International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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Design, synthesis, and spectral characterization of series of thiocarbamides with coumarin backbone

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International Journal of Science and Research Archive, 2023, 10(02), 855–859

Publication history: Received on 01 November 2023; revised on 10 December 2023; accepted on 12 December 2023

Article DOI: https://doi.org/10.30574/ijsra.2023.10.2.1035

Abstract

Recently a series of 7-(3-thiocarbamido), 7-(3-phenylthiocarbamido), 7-(3-(1,3-dimethyl) thiocarbamido), 7-(3-methylthiocarbamido), 7-(3-allylthiocarbamido)-4-methyl-2H-chromen-2-one (IIIa-e) had been synthesized by refluxing 7-chloro-4-methyl-2H-chromen-2-one (I) with thiourea, N-phenylthiourea, 1,3-dimethylthiourea, N-methylthiourea and N-allylthiourea (IIa-e) in isopropanol medium in 1:1 molar proportion for 5 hours. All the synthesized compounds structures were justified on the basis of chemical tests, elemental study and spectral characterization.

Keywords: 7-chloro-4-methyl-2H-chromen-2-one; Substituted thioureas; Isopropanol; Sodium Bicarbonate; Ethyl alcohol.

1. Introduction

7-chloro-4-methyl-2H-chromen-2-one **(I)** is one of the coumarin, derived from the interactions of 7-Hydroxy-4-methyl-2H-chromen-2-one with phosphoryl chloride. Coumarins are well known very potent intermediates[1] for synthesizing various heterocyclic compounds as well as for their various biological activities. The compounds with the coumarin backbone have been reported to possess various biological activities such as anti-microbial[2], anti-cancer[3,12], anti-inflammatory[4], anti-convulsant[5], anti-oxidant[6], anti-HIV[7], anti-tumor[8-9], anti-coagulant[10], anti-bacterial[15].

Literature study displayed coumarins[11-14] gives different reactions with different types of reagents, hence reflects overall diverse scope. Reactivity of coumarin changes with change in the medium viz, acidic, basic and neutral. Acidic and basic medium reactions are reported the synthesis of different biological potent heterocyclic compounds. The reactions of halo coumarin in neutral medium proceeds with the orbital interaction of halo group with the thioureas. Holding the sense of information in observance, it is decided to investigate the interactions of 7-chloro-4-methyl-2H-chromen-2-one, with different thioureas to synthesize the novel series of thiocarbamides 7-(3-substitutedthiocarbamido)-4-methyl-2H-chromen-2-one. All the synthesized substituted thiocarbamides are important class of compounds which possess antibacterial[16], antifugicidal[17], antiviral[20] and biological activities[16-20], These are widely used commercial pesticides mainly herbicides[18]. Believing all the above objectives in mind, it was planned to carry out the interaction of coumarins and different substituted thioureas.

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2. Materials and method

2.1. Materials

All the chemicals used were of Loba Chemie (AR Grade). 7-chloro-4-methyl-2H-chromen-2-one, were prepared by known literature method [21].

2.2. Method

Method employed in the present experiments for the synthesis of various substituted thiocarbamidocoumarins is conventional refluxing under water bath for different hours for different experiments.

2.3. Experimental

The melting points of synthesized compounds were recorded using hot paraffin bath. The carbon and hydrogen analysis were carried out on Carlo-Ebra-1106 analyser. Nitrogen estimation was carried out on Colman-N-analyzer-29. IR spectra were recorded on Perkin Elmer spectrometer in the range 4000-400 cm-1 in KBr pellets. PMR spectra were recorded on BRUKER AVANCE II 400 NMR spectrometer with TMS as an internal standard using CDCl3 as a solvent. The purity of the compounds was checked on silica gel-G plates by TLC with layer thickness of 200 μm.

