AMERICAN JOURNAL OF
CHEMISTRY AND PHARMACY (AJCP)
ISSN: 2834-0116 (ONLINE)
VOLUME 2 ISSUE 2 (2023)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Chemistry and Pharmacy (AJCP)

Volume 2 Issue 2, Year 2023
ISSN: 2834-0116 (Online)
DOI: https://doi.org/10.54536/ajcp.v2i2.1686
https://journals.e-palli.com/home/index.php/ajcp

Potent Antioxidant Agents: Dithiocarbamates of Ω-Substituted (2-Naphthyloxy) Alkanes

Sadaf Zaidi[1*], Devdutt Chaturvedi[2], Nitin Srivastava[1], Manisha Shukla[3]

Article Information

Received: May 25, 2023
Accepted: June 10, 2023
Published: July 13, 2023

Keywords

Amines, Antioxidant, Dithiocarbamates, Condensation, Catalyst

ABSTRACT

A series of dithiocarbamates of ω-substituted (2-naphthyloxy) alkanes (4-48) was tested for antioxidant activity by radicals 2,2-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) (ABTS) assay, DPPH assay (1,1-diphenyl-2-picryl-hydrazyl), $O_2^{\cdot}$ (NET) assay and ROO (TRAP) assay against curcumin and vitamin C as standard drugs. Most of these compounds have shown promising activities, such compounds are 11, 12, 13, 25, 26, 27, 28, 41, 42, and 43. The series was synthesized by the condensation reaction of 2-(2-chloro-alkoxy)-naphthalene with different types of aliphatic, alicyclic, aromatic, heterocyclic primary, as well as secondary amines to develop dithiocarbamates of ω-substituted (2-naphthyloxy) alkanes.

INTRODUCTION

Dithiocarbamates have procured a very special position in various areas of organic chemistry such as pharmaceuticals (Shaw, 2008) intermediates in organic synthesis (Halls, 1969) peptide chemistry (Greene & Wurtz, 2007) and combinatorial chemistry linkage (Mayer *et al*, 1997) Organic dithiocarbamates are also used to synthesize structurally varied biologically potent molecules such as antimalarial(Yang Liu Y *et al* , 2011) anticholinergics, (Ozkanli F *et al* 2010) antimicrobial (Ozkanli F *et al* 2010) antimitotic (Bacharaju K *et al* 2012) antitubercular (Horita Y *et al* 2011) antifungal (Zou Y *et al* 2014) , anticancer (Cao SL *et al* 2010) antioxidant (Zahram M A H *et al* 2008) , antiprotozoal (Coro J *et al* 2006), antileprosy (Marakov V *et al* 2006) antifolates (Cao SL *et al* 2006) antitubulin(Hou X *et al* 2011), antialzheimer (Mohsin UA anti-HIV (He XY *et al* 2013) antipoliferative (Cao SL *et al* 2013), and anticontraceptives (Jangir S *et al* 2014) active agents (Figure 1). A wide range of dithiocarbamates has been found to act as starting material to synthesize

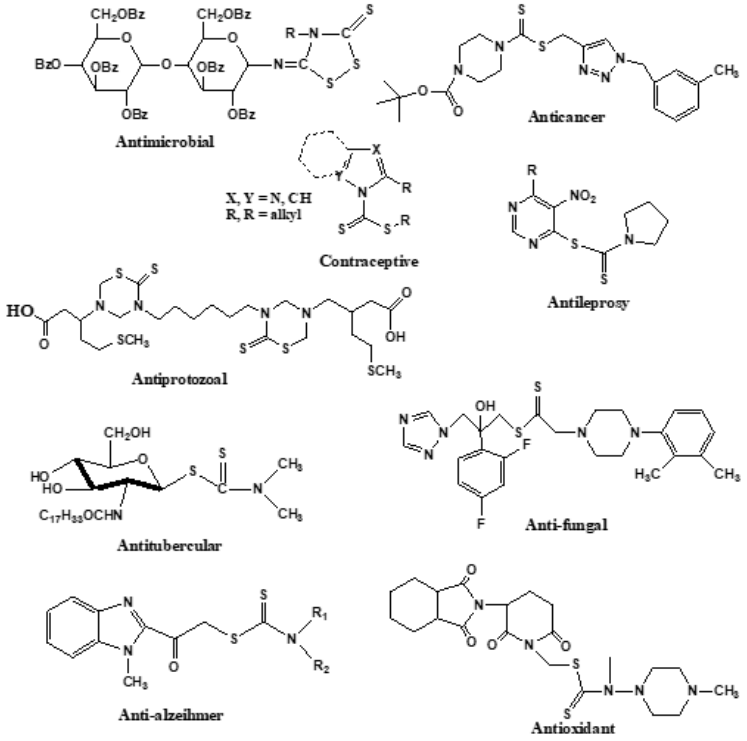


Figure 1: Structurally diverse biologically potent dithiocarbamates

[1] Department of Applied Chemistry, Amity School of Applied Sciences, Amity University Uttar Pradesh (AUUP), Lucknow Campus, Lucknow-226028, U. P. India
[2] Department of Chemistry, School of Physical & Material Sciences, Mahatma Gandhi Central University (MGCU), Motihari, Bihar, India
[3] Department of Chemistry, Babu Banarasi Das National Technology & Management, Lucknow-227105, U. P. India
[*] Corresponding author's e-mail: sadaf.zaidi00@gmail.com

structurally diverse biological strong synthetic molecules or intermediates such as isothiocyanates (Liu P *et al* 2013), thiourea (Halimjani AZ *et al* 2009) cynamide (Jamir J *et al* 2012), dithiobenzophene (Kienle M *et al* 2010), glycosides (Aucagne V *et al* 2005) amide (Kumar NK *et al* 2010) dicarboxylates (Khalizadeh MA *et al* 2010) benzimidazole (Das P *et al* 2008), carbamate (Tandel SK *et al* 1993) pyran (Charati FR *et al* 2012) flavonoids (Bahrin LJ *et al* 2012), etc. In recent years, much focus has been made upon the antioxidant activity of dithiocarbamates, keeping in view the high utility of pyrrolidine dithiocarbamate (PTDC) 2 as an inhibitor of nuclear factor-kappa B (Moellering D *et al* 1999) and diethyl dithiocarbamate (DTDC) 3 is widely used both in basic and clinical research (Zhu BZ *et al* 2002). Other dithiocarbamate compounds like thalidomide sulphur analog 1 (Zahran MAH *et al* 2008) and aliphatic amines 4 (Orlinski MM *et al* 1998) were also found to exhibit pronounced antioxidant activity (Figure 1&2).

Based upon our on-going research work of drug designing

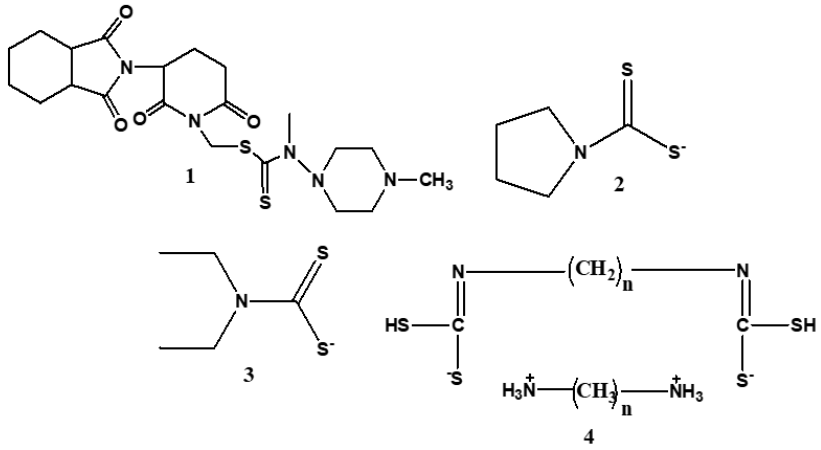


Figure 2: Structurally diverse antioxidant dithiocarbamates

and synthesizing of semisynthetic/natural/synthetic molecules (Zaidi S *et al* 2019), we became inquisitive to explore the "antioxidant activity of dithiocarbamates of ω-substituted (2-naphthyloxy) alkanes (Prototype I)".

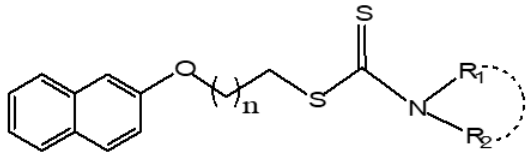
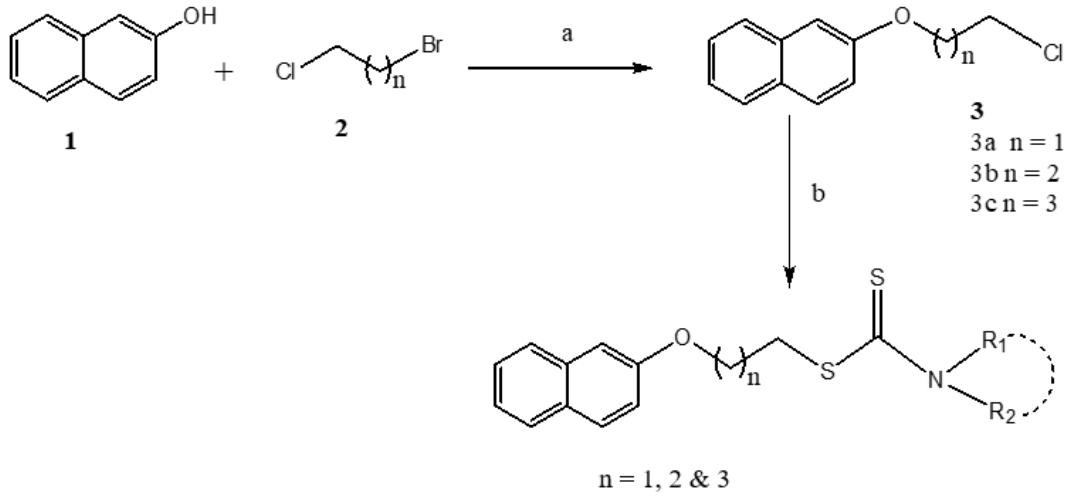


Figure 3: Prototype I (Comp. no. 4-48)

RESULT AND DISCUSSION

Chemistry

As already reported, a series of of dithiocarbamates of ω-substituted (2-naphthyloxy) alkanes (4–48) Scheme 1 is produced by using different types of alicyclic, aromatic, aliphatic, heterocyclic primary as well as secondary amines. It was noticed that the final production of Prototype I (4-48) dithiocarbamates depends on electron releasing impact of the amines such as phenyl ethyl, cyclohexane, N-methyl piperazine, piperidine, and pyrrolidine amine



Prototype I (Comp. no. **4-48**)

Scheme 1: Reaction procedure for the synthesis of Prototype I: a Anhyd. K_2CO_3, dry acetone, reflux, 12-15 h, 98%; b Triton B, CS_2, Dry DMSO, Amine, 20-30 min.

and Table 1 illustrates that phenyl propyl amine has a highest yield than primary amines.

