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REACTIONS OF 2-ARYL-HYDRAZONOACETAMIDES WITH ORTHOESTERS. SYNTHESIS OF NEW TETRAHYDRO-1,2,4-TRIAZINES

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The reactions of arylhydrazonocyanoacetamides with triethyl orthoformate and triethyl orthoacetate have been studied. Interaction of triethyl orthoformate with amides bearing normal alkyl substituents on the carbamoyl group resulted in cyclization to 2-aryl-4-alkyl-5-oxo-3-ethoxy-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles, whereas reaction of N-phenyl- and N-cycloalkylacetamides with triethyl orthoformate gave products of ethylation at the hydrazone group. Reactions of arylhydrazonocyanoacetamides with triethyl orthoacetate led to 2-(arylethylhydrazono)acetamides exclusively.

Keywords: arylhydrazones, orthoesters, tetrahydrotriazinones.

Arylhydrazones have been known for more than 100 years and have been thoroughly studied in recent times [1]. It has been shown that these compounds can react with electrophiles [2], nucleophiles [3], and free radicals [4]. They can also enter into cycloaddition reactions [5]. A variety of organic compounds, including five-, six-, and seven-membered heterocycles have been obtained based on these hydrazones [6].

Despite the large number of publications concerned with the chemistry of hydrazones, the reaction of arylhydrazonoacetamides with orthoesters had not been reported before our preliminary publication [7]. By analogy with the reactions of orthoaminoamides [8] and orthoaminohydrazides [9] with ethyl orthoacetate and ethyl orthoformates, it may be proposed that this reaction might serve as a method for the synthesis of 1,2,4-triazines, *via* rarely used type of (5+1) combination of atomic units [10].

The starting N-carbamoyl-substituted arylhydrazonoacetamides **1-5** were obtained by coupling of aromatic diazo derivatives with cyanoacetamides by a known method [1].

The reactions of compounds **1-5** with ethyl orthoformate or ethyl orthoacetate were carried out by prolonged heating in an excess of the orthoester by analogy with a method [8, 9]. The only products in the reactions of hydrazones **1-5** with triethyl orthoformate, which evidently occurred *via* the intermediates **6-10**, which were stabilized by loss of ethanol molecule, were 2-aryl-3-ethoxy-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles **11-15**, containing an alkyl or benzyl substituent at position 4 of the triazine ring (Scheme 1).

Peaks for the molecular ions M^+ occur in the mass spectra of compounds **11-15** with intensities of 10-100%. The presence of the ion $[M - OC_2H_5]^{+\cdot}$ (5-100%) in the mass spectra of compounds **11-15** is also characteristic. The maximum peak is most commonly that of the alkyl substituent with $m/z = R^2$ (78-100%). Peaks of ions corresponding to reported fragmentation of the triazine ring [10] are also present (Scheme 2).

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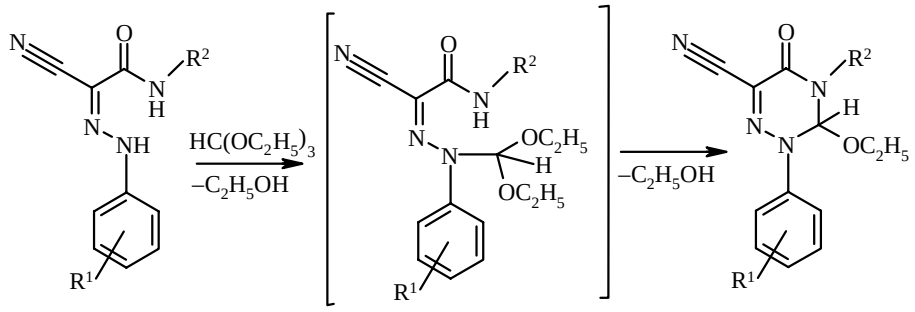
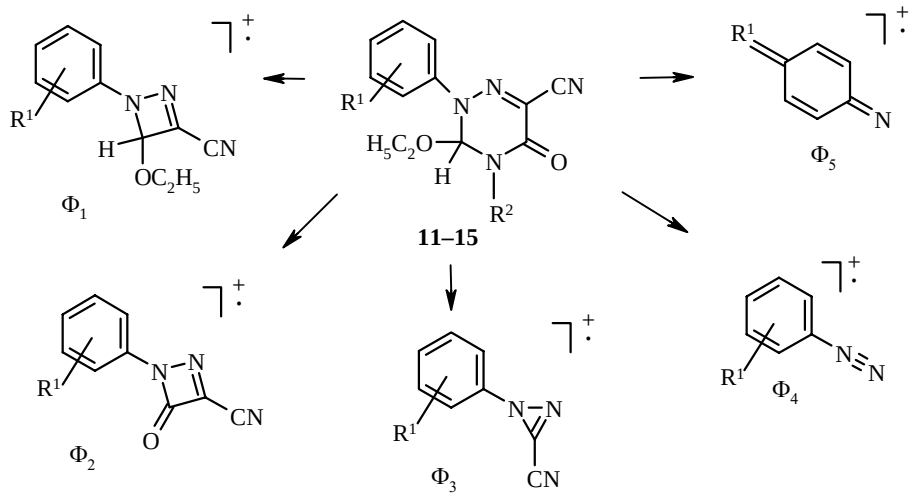
Scheme 1



