Egypt.J.Chem. **Vol. 61**, No. 6 pp.1111 - 1119 (2018)

β-Oxo Anilides in Heterocyclic Synthesis: Novel Synthesis of Pyridazinones, Pyrazolopyridazines and Cinnolines

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COMPOUND 1 coupled smoothly with aromatic diazonium salts to yield the corresponding arylhydrazones 2a-d. Compounds 2a-d condensed with DMF-DMA in refluxing xylene to yield the pyridazinones 3a-d. Compounds 3a-d were also established based on its further reaction with some active methylene reagents and some nucleophilic reagents. So, reactions of 3a, b with malononitrile in refluxing ethanolic piperidine afforded arylidinemalononitrile 4a,b. The pyridazinone derivatives 3a, b reacted with hydrazine hydrate to afford the hydrazine derivatives 5a, b. When 3a,b were fused with hydrazine hydrate without solvent, the pyrazolo[4,3-c]-pyridazines 6a,b were obtained. Compounds 6a, b were also obtained when compounds 5a, b melt over melting point for short time. Condensation of 2a, b with ethyl cyanoacetate yield 7a, b. Similarly, reactions of 2a,b with 1 mole of malononitrile afforded the pyridazine derivatives 8a,b. While, two moles of malononitrile reacted with 2a, b in the same experimental conditions to yield the cinnoline derivative 9a, b. Reactions of pyridazine 8a,b with 1 mole of malononitrile afforded 9. Compound 2b was reacted with a mixture of arylidinemalononitrile and acrylonitrile to yield product formulated as triazole moieties 12a, b. Similarly compound 2b was reacted with a mixture of maleic anhydride and acrylonitrile in the same above experimental conditions to give 13. Also, reactions of 2b with hydroxylamine hydrochloride yield 14.

Keywords: Pyridazinones, Dyes, Pyrazolopyridazines and Cinnolines.

Introduction

Polyfunctionally substituted heteroaromatics are interesting as potential agrochemicals [1-3], pharmaceuticals [4, 5] and intermediates for the preparation of dyes [6, 7]. Specially condensed pyridazinones are biologically interesting molecules and their chemistry is now receiving considerable interest [8-15]. In conjunction with our interest in the synthesis of azines and condensed azines [16-18]. New route to pyridazinones has been discovered in our laboratory. This route enabled the reactivity of β-oxo anilide 1 toward aromatic and heteroaromatic diazonium salt as a route to new azines and condensed azines of potential activity as dyes, dye intermediates and agrochemicals.

Results and Discussions

β-Oxo anilide 1 coupled smoothly with aromatic diazonium salts in ethanolic sodium acetate to yield the corresponding arylhydrazones 2a-d in good yield [19, 20], these compounds could be also used as disperse dyes [21]. Compounds 2a-d condensed with DMF-DMA in refluxing xylene to yield the pyridazinones 3a-d in excellent yield (Scheme 1).

These structures were established on the basis of spectral analysis as well as elemental analysis. ^{1}H NMR spectrum of compound 3a as an example showed two douplet signals in the range of δ 7.63-7.65 ppm and δ 7.82-7.84 ppm corresponding to the two pyridazine CH protons (H-5 and H-6) respectively. Compounds 3a-d were also established based on its further

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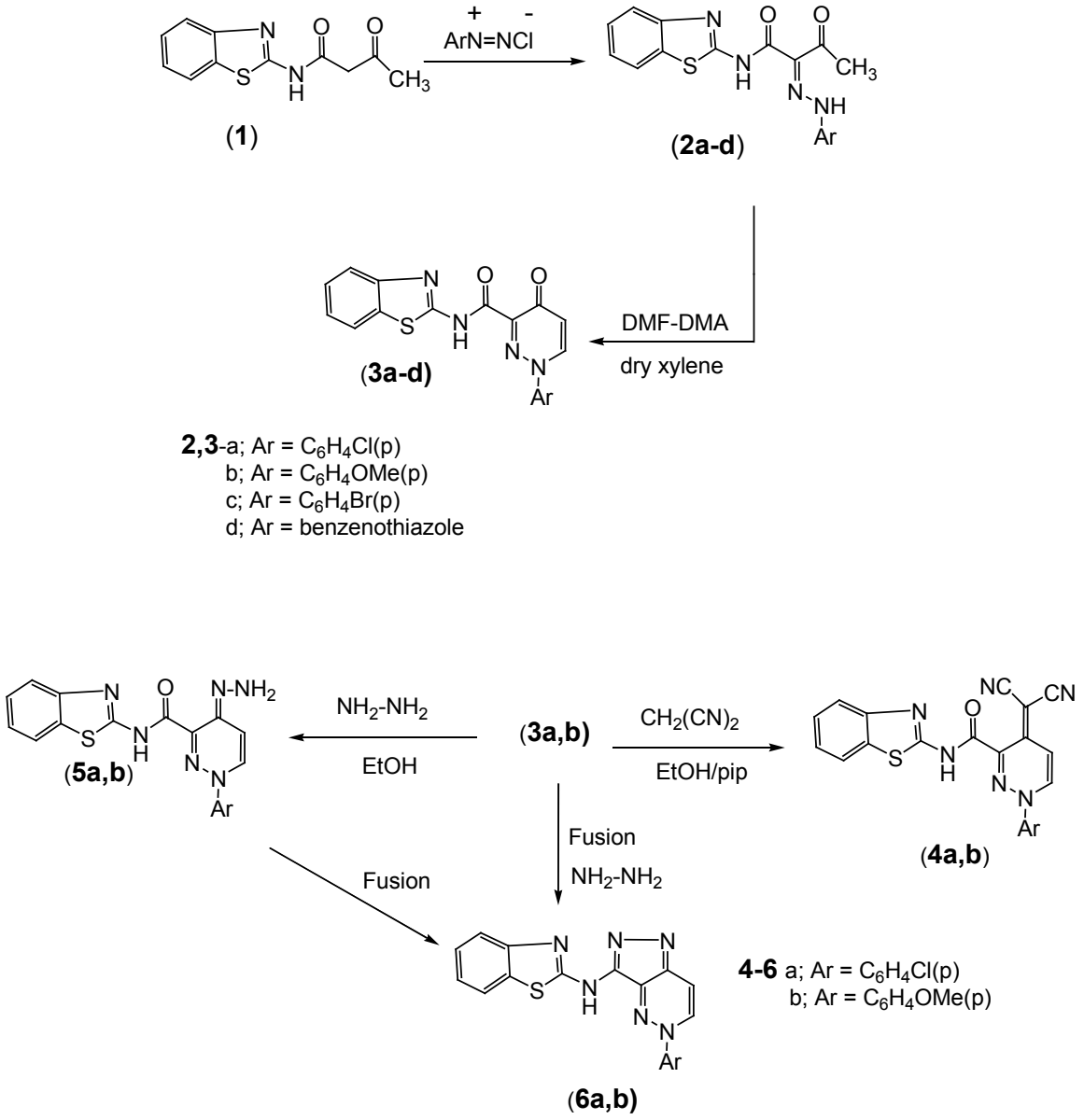
DOI: 10.21608/ejchem.2018.3901.1343

