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A NOVEL SYNTHETIC APPROACH TOWARDS 1*H*-PYRAZOLE-5-CARBOXYLIC ACID DERIVATIVES USING 4-(4-METHYLBENZOYL)-5-(4-METHYLPHENYL)FURAN-2,3-DIONE

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Abstract – The 1*H*-pyrazole-5-carboxylic acid derivatives were obtained by reactions of 4-(4-methylbenzoyl)-5-(4-methylphenyl)furan-2,3-dione with 2,4-dinitrophenyhydrazine. So, new derivatives of 1*H*-pyrazole-5-carboxylic acid which are potential biological active compounds, were synthesized for the first time. The structures of all new synthesized products were characterized by IR, ^{1}H-, ^{13}C NMR, APT, and 2D NMR (HETCOR, COSY) spectroscopic data and elemental

INTRODUCTION

The pyrazole scaffold represents a common motif in many pharmaceutical active and remarkable compounds demonstrating a wide range of pharmacological activities; the most important activities are the anti-inflammatory,[1] the antibacterial, antifungal,[2-5] the hypoglycemic,[6,7] the anti-hyperlipidemic,[8] the inhibition of cyclooxigenase-2,[9,10] p38 MAP kinase[11] and CDK2/Cyclin A,[12,13] and the antiangiogenic.[13] Some bioactive small molecules with pyrazole substructure are currently used as therapeutic agents (Figure 1). Therefore, continuous efforts are being made to develop a more efficient and generally applicable synthetic protocol for the synthesis of diversified pyrazole derivatives.

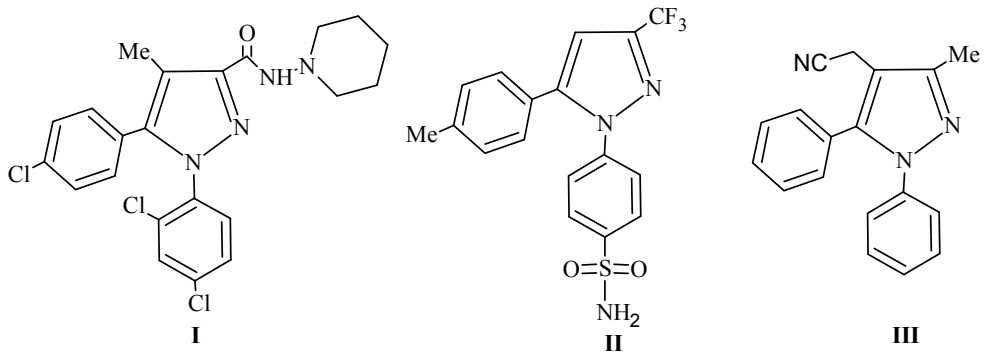
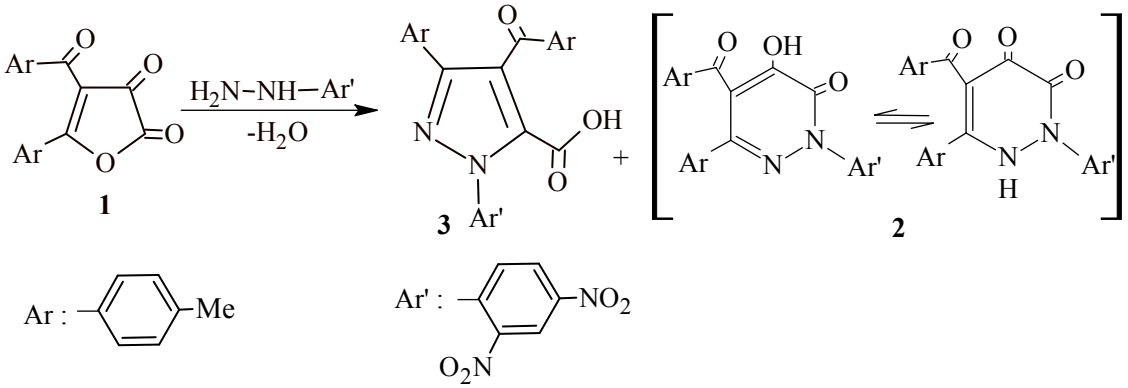


Figure 1. A series of important substituted pyrazoles. (I) Rimonabant, CB1 receptor inverse agonist; (II) Celebrex, anti-inflammatory drug; (III) PNU-32945, non-nucleoside reverse transcriptase inhibitors.

2,3-Furandiones are very susceptible to attacking of nucleophiles and are very important synthons for lots of heterocyclic compounds,[14-17] one of which is pyrazole derivatives. The reactions of furan-2,3-diones of type **1** with various hydrazines to yield derivatives of pyrazole-3-carboxylic acid were reported by Akçamur and co-workers,[14-17] but they couldn't obtain 1*H*-pyrazole-5-carboxylic acid derivatives. Herein, we report the first synthesis of a new 1*H*-pyrazole-5-carboxylic acid derivative **3** from the reactions of 4-(4-methylbenzoyl)-5-(4-methylphenyl)furan-2,3-dione (**1**) with 2,4-dinitrophenylhydrazine (Scheme 1). In progression of our study, we also present new reactions of 1*H*-pyrazole-5-carboxylic acid **3** with various N- and O-nucleophiles such as amine, hydrazine and alcohol derivatives (see Scheme 3). As seen from Scheme 1 in particular, the compound **3** has been first synthesized from these reactions, and the results obtained from all experiments are discussed in this study.

