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Original Research Article

S-Alkylated/aralkylated 2-(1*H*-indol-3-yl-methyl)-1,3,4-oxadiazole-5-thiol derivatives. 1. Synthesis and characterization

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Abstract

Purpose: *To synthesize and characterize S-alkylated/aralkylated 2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiol derivatives.*
Methods: *2-(1H-indol-3-yl)acetic acid (1) was reacted with absolute ethanol and catalytic amount of sulfuric acid to form ethyl 2-(1H-indol-3-yl)acetate (2) which was transformed to 2-(1H-indol-3-yl)acetohydrazide (3) by refluxing with hydrazine hydrate in methanol. Ring closure reaction of 3 with carbon disulfide and ethanolic potassium hydroxide yielded 2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiol (4) which was finally treated with alkyl/aralkyl halides (5a-u) in DMF and NaH to yield S-alkylated/aralkylated 2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiols (6a-u). Structural elucidation was done by IR, 1H-NMR and EI-MS techniques*
Results: *2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiol (4) was synthesized as the parent molecule and was characterized by IR and the spectrum showed peaks resonating at (cm^{-1}) 2925 (Ar-H), 2250 (S-H), 1593 (C=N) and 1527 (Ar C=C); 1H-NMR spectrum showed signals at δ 11.00 (s, 1H, NH-1'), 7.49 (br.d, J = 7.6 Hz, 1H, H-4'), 7.37 (br.d, J = 8.0 Hz, 1H, H-7'), 7.34 (br.s, 1H, H-2'), 7.09 (t, J = 7.6 Hz, 1H, H-5'), 7.00 (t, J = 7.6 Hz, 1H, H-6') and 4.20 (s, 2H, CH2-10'). EI-MS presented different fragments peaks at m/z 233 $(C_{11}H_9N_3OS)^{\cdot+}$ $[M+2]^+$, 231 $(C_{11}H_9N_3OS)^{\cdot+}$ $[M]^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$. The derivatives (6a-6u) were prepared and characterized accordingly.*
Conclusion: *S-alkylated/aralkylated 2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiols (6a-u) were successfully synthesized.*

Keywords: *2-(1H-indole-3-ylmethyl)-1,3,4-oxadiazole-5-thiol, S-alkylated/aralkylated derivatives, Synthesis, Characterization, ^{1}H-NMR and EI-MS*

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INTRODUCTION

The synthesis and analysis of chemical and biological behaviors of 2, 5-disubstituted-1,3,4-oxadiazole-2-thiol derivatives have gained substantive importance in the past few decades for biological, medical and agricultural reasons [1-5]. Synthesis of 2,5-disubstituted 1,3,4-oxadiazoles from acyl hydrazides and acids can be done by acid activation with CDI, followed by coupling with the required acyl hydrazide and dehydration in the same pot with CBr_4 and Ph_3P [6]. The appropriate aromatic acids are transformed to corresponding oxadiazoles through their hydrazides [7,8]. Substitution of alkyl/aralkyl halides can be done at 1, 3, 4-

oxadiazole-2-thiol, to study structure-activity relationship [9].

Indole derivatives display a wide range of biological activities. 2-(1H-indol-3-yl) acetic acid is a plant growth hormone. It is obtained naturally from diets rich in vegetable stems and is synthesized from tryptophan, which is also used for the hormones serotonin and melatonin, the anti-inflammatory drug indomethacin, the psychotropic drug LSD and the anti-tumor agent vinblastine [10,11]. In continuation of our ongoing research efforts [12,13], we report herein the synthesis of alkylated/aralkylated 2-[1H-indol-3-ylmethyl]-1,3,4-oxadiazole-5-thiols (**6a-u**) which might be employed for pharmacological evaluation in search of new drug candidates.

EXPERIMENTAL

Materials and instruments

Alkyl halides were purchased from Sigma Aldrich and Alfa Aesar, while 3-indoleacetic acid and hydrated hydrazine were from DAE Jung. All solvents were obtained through local supplier and used after distillation. Thin layer chromatography (TLC) was carried out on pre-coated silica gel G-25-UV_{254} plates, run in different ratios of EtOAc and n-hexane and visualized at UV 254 nm. Melting points of synthesized compounds were recorded on Griffin and George melting point apparatus by open capillary tube and were uncorrected; IR spectra, was recorded in KBr pellet method on a Jasco-320-A spectrometer (Germany) in cm^{-1}; ^{1}H-NMR spectra were recorded in DMSO on a Bruker spectrometer (USA) at 300, 400 & 500 MHz with chemical shifts in ppm; and EIMS spectra were recorded on a JMS-HX-110 spectrometer with a data system.

Synthesis

Ethyl 2-(1H-indol-3-yl)acetate (2): 2-(1H-indol-3-yl)acetic acid (20.0 g; 0.11 mol; 1) in absolute ethanol (60 mL) and catalytic amount of concentrated sulfuric acid (10 mL; 0.18 mol) were put into a round bottomed flask and refluxed for 8 h. The flask contents were then neutralized with 25 mL of 10 % Na_2CO_3 solution. The product was isolated by solvent extraction with chloroform.

2-(1H-indol-3-yl)acetohydrazide (3): Ethyl 2-(1H-indol-3-yl) acetate (19.0 mL; **2**) and 80 % hydrazine hydrate (25 mL) in 30 mL methanol were put into a round bottomed flask. The reaction mixture was stirred for 3 h at room temperature and the resultant acid hydrazide was obtained by distilling methanol from the reaction mixture.

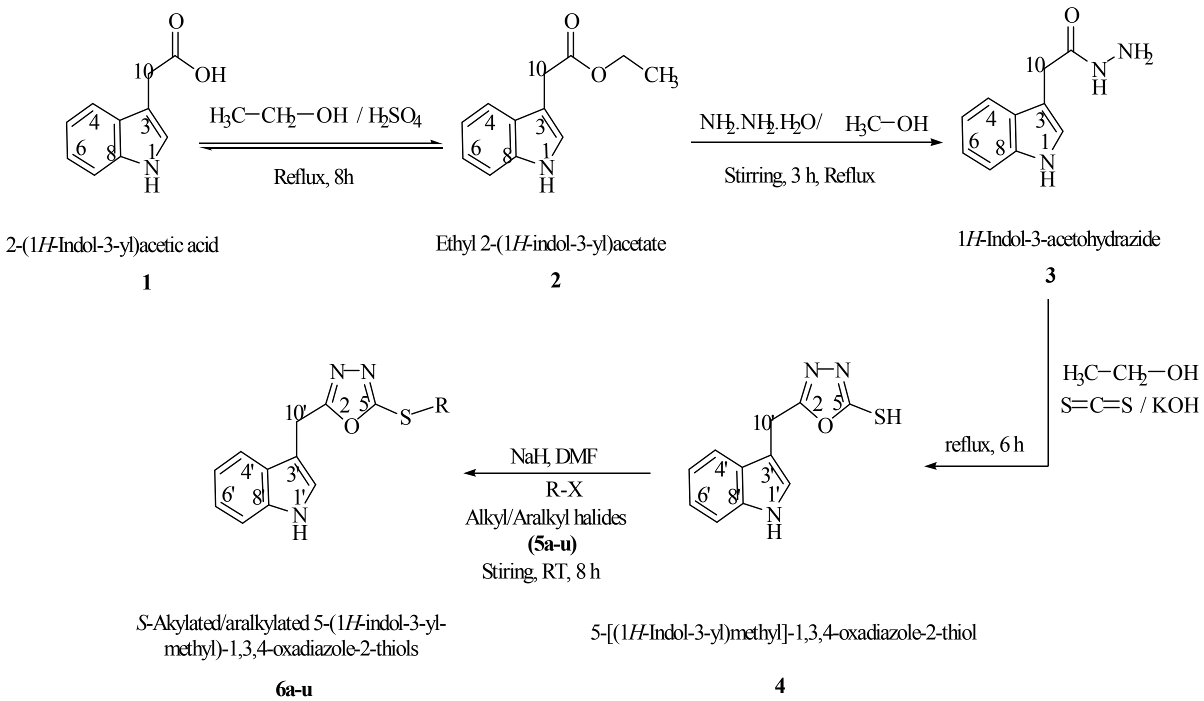
2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiol (4): 2-(1H-indol-3-yl) acetohydrazide (20.0 g, 0.11 mol; **3**) and absolute ethanol (30 mL) were put into a round bottom flask. Carbon disulfide (14.0 mL, 22 mol) was then added to the solution, followed by addition of potassium hydroxide (6.3 g, 0.11 mol). The mixture was refluxed for 6 h. and then diluted with distilled water (50 mL) and acidified with dilute hydrochloric acid to pH 2-3. The precipitate thus formed was filtered, washed with water and re-crystallized in ethanol.