2.3.1. Experiment No. 1

7-(3-thiocarbamido)-4-methyl-2H-chromen-2-one (IIIa)

A mixture of 7-chloro-4-methyl-2H-chromen-2-one (I) 1.94gm (0.01M) and thioureas (IIa) 0.76gm (0.01M) was refluxed over water bath in isopropanol (40ml) medium for 5-6 hours. After the new product was found to be gradually separated out, which on basification with dilute sodium bicarbonate afforded white crystals. It was recrystallized with aqueous ethanol.

Yield - 94%, melting point - 170 ^{0}C

2.3.2. Experiment No. 2

7-(3-phenylthiocarbamido)-4-methyl-2H-chromen-2-one (IIIb)

A mixture of 7-chloro-4-methyl-2H-chromen-2-one (I) 1.94gm (0.01M) and 1-phenylthiourea (IIb) 0.75gm (0.01M) was refluxed over water bath in isopropanol (40ml) medium for 5-6 hours. After the new product was found to be gradually separated out, this on basification with dilute sodium bicarbonate afforded creamy white crystals. It was recrystallized with aqueous ethanol.

Yield- 90.60 %, Melting Point - 80 ^{0}C

2.3.3. Experiment No. 3

7-(3-(1, 3-dimethyl) thiocarbamido)-4-methyl-2H-chromen-2-one (IIIc)

A mixture of 7-chloro-4-methyl-2H-chromen-2-one (I) 1.94gm (0.01M) and 1,3-dimethyl thiourea (IIc) 1.04gm (0.01M) was refluxed over water bath in isopropanol (40ml) medium for 4-5 hours. After the new product was found to be gradually separated out, which on basification with dilute sodium bicarbonate afforded white crystals. It was recrystallized with aqueous ethanol.

Yield- 83.81%, Melting Point - 280 ^{0}C

2.3.4. Experiment No. 4

7-(3-methylthiocarbamido)-4-methyl-2H-chromen-2-one (IIId)

A mixture of 7-chloro-4-methyl-2H-chromen-2-one (I) 1.94gm (0.01M) and N-methyl thiourea (IId) 0.90gm (0.01M) was refluxed over water bath in isopropanol (40ml) medium for 4-5 hours. After the new product was found to be gradually separated out, which on basification with dilute sodium bicarbonate afforded yellow crystals. It was recrystallized with aqueous ethanol.

Yield- 87.45%, Melting Point - 85 ^{0}C

2.3.5. Experiment No. 5

7-(3-allylthiocarbamido)-4-methyl-2H-chromen-2-one (IIIe)

A mixture of 7-chloro-4-methyl-2H-chromen-2-one (I) 1.94gm (0.01M) and N-Allyl thiourea (IIe) 1.16gm (0.01M) was refluxed over water bath in isopropanol (40ml) medium for 5-6 hours. After the new product was found to be gradually separated out, which on basification with dilute sodium bicarbonate afforded pale yellow crystals. It was recrystallized with aqueous ethanol.

