Chemical composition and biofuels potentials of a wide diversity of plant biomasses

Bruno Godin[1,2], Richard Agneessens[1], Thomas Schmit[1], Stéphane Lamaudière[2], Jean-Pierre Goffart[1], Didier Stilmant[1], Patrick A. Gerin[2], Jérôme Delcarte[1]

[1] *Walloon Agricultural Research Center - CRA-W. Chaussée de Namur, 146. B-5030 Gembloux, Belgium*

[2] *Université catholique de Louvain - UCL. Earth & Life Institue, Bioengineering group - Croix du Sud, 2 box L7.05.19. B-1348 Louvain-la-Neuve, Belgium*

Corresponding email : b.godin@cra.wallonie.be

Introduction

• **To reduce** simultaneously human induced **global warming** and the **depletion of fossil fuel resources**, alternative production chains are necessary. One of the promising sources of **renewable and sustainable energy** are **plant biomasses**. They represent a huge amount of renewable resource for a sustainable bio-based economy. The **optimal valorization** of these biomasses chemical components, for energy and for green chemistry production, requires a **good knowledge** of the contents and molecular composition of **their components**.

Biomass suitability for energy conversion processes

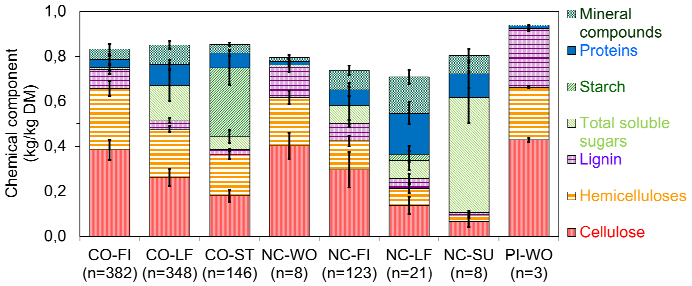
• **Depending on its composition**, each type of biomass can be better **suited to specific types of conversion processes**. In order to rapidly **compare the energy value of a wide diversity of plant biomasses and their suitability for conversion processes**, we selected and analyzed 3 properties, in addition to the chemical composition (main chemical components) and the dry matter content:

i)the **enzymatically digestible organic matter** (DOM) as a fast assessment of the **anaerobic digestibility** (biomethanation),

ii)the **theoretical bioethanol potential**, as a fast assessment of the **ethanolic fermentation**,

iii)the **higher heating values** (HHV), as a fast assessment for conversion by **combustion**.

Main chemical components

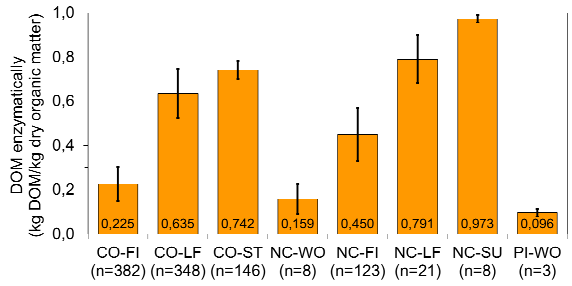


• The **8 distinctive biomass groups** have been clustered based on the results of the principal component analysis of the main chemical components.

• A **wide diversity of plant biomasses** revealed a **wide diversity of main chemical components contents**

CO-FI: **Commelinid fibrous biomass** (e.g. miscanthus, switchgrass)
CO-LF: **Commelinid less fibrous biomass** (e.g. fiber sorghum, fescue)
CO-ST: **Commelinid high starch biomass** (e.g. fiber corn)
NC-WO: **Non-commelinid woody biomass** (e.g. willow, aspen, oak wood)
NC-FI: **Non-commelinid fibrous biomass** (e.g. hemp, sunflower stalk)
NC-LF: **Non-commelinid less fibrous biomass** (e.g. potato leaf, alfalfa)
NC-SU: **Non-commelinid high sugars biomass** (e.g. chicory tuber)
PI-WO: **Pinophyta woody biomass** (e.g. spruce, pine wood)