Table 1: Synthesis designed dithiocarbamates of Prototype I (Comp. No. 4-48)

Comp. No.	n	R_1	R_2	Time (min.)	Yield (%)
4	1	C_4H_9	H	35	93
5	1	C_6H_{11}	H	30	94
6	1	C_8H_{15}	H	40	90
7	1	$C_{10}H_{19}$	H	40	93
8	1	R_1=R_2= Pyrrolidine		25	96
9	1	R_1=R_2= Piperidine		30	98
10	1	R_1=R_2= N methyl piperazine		20	98
11	1	R_1=R_2= Morpholine		25	90
12	1	R_1=R_2= Toluidine		25	92
13	1	R_1=R_2= Anisidine		30	92
14	1	R_1=R_2= Cyclohexane		25	95
15	1	Ph(CH_2)	H	30	82
16	1	Ph(CH_2CH_2)	H	30	97
17	1	Ph($CH_2CH_2CH_2$)	H	25	95
18	1	R¬1=R2= Dibutyl		35	80
19	2	C_4H_9	H	35	93
20	2	C_6H_{11}	H	30	94
21	2	C_8H_{15}	H	40	90
22	2	$C_{10}H_{19}$	H	40	93
23	2	R_1=R_2= Pyrrolidine		25	96
24	2	R_1=R_2= Piperidine		30	98
25	2	R_1=R_2= N methyl piperazine		20	98
26	2	R_1=R_2= Morpholine		25	90
27	2	R_1=R_2= Toludine		25	92
28	2	R_1=R_2= Anisidine		30	92
29	2	R_1=R_2= Cyclohexane		25	95
30	2	Ph(CH_2)	H	30	82
31	2	Ph(CH_2CH_2)	H	30	97
32	2	Ph($CH_2CH_2CH_2$)	H	25	95
33	2	R_1=R_2= Dibutyl		35	80
34	3	C_4H_9	H	35	93
35	3	C_6H_{11}	H	30	94
36	3	C_8H_{15}	H	40	90
37	3	$C_{10}H_{19}$	H	40	93
38	3	R_1=R_2= Pyrrolidine		25	96
39	3	R_1=R_2= Piperidine		30	98
40	3	R_1=R_2= N methyl piperazine		20	98
41	3	R_1=R_2= Morpholine		20	98
42	3	R_1=R_2= Toludine		25	90
43	3	R_1=R_2= Anisidine		25	92
44	3	R_1=R_2= Cyclohexane		30	92
45	3	Ph(CH_2)	H	25	95
46	3	Ph(CH_2CH_2)	H	30	97
47	3	Ph($CH_2CH_2CH_2$)	H	25	95
48	3	R_1=R_2= Dibutyl		35	80

Biological Evaluation

TRAP and NET radical scavenging (Kienle M *et al* 2010), DPPH (Aucagne V *et al* 2005), and ABTS assays (Kumar NK *et al* 2010) in vitro were done to examine the series of compounds for antioxidant activities. Table 2 illustrates that the results have been normalized using IC_{50}. By varying the alkyl chain and its connected amines, wide range of compounds are produced, the SAR of these compounds may be determined. It has been shown that compounds with the three-carbon chain are more potent than those with the two-carbon or four-carbon chain. The 25, 26, 27 and 28 compounds have a greater potency than other compounds due to the three-carbon chain bound to them. The hydrophilicity is responsible for the increased potency of the three-carbon chain. When analysing the effects of different amines groups, we observed that compounds as 12, 13, 26, 27, 28, 41, 42 and 43 having aromatic amines like anisidine and toludine show comparable value to control drugs curcumin and Vc.

Compounds having substituted heterocyclic amines (10, 11, 25, 26, 40 and 41), generated promising results. Better results were obtained by substitution of aromatic amines like benzyl amine (15, 30 & 45) when compared with phenyl propyl amine (17, 32 and 47) and phenyl ethyl (16, 31 and 46).

Table 2: Antioxidant activities of Prototype I (Comp. 4-48)

Compound	DPPH IC_{50} (µM)	ABTS IC_{50} (µM)	TRAP IC_{50} (µM)	NET IC50 (µM)
4	42.78±0.65	88.45±0.67	95.35±0.34	156.76±1.12
5	50.12±0.45	90.54±1.15	98.12±1.12	175.54±0.67
6	30.21±0.65	68.15±0.25	78.67±1.12	126.65±0.67
7	>4820	>4820	>4820	>4820
8	29.21±0.65	62.15±0.25	72.67±1.12	125.65±0.67
9	31.89±0.90	64.45±0.55	74.35±0.85	122.56±0.89
10	28.09±0.48	60.65±0.55	76.54±0.98	120.54±0.45
11	25.45±0.98	85.89±0.78	74.67±0.85	112.45±0.58
12	24.78±0.25	58.34±0.45	74.32±0.98	110.25±0.65
13	22.89±1.05	55.98±1.76	70.56±0.78	105.32±0.89
14	>4820	>4820	>4820	>4820
15	33.35±1.43	66.56±0.43	86.45±0.67	130.24±0.65
16	35.68±0.47	68.24±0.56	88.25±0.65	138.75±0.34
17	38.65±0.90	70.89±0.35	102.34±0.54	142.89±0.67
18	>4820	>4820	>4820	>4820
19	25.45±0.83	82.32±0.78	85.15±0.65	142.32±0.56
20	28.09±0.98	88.09±0.45	88.45±1.35	155.24±0.45
21	25.24±0.90	66.01±0.34	82.45±1.21	120.22±1.34
22	61.25±1.21	175.45±0.65	178.32±0.48	204.32±0.45
23	24.24±0.90	61.01±0.34	80.45±1.21	110.22±1.34
24	26.89±1.05	62.56±1.02	83.62±1.43	118.56±1.25
25	22.65±0.47	57.56±2.01	68.45±0.98	105.24±1.24
26	30.56±2.01	76.98±1.35	85.65±1.28	133.22±1.21
27	15.24±1.85	54.34±0.35	60.65±1.05	92.45±1.89
28	18.56±2.01	54.15±1.47	61.12±1.85	96.78±1.85
29	>4820	>4820	>4820	>4820
30	28.89±0.45	68.98±1.76	76.01±0.78	120.25±1.76
31	32.28±2.06	72.45±2.16	85.65±1.21	125.89±1.32
32	34.45±0.56	88.34±0.18	98.32±1.35	134.24±1.25
33	>4820	>4820	>4820	>4820
34	40.22±0.34	78.58±0.25	86.45±0.56	135.75±0.56
35	45.67±0.52	84.45±0.65	90.12±0.45	140.45±0.65
36	26.14±0.34	62.65±1.12	75.34±0.65	118.34±0.45
37	>4820	>4820	>4820	>4820
38	28.14±0.34	61.65±1.12	76.34±0.65	115.34±0.45

39	30.56±0.87	63.25±0.54	78.45±1.12	120.45±0.56
40	25.94±0.65	60.15±0.55	74.34±0.56	110.45±0.46
41	35.18±1.21	68.32±0.85	81.24±0.85	126.54±0.65
42	24.45±0.89	58.34±0.54	70.34±0.98	105.65±0.56
43	21.89±0.75	56.45±0.75	68.54±0.65	102.34±0.45
44	>4820	>4820	>4820	128.89±0.45
45	32.34±0.45	65.32±0.85	80.32±0.65	132.45±0.98
46	34.67±1.12	66.35±0.55	88.45±0.24	145.67±0.56
47	38.55±0.35	68.34±0.54	110.56±0.85	>4820
48	>4820	>4820	>4820	>4820
Vc	43.41±1.80	104.47±3.10	103.22±2.22	165.±1.45
Curcumin	12.63±0.50	49.55±2.15	55.22±2.10	88.91±1.25

Experimental

All of the synthesized compounds were detected by melting point, 1H NMR, 13C NMR, and HRMS. Chemicals have been acquired from Fluka, Aldrich, and Merck chemical firms. Bomem MB-104–FTIR spectrophotometer has recorded the IR spectra of 4000-200 cm^{-1} range, while AC-300F was used to scan NMRs, NMR (300MHz) is carried out with $CDCl_3$ and TMS and other deuterated solvents as an internal standard. "Carlo-Erba EA 1110-CNNO-S" analyser performed the elemental analysis and accepted favourably the measured values.

Synthetic Process

For ω-substituted 2-napthyloxy haloalkanes Typical Procedure

Measured amount of β-naphthol 1 was poured in dry acetone and later anhydrous K_2CO_3 (10 eqv.) was added into it. For alkylation, 1-bromo-3-chloro propane 2 (2.5 eqv.) was also included and the reaction mixture was allowed to reflux for 12-15h. The progress of reaction has been recorded by TLC and a new less polar spot appeared on the TLC which indicated the formation of a product. The filtrate of the reaction was extracted thrice with ethyl acetate. The organic layer which afforded the required compound 3 was separated, dried over anhydrous Na_2SO_4. Different spectroscopic, as well as analytical methods, have verified compound 3.

General Procedure for dithiocarbamates of Prototype I (4-48) Synthesis

Measured amount of required amine was dissolved in dry DMSO. To this Triton-B, as well as CS_2, were also introduced in the reaction mixture drop by drop along with constant stirring for around 15 min. The reaction mixture was later mixed with compound 3, which was stirred for around 20-40 minutes. The formation of desired product was monitored by TLC. At the completion of the reaction, the resultant mixture was extracted thrice by using ethyl acetate. The organic layer has been isolated as well as dried over anhydrous Na_2SO_4 which gave the product, i.e., the prototype I (compound no. 4-48).

Experimental Methods

Synthesis

A general method to prepare Ω naphthyloxy halo alkanes (3a–c)

In dry acetone (200 mL), the mixture was refluxed for around 12–15 hours comprising of β-naphthol 1 (20 grams, 0.14 mol), anhydrous K_2CO_3 (in excess amount of 100 g) and bromochloroalkane 2 (0.14 mol). The reaction mixture was purified, and the filtrate was condensed to obtain the oily compound crystallized by using benzene-hexane, giving the pure desired compound which is colourless crystals.

2-(2-Naphthyloxy)-1-chloroethane (3a)

Yield: 27.5 g (96%); mp: 94 0C; IR (KBr, cm-1): ν = 1455 (Ar), 1508 (Ar), 1585 (Ar), 2878 (CH), 2927 (CH); 1H NMR (400 MHz, $CDCl_3$): δ = 3.81 (t, 2H, CH_2Cl), 4.26 (t, 2H, OCH_2), 6.97–7.64 (m, 7H, Ar–H); 13C NMR (100 MHz, $CDCl_3$): δ = 45.3, 75.1, 105.8, 118.6, 123.6, 126.4, 129.5, 134.5, 157.7 ppm; Mass (EIMS): m/z = 206; Analysis: $C_{12}H_{11}ClO$, Calcd: C, 69.74; H, 5.36; Obsd: C, 70.04; H, 5.66%.

