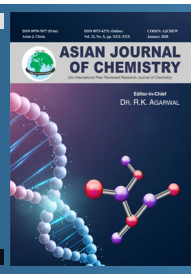
Asian Journal of Chemistry; Vol. 32, No. 1 (2020), 205-208

ASIAN JOURNAL OF CHEMISTRY

https://doi.org/10.14233/ajchem.2020.22376



Green Synthesis of Spiropyranone 3-Aryl-4-Methylcoumarin Derivatives using Carbonyldiimidazole

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Received: 4 August 2019; *Accepted*: 28 October 2019; *Published online*: 18 November 2019; AJC-19699

A series of spiropyranone 3-aryl-4-methylcoumarin derivatives have been synthesized from monospiro-2-hydroxy acetophenone in a novel and efficient green method using imidazolyl intermediates and inorganic base. Imidazolyl intermediates were in turn generated by grinding the respective phenylacetic acid along with carbonyldiimidazole (CDI). Similarly, monospiro-2-hydroxy acetophenone derivatives were prepared selectively by avoiding formation of *bis* derivatives following literature procedure. The titled compounds were purified by preparative TLC technique and were characterized by IR, ^{1}H NMR, ^{13}C NMR as well as mass spectral methods.

Keywords: Spiropyranone coumarin, Carbonyl diimidazole, Green synthesis.

INTRODUCTION

Benzopyrone analogues known as coumarins are widely known fused heterocyclic framework that served as the prototype scaffold for the synthesis of a wide variety of heterocyclic systems in order to evaluate their biological activity. Moreover, several synthetic coumarin derivatives have important pharmacological potential as they proved to be efficient inhibitors of a variety of enzymes such as the human 5-lipoxygenase [1], aromatase [2], horseradish peroxidase [3], hAChE/BACE1 [4] and 17b-hydroxysteroid dehydrogenase type 3 [5].

2*H*-Chromen-2-one *i.e*. coumarins and their various derivatives are widely known in many natural products and are effective pharmacophores. Warfarin, a coumarin based compound is a known cardiovascular agent. Similarly, novobiocin, another coumarin based compound is an antimicrobial agent. Added to this importance of coumarins in different fields is widely known in literature [6-12].

Based on the biological applications and various uses, synthesis of coumarins gained lot of importance in medicinal chemistry. Approaches to synthesize coumarins include prototype reactions such as Perkin reaction [13-15], Pechmann reaction [16-18], Knoevenagel reaction [19], Wittig reaction [20], Kostanecki-Robinson reactions [21,22]. Besides these routes, 3-aryl coumarin derivatives were also prepared using reagents such as DCC, DDQ, NaOH, $POCl_3$ and Mukaiyama reagent (2-chloro-1-methylpyridiniumiodide) [23-26]. Many of these methods suffer limitations such as formation of complex mixture of products, usage of excess reagents and longer reaction times. Hence a relatively more sustainable reagent such as carbonyldiimidazole (CDI) gains more importance. Carboxylic acid group in various anhydrous solvent such as chloroform, DMF, THF, benzene, *etc*. can be activated to corresponding acid imidazolyl group by treating with excess CDI, which can be directly used for next step without further purification [27].

EXPERIMENTAL

Phenylacetic acid, 4-chlorophenylacetic acid, 4-methylphenylacetic acid, 4-methoxyphenylacetic acid, DABCO (1,4-diazabicyclo[2.2.2]octane) and carbonyldiimidazole, were obtained from Aldrich Chemical Co. All common chemicals were of synthetic grade. Reactions were monitored by thin layer chromatography (TLC) on silica gel plates (60 F_{254}), visualizing with ultraviolet light. ^{1}H and ^{13}C nuclear magnetic resonance (NMR) spectra using $CDCl_3$ as solvent were recorded on Bruker Avance II 400 MHz spectrometer at the frequency

indicated. Proton chemical shifts (δ) are relative to tetramethylsilane (TMS) as internal standard and expressed in ppm. Coupling constants (*J*) are given in hertz. Mass spectra were recorded on GCMS-QP 1000, The IR spectra were recorded on Shimadzu FTIR 8400S spectrophotometer. Melting points of synthesized compounds were determined in Polmon make instrument (model No. MP-96) and are uncorrected.

