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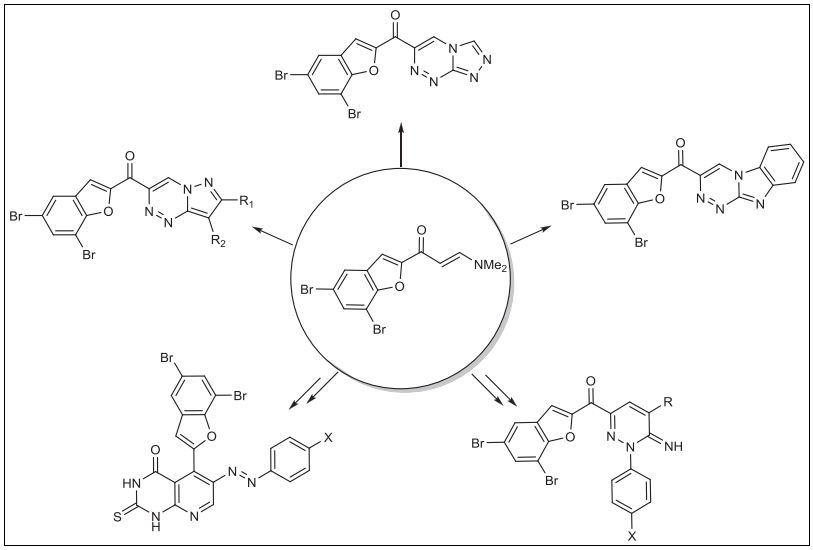

2-Acetyl-5,7-dibromobenzo[*b*]furan (**1**) reacted with dimethylformamide-dimethylacetal to give the corresponding (*E*)-enaminone **3** which coupled with aromatic diazonium chloride to afford the corresponding key intermediates 3-oxo-2-(2-arylhydrazono)propanals **6a**,**b**. Compounds **6a**,**b** were used to prepare novel 3-imino-2,3-dihydropyridazines **10a**,**b** and 6-phenylazopyrido[2,3-*d*]pyrimidin-4(1*H*)-one derivatives **15a**,**b** through their reaction with acetonitrile derivatives **8a**,**b** and 6-aminopyrimidin-4(1*H*)-one **13**, respectively. On the other hand, the enaminone **3** was taken as a synthetic precursor to synthesize novel pyrazolo[5,1-*c*][1,2,4]triazines **21a**–**c**, [1,2,4]triazolo[3,4-*c*][1,2,4]triazines **25** and benzimidazo[2,1-*c*][1,2,4]triazine **29** containing 5,7-dibromobenzofuran-2-oyl moiety *via* its coupling with the appropriate diazonium salts of a variety of hetero-armomatic amines in a facile one-step route.

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INTRODUCTION

Benzofurans constitute a significant class of heterocyclic compounds that is present as key precursor in several natural products with biological importance, such as Viniferifuran, Anigopreissin A, and Moracin [1–9]. Also, synthetic pharmaceutical compounds holding benzofuran ring are important, such as Amiodarone (anti-arrhythmic agent), Dronedarone (anti-arrhythmic agent), and 2-methylbenzofuran (anti-helminthic, anti-inflammatory, and anti-diarrheal) (Fig. 1) [10–12]. On the other hand, benzofuran derivatives have emerged as organic transistors as an example of using benzofurans [13].

In addition, the introduction of bromo-groups enhances the bioactivity of the synthesized derivatives such as increasing the cytotoxicity to the human lung cancer A549 cell line significantly due to necrosis, enhances the antibacterial activity, and led to increased inhibitory activity of BoNT/A LC protease inhibitors [14–16].

Owing to the importance of benzofuran derivatives, the finding of new efficient methods for their preparation and derivatization is an intensive field of study [17–19]. Therefore, in this study, the enaminone of 2-acetyl-5,7-dibromobenzo[*b*]furan was used as key intermediate to prepare a variety of novel azines and fused azolotriazines derivatives containing benzofuran moiety.

RESULTS AND DISCUSSION

Reaction of 2-acetyl-5,7-dibromobenzo[*b*]furan [20] (**1**) with dimethylformamide-dimethylacetal in boiled toluene under reflux for 20 h yielded the corresponding 3-(*N*,*N*-dimethylamino)prop-2-en-1-one derivative **3**. The ^{1}H NMR spectrum of such product revealed two singlets at δ 2.95 and 3.19 corresponding to *N*,*N*-dimethylamio protons, two doublets at δ 5.81 and 7.82 (J = 12.4 Hz) corresponding to ethylenic protons, in addition to three

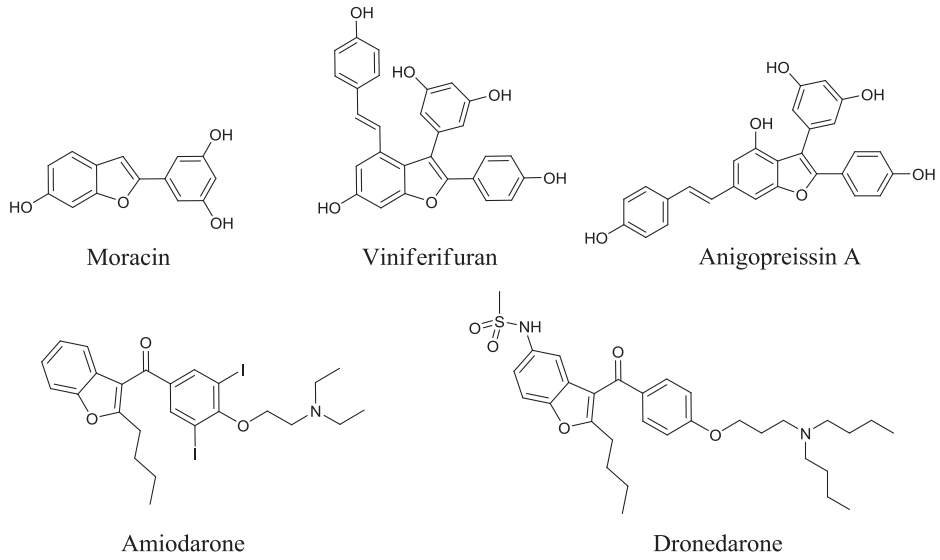


Figure 1. Selected bioactive benzo[*b*]furan derivatives.

