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Short Communication

A Convenient Synthesis of 2-(1*H*-1,2,4-Triazol-1-yl)-2*H*-1,4-benzothiazine Derivatives

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ABSTRACT: *A series of 2-(1H-1,2,4-triazol-1-yl)-2H-1,4-benzothiazines were designed and synthesized by condensation of 1,2,4-triazole-substituted ω-bromoacetophenones and o-aminothiophenols with the aid of K_2CO_3 under mild conditions with moderate to high yields.* Heteroatom Chem 19:332–336, 2008; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/hc.20434

INTRODUCTION

Heterocycles containing sulfur and nitrogen are biologically and industrially important compounds. 2*H*-1,4-Benzothiazine derivatives have attracted much interest in modern society due to their biological properties [1]. On the other hand, 1,2,4-triazole derivatives are one of the most widely used fungicides due to their high efficiency, low toxicity, and absorbent properties [2–4]. For example, 2*H*-1,4-benzothiazine derivatives can be used as central nervous system depressants, ataractic agents, antispasmodics, and ciliary relaxants for pseudomyopia and eye fatigue [5]. Many methods have been introduced for the preparation of 2*H*-1,4-benzothiazine derivatives, for example, by ring expansion of benzothiazoles or benzothiazolines [6], by the reaction of *o*-nitrobenzenesulfenyl chlorides with ketones in the presence of HCl [7], by the treatment of aminothioalkenols with TsOH or H_3PO_4[8], by using 3*H*-1,2,3-benzodithiazole-2-oxides as synthons or by the reaction of bis(*o*-aminophenyl)disulfide with ketones [9], by the reaction of bis(*o*-nitrophenyl)disulfide with ω-bromoacetophenones promoted by samarium di-iodide [10,11], by condensation of ω-bromoacetophenones and *o*-aminothiophenols in the presence of sodium in ethanol [12]. Most of above-mentioned methods involve harsh conditions such as strong acidic or basic catalysts, special reagents, as well as long reaction time. To the best of our knowledge, although many methods have been introduced for the preparation of 2*H*-1,4-benzothiazine derivatives or triazole derivatives, the synthesis of a heterocyclic compound that contains both 2*H*-1,4-benzothiazine moiety and 1,2,4-triazole active group with a potential biological activity has not been reported.

Here, we report a simple and convenient method for the preparation of 2-(1*H*-1,2,4-triazol-1-yl)-2*H*-1,4-benzothiazine derivatives by condensation of 1,2,4-triazole-substituted ω-bromoacetophenones and *o*-aminothiophenols with the aid of K_2CO_3 in aqueous EtOH media. The desired compounds could be obtained under mild conditions with moderate to high yields.

RESULTS AND DISCUSSION

Our first attempt was carried out by using 1*H*-1,2,4-triazol-1-yl acetophenone **1a** as a model substrate

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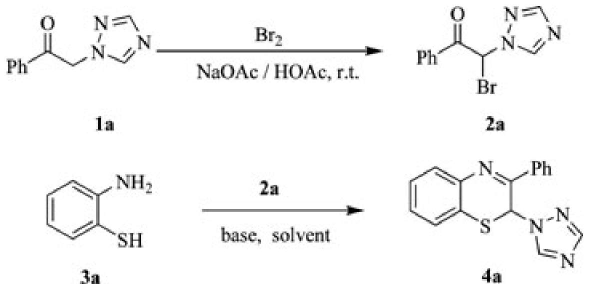
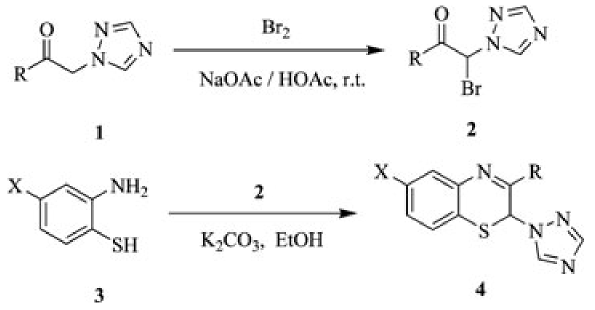