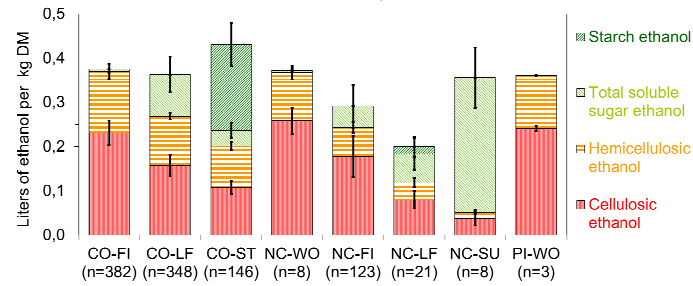
Enzymatically digestible organic matter



• **High enzymatically DOM→ High total soluble sugars**, **starch** and **proteins** contents
• **Low enzymatically DOM → High fibers** (cellulose, hemicelluloses and lignin) contents

• **Very suitable for anaerobic digestion process → CO-LF**, **CO-ST** (high starch content), **NC-LF** (high protein content) and **NC-SU** (high total soluble sugars content)
• **Suitable for anaerobic digestion process → NC-FI**
• **Unsuitable for anaerobic digestion process → CO-FI** (high fibers contents), **NC-WO** (high fibers contents) and **PI-WO** (high cellulose and hemicelluloses contents ; very high lignin content)

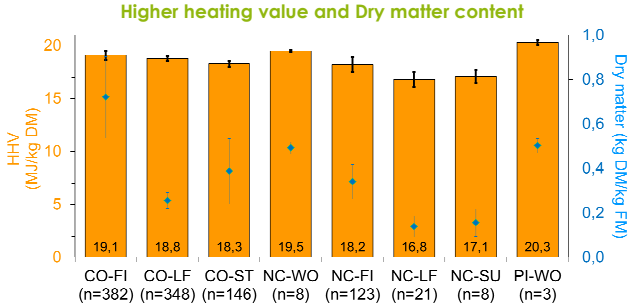
Theoretical bioethanol potential



• **High structural carbohydrates ethanol → High cellulose** and **hemicelluloses** contents
• **Very suitable structural carbohydrates ethanol process → CO-FI**, **NC-WO** and **PI-WO**
• **Suitable structural carbohydrates ethanol process → CO-LF**, **CO-ST**, **NC-FI**
• **Unsuitable structural carbohydrates ethanol process → NC-LF** and **NC-SU**

• **High non-structural carbohydrates ethanol → High total soluble sugars** and/or **starch** contents
• **Very suitable non-structural carbohydrates ethanol process → CO-ST** (high starch content) and **NC-SU** (high total soluble sugars content)
• **Suitable non-structural carbohydrates ethanol process → CO-LF**
• **Unsuitable non-structural carbohydrates ethanol process → CO-FI**, **NC-WO**, **NC-FI**, **NC-LF** and **PI-WO**

Higher heating value and Dry matter content



• **High HHV→ High organic matter** content (complement of mineral compounds content)
• **Combustion process** needs **biomasses** with **low water** content (complement of dry matter content)

• **Very suitable for combustion process → PI-WO**, **NC-WO** and the **most fibrous CO-FI** (e. g. miscanthus and bamboo)
• **Suitable for combustion process → CO-FI**
• **Unsuitable for combustion process → CO-LF**, **CO-ST**, **NC-FI**, **NC-LF** and **NC-SU**

Conclusion

• **Each type of biomass** is **suitable** for a **given energy conversion** processes because of the specifity of each type of process. This **suitability** can be **determined** based on the **main chemical component** contents which are **linked** to the **fast assessment method** of each process.

Programme cofinancé par l'Union européenne
Fonds européen de développement régional
EU-gefördertes Programm
Europäischer Fonds für regionale Entwicklung

Walloon Agricultural Research Centre