S-alkylated/aralkylated 2-(1H-indol-3-ylmethyl)-1, 3, 4-oxadiazole-5-thiols (6a-u): 2-(1H-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiol (0.20 g; 0.001 mol; **4**) as a nucleophile in N,N-dimethyl formamide was placed in a round bottom flask followed by addition of sodium hydride (0.002 g, 0.1 mmol) to the reaction mixture, which was then stirred for about half an hour at room temperature. The electrophiles, alkyl/aralkyl halides (**5a-5u**), were added in stoichiometric amounts and stirred for 8 h. After completion of reaction, the derivatives (**6a-6u**) were obtained as precipitates by addition of distilled water or by solvent extraction depending on the nature of the product.

RESULTS

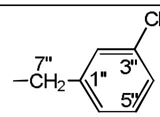
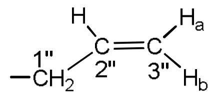
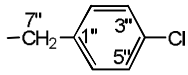
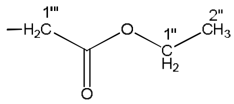
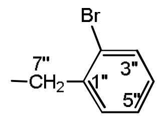
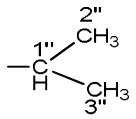
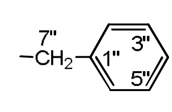
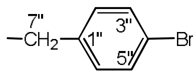
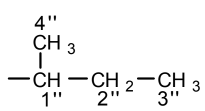
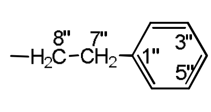
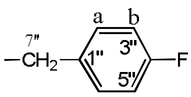
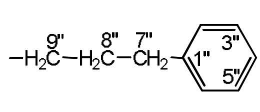
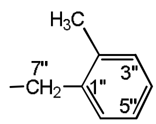
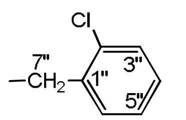
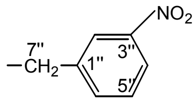
The *S*-substituted derivatives (**6a-6u)** of 2-(1*H*-indol-3-yl-methyl)-1,3,4-oxadiazole-5-thiol (**4**) were synthesized by the protocol sketched in **Scheme 1** and the different *S*-substituted alkyl/aralkyl groups are listed in **Table 1** while the spectral and mass fragmentation patterns are shown in Fig 1-4. The spectral characterizations of the compounds are provided below.

2-(1*H*-indol-3-yl)acetate (2): Brownish liquid, Yield: 85 %; Molecular formula: $C_{12}H_{13}NO_2$; Molecular weight: 203 $gmol^{-1}$; IR (KBr) v_{max}: 3315 (N-H), 2930 (Ar-H), 1624 (C=O), 1531 (Ar. C=C); ^{1}H-NMR (400 MHz, DMSO-d_6): δ 10.9 (s, 1H, NH-1'), 7.48 (br.d, *J* = 8.0 Hz, 1H, H-4'), 7.34 (br.d, *J* = 8.0 Hz, 1H, H-7'), 7.23 (br.s, 1H, H-2'), 7.06 (t, *J* = 7.6 Hz, 1H, H-5'), 6.97 (t, *J* = 7.6 Hz, 1H, H-6'),4.16 (q, *J*= 7.2, 2H, -O$\underline{CH_2}$CH$_3$), 3.71 (s, 2H, CH_2-10'),1.17 (t, *J* = 7.2 Hz, 3H, -OCH$_2\underline{CH_3}$). EIMS: *m/z* 203 $(C_{12}H_{13}NO_2)^{\cdot+}$ $[M]^+$, 158 $(C_{10}H_8NO)^+$, 130 $(C_9H_8N)^+$, 73 $(C_3H_5O_2)^+$.



Scheme 1: Steps in the synthesis of *S*-alkylated/aralkylated 2-(1*H*-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiols (6a-6u)

Table 1: *S*-Alkylated/aralkylated 2-(1*H*-indol-3-ylmethyl)-1,3,4-oxadiazole-5-thiols **(6a-u)**

Code	R	Code	R	Code	R
6a	$-\underset{1''}{CH_2}-\underset{2''}{CH_2}-Br$	6h	$-\underset{1''}{CH_2}-\underset{2''}{CH_2}-\underset{3''}{CH_2}-\underset{4''}{CH_2}-\underset{5''}{CH_2}-\underset{6''}{CH_2}-\underset{7'}{C}$	6o	
6b	$-\underset{1''}{CH_2}-\underset{2''}{CH_2}-Cl$	6i		6p	
6c	$-\underset{1''}{CH_2}-\underset{2''}{CH_2}-\underset{3''}{CH_3}$	6j		6q	
6d		6k		6r	
6e		6l		6s	
6f	$-\underset{1''}{CH_2}-\underset{2''}{CH_2}-\underset{3''}{CH_2}-\underset{4''}{CH_3}$	6m		6t	
6g	$-\underset{1''}{CH_2}-\underset{2''}{CH_2}-\underset{3''}{CH_2}-\underset{4''}{CH_2}-\underset{5''}{CH}$	6n		6u	

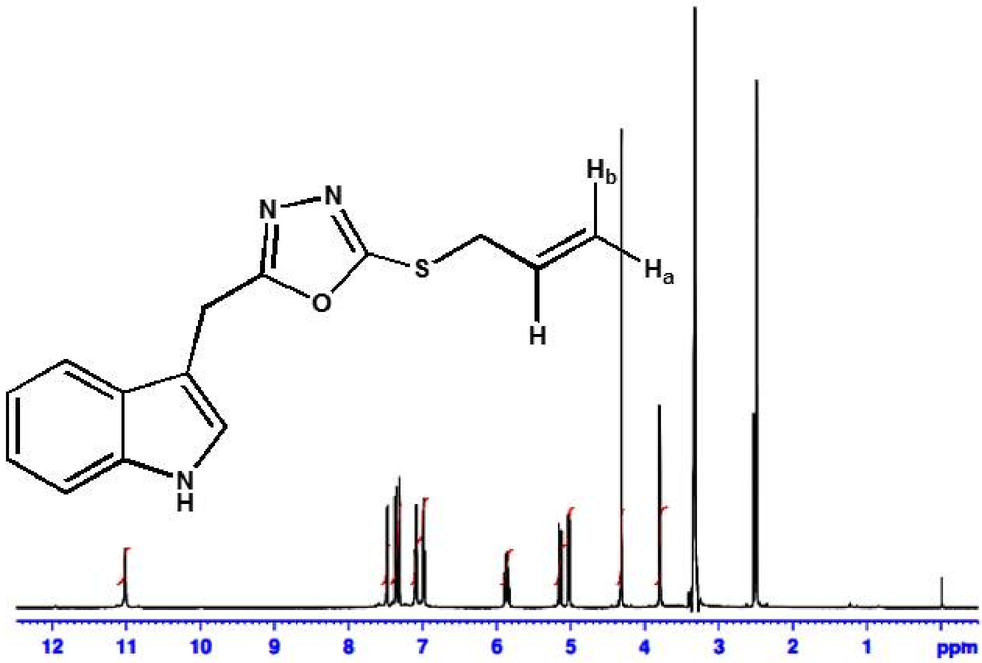


Figure 1: ^{1}H-NMR spectrum of 3-{[5-(Allylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (**6i)**