SCHEME 1



SCHEME 2

(Scheme 1). The compound **1a** was prepared according to the method described in [13]. When **1a** was treated with 1.1 equivalent bromine in a solution of AcOH at room temperature for about 30 min, the color of solution was changed from red to colorless and the intermediate **2a** could be isolated, which reacted with *o*-aminothiophenol **3a** in the presence of various bases to afford the corresponding product 2-(1*H*-1,2,4-triazol-1-yl)-2*H*-1,4-benzothiazine **4a** and its structure was confirmed by ^1H NMR, ^{13}C NMR, IR, mass spectra, and elemental analysis.

The cyclization of compound **3a** with **2a** is the key step during the preparation of product **4a**, so influence of solvents and catalysts was investigated in our experiment and the results are summarized in Table 1. First, some solvents, such as acetone, acetonitrile, and ethanol, were used for this reaction. Acetone lessened the yield because it can react with *o*-aminothiophenol **3a** to afford the byproduct 2,2-dimethyl-2,3-dihydrobenzo[d]thiazole (entry 1), whereas ethanol was proved to be efficient and gave a good yield at room temperature (entry 3). Increasing the reaction temperature did not change the yield evidently (entry 4). Second, some bases, such as Et_3N, K_2CO_3, and NaOEt, were tested, and it is evident from Table 1 that K_2CO_3 is a cheaper and more efficient base for this reaction (entry 7). However, when using Lewis acid ($ZnCl_2$, $LiClO_4$, or AcOH) as a catalyst in ethanol, only a trace product was detected even at high temperature or prolonging reaction time (entries 10–13). So, we chose K_2CO_3 as a base and ethanol as a reaction solvent for this reaction.

TABLE 1 Preparation of **4a** under Different Conditions

Entry	*Base*	*Solvent*	*T (°C)*	*Yield (%)*[a]
1	Et_3N	Acetone	60	37
2	Et_3N	CH_3CN	60	43
3	Et_3N	EtOH	r.t.	65
4	Et_3N	EtOH	60	66
5	K_2CO_3	Acetone	60	38
6	K_2CO_3	CH_3CN	60	46
7	K_2CO_3	EtOH	r.t.	67
8	K_2CO_3	EtOH	60	68
9	NaOEt	EtOH	r.t.	67
10	DABCO	EtOH	r.t. or 60	Trace
11	AcOH	EtOH	r.t. or 60	Trace
12	$ZnCl_2$	EtOH	r.t. or 60	Trace
13	$LiClO_4$	EtOH	r.t. or 60	Trace

[a] Isolated yields based on compounds **1a**.

After the reaction condition was optimized, we explored the reaction with various 1,2,4-triazole-substituted ω-bromoacetophenones **2** and *o*-aminothiophenols **3** (Scheme 2). The results are summarized in Table 2.

According to Table 2, it was found that the substrates with electron-donating groups (entry 4) provided higher yields than those with electron withdrawing groups on the aromatic ring (entry 13), but it is not confirmed. Moreover, when R is an alkyl group such as *tert*-butyl, the corresponding product **4n** can also be obtained with moderate yield.

TABLE 2 Preparation of 2-(1*H*-1,2,4-Triazol-1-yl)-2*H*-1,4-benzothiazine Derivatives