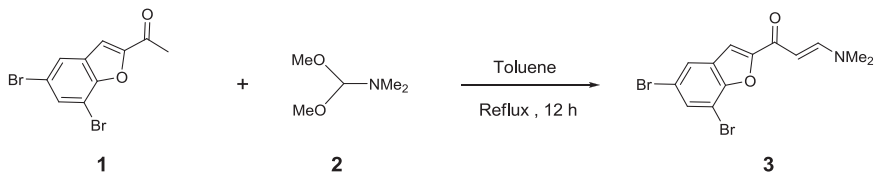
singlet signals at δ 7.62, 7.86, and 7.98 due to benzofuran protons. On the basis of the coupling constant value for the olefinic protons, the enaminone **3** exists most likely in the *E*-configuration (Scheme 1).

The synthetic potentiality of the enaminone **3** was investigated *via* its coupling reaction with aromatic diazonium chloride in alcoholic sodium acetate solution at 0°C [21]. Thus, **3** reacted with benzene diazonium chloride (**4a**) to afford the corresponding 3-(5,7-dibromobenzofuran-2-yl)-3-oxo-2-(2-phenylhydrazono)propanal (**6a**) through the intermediate **5a**. The infrared (IR) spectrum (cm^{-1}) of **6a** showed NH stretching band at 3433 in addition to two strong bands 1676 and 1648 attributed to two CO groups. The ^{1}H NMR spectrum (δ ppm) of **6a** revealed two singlets at 10.08 and 14.20 corresponding to CHO and NH, respectively, in addition to signals at the region 6.88–7.98 due to benzofuran and aromatic protons. On the basis of the aforementioned data, compound **6a** is more likely to be existed in the anti-form rather than the syn-form **7a** [22,23] (Scheme 2). Another analogue 3-(5,7-dibromobenzofuran-2-yl)-3-oxo-2-(2-(4-methylphenyl)hydrazono)propanal (**6b**) obtained *via* reacting **3** with **4b** through the intermediate **5b** (Scheme 2).

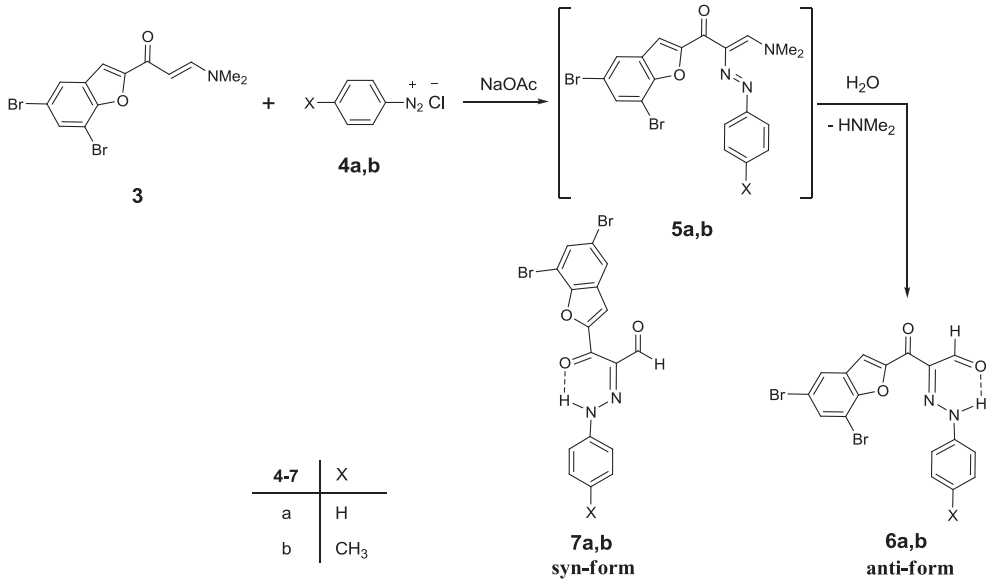
The isolation of 3-oxo-2-(2-arylhydrazono)propanal derivatives **6a**,**b** with two carbonyl groups adjacent to arylhydrazone group [24–26] stimulates our interest to construct the pyridazine ring by reacting **6a**,**b** with acetonitrile derivatives **8a**,**b**, namely, malononitrile (**8a**) and ethyl cyanoacetate (**8b**) (Scheme 3). Two possible pathways "A" or "B" were proposed to the reaction attributed to which carbonyl group condensed first with the active methylene in **8** following by intramolecular cyclization to afford 3-imino-2,3-dihydropyridazines **10** or **12**. Thus, **6a** was reacted with **8a** in boiled pyridine under reflux for 10 h to give the corresponding 3-imino-2,3-dihydropyridazine derivative **10a** or **12a**. The IR spectrum (cm^{-1}) of the reaction product showed the absorption bands at 3376, 2223, and 1638 corresponding to NH, CN, and CO groups, respectively. The ^{1}H NMR spectrum (δ ppm) of the same compound revealed the absence of CHO signal and the presence of two singlet signals at 7.72 and 8.27 corresponding to pyridazine H5 and NH, respectively. These results confirm the formation of 6-(5,7-dibromobenzofuran-2-oyl)-3-imino-2-phenyl-2,3-dihydropyridazine-4-carbonitrile (**10a**) through the non-isolable intermediate **9a** and rule out the structure **12a**. In a similar manner, **10b**–**d** were prepared by reacting **6a**,**b** with **8a**,**b** in pyridine under reflux (Scheme 3).

Furthermore, we have investigated the synthetic potential of **6a**,**b** as 1,3-dicarbonyl derivatives by performing its reaction with 6-amino-2-thioxo-2,3-dihydropyrimidin-4(1*H*)-one (**13**) in acetic acid under reflux. Therefore, the

Scheme 1. Preparation of (*E*)-3-(*N*,*N*-dimethylamino)prop-2-en-1-one derivative **3**.



