RUHR-UNIVERSITÄT BOCHUM

Synthesis of bio-based surfactants from cashew nut shell liquid in water

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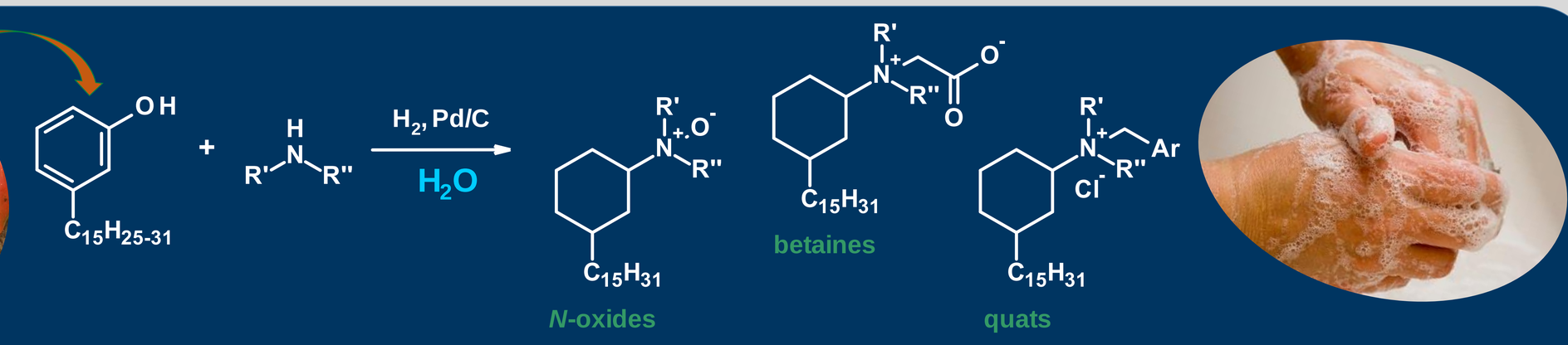
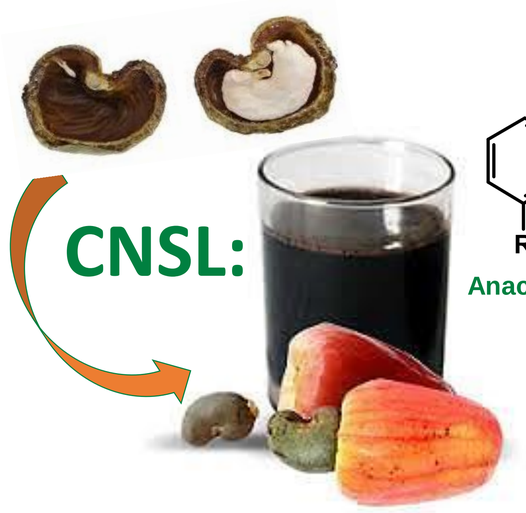
Abstract

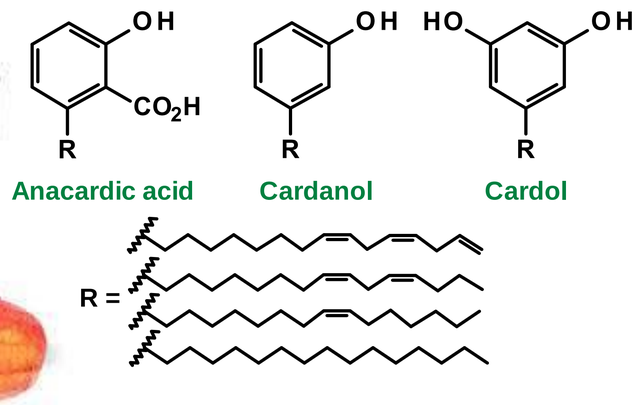


An eco-friendly and waste-minimised synthesis of amine-based surfactants was developed starting from cashew nut shell liquid (CNSL), an inedible renewable resource. The key step of the procedure is a reductive amination of CNSL with molecular hydrogen in water. The resulting cyclohexyl amines were successfully converted into *N*-oxide, betaine and quaternary ammonium tensides.

