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Synthesis of 2[1'(3',5'-Disubstituted Pyrazolyl) Methyl]5-Phenyl Amino-1,3,4-Thiadiazoles and 1,2,4-Triazoles as Potential Therapeutic Agents

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A complete synthesis of 2[1'(3', 5'-disubstituted pyrazolyl) methyl] 5- phenyl-1,3,4-thiadiazole V(a-b) and 1,2,4-trizole VI (a-b) is reported. Cyclocondensation of β-diketones with etylhydrazino acetate hydrochloride yielded ethyl 3,5-disubstituted pyrazolyl acetate II(a-c) which on treatment with hydrazine hydrate resulted in the formation of their hydrazide derivatives III(a-c). These hydrazides, when treated with phenyl isothiocyanate, gave thiosemicarbazide derivatives IV(a-c), which were cyclised in the presence of con. H_2SO_4 and $NaOH$ to give V(a-b) and VI(a-b), respectively.

1. Introduction

Synthesis of compounds containing condensed rings and/or more than one heterocyclic nuclei is gaining more and more popularity due to their specific use in medicine. Pyrazole ring compounds connected with other five membered aza heterocycles directly or via $-CH_2-$ or $C = 0$ bridges have been synthesised for their use as antiinflammatory, antiparasitic, antimicrobial and herbicidal properties, respectively. Thus pyrazolyl pyrazoles[1], pyrazolyl thiadiazoles[1], pyrazolyl oxadiazoles[2] and pyrazolyl benzothiadiazoles[3] have been reported to show antiinflammatory activity. Some pyrazoles connected with other pyrazole derivatives via $-CH_2$- bridge have shown antiparacitic activity[4]. Herbicidal activity[5] has been shown by pyrazole derivatives connected with thiadiazoles and oxadiazoles via $C = 0$ bridge.

In continuation of our work on the synthesis of novel five membered aza heterocyclic compounds, we wish to report the synthesis and spectroscopy of 2[1'(3',5'-disubstituted pyrazolyl) methyl] 5-phenyl amino-1,3,4- thiadiazoles and 1,2,4-triazoles (Figure 1).

