

Citrated crystal nanocellulose from post consumer cotton textile

A case study within Mistra SafeChem



Project funded by the European Union with the number 101060546. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union

FORMAS 

Funding received from Formas – a Swedish Research Council for Sustainable Development, project No 2021-00445

MISTRA SAFE CHEM 

Funding received from Mistra – the Swedish Foundation for Strategic Environmental Research, project No 2018/11



Background


A case study from Mistra Safechem program;
“Citrated cellulose nanocrystals (CNC) from post consumer cotton textiles”

Collaboration between Stockholms University and RISE

Publication:

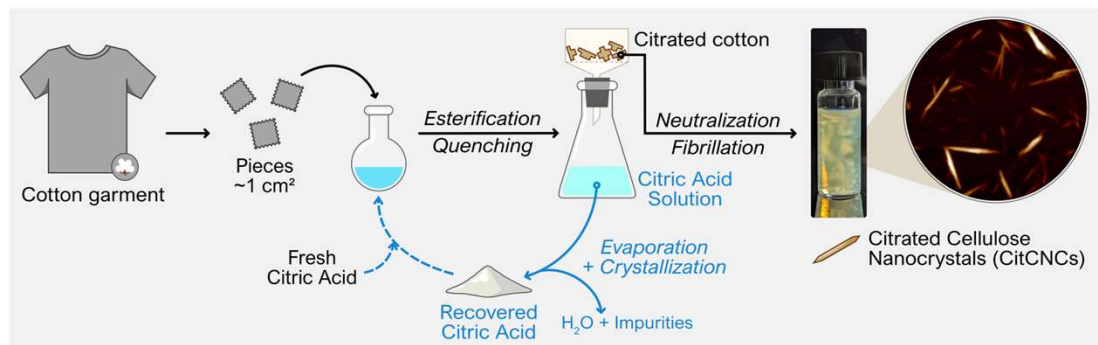
Citrated cellulose nanocrystals from post-consumer cotton textiles

M. X. Ruiz-Caldas, V. Apostolopoulou-Kalkavoura, A. K. Hellström, J. Hildenbrand, M. Larsson, A. Jaworski, et al.,
Journal of Materials Chemistry A 2023 Vol. 11 Issue 13 Pages 6854-6868, DOI: 10.1039/d2ta09456h




Motivation

- Novel route for extraction of cellulose nanocrystals (CNCs) from post-consumer cotton textiles by citric acid hydrolysis





Goal and Scope

- Evaluate the environmental sustainability, direct toxicity potential and identify hotspots of the novel route for cellulose nanocrystals preparation from post-consumer cotton by citric acid hydrolysis (CitCNC) (TRL 4)
 - Compare the novel route with CNC extracted from post-consumer cotton by sulfuric acid hydrolysis (SCNC) (TRL 4)
- 



Goal and Scope

Lab scale (early-stage), contemporary, attributional screening and mapping analysis of the CNC preparation based on the framework developed by Piccinno et al.

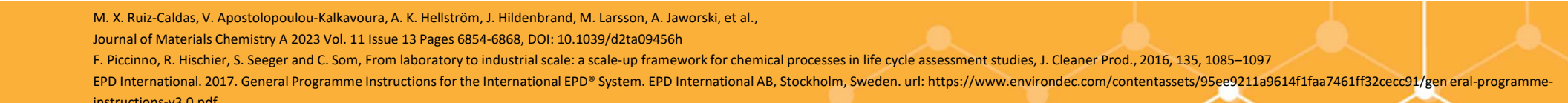
Functional unit: 1 gram CNC

Cut-off approach

M. X. Ruiz-Caldas, V. Apostolopoulou-Kalkavoura, A. K. Hellström, J. Hildenbrand, M. Larsson, A. Jaworski, et al., *Journal of Materials Chemistry A* 2023 Vol. 11 Issue 13 Pages 6854-6868, DOI: 10.1039/d2ta09456h

F. Piccinno, R. Hischer, S. Seeger and C. Som, From laboratory to industrial scale: a scale-up framework for chemical processes in life cycle assessment studies, *J. Cleaner Prod.*, 2016, 135, 1085–1097

EPD International. 2017. General Programme Instructions for the International EPD® System. EPD International AB, Stockholm, Sweden. url: <https://www.environdec.com/contentassets/95ee9211a9614f1faa7461ff32cecc91/general-programme-instructions-v3.0.pdf>