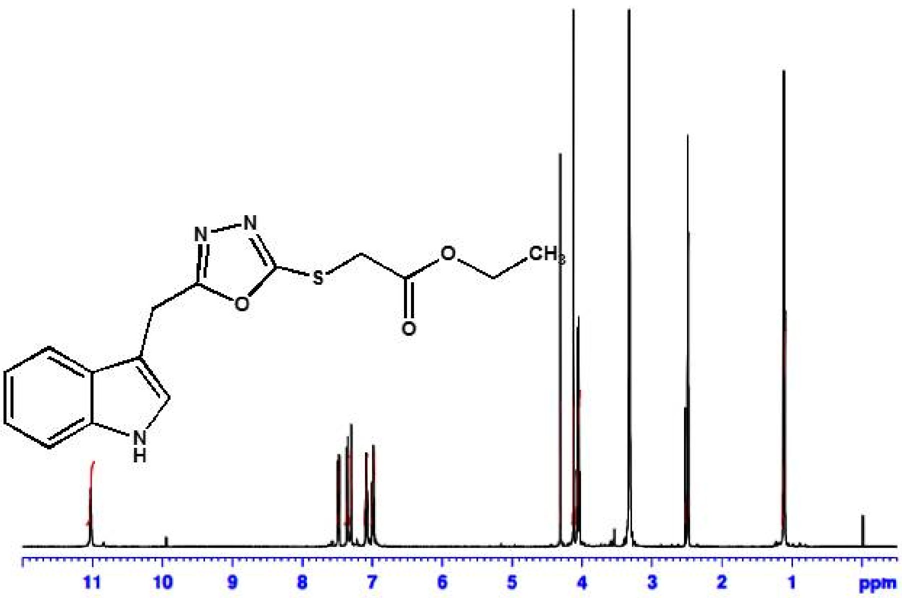


Figure 2: ^{1}H-NMR spectrum of 3-[(5-(Ethoxycarbonylmethylsulfanyl)-1,3,4-oxadiazole-2-yl)methyl]-1*H*-indole (**6j**)

2-(1*H*-indol-3-yl)acetohydrazide (3): Brownish crystals; Yield: 89 %; M.P. 113 °C; Molecular formula: $C_{10}H_{11}N_3O$; Molecular weight: 189 gmol^{-1}; IR (KBr) v_{max}: 3310 (N-H), 2930 (Ar-H), 1630 (C=O), 1529 (Ar. C=C); ^{1}H-NMR (400 MHz, DMSO-*d*$_6$): δ 10.8 (s, 1H, NH-1'),9.08 (s, 1H, <u>NH</u>NH$_2$), 7.55 (br.d, *J* = 7.6 Hz, 1H, H-4'), 7.31 (br.d, *J* = 8.0 Hz, 1H, H-7'), 7.16 (br.s, 1H, H-2'), 7.04 (t, *J* = 7.2 Hz, 1H, H-5'), 6.95 (t, *J* = 7.6 Hz, 1H, H-6'), 4.16 (s,1H, NH<u>NH$_2$</u>) 3.43 (s, 2H, CH$_2$-10'). EIMS: *m/z* 203 $(C_{10}H_{11}N_3O)^{\cdot+}$ [M]$^+$, 158 $(C_{10}H_8NO)^+$, 130 $(C_9H_8N)^+$, 59 $(C_3H_5O_2)^+$.

2-(1*H*-indol-3-yl-methyl)-1,3,4-oxadiazole-5-thiol (**4**)**:** Dark brown powder; Yield: 76 %; M.P. 125 °C; Molecular formula: $C_{11}H_9N_3OS$; Molecular weight: 231 gmol^{-1}; IR (KBr) v_{max}: 2925 (Ar-H), 2250 (S-H), 1593 (C=N), 1527 (Ar C=C) ; ^{1}H-NMR (400 MHz, DMSO-*d*$_6$): δ 11.0 (s, 1H, NH-1'), 7.49 (br.d, *J* = 7.6 Hz, 1H, H-4'), 7.37 (br.d, *J* = 8.0 Hz, 1H, H-7'), 7.34 (br.s, 1H, H-2'), 7.09 (t, *J* = 7.6 Hz, 1H, H-5'), 7.00 (t, *J* = 7.6 Hz, 1H, H-6'), 4.20 (s, 2H, CH$_2$-10'). EIMS: *m/z* 233 $(C_{11}H_9N_3OS)^{\cdot+}$ [M+2]$^+$, 231 $(C_{11}H_9N_3OS)^{\cdot+}$ [M]$^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$.

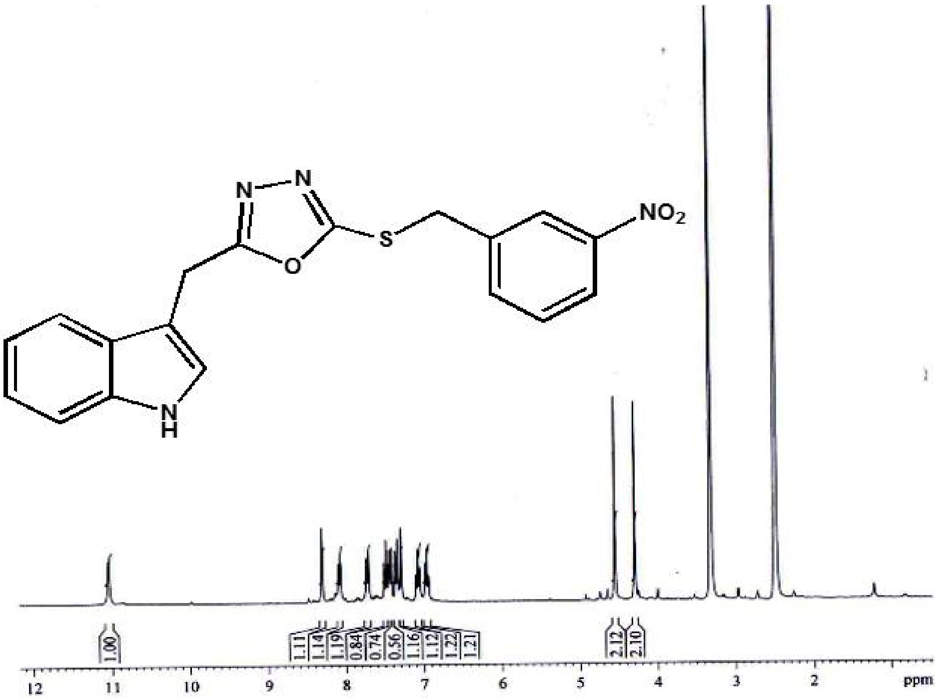


Figure 3: ^{1}H-NMR spectrum of 3-({5-[(3-nitrobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (**6u)**

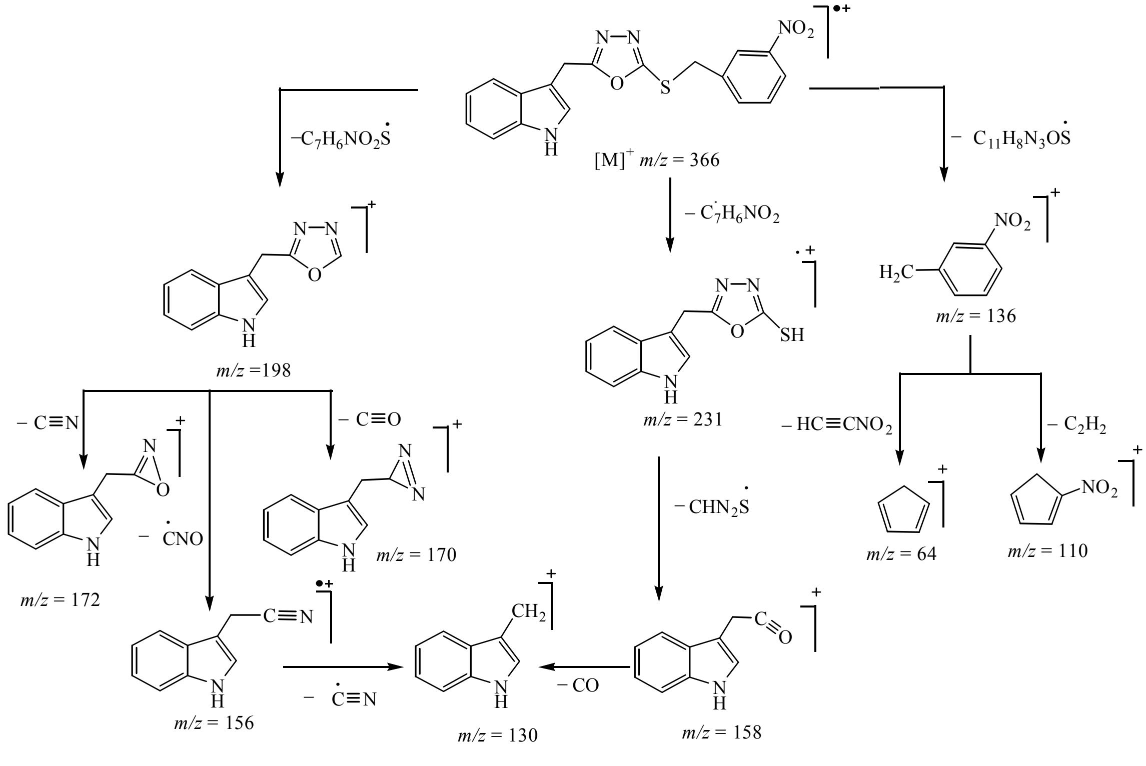


Fig 4: Mass fragmentation pattern 3-({5-[(3-nitrobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole **(6u)**

3-({5-[(2-Bromoethyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6a): Light brown amorphous solid; Yield: 81 %; M.P. 146 °C; Molecular formula: $C_{13}H_{12}N_3OSBr$; Molecular weight: 338 gmol^{-1}; IR (KBr): v_{max} 3226 (N-H), 2910 (C-H Ar), 1484 (C=N), 1476 (C=C Ar), 840 (C-N) and 810 (C-S); ^{1}H-NMR (300 MHz, DMSO-d_6): δ 11.0 (s, 1H, NH-1'), 7.47 (br.d, J = 7.8 Hz, 1H, H-4'), 7.35 (br.d, J = 7.8 Hz, 1H, H-7'), 7.31 (br.s, 1H, H-2'), 7.09 (t, J = 6.9 Hz, 1H, H-5'), 6.98 (t, J = 7.2 Hz, 1H, H-6'), 4.13 (s, 2H, CH_2-10'), 3.22-3.25 (m-overlapped, 4H, CH_2-1'' & CH_2-2''); EIMS: *m/z* 341 $(C_{13}H_{12}N_3OSBr)^{\cdot+}$ $[M+4]^+$, 339 $(C_{13}H_{12}N_3OSBr)^{\cdot+}$ $[M+2]^+$, 337

$(C_{13}H_{12}N_3OSBr)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8NO)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 158 $(C_6H_4Br+2)^+$, 156 $(C_6H_4Br)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 110 $(C_2H_4Br)^+$,108 $(C_2H_4Br)^+$.

3-({5-[(2-Chloroethyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6b): Light brown amorphous solid; Yield: 85 %; M.P. 208 °C; Molecular formula: $C_{13}H_{12}N_3OSCl$; Molecular weight: 293.5 gmol^{-1}; IR (KBr): v_{max}: 3221 (N-H), 2919 (C-H Ar), 1484 (C=N), 1470 (C=C Ar), 843 (C-N) and 814 (C-S); ^{1}H-NMR (500 MHz, DMSO-d_6): δ 10.99 (s, 1H, NH-1'), 7.51 (br.d, *J* = 8.0 Hz, 1H, H-4'), 7.38 (br.d, *J* = 8.0 Hz, 1H, H-7'), 7.33 (br.s, 1H, H-2'), 7.10 (t, *J* = 8.0 Hz, 1H, H-5'), 7.00 (t, *J* = 8.0 Hz, 1H, H-6'), 4.34 (s, 2H, CH_2-10'), 3.91 (t, 2H, *J* = 7.0 Hz, CH_2-2''), 3.56 (t, 2H, *J* = 7.0 Hz, CH_2-1''); EIMS: *m/z* 297 $(C_{13}H_{12}N_3OSCl)^{\cdot+}$ [M+4]$^+$, 295 $(C_{13}H_{12}N_3OSCl)^{\cdot+}$ [M+2]$^+$, 293 $(C_{13}H_{12}N_3OSCl)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130$(C_9H_8N)^+$, 65 $(C_2H_4Cl+2)^+$, 63 $(C_2H_4Cl)^+$.

3-{[5-(Propylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6c): Brown amorphous solid; Yield: 70 %; M.P. 103°C; Molecular formula: $C_{14}H_{15}N_3OS$; Molecular weight: 273 gmol^{-1}; IR (KBr): v_{max}: 3225 (N-H), 2932 (C-H Ar), 1479 (C=N), 1474 (C=C Ar), 840 (C-N) and 816 (C-S); ^{1}H-NMR (400 MHz, DMSO-d_6): δ 11.0 (s, 1H, NH-1'), 7.47 (br.d, *J* = 7.6 Hz, 1H, H-4'), 7.35 (br.d, *J* = 7.6 Hz, 1H, H-7'), 7.31 (br.s, 1H, H-2'), 7.09 (t, *J* = 6.8 Hz, 1H, H-5'), 6.98 (t, *J* = 7.2 Hz, 1H, H-6'), 4.16 (s, 2H, CH_2-10'), 3.84 (t, *J* = 7.6 Hz, 2H, CH_2-1''), 1.64 (sex, *J* = 7.2 Hz, 2H, CH_2-2''), 1.05 (t, *J* = 7.2 Hz, 3H, CH_3-3''); EIMS: *m/z* 275 $(C_{14}H_{15}N_3OS)^{\cdot+}$ [M+2]$^+$, 273 $(C_{14}H_{15}N_3OS)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$,43$(C_3H_7)^+$.

3-{[5-(*iso*-Propylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6d): Light brown amorphous solid; Yield: 75 %; M.P. 78 °C; Molecular formula: $C_{14}H_{15}N_3OS$; Molecular weight: 273 gmol^{-1}; IR (KBr): v_{max}: 3225 (N-H), 2928 (C-H Ar), 1478 (C=N), 1470 (C=C Ar), 845 (C-N) and 809 (C-S); ^{1}H-NMR (500 MHz, DMSO-d_6): δ 11.02 (s, 1H, NH-1'), 7.50 (br. d, *J* = 8.0 Hz, 1H, H-4'), 7.37 (br. d, *J* = 8.0 Hz, 1H, H-7'), 7.33 (br. s, 1H, H-2'), 7.10 (t, *J* = 7.0 Hz, 1H, H-5'), 7.00 (t, *J* = 7.5 Hz, 1H, H-6'), 4.78 (s, 2H, CH_2-10'), 3.76-3.71 (m, 1H, CH-1''), 1.36 (d, *J* = 6.0 Hz, 6H, CH_3-2'' & CH_3-3''); EIMS: *m/z* 275 $(C_{14}H_{15}N_3OS)^{\cdot+}$ [M+2]$^+$, 273 $(C_{20}H_{19}N_3OS)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231($C_{14}H_{15}N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 43 $(C_3H_7)^+$.

3-{[5-(*sec*-Butylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6e): Dark brown sticky solid; Yield: 73 %; Molecular formula: $C_{15}H_{17}N_3OS$; Molecular weight: 287 gmol^{-1}; IR (KBr): v_{max}: 3220 (N-H), 2930 (C-H Ar), 1485 (C=N), 1472 (C=C Ar), 838 (C-N) and 814 (C-S); ^{1}H-NMR (400 MHz, DMSO-d_6): δ 11.0 (s, 1H, NH-1'), 7.47 (br. d, *J* = 7.6 Hz, 1H, H-4'), 7.35 (br. d, *J* = 8.0 Hz, 1H, H-7'), 7.31 (br. s, 1H, H-2'), 7.09 (t, *J* = 6.8 Hz, 1H, H-5'), 6.98 (t, *J* = 7.2 Hz, 1H, H-6'), 4.43 (s, 2H, CH_2-10'), 4.25-4.21 (m, 1H, H-1''), 1.01 (d, *J* = 6.8 Hz, 3H, CH_3-4''), 0.90-0.85 (m, 2H, H-2''), 0.74 (t, *J* = 7.2 Hz, 3H, CH_3-3''). EIMS: *m/z* 289 $(C_{15}H_{17}N_3OS)^{\cdot+}$ [M+2]$^+$, 287 $(C_{15}H_{17}N_3OS)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 58 $(C_4H_9)^+$, 43 $(C_3H_6)^{\cdot+}$.

3-{[5-(Butylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6f): Brown amorphous solid; Yield: 87 %; M.P. 83 °C; Molecular formula: $C_{15}H_{17}N_3OS$; Molecular weight: 287 gmol^{-1}; IR (KBr): v_{max}: 3220 (N-H), 2925 (C-H Ar), 1480 (C=N), 1477 (C=C Ar), 839 (C-N) and 805 (C-S); ^{1}H-NMR (500 MHz, DMSO-d_6): δ 11.02 (s, 1H, NH-1'), 7.49 (br. d, *J* = 8.0 Hz, 1H, H-4'), 7.37 (br.d, *J* = 8.5 Hz, 1H, H-7'), 7.32 (br.s, 1H, H-2'), 7.09 (t, *J* = 8.0 Hz, 1H, H-5'), 6.99 (t, *J* = 7.5 Hz, 1H, H-6'), 4.25 (s, 2H, CH_2-10'), 3.15 (t, *J* = 7.5 Hz, 2H, CH_2-1''), 1.61 (quint., *J* = 7.5 Hz, 2H, CH_2-2''), 1.31 (sext, *J* = 7.0 Hz, 2H, CH_2-3''), 0.84 (t, *J* = 7.5 Hz, 3H, CH_3-4''). EIMS: *m/z* 289 $(C_{15}H_{17}N_3OS)^{\cdot+}$ [M]$^+$, 287 $(C_{15}H_{17}N_3OS)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 58 $(C_4H_9)^+$, 42 $(C_3H_6)^{\cdot+}$.

3-{[5-(Pentylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6g): Brown amorphous solid; Yield: 78 %; M.P. 62 °C; Molecular formula: $C_{16}H_{19}N_3OS$; Molecular weight: 301 gmol^{-1}; IR (KBr): v_{max}: 3224 (N-H), 2927 (C-H Ar), 1484 (C=N), 1470 (C=C Ar), 847 (C-N) and 812 (C-S); ^{1}H-NMR (500 MHz, DMSO-d_6): δ 11.03 (s, 1H, NH-1'), 7.46 (br. d, *J* = 8.0 Hz, 1H, H-4'), 7.33 (br. d, *J* = 8.0 Hz, 1H, H-7'), 7.29 (br. s, 1H, H-2'), 7.06 (t, *J* = 7.0 Hz, 1H, H-5'), 6.96 (t, *J* = 7.5 Hz, 1H, H-6'), 4.29 (s, 2H, CH_2-10'), 3.11 (t, *J* = 7.5 Hz, 2H, CH_2-1''), 1.61 (quint., 2H, CH_2-2''), 1.38-1.17 (m, 4H, CH_2-3'', CH_2-4''), 0.79 (t, *J* = 7.0 Hz, 3H, CH_3-5''); EIMS: *m/z m/z* 303 $(C_{16}H_{19}N_3OS)^{\cdot+}$ [M+2]$^+$, 301 $(C_{16}H_{19}N_3OS)^{\cdot+}$ [M]$^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198

$(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8NO)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 71 $(C_5H_{11})^+$, 55$(C_4H_7)^{\cdot+}$.

3-{[5-(Heptylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6h): Dark brown amorphous solid; Yield: 88 %; M.P. 133 °C; Molecular formula: $C_{18}H_{23}N_3OS$; Molecular weight: 329 gmol^{-1}; IR (KBr): v_{max}: 3225 (N-H), 2931 (C-H Ar), 1480 (C=N), 1475 (C=C Ar), 845 (C-N) and 810 (C-S); ^{1}H-NMR (400 MHz, DMSO-*d$_6$*): δ 11.0 (s, 1H, NH-1'), 7.47 (br.d, *J* = 7.6 Hz, 1H, H-4'), 7.35 (br.d, *J* = 7.6 Hz, 1H, H-7'), 7.31 (br.s, 1H, H-2'), 7.09 (t, *J* = 6.8 Hz, 1H, H-5'), 6.98 (t, *J* = 7.2 Hz, 1H, H-6'), 4.17 (s, 2H, CH$_2$-10'),3.67-3.64 (m, 1H, H-1''), 2.02-1.97 (m, 4H, H-2'' & H-3''), 1.25-1.18 (m, 6H, H-4'' to H-6''), 0.82 (t, *J* = 7.2 Hz, 3H, CH$_3$-7''); EIMS: *m/z* 331 $(C_{18}H_{23}N_3OS)^{\cdot+}$ $[M+2]^+$, 329 $(C_{18}H_{23}N_3OS)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 99 $(C_7H_{14})^+$, 84 $(C_6H_{12})^{\cdot+}$, 56 $(C_4H_8)^{\cdot+}$.

3-{[5-(Allylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6i): Dark brown shiny solid; Yield: 76 %; M.P. 105 °C; Molecular formula: $C_{14}H_{14}N_3OS$; Molecular weight: 272 gmol^{-1}; IR (KBr): v_{max}: 3226 (N-H), 2933 (C-H Ar), 1481 (C=N), 1470 (C=C Ar), 843 (C-N) and 812 (C-S); ^{1}H-NMR (500 MHz, DMSO-*d$_6$*): δ 11.01 (s, 1H, NH-1'), 7.48 (br.d, *J* = 8.0 Hz, 1H, H-4'), 7.36 (br.d, *J* = 8.5 Hz, 1H, H-7'), 7.31 (br. s, 1H, H-2'), 7.08 (t, *J* = 7.5 Hz, 1H, H-5'), 6.98 (t, *J* = 8.0 Hz, 1H, H-6'), 5.90-5.80 (m, 1H, H-2''), 5.14 (dd, *J* = 17.0, 1.5 Hz, 1H, H$_b$-3''), 5.08 (dd, *J* = 10.0, 0.5 Hz, 1H, H$_a$-3''), 4.31 (s,2H, CH$_2$-10'), 3.80 (d, *J* = 6.9 Hz, 2H, CH$_2$-1''). EIMS: *m/z* 274 $(C_{14}H_{14}N_3OS)^{\cdot+}$ $[M+2]^+$, 272 $(C_{14}H_{14}N_3OS)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 41 $(C_3H_5)^+$.