Yield- 90.11%, Melting Point - 110 ^{0}C

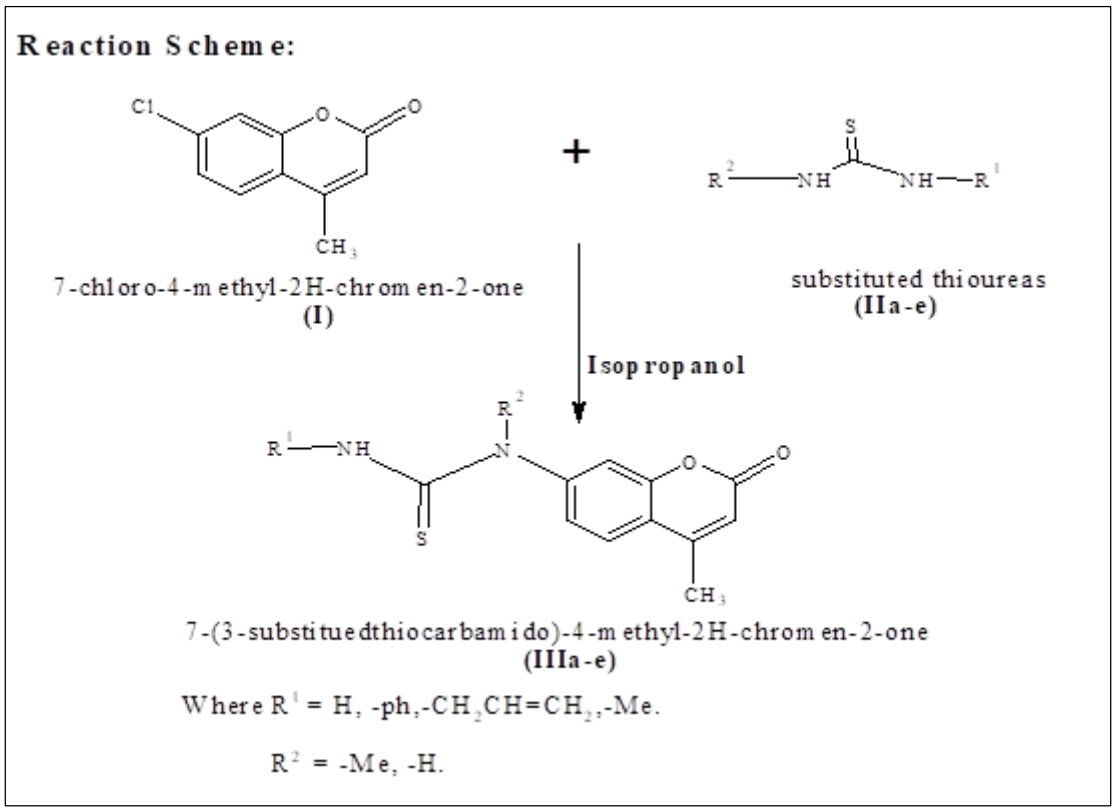

Figure 1 General reaction scheme of synthesis of substituted thiocarbamidocoumarin

3. Results and discussion

Spectral data obtained from the present research support the formation of designed or target products. Spectral characterization results of all the synthesized compounds are also given below:

3.1. Spectral Characterization

3.1.1. 7-(3-thiocarbamido)-4-methyl-2H-chromen-2-one (IIIa)

White coloured crystals, $C_{11}H_{10}N_2O_2S$, yield 94%, melting point 170 ^{0}C. % Composition found (calculated) C-65.73(65.76), H-4.26(4.30), N-11.95(11.95), S-13.65(13.68), O-13.65(13.65) FTIR (Kbr) υ cm^{-1} 3017.12 (Ar-stretching) 1066.06 (C=S stretching), 3381.12 (NH_2 Stretching), 1735.94 (C=O stretching), 2934.66 (C-H stretching). ^{1}H NMR (400 MHz $CDCl_3$ δ ppm) 2.409(s, 3H, CH_3), 7.480, 7.502, 7.769(d, 1H, CH), 5.71(s, 1H, CH). Mol. Wt.:234.27. Mass: Molecular ion peak M/Z$^+$ =234.05, Base peak M/Z$^+$ =175.18, M/Z$^+$=190.19.

3.1.2. 7-(3-phenylthiocarbamido)-4-methyl-2H-chromen-2-one (IIIb)

white coloured crystalline solid, $C_{17}H_{14}N_2O_2S$, yield 94 %, melting point 80 ^{0}C. % Composition found (calculated) C-65.72 (65.78), H-4.51(4.54), N-9.03(9.25), S-10.31 (10.33). FTIR (Kbr) υ cm^{-1} 3035.98 C-H (Ar)stretching, 1050 C=S stretching, 3162.58 CH_3 stretching, 3450.42 N-H stretching. ^{1}H NMR (400 MHz $CDCl_3$ δ ppm): 2.402(s, 3H, CH_3), 7.469(d, 1H, CH), 7.336, 7.262(d, 2H, CH), 6.922(t, 1H, CH). 7.47(d, 1H, CH). Mol. Wt.:310.27. Mass: Molecular ion peak M/Z^+ =310.37, Base peak M/Z^+ =152.216, M/Z^+=175.18, M/Z^+=160.16, M/Z^+=234.27.