Initial efforts for preparing coumarin from phenylacetic acid were attempted using different reagents as well as various bases in different solvents for standardization of reaction conditions. Inspired by the results of Foroumadi *et. al*. [28], the first trial was initiated using neat DABCO as coupling reagent. Unfortunately, the yields were poor on targeted substrate which forced to look for alternate methods. These results prompted to try the synthesis of coumarins with acid imidazole in the presence of different base and solvents as according to Hamilakis *et al*. report [29]. Activation of acid using carbonyldiimidazole using 1 equiv. of DBU as base for 2 h as well as 4 h, did not result in improvement of reaction yield. Increasing the amount of DBU to 3 and 5 equiv. also did not help in further improvement of yield. Based on reports of Kaushik *et. al*. [30], solvent was changed from DCM to toluene. The reaction performed at room temperature as well as 80 ºC in toluene with DBU as a base did not help much in improvization of yield. Parallel effort by changing the base to triethylamine, resulted in even poor results. Use of K_2CO_3 as a base improved the yield to around 45 %. Finally, a trial using acid imidazole in dry acetone as solvent and K_2CO_3 as base under microwave irradiation resulted in improved yield (**Scheme-I**). However, several trials to purify the compound by column chromatography were unsuccessful, as impurities got eluted along with desired product. Finally, all the targeted compounds were purified by preparative TLC technique, which resulted in 72-76 % yield of pure product. All the compounds were well characterized by IR, ^{1}H NMR, ^{13}C NMR and mass spectral studies.

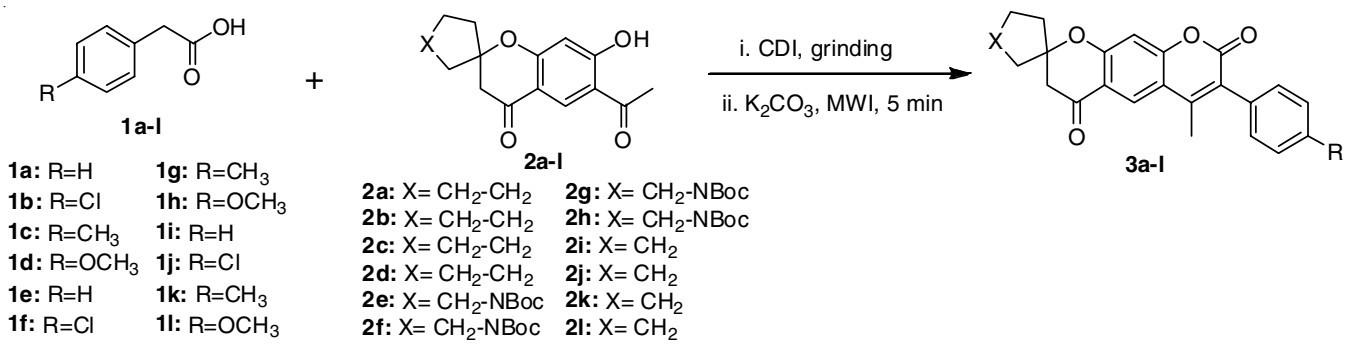
General procedure for synthesis of spiropyranone 3-aryl-4-methylcoumarin (3a-l): Substituted phenylacetic acid (**1a-d**) (1 mmol) and 1,1-carbonyldiimidazole (CDI, 1.2 mmol) were grinded with the help of a glass rod for 3 min to generate acid imidazole. To this a mixture of spirochromanone bearing 2-hydroxyacetophenone (**2a-c**) (1 mmol) and K_2CO_3 were introduced into a CEM Discover Microwave reaction vessel which is equipped with a magnetic stirrer. This vessel was sealed and then placed into the cavity. A microwave irradiation of 180 W was used and the temperature being ramped from room temperature to desired 50 ºC temperature. The reaction mixture was heated at this temperature for appropriate time. To the reaction mixture water was added and solid obtained was filtered. This filtrate was dissolved in ethyl acetate and purified by preparative TLC (5 % ethylacetate in *n*-hexane) to obtain desired coumarins (**3a-l**) in better yields.