3-(2-Naphthyloxy)-1-chloropropane (3b)

Yield: 29.7 g (97%); mp: 980C; IR (KBr, cm-1): ν = 1461 (Ar), 1512 (Ar), 1596 (Ar), 2855 (CH), 2940 (CH) cm-1; 1H NMR (400 MHz, $CDCl_3$): δ = 2.27– 2.33 (m, 2H, CH_2), 3.80 (t, 2H, CH_2Cl), 4.25 (t, 2H, OCH_2), 7.12–7.77 (m, 7H, Ar–H) ppm; Mass (EIMS): m/z = 220; Analysis: $C_{13}H_{13}ClO$, Calcd: C, 70.75; H, 5.94; Obsd: C, 70.79; H, 6.21%.

4-(2-Naphthyloxy)-1-chlorobutane (3c)

Yield: 32 g (98%); mp: 1120C; IR (KBr, cm-1): ν = 1464 (Ar), 1510 (Ar), 1599 (Ar), 2887 (CH), 2941 (CH); 1H NMR ($CDCl_3$): δ = 2.15–2.20 (m, 4H, CH_2CH_2), 3.79 (t, 2H, CH_2Cl), 4.24 (t, 2H, OCH2), 7.13–7.78 (m, 7H, Ar–H) ppm; Mass (EIMS): m/z = 234; Analysis:$C_{14}H_{15}ClO$,

A General Method to Prepare dithiocarbamates of ω-substituted (2-naphthyloxy) Alkanes

A mixture of Dry DMSO of 35 ml along with desired amines (0.6 ml, 5 m mole) comprising of carbon

disulphide (in excess amount 3 ml) and Triton-B (0.9 ml, 4 m mole) system. At room temperature, the reaction has been agitated for 1 h and finally (2-naphthyloxy)-1-chloroalkanes (0.5 grams, 2 m mole) was added. The reaction was allowed to proceed until they were complete (2 hours) under TLC monitoring. The final reaction mixture was poured into 50 ml of distilled water and extraction was done thrice by using ethyl acetate. The organic layer was segregated as well as dried over anhydrous sodium sulphate, then condensed to produce the ω-substituted dithiocarbamate (2-naphthyloxy) alkanes (4-48). The compound was generated as a yellow solid.

Butyl-dithiocarbamic acid-2-(napthalen-2-yloxy)ethyl ester (4)

Yield: 0.73 g (93.5 %); m.p.: 106°C; IR (KBr, νmax, cm-1): 661 (C-S), 1114 (C=S), 1454 (Ar), 1511 (Ar), 1612 (Ar), 2864 (CH), 2936 (CH), 3390 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.96 (t, 3H, CH_3), 1.30-1.34 (m, 2H, CH_2CH_3), 1.53- 1.56 (m, 2H, $CH_2.CH_2.CH_3$), 2.0 (bs, H, NH), 2.62-2.64 (m, 2H, $NHCH_2$), 3.28-3.32 (t, 2H, CH_2-S-C=S), 4.71-4.74 (t, 2H, CH_2-O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 319; Analysis: $C_{17}H_{21}NOS_2$, Calcd. (%): C, 63.91, H 6.63, N, 4.38; Obsd. (%): C, 64.19, H, 6.49, N, 4.24.

Butyl-dithiocarbamic acid-3-(naphthalene-2-yloxy)-propyl ester (5)

Yield: 0.73 g (93.5 %); m.p.: 106°C; IR (KBr, νmax, cm-1): 661 (C-S), 1115 (C=S), 1454 (Ar), 1511 (Ar), 1610 (Ar), 2864 (CH), 2935 (CH), 3390 (NH); 1 H NMR ($CDCl_3$): δ = 0.93-0.96 (t, 3H, CH_3), 1.33-1.35 (m, 2H, CH_2CH_3), 1.53-1.55 (m, 2H, $CH_2.CH_2.CH_3$), 2.0 (bs, H, NH), 2.62-2.65 (m, 2H, $NHCH_2$), 2.84-2.86 (t, 2H, CH_2-S-C=S), 2.35-2.39 (m, 2H, $CH_2CH_2CH_2$) 4.01-4.05 (t, 2H, CH_2-Onaphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 333; Analysis: $C_{18}H_{23}NOS_2$, Calcd. (%): C, 65.91, H 6.83, N, 4.38, S, 19.15, Obsd. (%): C, 65.82, H, 6.95, N, 4.20, S, 19.23 %: O, 4.80.

Butyl-dithiocarbamic acid-4-(naphthalene-2-yloxy)-butyl ester (6)

Yield: 0.73 g (93.5 %); m.p.: 106 °C; IR (KBr, νmax, cm-1): 661 (C-S), 1114 (C=S), 1454 (Ar), 1511 (Ar), 1612 (Ar), 2864 (CH), 2936 (CH), 3390 (NH); 1 H NMR ($CDCl_3$): δ = 0.93-0.96 (t, 3H, CH_3), 1.33-1.35 (m, 2H, CH2CH3), 1.53- 1.55 (m, 2H, $CH_2.CH_2.CH_3$), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, $NHCH_2$), 2.85-2.87 (t, 2H, CH_2-S-C=S), 1.92-1.96 (m, 2H, $CH_2CH_2CH_2$), 1.68-1.71 (m, 2H, $CH_2CH_2CH_2$), 4.00-4.03 (t, 2H, CH_2-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 347.14; Analysis: $C_{19}H_{25}NOS_2$, Calcd. (%): C, 65.60, H 7.22, N, 4.58; S, 18.42 %: O, 4.58. Obsd. (%): C, 65.66, H, 7.25, N, 4.60, S, 18.45 %: O, 4.60.

Hexyl-dithiocarbamic acid - 2 -(napthalen-2-yloxy)ethyl ester (7)

Yield: 0.8 g (96.4 %); m.p.: 119 °C; IR (KBr, νmax, cm-1): 665 (C-S), 1116 (C=S), 1475 (Ar), 1514 (Ar), 1602 (Ar), 2875 (CH), 2936 (CH), 3394 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.95 (t, 3H, CH_3), 1.27-1.29 (m, 4H, $CH_2CH_2CH_2CH_3$ of hexyl group), 1.31-1.35 (m, 2H, CH_2CH_3 of hexyl group), 1.52-1.56 (m, 2H, $CH_2.CH_2.CH_3$ of hexyl group), 2.0 (bs, H, NH), 2.36-2.40 (m, 2H, naphthyl-O-$CH_2CH_2CH_2$-S-C=S), 2.63-2.65 (m, 2H, $NHCH_2$), 3.24-3.29 (t, 2H, CH_2-S-C=S), 4.68-4.73 (t, 2H, CH_2-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 347.14; Analysis: $C_{19}H_{25}NOS_2$, Calcd. (%): C, 66.44, H 7.53, N, 3.87, 18.45 %: O, 4.60. Obsd. (%): C, 65.66, H, 7.25, N, 4.03, S, 18.45 %: O, 4.60.

Hexyl-dithiocarbamic acid-3-(naphthalene-2-yloxy)-propyl ester (8)

Yield: 0.8 g (96.4 %); m.p.: 119°C; IR (KBr, νmax, cm-1): 662 (C-S), 1116 (C=S), 1475 (Ar), 1514 (Ar), 1602 (Ar), 2875 (CH), 2936 (CH), 3394 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.94 (t, 3H, CH_3), 1.27-1.29 (m, 4H, $CH_2CH_2CH_2CH_3$ of hexyl group), 1.31-1.35 (m, 2H, CH_2CH_3 of hexyl group), 1.52-1.58 (m, 2H, $CH_2.CH_2.CH_3$ of hexyl group), 2.0 (bs, H, NH), 2.34-2.42 (m, 2H, naphthyl-O-$CH_2CH_2CH_2$-S-C=S), 2.63-2.66 (m, 2H, $NHCH_2$), 2.81-2.86 (t, 2H, CH_2-S-C=S), 4.02-4.05 (t, 2H, CH_2-O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 361; Analysis: $C_{20}H_{27}NOS_2$, Calcd. (%): C, 66.44, H 7.53, N, 3.87, Obsd. (%): C, 66.75, H, 7.38, N, 3.71.

Hexyl-dithiocarbamic acid-4-(naphthalene-2-yloxy)-butyl ester (9)

Yield: 0.72 g (98 %); m.p.: 129 °C; IR (KBr, νmax, cm-1): 669 (C-S), 1116 (C=S), 1475 (Ar), 1514 (Ar), 1610 (Ar), 2875 (CH), 2936 (CH), 3410 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.96 (t, 3H, CH_3), 1.25-1.29 (m, 4H, $CH_2CH_2CH_2CH_3$ of hexyl group), 1.30-1.34 (m, 2H, CH_2CH_3 of hexyl group), 1.53-1.56 (m, 2H, $CH_2CH_2CH_2.CH_2.CH_3$ of hexyl group), 1.71- 1.73 (m, 2H, naphthyl-O-CH_2CH_2), 1.94-1.96 (m, 2H, SCH_2CH_2), 2.0 (bs, H, NH), 2.62-2.64 (m, 2H, $NHCH_2$), 2.82- 2.86 (t, 2H, CH_2-S-C=S), 4.02-4.06 (t, 2H, CH2-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 375; Analysis: $C_{21}H_{29}NOS_2$, Calcd. (%): C, 67.15, H 7.78, N, 3.73, Obsd. (%): C, 67.59, H, 7.56, N, 3.51.

Octyl-dithiocarbamic acid-2-(napthalen-2-yloxy) ethyl ester (10)

Yield: 0.85 g, (96.2 %); m.p.: 172 °C; IR (KBr, νmax, cm-1): 667 (C-S), 1120 (C=S), 1475 (Ar), 1521 (Ar), 1612 (Ar), 2886 (CH), 2941 (CH), 3399 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.94 (t, 3H, CH_3), 1.27-1.29 (m, 8H, $CH_2CH_2CH_2CH_2CH_2CH_3$ of octyl group), 1.32-1.34 (m, 2H, CH_2CH_3 of octyl group), 1.53-1.56 (m, 2H, CH_2CH_2N of n-octyl group), 2.0 (bs, H, NH), 2.62-2.64 (m, 2H, $NHCH_2$), 3.25-3.29 (t, 2H, CH2-S-C=S), 4.01-4.04 (t, 2H, CH_2-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 375.17; Analysis: $C_{21}H_{29}NOS_2$, Calcd. (%): C, 67.15, H, 7.78, N, 3.73; O, 4.22; S, 17.04. Obsd. (%): C, 67.15, H, 7.78, N, 3.73, O, 4.26; S, 17.07.