Scheme 2. Preparation of arylhydrazonopropanal derivatives **6a**,**b**.

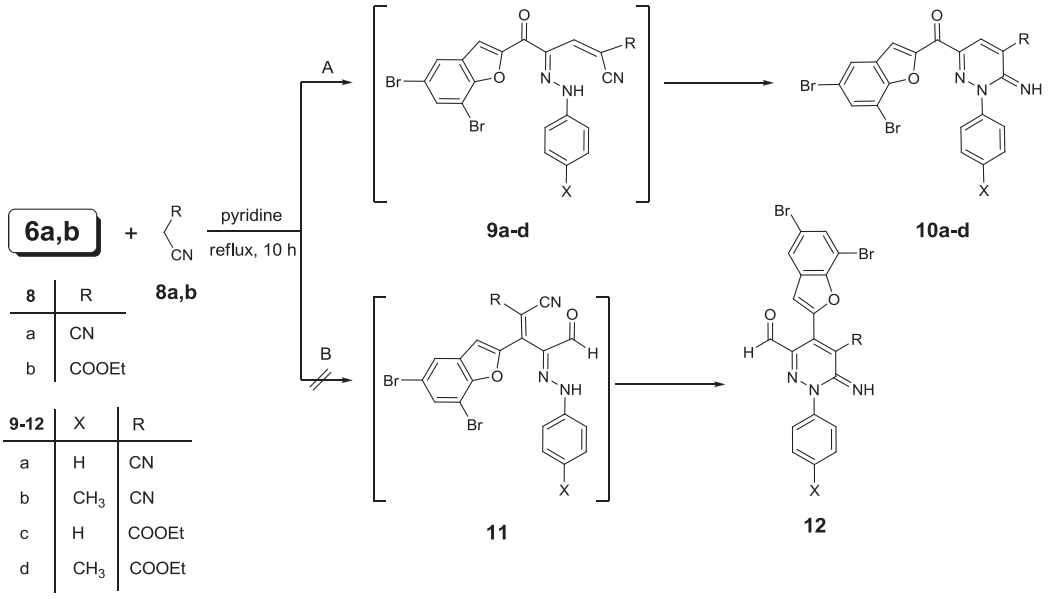


reaction of arylhydrazonopropanal derivative **6a** with **13** afforded 5-(5,7-dibromobenzofuran-2-yl)-6-phenylazo-2-thioxo-2,3-dihydropyrido[2,3-*d*]pyrimidin-4(1*H*)-one (**15a**) or the isomeric structure **17a** which could not be distinguished based on the elemental analysis and the spectral data. The structure was established to be **15** based on literature similarity. The ^{1}H NMR spectrum of the isolated product revealed a singlet signal at δ 8.54 ppm attributed to a pyridine H2 proton rather than a pyridine H4 proton [27–31] (Scheme 4).

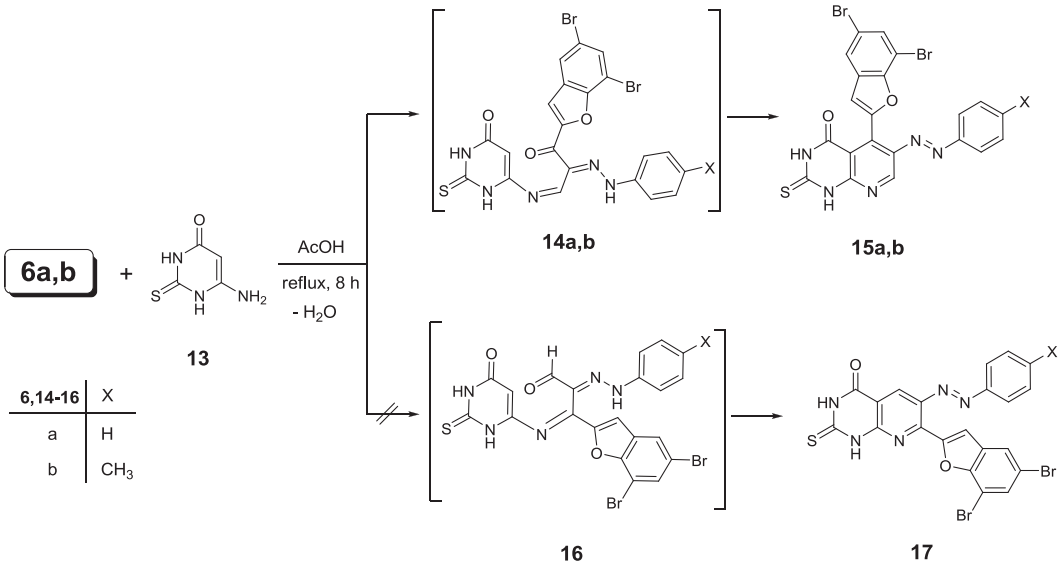
The reaction is more likely to proceed by condensing the amino group in **13** with the more electrophilic formyl group in **6a** to form the non-isolable Schiff's base **14a** which underwent intramolecular cyclization by elimination of a second molecule of water to afford the corresponding **15a**. In a similar manner, **6b** reacted with **13** to afford **15b** in acetic acid under reflux through the intermediate **14b** (Scheme 4).

On the other hand, a facile one-step route to interesting biologically active fused [1,2,4]triazine derivatives was

Scheme 3. Preparation of 3-imino-2,3-dihydropyridazines **10a**–**d**.



Scheme 4. Preparation of 2-thioxo-2,3-dihydropyrido[2,3-*d*]pyrimidin-4(*1H*)-ones **15a**,**b**.

