CARBOHYDRATE COMPOSITION AND ETHANOL CONVERSION OF HERBACEOUS BIOMASS

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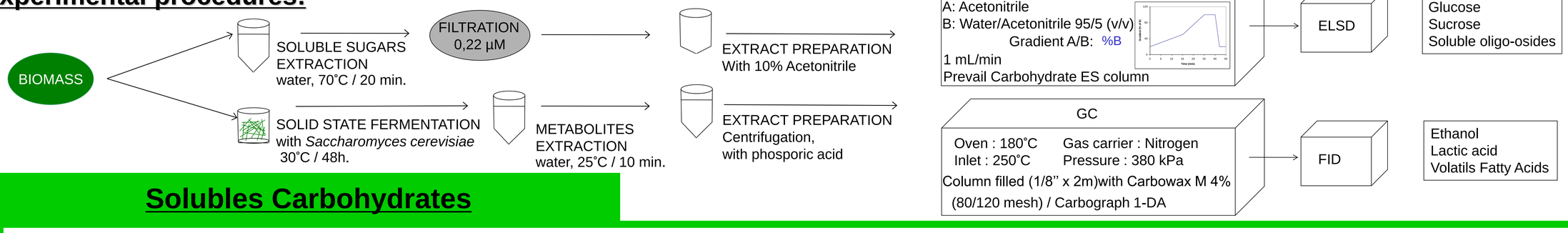
Introduction: Herbaceous biomass consists mainly of structural polysaccharides, reserve polyfructans and solubles sugars that can be converted by micro-organisms to ethanol.

Aim: - To examine the composition of Perennial ryegrass (*Lollium perenne), Hybid ryegrass (L .hybridum) and Italian ryegrass (L. multiforum)*

- To investigate the influence of cultivar (early, intermediate, and late precocity degree; diploid and tetraploïd), development stage (elongation, heading, flowering), harvest time in the day, and tedding on carbohydrate availability in the harvested biomass.

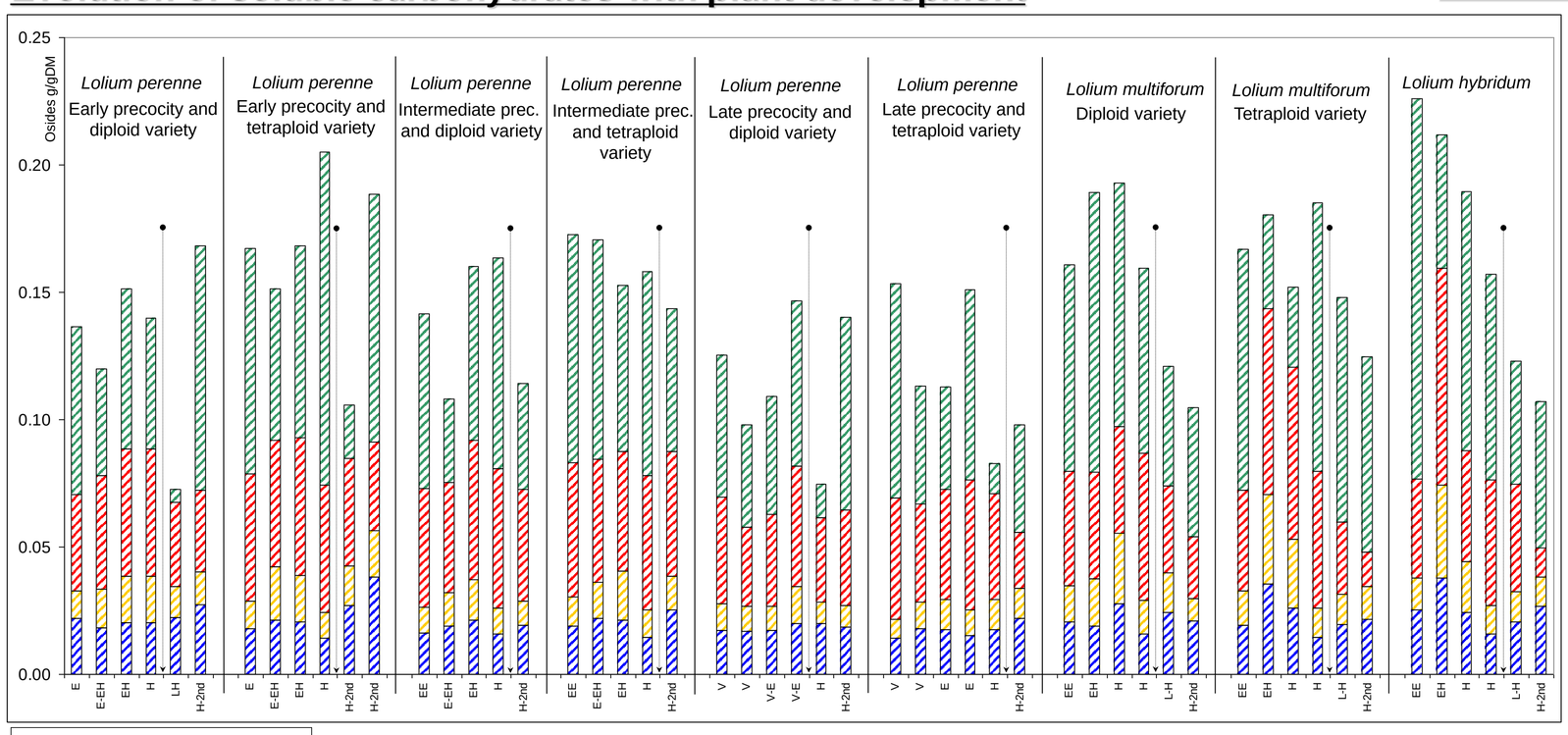
- To check their suitability for a direct conversion of the soluble sugars to ethanol.

