Cellulose from sugarcane bagasse as a potential prebiotic agent

Ricardo Freixo[1], Francisca Bastos[1], Eduardo Costa[1] , Alessandra Ribeiro[1] , Carla F. Pereira[1], Manuela E. Pintado[1] & Oscar L. Ramos[1],*

[1]Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho 1327, 4169-005 Porto, Portugal
*oramos@ucp.pt

CATÓLICA FACULTY OF BIOTECHNOLOGY PORTO

amyris

Introduction

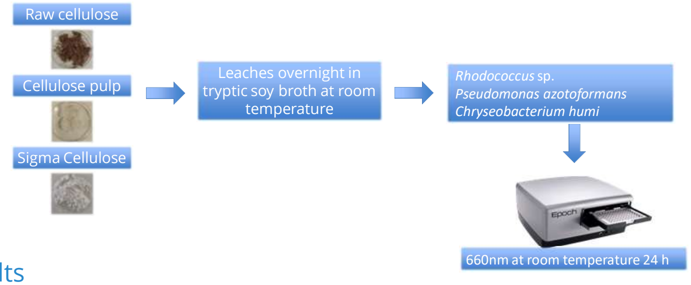
Organic farming practices have been slowly replacing intensive agriculture with the use of plant growth promoting bacteria as key factor, as these bacteria interact effectively with plants and increase crop yields. However, despite the potential of bioinoculants, its usage in agriculture is still limited as their efficacy also depends upon other abiotic factors such as the soil type and its nutrients. A novel approach to bypass this limitation is the introduction of prebiotic agents to increase the richness of the soil and thus promote bacterial growth (Arif et., al 2020). Among the possible alternatives for soil supplementation, cellulose constitutes one of the best choices, as it is a renewable carbon source, widely abundant in nature and for which a great number of microorganisms produce enzymes.

Objectives

The aim of this work is to evaluate the prebiotic potential of cellulose, extracted from sugarcane bagasse, as prebiotic agent of soil microorganisms. To that end, cellulose was firstly extracted from sugarcane bagasse through an optimized procedure comprising an alkaline extraction with sodium hydroxide followed by a bleaching process with hydrogen peroxide. The capacity to promote the growth (prebiotic effect) of three soil representative microorganisms and nitrogen fixators i.e., *Rhodococcus* sp. EC35, *Pseudomonas azotoformans* and *Chryseobacterium humi* was evaluated for two cellulose extracts (i.e., raw cellulose and cellulose pulp) obtained from sugarcane bagasse and its performance was compared to the exhibited by a standard cellulose obtained from Sigma.

Methods

Cellulose was firstly extracted from sugarcane bagasse through an optimized procedure comprising an alkaline extraction with sodium hydroxide followed by a bleaching process with hydrogen peroxide. The capacity to promote the growth (prebiotic effect) of three soil representative microorganisms and nitrogen fixators i.e., *Rhodococcus* sp. EC35, *Pseudomonas azotoformans* and *Chryseobacterium humi* was evaluated for two cellulose extracts (i.e., raw cellulose and cellulose pulp) obtained from sugarcane bagasse.



Results

Results showed that the extraction process yielded ca. 63% and 42% for raw cellulose and cellulose pulp, respectively, being both extracts effective as prebiotic agents for the target microorganisms. Growth rates of 38 and 68% for *Rhodococcus* sp., and of 67 and 84% for *C. humi* was found for cellulose pulp and raw cellulose, respectively. On the other hand, for *P. azotoformans*, raw cellulose had no impact upon the growth rate, while cellulose pulp lead to a small decrease (ca. 7%) (Figure 1). When comparing this data with the obtained for a standard cellulose from Sigma, it was possible to observe that the commercial cellulose was, in general, less effective as an environmental prebiotic as it only exhibited significant effects in the growth of *C. humi*.

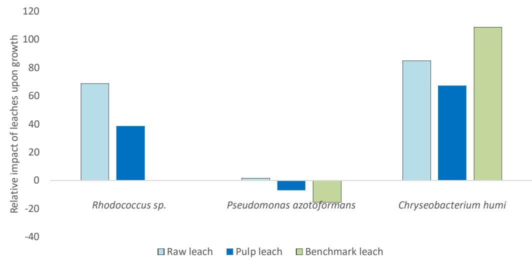


Figure 1. Impact (in percentage) of leaches from raw cellulose and cellulose pulp in comparison to the leach from standard cellulose from Sigma upon the microorganisms μmax.

As can be seen from Table 1, the leach from the standard cellulose from Sigma only produced a significant increase in maximum growth rate for *C. humi*, while for the raw cellulose and cellulose pulp extracts wider impacts upon the growth rates was observed.

Table 1. Comparison between the maximum growth rates obtained for leaches from raw cellulose and cellulose pulp extract in comparison to the leach from standard cellulose from Sigma.

	μ_{max} (h^{-1})		
	***Rhodococcus* sp.**	***Pseudomonas azotoformans***	***Chryseobacterium humi***
Plain media	0.0518	0.1811	0.0414
Raw cellulose leach	0.0874	0.1838	0.0765
Cellulose pulp leach	0.0717	0.1686	0.0692
Plain media (benchmark assay)	0.0958	0.3227	0.0324
Cellulose Sigma leach	0.0959	0.2728	0.0676

Conclusions

These results showed the potential of sugarcane bagasse as source of a natural bioinocula with prebiotic effect, thus potentiating the valorization of an industrial byproduct with low commercial value into a product with biological effect on soils supplementation.

Acknowledgements

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References

Arif, I., Batool, M., Schenk, P. M., 2020. Plant Microbiome Engineering: Expected Benefits for Improved Crop Growth and Resilience. Trends in Biotechnology, 38, 12.