Cashew nut shell liquid (CNSL)

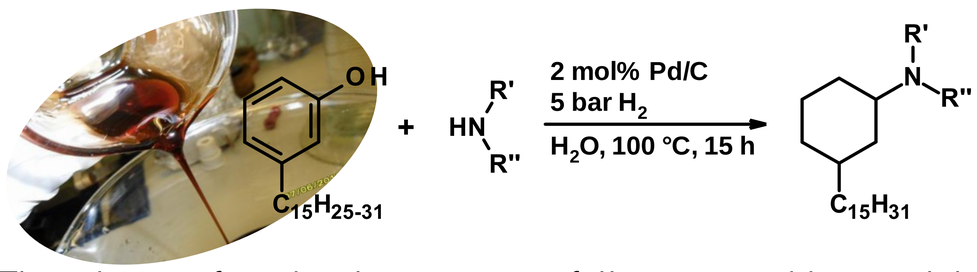
CNSL is an inedible waste product of the cashew nut processing, for which no competition occurs between land use for food production. It is a dark brown, viscous liquid consisting of a mixture of phenolic compounds.[1,2] Technical CNSL is rich in cardanol, whereas natural CNSL is rich in anacardic acid.



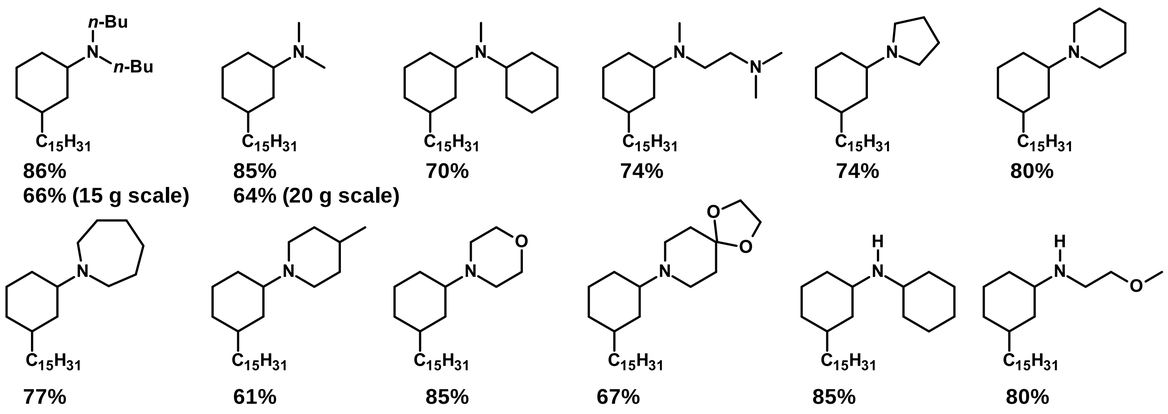


Starting from technical CNSL, a straightforward and atom-economic process was achieved with the synthesis of non-aromatic amine surfactants.[3]

