Synthesis of Coumarin Substituted Triazolothiadiazine Derivatives *via* Ring Transformation Reaction

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Received November 30, 2010
DOI 10.1002/jhet.958
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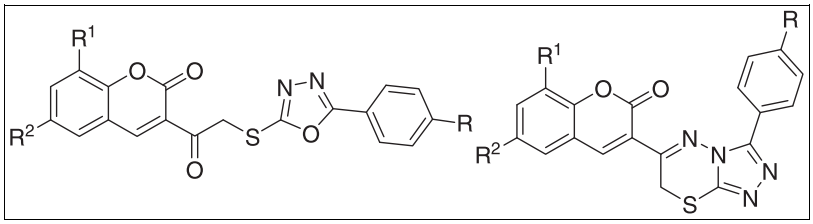


A novel ring transformation reaction for the synthesis of 3-(3-aryl-*7H*-[1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-ones has been described. Reaction of 3-(2-bromoacetyl)coumarins (**1**) with 5-aryl-1,3,4-oxadiazole-2-thiol (**2**) gave ketones (**4a–h**). The *in situ* formed ketones (**4a–h**) were reacted with hydrazine hydrate to give 3-(3-aryl-*7H*-[1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-ones (**3a–h**) and not **5** or **6**. The compounds (**3a–h**) can also be prepared by the reaction of 3-(2-bromoacetyl)coumarins (**1**) with 5-aryl-1,3,4-oxadiazole-2-thiol (**2**) in anhydrous ethanol to give corresponding 3-(2-(5-aryl-1,3,4-oxadiazol-2-ylthio)acetyl)-2*H*-chromen-2-ones (**4a–h**). These on reaction with hydrazine hydrate in acetic acid gave corresponding 3-(3-aryl-*7H*-[1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-ones (**3a–h**).

J. Heterocyclic Chem., **50**, 159 (2013).

INTRODUCTION

In the last few decades, the chemistry of 1,2,4-triazoles and their fused heterocyclic system have received considerable attention due to their synthetic and effective biological importance. The biological activities of various 1,2,4-triazole derivatives have been extensively studied. Many of these derivatives exhibit antiviral, potential analgesic, anti-inflammatory, CNS stimulants, sedatives, antianxiety, and antimicrobial activities [1–4]. These derivatives also act as antimycotic agents [5], [6]. The triazole fused with six-membered ring system like thiadiazine is also found to possess various applications in the field of medicine. The literature survey reveals that there are few examples of triazoles fused with thiadiazines. These fused 1,2,4-triazolo [3,4-b][1,3,4]thiadiazines exhibit a broad spectrum of antimicrobial activity [7–11] due to N C S linkage.

