

# Bioconversion of green herbaceous and agricultural biomass to ethanol: influence of enzymatic and thermo-chemical treatments

Stéphane Lamaudière, Bruno Godin, François Ghysel\*, Richard Agneessens\*, Thomas schmit\*, Sébastien Gofflot\*, George Sinnaeve\*, Didier Stilmant\*, Jérôme Delcarte\* and Patrick A. Gerin

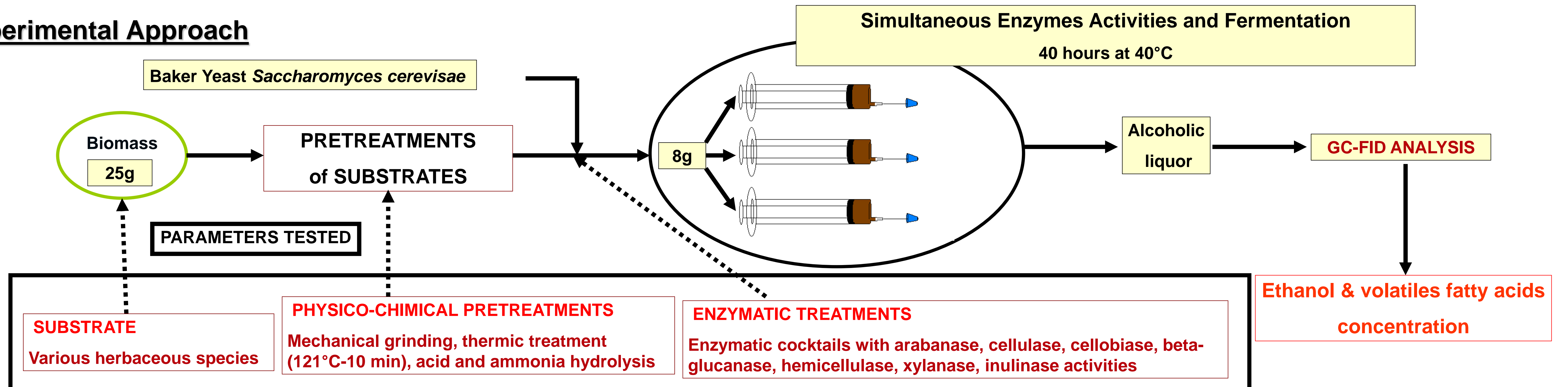
Unit of Bioengineering, Université catholique de Louvain, Croix du Sud 2/19, B-1348 Louvain-la-Neuve, Belgium (stephane.lamaudiere@uclouvain.be)

\* Walloon Agricultural Research Center, Agricultural engineering Department, Chaussée de Namur 146, 5030 Gembloux, Belgium

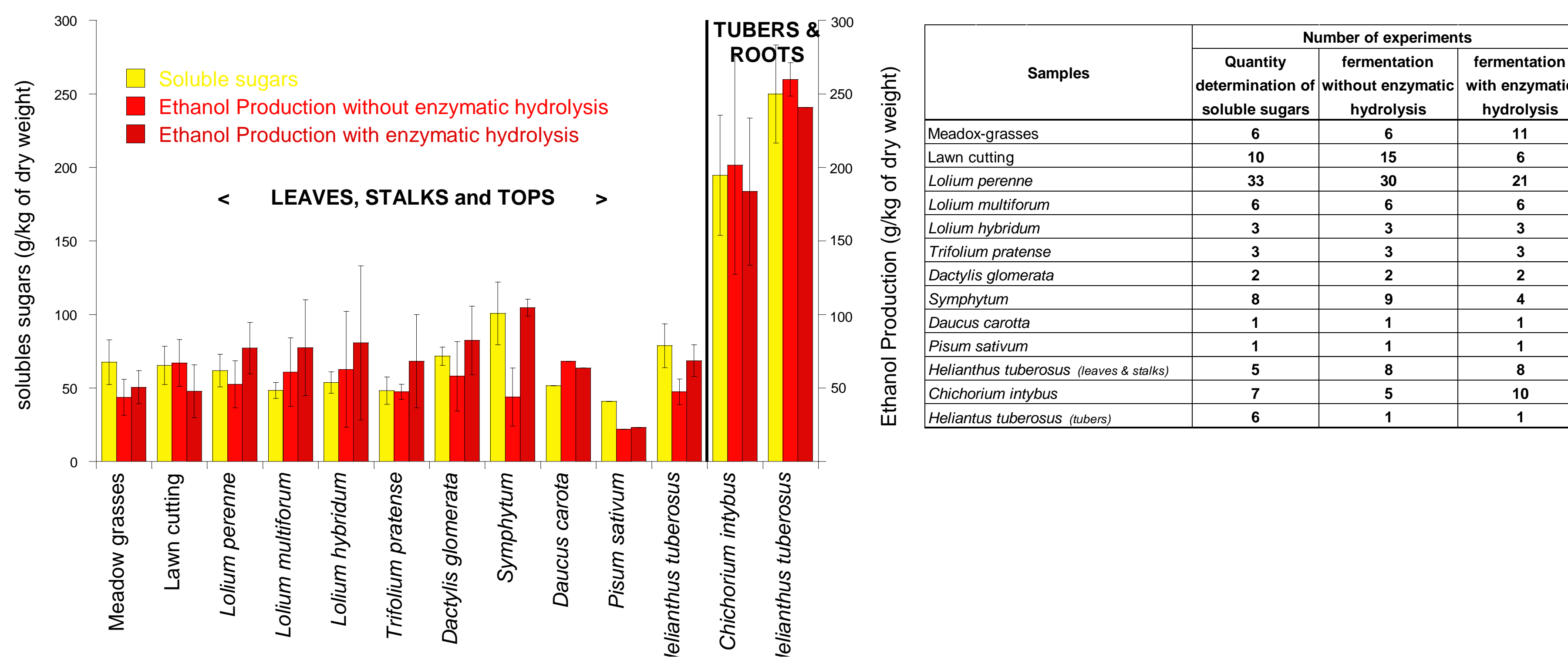
**Introduction:** Green agricultural residues and herbaceous biomass, could be a source of bioethanol and are potentially easier to hydrolyse than lignocellulosics.

