Dissolution of biopolymers and extraction of bioactive compounds with biobased ionic liquids

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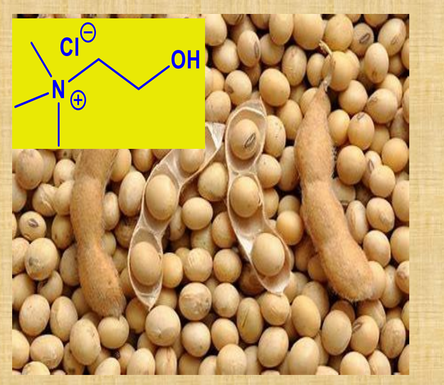
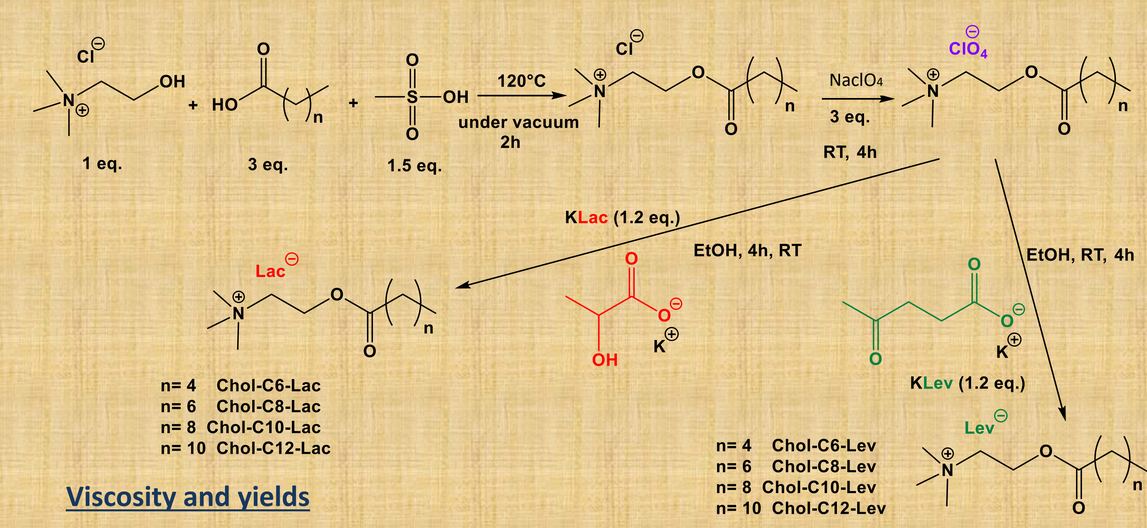
Introduction

In the current context linked to questions about sustainable development, manufacturers want to replace petrochemical raw materials with renewable resources. In this context, a new category of solvents has emerged as an alternative to traditional ones, the category of ionic liquids. If these ones are biosourced, they can be bio- and eco-compatible. In this work, we have developed biosourced ionic liquids based on the choline, which can be found in particular in soy. These low toxic solvents (eco- & cyto-toxicity collaboration with SEBIO UMR I-02 and MEDyC UMR CNRS 7369) have been used in the dissolution of biopolymers (cellulose or Kraft lignin) for their transformation or for the extraction of bioactive agents such as curcuminoids from curcuma longa. This dual application of these biosourced solvents could enable the development of sustainable chemistry as part of the bioeconomy in sectors such as materials and pharmaceuticals.

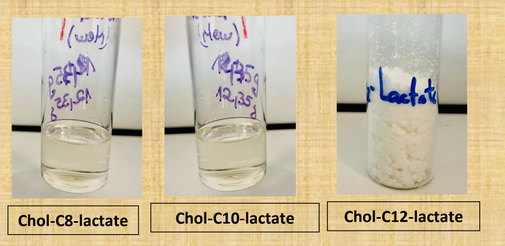


Synthesis of biobased Ionic Liquids (ILs) [1,2]



