7.1 INTRODUCTION

2, 3-Dihydroquinazolinones belong to an interesting class of heterocycles that possess a wide range of biological and pharmaceutical activities (Chinigo et al. 2008; Alagarsamy et al. 2007a; Alagarsamy et al. 2007b). Some examples of very significant quinazolinone molecules include medicinally approved drugs like metolazone, quinethazone, raltitrexed, fenquizone, as well as bio-active natural products such as febrifugine and isofebrifugine (Cohen et al. 1960; Theivendren et al. 2011).

Conventionally, 2,3-dihydroquinazolinones have been synthesized by variety of procedures as stated in literature (Yu et al. 2002; Armarego 1979; Kamal et al. 2002; Akazome et al. 1995; Segarra et al. 1998; Staiger et al. 1963). However, one-pot synthesis of such significant heterocycles from components like isatoic anhydride, aldehyde and amines using acidic catalyst or media has been the subject of interest for many researchers owing to the growing interest in multi-component reactions (MCRs). MCRs offer several benefits including low cost, shorter reaction times, high atom economy, lesser requirement of energy and easier access to diverse functional compound libraries.

The catalysts reported for the above stated one-pot procedure include inorganic catalysts like aluminium tris (dihydrogen phosphate) (Hamid et al. 2010) silica sulfuric acid (Peyman et al. 2005) alum (Minoo et al. 2005), gallium (III) triflate (Chen et al. 2008) magnetic Fe₃O₄ particles (Zhan et al. 2010) reaction media like acidic ionic liquid (Chen et al. 2007) and acetic acid (Zahed et al. 2011). However,
some of these reported procedures hold limitations like low yields, requirement of high reaction temperature, strong acidic conditions, use of expensive and toxic catalysts etc.

Consequently, there is a need for an acidic catalyst that could overcome the demerits and retain the benefits of the earlier procedures but in a simpler and environmentally benign manner. In addition, use of a non-toxic and bio-degradable catalyst would amplify the aspect of environmental benignness of reaction integrated by use of multi-component route.

In an attempt to achieve this, we have explored the catalytic activity of deep eutectic solvents (DES) in multi-component synthesis of quinazolinone derivatives. Deep eutectic solvents are simple ionic mixtures derived by combining quaternary ammonium salts, like choline chloride, with either hydrogen bond donors like urea and glycerol, or with Lewis acids like zinc chloride. The ability to form a hydrogen bond with the halide ion leads to a eutectic combination since these hydrogen-bonding interactions lead to depression in freezing point. Thus the formation of eutectic is more energetically favoured relative to the lattice energies of the pure constituents (Abbott et al. 2003). The class of DES derived from choline chloride is bio-degradable, non-toxic, insensitive towards moisture, recyclable and cost-effective. This is obvious since the component choline is a naturally occurring bio-compatible compound and choline chloride is also commercially produced on a large scale as a chicken feed additive (Gorke et al. 2008). In addition to this, DES also possesses many positive aspects of ionic liquids like low vapor pressure and low flammability.
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

In the past few years, our research group has explored applicability of deep eutectic mixtures based on choline chloride in several significant organic transformations (Singh et al. 2011; Singh et al. 2012a; Lobo et al. 2012; Singh et al. 2012b). We now extend their catalytic use in multi-component reaction wherein acidic deep eutectic solvent (DES), prepared from choline chloride and malonic acid was used in one-pot synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives. Earlier, this deep eutectic mixture has been used in electrochemistry (Chiemela et al. 2007) and inorganic synthesis (Chyi et al. 2006). However, no report related to the catalytic use of this mixture has been done in multi-component organic synthesis. This catalyst can be easily prepared from inexpensive starting materials in addition to being biodegradable and recyclable. We also optimized various parameters of the reaction and studied the recycling of catalyst.
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

7.2 RESULTS AND DISCUSSION

7.2.1 Influence of type and quantity of catalyst on Multicomponent Reaction (MCR) yield

Table 7.1: Optimization of catalysts in one-pot synthesis of 2-(4-chlorophenyl)-3-(4-methylphenyl)-2, 3-dihydroquinazolin-4(1H)-one

