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A Facile Synthesis of Biologically Significant 2-(1,3-benzothiazol-2-ylimino)-1,3-thiazolidin-4-one / 3-(1,3-benzothiazol-2-yl)-2-thioxoimidazolidin-4-one Analogues from 1-(1,3-benzothiazol-2-yl)thiourea and their Alpha-hydroxylamine Derivatives

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Abstract: In the present study, a series of 2-(2-{2-(Benzothiazol-2-ylimino)-5-[3-(4-substituted-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-4-oxo-thiazolidin-3-yl}-ethoxy)-isoindole-1,3-dione **(6a-d)** and 2-{2-[1-Benzothiazol-2-yl-4-(1H-indol-3-ylmethylene)-5-oxo-4,5-dihydro-1H-imidazol-2-ylsulfanyl]-ethoxy}-isoindole-1,3-dione **(9)** have been designed and synthesized starting from 2-amino-benzothiazole using appropriate synthetic routes. Structures of all the newly constructed compounds were corroborated by the elemental, spectral data (FT-IR, NMR, & Mass) and chemical tests. These compounds were subjected to their *in-vitro* antibacterial, antifungal activity against a panel of pathogenic strains of bacteria and fungi. Some of the compounds were found to be equipotent or more potent than the reference antibiotics.

Keywords: Antimicrobial activity, Benzothiazole, Thiazolidinone, Pyrazole, Ethoxyphthalimide.

Introduction

Nitrogen and sulfur containing scaffolds have played a crucial part in the history of heterocyclic chemistry and also been extensively used as important synthons in organic synthesis. In the last few years many researchers have reported on N/S regioselective nucleophilic completion in the synthesis of heterocyclic derivatives by intermolecular cyclisation reactions. A small change in reaction conditions might favour N-attack or S-attack to afford different cyclic compounds from the same reaction precursor. Thiourea as is versatile synthetic intermediate for the synthesis of different heterocyclic moieties like thiazolidinone, thiohydantoin etc. The benzothiazole derivatives have gathered a curious attention because of their abundant biological and pharmacological applications such as anticonvulsant,[1] antitumor,[2] anti-inflammatory,[3] antitubercular[4], Hypoglycemic [5] activities, and also act as chemo sensitizers in chemotherapy and neuroprotectant-cerebral antischemic agents [6]. Similarly, thiazolidinone derivatives are well known for their biological activities, such as anti-inflammatory,[7] antitubercular,[8] antibacterial,[9] antihistaminic,[10] antifungal,[11] anti-HIV,[12] anticonvulsant[13] and cardiovascular[14] etc. Furthermore, pyrazole framework plays an essential role in biologically active compounds and therefore represents an interesting template for combinatorial as well as medicinal chemistry. Substituted pyrazolone derivatives are reported to possess kinase inhibitory properties, particularly of enzymes that catalyze the

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phosphorylation of serine and threonine in proteins. Therefore, an inhibitor of these protein kinases can be developed as a drug candidate for treating diseases related to these enzymes, such as rheumatoid arthritis, psoriasis, septic shock, bone loss, cancers, and other proliferative diseases [15]. In addition, some pyrazoles are recognized as COX-I, COX-II and human lipooxygenase inhibitors [16]. Heterocyclic ring attached to ethoxyphthalimide functionality have been reported to their antimicrobial [17-21], anti-malarial [22], and anti-inflammatory [23] activities.

In view of these findings and in continuation of our interest in the synthesis of new alpha-hydroxylamine containing heterocyclic framework, the plan was to design and synthesize a new class of combinational molecule in which all of the above moieties are present with the hope to achieve enhanced pharmacological activity.

