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SYNTHESIS AND SOME REACTIONS OF 1-α-CYANOALKYL(ARALKYL)-2-PYRAZOLINES

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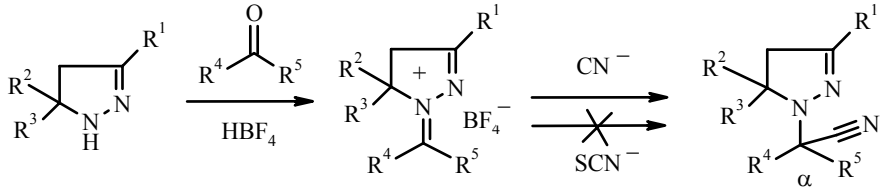
1-α-Cyanoalkyl(aralkyl)-2-pyrazolines were obtained by the reaction of 1-alkylidene(arylidene)-2-pyrazolinium tetrafluoroborates with metal cyanides. Reduction of the products led to substituted β-aminoalkyl-2-pyrazolines. Hydrolysis of the nitrile groups gave the corresponding substituted acetamides.

Keywords: 1-alkylidene(arylidene)2-pyrazolinium tetrafluoroborates, β-(4,5-dihydropyrazol-1-yl)-alkylamines, α-(4,5-dihydropyrazol-1-yl)acetamides, α-(4,5-dihydropyrazol-1-yl)acetonitriles.

We have shown [1,2] that 1-alkylidene(arylidene)2-pyrazolinium tetrafluoroborates **1** are prospective synthons for the preparation of both 1-benzyl(hetarylmethyl)-2-pyrazolines and 1-benzyl(hetarylmethyl)-pyrazolidines. The success of these syntheses depends on the us of C=N bonds with different reactivities in these salts. We have shown previously the possibility in principle of the reaction of salt **1** with metal cyanides [2]. The present paper is concerned with further study of this process and further reactions of the functional derivatives of the 2-pyrazolines synthesized. Under inter-phase reaction conditions (ether-water) attack by the cyanide occurs regioslectively only at the exocyclic C=N$^+$ bond of the arylidenium salt at room temperature for 1-3 h to give 1-α-cyanobenzyl-2-pyrazolines **2a-f, i, j, m, n.**



1a–n **2 a–n**

1, 2 a–h, **n** R^1 = Ph, **i–m** R^1 = Me; **a–l, n** R^2 = H, **m** R^2 = Me; **a–h** R^3 = H, **i–l, n** R^3 = Ph, **m** R^3 = Me; **a–f, i, j, m, n** R^4 = H; **g, k** R^4 = Me, **h, l** R^4+R^5 = *c*-C_6H_{10}; **a, j, m, n** R^5 = Ph, **b** R^5 = C_6H_4Cl-*p*, **c** R^5 = C_6H_4OMe-*p*, **d** R^5 = 1-ethyl-3-methyl-4-pyrazolyl, **e, i** R^5 = Fur-2, **f** R^5 = Ind-3, **g, k** R^5 = Me

The reaction is of a general nature. The yields of the desired products (85-95%) depend only slightly on the substituents on either the pyrazoline nucleus or the arylidenium unit. It was determined chromatographically that the reaction mixtures contained negligible amounts of 2-pyrazolines without substituents at N, formed by hydrolytic scission of salt **1**.

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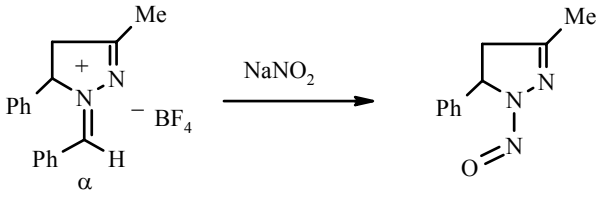
In the ^{1}H NMR spectra of compounds **2** the signals of the protons of the pyrazoline ring are shifted to strong field in comparison with the arylidenium salts of 2-pyrazoline [1,2]. The α-H signal appears in the region of 4.8-5.2 ppm. The C=N$^+$ vibration (1640) is absent from the IR spectrum and the carbon-nitrogen triple bond absorption appears in the 2320-2240 cm^{-1} region (Tables 1 and 2).