1-5 **6-10** **11-15**

1, 6, 11a–j, $R^2 = CH_3$, **a** $R^1 = 4\text{-}OCH_3$, **b** $R^1 = 4\text{-}CH_3$, **c** $R^1 = H$, **d** $R^1 = 4\text{-}Cl$, **e** $R^1 = 4\text{-}F$, **f** $R^1 = 3\text{-}CF_3$, **g** $R^1 = 2,4\text{-dichloro}$, **h** $R^1 = 4\text{-}COOC_2H_5$, **i** $R^1 = 4\text{-}NO_2$, **j** $ArR^1 = \beta\text{-naphthyl}$;
2, 7, 12b, d, f $R^2 = C_2H_5$, **b** $R^1 = 4\text{-}CH_3$, **d** $R^1 = 4\text{-}Cl$, **f** $R^1 = 3\text{-}CF_3$;
3, 8, 13a, d, i $R^2 = C_2H_4OCH_3$, **a** $R^1 = 4\text{-}OCH_3$, **d** $R^1 = 4\text{-}Cl$, **i** $R^1 = 4\text{-}NO_2$;
4, 9, 14a, b, d, i $R^2 = C_4H_9$, **a** $R^1 = 4\text{-}OCH_3$, **b** $R^1 = 4\text{-}CH_3$, **d** $R^1 = 4\text{-}Cl$, **i** $R^1 = 4\text{-}NO_2$;
5, 10, 15a, d, i $R^2 = CH_2C_6H_5$, **a** $R^1 = 4\text{-}OCH_3$, **d** $R^1 = 4\text{-}Cl$, **i** $R^1 = 4\text{-}NO_2$

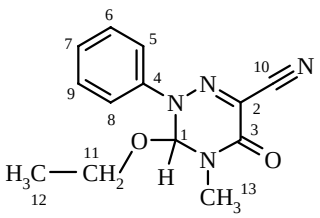
Scheme 2



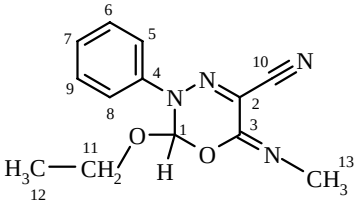
Characteristic stretching frequencies of the cyano group (2210-2230 cm^{-1}), the carbonyl group (1680 cm^{-1}), and the methyl and methylene C–H bonds (2890, 2930, 2940, and 2980 cm^{-1}) were present in the IR spectra of triazines **11-15**. In contrast to the spectra of starting hydrazones **1-5**, the ^1H NMR spectra of triazines **11-15** lacked the signals of the NH protons but included signal of the proton connected with C(3) of the heterocycle at 6.55-7.25 ppm and signals of the ethoxy group protons at 1.0 and 3.4 ppm. The structure of products **11a**,**c**,**d**,**h**, **12d**, **13d**, **14d** was also confirmed by ^{13}C NMR spectra in which the following signals were present: ethoxy group carbons at 13.12-14.65 and 59.52-61.07, an intense signal for C(3) at 90.94-93.26, the carbon of the triazine ring bonded to the cyano group at 113.68-115.50, and the carbon of the CN group at 113.05-113.70 ppm. Carbon atoms of aromatic ring gave resonance signals at 114.74-158.49 , while the signal for the carbon of the carbonyl group appeared at 152.12-152.97 ppm. The possibility of cyclization in this reaction occurring at the other nucleophilic center, the oxygen atom of the carboxamide group, is not excluded. This direction of cyclization should produce ozadiazine **16**.