Entry	*R*	*X*	*t (h)*	*T (°C)*	*Product*[a] *Yield (%)*
1	C_6H_5	H	1.5	r.t.	**4a** (67)
2	*p*-MeC_6H_4	H	1.0	r.t.	**4b** (68)
3	*o*-$MeOC_6H_4$	H	1.0	r.t.	**4c** (66)
4	2,4-$(MeO)_2C_6H_3$	H	0.5	r.t.	**4d** (70)
5	9H-Flurenyl	H	0.5	60	**4e** (65)
6	2-Furyl	H	2.0	60	**4f** (45)
7	*p*-ClC_6H_4	H	2.0	60	**4g** (43)
8	C_6H_5	Cl	1.5	r.t.	**4h** (50)
9	*p*-MeC_6H_4	Cl	1.0	r.t	**4i** (62)
10	2,4-$(MeO)_2C_6H_3$	Cl	1.0	r.t	**4j** (68)
11	9H-Flurenyl	Cl	0.5	60	**4k** (66)
12	2-Furyl	Cl	2.0	60	**4l** (64)
13	*m*-$NO_2C_6H_4$	Cl	2.0	60	**4m** (58)
14	*t*-Butyl	Cl	2.0	r.t.	**4n** (65)

[a] Isolated yields based on compounds **1**.

In conclusion, we developed an efficient and comparatively inexpensive methodology for the synthesis of 2-(1*H*-1,2,4-triazol-1-yl)-2*H*-1,4-benzothiazines by condensation of 1,2,4-triazole-substituted ω-bromoacetophenones and *o*-aminothiophenols. The advantages of the present method are simple operation, mild reaction condition, and high yields.

EXPERIMENTAL

Instruments and Reagents

All reagents were commercially available and were used without purification. Compounds **1** were prepared according to the method described in [12]. Infrared spectra were recorded on a Thermo Nicolet Avatar 370 spectrophotometer. ^{1}H NMR and^{13}C NMR spectra were measured on a Varian Mercury plus-400 spectrometer with tetramethylsilane (TMS) as an internal standard and $CDCl_3$ as the solvent. Mass spectra were obtained with a Thermo Finnigan LCQ-Advantage (EI). Elemental analyses were carried out on a Vario EL III instrument. High-resolution mass spectral (HRMS) analyses were measured on an APEX (Bruker) mass III spectrometer using ESI (electrospray ionization) techniques.

General Procedure for the Preparation of 2-Bromo-1-phenyl-2-(1H-1,2,4-triazol-1-yl)ethanone **2**

To a mixture of 1-aryl-2-(1*H*-1,2,4-triazol-1-yl)-ethanone **1** (2.0 mmol) and sodium acetate (0.16 g, 2.0 mmol) in acetic acid (5 mL), a solution of bromine (0.32 g, 2.0 mmol) in acetic acid (1 mL) at 15°C was added slowly. The mixture was stirred at room temperature until the color of solution became colorless from red. The reaction was quenched with ice water and was extracted with chloroform (15 mL). The organic phase was washed with brine and dried over anhydrous Na_2SO_4. After evaporating under reduced pressure, the crude product 2-bromo-1-aryl-2-(1*H*-1,2,4-triazol-1-yl)ethanone **2** was obtained and was used for the next step.

General Procedure for the Preparation of 3-Aryl-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine **4**

A mixture of the crude product 2-bromo-1-aryl-2-(1*H*-1,2,4-triazol-1-yl)ethanone **2**, *o*-aminothiophenol (2.0 mmol), and K_2CO_3 (1.0 mmol) in EtOH (10 mL) was stirred at room temperature or 60°C at a given time (Table 1). The reaction was monitored by TLC. Then, the reaction mixture was filtered and the filtrate was evaporated under reduced pressure. The crude product was purified by column chromatography on silica gel (100–200 mesh) with petroleum ether–ethyl acetate (2:1 v/v) as an eluent to give the title compounds **4**.

DATA OF PRODUCTS

*3-Phenyl-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4a***)*

Light-yellow crystals, mp 56.8–57.3°C; IR (KBr), ν_{max}: 2990, 1639, 1622, 765 cm^{-1}; ^{1}H NMR ($CDCl_3$), δ_H: 6.76 (1H, s, CH), 7.25–7.28 (1H, m, Ar-H), 7.34–7.41 (2H, m, Ar-H), 7.48–7.53 (3H, m, Ar-H), 7.65 (1H, s, triazole-H), 7.73 (1H, d, $J = 8.0$ Hz, Ar-H), 7.92 (1H, s, triazole-H), 8.06 (2H, d, $J = 8.0$ Hz, Ar-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 50.3, 117.2, 127.4, 127.6, 128.0, 128.4, 128.9, 129.2, 129.6, 131.5, 135.7, 140.8, 142.4, 149.4, 152.1, 162.4; *m/z* (%): 292 (M$^+$, 2.0), 223 (3.0), 211 (100). Anal. Calcd for $C_{16}H_{12}N_4S$: C, 65.73; H, 4.14; N, 19.16. Found: C, 65.69; H, 4.08; N, 19.20.

