

Synthesis, characterization and spectral evaluation of some new substituted thiosemicarbazides and thiosemicarbazones

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(Received: April 15, 2010; Accepted: May 20, 2010)

ABSTRACT

A new series of substituted thiosemicarbazides and substituted thiosemicarbazones containing different functional groups, thiosemicarbazones have been synthesized by the condensation reaction between newly synthesized substituted thiosemicarbazides with suitable aromatic aldehydes and ketone in the presence of glacial acetic acid as a condensing agent. They are coloured solids, having high melting points. The substituted thiosemicarbazides have been obtained by the usual method as described in the literature. The structures of all the newly synthesized compounds have been characterized on the basis of their elemental analysis, physical properties, spectroscopic technique viz: IR.

Key words: Synthesis, Thiosemicarbazides, Thiosemicarbazones, Substituted Aldehydes and Ketone, Condensation, GAA, Spectral data.

INTRODUCTION

The importance of thiosemicarbazides and thiosemicarbazone derivatives lie in the field that these have occupied a unique position in heterocyclic chemistry due to their anti-tubercular, anti-bacterial¹ and biological activity². Thiosemicarbazide and their derivatives have been marked as biologically and pharmacologically active product. The literature survey revealed that substituted thiosemicarbazides also possess different activities like anti-bacterial³, anti-tubercular⁴, anti-fungal⁵. It has also been found to possess herbicidal⁶, hypoglycaemic⁷ activity.

Thiosemicarbazones and their derivatives have received considerable attention because of their anti-tubercular⁸, anti-viral^{9,10}, anti-amoebic¹¹, trypanocidal¹² and anti-inflammatory activities. Some of the substituted thiosemicarbazones have also been found to possess antitumor¹³, antiviral¹⁴ activity. Substituted thiosemicarbazides and substituted thiosemicarbazones are studied due to

its biological activities, analytical properties. In the view of these observations and our continuing interest in the synthesis of heterocyclic compounds, it is also of interest to synthesize some new novel substituted thiosemicarbazides and substituted thiosemicarbazones, derived from substituted thiosemicarbazides with substituted aldehydes and ketone in the presence of glacial acetic acid, several thiosemicarbazides and thiosemicarbazones and their derivatives have been prepared by various workers in this laboratory¹⁵⁻¹⁸.

EXPERIMENTAL

Material and Methods

All the mentioned melting points of derivatives were determined by open capillary tube method and are uncorrected. The chemicals used in the synthesis were of analytical grade and obtained from Sigma-Aldrich Company, purity of the synthesized compounds was determined by TLC using silica-gel-coated Al Plates. IR spectra obtained by KBr-disc method using Perkin-Elmer

spectrum RX-1 FT-IR spectrophotometer at ST. John's College Agra.

General method for the synthesis of substituted thiosemicarbazide (1a, 1b-1n)

To the substituted aniline (a-n; 0.1 mole) in (20 ml) of ammonia with 5 ml water, then add slowly carbon disulphide (7.6 ml) with ethanol (20ml) and stir vigorously for 45 minutes, then the solution of sodium carbonate (5.3 gm) and mono chloro acetic acid (9.5 gm) in distilled water (40 ml) was added to it followed by the addition of hydrazine hydrate 99% (6 ml), reaction mixture was refluxed for 30-45 minutes on steam-bath. Thus the resulting solid product was obtained on cooling, was recrystallized with absolute ethanol.

General method for the synthesis of substituted thiosemicarbazone (2a-2n, 3a-3g, 4a-4g)

A mixture of (1a, 1b-1n; 0.001 mole) and substituted aldehyde (R^1 , a₁-g₁ & g₂; 0.001 mole) in equi molar quantity (1:1), was refluxed in ethanol 99% with few drops of glacial acetic acid for 2-3 hours, the reaction mixture was allowed to cool overnight at room temperature. The resulting crystal

product separated, recrystallized from proper solvent. It was identified to be (R) phenyl thiosemicarbazone of 4-bromo-2-fluoro benzaldehyde (2a-2n) adopting the same method for the following substituted thiosemicarbazone (3a-3g, 4a-4g) are recorded in the Table-1.

RESULTS AND DISCUSSION

The IR (Kbr-disc method) spectrum of some newly synthesized compounds have been recorded in the frequency region 4000-500 cm^{-1} are listed in the Table-2.

