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Application of Lanthanide Polychelates Derived from 2,4-dihydroxy acetophenone Based Resin as Green Catalyst for Biginelli Reactions

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ABSTRACT

In the present study, lanthanide polychelates of 2,4-dihydroxy acetophenone (DHAP) were evaluated for their applicability as green catalyst for various Biginelli reactions. Polymeric resins of DHAP (DHAP-1,2 PD, DHAP-1,3 PD, DHAP-1,3 BD and DHAP-1,4 BD) were synthesized and carried forward for the preparation of their polychelates with lanthanide metal ions *viz.* La^{3+}, Pr^{3+}, Nd^{3+}, Sm^{3+}, Gd^{3+}, Tb^{3+} and Dy^{3+}. The polychelates were assessed for their catalytic activity in the preparation of substituted 3,4-dihydropyrimidin-2(1H)-ones, largely known as the Biginelli compounds. In order to study the versatility and provide a comparative evaluation of the polychelates, a number of aldehyde derivatives and substituted 1,3-diketones were used. According to the results obtained, it was summarized that the polychelates possess desired catalytic effect for the aforementioned synthesis. The three component mixture of aldehyde, 1,3-dicarbonyl compound and urea were heated in presence of desired catalytic amount of lanthanide(III) polychelates to give corresponding 3,4-dihydropyrimidin-2(1H)-ones in 87-92 % yield. The reaction was completed within a reaction time of 2-6 h, and the polychelate catalysts could efficiently be reused for several times after simple washing step with distilled water.

Keywords: Phenolic Resin; 2,4-dihydroxyacetophenone; 4-dihydropyrimidin-2(1H)-ones; Polychelates; Lanthanides; Biginelli reaction

INTRODUCTION

Biginelli reaction, firstly reported by an Italian chemist Pietro Biginelli, is a cyclocondensation reaction between ethylacetoacetate, benzaldehyde, and urea to obtain a heterocyclic system of 3,4-dihydropyrimidinones (DHPMs) [1]. 3,4-dihydropyrimidin-2(1H)-one-type Biginelli products are structurally similar to dihydropyridines (DHP), which is a class of compounds which has shown remarkable pharmacological properties as calcium channel antagonists, as therapeutics in the clinical treatment of cardiovascular diseases such as hypertension, cardiac arrhythmias, or angina pectoris. Sufficient work has been done to study a wide range of biological activities of DHPMs namely antiviral, antitumor, and antibacterial andante-inflammatory activities [2]. Furthermore, several Biginneli products themselves have emerged as potential calcium channel blockers, and antihypertensives [3]. In addition, several marine natural products e.g. batzelladine alkaloids, are also found to contain active pyrimidine units and are found to act as HIVgp-120-CD4 inhibitors [4]. Hence, the Biginelli reaction continues to attract the attention of organic chemists interested in finding milder and more efficient procedures for the synthesis of dihydropyrimidinones [5–7]. As discussed in several previous reports, a number of advanced strategies have been developed for the synthesis of dihydropyrimidinone nucleus based on one-pot and multistep approaches. The studied reagents largely includes those based on Lewis and protic acids namely $BF_3·OEt_2$ [8], $ZrCl_4$ [9-10], $Sc(OTf)_3$ [11], $Al(NO_3)_3.9H_2O$ [12], silica triflate [13], europium triflate [14], zeolites [15], $SbCl_3$ [16], $CuCl_2·2H_2O$ [17], trichloroisocyanuric acid [18], $RuCl_3$ [19] silica sulfuric acid [20], and 1,3-dichloro-5,5-dimethylhydantoin [21]. Debache et al. [22] have also reported a solvent free triethanolamine promoted synthetic mode for 3,4-dihydropyrimydin-2(1H)-ones/thiones. Despite the fact that these reactions possess several advantages over the classical synthesis, many of these methods are too expensive and suffer from several shortfalls such as the use of toxic reagents, strongly acidic conditions, longer reaction time, high reaction temperatures, poor yields, incompatibility with other functional groups and difficult product isolation procedures. On the other hand green catalysts, especially those supported on polymer, have achieved paramount interest in various organic syntheses. The need for waste and hazard reduction, driven by the use of environment friendly conditions is gaining much interest in the context of chemical developments. The coordination polymers belong to one significantly emerging field of green chemistry, attributable to their catalytic property and non-hazardous nature [23]. Many of the coordination polymers have been shown to possess economical and easier production, higher reaction efficiency with minimum by-products and reusability [24]. A coordination polymer represents a class of polymers generally consisting of a metal ion and polymeric ligands, however they may also have guests and counter ions in some cases. Although the transition metals possess several advantages over lanthanides as indicated by numerous reports devoted to their studies, in recent times coordination polymers based on lanthanide metal ions have also grown with adequate potency. Lanthanide metal ions hold higher connectivity, predictable and controllable topologies, versatile compatibility as a catalyst for various organic reactions.