*3-p-Tolyl-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4b***)*

Light-yellow crystals, mp 62.5–63.1°C; IR (KBr) ν_{max}: 3010, 2896, 1610, 1590, 1475, 1380, 760 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$), δ_H: 2.40 (3H, s, CH_3), 6.75 (1H, s, CH), 7.23–7.37 (5H, m, Ar-H), 7.64 (1H, s, triazole-H), 7.70 (1H, d, $J = 8.4$ Hz, Ar-H), 7.90 (1H, s, triazole-H), 7.95 (2H, d, $J = 8.0$ Hz, Ar-H); ^{13}C NMR (100 Hz, $CDCl_3$) δ: 21.4, 50.4, 117.2, 127.5, 127.6, 127.7, 128.3, 129.1, 129.3, 129.7, 132.9, 140.9, 141.0, 142.3, 142.5, 149.4, 152.2; *m/z* (%): 306(M$^+$, 16.9), 237 (100), 225 (82.0). Anal. Calcd for $C_{17}H_{14}N_4S$: C, 66.64; H, 4.61; N, 18.29. Found: C, 66.75; H, 4.52; N, 18.33.

*3-(2-Methoxyphenyl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4c***)*

Light-yellow crystals, mp 56.8–57.3°C; IR (KBr) ν_{max}: 3100, 2983, 1620, 1585, 1465, 1250 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 3.69 (3H, s, OCH_3), 6.69 (1H, s, CH), 6.83 (1H, d, $J = 8.8$ Hz, Ar-H), 7.22–7.27 (2H, m, Ar-H), 7.32–7.39 (2H, m, Ar-H), 7.55 (1H, dd, $J = 8.8$ Hz and $J = 2.8$ Hz, Ar-H), 7.63 (1H, s, triazole-H), 7.72–7.74 (1H, m, Ar-H), 7.87 (1H, s, triazole-H), 7.98 (1H, d, $J = 2.8$ Hz, Ar-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 51.8, 56.0, 113.1, 113.8, 118.4, 127.6, 127.7, 128.0, 128.6, 129.0, 134.2, 135.2, 141.2, 142.8, 148.9, 152.0, 157.0; *m/z* (%): 322 (M$^+$, 2.0), 253

(1.0), 83(100). Anal. Calcd for $C_{17}H_{14}N_4OS$: C, 63.33; H, 4.38; N, 17.38. Found: C, 63.17; H, 4.23; N, 17.44.

*3-(2,5-Dimethoxyphenyl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4d***)*

Light-yellow crystals, mp 66.2–66.7°C; IR (KBr) ν_{max}: 3093, 2985, 1625, 1580, 1465, 1252 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 3.64 (3H, s, OCH_3), 3.82 (3H, s, OCH_3), 6.76 (1H, s, CH), 6.88 (1H, d, $J = 9.2$ Hz, Ar-H), 7.03 (1H, dd, $J = 8.8$ Hz and $J = 3.0$ Hz, Ar-H), 7.20–7.27 (1H, m, Ar-H), 7.32–7.37 (2H, m, Ar-H), 7.42 (1H, d, $J = 2.8$ Hz, Ar-H), 7.66 (1H, s, triazole-H), 7.73 (1H, d, $J = 8.0$ Hz, Ar-H), 7.87 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 52.0, 55.8, 56.1, 112.7, 115.6, 118.4, 119.1, 126.1, 127.5, 127.9, 128.2, 128.7, 141.4, 142.9, 150.2, 151.9, 152.4, 153.9; *m/z* (%) : 352 (M^+, 3.0), 271 (62.0), 238 (100). Anal. Calcd for $C_{18}H_{16}N_4O_2S$: C, 61.35; H, 4.58; N, 15.90. Found: C, 61.29; H, 4.38; N, 16.12.

