Heterocyclic Letters
Vol. 8| No.2|303-311|Feb-April |2018
ISSN : (print) 2231–3087 / (online) 2230-9632
CODEN: HLEEAI
http://heteroletters.org

SIMPLE AND EFFICIENT SYNTHESIS OF NOVEL CHROMONE/BENZIMIDAZOLE/BENZOTHIAZOLE HYBRID HETEROCYCLES

A.Srinivas[a] , Y.Hemasri[b], Y.Jayaprakash Rao[b,c]*

[a]*Department of Chemistry, Rayalaseema University, Kurnool-518002, India..*
[b]*Department of Chemistry, Osmania University, Hyderabad-500001, India*
[c]*Department of Chemistry, Telangana University, Nizamabad-503322, India.*
(Tel.: +91-9849814236: E-mail id: yjpr_19@yahoo.com

Abstract- A new series of chromone linked benzimidazole/benzothiazole hybrid heterocycles synthesized by conventional and microwave assisted methods from chromone-2-carbaldehydes by coupling with *o*-phenylenediamine/2-aminothiophenol without using any oxidizing agents. All the new compounds characterized by NMR, Mass and IR spectral analysis.

Keywords: Chromone-2-carbaldehydes, *o*-Phenylenediamine, 2-Amino thiophenol, Chromones/benzimidazole/benzothiazole hybrids.

Introduction

Chromone scaffold is an important class of oxygen heterocycle of high interest in medicinal chemistry [i], The numerous derivatives of chromone showed various biological activities like anti-HIV [ii], anticancer [iii], antioxidants [iv-vi], antiparkinson [vii], antitumorals [viii], antivirals [ix], antianaphilactics [x-xi], antiasthmatics [xii], antiallergics [xiii], and as antimicrobials [xiv-xvi]. Therefore, it is highly attractive to prepare diversified chromone analogues *via* a simple and convenient chemical method, which could be easily applied to produce chromone-containing bioactive molecules in medicinal chemistry.

Benzimidazoles are one of the most privileged classes of nitrogen heterocycles for the development of drugs and materials [xvii]. Large number of molecules containing benzimidazoles are showing potential biological activities such as anti-inflammatory, antiallergic antihistaminic, anticonvulsant, antidepressive, antihistaminic antipyretic, antiallergic [xviii-xix]. This scaffold can be found in many known active drugs, such as albendazole [xx], bendamustine [xxi], omeprazole [xxii]. Moreover 2-substituted benzimidazoles and their analogues were shown to display fungicide, antitumour, immunosuppressant and anticonvulsant activities, and recently used as ligands for asymmetric catalysis [xxiii]. Furthermore 2-arylbenzothiazoles are presently confirmed as a fresh class of potent and selective antitumor moieties .

Microwave irradiation green technique is known to provide improved product yield with enhanced reaction rate in chemical syntheses and it is a successful protocol in the preparation of variety of heterocycles [xxiv-xxv].

In view of potent biologicl activities of three scaffolds chromone, benzimidazole, benzothiazoles we planned for the synthesis of novel chromone/benzimidazole and chromone/benzothiazole hybrides from chromone 2-carbaldehydes by adopting molecular hybridization strategy using conventional and microwave irradiation methods. Earlier few substituted chromones based benzimidazoles prepared from chromones 2- carboxylic esters, which involves high reaction times, very low yields of products and competitive side products [xxvi]. Literature survey revealed that, while extensive synthetic study was carried out on chromone-3-carbaldehyde, there is no much work done on the synthesis and chemistry of chromone-2-carbaldehyde.

Results & Discussion

Chromone-2-carbaldehydes **2a-c** were synthesized by SeO_2 oxidation of 2-methyl-4H-chromen-4-ones **1a-c** [xxvii]. The compounds **2a-c** were condensed with 1,2-phenylenediamine **3a-f** in AcOH at room temperature for 3-8 hours using PTSA as a catalyst to afford chromone/benzimidazole hybrides **4a-j (Scheme 1**). Under the present reaction conditions formation of two products a) cyclized product and b) imine intermediate was possible, but only the desired cyclized products **4a-j** obtained in good yields.