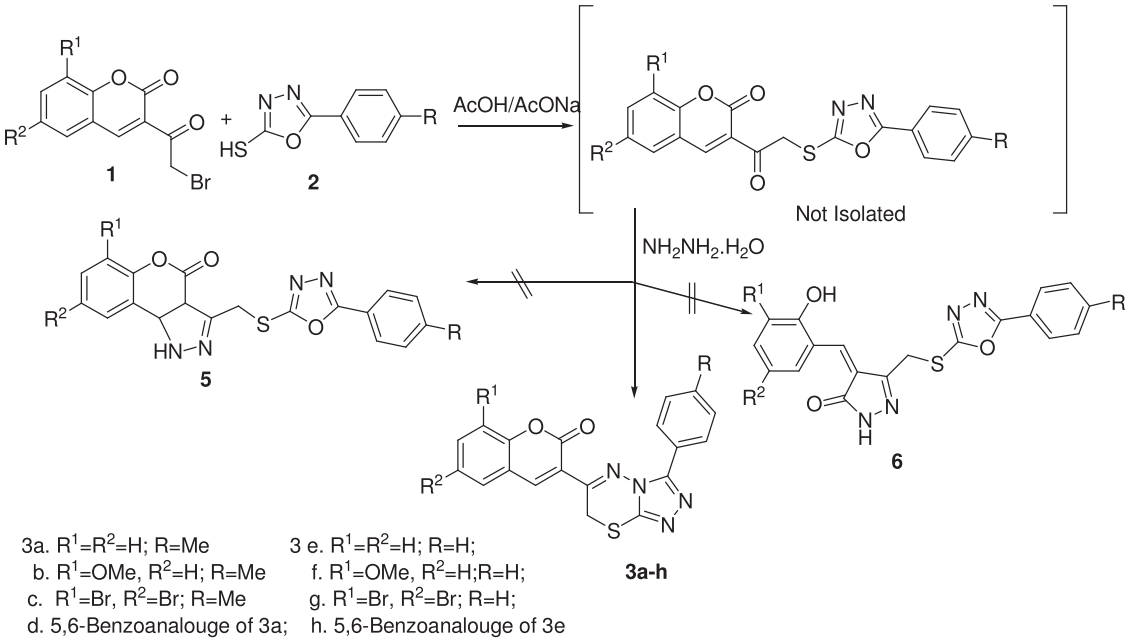
Benzopyran-2-one derivatives also called coumarins, and related compounds exhibit various biological activities, including anticoagulant and antithrombotic properties [12]. These derivatives have also been shown to be novel lipid lowering agents that possess moderate triglyceride lowering activity [13]. Many coumarin derivatives have the unique ability to scavenge reactive oxygen species such as hydroxyl free radicals, super oxide radicals, or hypochlorous acid to prevent free radical injury [14]. Recently, certain coumarin derivatives have been shown to function as human immunodeficiency virus (HIV) integrase inhibitors and have been evaluated in the treatment of HIV infection [15]. Some of the coumarin derivatives have been evaluated as anti-invasive compounds due to their inhibitory activity against serine proteases and matrix metalloproteases (MMPs) [16].

On the basis of these investigations and in continuation of our research work on the synthesis of novel heterocyclic compounds [17–21], it was thought to be interesting to synthesize compounds containing the fused ring system [1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazine substituted with 2H-benzopyran-2-one. The newly synthesized compounds might result in enhanced biological activities, lead to use in drug discovery.

RESULTS AND DISCUSSION

Reaction of equimolar mixture of 3-(2-bromoacetyl)coumarin **1** and 5-aryl-1,3,4-oxadiazole-2-thiol **2** in AcOH/AcONa at 60°C for 1 h, followed by the addition of hydrazine hydrate and heating the reaction mixture for another 2 h led to a fused ring system 3-(3-aryl-*7H*-[1,2,4]triazolo [3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-ones **3a**–**h** in good yields (Scheme 1). The reaction of **1** with **2** gave compound **4**. The *in situ* generated compound **4** on reaction with hydrazine hydrate may give two types of cyclized products like **5** and **6** or both. The cyclocondensation product **5** having pyrazole fused to benzopyran-2-one is believed to be obtained via Michael reaction [22]. On the other hand, another cyclo product **6** may be obtained through intramoleculer amidation reaction. But in our case only one product **3** (by TLC) is obtained in a selective ring

Scheme 1. One-pot synthesis of 3-(3-aryl-7*H*-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-ones (**3a**–**h**).

