Ultrasound-Assisted One Pot Synthesis of Novel 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole

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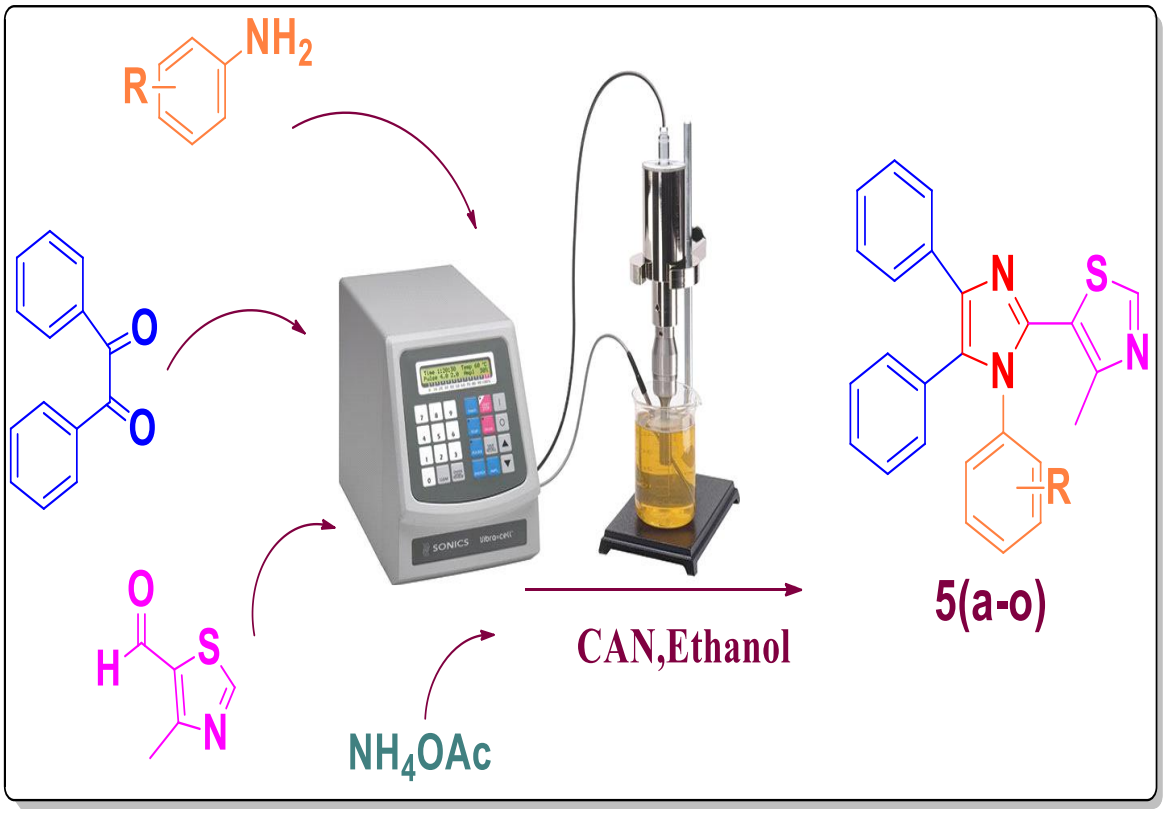
Graphical Abstract:



Abstract: The work reports synthesis of ten novel derivatives of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o).** The reaction of benzil, primary aryl amines, 4-methylthiazole-5-carbaldehyde and ammonium acetate was carried out in one pot in presence of eco-friendly catalyst Cerric ammonium nitrate in solvent ethanol to give final compounds. The structures of the synthesized compounds were confirmed by spectral characterization such as IR, ^{1}H NMR, ^{13}CNMR and Mass spectral studies.

Keywords: Azetidin-2-one, Green chemistry, Ultrasound, CAN, Multicomponent reaction.

Introduction:

Imidazole is a privileged fragment in modern medicinal chemistry considering its broad spectrum and affinity towards various biological targets specially as antifungal agent [1, 2].