6′-Methyl-7′-phenyl-8′H-spiro[cyclohexane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3a): Yield: 75 %, White solid; m.f. $C_{24}H_{22}O_4$; m.p.: 156-158 ºC; IR (KBr, ν_{max}, cm^{-1}): 2952, 1718, 1693, 1622; ^{1}H NMR ($CDCl_3$, 400 MHz): δ 8.21 (s, 1H, Ar-H), 7.47-7.37 (m, 3H, Ar-H), 7.29-7.27 (m, 2H, Ar-H), 6.91 (s, 2H, Ar-H), 2.77 (s, 2H, -CH_2), 2.31 (s, 3H, -CH_3), 2.04-2.00 (m, 2H, -CH_2), 1.78-1.66 (m, 3H, -CH_2), 1.57-1.52 (m, 5H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.23, 161.62, 160.31, 158.07, 147.83, 134.10, 130.05, 128.44, 125.53, 124.78, 117.95, 115.15, 105.33, 81.51, 47.98, 34.88, 24.99, 21.37, 16.71; MS (*m/z*): 375 $[M+H]^+$ (100 %).

7′-(4-Chlorophenyl)-6′-methyl-8′H-spiro[cyclohexane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3'H)-dione (3b): Yield: 75 %, White solid; m.f. $C_{24}H_{21}O_4Cl$; m.p.: 152-154 ºC; IR (KBr, ν_{max}, cm^{-1}): 2952, 1714, 1694, 1624; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 (s, 1H, Ar-H), 7.44-7.42 (d, 2H, *J* = 8.28 Hz, Ar-H), 7.24-7.22 (d, 2H, *J* = 8.28 Hz, Ar-H), 6.91 (s, 1H, Ar-H), 2.78 (s, 2H, -CH_2), 2.31 (s, 3H, -CH_3), 2.02-1.99 (m, 2H, -CH_2), 1.74-1.69 (m, 4H, -CH_2), 1.55-1.51 (m, 4H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.14, 161.78, 160.10, 158.00, 148.20, 134.39, 132.48, 131.54, 128.74, 124.86, 124.34, 118.04, 114.93, 105.40, 81.61, 47.96, 34.88, 24.97, 21.36, 16.72; MS (*m/z*): 409 $[M+H]^+$ (100 %).

6′-Methyl-7′-(*p*-tolyl)-8′H-spiro[cyclohexane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3c): Yield: 72 %, White solid; m.f. $C_{25}H_{24}O_4$; m.p.: 198-200 ºC ; IR (KBr, ν_{max}, cm^{-1}): 2952, 1713, 1695, 1623; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.20 (s, 1H, Ar-H), 7.27-7.25 (d, 2H, *J* = 8.03Hz, Ar-H), 7.18-7.16 (d, 2H, *J* = 8.03Hz, Ar-H), 6.90 (s, 1H, Ar-H), 2.77 (s, 2H, -CH_2), 2.40 (s, 3H, -CH_3), 2.31 (s, 3H, -CH_3), 2.03-2.00 (m, 2H, -CH_2), 1.75-1.65 (m, 4H, -CH_2), 1.55-1.51 (m, 4H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.24, 161.53, 158.04, 147.59, 138.11, 131.08, 129.90, 129.15, 125.52, 124.71, 117.92, 115.24, 105.29, 81.47, 47.98, 34.88, 24.99, 21.37, 16.70; MS (*m/z*): 389 $[M+H]^+$ (100 %).