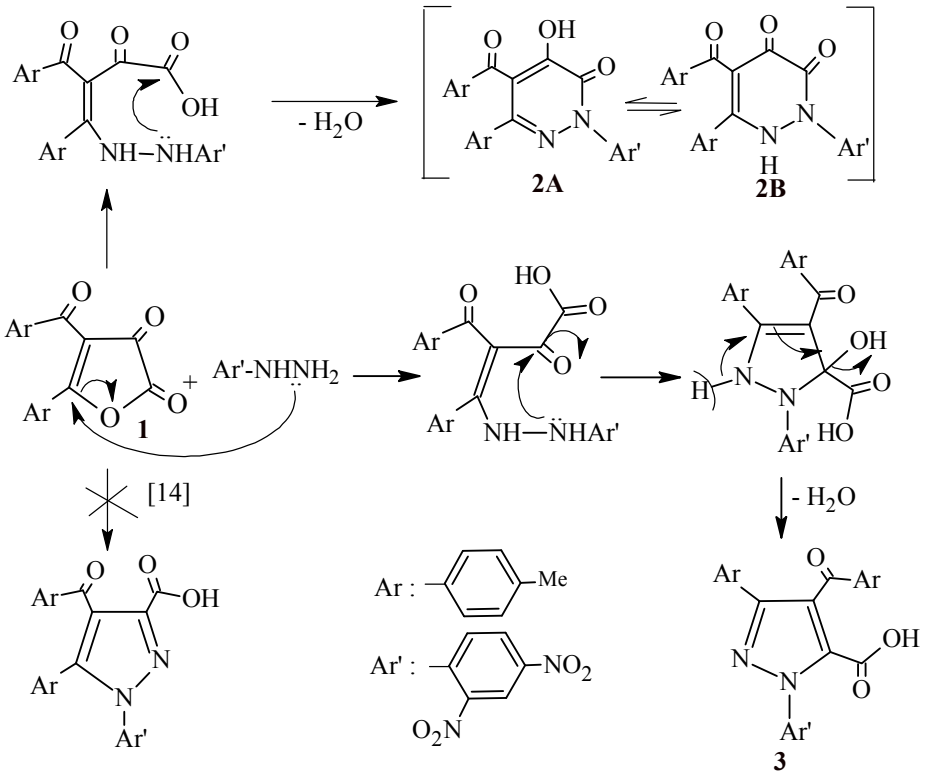


Scheme 1

RESULTS AND DISCUSSION

The reaction of the compound **1** with 2,4-dinitrophenylhydrazine led to the formation of the corresponding white colored 1*H*-pyrazole-5-carboxylic acid **3** under reflux in toluene. The progress of the reactions was monitored by thin-layer chromatography until complete consumption of the starting materials. Work-up of the reaction did not yield the expected pyrazole-3-carboxylic acid, however, the 1*H*-pyrazole-5-carboxylic acid **3** was obtained in 77% yield (Scheme 1). The moderate to good yield of the reaction can be explained by the chemical behavior of furan-2,3-dione, similar to the behavior of the compound **1** toward N-nucleophiles.[14-23] Due to the presence of three electrophilic sites with different reactivity at C2, C3 and C5 in furandiones of type **1** that can react with nucleophiles, the reactions of **1** with 2,4-dinitrophenylhydrazine may produce three isomeric products (see Scheme 2). When the reaction mixture was analyzed, signals corresponding to the second product **2** was observed in both ^{1}H and ^{13}C NMR spectra. We then proved the effect of solvent for any noticeable change in selectivity and yield for the reaction of the compound **1** with 2,4-dinitrophenylhydrazine. Various other solvents such as toluene, benzene, xylene, and acetonitrile were used as the reaction medium to optimize the reaction conditions. The reaction in toluene reached completion in 30 min, with isolated yield of 77% of the product. This result indicated that toluene was the suitable solvent for the formation of the compound **3**. On the other hand, the reaction in benzene reached completion in 5 h, with isolated yield of 45% of the product. This result indicated that benzene was the suitable solvent for the compound **2.** The formation of the products **2** and **3** was identified by elemental analyses and IR, ^{1}H- and ^{13}C NMR spectroscopic data. The ^{1}H NMR spectrum of **2**, displays a singlet at 10.30 ppm attributable to the -OH proton (D_2O exchangeable) of the pyridazine ring. The singlets at 2.31 and 2.19 ppm could be ascribed to the -CH_3 protons of the phenyl and benzoyl ring. The IR spectra of the pyridazin-3(2*H*)-one **2** showed characteristic absorption bands at 3288 cm^{-1} and 1786, 1689 cm^{-1} due to O-H stretchings and two C=O groups, respectively. The product **2** did not show any tendency to tautomer **2B** both in DMSO and acetone, therefore, its **2A** was anticipated to be more stabilized form by spectroscopic analyses and intramolecular hydrogen bridges. The IR spectra of the 1*H*-pyrazole-5-carboxylic acid **3** showed broad absorption in the region 3162-3048 cm^{-1} indicating the appearance of CO_2H. ^{1}H NMR spectra of the compound **3** have signals of all corresponding protons and the integration curves to prove the number of protons. The 11 aromatic protons of the aryl groups in compound **3** appear as a ABX and two AA'BB' spin systems in the area of 9.10-7.03 ppm. Two methyl groups have two singlet signals in the area of 2.41 and 2.28 ppm. The ^{1}H-decoupled ^{13}C NMR spectrum of **3** showed 21 resonances, in good agreement with the proposed structure (see Experimental Section). The values of the elementel analysis were found to be in good agreement (±0.3) with the calculated values. The structures of all new synthesized products were also based on an X-ray study (**5b**).

The formation of compounds **2** and **3** may be initiated by Michael addition, *via* nucleophilic attack at C5 atom of the furan ring in **1** by the NH_2 group of 2,4-dinitrophenylhydrazine. Whereas, in the previous reactions, nucleophilic attack of the NH_2 groups of the hydrazines occurred at C3 atom of the furan ring. However, unlike the reaction to the literature,[14-16,21] the nucleophilic attack of the hydrazine derivative took place at C5 instead of C3 atom of the furan ring in **1**. 2,4-Dinitrophenylhydrazine behaved differently in these reactions. This situation is compatible with the fact that the 2,4-dinitrophenyl group is electron acceptor group due to the inductive and resonance effects and steric hindrance. Then, the compounds **2** and **3** obtained with an attack of second NH group to the antibonding (π*) orbitals at the carbonyl carbons at C2 and C3 positions, respectively. Therefore, the new products **2** and **3** obtained arise from the sequential attacks of the hydrazine derivative at the lactone moiety of **1**, followed by the elimination of a molecule of water. In addition, the reaction speeds of the final steps of these reactions should probably be much slower than the reaction speeds of their first steps. A reasonable proposal for the reaction pathways from furandione **1** to the pyridazin-3(2*H*)-one **2** and 1*H*-pyrazole-5-carboxylic acid derivative **3** is outlined briefly in Scheme 2.



Scheme 2

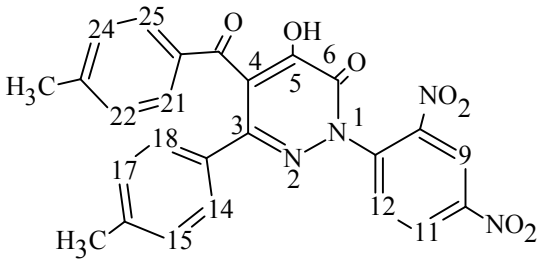


Figure 2. *Atom-numbering scheme of the compound* **2**.

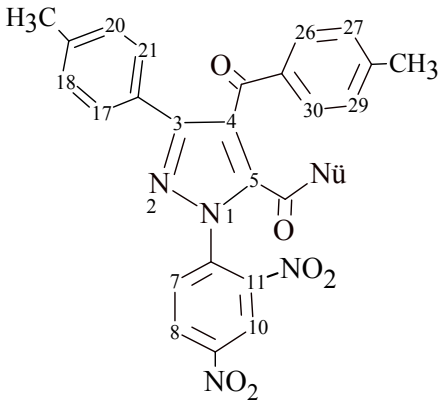
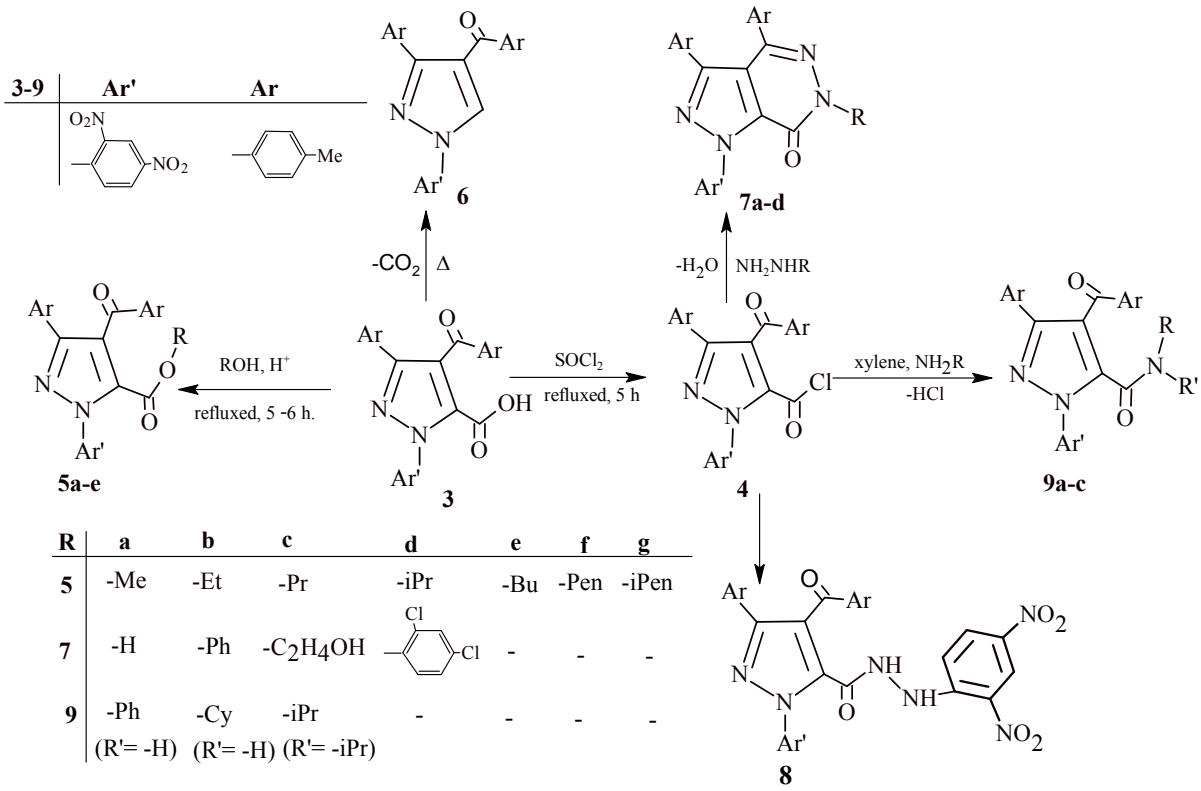


