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Synthesis a new series of α-acyloxycarboxamides-linked dithiocarbamates *via* passerini reaction

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Abstract: Novel α-acyloxycarboxamides containing dithiocarbamate groups were synthesized via the passerini condensation reaction. In this project, dithiocarbamate group were linked with carboxylic acid in a separate step and in continuance this acid were used in passerini three-component reaction.

Keywords: Dithiocarbamate, Multi-component reaction, Passerini reaction, α-acyloxycarboxamides.

Introduction

α-acyloxycarboxamides are one of important and well known organic compounds due to their use and presence in organic synthesis [1].The passerini reaction is the best way for the synthesis of α-acyloxycarboxamides involving the one-pot three-component condensation of isocyanides, aldehydes (carbonyl compounds) and carboxylic acids which are introduced for the first time by Passerini [2]. Various optimizations were done on this reaction to eventuate less reaction time and more yield [3]. Moreover, various modification of classical passerini-3-CR have been introduced which leading to the synthesis of new derivatives of α-acyloxycarboxamides with novel biological activities.

Dithiocarbamates are found valuable compounds among chemists and pharmacists due to their ability to use in organic synthesis as an intermediate compounds,[4]in molecular electronic devices [5], and etc,. Furthermore they are found valuable due to their biological activities like antifungal ones especially pathogenic fungal strains such as Candida Albicans, Aspergillus Flavus and Aspergillus Niger [6].

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In continue, the other example of biological activities are antibacterial activities which have shown positive results against pathogenic bacterial strains such as *Escherichia Coli*, *KlebsiellaPneumoniae*, *StaphylococeusAureus* and *Bacillus Subtilis* [6]. Moreover, It can be said that dithiocarbamates are found as anticancer agents in recent reports [7]. Also these are used in agriculture as pesticides and fungicides [8].

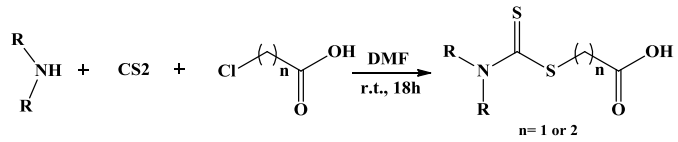
Result and Discussion

In the result of studying the importance of dithiocarbamates, herein we report thesynthesis of new α-acyloxycarboxamides containing dithiocarbamate *via* passerini three-component reaction (3CR) as an efficient method. To achieve this purpose, in the first step, a series of carboxylic acidcontaining dithiocarbamates were synthesized *via* one-pot three-component reaction of an amine, CS_2 and chloroacetic acid or chloropropionic acid as outline in Scheme **1**.

After this step, passerini three-component reaction between an aldehyde, a carboxylic acid containing dithiocarbamate group and an isocyanide were used for

the preparation of novel α-acyloxycarboxamides containing dithiocarbamate group.

The reaction proceeded in over-night time and in room temperature with good to excellent yields in the presence of CH_3OH as a solvent. The process is summarized in Table 1and products are shown in Table **2**.



Amine	n	Product	Yield(%)[a]
Diethylamine	1	1a	50
	2	1b	47
Pyrrolidine	1	1c	72
	2	1d	65
Piperidine	1	1e	62
	2	1f	59
Morpholine	1	1g	63
	2	1h	61

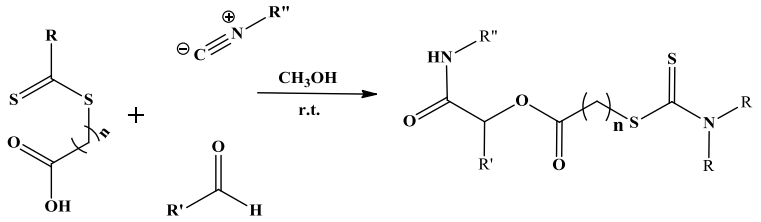
[a]observed yields in this project

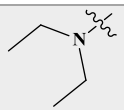
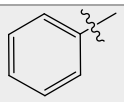
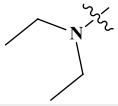
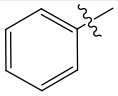
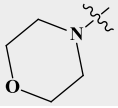
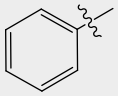
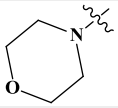
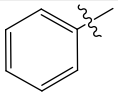
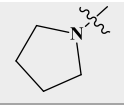
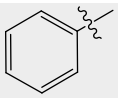
Different isocyanides such as cyclohexylisocyanide and *tert*-octylisocyanide were used with high yields. Also carboxylic acids containing dithiocarbamate group **1a-h** were used successfully in this reaction. Aliphatic and aromatic aldehydes were used in the process and aromatic aldehydes gave higher yield of products compare to the aliphatic ones.