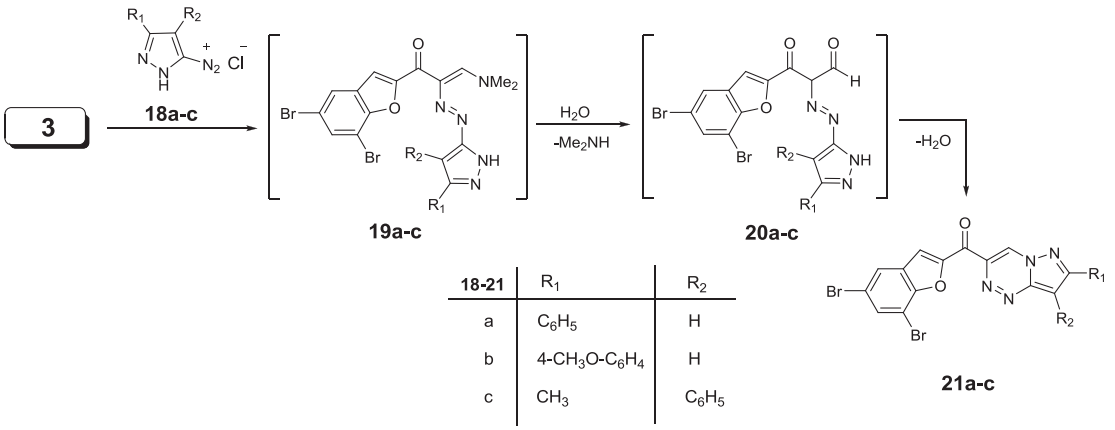


investigated using enaminone **3** as a potential precursor [32,33]. Thus, the enaminone **3** was coupled with diazonium salt of 3-amino-5-phenylpyrazole **18a** in pyridine to yield directly the corresponding 3-(5,7-dibromobenzofuran-2-oyl)-7-phenylpyrazolo[5,1-*c*][1,2,4] triazine (**21a**). The ^{1}H NMR spectrum of **21a** revealed the presence of two singlets at δ 7.12 and 9.36 ppm corresponding to H8 and H4, respectively. The reaction may proceed through the intermediate **19a** which hydrolyzed, with elimination of dimethylamine, to give the non-isolable 3-oxo-2-(2-(pyrazol-3-yl)hydrazono) propanal derivative **20a** which then underwent intramolecular cyclization by addition of pyrazole-NH to the formyl function followed by the loss of one molecule of water to afford the final isolable pyrazolo[5,1-*c*][1,2,4] triazine derivative **21a**. In a similar manner, **3** was coupled with diazonium salt of aminopyrazole derivatives **18b**,**c** to afford the corresponding pyrazolotriazine derivatives **21b**,**c** (Scheme 5).

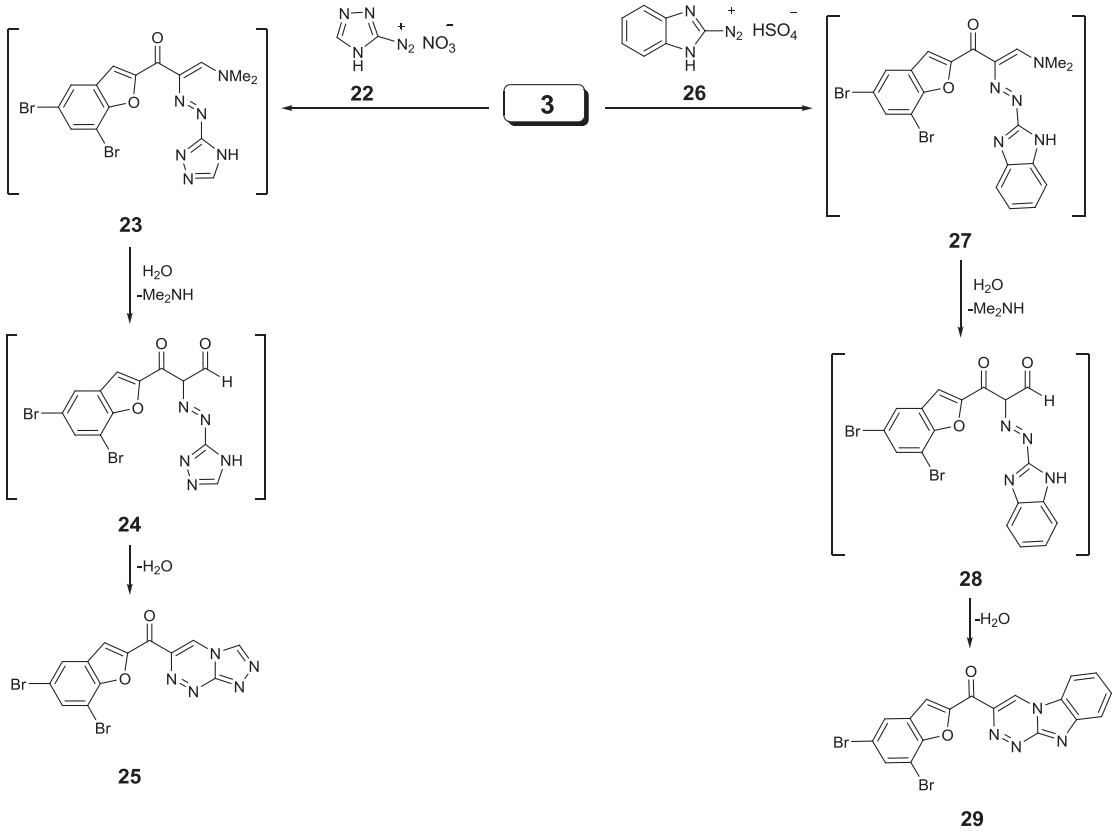
In the same way, enaminone **3** coupled with diazonium nitrate of 3-amino-[1,2,4]triazole **22** under the same experimental conditions. On the basis of the elemental analysis and spectral data, the structure of the isolated product was identified as 3-(5,7-dibromobenzofuran-2-oyl)[1,2,4]triazolo[3,4-*c*][1,2,4]triazine (**25**) (Scheme 6). Compound **25** is properly formed through the intermediates **23** and **24** which then underwent intramolecular cyclization by addition of the endocyclic triazole-4-NH to formyl function followed by loss of one molecule of water [22,34,35].