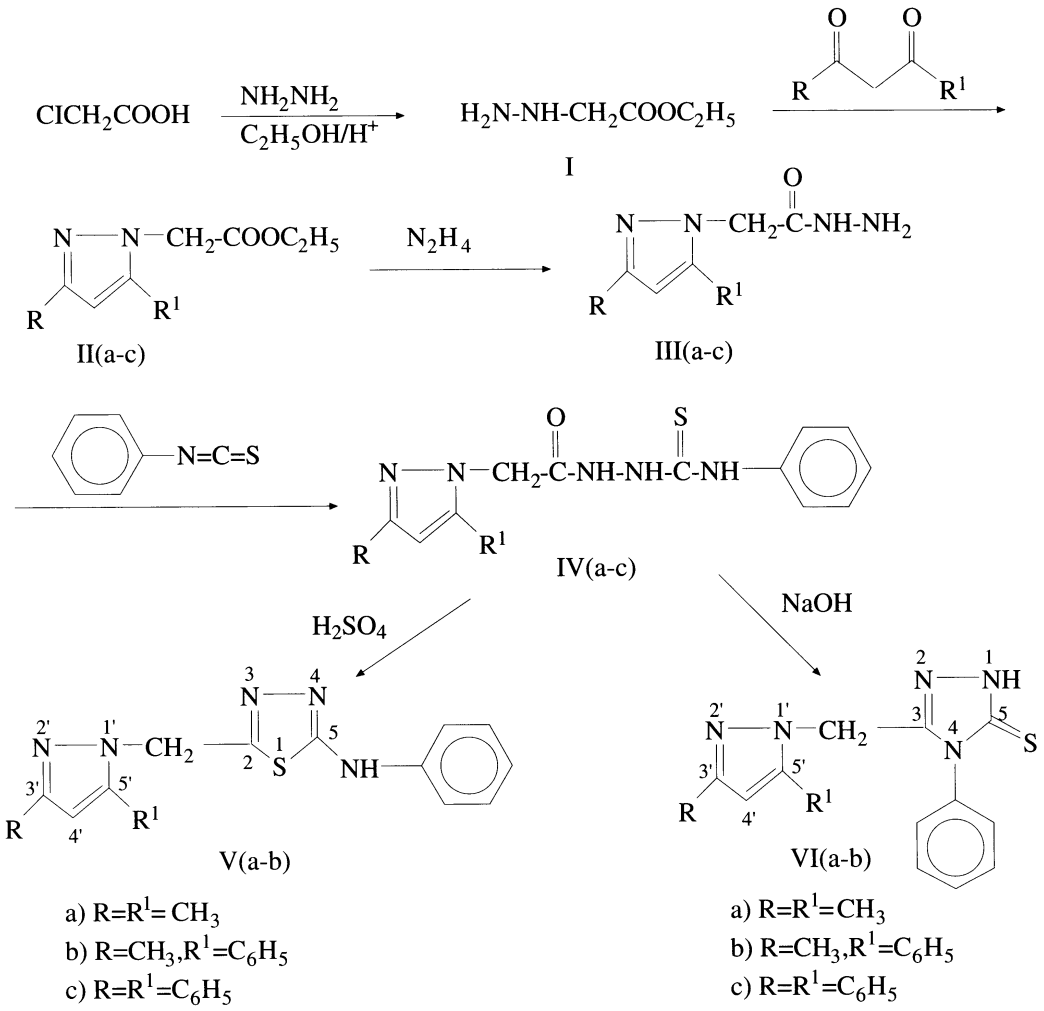


Figure 1.

2. Results and Discussion

Synthesis

Hydrazino acetic ester hydrochloride was prepared by a known method with the same yield and melting point[6]. Cyclocondensation reaction was carried out in glacial acetic acid and the product ethyl-1[3,5-disubstituted pyrazolyl acetate II(a-c) was obtained in 76-81% yield. The hydrazide derivatives III(a-c) were obtained by treating the corresponding ester derivatives II(a-c) with hydrazine hydrate 100%. The hydrazide derivatives III(a-c) were refluxed with phenyl isothiocyanate in absolute ethanol to obtain the corresponding phenyl thiosemicarbazide IV(a- c). Attemps were made to react isocyanates with the hydrazides III(a-c), but the reaction was not successful due to very low yields. The thiosemicarbazide derivatives IV(a-b) were cyclised in the presence of con. H_2SO_4 and $NaOH$ and the products were obtained in reasonable yield. However the cyclisation of IVc was not successful as the product obtained did not give the desired results.

Spectroscopy

IR spectra of II(a-c) showed carbonyl stretching of ester group in the region 1728-1733 cm^{-1}. The C-O-C stretching of ester appeared at 1176- 1192 cm^{-1}. The $^1H - NMR$ spectra of these compound exhibited

singlets due to $C-CH_3$ group in the region δ 1.12-1.14. The $-O-CH_2-C$ protons resonated at δ 4.05-4.09, as quartets. Protons of methylene group attached with nitrogen of pyrazole ring exhibited a singlet at δ 4.64-4.70. Singlet of methine proton of pyrazole ring was observed at δ 7.20-7.33. In compound IIa, the two methyl groups directly attached with pyrazole ring, due to unequal environmental conditions, showed two singlets of three protons each in the region δ 2.03 and δ 2.05. In compound IIb, in order to establish the spatial proximity of the N-substituent and 3/5 substituents of the pyrazole ring nOe difference experiment was carried out. Irradiation of triplet due to methyl protons at δ 1.12-1.14 resulted in 17.5% and 6.7% nOe at δ 4. 05-4.09 and δ 7.3, respectively. No interactions were observed with the methyl protons linked with pyrazole moiety. These nOe interactions (Figure 2) confirmed that the phenyl ring is present at C-5 of the pyrazole ring. These interactions were not possible in the alternative structural isomer when a phenyl ring is present at C-3 of the pyrazole moiety. The IR spectra of pyrazolyl acetic ester hydrazides III(a-c) showed carbonyl stretching of $-C-NH-NH_2$ group at 1602-1659 cm^{-1}. ^{1}H-NMR spectra exhibited a singlet due to methine proton of pyrazole ring at δ 5.82-6.67. Methylene protons resonated as singlets at δ 4.73-4.85. methyl groups attached with pyrazole ring showed singlets at δ 2.03-2.33. In compound IIIa, two singlets of three protons each were observed due to unequal environmental conditions of methyl groups. In mass spectra of compounds III(a-c), the molecular ion peaks were prominent. Base peaks were observed due to the cleavage of $CONHNH_2^+$ from the molecular ion. Other prominent peaks were resulted due to the cleavages of $-NH-NH_2^+$, $-CH_2CONHNH_2^+$ and $-RC_5H_6N_4^+O$ from the molecular ion.