reaction with some active methylene reagents and some nucleophilic reagents. So, reactions of 3a, b with malononitrile in refluxing ethanolic piperidine afforded arylidinemalononitrile 4a,b (Scheme 1). These compounds were established based on its spectroscopic analysis. The IR spectrum of compound 4a showed characteristic bands at 2200 cm^{-1} of two CN groups and disappearance of carbonyl group at δ 1698 of compound 3a.

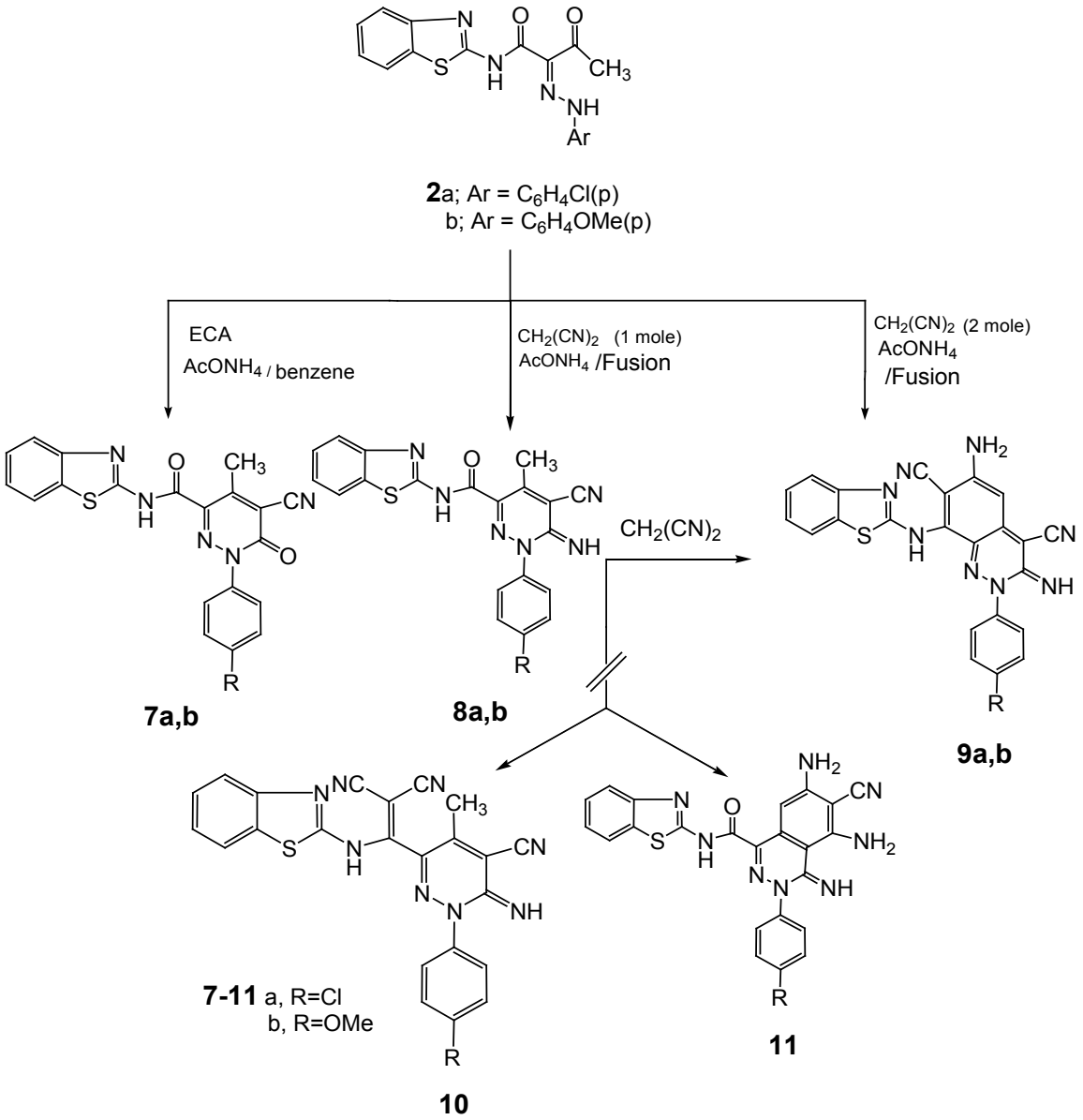
The pyridazinone derivatives 3a, b reacted with hydrazine hydrate in refluxing ethanol to afford the hydrazine derivatives 5a, b (Scheme 1). Compounds 5a,b were established based on its elemental analysis and spectroscopic data. IR spectrum for 5a as an example showed the presence of NH_2 group at ν 3340, 3300 cm^{-1} beside NH group at 3184 cm^{-1} and disappearance of carbonyl group (CO) of compound (3a). Also, the ^1H NMR spectrum of compound (5a) showed the presence of broad signal at δ 4.32 ppm for protons of NH_2 and deuterable signal at δ 12.62 ppm for one proton (NH).