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Reaction medium&lt;sup&gt;a&lt;/sup&gt;</th>
<th>DES&lt;sup&gt;b&lt;/sup&gt; Catalyst</th>
<th>Yield (%)&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Methanol</td>
<td>-</td>
<td>Traces</td>
</tr>
<tr>
<td>2</td>
<td>Methanol</td>
<td>5% DES (CHCl: malonic acid)</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% DES (CHCl: malonic acid)</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15% DES (CHCl: malonic acid)</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20% DES (CHCl: malonic acid)</td>
<td>94</td>
</tr>
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<td></td>
<td></td>
<td>25% DES (CHCl: malonic acid)</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>Methanol</td>
<td>20% DES (CHCl:glycerol)</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Methanol</td>
<td>20% DES (CHCl:urea)</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Methanol</td>
<td>20% DES (CHCl:Zinc chloride)</td>
<td>45</td>
</tr>
</tbody>
</table>

<sup>a</sup> Reaction conditions: Isatoic anhydride (1g, 6.1 mmol), 4-chlorobenzaldehyde (0.87 g, 6.1 mmol), 4-methylaniline (0.67g, 6.1 mmol), DES catalyst(% v/v), methanol (10 vol), Reaction time = 2 hrs; Reaction temperature = 65 °C

<sup>b</sup> DES : Deep eutectic solvent, <sup>c</sup> Isolated yields
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

We initially screened various deep eutectic mixtures as catalyst in methanolic media to derive the best outcome. The deep eutectic solvents generated from glycerol or urea gave very less yields owing to their lesser acidity than DES made from acidic components. However, the eutectic mixture of choline chloride: malonic acid gave best results amongst all other eutectic mixtures (Table 7.1). The optimization for quantity of catalyst suggested 20% (v/v) of DES catalyst in methanol as the optimum quantity for effective results.

7.2.2 Multi-component synthesis of Quinazolinone derivatives by use of functionalized substrates

A variety of aromatic as well as heteroaromatic aldehydes and amines underwent three component condensation with isatoic anhydride by this procedure to produce several novel 2,3-dihydroquinazolin-4(1H)-one derivatives (Scheme 7.1). The results are summarized in Table 7.1. The aromatic amines selected include phenyl substituted amines, 2-methyl-8-amino quinolines and 2-amino thiazole. The aldehydes involved substituted benzaldehydes, pyridine-2-aldehyde and indole-3-aldehyde. The method showed good tolerance towards various functional groups including nitro, chloro and methoxy. The reaction gave high yields of product.

Scheme 7.1: Synthesis of novel quinazolinone derivatives via multi-component reaction by the catalytic activity of acidic deep eutectic mixture

\[
\begin{align*}
\text{O} & \quad + \quad \text{Ar}_1-\text{CHO} \quad + \quad \text{Ar}_2-\text{NH}_2 \\
\text{DES (ChCl:malonic acid)} & \quad \text{Methanol} \quad 65 ^\circ \text{C} \\
\text{[1]} & \quad \text{[2]} \quad \text{[3]} \\
\text{[4a-4i]} & \quad \text{[4a-4i]} \\
\end{align*}
\]
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

Table 7.2: One Pot Synthesis of 2,3-disubstituted-2,3-dihydroquinazolin-4(1H)-ones by reaction of isatoic anhydride with primary amines and aldehydes

<table>
<thead>
<tr>
<th>Entry No.</th>
<th>Aldehydes</th>
<th>Amines</th>
<th>Products&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Reaction Time (hrs)</th>
<th>Yields (%)&lt;sup&gt;b&lt;/sup&gt;</th>
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</thead>
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<td>CHO</td>
<td>NH₂</td>
<td><img src="image" alt="Product 4a" /></td>
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<td>94</td>
</tr>
<tr>
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<td>OHC</td>
<td>NH₂</td>
<td><img src="image" alt="Product 4b" /></td>
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<td>92</td>
</tr>
<tr>
<td>3.</td>
<td>CHO</td>
<td>H₂C-N</td>
<td><img src="image" alt="Product 4c" /></td>
<td>3</td>
<td>89</td>
</tr>
<tr>
<td>4.</td>
<td>CHO</td>
<td>H₂N-S</td>
<td><img src="image" alt="Product 4d" /></td>
<td>3.5</td>
<td>80</td>
</tr>
</tbody>
</table>
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