With a view to enhance yields of product and reduce réaction time, the reaction was carried out under microwave irradiation. The synthesis of desired compounds **4a-j** in multisynth microwave system was optimized by varying reaction time and irradiation power. It was observed that irradiation at a power of 100 W over a period of 5–6 min gave excellent yields of **4a-j** in 80-90%. We compared the yields of the final products under both conventional heating and MW irradiation (Table 1).

The structures of products confirmed by spectral data. IR (solid, KBr) spectrum of 2-(5-bromo-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one **4a** showed bands at 3212 cm^{-1} (NH), 1633 cm^{-1} (CO). In the ^{1}HNMR (200 MHz, DMSO-d_6) spectrum of the compound **4a,** the aldehyde proton of 4-oxo-4H-chromen-2-carbaldehyde **4a** was disappeared. Exchangeable protons were identified by D_2O exchange analysis at δ 13.61 ppm s (1H, NH). Characteristic chromones H-3 proton appeared at δ 7.11 ppm s (1H). The ^{13}C NMR (50 MHz, DMSO, d_6) spectrum of **4a** showed chromone ketone carbonyl carbon at δ 178.3 ppm, C-3 at δ 117.4 ppm and aldehyde carbonyl carbon was disappeared. The other carbons observed between δ 118 ppm and δ 179 ppm. The positive ESI-MS data of **4a** showed protonated molecular ion at m/z 263 $[M+H]^+$. The ^{1}HNMR spectrum of compounds clearly indicated formation of cyclised products, but not the alternate imine or simple cyclised products.

Scheme 1. Synthesis of **4a-j**

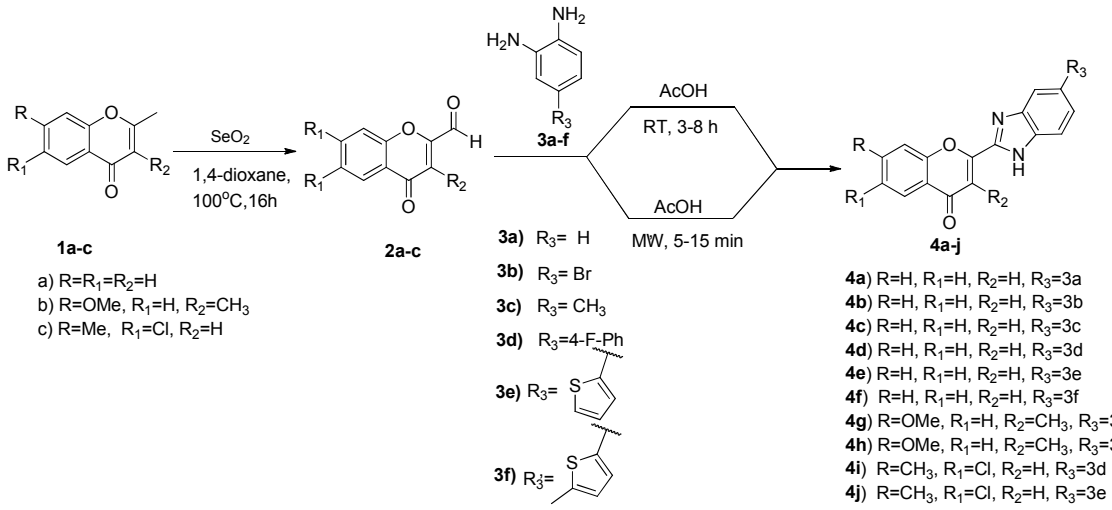


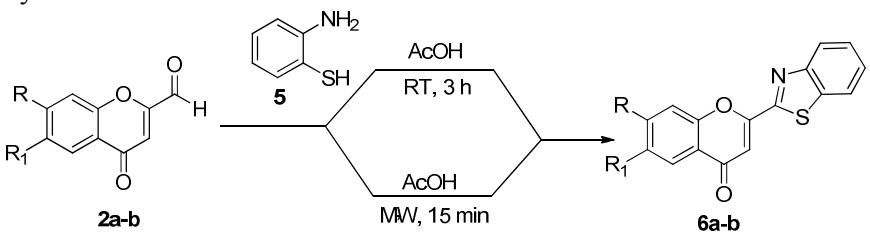
Table 1. Synthesis of chromone/benzimidazole hybrids **4a–j**