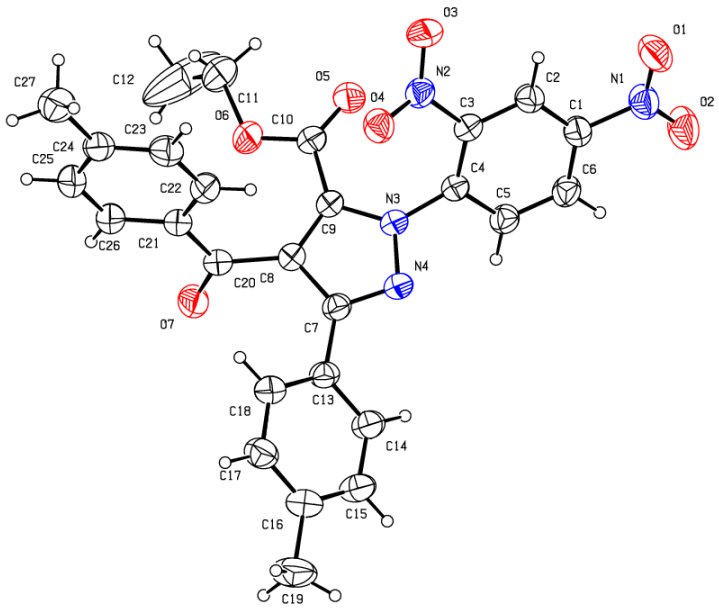
Figure 3. *Atom numbering scheme of the compound* **3** and *the compounds* **4**-**8**.

The compound **3** can easily be transformed into the corresponding 1*H*-pyrazole-5-carboxylic acid chloride **4** by usual chemical procedures[15] (see Scheme 3). Substituted furan-2,3-dione, acid **3** and acid chloride **4**, which are used as an important initial materials in the synthesis of the target heterocycles, were prepared using the literature procedures.[14,15,23] The structure of **4** was confirmed by analytical and spectral data. In addition, conversion of 1*H*-pyrazole-5-carboxylic acid **3** into their corresponding ester derivative **5** has been accomplished by Fischer esterification. The structure of the product **5** was confirmed by spectroscopic data. The IR spectrum of 1*H*-pyrazole-5-carboxylate derivative **5a** showed broad absorption bands at 1722 (O-C=O), 1659 cm^{-1} (Ar-C=O) due to carbonyl groups. In the ^{1}H NMR spectrum of **5a** revealed three singlet signals at 3.43, 2.38, 2.25 ppm due to methyl protons (*Me*O, 2 *Me*C_6H_4, respectively). The ^{13}C NMR spectrum of **5a** exhibited signals at 190.84 (Ar-C=O) and 177.80 ppm (O-C=O).

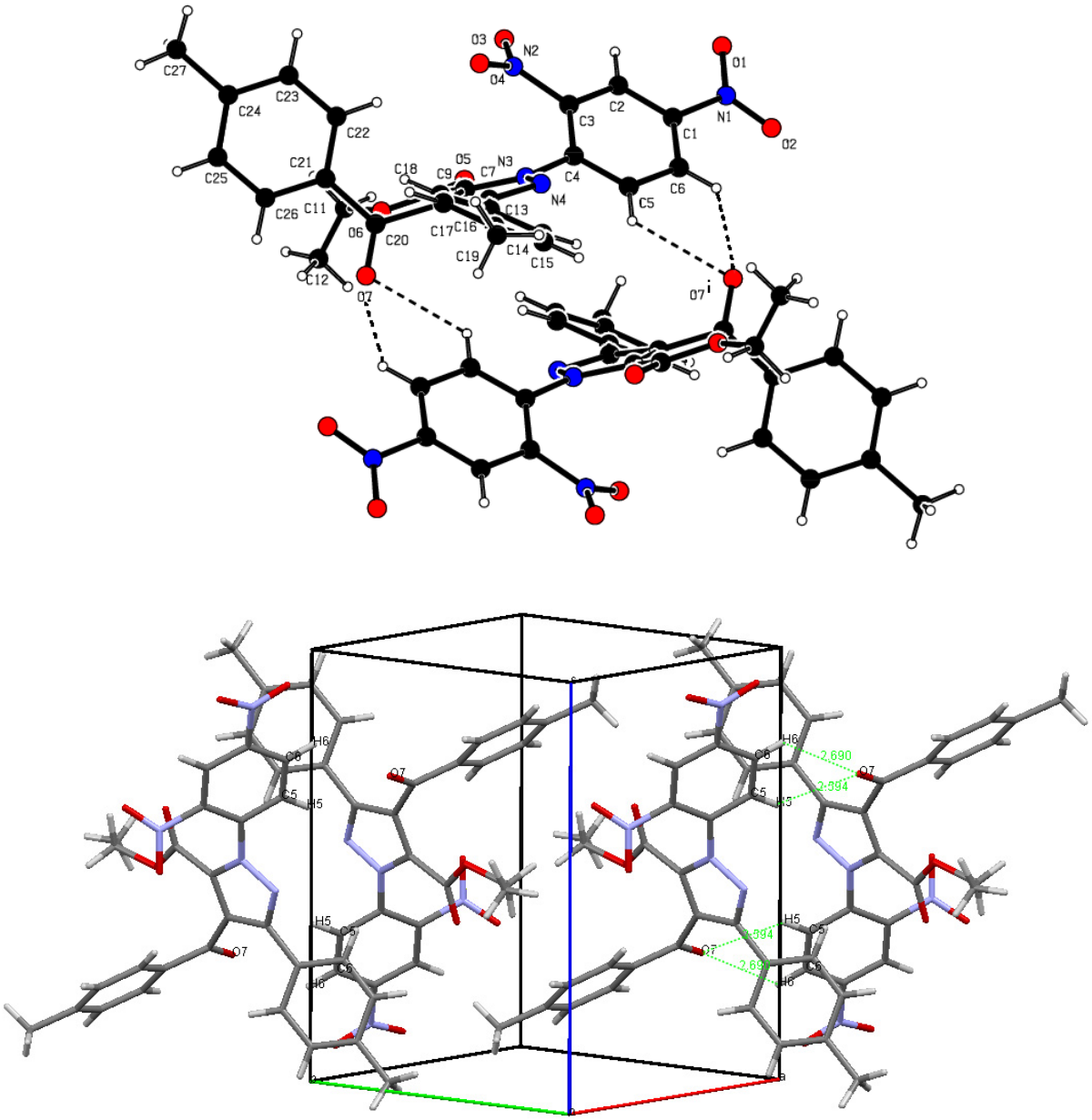


Scheme 3

The structure of the product **5b** is based on an X-ray study of ethyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-nitrophenyl)-1*H*-pyrazole-5-carboxylate, thus excluding the other possible isomers. An ORTEP plot of the **5b** is shown in the Figure 4.