<p>| | | | | | |</p>
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<td><img src="" alt="Formula" /></td>
<td><img src="" alt="Formula" /></td>
<td><img src="" alt="Formula" /></td>
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</tr>
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<td><img src="" alt="Formula" /></td>
<td><img src="" alt="Formula" /></td>
<td><img src="" alt="Formula" /></td>
<td><img src="" alt="Formula" /></td>
<td>2.5</td>
</tr>
<tr>
<td>7.</td>
<td><img src="" alt="Formula" /></td>
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</tr>
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<td><img src="" alt="Formula" /></td>
<td><img src="" alt="Formula" /></td>
<td>3</td>
</tr>
</tbody>
</table>

Synthesis of novel colorants for dye-sensitized solar cells and use of greener protocols for heterocyclic synthesis
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

a Reaction conditions: Isatoic anhydride (1g, 6.1 mmol), aldehyde derivative (6.1 mmol), aniline derivative (6.1 mmol), 20% DES catalyst (2 ml) in methanol (10 ml), reaction temp = 65 °C

b Isolated yields

7.2.3 Scale-up batch and recyclability studies

The batch of reaction between isatoic anhydride, 4-chlorobenzaldehyde and 4-methylaniline was scaled up to understand the functioning of the method at larger scale. The deep eutectic mixture recovered from the scale-up batch was re-used for further runs of recycling studies (Figure 7.1). The recovery was very simple involving evaporation of the methanol and water after isolation of product by extraction. The deep eutectic solvent was reused without any loss in activity till five consecutive runs.

Figure 7.1: Studies in recycling of deep eutectic mixture in the multi-component synthesis of quinazolinone derivative 4a
7.2.4 Proposed mechanism

In sync with earlier proposed mechanism for quinazolinone synthesis (Hamid et al. 2010; Chen et al. 2008) and in view of our experimental results, we suggest a mechanism that highlights the probable role of acidic deep eutectic mixtures in multicomponent synthesis of quinazolinone (Figure 7.2). The sequence of steps includes attack of aromatic amine on carbonyl group of anhydride followed by decarboxylation wherein hydrogen bonding ability of acidic deep eutectic mixture plays an important role. DES also might assist in improving reactivity of aromatic aldehyde and finally in promoting cyclization to form the quinazolinone core. The formation of intermediate 2-amino-N-arylbenzamide, as depicted in the mechanism, has been confirmed experimentally by earlier reports (Minoo et al. 2005).

![Proposed reaction mechanism in synthesis of quinazolinone derivatives using acidic deep eutectic solvent as catalyst](image)

**Figure 7.2:** Proposed reaction mechanism in synthesis of quinazolinone derivatives using acidic deep eutectic solvent as catalyst
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

7.3 EXPERIMENTAL

7.3.1 Materials and equipments

All the solvents and chemicals were procured from S D fine chemicals (India) and were used without further purification. The reactions were monitored by TLC using 0.25 mm E-Merck silica gel 60 F254 precoated plates, which were visualized with UV light. \(^1\)H NMR and \(^{13}\)C-NMR spectrums were recorded on Varian 300 MHz mercury plus spectrometer, and chemical shifts are expressed in \(\delta\) ppm using TMS as an internal standard. Mass spectral data were obtained with micromass-Q-Tof (YA105) spectrometer. Elemental analysis was done on Harieus rapid analyzer.

7.3.2 Preparation of Deep eutectic solvent (DES)

The deep eutectic solvents were prepared by combining choline chloride with various other components like malonic acid, zinc chloride, urea and glycerol according to the procedures reported in the literature (Abbott et al. 2003; Abbott et al. 2004; Abbott et al. 2004a). Choline chloride (100 g, 714 mmol) and malonic acid (75 g, 714 mmol) were heated with stirring at 100ºC until a clear solution began to form. The deep eutectic solvent (Figure 7.3) thus formed (175 g, 100%) was cooled and used in reactions without any purification. The reaction was atom efficient since all the atoms present in the starting materials were incorporated in the products.

![Figure 7.3: Deep eutectic mixture of choline chloride and malonic acid](image-url)
7.3.3 General Procedure for deep eutectic solvent catalyzed synthesis of 2,3-disubstituted quinazolinones

A mixture of isatoic anhydride (1g, 6.1 mmol), aldehyde derivative (6.1 mmol) and aniline derivative (6.1 mmol) were stirred in methanol (10 ml) at 65 °C. To this mixture, 20% (v/v) of DES catalyst (2 ml) was added and the stirring was continued at the same temperature till completion of reaction. The progress of reaction was monitored on thin layer chromatography plate. For isolation of product, water was added to the reaction mixture and the product was extracted with ethyl acetate. The ethyl acetate was evaporated using rotary evaporator to give crude solid which was purified by column chromatography using hexane: ethyl acetate in 8:2 ratio (v/v). The compounds were characterized using elemental analysis and spectroscopic data (FT-IR, Mass, $^1$H NMR, $^{13}$C NMR). The deep eutectic solvent was recovered by removing the aqueous layer using rotary evaporator. Even though the procedure was described with a 1g scale, it was easily scalable upto 10 g to obtain yields of about 93%. The recovered catalyst obtained from the scale up batch was re-used upto four runs without any loss in yields.
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

7.4 CONCLUSION

In conclusion, we prepared novel derivatives of quinazolinone with varied substitutions at 2, 3 positions by using bio-degradable acidic deep eutectic catalyst in one pot, multi-component synthesis. The products, involving different aromatic and heteroaromatic substitutions like quinaldine, indole, pyridine, thiazole and furan moieties, were prepared in excellent yields. The highlights of the catalyst include its bio-degradability, non-toxic nature, ease in preparation and requirement of inexpensive starting materials. The catalyst was also easily recyclable with no loss in yields at least up to five runs.
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

7.5 Spectral data of compound

2-(4-Chlorophenyl)-3-(4-methylphenyl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4a, Table 7.2)

(2.0 g , 94%, solid, m.p. 270-274°C); FT-IR ν = 3299, 1633, 1607, 1508, 1484, 1385, 1315, 1086, 820 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl3): δ 2.30 (s, -CH\(_3\), 3H), 6.10 (s, -CH, 1H), 6.60-8.0 (m, Ar-H, 12H); \(^1^3\)C NMR (300 MHz): (3-2C) δ 21.1, 74.1, 115.0, 119.9, 126.8, 128.3, 128.9, 129.0, 129.1, 129.8, 131.6, 134.0, 136.9, 137.8, 138.6, 145.1; EIMS m/z=349.1, C\(_{21}\)H\(_{17}\)ClN\(_2\)O, calculated m/z: 348.8; Anal. Calcd for C\(_{21}\)H\(_{17}\)ClN\(_2\)O: C, 72.31; H, 4.91; N, 8.03. Found: C, 71.81; H, 4.95; N, 8.27.

3-(4-Chlorophenyl)-2-pyridin-3-yl-2,3-dihydroquinazolin-4(1H)-one (Entry 4b, Table 7.2)

(1.99 g, 97%, liquid) FT-IR ν = 3479, 3371, 3028, 1737, 1690, 1615, 1587, 1561, 1437, 1293, 1242,1103, 750cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl3): δ 5.70 (bs, -NH, 1H), 6.60-7.90 (m, Ar-H, 13H); \(^1^3\)C NMR (300 MHz): (3-2C) δ 51.5, 110.7, 116.2, 116.7, 131.2, 134.1, 150.4, 168.6; EIMS m/z= 336.1, C\(_{19}\)H\(_{14}\)ClN\(_3\)O, calculated m/z: 335.56; Anal. Calcd for C\(_{19}\)H\(_{14}\)ClN\(_3\)O: C, 67.96; H, 4.20; N,12.51. Found: C, 67.49; H, 4.90; N, 12.63.
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

2-(4-Chlorophenyl)-3-(2-methylquinolin-8-yl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4c, Table 7.2)

(2.17 g, 89%, solid, m.p.186-190°C); FT-IR ν = 3472, 3026, 1738, 1596, 1486, 1373, 1229, 1216, 1090, 826 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 2.30 (s, -CH₃, 3H), 5.70 (bs, -NH, 1H), 6.10 (s, -CH, 1H), 6.60-8.20 (m, Ar-H, 13H); ¹³C NMR (300 MHz): (3-2C) δ 25.1, 51.9, 116.5, 116.7, 116.8, 117.6,121.3, 122.4, 126.2, 126.8, 127.7, 128.1, 128.9, 129.1, 129.4, 131.3, 132.7, 134.1, 134.3, 134.7, 136.5, 142.9, 143.5, 167.7, 168.6; EIMS m/z=400.1, C₂₄H₁₈ClN₃O, calculated m/z: 399.8; Anal. Calcd for C₂₄H₁₈ClN₃O: C, 72.09; H, 4.54; N, 10.51, Found: C, 71.77; H, 4.81; N, 10.31.

