Investigation of Pyrolysis Aqueous-Phase Fraction as a Possible Feedstock for Mixed Microbial Cultures

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Introduction and Methods

Pyrolysis is the thermal degradation in absence of oxygen, and can be used as a simple method to brake down the Macromolecules of different biomass in order to make them more bioavailable for the biological conversion into Valuable platform chemicals such as Volatile Fatty Acids or Ethanol. Pyrolysis yield for different products: Biochar, Aqueous Phase Liquid (APL), non water-soluble oil (Pyrolytic Lignin), and syngas. Since the potential fermentable products are APL and syngas, Chemical Oxygen Demand (COD) was used as a energy tracker to determine the best conditions that maximise the yield of those fractions. Using different chemical analysis techniques, four representative categories of pyrolysis product were tracked to investigate the concentration of easily biodegradable compound (such as anhydro-sugars or light carbon compounds) and potentially toxic molecules (furans and phenols) in APL. In the first part, three different biomass (Fir, Switchgrass, and Cellulose) were used to compere the yield of pyrolysis product and the difference in the composition of APL. Further, temperature effect on FIR pyrolysis products was investigated.

All the experiments were conducted with a Quartz Tube Reactor, using nitrogen as carrier gas. The setup is shown in **Figure 1**, the system was closed and the gas was recirculated through a peristaltic pump.