*3-(9H-Fluoren-2-yl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4e***)*

Light-yellow crystals, mp 106.4–107.9°C; IR (KBr), ν_{max}: 3110, 2856, 1615, 1580, 1475, 1255 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 3.94 (2H, s, CH_2), 6.82 (1H, s, CH), 7.24–7.26 (1H, m, Ar-H), 7.33–7.40 (4H, m, Ar-H), 7.56 (1H, d, $J = 7.2$ Hz, Ar-H), 7.69 (1H, s, Ar-H), 7.74 (1H, d, $J = 7.6$ Hz, Ar-H), 7.82(2H, t, $J = 7.2$ Hz, Ar-H), 7.94 (1H, s, triazole-H), 8.05 (1H, d, $J = 8.0$ Hz, Ar-H), 8.26 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 36.9, 53.8, 117.3, 120.2, 120.7, 124.2, 125.2, 126.7, 127.0, 127.4, 127.8, 127.9, 128.3, 129.2, 134.1, 140.5, 141.2, 142.6, 143.9, 144.2, 145.3, 149.9, 152.3; *m/z* (%): 380 (M^+, 18.0), 312 (16.0), 299 (100). Anal. Calcd for $C_{23}H_{16}N_4S$: C, 72.61; H, 4.24; N, 14.73. Found: C, 72.46; H, 4.09; N, 14.91.

*3-(Furan-2-yl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4f***)*

Oil, IR (neat) ν_{max}: 3050, 1615, 1570, 1455, 1250 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 6.61–6.62 (1H, m, Ar-H), 6.71 (1H, s, CH), 7.23–7.39 (4H, m, Ar-H), 7.65–7.70 (2H, m, Ar-H), 7.73 (1H, s, triazole-H), 7.87 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 49.5, 113.0, 115.2, 117.6, 127.8, 128.3, 128.3, 129.1, 140.7, 141.0, 142.3, 146.3, 150.3, 152.1; *m/z* (%): 282 (M^+, 72.2), 253 (62.5), 214 (100), 201 (53.1), 186 (24.0). HRMS (ESI) Calcd for $C_{14}H_{10}N_4OS$ $(M + H)^+$, 283.0575. Found: $(M + H)^+$, 283.0571.

*3-(4-Chlorophenyl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4g***)*

Light-yellow crystals, mp 61.8–62.6°C; IR (KBr) ν_{max}: 2935, 1655, 1645, 1090, 755 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 6.70 (1H, s, CH), 7.26–7.29 (1H, m, Ar-H), 7.34–7.40 (2H, m, Ar-H), 7.45 (2H, d, $J = 8.4$ Hz, Ar-H), 7.65 (1H, s, triazole-H), 7.70 (1H, d, $J = 8.0$ Hz, Ar-H), 7.90 (1H, s, triazole-H), 8.02 (2H, d, $J = 8.8$ Hz, Ar-H);^{13}C NMR ($CDCl_3$), δ: 50.3, 117.2, 127.7, 127.9, 128.8, 128.9, 129.2, 129.3, 129.4, 129.5, 134.3, 138.0, 140.8, 142.5, 148.5, 152.3; *m/z* (%): 328($M^+ + 2$, 5.5), 326(M^+, 15.0), 258 (80.0), 245 (100). Anal. Calcd for $C_{16}H_{11}ClN_4S$: C, 58.80; H, 3.39; N, 17.14. Found: C, 58.88; H, 3.33; N, 17.01.

