Supporting information

Anion Functionalized Ionic liquid From Artificial Sugar: A Sustainable Pathway for Diverse Bis-enol Derivatives

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General remarks:

Chemical and Instrument: All of the reagents purchased were of AR grade and used without further purification. Melting points were detected with a Stuart SMP30 Melting Point Measurer (Designed in UK) without correction; $^1$H spectra were recorded on Jeol JNM ECX 500 MHz spectrometer in CDCl$_3$ and DMSO-d$_6$.

Typical experimental procedure for the [Bmim]Sac$^1$: To a solution of 1-$n$-butyl-3-methylimidazolium bromide [Bmim]Br 26.7g (0.122 mol) in 100 mL acetone at room temperature, Sodium Saccharinate 25.0 g (0.122 mol) was added and stirred for about 30h. The reaction mixture was then filtered through a plug of Celite. The volatiles were removed under reduced pressure overnight and yield of 32.0 g (96%) of viscous oil was obtained.

General procedure for the synthesis of Biscoumarin / Bipyranymethane / Tetraketones: In a 50 ml round bottom flask, mixture of substituted aldehyde (1.0 mmol), 4-hydroxy coumarin / 4-hydroxy-6-methyl-2-pyrene / dimedone / 1,3-cyclohexanedione (2.0 mmol) and Bmim(Sac) (10 mol%), was stirred at 80°C in water (2 ml) for time specified in Table 2. After completion of the reaction as monitored by TLC, the obtained solid precipitate was collected by filtration or the reaction mixture was extracted with ethyl acetate and water (in case of no precipitate). Then, the crude product was purified by recrystallization from EtOH.

Reusability of the [Bmim]Sac: The reusability of [Bmim]Sac was investigated from the reaction between benzaldehyde and 4-hydroxycoumarin as a model system. After completion of the reaction, precipitates separated out in the reaction mixture were filtered and aqueous layer containing catalyst was recovered under reduced pressure, dried, and reused for additional five times for subsequent reactions.
Experimental data of all products:

[Bmim][Sac]¹:

\[
\begin{align*}
\text{viscous oil (86\%)} \quad ^1\text{H NMR (300 MHz, DMSO-}\text{d}_6\text{)}: \delta &= 9.17 \text{ (s, 1H, ArH), } 7.89 \text{ (d, } J = 5.4\text{Hz, 1H, ArH), } \\
&7.78 \text{ (d, } J = 2.0\text{Hz, 4H, ArH), } 7.71 \text{ (s, 1H, ArH), } 4.18 \text{ (t, } 2\text{H, } J = 7.2\text{Hz, NCH}_2\text{), } 3.85 \text{ (s, 3H, CH}_3\text{), } 1.80 \text{ (m, } 2\text{H, CH}_2\text{), } 1.28 \text{ (m, 2H, CH}_2\text{)}, \ 0.90 \text{ (t, } 3\text{H, } J = 7.3\text{ Hz, CH}_3\text{);} \\
\text{ } ^{13}\text{C NMR (75 MHz, DMSO}_d\text{)}: \delta &= 164.7, \\
&142.5, 136.5, 133.0, 131.5, 123.5, 122.2, 120.0, 48.4, 35.7, 31.3, 18.7, 13.2.
\end{align*}
\]

3,3′-(Phenylmethylene)bis(4-hydroxy-2H-chromen-2-one) 4ₐ²:

\[
\begin{align*}
\text{White solid, m. p. 230-232 °C; } ^1\text{H NMR (500MHz, DMSO-}\text{d}_6\text{): } \delta &= 6.21 \text{ (s, 1H, CH), } 7.00-7.23 \text{ (m, 8H, ArH), } 7.44-7.48 \text{ (m, 2H, ArH), } 7.75-7.77 \text{ (m, 3H, ArH), Anal. Calcd. C}_{25}\text{H}_{16}\text{O}_6: C, } \\
&72.81; \ H, 3.91. \text{ Found: C, 72.65; H, 3.97.}
\end{align*}
\]

3,3′-((4-Chlorophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4ₐ²:

\[
\begin{align*}
\text{White solid, m. p. 242-245 °C; } ^1\text{H NMR (500MHz, CDCl}_3\text{): } \delta &= 6.03 \text{ (s, 1H, CH), } 7.14-7.15 \text{ (m, 2H, ArH), } 7.27-7.29 \text{ (d, } J = 8.65\text{Hz, 2H, ArH), } 7.39-7.42 \text{ (m, 4H, ArH), } 7.61-7.63 \text{ (m, 2H, ArH),}
\end{align*}
\]