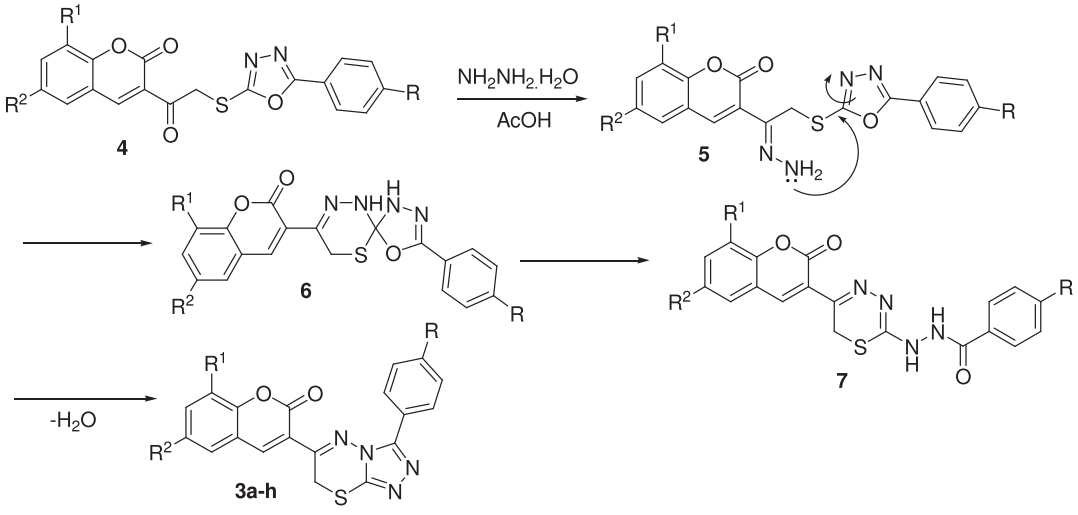


transformation process (Scheme 2). The structures of compounds **3a**–**h** were established on the basis of their spectral and analytical data.

The ^{1}H-NMR spectra of **3a** showed three singlets at δ 2.37, δ 4.32, and δ 8.60 ppm because of the methyl, CH_2 protons of thiadiazine and C-4 proton of coumarin, respectively. Similarly, the ^{1}H-NMR spectra of **3e** shows singlets at δ 4.12 and δ 8.34 because of the CH_2 protons of thiadiazine and C-4 proton of coumarin, respectively. The ^{13}C-NMR spectra of compound **3a** also shows characteristic peaks for CH_2 of thiadiazine and C O of coumarin ring at δ 24.4 and δ 164.6, respectively. The IR spectrum of **3a** and **3e** showed strong peaks at 1724 cm^{-1} and 1715 cm^{-1}, respectively, which were attributed to the lactone of coumarin. All the above spectral data supports the formation of the title products.

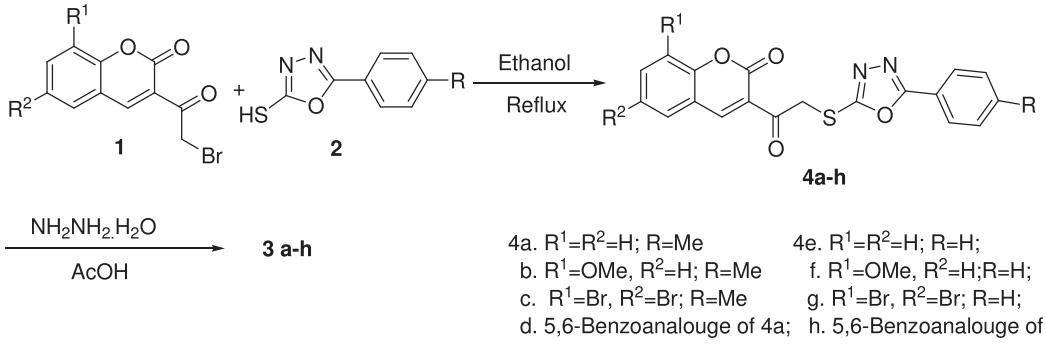
The compounds **3a**–**h** can also be synthesized by alternative method involving condensation of 3-(2-bromoacetyl) coumarins with 5-aryl-1,3,4-oxadiazole-2-thiol in anhydrous ethanol to yield the corresponding 3-(2-(5-aryl-1,3,4-oxadiazol-2-ylthio)acetyl)-2*H*-chromen-2-ones **4a**–**h** in good yields (Scheme 3). These on reaction with hydrazine hydrate

Scheme 2. Plausible mechanism for the formation of products (**3a**–**h**).



Scheme 3. 3-(3-Aryl-7*H*-[1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-one (**4a**–**h**) by two-step method.