Key results

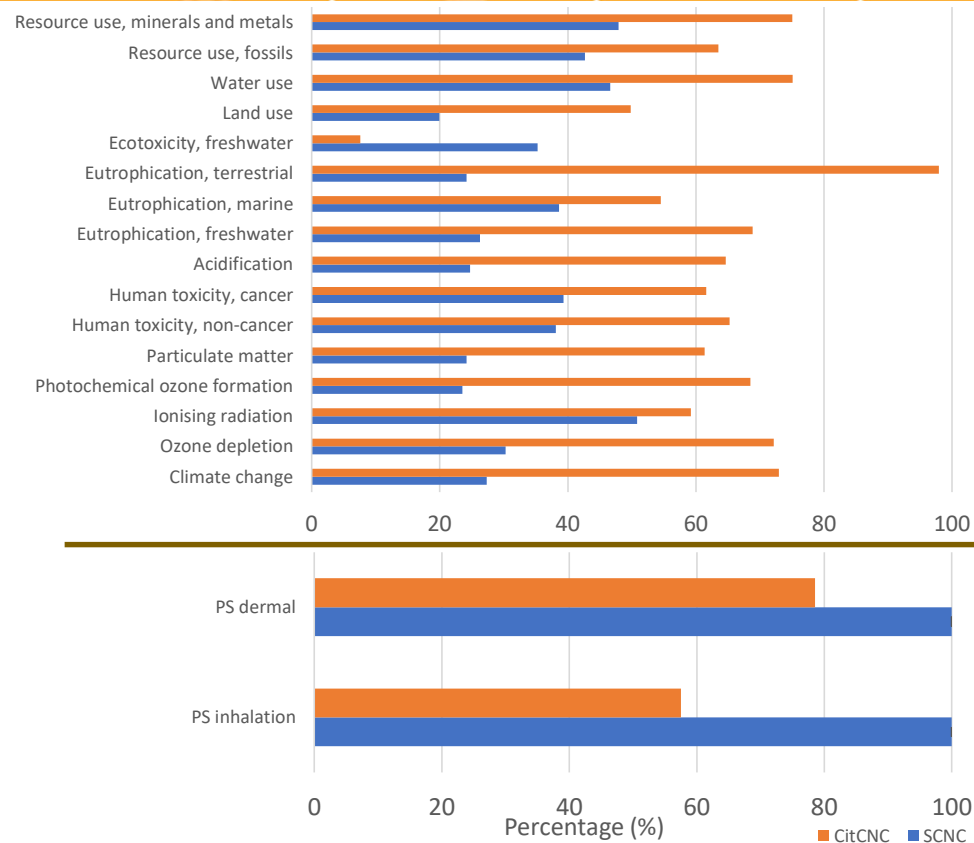
- Environmental impact was higher for CitCNC compared to SCNC in 15 impact categories (EF 3.0)
- Direct toxicity potential (PS) was slightly higher for SCNC than CitCNC