Experimental procedures:



Solubles Carbohydrates

Evolution of soluble carbohydrates with plant development



H-2nd : 2nd Heading
L : Leafy
H : Boot head emergence
EH : Boot stage
E : Elongation
EE : Early elongation
V : Vegetative

Harvest

others oligosides
Sucrose
Glucose
Fructose

Evolution of soluble carbohydrates during the day

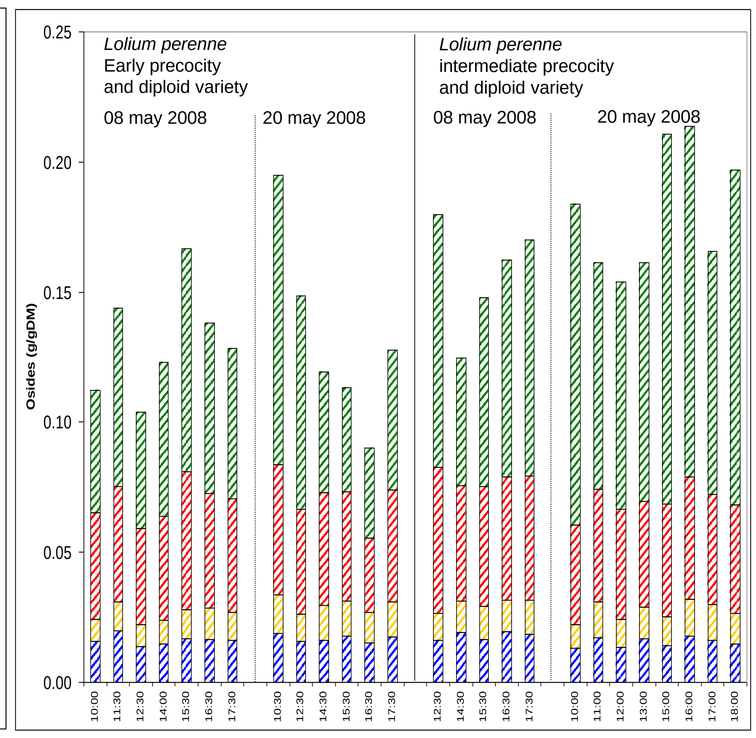
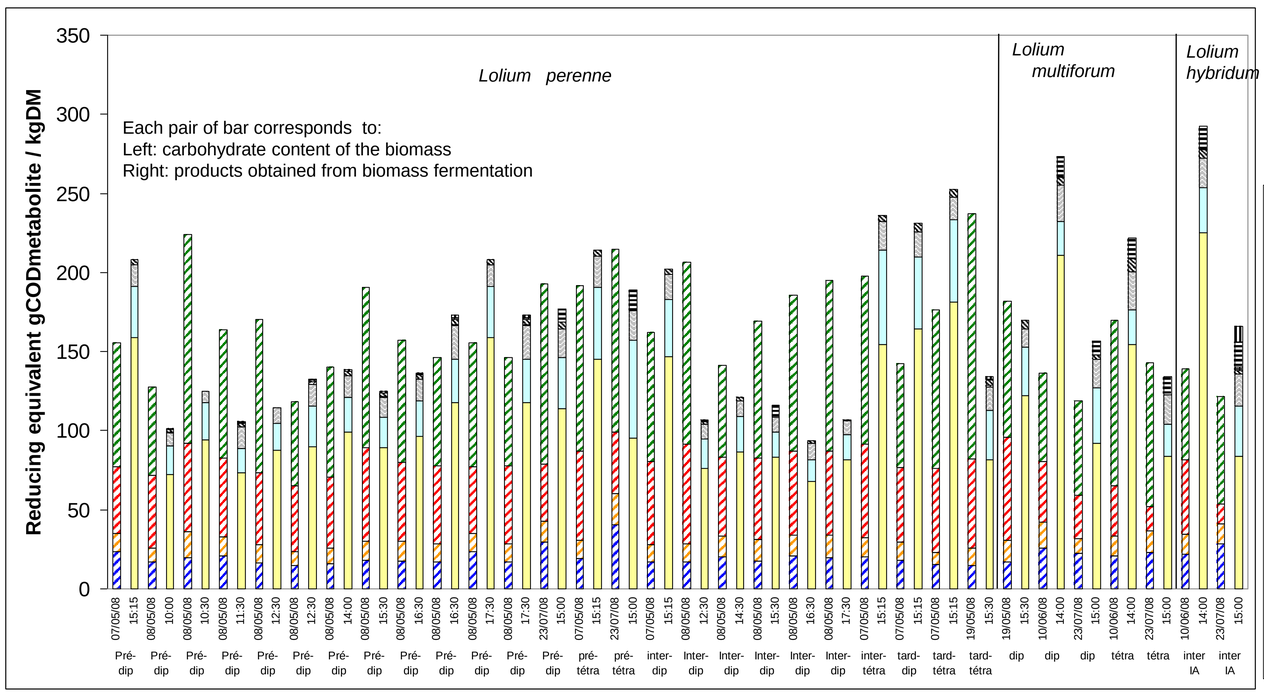