7′-(4-Methoxyphenyl)-6′-methyl-8′H-spiro[cyclohexane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3d): Yield: 74 %, White solid; m.f. $C_{25}H_{24}O_5$; m.p.: 204-206 ºC; IR (KBr, ν_{max}, cm^{-1}): 2952, 1712, 1694, 1626; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.20 (s, 1H, Ar-H), 7.23-7.20 (d, 2H, *J* = 8.78Hz, Ar-H), 6.99-6.97 (d, 2H, *J* = 8.78Hz, Ar-H), 6.90 (s, 1H, Ar-



Scheme-I: Synthesis of spiropyranone 3-aryl-4-methylcoumarin derivatives

H), 3.85 (s, 3H, -OCH_3), 2.77 (s, 2H, -CH_2), 2.33 (s, 3H, -CH_3), 2.03-2.00 (m, 2H, -CH_2), 1.75-1.65 (m,3H, -CH_2), 1.56-1.52 (m, 5H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.25, 161.50, 160.58, 159.47, 157.99, 147.53, 131.36, 126.21, 125.16, 124.70, 117.92, 115.28, 113.90, 105.27, 81.47, 55.30, 47.99, 34.88, 24.99, 21.37, 16.75; MS (*m/z*): 405 $[M+H]^+$ (100 %).

6′-Methyl-7′-phenyl-1-pivaloyl-8′H-spiro[piperidine-4,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3e): Yield: 73 %, White solid; m.f. $C_{28}H_{29}NO_5$; m.p.: 208-210 ºC; IR (KBr, ν_{max}, cm^{-1}): 2965, 1719, 1683, 1611; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.23 (s, 1H, Ar-H), 7.48-7.40 (m, 3H, Ar-H), 7.29-7.27 (m, 2H, Ar-H), 6.93 (s, 1H, Ar-H), 3.89 (bs, 2H, -NCH_2), 3.25 (bs, 2H, -NCH_2), 2.79 (s, 2H, -CH_2), 2.32 (s, 3H, -CH_3), 2.06-2.02 (m, 2H, -CH_2), 1.71-1.63 (m, 2H, -CH_2), 1.47 (s, 9H, -$C(CH_3)_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.13, 160.91, 160.10, 158.19, 154.62, 147.61, 133.94, 130.01, 128.46, 125.90, 124.97, 117.79, 115.64, 105.36, 79.97, 79.32, 47.84, 28.39, 16.71; MS (*m/z*): 460 $[M+H]^+$ (100 %).

7′-(4-Chlorophenyl)-6′-methyl-1-pivaloyl-8′H-spiro-[piperidine-4,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3f): Yield: 74 %, White solid; m.f. $C_{28}H_{28}NO_5Cl$; m.p.: 196-198 ºC; IR (KBr, ν_{max}, cm^{-1}): 2962, 1718, 1681, 1612; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.23 (s, 1H, Ar-H), 7.45-7.42 (d, 2H, *J* = 8.53 Hz, Ar-H), 7.24-7.22 (d, 2H, *J* = 8.53 Hz, Ar-H), 6.93 (s, 1H, Ar-H), 3.89 (bs, 2H, -NCH_2), 3.25 (bs, 2H, -NCH_2), 2.79 (s, 2H, -CH_2), 2.32 (s, 3H, -CH_3), 2.05-2.02 (m, 2H, -CH_2), 1.71-1.63 (m, 2H, -CH_2), 1.47 (s, 9H, -$C(CH_3)_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.05, 161.06, 159.89, 158.11, 154.61, 148.00, 134.48, 132.30, 131.50, 128.76, 125.05, 124.72, 117.87, 115.41, 105.43, 79.99, 79.40, 47.81, 28.39, 16.73; MS (*m/z*): 494 $[M+H]^+$ (100 %).