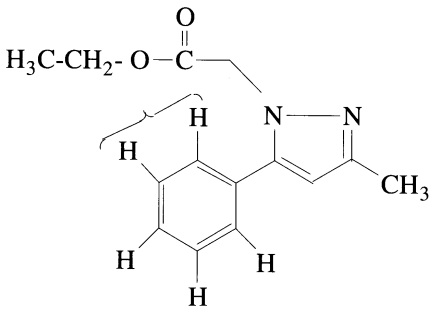


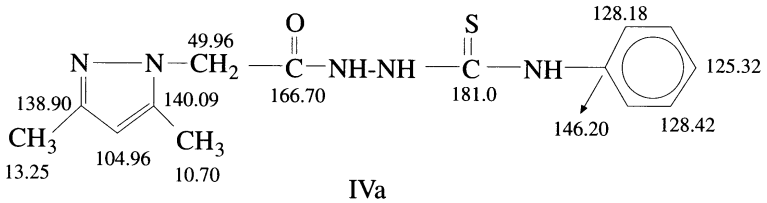
Figure 2.

The IR spectra of thiosemicarbazide IV(a-c) showed carbonyl stretching at 1657-1668 cm^{-1}. The ^1H-NMR spectra of these compounds showed a singlet due to methine protons at δ 5.83-6.77. The $N-CH_2$- protons resonated as singlet at δ 4.75-4.86. Aromatic protons were observed at δ 7.16-7.69. In compounds IVa and b, methyl groups present with pyrazole ring exhibited singlets at δ 2.03-2.20. In ^{13}C-NMR spectra (Figure 3a), the methyl groups attached with pyrazole ring in compounds IVa and IVb resonated at δ 10.7-13.95. The signals due to C-4 of pyrazole rings were observed at δ 104.15-106.33. The C=S resonated downfield in the region δ 150.65-181.73. The C=O signals were observed at δ 139.71-167.81. Methylene carbon resonated at δ 49.96-57.20. The electron ionization mass spectra of IV(a-c) did not show a molecular ion peak. However the field desorption (FD) mass spectra showed molecular ion peaks at 302, 364.8 and 426.9 respectively. Base peaks in all these compounds were observed due to the cleavage of $CONHNHCSNHC_6H_5$ from the molecular ion. Other prominent peaks were observed due to the cleavage of $C_6H_5NNS, C_6H_5NH_2$, and H_2O from the molecular ion.

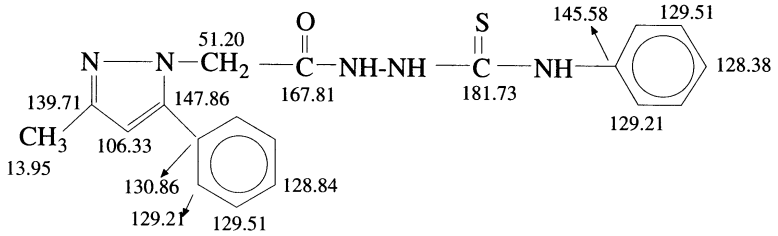
IR spectra of V(a-b) showd C=N stretching vibrations at 1581-1593 cm^{-1}. In ^{1}H-NMR spectra, methne proton of pyrazole ring resonated as a singlet at δ 6.14-6.26. The methylene protons exhibited a singlet at δ 5.51-5.72. Methyl protons were observed at δ 2.19-2.31. In compound Va, two different signals for two methyl groups indicated the unequal environmental conditions present there. In ^{13}C-NMR spectra

