N-butylpyridinium heptachlorodialuminate as a highly efficient catalyst for the synthesis of polyhydroquinolines under solvent-free ultrasound condition.

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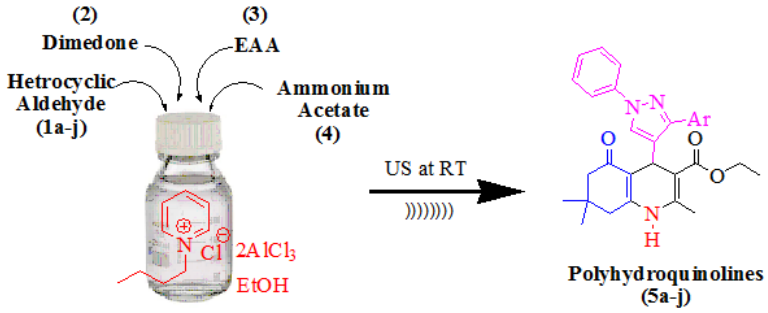
Abstract: A novel, simple and green protocol were adopted for the one pot synthesis of polyhydroquinoline derivatives from heterocyclic aldehydes, dimedone, ethyl acetoacetate and ammonium acetate by ultrasound irradiation at room temperature. The catalytic system is very effective for the bulkier aldehydes to give the corresponding polyhydroquinoline derivatives in excellent yield (80-92%) and easy for isolation of the product. This approach has the various benefits includes simple work-up procedure, excellent yields and environmentally benign path. The structure of synthesized compounds was confirmed by analytical techniques such as FTIR, 1HNMR, 13C NMR and Mass spectrometry.

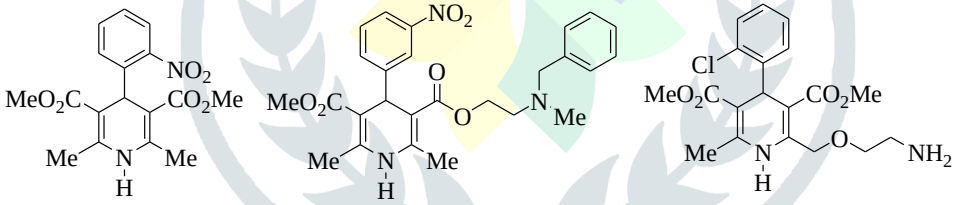


Keywords: 3-aryl-1-phenyl-1*H*-pyrazole-4-carboxaldehydes, *N*-butylpyridinium heptachlorodialuminate, Ultrasound Irradiation, polyhydroquinoline, multicomponent reaction.

1. Introduction

In recent years, Ionic liquids have been widely employed as green alternatives to those of conventional hazardous organic solvent. ILs has also been made significant growth in the catalytic processes. ILs has the potential to exhibit low human toxicities as well as eco-toxicities. It has been employed for various organic reactions include coupling reaction, hydrogenation, Diels-alder reaction, electrochemical reaction, esterification, friedal-Craft reaction, multicomponent reaction, etc. as a catalyst or solvent.[1-10]

Heterocycles are of enormous significance in the design and discovery of new compounds for biological applications.[11-12] The polyhydroquinoline scaffolds are also an important group of nitrogen containing heterocycle of extensive interest due to the significant structural design of the drugs for the treatment of cardiovascular diseases as well as hypertension.[13-14] They have also shows broad spectrum of biological activities such as antidiabetic, antiatherosclerotic, antitumor, bronchodilator, geroprotective, hepatoprotective, neuroprotectant, platelet anti-aggregratory activity, cerebral anti-ischemic activity in the treatment of Alzheimers disease and chemosensitizers in tumor therapy.[15-23] The some important drugs containing 1,4-dihyropyridine nucleus is given in below Figure 1.



