Synthesis and Antimicrobial Activity of 2-(Pyridine-3-yl)-4*H*-chromen-4-one Derivatives

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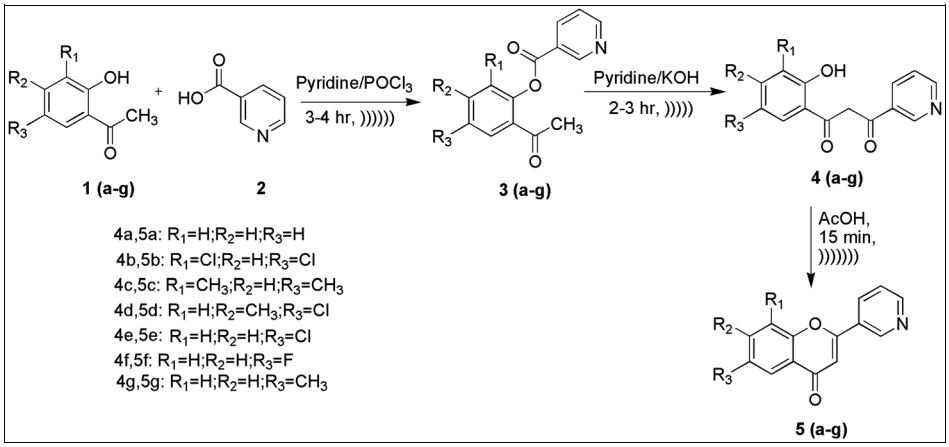

An efficiently synthesis of chromones *via* cyclodehydration of corresponding 1-(2-hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione is described under ultrasound irradiation. A series of novel 2-(pyridine-3-yl)-4*H*-chromen-4-one derivatives was confirmed on the basis of ^{1}H-NMR, mass, IR spectral data, and elemental analysis. The synthesized compounds were evaluated for their antibacterial and antifungal activities. Most of the compounds were found to be comparable potent than the reference standard drugs. Utilization of ultrasound irradiation, simple reaction conditions, isolation, and purification makes this manipulation very interesting from an economic and environmental perspective.

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INTRODUCTION

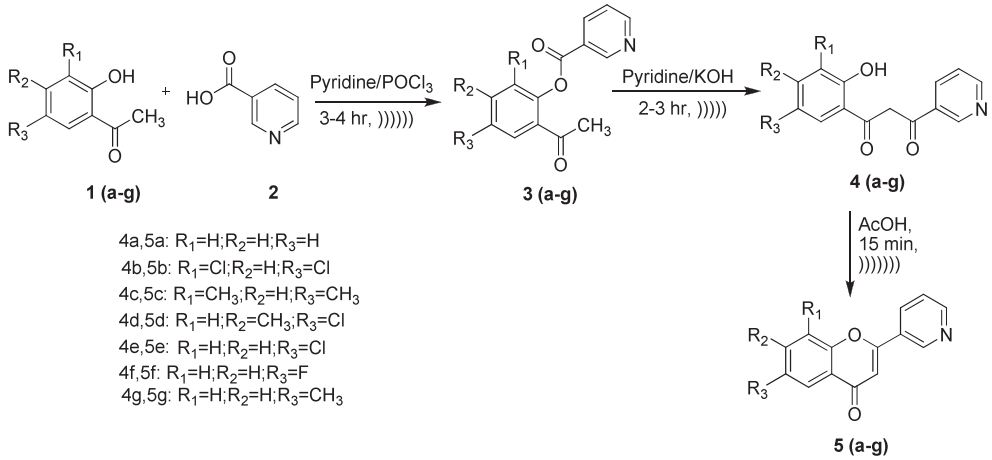
The chromones represent one of the largest groups of natural products known and several thousand derivatives have been identified [1]. The chromones are based on the flavones (2-phenyl-4*H*-chromone) and related ring systems and constitute an important class of widely distributed plant secondary metabolites. In addition to the various functions of chromones in plants, their widespread distribution in nature, their structural variability and their antioxidant activities have increased the interest in chromones as beneficial for human health [2]. Several therapeutically interesting biological activities of certain chromones have been reported including anticancer [3], anti-HIV [4], anticholestenic, antidiabetic, and antiallergic, their glycosides are cardiac stimulants, vaso contractors diuretic activity [5, 6] coupled with low toxicity [7]. Chromones have been reported to exert multiple biological effects including cytotoxicity [8], antiinflammatory [9] as well as antitumor activities [10]. Chromones having heterocyclic substituents at 2 and 3 positions have been reported to possess antiallergic activity [11], muscular relaxation effect, and antimicrobial activity [12].

