REACTION OF 4-OXOCHROMENE-3-CARBOXALDEHYDES WITH PRIMARY AMIDES AND BENZOTRIAZOLE OR 1*H*-1,2,4-TRIAZOLE

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N-[(6-substituted-4-oxochromen-3-yl)(1,2,4-triazol-3-yl)methyl]amides **5** and *N*-[(6-substituted-4-oxochromen-3-yl)(benzotriazol-1-yl)methyl]amides **6** were prepared by the reaction of 6-substituted 4-oxochromene-3-carboxaldehydes **1** with primary amides and 1*H*-1,2,4-triazole or 1*H*-benzotriazole. 6-Substituted 3-[hydroxy(1,2,4-triazol-1-yl)methyl]chromen-4-one **2** and 6-substituted 3-[hydroxy-(benzotriazol-1-yl)methyl]chromen-4-one **3** were isolated as stable intermediates of these reactions. Beneficial effect of microwave irradiation on length of reaction time was observed. Some reactions of these derivatives with O, S, and N nucleophiles are described.

Key words: 4-Oxochromene-3-carboxaldehydes; Microwave irradiation; Enamides.

Chromenone derivatives are important heterocyclic compounds due to their widespread occurrence in plants and their potential as important pharmaceuticals. The reactivity of 4-oxo-chromene-3-carboxaldehydes has been the focus of much interest as these compounds are useful intermediates in the synthesis of a wide variety of heterocycles; they undergo both nucleophilic attack at the carbonyl function as well as conjugate addition[1–3]. Our recent investigations were devoted to the synthesis of new derivatives of chromones[4–6] and to the study of biological[5,6], spectral and theoretical[7,8] aspects of reactions of 4-oxochromene-3-carboxaldehydes, such as reactions with active methylene groups of various heterocycles[4], with amines[5] or hydrazide groups[6].

It is known that the amide group is an important constituent of many biologically important compounds. Therefore, we aimed at searching for a convenient method for preparation of chromenone derivatives containing various amide moieties. Our interest was focused to 1*H*-1,2-4-triazole or 1*H*-benzotriazole, as potential building blocks of the target compounds.

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Our investigations led to an extension of the utilization of 4-oxochromene-3-carboxaldehydes **1** in reaction with two base components 1*H*-1,2,4-triazole or 1*H*-benzotriazole to form stable alcohols **2** and **3**, and their reaction with amides **4** to form aminal-type derivatives **5** and **6** (Scheme 1). We found that the reaction can be further extended to 4-oxo-chromene-3-carboxaldehydes and primary aliphatic, aromatic and heterocyclic amides.

The advantage of the reactions is that, unlike the starting compounds, the products **5** and **6** are little soluble in hot toluene, precipitating from reaction mixture thus and indicating the course of reaction. Equivalent amounts of starting compounds, on refluxing in dry toluene for 18–50 h give amides **5** and **6** as solid in the yields 50–90% (Table I). Using xylene instead of toluene leads to lower yields and difficult isolation of the products.

As microwaves are known to shorten reaction time in various types of reactions[4,9,10], we have studied the effect of microwave heating on the yields of products **5** and **6**. We found out that the yields under classic conditions and those in the microwave oven were comparable. The only difference was in shorter reaction times (17–33 min).