6′-Methyl-1-pivaloyl-7′-(*p*-tolyl)-8′H-spiro[piperidine-4,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3g): Yield: 72 %, White solid; m.f. $C_{29}H_{31}NO_5$; m.p.: 186-188 ºC; IR (KBr, ν_{max}, cm^{-1}): 2964, 1717, 1684, 1613; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.22 (s, 1H, Ar-H), 7.27 (d, 2H, *J* = 8.0 Hz, Ar-H), 7.18-7.16 (d, 2H, *J* = 8.03Hz, Ar-H), 6.92 (s, 1H, Ar-H), 3.91 (bs, 2H, -N-CH_2), 3.26 (bs, 2H, -N-CH_2), 2.79 (s, 2H, -CH_2), 2.40 (s, 3H, -CH_3), 2.32 (s, 3H, -CH_3), 2.06-2.02 (m, 2H, -CH_2), 1.69-1.62 (m, 2H, -CH_2), 1.47 (s, 9H, -$C(CH_3)_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.17, 160.83, 160.26, 158.15, 154.63, 147.39, 138.23, 129.87, 129.17, 125.89, 124.90, 117.75, 115.73, 105.32, 79.97, 79.28, 47.85, 34.13, 28.39, 21.31, 16.71; MS (*m/z*): 474 $[M+H]^+$ (100 %).

7′-(4-Methoxyphenyl)-6′-methyl-1-pivaloyl-8′H-spiro[piperidine-4,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3h): Yield: 72 %, White solid; m.f. $C_{29}H_{31}NO_6$; m.p.: 202-204 ºC; IR (KBr, ν_{max}, cm^{-1}): 2964, 1719, 1684, 1615; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.22 (s, 1H, Ar-H), 7.23-7.20 (d, 2H, *J* = 8.78 Hz, Ar-H), 6.99-6.97 (d, 2H, *J* = 8.78 Hz, Ar-H), 6.92 (s, 1H, Ar-H), 3.85 (bs, 5H, -OCH_3, -N-CH_2), 3.25 (bs, 2H, -NCH_2), 2.79 (s, 2H, -CH_2), 2.33 (s, 3H, -CH_3), 2.05-2.02 (m, 2H, -CH_2), 1.70-1.63 (m, 2H, -CH_2), 1.47 (s, 9H, -$C(CH_3)_3$); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.15, 161.83, 160.30, 158.51, 155.63, 147.96, 138.58, 129.90, 129.00, 126.89, 125.90, 118.75, 115.83, 106.32, 81.23, 79.89, 47.85, 34.13, 28.39, 25.56, 21.31, 16.71; MS (*m/z*): 490 $[M+H]^+$ (100 %).

6′-Methyl-7′-phenyl-8′H-spiro[cyclopentane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3i): Yield: 76 %, White solid; m.f. $C_{23}H_{20}O_4$; m.p.: 168-170 ºC; IR (KBr, ν_{max}, cm^{-1}): 2954, 1716, 1691, 1620; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.23 (s, 1H, Ar-H), 7.48-7.38 (m, 3H, Ar-H), 7.29-7.27 (m, 2H,Ar-H), 6.87 (s, 1H, Ar-H), 2.90 (s, 2H, -CH_2), 2.32 (s, 3H, -CH_3), 2.14-2.09 (m, 2H, -CH_2), 1.94-1.90 (m, 2H, -CH_2), 1.76-1.69 (m, 4H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.21, 162.29, 160.30, 157.92, 147.80, 134.07, 130.05, 128.44, 125.58, 125.04, 118.08, 115.22, 105.51, 91.25, 46.92, 37.62, 23.87, 16.71; MS (*m/z*): 361 $[M+H]^+$ (100 %).

7′-(4-Chlorophenyl)-6′-methyl-8′H-spiro[cyclopentane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3j): Yield: 72 %, White solid; m.f. $C_{23}H_{19}O_4Cl$; m.p.: 198-200 ºC; IR (KBr, ν_{max}, cm^{-1}): 2956, 1716, 1691, 1618; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.23 (s, 1H, Ar-H), 7.44-7.42 (d, 2H, *J* = 8.28 Hz, Ar-H), 7.24-7.22 (d, 2H, *J* = 8.28 Hz, Ar-H), 6.87 (s, 1H, Ar-H), 2.90 (s, 2H, -CH_2), 2.32 (s, 3H, -CH_3), 2.13-2.09 (m, 2H, -CH_2), 1.94-1.88 (m, 2H, -CH_2), 1.78-1.69 (m, 4H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.12, 162.44, 160.10, 157.84, 148.19, 134.39, 132.44, 131.54, 128.73, 125.12, 124.38, 118.15, 114.99, 105.57, 91.33, 46.89, 37.62, 29.69, 23.86, 16.72; MS (*m/z*): 395 $[M+H]^+$ (100 %).