- Aim:**
- To examine the feasibility of a simple ethanol fermentation process directly from crude, not sterilised, herbaceous biomass with baker yeast.
  - To investigate the influence of physico-chemical and enzymatic pretreatments on the ethanol fermentation on the conversion yield

## Experimental Approach

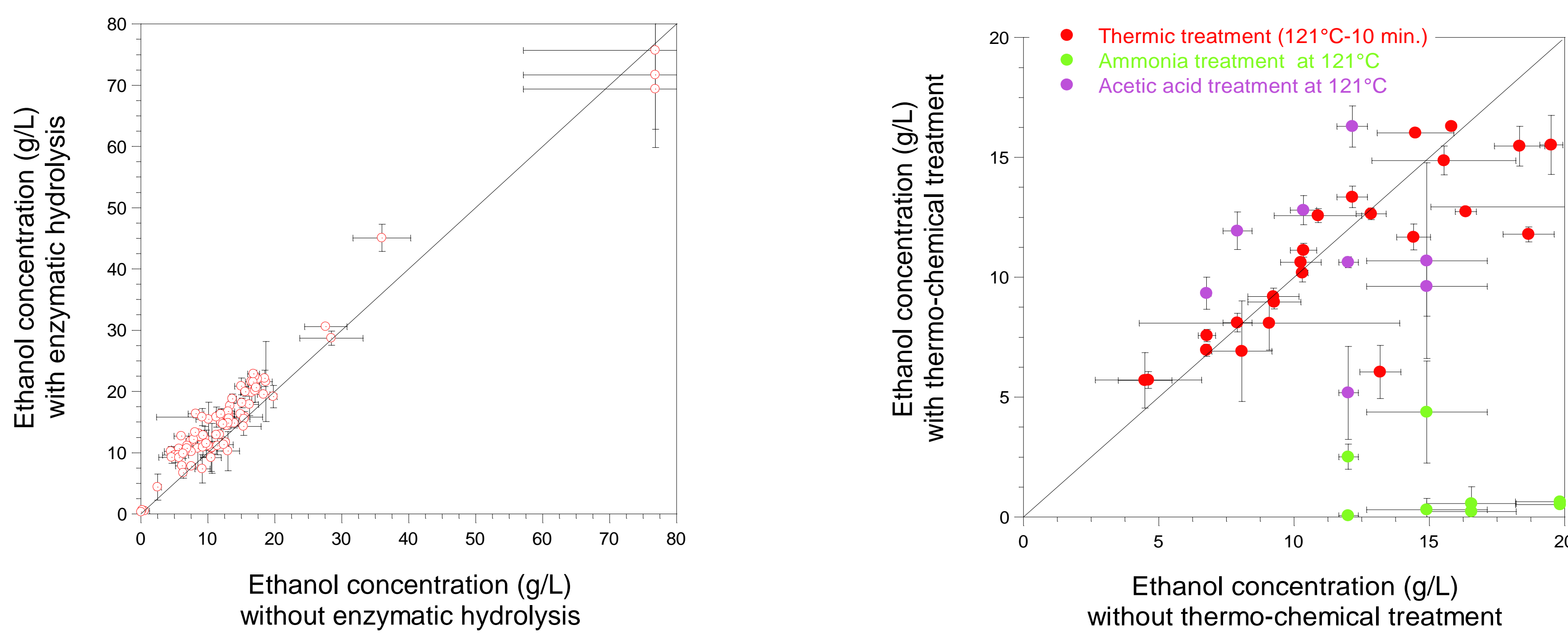


## Results



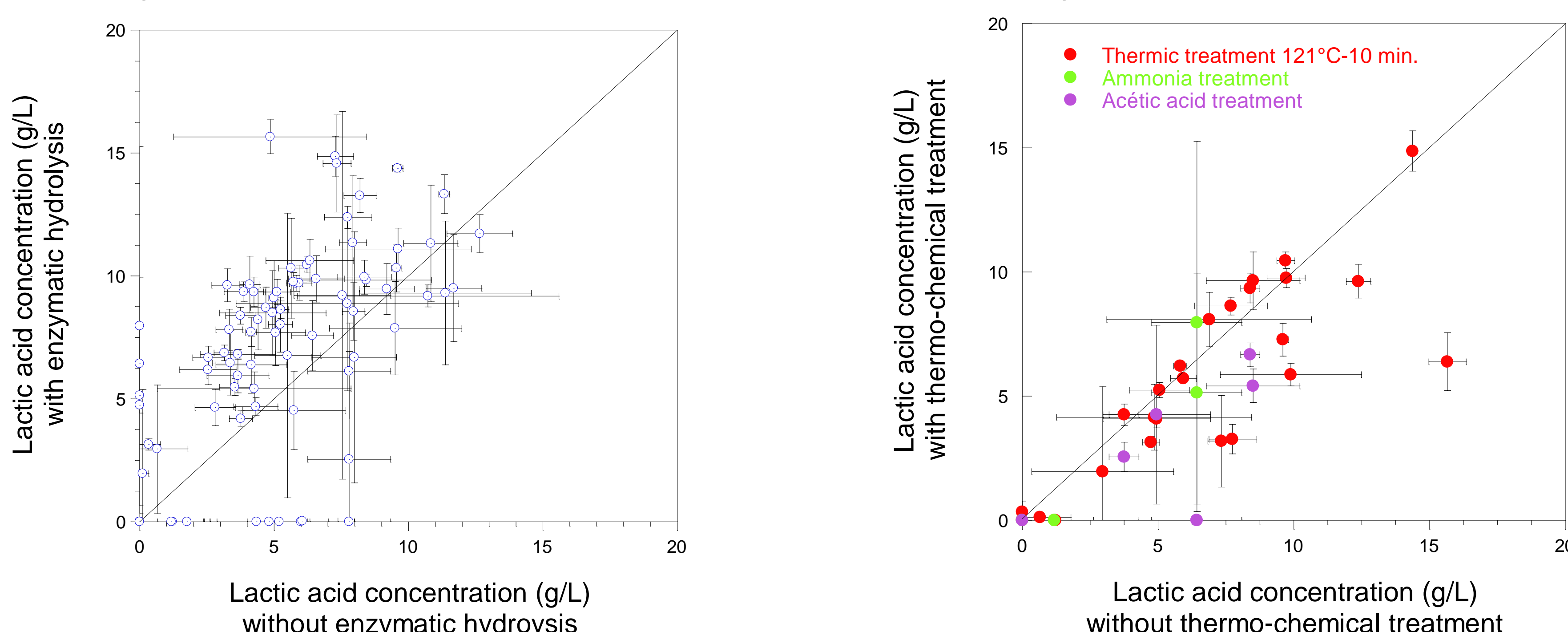
The conversion yield of soluble sugars to ethanol is in the range 80 – 100% of the theoretical yield (1 mole of glucose gives 2 moles of ethanol)

### Soluble sugars of various plants species are efficiently converted to Ethanol



- Ethanol concentration, range between 5-18 g/L for the herbaceous substrates and 30 g/L to 70 g/L with respectively chicory roots and Jerusalem's artichoke tubers.
- Enzymatic treatment (left) increases the ethanol concentration by about 2 to 3 g/L (left) but thermo-chemical treatments (right) are inefficient.
- Hot acetic acid and ammonia vapors and do not improve the ethanol concentration

### Enzymatic and thermo-chemical treatments are not very efficient to improve the conversion of green biomass to ethanol



- Up to 30% of soluble sugars can be converted to lactic acid by the substrate endogenous flora (also responsible for acetic and butyric acids production)

### Enzymatic and thermo-chemical treatments affect only slightly the competition between ethanol and lactic acid fermentations

## Interpretation and Conclusion

- Baker yeasts (*Saccharomyces cerevisiae*) can efficiently convert soluble sugars to ethanol directly from green herbaceous biomass and agricultural residues
- The ethanol concentration is low with respect to the requirements of recovery processes
- The loss of soluble sugars by thermo-chemical treatments is higher than the gain allowed by these treatments