Supplementary Material (ESI) for Green Chemistry

Ionic liquids containing media for isolated BVMO-catalysed oxidations

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Supporting Information

Contents

1. Experimental data.

1.1. Effect of different ILs in PAMO activity

The enzymatic activity was determined spectrophotometrically by monitoring NADPH consumption at 340 nm (ε_{340} = 6.22 mM^{-1} cm^{-1}) using as the assay media Tris/HCl 50 mM pH 8.0 (pH 9.0 for [thma]$MeSO_4$) buffer / ionic liquid mixtures (1.0 mL), containing 1.0 mM phenylacetone **1a** (1% DMSO), 0.1 mM NADPH and 0.05 μM PAMO.

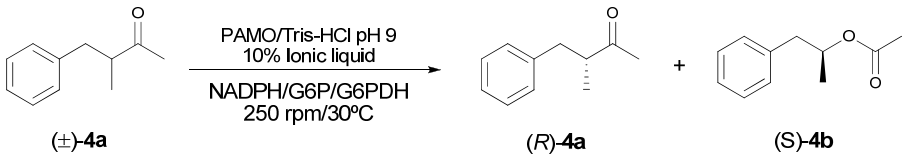
Table S1. Effect of ionic liquids in PAMO initial activity with **1a** as substrate.

Entry	Ionic Liquid	% IL	k_{obs} (s^{-1})	Rel. activity (%)
1	None	--	2.17	100
2	[thma]$MeSO_4$	10	0.92	42
3	[thma]$MeSO_4$	30	0.36	17
4	[tbma]$MeSO_4$	10	0.87	40
5	[tbma]$MeSO_4$	30	0.28	13
6	[bdmim]OTf	10	0.78	36
7	[bdmim]OTf	30	0.24	11
8	Ammoeng^{TM} 100	10	1.01	46
9	Ammoeng^{TM} 102	10	1.21	56
10	Ammoeng^{TM} 102	30	0.97	45

1.2. Effect of ILs in the enantioselectivity of PAMO.

In order to investigate the effect of the IL-containing media in the enantioselectivity of PAMO, the oxidations of (±)-3-methyl-4-phenylbutan-2-one [(±)-**4a**] (Table S1) and benzylketones aryl-substituted [(±)-**5a-7a**] (Table S2) were studied. Conversions and enantiomeric excesses of (*R*)-ketones and (*S*)-esters were determined by GC analysis.

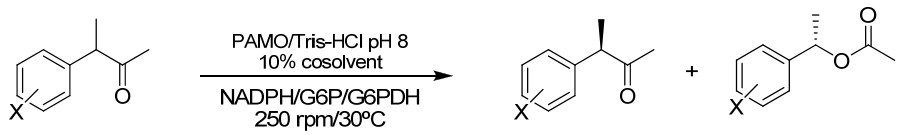
Table S2. Oxidation of (±)-**4a** catalysed by PAMO in presence of 10% (v v^{-1}) ILs.



Ionic liquid	t (h)	*ee* (*R*)-**4a** (%)[a]	*ee* (*S*)-**4b** (%)[a]	*c* (%)[b]	*E*[b]
None	3.5	99	79	56	42
[bmp]PF_6	6	76	88	46	36
[bmim]PF_6	6	17	95	14	48
[hmim] PF_6	6	11	96	10	48
[bmim]BF_4	6	10	94	10	35
[bmp]BF_4	6	n.d.	n.d.	≤3	n.d.
[bdmim]OTf	6	16	96	14	52
[tbma]$MeSO_4$	3.5	82	88	48	38
[thma]$MeSO_4$	3.5	99	71	58	38
[tbmp]$MeSO_4$	3.5	60	90	40	35
[bmim]$MeSO_4$	3.5	49	98	33	129
[bmim]$MeSO_4$	6	60	97	38	121
Ammoeng™ 100	6	16	98	14	105
Ammoeng ™ 101	6	55	97	36	96
Ammoeng ™ 102	6	31	98	24	111

n.d. not determined. [a] Measured by GC. [b] Conversion, $c=ee_s/(ee_s+ee_p)$. [c] Enantiomeric ratio, $E=\ln[ee_p(1-ee_s)/(ee_s+ee_p)]/\ln[ee_p(1+ee_s)/(ee_s+ee_p)]$.