3.1.3. 7-(3-(1,3-dimethyl) thiocarbamido)-4-methyl-2H-chromen-2-one (IIIc)

White coloured crystals, $C_{12}H_{14}N_2O_2S$, yield 83.81%, Melting point 280 ^{0}C. % Composition found (calculated) C-54.89 (54.94), H-5.33(5.37), N-10.67(10.67), S-12.19 (12.22), and O-12.19 (12.19). FTIR (Kbr) υ cm^{-1} 3052.27 -C-H (Ar) stretching, 1144.00 C=S stretching, 3447.98 N-H stretching, 1622.98 N-H bending, 1728.04 C=O stretching, 1493.21 H-C (-CH_3) bend. ^{1}H NMR (400 MHz $CDCl_3$ δ ppm): 2.510, 2.655(s, 3H, CH_3), 7.282, 7.767(d, 1H, CH), Mol. Wt.: 262.32 Mass: Molecular ion peak M/Z^+ =262, M/Z^+=183.00, M/Z^+=253.00, M/Z^+=225.7.

3.1.4. 7-(3-methylthiocarbamido)-4-methyl-2H-chromen-2-one (IIId)

Yellow coloured crystals, $C_{12}H_{12}N_2O_2S$, yield 87.45%, Melting point 85 ^{0}C. % Composition found (calculated) C-57.99(58.04), H-4.83(4.87), N-11.27 (11.28), S-12.88 (12.91), and O-12.88 (12.88). FTIR (Kbr) υ cm^{-1} 3023.70 -C-H (Ar) stretching, 1129.16 C=S stretching, 3462.11 N-H stretching, 1598.84 N-H bending, 1773.76 C=O stretching, 2797.51 H-C (-CH_3) stretching. ^{1}H NMR (400 MHz $CDCl_3$ δ ppm): 2.408, 2.631(s,3H, CH_3), 5.794(s, 1H, CH), 7.476, 7.498, 7.772(d, 1H, CH). Mol. Wt.: 248.30 Mass: Molecular ion peak M/Z^+ =248.10, base peak M/Z^+ =175.2, M/Z^+=205.00, M/Z^+=253.00, M/Z^+=145.00.

3.1.5. 7-(3-allylthiocarbamido)-4-methyl-2H-chromen-2-one (IIIe)

Pale yellow-coloured crystals, $C_{14}H_{14}N_2O_2S$, yield 90.11%, Melting point 110 ^{0}C % Composition: found (calculated): C-61.24(61.29), H-5.10(5.14), N-10.20(10.21), S-11.66(11.68), and O-11.66 (11.66). FTIR (Kbr) υ cm^{-1} 1139.60 C=S stretching, 1610.17 N-H bending, 1675.84 C=O stretching, 3160.35 H-C (=CH) stretching. ^{1}H NMR (400 MHz $CDCl_3$ δ ppm): 2.407(s, 3H, CH_3), 5.868(s, 1H, CH), 5.299, 5.06, 7.494, 7.773, 7.462(d, 1H, CH). Mol. Wt.: 274.33 Mass: Molecular ion peak M/Z^+ =274.1, base peak M/Z^+ =175.2, M/Z^+=211.2, M/Z^+=205.00.

4. Conclusion

In all the synthesized compounds (IIIa-IIIe), it can conclude that the present research work is best, cheaper and less time-consuming method of synthesis. In all the synthesized compounds, had maximum yield.

Compliance with ethical standards

Acknowledgement

I'm so much happy and grateful for the completion of my dissertation research work which was not possible without the support of my guide Dr S. A. Waghmare sir and especially I Would like to says thanks to my collagious friend Mr. Swapnil B. Sarkate who was always there for helping me ..Once again thanks a lot both of you!

Disclosure of conflict of interest

The authors declare no conflict of interest.

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