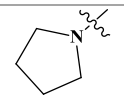
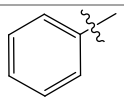
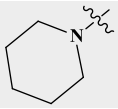
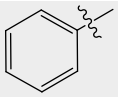
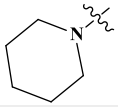
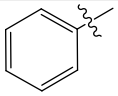
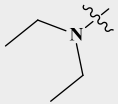
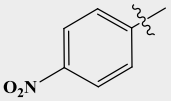
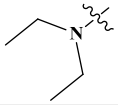
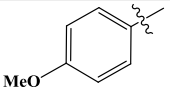
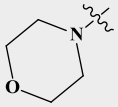
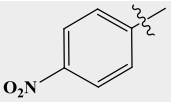
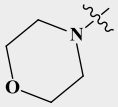
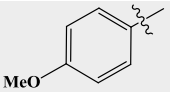
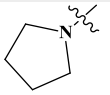
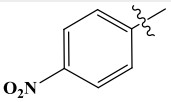
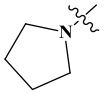
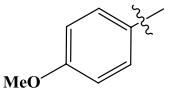
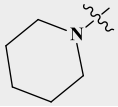
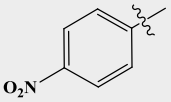
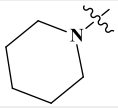
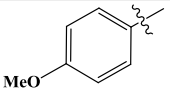
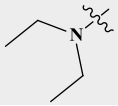
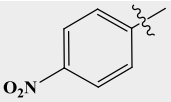
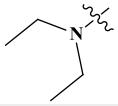
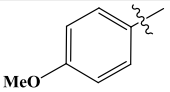
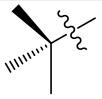
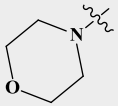
The effect of reflux condition in the yields and in the reaction times was also surveyed. In this step of research, 11 reactions representing the all reactions in table 1 in reflux condition were checked out (Table **3**).

Scheme 1: Synthesis of dithiocarbamates

Table 1: Synthesis of α-acyloxycarboxamides containing dithiocarbamate group via passerini reaction



Entry	R	R’	R”	n	Product	Yield (%)
1				1	**2a**	68
2				2	**2b**	65
3				1	**2c**	88
4				2	**2d**	85
5				1	**2e**	68