6′-Methyl-7′-(*p*-tolyl)-8′H-spiro[cyclopentane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3k): Yield: 73 %, White solid; m.f. $C_{24}H_{22}O_4$; m.p.: 156-158 ºC; IR (KBr, ν_{max}, cm^{-1}): 2956, 1716, 1693, 1612; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 (s, 1H, Ar-H), 7.27-7.25 (d, 2H, Ar-H), 7.18-7.16 (d, *J* = 8.03 Hz, 2H, Ar-H), 6.86 (s, 1H, Ar-H), 2.89 (2H, s, -CH_2), 2.40 (s, 3H, -CH_3), 2.32 (s, 3H, -CH_3), 2.13-2.08 (m, 2H, -CH_2), 1.94-1.90 (m, 2H, -CH_2), 1.77-1.66 (m, 4H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.23, 162.21, 157.88, 138.14, 131.05, 129.90, 129.15, 128.44, 124.97, 118.04, 115.31, 105.46, 91.22, 46.93, 37.62, 34.88, 29.69, 23.87, 21.31, 16.71; MS (*m/z*): 375 $[M+H]^+$ (100 %).

7′-(4-Methoxyphenyl)-6′-methyl-8′H-spiro[cyclopentane-1,2′-pyrano[3,2-*g*]chromene]-4′,8′(3′H)-dione (3l): Yield: 74 %, White solid; m.f. $C_{24}H_{22}O_5$; m.p.: 146-148 ºC; IR (KBr, ν_{max}, cm^{-1}): 2956, 1712, 1614; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 (s, 1H, Ar-H), 7.23-7.21 (d, 2H, *J* = 8.53 Hz, Ar-H), 6.99-6.97 (d, 2H, *J* = 8.53 Hz, Ar-H), 6.86 (s, 1H, Ar-H), 3.85 (s, 3H, -OCH_3), 2.89 (s, 2H, -CH_2), 2.33 (s, 3H, -CH_3), 2.11-2.08 (m, 2H, -CH_2), 1.96-1.89 (m, 2H, -CH_2), 1.77-1.68 (m, 4H, -CH_2); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.24, 162.17, 160.57, 159.47, 157.82, 147.51, 131.35, 129.30, 126.17, 124.95, 118.03, 115.34, 113.89, 105.44, 91.21, 55.29, 46.92, 37.60, 23.86, 16.75; MS (*m/z*): 391 $[M+H]^+$ (100%).

RESULTS AND DISCUSSION

Compounds **3a-l** were synthesized both in conventional and green methods using different solvents and reagents. The comparison of temperature required, yield and time taken for completion of the reaction are given in Table-1.

Characterization of compound 3i: The structures of synthesized spiropyranone coumarin derivatives were established on the basis of IR, ^{1}H NMR, ^{13}C NMR and mass spectral data. In the IR spectrum (KBr) of compound **3i**, the characteristic absorption peaks appeared at 1716 cm^{-1} corresponds to CH_2-C=O, 1691 cm^{-1} corresponds to -O-C=O of coumarin ring functional group. ^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3i** showed multiplet at δ 7.27-7.48 ppm representing the newly

TABLE-1
OPTIMIZATION OF REACTION
CONDITIONS FOR COUMARIN SYNTHESIS

Reagent	Base	Solvent	Temp. (°C)	Time (h)	Yield (%)
DABCO	–	–	180	1.5	35
CDI	DBU 1eq	DCM	Rt	2	36
CDI	DBU 1eq	DCM	Rt	4	36
CDI	DBU 3eq	DCM	Rt	2	37
CDI	DBU 5eq	DCM	Rt	2	37
CDI	DBU 1eq	Toluene	Rt	4	37
CDI	DBU 1eq	Toluene	80	4	40
CDI	TEA	DCM	Rt	6	23
CDI	K_2CO_3	DCM	Rt	4	45
CDI	K_2CO_3	Dry acetone	Rt	3	57
CDI	K_2CO_3		MWI	5 min	75

attached phenyl ring. A singlet corresponding to methyl group appeared at δ 2.32 ppm. ^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3i** exhibited characteristic peak of newly formed lactone carbon at δ 162 ppm, carbonyl carbon of chromanone ring appears at δ 191 ppm. ESI mass spectrum of compound **3i** exhibited a base peak at *m/z* 361 $[M+H]^+$.