TABLE 1. Mass Spectroscopic Data for Triazines **11a,c,d,f,h, 12b,f, 13d,i, 14a, 15d,i** , *m/z* (%)

Com-pound	M^+	$(M–OEt)^+$	Φ_1	Φ_2	Φ_3	Φ_4	Φ_5	R_2^+
11a	288 (14.58)	243 (12.51)	231 (0.29)	201 (2.42)	173 (38.23)	135 (9.55)	121 (100)	
11c	258 (38.99)	213 (100)	201 (1.07)	171 (1.82)	143 (25.54)	105 (42.21)	91 (46.91)	
11d	292 (33.37)	247 (31.00)	235 (100)	—	177 (33.64)	139 (39.93)	125 (56.63)	
11f	326 (92.77)	281 (91.85)	269 (6.63)	239 (2.92)	211 (19.75)	173 (27.10)	159 (44.31)	
11h	330 (100)	285 (95.68)	273 (1.25)	243 (0.72)	215 (64.19)	177 (27.15)	163 (88.13)	
12b	286 (77.14)	241 (74.01)	215 (2.27)	185 (3.18)	157 (44.43)	119 (27.52)	105 (48.10)	
12f	340 (56.06)	295 (43.66)	269 (2.77)	239 (1.65)	211 (13.46)	173 (20.99)	159 (27.21)	
13d	336 (100)	291 (77.83)	235 (2.60)	205 (2.33)	177 (42.68)	139 (53.85)	125 (48.71)	59 (84.22)
13i	347 (49.42)	302 (59.72)	246 (2.35)	216 (1.72)	188 (15.55)	150 (46.81)	136 (14.92)	59 (100)
14a	330 (23.80)	285 (22.57)	231 (2.12)	201 (5.83)	173 (40.31)	135 (14.63)	121 (35.12)	57 (100)
15d	368 (24.74)	323 (4.27)	—	—	177 (1.44)	139 (6.13)	125 (6.47)	91 (100)
15i	379 (47.45)	334 (7.31)	—	—	—	150 (4.38)	136 (1.49)	91 (100)



11c



16c

However an investigation of long-range $^{13}C–^{1}H$ coupling constants in the spectrum of compound **11c** showed that, in contrast to structure **16c** for which interaction between C(1)-H(13) and C(13)-H(1) occurs *via* five bonds, these atoms are separated by only three σ-bonds and the appearance of coupling is more likely in this case. Considering the nature of the observed signals (a doublet of quartets) and the presence of the corresponding coupling constants ($^3J_{C(13)–H(1)}$ = 2.0 Hz, $^3J_{C(1)–H(13)}$ = 3.3 Hz) it can be concluded unambiguously that the cyclic product is triazine and not oxadiazine.

In contrast to the reactions of hydrazones **1-5** with normal alkyl substituents on the amide nitrogen, the reactions of the N-phenyl- and N-cyclohexylcarboxamido derivatives **17** and **18** with triethyl orthoformates gave crystalline products which were ascribed the 2-(arylethylhydrazono)-2-cyanoacetamide structures **19** and **20** on the basis of elemental analysis, IR, and ^{1}H NMR spectra. Their formation may be explained by the decrease in reactivity of the amide NH group in hydrazone **1** as a result of introduction of aryl or cycloalkyl substituent which hinders cyclization of intermediates **6-10**. Migration of an ethyl group to the N atom of the hydrazone fragment and ejection of ethyl formate then occurs. Note that reaction of hydrazones **1** with triethyl orthoacetate leads exclusively to the formation of ethylation products, hydrazones **19-21**.

TABLE 2. ^{13}C NMR Spectra of Compounds **11a,c,d,h, 12d, 13d, 14d**, DMSO-d_6, δ, ppm

Compound	–CH_2– $\underline{C}H_3$	R^2	R^1	–$\underline{C}H_2$– CH_3	>CH– (OEt)	C–$\underline{C}$N	$\underline{C}$–CN	C_{ap}	C=O
11a*	14.65	31.84	55.64	59.58	93.26	113.37	113.68	114.74 119.92 135.69 158.49	152.97
11c*[2]	14.46	31.47	—	61.02	91.96	113.37	114.02	117.92 125.97 129.15 141.63	152.36
11d	14.65	31.81	—	61.07	91.90	113.69	114.44	119.81 129.45 130.55 140.52	152.39
11h	14.45	32.15	14.48 61.17 170.05	59.52	92.85	113.05	115.50	117.05 127.85 130.12 145.00	152.55
12d	14.55	13.12 40.71	—	60.51	90.97	113.70	114.71	119.85 129.41 130.50 140.56	151.95
13d	14.58	44.20 58.07 69.02	—	61.10	91.17	113.65	114.98	119.81 129.53 130.60 140.59	152.22
14d	14.56	13.50 19.47 29.59 45.17	—	60.86	90.94	113.67	114.98	119.78 129.39 130.51 140.59	152.12

* Spectrum recorded in $CDCl_3$.