Figure 1a et 1b:. Soluble sugar concentrations is in the range 0.1 g/gDM and 0.2 g/gDM (corresponding to 0.02 g/gFM to 0.03 g/gFM) with fructose and glucose: 0.01 to 0.04 g/gDM (0.003 to 0.005 g/gFM), sucrose: 0.03 to 0.07 g/gDM (0,007 to 0,011 g/gFM) and others soluble carbohydrates 0.03 to 0.10 g/gDM (0.011 to 0.022 g/gFM). Furthermore, the figure shows a decrease of total soluble oligosides in biomass regrown after first harvest.

•The total soluble carbohydrates contained in herbaceous biomass do not seem to vary significantly either during its development or during the day (no significant effect of photosynthesis). Soluble carbohydrates concentrations in *Lolium* would theoreticaly enable an ethanol conversion to 10 to 15 gEthanol/kgFM.

Experimental ethanol/carbohydrate yield



Others oligosides
Sucrose
Glucose
Fructose
Valeric acid
Iso-valeric acid
Butyric acid
iso-butyric acid
Propionic acid
Acetic acid
Lactic acid
Ethanol

Figure 2 : The conversion yields of total soluble carbohydrates to ethanol and lactic acid are between 50 to 100% (some results above 100% are not explained). During the ethanol fermentation, volatile fatty acids, mainly acetic acid, are also produced without clear negative influence on ethanol production.

- The total soluble carbohydrates are maily converted into ethanol.
- The endogeneous microbial flora (the biomass is not sterilized) is responsible for the production of lactic acid and other volatil fatty acids.
- The competition by the endogeneous lactic acid microorganisms converts at most 20% to 25% of the the total soluble carbohydrates

Interpretation and Conclusion

- Herbaceous Biomass contents soluble carbohydrates (0.1 g/gDM to 0.2 g/gDM) that can be converted to ethanol
- Ethanol concentration obtained are 10 to 15 gEthanol/kgFM (1.0 to 1.5%w/w)
- The conversion yields of soluble carbohydrates to ethanol are good but the fermentation process have to be improved to limit competions

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