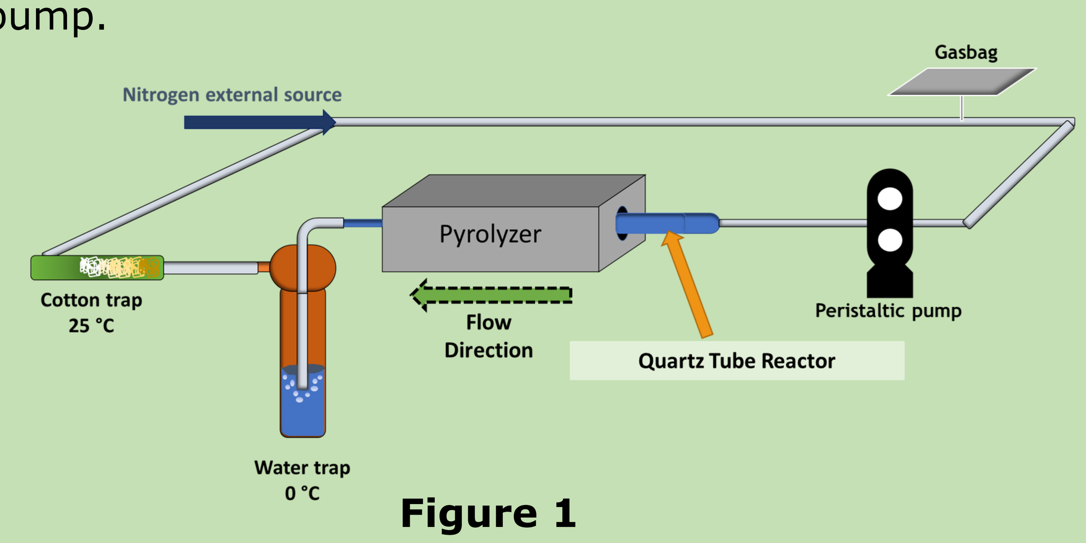
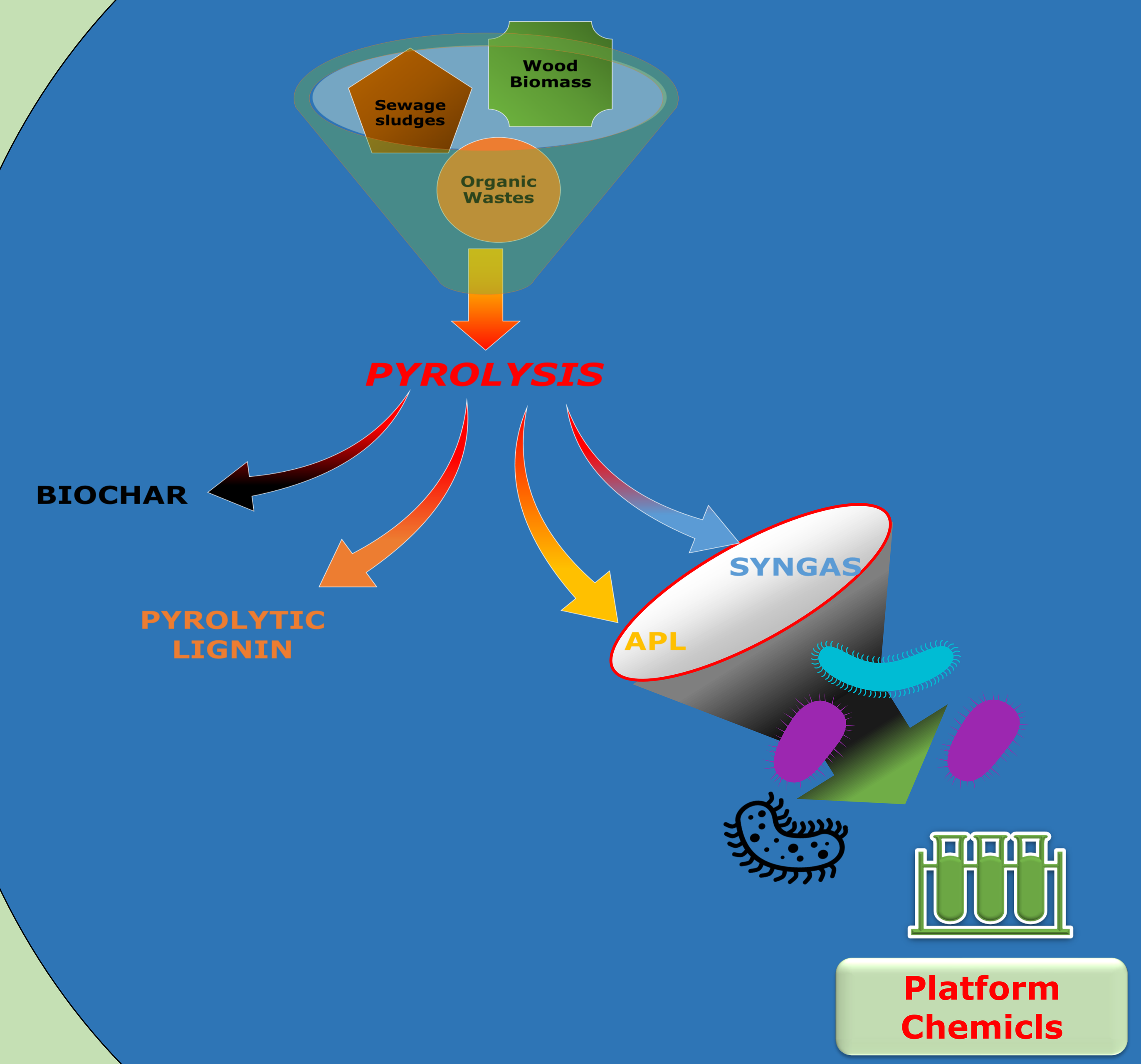
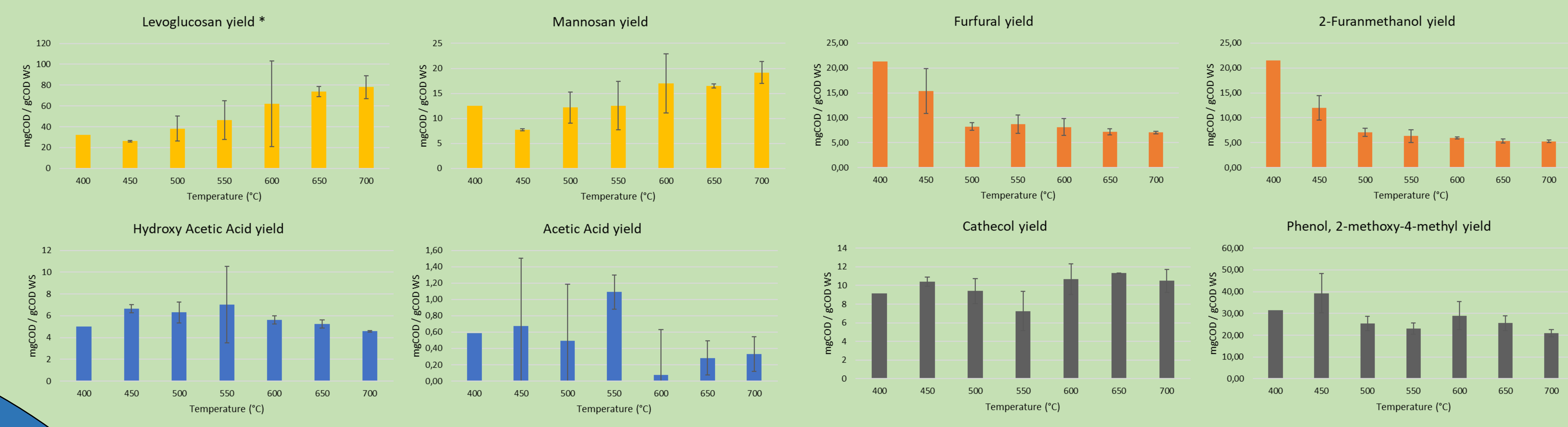