6				2	**2f**	66
7				2	**2g**	73
8				1	**2h**	75
9				1	**2i**	85
10				1	**2j**	82
11				1	**2k**	95
12				1	**2l**	92
13				1	**2m**	78
14				1	**2n**	74
15				1	**2o**	86
16				1	**2p**	82
17				1	**2q**	87
18				1	**2r**	84
19				1	**2s**	96
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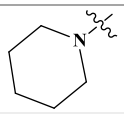
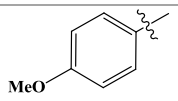
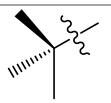
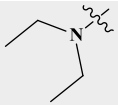
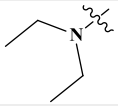
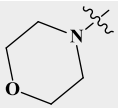
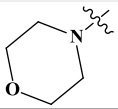
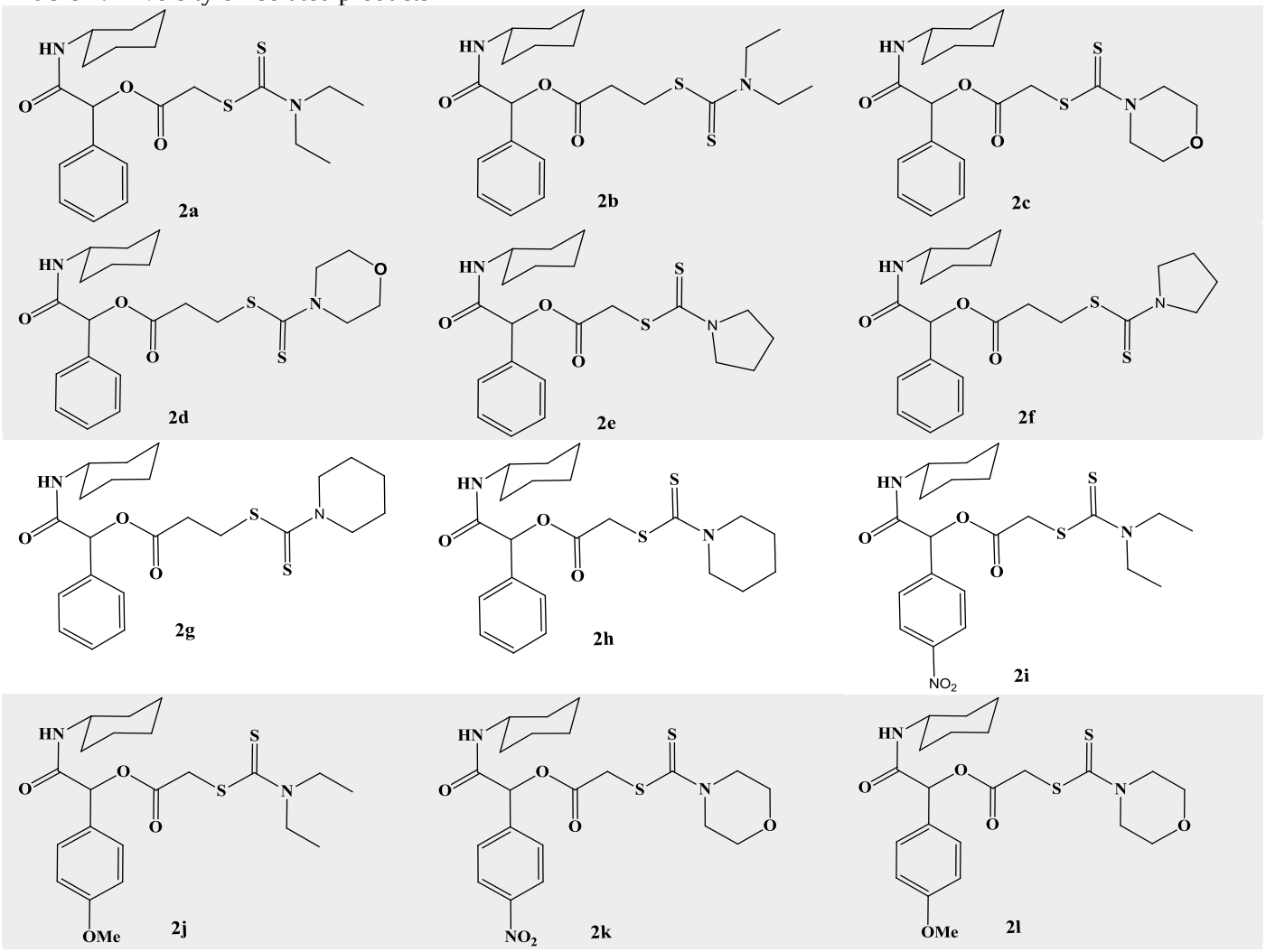
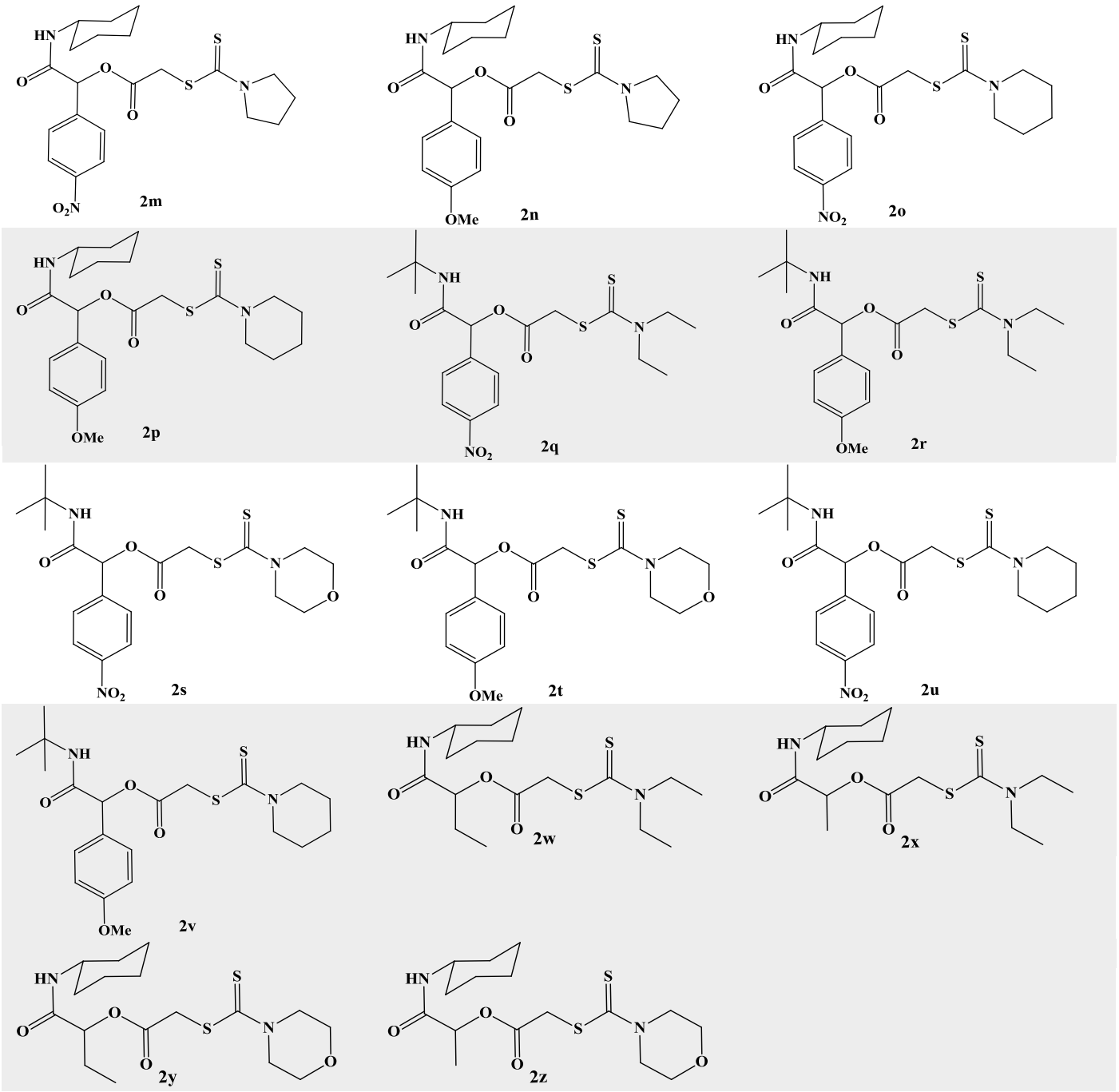
22				1	**2v**	77
23				1	**2w**	43
24				1	**2x**	47
25				1	**2y**	52
26				1	**2z**	54

[a]Refers to purified yield

Table 2: Diversity of isolated products





Experimental Section

*General procedure for synthesis of compounds **2a-z***

In a 25 mL round bottom flask, methanol (8 mL), an aldehyde (1 mmol) and carboxylic acid containing dithiocarbamate group (1 mmol) were added. After 10 min stirring at room temperature, an isocyanide was added to the stirring solution. Progress of reaction was monitored by TLC (ethylacetate:n-hexane; 60:40). After 24 hours the solvent was removed and diethyl ether was added to oily residue. The solid was appeared after some minutes and washed with a little ethylacetate and diethyl ether. Finally recrystallization in ethanol or ethyl acetate gave the pure products.