There are several methods reported for the synthesis of 2-phenyl chromone such as Wan-Robinson synthesis [13], Baker-Venkataraman method [14], and oxidative cyclization of synthesis from 2′-hydroxychalcones [15]. However, the cyclodehydration of flavones obtained by Baker-Venkataraman rearrangement of 2-aryloxy acetophenones remains the most practical method for their preparation [16]. The cyclodehydration of 1,3-diketones required strong drastic condition such as heating under strongly acidic condition using hydrochloric acid [17], sulphuric acid [18], and *p*-tolunesulphonic acid [19]. Recently, the cyclodehydration of these 1,3-diketones has been reported with $CuCl_2$ in ethanol [20] under microwave irradiation. Herein, we report the simple synthesis of 2-phenylchromone in acetic acid and new substituted 2-(pyridine-3-yl)-4*H*-chromen-4-one **5** (**a–g**) using ultrasound irradiation with comparative analysis through classical approach. The synthesized compounds were screened for their antibacterial and antifungal activities.

RESULT AND DISCUSSION

Chemistry. In the present study, we have synthesized the novel series of substituted 2-(pyridine-3-yl)-4*H*-chromen-

Scheme 1. Synthesis of 1,3-diketones and 2-phenylchromones.



4-one (**5a**) by cyclodehydration of 1,3-diketone in acetic acid under ultrasonic irradiation shown in Scheme 1. Initially, the substituted 2-hydroxy acetophenones reacted with nicotinic acid in presence of phosphonyl chloride in pyridine at room temperature to give corresponding benzoyl ester. Further by Baker-Venkataraman transformation [21], the benzoyl ester is converted into 1,3-diketones using base potassium hydroxide to effect an intramolecular Claisen condensation. Further, the cyclodehydration of 1,3-diketones under ultrasound irradiation using acetic acid afford the corresponding 2-phenylchromones.

To obtain the optimum experimental conditions, the reaction of chromone under ultrasonic irradiation has been considered as a model reaction (Table 1). The ultrasonic irradiation plays an important role in the synthesis of 1,3-diketones and 2-phenylchromone, the reaction rate was improved in short time span. To determine the appropriate time of the reaction, we investigated the model reaction at different times (5, 10, and 15 min). The product was formed in lower yield at 5 min, and higher at 15 min. This indicates that 15 min was sufficient for the result. The reaction yield was improved under sonication at appropriate temperature. The best yield for **5a** was obtained by ultrasonic irradiation at a temperature of 65°C. The product was obtained within 15 min in 93% yield. In conventional method, the yield **5a** was gained in 57% after heating for 1 h at 65°C. It was observed that the reaction under ultrasonic irradiation had significantly improved yields.

Spectral analysis. The structural assignment of the title compounds **5** (**a–g**) has been made on the basis of ^{1}H-NMR, mass, and IR spectral studies which were in full agreement with the proposed structures.

The structure of **4c** is interpreted from spectroscopic data. In the ^{1}H-NMR spectra of **4c**, exhibits a vinylic protons as a singlet at δ = 8.99 ppm, two singlet at 2.40 ppm, and 2.51 ppm due to two -CH_3 and rest of aromatic protons appears in the region 6.82–8.89 ppm. The broad singlet appears at δ = 12.93 and 15.73 ppm due to phenolic -OH and enolic-OH. Mass spectrum was consistent with assigned structure showing (M + 1) peak at 270.08. IR spectra of compound **4c** reveals absorption band in the region 3348 cm^{-1} corresponding to -OH stretching of phenolic broad band and 1612 due to C═N. ^{1}H-NMR spectra of **5c** reveal the presence of two unequivalent protons of a methyl group at δ = 2.43 and 2.57 ppm, and the C_2H proton of chromone ring appears at δ = 8.77 ppm as singlet and rest of aromatic protons appears at δ = 6.83–9.20 ppm, from all aromatic proton two aromatic proton appears in the region δ = 8.77 ppm as a singlet and δ = 9.20 ppm as doublet due to pyridine ring. The mass spectrum was consistent with assigned structure showing (M+1) peak at 252.01. The cyclodehydration of 1,3-diketone gave corresponding chromone. The IR showed the absorption band at 1688 and 1610 cm^{-1} due to the γ-pyrone ring and C═N in pyridine. The absence of -OH stretching due to ring cyclodehydration confirmed the formation of **5c**.