(Figure 3b), C-4 of pyrazole ring resonated at δ 106.41-106.07. Methyl carbons attached at C-3 and C-5 position of pyrazole ring resonated at δ 10.55-13.32. Methylene carbon present between two heterocyclic rings resonated at δ 46.38-47.76. In the mass spectra of compounds V(a-b), the base peaks were observed due to the cleavage of $RR^1C_3HN_2CHCNNCS$ from the molecular ion. Other prominent fragments were obtained due to cleavage of C_6H_5NCS, $C_6H_5NCSNHNH_2$, $C_2N_2SNHC_6H_5$ from the molecular ion.

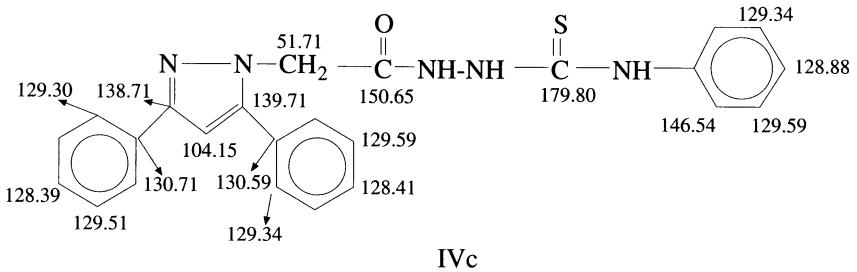
IR spectra of compound VI(a-b) exhibited C=S stretching in the region 1273- 1296 cm^{-1}. In ^{1}H-NMR spectra the methine protons of pyrazole ring resonated at δ 5.62-5.99. The methylene protons exhibited as singlet in the region δ 5.04-5.17. Aromatic protons were observed in the region δ 7.03-7.45. The two methyl groups attached with pyrazole ring in compounds VIa, exhibited two different singlets of three protons each in the region δ 1.74 and δ 2.00. In compound VIb, the methyl protons were observed as singlets at δ 2.12. In ^{13}C-NMR spectra of VI(a-b), (Figure 3b) C-4 of pyrazole ring resonated at δ 104.82-105.1. Methylene carbon present between two heterocyclic rings resonated at δ 42.99-44.03. Carbons of methyl groups attached with pyrazole ring resonated at δ 9.93-13.22. In EI mass spectrum of compound VIa, mass peak was also the base peak while in compound VIb, base peak was observed at m/z 158 due to the cleavage of $C_9H_7N_3S$ fragment from the molecular ion. Other major fragments obtained were due to the cleavage of N_2, $C_7H_8N_3S$, $RR^1C_6H_2N_4S$, $RR^1C_5H_3N_3$, $C_6H_5C_3H_3N_2S$ and $RR^1C_3HN_2$ from the molecular ion.



IVa

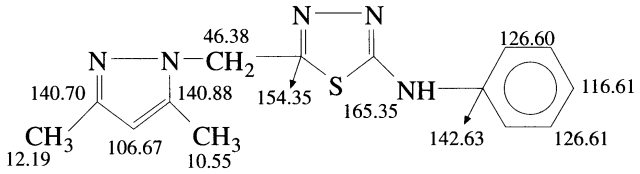


IVb

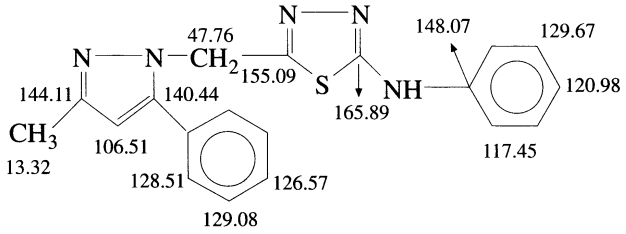


IVc

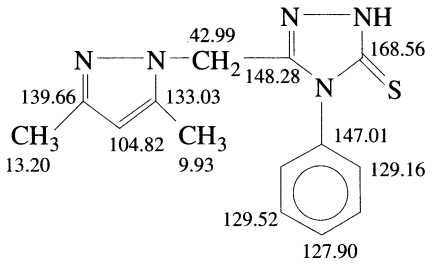
Figure 3a. ^{13}C-NMR spetroscopic data of compounds IV(a- c)