3,3''-(p-Tolylmethylene)bis(4-hydroxy-2H-chromen-2-one) 4c^{2}:

White solid, m. p. 263-265°C; \(^{1}\)H NMR (500MHz, CDCl\(_3\)): \(\delta = 2.32\) (s, 3H, CH\(_3\)), 6.05 (s, 1H, CH), 7.08-7.12 (m, 4H, ArH), 7.39 (d, \(J = 8.30\)Hz, 4H, ArH), 7.59-7.63 (m, 2H, ArH), 7.96-8.05(m, 2H, ArH), 11.50 (brs, 2H, OH); Anal. Calcd. C\(_{26}\)H\(_{18}\)O\(_6\): C, 73.23; H, 4.25. Found: C, 73.10; H, 4.30.

3,3''-((2-Nitrophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4d:

Pale yellow solid; m. p. 106-108°C; \(^{1}\)H NMR (500 MHz, CDCl\(_3\)): \(\delta = 6.61\) (s, 1H, CH), 7.38-7.45 (m, 6H, ArH), 7.53-7.65 (m, 4H, ArH), 7.96-8.07 (m, 2H, ArH), 11.54 (br s, 2H, OH); Anal. Calcd. C\(_{25}\)H\(_{15}\)NO\(_8\): C, 65.65; H, 3.31; N, 3.06. Found: C, 65.49; H, 3.49; N, 3.14.

3,3''-((4-Bromophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4e\(^{2}\):
White solid, m. p. 260-262°C; \(^1\)H NMR (500MHz, CDCl\(_3\)): \(\delta = 6.01\) (s, 1H, CH), 7.08 (dd, \(J = 13.5\)Hz, 2H, ArH), 7.36-7.49 (m, 8H, ArH), 7.61-7.65 (m, 2H, ArH), 11.53 (brs, 2H, OH); Anal. Calcd. \(\text{C}_{25}\text{H}_{15}\text{BrO}_6\): C, 61.12; H, 3.08. Found: C, 61.02; H, 3.17.

3, 3’-((4-Fluorophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4f:

![Image of 3, 3’-((4-Fluorophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4f]

White solid, m. p. 213-216°C; \(^1\)H NMR (500MHz, CDCl\(_3\)): \(\delta = 6.04\) (s, 1H, CH), 6.98-7.02 (t, \(J = 8.7\)Hz, 2H, ArH), 7.16(dd, \(J = 5.2\)Hz, 2H, ArH), 7.36-7.41 (m, 4H, ArH), 7.61-7.64 (m, 2H, ArH), 7.98-8.07 (m, 2H, ArH), 11.31 (br s, 1H, OH); 11.53 (br s, 1H, OH); Anal. Calcd. \(\text{C}_{25}\text{H}_{15}\text{FO}_6\): C, 69.77; H, 3.51. Found: C, 69.65; H, 3.62.

3,3’-((3-Nitrophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4g:

![Image of 3,3’-((3-Nitrophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4g]

White solid, m. p. 125-127°C; \(^1\)H NMR (500 MHz, CDCl\(_3\)): \(\delta = 6.12\) (s, 1H, CH), 7.38-7.44 (m, 4H, ArH), 7.49-7.57 (m, 2H, ArH), 7.65-7.68 (m, 2H, ArH), 7.82-8.15 (m, 4H, ArH), 11.57(br s, 2H, OH); Anal. Calcd. \(\text{C}_{25}\text{H}_{15}\text{NO}_8\): C, 65.65; H, 3.31; N, 3.06. Found: C, 65.53; H, 3.38; N, 3.11

3,3’-((4-Nitrophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4h:

![Image of 3,3’-((4-Nitrophenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4h]
Yellow solid, m. p. 242-244 °C; \(^1\)H NMR (500MHz, CDCl\(_3\)): \(\delta = 6.45\) (s, 1H, CH), 7.32-7.44 (m, 4H, ArH), 7.47 (d, \(J = 8.4\) Hz, 2H, ArH), 7.62 (d, \(J = 8.0\) Hz, 2H, ArH), 7.93 (d, \(J = 8.0\) Hz, 2H, ArH), 8.13 (d, \(J = 8.8\) Hz, 2H, ArH), 11.51 (brs, 2H, OH); Anal. Calcd. C\(_{25}\)H\(_{15}\)NO\(_8\): C, 65.65; H, 3.31; N, 3.06. Found: C, 65.51; H, 3.39; N, 3.12.