Viscosity and yields

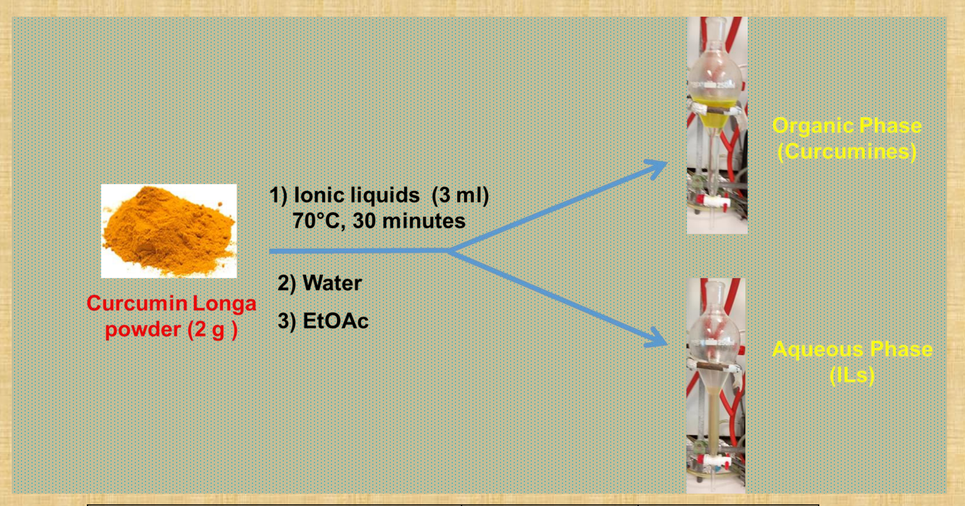
Ionic liquid	Aspect	Yield (%)	Viscosity (cP) at 60°c
Chol-C6-Lac	Colorless oil	60	19.8
Chol-C6-Lev	Colorless oil	70	28.4
Chol-C8-Lac	Colorless oil	79	49.3
Chol-C8-Lev	Light beige wax	76	67.8
Chol-C10-Lac	Slightly yellow wax	60	Nd
Chol-C10-Lev	Slightly yellow wax	71	Nd
Chol-C12-Lac	White wax	57	Nd
Chol-C12-Lev	White wax	59	Nd



Chol-C8-lactate | Chol-C10-lactate | Chol-C12-lactate

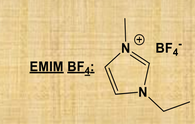
Better yield & high viscosity

Extraction of bioactive compounds

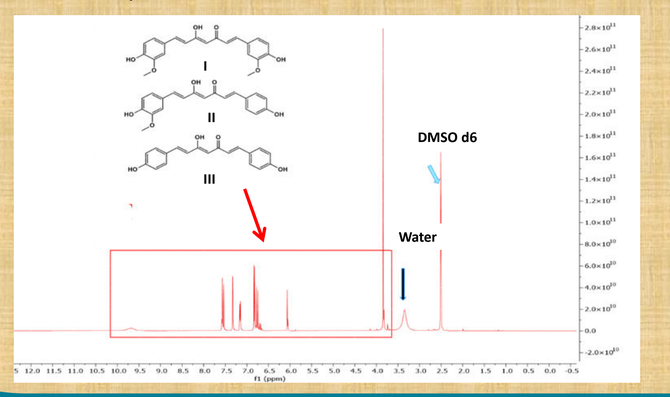


Extraction Solvent		Mass of curcuminoids extracted (mg)	CurcuminoidS extraction yield (%)
Biosourced ILs	Chol-C12-Lact	562.35	28.12
	Chol-C12-Lev	367.5	18.38
	Chol-C10-Lac	326.80	16.34
	Chol-C6-Lac	291.60	14.58
	Chol-C8-Lac	250.00	12.50
	Chol-C6-Lev	212.67	10.63
	Chol-C8-Lev	175.00	8.75
	Chol-C10-Lev	172.00	8.60
Comparative solvents	EMIM-BF_4 [3]	235.60	11.78
	2 methylpropanol (x2)	223.78	11.19
	Acétone (x2)	183.33	9.20

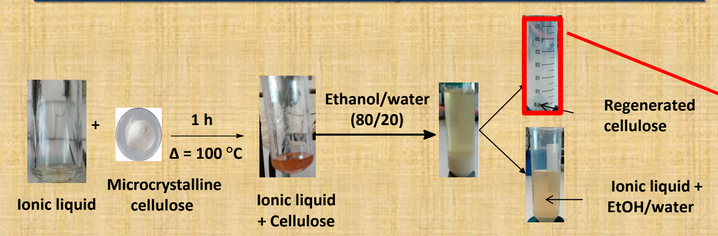
EMIM BF_4:

