Biomass characterization related to biomass for bioenergy

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Technologies for conversion of biomass to bioenergy

Biological:

Fermentation to produce ethanol 1. and 2. generation

Fermentation to produce methane

Chemical:

Combustion to produce electricity and heat

Thermochemical conversion to produce syngas and biooil

Effect of feedstock quality on

Biological conversion techniques are always incomplete

Conversion efficiency will depend on feedstock characteristics

Characterization methods can be useful for:

1. **Understanding what aspects of composition impedes conversion**
2. **Selecting and developing feedstocks that are easily converted (plant breeding)**
3. **Adapt conversion conditions to feedstock characteristics**
4. **Pricing of feestocks**

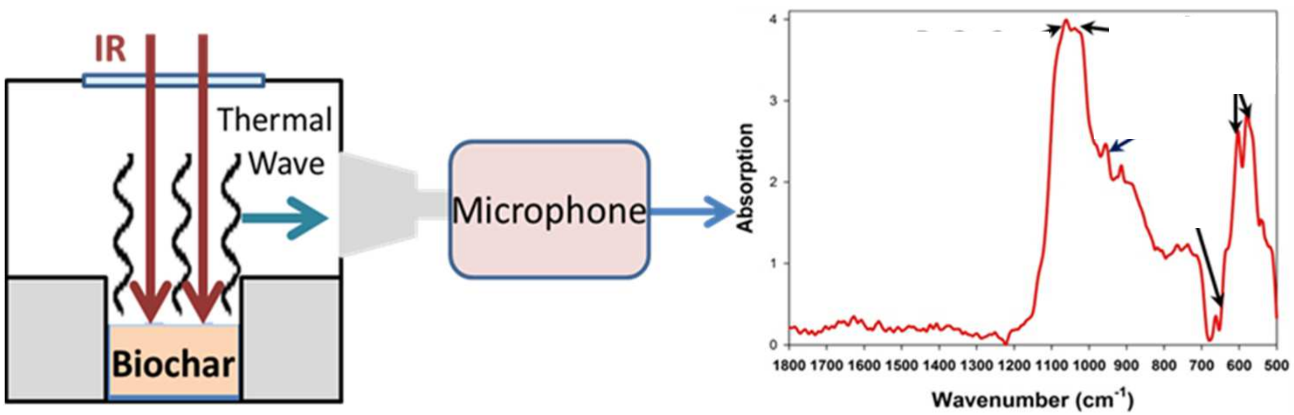
Characterization methods used in our group

NIR spectroscopy

Rapid method which gives very detailed information. Overtones and combination bands of primary vibrations of chemical bonds in the IR range. Very good for predictions. Spectra are difficult to interpret because of overlapping bands.

FTIR-PAS

Advantetous in opaque samples. Primary vibrations in the IR range. Possible to interpret peaks in spectra. Also good for predictions.



Reference method

Measure of conversion effeciency:

- Ruminant digistibility
- Bioethanol potential – saccharification potential – sugar release - HTHP
- Biomethane potential – BMP

Calibration:

Esablish a relationship between spectra and reference method

Validation

Check that is working on unknown samples

Prediction and interpretation

Learn something from what bands are correlated with reference methods and use model to predict new samples