*PROC 15 – small scale laboratories

*Uncertainties – citric acid production

*Uncertainties – charging of the fungi *Aspergillus*

*Data gap CNC

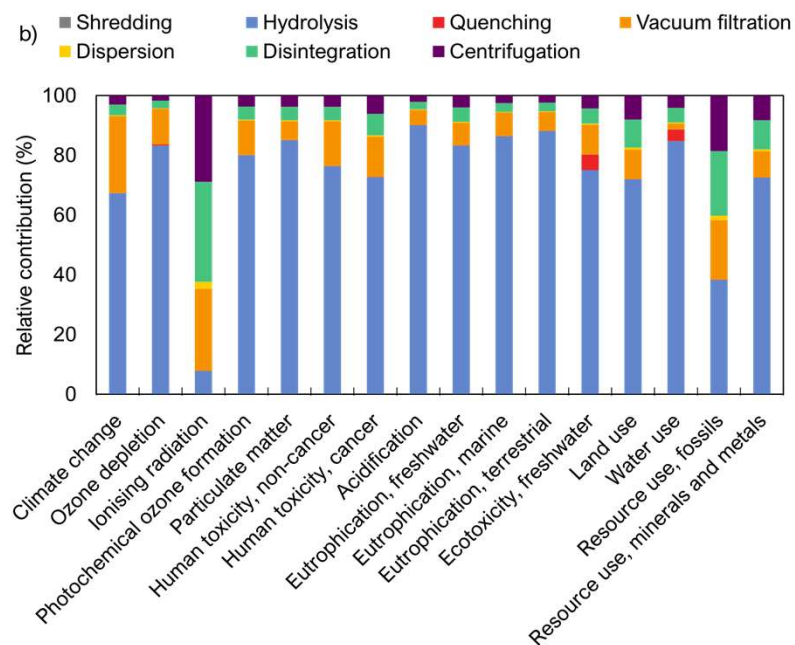


Key results

Contribution analysis

CNC prepared by citric acid hydrolysis

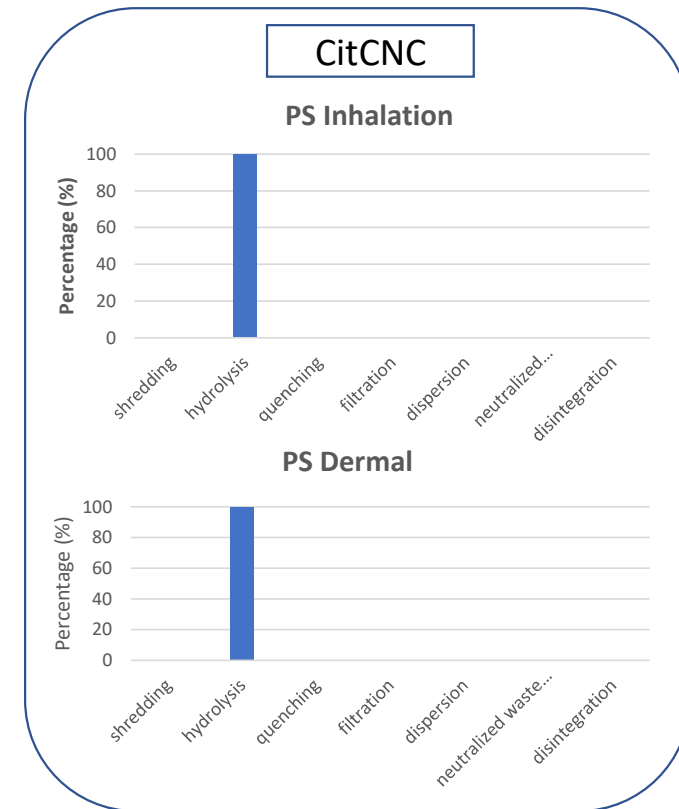
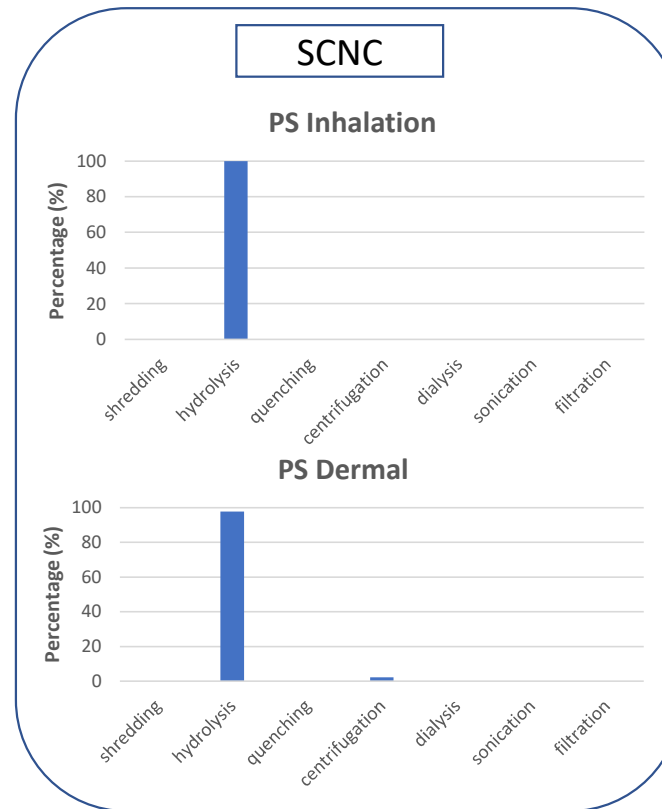
CitCNC



Key results


PROC 15 – small scale laboratories
PROC varied for the upstream processes

- ✓ Uncertainties – citric acid production
- ✓ Uncertainties – charging of the fungi *Aspergillus*






Takeaways

- Despite the high uncertainty of laboratory data, implementing LCA studies in the early stages can assist in identifying hotspots which can facilitate future scale-up
 - ProScale could be a useful complementary tool in Alternatives Assessment and Safe and Sustainable-by-design
- 



Takeaways

ProScale

- User friendly interface
 - Easy to use
 - Transdisciplinary teams are the key to success!
 - Input data and parameter selection can have a significant impact on the result
- 



The team

Stockholms University, Sweden

Maria-Ximena Ruiz-Caldas

Varvara Apostolopoulou-Kalkavoura

Aleksander Jaworski

Joseph. M. Samec

Aji Matthew

VVT, Finland

Panu Lahtinen

Tekla Tammelin

RISE, Sweden

Jutta Hildenbrand

Mikael Larsson

Anna-Karin Hellström



Acknowledgment

- The European Union (project number 101060546) for financial support.
- The Swedish Research Council for Sustainable Development (FORMAS, grant 2021-00445) for financial support.
- The Swedish Foundation for Strategic Environmental Research (Mistra: project Mistra SafeChem, project number 2018/11) for financial support.



FORMAS 

The text "FORMAS" is in a bold, black, sans-serif font. To its right is a logo icon consisting of four colored dots (red, green, blue, yellow) arranged in a square pattern.

MISTRA
SAFE CHEM 

The text "MISTRA" is in a small, black, sans-serif font above the text "SAFE CHEM" in a larger, bold, black, sans-serif font. To the right is a logo icon consisting of several green circles of varying sizes connected by thin green lines, resembling a molecular structure.