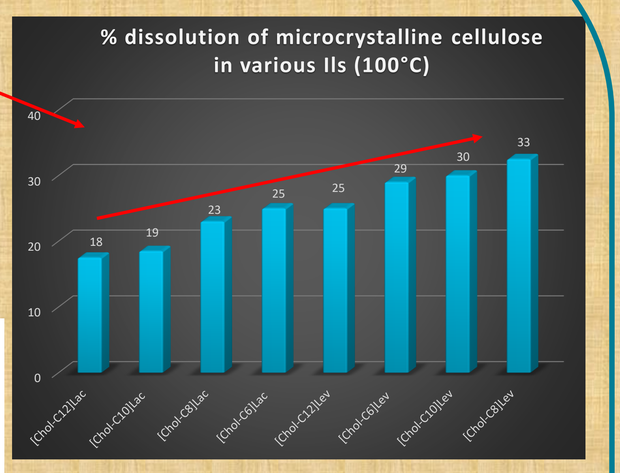


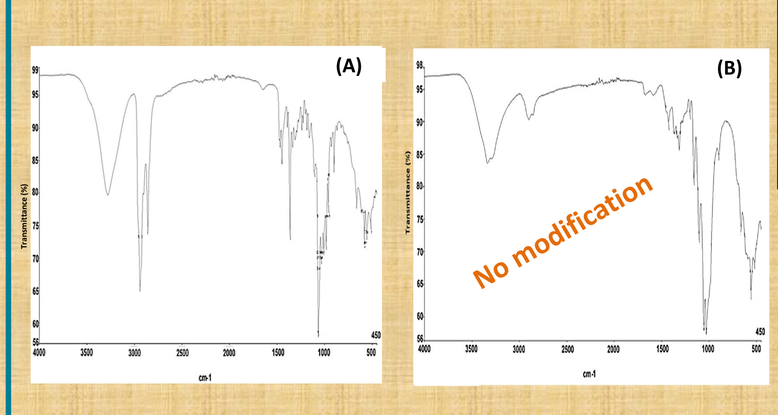
[1]H NMR spectrum of extracted curcuminoids



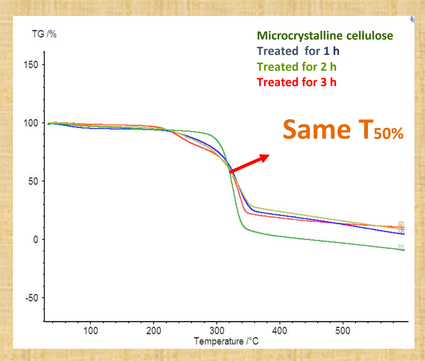
Dissolution of microcrystalline cellulose [4]



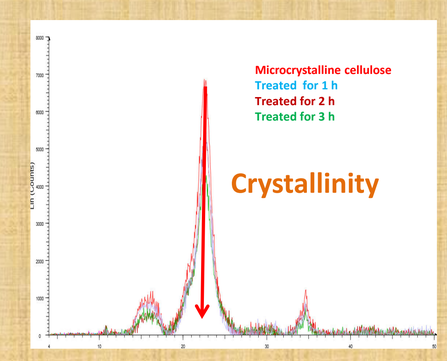




FT -IR spectrum of cellulose (A) and of polymer recovered after treatment with Chol - C12 - Lac for 3 hours (B)

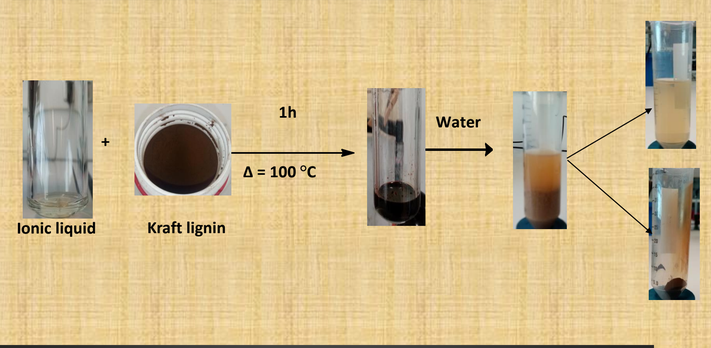


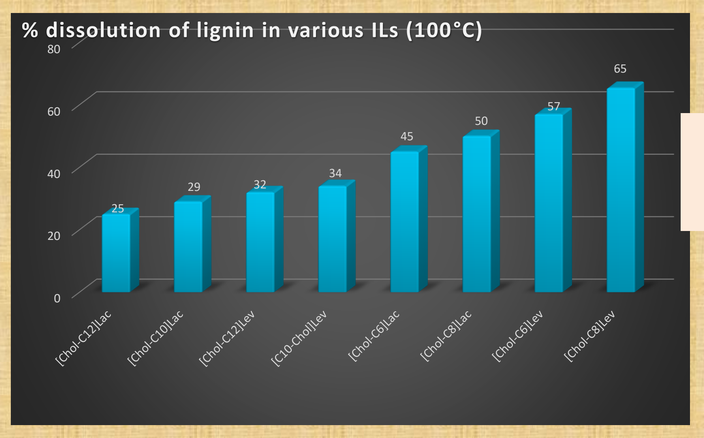
TGA of native of microcrystalline cellulose and recovered celulose



XRD of native microcrystalline cellulose and of recovered cellulose

Dissolution of the Kraft lignin [4]





Efficient dissolution of lignin up to 65% (mass)

Conclusion and perspectives

In this work, new choline-based ionic liquids were synthesized with high yields through a three-steps procedure.

These ionic liquids show a remarkable effect in biomass (cellulose and lignin) dissolution without releasing toxic substances into the environment; furthermore, they can also be used as solvent for extracting bioactive compounds. The study of their used will be extended to other (bio)polymers (for example of algae origin) or to the extraction of other natural extraction bioactive products.

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Acknowledgments

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