Characterization of hemicellulose

The high hemicellulose content of biomass offers significant potential for new wood-based products and gives opportunities for the future biorefineries. Once isolated, the potential applications for hemicellulose include barrier materials for food packaging or biopolymers with new properties.

Hemicelluloses are heteropolysaccharides and their structure and polymeric properties vary depending on origin, i.e. plant species, industrial processing as well as isolation and purification procedure.

Technical grade hemicelluloses obtained from the biorefinery may contain different impurities that have to be taken into account from an analytical perspective.

The properties of hemicelluloses are to a great extent influenced by their chemical and molecular structure.

We have identified three groups of properties that we need to analyse in order to characterize hemicelluloses:

- Carbohydrate composition
- Content and distribution of side groups
- Average molecular mass and molecular mass distribution.

In addition, for technical hemicelluloses, it is also of interest to characterize the overall chemical composition or purity.

A list of analytical services related to hemicelluloses is appended.

Contact persons
Anna Jacobs
+46 8 676 7152
anna.jacobs@ri.se

Fredrik Aldaeus
+46 8 676 7188
fredrik.aldaeus@ri.se

CARBOHYDRATE COMPOSITION

Carbohydrate composition (standard method)
The content of non-glucose monosaccharides is assumed to correspond to the hemicellulose con¬tent. We measure the carbohydrate composition according to standard SCAN-CM 71, and deliver the content of glucose, mannose, arabinose, xylose and galactose in mg per g dry pulp. 2 g of sample is required.

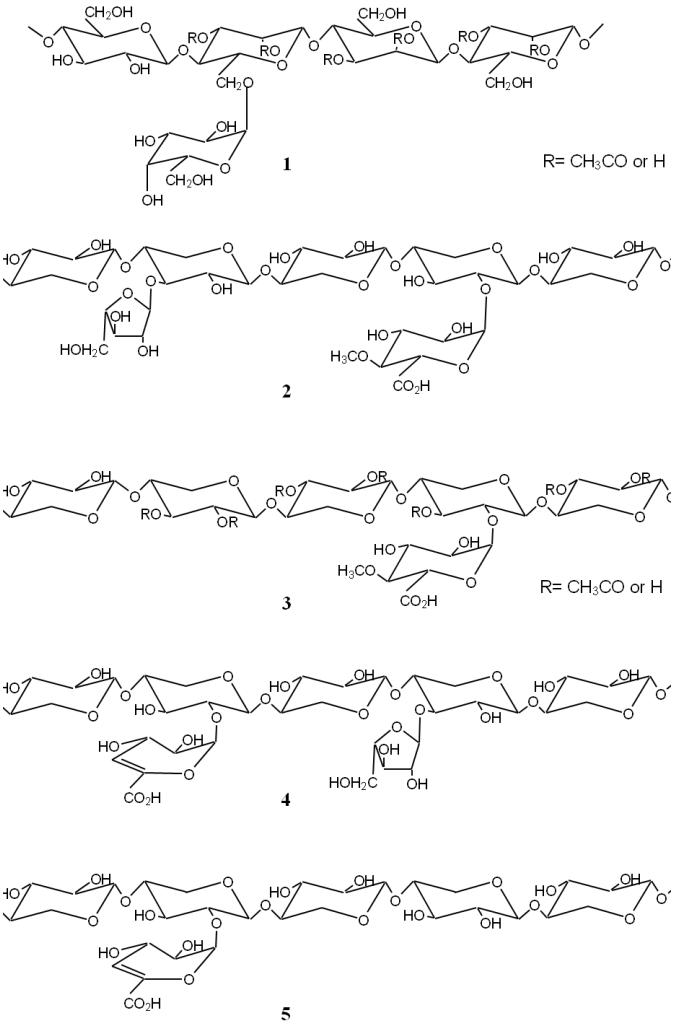
Carbohydrate composition incl. uronic acids
In order to determine both neutral and acidic carbohydrates we use enzymatic hydrolysis in combination with capillary electrophoresis. In addition to the saccharides obtained by the standard method, this procedure provides the content of hexenuronic acid, 4-O-methylglucuronic acid and galacturonic acid. 1 g of sample is required.

Acetyl group content
The content of acetyl side groups is determined by deacetylation followed by quantification by ion chromatography. 1 g of sample is required.
The acetyl group content can also be studied by NMR spectroscopy.

MOLECULAR PROPERTIES

Molecular mass distribution
We use size-exclusion chromatography (SEC) characterise different molecular properties of hemicelluloses. We have calibrated the molecular mass scale for hemicellulose analysis by collection of narrow-polydisperse hemicellulose fractions from the SEC system, followed by mass spectrometric (MALDI-TOF-MS) analysis of each fraction. 0.1 g of sample is required.

Distribution of side groups
Partial acid hydrolysis in combination with MALDI-TOF-MS gives information about the distribution of side groups, for instance uronic acid or acetyl groups, along the polysaccharide backbones.
Information about distribution of acetyl groups between different saccharide units can be obtained by NMR spectroscopy.



Typical partial structures of hemicelluloses from wood and pulp: 1) Galactoglucomannan, 2) Arabinoglucuronoxylan, 3) Glucuronoxylan, 4) Arabinohexenuronoxylan, 5) Hexenuronoxylan

PURITY

Acid-insoluble (Klason) and acid-soluble lignin
We measure the content of acid-insoluble (Klason) and acid-soluble according to standards TAPPI T 222 om and TAPPI UM 250, and deliver the results in mg per g dry pulp. 2 g of sample is required.

Acetone extractable matter
We measure the acetone extractable matter (ie. extractives) according to standard SCAN-CM 49, and deliver the results in percent extractives per dry pulp. 2 g of sample is required.

Ash content
We measure the residue (ie. ash) on ignition at 525°C according to standard ISO 1762, and deliver the results in percent ash per dry pulp. 1 g of sample is required.

Metals/elements content
A variety of different metals and elements may be measured using atomic emission spectroscopy (ICP-AES), for instance Al, Ba, Ca, Cu, Fe, K, Mg, Mn, Ma, S and P. We deliver the results in mg of each element per g dry pulp.
2 g of sample is required.

ID: 249

RESEARCH INSTITUTES OF SWEDEN
RISE Bioeconomy

ADDRESS
Drottning Kristinas Väg 61
Box 5604, SE-114 86 Stockholm, Sweden

CONTACT
+46 8 676 70 00
info@ri.se, www.ri.se