*[2] Spectrum recorded in 1:1 DMSO-d_6–CCl_4.

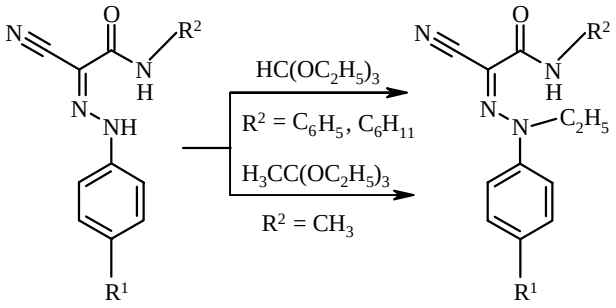
TABLE 3. Characteristics of the Compounds Synthesized

Compound	Empirical formula	Found, % / Calculated, %				mp, °C	Time*	Yield, %
		C	H	N	Cl			
1	2	3	4	5	6	7	8	9
11a	$C_{14}H_{16}N_4O_3$	57.95 58.33	5.43 5.56	19.13 19.44	—	125-126	20	56
11b	$C_{14}H_{16}N_4O_2$	61.82 61.76	6.03 5.88	21.15 21.59	—	160-162	16	48
11c	$C_{13}H_{14}N_4O_2$	60.35 60.47	5.25 5.43	22.11 21.71	—	119-121	14	65
11d	$C_{13}H_{13}ClN_4O_2$	53.44 53.33	4.61 4.44	19.15 19.29	11.86 12.14	157-158	10	67
11e	$C_{13}H_{13}FN_4O_2$	56.45 56.52	4.68 4.71	21.05 20.29	—	116-118	8-9	56
11f	$C_{14}H_{13}F_3N_4O_2$	51.42 51.53	4.05 3.99	17.21 17.18	—	70-72	6	46
11g	$C_{13}H_{12}Cl_2N_4O_2$	47.88 47.71	3.58 3.67	17.50 17.13	21.23 21.71	125-126	12	66
11h	$C_{16}H_{18}N_4O_4$	58.37 58.18	5.61 5.45	17.29 16.97	—	150-152	10	88
11i	$C_{13}H_{13}N_5O_4$	51.55 51.49	4.35 4.29	22.62 23.10	—	149-150	30	54

TABLE 3 (continued)

1	2	3	4	5	6	7	8	9
11j	$C_{17}H_{16}N_4O_2$	66.53 66.22	5.02 5.23	18.50 18.17	—	150-153	15	62
12b	$C_{15}H_{18}N_4O_2$	56.42 56.60	5.52 5.66	20.58 19.58	—	105-109	15	47
12d	$C_{14}H_{15}ClN_4O_2$	54.56 54.81	5.02 4.89	18.56 18.27	11.83 11.58	108-112	16	36
12f	$C_{15}H_{15}F_3N_4O_2$	53.25 53.00	4.68 4.73	24.89 24.08	—	115-118	8	56
13a	$C_{16}H_{20}N_4O_4$	57.75 57.83	5.95 6.02	17.07 16.87	—	98-100	56	49
13d	$C_{15}H_{17}ClN_4O_3$	53.56 53.49	5.14 5.05	16.99 16.64	10.01 10.55	103-105	16	51
13i	$C_{15}H_{17}N_5O_5$	51.93 51.87	5.12 4.90	19.88 20.17	—	144-145	32	59
14a	$C_{17}H_{22}N_4O_3$	62.06 61.81	6.59 6.67	17.03 16.97	—	110-111	18	50
14b	$C_{17}H_{22}N_4O_2$	65.11 64.97	7.12 7.01	18.50 17.84	—	109-110	15	54
14d	$C_{16}H_{19}ClN_4O_2$	57.55 57.40	6.45 5.68	16.92 16.74	11.21 10.61	118-122	7	76
14i	$C_{16}H_{19}N_5O_4$	55.39 55.65	5.67 5.51	19.97 20.29	—	158-162	12	49
15a	$C_{20}H_{20}N_4O_3$	66.21 65.93	5.32 5.49	15.01 15.38	—	88-90	16	55
15d	$C_{19}H_{17}ClN_4O_2$	61.89 61.87	4.45 4.61	15.01 15.19	10.02 9.63	99-102	10	52
15i	$C_{19}H_{17}N_5O_4$	59.98 60.16	4.62 4.49	19.10 18.46	—	164-165	56	58
19d	$C_{17}H_{15}ClN_4O$	62.59 62.48	4.35 4.59	16.77 17.15	11.22 10.87	262-264	20	53
20h	$C_{20}H_{26}N_4O_3$	65.18 64.85	6.92 7.07	15.10 15.12	—	164-165	15	35
20k	$C_{19}H_{26}N_4O_2$	66.89 66.64	7.15 7.65	16.12 16.36	—	165-168	10	40
21d	$C_{12}H_{13}ClN_4O$	54.65 54.44	5.16 4.91	21.07 21.17	13.25 13.42	172-174	5	38
21h	$C_{15}H_{18}N_4O$	66.58 66.66	6.78 6.67	20.81 20.74	—	152-153	8	38
21i	$C_{12}H_{13}N_5O_3$	52.54 52.36	4.63 4.73	25.67 25.45	—	168-170	7	37