Synthesis of organic molecules through multicomponent reactions (MCRs) is a fascinating area of research [3-9], because they are significant basis of automated and high throughput synthesis, molecular diversity and empowering rapid generation of organic molecules. MCRs are distinct as reactions that materialize in one reaction vessel (one pot) having more than two starting reactants to form a single product [10-11]. MCRs in numerous occasions are effective alternative to multistep sequential synthesis for instance, they show high degree of atom efficiency as the maximum if not all of the atoms of the starting reactants are transformed in to the product [12-13]. They are convergent as a number of starting reactants combine in one step reaction to form the target molecules, they are having higher degree of efficiency since the product formation takes place in one-step in place of multiple sequential steps, bond formation between several atoms other than hydrogen atoms takes place in one synthetic step therefore they display extremely high bond-forming-index (BFI) [14-18].There is still a need of general awareness among synthetic chemists that MCRs are undeniably able to deal with delicate chemical problems in an environmentally friendly manner. This work thus aims to explore the scope and opportunities of utilization of MCRs that can bring for eco-friendly green synthesis and process design.

The shortcomings associated with existing methods of organic synthesis reported for the imidazole derivatives by a conventional method like stirring at room temperature and by refluxing required several hours for completion of reaction with very less amount of product yield and consumes more solvents, time and electricity. Green chemistry is a new branch of chemistry which has become a major motivation for organic chemists and druggist to develop environmentally gentle path for synthesis of organic compounds of biological importance.

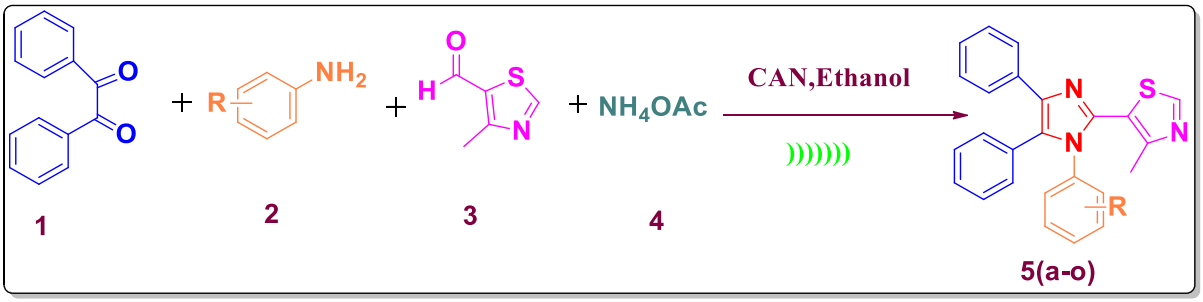
The use of ultrasound to promote chemical reactions is called sono-chemistry. Ultrasonic-assisted organic synthesis (UAOS) is a green synthetic approach and it is a powerful technique

towards the increase in reaction rate [19-21]. It can also be considered as important tool for conservation of energy and minimization of waste as compared to the conventional techniques [22-23]. This research work is introducing ultrasound- promoted synthesis of thiazolinedin-4-one derivative from the readily available starting materials under mild and selective conditions. In this research work we are reporting the synthesis of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** derivatives in excellent yield using eco- friendly, prompt and suitable ultrasound-assisted green chemistry protocol.

Results and discussion

2.1. Chemistry

Herein, we are reporting the synthesis 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** as illustrated in **Scheme 1.**



One pot synthesis of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** is as shown in **Scheme 1.**

A mixture of benzil (0.01 mol), 4-methylthiazole-5-carbaldehyde (0.01 mol), primary aryl amines (0.01 mol), ammonium acetate (0.01 mol) and cerric ammonium nitrate (15 mol %) as an eco-friendly catalyst was dissolved in solvent ethanol (5 m1) was subjected to ultra-sonication at room temperature. The obtained products **5(a–j)** were recrystallized from ethanol and were obtained in better yields. Synthesis by a conventional method like reflexing required 3-4 hrs for completion of reaction; whereas by using green chemistry tool like ultra-sonication the time of synthesis was reduced to 25 to 35 minutes. The physical characterisation is as shown in **Table1.**

Table1. Physical characterization of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)**

Compound	Ar	Mol. Formula	Mol. weight	% Yield	M.P (°C)