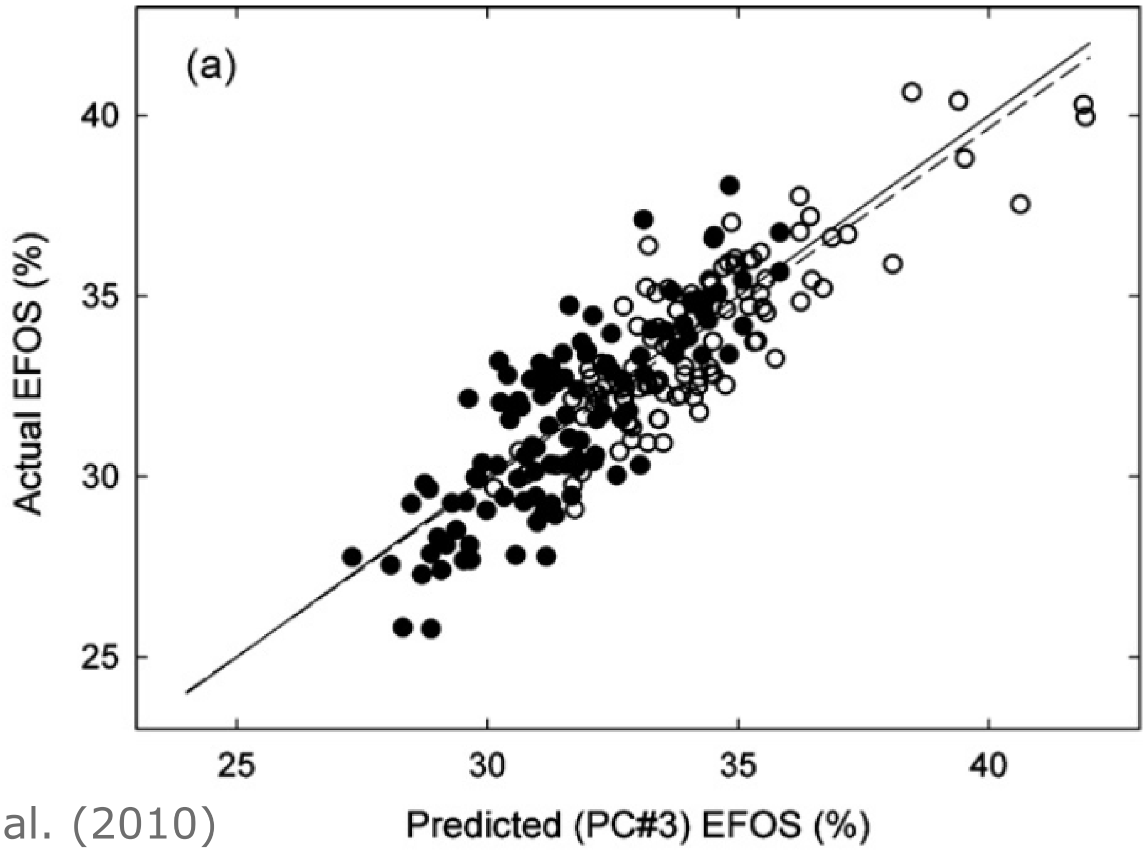
Why look at cereal straw?

Biomass	Potential 2012 (t DM)
Animal slurry	2.106.000
Deep litter	937.000
Farm yard manure	900.000
Straw	2.125.000-2.550.000
Cover crops	40.000
Aquatic biomass	7.100
Household waste	250.000
Garden waste	108.000
Woodchips	Sizable but already large import

From Birkmose et al. (2015)