The IR spectrum of the compounds (1a, 1b) showed absorption bands 3416.0-3418.2 cm^{-1} (broad str. -NH), 3020.0-3029.8 cm^{-1} (Aromatic -CH str.), absorption bands in the region 1360.0-1343.1 cm^{-1} (-C=S str.) and 1240.5-1266.8 cm^{-1} (-C-N str.), stretching vibrations in the region 637.8-674.0 cm^{-1} indicates the mono substitution. These results confirming the structures of compounds (1a, 1b). Infrared spectrum of newly synthesized compounds (2a, 2b) showed absorption bands in the region 3424.0-3467.9 cm^{-1} (broad str. -NH), 2982.0-2985.0

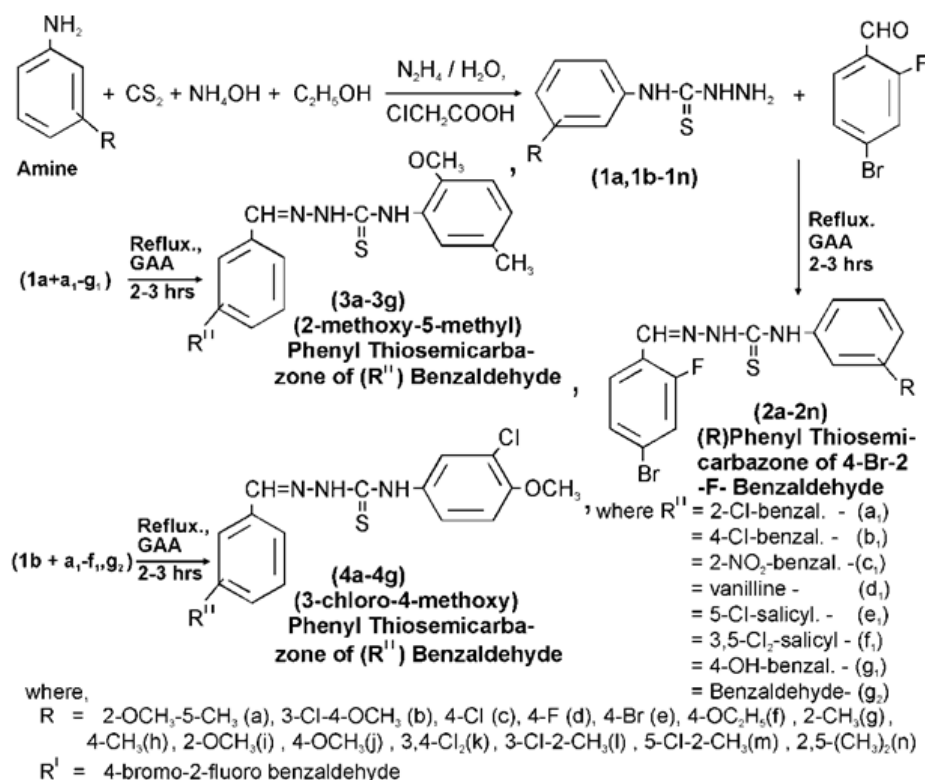


Table 1: Physical and Analytical data of newly synthesized compounds

codes	Molecular Formula	Molecular Weight	Yield %	M.P 0°C	C			H			N			S			colour
					cal. %	(found)	cal. %	(found)	cal. %	(found)	cal. %	(found)	cal. %	(found)	cal. %	(found)	
1a	C ₆ H ₁₃ N ₃ O ₁	211.23	49.23	160°	51.17	(51.19)	6.20	(6.22)	19.89	(19.93)	15.15	(15.18)	crystalline white				
1b	C ₈ H ₁₀ N ₃ O ₁ Cl ₁	231.65	74.68	178°	41.47	(41.48)	4.35	(4.37)	18.14	(18.18)	13.81	(13.84)	dirty spice				
2a	C ₁₀ H ₁₀ N ₃ O ₁ Br ₁ F ₁	396.24	52.41	203°	48.50	(48.52)	3.81	(3.82)	10.60	(10.64)	08.07	(08.09)	pineapple yellow				
2b	C ₁₅ H ₁₂ N ₃ O ₁ Br ₁ F ₁ Cl ₁	416.65	58.75	194°	43.24	(43.26)	2.89	(2.90)	10.08	(10.11)	07.68	(07.72)	dirty white				
2c	C ₁₄ H ₁₀ N ₃ Br ₁ F ₁ Cl ₁	386.63	51.48	182°	43.49	(43.50)	2.60	(2.61)	10.87	(10.90)	08.27	(08.29)	morning glory				
2d	C ₁₄ H ₁₀ N ₃ Br ₁ F ₂	370.18	43.29	168°	45.42	(45.43)	2.72	(2.74)	11.35	(11.38)	08.64	(08.68)	light cream				
2e	C ₁₄ H ₁₀ N ₃ Si ₁ Br ₁ F ₁	431.09	52.78	186°	39.00	(39.01)	2.33	(2.34)	09.74	(09.78)	07.42	(07.45)	crystalline white				
2f	C ₁₆ H ₁₆ N ₃ Si ₁ O ₁ Br ₁ F ₁	396.24	55.31	190°	48.50	(48.52)	3.81	(3.82)	10.60	(10.64)	08.07	(08.09)	basra pearl				
2g	C ₁₆ H ₁₆ N ₃ Si ₁ Br ₁ F ₁	366.21	50.78	178°	49.19	(49.21)	3.57	(3.55)	11.47	(11.52)	08.74	(08.77)	crystalline white				
2h	C ₁₅ H ₁₃ N ₃ Si ₁ Br ₁ F ₁	366.21	59.37	183°	49.19	(49.20)	3.57	(3.58)	11.47	(11.51)	08.74	(08.78)	crystalline cream				
2i	C ₁₅ H ₁₃ N ₃ Si ₁ O ₁ Br ₁ F ₁	382.21	57.75	188°	47.13	(47.11)	3.42	(3.40)	10.99	(11.02)	08.37	(08.40)	crystalline pineapple				