The enaminone **3** coupled also with diazonium salt of 2-aminobenzoimidazole **26** to afford 3-(5,7-dibromobenzofuran-2-oyl)benzimidazo[2,1-*c*][1,2,4]triazine (**29**) (Scheme 6). The IR spectrum of the latter product

Scheme 5. Preparation of pyrazolo[5,1-*c*][1,2,4]triazines **21a**–**c**.



Scheme 6. Preparation of benzoimidazo[2,1-*c*][1,2,4]triazine derivative **25** and [1,2,4]triazolo[3,4-*c*][1,2,4]triazine derivative **29**.



revealed a band at 1643 cm^{-1} characteristic to the carbonyl group. Its mass spectrum showed a peak corresponding to its molecular ion peak at *m/z* 470. The ^{1}H NMR of the same compound revealed characteristic signal at δ 9.33 ppm due to triazine proton, in addition to signals at the region δ 7.15–8.01 ppm due to benzofuran and aromatic protons.

CONCLUSION

In this manuscript, facile synthetic routes to a novel pyridazines and fused pyridopyrimidines in addition one-step routes to a wide variety of fused triazine derivatives at position-2 of 5,7-dibromobenzofuran ring were developed using novel (*E*)-enaminone and readily available diazonium salts of both aromatic and heterocyclic amine as key starting materials.

EXPERIMENTAL

Introduction. All organic solvents were purchased from commercial sources and used as received unless otherwise stated. All other chemicals were purchased from Merck, Aldrich, or Acros and used without further purification. Thin-layer chromatography was performed on precoated Merck 60 GF254 silica gel plates with a fluorescent indicator and detection by means of UV light at 254 and 360 nm. The melting points were measured on a Stuart melting point apparatus and are uncorrected. IR spectra were recorded on a Smart iTR, which is an ultra-high-performance, versatile attenuated total reflectance sampling accessory on the Nicolet iS10 FT-IR spectrometer (Madison, WI). The NMR spectra were recorded on a Bruker Avance III 400 (Zurich, Switzerland) (9.4 T, 400.13 MHz for ^{1}H, and 100.62 MHz for ^{13}C) spectrometer with a 5-mm BBFO probe, at 298 K. Chemical shifts (δ in ppm) are given relative to the NMR solvent signals [hexadeuterated dimethyl sulfoxide (DMSO-*d6*) 2.50 and 39.50 ppm, $CDCl_3$ 7.26 and 77.00 ppm for ^{1}H and ^{13}C NMR, respectively]. Mass spectra were recorded on a Thermo ISQ Single Quadrupole (Austin, TX) Gas Chromatography Mass Spectrometry (GC-MS). Elemental analyses were carried out on a EuroVector instrument C, H, N, S analyzer EA3000 Series (Milano, Italy). 2-Acetyl-5,7-dibromobenzo[*b*]furan (**1**) [20], 1*H*–pyrazole diazonium chloride derivatives **18a**–**c** [36], l,2,4-triazole diazonium nitrate (**22**) [36], and 1*H*–

benzimidazole diazonium sulfate (**26**) [36] were prepared according to the reported *literature*.

General methods and spectral data. ***Preparation of (E)-1-(5,7-dibromobenzofuran-2-yl)-3-(dimethylamino)prop-2-en-1-one (3).*** Dimethylformamide-dimethylacetal (40 mmol) was added to 2-acetyl-5,7-dibromobenzo[*b*]furan (**1**) (20 mmol) in dry toluene (50 mL), and the resulting mixture was boiled under reflux for 20 h. The excess dimethylformamide-dimethylacetal and solvent were distilled off under vacuum. The remaining solid was collected in petroleum ether (40 mL), and the resulting crystals were filtrated, washed with petroleum ether, dried, and finally recrystallized from dry benzene to give the enaminone **3**. Orange solid (82%), m.p. 160–162°C; IR: ν 1637 (CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 2.95 (s, 3H, CH_3), 3.19 (s, 3H, CH_3), 5.81 (d, 1H, ═CH─CO, *J* = 12.4 Hz), 7.62 (s, 1H, benzofuran-CH), 7.82 (d, 1H, ═CH─N, *J* = 12.4 Hz), 7.86 (s, 1H, benzofuran-CH), 7.98 (s, 1H, benzofuran-CH); ^{13}C NMR (DMSO-d_6): δ 37.77, 45.31, 105.23, 109.36, 114.27, 116.35, 125.08, 130.97, 131.28, 150.97, 155.01, 157.28, 175.58; MS: 371 (M^+, 50%), 373 (M + 2, 100%), 375 (M + 4, 50%); $C_{13}H_{11}Br_2NO_2$: *Anal*. Calcd: C, 41.86; H, 2.97; N, 3.75. Found: C, 41.79; H, 3.03; N, 3.80%.

General method for the preparation of arylhydrazonopropanal derivatives 6a,**b**. An appropriate aryldiazonium chloride solution **4a**,**b** (10 mmol) was prepared *via* the addition of sodium nitrite solution of (1.5 g into 10 mL of water) to arylamine hydrochloride (10 mmol of arylamine in 5 mL of concentrated HC1) with stirring in ice bath. The obtained solution was then poured to ethanolic solution (30 mL) of compound **3** (10 mmol) in presence of sodium acetate (5 g) with stirring for 45 min at 0–5°C. The reaction mixture was stirred for additional 3 h in ice bath and then left for 12 h at 4°C in a refrigerator. The solid obtained was filtrated and recrystallized from ethanol to afford the corresponding arylhydrazonopropanals **6a**,**b**.

3-(5,7-Dibromobenzofuran-2-yl)-3-oxo-2-(2-phenylhydrazono) propanal (6a). Orange solid (85%), m.p. 110–112°C; IR: ν 3433 (NH), 1676, 1648 (2 CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 6.88 (t, 1H, ArH, *J* = 8 Hz), 7.22 (t, 2H, ArH, *J* = 8.4 Hz), 7.35 (d, 2H, ArH, *J* = 8 Hz), 7.63 (s, 1H, benzofuran-CH), 7.87 (s, 1H, benzofuran-CH), 7.98 (s, 1H, benzofuran-CH), 10.08 (s, 1H, CHO), 14.20 (s, 1H, NH, D_2O-exchangeable); ^{13}C NMR (DMSO-d_6): δ 105.32, 111.83, 114.20, 116.41, 122.19, 125.11, 130.59, 131.02, 131.57, 132.27, 139.71, 151.10, 155.23, 176.74, 189.73; MS: 448 (M^+, 50%), 450 (M + 2, 100%), 452 (M + 4, 48%); $C_{17}H_{10}Br_2N_2O_3$: *Anal*. Calcd: C, 45.37; H, 2.24; N, 6.22. Found: C, C, 45.26; H, 2.28; N, 6.30%.

