	Cl	H	NH(CH ₂) ₃ CH ₃	30.	H	H	H	4-CH ₃ C ₆ H ₄
13.	OCH ₃	H	H	NH(CH ₂) ₃ CH ₃	31.	H	CH ₃	H	4-CH ₃ C ₆ H ₄
14.	OCH ₃	CH ₃	H	NH(CH ₂) ₃ CH ₃	32.	H	OCH ₃	H	4-CH ₃ C ₆ H ₄
15.	OCH ₃	OCH ₃	H	NH(CH ₂) ₃ CH ₃	33.	H	Cl	H	4-CH ₃ C ₆ H ₄
16.	OCH ₃	Cl	H	NH(CH ₂) ₃ CH ₃	34.	OCH ₃	H	H	4-CH ₃ C ₆ H ₄
17.	H	CH ₃	H	CH ₃	35.	OCH ₃	CH ₃	H	4-CH ₃ C ₆ H ₄
18.	H	OCH ₃	H	CH ₃	36.	IOCH ₃	Cl	H	—



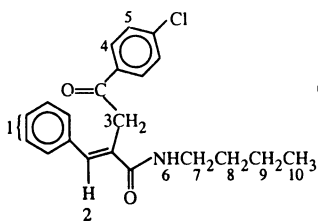
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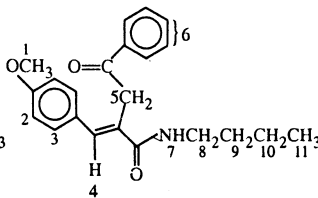
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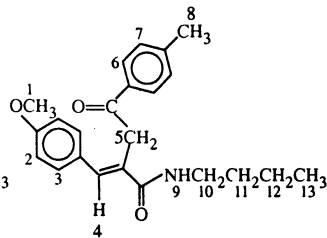
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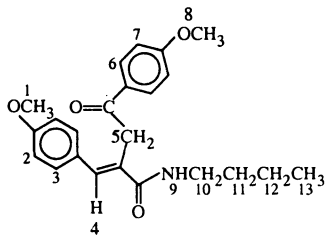
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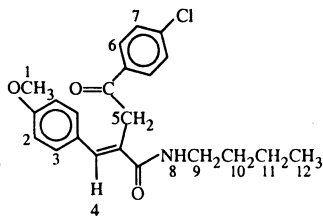
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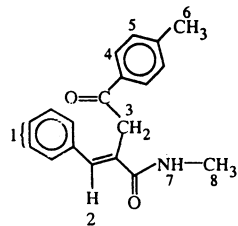
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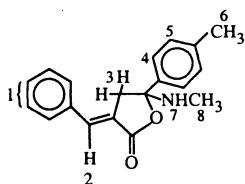
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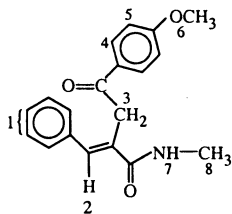
16



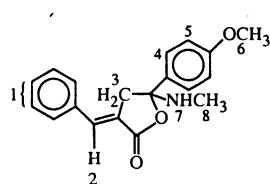
17(a)



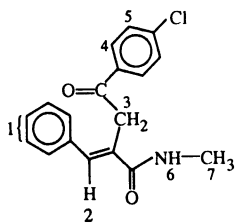
17(b)



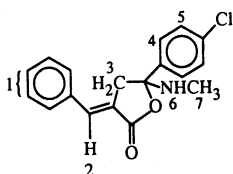
18(a)



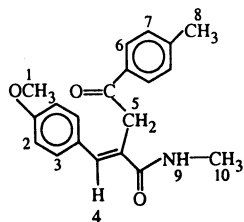
18(b)



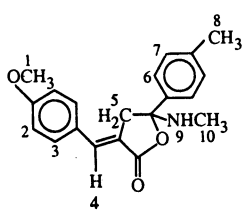
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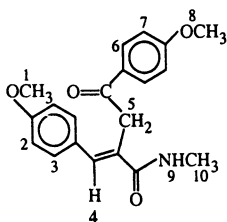
19(b)