(a)



(b)

Figure 4. a) *ORTEP Plot of* **5b***, with the atom-numbering scheme*. Displacement ellipsoids are drawn at the 50% probability level. H-atoms are shown as small spheres of arbitrary radii. b) Hydrogen-bonded (dashed lines) dimeric aggregates in the crystal structure of **5b** and the unit cell.

The compound **5b** crystallizes in triclinic space group *P*-1 with two molecules in the unit cell. The structure contains the central pyrazole ring and 4-methylphenyl, 2,4-dinitrophenyl, 4-methylbenzoyl and formic acid ethyl ester units. The pyrazole ring adopts planar conformation. The sum of the angles at N3 of the pyrazole ring (359.87°) is in accordance with sp^2 hybridization.[24] The C—N bond lengths in the

pyrazole ring are 1.327 (2) and 1.371 (2) Å, which are shorter than a C—N single bond length of 1.443 Å, but longer than a double bond length of 1.269 Å,[25] indicating electron delocalization. It is likely that four substituent groups influence the aromaticity of that ring. Dinitrophenyl, tolyl and C21/C26 phenyl rings are significantly twisted from the pyrazole ring as can be seen from the inter-ring dihedral angles of 50.88 (9)°, 33.84 (11)° and 72.05 (9)° respectively.

There are intermolecular non-classic hydrogen bonds C5–H5···O7^{i} and C6–H6···O7^{i} [symmetry code (i): -x+2,-y,-z+1] forming centrosymmetric dimers, as shown in Figure 2b with C-H···O contacts of 3.228(4) and 3.269(4) Å, respectively.

Reactions of pyrazole derivatives having the dicarbonyl groups with hydrazine derivatives may be a convenient method to build the pyrazolo[3,4-*d*]pyridazine systems.[20-22] Thus, the pyrazole acid chloride **4** and some hydrazines were refluxed in xylene with no catalytic amounts of pyridine for 1-6 h and cyclized to pyrazolo[3,4-*d*]pyridazinones **7a-d**, in approximately 77, 65, 70, 63% yields without any side reaction, while with 2,4-dinitrophenylhydrazine the corresponding derivative **8** was obtained. In contrast, the reaction of **4** with 2,4-dinitrophenylhydrazine instead of hydrazine hydrate or phenylhydrazine did not lead to form the corresponding pyrazolo[3,4-*d*]pyridazine derivative. However, 2,4-dinitrophenyl-hydrazine was added to **4** to yield a new pyrazole acid derivative **8** containing a hydrazino group, as the literature procedure.[16] The difficulty in forming the pyridazine nucleus from **8** can be explained by steric hindrances of the nitro groups attached to the phenyl ring (see Scheme 3 and Experimental Section). In the ^{1}H NMR spectra of **8** the NH and OH signals revealed the presence of keto (48%) and enol (52%) tautomers in DMSO-d_6 solution. The structures of all compounds were established by elemental analysis, IR and NMR spectroscopy.

We also investigated the reactions of the compound **4** with amine derivatives. It was performed in refluxing xylene to furnish the corresponding 1*H*-pyrazole-5-carboxamides **9a-c** as the single proudct. The formation of **9a** was supported by the results of both analytical and spectroscopic measurements, particularly by the presence of characteristic absorption bands (IR: 3103 cm^{-1}) for N-H group, (IR: 1674 cm^{-1}) for carbonyl group and the skeleton bands of benzene or pyrazole rings observed at 1601-1450 cm^{-1} (C=C, C=N). Important structural information about **9a** could be obtained from its ^{13}C NMR spectrum. The ^{13}C NMR peaks were found to be at δ 190.86 (Ar-C=O), 153.05 (N-C=O), 148.13 (C3), 141.82 (C6), 139.82 (C11), 139.13, 135.28, 135.07, 133.75, 132.54, 130.17, 129.97, 135.60, 133.75, 132.54, 130.17, 129.97, 129.60, 129.52, 129.02, 128.97, 128.48, 127.75, 127.22, 124.01, 121.25, 120.75 (C-Ph), 21.21 (CH_3), 21.17 (CH_3). The ^{1}H NMR spectrum of **9a** showed signals for NH (10.67 ppm, it was exchanged with D_2O), the aromatic substituent protons (8.98-7.06 ppm) and methyl groups (2.45, 2.39 ppm). Other spectral and analytical data of all synthesized compounds are in good agreement with their proposed structures.

ACKNOWLEDGEMENT

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EXPERIMENTAL

Reagents and solvents were purchased from Merck, Fluka and Sigma, used without further purification. For purity tests, tlc: Merck precoated silica gel plates 60 F 254. Melting point: Electrothermal 9200 apparatus; uncorrected. IR Spectra: Shimadzu 8400 FT-IR spectrometer; in cm^{-1}. ^1H- and ^{13}C NMR Spectra: Bruker Avance III Ultrashield spectrometer operating at 400.13 MHz (^1H) and 100.61 MHz (^{13}C) in DMSO-d_6 and/or $CDCl_3$; δ in ppm, coupling constants J in Hz. The following abbreviations are used: singlet (s), doubled (d), triplet (t), doubled triplet (dt), doubled doupled (dd), multiplet (m), broad signal (br). When necessary to identify all carbon atoms, complementary NMR experiments (COSY and APT) were performed. Elemental analyses (C, H, N, S): LECO-932 CHNS-O analyzer. X-Ray: Rigaku R-AXIS RAPID-S diffractometer.

4-Hydroxy-5-(4-methylbenzoyl)-2-(4-methylphenyl)-6-(2,4-dinitrophenyl)-pyridazin-3(2*H*)-one (2). Compound **1** (0.31 g, 1 mmol) and 2,4-dinitrophenylhydrazine (0.20, 1 mmol) were dissolved in dry benzene (30 mL) and refluxed for 30 min. After cooling to rt, the red precipitate was separated by filtering and recrystallized from butanol to give 0.14 g (45%) of **2**. mp 238 °C; IR (ATR, cm^{-1}): 3288 (N-H), 3086 (arom. CH), 2976 (alip. CH), 1786, 1689 (C=O), 1602, 1587, 1580, 1520, 1450 (C=C, C=N); ^1H NMR (400 MHz, acetone-d_6): δ 10.30 (s, 1H, NH), 8.98 (d, 1H, 9-H, ^4J = 2.61), 8.54 (dd, 1H, 11-H, ^3J = 9.40, ^4J = 2.61), 8.29 (d, 1H, 12-H, ^3J = 9.40), 7.69 (quasi d, 2H, A part of AA'BB' system, 14- and 18-H, ^3J = 8.17), 7.29 (quasi d, 2H, A part of AA'BB' system, 21- and 25-H, ^3J = 8.20), 7.14 (quasi d, 2H, B part of AA'BB' system, 15- and 17-H, ^3J = 8.17), 7.03 (quasi d, 2H, B part of AA'BB' system, 22- and 24-H, ^3J = 8.20), 2.31 (s, 3H, CH_3), 2.19 (s, 3H, CH_3); ^{13}C NMR (100 MHz, acetone-d_6): δ 188.78, 177.70 (C=O), 170.69 (C-OH), 159.77, 148.00, 144.02, 143.97, 139.20, 134.91, 131.26, 131.18, 129.96, 129.86, 129.59, 129.18, 123.84, 123.51, 116.99, 115.04 (C-Ph), 21.67, 21.57 (CH_3). Anal. Calcd for $C_{25}H_{18}N_4O_7$ (486.43): C, 61.73; H, 3.73; N, 11.52. Found: C, 61.99; H, 3.74; N, 11.49.