Conclusion

A series of novel spiropyranone coumarin derivatives **3a-l** were successfully synthesized by microware irradiation method to obtain better yields and shorter time compared to conventional method. The derivatives were synthesized using carbonyldiimidazole (CDI) and corresponding acid, while K_2CO_3 was used as base. The purification of compounds was done using preparative TLC method. All the compounds were characterized by spectral analysis.

ACKNOWLEDGEMENTS

This work was supported by University Grants Commission (UGC) as UGC-MRP, Project sanction letter No.: F. 43-211/2014 (SR), New Delhi and is gratefully acknowledged. The authors thank Central Facilities For Research and Development (CFRD) and Indian Institute of Chemical Technology (IICT), Hyderabad, India for providing the spectral analytical facilities. One of the authors, D. Ashok is thankful to BSR.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

REFERENCES

1. E.L. Grimm, C. Brideau, N. Chauret, C. Chan, D. Delorme, Y. Ducharme, D. Ethier, J.P. Falgueyret, R.W. Friesen, J. Guay, P. Hamel, D. Riendeau, C. Soucy-Breau, P. Tagari and Y. Girard, *Bioorg. Med. Chem. Lett*., **16**, 2528 (2006); https://doi.org/10.1016/j.bmcl.2006.01.085.
2. F. Leonetti, A. Favia, A. Rao, R. Aliano, A. Paluszcak, R. W. Hartmann and A. Carotti, *J. Med. Chem*., **47**, 6792 (2004); https://doi.org/10.1021/jm049535j.
3. L.M. Kabeya, A.A. de Marchi, A. Kanashiro, N.P. Lopes, C.H.T.P. de Silva, M.T. Pupo and Y.M. Lucisano-Valim, *Bioorg. Med. Chem*., **15**, 1516 (2007); https://doi.org/10.1016/j.bmc.2006.10.068.
4. L. Piazzi, A. Cavalli, F. Colizzi, F. Belluti, M. Bartolini, F. Mancini, M. Recanatini, V. Andrisano and A. Rampa, *Bioorg. Med. Chem. Lett*., **18**, 423 (2008); https://doi.org/10.1016/j.bmcl.2007.09.100.
5. K. Harada, H. Kubo, Y. Tomigahara, K. Nishioka, J. Takahashi, M. Momose, S. Inoue and A. Kojima, *Bioorg. Med. Chem. Lett*., **20**, 272 (2010); https://doi.org/10.1016/j.bmcl.2009.10.111.
6. F. Borges, F. Roleira, N. Milhazes, L. Santana and E. Uriarte, *Curr. Med. Chem*., **12**, 887 (2005); https://doi.org/10.2174/0929867053507315.
7. P. Anand, B. Singh and N. Singh, *Bioorg. Med. Chem*., **20**, 1175 (2012); https://doi.org/10.1016/j.bmc.2011.12.042.
8. I.S. Vinyarov and M.G. Bogdanov, *Eur. J. Med. Chem*., **78**, 198 (2014); https://doi.org/10.1016/j.ejmech.2014.03.053.
9. C. Mattsson, P. Svensson and C. Sonesson, *Eur. J. Med. Chem*., **73**, 177 (2014); https://doi.org/10.1016/j.ejmech.2013.11.035.
10. F. Belluti, G. Fontana, L. dal Bo, N. Carenini, C. Giommarelli and F. Zunino, *Bioorg. Med. Chem*., **18**, 3543 (2010); https://doi.org/10.1016/j.bmc.2010.03.069.