5a	Phenyl	$C_{25}H_{19}N_3S$	393.50	88	202-204
5b	4-Chlorophenyl	$C_{25}H1_8ClN_3S$	427.95	89	252-254
5c	4-Bromophenyl	$C_{25}H_{18}BrN_3S$	472.40	90	254-256
5d	4-Nitrophenyl	$C_{25}H_{18}N_4O_2S$	438.50	89	225-228
5e	2-Methylphenyl	$C_{26}H_{21}N_3S$	407.53	87	214-216
5f	4-Methylphenyl	$C_{26}H_{21}N_3S$	407.53	88	210-212
5g	2-Methoxyphenyl	$C_{26}H_{21}N_3OS$	423.53	89	228-230
5h	4-Methoxyphenyl	$C_{26}H_{21}N_3OS$	423.53	89	232-234
5i	2,4 -Dichlorophenyl	$C_{25}H_{17}Cl_2N_3S$	462.39	89	256-258
5j	2,4-Dimethylphenyl	$C_{27}H_{23}N_3S$	421.56	90	200-202
5k	2,4-Dinitrophenyl	$C_{25}H_{17}N_5O_4S$	483.50	87	218-220
5l	4-Chloro-2-nitrophenyl	$C_{25}H_{17}ClN_4O_2S$	472.95	86	232-234
5m	2,6-Dichloro-4-nitrophenyl	$C_{25}H_{16}Cl_2N_4O_2S$	507.39	88	234-236
5n	Benzyl	$C_{26}H_{21}N_3S$	407.53	90	220-222
5o	Naphthalen-1-yl	$C_{29}H_{21}N_3S$	443.56	87	210-212

The synthesis of all derivatives of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** was carried out by refluxing and ultrasonic irradiation methods for comparison of conventional and modern green chemistry tool using ultra-sonication. The time required for completion of reaction with yield in percent is mentioned in **Table 2.**

Table 2. Comparison of reaction kinetics of conventional refluxing and ultrasonic irradiation methods for the synthesized compounds **5(a–o)**

Entry	**Conventional Refluxing**		**Ultrasonic Irradiation**	
	Time(min)	**Yield(%)**	**Time(min)**	**Yield(%)**
5a	240.00	72	30	88
5b	180.00	62	25	89
5c	230.00	74	25	90
5d	240.00	71	30	89
5e	230.00	73	30	87

5f	200.00	65	30	88
5g	230.00	67	35	89
5h	190.00	68	35	89
5i	220.00	66	30	89
5j	240.00	69	25	90
5k	240.00	71	35	87
5l	195.00	77	35	86
5m	200.00	78	35	88
5n	225.00	69	30	90
5o	235.00	65	35	87

Synthesis of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** derivatives was carried out by green protocol in excellent yield with 87 to 90% by one pot, four component reaction of benzil, 4-methylthiazole-5-carbaldehyde, primary aryl amines, and ammonium acetate in presence catalyst Cerric ammonium nitrate in benign solvent ethanol by eco- friendly, rapid and suitable ultrasound-promoted green chemistry protocol. The structures of the synthesized compounds **5(a-o)** were confirmed on the basis of their respective spectral data like IR, mass, ^{1}H-NMR, ^{13}C-NMR spectra and elemental analysis.

3. Materials and Methods

3.1. General Information

All the reactions were performed in oven-dried glass wares. All the chemicals used for synthesis were procured from Merck (Mumbai, Maharashtra, India), Sigma (Mumbai), HiMedia (Mumbai) or Qualigens (Mumbai) and used without further purification. The ultrasound sonicator (Sonics Vibra-cell, Model no. VCX 500, Newtown, CT, USA) equipped with solid synthetic probe, 13 mm in tip diameter, operating at 20 kHz with a maximum power output of 500 W, was used for synthesis of final title compounds. The progress of each reaction was monitored by ascending thin layer chromatography (TLC) using pre-coated silica gel F254 aluminum TLC sheets (Merck) and the spots were visualized by UV light and iodine vapors. Elemental analyses (C, H, and N) was done with a FLASHEA 112 Shimadzu'analyzer (Mumbai) and all analyses were consistent (within 0.4%) with theoretical values. Infrared (IR) spectra were recorded on a PS 4000 FTIR (JASCO, Tokyo, Japan) using KBr pellets. ^{1}H and ^{13}C-NMR spectra were recorded on a Avance 400 spectrometer (Bruker, Billerica, MA, USA)

fitted with an Aspect 3000 computer and all the chemical shifts (ppm) were referred to internal TMS for ^{1}H and DMSO-*d6* for ^{13}C-NMR. ^{1}H-NMR data are reported in the order of chemical shift, multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; br, broad; br s, broad singlet; m, multiplet and/or multiple resonance), number of protons. A Micro TOF-Q-II (Bruker Daltonics, Billerica, MA, USA with electron spray ionization (ESI) was used to obtain the HRMS data.