* Duration of boiling, h.



17, **18** **19-21**

17, 19, $R^2 = C_6H_5$, **d** R^1 = 4-Cl; **18, 20h,k** $R^2 = C_6H_{11}$, **h** R^1 = 4-$COOC_2H_5$, **k** R^1 = 4-OC_2H_5; **1, 21d,h,i,** $R^2 = CH_3$, R^1= 4-Cl, **h** R^1 = 4-$COOC_2H_5$, **i** R^1 = 4-NO_2

Tetrahydrotriazinones **11-15** are crystalline substances which are quite stable to acids and bases at room temperature, but when boiled in ethanol with an equimolar amount of sulfuric acid they decompose to the starting hydrazones.

Table 4. Spectroscopic Characteristics of 4-Methyltriazinones **11a-j**.

Compound	IR spectrum, ν, cm^{-1}	^{1}H NMR spectrum, δ, ppm, coupling constants (*J*), Hz					
	CH, C≡N, C=O	CH_3CH_2	NCH_3	CH_3CH_2	R^1	CH_{triaz}	CH_{arom}
11a	2980, 2945, 2910, 2230, 1670	1.05 (3H, t, *J* = 8.0)	3.09 (3H, s)	3.41 (2H, ABX_3, *J* = 8.0)	3.80 (3H, s)	6.95 (1H, s)	7.06 and 7.52 (4H, AA'XX', *J* = 9.5)
11b	2985, 2935, 2905, 2230,1670	1.05 (3H, t, *J* = 7.0)	3.10 (3H, s)	3.41 (2H, ABX_3, *J* = 7.0)	2.33 (3H, s)	7.02 (1H, s)	7.25 and 7.56 (4H, AA'BB', *J* = 8.4)
11c	2980, 2940, 2910, 2230, 1670	1.06 (3H, t, *J* = 7.0)	3.12 (3H, s)	3.44 (2H, ABX_3, *J* = 7.0)	—	7.06 (1H, s)	7.45-7.60 (4H, m)
11d	2980, 2940, 2905, 2230, 1670	1.07 (3H, t, *J* = 7.1)	3.09 (3H, s)	3.39 (2H, ABX_3, *J* = 7.1)	—	7.06 (1H, s)	7.60 and 7.55 (4H, AA'BB', *J* = 9.6)
11e	2990, 2945, 2910, 2230, 1670	1.06 (3H, t, *J* = 7.1)	3.11 (3H, s)	3.42 (2H, ABX_3, *J* = 7.1)	—	7.01 (1H, s)	7.30-7.39 (2H, m); 7.50-7.62 (2H, m)
11f	2980, 2240, 1685	1.06 (3H, t, *J* = 7.1)	3.10 (3H, s)	3.41 (2H, ABX_3, *J* = 7.1)	—	7.19 (1H, s)	7.06-7.95 (4H, m)
11g	2980, 2930, 2230, 1670	1.05 (3H, t, *J* = 7.0)	3.09 (3H, s)	3.50 (2H, ABX_3, *J* = 7.0)	—	6.55 (1H, s)	7.62, 7.74, 7.89 (3H, ABX, ^3J = 8.7, ^4J = 2.0)
11h	2980, 2935, 2230, 1715, 1675	1.06 (3H, t, *J* = 7.0)	3.13 (3H, s)	3.45 (2H, ABX_3, *J* = 7.0)	1.34 (3H, t, *J* = 7.5); 4.33 (2H, q, *J* = 7.5)	7.15 (1H, s)	7.65 and 8.05 (4H, AA'XX', *J* = 9.3)
11i	2990, 2950, 2910, 2240, 1690	1.07 (3H, t, *J* = 7.0)	3.14 (3H, s)	3.50 (2H, ABX_3, *J* = 7.0)	—	7.21 (1H, s)	7.78 and 8.36 (4H, AA'XX', *J* = 9.5)
11j	2975, 2930, 2230, 1675	1.06 (3H, t, *J* = 7.1)	3.16 (3H, s)	3.50 (2H, ABX_3, *J* = 7.1)	—	7.25 (1H, s)	7.80 (1H, dd, ^3J = 9.5, ^4J = 2.5); 7.46-7.61 (2H, m); 7.95-8.02 (4H, m)