Compound	Conventional heating		Microwave irradiation	
	time, h	yield, %	time, min	yield, %
4a	4	68	5	88
4b	5	72	6	86
4c	6	65	5	88
4d	5	70	6	89
4e	6	62	6	84
4f	5	69	6	81
4g	6	67	8	90
4h	5	68	6	86
4i	8	68	8	86
4j	7	66	6	85

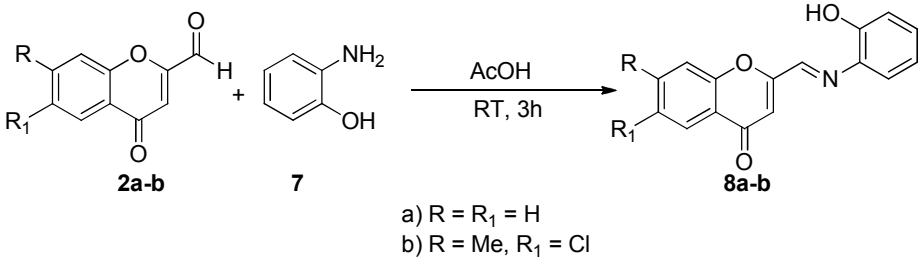
In order to investigate the reactivity of chromone-2-carbaldehydes and to develop chromone/benzthiozole, chromone/benzoxazole, hybrids, equimolar quantities of chromone-2-carbaldehydes **2a-b** were condensed with 2-aminothiophenol **(5) ,** AcOH and PTSA medium at room temperature for 3 hours the reaction afforded products **6a-b** in 40-50% of yield **.**The condensation reaction under MW irradiation gave higher yields of 80-90% for 15min **(Scheme-2),** where as chromone-2-carbaldehydes **2a-b** on reaction with 2-

aminophenol **7** under similar conditions, surprisingly formed only imine intermediates **8a-b** but not the expected cyclize products **(Scheme-3).** All these compounds **6a-b** and **8a-b** structures conformed by spectral analysis.

Scheme 2. Synthesis of **6a-b**



Scheme 3. Synthesis of **8a-b**



Experimental

All used materials were commercial products purchased mostly from Sigma Aldrich and were used without further purification. The melting points were determined in open capillaries and are uncorrected. The purity of the newly synthesized compounds was checked by TLC on silica gel 60 F254 (Merck). The ^{1}H NMR and ^{13}C NMR spectra were recorded on a Varian Gemini 200 MHz spectrometer using tetramethylsilane as internal standard. The IR spectra were recorded in KBr on a Shimadzu FTIR 8400S spectrometer. The mass spectra were obtained on a Shimadzu GCMS-QP 1000 instrument. Microwave-assisted reactions were carried out in a Milestone multiSYNTH microwave system.

General Procedure for synthesis of chromone-2-carbaldehydes (2a-c). To a solution of compound **1a-c** (93.6 mmol) in 1, 4-Dioxane was added Selenium dioxide (SeO_2) (280.9 mmol) under N_2 atmosphere and the resulting reaction mixture was heated to 100^{o}C, stirred for 16 h at same temperature. The reaction mixture was allowed to room temperature and filtered the selenium block solids. The filtrate was evaporated, obtained crude passed through silica gel (60-120 mesh) column chromatography afforded chromone-2-carbaldehydes **(2a-c)** in 75-84 % of yields.

4-Oxo-4H-chromene-2-carbaldehyde (2a). Yield 81%, mp 198-202°C. IR (KBr, cm^{-1}) : 1632 (C=O); ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 6.92 (s ,1H), 7.46 (s ,1H), 7.62 (d „*J* = 8.25 Hz, 1H), 7.68-7.81 (m, 1H), 8.21 (d, *J* = 8.25 Hz, 1H), 9.82 (s, 1H), ^{13}C NMR (DMSO-D_6,400MHz)/ δ (ppm): 188.2, 177.4, 157.3, 155.1, 135.2, 126.3, 125.5, 124.5, 119.1, 117.1, Mass (*m/z*) = 175 (M+H). Found, %: C 68.92, H 3.45. $C_{10}H_6O_3$. Calculated, %: C 68.97, H 3.47.