Scheme 1.

When 3a, b were fused with hydrazine hydrate without solvent, the pyrazolo[4,3-c]pyridazines 6a,b were obtained. Compounds 6a, b were also obtained when compounds 5a, b melt over melting point for short time (Scheme 1). The IR spectrum of compound 6a as an example showed the disappearance of NH_2 and CO bands. Also, the ^{1}H NMR spectrum of compound 6a revealed only the two protons of pyridazine, aromatic protons and NH protons at δ = 7.03, 7.96 and 10.73 ppm respectively beside the aromatic protons at δ = 7.11-7.78.

Condensation of 2a,b with ethyl cyanoacetate proceeded very readily either by fusion in the presence of ammonium acetate or by refluxing in the presence of the latter reagent in benzene utilizing a water separator for 5 hours to yield 7a,b (Scheme 2). Compounds 7a,b were established based on spectral data (IR, ^{1}H NMR) and elemental analysis. The IR spectrum of compound 7a as an example revealed a CN band at ν 2199 cm^{-1}, two carbonyl at ν 1670 and 1630 cm^{-1}. Also, ^{1}H NMR spectrum of that compound revealed singlet signal at δ 2.19 ppm assigned to CH_3, multiplet signals at δ 7.28-7.95 ppm corresponding to Ar-H, and singlet signal at δ 12.29 ppm assigned to NH.

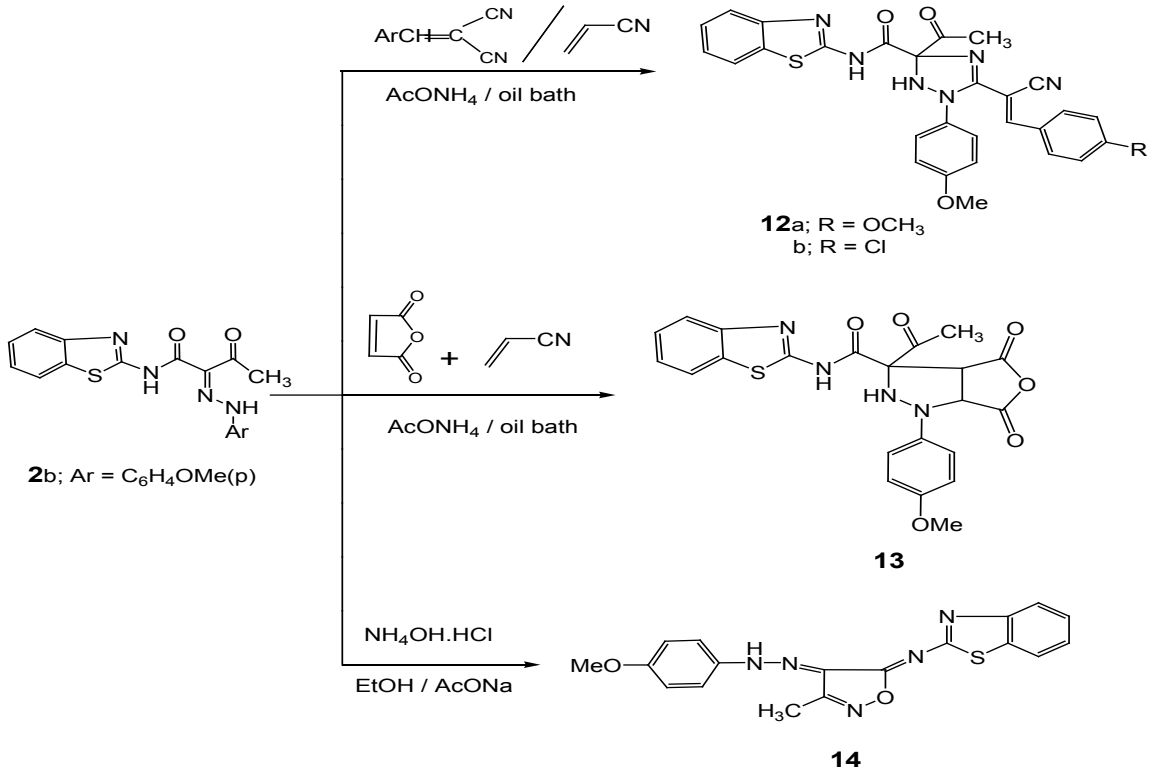


Scheme 2.