Results and discussion

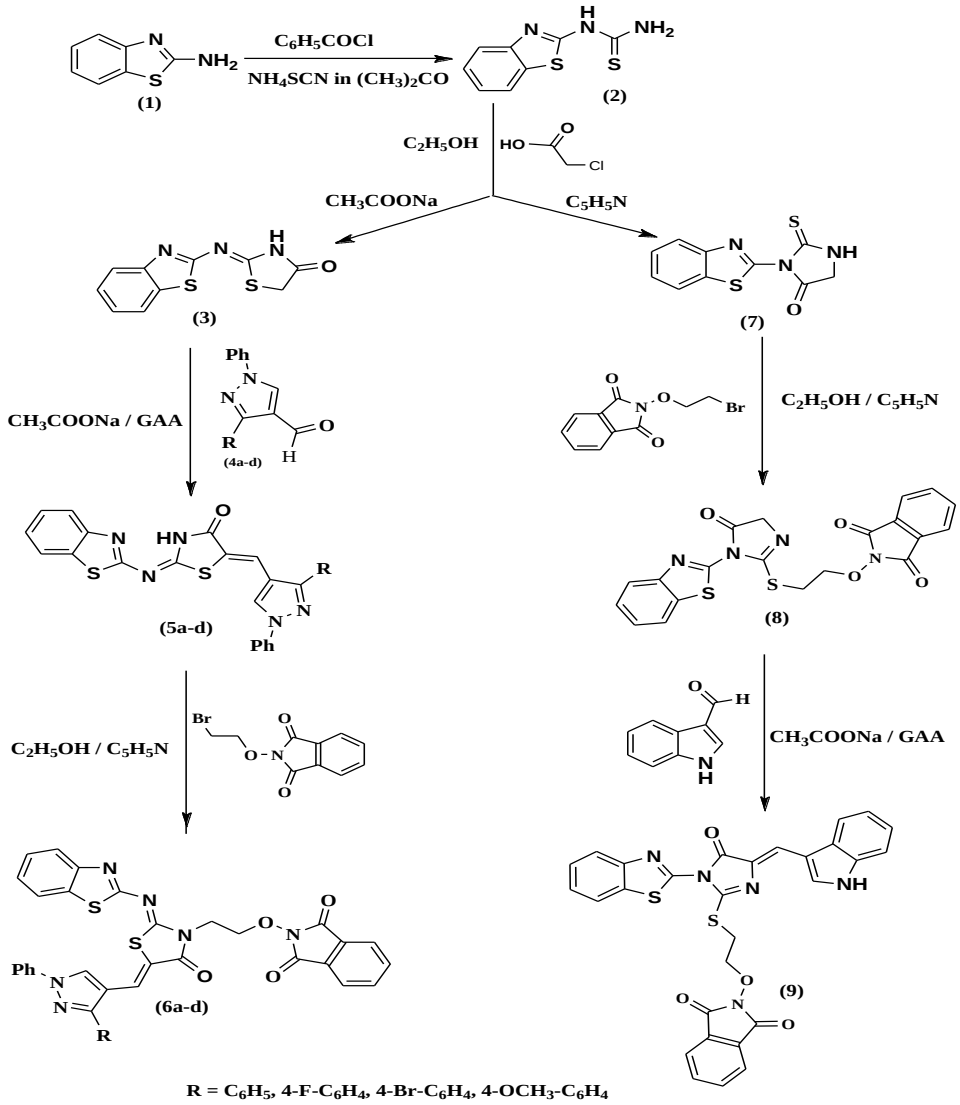
The synthetic pathways used to synthesize the unreported title compounds **6a-d** and **9** are illustrated in Scheme 1. 2-aminobenzothiazole **(1)** on reacting with benzoyl thiocyanate and hydrolyzing the product with NaOH gave corresponding thiocarbamide **(2)** in 72 % yield. In first pathway, the required (2*Z*)-2-(1,3-benzothiazol-2-ylimino)-1,3-thiazolidin-4-one **(3)** was prepared by the condensation of 1-(1,3-benzothiazol-2-yl)thiourea with chloroacetic acid in ethanol containing anhydrous sodium acetate. Formation of this compound was assigned on the basis of spectral data at 1692 cm^{-1} due to imide carbonyl group in IR and two singlets at 9.12, 4.34 δ due to NH and CH_2 groups of thiazolidinone respectively, in ^{1}H NMR spectrum. Compound **(3)** on condensation with various 3-(4-substituted-phenyl)-1-phenyl-1*H*-pyrazole-4-carbaldehydes **(4a-d)** in acetic acid media in the presence of anhydrous sodium acetate gave compounds **(5a-d).** Formation of products was confirmed by disappearance of the IR band at 2950 cm^{-1} and ^{1}H NMR signals at 4.34 δ (singlet) for the CH_2 group of thiazolidinone nucleus in **3** and appearance of new ^{1}H NMR signal at 6.37 δ of C=CH (chalcone) in **5a.** Further replacement of reactive hydrogen takes place by nucleophilic substitution of ethoxyphthalimide group in the presence of pyridine in ethanol media using bromoethoxyphthalimde **(1)** to obtain final product **6a**. It was confirmed by appearance of band at 1365 cm^{-1} for N-O group in IR and two new triplets at 3.28, 3.75 δ for N-CH_2 and O-CH_2 of ethoxyphthalimide moiety in ^{1}H-NMR spectrum. In another pathway, 3-(1,3-benzothiazol-2-yl)-2-thioxoimidazolidin-4-one **(7)** was obtained by the condensation of 1-(1,3-benzothiazol-2-yl)thiourea with chloroacetic acid in the presence of pyridine. Structure of this compound was confirmed by appearance of two bands at 1212 and 1705 cm^{-1} attributed to C=S and C=O groups in IR. While the new signals appeared at 10.13, 4.16 δ due to NH and $COCH_2$ groups of thiohydantoin in ^{1}H NMR. Subsequently, compound condensed with bromoethoxyphthalimide gave product **8**. Formation of this product was confirmed by appearance of band at 1342 cm^{-1} for N-O group in IR and two new triplets at 3.60, 3.93 δ for S-CH_2 and O-CH_2 respectively, of ethoxyphthalimide moiety in ^{1}H NMR. It was further converted into their chalcone derivative (**9)** by reaction with 1*H*-indole-3-carbaldehyde. The presence a strong band at 3382 cm^{-1} due to NH group in IR and two new signals at 6.62, 8.87 δ attributed to -C=CH- and NH (indole) in ^{1}H NMR confirmed the formation of compound **9**. The synthesized compounds have also been characterized by their mass spectral and elemental analysis studies. Addition confirmation of ethoxyphthalimide group attachment was done by usual chemical test including fluorescence formation.