3-(5,7-Dibromobenzofuran-2-yl)-3-oxo-2-(2-(4-methylphenyl) hydrazono)propanal (6b). Orange solid (87%), m.p. 128–130°C; IR: ν 3437 (NH), 1673, 1650 (2 CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 2.36 (s, 3H, CH_3), 7.24 (d, 2H, ArH, *J* = 8.4 Hz), 7.39 (d, 2H, ArH, *J* = 8.4 Hz), 7.64 (s, 1H, benzofuran-CH), 7.85 (s, 1H, benzofuran-CH), 7.98 (s, 1H, benzofuran-CH), 10.05 (s, 1H, CHO), 14.66 (s, 1H, NH, D_2O-exchangeable); ^{13}C NMR (DMSO-d_6): δ 20.34, 105.27, 110.16, 114.16, 116.52, 117.09, 125.06, 130.05, 131.10, 131.68, 133.42, 138.90, 152.03, 155.29, 176.83, 189.68; MS: 462 (M^+, 50%), 464 (M + 2, 100%), 466 (M + 4, 52%); $C_{18}H_{12}Br_2N_2O_3$: *Anal*. Calcd: C, 46.58; H, 2.61; N, 6.04. Found: C, 46.49; H, 2.67; N, 5.98%.

General method for the preparation of 3-imino-2,3-dihydropyridazines 10a–d. The appropriate arylhydrazonal derivatives **6a**,**b** (15 mmol) and acetonitrile compounds **8a**, **b** (15 mmol) in pyridine (30 mL) in presence of two drops of piperidine as a catalyst were boiled under reflux for 8 h. The reaction mixture was evaporated under vacuum, and the products obtained were triturated with ethanol, filtrated, and recrystallized from a mixture of EtOH/DMF (10:1) to afford the corresponding compounds **10a**–**d**.

6-(5,7-Dibromobenzofuran-2-oyl)-3-imino-2-phenyl-2,3-dihydropyridazine-4-carbonitrile (10a). Yellow solid (78%), m.p. 230–232°C; IR: ν 3376 (NH), 2223 (CN), 1638 (CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 7.24 (d, 2H, ArH, *J* = 8.4 Hz), 7.42 (t, 1H, ArH, *J* = 8 Hz), 7.51 (t, 2H, ArH, *J* = 8 Hz), 7.62 (s, 1H, benzofuran-CH), 7.72 (s, 1H, pyridazine-5-CH), 7.85 (s, 1H, benzofuran-CH), 7.97 (s, 1H, benzofuran-CH), 8.27 (s, 1H, NH, D_2O-exchangeable); ^{13}C NMR (DMSO-d_6): δ 105.42, 108.74, 114.34, 115.73, 116.47, 120.62, 122.14, 126.13, 129.70, 130.76, 132.28, 139.13, 139.44, 143.81, 151.17, 154.95, 159.48, 176.72; MS: 496 (M^+, 16.3%), 498 (M + 2, 34%), 500 (M + 4, 17%); $C_{20}H_{10}Br_2N_4O_2$: *Anal*. Calcd: C, 48.22; H, 2.02; N, 11.25. Found: C, 48.13; H, 2.11; N, 11.20%.

6-(5,7-Dibromobenzofuran-2-oyl)-3-imino-2-(4-methylphenyl)-2,3-dihydropyridazine-4-carbonitrile (10b). Yellow solid (80%), m.p. 252–254°C; IR: ν 3370 (NH), 2224 (CN), 1645 (CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 2.38 (s, 3H, CH_3), 7.34 (d, 2H, ArH, *J* = 8.4 Hz), 7.50 (d, 2H, ArH, *J* = 8.4 Hz), 7.62 (s, 1H, benzofuran-CH), 7.72 (s, 1H, pyridazine-5-CH), 7.85 (s, 1H, benzofuran-CH), 7.99 (s, 1H, benzofuran-CH), 8.23 (s, 1H, NH, D_2O-exchangeable); ^{13}C NMR (DMSO-d_6): δ 20.40, 105.33, 108.89, 114.39, 115.82, 116.40, 122.49, 126.25, 130.07, 130.88, 132.37, 133.14, 137.52, 139.28, 144.36, 151.26, 154.71, 159.53, 176.87; MS: 510 (M^+, 20%), 512 (M + 2, 40%), 514 (M + 4, 20.7%); $C_{21}H_{12}Br_2N_4O_2$: *Anal*. Calcd: C, 49.25; H, 2.36; N, 10.94. Found: C, 49.31; H, 2.44; N, 10.83%.

Ethyl 6-(5,7-dibromobenzofuran-2-oyl)-3-imino-2-phenyl-2,3-dihydropyridazine-4-carboxylate (10c). Yellow solid (75%), m.p. 162–164°C; IR: ν 3400 (NH), 1720, 1635 (2 CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 1.05 (t, 3H, CH_3, *J* = 7 Hz), 4.13 (q, 2H, CH_2, *J* = 7 Hz), 7.27 (d, 2H, ArH, *J* = 8.4 Hz), 7.45 (t, 1H, ArH, *J* = 8 Hz), 7.51 (t, 2H, ArH, *J* = 8 Hz), 7.63 (s, 1H, benzofuran-CH), 7.70 (s, 1H, pyridazine-5-CH), 7.85 (s, 1H, benzofuran-CH),

7.98 (s, 1H, benzofuran-CH), 8.30 (s, 1H, NH, D_2O-exchangeable); ^{13}C NMR (DMSO-d_6): δ 14.11, 61.87, 105.37, 114.29, 116.34, 120.84, 122.45, 126.23, 127.55, 130.21, 130.69, 132.19, 137.61, 139.10, 139.57, 151.12, 153.86, 159.37, 161.73, 176.75; MS: 543 (M^+, 13%), 545 (M + 2, 26%), 547 (M + 4, 13.5%); $C_{22}H_{15}Br_2N_3O_4$: *Anal*. Calcd: C, 48.47; H, 2.77; N, 7.71. Found: C, 48.40; H, 2.82; N, 7.80%.

