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$_2^.$ (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), antiprotrozoal (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) antiproliferative (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 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), antiprotrozoal (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) antiproliferative (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
structurally diverse biological strong synthetic molecules 
or intermediates such as isothiocyanates (Liu P et al 2013), 
thiourea (Halimjani AZ et al 2009) cyanamide (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 piperezine, piperidine, and pyrrolidine amine

Figure 2: Scheme 1: Reaction procedure for the synthesis of Prototype I: a Anhyd. K₂CO₃, dry acetone, reflux, 12-15 h, 98%; 
b Triton B, CS₂, Dry DMSO, Amine, 20-30 min.

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

Table 1: 

Prototype I (Comp. no. 4-48)

<table>
<thead>
<tr>
<th>Reaction Procedure</th>
<th>Result</th>
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<tbody>
<tr>
<td>a</td>
<td>Phenyl propyl amine (Comp. no. 4-48)</td>
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<td>b</td>
<td>Primary amine</td>
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https://journals.e-palli.com/home/index.php/ajcp
Table 1: Synthesis designed dithiocarbamates of Prototype I (Comp. No. 4-48)

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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, 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)

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<tr>
<th>Compound</th>
<th>DPPH IC_{50} (µM)</th>
<th>ABTS IC_{50} (µM)</th>
<th>TRAP IC_{50} (µM)</th>
<th>NET IC50 (µM)</th>
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</table>
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 CDCl₃ 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 K₂CO₃ (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 Na₂SO₄. 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 CS₂, 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 Na₂SO₄ which gave the product, i.e., the prototype I (compound no. 4-48).

Experimental Methods

Synthesis

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

In dry acetonitrile (200 mL), the mixture was refluxed for around 12–15 hours comprising of β-naphthol 1 (20 grams, 0.14 mol), anhydrous K₂CO₃ (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°C; IR (KBr, cm⁻¹): ν = 1455 (Ar), 1508 (Ar), 1585 (Ar), 2878 (CH), 2927 (CH); 1H NMR (400 MHz, CDCl₃): δ = 3.81 (t, 2H, CH₂Cl), 4.26 (t, 2H, OCH₂), 6.97–7.64 (m, 7H, Ar–H); 13C NMR (100 MHz, CDCl₃): 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: C₁₂H₁₁ClO, 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: 98°C; IR (KBr, cm⁻¹): ν = 1461 (Ar), 1512 (Ar), 1596 (Ar), 2855 (CH), 2940 (CH) cm⁻¹; 1H NMR (400 MHz, CDCl₃): δ = 2.27–2.33 (m, 2H, CH₂), 3.80 (t, 2H, CH₂Cl), 4.25 (t, 2H, OCH₂), 7.12–7.77 (m, 7H, Ar–H) ppm; Mass (EIMS): m/z = 220; Analysis: C₁₃H₁₃ClO, Calcd: C, 70.75; H, 5.36; Obsd: C, 70.79; H, 6.21%.

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

Yield: 32 g (98%); mp: 1120C; IR (KBr, cm⁻¹): ν = 1461 (Ar), 1510 (Ar), 1599 (Ar), 2887 (CH), 2941 (CH) cm⁻¹; 1H NMR (400 MHz, CDCl₃): δ = 2.15–2.20 (m, 4H, CH₂CH₂), 3.79 (t, 2H, CH₂Cl), 4.24 (t, 2H, OCH₂), 7.13–7.77 (m, 7H, Ar–H) ppm; Mass (EIMS): m/z = 234; Analysis: C₁₄H₁₅ClO, 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
Butyl-dithiocarbamic acid-2-(naphthalen-2-xylo)ethyl ester (4)

Yield: 0.73 g (93.5 %); m.p.: 106°C; IR (KBr, νmax, cm⁻¹): 2968 (CH), 2930 (CH), 2875 (CH), 2864 (CH), 2395 (CH), 1725 (C=O); 1 H NMR (CDCl₃): δ = 0.93-0.96 (t, 3H, CH₃), 1.30-1.34 (m, 2H, CH₂CH₃), 1.53-1.55 (m, 2H, CH₂CH₂CH₃), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, NHCH₂), 3.82-3.86 (t, 2H, CH₂S-C=S), 4.02-4.04 (t, 2H, CH₂-O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthoxy); Mass: m/e 375; Analysis: C₂₂H₂₂N₂O₂S. Calcd. (%): C, 63.91; H, 6.63; N, 4.38; Obsd. (%): C, 64.19; H, 6.49; N, 4.24.

