ISGC 2022

N°576 / OC
TOPIC(s) : Biomass conversion / Alternative solvents

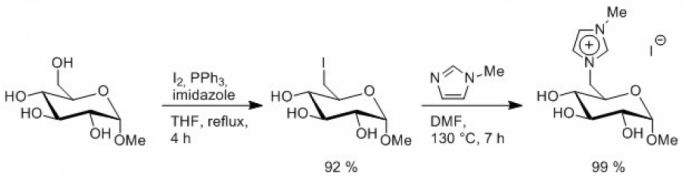
One For All - On the versatility of Glucosylimidazolium Ionic Liquids

AUTHORS
Stefan JOPP / UNIVERSITY OF ROSTOCK, ALBERT-EINSTEIN-STR. 25, ROSTOCK

PURPOSE OF THE ABSTRACT

Ionic Liquids are a widely known class of molecules, defined as salts with melting points under 100 °C. They are often composed of organic cations based on imidazole, pyridine or amines in combination with halides or fluorine-containing anions like triflate or bistriflylimide.
Mostly attributed to their outstandingly low vapor-pressure, ionic liquids (ILs) have often been depicted as Green Solvents.
Contrary to this, it has been investigated by now that many commonly available ionic liquids are harmful and eco-toxic substances, which fundamentally contradicts the principles of green chemistry.
On the other hand, carbohydrate based ionic liquids (CHILs), a new and uprising subclass of ILs, have been proven to exhibit an elevated biocompatibility. Besides this potential as greener ionic liquids, several working groups have already proven many potential applications for CHILs, including asymmetric catalysis, biocatalysis and metal-cation removal from aqueous solutions among others.
However, the benefits of carbohydrate based ionic liquids do not come without a cost. The synthesis of CHILs usually needs several additional synthetic steps of protecting group chemistry to enable the transformation of a basic mono-saccharide into an ionic liquid bearing a carbohydrate moiety. Current examples in the literature vary between 3- and 7-step syntheses and usually have low overall yields in the region of 50 % and less.
With this knowledge in mind, our working group has recently focused on the synthesis of CHILs based on a glucosylimidazolium core. This core structure is efficiently synthesizable in a 2-step procedure with over 90 % overall yield. In the first step, commercially available methyl-alpha-D-glucopyranoside is iodinated in 6-position, which is then quarternized with an imidazole in the second step. This synthetic strategy offers a lot of versatility, since e.g. the choice of the imidazole or other heterocycles or the additional protection of the free OH-groups allows to vary the properties of the final CHIL product.
Currently, several projects are running to apply these versatile new CHILs in polymer science, biocatalysis and or as pre-cursor for N-heterocyclic carbenes (NHCs).

FIGURES



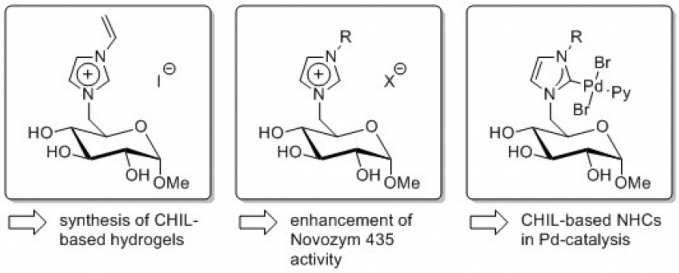


FIGURE 1

2-step synthesis of glucosylimidazolium-based ionic liquids

This figure shows the efficient 2-step synthesis of glucosylimidazolium-based ionic liquids with an overall yield over 90 %.

FIGURE 2

Different applications of glucosylimidazolium ionic liquids

This figure shows three projects (in polymer science, biocatalysis and as NHCs) currently running in our working group.

KEYWORDS

carbohydrates | glucose | ionic liquids | polymers

BIBLIOGRAPHY

[1] T. Welton, Biophys. Rev. 2018, 10, 691–706.
[2] A. Oskarsson, M. C. Wright, Environ. Sci. Technol. 2019, 10539–10541.
[3] A. Jordan, N. Gathergood, Chem. Soc. Rev. 2015, 22, 8200–8237.
[4] J. Flieger, M. Flieger, Int. J. Mol. Sci. 2020, 21, 6267.
[5] M. Reiß, A. Brietzke, T. Eickner, F. Stein, A. Villinger, C. Vogel, U. Kragl, S. Jopp, RSC Adv. 2020, 10, 14299–14304.
[6] K. Erfurt, I. Wandzik, K. Walczak, K. Matuszek, A. Chrobok, Green Chem. 2014, 16, 3508–3514.
[7] O. Nguyen Van Buu, A. Aupoix, N. D. T. Hong, G. Vo-Thanh, New J. Chem. 2009, 33, 2060–2072.
[8] A. Szelwicka, K. Erfurt, S. Jurczyk, S. Boncel, A. Chrobok, Materials 2021, 14, 3090.
[9] R. Devanathan, G. L. Balaji, R. Lakshmipathy, J. Environ. Public Health 2021, 6612500.
[10] S. Jopp, Eur. J. Org. Chem. 2020, 6418–6428.
[11] J. Schnegas, S. Jopp, Compounds 2021, 1, 154–163.