Prediction of ruminant digestibility using NIR

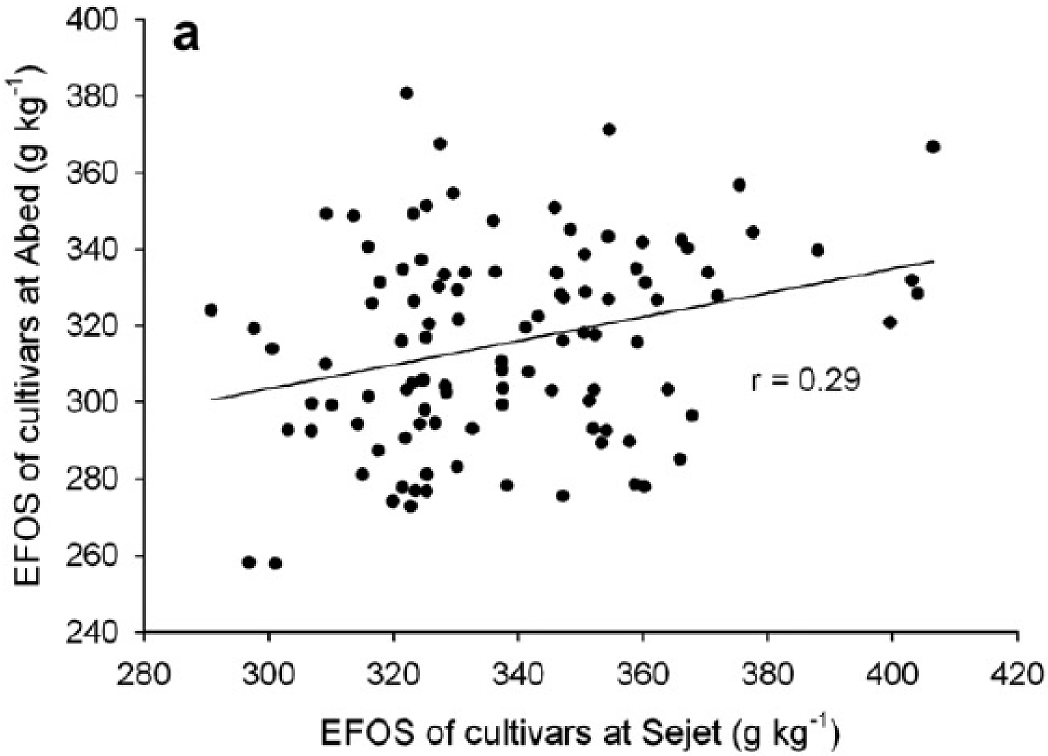
EFOS measure of ruminant digestibility



Validation
$r^2 = 0.73$
RMSE = 1.47%

Bruun et al. (2010)

Heretability of ruminant digestibility

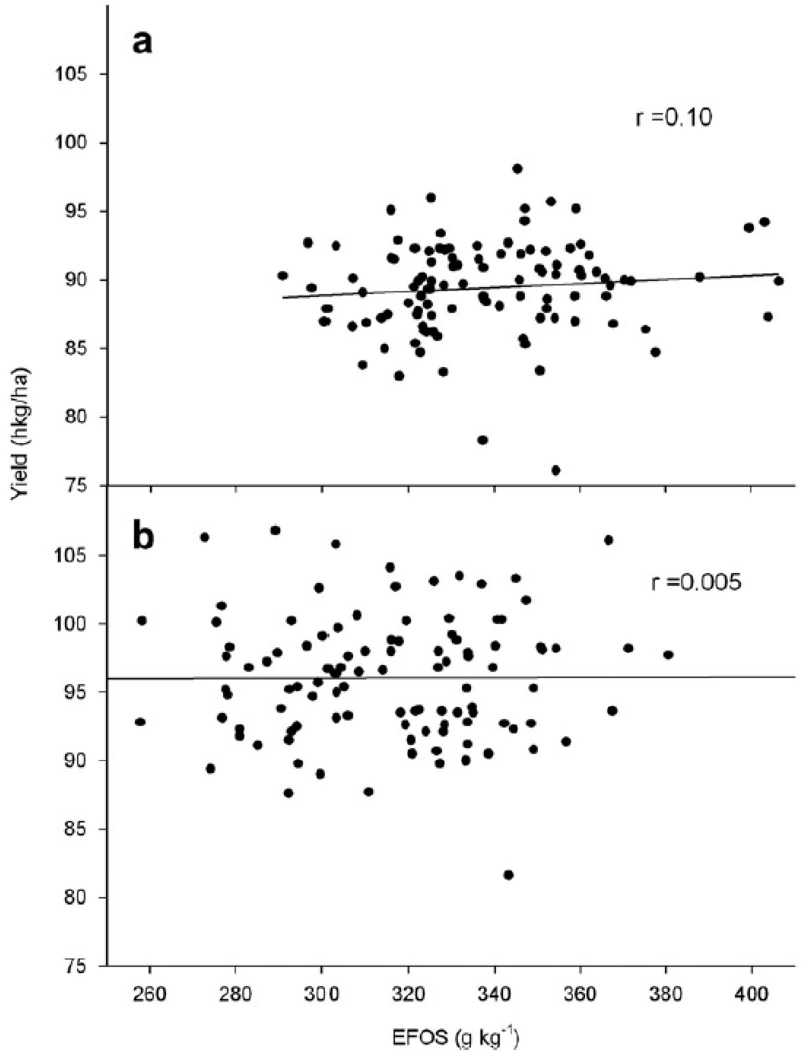


$$h^2 = \frac{\sigma_g^2}{\sigma_g^2 + \sigma_r^2}$$

Jensen et al. (2011)