Butyl-dithiocarbamic acid-3-(naphthalen-2-xylo)propyl ester (5)

Yield: 0.73 g (93.5 %); m.p.: 106°C; IR (KBr, νmax, cm⁻¹): 2968 (CH), 2930 (CH), 2875 (CH), 2864 (CH), 2395 (CH), 1725 (C=O); 1 H NMR (CDCl₃): δ = 0.93-0.96 (t, 3H, CH₃), 1.33-1.35 (m, 2H, CH₂CH₃), 1.53-1.55 (m, 2H, CH₂CH₂CH₃), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, NHCH₂), 2.84-2.86 (t, 2H, CH₂S-C=S), 3.55-3.59 (m, 2H, CH₂CH₂CH₃), 4.01-4.05 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthoxy); Mass: m/e 333; Analysis: C₁₅H₁₅N₂O₂S. Calcd. (%): C, 65.91; H, 6.63; 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-(naphthalen-2-xylo)butyl ester (6)

Yield: 0.73 g (93.5 %); m.p.: 106°C; IR (KBr, νmax, cm⁻¹): 2968 (CH), 2930 (CH), 2875 (CH), 2864 (CH), 2395 (CH), 1380 (C-S), 1116 (C=S), 1454 (Ar), 1511 (Ar), 1610 (Ar), 2864 (CH), 2935 (CH), 3390 (NH); 1 H NMR (CDCl₃): δ = 0.93-0.96 (t, 3H, CH₃), 1.30-1.35 (m, 2H, CH₂CH₃), 1.53-1.55 (m, 2H, CH₂CH₂CH₃), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, NHCH₂), 2.85-2.87 (t, 2H, CH₂S-C=S), 3.55-3.59 (m, 2H, CH₂CH₂CH₃), 4.00-4.05 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthoxy); Mass: m/e 375; Analysis: C₁₅H₁₅N₂O₂S. Calcd. (%): C, 65.91; H, 6.63; N, 4.38; S, 19.15; Obsd. (%): C, 65.82; H, 6.95; N, 4.20; S, 19.23 %; O, 4.80.

Hexyl-dithiocarbamic acid-2-(naphthalen-2-xylo)ethyl ester (7)

Yield: 0.8 g (96.4 %); m.p.: 119°C; IR (KBr, νmax, cm⁻¹): 2936 (CH), 3394 (NH); 1 H NMR (CDCl₃): δ = 0.92-0.95 (t, 3H, CH₃), 1.27-1.29 (m, 4H, CH₂CH₂CH₂CH₃ of hexyl group), 1.31-1.35 (m, 2H, CH₂CH₃ of hexyl group), 1.52-1.56 (m, 2H, CH₂CH₂CH₃ of hexyl group), 2.0 (bs, H, NH), 2.36-2.40 (m, 2H, naphthyl-O-CH₂CH₂CH₃-C=S), 2.63-2.65 (m, 2H, NHCH₂), 3.24-3.29 (t, 2H, CH₂S-C=S), 4.68-4.73 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthoxy); Mass: m/e 347.14; Analysis: C₂₀H₁₉N₂O₂S. Calcd. (%): C, 66.44; H, 7.53; N, 3.87; Obsd. (%): C, 66.15; H, 7.25; N, 4.00; S, 18.45 %; O, 4.60.

Octyl-dithiocarbamic acid-2-(naphthalen-2-xylo)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), 2866 (CH), 2941 (CH), 3399 (NH); 1 H NMR (CDCl₃): δ = 0.92-0.94 (t, 3H, CH₃), 1.27-1.29 (m, 8H, CH₂CH₂CH₂CH₂CH₂CH₂CH₃ of octyl group), 1.32-1.34 (m, 2H, CH₂CH₃ of octyl group), 1.53-1.56 (m, 2H, CH₂CH₂N of n-octyl group), 2.0 (bs, H, NH), 2.62-2.64 (m, 2H, NHCH₂), 3.25-3.29 (t, 2H, CH₂S-C=S), 4.01-4.04 (t, 2H, CH₂-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthoxy); Mass: m/e 375.17; Analysis: C₂₃H₂₃N₂O₂S. Calcd. (%): C, 74.05; H, 7.78; N, 3.73; O, 4.22; S, 17.04; Obsd. (%): C, 74.63; H, 7.78; N, 3.73; O, 4.22; S, 17.07.