EXPERIMENTAL

Melting points were determined on a Veego apparatus and are uncorrected. Infrared spectra were recorded on a Bruker spectro-photometer in a KBr disc, and the absorption bands are expressed in cm^{-1}. ^{1}H-NMR spectra were recorded on a Varian AS 400 MHz spectrometer in $CDCl_3$/DMSO-d_6, chemical shifts (δ) are in ppm relative to TMS, and coupling constants (*J*) are expressed in Hertz (Hz). Mass spectra were taken on a Macro mass spectrometer (Waters) by electro-spray method. Bandelin Sonorex (with a frequency of 35 kHz and a nominal power 200 W) ultrasonic bath was used for ultrasonic irradiation. Built-in heating, 30–80°C is thermostatically adjustable. The reaction vessel was placed inside the ultrasonic bath containing water.

General procedure for the synthesis of compounds (3e). To the mixture of 5-chloro-2-hydroxyacetophenone (2.50 g, 0.0146 mmol) and nicotinic acid (2.34 g, 0.026 mmol) a

dry pyridine (15 mL) and $POCl_3$ (4.71 g, 0.037 mmol) was added drop wise at 0°C. The reaction mixture was irradiated for about 3–4 h under ultrasound. After completion of the reaction, it was poured on crushed ice and the solid obtained was dissolved in ethyl acetate (25 mL) and washed with saturated solution of $NaHCO_3$. The organic layer was dried over anhydrous sodium sulphate and was concentrated under reduced pressure.

General procedure for the synthesis of compounds (4e). Compound **3e** (2.25 g, 0.078 mmol) was dissolved in dry pyridine (10 mL). To this powdered KOH (0.87 g, 0.015 mmol) was added and the reaction mixture was irradiated for 2–3 h under ultrasound. The reaction mixture was poured on ice cold water and acidified with conc. HCl. The yellow solid obtained was filtered off and crystallized from ethanol to obtain pure product.

1-(2-Hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione (4a). Yellow solid. mp 109–111°C. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 6.32 (d, 1H, Ar–H), 6.89 (dd, 1H, Ar–H), 7.10 (dd, 1H, Ar–H), 7.31 (m, 1H, Ar–H), 7.54 (dd, 1H, Ar–H), 7.56 (d, 1H, Ar–H), 8.49 (m, 1H, Ar–H), 8.99 (dd, 1H, Ar–H), 9.26 (s, 1H, vinylic proton), 12.67 (s, 1H, OH), 15.45 (s, 1H, Enolic-OH). EC–MS: 242.05 (M+1). IR (KBr) cm^{-1}: 3340 (-OH), 2933 (Ar–H), 1705 (C═O), 1612 (C═N). Elemental analysis Calcd. for $C_{14}H_{11}NO_3$. C, 69.70; H, 4.60; N, 5.81. Found: C, 69.44; H, 4.38; N, 5.52.

1-(3,5-Dichloro-2-hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione (4b). Yellow solid. mp 105–107°C. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 6.93 (dd, 1H, Ar–H), 7.12 (d, 1H, Ar–H), 7.26 (d, 1H, Ar–H), 7.47 (dd, 1H, Ar–H), 7.92 (m, 1H, Ar–H), 8.23 (s, 1H, vinylic proton), 8.99 (d, 1H, Ar–H), 12.72 (s, 1H, OH), 15.35 (s, 1H, Enolic-OH). EC–MS: 310.03 (M+1) and 312.06 (M+3). IR (KBr) cm^{-1}: 3350 (-OH), 2952 (Ar–H), 1698 (C═O), 1612 (C═N), 761 (Ar–Cl). Elemental analysis Calcd. for $C_{14}H_9Cl_2NO_3$. C, 54.22; H, 2.93; N, 4.52. Found: C, 53.94; H, 2.65; N, 4.25.