3-Methyl-7-methoxy-4-oxo-4H-chromene-2-carbaldehyde (2b). Yield 79%, mp 205-208°C. IR (KBr, cm^{-1}) : 1622 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.24 (s, 3H),

3.98 (s, (3H), 7.12 (d, *J* = 8.25 Hz, 1H), 7.21 (s, 1H), 7.98 (d, *J* = 8.25 Hz, 1H), 10.16 (s, 1H), ^{13}C NMR (DMSO-D_6,400MHz)/ δ (ppm): 186.1, 178.2, 156.2, 154.3, 151.6, 135.6, 127.6, 125.6, 122.1, 119.8, 62.1, 26.3, Mass (*m/z*) = 219 (M+H). Found, %: C 66.00, H 4.05. $C_{12}H_{10}O_4$. Calculated, %: C 66.05, H 4.02.

6-Chloro-7-methyl-4-oxo-4H-chromene-2-carbaldehyde (2c). Yield 74%, mp 210-215°C. IR (KBr, cm^{-1}) : 1643 (C=O), ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.48 (s, 3H), 7.12 (s, 1H), 7.81 (s, 1H), 7.98 (s, 1H), 9.79 (s, 1H), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 187.1, 178.2, 154.6, 152.4, 136.5, 128.8, 126.1, 124.1, 119.9, 111.2, 28.1. Mass (*m/z*) = 223 (M+1). Found, %: C 59.31, H 3.19. $C_{11}H_7ClO_3$. Calculated, %: C 59.35, H 3.17.

General Procedure for synthesis of 2-(1H-benzo[d]imidazol-2-yl)-4H-chromen-4-ones (4a-4j). *a. Conventional method;* To a stirred solution of compounds (**2a-c**) (28.7 mmol) in AcOH (6 ml.) added substituted *o*-phenylenediamine (**3a-f**) (31.7 mmol) to the reaction mixture was stirred at room temperature for 3-8 h. The reaction mixture was poured into ice-cold water and solid precipitate was filtered, dried under vacuum to afford 2-(1H-benzo[d]imidazol-2-yl)-4H-chromen-4-ones **(4a-j)** in 50-60 % of yields.

b. Microwave-assisted reaction; A round-bottom flask was charged with compounds (**2a-c**) (28.7 mmol), AcOH (4 ml.) and added substituted *o*-phenylenediamine (**3a-f**) (31.7 mmol) to the reaction mixture and was then irradiated in a multisynth microwave furnace at 100 W over a period indicated in Table 1. The mixture was poured into ice water and the solid precipitate was filtered and dried under vaccum to get 2-(1H-benzo[d]imidazol-2-yl)-4H-chromen-4-ones **(4a-j)** in 80-90 % of yields.

2-(1H-Benzo[d]imidazol-2-yl)-4H-chromen-4-one (4a). Yield 88%, mp 295-298°C. IR (KBr, cm^{-1}) : 3313 (N-H), 1622 (C=O), ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 7.11 (s, 1H), 7.31-7.42 (m, 2H), 7.54-7.86 (m, 5H), 8.10 (d, *J* = 8.25 Hz, 1H), 13.61 (s, 1H, D_2O exchangeable), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 178.1, 156.6, 154.1, 144.6, 135.1, 126.5, 125.4, 125.4, 124.7, 121.1, 119.1, 112.1, 108.4. Mass (*m/z*) = 263 (M+1). Found, %: C 73.22, H 3.86, N 10.62. $C_{16}H_{10}N_2O_2$. Calculated, %: C 73.27, H 3.84, N 10.68.

2-(5-Bromo-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one (4b). Yield 86%, mp 306-309°C, IR (KBr, cm^{-1}) : 3216 (N-H), 1608 (C=O), ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 6.88 (d, *J* = 8.25 Hz, 1H), 7.14 (s, 1H), 7.41-7.64 (m, 2H), 7.69-7.99 (m, 3H), 8.11 (d, *J* = 8.25 Hz, 1H), 13.64 (s, 1H, D_2O exchangeable), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 178.4, 155.2, 152.1, 143.6, 135.4, 132.4, 126.1, 125.4, 124.2, 120.2, 118.8, 112.1, 107.4. Mass (*m/z*) = 341 (M+1). Found, %: C 56.36, H 2.61, N 8.20. $C_{16}H_9BrN_2O_2$. Calculated, %: C 56.33, H 2.66, N 8.21.