Similar to this reaction, reactions of 2a,b with one mole of malononitrile afforded the pyridazine derivatives 8a,b which were established based on its spectral data and elemental analysis, while, when two moles of malononitrile was reacted with 2a,b in the same experimental conditions, cinnoline derivatives 9a,b were formed. These compounds were established based on its spectroscopic data and elemental analysis. The infrared spectrum of compound 9a as an example was characterized by the presence of amino function groups at 3400, 3341 and 3194 cm^{-1}, cyano function group at 2202 cm^{-1} and disappearance of carbonyl function group. Reactions of pyridazine 8a,b with (one mole) of malononitrile in presence of ammonium acetate in oil bath without solvent, three possible structures 9, 10 and 11 can be formed. Structures 10, 11 were eliminated on the basis of analytical and spectral data. Establishing the exact structure of the reaction product as structure 9 based on the comparison of spectroscopic data, also, the IR spectrum of product don't show band of C=O group at range 1725-1660 cm^{-1} characteristic to phthalazine derivative 11 (Scheme 2).

The behaviour of arylhydrazone 2 towards α,β-unsaturated nitrile and nucleophilic reagents was also investigated. Thus, compound 2b was reacted with a mixture of arylidinemalononitrile and acrylonitrile in oil bath without solvent and in presence of ammonium acetate to yield product which was formulated as triazole moities 12a, b (Scheme 3). Compounds 12a, b were compatible establishing based on its elemental analysis and spectral data. The IR spectrum of 12a as an example showed the appearance of CN group at ν 2201 cm^{-1}. Also, ^{1}H NMR spectrum revealed a singlet signal for NH group at δ 8.77 ppm, olefinic (CH) at δ 5.93 ppm.

Similarly compound 2b was reacted with a mixture of maleic anhydride and acrylonitrile in the same above experimental conditions to give compound 13. Also, reactions of 2b with hydroxylamine hydrochloride in refluxing ethanol containing few grams of sodium acetate yield the hydrazone derivative 14 [21]. The structure of isoxazole derivatives 14 was established based on spectroscopic data (IR and ^{1}H NMR). Thus, IR spectrum showed the disappearance of two carbonyl group (2C=O). Also, the ^{1}H NMR spectrum exhibited a singlet signal at δ 2.48 ppm assigned to CH_3, singlet signal at δ 3.80 ppm assigned to OCH_3, multiplet signals at δ 6.99-7.99 coresponding to Ar-H, and singlet signal at δ 12.71 ppm assigned to NH. (Scheme 3).



Scheme 3.

Materials and Methods

All melting points are uncorrected. IR spectra (KBr) were recorded on a FTIR 5300 spectrometer (ν, cm^{-1}). The ^1H NMR spectra were recorded in DMSO-d_6 and $CDCl_3$ at 200, 400 MHz on a Varian Gemini NMR spectrometer (δ, ppm) using TMS as an internal standard. Mass spectra were obtained on GC Ms-QP 1000 EX mass spectrometer at 70 ev. Elemental analysis was carried out by the Microanalytical Research Center, Faculty of Science, Cairo University and Microanalytical Research Center, Assiut University.

Preparation of Compounds (2a-d): General Procedure

A solution of (1) (0.01 mole) in ethanol (100 ml) containing sodium acetate (2.0 g) was cooled to 0°c, stirred and treated gradually with a cooled solution of aryldiazonium chloride (prepared from 0.01 mole of amine and the appropriate quantities of HCl and $NaNO_2$). The solid product formed on standing was collected and recrystallized from the appropriate solvent to give (2a-d).

N-1,3-Benzothiazol-2-yl-2-[(4-chloro-phenyl)-hydrazono]-3-oxo-butanamide (2a)

It was obtained as yellow crystals from dioxane/ethanol; yield 90%; m.p. 260°C; IR (KBr) ν cm^{-1} 3420, 3240 (2NH), 3075 (CH-arom), 2965 (CH-aliph), 1650, 1630 (2C=O); ^1H NMR ($CDCl_3$) δ = 2.57 (s, 3H, CH_3), 7.24-7.85 (m, 8H, Ar-H), 12.70 (s, 1H, NH), 14.32 (s, 1H, NH). Found; C, 54.78; H, 3.53; N, 15.04; cald. For $C_{17}H_{13}ClN_4O_2S$ (372.84): C, 54.77; H, 3.51; N, 15.03.