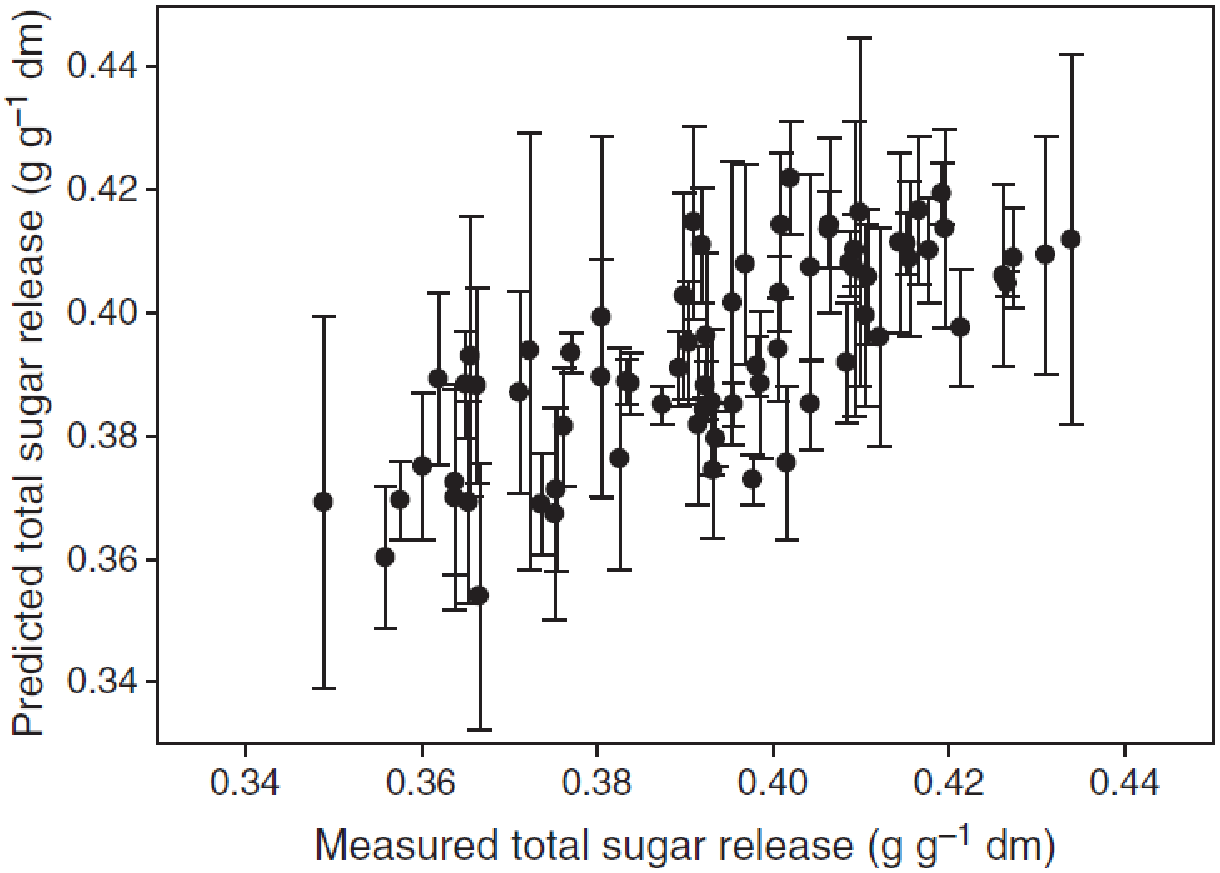
$$R = h^2 S$$

Relation with yield is important



Jensen et al. (2011)