Table 3: Reflux effect on the reaction procedure.

Entry	product	Reaction time	Yield(%)
1	2a	8*h*	80
2	2c	7*h*	92
3	2e	8*h*	75
4	2h	7*h*	87
5	2i	5*h*	95
6	2k	3*h*	97
7	2r	6*h*	93
8	2s	3*h*	98
9	2u	5*h*	91
10	2x	8*h*	72
11	2z	5*h*	83

The above table shows a better qualification in reflux mode which lead to more yield of products and less reaction time.

2-(cyclohexylamino)-2-oxo-1-phenylethyl {[(diethylamino)carbonothioyl]thio}acetate **(2a)**
m.p. 158-161°C; IR (KBr) (ν_{max}, cm^{-1}): 3338 (N-H), 1731, 1661, 1645 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): δ_H 1.20-1.83 (16H, m, $5CH_2$ + $2CH_3$), 3.67 (2H, q, $^3J_{HH}$= 7.16, CH_2), 3.74-3.77 (1H, m, NH-C*H*), 3.98 (2H, q, $^3J_{HH}$ = 7.13 Hz, CH_2), 4.16 (2H, s, O=C-CH_2-S), 6.10 (1H, s, O=C-C*H*), 6.50 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.34-7.47 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 171.4, 167.7(2C=O, 1C=S); 136.0, 128.9, 128.7, 126.5(arom. C); 74.3, 52.5, 47.2, 42.9, 36.7, 32.8, 25.7, 25.3, 16.4, 12.7(aliphatic C).

2-(cyclohexylamino)-2-oxo-1-phenylethyl 3-{[(diethylamino)carbonothioyl]thio}propanoate **(2b)**
m.p. 159-162°C; IR (KBr) (ν_{max}, cm^{-1}): 3342 (N-H), 1731, 1661, 1647 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): δ_H 1.18-1.75 (16H, m, $5CH_2$ + $2CH_3$), 2.57(2H, t, $^3J_{HH}$= 6.8 Hz, O=C-C*H*$_2$), 3.49 (2H, t, $^3J_{HH}$= 6.8 Hz, S-CH_2), 3.56 (2H, q, $^3J_{HH}$= 7.15, CH_2), 3.65-3.69 (1H, m, NH-C*H*), 3.89 (2H, q, $^3J_{HH}$= 7.13 Hz, CH_2), 6.09 (1H, s, O=C-C*H*), 6.51 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.28-7.40 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ_C 194.6, 169.0, 167.7(2C=O, 1C=S); 136.4, 128.9, 128.7, 125.1(arom. C); 76.6, 52.5, 47.2, 42.9, 32.8, 32.7, 31.0, 25.7, 25.3, 16.4, 12.7(aliphatic C).

2-(cyclohexylamino)-2-oxo-1-phenylethyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2c)**
m.p. 166-169°C; IR (KBr) (ν_{max}, cm^{-1}): 3314 (N-H), 1734, 1663, 1648 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): δ_H 1.18-1.63 (10H, m, $5CH_2$), 3.57-4.16 (11H, m, $5CH_2$, NH-C*H*), 6.14 (1H, s, O=C-C*H*), 6.53 (1H, d, $^3J_{HH}$= 8.01 Hz, CH-N*H*), 7.34-7.47 (5H, m, arom. H); 7.31-7.44 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ_C 195.8, 171.4, 167.7(2C=O, 1C=S); 135.9, 128.9, 128.7, 126.5(arom. C); 74.3, 67.1, 51.3, 42.9, 36.7, 32.8, 25.7, 25.3(aliphatic C).

2-(cyclohexylamino)-2-oxo-1-phenylethyl 3-[(morpholin-4-ylcarbonothioyl)thio]propanoate **(2d)**
m.p. 171-173°C; IR (KBr) (ν_{max}, cm^{-1}): 3325 (N-H), 1734, 1663, 1647 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.17-1.69 (10H, m, $5CH_2$), 2.95 (2H, t, $^3J_{HH}$= 6.9 Hz, O=C-C*H*$_2$), 3.39 (2H, t, $^3J_{HH}$= 6.9 Hz, S-C*H*$_2$), 3.62-3.87 and 4.08-4.22 (9H, m, $4CH_2$, NH-C*H*), 6.12 (1H, s, O=C-C*H*), 6.52 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.22-7.38 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.9, 169.1, 167.7(2C=O, 1C=S); 136.4, 128.9, 128.7, 125.1(arom. C); 76.6, 67.1, 51.3, 42.9, 32.8, 32.7, 31.0, 25.7, 25.3(aliphatic C).