4-(4-Methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylic acid (3). A milliequimolar mixture of furan-2,3-dione **1** (0.31 g, 1 mmol) and 2,4-dinitrophenylhydrazine (0.20, 1 mmol) was refluxed in 30 mL of dry toluene for aproximately 5 h. After evaporation, obtained was treated with dry Et_2O. The crude product formed was recrystallized from toluene to give 0.24 g (77%) of **3**, mp 156 °C; IR (ATR, cm^{-1}): 3162-3048 (b, O-H, COOH), 1695 (Ar-C=O), 1659 (C=O, COOH), 1605,

1533, 1498, 1448, 1435 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.10 (d, 1H, 10-H, ^4J = 2.48), 8.64 (dd, 1H, 8-H, ^3J = 8.69, ^4J = 2.48), 7.90 (d, 1H, 7-H, ^3J = 8.69), 7.69 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^3J = 8.23), 7.29 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^3J = 7.62), 7.14 (d, 2H, B part of AA'BB' system, 18- and 20-H, ^3J = 7.62), 7.03 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^3J = 8.23), 2.41 (s, 3H, CH_3), 2.28 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 193.28 (C=O, benzoyl); 158.29 (C=O, COOH), 153.72 (C3), 151.93 (C-NO_2), 147.80, 145.56, 145.09, 139.31, 138.63, 134.07, 131.63, 130.23, 129.35, 129.27, 128.13, 128.08, 127.46, 122.80, 120.91 (C-Ph), 21.78, 21.21 (CH_3). Anal. Calcd for $C_{25}H_{18}N_4O_7$ (486.43): C, 61.73; H, 3.73; N, 11.52. Found: C, 61.72; H, 3.75; N, 11.47.

4-(4-Methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carbonyl chloride (4). Acid **2** (0.49 g, 1 mmol) and thionyl chloride (1.64 g, 13.80 mmol) were refluxed on a steam bath for 5 h. After cooling, the crude precipitate was filtered off and recyrstallized from xylene, yield 0.20 g (41%) of **4**, mp 160 °C; IR (ATR, cm^{-1}): 3082 (arom. CH), 2951 (alip. CH), 1791 (C=O, COCl), 1662 (Ar-C=O), 1600, 1537, 1498, 1453, 1438 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 8.98 (d, 10-H, ^4J = 2.56), 8.75 (dd, 8-H, ^3J = 8.72, ^4J = 2.56), 8.33 (d, 7-H, ^3J = 8.72), 7.78 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^3J = 8.24), 7.37 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^3J = 7.65), 7.25 (d, 2H, B part of AA'BB' system, 18- and 20-H, ^3J = 7.65), 7.15 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^3J = 8.24), 2.29 (s, 3H, CH_3), 2.25 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 191.16 (C=O, benzoyl); 159.15 (C=O, COCl), 150.52 (C3), 147.90 (C-NO_2), 145.31, 145.28, 139.24, 137.83, 135.22, 132.50, 129.92, 129.67, 129.34, 128.95, 128.64, 127.14, 123.88, 121.09 (C-Ph), 21.65, 21.45 (CH_3). Anal. Calcd for $C_{25}H_{17}N_4O_6Cl$ (504.88): C, 59.47; H, 3.39; N, 11.10. Found: C, 59.50; H, 3.40; N, 11.20.

Methyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5a).

General Procedure: To the cold solution of the pyrazole acid **2** (0.49 g, 1mmol) in a few drops of sulfuric acid was added a large exess of MeOH with stirring. Then the reaction mixture was refluxed on a steam bath for 8 h with stirring. After cooling to 5 °C, the precipitate formed was filtered off and recrystallized from the same alcohol to give 0.24 g (49%) of **5a**, mp 184 °C; IR (ATR, cm^{-1}): 3064 (arom. CH), 2974 (aliph. CH), 1722 (O-C=O), 1659 (Ar-C=O), 1610, 1533, 1450, 1443 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.00 (d, 1H, 10-H, ^4J = 2.52), 8.78 (dd, 1H, 8-H, ^3J = 8.76, ^4J = 2.52), 8.39 (d, 1H, 7-H, ^3J = 8.76), 7.78 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^3J = 8.20), 7.38 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^3J = 8.00), 7.32 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^3J = 8.20), 7.18 (d, 2H, B part of AA'BB' system, 18- and 20-H, ^3J = 8.00), 3.43, (s, 3H, OCH_3), 2.38 (s, 3H, CH_3), 2.25 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 190.84 (Ar–C=O), 177.80 (C=O, ester), 158.10 (C3), 150.63 (C-NO_2),

146.13, 145.50, 145.34, 139.43, 137.35, 135.07, 133.75, 132.54, 130.17, 129.97, 127.95, 121.25 (C-Ph), 53.10 (OCH_3), 21.27, 21.20 (2xCH_3). Anal. Calcd for $C_{26}H_{20}N_4O_7$ (500.46): C, 62.40; H, 4.03; N, 11.19. Found: C, 62.43; H, 4.00; N, 11.18.

Ethyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5b). Compound **5b** was obtained by the general procedure above with a reflux time of 7 h. Yield: 0.23 g (47%); mp 153 °C (EtOH); IR (ATR, cm^{-1}): 3072 (arom. CH), 2974 (aliph. CH), 1734 (O-C=O), 1651 (Ar-C=O), 1601, 1553, 1457, 1415 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.08 (d, 1H, 10-H, ^4J = 2.52), 8.65 (dd, 1H, 8-H, ^3J = 8.69, ^4J = 2.52), 7.95 (d, 1H, 7-H, ^3J = 8.69), 7.87 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^3J = 8.16), 7.54 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^3J = 7.99), 7.33 (d, 2H, B part of AA'BB' system, 18- and H-20, ^3J = 7.99), 7.13 (d, 2H, B part of AA'BB' system, 27- and H-29, ^3J = 8.16), 4.00 (q, 2H, CH_2, ^3J = 7.12), 2.40 (s, 3H, CH_3), 2.30 (s, 3H, CH_3), 0.85 (t, ^3J = 7.14, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 191.13 (Ar-C=O), 170.89 (O-C=O), 158.03 (C3), 152.36 (C-NO_2), 147.66, 145.14, 143.02, 142.31, 139.31, 138.31, 135.14, 131.83, 130.94, 129.43 129.22, 129.15, 128.28, 127.98, 124.36, 124.03, 121.34, 120.74, 110.94 (C-Ph), 63.26 (CH_2), 21.77, 21.69 (CH_3), 13.67 (CH_3). Anal. Calcd for $C_{27}H_{22}N_4O_7$ (514.49): C, 63.03; H, 4.31; N, 10.89. Found: C, 63.05; H, 4.26; N, 10.92.

Propyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5c). Compound **5c** was obtained by the general procedure above with a reflux time of 6 h. Yield: 0.21 g (43%); mp 104 °C; (*n*-PrOH); IR (ATR, cm^{-1}): 3088 (arom. CH), 2959 (aliph. CH), 1703 (O-C=O), 1674 (Ar-C=O), 1604, 1533, 1447 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 8.95 (d, 1H, 10-H, ^4J = 2.56), 8.75 (dd, 1H, 8-H, ^3J = 8.77, ^4J = 2.56), 8.35 (d, 7-H, ^3J = 8.77), 7.77 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^3J = 8.20), 7.39 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^3J = 8.15), 7.31 (d, 2H, B part of AA'BB' system, 18- and 20-H, ^3J = 8.20), 7.19 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^3J = 8.15), 3.40 (t, 2H, CH_2, ^3J = 7.20), 2.35 (s, 3H, CH_3), 2.21 (s, 3H, CH_3), 1.35 (m, 2H, CH_2), 0.88 (t, 3H, CH_3, ^3J = 7.18); ^{13}C NMR (DMSO-d_6): δ 191.17 (Ar-C=O), 170.25 (O-C=O), 159.19 (C3), 150.51 (C-NO_2), 147.90, 145.31, 145.28, 139.24, 137.83, 135.22, 132.49, 130.08, 129.92, 129.67, 128.95, 127.14, 123.87, 121.09 (C-Ph), 60.82 (CH_2), 23.05 (CH_2), 21.68 (CH_3), 21.18 (CH_3), 14.28 (CH_3). Anal. Calcd for $C_{28}H_{24}N_4O_7$ (528.51): C, 63.63; H, 4.58; N, 10.60. Found: C, 63.59; H, 4.61; N, 10.58.