11. M.J. Matos, D. Viña, F.J. Borges, L. Santana and E. Uriarte, *Bioorg. Med. Chem. Lett*., **20**, 5157 (2010); https://doi.org/10.1016/j.bmcl.2010.07.013.
12. D. Bogdal, *J. Chem. Res. (S)*, 468 (1998); https://doi.org/10.1039/A801724G.
13. M. Trkovnik and Z. Ivezic, *J. Heterocycl. Chem*., **37**, 137 (2009); https://doi.org/10.1002/jhet.5570370123.
14. S.H. Mashraqui, D. Vashi and H.D. Mistry, *Synth. Commun*., **34**, 3129 (2004); https://doi.org/10.1081/SCC-200028575.
15. M.J. Matos, D. Viña, C. Picciau, F. Orallo, L. Santana and E. Uriarte, *Bioorg. Med. Chem. Lett*., **19**, 3268 (2009); https://doi.org/10.1016/j.bmcl.2009.04.085.
16. M. M. Potdar, S.S. Mohile and M.M. Salunkhe, *Tetrahedron Lett*., **42**, 9285 (2001); https://doi.org/10.1016/S0040-4039(01)02041-X.
17. Y. Ming and D.W. Boykin, *Heterocycles*, **26**, 3229 (1987); https://doi.org/10.3987/R-1987-12-3229.
18. L. Santana, H. González-Díaz, E. Quezada, E. Uriarte, M. Yáñez, D. Viña and F.J. Orallo, *Med. Chem*., **51**, 6740 (2008); https://doi.org/10.1021/jm800656v.
19. R.S. Mali and S.G. Tilve, *Synth. Commun*., **20**, 1781 (1990); https://doi.org/10.1080/00397919008053103.
20. R.S. Mali and P.P. Joshi, *Synth. Commun*., **31**, 2753 (2001); https://doi.org/10.1081/SCC-100105321.
21. A.K. Prasad, H.N. Pati, A. Azim, S. Trikha and Poonam, *Bioorg. Med. Chem*., **7**, 1973 (1999); https://doi.org/10.1016/S0968-0896(99)00109-1.
22. H.M.F. Madkour, *Heterocycles*, **36**, 947 (1993); https://doi.org/10.3987/COM-92-6079.
23. N. Hans, M. Singhi, V. Sharma and S.K. Grover, *Indian J. Chem*., **35B**, 1159 (1996).
24. D.V. Kadnikov and R.C. Larock, *J. Organomet. Chem*., **687**, 425 (2003); https://doi.org/10.1016/S0022-328X(03)00786-1.
25. P. Bäuerle and M.S. Schiedel, Process for the Parallel Synthesis of Atleast Two Organic Dyes and Substituted Coumarin Derivatives and Arylboronic Acid Propanediol Esters, WO Patent 2001068635A2 (2001).
26. D. Olmedo, R. Sancho, L.M. Bedoya, J.L. López-Pérez, E.D. Olmo, E. Muñoz, J. Alcamí, M.P. Gupta and A.S. Feliciano, *Molecules*, **17**, 9245 (2012); https://doi.org/10.3390/molecules17089245.
27. M. Roberct, E. Angrooan and D.G. Gerhared, *Can. J. Chem*., **66**, 1701 (1988); https://doi.org/10.1139/v88-275.
28. S. Rahmani-Nezhad, L. Khosravani, M. Saeedi, L. Firoozpour, K. Divsalar, Y. Pourshojaei, Y. Sarrafi, H. Nadri, A. Moradi, M. Mahdavi, A, Shafiee and A. Foroumadi, *Synth. Commun*., **45**, 741 (2015); https://doi.org/10.1080/00397911.2014.979947.
29. M. Roussaki, C.A. Kontogiorgis, D. Hadjipavlou-Litina, S. Hamilakis and A. Detsi, *Bioorg. Med. Chem. Lett*., **20**, 3889 (2010); https://doi.org/10.1016/j.bmcl.2010.05.022.
30. S.K. Verma, R. Ghorpade, A. Pratap and M.P. Kaushik, *Tetrahedron Lett*., **53**, 2373 (2012); https://doi.org/10.1016/j.tetlet.2012.01.125.