2-(cyclohexylamino)-2-oxo-1-phenylethyl [(pyrrolidin-1-ylcarbonothioyl)thio]acetate **(2e)**
m.p. 160-163°C; IR (KBr) (ν_{max}, cm^{-1}): 3305 (N-H), 1731, 1661, 1647 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): δ_H 1.18-2.07 (14H, m, $7CH_2$), 3.63-3.88 (4H, m, $2CH_2$), 3.98-4.14 (3H, m, O=C-C*H*$_2$-S, NH-C*H*), 6.13 (1H, s, O=C-C*H*), 6.53 (1H, d, $^3J_{HH}$= 8.00 Hz, CH-N*H*), 7.31-7.45 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ_C 194.2, 171.4, 167.7(2C=O, 1C=S); 136.0, 128.9, 128.7, 126.5(arom. C); 74.3, 53.1, 42.9, 35.4, 32.8, 25.6, 25.5, 25.3(aliphatic C).

*2-(cyclohexylamino)-2-oxo-1-phenylethyl 3-[(pyrrolidin-1-ylcarbonothioyl)thio]propanoate **(2f)***
m.p. 165-169°C; IR (KBr) (ν_{max}, cm^{-1}): 3309 (N-H), 1732, 1661, 1647 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.18-2.05 (14H, m, $7CH_2$), 2.91 (2H, t, $^3J_{HH}$= 6.9 Hz, O=C-C*H*$_2$), 3.35 (2H, t, $^3J_{HH}$= 6.9 Hz, C*H*$_2$-S), 3.69-3.91(4H, m, $2CH_2$), 4.02-4.07 (1H, m, NH-C*H*), 6.10 (1H, s, O=C-C*H*), 6.54 (1H, d, $^3J_{HH}$= 8.00 Hz, CH-N*H*), 7.24-7.41 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ_C 194.8, 169.0, 167.7(2C=O, 1C=S); 136.4, 128.9, 128.7, 125.1(arom. C); 76.6, 53.1, 42.9, 32.8, 32.7, 31.0, 25.6, 25.5, 25.3(aliphatic C).

2-(cyclohexylamino)-2-oxo-1-phenylethyl 3-[(piperidin-1-ylcarbonothioyl)thio]propanoate **(2g)**
m.p. 173-177°C; IR (KBr) (ν_{max}, cm^{-1}): 3300 (N-H), 1732, 1661, 1647 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.14-1.88 (16H, m, $8CH_2$), 2.75 (2H, t, $^3J_{HH}$=

6.8 Hz, O=C-C*H*$_2$), 3.19 (2H, t, $^3J_{HH}$= 6.8 Hz, S-C*H*$_2$), 3.72-4.13 (5H, m, 2CH$_2$, NH-C*H*), 6.09 (1H, s, O=C-C*H*), 6.51 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.25-7.41 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): δ_C 194.5, 169.0, 167.7(2C=O, 1C=S); 136.4, 128.9, 128.7, 125.1(arom. C); 76.6, 52.8, 52.1, 42.9, 32.8, 32.7, 31.0, 26.7, 26.6, 25.5, 25.3, 24.1(aliphatic C).

2-(cyclohexylamino)-2-oxo-1-phenylethyl [(piperidin-1-ylcarbonothioyl)thio]acetate **(2h)**

m.p. 172-175°C; IR (KBr) (ν_{max}, cm^{-1}): 3310 (N-H), 1729, 1661, 1644 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.14-1.85 (16H, m, 8CH$_2$), 3.69-4.15 (7H, m, 3CH$_2$, NH-C*H*), 6.11 (1H, s, O=C-C*H*), 6.49 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.19-7.40 (5H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 193.9, 171.4, 167.7(2C=O, 1C=S); 136.0, 128.9, 128.7, 126.5(arom. C); 74.3, 52.8, 52.1, 42.9, 36.7, 32.8, 26.7, 26.6, 25.5, 25.3, 24.1(aliphatic C).

2-(cyclohexylamino)-1-(4-nitrophenyl)-2-oxoethyl {[(diethylamino)carbonothioyl]thio}acetate **(2i)**

m.p. 194-197°C; IR (KBr) (ν_{max}, cm^{-1}): 3283 (N-H), 1727, 1658, 1641 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.20-1.81 (16H, m, 5CH$_2$ + 2CH$_3$), 3.71 (2H, q, $^3J_{HH}$= 7.15, CH$_2$), 3.72-3.81 (1H, m, NH-C*H*), 4.01 (2H, q, $^3J_{HH}$= 7.12 Hz, CH$_2$), 4.14 (2H, s, O=C-CH$_2$-S), 6.12 (1H, s, O=C-C*H*), 6.55 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.45-7.49 (2H, m, arom. H), 7.91-7.95 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 171.4, 167.7(2C=O, 1C=S); 145.7, 139.5, 126.9, 122.0(arom. C); 74.3, 52.5, 47.2, 42.9, 36.7, 32.8, 25.7, 25.3, 16.4, 12.7(aliphatic C).