2-(5-Methyl-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one (4c). Yield 88%, mp 291-294°C. IR (KBr, cm^{-1}) : 3218 (N-H), 1614 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.42 (s, 3H), 7.08 (s, 1H), 7.18-7.22 (m, 1H), 7.41-7.59 (m, 2H), 7.62-7.94 (m, 3H), 8.11 (d, *J* = 8.25 Hz, 1H), 13.41 (s, 1H, D_2O exchangeable), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 179.1, 156.1, 153.8, 143.8, 134.8, 128.4, 126.1, 125.9, 124.5, 122.2, 119.1, 114.4, 108.8, 28.3. Mass (*m/z*) = 277 (M+1). Found, %: C 73.86, H 4.39, N 10.10. $C_{17}H_{12}N_2O_2$. Calculated, %: C 73.90, H 4.38, N 10.14.

2-(5-(4-Fluorophenyl)-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one (4d). Yield 89%, mp 301-304°C. IR (KBr, cm^{-1}): 3301 (N-H), 1621 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 7.16 (s, 1H), 7.21-7.28 (m, 2H), 7.48-7.69 (m, 5H), 7.88-7.92 (m, 3H), 8.11 (d, *J* = 8.25 Hz, 1H), 13.68 (s, 1H, D_2O exchangeable), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 179.5, 156.5, 154.8, 145.6, 136.7, 128.9, 126.1, 125.8, 124.4, 120.2, 119.1, 111.8, 106.1. Mass (*m/z*) = 357 (M+1). Found, %: C 74.11, H 3.67, N 7.89. $C_{22}H_{13}FN_2O_2$. Calculated, %: C 74.15, H 3.68, N 7.86.

2-(5-(Thiophen-2-yl)-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one (4e). Yield 84%, mp 310-315°C, IR (KBr, cm^{-1}): 3305 (N-H), 1629 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 7.08 (s, 1H), 7.12 (s, 1H), 7.42-7.94 (m, 8H), 8.09 (d, *J* = 8.25 Hz, 1H), 13.62 (s,1H, D_2O exchangeable), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 177.8, 158.5, 156.2, 144.1, 135.6, 129.2, 128.8, 127.4, 126.6, 124.4, 123.2, 120.5, 119.9, 112.4, 109.1, Mass (*m/z*) = 345 (M+1). Found, %: C 69.71, H 3.56, N 8.11. $C_{20}H_{12}N_2O_2S$. Calculated, %: C 69.75, H 3.51, N 8.13.

2-(5-(5-Methylthiophen-2-yl)-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one (4f). Yield 81%, mp 279-283°C. IR (KBr, cm^{-1}): 3327 (N-H), 1654 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.62 (s, 3H), 6.85 (s, 1H), 7.08 (s, 1H), 7.30 (m, 1H), 7.61 (m, 1H), 7.72-7.92 (m, 2H), 8.11 (d, *J* = 8.25 Hz, 1H), 13.68 (s, 1H, D_2O exchangeable). ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 178.1, 157.5, 154.6, 143.4, 135.8, 129.4, 127.8, 125.5, 124.4, 122.7, 120.4, 118.6, 115.4, 108.9, 33.1, Mass (*m/z*) = 359 (M+1). Found, %: C 70.29, H 3.89, N 7.91. $C_{21}H_{14}N_2O_2S$. Calculated, %: C 70.37, H 3.94. N 7.82.

2-(5-(4-Fluorophenyl)-1H-benzo[d]imidazol-2-yl)-7-methoxy-3-methyl-4H-chromen-4-one (4g). Yield 90%, mp 288-291°C. IR (KBr, cm^{-1}): 3189 (N-H), 1616 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.48 (s, 3H), 3.98 (s, 3H), 7.06 (d, *J* = 8.25 Hz, 1H), 7.11-7.16 (m, 4H), 7.41-7.66 (m, 4H), 8.00 (d, *J* = 8.25 Hz, 1H), 13.48 (s, 1H, D_2O exchangeable). ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 178.5, 156.4, 153.4, 143.6, 135.4, 127.8, 126.6, 125.4, 124.5, 120.1, 119.9, 112.7, 108.1, 62.5, 29.1, Mass (*m/z*) =325 (M+1). Found, %: C 71.96, H 4.23, N 7.04. $C_{24}H_{17}FN_2O_3$. Calculated, %: C 71.99, H 4.28, N 7.00.