Prediction of ethanol potential using NIR



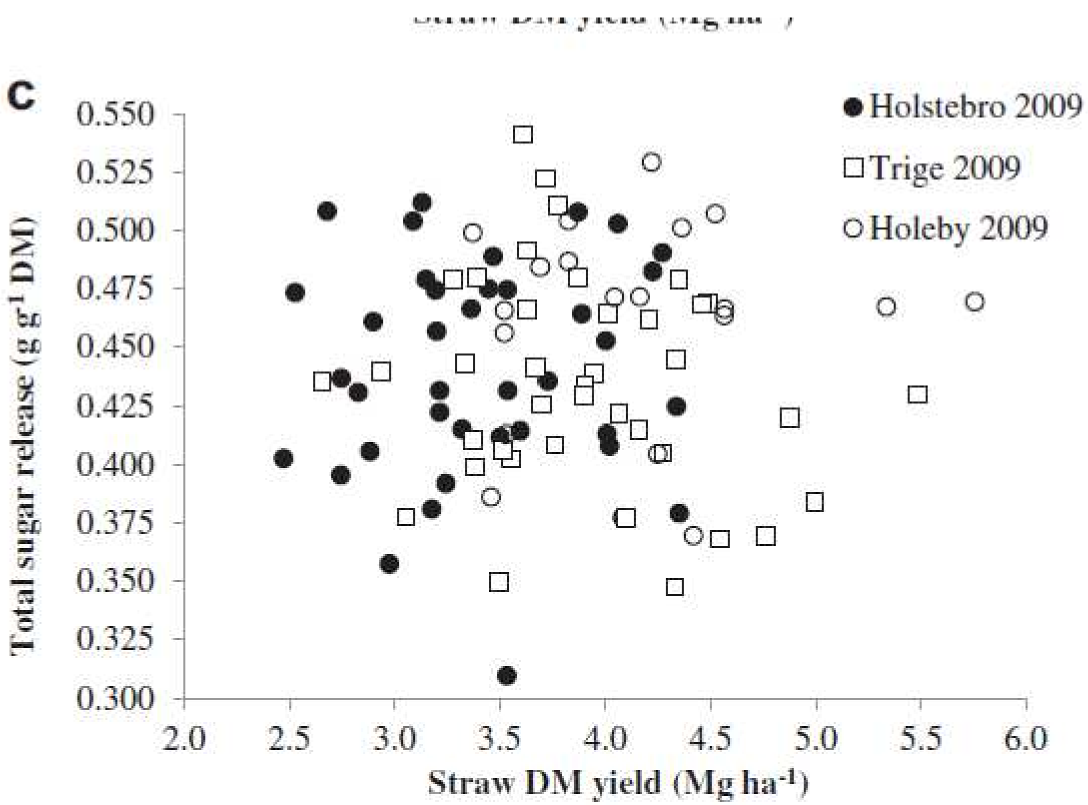
Validation
RRCV
$r^2 = 0.56$
RMSE = 0.014

SSCV
$r^2 = 0.46$
RMSE = 0.016

Lindedam et al. (2010)