Ethyl 6-(5,7-dibromobenzofuran-2-oyl)-3-imino-2-(4-methylphenyl)-2,3-dihydro-pyridazine-4-carboxylate (10d). Yellow solid (78%), m.p. 187–189°C; IR: ν 3380 (NH), 1725, 1632 (2 CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 1.08 (t, 3H, CH_3, J = 7 Hz), 4.12 (q, 2H, CH_2, J = 7 Hz), 7.27 (d, 2H, ArH, J = 8 Hz), 7.50 (d, 2H, ArH, J = 8 Hz), 7.61 (s, 1H, benzofuran-CH), 7.76 (s, 1H, pyridazine-5-CH), 7.84 (s, 1H, benzofuran-CH), 7.99 (s, 1H, benzofuran-CH), 8.27 (s, 1H, NH, D_2O-exchangeable); ^{13}C NMR (DMSO-d_6): δ 14.11, 20.57, 61.85, 105.32, 114.34, 116.37, 122.44, 126.25, 127.47, 130.10, 130.71, 132.28, 133.09, 137.49, 139.30, 139.57, 151.30, 154.42, 159.44, 161.69, 176.80; MS: 557 (M^+, 20.2%), 559 (M + 2, 42%), 561 (M + 4, 21%); $C_{23}H_{17}Br_2N_3O_4$: *Anal*. Calcd: C, 49.40; H, 3.06; N, 7.51. Found: C, 49.47; H, 3.01; N, 7.43%.

General method for the preparation of 2-thioxo-2,3-dihydropyrido[2,3-*d*]pyrimidin-4(1H)-ones 15a,**b**. The appropriate arylhydrazonals **6a**,**b** (15 mmol) and 6-amino-2-thioxo-2,3-dihydropyrimidin-4(1*H*)-one (**13**) (15 mmol) in acetic acid (50 mL) were boiled under reflux for 8 h. After cooling, the mixture was diluted with methanol, and the obtained solid was filtrated and recrystallized from acetic acid to afford **15a**,**b**.

5-(5,7-Dibromobenzofuran-2-yl)-6-phenylazo-2-thioxo-2,3-dihydropyrido[2,3-d]-pyrimidin-4(1H)-one (15a). Yellow solid (64%), m.p. > 300°C; IR: ν 3320, 3305 (2NH), 1638 (CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 7.21 (t, 1H, ArH, J = 8 Hz), 7.49–7.63 (m, 5H, benzofuran-CH, and ArH), 7.85 (s, 1H, benzofuran-CH), 7.98 (s, 1H, benzofuran-CH), 8.54 (s, 1H, pyridine-CH), 12.71 (s, 1H, NH), 13.22 (s, 1H, NH); ^{13}C NMR (DMSO-d_6): δ 103.56, 105.33, 117.10, 118.63, 124.60, 126.17, 127.24, 127.78, 128.11, 129.61, 132.37, 137.34, 139.73, 141.45, 150.35, 154.63, 156.70, 164.82, 167.93; MS: 555 (M^+, 6.0%), 557 (M + 2, 12.0%), 559 (M + 4, 6.2%); $C_{21}H_{11}Br_2N_5O_2S$: *Anal*. Calcd: C, 45.27; H, 1.99; N, 12.57; S, 5.75. Found C, 45.20; H, 2.03; N, 12.62; S, 5.68%.

5-(5,7-dibromobenzofuran-2-yl)-6-(4-methylphenylazo)-2-thioxo-2,3-dihydropyrido-[2,3-d]pyrimidin-4(1H)-one (15b). Yellow solid (64%), m.p. > 300°C; IR: ν 3295, 3280 (2NH), 1640 (CO) cm^{-1}; ^1H NMR (DMSO-d_6): δ 2.36 (s, 3H, CH_3), 7.23 (d, 2H, ArH, J = 8 Hz), 7.60 (s, 1H, benzofuran-CH), 7.79–7.85 (m, 3H, benzofuran-CH, and ArH), 8.00 (s, 1H, benzofuran-CH), 8.51 (s, 1H, pyridine-CH), 12.63 (s, 1H, NH), 13.12 (s, 1H, NH); ^{13}C NMR (DMSO-d_6): δ 19.74, 103.47, 105.28, 115.44, 117.24, 124.71, 126.11, 126.22, 129.31, 129.86, 132.29, 137.21, 137.30, 139.80, 142.09, 150.30, 154.92, 156.54, 163.91, 168.29; MS: 569 (M^+, 9.1%), 571 (M + 2, 19.1%), 573 (M + 4, 9.5%); $C_{22}H_{13}Br_2N_5O_2S$: *Anal*. Calcd: C, 46.26; H, 2.29; N, 12.26; S, 5.61. Found C, 46.19; H, 2.33; N, 12.21; S, 5.70%.

Coupling of enaminone 3 with diazonium salts of heteroaromatic amines. A solution of the compound **3** (15 mmol) in pyridine (50 mL) was added the appropriate diazonium salt prepared from 3-aminopyrazoles **18a**–**c**, 3-amino-1,2,4-triazole (**22**) or 2-aminobenzoimidazole (**26**) (15 mmol) portion wisely over a period of 45 min at 0–5°C. The mixture was stirred for additional 5 h in ice bath. The mixture was then left in a refrigerator for 2 days. The obtained solid was filtered off, washed with water, dried, and recrystallized from a mixture of EtOH/DMF (10:1) to afford product **21a**–**c**, **25**, or **29**, respectively.