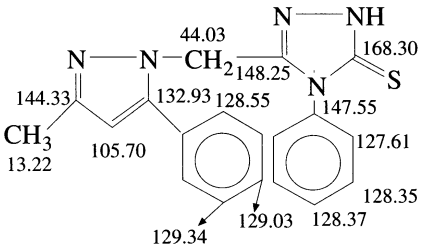
Va



Vb



VIa



VIb

Figure 3b. ^{13}C-NMR spectroscopic data of compounds V(a- b)& VI(a-b)

Experimental

Melting points are uncorrected and determined on a Gallenkamp digital melting point apparatus. IR spectra were recorded on a Hitachi 270-50 Infrared spectrophotometer. For NMR and Mass spectra Jeol JNM FX 900(300 MHz) and Varian Mat CH-5 were used respectively.

Synthesis

General procedure for cyclization of ethyl hydrazinoacetate hydrochloride with β-diketones Ethyl hydrazinoacetate hydrochloride (25 m.mole) was dissolved in 8 ml of distilled water neutralized with sodium bicarbonate. A mixture of β- diketone (25 m. mole) and glacial acetic acid (25 ml) was added. The reaction mixture was refluxed for 2 hours. The solution was poured into crushed ice, extracted with

ethylacetate (3x25 ml) and dried over anhydrous sodium sulfate. The resulting solution was evaporated to dryness in vacuum, and purified by column chromatography using ethylacetate and pet ether (b.p. 60-70° C) in 1:3 ratio V/V.

Ethyl-1(3,5-dimethyl) pyrazolylacetate (IIa) yield 81%, IR (ν_{max},NaCl, cm^{-1}): 3309, 3218, 3005, 2012, 1733, 1601, 1613, 1511, 1208, 1192, 755, 639, ^{1}H-NMR ($CDCl_3$) (δ): 1.12(s, 3H, -CH_3) 2.03(s, 3H, -CH_3), 2.05(s, 3H, $-CH_3$), 4.05 (q, 2H, $-CH_2$), 4.64(s, 2H, $N-CH_2$-), 5.70(s, 1H, pyrazole C-4 H).

Ethy-1(3-methyl-5-phenyl) pyrazolylacetate (IIb) yield 78%, IR (ν_{max}, NaCl, cm^{-1}): 3368, 2916, 2440, 2320, 1728, 1606, 1542, 1370, 1296, 1176, 1008, 920, 872, 756, 680, 378. ^{1}H-NMR ($CDCl_3$)(δ): 1.14 (t, 3H, $-CH_3$, 2.22 (s, 3H, CH_3), 4.09 (q, 2H, $O-CH_2-$), 4.70 (s, 2H, $-N-CH_2$-) 6.04 (s, 1H, pyrazol-H), 7.30 (t, 2H, m-H of phenyl ring), 7.31-7.33 (m, 3H, o& p-H of phenyl ring).

Ethyl-1(3,5-diphenyl) pyrazolylacetate (IIc) yield 76%, IR ($\nu_{max}, NaCl, cm^{-1}$): 1728, 1419, 1356, 1302. 1254, 1242, 1185, 1008, 756, 684, 672. ^{1}H-NMR ($CDCl_3$) (δ): 1.17(t, 3H, $-CH_3$), 4.07(q, 2H, $-0-CH_2-$), 4.69(s, 2H, $-N-CH_2-$), 6.11(s, 1H, Pyr-H), 7.20(t, 2H, m-H of C-3'-phenyl ring), 7.27(t, 2H, m-H of C-5'phenyl ring), 7.37-7.38(m, 6H, Ar-H).

General procedure for the preparation of 1(3,5-disubstituted pyrazolyl) acetic acid hydrazide.