Method-II



4a. R^1=R^2=H; R=Me
b. R^1=OMe, R^2=H; R=Me
c. R^1=Br, R^2=Br; R=Me
d. 5,6-Benzoanalouge of 4a;
4e. R^1=R^2=H; R=H;
f. R^1=OMe, R^2=H;R=H;
g. R^1=Br, R^2=Br; R=H;
h. 5,6-Benzoanalouge of 4e

resulted in the formation of **3a**–**h**. The products obtained by both the methods were found to be identical by mixed melting point measurements, Co-TLC and spectral data. The yields obtained by both the methods were shown in Table 1. The yields obtained by method-I were found to be good when compared to the method-II.

The ring closer was verified by the disappearance of the C O absorptions in the IR spectra of **3a**–**h** and by the up-field shift of the CH_2 protons in the ^{1}H-NMR spectra of **3a**–**h**.

CONCLUSION

In conclusion, we have developed a novel ring transformation reaction for synthesis of 3-(3-aryl-7*H*-[1,2,4] triazolo[3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-ones via one-pot reaction and also unambiguously. This protocol can provide a novel and effective methodology for the preparation of this type of compound using readily available starting materials. The biological activity of these compounds is under investigation.

EXPERIMENTAL

General. All the reagents, solvents and 5-aryl-1,3,4-oxadiazole-2-thiol were purchased from commercial sources and were used without any further purification unless otherwise stated. 3-(2-Bromoacetyl)coumarins [23] were prepared according to the literature procedure. Melting points were determined in open capillaries with a "Cintex" melting point apparatus Mumbai, India and were uncorrected. CHNS analysis was done by Carlo Erba EA 1108 automatic elemental analyzer. The purity of the compounds was checked by TLC plates (E. Merck Mumbai, India). IR spectra (KBr) were recorded on a Bruker WM-4(X) spectrometer (577 Model). ^{1}H-NMR spectra were recorded on the Bruker WM-400 spectrometer in δ ppm using TMS as standard. Mass spectra (EI-MS) were determined on Perkin Elmer (SCIEX API- 2000, ESI) at 12.5 eV.

General procedure for the synthesis of 3-(3-aryl-7H-[1,2,4] triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2H-chromen-2-one (3a–h). To a solution containing 3-(2-bromoacetyl)coumarin (1 mmol), 2-mercapto-5-aryl-1,3,4-oxadiazole (1 mmol) and sodium acetate (1 mmol) in acetic acid (5 mL) were heated at 60–65°C for about 1 h. The reaction mixture was cooled to room temperature, hydrazine hydrate (1 mmol) was added and heated at 80–85°C for about 2 h. After completion of the reaction, the reaction mixture was cooled to room temperature and poured in water. The solid separated was filtered, washed with water, and recrystallized from ethanol.

3-(3-p-Tolyl-7H-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2H-chromen-2-one (3a). Color: yellow; mp 251–253°C (252°C) [24]; IR (potassium bromide): 1608 (C N), 1724 (O C O), 3052 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 2.37 (s, 3H, CH_3), 4.32 (s, 2H, S CH_2), 7.35–7.46 (m, 4H, ArH), 7.74 (d, 2H, *J* = 8 Hz, ArH), 7.90 (d, 2H, *J* = 7.6 Hz, ArH), 8.60 (s, 1H, C-4 of coumarin); ^{13}C-NMR (deuteriochloroform): δ 21.4, 24.4, 116.8, 118.3, 122.8, 125.3, 126.5, 128.1, 129.5, 134.0, 140.8, 142.9, 145.0, 152.0, 152.8, 154.5, 159.3, 164.6; EI-MS 375 $[M + H]^+$. Anal. Calcd for $C_{20}H_{14}N_4O_2S$: C, 64.16; H, 3.77; N, 14.96; S, 8.56; Found: C, 64.10; H, 3.73; N, 14.90; S, 8.51.