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Octyl-dithiocarbamic acid -3-(naphthalene-2-yloxy) propyl ester (11)
Yield: 0.86 g (96.2 %); m.p.: 172 °C; IR (KBr, νmax, cm-
-1): 667 (C=S), 1200 (C=S), 1472 (Ar), 1521 (Ar), 1612 (Ar), 2884 (CH), 2941 (CH), 3399 (NH); 1 H NMR (CDCl3): δ = 0.92-0.94 (t, 3H, CH3), 1.27-1.29 (m, 8H, CH3CH2CH2CH3 of octyl group), 1.30-1.32 (m, 2H, CH2CH of octyl group), 1.53-1.56 (m, 2H, CH2CHN of n-octyl group), 2.0 (bs, H, NH), 2.38-2.42 (m, 2H, naphthyl-OCH2CH2CH2CH3 of octyl group), 2.45-2.50 (t, 2H, CH2S=C=S), 4.01-4.04 (t, 2H, CH2O-naphthyl), 6.98-7.60 (m, 7H, Ar-H of naphthoxy); Mass: m/e 389; Analysis: C31H31NOS3, Calcd. (%): C, 67.62, H, 8.02, N, 3.59; Obsd. (%): C, 67.89, H, 7.90, N, 3.44.

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 (CDCl3): δ = 0.92-0.94 (t, 3H, CH3), 1.27-1.29 (m, 10H, CH3CH2CH2CH2CH2CH2CH3 of decyl group), 1.30-1.34 (m, 2H, CH2CH of decyl group), 1.52-1.58 (m, 2H, CH2CHN of n-decyl group), 2.0 (bs, H, NH), 2.62-2.66 (m, 2H, NHCH3), 2.84-2.87 (t, 2H, CH2S=C=S), 4.19-4.25 (m, 2H, S-CH2CH2CH2CH3 of pyrolidine ring), 2.84-2.87 (t, 2H, CH2S=C=S), 4.19-4.25 (m, 2H, S-CH2CH2CH2CH3 of pyrolidine ring), 2.8 (t, 2H, CH2O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthoxy); Mass: m/e 43170; Analysis: C31H31NOS3, 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-(naphthalen-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), 3392 (NH); 1 H NMR (CDCl3): δ = 1.58-1.60 (m, 4H, CH2 of propyridine ring), 2.8 (t, 4H, CH2N of propyridine ring (2H, CH2S=C=S), 4.71-4.73 (t, 2H, CH2O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthoxy); Mass: m/e 317; Analysis: C23H23NOS3, Calcd. (%): C, 64.32, H, 6.03, N, 4.41. Obsd. (%): C, 63.85, H, 6.29, N, 4.64.

Pyrollidine-dithiocarbamic acid-3-(naphthalen-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 (CDCl3): δ = 1.57-1.61 (m, 4H, CH2 of propyridine ring), 2.35-2.38 (m, 2H, naphthyl-OCH2CH2CH2CH3 of propyridine ring), 2.8 (t, 4H, CH2N of propyridine ring), 2.82-2.86 (t, 2H, CH2S=C=S), 4.02-4.04 (t, 2H, CH2O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthoxy); Mass: m/e 311; Analysis: C23H23NOS3, Calcd. (%): C, 65.22, H, 6.39, N, 4.23. Obsd. (%): C, 65.63, H, 6.12, N, 4.01.