2-(5-Bromo-1H-benzo[d]imidazol-2-yl)-7-methoxy-3-methyl-4H-chromen-4-one (4h). Yield 86%, mp 295-298°C, IR (KBr, cm^{-1}): 3222 (N-H), 1644 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.62 (s, 3H), 3.98 (s, 3H), 7.02 (d, *J* = 8.25 Hz, 1H), 7.41-7.49 (m, 2H), 7.61-7.68 (m, 2H), 8.02 (d, *J* = 8.25 Hz, 1H), 13.76 (s, 1H, D_2O exchangeable). ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 179.2, 156.2, 153.1, 144.2, 134.3, 126.4, 125.4, 125.2, 124.6, 120.2, 119.4, 112.1, 108.8, 62.1, 28.1. Mass (*m/z*) = 385 (M+1). Found, %: C 56.10, H 3.41, N 7.29. $C_{18}H_{13}BrN_2O_3$. Calculated, %: C 56.12, H 3.40, N 7.27.

2-(1H-Benzo[d]imidazol-2-yl)-6-chloro-7-methyl-4H-chromen-4-one (4i). Yield 86%, mp 320-328°C, IR (KBr, cm^{-1}): 3027 (N-H), 1653 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.48 (s, 3H), 7.06 (s, 1H), 7.16 (m, 1H), 7.49-7.81 (m, 4H), 7.99 (s, 1H), 13.81 (s, 1H, D_2O exchangeable), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm): 177.9, 156.2, 154.2, 143.3, 134.2, 126.2, 125.1, 125.5, 124.1, 122.2, 119.2, 112.5, 108.2, 30.0, Mass (*m/z*) = 405 (M+1). Found, %: C 65.76, H 3.51, N 9.00. $C_{17}H_{11}ClN_2O_2$. Calculated, %: C 65.71, H 3.57, N 9.02.

6-Chloro-7-methyl-2-(5-(thiophen-2-yl)-1H-benzo[d]imidazol-2-yl)-4H-chromen-4-one (4j). Yield 85%, mp 321-324°C, IR (KBr, cm^{-1}): 3127 (N-H), 1633 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.48 (s, 3H), 7.04 (s, 1H), 7.08-7.18 (m, 2H), 7.48-7.81 (m, 4H), 7.99 (s, 2H), 13.76 (s, 1H, D_2O exchangeable). ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm):179.0, 156.1, 154.5, 145.2, 135.1, 126.5, 125.8, 125.1, 122.2, 121.3, 119.8, 112.1, 108.1, 28.2, Mass (*m/z*) = 393 (M+1). Found, %: C 64.16, H 3.38, N 7.10. $C_{21}H_{13}ClN_2O_2S$. Calculated, %: C 64.20, H 3.34, N 7.13.

General Procedure for synthesis of 2-(benzo[d]thiazol-2-yl)-4H-chromen-4-ones (6a-b). *a. Conventional method*; To a stirred solution of compound (**2a-b**) (1 mol) in AcOH (6 ml). and added thiophenol (**5a**)(1.1 mol) to the reaction mixture was stirred at room temperature for 3h. The reaction mixture was poured into ice-cold water and solid precipitate was filtered, dried under vacuum to afford title compound **(6a-b)** in 56-66 % of yields.

b. Microwave-assisted reaction; A round-bottom flask was charged with compound (**2a-b**) (28.7 mmol), AcOH (4 ml.) and added thiophenol (**5a**)(31.7 mmol) to the reaction mixture and was then irradiated in a multisynth microwave furnace at 100 W over a period of 15 min. The mixture was poured into ice water and the solid precipitate was filtered and dried under vaccum to get 2-(benzo[d]thiazol-2-yl)-4H-chromen-4-ones **(6a-b)** in 75-80 % of yields.

2-(Benzo[d]thiazol-2-yl)-4H-chromen-4-one (6a). Yield 76%, mp 238-241°C,IR (KBr, cm^{-1}): 1633 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 6.31 (s, 1H), 6.62-6.99 (m, 3H), 7.06-7.44 (m, 2H), 7.49-7.66 (m, 2H), 7.98 (d, *J* = 8.25 Hz, 1H). ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm); 179.2, 157.9, 155.3, 135.2, 126.2, 125.5, 124.7, 119.5, 117.5, Mass (*m/z*) = 280 (M+1). Found, %: C 68.86, H 3.20, N 5.00. $C_{16}H_9NO_2S$. Calculated, %: C 68.80, H 3.25, N 5.01.