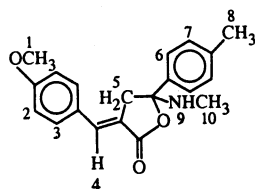
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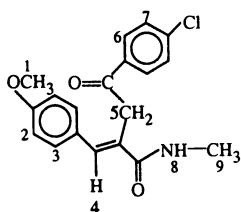
20(b)



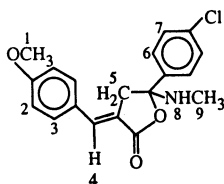
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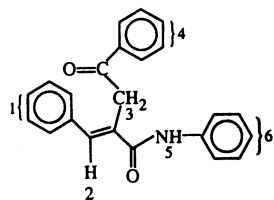
21(b)



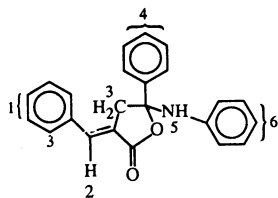
22(a)



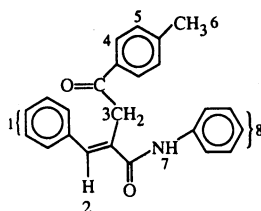
22(b)



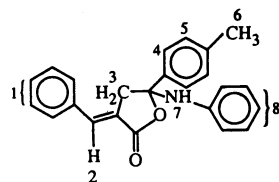
23(a)



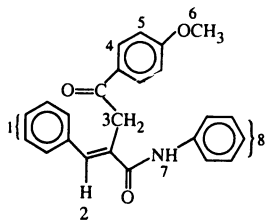
23(b)



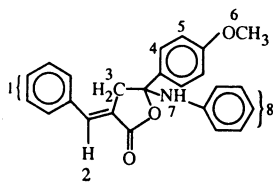
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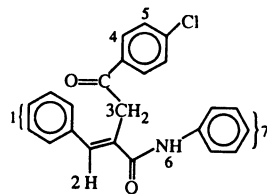
24(b)



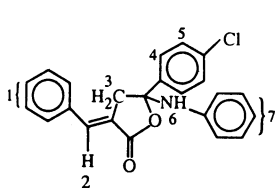
25(a)



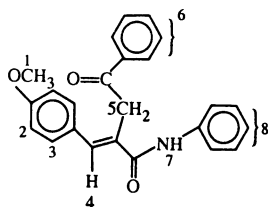
25(b)



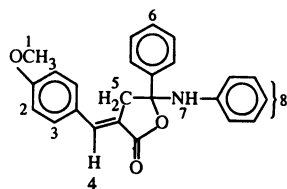
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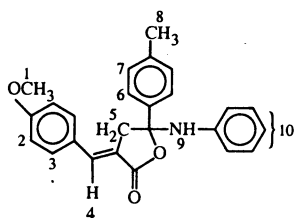
26(b)



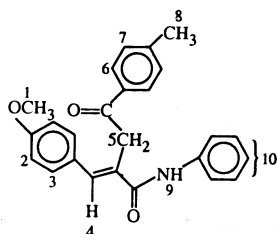
27(a)



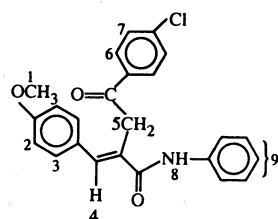
27(b)



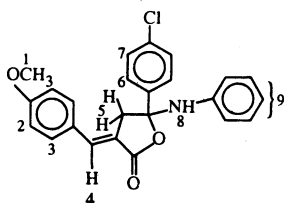
28(a)



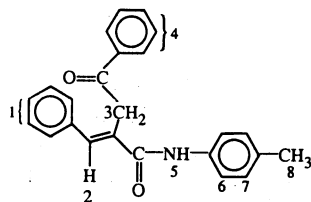
28(b)



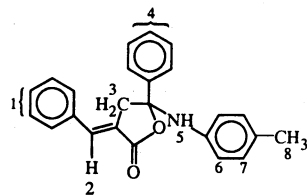
29(a)



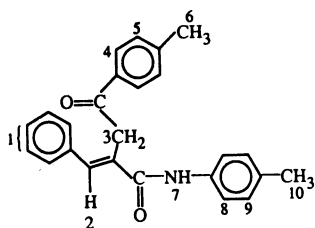
29(b)



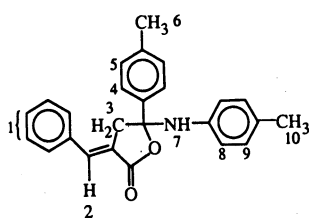
30(a)



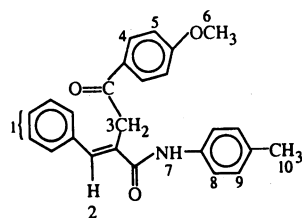
30(b)



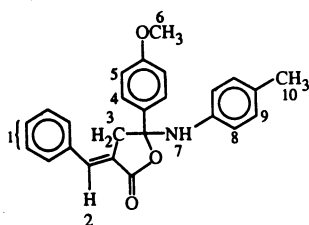
31(a)



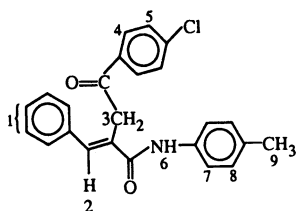
31(b)



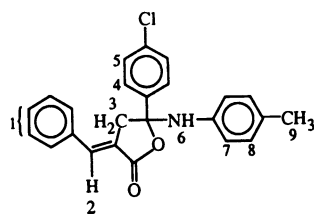
32(a)



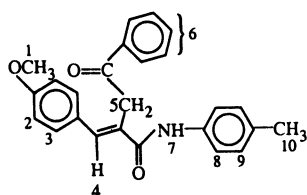
32(b)



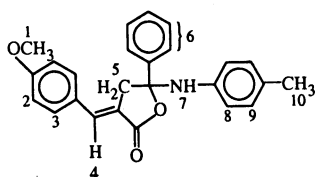
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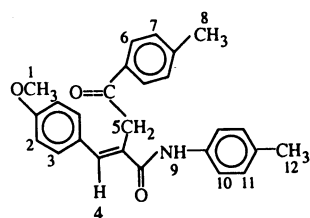
33(b)



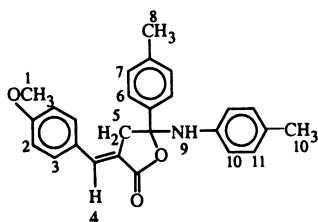
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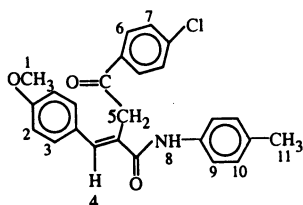
34(b)



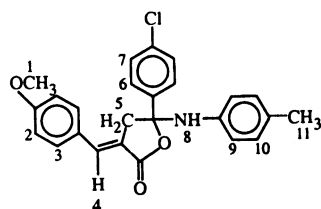
35(a)



35(b)



36(a)



36(b)

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11th INTERNATIONAL CONFERENCE ON BIOINORGANIC CHEMISTRY (ICBIC 11)

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Contact:

Conference Secretariat ICMS Pty Ltd
84 Queensbridge Street Southbank, Melbourne, Victoria 3006, Australia
Tel: +61 3 9682 0244 Fax: +61 3 9682 0288
E-mail: icbic11@icms.com.au
<http://www.icms.com.au/icbic11>

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Contact:

Ferdinand Wild
Anorganisch-chemisches Institut Universität Zürich Winterthurerstr
190 Zürich 8057, Switzerland
Tel: +41 1 635 4646 Fax: +41 1 635 6802
E-mail: fechem@aci.unizh.ch
<http://www.fechem.unizh.ch>