N-1,3-Benzothiazol-2-yl-2-[(4-methoxy-phenyl)-hydrazono]-3-oxo-butanamide (2b)

It was obtained as yellow crystals from dioxane/EtOH; yield 87%; m.p. 216°C; IR (KBr) ν cm^{-1} 3178, 3142 (2NH), 3063 (CH-arom), 2916, 2863 (CH-aliph), 1718, 1660 (2C=O); ^1H NMR (DMSO-d_6) δ = 2.60 (s, 3H, CH_3), 3.86 (s, 3H, OCH_3), 6.97-7.89 (m, 8H, Ar-H), 12.82 (s, 1H, NH), 14.46 (s, 1H, NH). Found; C, 58.69; H, 4.37; N, 15.23; cald. For $C_{18}H_{16}N_4O_3S$ (368.42): C, 58.68; H, 4.38; N, 15.21.

N-1,3-Benzothiazol-2-yl-2-[(4-bromo-phenyl)-hydrazono]-3-oxo-butanamide (2c)

It was obtained as yellow crystals from ethanol; yield 80%; m.p. 200°C; IR (KBr) ν cm^{-1} 3301, 3177 (2NH), 3063 (CH-arom), 2920 (CH-aliph), 1715, 1658 (2C=O). Found; C, 48.95; H, 3.15; N, 13.45; cald. For $C_{17}H_{13}BrN_4O_2S$ (417.29): C, 48.93; H, 3.14; N, 13.43.

N-1,3-Benzothiazol-2-yl-2-(1,3-benzothiazol-2-yl-hydrazono)-3-oxo-butanamide (2d)

It was obtained as brown crystals from dioxane/EtOH; yield 86%; m.p. 214°C; IR (KBr) ν cm^{-1} 3415, 3240 (2NH), 3070 (CH-arom), 2965 (CH-aliph), 1715, 1659 (2C=O). Found; C, 54.68; H, 3.33; N, 17.73; cald. For $C_{18}H_{13}N_5O_2S_2$ (395.46): C, 54.67; H, 3.31; N, 17.71.

Preparation of Compounds (3a-d): General Procedure

Equimolar amounts of DMF-DMA (0.01 mole) and compounds (2a-d) (0.01 mole) in dry xylene (30 ml) were refluxed for 6 hr. The reaction mixture was left to stand at room temperature. The product formed was collected by filtration and recrystallized from the proper solvent to give (3a-d).

N-1,3-Benzothiazol-2-yl-1-(4-chlorophenyl)-4-oxo-1,4-dihydropyridazine-3-carboxamide (3a)

It was obtained as brown crystals from DMF/ethanol; yield 70%; m.p. >300°C; IR (KBr) ν cm^{-1} 3470 (NH), 1698, 1651 (2C=O); ^1H NMR (DMSO-d_6) δ = 7.05-7.45 (m, 9H, Ar-H and NH), 7.63-7.65 (d, 1H, pyridazine-H) J = 8.2 (Hz), 7.82-7.84 (d, 1H, pyridazine-H) J = 8.0 (Hz). Found; C, 56.48; H, 2.91; N, 14.62; cald. For $C_{18}H_{11}ClN_4O_2S$ (382.83): C, 56.47; H, 2.90; N, 14.63.

N-1,3-Benzothiazol-2-yl-1-(4-methoxyphenyl)-4-oxo-1,4-dihydropyridazine-3-carboxamide (3b)

It was obtained as brown crystals from DMF/EtOH; yield 80%; m.p. 270-2°C; IR (KBr) ν cm^{-1} 3427 (NH), 3037 (CH-arom), 2922 (CH-aliph), 1644, 1630 (2C=O); ^1H NMR (DMSO-d_6) δ = 3.80 (s, 3H, OCH_3), 7.03-7.79 (m, 8H, Ar-H), 7.83-7.85 (d, 1H, pyridazine-H), 8.02-8.04 (d, 1H, pyridazine-H), 13.00 (s, 1H, NH). Found; C, 60.32; H, 3.75; N, 14.82; cald. For $C_{19}H_{14}N_4O_3S$ (378.41): C, 60.31; H, 3.73; N, 14.81.

N-1,3-Benzothiazol-2-yl-1-(4-bromophenyl)-4-oxo-1,4-dihydropyridazine-3-carboxamide (3c)

It was obtained as brown crystals from ethanol; yield 72%; m.p. 220°C; IR (KBr) ν cm^{-1} 3436 (NH), 3050 (CH-arom), 1676, 1636 (2C=O). Found; C, 50.62; H, 2.58; N, 13.13; cald. For $C_{18}H_{11}BrN_4O_2S$ (427.28): C, 50.60; H, 2.59; N, 13.11.

N,1-bis (1,3-Benzothiazol-2-yl) -4- oxo-1,4-dihydropyridazine -3- carboxamide (3d)

It was obtained as pale yellow crystals from ethanol; yield 66%; m.p. 286°C; IR (KBr) ν cm^{-1} 3422 (NH), 3050 (CH-arom), 1684, 1670 (2C=O); ^{1}H NMR (DMSO-d_6) δ = 7.27-8.19 (m, 8H, Ar-H), 8.30-8.33 (d, 1H, pyridazine-H), 8.78 (s, 1H, NH), 8.93-8.95 (d, 1H, pyridazine-H). Found; C, 56.29; H, 2.75; N, 17.28; cald. For $C_{19}H_{11}N_5O_2S_2$ (405.46): C, 56.28; H, 2.73; N, 17.27.