3-[(5-(Ethoxycarbonylmethylsulfanyl)-1,3,4-oxadiazole-2-yl)methyl]-1*H*-indole (6j): Dark brown shiny solid; Yield: 82 %; M.P. 97 °C; Molecular formula: $C_{15}H_{15}N_3O_3S$; Molecular weight: 317 gmol^{-1}; IR (KBr): v_{max}: 3225 (N-H), 2934 (C-H Ar), 1484 (C=N), 1470 (C=C Ar), 840 (C-N) and 814 (C-S); ^{1}H-NMR (500 MHz, DMSO-*d$_6$*): δ 11.04 (s, 1H, NH-1'), 7.48 (br.d, *J* = 8.0 Hz, 1H, H-4'), 7.36 (br.d, *J* = 8.0 Hz, 1H, H-7'), 7.30 (br.s, 1H, H-2'), 7.08 (t, *J* = 7.0 Hz, 1H, H-5'), 6.98 (t, *J* = 8.0 Hz, 1H, H-6'), 4.31 (s, 2H, CH$_2$-10'), 4.12 (s, 2H, CH$_2$-1'''), 4.04 (q, *J* = 7.2 Hz, 2H, CH$_2$-1''), 1.11 (t, *J* = 7.0 Hz, 3H, CH$_3$-2''); EIMS: *m/z* 319 $(C_{15}H_{15}N_3O_3S)^{\cdot+}$ $[M+2]^+$,317 $(C_{15}H_{15}N_3O_3S)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 87 $[C_4H_7O_2]^+$, 42 $[C_2H_2O]^+$.

3-{[5-(Benzylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1*H*-indole (6k): Light brown amorphous solid; Yield: 79 %; M.P. 110 °C; Molecular formula: $C_{18}H_{15}N_3OS$; Molecular weight: 321 gmol^{-1}; IR (KBr): v_{max}: 3224 (N-H), 2928 (C-H Ar), 1486 (C=N), 1477 (C=C Ar), 838 (C-N) and 810 (C-S); ^{1}H-NMR (400 MHz, DMSO-*d$_6$*): δ 11.02 (s, 1H, NH-1'), 7.49 (br.d, *J* = 8.0 Hz, 1H, H-4'), 7.38 (br.d, *J* = 8.5 Hz, 1H, H-7'), 7.32 (br.s, 1H, H-2'), 7.28- 7.25 (m, 2H, H-2''& H-6''), 7.24- 7.19 (m, 3H, H-3'' to H-5''), 7.11 (t, *J* = 8.0 Hz, 1H, H-5'), 7.00 (t, *J* = 8.0 Hz, 1H, H-6'), 4.35 (s, 2H, CH$_2$-10'), 4.25 (s, 2H, CH$_2$-7''); EIMS: *m/z* 323 $(C_{18}H_{15}N_3OS)^{\cdot+}$ $[M+2]^+$, 321 $(C_{18}H_{15}N_3OS)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$,91 $(C_7H_7)^+$, 65 $(C_5H_5)^+$.

3-({5-[(3-Phenylethyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6l): Dark brown solid; Yield: 80 %; M.P. 75 °C; Molecular formula: $C_{19}H_{17}N_3OS$; Molecular weight: 335 gmol^{-1}; IR (KBr): v_{max}: 3215 (N-H), 2930 (C-H Ar), 1485 (C=N), 1479 (C=C Ar), 846(C-N) and 810 (C-S); ^{1}H-NMR (400 MHz, DMSO-*d$_6$*): δ 11.0 (s, 1H, NH-1'), 7.49 (br.d, *J* = 7.6 Hz, 1H, H-4'), 7.36 (br.d, *J* = 8.0 Hz, 1H, H-7'),7.33 (br.s, 1H, H-2'), 7.26-7.22 (m, 3H, H-3'', H-4'' & H-5''), 7.18-7.12 (m,2H, H-2'' & H-6''), 7.09 (t, *J* = 7.6 Hz, 1H, H-5'), 6.98 (t, *J* = 7.6 Hz, 1H, H-6'), 4.32 (s, 2H, CH$_2$-10'), 3.39 (t, *J* = 7.2 Hz, 2H, CH$_2$-8''), 2.95 (t, *J* = 7.6 Hz, 2H, CH$_2$-7''); EIMS: *m/z* 337 $(C_{19}H_{17}N_3OS)^{\cdot+}$ $[M+2]^+$, 335 $(C_{19}H_{17}N_3OS)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$,105 $(C_8H_9)^+$, 91 $(C_7H_7)^+$, 65 $(C_5H_5)^+$.

3-({5-[(3-Phenylpropyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6m): Dark brown shiny powder; Yield: 77 %; M.P. 64 °C; Molecular formula: $C_{20}H_{19}N_3OS$; Molecular weight: 349 gmol^{-1}; IR (KBr): v_{max}: 3225 (N-H), 2927 (C-H Ar), 1484 (C=N), 1476 (C=C Ar), 847 (C-N) and 812 (C-S); ^{1}H-NMR (300 MHz, DMSO-*d$_6$*): δ 11.0 (s, 1H, NH-1'), 7.47 (br.d, *J* = 7.8 Hz, 1H, H-4'), 7.35 (br.d, *J* = 7.8 Hz, 1H, H-7'), 7.31 (br.s, 1H, H-2'), 7.27-7.23 (m, 3H, H-3'', H-4'' & H-5''), 7.18-7.12 (m,2H, H-2'' & H-6''),7.08 (t, *J* = 7.2 Hz, 1H, H-5'), 6.97 (t, *J* = 6.9 Hz, 1H, H-6'), 4.31 (s, 2H, CH$_2$-10'), 3.15 (t, *J* = 7.2 Hz, 2H, CH$_2$-9''), 2.63 (t, *J* = 8.1 Hz, 2H, CH$_2$-7''), 1.94 (quint., *J* = 7.5 Hz, 2H, CH$_2$-8''); EIMS: *m/z* 351

$(C_{20}H_{19}N_3OS)^{\cdot+}$ $[M+2]^+$, 349 $(C_{20}H_{19}N_3OS)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$,119 $(C_9H_{11})^+$, 91 $(C_7H_7)^+$, 65 $(C_5H_5)^+$.

3-({5-[(2-Chlorobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6n): Dark brown amorphous solid; Yield: 83 %; M.P. 126 °C; Molecular formula: $C_{18}H_{14}N_3OSCl$; Molecular weight: 355.5 $gmol^{-1}$; IR (KBr): v_{max}: 3230 (N-H), 2929 (C-H Ar), 1480 (C=N), 1472 (C=C Ar), 8441(C-N) and 812 (C-S); ^{1}H-NMR (400 MHz, DMSO-d_6): δ 11.0 (s, 1H, NH-1'), 7.47 (br.d, J = 8.0 Hz, 1H, H-4'), 7.35 (br.d, J = 7.6 Hz, 1H, H-7'), 7.34 (br.s, 1H, H-2'),7.32 (dd, J = 1.2, 8.0 Hz, 1H, H-3''), 7.29 (br.d, J = 7.6 Hz, 1H, H-6''), 7.16-7.10 (m, 2H, H-4'' & H-5''), 7.08 (t, J = 7.2 Hz, 1H, H-5'), 6.97 (t, J = 6.8 Hz, 1H, H-6'), 4.55 (s, 2H, CH_2-7''), 4.31 (s, 2H, CH_2-10'); EIMS: *m/z* 359 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M+4]^+$, 357 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M+2]^+$, 355 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 127 $(C_7H_6Cl+2)^+$, 125 $(C_7H_6Cl)^+$, 101 $(C_5H_4Cl+2)^+$, 99 $(C_5H_4Cl)^+$, 90 $(C_7H_6)^+$, 64 $(C_5H_4)^+$.