Pharmacology:

In-vitro antimicrobial screening:

The synthesized compounds **6a-d**, **7a-d**, **8**, and **9** have been studied for their antibacterial activity against 2 gram positive bacteria (*Staphylococcs aureus* **MTCC 96**, *Streptococcus pyogenes* **MTCC 443**) and 2 gram negative bacteria (*Escherichia coli* **MTCC 442**, *Pseudomonas aeruginosa* **MTCC 441**) by using 'Ampicillin' as standard antibacterial drug. Antifungal activity was also studied against three fungal species (*Candida albicans* **MTCC 227**, *Aspergillus niger* **MTCC 282**, and *Aspergillus clavatus* **MTCC 1323**) where 'Griseofulvin' were used as the standard antifungal drug. The minimal inhibitory concentration (MICs μg/mL) of the synthesized compounds was determined by the broth micro-dilution method according to National Committee for Clinical Laboratory Standards. Most of the compounds have shown appreciable antibacterial and antifungal activity against all pathogenic strains.

The outcome of this investigation is presented in tabular form in Table **1**.



Scheme 1. Synthesis of ethoxyphthalimide derivatized compounds **6a-d**, **8** and **9**

Table 1: *In-vitro* antimicrobial activity (MICs μg/mL) of the synthesized compounds **5a-d**, **6a-d**, **8** and **9**.

