# Biosynthesis of highly flexible lignosulfonate–starch based materials

**Myleidi Vera [a,*], Sabrina Bischof [b], Bernab´e L. Rivas [a], Hedda Weber [d], Arnulf Kai Mahler [d], Martin Kozich [e], Georg M. Guebitz [b,c], Gibson S. Nyanhongo [b,c,f]**

[a] Facultad de Ciencias Químicas, Departamento de Polímeros, Universidad de Concepci´on, Casilla 160-C, Concepci´on, Chile
[b] Institute of Environmental Biotechnology, University of Natural Resources and Life Sciences, Vienna, Konrad Lorenz Strasse 20, 3430 Tulln, Austria
[c] Austrian Centre for Industrial Biotechnology (ACIB), Konrad Lorenz Strasse 20, 3430 Tulln an der Donau, Austria
[d] Sappi Papier Holding GmbH BruckerStrasse 21, 8101 Gratkorn, Austria
[e] Agrana Research & Innovation Center GmbH, Josef Reitherstraße 21-23, 3430 Tulln, Austria
[f] Department of Biotechnology and Food Technology, Faculty of Science, University of Johannesburg, Doornfontein Campus, Gauteng, South Africa

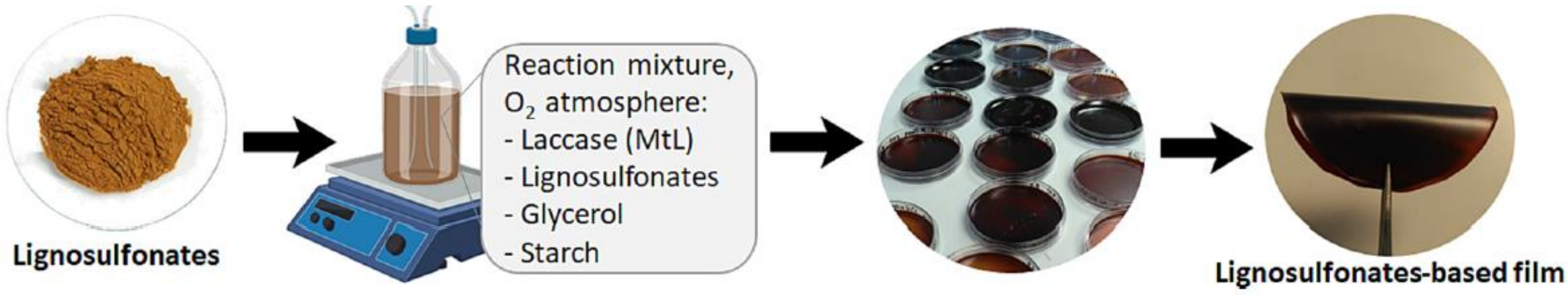
Further information
boku.ac.at/en/ifa-tulln
**Contact:** sabrina.bischof@boku.ac.at

## Background & introduction

Most plastics come from non-renewable fossil sources [1], which implies an environmental concern attributed to its challenging degradation process, the subsequent generation of microplastics within ecosystems, and dependence on non-renewable natural resources that are progressively diminishing [2]. To solve this problem, the scientific community, as well as the governments and industry, have combined efforts to move towards the use of new bio-based renewable resources [3], which guarantee the development and growth of the plastic industry and the sustainable exploitation of natural resources.

Synthesis of biofilms obtained from the polymerization of lignosulfonates using laccase as a biocatalyst and blending with starch:

- Effect of the reaction conditions on the formation of stable starch-lignosulfonate polymers
- Monitoring of performances regarding force, tensile strength, elongation and young modulus as well as water uptake capacity