8-Methoxy-3-(3-p-tolyl-7H-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2H-chromen-2-one (3b). Color: yellow; mp 184–186°C; IR (potassium bromide): 1610 (C N), 1720 (O C O), 3047 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 2.40 (s, 3H, CH_3), 4.00 (s, 3H, OMe), 4.10 (s, 2H, S CH_2), 7.18–7.21 (m, 3H, ArH), 7.29 (d, 2H, *J* = 8 Hz, ArH), 7.92 (d, 2H, *J* = 8.0 Hz, ArH), 8.30 (s, 1H, C-4 of coumarin); ^{13}C-NMR (deuteriochloroform): 21.4, 24.3, 56.3, 115.6, 118.9, 120.6, 122.4, 122.8, 124.0, 125.2, 129.3, 140.7, 142.9, 144.2, 145.2, 147.1, 152.8, 158.9, 164.7; EI-MS 405 $[M + H]^+$. Anal. Calcd for: $C_{21}H_{16}N_4O_3S$: C, 62.36; H, 3.99; N, 13.85; S, 7.93; Found: C, 62.30; H, 3.94; N, 13.89; S, 7.88.

Table 1

Comparison of yields by both the methods for the synthesis of 3-(3-aryl-7*H*-[1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazin-6-yl)-2*H*-chromen-2-one (3**a**–**h**).

S. no.	Entry	Yield (%) in method-I[a]	Yield (%) in method-II[b]
1	**3a**	85	76
2	**3b**	83	74
3	**3c**	80	76
4	**3d**	85	72
5	**3e**	86	80
6	**3f**	83	79
7	**3g**	80	75
8	**3h**	81	77

[a]Isolated yields of **3a**–**h** via one-pot method.
[b]Isolated yields **3a**–**h** via two-step method.

6,8-Dibromo-3-(3-p-tolyl-7H-[1,2,4]triazolo[3,4-b][1,3,4] thiadiazin-6-yl)-2H-chromen-2-one (3c). Color: yellow; mp 200–202°C; IR (potassium bromide): 1618 (C N), 1730 (O C O), 3064 (C H) cm^{-1}; ^{1}H-NMR (dimethyl sulfoxide d_6): δ 2.32 (s, 3H, CH_3), 4.15 (s, 2H, S CH_2), 7.48–7.62 (m, 4H, ArH), 8.14 (s, 1H, ArH), 8.35 (s, 1H, ArH), 8.68 (s, 1H, C-4 of coumarin). ^{13}C-NMR (dimethyl sulfoxide d_6): 19.0, 24.8, 116.2, 118.5 119.6, 126.6, 128.2, 128.6, 129.2, 129.6, 133.3, 133.8, 138.8, 145.4, 152.5, 153.6, 158.8, 167.6. Anal. Calcd for: $C_{20}H_{12}Br_2N_4O_2S$: C, 45.14; H, 2.27; N, 10.53; S, 6.02; Found: C, 45.18; H, 2.24; N, 10.49; S, 5.98.

2-(3-p-Tolyl-7H-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-3H-benzo[f]chromen-3-one (3d). Color: yellow; mp 186–188°C; IR (potassium bromide): 1604 (C N), 1720 (O C O), 3057 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 2.40 (s, 3H, CH_3), 4.18 (s, 2H, S CH_2), 7.29 (d, 2H, *J* = 8 Hz, ArH), 7.54 (d, 1H, *J* = 8 Hz, ArH), 7.64 (d, 1H, *J* = 8 Hz, ArH), 7.73–7.99 (m, 4H, ArH), 8.12–8.17 (m, 1H, ArH), 8.28 (d, 1H, *J* = 8.4 Hz, ArH), 9.12 (s, 1H, C-4 of coumarin). EI-MS 425 $[M + H]^+$. Anal. Calcd for $C_{24}H_{16}N_4O_2S$: C, 67.91; H, 3.80; N, 13.20; S, 7.55; Found: C, 67.95; H, 3.75; N, 13.17; S, 7.51.

3-(3-Phenyl-7H-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2H-chromen-2-one (3e). Color: yellow; mp 248–250°C (ref. [24], 250° C); IR (potassium bromide): 1602 (C N), 1715 (O C O), 3054 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 4.12 (s, 2H, S CH_2), 7.39–7.50 (m, 5H, ArH), 7.64–7.69 (m, 2H, ArH), 8.05 (m, 2H, ArH), 8.34 (s, 1H, C-4 of coumarin). EI-MS 361 $[M + H]^+$. Anal. Calcd for $C_{19}H_{12}N_4O_2S$: C, 63.32; H, 3.36; N, 15.55; S, 8.90; Found: C, 63.25; H, 3.31; N, 15.51; S, 8.84.