***i*-Propyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5d).** Compound **5d** was obtained by the general procedure above with a reflux time of 6 h. Yield: 0.18 g (37%); mp 124 °C; (*i*-PrOH); IR (ATR, cm^{-1}): 3096 (arom. CH), 2959 (aliph. CH), 1722 (O-C=O), 1674 (Ar-C=O), 1606, 1530 1452 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.00 (d, 1H, 10-H, ^4J = 2.57),

8.80 (dd, 1H, 8-H, ^{3}J = 8.78, ^{4}J = 2.57), 8.35 (d, 1H, 7-H, ^{3}J = 8.78), 7.80 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^{3}J = 8.20), 7.40 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^{3}J = 8.16), 7.32 (d, 2H, B part of AA'BB' system, 18 and 20-H, ^{3}J = 8.20), 7.19 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^{3}J = 8.16), 3.85 (m, 1H, CH), 2.40 (s, 3H, CH_3), 2.21 (s, 3H, CH_3), 1.02 (d, 6H, $2CH_3$, ^{3}J = 7.35); ^{13}C NMR (DMSO-d_6): δ 191.17 (Ar-C=O), 170.89 (O-C=O), 159.14 (C3), 150.51 (C9), 147.90 (C11), 145.31 (C5), 145.28, 139.24, 137.83, 135.22, 135.11, 132.49, 130.08, 129.92, 129.67, 128.95, 128.14, 127.13, 123.86, 121.09 (C-Ph), 62.47 (CH), 21.68 (CH_3), 21.19 (CH_3), 14.41 (CH_3). Anal. Calcd for $C_{28}H_{24}N_4O_7$ (528.51): C, 63.63; H, 4.58; N, 10.60. Found: C, 63.61; H, 4.56; N, 10.61.

Butyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5e). Compound **5e** was obtained by the general procedure above with a reflux time of 5 h. Yield: 0.16 g (33%); mp 142 °C; (*n*-BuOH); IR (ATR, cm^{-1}): 3088 (arom. CH), 2959 (aliph. CH), 1722 (O-C=O), 1674 (Ar-C=O), 1604, 1533, 1460, 1408 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.00 (d, 1H, 10-H, ^{4}J = 2.57), 8.80 (dd, 1H, 8-H, ^{3}J = 8.77, ^{4}J = 2.57), 8.35 (d, 1H, 7-H, ^{3}J = 8.77), 7.80 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^{3}J = 8.21), 7.38 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^{3}J = 8.16), 7.34 (d, 2H, B part of AA'BB' system, 18- and 20-H, ^{3}J = 8.21), 7.15 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^{3}J = 8.16), 3.85 (q, 2H, CH_2), 2.54 (s, 3H, CH_3), 2.21 (s, 3H, CH_3), 1.10 (m, 2H, CH_2), 0.80 (m, 2H, CH_2), 0.60 (t, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 190.85 (Ar-C=O), 170.20 (O-C=O), 157.77 (C3), 150.73 (C-NO_2), 148.12, 145.61, 145.37, 139.40, 137.48, 135.07, 133.69, 132.49, 130.13, 129.98, 129.04, 127.92, 127.17, 123.80, 121.10 (C-Ph), 66.09 (OCH_2), 29.86 (CH_2), 21.71 (CH_2), 21.20 (CH_3), 18.70 (CH_2), 13.70 (CH_3). Anal. Calcd for $C_{29}H_{26}N_4O_7$ (542.54): C, 64.20; H, 4.83; N, 10.33. Found: C, 64.23; H, 4.83; N, 10.32.

Pentyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5f). Compound **5f** was obtained by the general procedure above with a reflux time of 5 h. Yield: 0.19 g (39%); mp 120 °C; (*n*-PeOH); IR (ATR, cm^{-1}): 3088 (arom. CH), 2959 (aliph. CH), 1718 (O-C=O), 1675 (Ar-C=O), 1609, 1536, 1434, 1405 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.05-7.12 (m, 11H, phenyl protons), 3.77 (q, 2H, CH_2), 2.48 (s, 3H, CH_3), 2.20 (s, 3H, CH_3), 1.65 (m, 2H, CH_2), 1.30 (m, 2H, CH_2), 1.08 (m, 2H, CH_2), 0.86 (t, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 191.17 (Ar-C=O), 170.17 (O-C=O), 159.15 (C3), 157.78 (C-NO_2), 150.72, 150.51, 148.11, 147.89, 145.58, 145.28, 139.39, 137.84, 137.51, 135.22, 132.69, 130.13, 129.97, 129.68, 129.04, 127.91, 127.14, 123.83, 121.08 (C-Ph), 66.41 (OCH_2), 37.48 (CH_2), 27.64 (CH_2), 27.57 (CH_2), 21.68 (CH_3), 21.19 (CH_3), 13.99 (CH_3). Anal. Calcd for $C_{30}H_{28}N_4O_7$ (556.56): C, 64.74; H, 5.07; N, 10.07. Found: C, 64.73; H, 5.07; N, 10.08.

***i*-Pentyl 4-(4-methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole-5-carboxylate (5g).** Compound **5g** was obtained by the general procedure above with a reflux time of 5 h. Yield: 0.17 g (35%); mp 128 °C; (*i*-PeOH); IR (ATR, cm^{-1}): 3088 (arom. CH), 2951 (aliph. CH), 1699 (O-C=O), 1670 (Ar-C=O), 1604, 1536, 1435, 1460 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 9.05-7.12 (m, 11H, phenyl protons), 3.80 (t, 2H, CH_2), 2.41 (s, 3H, CH_3), 2.22 (s, 3H, CH_3), 1.65 (m, 2H, CH_2), 1.35 (m, 2H, CH_2), 0.80 (d, 6H, 2 CH_3); ^{13}C NMR (DMSO-d_6): δ 191.17 (Ar-C=O), 170.15 (O-C=O), 159.15 (C3), 157.74 (C-NO_2), 150.77, 150.51, 148.12, 147.89, 145.61, 145.28, 139.42, 139.23, 137.54, 135.22, 133.69, 132.67, 130.08, 129.97, 129.06, 127.91, 123.76, 121.04 (C-Ph), 66.34 (OCH_2), 37.44 (CH_2), 24.69 (CH_2), 22.26 (CH_2), 21.68 (CH_3), 21.19 (2 × CH_3). Anal. Calcd for $C_{30}H_{28}N_4O_7$ (556.57): C, 64.74; H, 5.07; N, 10.07. Found: C, 64.76; H, 5.05; N, 10.06.

4-(4-Methylbenzoyl)-3-(4-methylphenyl)-1-(2,4-dinitrophenyl)-1*H*-pyrazole (6). Compound **3** (0.49 g, 1 mmol) was heated to 180 °C in an oil bath for about 30 min without any solvent. After cooling to room temperature, the residue was treated with ether to give the crude product, which was recrystallized from MeOH, to yield 0.37 g (75%); mp 193 °C; IR (ATR, cm^{-1}): 3096, 3034 (arom. CH), 2978 (aliph. CH), 1639 (C=O), 1601, 1549, 1545, 1534, 1450 (C=C, C=N); ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.03 (s, 1H, H5), 8.92 (quasi d, 1H, 10-H, ^4J = 2.56), 8.66 (dd, 1H, 8-H, ^3J = 8.96, ^4J = 2.56), 8.32 (d, 1H, 7-H, ^3J = 8.96), 7.85 (d, 2H, A part of AA'BB' system, 26- and 30-H, ^3J = 8.20), 7.45 (d, 2H, A part of AA'BB' system, 17- and 21-H, ^3J = 8.12), 7.37 (d, 2H, B part of AA'BB' system, 18- and 20-H, ^3J = 8.12), 7.20 (d, 2H, B part of AA'BB' system, 27- and 29-H, ^3J = 8.20), 2.41 (s, 3H, CH_3), 2.28 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 188.95 (C=O), 146.44 (C3), 144.31 (C11), 139.05 (C9), 136.89 (C28), 135.74 (C19), 130.11, 129.78, 129.37, 128.70, 128.61, 128.43 (C-Ph), 126.84 (C4), 121.64 (C10), 21.63 (CH_3), 21.32 (CH_3). Anal. Calcd for $C_{24}H_{18}N_4O_5$ (442.42): C, 65.15; H, 4.10; N, 12.66. Found: C, 65.13; H, 4.11; N, 12.69.