In our previous work, we have reported the synthesis and characterization of polymer supported chelates of lanthanide metal ions [25]. The synthesized polychelates were evaluated for their anti-microbial activity [26]. Prior studies have also been undertaken to establish the ion-exchange behavior of synthesized polymers with the lanthanide metal ions [27]. The lanthanide polychelates of 2, 4-dihydroxy acetophenone ethane diol were evaluated for their catalytic activity [28]. In the present study, the several analogous lanthanide polychelates were studied for their catalytic usefulness for the one pot synthesis of substituted 3,4-dihydropyrimidin-2(1H)-ones, known as Biginelli reaction.

MATERIALS AND METHODS

Chemicals and materials

All the chemicals used in the present investigation were of Analytical grade, and were used without further purification unless otherwise stated. The reagents and reactants used for the synthesis of polymeric resin, polychelates and 3,4-dihydropyrimidin-2(1H)-ones were purchased from E. Merck (Mumbai, India). The solvents used for the synthesis namely, dimethyl sulphoxide, polyphosphoric acid among others were of AR grade, procured from Central Drug House Pvt. Ltd. (New Delhi, India). Hydrated acetate salts of lanthanide ions such as Pr(III), Nd(III) and Sm(III) were procured with minimum 99% purity from Otto Chemie Pvt. Ltd. (Mumbai, India), while Alpha Chemica (Mumbai, India) provided acetate salts of La(III) (>99.9% purity). Melting points for the products were recorded using a Toshniwal melting point apparatus. FT-IR spectra were recorded on Bruker tensor 27 Infrared Spectrophotometer as KBr pellets and expressed in cm^{-1}. ^{13}C NMR and ^{1}H NMR spectra were recorded on Bruker DPX- 400 AVANCE in DMSO-d6 and $CDCl_3$, and tetramethylsilane was used as internal standard.

Synthesis of polymeric resins and their Ln(III) polychelates

The synthesis of all the polymeric resins was merely adopted from our previous report [25]. Briefly, polyphosphoric acid (as a catalyst) was added to a well stirred ice-cooled mixture of 2,4-dihydroxy acetophenone and 1,2-propanediol/1,3-proponediol/1,3-butanediol/1,4-butanediol. The reaction mixture was then allowed to stand for 30 min, and condensed at 140 °C. After 10 h, the mixture was cooled and poured on crushed ice and left overnight; the precipitated polymeric resin was collected by filtration and washing with cold water and methanol. The obtained yield ranged from 80-83 % for all the analogous resins (Figure 1). The polychelates were synthesized by addition of lanthanide acetate solutions to hot and clear solution of polymeric resin with constant stirring. The reaction mixture was digested on a water bath for 2 h and then filtered. The polychelates were obtained as blackish-brown products which were then washed, first with DMSO and then with acetone, and dried.