2j	C ₁₅ H ₁₃ N ₃ Si ₁ O ₁ Br ₁ F ₁	382.21	48.50	179°	47.13	(47.15)	3.42	(3.41)	10.99	(11.03)	08.37	(08.42)	light cream				
2k	C ₁₄ H ₁₃ N ₃ Br ₁ F ₁ Cl ₂	421.08	41.91	204°	39.93	(39.95)	12.15	(12.14)	09.98	(10.01)	07.60	(07.62)	wild yellow				
2l	C ₁₅ H ₁₂ N ₃ Si ₁ Br ₁ F ₁ Cl ₁	400.66	54.54	201°	44.96	(44.94)	3.01	(3.00)	10.48	(10.51)	07.98	(07.96)	crystalline white				
2m	C ₁₅ H ₁₂ N ₃ Si ₁ Br ₁ F ₁ Cl ₁	400.66	48.08	190°	44.96	(44.97)	3.01	(3.02)	10.48	(10.53)	07.98	(08.00)	crystalline white				
2n	C ₁₆ H ₁₅ N ₃ Br ₁ F ₁	380.24	47.23	194°	50.54	(50.52)	3.97	(3.95)	11.05	(11.07)	08.41	(08.42)	crystalline white				
3a	C ₁₆ H ₁₆ N ₃ O ₁ Cl ₁	333.79	48.71	178°	57.57	(57.59)	4.83	(4.84)	12.59	(12.61)	09.58	(09.60)	light limon				
3b	C ₁₆ H ₁₆ N ₃ O ₁ Cl ₁	333.79	54.13	187°	57.57	(57.58)	4.83	(4.85)	12.59	(12.62)	09.58	(09.61)	crystalline limon				
3c	C ₁₆ H ₁₆ N ₄ O ₃	344.34	57.18	182°	55.81	(55.82)	4.68	(4.70)	16.27	(16.30)	09.29	(09.32)	sporty yellow				
3d	C ₁₇ H ₁₈ N ₃ O ₃	345.37	52.06	200°	59.12	(59.11)	5.54	(5.52)	12.16	(12.20)	09.26	(09.28)	light pineapple				
3e	C ₁₆ H ₁₆ N ₃ O ₂ Cl ₁	349.79	47.13	194°	54.94	(54.95)	4.61	(4.62)	12.01	(12.05)	09.15	(09.18)	light limon				
3f	C ₁₆ H ₁₆ N ₃ O ₂ Cl ₂	384.24	53.98	187°	56.01	(56.02)	3.93	(3.92)	10.93	(10.96)	08.33	(08.36)	light limon				
3g	C ₁₆ H ₁₇ N ₃ O ₂	315.34	50.15	194°	60.94	(60.93)	5.43	(5.44)	13.32	(13.36)	10.14	(10.16)	light raw silk				
4a	C ₁₅ H ₁₅ N ₃ O ₁ Cl ₂	354.21	43.39	133°	50.86	(50.88)	3.70	(3.71)	11.86	(11.90)	09.03	(09.05)	crystalline dirty white				
4b	C ₁₆ H ₁₅ N ₃ O ₁ Cl ₂	354.21	56.87	191°	50.86	(50.87)	3.70	(3.72)	11.86	(11.88)	09.03	(09.06)	dirty white				
4c	C ₁₆ H ₁₅ N ₃ Si ₁ O ₁ Cl ₁	364.76	52.88	181°	49.39	(49.41)	3.59	(3.58)	15.36	(15.40)	08.77	(08.79)	deep raw silk				
4d	C ₁₆ H ₁₆ N ₃ Si ₁ O ₁ Cl ₁	365.79	47.25	197°	52.53	(52.51)	4.41	(4.43)	11.48	(11.52)	08.75	(08.77)	limon				
4e	C ₁₅ H ₁₃ N ₃ Si ₁ O ₁ Cl ₂	370.21	45.99	166°	48.66	(48.68)	3.54	(3.52)	11.35	(11.38)	08.64	(08.66)	wild yellow				
4f	C ₁₅ H ₁₂ N ₃ Si ₁ O ₁ Cl ₅	404.66	50.71	172°	44.52	(44.53)	2.99	(2.98)	10.38	(10.41)	07.91	(07.94)	light beacon				
4g	C ₁₅ H ₁₄ N ₃ Si ₁ O ₁ Cl ₁	319.76	53.11	161°	56.34	(56.35)	4.41	(4.42)	13.14	(13.17)	10.00	(10.02)	light sugarcane				