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 (CDCl3): δ = 0.92-0.94 (t, 3H, CH3), 1.27-1.29 (m, 10H, CH3CH2CH2CH2CH2CH2CH3 of decyl group), 1.31-1.35 (m, 2H, CH2CH of decyl group), 1.53-1.56 (m, 2H, CH2CHN of n-decyl group), 2.01 (bs, H, NH), 2.36-2.56 (m, 2H, NHCH3), 3.25-3.29 (t, 2H, CH2S=C=S), 4.68-4.71 (t, 2H, CH2O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthoxy); Mass: m/e 403.25; Analysis: C25H25NOS3, 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 (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 (CDCl3): δ = 1.56-1.60 (m, 4H, CH2 of propyridine ring), 1.71-1.72 (m, 2H, naphthyl-OCH2CH3 of propyridine ring), 1.95-1.98 (m, 2H, S-CH2CH3), 2.8 (t, 4H, CH2N of propyridine ring), 2.84-2.88 (t, 2H, CH2S=C=S), 4.02-4.05 (t, 2H, CH2O-naphthyl), 6.97-7.64 (m, 7H, Ar-H of naphthoxy); Mass: m/e 345; Analysis: C25H25NOS3, 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, v max, cm⁻¹): 1605 (Ar), 1509 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR (CDCl₃): δ = 1.48-1.50 (m, 6H, CH₂ of piperidine ring), 2.7 (t, 4H, CH₂N of piperazine ring), 3.28-3.30 (t, 2H, CH₂-S=C=S), 4.71-4.73 (t, 2H, CH₂-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 375.55; Analysis: C₁₂H₁₃N₂O₂S, Calcd. (%): C, 60.72, H, 6.69, N, 11.23, O, 0.42, 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 - (naphthalen-2-yloxy)butyl ester (24)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, v max, cm⁻¹): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2925 (CH); 1 H NMR (CDCl₃): δ = 2.24-2.27 (s, 3H, CH₃ of methyl piperazine ring), 2.44-2.48 (t, CH₂N of piperazine ring), 2.0 (bs, H, NH), 2.84-2.87 (t, 2H, CH₂-SC=S), 2.34-2.38 (m, 2H, CH₂CH₂), 4.68-4.71 (t, 2H, CH₂-Onaphthyl), 6.96-7.63 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 375.55; Analysis: C₁₂H₁₃N₂O₂S, Calcd. (%): C, 60.72, H, 6.69, N, 11.23, O, 0.42, S, 17.05 % Obsd. (%): C, 60.76, H, 6.71, N, 11.19, O, 4.26, S, 17.08.

Morpholine 4-dithiocarbamic acid-2- (napthalen-2-yloxy)ethyl ester (25)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, v max, cm⁻¹): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR (CDCl₃): δ = 1.94-1.96 (m, 2H, CH₂CH₂CH₂), 1.68-1.71 (m, 2H, CH₂CH₂CH₂), 4.68-4.71 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 389.58; Analysis: C₁₂H₁₃N₂O₂S, 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.

4 - Methyl - piperazine - dithiocarbamic acid - 3 - (napthalen-2-yloxy)propyl ester (26)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, v max, cm⁻¹): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR (CDCl₃): δ = 1.94-1.96 (m, 2H, CH₂CH₂CH₂), 1.68-1.71 (m, 2H, CH₂CH₂CH₂), 4.68-4.71 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 382.50; Analysis: C₁₂H₁₃N₂O₂S, 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, v max, cm⁻¹): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR (CDCl₃): δ = 1.94-1.96 (m, 2H, CH₂CH₂CH₂), 1.68-1.71 (m, 2H, CH₂CH₂CH₂), 4.68-4.71 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 396.52; Analysis: C₁₂H₁₃N₂O₂S, 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-4- (napthalen-2-yloxy)propyl ester (27)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, v max, cm⁻¹): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR (CDCl₃): δ = 1.94-1.96 (m, 2H, CH₂CH₂CH₂), 1.68-1.71 (m, 2H, CH₂CH₂CH₂), 4.68-4.71 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 396.52; Analysis: C₁₂H₁₃N₂O₂S, 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-4- (napthalen-2-yloxy)propyl ester (27)
Yield: 0.66 g (82.5 %); m.p.: 89 °C; IR (KBr, v max, cm⁻¹): 662 (C-S), 1112 (C=S), 1461 (Ar), 1509 (Ar), 1605 (Ar), 2859 (CH), 2926 (CH); 1 H NMR (CDCl₃): δ = 1.94-1.96 (m, 2H, CH₂CH₂CH₂), 1.68-1.71 (m, 2H, CH₂CH₂CH₂), 4.68-4.71 (t, 2H, CH₂-O-naphthyl), 6.96-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 396.52; Analysis: C₁₂H₁₃N₂O₂S, 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.