3,3'-((4-Methoxyphenyl)methylene)bis(4-hydroxy-2H chromen-2-one) 4i:

White solid, m. p. 228-230°C; \(^1\)H NMR (500MHz, CDCl\(_3\)): \(\delta = 3.78\) (s, 3H, CH\(_3\)), 6.03 (s, 1H, CH), 6.82 (d, \(J = 8.9\) Hz, 2H, ArH), 7.10 (d, \(J = 8.2\) Hz, 2H, ArH), 7.38 (d, \(J = 8.2\) Hz, 4H, ArH), 7.59-7.64 (m, 2H, ArH), 7.98-8.04 (m, 2H, ArH), 11.51 (brs, 2H, OH); Anal. Calcd. C\(_{26}\)H\(_{18}\)O\(_7\): C, 70.58; H, 4.10. Found: C, 70.48; H, 4.18.

3,3'-(Thiophen-2-ylmethylene)bis(4-hydroxy-2H-chromen-2-one) 4j:

Yellow solid, m. p. 211-213 °C; \(^1\)H NMR (500MHz, DMSO-\(d_6\)): \(\delta = 6.19\) (s, 1H, CH), 6.85-6.94(m, 2H, ArH), 7.20(d, \(J= 5.0\)Hz, 1H, ArH), 7.39 (d, \(J = 8.2\)Hz, 4H, ArH), 7.61-7.62 (m, 2H, ArH), 8.00-8.06(m, 2H, ArH), 11.29 (br s, 1H, OH), 11.79 (br s, 1H, OH); Anal. Calcd. C\(_{23}\)H\(_{14}\)O\(_6\)S: C, 66.02; H, 3.37. Found: C, 66.09; H, 3.32.

3,3'-(Furan-2-ylmethylene) bis(4-hydroxy-2H-chromen-2-one) 4k:
Off-white solid, m. p. 201-203°C; \( ^1H \) NMR (500MHz, DMSO-\( d_6 \)): \( \delta = 5.96 (m, 1H, \text{FuranCH}), 6.19 (s, 1H, \text{CH}), 6.26 (m, 1H, \text{FuranCH}), 7.23-7.30 (m, 4H, \text{ArH}), 7.39 (m, 1H, \text{ArH}), 7.51-7.55 (m, 2H, \text{ArH}), 7.85 (d, \( J = 10.0 \) Hz, 2H, \text{ArH}); \text{Anal. Calcd. } C_{23}H_{14}O_7: \text{C, 68.66; H, 3.51. Found: C, 68.54; H, 3.63.}

3,3’-(Butane-1,1-diyl)bis(4-hydroxy-2H-chromen-2-one) 4l²:

White solid, m. p. 119-123 °C; \( ^1H \) NMR (500MHz, DMSO-\( d_6 \)): \( \delta = 0.90 (t, 3H, \text{CH}_3), 1.25-1.31 (m, 2H, \text{CH}_2), 2.13 (q, \( J = 7.2 \) Hz, 2H, \text{CH}_2), 4.96 (d, \( J = 8.0 \) Hz, 1H, \text{CH}), 7.38-7.41 (m, 4H, \text{ArH}), 7.63 (t, \( J = 7.2 \) Hz, 2H, \text{ArH}), 7.99 (d, \( J = 7.2 \) Hz, 2H, \text{ArH}), 11.97 (brs, 2H, \text{OH}); \text{Anal. Calcd. } C_{22}H_{18}O_6: \text{C, 69.83; H, 4.79. Found: C, 69.74; H, 4.88.}

3,3’-((4-(Dimethylamino)phenyl)methylene)bis(4-hydroxy-2H-chromen-2-one) 4m:

Pink solid, m. p. 223-225°C; \( ^1H \) NMR (500MHz, DMSO-\( d_6 \)): \( \delta = 3.09 (s, 6H, 2x\text{CH}_3), 6.24 (s, 1H, \text{CH}), 7.18-7.24 (m, 6H, \text{ArH}), 7.46-7.48(m, 4H, \text{ArH}), 7.37(s, 2H, \text{ArH}), 7.76-7.77 (m, 2H, \text{ArH}).