The standard procedure was followed[7]. To a 100 ml flask equipped with a condensor, surrounded by a calcium chloride drying tube, was added ethyl- 1(3,5-disubstituted) pyrazolyl acetate (0.022 moles). Hydrazine hydrate (22. 95 m. m. moles, 100% solution) was dropped slowly with continuous stirring and the mixture was refluxed for 1-3 hours. The reaction mixture was than cooled, filtered and dried. Recrystalization was carried out from absolute ethanol.

1(3,5-dimethylpyrazolyl) acetic acid hydrazide (IIIa), m.p.189-190° C, yield 87% IR (ν_{max}, KBr, cm^{-1}): 3380, 3139, 1627, 1613, 1610, 1560, 1441, 1352, 1109, 732. ^{1}H-NMR ($CDCl_3$) (δ): 2.03(s, 3H, $-CH_3$), 2.18(s, 3H, $-CH_3$), 3.41(s, 2H, $-NH_2$), 4.75(s, 2H, N-CH_2-), 5.82(s, 1H, py-H), 7.4(s, 1H, -NH-H). Mass m/z (%): 168(M^+, 50), 137(19.2), 109(100), 95(7.6), 67(8.4).

1(3-methyl-5-phenylpyrazolyl) acetic acetic acid hydrazide (IIIb), m. p. 164-167° C, yield 85%, IR (ν_{max}, KBr, cm^{-1}): 3550, 3124, 2212, 1602, 1593, 1533, 1446, 1365, 1245, 1128, 912, 675, 570, 528. ^{1}H-NMR ($CDCl_3$) (δ): 2.32(s, 3H, $-CH_3$), 3.87(s, broad, 2H, $-NH_2$), 4.73(s, 2H, $N-CH_2$-), 6.14(s, t-H, py-H), 7.30(t, 2H, m-H of $C-5'$ phenyl ring), 7.43-7.47(m, 3H, Ar-H). 7.68(s,broad, 1H, -NH-). Mass m/z (%): 230 (M^+, 55.7), 199(10), 171(100), 157(72.14), 129(14.28), 77(14.28).

1(3,5-Diphenylpyrazolyl) acetic acid hydrazide (IIIc), m. p. 63.6%, yield 86%, IR (ν_{max}, KBr, cm^{-1}): 3544, 3496, 3436, 3166, 3118, 3058, 3028, 2986, 2890, 2812, 2716, 2680, 2656, 2236, 1659, 1617, 1554, 1467, 1446, 1434, 1404, 1377, 1299. ^{1}H-NMR ($CDCl_3$) (δ): 3.61(s, broad, 2H $-NH_2$), 4.85(s, 2H, $N-CH_2$), 6.67(s, 1H, py-H), 7.26(t, 2H, m-H of C-5' phenyl ring), 7.34-7.61(m, 6H, Ar-H), 7.82(d, 2H, o-H of C-3' phenyl ring). 7.85(s, 1H, NH). Mass m/z (%): 292(M^+, 53.57), 261(8.57), 283(100), 219(14.28), 191(3.57), 77(10).

General procedure for the preparation of 1[1'(3',5'- disubstituted pyrazolyl) acetyl] 4-phenylthiosemicarbazides.

The standard procedure was followed[7]. A solution of 1(3,5- disubstituted pyrazolyl) acetic acid hydrazide (0.022 moles) in absolute ethanol (200 ml) was mixed with a solution of phenylisothiocyanate (0.02 moles) in absolute ethanol (25 ml). The mixture was refluxed for six hours. On cooling, solid appeared, was filtered, dried and recrystallized from absolute ethanol.

1[1'(3',5'-Dimethyl pyrazolyl) accetyl] 4- phenylthiosemicarbazide (IVa), m.p. 193.5-195° C. yield 72.5%, IR (ν_{max}, KBr, cm^{-1}): 3403, 3356, 3280, 3102, 2805, 2212, 1657, 1622, 1571, 1501, 1427, 1239. ^{1}H-NMR ($CDCl_3$) (δ):2.03(s, 3H, $-CH_3$), 2.19(s, 3H, $-CH_3$), 4.75(s, 2H, $N-CH_2-$), 5.83(s, 1H, py-H),

7.16(t, 2H, Ar-H), 7.23-7.50(m, 3H, Ar-H), 9.75(s, 2H, NH), 10.34(s, 1H, -NH-). ^{13}C-NMR ($CDCl_3$) (δ): 10.70, 13.25, 49.96, 104.96, 125.32, 128.42, 128.18, 138.90, 140.09, 146.20, 166.70, 181.00. Mass m/z(%), 320(M^+, 9.2), 168(40), 137(17.6), 109(100), 95(9.2), 67(7.6), 210(26.9), 285(7.6), 77(41.5).