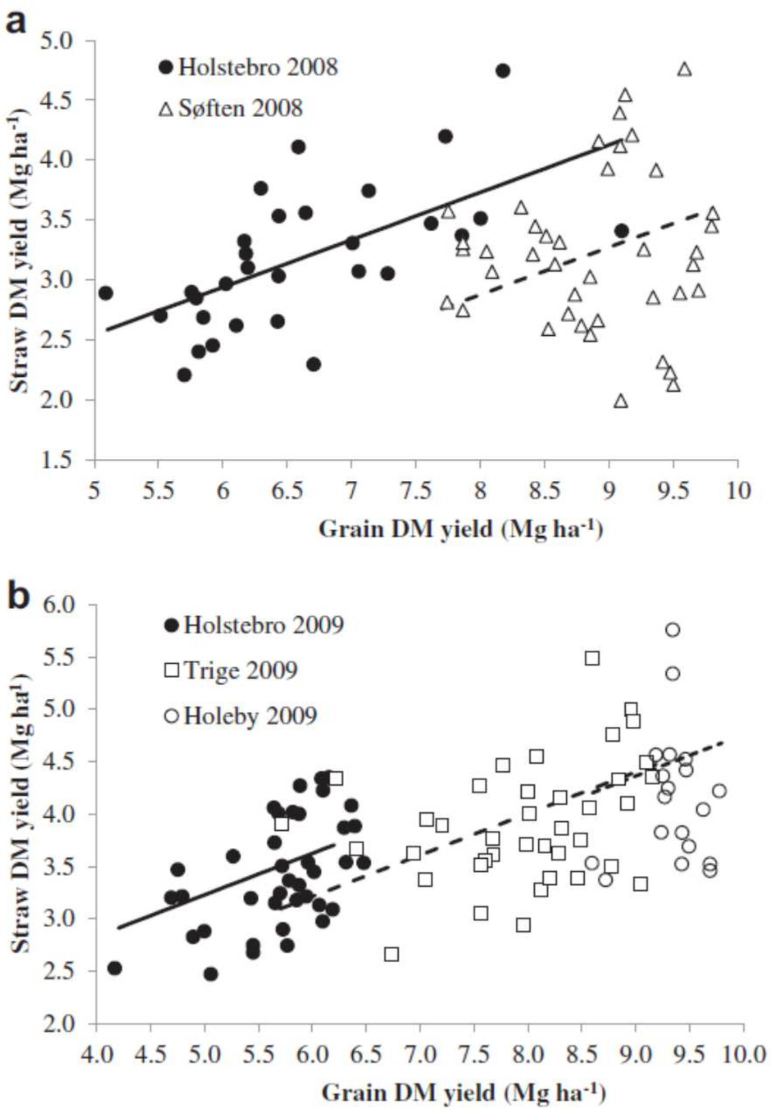
Heretability 0.57

Relation between straw yield and ethanol potential



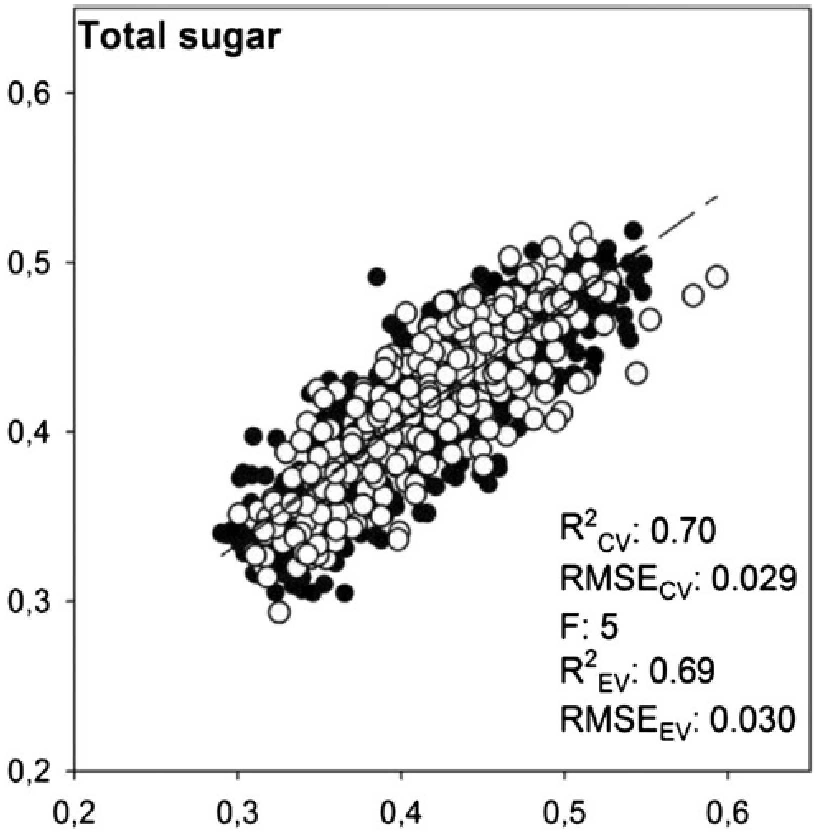
Larsen et al. (2012)

Relation between grain yield and straw yield



Larsen et al. (2012)

FTIR-PAS prediction of of humongous dataset



Ligning inhibits release of both xylose and glucuse

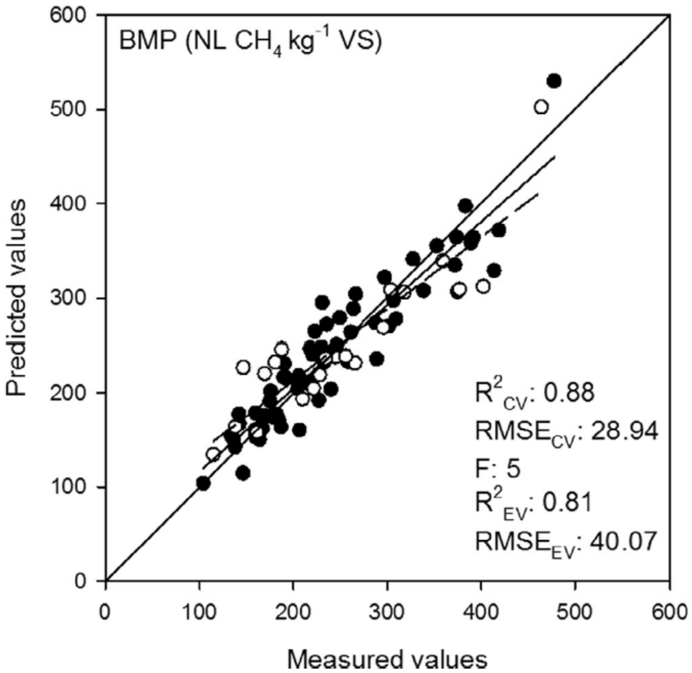
Chrystalinization of cellulose inhibits release of glucose.