Catalytic production of substituted 3,4-dihydropyrimidin-2(1h) - ones

The Biginelli reaction i.e. the synthesis of substituted 3,4-dihydropyrimidin-2(1h)-ones was carried out using the methods reported in our previous article [28]. Briefly, the three component mixture of aldehyde, 1,3-dicarbonyl compound and urea were heated in presence of desired catalytic amount of lanthanide(III) polychelates to give corresponding 3,4-dihydropyrimidin-2(1H)-ones. The three component mixture along with the metal polychelates was refluxed at the boiling temperature. The progress of the reaction was tracked by TLC. Once the reaction was completed, the solution was allowed to cool and the produced 3,4-dihydropyrimidin-2(1h)-ones were filtered. The amount of polychelate catalyst present in the crude product was removed by filtration after dissolution of the product in ethanol. The desired product was obtained in purified form after recrystallization in DMSO. The synthesized substituted 3,4-dihydropyrimidin-2(1h)-ones were characterized using IR, ^{1}H NMR, and ^{13}C NMR techniques as described in previous section.

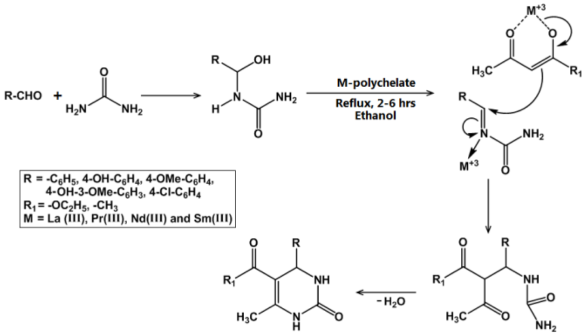

Figure 1 Generalized mechanism for lanthanide polychelates mediated Beginelli reactions.

RESULTS AND DISCUSSION

Synthesis of Ln(III)-polychelates and substituted 3,4-dihydropyrimidin- 2(1h)-ones

Condensation of 2-4-dihydroxy acetophenone with 1,2-propane diol, 1,3-propane diol, 1,3-butane diol and 1,4-butane diol was carried out using equimolar mixture of reactants at different amount of acid catalyst, duration of reaction time and suitable temperature. Then the polychelates were synthesized by mixing the hot and clear solution of polymeric resin with solution of hydrated acetates of lanthanide metal ions. The resin and polychelates were characterized using modern analytical techniques as reported in our previous report [25, 28].

In Biginelli cyclocondensation three component reactions are found to be promoted by the presence of Lewis acid catalyst. In the present studies, we have used lanthanide polychelates (ion exchange resin) as the heterogeneous Lewis acid catalyst. The quantitative conversion towards the entire selected range of substituted 3,4-dihydropyrimidin-2(1h)-ones was completed within 2-6 h and the yield of the reaction ranged from 87 to 92 %. From the results as presented in Tables 1-4, it can be demonstrated that the high percent yield was afforded by the presence of electron withdrawing or donating groups attached to aromatic aldehyde substrates. The synthesized Biginelli product and its derivatives were screened for their melting points which were in good agreement with the reported values given by Kappe [29] and Salehi et al. [20].

The synthesized 3,4-dihydropyrimidine-2(1H)-ones and their derivatives were characterized by FTIR, ^{1}H NMR and ^{13}C NMR spectroscopy; the data have been presented for the products through Entry 1 to Entry 10 [28].

Entry 1 (Table 1): 5-(Ethoxycarbonyl) 4-phenyl-6-methyl -3,4-dihydropyrimidin-2(1H)-one:

IR (KBr): 3234, 3106, 2928, 1730, 1646, 1598, 1464, 1417, 1339, 1315, 1288, 1092, cm^{-1}.

^{1}H NMR ($CDCl_3$ + DMSO-d6): $\delta = 1.17$ (t, 3H, -OC_2H_5), 2.35 (t, 3H, -CH_3), 4.07 (q, 2H, -OC_2H_5), 5.28 (d, 1H, -CH), 5.67 (s, 1H, -NH), 7.22-7.47 (5H, Ar-H), 9.20 (s, 1H, -NH).