2-(1-Butyl-1H-indol-3-yl)-3-(4-phenylthiazol-2-yl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4d, Table 7.2)

(2.55 g, 87%, liquid); FT-IR ν = 3479, 3371, 3027, 1737 , 1691, 1615, 1587, 1434, 1293, 1243, 1160, 1103, 749 cm⁻¹; ¹H NMR (300 MHz, CDCl₃): δ 0.90 (m, -CH₃, 3H), 1.20 (m, CH₂, 2H), 1.70 (m, -CH₂, 2H), 3.75 (m, -CH₂, 2H), 5.70 (bs, NH, 1H) 6.56-6.64 (m, Ar, 4H), 7.18-7.26 (m, Ar, 7H), 7.78-7.84 (m, Ar, 4H); ¹³C NMR (300 MHz): (3-2C) δ 14.0, 20.0, 30.0, 32.0, 51.5, 110.7, 116.3, 116.7, 131.2, 134.1, 150.5, 168.6; EIMS m/z= 258.1, C₂₉H₂₆N₄O S, calculated m/z: 478.6; Anal. Calcd for C₂₉H₂₆N₄OS: C, 72.78; H, 5.48; N, 11.71; S, 6.70. Found: C, 72.35; H, 5.74; N, 11.54; S, 6.10.
3-(4-Methoxyphenyl)-2-pyridin-3-yl-2,3-dihydroquinazolin-4(1H)-one  (Entry 4e, Table 7.2)

(1.92 g, 95%, liquid); FT-IR $\nu = 3478, 3371, 3027, 1738, 1691, 1615, 1587, 1434, 1366, 1293, 1241, 1159, 1103, 749 \text{ cm}^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 3.80 (s, -CH$_3$, 3H), 5.70 (s, NH, 1H), 6.60 (m, Ar, 6H), 7.20 (m, Ar, 4H), 7.80 (m, Ar, 1H);
$^{13}$C NMR (300 MHz): (3-2C) $\delta$ 51.5, 110.7, 116.2, 116.7, 131.2, 134.1, 150.5, 168.6; EIMS m/z= 192.1 (base peak), C$_{20}$H$_{17}$N$_3$O$_2$, calculated m/z: 331.4; Anal. Calcd for C$_{20}$H$_{17}$N$_3$O$_2$: C, 72.49; H, 5.17; N, 12.68.
Found: C, 72.80; H, 5.00; N, 12.63.

3-(4-Chlorophenyl)-2-(2-furyl)-2,3-dihydroquinazolin-4(1H)-one  (Entry 4f, Table 7.2)

(1.68 g, 85%, solid, 200-204°C); FT-IR $\nu = 3400, 3027, 1738, 1612, 1488, 1366, 1216, 1089, 751 \text{ cm}^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 6.0 (s, NH, 1H), 6.2-8.1 (m, Ar, 12H); $^{13}$C NMR (300 MHz): $\delta$ 114.1, 121.7, 127.2, 127.5, 128.3, 128.6, 129.0, 129.4, 131.3, 134.0; EIMS m/z= 325.1; C$_{18}$H$_{13}$ClN$_2$O$_2$, calculated m/z: 324.7; Anal. Calcd for C$_{18}$H$_{13}$ClN$_2$O$_2$: C, 66.57; H, 4.03; N, 8.63; Found: C, 66.62; H, 4.13; N, 8.22.

