LOW TOXICITY IONIC LIQUIDS PREPARED FROM BIOMATERIALS

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Keywords: Biomaterials, Choline, Amino acids, Artemia salina, Toxicity.

Introduction: It is known that ionic liquids (ILs) have been object of intense investigation towards uncountable applications, for example, as catalysts and thermal fluids. The ILs were initially considered benign, however, they have been subjected to toxicity studies at several biologic levels to evaluate the risks of their environmental impact resulting from their applications in production process [1]. In fact, it was already been shown that there are ILs, such as some imidazole-based ILs, to be more toxic than certain volatile organic compounds used in chemical industry like methanol and dichloromethane [2]. Therefore, in sense for more responsibility and sustainability in respect to the environment and the society, Green Chemistry appeals for development of "green" environmental products and process (including human beings) and, at the same time, economically feasible. There are already ILs synthesized containing cations or anions derived from biomaterials such as amino acids (AAs) and so it is expected they would be less toxic and more biodegradable in comparison with others ILs not derived from biosources [3]. Recognizing the possibility of the ILs to be sustainable products, it is of major importance to understand, in terms of toxicity, the individual effects of different substructures that compose the ILs aiming to decreasing their potential risks. Generally, three substructures are considered in the evaluation of their toxicity: 1) a positive portion designated by head-group, 2) the substituents present in that head-group and 3) the type of anion [3]. In this study we tested the ecotoxicity of some ILs (Figure 1) in the crustacean *Artemia salina*, which is an invertebrate organism existing in marine ecosystems and is widely employed in laboratory bioassays for toxicological applications [4]. Median lethal concentration (LC_{50}) was determined using probit method and data is discussed.

Experimental: Ionic liquids (1-butylpyridinium bromide [Bpy][Br], 1-hexylpyridinium bromide [Hpy][Br], 1-butyl-3-methylimidazolium bromide [Bmim][Br], 1-hexyl-3-methylimidazolium bromide [Hmim][Br] and (2-hydroxyethyl)trimethylammonium DL-3-aminopropanoate [Cho][Ala]) were prepared according to the procedures described in literature [5, 6]. The following yields were obtained: [Bpy][Br] 94%; [Hpy][Br] 95%; [Bmim][Br] 62%; [Hmim][Br] 67%; [Cho][Ala] 78%.

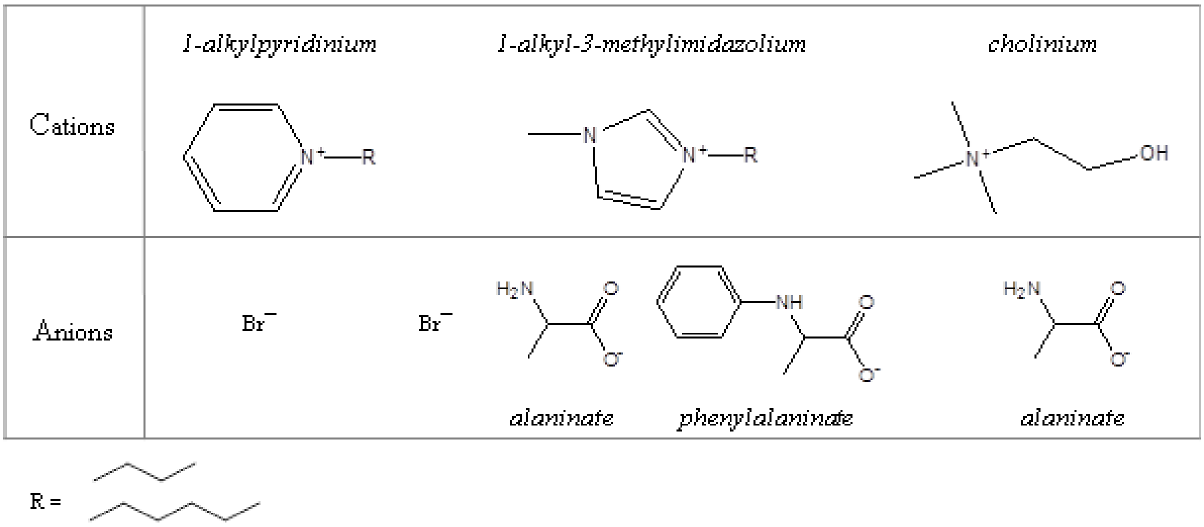

Figure 1: Structure of ILs synthesized.