^{13}C NMR: $\delta = 165.8$, 152.6, 148.8, 145.3, 128.8, 127.7, 126.7, 99.8, 59.6, 54.5, 18.2, 14.5.

Table 1 Summarized results for Beginelli reaction catalyzed by Ln(III) polychelates of DHAP-1,2-PD

Entry	R	R^1	Reaction time (h)	% yield in presence of polychelates as catalyst				Melting point (^{o}C)	
				La	Pr	Nd	Sm	Found	Reported*
1	C_6H_5	C_2H_5O	2	88	91	91	90	203	202-204
2	C_6H_5	CH_3	2	89	90	90	92	234	234-235
3	4-OH-C_6H_4	C_2H_5O	4	90	88	89	89	199	199-200
4	4-OH-C_6H_4	CH_3	4	89	89	90	91	211	210-211
5	4-OCH_3-C_6H_4	C_2H_5O	2	90	91	88	90	200	200-201
6	4-OCH_3-C_6H_4	CH_3	2	91	89	89	87	179	178-180
7	4-OH-3-OCH_3-C_6H_3	C_2H_5O	6	92	92	90	89	209	208-211
8	4-OH-3-OCH_3-C_6H_3	CH_3	6	90	89	92	91	247	246-248
9	4-Cl-C_6H_4	C_2H_5O	5	87	88	87	92	212	213-214
10	4-Cl-C_6H_4	CH_3	5	90	87	90	90	216	215-216

*The literature values for melting points were obtained from ref. 20 and 29.

Table 2 Summarized results for Beginelli reaction catalyzed by Ln(III) polychelates of DHAP-1,3-PD

Entry	R	R^1	Reaction time (h)	% yield in presence of polychelates as catalyst				Melting point (^{o}C)	
				La	Pr	Nd	Sm	Found	Reported*
1	C_6H_5	C_2H_5O	2	89	87	89	91	203	202-204
2	C_6H_5	CH_3	2	88	90	88	90	234	234-235
3	4-OH-C_6H_4	C_2H_5O	4	91	89	90	89	199	199-200
4	4-OH-C_6H_4	CH_3	4	90	91	89	88	211	210-211
5	4-OCH_3-C_6H_4	C_2H_5O	2	89	92	91	87	200	200-201
6	4-OCH_3-C_6H_4	CH_3	2	87	90	92	91	179	178-180
7	4-OH-3-OCH_3-C_6H_3	C_2H_5O	6	90	91	91	92	209	208-211
8	4-OH-3-OCH_3-C_6H_3	CH_3	6	91	90	93	90	247	246-248
9	4-Cl-C_6H_4	C_2H_5O	5	89	89	88	89	212	213-214
10	4-Cl-C_6H_4	CH_3	5	91	88	89	87	216	215-216

*The literature values for melting points were obtained from ref. 20 and 29.

Table 3 Summarized results for Beginelli reaction catalyzed by Ln(III) polychelates of DHAP-1,3-BD

Entry	R	R^1	Reaction time (h)	% yield in presence of polychelates as catalyst				Melting point (^{o}C)	
				La	Pr	Nd	Sm	Found	Reported*
1	C_6H_5	C_2H_5O	2	90	91	89	91	203	202-204
2	C_6H_5	CH_3	2	88	88	90	92	234	234-235
3	4-OH-C_6H_4	C_2H_5O	4	87	89	89	89	199	199-200
4	4-OH-C_6H_4	CH_3	4	91	90	87	90	211	210-211
5	4-OCH_3-C_6H_4	C_2H_5O	2	90	92	91	91	200	200-201
6	4-OCH_3-C_6H_4	CH_3	2	92	89	90	92	179	178-180
7	4-OH-3-OCH_3-C_6H_3	C_2H_5O	6	89	88	92	89	209	208-211
8	4-OH-3-OCH_3-C_6H_3	CH_3	6	88	89	89	88	247	246-248
9	4-Cl-C_6H_4	C_2H_5O	5	92	87	91	87	212	213-214
10	4-Cl-C_6H_4	CH_3	5	90	89	89	90	216	215-216

*The literature values for melting points were obtained from ref. 20 and 29.

Table 4 Summarized results for Beginelli reaction catalyzed by Ln(III) polychelates of DHAP-1,4-BD

Entry	R	R^1	Reaction time (h)	% yield in presence of polychelates as catalyst				Melting point (°C)	
				La	Pr	Nd	Sm	Found	Reported*
1	C_6H_5	C_2H_5O	2	89	90	90	90	203	202-204
2	C_6H_5	CH_3	2	88	89	92	92	234	234-235
3	4-OH-C_6H_4	C_2H_5O	4	90	92	87	87	199	199-200
4	4-OH-C_6H_4	CH_3	4	89	91	86	90	211	210-211
5	4-OCH_3-C_6H_4	C_2H_5O	2	90	89	90	89	200	200-201
6	4-OCH_3-C_6H_4	CH_3	2	91	90	93	90	179	178-180
7	4-OH-3-OCH_3-C_6H_3	C_2H_5O	6	92	90	89	92	209	208-211
8	4-OH-3-OCH_3-C_6H_3	CH_3	6	89	89	91	89	247	246-248
9	4-Cl-C_6H_4	C_2H_5O	5	91	88	90	90	212	213-214
10	4-Cl-C_6H_4	CH_3	5	89	91	89	87	216	215-216

*The literature values for melting points were obtained from ref. 20 and 29.

Entry 2 (Table 1): *5-(Ethoxycarbonyl)-4-(4-Hydroxyphenyl)-6-methyl-3,4-dihydropyrimidin-2(1 H)-one:*

IR (KBr): 3444, 3291, 3126, 2919, 1702, 1651, 1619, 1491, 1425, 1388, 1364, 1314, 1262, 1237, 1142, 1092, 1015, 967, 837 cm^{-1}.

^1H NMR ($CDCl_3$ + DMSO-d6): δ = 1.09 (t, 3H, -OC_2H_5), 2.24 (s, 3H, -CH_3), 4.01 (q, 2H, -OC_2H_5), 5.06 (d, 1H, -CH), 7.60 (s, 1H, -NH), 6.68-7.04 (m, 4H, Ar-H), 9.31 (s, 1H, -NH), 9.09 (s, 1H phenolic -OH).

^{13}C NMR: δ = 168.5, 158.9, 152.5, 148.3, 136.7, 128.1, 114.3, 110.1, 63.7, 55.5, 15.6, 13.7

Entry 3 (Table 1): *5-(Ethoxycarbonyl)-4-(4- methoxyphenyl) -6-methyl-3,4- dihydropyrimidin-2 (1H)-one:*

IR (KBr): 3444, 3291, 3126, 2919, 1702, 1651, 1619, 1491, 1425, 1388, 1364, 1314, 1262, 1237, 1142, 1092, 1015, 967, 837 cm^{-1}.

^1H NMR ($CDCl_3$ + DMSO-d6): δ = 1.20 (t, 3H, -OC_2H_5) 2.35 (s, 3H, -CH_3), 3.80 (s, 3H, -OCH_3), 4.08 (q, 2H, -OC_2H_5), 5.36 (d, 1H, -CH), 5.88 (S, 1H, -NH), 7.23-7.29 (m, 4H, Ar-H), 8.29 (s, 1H, -NH).

^{13}C NMR: δ = 165.7, 159.2, 153.8, 146.1, 136.1, 127.8, 113.9, 101.6, 59.9, 55.2, 55, 18.5, 14.2.

Entry 4 (Table 1): *5-(Ethoxycarbonyl)-4 -(4-Hydroxy-3-Methoxphenyl) -6-methyl-3,4-dihydro pyrimidin-2(1H)-one:*

IR (KBr): 3444, 3290, 3126, 2922, 1704, 1641, 1621, 1491, 1425 cm^{-1}.

^1H NMR ($CDCl_3$): δ = 1.1 (t, 3H, -OC_2H_5), 2.27 (s, 3H, -CH_3), 3.74 (s, 3H, -OCH_3), 3.98 (q, 2H, -OC_2H_5), 5.09 (d, 1H, -CH), 6.61 -6.81 (m, 3H, Ar-H), 7.59 (s, 1H, -NH), 8.88 (s, 1H phenolic -OH), 9.11 (s, 1H, -NH).

^{13}C NMR: δ = 165.9, 152.7, 148.3, 147.7, 146.2, 136.4, 118.8, 115.7, 111.4, 100.07, 59.6, 56.1, 54.04, 18.2, 14.6.

Entry 5 (Table 1): *5-(Ethoxycarbonyl)-4-(4-Chlorophenyl) -6-methyl-3,4-dihydropyrimidin-2(1H)-one:*

IR (KBr): 3462, 3249, 3126, 2979, 2923, 1721, 1710, 1652, 1577, 1491, 1465, 1388 cm^{-1}.

^1H NMR ($CDCl_3$ + DMSO-d6): δ =1.17 (t, 3H, -OC_2H_5), 2.37 (s, 3H, -CH_3), 4.12 (q, 2H, -OC_2H_5) 5.40 (d, 1H, -CH), 6.40 (s, 1H, -NH), 7.19-7.42 (m, 4H, Ar-H), 8.50 (s, 1H, -NH).

^{13}C NMR: δ = 165.6, 152.9, 147.7, 143.03, 132.9, 128.4, 128.06, 100.06, 59.6, 54.5, 18.3, 14.07.

Entry 6 (Table 1): *5-Acetyl-4-phenyl-6-methyl-3 ,4-dihydropyrimidin-2(1H)-one:*

IR(KBr): 3284, 3126, 2918, 1703, 1643, 1618, 1494, 1427, 1389, 1361, 1315, 1278, 1235, 1146, 1099, 1018, 968, 833 cm^{-1}.

^1H NMR ($CDCl_3$ + DMSO-d6): δ = 2.10 (s, 3H, -$COCH_3$), 2.29 (s, 3H,-CH_3), 5.47 (d, 1H, -CH), 5.75 (s, 1H, -NH), 7.28-7.42 (m, 5H, Ar-H), 9.20 (s, 1H, -NH).

^{13}C NMR: δ= 194.8, 152.6, 148.6, 144.6, 129, 127.8, 126.9, 110.08, 54.3, 30.8,19.38.

Entry 7 (Table 1): *5-Acetyl-4-(4-Hydroxyphenyl)-6-methyl-3,4-dihydropyrimidin-2(1H)-one:*

IR (KBr): 3373, 3256, 3116, 2965, 2920, 1702, 1681, 1669, 1609,1449, 1425, 1388, 1364, 1314, 1262 cm^{-1}.

^1H NMR ($CDCl_3$ + DMSO-d6): δ = 2.05 (s, 3H, -$COCH_3$), 2.27 (s, 3H, -CH_3), 5.14 (d, 1H, -CH), 6.65 (s, 1H, phenolic –OH), 6.94 -7.38 (m, 4H, Ar-H), 7.59 (s, 1H, -NH), 9.10 (s, 1H, -NH).

^{13}C NMR: δ = 194.9, 152.5, 148.02, 147.07, 131.68, 128.12, 125.9, 110.05, 54, 30.54, 19.26.

Entry 8 (Table 1): *5-Acetyl-4-(4-methoxylphenyl)-6-methyl-3,4-dihydropyrimidin-2(1H)-one:*

IR (KBr):3224, 3109, 2929, 2848, 1679, 1602, 1461, 1436, 1384, 1321, 1278, 1092, 759 cm^{-1}.

^1H NMR (DMSO-d6): δ =2.09 (s, 3H, -$COCH_3$), 2.29 (s, 3H, -CH_3), 3.74 (s, 3H,-OCH_3), 5.21 (s, 1H, -CH), 6.85 - 6.91 (m, 2H, Ar-H), 7.13- 7.19 (m, 2H, Ar-H), 7.78 (s, 1H, -NH), 9.17 (s, 1H, -NH).