Octyl-dithiocarbamic acid -3-(naphthalene-2-yloxy)-propyl ester (11)

Yield: 0.85 g, (96.2 %); m.p.: 172 °C; IR (KBr, νmax, cm-1): 667 (C-S), 1120 (C=S), 1472 (Ar), 1521 (Ar), 1612 (Ar), 2884 (CH), 2941 (CH), 3399 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.94 (t, 3H, CH_3), 1.27-1.29 (m, 8H, $CH_2CH_2CH_2CH_2CH_2CH_3$ of octyl group), 1.30-1.32 (m, 2H, CH_2CH_3 of octyl group), 1.53-1.56 (m, 2H, CH_2CH_2N of noctyl group), 2.0 (bs, H, NH), 2.38-2.42 (m, 2H, naphthyl-$OCH_2CH_2CH_2$-S-C=S), 2.63-2.66 (m, 2H, NHCH2), 2.83-2.87 (t, 2H, CH_2-S-C=S), 4.01-4.04 (t, 2H, CH_2-O-naphthyl), 6.98- 7.66 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 389; Analysis: $C_{22}H_{31}NOS_2$, Calcd. (%): C, 67.62, H, 8.02, N, 3.59; Obsd. (%): C, 67.89, H, 7.90, N, 3.44.

Octyl-dithiocarbamic acid -4-(naphthalene-2-yloxy)-butyl ester (12)

Yield: 0.86 g (94 %); m.p.: 156 °C; IR (KBr, νmax, cm-1): 664 (C-S), 1108 (C=S), 1463 (Ar), 1514 (Ar), 1602 (Ar), 2862 (CH), 2926 (CH), 3392 (NH); 1 H NMR ($CDCl_3$): δ = 0.93- 0.95 (t, 3H, CH_3), 1.27-1.29 (m, 8H, $CH_2CH_2CH_2CH_2CH_2CH_3$ of octyl group), 1.30-1.34 (m, 2H, CH_2CH_3 of octyl group), 1.52-1.57 (m, 2H, CH_2. CH_2.N), 2.0 (bs, H, NH), 2.63-2.67 (m, 2H, $NHCH_2$), 3.26-3.32 (t, 2H, CH_2-S-C=S), 4.71-4.74 (t, 2H, CH_2-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 375; Analysis: $C_{21}H_{29}NOS_2$, Calcd. (%): C, 67.15, H 7.78, N, 3.73, Obsd. (%): C, 67.54, H, 7.56, N, 3.56.

Decyl-dithiocarbamic acid-2-(napthalen-2-yloxy)ethyl ester (13)

Yield: 0.86 g (94 %); m.p.: 156 °C; IR (KBr, νmax, cm-1): 663 (C-S), 1108 (C=S), 1465 (Ar), 1511 (Ar), 1605 (Ar), 2862 (CH), 2926 (CH), 3392 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.94 (t, 3H, CH_3), 1.27-1.29 (m, 10H, $CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ of decyl group), 1.31-1.35 (m, 2H, CH_2CH_3 of decyl group), 1.53-1.56 (m, 2H, CH_2CH_2N of n-decyl group), 2.01 (bs, H, NH), 2.63-2.65 (m, 2H, $NHCH_2$), 3.25- 3.29 (t, 2H, CH_2-S-C=S), 4.68-4.71 (t, 2H, CH_2-O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 403.25; Analysis: $C_{23}H_{33}NOS_2$, Calcd. (%): C, 68.40, H 8.20, N, 3.90, O, 3.92, S, 15.86; Obsd. (%): C, 68.44, H, 8.24, N, 3.96. O, 3.96, S, 15.89.

Decyl-dithiocarbamic acid-3-(naphthalene-2-yloxy)-propyl ester (14)

Yield: 0.86 g (94 %); m.p.: 156 °C; IR (KBr, νmax, cm-1): 664 (C-S), 1109 (C=S), 1462 (Ar), 1513 (Ar), 1602 (Ar), 2863 (CH), 2925 (CH), 3392 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.95 (t, 3H, CH_3), 1.27-1.29 (m, 10H, $CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ of decyl group), 1.31-1.35 (m, 2H, CH_2CH_3 of decyl group), 1.53-1.56 (m, 2H, CH_2CH_2N of n-decyl group), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, $NHCH_2$), 2.84-2.87 (t, 2H, CH_2-S-C=S), 2.34-2.38 (m, 2H, CH_2CH_2), 4.68-4.71 (t, 2H, CH_2-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 417.67; Analysis: $C_{24}H_{35}NOS_2$, Calcd. (%): C, 69, H 8.40, N, 3.35, O, 3.80, S, 15.31. O, 3.83, S, 15.35. Obsd. (%): C, 69.02, H, 8.45, N, 3.35, O, 3.83, S, 15.35.

Decyl-dithiocarbamic acid-4-(naphthalene-2-yloxy)-butyl ester (15)

Yield: 0.86 g (94 %); m.p.: 156 °C; IR (KBr, νmax, cm-1): 663 (C-S), 1107 (C=S), 1462 (Ar), 1510 (Ar), 1606 (Ar), 2865 (CH), 2926 (CH), 3392 (NH); 1 H NMR ($CDCl_3$): δ = 0.92-0.94 (t, 3H, CH_3), 1.27-1.29 (m, 10H, $CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$ of decyl group), 1.30-1.34 (m, 2H, CH_2CH_3 of decyl group), 1.52-1.58 (m, 2H, CH_2CH_2N of n-decyl group), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, $NHCH_2$), 2.84- 2.87 (t, 2H, CH_2-S-C=S), 1.93-1.95 (m, 2H, $CH_2CH_2CH_2$), 1.67-1.71 (m, 2H, $CH_2CH_2CH_2$),4.68-4.71 (t, 2H, CH_2-Onaphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthyloxy); Mass: m/ e 431.70; Analysis: $C_{25}H_{37}NOS_2$, Calcd. (%): C, 69.52, H 8.63, N, 3.21, O, 3.70, S, 14.82. Obsd. (%): C, 69.56, H, 8.64, N, 3.24, O, 3.71, S, 14.86.

Pyrollidine-dithiocarbamic acid-2-(napthalen-2- yloxy) ethyl ester (16)

Yield: 0.62 g (80.8 %); m.p.: 79 °C; IR (KBr, νmax, cm-1): 657 (C-S), 1106 (C=S), 1454 (Ar), 1502 (Ar), 1600 (Ar), 2863 (CH), 2925 (CH); 1 H NMR ($CDCl_3$): δ = 1.58-1.60 (m, 4H, CH_2 of pyrrolidine ring), 2.8 (t, 4H, CH_2N of pyrrolidine ring (2H, CH_2-S-C=S), 4.71-4.73 (t, 2H, CH_2- O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 317; Analysis: $C_{17}H_{19}NOS_2$, Calcd. (%): C, 64.32, H, 6.03, N, 4.41, Obsd. (%): C, 63.85, H, 6.29, N, 4.64.

Pyrollidine-dithiocarbamic acid-3-(napthalen-2- yloxy) propyl ester (17)

Yield: 0.63 g (83.2 %); m.p.: 86 °C; IR (KBr, νmax, cm-1): 672 (C-S), 1124 (C=S), 1475 (Ar), 1524 (Ar), 1605 (Ar), 2885 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 1.57-1.61 (m, 4H, CH_2 of pyrolidine ring), 2.35-2.38 (m, 2H, naphthyl-O-$CH_2CH_2CH_2$-S-C=S), 2.8 (t, 4H, CH_2N of pyrolidine ring), 2.82-2.86 (t, 2H, CH_2-S-C=S), 4.02-4.04 (t, 2H, CH_2-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 331; Analysis: $C_{18}H_{21}NOS_2$, Calcd. (%): C, 65.22, H, 6.39, N, 4.23, Obsd. (%): C, 65.63, H, 6.12, N, 4.01.

Pyrollidine - dithiocarbamic acid - 4 - (napthalen - 2 - yloxy) - butyl ester (18)

Yield: 0.64 g (86.5 %); m.p.: 95 °C; IR (KBr, νmax, cm-1): 679 (C-S), 1125 (C=S), 1484 (Ar), 1525 (Ar), 1610 (Ar), 2885 (CH), 2947 (CH); 1 H NMR ($CDCl_3$): δ = 1.56-1.60 (m, 4H, CH_2 of pyrolidine ring), 1.71-1.72 (m, 2H, naphthylO-CH_2CH_2), 1.95-1.98 (m, 2H, S-CH_2CH_2), 2.8 (t, 4H, CH_2N of pyrolidine ring), 2.84-2.88 (t, 2H, CH_2-S-C=S), 4.02-4.05 (t, 2H, CH_2-O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 345; Analysis: $C_{19}H_{23}NOS_2$, Calcd. (%): C, 66.09, H, 6.57, N, 4.15, Obsd. (%): C, 66.57, H, 6.32, N, 3.86.

Piperidine-1-dithiocarbamic acid-2-(napthalen-2- yloxy) ethyl ester (19)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 660 (C-S), 1110 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 1.48-1.50 (m, 6H, CH_2 of piperidine ring), 2.7 (t, 4H, CH_2N of piperidine ring), 3.28-3.30 (t, 2H, CH_2-S-C=S), 4.71-4.73 (t, 2H, CH_2-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 331; Analysis: $C_{18}H_{21}NOS_2$, Calcd. (%): C, 65.22, H 6.39, N, 4.23, Obsd. (%): C, 65.73, H, 6.13, N, 3.98.

Piperidine-1-dithiocarbamic acid-3-(napthalen-2-yloxy) propyl ester (20)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2927 (CH); 1 H NMR ($CDCl_3$): δ = 1.48-1.50 (m, 6H, CH_2 of piperidine ring), 2.7 (t, 4H, CH_2N of piperidine ring), 2.82-2.86 (t, 2H, CH_2-S-C=S), 2.35-2.38 (m, 2H, CH_2CH_2), 4.01-4.04 (t, 2H, CH_2-O-naphthyl), 6.95- 7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 392.54; Analysis: $C_{19}H_{24}N_2O_2S_3$, Calcd. (%): C, 58.22, H 6.20, N, 7.23, Obsd. (%): C, 58.14.73, H, 6.16, N, 7.14, O, 12.23, S, 16.13.

Piperidine-1-dithiocarbamic acid-4-(napthalen-2- yloxy) butyl ester (21)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 660 (C-S), 1110 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2925 (CH); 1 H NMR ($CDCl_3$): δ = 1.48-1.50 (m, 6H, CH_2 of piperidine ring), 2.7 (t, 4H, CH_2N of piperidine ring), 2.83-2.86 (t, 2H, CH_2-S-C=S), 1.92-1.96 (m, 2H, CH_2CH_2), 1.68-1.71 (m, 2H, CH_2CH_2), 4.00-4.02 (t, 2H, CH_2-O-naphthyl), 6.96-7.65 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 406.56; Analysis: $C_{20}H_{26}N_2O_3S_2$, Calcd. (%): C, 59.12, H 6.49, N, 6.82, O, 11.82, S, 15.75. Obsd. (%): C, 59.08, H, 6.45, N, 6.89, O, 11.89, S, 15.79.