Ionic liquids (1-butyl-3-methylimidazolium DL-3-aminopropanoate [Bmim][Ala] and 1-butyl-3-methylimidazolium DL-2-amino-3-phenylpropanoate [Bmim][Phe]) were prepared according to the procedures described in literature [5] with a slight modification. Briefly, the intermediate [Bmim][OH] was prepared reacting [Bmim][Br] (20,70 mmol) with KOH (21,85 mmol) in methanol (30 mL). The reaction occurred in water bath at 60 °C during 12 h. Water (120 mL) was added to the mixture and then methanol was evaporated. It was added the amino acid (20,68 mmol) aqueous solution (20 mL) to the [Bmim][OH] solution, and the mixture was stirred vigorously for 12 h at room temperature. The product was dried in vacuum for one day and then characterized by FTIR and ^{1}H NMR spectroscopy techniques. The following yields were obtained: [Bmim][Ala] 75%; [Bmim][Phe] 73%. All ILs were characterized by FTIR, ^{1}H NMR and ^{13}C NMR. Purity of the ILs prepared was checked by ^{1}H NMR. For ILs already described ([Bpy][Br], [Hpy][Br], [Bmim][Br], [Hmim][Br], [Bmim][Ala], [Bmim][Phe] and [Cho][Ala]) spectroscopic data agreed with literature and the full data will be presented in the communication. Evaluation of toxicity of ILs against *Artemia salina* (Table 1) followed the procedure describe by Parra and al [4].

Results and discussion: The [Bmim][AA] were obtained with good purity level, good yield and they are pale yellow viscous liquids.

Ecotoxicity was evaluated against *Artemia salina* since this organism is very sensitive to many chemicals [4]. This microcrustacean exists in salty waters namely in lagoons, deltas and estuaries and is a good model to evaluate the impact of an accidental release or disposal of this kind of compounds by an industrial plant, since this organism was already used for ecotoxicological analysis of leachate water from landfills and of industry effluents [7]. This organism had been also used to test toxicity of widely used organic solvents like DMSO or acetonitrile [8]. Data from Table 1 shows that, for the same anion bromide, toxicity increases slightly with the increasing length of substituent (butyl to hexyl) present in both the head-groups pyridinium (entries 1 and 2) and imidazolium (entries 3 and 4). Even more remarkable is the fact that changing both the cation and the anion to build an ionic liquid composed of ions derived only by biomaterials (choline and amino acids), that is, an ionic liquid [Cho][AA], the toxicity can be one hundred times less (LC_{50} is one hundred times bigger, entry 7) in respect to the others.

Table 1. Median lethal concentrations of different ionic liquids to *Artemia salina*.

Entry	ILs	LC_{50} (μM) ± SD
1	[Bpy][Br]	117,4 ± 5,5
2	[Hpy][Br]	86,5 ± 0,6
3	[Bmim][Br]	92,2 ± 5,3
4	[Hmim][Br]	79,2 ± 2,6
5	[Bmim][Ala]	113,9 ± 8,6
6	[Bmim][Phe]	94,2 ± 6,0
7	[Cho][Ala]	9001,7 ± 319,3
8	AAs (10 x 10^5 μM)	≤ 7 %
9	$K_2Cr_2O_7$ (85 μM)	100 %

Conclusions: Toxicity of hydrophilic ILs can be easily assed using the brine shrimp (*Artemia salina*) assay. Regarding experimental data obtained, toxicity depends on both cation and anion. However, an exchange in the cation from methylimidazolium to cholinium strongly lowers the toxicity against *A. salina*.

The Bio-ILs here described is a new promising class of materials with low toxicity.

Acknowledgments: Funding for this project, PEst-OE/QUI/UI0612/2011, was supported by FCT (Fundação para a Ciência e Tecnologia).

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