8-Methoxy-3-(3-phenyl-7H-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2H-chromen-2-one (3f). Color: yellow; mp 210–212°C; IR (potassium bromide): 1606 (C N), 1730 (O C O), 3039 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 3.86 (s, 3H, OMe), 4.20 (s, 2H, S CH_2), 7.26–7.48 (m, 7H, ArH), 7.91 (s, 1H, ArH), 8.32 (s, 1H, C-4 of coumarin). EI-MS 391 $[M + H]^+$. Anal. Calcd for $C_{20}H_{14}N_4O_3S$: C, 61.53; H, 3.61; N, 14.35; S, 8.21; Found: C, 61.50; H, 3.58; N, 14.30; S, 8.15.

6,8-Dibromo-3-(3-phenyl-7H-[1,2,4]triazolo[3,4-b][1,3,4] thiadiazin-6-yl)-2H-chromen-2-one (3g). Color: yellow; mp 222–224°C; IR (potassium bromide): 1610 (C N), 1730 (O C O), 3053 (C H) cm^{-1}; ^{1}H-NMR (dimethyl sulfoxide d_6): δ 3.98 (s, 2H, S CH_2), 7.60–7.78 (m, 5H, ArH), 8.15 (s, 1H, ArH), 8.34 (s, 1H, ArH), 8.76 (s, 1H, C-4 of coumarin). ^{13}C-NMR (dimethyl sulfoxide d_6): 23.8, 117.1, 118.4 119.6, 124.6, 128.2, 128.7, 129.1, 129.7, 132.9, 133.4, 138.6, 145.2, 149.5, 153.2, 159.6, 164.6. Anal. Calcd for $C_{19}H_{10}Br_2N_4O_2S$: C, 44.04; H, 1.95; N, 10.81; S, 6.19; Found: C, 44.12; H, 1.90; N, 10.85; S, 6.10.

2-(3-Phenyl-7H-[1,2,4]triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-3H-benzo[f]chromen-3-one (3h). Color: yellow; mp 194–196°C; IR (potassium bromide): 1607 (C N), 1706 (O C O), 3042 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 4.08 (s, 2H, S CH_2), 7.62–7.92 (m, 7H, ArH), 8.12 (d, 1H, *J* = 8.4, ArH), 8.24 (d, 1H, *J* = 8.4, ArH), 8.42–8.50 (m, 1H, ArH), 8.24 (d, 1H, *J* = 8.4, ArH), 9.14 (s, 1H, C-4 of coumarin). EI-MS 411 $[M + H]^+$. Anal. Calcd for $C_{23}H_{14}N_4O_2S$: C, 67.30; H, 3.44; N, 13.65; S, 7.81; Found: C, 67.35; H, 3.41; N, 13.61; S, 7.75.

General procedure for the synthesis of 3-(2-(5-aryl-1,3,4-oxadiazol-2-ylthio)acetyl)-2H-chromen-2-ones (4a–h). 3-(2-Bromoacetyl)coumarin (1 mmol) and 2-mercapto-5-aryl-1,3,4-oxadiazole (1 mmol) were taken in 5 mL anhydrous ethanol and refluxed for about 2 h. Then reaction mixture was cooled to room temperature, the solid separated was filtered and recrystallized from ethanol.