4- Methyl - piperazine-dithiocarbamic acid - 2 - (napthalen2 - yloxy) ethyl ester (22)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 2.24-2.27 (s, 3H, CH_3 of methyl piperazine ring), 2.44-2.48 (t, CH_2N of piperazine ring), 2.62-2.65 (t, CH_2N of piperazine ring), 2.0 (bs, H, NH), 3.25-3.29 (t, 2H, CH_2-S-C=S), 4.68- 4.71 (t, 2H, CH_2-O-naphthyl), 6.96-7.65 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 361; Analysis: $C_{18}H_{23}N_3OS_2$, Calcd. (%): C, 59.84, H 6.39, N, 11.60, O, 4.40, S, 17.72 % Obsd. (%): C, 59.80, H, 6.41, N, 11.62 % O, 4.43, S, 17.74.

4- Methyl - piperazine - dithiocarbamic acid - 3 - (napthalen2-yloxy)propyl ester (23)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 660 (C-S), 1110 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 2.24-2.27 (s, 3H, CH_3 of methyl piperazine ring), 2.44-2.48 (t, CH_2N of piperazine ring), 2.62-2.65 (t, CH_2N of piperazine ring), 2.0 (bs, H, NH), 2.84-2.87 (t, 2H, CH_2-SC=S), 2.34-2.38 (m, 2H, CH_2CH_2), 4.68-4.71 (t, 2H, CH_2-Onaphthyl), 6.96-7.63 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 375.55; Analysis: $C_{19}H_{25}N_3OS_2$, Calcd. (%): C, 60.72, H 6.69, N, 11.23, O, 4.22, S, 17.05 % Obsd. (%): C, 60.76, H, 6.71, N, 11.19, O, 4.26, S, 17.08.

4 - Methyl - piperazine - dithiocarbamic acid - 4 - (napthalen2-yloxy)butyl ester (24)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2925 (CH); 1 H NMR ($CDCl_3$): δ = 2.24-2.27 (s, 3H, CH_3 of methyl piperazine ring), 2.44-2.48 (t, CH_2N of piperazine ring), 2.62-2.65 (t, CH_2N of piperazine ring), 2.0 (bs, H, NH), 2.84-2.86 (t, 2H, CH_2-S-C=S), 1.94- 1.96 (m, 2H, $CH_2CH_2CH_2$), 1.68-1.71 (m, 2H, $CH_2CH_2CH_2$), 4.68-4.71 (t, 2H, CH_2-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 389.58; Analysis: $C_{20}H_{27}N_3OS_2$, Calcd. (%): C, 61.64, H 6.93, N, 10.73, O, 4.08, S, 16.42 % Obsd. (%): C, 61.66, H, 6.99, N, 10.79, O, 4.11, S, 16.46.

Morpholine 4 - dithiocarbamic acid - 2 - (napthalen-2-yloxy)ethyl ester (25)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 660 (C-S), 1110 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 3.62-3.67 (t, 2H, CH_2 of morphaline ring), 2.34-2.37 (t, CH_2N of morphaline ring), 2.35-2.40 (s, CH_2SCS), 2.84-2.86 (t, 2H, CH_2-S-C=S), 2.34-2.38 (m, 2H, CH_2CH_2), 4.68-4.71 (t, 2H, CH_2-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 382.50; Analysis: $C_{17}H_{22}N_2O_4S_2$, Calcd. (%): C, 53.35, H 5.79, N, 7.30, O, 16.70, S, 16.72 Obsd. (%): C, 53.38, H, 5.80, N, 7.32, O, 16.73, S, 16.77.

Morpholine 4 - dithiocarbamic acid - 3 - (napthalen-2-yloxy)propyl ester (26)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 3.62-3.67 (t, 2H, CH_2 of morphaline ring), 2.34-2.37 (t, CH_2N of morphaline ring), 2.35-2.40 (s, CH_2-S-C=S), 1.95-1.99 (m, 4H, CH_2CH_2), 4.68-4.71 (t, 2H, CH_2-O-naphthyl), 6.96-7.65 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 396.52; Analysis: $C_{18}H_{24}N_2O_4S_2$, Calcd. (%): C, 45.50, H 6.09, N, 7.10, O, 16.10, S, 16.15. Obsd. (%): C, 45.52, H, 6.10, N, 7.06 % O, 16.14, S, 16.17.

Morpholine 4 - dithiocarbamic acid - 4 - (napthalen-2-yloxy)butyl ester (27)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, νmax, cm-1): 660 (C-S), 1110 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR ($CDCl_3$): δ = 3.62-3.67 (t, 2H, CH_2 of morphaline ring), 2.34-2.37 (t, CH_2N of morphaline ring), 2.35-2.40 (s, CH_2SCS), 3.25-3.28 (t, 2H, CH_2-S-C=S), 1.94-1.96 (m, 2H, $CH_2CH_2CH_2$), 1.68-1.71 (m, 2H, $CH_2CH_2CH_2$), 4.68-4.71 (t, 2H, CH_2-

O-naphthyl), 6.96- 7.63 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 410.55; Analysis: $C_{19}H_{26}N_2O_4S_2$, Calcd. (%): C, 55.55, H 6.39, N, 6.30, O, 15.55, S, 15.60. Obsd. (%): C, 55.58, H, 6.35, N, 6.85, O, 15.59, S, 15.62.

p -Tolyl - dithiocarbamic acid-2-(napthalen-2-yloxy)-ethyl ester (28)

Yield: 0.76 g (88.4 %); m.p.: 137 °C; IR (KBr, νmax, cm-1): 660 (C-S), 1111 (C=S), 1454 (Ar), 1502 (Ar), 1602 (Ar), 2851 (CH), 2928 (CH), 3388 (NH); 1 H NMR ($CDCl_3$): δ = 2.34 (s, 3H, CH_3), 3.28-3.30 (t, 2H, CH_2-S-C=S), 4.0 (bs, H, NH), 4.70-4.72 (t, 2H, CH_2-O-naphthyl), 6.35-7.62 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 353; Analysis: $C_{20}H_{19}NOS_2$, Calcd. (%): C, 67.89, H, 5.45, N, 3.99, Obsd. (%): C, 67.63, H, 5.58, N, 4.12.

p-Tolyl-dithiocarbamic acid-3-(napthalen-2-yloxy)-propyl ester (29)

Yield: 0.76 g (88.4 %); m.p.: 137 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1111 (C=S), 1454 (Ar), 1502 (Ar), 1601 (Ar), 2851 (CH), 2928 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 2.34 (s, 3H, CH_3), 3.28-3.30 (t, 2H, CH_2-S-C=S), 4.0 (bs, H, NH), 2.35-2.40 (s, CH_2-S-C=S), 1.95-1.99 (m, 4H, CH_2CH_2), 4.68-4.71 (t, 2H, CH_2-O-naphthyl), 6.34-7.64 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 367.53; Analysis: $C_{21}H_{21}NOS_2$, Calcd. (%): C, 68.60, H, 5.72, N, 3.80, O, 4.31, S, 17.45 % Obsd. (%): C, 68.63, H, 5.76, N, 3.81 % O, 4.35, S, 17.45.

p -Tolyl - dithiocarbamic acid-4-(napthalen-2-yloxy)-butyl ester (30)

Yield: 0.76 g (88.4 %); m.p.: 137 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1111 (C=S), 1454 (Ar), 1502 (Ar), 1601 (Ar), 2851 (CH), 2928 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 2.34 (s, 3H, CH_3), 3.28-3.30 (t, 2H, CH_2-S-C=S), 4.0 (bs, H, NH), 2.35-2.40 (s, CH_2SCS), 3.25-3.27 (t, 2H, CH_2-S-C=S), 1.94-1.96 (m, 2H, $CH_2CH_2CH_2$), 1.68-1.71 (m, 2H, $CH_2CH_2CH_2$), 4.71-4.73 (t, 2H, CH_2-O-naphthyl), 6.35-7.63 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 381.55; Analysis: $C_{22}H_{23}NOS_2$, Calcd. (%): C, 69.20, H, 6.06, N, 3.62, O, 4.15, S, 16.79. Obsd. (%): C, 69.25, H, 6.08, N, 3.67, O, 4.19, S, 16.81.

(4 - Methoxy - 4 - phenyl) dithiocarbamic acid - 2 - (napthalen2-yloxy)ethyl ester (31)

Yield: 0.8 g (89.2 %); m.p.: 117 °C; IR (KBr, νmax, cm-1): 659 (C-S), 1106 (C=S), 1455 (Ar), 1502 (Ar), 1600 (Ar), 2854 (CH), 2926 (CH), 3389 (NH); 1 H NMR (CDCl3): δ = 3.28-3.30 (t, 2H, CH_2-S-C=S), 3.72 (s, 3H, OCH_3), 4.0 (bs, H, NH), 4.70-4.72 (t, 2H, CH_2-O-naphthyl), 6.35-7.64 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 369; Analysis: $C_{20}H_{19}NO_2S_2$, Calcd. (%): C, 65.01, H, 5.18, N, 3.79, Obsd. (%): C, 65.47, H, 5.03, N, 3.48.

(4 - Methoxy - 4 - phenyl) dithiocarbamic acid- 3 - (napthalen2-yloxy)propyl ester (32)

Yield: 0.82 g (93.8 %); m.p.: 139 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1117 (C=S), 1472 (Ar), 1524 (Ar), 1614 (Ar), 2876 (CH), 2938 (CH), 3396 (NH); 1 H NMR (CDCl3): δ = 2.38-2.42 (m, 2H, naphthyl-$OCH_2CH_2CH_2$-S-C=S), 2.84-2.88 (t, 2H, CH_2-S-C=S), 3.74 (s, 3H, OCH_3), 4.0 (bs, H, NH), 4.02-4.05 (t, 2H, CH_2-Onaphthyl), 6.34-7.65 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 383; Analysis: $C_{21}H_{21}NO_2S_2$, Calcd. (%): C, 65.76, H 5.52, N, 3.65, Obsd. (%): C, 65.27, H, 5.85, N, 3.81.

(4-Methoxy- 4 - phenyl) dithiocarbamic acid - 4 - (napthalen2-yloxy)butyl ester (33)

Yield: 0.83 g (94.5 %); m.p.: 126 °C; IR (KBr, νmax, cm-1): 681 (C-S), 1126 (C=S), 1484 (Ar), 1523 (Ar), 1610 (Ar), 2885 (CH), 2936 (CH), 3407 (NH); 1 H NMR (CDCl3): δ = 1.71-1.74 (m, 2H, naphthyl-O-CH_2CH_2), 1.94-1.96 (m, 2H, S-CH_2CH_2), 2.01 (bs, H, NH), 2.82-2.86 (t, 2H, CH_2-S-C=S), 3.72 (s, 3H, OCH_3),3.92-3.94 (d, 2H, CH_2 of benzylic proton),4.01-4.04 (t, 2H, CH_2-O-naphthyl), 6.65- 7.62 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 411; Analysis: $C_{23}H_{25}NO_2S_2$, Calcd. (%): C, 67.12, H, 6.12, N, 3.40, Obsd. (%): C, 67.67, H, 6.40, N, 3.67.

Cyclohexyl - dithiocarbamic acid - 2 - (napthalen - 2 - yloxy)ethyl ester (34)

Yeild: 0.714 g (85.5 %), m.p; 112 °C; IR (KBr, νmax, cm-1): 658 (C-S), 1103 (C=S), 1454 (Ar), 1502 (Ar), 1600 (Ar), 2851 (CH), 2926 (CH), 3373 (NH); 1 H NMR (CDCl3): δ = 1.41-1.45 (m, 6H,CH_2 of cyclohexyl ring), 1.62- 1.64 (m, 4H, CH_2 of cyclohexyl ring), 2.0 (bs, H, NH), 2.54-2.58 (m, H, tertiary H of cyclohexyl ring), 3.26-3.29 (t, 2H, CH_2-S-C=S), 4.71-4.74 (t, 2H, CH_2-O-naphthyl), 6.98-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 345; Analysis: $C_{19}H_{23}NOS_2$, Calcd. (%): C, 66.05, H, 6.71, N, 4.05, Obsd. (%): C, 65.65, H, 6.97, N, 4.23.

Cyclohexyl - dithiocarbamic acid - 3 - (napthalen-2-yloxy)propyl ester (35)

Yield: 0.714 g (85.5 %); m.p.: 112 °C; IR (KBr, νmax, cm-1): 658 (C-S), 1103 (C=S), 1454 (Ar), 1502 (Ar), 1600 (Ar), 2851 (CH), 2927 (CH), 3373 (NH); 1 H NMR (CDCl3): δ = 1.44-1.48 (m, 6H,CH_2 of cyclohexyl ring), 1.63-1.66 (m, 4H, CH_2 of cyclohexyl ring), 2.0 (bs, H, NH), 2.54-2.59 (m, H, tertiary H of cyclohexyl ring), 3.28-3.30 (t, 2H, CH_2-S-C=S), 4.71-4.73 (t, 2H, CH_2-O-naphthyl), 6.95- 7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 345; Analysis: $C_{19}H_{23}NOS_2$, Calcd. (%): C, 66.05, H, 6.71, N, 4.05, Obsd. (%): C, 65.65, H, 6.97, N, 4.23.

Cyclohexyl - dithiocarbamic acid - 4 - (napthalen-2-yloxy)butyl ester (36)

Yield: 0.75 g (94.5 %); m.p.: 126 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1121 (C=S), 1469 (Ar), 1523 (Ar), 1617 (Ar), 2879 (CH), 2937 (CH), 3408 (NH); 1 H NMR (CDCl3): δ = 1.42-1.44 (m, 6H, CH_2 of cyclohexyl ring), 1.65-1.68 (m, 4H, CH_2 of cylohexyl ring), 1.71-1.73 (m, 2H, naphthyl-O-CH_2CH_2), 1.94-1.96 (m, 2H, S-CH_2CH_2), 2.0 (bs, H, NH), 2.54-2.57 (m, H, tert. CH of cylohexyl ring), 2.84- 2.88 (t, 2H, CH_2-S-C=S), 4.02-4.06 (t, 2H, CH_2-O-

naphthyl), 6.98-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 373; Analysis: $C_{21}H_{27}NOS_2$, Calcd. (%): C, 67.52, H, 7.28, N, 3.75, Obsd. (%): C, 67.84, H, 7.12, N, 3.59.

Benzyl - dithiocarbamic acid -2-(napthalen-2-yloxy)-ethyl ester (37)

Yield: 0.75 g (87.3 %); m.p.: 101 °C; IR (KBr, νmax, cm-1): 662 (C-S), 1112 (C=S), 1464 (Ar), 1512 (Ar), 1603 (Ar), 2865 (CH), 2926 (CH), 3385 (NH); 1 H NMR (CDCl3): δ = 2.0 (bs, H, NH), 3.26-3.32 (t, 2H, CH_2-S-C=S), 3.92-3.94 (d, 2H, benzylic proton), 4.71-4.73 (t, 2H, CH_2-O-naphthyl), 6.98-7.65 (m, 12H, Ar-H of naphthyloxy); Mass: m/e 353; Analysis: $C_{20}H_{19}NOS_2$, Calcd. (%): C, 67.95, H 5.42, N, 3.96, Obsd. (%): C, 67.63, H, 5.58, N, 4.12.

Benzyl - dithiocarbamic acid -3-(napthalen-2-yloxy)-propyl ester (38)

Yield: 0.75 g (89.8 %); m.p.: 109 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1114 (C=S), 1474 (Ar), 1514 (Ar), 1612 (Ar), 2863 (CH), 2926 (CH), 3398 (NH); 1 H NMR (CDCl3): δ = 2.0 (bs, H, NH), 2.38-2.42 (m, 2H, naphthyl-$OCH_2CH_2CH_2$-S-C=S), 2.82-2.86 (t, 2H, CH_2-S-C=S), 3.91-3.93 (d, 2H, CH_2 of benzylic hydrogens), 4.01-4.04 (t, 2H, CH_2-Onaphthyl), 6.96-7.62 (m, 12H, Ar-H of naphthyloxy); Mass: m/e 367; Analysis: $C_{21}H_{21}NOS_2$, Calcd. (%): C, 68.63, H, 5.76, N, 3.81, Obsd. (%): C, 68.27, H, 5.94, N, 4.02.

Benzyl - dithiocarbamic acid -4-(napthalen-2-yloxy)-butyl ester (39)

Yield: 0.75 g (92.8 %); m.p.: 119 °C; IR (KBr, νmax, cm-1): 673 (C-S), 1126 (C=S), 1484 (Ar), 1529 (Ar), 1612 (Ar), 2873 (CH), 2936 (CH), 3398 (NH); 1 H NMR (CDCl3): δ = 1.71-1.74 (m, 2H, naphthyl-O-CH_2CH_2), 1.96-1.99 (m, 2H, S-CH_2CH_2), 2.0 (bs, H, NH), 2.84-2.88 (t, 2H, CH_2-S-C=S), 3.91-3.94 (d, 2H, CH_2 of benzylic proton), 4.01-4.04 (t, 2H, CH_2-O-naphthyl), 6.96-7.65 (m, 12H, Ar-H of naphthyloxy); Mass: m/e 381; Analysis: $C_{22}H_{23}NOS_2$, Calcd. (%): C, 69.25, H 6.08, N, 3.67, Obsd. (%): C, 69.67, H, 5.87, N, 3.46.

Phenyl ethyl - dithiocarbamic acid - 2 - (napthalen-2-yloxy)ethyl ester (40)

Yield: 0.78 g (88.2 %); m.p.: 146 °C; IR (KBr, νmax, cm-1): 661 (C-S), 1112 (C=S), 1464 (Ar), 1514 (Ar), 1605 (Ar), 2865 (CH), 2923 (CH), 3376 (NH); 1 H NMR (CDCl3): δ = 2.0 (bs, H, NH), 2.80-2.82 (t, 2H, $PhCH_2$), 2.96- 2.98 (m, 2H, $NHCH_2CH_2Ph$), 3.28-3.31 (t, 2H, CH_2-S-C=S), 4.71-4.73 (t, 2H, CH_2-O-naphthyl), 6.98-7.62 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 367; Analysis: $C_{21}H_{21}NOS_2$, Calcd. (%): C, 68.63, H, 5.76, N, 3.81, Obsd. (%): C, 68.19, H, 6.06, N, 3.95.

Phenyl ethyl - dithiocarbamic acid - 3 - (napthalen-2-yloxy)propyl ester (41)

Yield: 0.8 g (91.4 %); m.p.: 172 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1126 (C=S), 1478 (Ar), 1519 (Ar), 1614 (Ar), 2878 (CH), 2933 (CH), 3396 (NH); 1 H NMR (CDCl3): δ = 2.0 (bs, H, NH), 2.35-2.41 (m, 2H, naphthyl-$OCH_2CH_2CH_2$-S-C=S), 2.80-2.82 (t, 2H, $PhCH_2$), 2.84-2.86 (t, 2H, CH_2-S-C=S), 2.96-3.02 (m, 2H, CH_2NH), 4.02-4.06 (t, 2H, CH_2-O-naphthyl), 6.95-7.62 (m, 12H, Ar-H of naphthyloxy and phenyl group); Mass: m/e 381; Analysis: $C_{22}H_{23}NOS_2$, Calcd. (%): C, 69.25, H, 6.08, N, 3.67, Obsd. (%): C, 68.87, H, 6.29, N, 3.89.

Phenyl ethyl - dithiocarbamic acid - 4 -(napthalen-2-yloxy)butyl ester (42)

Yield: 0.8 g (94.8 %); m.p.: 179 °C; IR (KBr, νmax, cm-1): 679 (C-S), 1149 (C=S), 1487 (Ar), 1533 (Ar), 1622 (Ar), 2884 (CH), 2944 (CH), 3438 (NH); 1 H NMR (CDCl3): δ = 1.72-1.74 (m, 2H, naphthyl-O-CH_2CH_2), 1.96- 1.97 (m, 2H, S-CH_2CH_2), 2.01 (bs, H, NH),2.80-2.82 (t, 2H, $PhCH_2$), 2.86-2.88 (t, 2H, CH_2-S-C=S), 2.96-3.00 (m, 2H, CH_2NH), 4.02-4.06 (t, 2H, CH_2-O-naphthyl), 6.98-7.62 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 395; Analysis: $C_{23}H_{25}NOS_2$, Calcd. (%): C, 69.93, H, 6.37, N, 3.54, Obsd. (%): C, 69.57, H, 6.55, N, 3.72.

Phenyl propyl - dithiocarbamic acid - 2 -(napthalen-2-yloxy)ethyl ester (43)

Yield: 0.84 g (90.2 %); m.p.: 119 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1114 (C=S), 1462 (Ar), 1514 (Ar), 1600 (Ar), 2862 (CH), 2925 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 1.86-1.88 (m, 2H, $PhCH_2CH_2CH_2NH$), 2.0 (bs, H, NH), 2.54-2.56 (t, 2H, $PhCH_2$), 2.65-2.64 (m, 2H, $NHCH_2CH_2CH_2Ph$), 3.28-3.31 (t, 2H, CH_2-S-C=S), 4.72-4.74 (t, 2H, CH_2-O-naphthyl), 6.95-7.62 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 381; Analysis: $C_{22}H_{23}NOS_2$, Calcd. (%): C, 69.25, H 6.08, N, 3.67, Obsd. (%): C, 69.66, H, 5.99, N, 3.35.

Phenyl propyl - dithiocarbamic acid - 3 - (napthalen-2-yloxy)propyl ester (44)

Yield: 0.84 g (93.2 %); m.p.: 135 °C; IR (KBr, νmax, cm-1): 682 (C-S), 1129 (C=S), 1481 (Ar), 1533 (Ar), 1626 (Ar), 2884 (CH), 2936 (CH), 3416 (NH); 1 H NMR (CDCl3): δ = 1.86-1.89 (m, 2H, $Ph.CH_2CH_2CH_2$), 2.0 (bs, H, NH), 2.38-2.42 (m, 2H, naphthyl-O-$CH_2CH_2CH_2$-SC=S), 2.52-2.55 (t, 2H, $PhCH_2$), 2.62-2.64 (m, 2H, $NHCH_2$), 2.84-2.88 (t, 2H, CH_2-S-C=S), 4.02-4.05 (t, 2H, CH_2-Onaphthyl), 6.98-7.65 (m, 12H, Ar-H of naphthyloxy and phenyl group); Mass: m/e 395; Analysis: $C_{23}H_{25}NOS_2$, Calcd. (%): C, 69.83, H 6.37, N, 3.54, Obsd. (%): C, 69.34, H, 6.66, N, 3.74.

Phenyl propyl - dithiocarbamic acid - 4-(napthalen-2-yloxy)butyl ester (45)

Yield: 0.85 g (97.6 %); m.p.: 154 °C; IR (KBr, νmax, cm-1): 692 (C-S), 1139 (C=S), 1486 (Ar), 1539 (Ar), 1628 (Ar), 2882 (CH), 2948 (CH), 3427 (NH); 1 H NMR (CDCl3): δ = 1.71-1.73 (m, 2H, naphthyl-O-CH_2CH_2), 1.86- 1.88 (m, 2H, $PhCH_2CH_2CH_2NH$), 1.96-1.99 (m, 2H, SCH_2CH_2), 2.02 (bs, H, NH), 2.54-2.56 (t, 2H, $PhCH_2$), 2.64- 2.68 (m,2H,$PhCH_2CH_2CH_2$-N), 2.84-2.86

(t, 2H, CH_2-S-C=S), 2.98-3.01 (m, 2H, CH_2NH), 4.02-4.06 (t, 2H, CH_2-Onaphthyl), 6.98-7.62 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 409; Analysis: $C_{24}H_{27}NOS_2$, Calcd. (%): C, 70.37, H, 6.64, N, 3.42, Obsd. (%): C, 69.95, H, 6.86, N, 3.62.

Di - sec - butyl - dithiocarbamic acid-2-(napthalen-2-yloxy)ethyl ester (46)

Yield: 0.84 g (90.2 %); m.p.: 119 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1115 (C=S), 1462 (Ar), 1514 (Ar), 1601 (Ar), 2865 (CH), 2926 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 1.08-1.10 (d, CH_3), 2.75-2.79 (m, 8H, $CH_3CH_2CH_3$), 1.38- 1.41 (M, 6H, CH_3CHCH_3), 0.94-0.96 (t, 2H,CH_3CHCH_2), 3.28- 3.30 (t, 2H, CH_2-S-C=S), 4.71-4.73 (t, 2H, CH_2-O-naphthyl), 6.95-7.63 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 375.59; Analysis: $C_{21}H_{29}NOS_2$, Calcd. (%): C, 67.10, H 7.75, N, 3.70, O, 4.22, S, 17.05. Obsd. (%): C, 67.15, H, 7.78, N, 3.73, O, 4.26, S, 17.07.

Di - sec - butyl - dithiocarbamic acid - 3-(napthalen-2-yloxy) propyl ester (47)

Yield: 0.84 g (90.2 %); m.p.: 119 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1114 (C=S), 1462 (Ar), 1514 (Ar), 1600 (Ar), 2862 (CH), 2925 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 1.08-1.10 (d, CH_3), 2.75-2.79 (m, 8H, $CH_3CH_2CH_3$), 1.38-1.41 (M, 6H, CH_3CHCH_3), 0.94-0.96 (t, 2H,CH_3CHCH_2), 3.28-3.30 (t, 2H, CH_2-S-C=S), 2.35-2.39(m, 2H, $CH_2CH_2CH_2$), 4.72-4.74 (t, 2H, CH2-O-naphthyl), 6.96- 7.62 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 389.62; Analysis: $C_{22}H_{31}NOS_2$, Calcd. (%): C, 67.80, H 8.01, N, 3.60, O, 4. 10, S, 16.42. Obsd. (%): C, 67.82, H, 8.02, N, 3.59, O, 4.11, S, 16.46.

Di - sec - butyl - dithiocarbamic acid - 4 -(napthalen-2-yloxy)butyl ester (48)

Yield: 0.84 g (90.2 %); m.p.: 119 °C; IR (KBr, νmax, cm-1): 668 (C-S), 1114 (C=S), 1465 (Ar), 1514 (Ar), 1600 (Ar), 2865 (CH), 2927 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 1.08-1.10 (d, CH_3), 2.75-2.79 (m, 8H, $CH_3CH_2CH_3$), 1.38- 1.41 (M, 6H, CH_3CHCH_3), 0.94-0.96 (t, 2H,CH_3CHCH_2), 3.27- 3.31 (t, 2H, CH_2-S-C=S), 1.92-1.96 (m, 2H, $CH_2CH_2CH_2$), 1.68-1.71 (m, 2H, $CH_2CH_2CH_2$), 4.71-4.73 (t, 2H, CH_2-Onaphthyl), 6.97-7.64 (m, 12H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 403.64; Analysis: $C_{23}H_{33}NOS_2$, Calcd. (%): C, 68.41, H 8.20, N, 3.44, O, 3.92, S, 15.87. Obsd. (%): C, 68.44, H, 8.24, N, 3.47, O, 3.96, S, 15.89.

Biological Testing

DPPH Radical Scavenging Activity of the Experiment

The initial absorbance of the DPPH in ethanol (concentration = 0.04 mM) was measured at 517 nm and was maintained constant throughout the period of assay. All the sample compounds were dissolved and eventually further diluted in 80% EtOH. Different test concentrations (2.5, 5, 10, 20 and 40 mg/ mL) or carrier solvent alone was added to 2 mL of ethanolic DPPH solution with three replicates each. The change in absorbance at 517 nm was measured with time and free radical scavenging activity was calculated as inhibition using following equation:

Percentage DPPH radical scavenging activity = 1 - [As/ Ac] X 100,

where As: absorbance of the DPPH solution containing samples. Ac: absorbance of the control solution without sample but with DPPH. The experiment was also conducted using vitamin C as a reference antioxidant.

ABTS Radical Scavenging Activity of the Experiment(TRAP)

In this method, an antioxidant was added to a pre-formed ABTS radical solution and after a fixed time period the remaining ABTS.+ was quantified spectrophotometrically at 734 nm. ABTS.+ was produced by reacting ABTS with oxidant solution ($K_2S_2O_8$) at the Volume ratio of 1:1, stored in the dark at room temperature for 16 h. The ABTS.+ solution was diluted to give an absorbance of 0.750 ± 0.025 at 734 nm in 80% EtOH. All the compounds tested were dissolved and eventually further diluted in 80% EtOH. 200 mL different test concentrations (2.5, 5, 10, 20 and 40 mg/mL) or carrier solvent alone was added to 4 mL of ethanolic DPPH solution with three replicates each. The absorbance was recorded as time goes on after mixing and the percentage of radical scavenging was calculated for each concentration relative to a blank containing no scavenger. The extent of decolorization was calculated as percentage reduction of absorbance.

Percentage ABTS radical scavenging activity = 1 - [As/ Ac] X 100,

where As: absorbance of the ABTS solution containing samples. Ac: absorbance of the control solution without sample but with ABTS. The experiment was also conducted using vitamin C as a reference antioxidant.

ROO_Radical Scavenging Activity of the Experiment (TRAP)

In this method, 0.02 g ABTS and 0.27 g of 2,20-Azobis (2-methylpropionamidine) dihydrochloride (AAPH) was dissolved in acetate buffer solution (PH = 4.3) and transferred to the 500mL volumetric flask. The solution was treated with 45 ^{0}C water bath for an hour, and then cooled to room temperature. 200 mL different concentrations (2.5, 5,10, 20, and 40 mg/mL) or carrier solvent alone was added to 4 mL of ethanolic ROO. solution with three replicates each. The changes in absorbance at 734 nm were recorded.

Percentage ROO. radical scavenging activity = 1 - [As/ Ac] X 100,

where As: absorbance of the ROO. solution containing samples. Ac: absorbance of the control solution without sample but with ROO.. The experiment was also conducted using vitamin C as a reference antioxidant.

O^{2-} Radical Scavenging Activity of the Experiment (NET)

0.04 g KO_2 and 0.3 g 18-Crown-6 were dissolved with 100 mL anhydrous DMSO to create O^{2-} radical. 1.2 g nitrotetrazolium blue chloride (NET) was dissolved in 100mL of anhydrous DMSO to be used for determining absorbance. 100 mL of different test concentrations (2.5, 5, 10, 20, and 40 mg/ mL) or carrier solvent alone was added to 200 mL of ethanolic O^{2-} solution with three replicates each react for 5 min and then added with 200 mL of NET solution reacted for 5 min. to determine the absorbance of 680 nm through following equation:-

Percentage O^{2-} radical scavenging activity = 1 - [As/Ac] X 100,

where As: absorbance of the O^{2-} solution containing samples. Ac: absorbance of the control solution without sample but with O^{2-}. The experiment was also conducted using vitamin C as a reference antioxidant.

CONCLUSION

We have synthesized a series of dithiocarbamates of ω-substituted (2-naphthyloxy) alkanes. Antioxidant activity of these hybrid compounds were studied by radicals 1,1-diphenyl-2-picryl-hydrazyl (DPPH) assay, 2,2-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid) (ABTS) assay, ROO. (TRAP) assay and O^2. (NET) assay against curcumin and vitamin C as standard drug.

ACKNOWLEDGEMENT

The authors gratefully acknowledge fruitful discussions with Dr. Devdutt Chaturvedi regarding the research and Amity University Uttar Pradesh (AUUP), Lucknow Campus, Lucknow, U.P., for their constant encouragement and support for research. Financial support from the Department of Science and Technology (DST), Govt. of India (Grant No.SR/FT/CS-147/2010) is gratefully acknowledged.

REFERENCES

Aucagne, V. Lorin, C. Tatibouet, A. & Rollin, P. (2005). Regioselective Michael-induced cyclisation of γ- and δ-hydroxy vinyl sulphides and vinyl dithiocarbamates. *Tetrahedron Letters, 46*, 4349-4352. https://doi.org/10.1016/j.tetlet.2005.04.112

Bacharaju, K. Jambula, S. R. Sivan, S. Tangeda, S. J. & Manga, V. (2012). Design, synthesis, molecular docking, and biological evaluation of new dithiocarbamates substituted benzimidazole and chalcones as possible chemotherapeutic agents. *Biomedicinal Medicinal Chemical Letters, 22,* 3274-3277. https://doi.org/10.1016/j.bmcl.2012.03.018

Bahrin, L. J. Jones, P. J. & Hopf, H. (2012). Tricyclic flavonoids with 1,3-dithiolium substructure. *Beilstein Journal of Organic Chemistry, 8,* 1999-2003. https://doi.org/10.3762/bjoc.8.226

Cao, S. L. Feng, Y. P. Zheng, X. L. Jiang, Y. Y. Zhang, M. Wang, Y. & Xu M. (2006). Synthesis of substituted benzylamino- and heterocyclylmethylamino carbodithioate derivatives of 4-(3H)-quinazolinone and their cytotoxic activity. Archiv der Pharmazie. *Chemistry in Life Sciences, 339,* 250-254. https://doi.org/10.1002/ardp.200500264

Cao, S. L. Han, Y. Yuan, C. Z. Wang, Y. Xiahou, Z. K. Liao, J. Gao, R. T. Mao, B. B. Zhao, B. L. Li, Z. F. & Xu, X. (2013). Synthesis and antipoliferative activity of 4-substituted-piperazine-1-carbodothioate derivatives of 2,4-diaminoqinazoline. *European Journal of Medicinal Chemistry, 64*, 401-409. https://doi.org/10.1016/j.ejmech.2013.04.017

Cao, S. L. Wang, Y. Zhu, L. Liao, J. Guo, Y. W. Chen, L. L. Liu, H. Q. & Xu, X. (2010). Synthesis and cytotoxic activity of N-((2-methyl-4(3H)-quinazolinon-6-yl) methyl) dithiocarbamates. *European Journal of Medicinal Chemistry, 45*, 3850-3857. https://doi.org/10.1016/j.ejmech.2010.05.038

Charati, F. R. Hossaini, Z. & Hajinasiri, R. (2012). Solvent-free multicomponent reactions of dithiocarbamates, activated acetylenes and isocyanide. *Journal of Applied Chemistry Research, 20*, 54-59.

Coro, J. Atherton, R. Little, S. Wharton, H. Yardley, V. Alvarez, A. Suarez, M. & Perez, R. (2006). Rodriguez H. Alkyl-linked bis-THTT derivatives as potent in vitro trypanocidal agents. *Biorganic Medicinal Chemistry, 16*, 1312-1315. http://dx.doi.org/10.1016/j.bmcl.2005.11.060

Das, P. Kumar, C. K. Kumar, N. Innus, M. Iqbal, J. & Srinivas, N. (2008). Dithiocarbamate and CuO promoted one-pot synthesis of 2-(N-substituted)-aminobenzimidazoles and related heterocycles. *Science Direct, 49*, 992 -995. http://dx.doi.org/10.1016%2Fj.tetlet.2007.12.022

Greene, T.W. & Wuts, T. P. G. M. (2006). Protective Group in Organic Synthesis. John Wiley and Sons Inc, 4th Ed. ISBN: 978-0-470-05348-5.

Halimjani, A. Z. Pourshojaei, Y. & Saidi, M. R. (2009). Highly efficient and catalyst-free synthesis of unsymmetrical thioureas under solvent-free conditions. *Tetrahedron Letters, 50*, 32-34. http://dx.doi.org/10.1016/j.tetlet.2008.10.063

Halls, D. J. (1969). The properties of dithiocarbamates. *Mikrochemica Acta, 57*, 62-77. https://doi.org/10.1007/BF01216666

He, X. Y. Lu, L. Qiu, J. Zou, P. Yu, F. Jiang, X. K. Li, L. Jiang, S. Liu, S. & Xie, L. (2013). Small molecule fusion inhibitors: design, synthesis and biological evaluation of (Z)-3-(5-(3-benzyl-4-oxo-2-thioxoazolidinylidene) methyl)-N-(3-carboxy-4-hydroxy)phenyl-2,5-dimethylpyrroles and related derivatives targeting HIV-1 gp41. *Bioorganic Medicinal Chemistry, 21*, 7539-7548. https://doi.org/10.1016/j.bmc.2013.04.046

Heda, K. M. & Deshmukh, S. P. (2011). Synthesis and antimicrobial activity of 4-aryl-5-hepta-O-benzoyl-β-D-lactosylimino-3-thio-1,2,4-dithioazolidine [hydrochloride]. *International Journal of Chemical Science, 9*, 1705-1710.

Horita, Y. Takii, T. Kuroishi, R. Chika, T. Ogawa, K. Kremer, L. Sato, Y. Lee, Y. Hassegawa, T. & Onozaki, K. (2011). Synthesis and evaluation of anti-tubercular

activity of new dithiocarbamate sugar derivative. *Biorganic Medicinal Chemistry, 21*, 899-903. https://doi.org/10.1016/j.bmcl.2010.12.084

Hou, X. Ge, Z. Wang, T. Guo, W. Wu, J. Cui, J. Lai, C. & Li, R. (2011). Synthesis, and structure-activity relationship of a novel class of dithiocarbamic acid esters as anticancer agent. Archiv der Pharmazie. *Chemistry in Life Sciences, 11*, 320-332. https://doi.org/10.1002/ardp.201000259

Jamir, J. Sinha, U. B. Nath, J. & Patel, B. K. (2012). Environmentally benign one-pot synthesis of cyannamide from dithiocarbamates using I_2 and H_2O_2. *Synthetic Communication, 4*, 951-958. https://doi.org/10.1080/00397911.2010.532276

Jangir, S. Bala, V. Lal. N, Kumar, L. Sarswat, A. Kumar, A. Hamidullah, S. K. S. Sharma, V. Verma, V. Maikhuri, J. P. Konwar, R. Gupta, G. & Sharma, V. L. (2014). Novel alkylphospholipid-DTC hybrids as promising agents against endocrine related cancers acting via modulation of Akt-pathway. *European Journal of Medicinal Chemistry, 85*, 638-647. https://doi.org/10.1016/j.ejmech.2014.08.028

Khalizadeh, M. A. Hossaini, Z. Baradaran, M. A. & Hassania, A. (2010). A novel isocyanide-based three-component reaction: a facile synthesis of substituted 2H-pyran-3,4-dicarboxylates. *Tetrahedron Letters, 66*, 8464-8467. https://doi.org/10.1016/J.TET.2010.08.041

Kienle, M. Unsinn, A. & Knoche, P. (2010). Synthesis of dithiobenzophenes and related class of heterocycles by using functionalized dithiocarbamates. *Angewandte Chemie, 49*, 4751-4754. https://doi.org/10.1002/anie.201001025

Kumar, N. K. Sreeramamurthy, K. Palle, S. Mukkanti, K. & Das, P. (2010). Dithiocarbamate and DBU-promoted amide bond formation under microwave condition. *Tetrahedron Letters, 51*, 899-902. https://doi.org/10.1016/j.tetlet.2009.11.127

Liu, P. Li, C. Zhang, J. & Xu, X. (2013). Facile and versatile synthesis of alkyl and aryl isothiocyanates by using triphosgene and coolent. *Synthetic Communication, 43*, 3342-3351. http://dx.doi.org/10.1080/00397911.2013.783600

Marakov, V. Riabova, O. B. Yuschenko, A. Urlyapova, N. Daudova, A. Ziplef, P. F. & Mollmann, U. (2006). Synthesis and antileprosy activity of some dialkyldithiocarbamates. *Journal of Antimicrobial Chemotherapy, 57*, 1134-1138. https://doi.org/10.1021/jm9509556

Mayer, J. P. Lewis, G. S. & Zhang, M. J. (1997). Solid phase synthesis of quinazolines. *Tetrahedron Letters, 38*, 8445-8448. https://doi.org/10.1016/S0040-4039(97)10276-3.

Moellering, D. Mcandrew, J. Jo, H. Darley-Usmar, V. M. (1999). Effects of pyrrolidine dithiocarbamate on endothelial cells: protection against oxidative stress. *Free Radical Biological & Medicinal Chemistry, 26*, 1138–1145. https://doi.org/10.1016/s0891-5849(98)00300-1

Mohsin, U. A. (2014). Synthesis and biological evaluation of some new benzimidazole derivatives bearing dithiocarbamate moiety as potential cholinesterase inhibitors. *Curkova Medical Journal, 39*, 729-735. https://doi.org/10.1002/ardp.201200384

Orlinski, M. M. & Zimenkovskii, B. S. (1998). Synthesis and antioxidant activity of dithiocarbamates based on aliphatic diamines. *Pharmaceutical Chemistry Journal, 32*, 516-518.

Ozkanli, F. Ozkanli, A. G. Ozadali, G. K. Yildirim, E. & Erol, K. (2010). Synthesis, and pharmacology of some new N, N-Disubstituted Dithiocarbamate. *FABAD Journal of Pharmaceutical Science, 35*,19-27.

Shaw, S. J. (2008). The structure activity relationship of discodermolide analogues. *Mini-Review Medicinal Chemistry, 8*, 276-84. https://doi.org/10.2174/138955708783744137

Tandel, S. K. Rajappa, S. & Pansare, S. S. V.(1993). Conversion of thiocarbamates to carbamates. *Tetrahedron, 49*, 7479-7486.

Yang, L. Y. Cui, K. Lu, W. Luo, W. Wang, J. Huang, J. & Guo, C. (2011). Synthesis and Antimalarial activity of novel Dihydro-Artemisinin Derivatives. *Molecules,16*, 4527-4538. https://doi.org/10.3390/molecules16064527

Zahram, M. A. H. Salem, T. A. R. Samaka, R. M. Agwa, H. S. & Awad, A. K. (2008). Design, synthesis and antitumor evaluation of novel thalidomide dithiocarbamate and dithioate analogs against ehrilch ascites carcinoma. *Biorganic Medicinal Chemistry, 16*, 9708-9718. https://doi.org/10.1016/j.bmc.2008.09.071

Zahran, M. A. H. Salem, T. A. R. Samaka, R. M. Agwa, H. S. & Awad, A. R. (2008). Design, synthesis, and antitumor evaluation of novel thalidomide dithiocarbamate and dithioate analogs against Ehrlich ascites carcinoma-induced solid tumor in Swiss albino mice. *Bioorganic & Medicinal Chemistry, 16*, 9708–9718. https://doi.org/10.1016/j.bmc.2008.09.071

Zaidi, S. Chaturvedi, A. K. Singh, N. & Chaturvedi, D. (2017). Triton-B catalyzed, efficient and solvent-free approach for the synthesis of dithiocarbamates. *Current Chemical Letters, 6*, 143-150. http://dx.doi.org/10.5267/j.ccl.2017.7.001

Zhu, B. Z. Carr, A. C. & Frei, B. (2002). Pyrrolidine dithiocarbamate is a potent antioxidant againsthypochlorous acid-induced protein damage. *FEBS Letters, 532*, 80-84. https://doi.org/10.1016/s0014-5793(02)03637-2

Zou, Y. Yu, S. Li, R. Zhao, Q. Li, X. Wu, M. Huang, T. Chai, X. Hu, H. and Wu, Q. (2014). Synthesis, antifungal activities and molecular docking studies of novel 2-(2,4-difluorophenyl)-2-hydroxy-3-(1H-1,2,4-triazol-1-yl) propyl dithiocarbamates. *European Journal of Medicinal Chemistry, 74*, 366-374. https://doi.org/10.3390%2Fmolecules23102457