Table S3. Oxidation of (±)-**5a-7a** catalysed by PAMO in presence of 10% (v v^{-1}) cosolvent.[a]



(±)-**5a:** X=*p*-Br
(±)-**6a:** X=*p*-Cl
(±)-**7a:** X=*m*-CF_3

(*R*)-**5a:** X=*p*-Br
(*R*)-**6a:** X=*p*-Cl
(*R*)-**7a:** X=*m*-CF_3

(*S*)-**5b:** X=*p*-Br
(*S*)-**6b:** X=*p*-Cl
(*S*)-**7b:** X=*m*-CF_3

Substrate	Cosolvent	t (h)	*ee* (*R*)-ketone (%)[b]	*ee* (*S*)-ester (%)[b]	*c* (%)	*E*
(±)-**5a**	None	1	17	48	26	3
(±)-**5a**	MeOH	1	22	73	23	8
(±)-**5a**	Ammoeng™ 102	6	96	79	55	34
(±)-**6a**	None	1	39	82	32	15
(±)-**6a**	MeOH	1	31	88	26	21
(±)-**6a**	Ammoeng ™ 102	1	46	97	32	107
(±)-**7a**	None	1	47	43	52	4
(±)-**7a**	MeOH	1	42	52	45	5
(±)-**7a**	Ammoeng ™ 102	1	94	94	50	111

[a] Reactions without the cosolvent were carried out at pH 8.0 and 20ºC. [b] Measured by GC.

1.3. PAMO-biocatalysed oxidation in 10% Ammoeng™ 102 at increasing concentrations of (±)-3-(m-trifluoromethylphenyl)-butan-2-one.

Increasing concentrations of racemic ketone (±)-**7a** (10-240 mM) were dissolved in 50 mM Tris/HCl pH 8.0 in the presence of 10% (v v^{-1}) Ammoeng™ 102 (1.0 mL), containing glucose-6-phosphate, glucose-6-phosphate dehydrogenase, NADPH and PAMO. In order to compare the activity of the enzyme, the reaction rate (expressed as mmol of ketone per L of solution h^{-1}) was defined (Table S3).

Table S4. Oxidation of (±)-**7a** catalysed by PAMO in presence 10% (v/v) of Ammoeng™ 102.

(±)-**7a** (mM)	t (h)	*ee* (*R*)-ketone (%)[a]	*ee* (*S*)-ester (%)[a]	*c* (%)[a]	*E*	v (mmol L^{-1} h^{-1})
10	1	94	94	50	111	5.00
20	1.5	96	94	51	127	6.80
40	2	44	96	31	77	6.20
80	4	48	96	33	63	6.60
120	4	40	94	30	51	9.00
200	4	14	94	13	38	6.50
240	4	n.d.	n.d.	10	n.d.	6.00

n.d. not determined. [a] Measured by GC.

2. Chromatographic data

GC analyses were performed on a Hewlett Packard 6890 Series II chromatograph equipped with the following columns: Restek RtβDEXse (30 m x 0.25 mm x 0.25 μm, 1.0 bar N_2) for chiral determinations or a HP-1 cross-linked methyl siloxane (30 m x 0.32 mm x 0.25 μm, 1.0 bar N_2) for measuring the conversion values (Table S4). For all the analyses, the injector temperature is 225ºC and the FID temperature is 250ºC.

Table S4. Determination of conversion and *ee* values by GC.

Compound	Program[a]	Column[b]	Retention times (min)
1a	70/7/10/90/0	A	6.0
1b	70/7/10/90/0	A	7.7
2a	140/0/2/200/0	B	14.0
2b	140/0/2/200/0	B	11.6 (*R*); 12.7 (*S*)
3	140/0/2/200/0	B	3.7
4a	90/30/5/120/10	B	46.9 (*R*); 48.5 (*S*)
4b	90/30/5/120/10	B	42.7 (*S*); 45.8 (*R*)
5a	100/5/1/150/5	B	56.6 (*R*); 58.2 (*S*)
5b	100/5/1/150/5	B	54.1 (*S*); 57.6 (*R*)
6a	110/10/1/140/0	B	37.4 (*R*); 39.0 (*S*)
6b	110/10/1/140/0	B	34.6 (*S*); 38.5 (*R*)
7a	100/20/2/150/0	B	21.7 (*R*); 23.7 (*S*)
7b	100/20/2/150/0	B	18.3 (*S*); 22.8 (*R*)

[a] Program: initial T (ºC)/ time (min)/ slope (ºC/min)/ T (ºC)/ time (min). [b] Column: A=> HP-1; B=> Restek RtβDEXse.