*6-Chloro-3-phenyl-2-(1H-1,2,4-triazol-1-yl)-2H-benzo [b] [1,4] thiazine (***4h***)*

Light-yellow crystals, mp 72.5–73.3°C; IR (KBr) ν_{max}: 2940, 1639, 1622, 763 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 6.78 (1H, s, CH), 7.23–7.29 (3H, m, Ar-H), 7.48–7.56 (3H, m, Ar-H), 7.68 (1H, s, triazole-H), 7.74 (1H, d, $J = 1.6$ Hz, Ar-H), 7.93 (1H, s, triazole-H), 8.06 (1H, d, $J = 7.6$ Hz, Ar-H);^{13}C NMR($CDCl_3$), δ: 50.3, 115.8, 127.7, 128.6, 129.0, 129.1, 132.1, 133.2, 135.4, 137.1, 138.5, 140.6, 141.8, 142.5, 150.7, 152.5; *m/z* (%): 328 ($M^+ + 2$, 5.5), 326 (M^+, 15.0), 258 (80.0), 245 (100); Anal. Calcd for $C_{16}H_{11}ClN_4S$: C, 58.80; H, 3.39; N, 17.14. Found: C, 58.66; H, 3.26; N, 17.21.

*6-Chloro-3-p-tolyl-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4i***)*

Yellow crystals, mp 76.8–77.5°C; IR (KBr) ν_{max}: 3116, 3019, 1635, 1612, 1215, 756 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 2.39 (3H, s, CH_3), 6.78 (1H, s, CH), 7.23–7.37 (5H, m, Ar-H), 7.67 (1H, s, triazole-H), 7.70 (1H, d, $J = 8.4$ Hz, Ar-H), 7.89 (1H, s, triazole-H), 7.95 (1H, d, $J = 8.0$ Hz, Ar-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 21.4, 50.1, 115.7, 127.6, 127.6, 128.1, 128.4, 128.7, 129.7, 129.7, 132.5, 133.0, 141.8, 142.4, 142.8, 150.5, 152.3; *m/z* (%): 342 ($M^+ + 2$, 32.0), 340 (M^+, 86.9), 271 (100), 259 (54.0). Anal. Calcd for $C_{17}H_{13}ClN_4S$: C, 59.91; H, 3.84; N, 16.44. Found: C, 59.78; H, 3.76; N, 16.62.

*6-Chloro-3-(2,5-dimethoxyphenyl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (***4j***)*

Light-yellow crystals, mp 78.3–78.9°C; IR (KBr) ν_{max}: 3063, 2925, 1620, 1570, 1450, 1252 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 3.64 (3H, s, OCH_3), 3.82 (3H, s, OCH_3), 6.82 (1H, s, CH), 6.88 (1H, d, $J = 8.8$ Hz, Ar-H), 7.03 (1H, dd, $J = 8.8$ Hz and $J = 2.8$ Hz, Ar-H), 7.18–7.27 (2H, m, Ar-H), 7.42 (1H, d, $J = 7.6$ Hz, Ar-H), 7.69(1H, s, triazole-H), 7.74 (1H, d, $J = 2.4$, Ar-H), 7.87 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 51.7, 55.7, 56.0, 112.8, 115.6, 116.9, 119.5, 125.7, 128.0, 128.3, 128.6, 132.8, 142.2, 142.8, 151.2, 152.0, 152,5, 153.9; *m/z* (%): 388($M^+ + 2$, 5.0), 386 (M^+, 16.0), 305 (41.5), 272 (100), 170 (87.1). Anal. Calcd for $C_{18}H_{15}ClN_4O_2S$: C, 55.88; H, 3.91; N, 14.48. Found: C, 55.81; H, 3.95; N, 14.62.