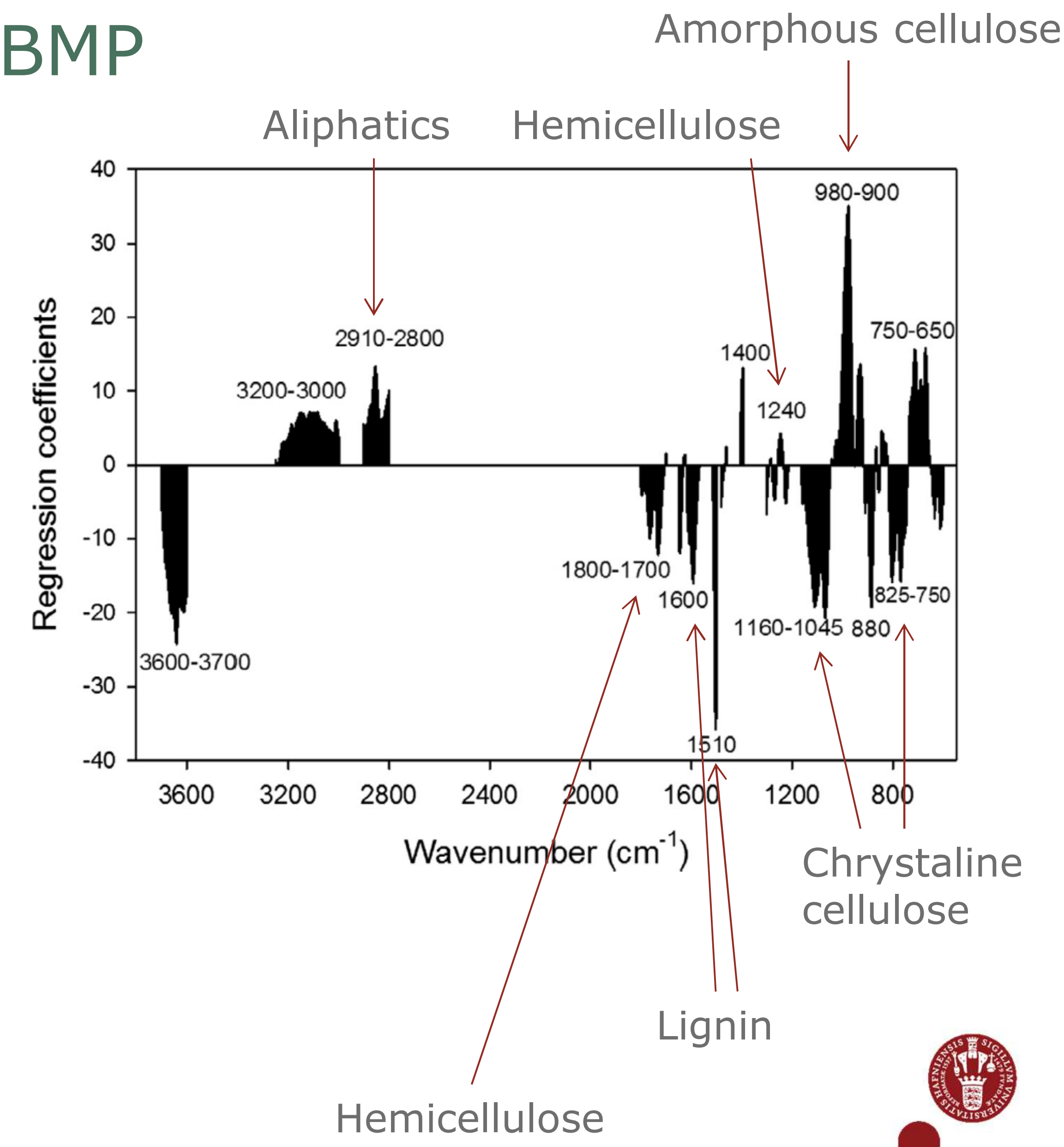
Amorhous cellulose increases release of glucose

Xylan increase release of xylose

Bekiaris et al. (2015a)

FTIR-PAS and BMP





Bekiaris et al. (2015b)