Comp.	Antibacterial activity				Antifungal activity		
	Gram +ve		Gram –ve				
	S.aureus **MTCC *96***	*S.pyogenes* **MTCC 443**	*E.coli* **MTCC 442**	*P.aeruginosa* **MTCC 441**	*C.albicans* **MTCC 227**	*A.niger* **MTCC 282**	*A.clavatus* **MTCC 1323**
5a	500	1000	500	**200**	1000	125	200
5b	**200**	**100**	1000	**200**	1000	200	>1000
5c	1000	125	>1000	**500**	**500**	1000	200
5d	>1000	200	250	**1000**	>1000	125	500

6a	500	500	125	**500**	1000	200	**100**
6b	**250**	**100**	200	**250**	**250**	250	**100**
6c	**200**	**62.5**	500	**100**	**200**	**100**	250
6d	**250**	125	**100**	**125**	**500**	125	**100**
8	500	200	250	**250**	**250**	200	200
9	**200**	125	**100**	**200**	**500**	**100**	125
STD_1	250	100	100	---	-	-	-
STD_2	-	-	-	-	500	100	100

STD_1 = Ampicillin, **STD_2** = Griseofulvin
MICs (μg/mL) value in bold letters indicate that the synthesized compounds are comparatively active as standard drugs.

Conclusion

In this paper, a series of hybrid molecules consisting of benzothiazole, thiazolidinone, pyrazole, indole and ethoxyphthalimide were synthesized, characterized and studied for their biological activity with the aim of discovering innovative structure leads serving as potent antibacterial, antifungal agents. Out of ten compounds screened five compounds i.e. **5b**, **6b**, **6c**, **6d**, and **9** showed good antimicrobial activity against most of bacterial and fungal strains when compared to standard drugs and they can be developed as potent chemotherapeutic agents. Our ongoing research focuses on the same molecular combinations with incorporation of more effective substituents in search of new bioactive agents.

Experimental

Material and methods:

All chemicals were commercially procured and were used without further purification. Melting points were determined in open capillary tube and are therefore uncorrected. Purity of synthesized compounds was checked by TLC using silica gel-G plates, n-hexane - ethyl acetate as developing solvent and the spots were exposed in an UV light or iodine chamber. FT-IR spectra were recorded with a Perkin-Elmer BX spectrum on KBr pellets and NMR were recorded on a Bruker DRX-400 MHz spectrometer with DMSO as solvent using TMS as an internal standard. The mass spectrum was recorded on Joel SX-102/DA-600-mass spectrometer and elemental analysis was carried out using Heraus C, H, and N rapid analyzer. Compounds **(4a-d)** and bromoethoxyphthalimide have been prepared by reported method [23, 24]. 1,3-benzothiazol-2-amine and 1*H*-indole-3-carbaldehyde have been purchased by commercial resources.

*Synthesis of 1-(1,3-benzothiazol-2-yl)thiourea **2**:*

A solution of ammonium thiocyanate (9 g) in acetone (50 ml) was taken inside a three necked flask provided with a reflux condenser, a dropping funnel and mechanical stirrer. Benzoyl chloride (13 ml) was added dropwise with stirring. A solution of 2-aminobenzothiazole (0.1 mol) in acetone (50 ml) was added dropwise so that the solution was refluxed at its own temperature. The whole reaction mixture was poured into cold water (800 ml) and the resulting precipitate was filtered off and hydrolyzed boiling with solution of NaOH (25 g) in water (250 ml). It was filtered and the filterate was acidified with conc. HCl. The solid was obtained was filtered, dried, and recrystalized from ethanol.

IR (ν_{max}, cm^{-1}): 3389 (NH_2), 3302 (NH), 3015 (ArH), 1665 (C=N), 1540, 1505 (C=C), 1264 (C-N), 1210 (C=S); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.10- 7.22(4H, m, ArH), 7.68 (s, 1H, NH), 4.29 (s, 2H, NH_2).

*Synthesis of (2Z)-2-(1,3-benzothiazol-2-ylimino)-1,3-thiazolidin-4-one **3**:*

A mixture of compound 2 (0.02 mol), monochloroacetic acid (0.02 mol) and anhydrous sodium acetate (0.02mol) refluxed in ethanol (25ml) for 6-7 h. Excess of solvent was removed by reduced pressure and residue was treated with water. The solid obtained was filtered, washed several time with hot water, dried and recrystallized from abs. alcohol.