Experimental section:

General procedure for the synthesis of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole 5(a-o)

In a borosil beaker, a mixture of benzil (0.01 mol), 4-methylthiazole-5-carbaldehyde (0.01 mol), primary aryl amines (0.01 mol), ammonium acetate (0.01 mol) and Cerric ammonium nitrate (15 mol %) as an eco-friendly catalyst was dissolved in solvent ethanol (5 m1) and the beaker was kept in acoustic chamber, the solid probe of ultrasound was lowered down in the beaker so as to immersed in the solvent and subjected to ultra-sonication at room temperature for 25 to 35 min. The completion of reaction was monitored by TLC. After completion of reaction, the mixture poured into ice-water mixture. The solid precipitate product was filtered dried. The crude product was purified by recrystallization from ethanol. Solvent system chosen determination was n-hexane: ethyl acetate (4:1). The products were obtained in good yield (88 % 92 %). The physical characterization data of the synthesized compounds 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** is as shown in **Table 1.**

Structures of the synthesized derivatives **5(a-o)** were confirmed by spectral studies as reported below:

4-Methyl-5-(1,4,5-triphenyl-1H-imidazol-2-yl) thiazole **5a**:

IR (KBr) ν_{max} (cm^{-1}): 3155 CH stretching, 1601 C=C stretching, 1580 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.12 (s, 3H, $-CH_3$ of thiazole ring), 7.51-7.85 (m, 5H, 5H, 5H of aromatic rings), 8.99 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 12.6, 114.5, 122.4(2), 127.6(4), 128.9(4), 129.1(4), 129.8(2), 131.5, 133.9, 138.3(2), 142.6, 150.7 and 152.4; MS (ESI) m/z: 395.13 $[M+2]^{+}$; Molecular Formula: $C_{25}H_{19}N_3S$; Elemental Analysis: Calculated (C, H, N, S) 76.31, 4.87, 10.68, 8.15. Found: 75.69, 5.01, 11.23, 9.75.

5-(1-(4-Chlorophenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5b:**

IR (KBr) ν_{max} (cm^{-1}): 3150 CH stretching, 1600 C=C stretching, 1580 C=N stretching, 699 C–Cl stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.10 (s,3H, $-CH_3$ of thiazole ring), 6.65-8.10 (m, 4H, 5H, 5H of aromatic rings), 8.85 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 11.93, 111.63, 125.31(2), 127.81(4), 128.5, 128.12, 128.71, 129.18, 129.65, 129.74, 129.87,

130.93(2), 131.43, 133.28(2), 136.34, 138.90(2), 145.55, and 161.36; MS (ESI) m/z: 431.72 $[M+4]^+$; Molecular Formula: $C_{25}H_{18}ClN_3S$; Elemental Analysis: Calculated (C, H, Cl, N, S) 70.16, 4.24, 8.28, 9.82, 7.49. Found: 71.21, 5.47, 7.98, 10.01, 8.12.

5-(1-(4-Bromophenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5c:**
IR (KBr) ν_{max} (cm^{-1}): 3100 CH stretching, 1607 C=C stretching, 1580 C=N stretching, 680 C–Br stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.15 (s, 3H,–CH_3 of thiazole ring), 7.52-7.84 (m, 4H, 5H, 5H of aromatic rings), 8.94 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.2, 115.2, 122.1, 125.2(2), 127.3(4), 128.5(3), 129.1(4), 130.7, 132.9(2), 133.2, 137.4, 139.2, 143.5, 151.7 and 152.5; MS (ESI) m/z: 476.04 $[M+4]^+$; Molecular Formula: $C_{25}H_{18}BrN_3S$; Elemental Analysis: Calculated (C, H, Br, N, S) 63.56, 3.84, 16.91, 8.90, 6.79. Found: 62.93, 3.55, 17.44, 9.14, 7.78.