General Procedure for the compounds 7 and 8. A milliequimolar mixture of **4** and hydrazine hydrate were refluxed in xylene for 1-6 h. The solvent was evaporated, then the oily residue was treated with Et_2O and the formed crude product was crystallized from proper solvent.

3,4-Di(4-methylphenyl)-1-(2,4-dinitrophenyl)-1,6-dihydropyrazolo[3,4-*d*]pyridazin-7-one (7a). Compound **7a** was prepared according to the general procedure above with a reflux time of 1 h resulting in yield 0.39 g (77%) of **7a**, mp 218 °C; (benzene); IR (ATR, cm^{-1}): 3200 (NH), 3085 (arom. CH), 2976 (aliph. CH), 1649 (C=O), 1607, 1533, 1505, 1344 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 13.31 (s, 1H, NH), 8.98 (quasi d, 1H, 10-H, ^4J = 2.52), 8.76 (dd, 1H, 8-H, ^3J = 8.80, ^4J = 2.52), 8.29 (d, 1H, 7-H, ^3J =

8.80), 7.13-6.92 (2xAA'BB' systems, 8H, phenyl protons), 2.27 (s, 3H, CH_3), 2.26 (s, 3H, CH_3); APT (DMSO-d_6): δ 153.34 (+), 150.15 (+), 147.45 (+), 144.23 (+), 143.99 (+), 138.82 (+), 136.09 (+), 134.55 (+), 131.93 (+), 131.90 (-), 129.64 (-), 129.10 (-), 128.83 (-), 128.80 (-), 128.75 (-), 127.75 (+), 121.30 (-), 118.90 (+), 21.28 (-). Anal. Calcd for $C_{25}H_{18}N_6O_5$ (482.45): C, 62.24; H, 3.76; N, 17.42. Found: C, 62.22; H, 3.80; N, 17.44.

3,4-Di(4-methylphenyl)-1-(2,4-dinitrophenyl)-6-phenyl-1,6-dihydropyrazolo[3,4-*d*]pyridazin-7-one (7b). Compound **7b** was prepared according to the general procedure above with a reflux time of 3 h resulting in yield 0.33 g (65%), mp 245 °C; (benzene); IR (ATR, cm^{-1}): 3033 (arom. CH), 2989 (aliph. CH), 1623 (C=O), 1599, 1501, 1404, 1344 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 8.95 (quasi d, 1H, 10-H, ^4J = 2.56), 8.74 (dd, 1H, 8-H, ^3J = 8.84, ^4J = 2.56), 8.23 (d, 1H, 7-H, ^3J = 8.84), 7.50-6.80 (m, 13H, phenyl protons), 2.32 (s, 3H, CH_3), 2.23 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 170.45 (C=O), 157.83 (C3), 147.31 (C11), 144.99 (C9), 144.49, 144.41, 139.79, 138.63, 134.41, 131.91, 130.58, 129.52, 129.05, 128.74, 128.65, 128.53, 127.05, 126.82, 121.01, 120.58 (C-Ph), 21.21, 21.15 (CH_3). Anal. Calcd for $C_{31}H_{22}N_6O_5$ (558.54): C, 66.66; H, 3.97; N, 15.05. Found: C, 66.69; H, 3.89; N, 15.09.

3,4-Di(4-methylphenyl)-1-(2,4-dinitrophenyl)-6-(hydroxyethyl)-1,6-dihydropyrazolo[3,4-*d*]pyridazin-7-one (7c). Compound **7c** was prepared according to the general procedure above with a reflux time of 4 h resulting in yield 0.35 g (69%), mp 210 °C; (xylene); IR (ATR, cm^{-1}): 3499 (OH), 3088 (arom. CH), 2920 (aliph. C-H), 1647 (C=O), 1608, 1545, 1540, 1499, 1446, 1340 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 8.96 (quasi d, 1H, 10-H, ^4J = 2.56), 8.76 (dd, 1H, 8-H, ^3J = 80, ^4J = 2.56), 8.26 (d, 1H, 7-H, ^3J = 8.80), 7.16-6.96 (2 × AA'BB' systems, 8H, phenyl protons), 3.83 (t, 1H, OH, ^3J = 5.84), 4.24 (t, 2H, CH_2, ^3J = 5.92), 3.78 (q, 2H, CH_2, ^3J = 5.76), 2.25 (s, 3H, CH_3), 2.27 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 170.00 (C=O); 152.31, 149.91, 147.53, 144.46, 142.97, 139.01, 138.92, 136.16, 134.50, 132.06, 131.76, 129,63, 128.81, 128.72, 127.74, 121.20, 118.54 (C-Ph), 59.06 (CH_2), 52.75 (CH_2), 21.28 (2 × CH_3). Anal. Calcd for $C_{27}H_{22}N_6O_6$ (526.50): C, 61.59; H, 4.21; N, 15.96. Found: C, 61.60; H, 4.20; N, 15.97.

3,4-Di(4-methylphenyl)-1-(2,4-dinitrophenyl)-6-(2,5-dichlorophenyl)-1,6-dihydropyrazolo[3,4-*d*]-pyridazin-7-one (7d). Compound **7d** was prepared according to the general procedure above with a reflux time of 6 h resulting in yield 0.32 g (63%), mp 257 °C; (EtOH); IR (ATR, cm^{-1}): 3034 (arom. CH), 2989 (aliph. CH), 1690 (C=O), 1602, 1556, 1540, 1483, 1440 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 8.96 (quasi d, 1H, 10-H, ^4J = 2.56), 8.76 (dd, 1H, 8-H, ^3J = 8.84, ^4J = 2.56), 8.29 (d, 1H, 7-H, ^3J = 8.84), 7.83 (quasi d, 1H, X part of ABX spin system, ^4J = 2.48), 7.84 (quasi d, 1H, A part of ABX spin system, ^3J =

8.69), 7.62 (dd, 1H, B part of ABX spin system, ^{3}J = 8.69, ^{4}J = 2.48), 7.19-6.87 (2 × AA'BB' spin systems, 8H, phenyl protons), 2.30, (s, 3H, CH_3), 2.29 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 170.39 (C=O), 155.83, 152.56, 151.74, 149.81, 147.31, 144.99, 144.49, 144.41, 139.79, 138.63, 134.41, 131.91, 130.58, 129.71, 129.24, 128.91, 128.78, 128.67, 126.82, 121.01, 119.78 (C-Ph), 21.20 (2 CH_3). Anal. Calcd for $C_{31}H_{20}Cl_2N_6O_5$ (627.43): C, 59.34; H, 3.21; N, 13.39. Found: C, 59.39; H, 3.20; N, 13.39.