3,3’-((2-Nitrophenyl)methylene)bis(4-hydroxy-6-methyl-2H-pyran-2-one) 4n:
3,3’-((3-Nitrophenyl)methylene)bis(4-hydroxy-6-methyl-2H-pyran-2-one) 4o:

White solid, m. p. 224-226°C; $^1$H NMR (500MHz, DMSO-d$_6$): $\delta = 2.10$ (s, 6H, 2xCH$_3$), 5.89 (s, 2H, CH), 5.99 (s, 1H, CH), 7.19 (d, $J$ = 7.9Hz, 1H, ArH), 7.33 (t, $J$ = 7.6Hz, 1H, ArH), 7.46(t, $J$ = 7.9Hz, 1H, ArH), 7.68(d, $J$ = 8.8Hz, 1H, ArH), 11.25 (br s, 2H, OH); Anal. Calcd. C$_{19}$H$_{15}$NO$_8$: C, 59.22; H, 3.92. Found: C, 59.17; H, 3.97.

3,3’-((3-Nitrophenyl)methylene)bis(4-hydroxy-6-methyl-2H-pyran-2-one) 4o:

White solid, m. p. 202-204°C; $^1$H NMR (500MHz, CDCl$_3$): $\delta = 2.31$ (s, 6H, CH$_3$), 5.78 (s, 1H, CH), 6.06 (m, 2H, CH), 7.49 (s, 2H, ArH), 7.99-8.10 (m, 3H, ArH), 10.99 (br s, 2H, OH). Anal. Calcd. C$_{19}$H$_{15}$NO$_8$: C, 59.22; H, 3.92. Found: C, 59.15; H, 3.98.

3,3’-((4-Nitrophenyl)methylene)bis(4-hydroxy-6-methyl-2H-pyran-2-one) 4p:

White solid, m. p. 234-236°C; $^1$H NMR (500MHz, CDCl$_3$): $\delta = 2.30$ (s, 6H, 2xCH$_3$), 5.77 (s, 1H, CH), 6.05-6.14 (m, 2H, CH), 7.31 (d, $J$ = 5.2Hz, 2H, ArH), 8.15 (d, $J$ = 8.8Hz, 2H, ArH), 10.96 (br s, 2H, OH); Anal. Calcd. C$_{19}$H$_{15}$NO$_8$: C, 59.22; H, 3.92. Found: C, 59.13; H, 3.96.
Yellow powder, m. p. 173-175°C; \(^1\)H NMR (500 MHz, DMSO-\(d_6\)) \(\delta = 2.07 \text{ (s, 6H, 2xCH}_3\), 3.69 (s, 3H, OCH\(_3\)), 5.63 (s, 2H, CH), 5.81 (s, 1H, CH), 6.71 (d, \(J=8.5\) Hz, 2H, ArH), 6.89 (d, \(J=8.5\) Hz, 2H, ArH); Anal. Calcd. C\(_{20}\)H\(_{18}\)O\(_7\): C, 64.86; H, 4.90. Found: C, 64.78; H, 4.98.

2,2'-(4-Chlorophenyl)methylene)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone) \(4r^5\)

White solid, m. p. 140-142°C; \(^1\)H NMR (500MHz, CDCl\(_3\)): \(\delta = 1.08 \text{ (s, 6H, 2xCH}_3\), 1.20 (s, 6H, 2xCH\(_3\)), 2.27-2.46 (m, 8H, CH\(_2\)), 5.45 (s, 1H, CH), 6.99 (d, \(J=7.85\)Hz, 2H, ArH), 7.23 (d, \(J=8.65\)Hz, 2H, ArH), 11.86 (s, 1H, OH); Anal. Calcd. C\(_{23}\)H\(_{27}\)ClO\(_4\): C, 68.56; H, 6.75. Found: C, 68.42; H, 6.87.

2,2'-(4-Nitrophenyl)methylene)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone): \(4s^6\)
Yellow solid, m. p. 188-189°C; $^1$H NMR (500 MHz, CDCl$_3$): $\delta$= 1.10 (s, 6H, 2xCH$_3$), 1.22 (s, 6H, 2xCH$_3$), 2.27-2.49 (m, 8H, 4xCH$_2$), 5.53 (s, 1H, CH), 7.22 (t, $J$= 8.55Hz, 2H, ArH), 8.11 (d, $J$ = 8.85 Hz, 2H, ArH ), 11.79 (br s, 2H, OH); Anal. Calcd. C$_{23}$H$_{27}$NO$_6$: C, 66.81; H, 6.58. Found: C, 66.72; H, 6.64.