^{13}C NMR: δ = 195.0, 158.9, 152.6, 148.4, 136.7, 128.1, 114.3, 110.1, 55.5, 53.7, 30.6, 19.3.

Entry 9 (Table 1): *5-Acetyl-4-(4-Hydroxy-3-Methoxphenyl) -6-methyl-3,4-dihydropyrimidin-2 (1H)-one:*

IR (KBr): 3444, 3290, 3126, 2922, 1704, 1641, 1621, 1491, 1425 cm^{-1}.

^1H NMR ($CDCl_3$): δ = 2.07 (s, 3H, -$COCH_3$), 2.28 (s, 3H, -CH_3), 3.74 (s, 3H, -OCH_3), 5.18 (d, 1H, -CH), 6.59 – 6.85 (m, 3H, Ar-H), 7.71 (s, 1H, -NH), 8.92 (s, 1H, phenolic -OH), 9.11 (s, 1H, -NH).

^{13}C NMR: δ = 195.05, 152.6, 148.2, 147.9, 146.4, 135.6, 118.9, 115.8, 111.7, 109.7, 56.06, 54.21, 30.5, 19.23.

Entry 10 (Table 1):*5-Acetyl-4-(4-Chlorophenyl)-6 -methyl-3, 4-dihydropyrimidin-2(1H)-one:*

IR (KBr): 3442, 3289, 3126, 2919, 1702, 1641.5, 1619, 1491, 1425, 1388, 1364, 1314, 1262, 1237, 1142, 1092, 1015, 967, 837 cm^{-1}.

^1H NMR ($CDCl_3$): δ = 2.26 (s, 3H, $-COCH_3$), 2.32 (s, 3H, $-CH_3$), 5.05 (d, 1H, -CH), 7.38 (s, 1H, -NH), 7.26-7.6 (m, 4H, Ar-H), 9.28 (s, 1H, -NH).

^{13}C NMR: δ = 194.8, 152.7, 147.5, 143.2, 133.1, 129.2, 128.02, 100.1, 54.3, 30.6, 19.4.

As found in our previous investigation, the Ln(III) polychelate catalyzed synthesis of 3,4-dihydropyrimidin-2(1H)-ones proceeds through an imine intermediate formed between the aldehydes and urea [28]. This intermediate is stabilized by the polychelate followed by the addition of the β-ketoesterenolate and cyclodehydration which finally results into the formation of 3,4-dihydropyrimidin-2(1H)-one and its derivatives (Figure 1). The stabilization of the intermediate by the heterogeneous lanthanide polychelate is thought to be the sole reason for the catalytic activity of the polychelates, which is in accordance with the mechanism of polychelate catalyzed Biginelli reactions as proposed by Kapp [29]. Further the polychelates were easily removed from the reaction system by simply dissolution of the obtained crude product; the product was then obtained in purified form through recrystallization in appropriate solvents. The once used polychelate did not show any remarkable drop in its catalytic activity; however it only needed a simple washing step using water followed by drying, labeled as the regeneration of the catalyst.

CONCLUSION

The present investigation represents the utilization of lanthanide polychelates as catalyst for well known organic reaction i.e. Biginelli reaction. The 3,4-dihydropyrimidine-2(1H)-ones and its derivatives were prepared from ternary mixture of aldehyde, 1,3-dicarbonyl compound and urea along with the solid catalyst following a one pot synthesis protocol. The spectral characteristics of the developed products were used to characterize their structure and prove their identity. The obtained melting points and mechanism of the reaction were in good accordance with those found in available reports. The present method uses nontoxic and economical alternative to existing methods, which can be effectively reused for several times after simple washing with water. The present method is a greener approach to Biginelli reaction, and several other merits may include mild reaction conditions, quantitative recovery, simple isolation of the products, and faster reaction rates.

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