Preparation of Compounds (4a, b): General Procedure

A mixture of (3a,b) (0.01 mole) and malononitrile (0.01 mole) in ethanol (20 ml) was treated with a few drops of piperidine and refluxed for 4 hrs. The solid product formed was filtered off and recrystallized from the proper solvent to give (4a,b).

N-1,3-Benzothiazol-2-yl-1-(4-chlorophenyl)-4-(dicyano-methylene)-1,4-dihydropyridazine-3-carboxamide (4a)

It was obtained as buff crystals from DMF/EtOH; yield 70%; m.p. 310°C; IR (KBr) ν cm^{-1} 3380 (NH), 3090 (CH-arom), 2200 (C≡N), 1655 (C=O); ^{1}H NMR (DMSO-d_6) δ = 6.43 (d, 1H, pyridazine-H), 7.62-7.72 (m, 9H, Ar-H and NH), 8.74 (d, 1H, pyridazine-H). Found; C, 58.55; H, 2.58; N, 19.52; cald. For $C_{21}H_{11}ClN_6OS$ (430.88): C, 58.54; H, 2.57; N, 19.50.

N-1,3-Benzothiazol-2-yl-4-(dicyanomethylene)-1-(4-methoxy-phenyl)-1,4-dihydropyridazine-3-carboxamide (4b)

It was obtained as brown crystals from ethanol; yield 64%; m.p. 220°C; IR (KBr) ν cm^{-1} 3427 (NH), 2931 (CH-aliph), 2202 (C≡N), 1651 (C=O); ^{1}H NMR (DMSO-d_6) δ = 3.75 (s, 3H, OCH_3), 6.99-7.01 (d, 1H, pyridazine-H), 7.25-7.78 (m, 9H, Ar-H and NH), 7.88-7.90 (d, 1H, pyridazine-H). Found; C, 61.96; H, 3.32; N, 19.73; cald. For $C_{22}H_{14}N_6O_2S$ (426.46): C, 61.96; H, 3.31; N, 19.71.

Preparation of Compounds (5a, b): General Procedure

A mixture of (3a,b) (0.01 mole) and hydrazine hydrate (0.02 mole) in ethanol (20 ml) was refluxed for 2 hr. The reaction mixture was left to stand and the obtained product was recrystallized from the proper solvent to give (5a,b).

N-1,3-Benzothiazol-2-yl-1-(4-chlorophenyl)-4-hydrazono-1,4-dihydropyridazine-3-carboxamide (5a)

It was obtained as buff crystals from ethanol; yield 66%; m.p. 182°C; IR (KBr) ν cm^{-1} 3340, 3300 (NH_2), 3184 (NH), 3050 (CH-arom), 1743 (C=O); ^{1}H NMR (DMSO-d_6) δ = 4.32 (hump, 2H, NH_2), 7.01 (s, 1H, pyridazine-H), 7.30-7.42 (m, 8H, Ar-H), 7.90 (s, 1H, pyridazine-H), 12.62 (s, 1H, NH). Found; C, 54.49; H, 3.32; N, 21.19; cald. For $C_{18}H_{13}ClN_6OS$ (396.86): C, 54.48; H, 3.30; N, 21.18.

N-1,3-Benzothiazol-2-yl-4-hydrazono-1-(4-methoxyphenyl)-1,4-dihydropyridazine-3-carboxamide (5b)

It was obtained as brown crystals from DMF/EtOH; yield 68%; m.p. >300°C; IR (KBr) ν cm^{-1} 3278, 3250 (NH_2), 3188 (NH), 3080 (CH-arom), 2919 (CH-aliph), 1660 (C=O). Found; C, 58.16; H, 4.13; N, 21.42; cald. For $C_{19}H_{16}N_6O_2S$ (392.44): C, 58.15; H, 4.311; N, 21.41.

Preparation of Compounds (6a, b): General Procedure

Method (A)

A mixture of (3a,b) (0.01 mole) and excess of hydrazine hydrate (10 ml) was refluxed for 24 hr. The solid product, so formed was collected by filtration and recrystallized from the proper solvent to give (6a,b).

Method (B)

Compounds (5a,b) was fused for 10 minutes at over melting point. The reaction mixture was left to stand, then triturated with ethanol. The solid product so formed was collected by filtration and recrsytallized from the proper solvent to give (6a,b).

N-1,3-Benzothiazol-2-yl-5-(4-chlorophenyl)-5H-pyrazolo-[4,3-c]pyridazin-3-amine (6a)

It was obtained as brown crystals from DMF/EtOH; yield 67%; m.p. >300°C; IR (KBr) ν cm^{-1} 3425 (NH); ^{1}H NMR (DMSO-d_6) δ = 7.03 (s, 1H, pyridazine-H), 7.11-7.78 (m, 8H, Ar-H), 7.96 (s, 1H, pyridazine-H), 10.73 (s, 1H, NH). Found; C, 57.08; H, 2.95; N, 22.19; cald. For $C_{18}H_{11}ClN_6S$ (378.85): C, 57.07; H, 2.93; N, 22.18.