4-Methyl-5-(1-(4-nitrophenyl)-4,5-diphenyl-1H-imidazol-2-yl) thiazole **5d:**
IR (KBr) ν_{max} (cm^{-1}): 3102 CH stretching, 1605 C=C stretching, 1581 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 2.99 (s, 3H, –CH_3 of thiazole ring), 7.55-8.68 (m, 4H, 5H, 5H of aromatic rings), 8.98 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 12.9, 113.8, 121.9(2), 123.5(2), 126.7(4), 127.9(2), 128.8(4), 130.5, 133.4, 138.6(2), 142.8, 145.2, 147.7, 149.9 and 153.1; MS (ESI) m/z: 440.12 $[M+2]^+$; Molecular Formula: $C_{25}H_{18}N_4O_2S$; Elemental Analysis: Calculated (C, H, N, S) 68.48, 4.14, 12.78, 7.31. Found: 69.17, 5.52, 13.44, 8.75.

5-(4,5-Diphenyl-1-o-tolyl-1H-imidazol-2-yl)-4-methylthiazole **5e:**
IR (KBr) ν_{max} (cm^{-1}): 3100 CH stretching, 1602 C=C stretching, 1580 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 2.03 (s, 3H,–CH_3 of aromatic ring), 2.98 (s, 3H,–CH_3 of thiazole ring), 7.53-7.87 (m, 4H, 5H, 5H of aromatic rings), 8.93 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.2, 17.5, 113.7, 121.0, 125.6(2), 126.7(4), 127.9(2), 130.2(4), 131.8, 132.7(2), 134.0, 138.8, 139.2, 139.7, 143.3, 151.1 and 153.6; MS (ESI) m/z: 409.15 $[M+2]^+$; Molecular Formula: $C_{26}H_{21}N_3S$; Elemental Analysis: Calculated (C, H, N, S) 76.63, 5.19, 10.31, 7.87. Found: 77.32, 6.45, 11.24, 8.12.

5-(4,5-Diphenyl-1-p-tolyl-1H-imidazol-2-yl)-4-methylthiazole **5f:**
IR (KBr) ν_{max} (cm^{-1}): 3100 CH stretching, 1604 C=C stretching, 1581 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 2.54 (s, 3H,–CH_3 of aromatic ring), 2.88 (s, 3H,–CH_3 of thiazole ring), 7.56-7.89 (m, 4H, 5H, 5H of aromatic rings), 8.87 (s, 1H of thiazole ring); ^{13}C-

NMR(DMSO-*d6*), δ ppm: 13.4, 22.3, 115.1, 124.5(2), 126.9(4), 128.3(2), 129.6(4), 130.4(2), 131.7, 134.2, 136.3, 137.4, 138.5(2), 143.6, 151.8 and 153.2; MS (ESI) m/z: 409.15 $[M+2]^+$; Molecular Formula: $C_{26}H_{21}N_3S$; Elemental Analysis: Calculated (C, H, N, S) 76.63, 5.19, 10.31, 7.87. Found: 77.24, 6.02, 11.14, 8.36.

5-(1-(2-Methoxyphenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5g:**

IR (KBr) ν_{max} (cm^{-1}): 3101 CH stretching, 1600 C=C stretching, 1565 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.07 (s, 3H,–CH_3 of thiazole ring), 4.11 (s, 3H, –OCH_3), 7.53-7.80 (m, 4H, 5H, 5H of aromatic rings), 8.88 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.5, 56.8, 113.5, 115.9, 118.7, 122.9, 125.7, 128.5(4), 128.9(2), 129.5(5), 131.2, 133.8, 138.4(2), 143.2, 151.6, 153.2 and 158.1; MS (ESI) m/z: 425.14 $[M+2]^+$; Molecular Formula: $C_{26}H_{21}N_3OS$; Elemental Analysis: Calculated (C, H, N, S) 73.73, 5.00, 9.92, 7.57. Found: 74.55, 6.12, 10.22, 8.14.