Table 5. Spectroscopic Characteristics of Compounds **12-15**

Com-pound	IR spectrum, ν, cm^{-1} (CH, C≡N, C=O)	^{1}H NMR spectrum, DMSO-d_6, δ, ppm, coupling constants (*J*), Hz					
		CH_3CH_2	R^2	CH_3CH_2	R^1	CH_{triaz}	CH_{arom}
1	2	3	4	5	6	7	8
12b	2980, 2930, 2230, 1650	1.04 (3H, t, *J* = 7.0)	1.22 (3H, t, *J* = 7.0); 3.58 (2H, q, *J* = 7.0)	3.35 (2H, ABX_3, *J* = 7.0)	2.33 (3H ,s)	7.06 (1H, s)	7.30 and 7.49 (4H, AA'BB', *J* = 8.6)
12d	2985, 2935, 2230, 1660	1.05 (3H, t, *J* = 7.0)	1.22 (3H, t, *J* = 7.0); 3.54 (2H, q, *J* = 7.0)	3.38 (2H, ABX_3, *J* = 7.0)	—	7.11 (1H, s)	7.56 and 7.63 (4H, AA'XX', *J* = 9.3)
12f	2985, 2940, 2225, 1650	1.05 (3H, t, *J* = 7.0)	1.24 (3H, t, *J* = 7.0); 3.61 (2H, q, *J* = 7.0)	3.39 (2H, ABX_3, *J* = 7.0)	—	7.23 (1H, s)	7.70 (2H, m); 7.91 (2H, br. s)
13a*	2980, 2890, 2830, 2230, 1670	1.10 (3H, t, *J* = 7.0)	3.30 (3H, s); 3.48-3.64 (3H, m); 3.83-3.94 (1H, m)	3.40 (2H, ABX_3, *J* = 7.0)	3.81 (3H, s)	6.86 (1H, s)	6.97 and 7.45 (4H, AA'XX', *J* = 9.2)
13d	2980, 2930, 2890, 2230, 1660	1.05 (3H, t, *J* = 6.7)	3.26 (3H, s); 3.50-3.70 (3H, m); 3.80-3.92 (1H, m)	3.40 (2H, ABX_3, *J* = 6.7)	—	7.04 (1H, s)	7.60 and 7.57 (4H, AA'BB', *J* = 9.3)
13i	2980, 2885, 2825, 2230, 1680	1.07 (3H, t, *J* = 6.7)	3.27 (3H, s); 3.58-3.78 (3H, m); 3.80-3.95 (1H, m)	3.43 (2H, ABX_3, *J* = 6.7)	—	7.20 (1H, s)	7.81 and 8.36 (4H, AA'XX', *J* = 9.2)
14a*[2]	2960, 2925, 2850, 2220, 1660	1.18 (3H, t, *J* = 6.7)	0.95 (3H, t, *J* = 7.3); 1.32 (2H, m); 1.63 (2H, m); 3.20-3.35 (1H, m); 3.65 (1H, m)	3.43 (2H, ABX_3, *J* = 6.7)	3.84 (3H, s)	6.34 (1H, s)	6.94 and 7.42 (4H, AA'XX', *J* = 9.3)

TABLE 5 (continued)