N-1,3-Benzothiazol-2-yl-5-(4-methoxyphenyl)-5H-pyrazolo-[4,3-c]pyridazin-3-amine (6b)

It was obtained as brown crystals from DMF/EtOH; yield 70%; m.p. >300°C; IR (KBr) ν cm^{-1}

3410 (NH), 3035 (CH-arom), 2915 (CH-aliph). Found; C, 60.96; H, 3.78; N, 22.46; cald. For $C_{19}H_{14}N_6OS$ (374.43): C, 60.95; H, 3.77; N, 22.45.

Preparation of Compounds (7a,b and 8a,b): General Procedure

A mixture of (2a,b) (0.01 mole), appropriate active methylene reagent (ethylcyanoacetate or malononitrile) (0.01 mole) and ammonium acetate (2.0 gm) was fused for 30 minutes at 140°C. The reaction mixture was left to stand, then triturated with ethanol. The solid product so formed was collected by filtration and recrystallized from the proper solvent to give (7a,b and 8a,b).

N-1,3-Benzothiazol-2-yl-1-(4-chlorophenyl)-5-cyano-4-methyl-6-oxo-1,6-dihydropyridazine-3-carboxamide (7a)

It was obtained as brown crystals from DMF/EtOH; yield 76%; m.p. >300°C; IR (KBr) ν cm^{-1} 3345 (NH), 2927 (CH-aliph), 2199 (C≡N), 1670, 1630 (2C=O); ^{1}H NMR (DMSO-d_6) δ = 2.19 (s, 3H, CH_3), 7.28-7.95 (m, 8H, Ar-H), 12.29 (s, 1H, NH). Found; C, 56.95; H, 2.89; N, 16.62; cald. For $C_{20}H_{12}ClN_5O_2S$ (421.87): C, 56.94; H, 2.87; N, 16.60.

N-1,3-Benzothiazol-2-yl-5-cyano-1-(4-methoxyphenyl)-4-methyl-6-oxo-1,6-dihydropyridazine-3-carboxamide (7b)

It was obtained as brown crystals from dioxane/ethanol; yield 80%; m.p. >300°C; IR (KBr) ν cm^{-1} 3370 (NH), 2200 (C≡N), 1660, 1640 (2C=O); ^{1}H NMR (DMSO-d_6) δ = 2.28 (s, 3H, CH_3), 3.81 (s, 3H, OCH_3), 7.02-8.22 (m, 9H, Ar-H and NH). Found; C, 60.43; H, 3.64; N, 16.79; cald. For $C_{21}H_{15}N_5O_3S$ (417.45): C, 60.42; H, 3.62; N, 16.78.

N-1,3-Benzothiazol-2-yl-1-(4-chlorophenyl)-5-cyano-6-imino-4-methyl-1,6-dihydropyridazine-3-carboxamide (8a)

It was obtained as green crystals from dioxane/ethanol; yield 71%; m.p. 270-2°C; IR (KBr) ν cm^{-1} 3170 (NH), 2950 (CH-aliph), 2200 (C≡N), 1660 (C=O); ^{1}H NMR (DMSO-d_6) δ = 2.52 (s, 3H, CH_3), 7.33-8.02 (m, 9H, Ar-H and NH), 9.97 (s, 1H, NH). Found; C, 57.09; H, 3.13; N, 19.98; cald. For $C_{20}H_{13}ClN_6OS$ (420.88): C, 57.08; H, 3.11; N, 19.97.

N-1,3-Benzothiazol-2-yl-5-cyano-6-imino-1-(4-methoxy-phenyl)-4-methyl-1,6-dihydropyridazine-3-carboxamide (8b)

It was obtained as brown crystals from ethanol; yield 69%; m.p. 238°C; IR (KBr) ν cm^{-1} 3357, 3300 (2NH), 3082 (CH-arom), 2196 (C≡N), 1661 (C=O). Found; C, 60.58; H, 3.88; N, 20.17; cald. For $C_{21}H_{16}N_6O_2S$ (416.46): C, 60.57; H, 3.87; N, 20.18.

Preparation of Compounds (9a,b): General Procedure

Method (A)

A mixture of (2a,b) (0.01 mole), malononitrile (0.02 mole) and ammonium acetate (2.0 gm) was fused for 30 minutes at 140°C. The reaction mixture was left to stand at room temperature and triturated with ethanol. The solid product so formed was collected by filtration and recrystallized from the proper solvent to give (9a,b).

Method (B)

A mixture of (8a,b) (0.01 mole), malononitrile (0.01 mole) and ammonium acetate (2.0 gm) was fused for 30 minutes at 140°C. The reaction mixture was left to stand and triturated with ethanol. The solid product so formed was collected by filtration and recrystallized from the proper solvent to give (9a,b).

6-Amino-8-(1,3-Benzothiazol-2-yl-amino)-2-(4-chloro-phenyl)-3-imino-2,3-dihydrocinnoline-4,7-dicarbonitrile (9a)

It was obtained as brown crystals from dioxane/ethanol; yield 75%; m.p. >300°C; IR (KBr) ν cm^{-1} 3400, 3341 (NH_2), 3194 (NH), 2202 (C≡N); ^{1}H NMR (DMSO-d_6) δ = 5.72 (s, 2H, NH_2), 7.54-8.17 (m, 11H, Ar-H and 2NH). Found; C, 58.92; H, 2.78; N, 23.91; cald. For $C_{23}H_{13}ClN_8S$ (468.93): C, 58.91; H, 2.79; N, 23.90.