Nitriles with pyrazole, indole, and furan nuclei in the arylidene unit of the molecule were prepared analogously. The reaction of 1-alkylidene-2-pyrazolium tetrafluoroborate with potassium cyanide also occurred selectively at the exocyclic C=N$^+$ bond.

When sodium cyanide was used as the nucleophile in the reaction with compound **1j** in the conditions described above the only product was 1-nitrosopyrazoline-2 **3**, the melting point of which agreed with the literature value [3]. The formation of the derivative **3** is evidently the result of the formation of pyrazoline with no substituent on N and its subsequent nitrosation.



1j **3**

The signals of one aromatic ring and α-H are absent from the ^{1}H NMR spectrum of compound **3** and the H-5 signal appears at a weaker field (5.63 ppm) than in alkyl-2-pyrazolines [1,2]. The synthesis of 1-nitrosopyrazolines is well known [3,4].

Salts **1** did not react with potassium thiocyanate under our reaction conditions.

TABLE 1. Characteristics of 2-Pyrazolines

Compound	Empirical formula	Found, % / Calculated, %			mp, °C	Yield, %
		C	H	N		
2a	$C_{17}H_{15}N_3$	78.16 / 78.21	5.75 / 5.66	16.36 / 16.09	91-93	79
2b	$C_{17}H_{14}ClN_3$	69.08 / 69.03	4.52 / 4.73	13.99 / 14.21	118-119	82
2c	$C_{18}H_{17}N_3O$	74.23 / 74.47	5.84 / 5.81	14.48 / 14.43	122-124	94
2d	$C_{17}H_{14}N_5$	69.59 / 69.62	6.75 / 6.48	23.94 / 23.80	138-139	80
2e	$C_{15}H_{13}N_3O$	71.99 / 71.71	5.09 / 5.18	16.99 / 16.73	86-87	68
2f	$C_{19}H_{16}N_4$	75.71 / 76.00	5.30 / 5.00	18.62 / 18.66	153-154	79
2g	$C_{13}H_{15}N_3$	73.55 / 73.24	6.98 / 7.04	19.56 / 19.72	104-105	86
2h	$C_{16}H_{19}N_3$	76.05 / 75.89	7.83 / 7.51	16.57 / 16.60	114-115	81
2i	$C_{16}H_{15}N_3O$	72.47 / 72.45	5.68 / 5.66	15.70 / 15.85	82-83	75
2l	$C_{17}H_{21}N_3$	76.58 / 76.40	8.10 / 7.86	15.90 / 15.73	89-90	84
2k	$C_{14}H_{17}N_3$	73.83 / 74.01	7.60 / 7.48	18.41 / 18.50	76-77	67
2n	$C_{23}H_{19}N_3$	81.87 / 81.89	5.77 / 5.64	12.50 / 12.46	155-156	78

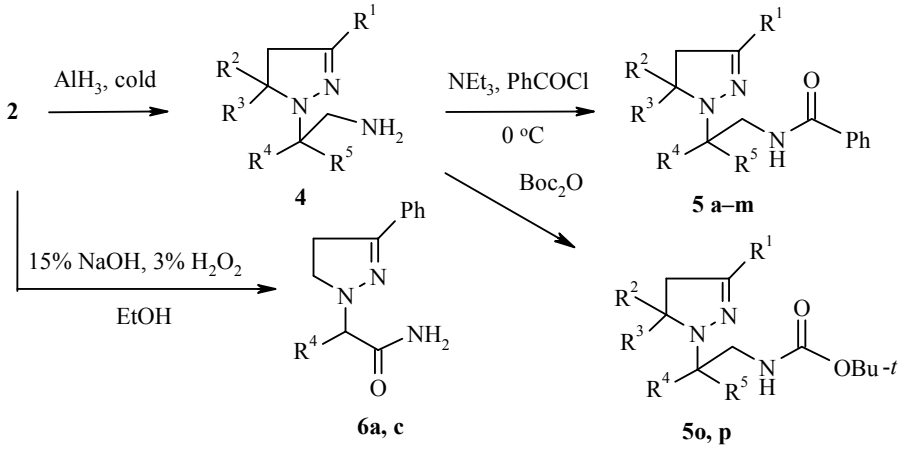
TABLE 2. Spectroscopic Characteristics of Compounds **2**