2-(cyclohexylamino)-1-(4-methoxyphenyl)-2-oxoethyl {[(diethylamino)carbonothioyl]thio}acetate **(2j)**

m.p. 190-194°C; IR (KBr) (ν_{max}, cm^{-1}): 3290 (N-H), 1727, 1660, 1642 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.21-1.81 (16H, m, 5CH$_2$ + 2CH$_3$), 3.69 (2H, q, $^3J_{HH}$= 7.15, CH$_2$), 3.71-3.80 (1H, m, NH-C*H*), 3.88 (3H, s, O-C*H*$_3$), 4.00 (2H, q, $^3J_{HH}$= 7.12 Hz, CH$_2$), 4.15 (2H, s, O=C-CH$_2$-S), 6.11 (1H, s, O=C-C*H*), 6.52 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.45-7.49 (2H, m, arom. H), 7.89-7.93 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 171.4, 167.7(2C=O, 1C=S); 160.4, 131.0, 125.1, 108.7(arom. C); 74.3, 55.6, 52.5, 49.4, 42.9, 36.7, 32.8, 25.7, 25.3, 16.4, 12.7(aliphatic C).

2-(cyclohexylamino)-1-(4-nitrophenyl)-2-oxoethyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2k)**

m.p. 225-229°C; IR (KBr) (ν_{max}, cm^{-1}): 3276 (N-H), 1726, 1658, 1640 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.23-1.75 (10H, m, 5CH$_2$), 3.68-4.22 (11H, m, 5CH$_2$, NH-C*H*), 6.15 (1H, s, O=C-C*H*), 6.55 (1H, d, $^3J_{HH}$= 8.01 Hz, CH-N*H*), 7.62-7.67 (2H, m, arom. H), 7.94-7.99 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.8, 171.4, 167.7(2C=O, 1C=S); 145.7, 139.5, 126.9, 122.0(arom. C); 74.3, 67.1, 51.3, 42.9, 35.4, 32.8, 25.7, 25.3(aliphatic C).

2-(cyclohexylamino)-1-(4-methoxyphenyl)-2-oxoethyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2l)**

m.p. 221-224°C; IR (KBr) (ν_{max}, cm^{-1}): 3287 (N-H), 1728, 1660, 1642 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.23-1.75 (10H, m, 5CH$_2$), 3.71-4.26 (14H, m, 5CH$_2$, NH-C*H*, CH$_3$), 6.14 (1H, s, O=C-C*H*), 6.57 (1H, d, $^3J_{HH}$= 8.01 Hz, CH-N*H*), 7.47-7.51 (2H, m, arom. H), 7.92-7.96 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.7, 171.4, 167.7(2C=O, 1C=S); 160.4, 131.0, 125.1, 108.7(arom. C); 74.3, 67.1, 55.6, 51.3, 42.9, 36.7, 32.8, 25.7, 25.3(aliphatic C).

2-(cyclohexylamino)-1-(4-nitrophenyl)-2-oxoethyl [(pyrrolidin-1-ylcarbonothioyl)thio]acetate **(2m)**

m.p. 215-218°C; IR (KBr) (ν_{max}, cm^{-1}): 3286 (N-H), 1727, 1658, 1641 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.19-2.08 (14H, m, 7CH$_2$), 3.75-4.02 (5H, m, NH-C*H*, 2CH$_2$), 4.16 (2H, s, O=C-CH$_2$-S), 6.09 (1H, s, O=C-C*H*), 6.58 (1H, d, $^3J_{HH}$= 8.00 Hz, CH-N*H*), 7.67-7.71 (2H, m, arom. H), 8.01-8.05 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.7, 171.4, 167.7(2C=O, 1C=S); 145.7, 139.5, 126.9, 122.0(arom. C); 74.3, 53.1, 42.9, 36.7, 32.8, 25.6, 25.5, 25.3(aliphatic C).

2-(cyclohexylamino)-1-(4-methoxyphenyl)-2-oxoethyl [(pyrrolidin-1-ylcarbonothioyl)thio]acetate **(2n)**

m.p. 210-214°C; IR (KBr) (ν_{max}, cm^{-1}): 3290 (N-H), 1730, 1661, 1642 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.21-2.08 (14H, m, 7CH$_2$), 3.77-4.04 (8H, m, NH-C*H*, 2CH$_2$, O-CH$_3$), 4.13 (2H, s, O=C-CH$_2$-S), 6.12 (1H, s, O=C-C*H*), 6.55 (1H, d, $^3J_{HH}$= 8.00 Hz, CH-N*H*), 7.42-7.46 (2H, m, arom. H), 7.87-7.91 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.7, 171.4, 167.7(2C=O, 1C=S); 160.4, 131.0, 125.1, 108.7(arom. C); 74.3, 55.6, 53.1, 42.9, 36.7, 32.8, 25.6, 25.5, 25.3(aliphatic C).

2-(cyclohexylamino)-1-(4-nitrophenyl)-2-oxoethyl [(piperidin-1-ylcarbonothioyl)thio]acetate **(2o)**

m.p. 217-220°C; IR (KBr) (ν_{max}, cm^{-1}): 3292 (N-H), 1729, 1660, 1640 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.16-1.92 (16H, m, $8CH_2$), 3.84-4.18 (7H, m, $3CH_2$, NH-C*H*), 6.13 (1H, s, O=C-C*H*), 6.51 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.61-7.65 (2H, m, arom. H), 7.99-8.03 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.8, 171.4, 167.7(2C=O, 1C=S); 145.7, 139.5, 126.9, 122.0(arom. C); 74.3, 52.8, 52.1, 42.9, 36.7, 32.8, 26.7, 26.6, 25.5, 25.3, 24.1(aliphatic C).