IR (ν_{max}, cm^{-1}): 3347 (NH), 3032 (ArH), 2950 (CH_2) 1690 (C=O), 1652 (C=N), 1522, 1515 (C=C), 1228 (C-N); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.12- 7.24

(4H, m, ArH), 9.12 (s, 1H, CONH), 4.34 (s, 2H, CH_2); MS *m/z* 249 [M^+].

*Synthesis of compound **5a**:*

Compound **3** (0.01 mol), glacial acetic acid 30ml, fused sodium acetate (0.01 mol) and compound **4a** (0.01 mol) were refluxed for 7 h. After cooling, reaction mixture was slowly poured into crushed ice and yellow solid obtained was filtered and washed with ethanol. The crude solid mass was recrystallized from glacial acetic acid. Other derivative **(5b-d)** were also prepared by similarly method with some changes in reflux time and reaction work up.

*2-(Benzothiazol-2-ylimino)-5-(1,3-diphenyl-1H-pyrazol-4-ylmethylene)-thiazolidin-4-one **5a**:*

IR (ν_{max}, cm^{-1}): 3359 (NH), 3036 (ArH), 1692 (C=O), 1643 (C=N), 1525, 1512 (C=C), 1226 (C-N); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.14- 7.43 (13H, m, ArH), 9.05 (s, 1H, CONH), 6.37 (s, 1H, C=CH-), 8.52 (s, 1H, C=CH pyrazole); MS *m/z* 479 [M^+].

*2-(Benzothiazol-2-ylimino)-5-[3-(4-fluoro-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-thiazolidin-4-one **5b**:*

IR (ν_{max}, cm^{-1}): 3365 (NH), 3010 (ArH), 1695 (C=O), 1625 (C=N), 1540, 1522 (C=C), 1222 (C-N); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.15- 7.47 (12H, m, ArH), 9.01 (s, 1H, CONH), 6.34 (s, 1H, C=CH), 8.49 (s, 1H, C=CH pyrazole); MS *m/z* 497 [M^+].

*2-(Benzothiazol-2-ylimino)-5-[3-(4-bromo-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-thiazolidin-4-one **5c**:*

IR (ν_{max}, cm^{-1}): 3349 (NH), 3052 (ArH), 1685 (C=O), 1638 (C=N), 1535, 1509 (C=C), 1228 (C-N); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.11- 7.49 (12H, m, ArH), 8.99 (s, 1H, CONH), 6.38 (s, 1H, C=CH), 8.44 (s, 1H, C=CH pyrazole); MS *m/z* 558 [M^+].

*2-(Benzothiazol-2-ylimino)-5-[3-(4-methoxy-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-thiazolidin-4-one **5d**:*

IR (ν_{max}, cm^{-1}): 3385 (NH), 3031 (ArH), 1688 (C=O), 1640 (C=N), 1525, 1507 (C=C), 1235 (C-N); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.10- 7.52 (12H, m, ArH), 8.95 (s, 1H, CON**H**), 6.31 (s, 1H, C=CH), 8.32 (s, 1H, C=CH pyrazole), 3.59 (s, 3H, OCH_3); MS *m/z* 509 [M^+].

*Synthesis of compound **6a**:*

Compound **5a** (0.01 mol) was dissolved in ethanol (25 ml) and bromoethoxyphthalimide (0.01 mol) was added to it with while constant stirring pyridine (0.05 mol). Reaction mixture was refluxed for 12 h. It was filtered and poured in crushed ice; solid separated, was filtered, dried and recrystallized from ethanol. Other derivative **(6b-d)** were also prepared by similarly method with some changes in reflux time and reaction work up.

*2-(2-{2-(Benzothiazol-2-ylimino)-5-[1,3-dipheny-1H-pyrazol-4-ylmethylene]-4-oxo-thiazolidin-3-yl}-ethoxy)-isoindole-1,3-dione **6a**:*

IR (ν_{max}, cm^{-1}): 3030 (Ar-H), 2895 (CH_2), 1680 (C=O), 1695 (CO-N-CO), 1627 (C=N), 1521 (C=C,), 1365 (N-O), 1246 (C-N), 1053 (C-O); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.24- 7.69 (17H, m, ArH), 6.38 (s, 1H, C=CH), 8.50 (s, 1H, C=CH pyrazole), 3.75 (t, 2H, OCH_2), 3.28 (t, 2H, NCH_2); MS *m/z* 668 [M^+].

