

Bioethanol from Sugar Beet Pulp – The Pectin Challenge

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Introduction

The 21st century energy needs brought focus on renewable energies. One potential source for sustainable production of biofuels is the use of side streams from the food industry. Sugar beet pulp (SBP) is the residual tissue after beet sugar production. Its high polysaccharide content makes it a potential source for biorefinery or bioethanol production.

The enzyme preparations Rocksoft MPL (Dyadic) and Pectinase Ultra SP (USP, Novozymes) were tested on their ability to degrade SBP alcohol insoluble solids (SBP-AIS).

Aim

The aim of this project is the complete degradation of pectins with focus on arabinose, galactose and galacturonic acid (GalA) release.

The structure and components of Sugar beet pulp

SBP-AIS contains 73% polysaccharides of which over 60% are present as pectic substances (see Fig. 1).

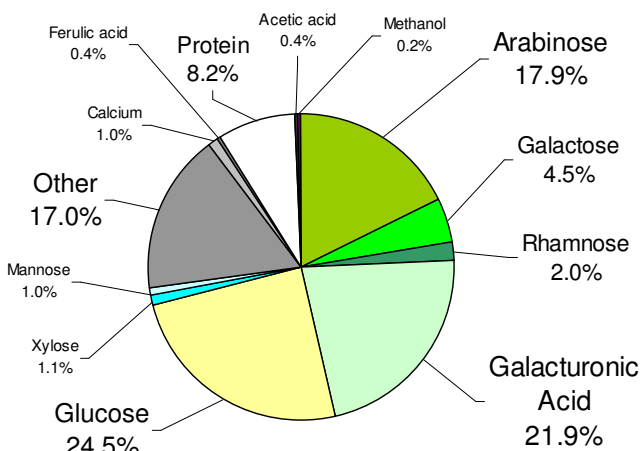


Fig. 1 The composition of SBP-AIS. Sugars in green are derived from pectin. Glucose comes from cellulose and residual sucrose. Out of 100 Galacturonic acids 30 are methyl esterified and 36 are acetylated. Ferulic acid is attached to arabinose and galactose of pectin side chains.

Long chains of GalA form the smooth regions (homogalacturonan). These are interspersed with regions of alternating rhamnose and GalA units (rhamnogalacturonan I, RG I). Together they make up the pectin backbone. The GalA units are partly methyl esterified and acetylated. Neutral sugar side chains, mainly arabinans and galactans, are attached to the rhamnose units of RG I which may be acetylated as well. The substitutions and side chains may influence enzyme accessibility and, thus, solubilisation of the material. They have to be removed to insure complete pectin degradation.

Workflow/Experimental

Enzyme digests were performed with 1% (v/v) enzyme and 0.5% (w/v) SBP-AIS in 50mM sodium acetate buffer at pH 5 for 24 hours at 40° C. Supernatant was separated from pellet after centrifugation. The sugar composition of the resulting fractions was determined by GC-FID analysis of the corresponding alditol acetates derivatives. The supernatant was analysed with respect to molecular weight distribution by high performance size exclusion chromatography. Monomer and oligomer content was assessed by high pH anion exchange chromatography.

Results

Fig. 3 shows the distribution of the sugars present in SBP-AIS after enzyme digest. Both enzyme mixtures can solubilise 75% of the sugars. USP releases 30% of all the sugars as monomers whereas MPL mainly produces larger oligomers and soluble polymers (70%).

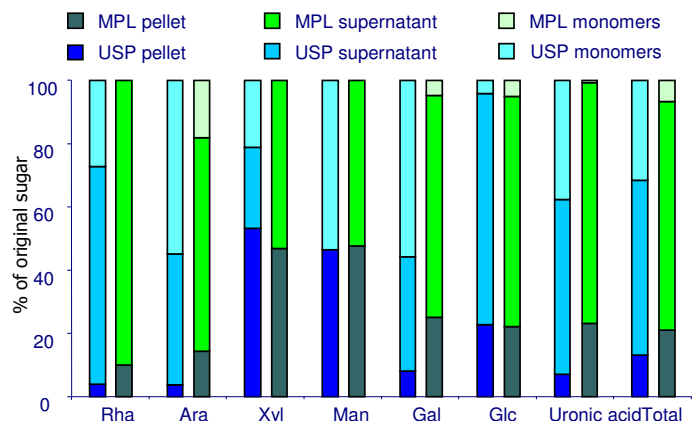


Fig. 3 Allocation of the different sugars after enzyme digest over 3 fractions. Pellet: water insoluble material, supernatant: water soluble material without monomers. Abscissa: Rha – rhamnose, Ara – arabinose, Xyl – xylose, Man – mannose, Gal – galactose, Glc – glucose, Total – overall sugar distribution.

Conclusions

The tested enzyme preparations are not suitable to degrade major parts of SBP-AIS to fermentable sugars. Complete breakdown could be hindered by product inhibition, lacking enzymes activities or hindrance by pectin substitutions such as methyl esters and acetyl groups.

Future work will focus on the identification and biochemical characterisation of potent esterases which can increase the action of pectin backbone degrading enzymes.

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<http://www.senternovem.nl/eos/index.asp>