Characterization and valorization of polysaccharides from microalgae

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Introduction

Microalgae are unicellular autotrophic organisms that are cultivated and exploited to produce biofuel from lipids. Currently, two main problems are encountered: the high production cost and the low yield. To make the process profitable and to solve the first problem, it is necessary to exploit the non-energy part of the microalgae and more particularly the polysaccharide fraction. The project thereby aims to produce, characterize and valorize these polysaccharides. The selected microalga is Spirulina platensis, a cyanobacterium belonging to the prokaryotic blue alga [1]

Oligosaccharides

They can be produced by organic synthesis or degradation of naturally occurring polysaccharides. However, the synthesis of oligosaccharides is more complex than other polymers due to the numerous combinations, the anomerity and the configuration of the carbohydrates. Since the past decades, different producing methods of polysaccharides by depolymerization have thereby been investigated [2][3] such as chemical, physical or enzymatic degradation. Green chemistry methods, particularly microwave treatments appear to be promising [4].

Polysaccharides

Optimization of the conventional method by using a physical method : ultrasound-assisted extraction in water.

Polysaccharides

Studying the biological properties of oligosaccharides, particularly for biostimulation of plants [6]

Production of oligosaccharides and polysaccharides

Value of oligosaccharides and polysaccharides

ValORIZATION OF OLIGOSACCHARIDES AND POLYSACCHARIDES

Structural analyses : mass spectrometry

Figure 1 : microalgae cultures

Figure 2 : structure of alginate

Figure 3 : Evolution of viscosity over time after microwave treatment at 150°C

Figure 4 : Evolution of absorbance over time after microwave treatment at 150°C

The viscosity of each solution is measured by a capillary viscometer. We observe a decrease of the viscosity over time, which demonstrates that smaller molecules are present

Dosage of the reducing-end of saccharides by reaction with the Neelon reagent to form molybdenum blue, which presents a high absorbance at 595 nm [5]. We observe an increase of the absorbance over time, which confirms the hydrolysis efficiency.

Figure 5 : Evolution of absorbance over time to 1 minutes

ESI-MS : Electrospray ionization mass spectrometry

In positive mode from methanol

MALDI-MS : Matrix assisted laser desorption/ionization mass spectrometry

In positive mode with DHB/DMA as matrix

In negative mode with harmane as matrix

Figure 6 : Hydrogel formation by photopolymerization

Conclusion and outlook

Currently, we produced oligosaccharides by microwave treatment at 150°C in 1 minute from alginate in water. This method seems really promising because no chemical reagents are required. The hydrolysis reaction is achieved in short reaction time. The hydrolysates are characterized by common methods, such as viscosity and reducing sugar analysis. ESI-MS measurements are clearly adding a great analytical value, when determining the composition and the structures of the oligosaccharide mixtures. GPC measurements are also in progress to have an information on the yield of oligosaccharide produced.

Those preliminary results pave the way to our further investigations that intend to prepare tailor-made oligosaccharide mixtures starting from algae-derived polysaccharides for which no enzyme is to date identified for the production of oligosaccharides.

Acknowledgments

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