2-(cyclohexylamino)-1-(4-methoxyphenyl)-2-oxoethyl [(piperidin-1-ylcarbonothioyl)thio]acetate **(2P)**
m.p. 216-218°C; IR (KBr) (ν_{max}, cm^{-1}): 3296 (N-H), 1731, 1661, 1641 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.16-1.92 (16H, m, $8CH_2$), 3.87 (3H, s, O-CH_3), 3.90-4.17 (7H, m, $3CH_2$, NH-C*H*), 6.12 (1H, s, O=C-C*H*), 6.49 (1H, d, $^3J_{HH}$= 7.9 Hz, CH-N*H*), 7.44-7.48 (2H, m, arom. H), 7.89-7.93 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.7, 171.4, 167.7(2C=O, 1C=S); 160.4, 131.0, 125.1, 108.7(arom. C); 74.3, 55.6, 52.8, 52.1, 42.9, 36.7, 32.8, 26.7, 26.6, 25.5, 25.3, 24.1(aliphatic C).

2-(tert-butylamino)-1-(4-nitrophenyl)-2-oxoethyl {[(diethylamino)carbonothioyl]thio}acetate **(2q)**
m.p. 210-213°C; IR (KBr) (ν_{max}, cm^{-1}): 3283 (N-H), 1730, 1662, 1642 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.44 (9H, s, C-$(CH_3)_3$), 3.69 (2H, q, $^3J_{HH}$= 7.14, CH_2), 3.99 (2H, q, $^3J_{HH}$= 7.11 Hz, CH_2), 4.09 (2H, s, O=C-CH_2-S), 6.07 (1H, s, O=C-C*H*), 6.51 (1H, s, N*H*), 7.68-7.72 (2H, m, arom. H), 8.05-8.09 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 171.4, 163.4(2C=O, 1C=S); 145.7, 141.3, 126.9, 125.7(arom. C); 77.6, 52.5, 50.5, 47.2, 36.7, 28.7, 16.4, 12.7(aliphatic C).

2-(tert-butylamino)-1-(4-methoxyphenyl)-2-oxoethyl {[(diethylamino)carbonothioyl]thio}acetate **(2r)**
m.p. 204-208°C; IR (KBr) (ν_{max}, cm^{-1}): 3288 (N-H), 1732, 1662, 1641 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.39 (9H, s, C-$(CH_3)_3$), 3.67 (2H, q, $^3J_{HH}$= 7.13, CH_2), 3.84 (3H, s, O-CH_3), 3.98 (2H, q, $^3J_{HH}$= 7.11 Hz, CH_2), 4.10 (2H, s, O=C-CH_2-S), 6.10 (1H, s, O=C-C*H*), 6.48 (1H, s, N*H*), 7.34-7.38 (2H, m, arom. H), 7.85-7.089 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 171.4, 168.4(2C=O, 1C=S); 160.4, 131.0, 127.8, 115.2(arom. C); 77.6, 55.6, 52.5, 50.5, 47.2, 36.7, 28.7, 16.4, 12.7(aliphatic C).

2-(tert-butylamino)-1-(4-nitrophenyl)-2-oxoethyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2s)**
m.p. 224-226°C; IR (KBr) (ν_{max}, cm^{-1}): 3274 (N-H), 1730, 1661, 1640 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.48 (9H, s, C-$(CH_3)_3$), 3.71-4.07 (8H, m, $4CH_2$), 4.12 (1H, m, O=C-CH_2-S), 6.12 (1H, s, O=C-C*H*), 6.51 (1H, s, N*H*), 7.62-7.67 (2H, m, arom. H), 8.04-8.09 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.9, 171.4, 168.4(2C=O, 1C=S); 145.7, 141.3, 126.4, 125.7(arom. C); 77.6, 67.1, 51.3, 50.5, 36.7, 28.7(aliphatic C).

2-(tert-butylamino)-1-(4-methoxyphenyl)-2-oxoethyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2t)**
m.p. 222-225°C; IR (KBr) (ν_{max}, cm^{-1}): 3288 (N-H), 1730, 1661, 1640 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.37 (9H, s, C-$(CH_3)_3$), 3.65-4.03 (11H, m, $4CH_2$, O-CH_3), 4.16 (1H, s, O=C-CH_2-S), 6.09 (1H, s, O=C-C*H*), 6.54 (1H, s, N*H*), 7.35-7.38 (2H, m, arom. H), 7.81-7.84 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.8, 171.4, 168.4 (2C=O, 1C=S); 160.4, 131.0, 127.8, 115.2(arom. C), 77.6, 67.1, 55.6, 51.3, 50.5, 36.7, 28.7(aliphatic C).

2-(tert-butylamino)-1-(4-nitrophenyl)-2-oxoethyl [(piperidin-1-ylcarbonothioyl)thio]acetate **(2u)**
m.p. 226-228°C; IR (KBr) (ν_{max}, cm^{-1}): 3295 (N-H), 1729, 1663, 1642 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.32 (9H, s, C-$(CH_3)_3$), 1.48-1.82 (6H, m, $3CH_2$), 3.58-4.07 (6H, 2N-CH_2, O=C-CH_2-S), 6.07 (1H, s, O=C-C*H*), 6.50 (1H, s, N*H*), 7.28-7.31 (2H, m, arom. H), 7.77-7.80 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 194.6, 171.4, 168.4(2C=O, 1C=S); 145.7, 141.3, 126.9, 125.7(arom. C); 77.6, 52.8, 52.1, 50.5, 36.7, 28.7, 26.7, 26.6, 24.1(aliphatic C).