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O-naphthyl), 6.96-7.63 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 410.55; Analysis: C_{21}H_{19}N_{2}O_{5}S_{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 - diithiocarbamic acid-2-(naphthalen-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), 1600 (Ar), 2851 (CH), 2928 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 2.34 (s, 3H, CH3), 3.28-3.30 (t, 2H, CH2-S=C-S), 4.0 (bs, H, NH), 4.70-4.72 (t, 2H, CH2-O-naphthyl), 6.35-7.62 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 353; Analysis: C_{19}H_{19}NO_{5}S_{2}. Calcd. (%): C, 76.79, H, 5.45, N, 3.99. Obsd. (%): C, 76.63, H, 5.58, N, 4.12.

**p-Tolyl - diithiocarbamic acid-3-(naphthalen-2-yloxy)propyl ester (29)**

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), 1601 (Ar), 2851 (CH), 2928 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 2.34 (s, 3H, CH3), 3.28-3.30 (t, 2H, CH2-S=C-S), 4.0 (bs, H, NH), 2.35-2.40 (s, CH2-NH2), 1.95-1.99 (m, 4H, CH2CH2), 4.68-4.71 (t, 2H, CH2-O-naphthyl), 6.34-7.64 (m, 11H, Ar-H of naphthyloxy and phenyl ring); Mass: m/e 367.53; Analysis: C_{22}H_{24}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 - diithiocarbamic acid-4-(naphthalen-2-yloxy)butyl ester (30)**

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), 1601 (Ar), 2851 (CH), 2928 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 2.34 (s, 3H, CH3), 3.28-3.30 (t, 2H, CH2-S=C-S), 4.0 (bs, H, NH), 2.35-2.40 (s, CH2-SCS), 3.25-3.27 (t, 2H, CH2-S-C=S), 1.94-1.96 (m, 2H, CH2CH2), 1.68-1.71 (m, 2H, CH2CH2CH2), 4.71-4.73 (t, 2H, CH2-O-naphthyl), 6.35-7.63 (m, 11H, Ar-H of naphthyl and phenyl ring); Mass: m/e 381.55; Analysis: C_{22}H_{24}NOS_{2}. Calcd. (%): C, 66.05, H, 6.71, N, 4.05. Obsd. (%): C, 65.65, H, 6.97, N, 4.23.

**Cyclohexyl - diithiocarbamic acid-2 - (naphthalen-2-yloxy)ethyl ester (34)**

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), 2926 (CH), 3373 (NH); 1 H NMR (CDCl3): δ = 1.41-1.45 (m, 6H, CH2 of cyclohexyl ring), 1.62-1.64 (m, 4H, CH2 of cyclohexyl ring), 2.0 (bs, H, NH), 2.54-2.58 (m, 2H, tertiary H of cyclohexyl ring), 3.26-3.29 (t, 2H, CH2-S=C=S), 4.71-4.74 (t, 2H, CH2-O-naphthyl), 6.98-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 345; Analysis: C_{15}H_{19}NOS_{2}. Calcd. (%): C, 66.05, H, 6.71, N, 4.05. Obsd. (%): C, 65.65, H, 6.97, N, 4.23.

**Cyclohexyl - diithiocarbamic acid-3 - (naphthalen-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, CH2 of cyclohexyl ring), 1.63-1.66 (m, 4H, CH2 of cyclohexyl ring), 2.0 (bs, H, NH), 2.54-2.59 (m, 2H, tertiary H of cyclohexyl ring), 3.28-3.30 (t, 2H, CH2-S=C=S), 4.71-4.73 (t, 2H, CH2-O-naphthyl), 6.95-7.62 (m, 7H, Ar-H of naphthyloxy); Mass: m/e 345; Analysis: C_{15}H_{19}NOS_{2}. Calcd. (%): C, 66.05, H, 6.71, N, 4.05. Obsd. (%): C, 65.65, H, 6.97, N, 4.23.

**Cyclohexyl - diithiocarbamic acid - 4 - (naphthalen-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, CH2 of cyclohexyl ring), 1.65-1.68 (m, 4H, CH2 of cyclohexyl ring), 1.71-1.73 (m, 2H, naphthyl-O-CH2CH2), 1.94-1.96 (m, 2H, S-CH2CH2), 2.0 (bs, H, NH), 2.54-2.57 (m, H, tert. CH of cyclohexyl ring), 2.84-2.88 (t, 2H, CH2-S=C=S), 4.02-4.06 (t, 2H, CH2-O-naphthyl).
naphthalen-2-yloxy)propyl ester (41)

