Identification of tissular origin of maize straw by multispectral image analysis in fluorescence to understand the bioconversion of the tissues at macroscopic scale

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3rd International Symposium on Green Chemistry
May 3-7, 2015 - La Rochelle - FRANCE

N°405 / PC

Biomass conversion

IDENTIFICATION OF TISSULAR ORIGIN OF MAIZE STRAW BY MULTISPECTRAL IMAGE ANALYSIS IN FLUORESCENCE TO UNDERSTAND THE BIOCONVERSION OF THE TISSUES AT MACROSCOPIC SCALE

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ABSTRACT

The optimization of lignocellulosic biomass bioconversion requires taking into account the variability in chemical composition of plant tissues. Histology can be determined on well-structured samples using morphological information together with chemical staining. However bioconversion comes after grinding plants to particles. Taking advantage of the autofluorescence of some cell wall specific components of lignocellulosic biomass, recording multispectral fluorescence images could be informative of particle tissue origin. The objective of this study is to evaluate the ability of using fluorescence multispectral imaging to identify the main tissues in maize stems.

Recent equipments are available to acquire multispectral fluorescence images using filters with specific excitation/emission wavelengths. These devices allow obtaining chemical related signal from cell walls in organ sections and also in powders at the macroscopic scale (~1 cm^2). Associated to the rapidity of multispectral image acquisition it is possible to envision statistical analysis including biological variability. In this study, a multi-zoom macroscope AZ100M has been equipped with 4 filter blocks to acquire images under UV, blue and green excitation light. Emission light was recovered through long pass filters and, taking advantage of the RGB channels of the color camera, each image were split in three channels and stack all together to obtain a 12 channels multispectral image. In such multispectral images, each pixel is characterized by an intensity profile that can be considered as a spectral signature. Acquisition parameters have been set to obtain alignment of images with all filters, for good repeatability of intensities and magnification is a compromise between large field of view and good resolution.

Multispectral images were acquired on maize stem cross-section. Specific fluorescence profiles were extracted for tissues such as parenchyma, sclerenchyma, epiderma. Chemometric approach has been proposed to analyze such images considering pixels as spectra therefore ignoring the spatial information. Based on a priori knowledge, pixels coming from different tissues were selected in maize stem cross-section images to calibrate a model of supervised classification using linear discriminant analysis. The model was successfully applied to the entire images of maize stem sections. Most of pixels are correctly predicted.

This study shows the potential of macrofluorescence for identifying tissues in maize stems through their auto-fluorescence intensity profile acquired with multispectral imaging system. Clustering methods will be applied to determine the possible number of distinguishable groups by taking into account variability within sections in order to increase the prediction ability of the model.

Then the approach will be extended to particles to identify their tissue origin and to follow their behavior on dry fractionation process and enzymatic degradation.

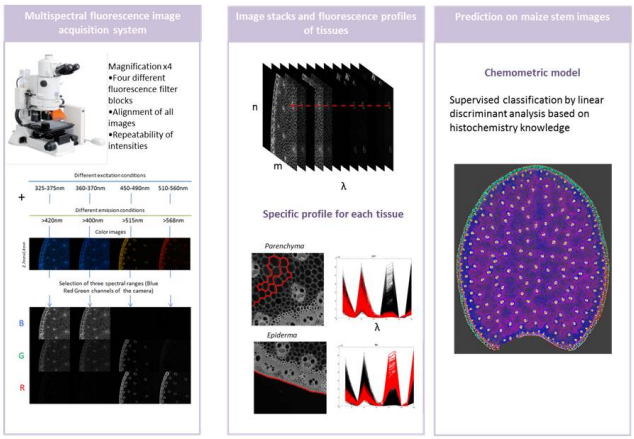

FIG1 LEGEND

Fluorescence multispectral imaging applied to maize stem section: the different steps from image acquistion to data processing

FIG2 LEGEND

KEYWORDS

Lignocelluloses | histology | autofluorescence | macroscope | multispectral fluorescence imaging | chemometric analysis

REFERENCES

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