1. Nifedipine **2.** Nicardipine **3.** Amlodipine

Cadiovascular agents effective in treatment of hypertension

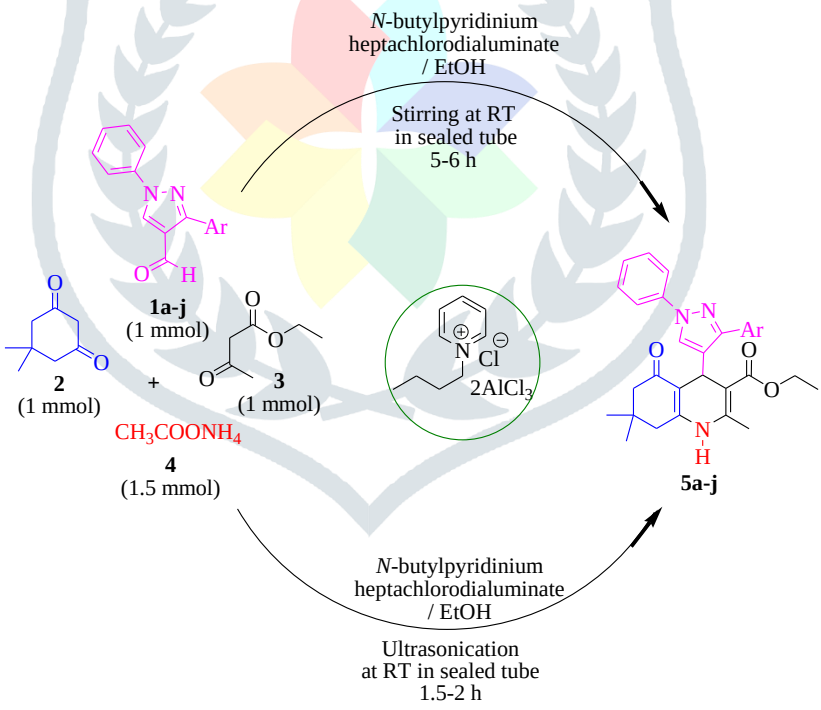
Figure 1. Illustrations of 1, 4-Dihydropyridine containing drugs

In 1882, the scientist Hantzsch and et al. firstly synthesized 1,4-DHPs by MCR of aldehyde, ethylacetoacetate and ammonia in AcOH under reflux condition in ethanol,[24] whereas polyhydroquinolines have been synthesized by using cyclic 1,3-dione instead of one mole ethyl acetoacetate. The various conventional and non-conventional methods has been employed for the synthesis of polyhydroquinoline derivatives in combination with different homogeneous as well as heterogeneous catalyst such as 5-pyrrolidin-2-yl-tetrazole,[25] Ni(0) nanoparticles,[26] La_2O_3/TFE,[27] cerium (IV) ammonium nitrate (CAN),[28] PPA-SiO_2,[29] TiO_2 NPs,[30] SnO_2,[31] SBA-15/SO_3H,[32] $HClO_4$-SiO_2,[33] $Gd(OTf)_3$,[34] (bzacen)MnCl,[35] $Cs_{2.5}H_{0.5}PW_{12}O_{40}$,[36] [1-Vinyl-3-ethyl imidazolium

iodide],[37] $[TBA]_2[W_6O_{19}]$,[38] bismuth(III) bromide,[39] Fe_3O_4@chitosan,[40] $[MSAIm]HSO_4$,[41] [2-MPyH]OTf,[42] DSIMHS,[43] [Pyridine-SO_3H]Cl,[44] $[hmim]BF_4$,[45] [SBA-IL],[46] molecular iodine[47] and Ni nanoparticle[48] etc.

In the last decades, ultrasound assisted synthesis is an important and well established technique, which were proceeds via the formation and adiabatic collapse of the transient cavitations bubble. It is used as an environmentally benign technique that is useful tool for achieving the green chemistry goals, helping to minimize the waste formation and reduce energy requirements. It also displays smooth and cleaner reactions by improving yields with homogeneous and heterogeneous processes.[49-52]

In present work instead of simple benzaldehyde derivatives, we have used 4-formyl pyrazole as a heterocyclic aldehyde for synthesis of polyhydroquinoline derivatives using *N*-butylpyridinium heptachlorodialuminate as a catalyst in ethanol under stirring condition and ultrasound irradiation for appropriate time. The syntheses of 3-aryl-1-phenyl-1*H*-pyrazole-4-carboxaldehydes were carried out by Vilsmeier-Haack reaction.[53]



Scheme 1. Synthesis of Polyhydroquinolene derivatives (5a-j)

2. Experimental

General procedure for the synthesis of polyhydroquinolene derivatives (5a-j)

2.1 Under stirring at room temperature

A 25 mL sealed tube was charged with 3-aryl-1-phenyl-1*H*-pyrazole-4-carboxaldehyde 1 (1 mmol), dimedone 2 (0.140 g, 1 mmol), ethyl acetoacetate 3 (0.130 g, 1 mmol), and NH_4OAc 4 (1.5 mmol) in 10 mL of ethanol. The sealed tube was placed in an ice bath to attain the temperature less than 10˚C. The catalytic amount of ionic liquid *N*-butylpyridinium heptachlorodialuminate was added. The sealed tube was capped and the reaction mixture was stirred for suitable time using a magnetic stirrer at room temperature. The progress of the reaction was monitored by TLC. After completion of the reaction, the content was poured into cold water; solid crude product thus obtained was separated by filtration. The product was dried and purified by recrystallization in n-hexane-ethyl acetate. The physical data of synthesized compounds are given in **Table 2**.

2.2 Under ultrasound irradiation at room temperature

A 25 mL sealed tube was charged with 3-aryl-1-phenyl-1*H*-pyrazole-4-carboxaldehyde 1 (1 mmol), dimedone 2 (0.140 g, 1 mmol), ethyl acetoacetate 3 (0.130 g, 1 mmol), and NH_4OAc 4 (1.5 mmol) in 10 mL of ethanol. The sealed tube was placed in an ice bath to attain the temperature less than 10˚C. The catalytic amount of *N*-butylpyridinium heptachloro-dialuminate was added. The sealed tube was capped and the reaction mixture was placed for ultra-sonication for suitable time at room temperature. The progress of the reaction was monitored by TLC. After completion of the reaction, the content was poured in cold water; solid crude product thus obtained was separated by filtration. The product was dried and purified by recrystallization in n-hexane-ethyl acetate. The physical data of synthesized compounds are given in **Table 2**.

3. Results and Discussion

Initially, we were interested in developing a facile protocol for the synthesis of polyhydroquinoline derivatives using ionic liquid *N*-butylpyridinium heptachlorodialuminate as catalyst. When 1-phenyl-3-*p*-tolyl-1*H*-pyrazole-4-carbaldehyde **1** was treated with dimedone **2**, ethylacetoacetate **3**, and NH_4OAc **4** by grinding and stirring in ethanol solvent without catalyst, formation of polyhydroquinoline was not observed. Also in the water and toluene the reaction did not proceed to any extent in the presence of a catalyst.

Table 1. Optimization of the reaction condition to synthesize ethyl 1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxo-4-(1-phenyl-3-*p*-tolyl-1*H*-pyrazol-4-yl)quinoline-3-carboxylate (5a)

Entry	Catalyst/Solvent	Reaction Condition	Time	Isolated Yield (%)
1	No catalyst/SF	Grinding	1 h	NR
2	No catalyst/EtOH	Stirring at RT	12 h	NR
3	100 mg IL-kit/SF	Grinding	1 h	NR
4	50 mg IL-Kit/H_2O	Stirring at RT	5 h	NR
5	50 mg IL-Kit/EtOH	Stirring at RT	5 h	55
6	75 mg IL-Kit/EtOH	Stirring at RT	5 h	72
7	100 mg IL-Kit/EtOH	Stirring at RT	5 h	88
8	125 mg IL-Kit/EtOH	Stirring at RT	5 h	88
9	100 mg IL-Kit/Toluene	Stirring at RT	5 h	NR
10	100 mg IL-Kit/EtOH	US Irradiation at RT	1.5 h	90

Reaction condition: aldehyde **1** (1 mmol), Dimedone **2** (1 mmol), ethyl acetoacetate **3** (1 mmol), NH_4OAc **4** (1.5 mmol) and 0-125 mg IL-kit

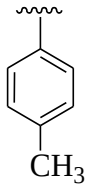
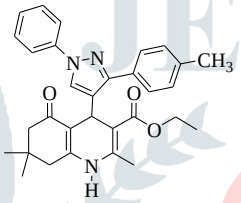
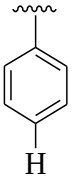
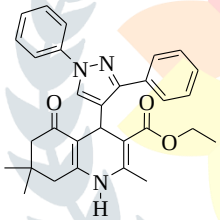
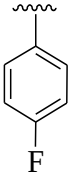
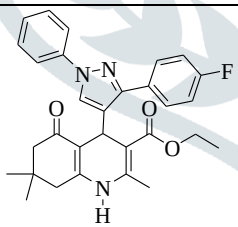
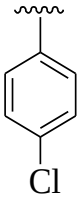
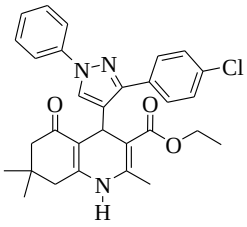
It was interesting to find that, the reaction was proceeding by simply stirring in ethanol at room temperature catalyzed by 50mg of *N*-butylpyridinium heptachlorodialuminate in low yield. However, by optimizing the amount of catalyst such as 50, 75, 100, 125 and optimum solvent quantity, it was possible to obtain polyhydroquinolines in good yields. Thus, the polyhydroquinoline derivative (**5a**) was obtained in excellent yield (88%) with high selectivity in the presence of 100 mg of ionic liquid by simply stirring at room temperature.

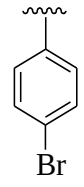
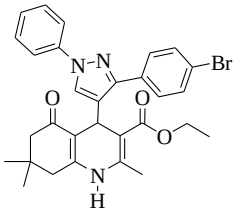
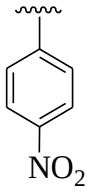
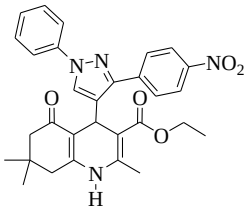
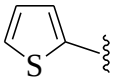
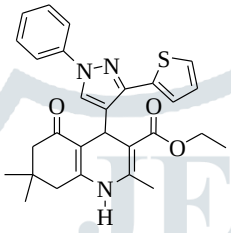
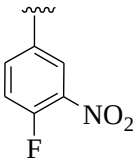
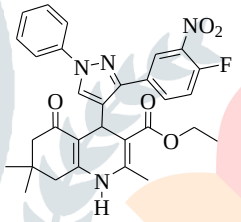
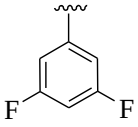
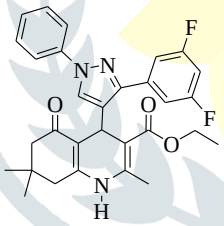
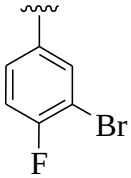
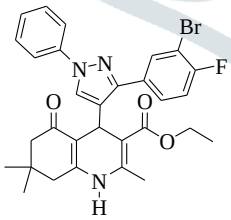
When the same model reaction was carried out under ultrasound irradiation at room temperature in the presence of *N*-butylpyridinium heptachloro-dialuminate in ethanol as solvent, the desired polyhydroquinoline (**5a**) was obtained in excellent yield (90%). Among all the systems studied, a combination of ionic liquid in ethanol was found to be the best preference, which was taken for synthesis of further derivatives.

To evaluate the efficiency and the applicability of the procedure, a variety of substituted heterocyclic aldehydes **1a-j** were used to give the corresponding polyhydroquinoline derivatives **5a-j** in good yields (80-92%) under optimized conditions.

The substrate with electron donating as well as electron withdrawing groups reacts smoothly to afford the product with excellent yield and selectivity. Also under the ultrasound irradiation yield of the product was increased with a reduction of reaction time than the stirring method. The data of synthesized polyhydroquinoline derivatives are given in **Table 2**.

Table 2. Synthesis of polyhydroquinoline derivatives (5a-j) using *N*-butylpyridinium heptachlorodialuminate.

Entry	Ar – Group	Product	Reaction Time (hrs)		Yield (%)		M.P. (˚C)
			Stirring at RT	US at RT	Stirring at RT	US at RT	
5a			5	1.5	88	90	224-226
5b			5	1.5	90	90	218
5c			5.5	1.5	84	84	206
5d			5.5	1.5	86	88	256-258

5e			6	2	88	92	262-264
5f			6	2	84	85	300<
5g			5.5	1.5	88	92	196-198
5h			6	2	82	82	300<
5i			6	2	82	84	300<
5j			5.5	1.5	82	86	226-228

Reaction condition: aldehyde **1** (1 mmol), dimedone **2** (1 mmol), ethyl acetoacetate **3** (1 mmol), NH_4OAc **4** (1.5 mmol) and 100 mg IL-kit in 10 mL ethanol.

4. Discussion of Spectral data of Synthesized Compounds

***ethyl 1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxo-4-(1-phenyl-3-p-tolyl-1H-pyrazol-4-yl)quinoline-3-carboxylate* (Table 2, Entry 5a).**

The product was obtained as white solid: mp 224-226˚C; FT-IR (KBr) ν: 3273, 3199, 3071, 2957, 1737, 1686, 1598, 1488, 1449, 1390, 1212, 1169, 1025, 830, 740; ^{1}H NMR (DMSO-d_6, 400 MHz) δ= 0.69 (t, J=6.0

Hz, 3H, -CH_3), 0.99 (s, 3H, -CH_3), 1.05 (s, 3H, -CH_3), 2.09 (s, 2H, -CH_2-), 2.24 (s, 3H, -CH_3), 2.39 (s, 5H, -CH_2- & -CH_3), 3.74 (m, J=6.0 Hz, 2H, -CH_2-), 5.10 (s, 1H, -CH-), 7.24 (d, J=6.2 Hz, 3H, Ar-H), 7.44 (t, 2H, Ar-H), 7.72 (d, J=7.2 Hz, 2H, Ar-H), 7.93 (s, 1H, Ar-H, Pyrazole ring-H), 7.96 (d, J=7.0 Hz, 2H, Ar-H), 8.98 (s, 1H, NH); ^{13}C NMR (DMSO-d_6, 100 MHz) δ: 13.53, 18.07, 20.90, 26.16, 27.10, 28.77, 32.17, 50.41, 58.45, 105.06, 110.37, 117.84, 125.60, 127.06, 128.26, 128.35, 129.21, 129.26, 131.65, 136.25, 139.25, 143.49, 149.49, 150.05, 166.70, 194.62; MS(ESI m/z %): 518.25 $[M+Na]^+$.

***ethyl 1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxo-4-(1,3-diphenyl-1H-pyrazol-4-yl)quinoline-3-carboxylate* (Table 2, Entry 5b)**.

The product was obtained as white solid: mp 218˚C; FT-IR (KBr) ν: 3275,3180, 3068, 2955, 1739, 1698, 1650, 1599, 1542, 1495, 1381, 1213, 1148, 1074, 959, 752; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.64 (t, J=5.6 Hz, 3H, -CH_3), 0.97 (s, 3H, -CH_3), 1.04 (s, 3H, -CH_3), 2.05 (s, 2H, -CH_2-), 2.08 (s, 3H, -CH_3), 2.31 (s, 2H, -CH_2-), 3.72 (q, J=5.6 Hz, 2H, -CH_2-), 5.10 (s, 1H, -CH-), 7.27 (t1H, Ar-H), 7.39 (t, 1H, Ar-H), 7.45-7.49 (m, 4H, Ar-H), 7.78 (m, 2H, Ar-H), 8.04 (s, 1H, Ar-H, Pyrazole ring-H), 8.08 (d, 2H, Ar-H), 9.05 (s, 1H, NH); ^{13}C NMR (DMSO-d_6, 100 MHz) δ: 14.14, 18.60, 26.65, 27.60, 29.22, 32.72, 50.85, 58.99, 105.26, 110.67, 118.47, 126.40, 127.80, 128.03, 128.37, 128.98, 129.93, 130.38, 135.01, 139.90, 144.28, 150.18, 150.50, 167.22, 195.28; MS(ESI m/z %): 504.32 $[M+Na]^+$.

***ethyl 4-(3-(4-fluorophenyl)-1-phenyl-1H-pyrazol-4-yl)-1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxoquinoline-3-carboxylate* (Table 2, Entry 5c).**

The product was obtained as white solid: mp 206˚C; FT-IR (KBr) ν: 3269, 3204, 3074, 2958, 1687, 1645, 1628, 1599, 1526, 1486, 1377, 1211, 1079, 844, 741; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.75 (t, J=6.8 Hz, 3H, -CH_3), 0.92 (s, 3H, -CH_3), 1.02 (s, 3H, -CH_3), 2.17 (s, 2H, -CH_2-), 2.22 (s, 3H, Ar-CH_3), 2.41 (s, 2H, -CH_2-), 3.79 (q, J=6.8 Hz, 2H, -CH_2-), 5.09 (s, 1H, -CH-), 7.34 (m, 1H, Ar-H), 7.45 (m, 3H, Ar-H), 7.83 (m, 2H, Ar-H), 7.97 (m, 2H, Ar-H), 8.14 (m, 2H, Ar-H and Pyrazole ring-H), 9.13 (s, 1H, NH).

***ethyl 4-(3-(4-chlorophenyl)-1-phenyl-1H-pyrazol-4-yl)-1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxoquinoline-3-carboxylate* (Table 2, Entry 5d).**

The product was obtained as white solid: mp 256-258˚C; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.72 (t, 3H, -CH_3), 0.98 (s, 3H, -CH_3), 1.06 (s, 3H, -CH_3), 2.09 (s, 2H, -CH_2-), 2.22 (s, 3H, Ar-CH_3), 2.39 (s, 2H, -CH_2-), 3.77

(m, 2H, -CH_2-), 5.07 (s, 1H, -CH-), 7.25 (s, 1H, Ar-H), 7.45 (s, 4H, Ar-H), 7.73 (s, 2H, Ar-H), 7.95 (s, 1H, Pyrazole ring-H), 8.14 (d, J=7.2 Hz 2H, Ar-H), 9.02 (s, 1H, NH); ^{13}C NMR (DMSO-d_6, 100 MHz) δ: 13.54, 18.16, 26.21, 27.07, 28.75, 32.20, 50.35, 58.53, 110.36, 117.98, 125.81, 127.41, 127.71, 129.19, 129.96, 130.04, 132.21, 133.30, 139.32, 143.80, 148.72, 149.52, 166.59, 194.74; MS(ESI m/z %): 538.18 $[M+Na]^+$.

ethyl 4-(3-(4-bromophenyl)-1-phenyl-1H-pyrazol-4-yl)-1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxoquinoline-3-carboxylate **(Table 2, Entry 5e).**

The product was obtained as white solid: mp 262-264˚C; FT-IR (KBr) ν: 3383, 3206, 3068, 2960, 1687, 1645, 1598, 1501, 1486, 1378, 1278, 1212, 1075, 961, 835; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.72 (t, J=6.0 Hz, 3H, -CH_3), 0.91 (s, 3H, -CH_3), 1.04 (s, 3H, -CH_3), 2.16 (s, 2H, -CH_2-), 2.23 (s, 3H, Ar-CH_3), 2.34 (m, 2H, -CH_2-), 3.81 (q, J=6.0 Hz, 2H, -CH_2-), 5.10 (s, 1H, -CH-), 7.32 (t, J=6.0 Hz, 1H, Ar-H), 7.47 (m, 2H, Ar-H), 7.73-7.82 (m, 3H, Ar-H), 7.99 (m, 2H, Ar-H), 8.19 (s, 1H, Ar-H, Pyrazole ring-H), 8.41 (m, 1H, Ar-H), 9.11 (s, 1H, NH).

ethyl 1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-4-(3-(4-nitrophenyl)-1-phenyl-1H-pyrazol-4-yl)-5-oxoquinoline-3-carboxylate **(Table 2, Entry 5f).**

The product was obtained as white solid: mp 300˚C<; FT-IR (KBr) ν: 3267, 3199, 3073, 2980, 1691, 1646, 1599, 1521, 1487, 1379, 1342, 1212, 1065, 866; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.67 (t, J=5.6 Hz, 3H, -CH_3), 0.95 (s, 3H, -CH_3), 1.04 (s, 3H, -CH_3), 2.00 (s, 2H, -CH_2-), 2.24 (s, 3H, Ar-CH_3), 2.41 (s, 2H, -CH_2-), 3.73 (q, J=5.6 Hz, 2H, -CH_2-), 5.09 (s, 1H, -CH-), 7.33 (t, J=6.0 Hz, 1H, Ar-H), 7.49 (m, 2H, Ar-H), 7.83 (d, J=6.0 Hz, 2H, Ar-H), 8.17 (s, 1H, Ar-H, Pyrazole ring-H), 8.36 (d, J=7.2 Hz, 2H, Ar-H), 8.43(d, J=7.2 Hz, 2H, Ar-H), 9.14 (s, 1H, NH).

ethyl 1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxo-4-(1-phenyl-3-(thiophen-2-yl)-1H-pyrazol-4-yl)quinoline-3-carboxylate **(Table 2, Entry 5g).**

The product was obtained as white solid: mp 196-198˚C; FT-IR (KBr) ν: 3273, 3180, 3069, 2954, 1698, 1642, 1599, 1494, 1381, 1309, 1278, 1212, 1148, 1074, 959, 749; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.75 (t, J=5.6 Hz, 3H, -CH_3), 0.92 (s, 3H, -CH_3), 1.03 (s, 3H, -CH_3), 2.10 (s, 2H, -CH_2-), 2.26 (s, 3H, Ar-CH_3), 2.40 (s, 2H, -CH_2-), 3.81 (q, J=5.6 Hz, 2H, -CH_2-), 5.14 (s, 1H, -CH-), 7.18 (m, 1H, Ar-H), 7.28 (t, 1H, Ar-H), 7.47 (m, 2H, Ar-H), 7.53 (m, 1H, Ar-H), 7.69 (d, 2H, Ar-H), 8.08 (s, 1H, Pyrazole ring-H), 8.13 (m, 1H, Ar-H), 9.09 (s, 1H, NH); ^{13}C NMR (DMSO-d_6, 100 MHz) δ:14.03, 18.72, 26.73, 27.33, 29.32, 32.71, 50.77, 59.28, 105.09,

110.85, 118.45, 125.59, 126.51, 127.11, 127.91, 128.57, 129.95, 130.49, 136.17, 139.63, 144.64, 145.00, 149.87, 167.28, 195.06; MS(ESI m/z %): 510.28 $[M+Na]^+$.

***ethyl 4-(3-(4-fluoro-3-nitrophenyl)-1-phenyl-1H-pyrazol-4-yl)-1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxoquinoline-3-carboxylate* (Table 2, Entry 5h).**

The product was obtained as white solid: mp 300˚C<; FT-IR (KBr) ν: 3383, 2981, 1687, 1645, 1588, 1541, 1473, 1380, 1214, 1069, 960; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.72 (t, J=5.6 Hz, 3H, -CH_3), 0.95 (s, 3H, -CH_3), 1.04 (s, 3H, -CH_3), 2.19 (s, 2H, -CH_2-), 2.25 (s, 3H, Ar-CH_3), 2.40 (m, 2H, -CH_2-), 3.79 (q, J=5.6 Hz, 2H, -CH_2-), 5.01 (s, 1H, -CH-), 7.29 (m, 1H, Ar-H), 7.49 (m, 3H, Ar-H), 7.81 (m, 2H, Ar-H), 8.11 (m, 2H, Ar-H and Pyrazole ring-H), 8.50 (m, 1H, Ar-H), 9.11 (s, 1H, NH).

***ethyl 4-(3-(3,5-difluorophenyl)-1-phenyl-1H-pyrazol-4-yl)-1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxoquinoline-3-carboxylate* (Table 2, Entry 5i).**

The product was obtained as white solid: mp 300˚C<; FT-IR (KBr) ν: 3273, 3203, 3076, 2962, 1686, 1643, 1625, 1595, 1539, 1480, 1377, 1209, 1115, 985, 743; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.71 (t, J=5.6 Hz, 3H, -CH_3), 0.95 (s, 3H, -CH_3), 1.04 (s, 3H, -CH_3), 2.20 (s, 2H, -CH_2-),2.24 (s, 3H, Ar-CH_3), 2.42 (m, 2H, -CH_2-), 3.80 (q, J=5.6 Hz, 2H, -CH_2-), 5.03 (s, 1H, -CH-), 7.28-7.32 (m, 2H, Ar-H), 7.48 (t, 2H, Ar-H), 7.81 (d, 2H, Ar-H), 7.92 (m, 2H, Ar-H), 8.12 (s, 1H, Ar-H, Pyrazole ring-H), 9.17 (s, 1H, NH).

***ethyl 4-(3-(3-bromo-4-fluorophenyl)-1-phenyl-1H-pyrazol-4-yl)-1,4,5,6,7,8-hexahydro-2,7,7-trimethyl-5-oxoquinoline-3-carboxylate* (Table 2, Entry 5j).**

The product was obtained as white solid: mp 224-226˚C; FT-IR (KBr) ν: 3282, 3228, 3084, 2962, 1696, 1633, 1601, 1541, 1487, 1439, 1376, 1209, 1066, 959, 750; ^{1}H NMR (DMSO-d_6, 400 MHz) δ: 0.73 (t, J=5.6 Hz, 3H, -CH_3), 0.94 (s, 3H, -CH_3), 1.03 (s, 3H, -CH_3), 2.19 (s, 2H, -CH_2-), 2.24 (s, 3H, Ar-CH_3), 2.38 (m, 2H, -CH_2-), 3.78 (q, J=5.6 Hz, 2H, -CH_2-), 5.01 (s, 1H, -CH-), 7.31 (t, J=6.0 Hz, 1H, Ar-H), 7.49 (m, J=6.0 and 4.8 Hz, 2H, Ar-H), 7.74-7.84 (m, 3H, Ar-H), 8.17 (s, 1H, Ar-H, Pyrazole ring-H), 8.54 (m, 1H, Ar-H), 8.92 (m, 1H, Ar-H), 9.14 (s, 1H, NH).

5. Conclusion

In conclusion, we have successfully demonstrated a novel method for the one pot synthesis of polyhydroquinoline derivatives from heterocyclic aldehydes, dimedone, ethyl acetoacetate and ammonium

acetate by simple stirring and ultrasound irradiation at room temperature. The catalytic system is very effective for the bulkier aldehydes to give the corresponding polyhydroquinoline derivatives in excellent yield (80-92%) and easy for isolation of the product. This approach has the various benefits includes simple work-up procedure, excellent yields and environmentally benign path.

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