2,2'-(4-Methoxyphenyl)methylene)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone) 4t$^6$:

White solid, m. p. 140-142°C; $^1$H NMR (500 MHz, CDCl$_3$): $\delta$= 1.09 (s, 6H, 2xCH$_3$), 1.22 (s, 6H, 2xCH$_3$), 2.51-2.28 (m, 8H, 4xCH$_2$), 3.76 (s, 3H, OCH$_3$), 5.49 (s, 1H, CH), 6.80 (d, $J$ = 8.7 Hz, 2H, ArH), 6.99 (d, $J$ = 8.3 Hz, 2H, ArH), 11.94 (s, 2H, OH); Anal. Calcd. C$_{24}$H$_{30}$O$_5$: C, 72.34; H, 7.59. Found: C, 72.22; H, 7.67.

2,2'-(Thiophen-2-ylmethylene)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone)4u:
White solid, m. p. 112-114°C. \(^1\)H NMR (500 MHz, CDCl\(_3\)): \(\delta\) = 1.09 (s, 6H, 2xCH\(_3\)), 1.20 (s, 6H, 2xCH\(_3\)), 2.25-2.39 (m, 8H, CH\(_2\)), 5.61 (s, 1H, CH), 6.62 (d, 1H, \(J = 3.2\)Hz, ArH), 6.85 (t, 1H, \(J = 5.0\)Hz, ArH), 7.11 (d, 1H, \(J = 5.2\)Hz, ArH), 12.31 (s, 2H, OH). Anal. Calcd. C\(_{21}\)H\(_{26}\)O\(_4\)S: C, 67.35; H, 7.00. Found: C, 67.20; H, 7.19.

**2,2'-(Butane-1,1-diyl)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone) 4v:**

White solid, m. p. 99-102 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)): \(\delta\) = 0.84-1.05 (t, 3H, CH\(_3\)), 1.06 (s, 6H, 2xCH\(_3\)), 1.09 (s, 6H, 2xCH\(_3\)), 1.17-1.20 (m, 2H, CH\(_2\)), 1.95-1.99 (m, 2H, CH\(_2\)), 2.25-2.27 (m, 8H, 4xCH\(_2\)), 3.90-3.94 (m, 1H, CH), 12.48 (s, 1H, OH). Anal. Calcd. C\(_{20}\)H\(_{30}\)O\(_4\): C, 71.82; H, 9.04. Found: C, 71.69; H, 9.20.

**2,2'-(4-Hydroxyphenyl)methylene)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone): 4w**
White solid, m. p. 194-196˚C; \(^1\)H NMR (500 MHz, CDCl\(_3\)): \(\delta = 0.98\) (s, 6H, 2xCH\(_3\)), 1.08 (s, 6H, 2xCH\(_3\)), 2.15-2.28 (m, 4H, 2xCH\(_2\)), 2.45 (s, 4H, 2xCH\(_2\)), 4.65 (s, 1H, CH), 6.54 (d, \(J = 8.55\)Hz, 2H, ArH), 7.07 (d, \(J = 8.6\) Hz, 2H, ArH). Anal. Calcd. C\(_{23}\)H\(_{28}\)O\(_5\): C, 71.85; H, 7.34. Found: C, 71.70; H, 7.51.

2,2'-(2-Hydroxyphenyl)methylene)bis(3-hydroxy-5,5-dimethylcyclohex-2-enone): 4x

![Diagram](image)

White solid, m. p. 120-133˚C; \(^1\)H NMR (500 MHz, CDCl\(_3\)): \(\delta = 0.97\) (s, 6H, 2xCH\(_3\)), 1.01 (s, 3H, CH\(_3\)), 1.11 (s, 3H, CH\(_3\)), 1.90-1.99 (m, 2H, CH\(_2\)), 2.28-2.60 (m, 6H, 3xCH\(_2\)), 4.65 (s,1H, CH), 6.97-7.03 (m, 3H, ArH), 7.12-7.16 (m, 1H, ArH), 10.47(s, 1H, OH).Anal. Calcd. C\(_{23}\)H\(_{28}\)O\(_5\): C, 71.85; H, 7.34. Found: C, 71.72; H, 7.48.