Com-pound	IR spectrum, ν, cm^{-1}	^1H NMR spectrum, δ, ppm (*J*, Hz)
2a	1575, 2242	3.16 (4H, m, H-4,5); 5.90 (1H, s, CH); 7.30-7.70 (5H, m, H_{Ph})
2b	1635, 2245	3.03 (1H, m, H-4); 3.18 (3H, m, H-4,5); 5.77 (1H, s, 1-CH); 7.38 (3H, m, H_{Ph}); 7.42 (2H, d, *J* = 8, H_{Ar}); 7.56 (2H, d, *J* = 8, H_{Ar}); 7.67 (2H, m, H_{Ph})
2c	1265, 1620, 2240	3.14 (4H, m, H-4,5); 3.85 (3H, s, OCH_3); 5.88 (1H, s, 1-CH); 6.95 (2H, d, *J* = 8, H_{Ar}); 7.39-7.53 (5H, m, H_{Ph}); 7.69 (2H, d, *J* = 8, H_{Ar})
2d	1560, 2245	1.42 (3H, t, *J* = 7, $\underline{CH_3}CH_2$); 2.28 (3H, s, CH_3); 3.09 (4H, m, H-4,5); 4.04 (2H, q, *J* = 7, $\underline{CH_2}CH_3$); 5.53 (1H, s, CH); 7.20 (1H, s, H_{Pyr}); 7.31 (3H, m, H_{Ph}); 7.61 (2H, m, H_{Ph})
2e	1570, 2250, 3160	2.97 (1H, m, H-4); 3.19 (3H, m, H-4,5); 5.78 (1H, s, CH); 6.37 (1H, m, 5-H_{Fur}); 6.55 (1H, m, 4-H_{Fur}); 7.31 (3H, m, H_{Ph}); 7.42 (1H, m, 3-H_{Fur}); 7.62 (2H, m, H_{Ph})
2f	1560, 2250, 3370	2.95 (1H, m, H-4); 3.23 (3H, m, H-4,5); 6.11 (1H, s, CH); 7.18 (1H, m, 5-H_{ind}); 7.25 (1H, m, 6-H_{Iind}); 7.42 (5H, m, H_{Ph}); 7.75 (2H, m, 4-H_{ind}, 7-H_{ind}); 7.88 (1H, d, *J* = 8, 2-H_{ind}); 8.40 (1H, s, NH)
2g	1570, 2235	1.72 (6H, s, CH_3); 3.08 (2H, t, *J* = 9, H-4); 3.35 (2H, t, *J* = 9, H-5); 7.35-7.69 (5H, m, H_{Ph})
2h	1570, 2230	1.41 (1H, m, *c*-C_6H_{10}); 1.70 (3H, m, *c*-C_6H_{10}); 1.87 (4H, m, *c*-C_6H_{10}); 2.38 (2H, m, *c*-C_6H_{10}); 3.06 (2H, t, *J* = 9, H-4); 3.35 (2H, t, *J* = 9, H-5); 7.35 (3H, m, H_{Ph}); 7.67 (2H, m, H_{Ph})
2i	1520, 2250, 3150	2.03 (3H, s, CH_3); 2.74 (1H, m, H-4); 3.04 (1H, m, H-4); 4.37 (1H, m, H-5); 4.87 (1H, s, CH); 6.39 (1H, m, 4-H_{fur}); 6.61 (1H, m, 3-H_{fur}); 7.18 (1H, m, 5-H_{fur}); 7.39 (3H, m, H_{Ph}); 7.51 (2H, m, H_{Ph})
2k	1630, 2235	1.04 (3H, s, 5-CH_3); 1.72 (3H, s, 5-CH_3); 1.94 (3H, s, 3-CH_3); 2.54 (1H, m, H-4); 3.15 (1H, m, H-4); 4.37 (1H, m, H-5); 7.18-7.33 (5H, m, H_{Ph})
2l	1610, 2230	1.10 (2H, m, *c*-C_6H_{10}); 1.34-1.62 (6H, m, *c*-C_6H_{10}); 1.78 (2H, m, *c*-C_6H_{10}); 2.00 (3H, s, CH_3); 2.58 (1H, m, H-4); 3.22 (1H, m, H-4); 4.47 (1H, m, H-5); 7.22-7.28 (5H, m, H_{Ph})
2n	1590, 2245	3.07 (1H, m, H-4); 3.74 (1H, m, H-4); 4.63 (1H, t, H-5); 5.01 (1H, s, CH); 7.32-7.72 (15H, m, H_{Ph})

From the structures of the pyrazolines synthesized it is seen that the products of selective reduction of the nitrile group should be derivatives of phenylethylamines which are known for their pharmacological activity [5]. The conditions for the reduction of nitrile grous are determined in large measure by the nature of the substituents [6-8], which frequently complicates the process. In fact reduction of compounds **2j,m** with an excess of either $LiAlH_4$ or AlH_3 in boiling ether gave a mixture which was difficult to separate. According to chromato-mass spectrometry, the mixture contained the desired product together with products of exhaustive reduction with elimination of the benzyl and methylimine groups. In order to avoid processes caused by the presence of the acidic H-α proton*, conditions for selective reduction were developed using the 1-cyanoalkyl-2-pyrazolines **2h,g,k,l** in which an α-H is absent. Reduction of these compounds with aluminum hydride at -4°C and an increased reaction time of 4 h allowed us to obtain the corresponding amines **4**, which were isolated as NHBoc **5o** or their benzoyl derivatives **5g,h,k,l***[2]. In the ^1H NMR spectra there are signals of non-equivalent protons of the CH_2 group at 3.44 and 3.73 pp. The nitrile group absorption is absent from the IR spectrum, but bands for the amide carbonyl group appear in the 1640-1660 cm^{-1} region.

* Formation of anions occurs even under weakly basic conditions with nitriles having a proton in the α-position [9].

*[2] The hydrochlorides of the amines formed are hygroscopic.



6 **a** R^4 = Ph; **c** R^4=C_6H_4OMe-*p*

Lower reaction temperatures (from ~50 to ~80°C) were necessary for the reduction of 1-α-cyanobenzyl-2-pyrazolines with a proton α to the nitrile group. The amines produced were also isolated as NHBoc **5p** or as the benzoyl derivatives **5a-f,i,j,m,n**. In their ^{1}H NMR spectra the signal of the α-H-1 was shifted to strong field from ~5.5 to ~4.0 ppm comparison with the pyrazoline starting materials **2** and the signal was split into a multiplet. Their IR spectra contained an amide carbonyl band at 1640-1660 cm^{-1}, but the nitrile band was absent. Molecular ions are absent from the mass spectra of these compounds **5**, but the fragmentation corresponds to the proposed structures. The reaction has a general nature, except for 1-cyanobenzyl-3,5-diphenylpyrazoline (**2n**) which was recovered unchanged from the reduction reaction under our conditions. It should be noted that

TABLE 3. Characteristics of the Pyrazolines **5**

Compound	Empirical formula	Found, % / Calculated, %			mp, °C	Yield, %
		C	H	N		
5a	$C_{24}H_{23}N_3O$	77.89 / 78.05	6.50 / 6.23	11.36 / 11.38	128-129	62
5b	$C_{24}H_{22}ClN_3O$	71.42 / 71.37	5.64 / 5.45	10.30 / 10.41	154-155	72
5c	$C_{25}H_{25}N_3O_2$	74.99 / 75.19	6.16 / 6.26	10.53 / 10.53	159-160	84
5d	$C_{24}H_{27}N_5O$	71.56 / 71.82	6.50 / 6.73	17.28 / 17.46	106-107	54
5e	$C_{22}H_{21}N_3O_2$	73.21 / 73.53	5.85 / 6.23	11.96 / 11.69	94-95	62
5f	$C_{26}H_{24}N_4O$	76.80 / 76.47	5.84 / 5.88	13.57 / 13.72	201-202	59
5g	$C_{20}H_{23}N_3O$	74.48 / 74.76	7.21 / 7.16	12.98 / 13.08	82-83	68
5h	$C_{23}H_{27}N_3O$	76.88 / 76.45	7.36 / 7.47	11.41 / 11.63	122-123	71
5i	$C_{23}H_{23}N_3O_2$	73.80 / 73.99	6.08 / 6.17	11.43 / 11.26	157-158	47
5j	$C_{25}H_{25}N_3O$	78.09 / 78.32	6.47 / 6.53	11.15 / 10.96	98-99	43
5k	$C_{24}H_{25}N_3O$	75.50 / 75.22	7.29 / 7.46	12.28 / 12.54	122-123	52
5l	$C_{24}H_{29}N_3O$	76.65 / 76.80	7.64 / 7.73	11.00 / 11.20	137-138	64
5m	$C_{21}H_{25}N_3O$	75.52 / 75.22	7.75 / 7.46	12.27 / 12.54	112-113	69

derivatives of 3-methyl-5-phenylpyrazoline were reduced in worse yields than pyrazolines which did not contain a 5-phenyl substituent (Table 3), so it can be proposed that not only a proton α to the nitrile but also a phenyl group at position 5 of the pyrazoline affects the reaction.

It is significant that the pyrazoline ring and other heterocyclic substituents at the α-position of nitriles **2** were retained under our reaction conditions.

Hydrolysis of 1-α-cyano derivatives of 2-pyrazolines **2a,c** with aqueous-ethanolic NaOH in the presence of hydrogen peroxide gave the corresponding amides **6a,c** in ~40% yield. In their ^{1}H NMR spectra the signal of α-H-1 is shifted to strong field at ~5.5 to ~4.5 ppm in comparison with the pyrazoline starting materials **2** and

TABLE 4. Spectral Characteristics of Compounds **5**

Com-pound	IR spectrum, ν, cm^{-1}	^{1}H NMR spectrum, δ, ppm (*J*, Hz)
5a	1570, 1655, 3310	2.95 (3H, m, H-4,5); 3.35 (1H, m, H-5); 3.95 (1H, m, CH_2); 4.12 (1H, m, CH); 4.27 (1H, m, CH_2); 7.32-7.88 (15H, m, H_{Ph})
5b	1565, 1650, 3420	2.95 (3H, m, H-4,5); 3.20 (1H, m, H-5); 3.95 (1H, m, CH_2); 4.08 (1H, m, CH); 4,18 (1H, m, CH_2); 7.32-7.39 (8H, m, H_{Ph}); 7.42 (2H, d, *J* = 8, H_{Ar}); 7.66 (2H, m, H_{Ph}); 7.79 (2H, d, *J* = 8, H_{Ar})
5c	1250, 1620, 1640, 1305	2.91 (3H, m, H-4,5); 3.22 (1H, m, H-5); 3.80 (3H, s, OCH_3); 3.95 (1H, m, CH_2); 4.06 (1H, m, CH); 4.18 (1H, m, CH_2); 6.89 (2H, d, *J* = 8, H_{Ar}); 7.35 (8H, m, H_{Ph}); 7.64 (2H, m, H_{Ph}); 7.79 (2H, d, *J* = 8, H_{Ar})
5d	1580, 1635, 3350	1.42 (3H, t, *J* = 7, $\underline{CH_3}CH_2$); 2.30 (3H, s, CH_3); 2.95 (2H, m, H-4); 3.07 (1H, m, H-5); 3.16 (1H, m, H-5); 3.90 (1H, m, CH_2); 4.05 (3H, m, CH_2, CH); 4.24 (2H, q, *J* = 7, $\underline{CH_2}CH_3$); 7.25 (1H, s, H_{Pyr}); 7.37-7.81 (10H, m, H_{Ph})
5e	1570, 1630, 3320	2.98 (2H, m, H-4); 3.22 (2H, m, H-5), 4.09 (1H, m, CH_2); 4.24 (1H, m, CH_2); 4.47 (1H, m, CH); 6.30 (1H, m, 5-H_{Fur}); 6.35 (1H, m, 4-H_{Fur}); 7.38-7.50 (8H, m, H_{Ph}); 7.65 (1H, m, 3-H_{Fur}); 7.81 (2H, m, H_{Ph})
5g	1590, 1650, 3300	1.24 (6H, s, CH_3); 2.09 (2H, t, *J* = 9, H-4); 3.33 (2H, t, *J* = 9, H-5); 3.75 (2H, d, *J* = 5.2, CH_2); 7.36-7.86 (10H, m, H_{Ph})
5h	1570, 1665, 3430	1.45-1.71 (8H, m, *c*-C_6H_{10}); 1.85 (2H, m, *c*-C_6H_{10}); 3.02 (2H, t, *J* = 9, H-4); 3.36 (2H, t, *J* = 9, H-5); 3.71 (2H, d, *J* = 5, CH_2); 7.29-7.45 (6H, m, H_{Ph}); 7.63 (2H, m, H_{Ph}); 7.75 (2H, m, H_{Ph})
5f	1580, 1630, 3280, 3365	2.86 (2H, m, H-4); 3.04 (1H, m, H-5); 3.23 (1H, m, H-5); 4.10 (1H, m, CH_2); 4.21 (1H, m, CH_2); 4.54 (1H, m, CH); 7.06 (1H, m, 5-H_{ind}); 7.11 (2H, m, 6-H_{ind}, H_{Ph}); 7.31 (6H, m, H_{Ph}); 7.40 (1H, m, 2-H_{ind}); 7.66 (2H, m, H_{Ph}); 7.82 (4H, m, 4-H_{ind}, 7-H_{ind}, H_{Ph}); 8.46 (1H, s, NH)
5i	1520, 1650, 3400	2.00 (3H, s, CH_3); 2.89 (1H, m, H-4); 3.00 (1H, m, H-4); 4.10 (1H, m, CH_2); 4.35 (1H, m, CH_2); 4.52 (1H, m, CH); 6.30 (1H, m, 5-H_{Fur}); 6.35 (1H, m, 4-H_{Fur}); 7.38-7.50 (8H, m, H_{Ph}); 7.65 (1H, m, 3-H_{Fur}); 7.81 (2H, m, H_{Ph})
5j	1570, 1765, 3420	1.95 (3H, s, CH_3); 2.62 (1H, m, H-4); 2.98 (1H, m, H-4); 3.68 (1H, m, CH_2); 3.88 (1H, m, CH_2); 4.19 (1H, m, H-5); 4.21 (1H, m, CH); 7.19-7.49 (8H, m, H_{Ph}); 7.74 (2H, m, H_{Ph})
5k	1580, 1640, 3310	0.89 (3H, s, CH_3); 1.12 (3H, s, CH_3); 1.97 (3H, s, CH_3); 2.57 (1H, m, H-4); 3.15 (1H, m, H-4); 3.44 (1H, m, CH_2); 3.74 (1H, m, CH_2); 4.48 (1H, m, H-5); 7.30 (3H, m, H_{Ph}); 7.38-7.48 (5H, m, H_{Ph}); 7.73 (2H, m, H_{Ph})
5l	1530, 1560, 3450	1.10 (1H, m, *c*-C_6H_{10}); 1.25 (1H, m, *c*-C_6H_{10}); 1.36-1.60 (8H, m, *c*-C_6H_{10}); 1.95 (3H, s, CH_3); 2.54 (1H, m, H-4); 3.18 (1H, m, H-4); 3.70 (1H, m, CH_2); 3.88 (1H, m, CH_2); 4.63 (1H, t, *J* = 11, H-5); 7.19-7.49 (8H, m, H_{Ph}); 7.74 (2H, m, H_{Ph})
5m	1540, 1630, 3320	0.78 (3H, s, 5-CH_3); 1.17 (3H, s, 5-CH_3); 2.00 (3H, s, 3-CH_3); 2.45 (2H, dd, *J* = 14, *J* = 6, H-4); 3.79 (1H, m, CH_2); 3.96 (1H, m, CH_2); 4.21 (1H, m, CH); 7.30 (3H, m, H_{Ph}); 7.40-7.49 (5H, m, H_{Ph}); 7.74 (2H, m, H_{Ph})

signals occur for the NH_2 group at 7.08 and 7.49 ppm. Absorption bands corresponding to the amide carbonyl group occur in the IR spectrum at 1640-1660 cm^{-1}. When the hydrolysis was carried out on an aluminum oxide surface without solvent but with microwave irradiation according to [10] the nitrile starting materials was only 25% hydrolyzed according to ^1H NMR data.

EXPERIMENTAL

The course of reactions was monitored by TLC on Silufol UV-254 strips with 4:1 benzene-ethyl acetate as eluant and with iodine vapor as developing agent. IR spectra of nujol mulls were recorded with a UR-20 machine. ^1H NMR spectra of $CDCl_3$ (**3,5,6a**) or DMSO-d_6 (**6c**) solutions with TMS as internal standard were recorded with Varian VXR-400 (400 MHz) and Bruker Avance 400 (400 MHz) machines.

Arylidenium Salts of 2-Pyrazolines 1a-n (General Method) [1, 2]. 50% HBF_4 (10 ml) was added slowly to a solution of 2-pyrazoline (0.1 mol) in methylene chloride (15 ml). An aldehyde or ketone (0.1 mol) in methylene chloride (5 ml) was added with vigorous stirring and stirring was continued for 2-6 h. The crystals* which formed were filtered off, washed with water until neutral and then several times with ether. The residue was recrystallized from ethanol.

1-α-Cyanobenzyl-2-pyrazolines 2a-n (General Method). A solution of a metal cyanide (0.3 mol) in water (50 ml) was added to a suspension of an arylidenium salt of 2-pyrazoline **1a-n** (15 mmol) in ether (100 ml). The reaction mixture was stirred until the pyrazolinium salt had dissolved completely. The ether layer was separated, the aqueous layer was extracted with ether, the combined ether extracts were dried over sodium sulfate and evaporated. The residue was recrystallized from ethanol or ethyl acetate (Tables 1 and 2).

3-Methyl-1-nitroso-5-phenyl-2-pyrazoline (3). Sodium nitrite (4.8 g, 700 mmol) in water (50 ml) was added to a suspension of the arylidenium salt **1j** (2 g, 7 mmol) in ether (100 ml). The reaction mixture was stirred until the pyrazolinium salt had dissolved completely. The ether layer was separated, the aqueous layer was extracted with ether, the combined ether extracts were dried over sodium sulfate and evaporated. The yield of compound **3** was 0.6 g (50%); mp 96-97°C (mp 96.5-97.5°C [7]). IR spectrum, ν, cm^{-1}: 1420 (NO), 1630 (C=N). ^1H NMR spectrum, δ, ppm: 2.26 (3H, s, CH_3); 2.75 (1H, m, H-4); 3.42 (1H, m, H-4); 5.63 (1H,m, H-5); 7.10-7.32 (5H, m, H_{Ph}).

[β-(4,5-Dihydropyrazol-1-yl)ethyl]benzamides 5a-n (General Method). Pyrazoline **2a-n** (5.7 mmol) was added to a cooled*[2] suspension of aluminum hydride (23 mmol), made by the usual method [11], in ether, the mixture was stirred for 4 h. Water (92 mmol) was added to the mixture at the same temperature, the inorganic residue was filtered off and washed with THF, the combined organic liquids were dried over potassium carbonate, and the solvents were evaporated. The residue was dissolved in methylene chloride, cooled to 0°C, triethylamine (5 mmol) was added followed by benzoyl chloride (5 mmol) which was added dropwise with vigorous stirring. The reaction mixture was stirred, poured into water, and extracted 4 times with chloroform. The organic layers were combined, washed with water and soda solution, dried over sodium sulfate, and evaporated. The residue was recrystallized from ethanol (an oil was chromatographed on a dry column with benzene).

***tert*-Butyl 1-(3-Methyl-5-phenyl-4,5-dihydro-1H-pyrazol-1-yl)cyclohexyl-1-methylcarbamate (5o).** Nitrile **2l** was reduced by the method given above. The oily residue was dissolved in ether, Boc_2O (0.7 g, 3.5 mmol) was added with cooling, the mixture was stirred for 6h, evaporated, chromatographed on a dry

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* If crystals did not separate, the aqueous layer was separated, the organic layer was washed with water to pH 7, evaporated, and the residue used in reactions without further purification.

*[2] A temperature from -50 to -70°C was used for 1-α-cyanobenzylpyrazolines and a temperature of -4°C for 1-α-cyanobenzyl-2-pyrazolines.

column, eluted with benzene and then 4:1 benzene–ethyl acetate to give compound **5o**, yield 0.8 g (58%); mp 86-87°C. IR spectrum, ν, cm^{-1}: 1635 (C=N), 1715 (C=O), 3440 (NH). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 1.30 (4H, m, *c*-C_6H_{10}); 1.41 (9H, s, CH_3); 1.46 (6H, m, *c*-C_6H_{10}); 1.91 (3H, s, 3-CH_3); 2.48 (1H, m, H-4); 3.15 (1H, m H-4); 3.44 (2H, d, *J* = 5.6, CH_2); 4.59 (1H, m, H-5); 5.25 (1H, s, NH); 7.27-7.36 (5H, m, H_{Ph}). Found, %: C 71.09; H 8.75; N 11.50. $C_{22}H_{33}N_3O_2$. Calculated, %: C 71.15; H 8.89; N 11.32.

***tert*-Butyl 1-(3,5,5-Trimethyl-4,5-dihydro-1H-pyrazol-1yl)-2-phenylethylcarbamate (5p)** was prepared analogously to **5o**. Yield 0.9 g (78%); mp 55-56°C. IR spectrum, ν, cm^{-1}: 1625 (C=N), 1710 (CO), 3290 (NH). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 0.74 (3H, s, 5-CH_3); 1.17 (3H, s, 5-CH_3); 1.41 (9H, s, CH_3); 1.93 (3H, s, 3-CH_3); 1.84 (2H, s, H-4); 3.49 (1H, m, CH_2); 3.56 (1H, m, CH_2); 4.07 (1H, m, CH); 5.18 (1H, m, NH); 7.22-7.43 (5H, m, H_{Ph}). Found, %: C 69.10; H 8.99; N 12.44. $C_{19}H_{29}N_3O_2$. Calculated, %: C 69.88; H 8.76; N 12.68.

1-(3-Phenyl-4,5-dihydropyrazol-1-yl)phenylacetamide (6a). A solution of 3% hydrogen peroxide (15 ml) and 15% aqueous sodium hydroxide (0.125 ml) was added dropwise to a hot solution of nitrile **2a** (1g, 3 mmol) in ethanol (20 ml). The reaction mixture was boiled until the initial nitrile **2a** disappeared (monitored by TLC). The solvent was evaporated and the residue was recrystallized from ethanol to give amide **6a**, 0.5 g, (47%); mp 165-166°C. IR spectrum, ν, cm^{-1}: 1660 (CO), 3455 (NH). ^{1}H NMR spectrum, δ, ppm: 3.00 (3H, m, H-4,5); 3.27 (1H, m, H-5); 4.59 (1H, s, CH); 5.74 (1H, s, NH_2); 7.11 (1H, s, NH_2) 7.22-7.67 (1oH, m, H_{Ph}). Found, %: C 73.21; H 6.23. $C_{17}H_{17}N_3O$. Calculated, %: C 73.12; H 6.09.

1-(3-Phenyl-4,5-dihydropyrazol-1-yl)(4-methoxyphenyl)acetamide (6c) was made analogously to amide **6a**. Yield 0.7 g (66%); mp 256-257°C. IR spectrum, ν, cm^{-1}: 1260 (CH_3O), 1610 (C=N), 1660 (C=O), 3420 (NH). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.88 (3H, m, H-4,5); 3.17 (1H, m, H-5); 3.74 (3H, s, CH_3O); 4.43 (1H, s, CH); 6.89 (2H, d, *J* = 8, H_{Ar}); 7.08 (1H, s, NH_2); 7.37 (5H, m, H_{Ph}); 7.49 (1H, s, NH_2); 7.59 (2H, d, *J* = 8, H_{Ar}). Found, %: C 69.57; H 5.93; N 13.31. $C_{18}H_{19}N_3O_2$. Calculated, %: C 69.90; H 6.15; N 13.59.

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