1-(2-Hydroxy-3,5-dimethylphenyl)-3-(pyridine-3-yl)propane-1,3-dione (4c). Yellow solid. mp 130–132°C. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 2.40 (s, 3H, CH_3), 2.51 (s, 3H, CH_3), 6.82 (dd, 1H, Ar–H), 6.92 (d, 1H, Ar–H), 7.06 (d, 1H, Ar–H), 7.34 (dd, 1H, Ar–H), 7.82 (m, 1H, Ar–H), 8.53 (s, 1H, vinylic proton), 8.89 (d, 1H, Ar–H), 12.93 (s, 1H, OH), 15.59 (s, 1H, Enolic-OH). EC–MS: 270.08 (M+1). IR (KBr) cm^{-1}: 3348 (-OH), 2943 (Ar–H), 1709 (C═O), 1614 (C═N). Elemental analysis Calcd. for $C_{16}H_{15}NO_3$. C, 71.36; H, 5.61; N, 5.20. Found: C, 70.98; H, 5.44; N, 4.93.

1-(5-Chloro-2-hydroxy-4-methylphenyl)-3-(pyridine-3-yl) propane-1,3-dione (4d). Yellow solid. mp 123–125°C. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 2.54 (s, 3H, CH_3), 6.85 (dd, 1H, Ar–H),), 6.90 (s, 1H, Ar–H), 7.61 (s, 1H, Ar–H), 7.82 (dd, 1H, Ar–H), 8.51 (m, 1H, Ar–H), 8.89 (s, 1H, vinylic proton), 9.37 (d, 1H, Ar–H), 12.04 (s, 1H, OH), 15.52 (s, 1H, Enolic-OH). EC–MS: 290.10 (M+1) and 392.06 (M+3). IR (KBr) cm^{-1}: 3342 (-OH), 2943 (Ar–H), 1702 (C═O), 1610 (C═N), 757 (Ar–Cl). Elemental analysis Calcd. for $C_{15}H_{12}ClNO_3$. C, 62.19; H, 4.17; N, 4.83. Found: C, 61.93; H, 3.99; N, 4.55.

1-(5-Chloro-2-hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione (4e). Yellow solid. mp 131–133°C. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 6.79 (dd, 1H, Ar–H), 6.89 (d, 1H, Ar–H), 7.14 (dd, 1H, Ar–H), 7.36 (dd, 1H, Ar–H), 7.57 (d, 1H, Ar–H), 8.53 (m, 1H, Ar–H), 8.98 (s, 1H, vinylic proton), 9.34 (d, 1H, Ar–H), 12.64 (s, 1H, OH), 15.41 (s, 1H, Enolic-OH). EC–MS: 276.05 (M+1) and 378.09 (M+3). IR (KBr) cm^{-1}: 3345(-OH), 2949 (Ar–H), 1700 (C═O), 1615 (C═N), 759 (Ar–Cl). Elemental analysis Calcd. for $C_{14}H_{10}ClNO_3$. C, 60.99; H, 3.66; N, 5.08. Found: C, 61.24; H, 3.37; N, 4.78.

1-(5-Fluoro-2-hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione (4f). Yellow solid. mp 117–120°C. ^{1}H-NMR (400 MHz, DMSO-d_6): δ = 5.98 (dd, 1H, Ar–H), 7.08 (d, 1H, Ar–H), 7.12 (dd, 1H, Ar–H), 7.48 (d, 1H, Ar–H), 7.58 (dd, 1H, Ar–H), 7.96 (m, 1H, Ar–H), 8.49 (dd, 1H, Ar–H), 8.79 (s, 1H, vinylic proton), 12.61 (s, 1H, OH), 15.57 (s, 1H, Enolic-OH). EC–MS: 270.09 (M+1). IR (KBr) cm^{-1}: 3398 (-OH), 1572 (C═C), 1219 (C═O), 1488 (C═N). Elemental analysis Calcd. for $C_{14}H_{10}FNO_3$. C, 64.86; H, 3.89; N, 5.40. Found: C, 64.58; H, 3.62; N, 5.89.