5-(1-(4-Methoxyphenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5h:**

IR (KBr) ν_{max} (cm^{-1}): 3107 CH stretching, 1605 C=C stretching, 1580 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 2.95 (s, 3H,–CH_3 of thiazole ring), 3.68 (s, 3H, –OCH_3), 6.64-7.94 (m, 4H, 5H, 5H of aromatic rings), 7.95 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.33, 55.39, 111.63, 114.33(2), 125.33(2), 126.60(2), 128.07, 128.12, 128.71, 129.18, 129.65, 129.74, 129.87, 130.93(4), 131.43(2), 136.34, 145.55, 161.15 and 161.36; MS (ESI) m/z: 425.72 $[M+2]^+$; Molecular Formula: $C_{26}H_{21}N_3OS$; Elemental Analysis: Calculated (C, H, N, S) 73.73, 5.00, 9.92, 7.57. Found: 74.85, 6.14, 10.34, 8.12.

5-(1-(2,4-Dichlorophenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5i:**

IR (KBr) ν_{max} (cm^{-1}): 3158 CH stretching, 1606 C=C stretching, 1587 C=N stretching, 701 C–Cl stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.19 (s, 3H,–CH_3 of thiazole ring), 7.45-7.81 (m, 3H, 5H, 5H of aromatic rings), 8.91 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.8, 113.4, 15.2, 126.8(4), 127.5, 128.9(2), 129.7(4), 131.5, 132.1, 134.6, 136.2(2), 138.1(2), 139.2, 141.5, 151.4 and 153.7; MS (ESI) m/z: 468.05 $[M+6]^+$; Molecular Formula: $C_{25}H_{17}Cl_2N_3S$; Elemental Analysis: Calculated (C, H, Cl, N, S) 64.94, 3.71, 15.33, 9.09, 6.93. Found: 65.11, 4.58, 16.47, 10.25, 7.12.

5-(1-(2,4-Dimethylphenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5j:**

IR (KBr) ν_{max} (cm^{-1}): 3161 CH stretching, 1612 C=C stretching, 1589 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 1.99 (s, 3H,–CH_3 of Ar. ring), 2.54 (s, 3H,–CH_3 of Ar. ring), 3.11 (s, 3H,–CH_3 of thiazole ring), 7.58-7.87 (m, 3H, 5H, 5H of aromatic rings), 8.87 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*),δ ppm: 11.9, 20.6, 23.8, 115.1, 126.7(4), 128.2(2), 129.8(4), 131.2, 132.4(2), 133.3, 134.9, 136.2, 138.3(2), 139.4, 143.5, 144.1, 151.9 and 153.5; MS (ESI) m/z: 423.16 $[M+2]^+$; Molecular Formula: $C_{27}H_{23}N_3S$; Elemental Analysis: Calculated (C, H, N, S) 76.93, 5.50, 9.97, 7.61. Found: 77.14, 6.98, 10.54, 8.57.

5-(1-(2,4-Dinitrophenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5k:**
IR (KBr) ν_{max} (cm^{-1}): 3112 CH stretching, 1614 C=C stretching, 1592 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.07 (s, 3H,–CH_3 of thiazole ring), 7.58-8.99 (m, 3H, 5H, 5H of aromatic rings), 9.08 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.4, 113.7, 121.2, 126.8(4), 128.7(2), 130.1(4), 130.8, 131.5(2), 133.7(2), 138.6(2), 142.9, 145.2, 149.3, 151.9 and 153.4; MS (ESI) m/z: 485.10 $[M+2]^+$; Molecular Formula: $C_{25}H_{17}N_5O_4S$; Elemental Analysis: Calculated (C, H, N, S) 62.10, 3.54, 14.48, 6.63. Found: 63.02, 4.21, 15.18, 7.98.

5-(1-(4-Chloro-2-nitrophenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5l:**
IR (KBr) ν_{max} (cm^{-1}): 3145 CH stretching, 1609 C=C stretching, 1586 C=N stretching, 705 C–Cl stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 2.95 (s, 3H,–CH_3 of thiazole ring), 7.51-8.68 (3H, 5H, 5H of aromatic rings), 8.89 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 12.9, 114.5, 123.6, 125.7(2), 126.5(4), 127.9(2), 128.7(4), 130.4, 134.2(2), 135.6, 138.4(2), 141.6, 143.5, 151.8 and 153.1; MS (ESI) m/z: 476.07 $[M+4]^+$; Molecular Formula: $C_{25}H_{17}ClN_4O_2S$; Elemental Analysis: Calculated (C, H, Cl, N, S) 63.49, 3.62, 7.50, 11.85, 6.78. Found: 64.57, 4.45, 8.71, 12.44, 7.54.