3-(2-(5-p-Tolyl-1,3,4-oxadiazol-2-ylthio)acetyl)-2H-chromen-2-one (4a). Yield 85%, mp 200–202°C, Color: yellow; IR (potassium bromide): 1606 (C N), 1676 (C O), 1732 (O C O), 3042 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 2.41 (s, 3H, CH_3), 4.87 (s, 2H, S CH_2), 7.28 (d, 2H, *J* = 8 Hz, ArH), 7.38–7.43 (m, 2H, ArH), 7.68 (d, 2H, *J* = 7.6Hz, ArH), 7.87 (d, 2H, *J* = 8 Hz, ArH), 8.63 (s, 1H, C-4 of coumarin). EI-MS 379 $[M + H]^+$. Anal. Calcd for $C_{20}H_{14}N_2O_4S$: C, 63.48; H, 3.73; N, 7.40; S, 8.47; Found: C, 63.41; H, 3.71; N, 7.44; S, 8.41.

3-(2-(5-p-Tolyl-1,3,4-oxadiazol-2-ylthio)acetyl)-8-methoxy-2H-chromen-2-one (4b). Yield 88%, mp 214–216°C, Color: yellow; IR (potassium bromide): 1599 (C N), 1681 (C O), 1720 (O C O), 3084 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 2.38 (s, 3H, CH_3), 4.10 (s, 3H, OMe), 4.84 (s, 2H, S CH_2), 7.25–7.48 (m, 5H, ArH), 7.88–7.96 (m, 2H, ArH), 8.32 (s, 1H, C-4 of coumarin). EI-MS 409 $[M + H]^+$. Anal. Calcd for $C_{21}H_{16}N_2O_5S$: C, 61.76; H, 3.95; N, 6.86; S, 7.85; Found: C, 61.74; H, 3.90; N, 6.81; S, 7.82.

3-(2-(5-p-Tolyl-1,3,4-oxadiazol-2-ylthio)acetyl)-6,8-dibromo-2H-chromen-2-one (4c). Yield 83%, mp 192–194°C; Color: yellow; IR (potassium bromide): 1600 (C N), 1678 (C O), 1725 (O C O), 3063 (C H) cm^{-1}; ^{1}H-NMR (dimethyl sulfoxide d_6): δ 2.43 (s, 3H, CH_3), 4.86 (s, 2H, S CH_2), 7.50 (d, 2H, *J* = 7.2 Hz, ArH), 7.73–7.81 (m, 2H, ArH), 7.99 (m, 2H, ArH), 8.36 (s, 1H, C-4 of coumarin). Anal. Calcd for $C_{20}H_{12}Br_2N_2O_4S$: C, 44.80; H, 2.26; N, 5.22; S, 5.98; Found: C, 44.75; H, 2.30; N, 5.20; S, 5.91.

2-(2-(5-p-Tolyl-1,3,4-oxadiazol-2-ylthio)acetyl)-3H-benzo[f]chromen-3-one (4d). Yield 90%, mp 176–178°C; Color: yellow; IR (potassium bromide): 1599 (C N), 1683 (C O), 1716 (O C O), 3053 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 2.38 (s, 3H, CH_3), 5.12 (s, 2H, S CH_2), 7.38 (d, 2H, *J* = 8 Hz, ArH), 7.70 (d, 2H, *J* = 8.4 Hz, ArH), 7.85 (d, 3H, *J* = 8 Hz, ArH), 8.13 (d, 1H, *J* = 8 Hz, ArH), 8.42 (d, 1H, *J* = 9.2 Hz, ArH), 8.71 (d, 1H, *J* = 8.4 Hz, ArH), 9.49 (s, 1H, C-4 of coumarin). EI-MS 429 $[M + H]^+$. Anal. Calcd for $C_{24}H_{16}N_2O_4S$: C, 67.28; H, 3.76; N, 6.54; S, 7.48; Found: C, 67.23; H, 3.71; N, 6.59; S, 7.42.

3-(2-(5-Phenyl-1,3,4-oxadiazol-2-ylthio)acetyl)-2H-chromen-2-one (4e). Yield 85%, mp 210–212°C; Color: yellow; IR (potassium bromide): 1610 (C N), 1680 (C O), 1701 (O C O), 3032 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 4.70 (s, 2H, S CH_2), 7.30–7.54 (m, 5H, ArH), 7.62–7.75 (m, 3H, ArH), 7.98 (d, 1H, *J* = 8 Hz, ArH), 8.58 (s, 1H, C-4 of coumarin). EI-MS 365 $[M + H]^+$. Anal. Calcd for $C_{19}H_{12}N_2O_4S$: C, 62.63; H, 3.32; N, 7.69; S, 8.80; Found: C, 62.67; H, 3.30; N, 7.73; S, 8.74.