Reductive amination of cardanol

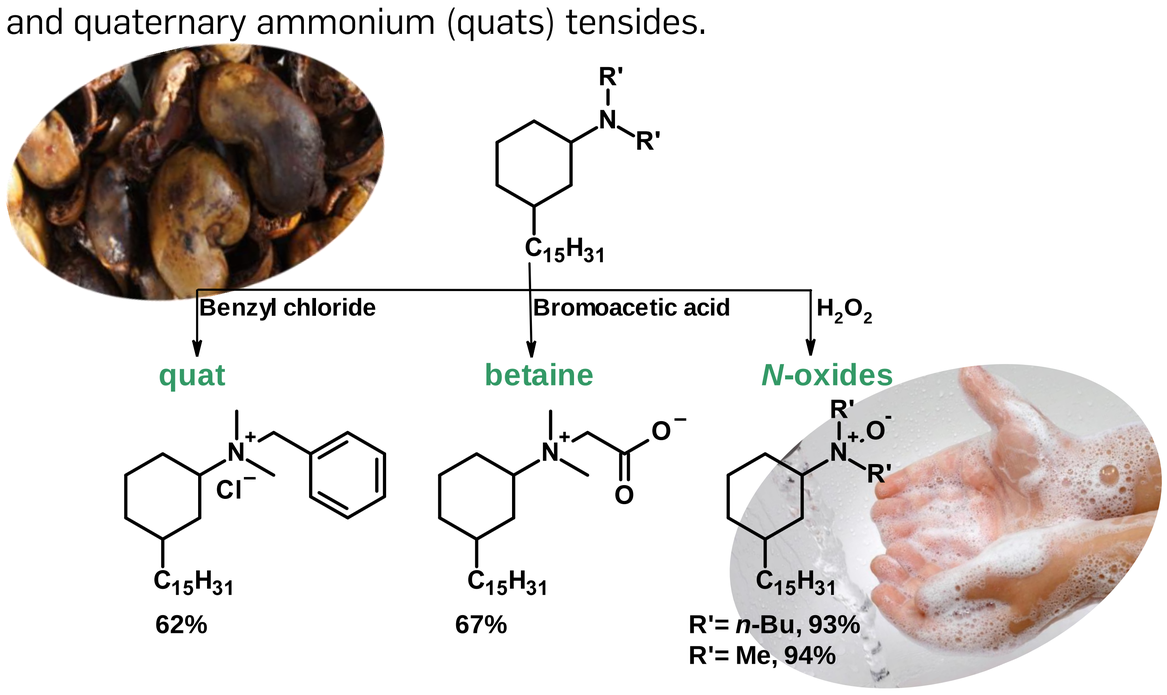


The mixture of cardanols was succesfully converted into cyclohexyl amine derivatives in water. On preparative scale, the amines could be isolated *via* simple acid-base extraction, thus avoiding the use of waste-intensive purification techniques.

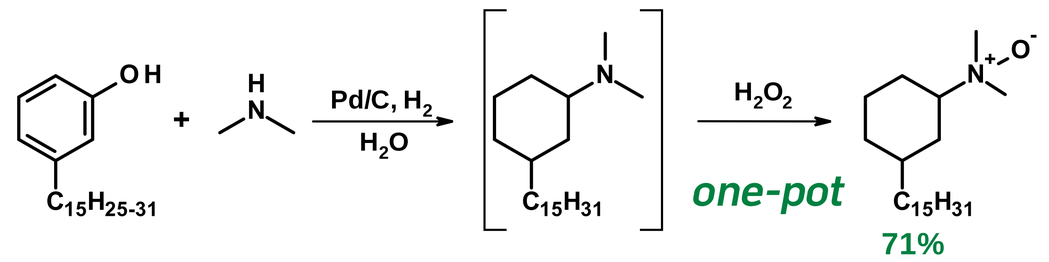


Synthesis of surfactants from cyclohexyl amines

Cyclohexyl amines were successfully converted into *N*-oxides, betaine and quaternary ammonium (quats) tensides.

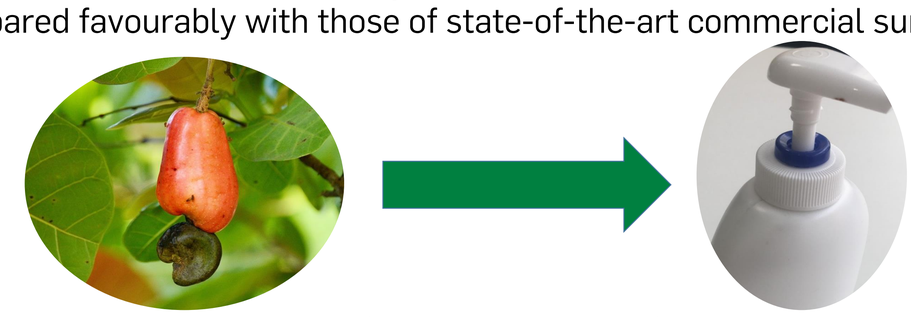


Furthermore, the synthesis of the *N*-oxide, was performed in one-pot with water as the sole solvent, resulting in a remarkably low E-factor of 2 (total kg of waste per kg product).



From waste to potential commercial applications

The surfactant properties (surface tension and critical micellar concentration, CMC) of the synthesised tensides were determined and compared favourably with those of state-of-the-art commercial surfactants.



CMC values of synthesised vs. commercial surfactants

N-oxide: 28 μM	Lauryldimethylamine oxide: 1.7 mM
Betaine: 10 μM	Lauryl betaine: 2.86 μM
Quat: 0,5 μM	Stearyldimethylbenzylammonium chloride 0.31 mM

References:

[1] A. Velmurugan, M. Loganathan, *World Acad. Sci. Eng. Technol*. **2011**, *5*, 738.
[2] V. S. Balachandran, S. R. Jadhav, P. K. Vemula, G. John, *Chem. Soc. Rev*. **2013**, *42*, 427.
R. Parama-shivappa, P. Phani Kumar, P. J. Vithayathil, A. Srinivasa Rao, *J. Agric. Food Chem*. **2001**, *49*, 2548.
[3] V. Bragoni, R. K. Rit, R. Kirchmann, A. S. Trita, L. J. Gooßen, *Green Chem*. **2018**, *20*, 3210.

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