3-(2-Methylquinolin-8-yl)-2-pyridin-3-yl-2,3-dihydroquinazolin-4(1H)-one

(Entry 4g, Table 7.2)

(1.86 g, 83%, liquid); FT-IR $\nu = 3479, 3371, 3026, 1738, 1692, 1615, 1587, 1434, 1366, 1232, 1103, 750 \text{ cm}^{-1}$; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ 2.3 (s, -CH$_3$, 3H), 5.20 (s, -CH, 1H), 5.60 (bs, NH, 1H), 6.60 (m, Ar, 6H), 7.10-7.30 (m, Ar, 4H), 7.80 (m,
Chapter 7: Bio-compatible eutectic mixture for multi-component synthesis: A valuable acidic catalyst for synthesis of novel 2, 3-dihydroquinazolin-4(1H)-one derivatives

3-(2-Methylquinolin-8-yl)-2-(4-nitrophenyl)-2,3-dihydroquinazolin-4(1H)-one (Entry 4h, Table 7.2)

(2.31 g, 92%, liquid); FT-IR ν = 3481, 3371, 1690, 1615, 1587, 1434, 1293, 1243, 1160, 1101, 749 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)): δ 3.30 (s, -CH\(_3\), 3H), 5.42 (s, CH, 1H), 5.70 (bs, NH, 1H), 6.62 (m, Ar, 4H), 7.25 (m, Ar, 3H) 7.60 (m, Ar, 2H), 7.85 (m, Ar, 3H), 8.20 (m, Ar, 1H); \(^{13}\)C NMR (300 MHz): δ 51.5, 52.8, 101.6, 110.8, 116.3, 116.7, 123.5, 127.8, 131.3, 134.1, 150.5, 168.6; EIMS m/z= 411.6, C\(_{24}\)H\(_{18}\)N\(_4\)O\(_3\), calculated m/z: 410.4; Anal. Calcd for C\(_{24}\)H\(_{18}\)N\(_4\)O\(_3\): C, 70.23; H, 4.42; N, 13.65. Found: C, 70.66; H, 4.02; N, 13.29.

2-(4-Chlorophenyl)-3-(4-methoxyphenyl)-2,3-dihydroquinazolin-4(1H)-one (Entry 4i, Table 7.2)

(1.98 g, 89%, solid, m.p. 210-214 °C) FT-IR ν = 3284, 2965, 1599, 1486, 1389, 1261, 1087, 1034, 1013, 754 cm\(^{-1}\); \(^1\)H NMR (300 MHz, CDCl\(_3\)): δ 5.45 (bs, NH, 1H), 6.0 (s, CH, 1H), 6.52-6.80 (m, Ar, 5H), 7.0-7.60 (m, Ar, 4H), 7.90 (m, Ar, 2H) 8.45 (m, Ar, 1H); \(^{13}\)C NMR (300 MHz): δ 55.4, 73.9, 106.2, 110.3, 112.7, 115.1, 116.9, 117.6, 118.9, 119.9, 127.2, 128.2, 128.9, 129.7, 132.8, 134.0, 138.5, 141.6, 148.9, 160.0, 160.2; EIMS m/z= 365.1, C\(_{21}\)H\(_{17}\)ClN\(_2\)O\(_2\), calculated m/z: 364.8; Anal. Calcd for C\(_{21}\)H\(_{17}\)ClN\(_2\)O\(_2\): C, 69.14; H, 4.70; N, 7.68. Found: C, 68.68; H, 4.88; N, 8.28.
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Mass Spectra

2-(4-chlorophenyl)-3-(4-methylphenyl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4a, Table 2)
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3-(4-chlorophenyl)-2-pyridin-3-yl-2,3-dihydroquinazolin-4(1H)-one

(Entry 4b, Table 2)
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2-(4-chlorophenyl)-3-(2-methylquinolin-8-yl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4c, Table 2)
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2-(1-butyl-1H-indol-3-yl)-3-(4-phenylthiazol-2-yl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4d, Table 2)
3-(4-methoxyphenyl)-2-pyridin-3-yl-2,3-dihydroquinazolin-4(1H)-one

(Entry 4e, Table 2)
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3-(4-chlorophenyl)-2-(2-furyl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4f, Table 2)
3-(2-methylquinolin-8-yl)-2-pyridin-3-yl-2,3-dihydroquinazolin-4(1H)-one
(Entry 4g, Table 2)
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3-(2-methylquinolin-8-yl)-2-(4-nitrophenyl)-2,3-dihydroquinazolin-4(1H)-one
(Entry 4h, Table 2)
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2-(4-chlorophenyl)-3-(4-methoxyphenyl)-2,3-dihydroquinazolin-4(1H)-one

(Entry 4i, Table 2)
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$^{1}$H NMR Spectra

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13C NMR Spectra

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IR Spectra

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