3-(2-(5-Phenyl-1,3,4-oxadiazol-2-ylthio)acetyl)-8-methoxy-2H-chromen-2-one (4f). Yield 85%, mp 188–190°C; Color: yellow; IR (potassium bromide): 1602 (C N), 1681 (C O), 1728 (O C O), 3028 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 4.00 (s, 3H, OMe), 4.89 (s, 2H, S CH_2), 7.22–7.26 (m, 2H, ArH), 7.29 (d, 1H, *J* = 8 Hz, ArH), 7.50 (t, 3H, *J* = 8.4 Hz, ArH), 7.97–8.00 (m, 2H, ArH), 8.60 (s, 1H, C-4 of coumarin). EI-MS 395 $[M + H]^+$. Anal. Calcd for $C_{20}H_{14}N_2O_5S$: C, 60.91; H, 3.58; N, 7.10; S, 8.13; Found: C, 60.88; H, 3.54; N, 7.14; S, 8.10.

3-(2-(5-Phenyl-1,3,4-oxadiazol-2-ylthio)acetyl)-6,8-dibromo-2H-chromen-2-one (4g). Yield 83%, mp 200–202°C; Color: yellow; IR (potassium bromide): 1600 (C N), 1678 (C O), 1724 (O C O), 3063 (C H) cm^{-1}; ^{1}H-NMR (dimethyl sulfoxide d_6): δ 5.02 (s, 2H, S CH_2), 7.60–7.78 (m, 5H, ArH), 8.12 (s, 1H, ArH), 8.34 (s, 1H, ArH), 8.68 (s, 1H, C-4 of coumarin). Anal.

Calcd for $C_{19}H_{10}Br_2N_2O_4S$: C, 43.70; H, 1.93; N, 5.36; S, 6.14; Found: C, 43.75; H, 10.96; N, 5.36; S, 6.10.

2-(2-(5-Phenyl-1,3,4-oxadiazol-2-ylthio)acetyl)-3H-benzo[f] chromen-3-one (4h). Yield 89%, mp 180–182°C; Color: yellow; IR (potassium bromide): 1599 (C N), 1681 (C O), 1735 (O C O), 3063 (C H) cm^{-1}; ^{1}H-NMR (deuteriochloroform): δ 4.96 (s, 2H, S CH_2), 7.22–7.28 (m, 2H, ArH), 7.47–7.53 (m, 3H, ArH), 7.64 (t, 1H, *J* = 7.2 Hz, ArH), 7.77 (t, 1H, *J* = 8.4 Hz, ArH), 7.94–8.01 (m, 2H, ArH), 8.17 (d, 1H, *J* = 8.8 Hz, ArH), 8.37 (d, 1H, *J* = 8.4 Hz, ArH), 9.44 (s, 1H, C-4 of coumarin); EI-MS 415 $[M + H]^+$. Anal. Calcd for $C_{23}H_{14}N_2O_4S$: C, 66.66; H, 3.40; N, 6.76; S, 7.74; Found: C, 66.61; H, 3.36; N, 6.72, S, 7.66.

General procedure for the synthesis of 3-(3-aryl-7H-[1,2,4] triazolo[3,4-b][1,3,4]thiadiazin-6-yl)-2H-chromen-2-one (3a–h) from compounds 4a–h. To a solution containing compound **4a**–**h** (1 mmol) and hydrazine hydrate (1 mmol) in acetic acid (5 mL) was heated at 80–85°C for about 2 h. The reaction mixture was cooled and poured in water. The separated solid was filtered, washed with water, and recrystallized from ethanol.

Acknowledgments. The authors are thankful to the Director, NIT, Warangal for providing facilities. One of the authors (CHVSR) is thankful to the Director for awarding Institute Fellowship.

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