**Scheme 1.** Summary of the process steps for synthesizing lignosulfonates-starch films by laccase polymerization.

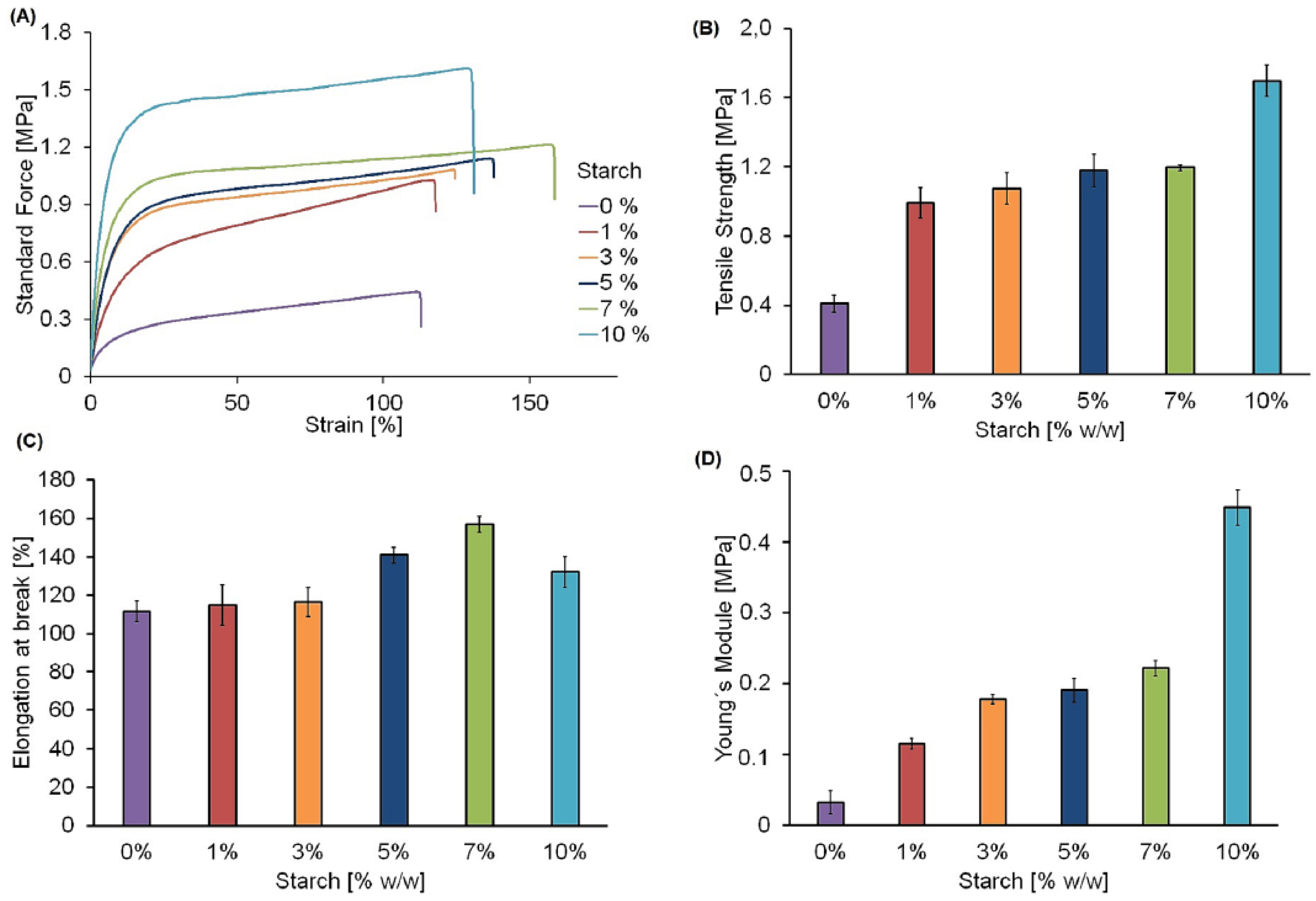



**Fig. 1.** Effect of starch concentration (0–10 %) on mechanical properties of enzymatically synthetized lignosulfonates-based films. (A) Stress–strain curves, (B) tensile strength, (C) elongation at break and (D) Younǵs module. The measures were carried out in triplicates and the results are presented with the corresponding standard deviation.