1-(2-Hydroxy-5-methylphenyl)-3-(pyridine-3-yl)propane-1,3-dione (4g). Yellow solid. mp 116–118°C. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 2.31 (s, 3H, CH_3), 6.85 (dd, 1H, Ar–H), 7.26 (dd, 1H, Ar–H), 7.43 (d, 1H, Ar–H), 7.46 (d, 1H, Ar–H), 7.55 (dd, 1H, Ar–H), 8.24 (m, 1H, Ar–H), 8.77 (s, 1H, vinylic proton), 9.16 (d, 1H, Ar–H), 11.80 (s, 1H, OH), 15.49 (s, 1H, Enolic-OH). EC–MS: 238.04 (M+1). IR (KBr) cm^{-1}: 3498 (-OH), 1575 (C═C), 1215 (C═O), 1490 (C═N). Elemental analysis Calcd. for $C_{15}H_{13}NO_3$. C, 70.58; H, 5.13; N, 5.49. Found: C, 70.96; H, 4.85; N, 5.20.

General procedure for the synthesis of the compounds (5e). Compound **4e** (1.0 g, 0.002 mol) was dissolved in gla. acetic acid (5 mL) in a round bottom flask and reaction mixture was irradiated under ultrasonication at 65°C for about 15 min. After completion of the reaction (monitored by TLC), it was cooled to the room temperature and poured on crushed ice. The solid obtained was filtered and crystallized from ethanol to get pure product.

2-(Pyridine-3-yl)-4H-chromen-4-one (5a). Creamy color. ^{1}H-NMR (400 MHz, DMSO-d_6): δ = 6.88 (dd, 1H, Ar–H), 7.22 (dd, 1H, Ar–H), 7.24–7.26 (m, 2H, Ar–H), 7.73 (dd, 1H, Ar–H), 7.76 (m, 1H, Ar–H), 7.98 (dd, 1H, Ar–H), 8.09 (s, 1H, Ar–H), 8.14 (d, 1H, Ar–H). EC–MS: 224.09 (M+1). IR (KBr) cm^{-1}: 1685 (γ-pyrone), 1602 (Ar–O–Ar), 1608 (C═N). Elemental analysis Calcd. for $C_{14}H_9NO_2$: C, 75.33; H, 4.06; N, 6.27. Found: C, 75.70; H, 3.87; N, 5.98.

6,8-Dichloro-2-(pyridine-3-yl)-4H-chromen-4-one (5b). Brown color. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 6.47 (d, 1H, Ar–H), 7.25 (dd, 1H, Ar–H),7.37 (d, 1H, Ar–H), 7.41 (d, 1H, Ar–H), 7.53 (m, 1H, Ar–H), 7.98 (dd, 1H, Ar–H), 8.54 (s, 1H, Ar–H). EC–MS: 292.05 (M+1) and 293.11 (M+3). IR (KBr) cm^{-1}: 1685 (γ-pyrone), 1602 (Ar–O–Ar),1608 (C═N).

Table 1

Physical and analytical data of substituted 2-(pyridine-3-yl)-4*H*-chromen-4-one **5(a–g)**.

		Comparative study			
		With ultrasound[a]		Without ultrasound[b]	
Entry	Melting point (°C)	Time (min)	Yield[c] (%)	Time (min)	Yield[c] (%)
5a	132–135	15	93	32	57
5b	156–158	15	91	32	59
5c	145–147	15	89	32	65
5d	160–162	15	93	32	67
5e	187–189	16	88	32	70
5f	167–169	15	90	32	69
5g	156–159	14	87	32	72

[a]Reaction of diketones with in acetic acid under ultrasonic waves.
[b]Reaction of diketone with in acetic acid under reflux condition.
[c]Isolated yield.

Elemental analysis Calcd. for $C_{14}H_7Cl_2NO_2$. C, 57.56; H, 2.42; N, 4.79. Found: C, 57.99; H, 2.13; N, 4.53.