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

Yield: 0.75 g (89.8 %); m.p.: 109 °C; IR (KBr, v_max, cm\(^{-1}\)): 668 (C-S), 1114 (C=S), 1474 (Ar), 1514 (Ar), 1612 (Ar), 2863 (CH), 2926 (CH), 3398 (NH); 1 H NMR (CDCl\(_3\)): δ = 1.71-1.74 (m, 2H, naphthyl-O-CH\(_2\)), 1.96-1.99 (m, 2H, S-CH\(_2\)S-C=S), 2.84-2.88 (t, 2H, CH\(_2\)-S-C=S), 3.91-3.94 (d, 2H, CH\(_2\) of benzylic hydrogens), 4.01-4.04 (t, 2H, CH\(_2\)-N), 6.96-7.62 (m, 12H, Ar-H of naphthyloxy); Mass: m/e 367; Analysis: C\(_{27}\)H\(_{28}\)NO\(_3\)S. Calcld. (%): C, 68.63, H, 5.76, N, 3.81, Obsd. (%): C, 68.67, H, 5.78, N, 3.46.

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

Yield: 0.78 g (88.2 %); m.p.: 146 °C; IR (KBr, v_max, cm\(^{-1}\)): 661 (C-S), 1126 (C=S), 1464 (Ar), 1514 (Ar), 1605 (Ar), 2865 (CH), 2923 (CH), 3376 (NH); 1 H NMR (CDCl\(_3\)): δ = 1.86-1.89 (m, 2H, phenyl-O-CH\(_2\)-CH\(_2\)), 2.38-2.42 (m, 2H, naphthyl-O-CH\(_2\)-CH\(_2\)-S-C=S), 2.52-2.55 (t, 2H, PhCH\(_2\)), 2.62-2.64 (m, 2H, NHCH\(_2\)CH\(_2\)Ph), 2.84-2.88 (t, 2H, CH\(_2\)-S-C=S), 4.02-4.05 (t, 2H, CH\(_2\)-Naphthyl), 6.98-7.65 (m, 12H, Ar-H of naphthyloxy and phenyl group); Mass: m/e 395; Analysis: C\(_{27}\)H\(_{28}\)NO\(_3\)S. Calcld. (%): C, 69.83, H, 6.37, N, 3.54, Obsd. (%): C, 69.66, H, 6.59, N, 3.35.

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

Yield: 0.8 g (91.4 %); m.p.: 172 °C; IR (KBr, v_max, cm\(^{-1}\)): 668 (C-S), 1126 (C=S), 1478 (Ar), 1519 (Ar), 1614 (Ar), 2878 (CH), 2933 (CH), 3396 (NH); 1 H NMR (CDCl\(_3\)): δ = 2.0 (bs, H, NH), 2.35-2.41 (m, 2H, naphthyl-OCH\(_2\)CH\(_2\)-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\(_2\)NH), 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\(_{27}\)H\(_{28}\)NO\(_3\)S. Calcld. (%): C, 69.25, H, 6.08, N, 3.67, Obsd. (%): C, 68.87, H, 6.29, N, 3.89.

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

Yield: 0.8 g (94.8 %); m.p.: 179 °C; IR (KBr, v_max, cm\(^{-1}\)): 679 (C-S), 1149 (C=S), 1487 (Ar), 1533 (Ar), 1622 (Ar), 2884 (CH), 2944 (CH), 3438 (NH); 1 H NMR (CDCl\(_3\)): δ = 1.72-1.74 (m, 2H, naphthyl-O-CH\(_2\)-CH\(_2\)), 1.96-1.97 (m, 2H, S-CH\(_2\)CH\(_2\)), 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\(_2\)NH), 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\(_{27}\)H\(_{28}\)NO\(_3\)S. Calcld. (%): C, 69.93, H, 6.37, N, 3.54, Obsd. (%): C, 69.57, H, 6.55, N, 3.72.

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

Yield: 0.84 g (90.2 %); m.p.: 119 °C; IR (KBr, v_max, cm\(^{-1}\)): 668 (C-S), 1114 (C=S), 1462 (Ar), 1514 (Ar), 1600 (Ar), 2862 (CH), 2925 (CH), 3388 (NH); 1 H NMR (CDCl\(_3\)): δ = 1.86-1.88 (m, 2H, PhCH\(_2\)CH\(_2\)CH\(_2\)NH), 2.0 (bs, H, NH), 2.54-2.56 (t, 2H, PhCH\(_2\)), 2.65-2.64 (m, 2H, NHCH\(_2\)CH\(_2\)Ph), 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\(_{30}\)H\(_{32}\)NO\(_3\)S. Calcld. (%): C, 69.25, H, 6.08, N, 3.67, Obsd. (%): C, 69.66, H, 5.99, N, 3.35.