5-(1-(2,6-Dichloro-4-nitrophenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5m:**
IR (KBr) ν_{max} (cm^{-1}): 3156 CH stretching, 1604 C=C stretching, 1585 C=N stretching, 698 C–Cl stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.11 (s, 3H,–CH_3 of thiazole ring), 7.37-8.19 (m, 2H, 5H, 5H of aromatic rings), 8.95 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.1, 115.4, 124.3(2), 128.2(4), 129.4(2), 130.1(4), 132.8, 134.5, 138.2(2), 138.6(2), 141.5, 143.8, 148.4, 151.7 and 153.9; MS (ESI) m/z: 513.04 $[M+6]^+$; Molecular Formula: $C_{25}H_{16}Cl_2N_4O_2S$; Elemental Analysis: Calculated (C, H, Cl, N, S) 59.18, 3.18, 13.97, 11.04, 6.32. Found: 60.11, 4.54, 14.21, 12.75, 7.30.

5-(1-Benzyl-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5n:**

IR (KBr) ν_{max} (cm−1): 3158 CH stretching, 1607 C=C stretching, 1587 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.04 (s, 3H,–CH_3 of thiazole ring), 5.87 (s, 2H, –CH2 of benzyl ring), 7.52-7.83 (m, 5H, 5H, 5H of aromatic rings), 8.99 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.5, 48.2, 115.4, 125.3, 127.1(4), 127.8(2), 128.5(4), 129.7(4), 130.2, 133.3, 138.4, 139.2, 142.3, 145.9, 151.4 and 153.7; MS (ESI) m/z: 408.15 $[M+2]^{+}$; Molecular Formula: $C_{26}H_{21}N_3S$; Elemental Analysis: Calculated (C, H, N, S) 76.63, 5.19, 10.31, 7.87. Found: 77.24, 6.35, 11.23, 8.28.

4-Methyl-5-(1-(naphthalen-1-yl)-4,5-diphenyl-1H-imidazol-2-yl) thiazole **5o:**

IR (KBr) ν_{max} (cm−1): 3151 CH stretching, 1609 C=C stretching, 1588 C=N stretching; ^{1}H-NMR(DMSO-*d6*), δ ppm: 3.02 (s, 3H,–CH_3 of thiazole ring), 7.58-8.15 (m, 5H, 5H, 7H of aromatic rings), 8.89 (s, 1H of thiazole ring); ^{13}C-NMR(DMSO-*d6*), δ ppm: 13.6, 115.3, 124.8, 126.1(2), 126.5, 127.3, 127.5(3), 127.9(2), 128.5(4), 129.6(4), 130.3, 131.2, 133.4, 135.6, 138.1, 138.9, 143.2, 151.6 and 153.4; MS (ESI) m/z: 444.15 $[M+2]^{+}$; Molecular Formula: $C_{29}H_{21}N_3S$; Elemental Analysis: Calculated (C, H, N, S) 78.53, 4.77, 9.47, 7.23. Found: 79.31, 5.47, 10.25, 8.45.

4. CONCLUSION

In conclusion, a novel series of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole **5(a-o)** was obtained using green synthetic tool like ultra-sonication. Use of green method i.e. use of ultra-sonication as a green synthetic strategy shows certain benefits over conventional refluxing as follows: (1) reactions required much less time for completion and were carried at room temperature (2) rate of reaction enhanced (3) the use of very less amount of solvent ethanol (5) ecofriendly as the reactions are carried out in closed acoustic chamber (6) and shortened and clean work-up procedure. The potential of 5-(1-(substituted phenyl)-4,5-diphenyl-1H-imidazol-2-yl)-4-methylthiazole can be developed as antimicrobial agents and can be expected to act as an excellent scaffold for lead optimization and drug discovery.

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