2,2'-(4-Bromophenyl)methylene)bis(3-hydroxycyclohex-2-enone): 4y

White solid; m. p. 226-228˚C; \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta = 1.96-2.07\) (m, 4H, CH\(_2\)), 2.33-2.50 (m, 4H, CH\(_2\)), 2.52-2.69 (m, 4H, CH\(_2\)), 5.39 (s, 1H, CH), 6.98 (d, 2H, \(J = 8.0\) Hz, ArH ), 7.38 (t, 2H, \(J=7.8\) Hz, ArH ), 12.32 (br s, 2H, OH); Anal. Calcd. C\(_{19}\)H\(_{19}\)BrO\(_4\): C, 58.33; H, 4.89. Found: C, 58.23; H, 4.95.
2,2'-(3-Nitrophenyl)methylene)bis(3-hydroxycyclohex-2-enone): 4z

Sand yellow solid, m. p. 205-207°C; $^1$H NMR (500 MHz, CDCl$_3$): $\delta$ = 2.04-2.12 (m, 4H, CH$_2$), 2.35-2.55 (m, 4H, CH$_2$), 2.58-2.73 (m, 4H, CH$_2$), 5.49 (s, 1H, CH), 7.41-7.47 (m, 2H, ArH), 7.97 (s, 1H, ArH), 8.05 (d, $J$ = 8.0 Hz, 1H, ArH), 12.31 (br s, 2H, OH); Anal. Calcd. C$_{15}$H$_{19}$NO$_6$: C, 63.86; H, 5.36; N, 3.92. Found: C, 63.72; H, 5.39; N, 3.97.

2,2'-(4-Methoxyphenyl)methylene)bis(3-hydroxycyclohex-2-enone): 4a

Light yellow solid, m. p. 192-194°C; $^1$H NMR (500 MHz, CDCl$_3$): $\delta$ = 1.93-2.68 (m, 4H, 2xCH$_2$), 2.32-2.51 (m, 4H, 2xCH$_2$), 2.52-2.69 (m, 4H, 2xCH$_2$), 3.78 (s, 3H, OCH$_3$), 5.43 (s, 1H, CH), 6.81 (d, $J$ = 8.8 Hz, 2H, ArH), 7.01 (t, $J$=8.4Hz, 2H, ArH), 12.36 (br s, 2H, OH); Anal. Calcd. C$_{20}$H$_{22}$O$_5$: C, 70.16; H, 6.48. Found: C, 70.02; H, 6.59
Fig 1. $^1$H NMR of [Bmim]Sac

Fig 2. $^{13}$C NMR of [Bmim]Sac
Fig 3. $^1$H NMR of [Bmim]Sac recovered after 3$^{\text{th}}$ cycle

Fig 4. $^1$H NMR of [Bmim]Sac recovered after 5$^{\text{th}}$ cycle
Fig. 5. IR of [Bmim]Sac
Fig 6. IR of [Bmim]Sac recovered after 5th cycle
Figure 7. $^1$H NMR of 4a in CDCl$_3$

Figure 8. $^1$H NMR of 4b 8 in CDCl$_3$
Figure 9. $^1$H NMR of $4c$ in CDCl$_3$

Figure 10. $^1$H NMR of $4d$ in CDCl$_3$
Figure 11. $^1$H NMR of $4e$ in CDCl$_3$

Figure 12. $^1$H NMR of $4f$ in CDCl$_3$
Figure 13. $^1$H NMR of 4g in CDCl$_3$

Figure 14. $^1$H NMR of 4i in CDCl$_3$
Figure 15. $^1$H NMR of 4j in CDCl$_3$.

Figure 16. $^1$H NMR of 4k in DMSO-d$_6$. 
Figure 17. $^1$H NMR of 4m in DMSO$_d_6$

Figure 18. $^1$H NMR of 4n in DMSO-$d_6$
Figure 19. $^1$H NMR of 4o in CDCl$_3$

Figure 20. $^1$H NMR of 4p in CDCl$_3$
Figure 21. $^1$H NMR of 4r in CDCl$_3$

Figure 22. $^1$H NMR of 4s in CDCl$_3$
Figure 23. $^1$H NMR of 4u in CDCl$_3$

Figure 24 $^1$H NMR of 4v in CDCl$_3$
**Figure 25.** $^1$H NMR of 4w in CDCl$_3$  

**Figure 26.** $^1$H NMR of 4x in CDCl$_3$
References: