Title
Discovery of substrate-targeted enzymes for the degradation of biomass by Metatranscriptomics

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Current bioethanol production from lignocellulosic biomass is a relatively inefficient process requiring energy-intensive chemical and physical pretreatments. The identification of robust cellulolytic enzymes (e.g., cellulases and hemicellulases) from lignocellulolytic microbial communities is a necessity to achieve the ambitious goal of replacing 30% of the national petroleum based gasoline with bioethanol by 2030. Switchgrass ( Panicum virgatum), a perennial, warm-season grass is native to most states of the U.S. and has drawn a lot of attention as a promising biofuel crop. Forage fermenters such as cattle and sheep possess an area within the gastrointestinal tract that is well separated from the acid-secreting portion of the stomach.

This fermentation chamber harbors a microbial community that is able to degrade the plant celluloses, hemicelluloses, pectins, fructans, starches, and other polysaccharides to monomeric and dimeric sugars. The bovine rumen exceeds a volume of 100 L and represents an enormous, easily accessible and manipulable system (Fig. 2) to study the microbial community and its biocatalysts adapted to the degradation of selected biofuel crops such as P. virgatum.

Metagenomics and Metatranscriptomics of the microbial community associated with biofuel crops will allow us to identify the microbes responsible for lignocellulose degradation and the genes that are overexpressed during fiber hydrolysis.

Sequence-independent enzyme activity assays will complement our quest for genes and proteins that are required for efficient lignocellulose degradation. An outline of our project is shown in Figure 3.

We hope that the findings of our project will provide significant insight into the process of lignocellulose degradation and facilitate the construction of genetically modified organisms (i.e. Escherichia coli, Saccharomyces cerevisiae, and Sulfolobus solfataricus) and ultimately the development of an efficient process to convert lignocellulosic biomass into bioethanol at industrial scale.