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

Yield: 0.84 g (93.2 %); m.p.: 135 °C; IR (KBr, v_max, cm\(^{-1}\)): 682 (C-S), 1129 (C=S), 1481 (Ar), 1533 (Ar), 1626 (Ar), 2884 (CH), 2936 (CH), 3416 (NH); 1 H NMR (CDCl\(_3\)): δ = 1.86-1.89 (m, 2H, PhCH\(_2\)CH\(_2\)CH\(_2\)), 2.38-2.42 (m, 2H, naphthyl-O-CH\(_2\)-CH\(_2\)-S-C=S), 2.52-2.55 (t, 2H, PhCH\(_2\)), 2.62-2.64 (m, 2H, NHCH\(_2\)CH\(_2\)Ph), 2.84-2.88 (t, 2H, CH\(_2\)-S-C=S), 4.02-4.05 (t, 2H, CH\(_2\)-Naphthyl), 6.98-7.65 (m, 12H, Ar-H of naphthyloxy and phenyl group); Mass: m/e 395; Analysis: C\(_{30}\)H\(_{32}\)NO\(_3\)S. Calcld. (%): C, 69.83, H, 6.37, N, 3.54, Obsd. (%): C, 69.34, H, 6.66, N, 3.74.
Di - sec - butyl - dithiocarbamic acid-2-(naphthalen-2-yl)oxy)ethyl ester (46)

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), 1601 (Ar), 2865 (CH), 2925 (CH), 3388 (NH); 1 H NMR (CDCl3): δ = 1.08-1.10 (d, CH₃), 2.75-2.79 (m, 8H, CH₂CH₂CH₃), 1.38-1.41 (M, 6H, CH₂CH₂CH₂), 0.94-0.96 (t, 2H, CH₂CH₂CH₂), 3.28-3.30 (t, 2H, CH₂-S-C=S), 4.71-4.73 (t, 2H, CH₂-O-naphthyl), 6.95-7.63 (m, 12H, Ar-H of naphthoxy and phenyl ring); Mass: m/e 403.64; Analysis: C, 69.95, H, 6.86, N, 3.62.

Di - sec - butyl - dithiocarbamic acid - 3-(naphthalen-2-yl)oxy) 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, CH₃), 2.75-2.79 (m, 8H, CH₂CH₂CH₂), 1.38-1.41 (M, 6H, CH₂CH₂CH₂), 0.94-0.96 (t, 2H, CH₂CH₂CH₂), 3.28-3.30 (t, 2H, CH₂-S-C=S), 4.71-4.73 (t, 2H, CH₂-O-naphthyl), 6.95-7.62 (m, 12H, Ar-H of naphthoxy and phenyl ring); Mass: m/e 389.62; Analysis: C, 67.82, H, 8.02, N, 3.59, O, 4.26, S, 16.46.

Di - sec - butyl - dithiocarbamic acid - 4-(naphthalen-2-yl)oxy)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, CH₃), 2.75-2.79 (m, 8H, CH₂CH₂CH₂), 1.38-1.41 (M, 6H, CH₂CH₂CH₂), 0.94-0.96 (t, 2H, CH₂CH₂CH₂), 3.27-3.31 (t, 2H, CH₂-S-C=S), 1.92-1.96 (m, 2H, CH₂CH₂CH₂), 1.68-1.71 (m, 2H, CH₂CH₂CH₂), 4.71-4.73 (t, 2H, CH₂-O-naphthyl), 6.97-7.64 (m, 12H, Ar-H of naphthoxy and phenyl ring); Mass: m/e 403.64; Analysis: 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 (K₂S₂O₅) 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)

This method, 0.02 g ABTS and 0.27 g of 2,20-Azobis (2-methylpropionamide) dihydrochloride (AAPH) was dissolved in acetate buffer solution (PH = 4.3) and transferred to the 500mL volumetric flask. The solution was treated with 45 °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 100 mL 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 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 = \( \frac{A_{Ac} - A_{As}}{A_{Ac}} \times 100 \)

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.

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