*2-(2-{2-(Benzothiazol-2-ylimino)-5-[3-(4-fluoro-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-4-oxo-thiazolidin-3-yl}-ethoxy)-isoindole-1,3-dione **6b**:*

IR (ν_{max}, cm^{-1}): 3035 (Ar-H), 2889 (CH_2), 1685 (C=O), 1698 (CO-N-CO), 1628 (C=N), 1529 (C=C,), 1352 (N-O), 1241 (C-N), 1056 (C-O); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.23- 7.72 (16H, m, ArH), 6.32 (s, 1H, C=CH), 8.52 (s, 1H, C=CH pyrazole), 3.76 (t, 2H, OCH_2), 3.26 (t, 2H, NCH_2); MS *m/z* 686 [M^+].

*2-(2-{2-(Benzothiazol-2-ylimino)-5-[3-(4-bromo-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-4-oxo-thiazolidin-3-yl}-ethoxy)-isoindole-1,3-dione **6c**:*

IR (ν_{max}, cm^{-1}): 3012 (Ar-H), 2896 (CH_2), 1684 (C=O), 1696 (CO-N-CO), 1635 (C=N), 1542 (C=C,), 1358 (N-O), 1238 (C-N), 1050 (C-O); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.20- 7.75 (16H, m, ArH), 6.39 (s, 1H, C=CH), 8.54 (s, 1H, C=CH pyrazole), 3.75 (t, 2H, OCH_2), 3.23 (t, 2H, NCH_2); MS *m/z* 747 [M^+].

*2-(2-{2-(Benzothiazol-2-ylimino)-5-[3-(4-methoxy-phenyl)-1-phenyl-1H-pyrazol-4-ylmethylene]-4-oxo-thiazolidin-3-yl}-ethoxy)-isoindole-1,3-dione **6d**:*

IR (ν_{max}, cm^{-1}): 3028 (Ar-H), 2905 (CH_2), 1680 (C=O), 1694 (CO-N-CO), 1622 (C=N), 1532 (C=C,), 1360 (N-O), 1220 (C-N), 1046 (C-O); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.18- 7.64 (16H, m, ArH), 6.37 (s, 1H, C=CH), 8.35 (s, 1H, C=CH pyrazole), 3.72 (t, 2H, OCH_2), 3.49 (s, 3H, OCH_3) 3.28 (t, 2H, NCH_2); MS *m/z* 698 [M^+].

*Synthesis of 3-(1,3-benzothiazol-2-yl)-2-thioxoimidazolidin-4-one **7**:*

An equimolar mixture of compound **1** (0.01 mol) and monochloroacetic acid (0.01 mol) in pyridine (20 ml) was warmed gently till the exothermic reaction started. After cooling the reaction mixture was treated with ethanol (15 ml) and refluxed for 7 h, poured into ice water, filtered, dried, and recrystallized from ethanol.

IR (ν_{max}, cm^{-1}): 3345 (NH), 3025 (ArH), 2935 (CH_2), 1705 (C=O), 1645 (C=N), 1535, 1520 (C=C), 1231 (C-N), 1212 (C=S); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.09- 7.18 (4H, m, ArH), 10.13 (s, 1H, NH), 4.16 (s, 2H, CH_2); MS *m/z* 249 [M^+].

*Synthesis of 2-(2-{[1-(1,3-benzothiazol-2-yl)-5-oxo-4,5-dihydro-1H-imidazol-2-yl]sulfanyl}ethoxy)-1H-isoindole-1,3(2H)-dione **8**:*

Compound **7** (0.01 mol) and Bromoethoxyphthalimide (0.01 mol) were dissolved in absolute alcohol (25 mL). Pyridine was added to this solution as a base. The reaction mixtue was refluxed for 12 h in a round bottom flask. Excess of solvent was distilled of under reduced pressure .The reaction mixture was cooled to room temperature and poured into crushed ice. Products were filtered, washed with cold water, dried and recrystallized from ethanol**.**

IR (ν_{max}, cm^{-1}): 3027 (ArH), 1694 (CO-N-CO), 1633 (C=N), 1545, 1528 (C=C), 1342 (N-O), 1232 (C-N), 685 (C-S); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 6.98- 7.35 (8H, m, ArH), 3.93 (t, 2H, OCH_2), 3.60 (t, 2H, SCH_2); 3.52 (s, 2H, CH_2 thiohydantoin); MS *m/z* 438 [M^+].