1[1'(3'-Methyl-5'phenyl pyrazolyl] acetyl] 4-phenyl thiosemicarbazide (IVb), m. p. 184-186.2°C, yield 89%, 1R (ν_{max}, KBr, cm^{-1}): 3370, 3238, 3036, 2740, 2452, 2416, 2260, 1965, 1662, 1533, 1413, 1311, 1266, 1233, 1071, 1008, 972, 546, 528, 504. ^{1}H-NMR (DMSO) (δ): 2.2(s, 3H, CH_3) 4.86(s, 2H, $-CH_2$,) 6.27(s, 1H, py-H), 7.27(t, 2H, Ar-H), 7.32-7.57(m, 8H, Ar-H), 9.79(d, 2H, NH), 10.43(s, broad, 1H, NH). ^{13}C-NMR (DMSO) (δ): 13.95, 51.20, 106.33, 128.89, 129.21, 129.51, 130.86, 139.71, 141.86, 145.58, 147.86, 167.81, 181.73. Mass (m/z) (%). 365($M^{+\cdot}$, 10), 230(27.4), 199(5.9), 171(100), 157(15.5), 129.(11.11), 272(17.7), 347(85.9), 77(10.37). Mass FD, m/z(%), 364.8($M^{+\cdot}$, 100).

1[1'(3'5'-Diphenyl pyrazolyl) acetyl] 4-phenyl thiosemicarbazide (IVc) m. p. 188-189.3 yield 88%, IR (ν_{max}, KBr, cm^{-1}) 3502, 3112, 1668, 1593, 1446, 1347, 1269, 1179, 957, 729, 672, 519, 480. ^{1}H-NMR (DMSO) (δ): 4.81(s, 2H, $-N-CH_2-$), 6.77(s, 1H, py-H), 7.18-7.43(m, 13H, Ar-H), 7.69(d, 2H, o-H of C-3' phenyl ring)., 9.6(d, 2H, $-NH_2$), 10.25(s, 1H, NH-). ^{13}C-NMR (DMSO) (δ): 51.71, 104.15, 130.59, 129.54, 139.71, 146.54, 150.65, 138.71, 128.88, 179.80. Mass m/z(%): 427($M^{+\cdot}$, 2), 292(51.6), 261(13.42), 233(100), 219(19.08), 191(8.13), 77(7.77).

General procedure for the preparation of 2[1'(3', 5'- disubstituted pyrazolyl) methyl] 5-phenylamino-1,3,4-thiadiazole

Concentrated sulphuric (40 ml) acid was cooled to 0° C and 4.m moles of thiosemicarbazide was added portion-wise with constant stirring. After complete addition, the reaction mixture was stirred for an additional 3 hours at room temperature and allowed to stand overnight. The solution was then poured into crushed ice, filtered, washed thoroughly with water, dried and recrystillized from acetic acid/H_2O (4:6 V/V).

2[1'(3', 5'-Dimethyl pyrazolyl) methyll-5-phenylamino 1,3,4- thiadiazoles (Va), m. p. 197-198°C, yield 63.8%, IR (ν_{max}, KBr, cm^{-1}): 3109, 3087, 2119, 1518, 1413, 972, 727, 611. ^{1}H-NMR (DMSO) (δ): 2.19(s, 3H, $-CH_3$), 2.31(s, 3H, $-CH_3$), 5.72(s, 2H, $-CH_2-$), 6.14(s, 1H, py-H), 7.52(t, 2H, Ar-H), 7.55-d.60(m, 3H, Ar-H), 9.43(s, broad, 1H, NH-). ^{13}C-NMR (DMSO) (δ): 10.55, 12.19, 46.38, 106.67, 116. 61, 126.60, 126.61, 140.70, 140.88, 142.63, 154.35, 165.35. Mass m/z(%). 285($M^{+\cdot}$, 5.1), 95(100), 150(4.4), 119(2.2), 136(2.2), 109(6.6), 77(2.2), 67(8.8).