2-(benzo[d]thiazol-2-yl)-6-chloro-7-methyl-4H-chromen-4-one (6b). Yield 80%, mp 265-269°C, IR (KBr, cm^{-1}):1643 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.44 (s, 3H), 7.09 (s, 1H), 7.16 (m, 2H), 7.49-7.81 (m, 3H), 7.98 (s, 1H), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm); 177.8, 157.5, 154.5, 136.1, 126.3, 125.5, 126.1, 119.9, 117.0, 26.4, Mass (*m/z*) = 328 (M+1). Found, %: C 62.22, H 3.18, N 4.21. $C_{17}H_{10}ClNO_2S$. Calculated, %: C 62.29, H 3.08, N 4.27.

General Procedure for synthesis of (E)-2-(((2-hydroxyphenyl)imino)methyl)-4H-chromen-4-ones (8a-b). To a stirred solution of compound (**2a-b**) (1 mol) in AcOH (5 vol.) and added 2-aminophenol (**7**) (1.1 mol) to the reaction mixture was stirred at room temperature for 3h.Then reaction mixture was poured into ice-cold water and solid precipitate was observed and stirred for 1h and filtered the solid then given cold water wash and dried under vacuum to afford title compounds **(8a-b)**.

(E)-2-(((2-Hydroxyphenyl)imino)methyl)-4H-chromen-4-one (8a). Yield 66%, mp 289-292°C. IR (KBr, cm^{-1}): 3310 (O-H), 1634 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 6.82 (s, 1H), 6.86-7.09 (m, 2H), 7.29-7.66 (m, 5H), 8.21 (d, *J* = 8.25 Hz, 1H), 8.48 (s, 1H), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm); 179.8, 157.6, 155.1, 151.0, 135.6, 126.8, 125.8, 124.3, 119.6, 117.1, 112.3, Mass (*m/z*) = 266 (M+1). Found, %: C 72.40, H 4.12, N 5.32. $C_{16}H_{11}NO_3$. Calculated, %: C 72.45, H 4.18, N 5.28.

(E)-6-chloro-2-(((2-hydroxyphenyl)imino)methyl)-7-methyl-4H-chromen-4-one (8b). Yield 59%, mp 301-304°C. IR (KBr, cm^{-1}) : 3390 (O-H), 1656 (C=O). ^{1}H NMR (DMSO-D_6,400MHz) / δ (ppm): 2.38 (s, 3H), 6.88 (s, 1H), 6.96-7.09 (m, 2H), 7.29-7.66 (m, 5H), 7.98 (s, 1H), 8.42 (s, 1H), ^{13}C NMR (DMSO-D_6,400MHz) / δ (ppm); 179.6, 157.5, 155.6, 151.1, 144.6, 135.1, 127.2, 125.1, 124.0, 119.3, 117.0, 112.0, 28.0, Mass (*m/z*) = 314 (M+1). Found, %: C 65.03, H 3.90, N 4.41. $C_{16}H_{11}NO_3$. Calculated, %: C 65.08, H 3.86, N 4.46.

Conclusion

In summary, we have synthesized a series of novel chromone/benzimidazole and chromone/benzothiazole hybrid heterocycles by oxidative cycloaddition of *o*-phenylenediamine/2-aminothiophenol with chromone-2-carbaldehydes under both conventional and microwave irradiation methods without isolating of any intermedites. The reactions under microwave irradiation were completed in shorter time with better yields than under conventional conditions.

Acknowledgements

This work was supported by Dept. of Chemistry, University College of Science, Rayalaseema University, Kurnool, Andhra Pradesh, India- 518002, Dept. of Chemistry, University College of Science, Osmania University, Hyderabad, Telangana, India -500007.

and Dept. of Chemistry, University College of Science, Telangana University, Nizambad, Telangana-503322 and

