**Kinetics of acid-catalyzed hydrolysis of oat β-glucan to produce short chain polysaccharides with controlled degree of polymerization**

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**Highlights**

* Mechanistic model developed for acid hydrolysis of beta-glucan from oat
* The non-random structure of the polysaccharide is included in the model
* Evolution of the molecular weight distribution during hydrolysis is explained

**1. Introduction**

Natural beta-glucan is a linear, nondigestible polysaccharide composed of D-glucose monomers linked by β-glycosidic bonds. Beta-glucan from cereals (oat and barley) consists of mixed-linkage β-(1,3) and β-(1,4)-D-glucose monomers, whereas β-glucan from yeasts or mushrooms is composed of mixed-linkage β-(1,3) and β-(1,6)-D-glucose units [1, 2]. Enzymatic or acid hydrolysis of β -glucan produces oligosaccharides and short chain polysaccharides that can be used as prebiotic food ingredients.

It is desirable to produce short chain polysaccharides (e.g. DP = 30…50) rather than oligosaccharides from large plant polysaccharides. To achieve this, the reaction conditions and operation of the reactor should be optimized such that degradation to oligosaccharides is minimized. In this work, an accurate kinetic model for acid hydrolysis is developed and validated using experimental data.

**2. Methods**

Homogeneous acid-catalyzed hydrolysis of oat β-glucan was studied at 323 K and 353 K using HCl and H2SO4. The kinetic experiments were carried out in a jacketed glass reactor (Orb system, Syrris Ltd., United Kingdom). The molecular weight distribution (MWD) of β-glucan was measured using SEC−MALLS on HPLC system (Agilent 1200 Infinity series) with an RI detector and a multi-angle laser light scattering detector. To deal with low intensity of small molecules in the samples, a two-step method was used. In this method, the samples withdrawn from the reactor were first fractionated in preparative scale SEC column and the MWD of each fraction was determined using the HPLC SEC-MALLS.

β-(1,4) and β-(1,3) glycosidic bonds are known to have different reactivity in acid hydrolysis [3]. A structured kinetic model was developed that takes into account the difference in the reactivity of β-(1,4) and β-(1,3) glycosidic bonds as well as their positions in the polysaccharide chain. Numerical solution of the large ODE system was accelerated by using an adaptive Jacobian matrix approach.

**3. Results and discussion**

The number average molecular weight of oat beta-glucan changes during acid hydrolysis in a manner consistent with assumption of first order kinetics. However, a random scission model does not explain the formation rates of oligosaccharides. The structured model presented here can explain the observations within good accuracy.



**Figure 1.** Evolution of the molecular weight distribution of β-glucan with HCl 0.05 M with HCl 0.25 M at 353 K. Oligosaccharides are shown in bottom left: blue = DP 1, red = DP 2, green = DP 3, black = DP 4, magenta = DP 5.

**4. Conclusions**

The simulation of β-glucan hydrolysis with the new model was in good agreement with the experimental data and shows improvement over existing non-structured models for hydrolysis of plant polysaccharides.

**References [Calibri 10]**

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