2-(tert-butylamino)-1-(4-methoxyphenyl)-2-oxoethyl [(piperidin-1-ylcarbonothioyl)thio]acetate **(2v)**
m.p. 224-227°C; IR (KBr) (ν_{max}, cm^{-1}): 3295 (N-H), 1734, 1662, 1643 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.33 (9H, s, C-$(CH_3)_3$), 1.49-1.84 (6H, m, $3CH_2$), 3.59-4.01 (11H, m, $3CH_2$, O-CH_3), 6.05 (1H, s, O=C-C*H*), 6.51 (1H, s, N*H*), 7.31-7.35 (2H, m, arom. H), 7.79-7.83 (2H, m, arom. H); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 194.6, 171.4, 168.4(2C=O, 1C=S); 160.4, 131.0, 127.8, 115.2(arom. C); 77.6, 55.6, 52.8, 52.1, 50.5, 36.7, 28.7, 26.7, 26.6, 24.1(aliphatic C).

1-[(cyclohexylamino)carbonyl]propyl {[(diethylamino)carbonothioyl]thio}acetate **(2w)**

m.p. 147-150°C; IR (KBr) (ν_{max}, cm^{-1}): 3340 (N-H), 1734, 1661, 1648 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.06 (3H, t, $^3J_{HH}$= 7.1, CH_3), 1.14-1.75 (16H, m, $5CH_2$ + $2CH_3$), 1.89-2.00 , 2.14-2.25 (2H, m, HC*-C*HH*-CH_3), 3.65 (2H, q, $^3J_{HH}$= 7.15, CH_2), 3.72-3.75 (1H, m, NH-C*H*), 3.96 (2H, q, $^3J_{HH}$= 7.13 Hz, CH_2), 4.14 (2H, s, O=C-CH_2-S), 5.86-5.90 (1H, m , O=C-C*H*), 6.22 (1H, d, $^3J_{HH}$= 8.01 Hz, CH-N*H*); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 171.5, 168.4(2C=O, 1C=S); 87.3, 52.5, 47.2, 46.6, 35.2, 32.8, 25.7, 25.3, 24.8, 16.4, 12.7, 9.2(aliphatic C).

2-(cyclohexylamino)-1-methyl-2-oxoethyl {[(diethylamino)carbonothioyl]thio}acetate **(2x)**

m.p. 140-144°C; IR (KBr) (ν_{max}, cm^{-1}): 3338 (N-H), 1732, 1664, 1645 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.14-1.75 (19H, m, $5CH_2$ + $3CH_3$), 3.67 (2H, q, $^3J_{HH}$= 7.15, CH_2), 3.70-3.74 (1H, m, NH-C*H*), 3.98 (2H, q, $^3J_{HH}$= 7.13 Hz, CH_2), 4.15 (2H, s, O=C-CH_2-S), 5.98 (1H, q, $^3J_{HH}$= 6.2, O=C-C*H*), 6.25 (1H, d, $^3J_{HH}$= 8.01 Hz, CH-N*H*); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 192.9, 172.2, 171.7(2C=O, 1C=S); 69.1, 52.5, 47.2, 46.5, 35.3, 32.8, 25.7, 25.3, 18.1, 16.4, 12.7(aliphatic C).

1-[(cyclohexylamino)carbonyl]propyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2y)**

m.p. 155-157°C; IR (KBr) (ν_{max}, cm^{-1}): 3325 (N-H), 1732, 1662, 1643 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.07 (3H, t, $^3J_{HH}$= 7.1, CH_3), 1.16-1.82 (10H, m, $5CH_2$), 3.71-4.26 (11H, m, $5CH_2$, NH-C*H*), 1.87-1.98 , 2.11-2.21 (2H, m, HC*-C*HH*-CH_3), 3.68-4.18 (11H, m, $5CH_2$, NH-C*H*), 5.87-5.91 (1H, m, O=C-C*H*), 6.37 (1H, d, $^3J_{HH}$= 8.00 Hz, CH-N*H*); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.8, 171.5, 168.4(2C=O, 1C=S); 87.3, 67.1, 51.3, 46.6, 35.2, 32.8, 25.7, 25.3, 24.8, 9.2(aliphatic C).

2-(cyclohexylamino)-1-methyl-2-oxoethyl [(morpholin-4-ylcarbonothioyl)thio]acetate **(2z)**

m.p. 151-154°C; IR (KBr) (ν_{max}, cm^{-1}): 3325 (N-H), 1734, 1661, 1643 (C=O, C=S); ^{1}HNMR ($CDCl_3$, 300.1 MHz): 1.15-1.80 (13H, m, $5CH_2$, $1CH_3$), 3.69-4.24 (11H, m, $5CH_2$, NH-C*H*), 5.97 (1H, q, $^3J_{HH}$= 6.2, O=C-C*H*), 6.28 (1H, d, $^3J_{HH}$= 8.01 Hz, CH-N*H*); ^{13}C NMR ($CDCl_3$, 75.5 MHz): 195.8, 172.3, 171.7(2C=O, 1C=S); 69.4, 67.1, 51.3, 46.5, 35.3, 32.8, 25.7, 25.3, 18.1(aliphatic C).

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