*Synthesis of 2-{2-[1-Benzothiazol-2-yl-4-(1H-indol-3-ylmethylene)-5-oxo-4,5-dihydro-1H-imidazol-2-ylsulfanyl]-ethoxy}-isoindole-1,3-dione **9**:*

Compound **8** (0.01 mol), glacial acetic acid 25 ml, anhydrous sodium acetate (0.01 mol) and 1*H*-indole-3-carbaldehyde (0.01 mol) were refluxed for 5 h. After cooling, reaction mixture was slowly poured into crushed ice. The solid obtained was filtered and washed with ethanol and recrystallized from glacial acetic acid.

The physical and analytical properties of all synthesized compounds presented in Table **2**.

IR (ν_{max}, cm^{-1}): 3382 (NH), 3015 (ArH), 1696 (CO-N-CO), 1633 (C=N), 1536, 1521 (C=C), 1346 (N-O), 1238 (C-N), 679 (C-S); ^{1}H-NMR (400 MHz, DMSO, ppm): δ 7.01- 7.72 (12H, m, ArH), 8.87 (s, 1H, NH indole), 6.62 (s, 1H, CH chalcone), 3.91 (t, 2H, OCH_2), 3.59 (t, 2H, SCH_2); 3.50 (s, 2H, CH_2 thiohydantoin); MS *m/z* 565 [M^+].

Table 2: The physical and analytical properties of synthesized compounds **2-9**.

Comp.	Mol. formula	Mol. wt.	R	mp °C	Yield (%)	(%) of C Found/cal.	(%) H Found/cal.	(%) of N Found/cal.
2	$C_8H_7N_3S_2$	209	-	225	72	45.97/45.91	3.45/3.37	19.97/20.08
3	$C_{10}H_7N_3OS_2$	249	-	210	70	48.10/48.18	2.86/2.83	16.78/16.85
5a	$C_{26}H_{17}N_5OS_2$	479	C_6H_5	166	68	65.05/65.12	3.65/3.57	14.02/14.08
5b	$C_{26}H_{16}FN_5OS_2$	497	4-F-C_6H_5	185	69	62.72/62.76	3.33/3.24	14.16/14.08
5c	$C_{26}H_{16}BrN_5OS_2$	558	4-Br-C_6H_5	160	71	55.98/55.92	2.97/2.89	12.48/12.54
5d	$C_{27}H_{19}N_5O_2S_2$	509	4-OCH_3-C_6H_5	192	65	63.57/63.64	3.65/3.76	13.65/13.74
6a	$C_{36}H_{24}N_6O_4S_2$	668	C_6H_5	149	62	64.75/64.66	3.56/3.62	12.62/12.57
6b	$C_{36}H_{23}FN_6O_4S_2$	686	4-F-C_6H_5	154	67	62.91/62.96	3.35/3.38	12.32/12.24
6c	$C_{36}H_{23}BrN_6O_4S_2$	747	4-Br-C_6H_5	132	60	57.90/57.83	3.15/3.10	11.35/11.24
6d	$C_{37}H_{26}N_6O_5S_2$	698	4-OCH_3-C_6H_5	138	59	63.68/63.60	3.84/3.75	12.11/12.03
7	$C_{10}H_7N_3OS_2$	249	-	204	72	48.12/48.18	2.92/2.83	16.94/16.85
8	$C_{20}H_{14}N_4O_4S_2$	438	-	169	68	54.71/54.78	3.31/3.22	12.70/12.78
9	$C_{29}H_{19}N_5O_4S_2$	565	-	248	62	61.67/61.58	3.48/3.39	12.45/12.38

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