References

i. Gaspar, A.; Matos, M. J.; Garrido, J.; Uriarte, E.; and Borges, F.; *Chem. Rev.,* (2014), 119, 4960.
ii. Yu, D.; Brossi, A.; Kilgore, N.; Wild, C.; Allaway, G.; and Lee, K.H.; *Bioorg. Med. Chem. Lett.* (2003), 13, 1575.
iii. Barve, V.; Ahmed, F.; Adsule, S.; Banerjee, S.; Kulkarni, S.; Katiyar, P.; Anson, C.E.; Powell, A.K.; Padhye, S.; and Sarkar, F.H.; *J. Med. Chem.* (2006), 49, 3800.
iv. Phosrithong, N.; Samee, W.; Nunthanavanit, P.; and Ungwitayatorn, J.; *Chem. Biol. Drug Des.* (2012), 79, 981.
v. Es-Safi., N.E.; Ghidouche, S.; and Ducrot, P.H.; *Molecules* (2007), 12, 2228.
vi. Saija, A.; Scalese, M.; Lanza, M.; Marzullo, D.; Bonina, F.; and Castelli, F.; *Free Radical Biol. Med.* (1995), 19, 481.
vii. Legoabe, L.J.; Petzer, A.; and Petzer, J.P.; *Bioorg. Med. Chem. Lett.* (2012), 22, 5480.
viii. Huang, W.; Liu, M. -Z.; Li, Y. Tan, Y.; and Yang, G. -F.; *Bioorg. Med. Chem.*(2007), 15, 5191.
ix. Desideri, N.; Conti, C.; Mastromarino, P.; and Mastropaolo, F.; *Antivir. Chem. Chemother.* (2000), 11, 373.
x. Nohara, A.; Kuriki, H.; Ishiguro, T.; Saijo, T.; Ukawa, K.; Maki, Y.; and Sanno, Y.; *J. Med. Chem.* (1979), 22, 290.
xi. Nohara, A.; Kuriki, H.; Saijo, T.; Sugihara, H.; Kanno, M.; and Sanno, Y.; *J. Med. Chem*. (1977), 20, 141.
xii. Venkateswararao, E.; Sharma, V.K.; Lee, K.C.; Roh, E.; Kim, Y.; and Jung, S.H.; *Bioorg. Med. Chem.* (2013), 21, 2543.
xiii. Oganesyan, E.T.; Tuskaev, V.A.; and Sarkisov, L.S.; *Pharm. Chem. J.* (1994), 28, 884.
xiv. Cano, P.A.; Islas-Jácome, A.; González-Marrero, J.; Yépez-Mulia, L.; Calzada, F.; and GámezMontaño, R.; *Bioorg. Med. Chem.*(2014), 22, 1370.
xv. Ali, T.E.S.; and Ibrahim, M.A.; *J. Braz. Chem. Soc.* (2010), 21, 1007.
xvi. Diwakar, D.D.; Bahgwat, S.S.; Shingare, M.S.; and Gill, C.H.; *Bioorg. Med. Chem. Lett.* (2008), 18, 4678.
xvii. Grimmett, M.R.; Imidazole and benzimidazolesynthesis. Academic Press: Boston, (1997).
xviii. Yadav. G.; and Ganguly, S.; *Eur. J. Med. Chem.* (2015), 97, 419.
xix. Scott, L.J.; Dunn, C.J.; Mallarkey. G.; and Sharpe, M.; *Drugs.* (2002), 62, 1503.
xx. El-Nezhawy A.O.; Biuomy, A.R.; Hassan, F.S.; Ismaiel, A.K.; and Omar, H.A.; *Bioorg Med Chem.* (2013), 21, 1661.
xxi. Kath R.; Blumenstengel, K.; Fricke, H.J.; and Höffken, K.; *J. Cancer Res ClinOncol.* (2001), 127, 48.
xxii. Navarrete-Vázquez, G.; Yépez, L.; Hernández-Campos, A.; *Bioorg Med Chem.* (2003), 11, 4615.
xxiii. Barot, K.P.; Nikolova, S.; Ivanov, I.; Ghate, M.D.; *Mini Rev. Med. Chem*. (2013), 13, 1421.
xxiv. Gedye, R.N.; and Wei, J.B.; *Can. J. Chem*., (1998),76, 525.
xxv. Varma, R.S.; *Green Chem*.,(1999), 1, 43.

xxvi. Reddy, K.R.S.; Srimannarayana, G.; Rao, N.V.S.; *Journal of the Indian Chemical Society* (1986), 63, 600.
xxvii. Jagadeesh,S.G.;Srimannarayana,G.;DavidKrupadanam,G.L.; *Synthetic communications*, (1998), 28, 3827.

Received on March 24, 2018.