6,8-Dimethyl-2-(pyridine-3-yl)-4H-chromen-4-one (5c). Creamy color. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 2.43 (s, 3H, CH_3), 2.57 (s, 3H, CH_3), 6.83 (dd, 1H, Ar–H),7.27 (d, 1H, Ar–H), 7.38 (d, 1H, Ar–H), 7.85 (dd, 1H, Ar–H), 8.17 (dd, 1H, Ar–H), 8.77 (s, 1H, Ar–H), 9.20 (d, 1H, Ar–H). EC–MS: 252.01 (M+1). IR (KBr) cm^{-1}: 1688 (γ-pyrone), 1606 (Ar–O–Ar), 1604 (C═N). Elemental analysis Calcd. for $C_{16}H_{13}NO_2$. C, 76.48; H, 5.21; N, 5.57. Found: C, 76.86; H, 4.92; N, 5.36.

6-Chloro-7-methyl-2-(pyridine-3-yl)-4H-chromen-4-one (5d). Creamy color. ^{1}H-NMR (400 MHz, DMSO-d_6): δ = 2.39 (s, 3H, CH_3), 6.91 (s, 1H, Ar–H), 7.24 (s, 1H, Ar–H), 7.38 (dd, 1H, Ar–H), 7.47 (d, 1H, Ar–H), 7.57 (m, 1H, Ar–H), 7.84 (dd, 1H, Ar–H), 7.88 (s, 1H, Ar–H). EC–MS: 272.03 (M +1) and 274.07 (M+3). IR (KBr) cm^{-1}: 1698 (γ-pyrone), 1598 (C═N), 1547 (Ar–O–Ar), 763 (Ar–Cl). Elemental analysis Calcd. for $C_{15}H_{10}ClNO_2$. C, 66.31; H, 3.71; N, 5.16. Found: C, 66.70; H, 3.43; N, 4.88.

6-Chloro-2-(pyridine-3-yl)-4H-chromen-4-one (5e). Brown color. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 6.87 (d, 1H, Ar–H), 6.97 (d, 1H, Ar–H), 7.15–7.24 (dd, 2H, Ar–H), 7.46 (d, 1H, Ar–H), 7.58 (m, 1H, Ar–H), 7.96 (dd, 1H, Ar–H), 8.30 (s, 1H, Ar–H). EC–MS: 258.04 (M+1) and 260.11 (M+3). IR (KBr) cm^{-1}: 1698 (γ-pyrone), 1598 (C═N), 1247 (Ar–O–Ar), 763 (Ar–Cl). Elemental analysis Calcd. for $C_{14}H_8ClNO_2$. C, 65.26; H, 3.13; N, 5.44. Found: C, 65.64; H, 2.84; N, 5.16.

6-Fluoro-2-(pyridine-3-yl)-4H-chromen-4-one (5f). Creamy color. ^{1}H-NMR (400 MHz, $CDCl_3$-d_6): δ = 7.02 (d, 1H, Ar–H),7.06 (d, 1H, Ar–H), 7.11–7.29 (dd, 2H, Ar–H), 7.42 (d, 1H, Ar–H), 7.54 (m, 1H, Ar–H), 7.89 (dd, 1H, Ar–H), 8.45 (s, 1H, Ar–H). EC–MS: 242.02 (M+1). IR (KBr) cm^{-1}: 1675 (γ-pyrone), 1582 (C═N), 1241 (Ar–O–Ar). Elemental analysis Calcd. for $C_{14}H_8FNO_2$. C, 69.71; H, 3.34; N, 5.81. Found: C, 70.10; H, 2.99; N, 5.53.

6-Methyl-2-(pyridine-3-yl)-4H-chromen-4-one (5g). Brown color. ^{1}H-NMR (400 MHz, DMSO-d_6): δ = 2.41 (s, 3H, CH_3), 6.89 (d, 1H, Ar–H), 7.12 (dd, 1H, Ar–H), 7.51 (d, 1H, Ar–H), 7.59 (dd, 1H, Ar–H), 8.29 (m, 1H, Ar–H), 8.89 (s, 1H, Ar–H), 8.93 (dd, 1H, Ar–H), 9.39 (d, 1H, Ar–H). EC–MS: (M+1). IR (KBr) cm^{-1}: 1669 (γ-pyrone), 1575 (C═N), 1239 (Ar–O–Ar). Elemental analysis Calcd. for $C_{15}H_{11}NO_2$. C, 75.94; H, 4.67; N, 5.90. Found: C, 76.31; H, 4.41; N, 5.71.