6-Amino-8-(1,3-Benzothiazol-2-yl-amino)-3-imino-2-(4-methoxyphenyl)-2,3-dihydrocinnoline-4,7-dicarbonitrile (9b)

It was obtained as brown crystals from dioxane/ethanol; yield 70%; m.p. >300°C; IR (KBr) ν cm^{-1} 3400, 3350 (NH_2), 3170 (NH), 2200 (C≡N); MS: m/z 462 (M^{-2}). Found; C, 62.08; H, 3.48; N, 24.13; cald. For $C_{24}H_{16}N_8OS$ (464.51): C, 62.06; H, 3.47; N, 24.12.

Preparation of Compounds (12a,b), (13): General Procedure

Equimolar amounts of (2b) (0.01 mole), arylidine malononitrile or maleic anhydride (0.01 mole), acrylonitrile (0.01 mole) and ammonium acetate (0.5 gm) were heated at 150°C for 2 hrs.

The reaction mixture was left to cool, triturated with ethanol and poured into water. The solid product so formed was collected by filtration and recrystallized from the proper solvent to give (12a,b), (13).

3-Acetyl-N-1,3-benzothiazol-2-yl-5-[1-cyano-2-(4-methoxy-phenyl)vinyl]-1-(4-methoxyphenyl)-2,3-dihydro-1H-[1,2,4]-triazole-3-carboxamide (12a):

It was obtained as brown crystals from ethanol; yield 70%; m.p. 230-32°C; IR (KBr) ν cm^{-1} 3328, 3114 (2NH), 2996, 2931, 2835 (CH-aliph), 2201 (C≡N), 1662 (C=O); ^1H NMR ($CDCl_3$) δ = 2.33 (s, 3H, $COCH_3$), 3.79 (s, 3H, OCH_3), 3.87 (s, 3H, OCH_3), 5.93 (s, 1H, CH), 6.82-7.98 (m, 13H, Ar-H and NH), 8.77 (s, 1H, NH). Found; C, 63.04; H, 4.39; N, 15.23; cald. For $C_{29}H_{24}N_6O_4S$ (552.62): C, 63.03; H, 4.38; N, 15.21.

3-Acetyl-N-1,3-benzothiazol-2-yl-5-[2-(4-chlorophenyl)-1-cyano-vinyl]-1-(4-methoxyphenyl)-2,3-dihydro-1H-[1,2,4]-triazole-3-carboxamide (12b)

It was obtained as brown crystals from benzene; yield 76%; m.p. 157-58°C; IR (KBr) ν cm^{-1} 3341, 3187 (2NH), 2950 (CH-aliph), 2204 (C≡N), 1650 (C=O); ^1H NMR ($CDCl_3$) δ = 2.52 (s, 3H, $COCH_3$), 3.79 (s, 3H, OCH_3), 5.83 (s, 1H, CH), 6.90-7.91 (m, 12H, Ar-H), 9.90 (s, 1H, NH), 12.77 (s, 1H, NH). Found; C, 60.39; H, 3.82; N, 15.08; cald. For $C_{28}H_{21}ClN_6O_3S$ (557.03): C, 60.38; H, 3.80; N, 15.09.

3-Acetyl-N-1,3-benzothiazol-2-yl-1-(4-methoxyphenyl)-4,6-dioxo-hexahydro-furo[3,4-c] pyrazole-3-carboxamide (13)

It was obtained as brown crystals from DMF/EtOH; yield 72%; m.p. >300°C; IR (KBr) ν cm^{-1} 3375, 3201 (2NH), 2850 (CH-aliph), 1710, 1649 (C=O). Found; C, 56.66; H, 3.90; N, 12.03; cald. For $C_{22}H_{18}N_4O_6S$ (466.48): C, 56.65; H, 3.89; N, 12.01.

5-(1,3-Benzothiazol-2-yl-imino)-3-methylisoxazol-4-(5H)-one-(4-methoxyphenyl) hydrazone (14)

A mixture of (2b) (0.01 mole), hydroxylaminehydrochloride (0.01 mole) and sodium acetate (0.5 g) in ethanol (30 ml) was treated with 1 ml of water and heated under reflux for 8 hrs. The solid product formed after cooling was collected by filtration and recrystallized from ethanol to give (14; 77%) as brown crystals, m.p. 230°C; IR (KBr) ν cm^{-1} 3470 (NH); 2990 (CH-aliph); ^1H NMR (DMSO-d_6) δ = 2.48 (s, 3H, CH_3), 3.80 (s, 3H, OCH_3), 6.99-7.99 (m, 8H, Ar-H), 12.71 (s, 1H, NH). Found; C, 59.17; H, 4.16; N, 19.18; cald. For $C_{18}H_{15}N_5O_2S$ (365.41): C, 59.16; H, 4.14; N, 19.17.

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(*Received* 24/5/2018; *accepted* 1/8/2018)

بيتا-اوكسو انيليدات فى تشييد الحلقات الغير متجانسه: تشييد فريد للبيريدازينونات، البيرازولوبيريدازينات والسينولينات

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تم تشييد فريد لمشتقات البيريدازينونات، البيرازولوبيريدازينات و السينولينات متعدد الوظائف وتم إثبات المركبات الجديدة التى تم الحصول عليها بأستخدام التحاليل الدقيقة و الاطياف الضوئية المختلفة.