cm⁻¹ (Ar. -CH str.), absorption bands in the region 2361.0-2372.0 cm⁻¹ indicates -CH=N str., 1340.0 & 1340.0 cm⁻¹ reveals -C=S str., 1243.4-1265.3 cm⁻¹ indicates the stretching vibrations of C-N, mono substitution are seen in the range 669.5-668.3 cm⁻¹

¹. According to these results of compounds (2a,2b) indicating absorption spectrum was in agreement with the assigned structures of these compounds and other compounds (2c-2n).

**Table 2: Spectral data of newly Synthesized Compounds
IR absorption bands in ν cm⁻¹**

compounds codes	-NH cm ⁻¹ stretching	Ar -CH cm ⁻¹ stretching	CH=N cm ⁻¹ stretching	C=S cm ⁻¹ stretching	C-N cm ⁻¹ stretching	mono substitution
1a	3416.0	3020.0	-	1360.0	1240.5	637.8
1b	3418.2	3029.8	-	1343.1	1266.8	674.0
2a	3424.0	2982.0	2372.0	1340.0	1243.4	669.5
2b	3467.9	2985.0	2361.0	1340.0	1265.3	668.3
3a	3415.1	2971.5	2368.7	1337.4	1236.8	696.3
3f	3423.4	2973.1	2375.9	1338.6	1241.3	677.6
4c	3415.1	2972.7	2364.0	1341.9	1231.5	669.5
4e	3416.4	2982.6	2365.6	1323.1	1250.0	716.8

The infrared spectrum of the compounds 3a,3f and 4c,4e showed absorption bands in the region 3415.1- 3423.4 cm⁻¹ (broad str. -NH), absorption bands in the range 2971.5-2982.6 cm⁻¹ indicates aromatic -CH str., 2364.0-2375.9 cm⁻¹ indicates -CH=N str., absorption bands in the range 1323.1-1341.9 cm⁻¹ confirm the presence of C=S str., 1231.5-1250.0 cm⁻¹ reveals the stretching of

C-N, mono substitution is confirm by stretching vibrations in the range 669.5-716.8 cm⁻¹. These infrared spectrum results indicates the absorption spectrum was in agreement with the assigned structure of newly synthesized compounds (3a,3f,4c,4e) and other newly synthesized compounds (3b-3d) and (4a, 4b,4d,4f-4g).

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