*6-Chloro-3-(9H-fluoren-2-yl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (**4k**)*

Light-yellow crystals, mp 131.8–133.0°C; IR (KBr) ν_{max}: 3017, 2927, 1639, 1612, 1216, 1091, 756 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 3.91 (2H, s, CH_2), 6.84 (1H, s, CH), 7.18–7.25 (2H, m, Ar-H), 7.34–7.41 (2H, m, Ar-H), 7.55 (1H, d, $J = 6.0$ Hz, Ar-H), 7.71–7.81 (4H, m, Ar-H), 7.93 (1H, s, triazole-H), 8.03 (1H, t, $J = 7.6$ Hz, Ar-H), 8.23 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ 36.8, 50.4, 115.7, 120.1, 120.7, 124.3, 125.1, 126.8, 127.0, 128.0, 128.2, 128.5, 128.7, 133.1, 133.5, 140.3, 142.0, 142.5, 143.9, 144.2, 145.7, 150.8, 152.4; *m/z* (%): 416($M^+ + 2$, 2.0), 414(M^+, 7.0), 347 (25.0), 333 (100). Anal. Calcd for $C_{23}H_{15}ClN_4S$: C, 66.58; H, 3.64; N, 13.50. Found: C, 66.45; H, 3.60; N, 13.59.

*6-Chloro-3-(furan-2-yl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo [b][1,4]thiazine (**4l**)*

Oil, IR (neat) ν_{max}: 3030, 1610, 1560, 1455, 1250 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 6.63–6.64 (1H, m, Ar-H), 6.73 (1H, s, CH), 7.21–7.34 (3H, m, Ar-H), 7.66–7.70 (2H, m, Ar-H), 7.77 (1H, s, triazole-H), 7.87 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 49.4, 113.4, 116.0, 126.4, 128.3, 128.6, 129.7, 133.3, 141.6, 141.8, 142.3, 146.7, 150.1, 152.5; *m/z* (%): 318 ($M^+ + 2$, 29.5), 316 (M^+, 91), 287 (86.0), 248 (100), 235 (58.0). HRMS (ESI) Calcd for $C_{14}H_9ClN_4OS$ $(M + H)^+$, 317.0186. Found: $(M + H)^+$, 317.0188.

*6-Chloro-3-(3-nitrophenyl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (**4m**)*

Light-yellow crystals, mp 116.7–117.8°C; IR (KBr) ν_{max}: 3087, 1641, 1612, 1568, 1532, 1350, 1215, 1091, 756 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 6.85 (1H, s, CH), 7.29–7.36 (2H, m, Ar-H), 7.68–7.83 (3H, m, Ar-H), 7.88 (1H, s, triazole-H), 8.35–8.43 (2H, m, Ar-H), 8.97 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ: 50.0, 115.9, 122.9, 126.1, 128.4, 129.3, 129.4, 130.2, 133.2, 133.5, 137.3, 141.3, 142.4, 148.5, 148.8, 152.6; *m/z* (%):373 ($M^+ + 2$, 15.0), 371 (M^+, 43.0), 302 (100), 290 (20.5), 257 (36.5). Anal. Calcd for $C_{16}H_{10}ClN_5O_2S$: C, 51.69; H, 2.71; N, 18.84. Found: C, 51.72; H, 2.59; N, 18.77.

*6-Chloro-3-(t-butyl)-2-(1H-1,2,4-triazol-1-yl)-2H-benzo[b][1,4]thiazine (**4n**)*

Oil, IR (neat) ν_{max}: 3052, 2930, 2840, 1621, 1560, 1091 cm^{-1}; ^{1}H NMR (400 Hz, $CDCl_3$) δ_H: 1.17 (9H, s, CH_3), 6.37 (1H, s, CH), 7.20–7.50 (3H, m, Ar-H), 7.87 (1H, s, triazole-H), 8.03 (1H, s, triazole-H); ^{13}C NMR (100 Hz, $CDCl_3$), δ 26.5, 26.5, 26.5, 40.7, 48.1, 116.1, 127.8, 128.0, 128.7, 132.8, 141.2, 142.5, 152.3, 163.6; *m/z*(%): 308 ($M^+ + 2$, 3.5), 306 (M^+, 11.0), 240 (7.0), 226 (10.0), 57 (100). HRMS (ESI) calcd for $C_{14}H_{15}ClN_4S$ $(M + H)^+$, 307.0706, Found: $(M + H)^+$, 307.0703.

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