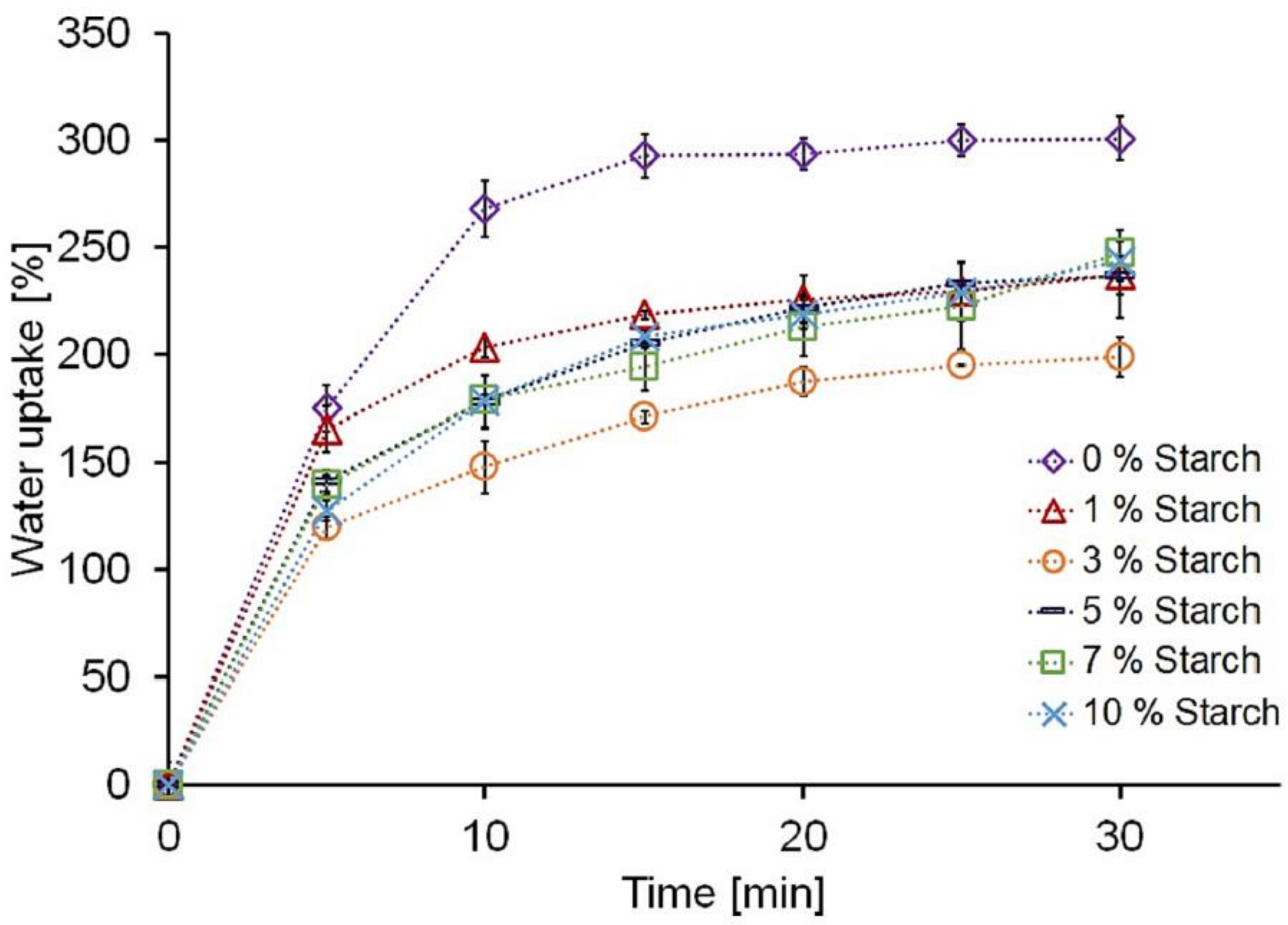



**Fig. 2.** Water uptake of lignosulfonates-based films with different starch concentrations (0–10 %). The measures were carried out in triplicates and are presented with the corresponding standard deviation.

## Results

Films obtained by laccase polymerization of lignin with different starch concentrations (0–10 %) were mechanically characterized by tensile strength measurements as shown in **Fig.1**. Stress–strain curves for each starch concentration are shown in **Fig. 1-A. Fig. 1-B** and **1-D** show that tensile strength and Young's modulus increased with increasing starch concentration in the film. Elongation at break associated to a lower ultimate stress increases slightly from 0 to 7 % of starch but decreases by adding 10 % of starch (**Fig. 1-C**). These results show that up to additions of 7 % starch, a more plasticized state of the films is achieved compared to the film containing only glycerol (0 % starch).

The lignosulfonates-based films obtained were characterized in terms of their water absorption capacity as a function of time. As shown in **Fig. 2**, all films exhibited rapid water absorption, indicating a fast diffusion of water molecules into the films.

## Conclusion

- The presence of starch in the films improved Young's modulus and tensile strength in the films.
- The water absorption capacity of the films decreased with the incorporation of starch.

→ In this work, a green strategy was carried out to produce **100% biobased films**, contributing to the creation of a possible alternative for replacing petroleum-based plastics with possible applications in active food packaging.

Sources:
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**Ing. Sabrina Bischof, M.Sc.**
Scientific Project Lead
Institute of Environmental BiotechnologyDepartment of Agrobiotechnology
IFA Tulln
BOKU - University of Natural Resources and Life Sciences, Vienna
Konrad Lorenz Str. 20A-3430 Tulln, Austria
sabrina.bischof@boku.ac.at