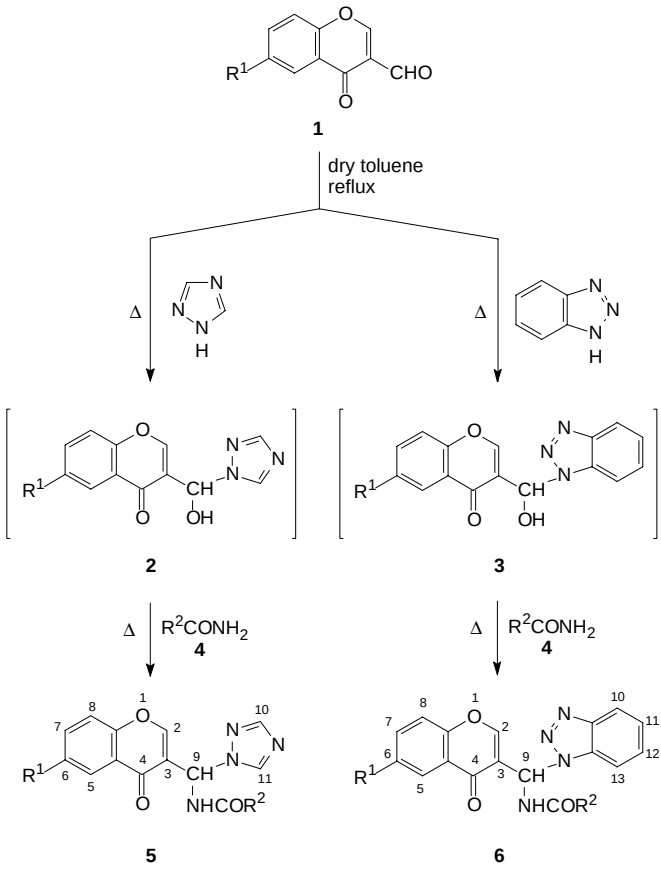
The structures of compounds **5** and **6** were established from IR and ^{1}H NMR spectra. IR spectra revealed the presence of a strong band of a stretching frequency of pyrone carbonyl at 1 675–1 640 cm^{-1}, of amide 1 640–1 620 cm^{-1} and a medium band of C=C at 1 620–1 600 cm^{-1} (Table II). ^{1}H NMR spectra of compounds **5** and **6** showed doublets of NH protons at δ 12.9–9.11 and CH protons at δ 8.2–7.99 and a singlet of H-2 of pyranone ring at δ 8.90–8.70 (Table III).

The assumption that the first step of the studied reaction is the formation of 3-[hydroxy(1,2,4-triazol-1-yl)methyl]chromen-4-ones **2** or 3-[hydroxy(benzotriazol-1-yl)-methyl]chromen-4-ones **3** was confirmed by isolation of derivatives **2** and **3** (Scheme 1). The products **2a** and **3a** underwent a 15 h reaction with benzamide in refluxing toluene to yield compounds **5b** or **6d**, respectively.

IR spectra of hydroxy derivatives **2a**, **2b**, **3a**, and **3b** showed broad absorptions band of bonded OH group at 3 189–3 140 cm^{-1}, while ^{1}H NMR spectra of these compounds revealed signals of OH proton at δ 2.30–1.56, which disappeared after treatment with deuterium oxide (Tables II and III). ^{1}H NMR spectra of the compounds **2** and **3** indicate the absence of equilibria with the starting materials. Compounds **2** and **3** are stable in aprotic solutions. No ^{1}H NMR signal of aldehyde proton could be found.

A successful preparation of compounds **2**, **3**, **5** and **6** requires special attention to purification of each component of the reaction mixture. In the presence of traces of water a mixture of undefined products is formed. The products, after drying at room temperature, could be stored in capped vials for months without any decomposition.

Compounds **5** and **6** readily undergo reactions with nucleophiles under mild conditions. Such reactions make it possible to prepare chromane derivatives of enamide type **7** as stable products in 50–75% yields (Scheme 2, Table I). For the reactions, various



	R^1	R^2
1a	NO_2	-
1b	Cl	-
1c	H	-
1d	CH_3	-
1e	Br	-
2a	NO_2	-
2b	Cl	-
3a	NO_2	-
3b	Cl	-
4a	-	C_6H_5
4b	-	CH_3
4c	-	3-pyridyl
4d	-	4-pyridyl

	R^1	R^2
5a	H	C_6H_5
5b	Cl	C_6H_5
5c	NO_2	C_6H_5
6a	H	C_6H_5
6b	CH_3	C_6H_5
6c	Br	C_6H_5
6d	Cl	C_6H_5
6e	NO_2	C_6H_5
6f	H	CH_3
6g	Br	CH_3
6h	Cl	CH_3
6i	Cl	3-pyridyl
6j	NO_2	3-pyridyl
6k	Cl	4-pyridyl

SCHEME 1

TABLE I
Characteristic data of prepared compounds

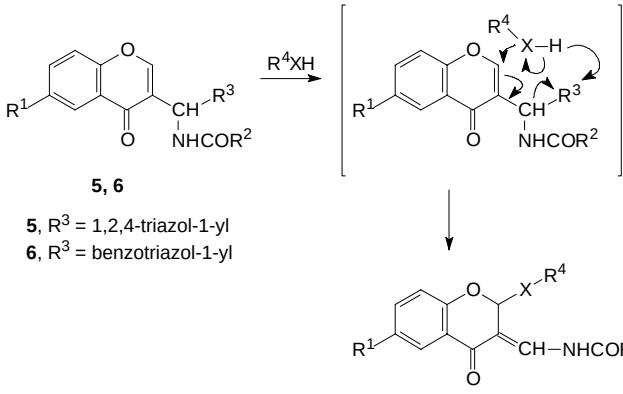
Compound	Formula M.w.	M.p., °C Yield, %	Starting compounds	Reflux, h MW, min	Calculated/Found			
					% C	% H	% N	% Cl[a]
2a	$C_{12}H_8N_4O_5$	80–84	**1a**	8	50.01	2.80	19.44	–
	288.2	89		–	49.85	2.80	19.29	–
2b	$C_{12}H_8ClN_3O_3$	104–105	**1b**	8	51.91	2.90	15.13	12.77
	277.7	85		–	51.75	2.75	15.12	12.77
3a	$C_{16}H_{10}N_4O_5$	223–225	**1a**	8	56.81	2.98	16.56	–
	338.3	90		–	56.87	2.87	16.45	–
3b	$C_{16}H_{10}ClN_3O_3$	111–114	**1b**	8	58.64	3.08	12.82	10.65
	327.7	85		–	58.60	3.06	12.74	10.65
5a	$C_{19}H_{14}N_4O_3$	158–160	**1c**, **4a**	24	65.89	4.07	16.18	–
	346.4	80		–	65.85	4.06	16.08	–
5b	$C_{19}H_{13}ClN_4O_3$	196–199	**1b**, **4a**	24	59.93	3.44	14.71	9.31
	380.8	85		–	59.91	3.40	14.69	9.28
5c	$C_{19}H_{13}N_5O_5$	102–105	**1a**, **4a**	20	58.31	3.35	17.90	–
	391.3	89		10	58.16	3.29	17.75	–
6a	$C_{23}H_{16}N_4O_3$	212–214	**1c**, **4a**	27	69.69	4.14	14.13	–
	396.4	70		–	69.46	4.07	14.12	–
6b	$C_{24}H_{18}N_4O_3$	190–192	**1d**, **4a**	27	70.23	4.42	13.65	–
	410.4	88		33	69.85	4.38	13.42	–
6c	$C_{23}H_{15}BrN_4O_3$	229–231	**1e**, **4a**	27	58.12	3.18	11.78	16.81
	475.3	85		–	58.11	3.16	11.76	16.65
6d	$C_{23}H_{15}ClN_4O_3$	222–225	**1b**, **4a**	27	64.12	3.51	13.00	8.23
	430.8	90		20	64.05	3.50	12.89	8.21
6e	$C_{23}H_{15}N_5O_5$	225–227	**1a**, **4a**	27	62.58	3.43	15.87	–
	441.4	84		27	62.49	3.39	15.86	–
6f	$C_{18}H_{14}N_4O_3$	183–186	**1c**, **4b**	50	63.35	4.38	17.38	–
	322.3	70		–	63.08	4.18	17.17	–
6g	$C_{18}H_{13}BrN_4O_3$	228–231	**1e**, **4b**	50	50.89	3.26	13.96	19.91
	401.2	78		20	50.75	3.12	13.60	19.70
6h	$C_{18}H_{13}ClN_4O_3$	224–227	**1b**, **4b**	50	57.23	3.67	15.70	9.94
	356.7	80		–	56.97	3.52	15.57	9.91

TABLE I
(*Continued*)

Compound	Formula M.w.	M.p., °C Yield, %	Starting compounds	Reflux, h MW, min	Calculated/Found			
					% C	% H	% N	% Cl[a]
6i	$C_{22}H_{14}ClN_5O_3$	240–242	**1b**, **4c**	18	61.19	3.27	16.22	8.02
	431.6	85		11	60.95	3.15	16.17	8.01
6j	$C_{22}H_{14}N_6O_5$	219–222	**1a**, **4c**	18	59.73	3.19	19.00	–
	442.4	79		–	59.72	3.18	18.85	–
6k	$C_{22}H_{14}ClN_5O_3$	215–218	**1b**, **4d**	48	61.19	3.27	16.22	8.02
	431.6	50		–	60.84	3.26	16.05	8.02
7a	$C_{19}H_{16}ClNO_4$	186–190	**6d**	3	63.78	4.51	3.96	9.91
	357.7	70		–	63.65	4.24	3.71	9.86
7b	$C_{19}H_{16}N_2O_6$	225–227	**6e**	3	61.96	4.38	7.61	–
	368.4	68		–	61.79	4.35	7.58	–
7c[b]	$C_{24}H_{18}ClNO_3S$	169–172	**6d**	10	66.13	4.16	3.21	8.13
	435.9	55		–	65.97	4.09	3.16	7.99
7d[b]	$C_{23}H_{16}ClNO_3S$	145–147	**6a**	10	65.48	3.82	3.32	8.40
	421.8	50		–	65.35	3.76	3.27	8.35
7e	$C_{20}H_{17}ClN_2O_3$	175–177	**5b**	4	65.13	4.65	7.60	9.61
	368.8	64		–	65.09	4.63	7.59	9.60
7f	$C_{20}H_{20}ClN_3O_3$	162–164	**6k**	4	62.26	5.22	10.89	9.19
	385.9	60		–	62.25	5.18	10.78	9.15
7g	$C_{25}H_{29}ClN_2O_3$	214–217	**6d**	4	68.09	6.63	6.35	8.04
	441.0	67		–	68.01	6.61	6.35	8.02
7h	$C_{21}H_{20}ClN_3O_3$	187–190	**6k**	4	63.40	5.07	10.56	8.91
	397.9	58		–	63.38	5.01	10.54	8.86

[a] % Br for compounds **6c** and **6g**; [b] % S: **7c** calculated: 7.35, found: 7.26; **7d** calculated: 7.60, found: 7.49.

O, S, N nucleophiles were used. Formation of enamide derivatives **7** can be explained by interaction of nucleophile. Nucleophilic attack on the 2-position of the chromenone ring in compounds **5** and **6** is followed by double bond shift and elimination of 1*H*-1,2,4-triazole or 1*H*-benzotriazole in the final step of the reaction. This reaction step was proved by isolation of both azoles from $NaHCO_3$ filtrate after acidification.



5, 6

5, R^3 = 1,2,4-triazol-1-yl
6, R^3 = benzotriazol-1-yl

7

	R^1	R^2	X	R^4
7a	Cl	C_6H_5	O	C_2H_5
7b	NO_2	C_6H_5	O	C_2H_5
7c	Cl	C_6H_5	S	$CH_2C_6H_5$
7d	H	C_6H_5	S	4-ClC_6H_4
7e	Cl	C_6H_5	NH	$CH_2CH{=}CH_2$
7f	Cl	4-pyridyl	NH	C_4H_9
7g	Cl	C_6H_5	N	$(C_4H_9)_2$
7h	Cl	4-pyridyl	N	$-(CH_2)_5-$

SCHEME 2

IR spectra of compound **7** indicated the presence of CO and NH groups (Table II). ^{1}H NMR revealed signal at δ 5.8–7 ppm thus supporting the presence of H-2 on a chromanone system and not on a chromenone system (Table III).

EXPERIMENTAL

Melting points were determined on a Kofler hot stage and are uncorrected. ^{1}H NMR spectra (δ, ppm; *J*, Hz) were measured on Spectrometer BS-487 (80 MHz, Tesla) in deuteriochloroform or hexadeuteriodimethyl sulfoxide with tetramethylsilane as internal standard. The reaction course was monitored by thin-layer chromatography in ethyl acetate–isohexane. The microwave synthetic study was realized using a DAEWOO microwave oven at 270 W in an Erlenmeyer flask with condenser

according to the described procedure[10]. The characteristic data of the prepared compounds and the reaction data are given in Table I, the IR spectra in Table II and the ^{1}H NMR spectra in Table III.

6-Substituted 3-[Hydroxy(1,2,4-triazol-1-yl)methyl]chromen-4-one **2** and 6-Substituted 3-[Hydroxy(benzotriazol-1-yl)methyl]chromen-4-one **3**. General Procedure

6-Substituted 4-oxochromene-3-carboxaldehyde **1a–1e** (2 mmol) and 1*H*-1,2,4-triazole or 1*H*-benzotriazole (2 mmol) were refluxed in dry toluene (5 ml) for 8 h. The solid product was filtered off, stirred with diethyl ether or acetone at room temperature for 1 h and dried.

N-[(6-Substituted-4-oxochromen-3-yl)(1,2,4-triazol-1-yl)methyl]amides **5** and *N*-[(6-Substituted-4-oxochromen-3-yl)(benzotriazol-1-yl)methyl]amides **6**. General Procedure

Method A. 6-Substituted 4-oxochromene-3-carboxaldehyde **1a–1e** (2 mmol), primary amide **4a–4d** (2 mmol) and 1*H*-1,2,4-triazole or 1*H*-benzotriazole (2 mmol) in dry toluene (10 ml) were refluxed for 27–50 h. The solid product was filtered off, stirred first with diethyl ether and then with acetone

TABLE II
IR spectra ($\tilde{\nu}$, cm^{-1}) of synthesized compounds measured in paraffinic oil

Compound	$\tilde{\nu}$(NH)	$\tilde{\nu}$(OH)	$\tilde{\nu}$(NH)	$\tilde{\nu}(CO)_{pyrone}$	$\tilde{\nu}(CO)_{amide}$	$\tilde{\nu}$(C=C)	δ(NH)	$\tilde{\nu}$(C–O–C)
2b	–	3 120–2 995	–	1 655	–	1 620	–[a]	1 120
3b	–	3 102–2 890	–	1 640	–	1 620	–[a]	1 130
5a	3 330	–	3 120–2 990	1 675	1 640	1 615	1 520	1 140
5b	3 310	–	3 110–2 980	1 640	1 635	1 600	1 530	1 140
5c	–	–	3 110–2 990	1 650	1 640	1 620	1 530[b]	1 130
6a	3 400	–	3 080–2 900	1 650	1 640	1 600	1 510	1 150
6b	3 375	–	3 090–2 990	1 650	1 638	1 605	1 510	1 110
6c	3 375	–	3 090–2 900	1 645	1 630	1 600	1 510	1 125
6d	3 400	–	3 105–2 920	1 670	1 660	1 620	1 530	1 150
6e	3 280	–	3 110–2 990	1 645	1 630	1 618	1 540[a]	1 150
6g	3 280	–	3 110–2 980	1 650	1 620	1 600	1 515	1 110
6j	3 210	–	3 130–3 020	1 665	1 640	1 620	1 530[a]	1 170
6k	3 360	–	3 080–2 975	1 648	1 638	1 615	1 512	1 152
7a[b]	–	–	–	1 654	1 605	1 590	1 550	1 195
7b[b]	–	–	–	1 657	1 613	1 594	1 525[a]	1 095
7c	3 295	–	3 090–3 030	1 650	1 625	1 600	1 510	1 160
7h	3 250	–	3 070–2 990	1 680	1 640	1 600	1 520	1 120

[a] $\tilde{\nu}_{as}(NO_2)$ 1 530–1 520 cm^{-1}, $\tilde{\nu}_s(NO_2)$ 1 355–1 340 cm^{-1}; [b] measured in chloroform.

TABLE III
^{1}H NMR spectral data of synthesized compounds

Compound	δ, ppm; *J*, Hz
2a[a]	1.87 s, 1 H (OH); 6.65 s, 1 H (H-9); 7.51 s, 1 H (H-triazole); 7.59 dd, 1 H, *J*(7,8) = 9, *J*(7,5) = 2.4 (H-7); 7.97 s, 1 H (H-triazole); 8.09 d, 1 H, *J*(8,7) = 9 (H-8); 8.42 s, 1 H (H-2); 8.46 d, 1 H, *J*(5,7) = 2.4 (H-5)
2b[a]	2.30 s, 1 H (OH); 7.20 s, 1 H (H-9); 7.75 d, 1 H, *J*(8,7) = 5.79 (H-8); 8.06 s, 1 H (H-triazole); 8.24 s, 1 H (H-triazole); 8.52 s, 1 H (H-2); 8.57 dd, 1 H, *J*(7,5) = 2.74, *J*(7,8) = 5.79 (H-7); 9.04 d, 1 H, *J*(5,7) = 2.74 (H-5)
3a[a]	1.95 s, 1 H (OH); 7.23 s, 1 H (H-9); 7.34–7.50 m, 4 H (H-10-13); 7.57 d, 1 H, *J*(8,7) = 2.44 (H-8); 7.69 dd, 1 H, *J*(7,8) = 2.44, *J*(7,5) = 1.83 (H-7); 8.05 d, 1 H, *J*(5,7) = 1.83 (H-5); 8.58 s, 1 H (H-2)
3b[a]	1.56 s, 1 H (OH); 7.30–7.80 m, 5 H (H-9-13); 8.16 s, 1 H (H-2); 8.38–8.68 m, 2 H (H-7,8); 9.07 d, 1 H, *J* = 2.44 (H-5)
5a	7.48–7.99 m, 10 H (arom.); 8.10 d, 1 H, *J* = 7.9 (H-9); 8.60 s, 1 H (H-triazole); 8.81 s, 1 H (H-2); 9.69 d, 1 H, *J* = 7.9 (NH)
5b	7.20–7.64 m, 5 H (arom.); 7.93 d, 1 H, *J* = 5.94 (H-8); 7.99 d, 1 H, *J* = 7.93 (H-9); 7.84–8.05 m, 2 H (arom.); 8.60 d 1 H, *J* = 5.94 (H-7); 8.64 s, 1 H (H-triazole); 8.80 s, 1 H (H-2); 9.69 d, 1 H *J* = 7.93 (NH)
5c	7.06–7.67 m, 3 H (arom.); 7.81–8.06 m, 4 H (arom.,H-triazole); 8.11 d, 1 H, *J* = 8.24 (H-9); 8.57 d, 1 H, *J* = 2.74 (H-8); 8.70 s, 1 H (H-2); 8.70 s, 1 H (H-2); 8.77 d, 1 H, *J* = 2.74 (H-7); 8.84 s, 1 H (H-5); 9.71 d, 1 H, *J* = 8.24 (NH)
6a	7.44–8.04 m, 13 H (arom.); 8.20 d, 1 H, *J* = 8.54 (H-9); 8.81 s, 1 H (H-2); 10.11 d, 1 H, *J* = 8.54 (NH)
6b	2.42 s, 3 H (CH_3); 7.42–8.033 m, 12 H (arom.); 8.20 d, 1 H *J* = 9 (H-9); 8.76 s, 1 H (H-2); 10.04 d, 1 H, *J* = 9 (NH)
6c	7.45–8.04 m, 12 H (arom.); 8.18 d, 1 H, *J* = 8.54 (H-9); 8.84 s, 1 H (H-2); 10.09 d, 1 H, *J* = 8.54 (NH)
6d	7.42–8.01 m, 12 H (arom.); 8.17 d, 1 H, *J* = 8.54 (H-9); 8.85 s, 1 H (H-2); 10.09 d, 1 H, *J* = 8.54 (NH)
6e	7.43–8.06 m, 6 H (arom.); 8.13–8.76 m, 7 H (arom.,H-9); 8.90 s, 1 H (H-2); 10.05 d, 1 H, *J* = 8.8 (NH)
6f	2.01 s, 3 H (CH_3); 7.35–8.13 m, 9 H (arom.,H-9); 8.81 s, 1 H (H-2); 9.72 d, 1 H *J* = 9 (NH)
6g	1.97 s, 3 H (CH_3); 7.43–8.09 m, 8 H (arom.,H-9); 8.84 s, 1 H (H-2); 9.68 d, 1 H, *J* = 9 (NH)
6h	1.98 s, 3 H (CH_3); 7.42–8.08 m, 8 H (arom.,H-9); 8.83 s, 1 H (H-2); 9.72 d, 1 H, *J* = 9 (NH)
6i	6.99–8.61 m, 11 H (arom.,H-9); 8.73 s, 1 H (H-2); 9.07 s, 1 H (H-2 pyridine); 9.11 d, 1 H, *J* = 8.4 (NH)
6j	7.4–8.60 m, 10 H (arom.,H-9); 8.71 s, 1 H (H-2); 8.96 s, 1 H (H-5); 9.13 s, 1 H (H-2 pyridine); 10.29 d, 1 H, *J* = 8.54 (NH)
6k	7.62 d, 1 H, *J* = 8.54 (H-9); 7.45–8.83 m, 10 H (arom.,H-2); 10.30–10.50 m, 2 H (H-pyridine); 12.90 d, 1 H, *J* = 8.54 (NH)

TABLE III
(*Continued*)

Compound	δ, ppm; *J*, Hz
7a[a]	1.20 t, 3 H, *J* = 7.08 (CH_3); 3.74–3.89 q, 2 H (CH_2); 5.81 s, 1 H (H-2); 6.93–8.09 m, 9 H (arom.,H-9); 12.61 d, 1 H, *J* = 11 (NH)
7b[a]	1.22 t, 3 H, *J* = 7.02 (CH_3); 3.78–3.93 q, 2 H (CH_2); 5.98 s, 1 H (H-2); 7.11–8.45 m, 8 H (arom.); 8.88 d, 1 H, *J* = 11.6 (H-9); 12.59 d, 1 H, *J* = 11.6 (NH)
7c[a]	3.93, 3.99 2 × s, 2 H (CH_2); 6.18 s, 0.5 H (H-2); 6.29 s, 0.5 H (H-2); 7.19–8.20 m, 14 H (arom.,H-9); 8.28 d, 1 H, *J* = 10 (NH)
7d	6.34 s, 0.5 H (H-2); 6.46 s, 0.5 H (H-2); 7.19–7.97 m, 12 H (arom.); 8.21 d, 1 H, *J* = 9.76 (H-9); 8.71 d, 1 H, *J* = 9.76 (NH)
7e	3.89 m, 2 H (CH_2); 5.30 d, 2 H, *J* = 12.5 (CH_2=); 5.73–5.93 m, 1 H (CH=); 6.86 s, 0.5 H (H-2); 6.98 s, 0.5 H (H-2); 7.10–8.46 m, 10 H (arom.,H-9,NH); 10.20 br s, 1 H (NH-amide)
7f	0.83 t, 3 H (CH_3); 1.38 m, 5 H (CH_2–CH_2,NH); 3.21 q, 2 H (CH_2); 6.75 s, 0.5 H (H-2); 6.84 s, 0.5 H (H-2); 7.00–7.68 m, 3 H (arom.,H-9); 7.81 d, 2 H, *J* = 2.7 (H-3 pyridine); 8.65–8.73 m, 3 H (H-3 pyridine,H-5); 9.89 d, 1 H, *J* = 12.5 (NH-amide)
7g	0.90, 0.97 2 × t, 6 H (CH_3,CH_3); 1.46 m, 8 H (2 × CH_2–CH_2); 3.69 2 × q, 4 H (2 × CH_2); 6.8 s, 0.5 H (H-2); 6.9 s, 0.5 H (H-2); 7.09–8.16 m, 9 H (arom.,H-9); 8.56 d, 1 H, *J* = 9 (NH)
7h	1.12 m, 2 H (CH_2); 1.74 m, 4 H (2 × CH_2); 3.47 q, 4 H (2 × CH_2–N); 6.87 s, 0.5 H (H-2); 6.98 s, 0.5 H (H-2); 7.22–7.51 m, 4 H (arom.,H-9); 8.06 d, 2 H, *J* = 6.01 (H-3 pyridine); 8.72 d, 2 H, *J* = 6.01 (H-2 pyridine); 10.08 d, 1 H, *J* = 7.63 (NH)

[a] Measured in deuteriochloroform.

at room temperature for 1 h and dried. From the reaction mixture filtrate toluene was removed at 60 °C/4 kPa. The residue was successively treated with diethyl ether and acetone and then filtered off. Both products were identical.

Method B. 6-Substituted 4-oxochromene-3-carboxaldehyde **1a–1e** (2 mmol), primary amide **4a–4d** (2 mmol) and 1*H*-1,2,4-triazole or 1*H*-benzotriazole (2 mmol) in dry toluene (10 ml) were irradiated in a microwave oven for 17–33 min. Toluene was removed and the solid product was washed with diethyl ether and with acetone and finally dried.

N-[(2,6-Disubstituted-4-oxochroman-3-ylidene)methyl]carboxamides **7**. General Procedure

Method A (*Preparation of compounds* **7a**, **7b**). Compound **6d** or **6e** (2 mmol) was refluxed in ethanol for 3 h. The solid product was filtered off, washed with cold water, dried and crystallized from ethanol.

Method B. To a hot solution of compound **5** or **6** (2 mmol) in dry dioxane, a dioxane solution of 2 mmol of the corresponding nucleophilic agent phenylmethanethiol, 4-chlorothiophenol, allylamine, butylamine, dibutylamine or piperidine was added. The reaction mixture was refluxed for 4–10 h. After distilling off dioxane, cold (5 °C) saturated solution of $NaHCO_3$ (15 ml) was added to the residue and stirred for 15 min at room temperature. The solid product was filtered off, washed with water and dried. The filtrate was acidified, precipitated azoles were filtered off and dried.

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