3-(5,7-Dibromobenzofuran-2-oyl)-7-phenylpyrazolo[5,1-c][1,2,4]triazine (21a). Yellowish green solid (70%), m.p. 270–272°C; IR: ν 1650 (CO), 1598 (C═N) cm^{-1}; ^1H NMR (DMSO-d_6): δ 7.12 (s, 1H, pyrazole-CH), 7.52 (t, 1H, ArH, J = 8 Hz), 7.59–7.65 (m, 3H, benzofuran-CH and ArH), 7.86 (s, 1H, benzofuran-CH), 7.97–8.05 (m, 3H, benzofuran-CH, and ArH), 9.36 (s, 1H, triazine-CH); ^{13}C NMR (DMSO-d_6): δ 101.44, 105.28, 114.57, 116.34, 125.87, 127.20, 128.21, 129.53, 135.71, 130.32, 132.54, 143.60, 147.52, 149.31, 156.73, 152.13, 153.70, 176.74; MS: 496 (M^+, 34.0%), 498 (M + 2, 68.0%), 500 (M + 4, 35.3%); $C_{20}H_{10}Br_2N_4O_2$: *Anal*. Calcd: C, 48.22; H, 2.02; N, 11.25. Found C, 48.13; H, 2.09; N, 11.19%.

3-(5,7-Dibromobenzofuran-2-oyl)-7-(4-methoxyphenyl)pyrazolo[5,1-c][1,2,4]triazine (21b). Yellow solid (82%), m.p. > 300°C; IR: ν 1655 (CO), 1602 (C═N) cm^{-1}; ^1H NMR (DMSO-d_6): δ 3.82 (s, 3H, CH_3), 7.15 (d, 2H, ArH, J = 8.4 Hz), 7.29 (s, 1H, pyrazole-CH), 7.57 (s, 1H, benzofuran-CH), 7.87 (s, 1H, benzofuran-CH), 7.99 (s, 1H, benzofuran-CH), 8.05 (d, 2H, ArH, J = 8.4 Hz), 9.31 (s, 1H, triazine-CH); ^{13}C NMR (DMSO-d_6): δ 61.35, 101.83, 105.22, 114.42, 116.10, 116.26, 124.63, 125.70, 129.18, 130.27, 132.44, 143.21, 146.75, 149.17, 156.50, 152.20, 153.55, 160.45, 176.65; MS: 526 (M^+, 34.5%), 528 (M + 2, 72.0%), 530 (M + 4, 36.0%); $C_{21}H_{12}Br_2N_4O_3$: *Anal*. Calcd: C, 47.76; H, 2.29; N, 10.61. Found C, 47.65; H, 2.34; N, 10.66%.

3-(5,7-dibromobenzofuran-2-oyl)-7-methyl-8-phenylpyrazolo[5,1-c][1,2,4]triazine (21c). Yellowish solid (87%), m.p. 266–268°C; IR: ν 1648 (CO), 1596 (C═N) cm^{-1}; ^1H NMR (DMSO-d_6): δ 2.60 (s, 3H, CH_3), 7.56–7.68 (m, 4H, benzofuran-CH, and ArH), 7.79–7.85 (m, 3H, benzofuran-CH, and ArH), 7.99 (s, 1H, benzofuran-CH), 9.34 (s, 1H, triazine-CH); ^{13}C NMR (DMSO-d_6): δ 14.27, 105.25, 114.39, 116.13, 125.67, 126.21, 127.10, 127.82, 129.74, 130.36, 132.50, 134.17, 139.11, 140.23, 143.15, 149.11, 152.18, 153.47, 160.45, 176.58; MS: 510 (M^+, 38.5%), 512 (M + 2, 77%), 514 (M + 4, 40%); $C_{21}H_{12}Br_2N_4O_2$: *Anal*. Calcd: C, 49.25; H, 2.36; N, 10.94. Found C, 49.19; H, 2.41; N, 10.89%.

3-(5,7-Dibromobenzofuran-2-oyl)[1,2,4]triazolo[[3,4-c][1,2,4] triazine (25). Yellow solid (84%), m.p. 214–216°C; IR: ν 1638 (CO), 1590 (C═N) cm^{-1}; ^1H NMR (DMSO-d_6): δ 7.59 (s, 1H, benzofuran-CH), 7.89 (s, 1H, benzofuran-CH), 7.98 (s, 1H, benzofuran-CH), 8.74 (s, 1H, triazole-5-CH), 9.13 (s, 1H, triazine-CH); ^{13}C NMR (DMSO-d_6): δ 105.48, 114.53, 116.33, 125.93, 130.65, 133.12, 135.24, 145.72, 148.11, 149.86, 151.17, 154.95, 176.77; MS: 421 (M^+, 32%), 423 (M + 2, 64%), 425 (M + 4, 33.2%); $C_{13}H_5Br_2N_5O_2$: *Anal*. Calcd: C, 36.91; H, 1.19; N, 16.56. Found: C, 36.80; H, 1.24; N, 16.49%.

3-(5,7-Dibromobenzofuran-2-oyl)benzimidazo[2,1-c][1,2,4] triazine (29). Orange solid (80%), m.p. > 300°C; IR: ν 1643 (CO), 1596 (C═N) cm^{-1}; ^1H NMR (DMSO-d_6): δ 7.15 (d, 2H, ArH, J = 8 Hz), 7.58 (s, 1H, benzofuran-CH), 7.79–8.01 (m, 5H, benzofuran-CH, and ArH), 9.33 (s, 1H, triazine-CH); ^{13}C NMR (DMSO-d_6): δ 105.30, 112.27, 114.67, 116.55, 118.74, 122.87, 123.14, 126.19, 128.19, 130.43, 132.71, 139.23, 141.70, 145.52, 149.63, 152.09, 153.89, 176.84; MS: 470 (M^+, 34.5%), 472 (M + 2, 76%), 474 (M + 4, 38%); $C_{18}H_8Br_2N_4O_2$: *Anal*. Calcd: C, 45.79; H, 1.71; N, 11.87. Found: C, 45.85; H, 1.74; N, 11.79%.

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