1	2	3	4	5	6	7	8
14b	2960, 2935, 2900, 2850, 2220, 1665	1.04 (3H, t, *J* = 7.0)	0.90 (3H, t, *J* = 7.0); 1.30 (2H, m); 1.61 (2H, m); 3.20-3.35 (1H, m); 3.61 (1H, m)	3.40 (2H, ABX_3, *J* = 7.0)	2.33 (3H, s)	7.02 (1H, s)	7.30 and 7.48 (4H, AA'BB', *J* = 8.9)
14d	2980, 2960, 2930, 2860, 2230, 1680	1.05 (3H, t, *J* = 7.0)	0.90 (3H, t, *J* = 7.0); 1.30 (2H, m); 1.60 (2H, m); 3.20-3.35 (1H, m); 3.60 (1H, m)	3.38 (2H, ABX_3, *J* = 7.0)	—	7.08 (1H, s)	7.56 and 7.62 (4H, AA'BB', *J* = 8.9)
14i	2955, 2930, 2860, 2225, 1670	1.06 (3H, t, *J* = 7.0)	0.91 (3H, t, *J* = 7.0); 1.32 (2H, m); 1.67 (2H, m); 3.20-3.35 (1H, m); 3.62 (1H, m)	3.45 (2H, ABX_3, *J* = 7.0)	—	7.24 (1H, s)	7.83 and 8.35 (4H, AA'XX', *J* = 9.0)
15a	2980, 2920, 2230, 1670	0.85 (3H, t, *J* = 7.0)	4.72 and 4.83 (2H, AB, *J* = 15.5); 7.25-7.37 (5H, m)	3.24 (2H, ABX_3, *J* = 7.0)	3.83 (3H, s)	—	6.97-7.25 (5H, m)*[3]
15d	2990, 2920, 2230, 1660	0.82 (3H, t, *J* = 6.7)	4.72 and 4.84 (2H, AB, *J* = 15.0); 7.25-7.42 (5H, m)	3.26 (2H, ABX_3, *J* = 6.7)	—	7.15 (1H, s)	7.57 and 7.62 (4H, AA'BB', *J* = 9.5)
15i	2990, 2930, 2230, 1680	0.83 (3H, t, *J* = 7.0)	4.73 and 4.90 (2H, AB, *J* = 15.3); 7.22-7.43 (6H, m)*[3]	3.25 (2H, ABX_3, *J* = 7.0)	—	—	7.80 and 8.38 (4H, AA'XX', *J* = 9.2)

* ^{1}H NMR spectrum recorded in 1:1 DMSO-d_6–CCl_4.

*[2] ^{1}H NMR spectrum recorded in $CDCl_3$.

*[3] CH-triazine signals hidden by aromatic signals.

TABLE 6. Spectroscopic Characteristics of Compounds **19-21**

Compound	IR spectrum, ν, cm^{-1} NH, C≡N, C=O	^{1}H NMR spectrum, DMSO-d_6, δ, ppm, coupling constants (*J*), Hz					
		CH_3CH_2N	R^1	CH_3CH_2N	R^2	NH	CH_{arom}
19d	3410, 2210, 1675	1.36 (3H, t, *J* = 7.8)	—	4.39 (2H, q, *J* = 7.0)	7.10 (1H, m); 7.35 (2H, m); 7.67 (2H, d, *J* = 7.4)	9.67 (1H, s)	7.52 and 7.60 (4H, AA'BB', *J* = 9.2)
20h	3410, 2210, 1710, 1675	1.36 (3H, t, *J* = 7.0)	1.33 (3H, t, *J* = 6.7); 4.49 (2H, q, *J* = 6.7)	4.32 (2H, q, *J* = 7.0)	1.00-1.85 (10H, m); 3.65 (1H, m)	7.57 (1H, d, *J* = 8.5)	7.65 and 8.00 (4H, AA'BB', *J* = 8.8)
20k	3410, 2210, 1675	1.33 (3H, br. s)	1.35 (3H, br. s); 4.48 (2H, q, *J* = 5.8)	4.31 (2H, q, *J* = 7.0)	1.00-1.95 (10H, m); 3.65 (1H, m)	7.57 (1H, d, *J* = 8.3)	7.65 and 8.00 (4H, AA'XX', *J* = 8.4)
21d	3410, 2210, 1675	1.30 (3H, t, *J* = 7.0)	—	4.36 (2H, q, *J* = 7.0)	2.74 (3H, d, *J* = 4.9)	7.85 (1H, q, *J* = 4.9)	7.47 and 7.58 (4H, AA'BB', *J* = 8.2)
21h	3420, 2210, 1710, 1680	1.30-1.40 (6H, m)	4.50 (2H, q, *J* = 7.3)*	4.35 (2H, q, *J* = 7.1)	2.76 (3H, d, *J* = 4.7)	7.90 (1H, q, *J* = 4.7)	7.70 and 8.24 (4H, AA'XX', *J* = 8.9)
21i	3420, 2210, 1680	1.36 (3H, t, *J* = 7.2)	—	4.55 (2H, q, *J* = 7.2)	2.78 (3H, d, *J* = 4.8)	8.03 (1H, q, *J* = 4.8)	7.84 and 8. (4H, AA'XX', *J* = 9.5)

* Signals of the $OCH_2\underline{CH_3}$ methyl group overlap those of the $NCH_2\underline{CH_3}$ methyl group.