***N*'-Bis-(2,4-dinitrophenyl)-4-(4-methylbenzoyl)-3-(4-methylphenyl)-1*H*-pyrazole-5-carbohydrazide (8).** Compound **8** was prepared according to the general procedure above with a reflux time of 2 h resulting in yield 0.27 g (54%), mp 211 °C; (*i*-PrOH); IR (ATR, cm^{-1}): 3346 (NH), 3080 (arom. CH), 2966 (aliph. CH), 1707 (C=O), 1612 (C=O), 1599, 1518, 1510, 1445 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 14.16 (s, 0.52H, OH), 11.75 (s, 0.48H, NH), 7.73 (s, 1H, NH), 8.94-7.12 (m, 11H, phenyl protons), 2.38 (s, 1.44H, CH_3), 2.32 (s, 1.56H, CH_3), 2.30 (s, 1.44H, CH_3), 2.27 (s, 1.56H, CH_3). Anal. Calcd for $C_{31}H_{22}N_8O_{10}$ (666.55): C, 55.86; H, 3.33; N, 16.81. Found: C, 55.88; H, 3.30; N, 16.80.

***N*-Phenyl-1-(2,4-dinitrophenyl)-4-(4-methylbenzoyl)-3-(4-methylphenyl)-1*H*-pyrazole-5-carboxamide (9a).**

General Procedure. Acid chloride **4** (0.51 g, 1 mmol) and aniline (0.19 g, 2 mmol) were refluxed in xylene for about 3 h. After evaporation, the oily residue was treated with dry ether and the crude product formed was crystallized from EtOH to give 0.25 g (50%) of **9a**; mp 298 °C; (EtOH); IR (ATR, cm^{-1}): 3103 (NH), 3018 (arom. CH), 2959 (aliph. CH), 1674 (broad, C=O), 1601, 1537, 1506, 1450 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 10.67 (s, 1H, NH), 8.98 (quasi d, 1H, 10-H, ^{4}J = 2.56), 8.77 (dd, 1H, 8-H, ^{3}J = 8.76, ^{4}J = 2.56), 8.19 (d, 1H, 7-H, ^{3}J = 8.76), 7.80-7.06 (m, 13H, phenyl protons), 2.45 (s, 3H, CH_3), 2.39 (s, 3H, CH_3); ^{13}C NMR (DMSO-d_6): δ 190.86 (Ar-C=O), 153.05 (N-C=O), 148.13 (C3), 141.82, 139.82, 139.13, 135.28, 133.75, 132.54, 130.17, 129.97, 135.60, 133.75, 132.54, 130.17, 129.97, 129.60, 129.02, 128.97, 128.48, 127.75, 124.01, 121.25, 120.75 (C-Ph), 21.21 (CH_3), 21.17 (CH_3). Anal. Calcd for $C_{31}H_{23}N_5O_6$ (561.54): C, 66.30; H, 4.13; N, 12.47. Found: C, 66.33; H, 4.12; N, 12.48.

***N*-Cyclohexyl-1-(2,4-dinitrophenyl)-4-(4-methylbenzoyl)-3-(4-methylphenyl)-1*H*-pyrazole-5-carboxamide (9b).** Compound **9b** was prepared according to the general procedure above with a reflux time of 6 h resulting in yield 0.28 g (56%), mp 156 °C; (EtOH); IR (ATR, cm^{-1}): 3354-3111 (NH), 3054 (arom. CH), 2943 (aliph. CH), 1655, 1614 (C=O), 1606, 1518, 1423, 1398 (C=C, C=N); ^{1}H NMR (DMSO-d_6): δ 8.85-7.38 (m, 11H, phenyl protons), 7.24 (d, 1H, NH), 3.84 (m, 2H, CH), 3.00 (s, 3H, CH_3), 2.88 (s, 3H, CH_3), 1.85-1.56 (m, 6H, CH_2), 1.15 (m, 4H, CH_2); ^{13}C NMR (DMSO-d_6): δ 190.08 (Ar-C=O), 171.18 (N-C=O), 152.18 (C3), 145.86, 141.33, 141.10, 138.66, 135.75, 129.99, 129.64, 129.08, 128.87, 127.36,

122.45, 121.68, 116.03 (C-Ph), 51.67 (CH), 32.02 (2xCH_2), 25.31 (2xCH_2), 24.04 (CH_2), 21.88 (2 × CH_3). Anal. Calcd for $C_{31}H_{29}N_5O_6$ (567.59): C, 65.60; H, 5.15; N, 12.34. Found: C, 65.63; H, 5.12; N, 12.33.

***N,N*-Diisopropyl-1-(2,4-dinitrophenyl)-4-(4-methylbenzoyl)-3-(4-methylphenyl)-1*H*-pyrazole-5-carboxamide (9c).** Compound **9c** was prepared according to the general procedure above with a reflux time of 6 h resulting in yield 0.27 g (54%), mp 197 °C; (benzene); IR (ATR, cm^{-1}): 3080 (arom. CH), 2966, 2873 (aliph. CH), 1670 (N-C=O), 1647 (C=O), 1601, 1533, 1339 (C⎓C, C⎓N); ^{1}H NMR (DMSO-d_6): δ 8.80-7.12 (m, 11H, phenyl protons), 2.65 (m, 1H, CH), 2.35 (s, 3H, CH_3), 2.21 (s, 3H, CH_3), 1.40 (d, 9H, CH_3); ^{13}C NMR (DMSO-d_6): δ 192.35 (Ar-C=O), 170.93 (N-C=O), 160.09 (C3), 149.50, 146.54, 145.34, 143.82, 143.63, 139.75, 138.33, 138.34, 136.45, 131.63, 129.61, 129.51, 129.45, 128.14, 127.04, 121.45, 120.18 (C-Ph), 48.54 (CH), 21.59 (CH_3), 21.18 (CH_3), 19.26 (CH_3). Anal. Calcd for $C_{31}H_{31}N_5O_6$ (569.61): C, 65.37; H, 5.49; N, 12.30. Found: C, 65.39; H, 5.48; N, 12.28.

Crystallography

For the crystal structure determination, single-crystal of compound **5b** was used for data collection on a four-circle Rigaku R-AXIS RAPID-S diffractometer (equipped with a two-dimensional area IP detector). Graphite-monochromated Mo-K_α radiation (λ = 0.71073 Å) and oscillation scans technique with $\Delta w = 5^o$ for one image were used for data collection. The lattice parameters were determined by the least-squares methods on the basis of all reflections with $F^2 > 2\sigma(F^2)$. Integration of the intensities, correction for Lorentz and polarization effects and cell refinement was performed using CrystalClear (Rigaku/MSC Inc., 2005) software.[26] The structures were solved by direct methods using SHELXS-97[27] and refined by a full-matrix least-squares procedure using the program SHELXL-97[27] H atoms were positioned geometrically and refined using a riding model. The final difference Fourier maps showed no peaks of chemical significance. *Crystal data for* ***5b***: $C_{27}H_{22}N_4O_7$, crystal system, space group: triclinic, *P*-1; (no:2); unit cell dimensions: a = 9.6716(2), b = 10.3003(2), c = 12.7144(3), Å, α = 89.716(4), β = 89.395(5), γ = 86.708(4)º; volume: 1264.44(5) $Å^3$; Z = 2; calculated density: 1.351 g/cm^3; absorption coefficient: 0.100 mm^{-1}; F(000):536; θ-range for data collection 2.5–26.4º; refinement method: full matrix least-square on F^2; data/parameters: 5154/347; goodness-of-fit on F^2: 1.019; final R-indices [I > 2r(I)]: R_1 = 0.0626, wR_2 = 0.147; largest diff. peak and hole: 0.284 and -0.213 e $Å^{-3}$.

Crystallographic data that were deposited in CSD under CCDC-928430 registration number contain the supplementary crystallographic data for this Letter. These data can be obtained free of charge from the Cambridge Crystallographic Data Centre (CCDC) via www.ccdc.cam.ac.uk/data_request/cif and are available free of charge upon request to CCDC, 12 Union Road, Cambridge, UK (fax: +441223 336033, e-mail: deposit@ccdc.cam.ac.uk).

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