Antimicrobial activity. The standardized agar well diffusion method [22] was followed to determine the activity of the synthesized compounds against the sensitive organisms *Staphylococcus aureus* (MRSA E710) and *Escherichia coli* (25922) as a gram positive bacteria, and two species of fungi, *Candida albicans* and *Aspergillus fumigates*. The vancomycin was used as reference in the case of antibacterial, while amphotericin B was used in the case of antifungal reference. The methanol was used as solvent control. The culture strains of bacteria were maintained on nutrient agar slant at 37°C for 24 h. The wells of 6 diameters were filled with 0.1 mL of solution at a fixed concentration of 20 μg/mL separately for each bacterial strain. All the plates were incubated at 37°C for 24 h. The zone of inhibition of compounds was measured using mm scale. Antimicrobial activity was determined by measuring the diameter of inhibition zone. Activity of each compound was compared with vancomycin (for antibacterial) and amphotericin B (for antifungal) as standards. The observed data of antimicrobial activity of compounds and the standard drugs are given in Table 2. From the obtained results it was evident that most of the compounds (i.e., **4a**, **4e**, **5e**, **5d**, **5e**, and **5f**) showed highest antibacterial activity and **4b**, **4d**, **4g**, **5a**, **5b**, **5d**, **5e**, and **5g** possess good antifungal activity comparable with that of standard drugs tested. Although with respect to standard drugs, all the tested compounds were found to be moderately activite. So, the result of all preliminarystudy indicated that the substituted 1-(2-hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione and 2-(pyridine-3-yl)-4*H*chromen-4-one moiety represent a new class of pharmacophorefor broad spectrum of antibacterial and antifungal activity.

Table 2

Antimicrobial activity of compounds **4(a–g)** and **5(a–g)**.

		Antibacterial activity		Antifungal activity	
Compd. No.	Conc. (μg/mL)	*S. aureus* (MRSA E710)[a]	*E. coli* (25922)[a]	*C. albicans*[a]	*A. fumigates*[a]
4a	200	16	32	16	26
	100	10	24	10	17
4b	200	18	26	13	32
	100	13	17	07	23
4c	200	15	28	15	27
	100	08	20	09	19
4d	200	17	31	14	30
	100	12	22	08	21
4e	200	22	30	18	33
	100	12	24	10	26
4f	200	16	27	15	26
	100	10	18	09	18
4g	200	20	25	16	29
	100	13	19	11	21
5a	200	21	32	17	28
	100	10	23	11	19
5b	200	14	21	17	39
	100	7	13	10	27
5c	200	19	28	14	26
	100	12	21	8	15
5d	200	28	32	17	34
	100	19	24	13	25
5e	200	19	30	19	28
	100	12	22	13	19
5f	200	19	28	27	26
	100	11	17	17	20
5g	200	14	24	18	23
	100	9	16	12	16
Vancomycin	20 μg/mL	NA	NA	15	19
Amphotericin B	20 μg/mL	20	21	NA	NA

5a, **5b**, **5d**, **5e**, and **5g** against antifungal activity was found to be comparable with that of standard drug tested. Although with respect to standard drugs, all the tested compounds were found to be moderately activite. So, the result of all preliminary study indicated that the substituted 1-(2-hydroxyphenyl)-3-(pyridine-3-yl)propane-1,3-dione and 2-(pyridine-3-yl)-4*H*-chromen-4-one moiety represent a new class of pharmacophore for broad spectrum of antibacterial and antifungal activity.

[a]Zone of inhibition.

CONCLUSION

In summary, this work demonstrates a rapid, efficient, and environmentally friendly method for the synthesis of novel title compounds **5** (**a–g**) under ultrasound irradiation and result obtained confirmed the superiority of ultrasound irradiation method over the conventional method. All newly synthesized compounds were analyzed by spectroscopic data, such as ^{1}H-NMR, mass, IR spectra, and elemental analysis. After evaluating the antimicrobial activity, the antimicrobial study showed that all compounds were moderately active against standard drug.

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