As a result of this study we have developed a new and convenient method for the synthesis of 4-alkyl-2-aryl-3-ethoxy-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles which opens a route to previously inaccessible functionally substituted tetrahydrotriazines.

EXPERIMENTAL

The course of reactions and the purity of the compounds synthesized were monitored by thin layer chromatography on Silufol UV-254 strips with the solvent systems 6:1, 10:1, and 15:1 chloroform–ethanol, and 2:1 hexane–ethyl acetate. IR spectra were recorded on a UR-20 spectrophotometer in KBr discs, ^{1}H NMR spectra were recorded with Bruker (80 MHz), Bruker WM-250 (250 MHz), and Bruker (400 MHz) with TMS as internal standard, and mass spectra by direct injection on a Varian MAT 311A mass spectrometer, ionizing voltage 70 eV. Physicochemical and spectroscopic characteristics of all the compounds synthesized are given in Tables 1-6.

2-Aryl-3-ethoxy-4-methyl-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles (11a-j). Hydrazone **1a-j** (0.002 mol) was boiled in triethyl orthoformate (5 ml). Completion of the reaction was determined by disappearance of the starting material using TLC (Table 3). The reaction mixture was evaporated in vacuum, the residue was treated with propanol-2 (5 ml) and kept in the refrigerator for 18-20 h. The resultant precipitate was filtered off and recrystallized from ethanol.

4-Methyl-3-ethoxy-5-oxo-2-phenyl-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitrile 11c. ^{13}C NMR spectrum (DMSO-d_6 + CCl_4, δ, ppm, coupling constant (*J*), Hz): 14.46 (qt, ^1J = 126.3, ^2J = 3.0, C(12)); 31.47 (qd, ^1J = 141.0, ^2J = 2.0, C(13)); 61.02 (tqd, ^1J = 143.0, ^2J = 4.7, C(11)); 91.96 (dtq, ^1J = 181.9, ^3J = 3.3, C(1)); 113.37 (s, C(10)); 114.02 (s, C(2)); 117.92 (ddt, ^1J = 161.0, ^2J = 5.5, C(6), C(9)); 125.7 (dt, ^1J = 164.2, ^2J = 7.4, C(7)); 129.15 (dd, ^1J = 163.6, ^{2}J = 8.0, C(5), C(8)); 141.63 (td, ^2J = 9.5, ^3J = 1.5 C(4)); 153.26 (dq, ^3J = 3.2 C(3)).

2-Aryl-3-ethoxy-4-ethyl-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles (12b,d,f), 2-Aryl-4-methoxyethyl-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles (13a,d,i), 2-Aryl-4-butyl-3-ethoxy-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles (14a,b,d,i), and 4-Benzyl-3-ethoxy-2-(4-nitrophenyl)-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitrile 15i were prepared by the same method as for triazinones **11a-i**.

2-Aryl-4-benzyl-3-ethoxy-5-oxo-2,3,4,5-tetrahydro-1,2,4-triazin-6-carbonitriles (15a,d). Hydrazones **5a-d** (0.002 mol) were boiled in triethyl orthoformate (5 ml). The solvent was evaporated in vacuum, the residue was treated with aqueous ethanol (5 ml) and extracted with hexane (3 × 10 ml). The extract was evaporated in vacuum, treated with propanol-2 (5 ml) and kept in the refrigerator for 18-20 h until a precipitate was formed. The product was filtered off and crystallized from propanol-2.

2-[(4-Chlorophenyl)ethylhydrazono]-N-phenyl-2-cyanoacetamide (19d), 2-(Arylethylhydrazono)-N-cyclohexyl-2-cyanoacetamides (20h,k), and 2-(Arylethylhydrazono)-N-methyl-2-cyanoacetamides (21d,h,i). Hydrazones **17d**, **18h,k**, or **1d,h** (0.002 mol) were boiled in triethyl orthoformate (5 ml). The reaction mixture was cooled, the precipitate was filtered off and recrystallized from ethanol.

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