3-({5-[(3-Chlorobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6o): Dark brown amorphous solid; Yield: 89 %; M.P. 85 °C; Molecular formula: $C_{18}H_{14}N_3OSCl$; Molecular weight: 355.5 $gmol^{-1}$; IR (KBr): v_{max}: 3219 (N-H), 2926 (C-H Ar), 1477 (C=N), 1478 (C=C Ar), 840(C-N) and 812 (C-S); ^{1}H-NMR (300 MHz, DMSO-d_6): δ 11.01 (s, 1H, NH-1'), 7.39 (br.s, 1H, H-2''), 7.36 (br.d, J = 8.6 Hz, 1H, H-4''), 7.35 (br.d, J = 7.5 Hz, 1H, H-6''), 7.33 (br.t, J = 8.1 Hz, 1H, H-5''), 7.31 (br.d, J = 7.8 Hz, 1H, H-4'), 7.30 (br.d, J = 8.1Hz, 1H, H-7'), 7.29 (br.s, 1H, H-2'), 7.11 (t, J = 7.2 Hz, 1H, H-5'), 6.97 (t, J = 7.2 Hz, 1H, H-6'), 4.54 (s, 2H, CH_2-7''), 4.30 (s, 2H, CH_2-10'); EIMS: *m/z* 359 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M+4]^+$, 357 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M+2]^+$, 355 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 127 $(C_7H_6Cl+2)^+$, 125 $(C_7H_6Cl)^+$, 101 $(C_5H_4Cl+2)^+$, 99 $(C_5H_4Cl)^+$, 90 $(C_7H_6)^+$, 64 $(C_5H_4)^+$.

3-({5-[(4-Chlorobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6p): Brown colored amorphous solid; Yield: 79 %; M.P. 121 °C; Molecular formula: $C_{18}H_{14}N_3OSCl$; Molecular weight: 355.5 $gmol^{-1}$; IR (KBr): v_{max}: 3215 (N-H), 2928 (C-H Ar), 1480 (C=N), 1470 (C=C Ar), 840(C-N) and 812 (C-S); ^{1}H-NMR (300 MHz, DMSO-d_6): δ11.01 (s, 1H, NH-1'), 7.49 (br.d, J = 7.8 Hz, 1H, H-4'), 7.42 (br.d, J = 7.2 Hz, 1H, H-7'), 7.37 (br.d, J = 8.4 Hz, 2H, H-2''& H-6''), 7.35 (br.s, 1H, H-2'), 7.30 (br.d, J = 8.4 Hz, 2H, H-3'' & H-5''), 7.09 (t, J = 6.9 Hz, 1H, H-5'), 6.98 (t, J = 7.2 Hz, 1H, H-6'), 4.55 (s, 2H, CH_2-7''), 4.31 (s, 2H, CH_2-10'); EIMS: *m/z* 359 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M+4]^+$, 357 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M+2]^+$, 355 $(C_{18}H_{14}N_3OSCl)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 127 $(C_7H_6Cl+2)^+$, 125 $(C_7H_6Cl)^+$, 101 $(C_5H_4Cl+2)^+$, 99 $(C_5H_4Cl)^+$, 90 $(C_7H_6)^+$, 64 $(C_5H_4)^+$.

3-({5-[(2-Bromobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6q): Light brown amorphous solid; Yield: 85 %; M.P. 133 °C; Molecular formula: $C_{18}H_{14}N_3OSBr$; Molecular weight: 399 $gmol^{-1}$; IR (KBr): v_{max}: 3217 (N-H), 2935 (C-H Ar), 1479 (C=N), 1481 (C=C Ar), 846 (C-N) and 816 (C-S); ^{1}H-NMR (400 MHz, DMSO-d_6): δ 11.02 (s, 1H, NH-1'), 7.47 (br.d, J = 7.6 Hz, 1H, H-4'), 7.35 (br.d, J = 7.6 Hz, 1H, H-7'), 7.31 (br.s, 1H, H-2'), 7.29 (dd, J = 1.2, 8.0 Hz, 1H, H-3''), 7.28 (br.d, J = 7.6 Hz, 1H, H-6''), 7.11-7.09 (m, 2H, H-4'' & H-5''), 7.07 (t, J = 7.2 Hz, 1H, H-5'), 6.96 (t, J = 7.6 Hz, 1H, H-6'), 4.55 (s, 2H, CH_2-7''), 4.29 (s, 2H, CH_2-10'); EIMS: *m/z* 403 $(C_{18}H_{14}N_3OSBr)^{\cdot+}$ $[M+4]^+$, 401 $(C_{18}H_{14}N_3OSBr)^{\cdot+}$ $[M+2]^+$, 399 $(C_{18}H_{14}N_3OSBr)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 171 $(C_7H_6Br+2)^+$,169 $(C_7H_6Br)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 90 $(C_7H_6)^+$, 145 $(C_5H_4Br+2)^+$,143 $(C_5H_4Br)^+$, 64 $(C_5H_4)^+$.

3-({5-[(4-Bromobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6r): Light brown amorphous solid; Yield: 86 %; M.P. 130 °C; Molecular formula: $C_{18}H_{14}N_3OSBr$; Molecular weight: 400 $gmol^{-1}$; IR (KBr): v_{max}: 3215 (N-H), 2927 (C-H Ar), 1484 (C=N), 1478 (C=C Ar), 848(C-N) and 812 (C-S); ^{1}H-NMR (300 MHz, DMSO-d_6): δ 11.0 (s, 1H, N-H-1'), 7.45 (br.d, J = 7.8, 1H, H-4'), 7.38-7.36 (m, 3H, H-2'', H-6'' & H-7'), 7.33 (br.s, 1H, H-2'), 7.17 (br.d, J = 8.4 Hz, 2H, H-3'' & H-5''), 7.09 (t, J = 6.9 Hz, 1H, H-5'), 6.98 (t, J = 7.2 Hz, 1H, H-6'), 4.35 (s, 2H, CH_2-7''), 4.31 (s, 2H, CH_2-10'); EIMS: *m/z* 403 $(C_{18}H_{14}N_3OSBr)^{\cdot+}$ $[M+4]^+$, 401 $(C_{18}H_{14}N_3OSBr)^{\cdot+}$ $[M+2]^+$, 399 $(C_{18}H_{14}N_3OSBr)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 171 $(C_7H_6Br+2)^+$,169 $(C_7H_6Br)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 90 $(C_7H_6)^+$, 145 $(C_5H_4Br+2)^+$,143 $(C_5H_4Br)^+$, 64 $(C_5H_4)^+$.

3-({5-[(4-Fluorobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6s): Brown amorphous solid; Yield: 90 %; M.P. 84 °C; Molecular formula: $C_{18}H_{14}N_3OSF$; Molecular weight: 339 $gmol^{-1}$; IR (KBr): v_{max}: 3245 (N-H), 2932 (C-H Ar), 1485 (C=N), 1480 (C=C Ar), 850 (C-N) and 825 (C-S); ^{1}H-NMR (400 MHz, DMSO-d_6): δ 11.0 (s, 1H, N-H-1'), 7.51 (br.d, J = 7.4 Hz, 1H, H-4'), 7.38 (br.s, 1H, H-7'), 7.37 (dist. dd, $J_{(a,b\&a,\ ^{19}F)}$ = 8.8, 5.6 Hz, 2H_b, H-2'' & H-6''),7.35 (br.d, J = 8.0 Hz, 1H, H-2'), 7.09 (t, J = 6.9 Hz, 1H, H-5'), 7.00 (t, $J_{(b,a\&b,\ ^{19}F)}$ = 8.8 Hz, 2H_a, H-3'' & H-5''), 6.98 (t, J = 7.2 Hz, 1H, H-6'), 4.55 (s, 2H, CH_2-7''), 4.31 (s, 2H, CH_2-10'); EIMS: *m/z* 341 $(C_{18}H_{14}N_3OSF\ )^{\cdot+}$ $[M+2]^+$, 339 $(C_{18}H_{14}N_3OSF\ )^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$, 109 $(C_7H_6F)^+$, 90 $(C_7H_6)^+$, 83 $(C_5H_4F)^+$. 64 $(C_5H_4)^+$.