2[1'(3'-Methyl-5'-phenylpyrazolyl) methyl]-5-phenylamino 1,3, 4-thiadiazole (Vb) m. p. 182-189°C, yield 60%, IR (ν_{max}, KBr, cm^{-1}): 2926, 1596, 1561, 1494, 1407, 1341, 1296, 1158, 1026, 993, 744, 681, 597, 555. ^{1}H-NMR (CD_3OD) (δ): 2.21(s, 3H, -CH_3), 6.26(s, 1H, py-H), 6.99(t, 2H, Ar-H), 7.09(t, 2H, Ar-H), 7.26-7.48(m, 6H, Ar-H), 10. 33(s, broad, 1H, NH). ^{13}C-NMR (DMSO) (δ): 13.32, 47.76, 106.51, 117.45, 126.57, 128.51, 128.98, 129.08, 129.67, 140.44, 144.11, 148.07, 155.09, 165.89. Mass m/z(%): 347($M^{+\cdot}$, 92.19), 314(56), 212(11.34), 181(52.481), 171(60.28), 157(58.15),136(23.4), 93(100), 77(58.86).

General procedure for the preparation of 3[1'(3',5'- disubstituted pyrazolyl) methyl]-1,2,4-triazole-5-thione

Solid thiosemicarbazide (4.m.mole) was added portion wise to 20 ml of 2N NaOH solution. The reaction mixture was refluxed for 2 hours. It was allowed to cool, filtered and filterate was acidified with 2N HC1. The precipitated solid was filtered, washed thoroughly with water, dried and recrystillized from ethanol/H_2O (1.1, v/v).

3[1'(3', 5'-Dimethyl pyrazolyl) methyl]-4-phenyl 1,2,4- triazole-5-thione (VIa), m. p. 262-264°C, yield 58%, IR (ν_{max}, KBr, cm^{-1}): 3401, 2881, 1572, 1570, 1273, 760, 611. ^{1}H-NMR (DMSO) (δ):1.74(s, 3H), 2.00(s, 3H), 5.04(s, 2H), 5.62(s, 1H), 7.10(t, 2H, Ar-H), 7.22-7.45(m, 3H, Ar-H) 13.93(b.s., 1H, NH).

^{13}C-NMR (DMSO) (δ_c): 9.93, 13.20, 42.99, 104.82, 127.90, 129.16, 129.52, 133.03, 139.66, 147.01, 148.28, 168.56. Mass m/z(%). 285(100), 257(0.7), 190(16.4), 136(6.4), 119(1.4), 109(41.4), 96(6.4), 93(2.8).

3[1'(3'-Methyl-5'-phenyl pyrazolyl) methyl]-4-phenyl 1,2,4- triazole-5-thione (VIb) m. p. 102-110°C, yield 72%, IR (ν_{max}, KBr, cm^{-1}): 2878, 1818, 1551, 1443, 1263m 990, 747, 687, 546. ^{1}H-NMR(DMSO) (δ): 2.12(s, 3H), 2.50(s,1H, CH_3), 3.36(s, 1H, CH_2), 5.99(s, 1H, pyrazolyl CH), 7.03(d, 2H, Ar-H), 7.09-7.13(m, 2H, Ar-H), 7.31-7.45 (m, 6H), 13.92(b. s 1H, NH). ^{13}C-NMR (DMSO) (δ_c). 13.22, 44. 03, 105.70, 127.61, 129.34, 128.35, 128.37, 128.55, 132.93, 144.33, 147.55, 148.25, 168.30. Mass m/z (%): 347(34.2) 319(4.2), 190(20.7), 181(44.2), 171(15.7), 158(100), 136(35.7), 93(31.4).

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