3-({5-[(2-Methylbenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6t): Light brown amorphous solid; Yield: 73 %; M.P. 126 °C; Molecular formula: $C_{19}H_{17}N_3OS$; Molecular weight: 335 $gmol^{-1}$; IR (KBr): v_{max}: 3245 (N-H), 2930 (C-H Ar), 1480 (C=N), 1470 (C=C Ar), 840 (C-N) and 810 (C-S); 1H-NMR (400 MHz, DMSO-d_6): δ 11.0 (s, 1H, NH-1'), 7.48 (d, J = 8.0 Hz, 1H, H-4'), 7.36 (d, J = 8.0 Hz, 1H, H-7'), 7.31 (br.s, 1H, H-2'), 7.14-7.12 (m, 3H, H-3'', H-4'' & H-5''), 7.09 (t, J = 8.0 Hz, 1H, H-5'), 7.00 (t, J = 7.8 Hz, 1H, H-6'),6.97 (d, J=4.8Hz, 1H, H-6''), 4.41 (s, 2H, CH_2-10'), 4.32 (s, 2H, CH_2-7''), 2.29 (s, 3H, CH_3-2''); EIMS: *m/z* 337 $(C_{19}H_{17}N_3OS)^{\cdot+}$ $[M+2]^+$, 335 $(C_{19}H_{17}N_3OS)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 130 $(C_9H_8N)^+$,105 $(C_8H_9)^+$, 90 $(C_7H)^+$, 79 $(C_6H_7)^+$, 64 $(C_5H_4)^+$.

3-({5-[(3-Nitrobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1*H*-indole (6u): Dark brown amorphous solid; Yield: 78 %; M.P. 101 °C; Molecular formula: $C_{18}H_{14}N_3OS$; Molecular weight: 366 $gmol^{-1}$; IR (KBr): v_{max}: 3240 (N-H), 2931 (C-H Ar), 1480 (C=N), 1475 (C=C Ar), 845 (C-N) and 820 (C-S); ^{1}H-NMR (300 MHz, DMSO-d_6): δ11.0 (s, 1H, N-H-1'), 8.30 (br.s, 1H, H-2''), 8.08 (d, J = 8.1 Hz, 1H, H-4''), 7.72 (br.d, J = 7.5 Hz, 1H, H-6''), 7.49 (br.d, J = 7.8 Hz, 1H, H-4'), 7.44 (br.t, J = 7.8 Hz, 1H, H-5''), 7.35 (br.d, J = 8.1 Hz, 1H, H-7'), 7.30 (br.s, 1H, H-2'), 7.07 (t, J = 6.9 Hz, 1H, H-5'), 6.96 (t, J = 7.2 Hz, 1H, H-6'), 4.55 (s, 2H, CH_2-7''), 4.29 (s, 2H, CH_2-10'); EIMS: *m/z* 368 $(C_{18}H_{14}N_4O_3S)^{\cdot+}$ $[M+2]^+$, 366 $(C_{18}H_{14}N_4O_3S)^{\cdot+}$ $[M]^+$, 233 $(C_{11}H_9N_3OS+2)^+$, 231 $(C_{11}H_9N_3OS)^+$, 198 $(C_{11}H_8N_3O)^+$, 172 $(C_{10}H_8N_2O)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$, 156 $(C_{10}H_8N_2)^{\cdot+}$, 136 $(C_7H_6NO_{2)}^+$,130 $(C_9H_8N)^+$, 110 $(C_6H_4NO_{2)}^+$, 64 $(C_5H_4)^+$.

DISCUSSION

In Figures 1 and 2, the ^{1}H-NMR spectra of the compounds 3-{[5-(Allylsulfanyl)-1,3,4-oxadiazol-2-yl]methyl}-1H-indole (**6i**) and 3-[(5-(Ethoxycarbonylmethylsulfanyl)-1,3,4-oxadiazole-2-yl)methyl]-1H-indole (**6j**) are provided. The compound **6u** was obtained as a dark brown amorphous solid; yield: 78 % and m. p. 101 °C and the molecular formula $C_{18}H_{14}N_3OS$ was ascertained by counting the number of protons in the ^{1}H-NMR spectrum and EIMS molecular ion peak at *m/z* 366. Infrared spectrum demonstrated N-H stretching at 3240 cm^{-1} and aromatic C-H stretching at 2931 cm^{-1}. C=N stretching was observed at 1480 cm^{-1} and aromatic C=C stretching at1475 cm^{-1}. C-N gave stretching at 845 cm^{-1} and C-S at stretching at 820 cm^{-1}. In the aromatic region of 1H-NMR spectrum, a broad singlet at δ 8.30 (s,1H, H-2''), two doublets and one triplet at δ 8.08 (d, J = 8.1 Hz, 1H, H-4''), 7.72 (d, J = 7.5 Hz, 1H, H-6'') and 7.44 (t, J = 7.8 Hz, 1H, H-5'') acquiring deshielded position due to the vicinity of an electron withdrawing nitro group which confirmed the substitution of 3-nitrobenzyl group on the parent indole-bearing oxadiazole molecule (**4**). Another set of two doublets appeared at δ 7.49 (J = 7.8 Hz, 1H, H-4') and 7.35 (J = 8.1 Hz, 1H, H-7') having an integration of one proton each for H-4' & H-7' of the indole moiety. A broad singlet of one proton appeared at δ 7.30 (1H, H-2') of indole moiety. Two triplets resonated at δ 7.07 (J = 6.9 Hz, 1H, H-5') and δ 6.96 (J = 7.2 Hz, 1H, H-6') belonging to phenyl ring of indole moiety. In the aliphatic region, a sharp singlet appeared at δ 4.55, a contributor of two methylene protons at C-7'', which confirms the attachment of 3-Nitrobenzyl group at the thiol position of 1,3,4-oxadizole ring. Another singlet appeared slightly up-field with integration of two protons of C-10' at δ 4.29 (2H, CH_2-10'). EIMS data further supported this structure by revealing base peak at *m/z* 130 for $(C9H8N)^+$ and other major fragments at *m/z* 231$(C_{11}H_9N_3OS)^+$,156 $(C_{10}H_8N_2)^{\cdot+}$, 172 $(C_{10}H_8NO)^+$, 170 $(C_{10}H_8N_3)^+$, 158 $(C_{10}H_8NO)^+$ for indole moiety. Fragments of 3-Nitrobenzyl substituent were observed at *m/z* 136 $(C_7H_6NO_2)^+$, 110 $(C_6H_4NO_2)^+$, 64 $(C_5H_4)^+$. On the basis of these features, the structure of compound **6u** was given as 3-({5-[(3-nitrobenzyl)sulfanyl]-1,3,4-oxadiazol-2-yl}methyl)-1H-indole. Similarly, the structures of other S-alkylated/aralkylated 2-(1H-indole-3-ylmethyl)-1,3,4-oxadiazole-5-thiols were also characterized by spectroscopic techniques.

CONCLUSION

All the synthesized compounds (**6a-6u**) were obtained in good yields and their structures were elucidated by IR, ^{1}H-NMR, and EI-MS spectral analysis. It is hoped that further studies on possible biological activities of these compounds might produce useful results for the pharmaceutical industries.

DECLARATIONS

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

The authors declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by them.

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