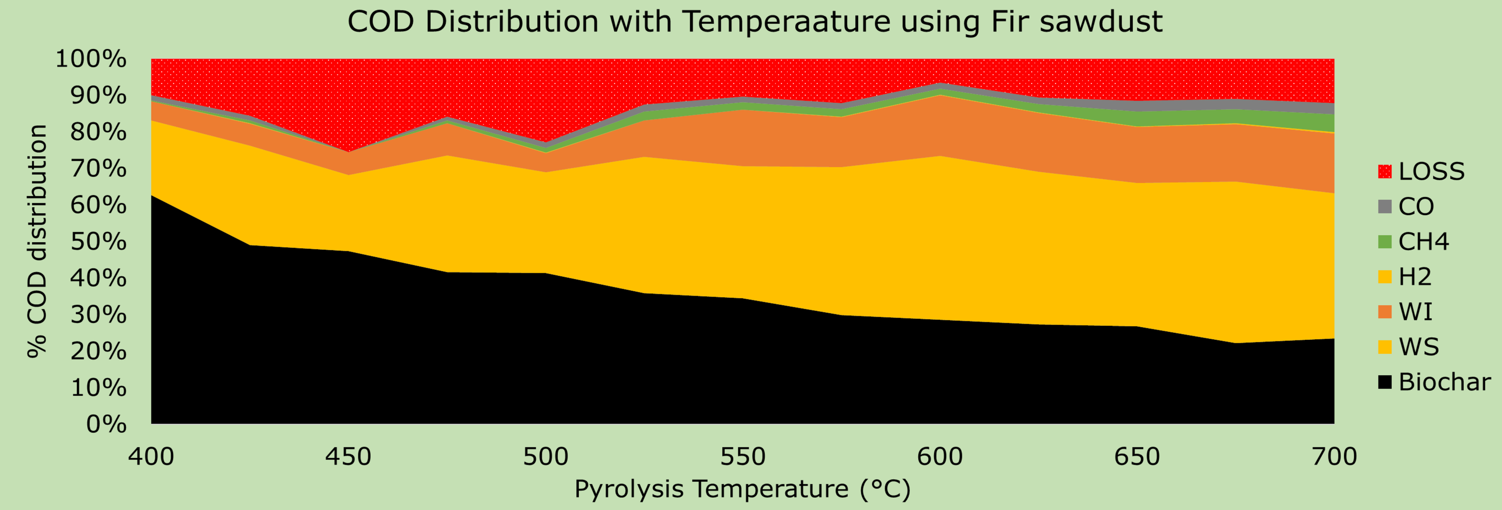
Figure 1



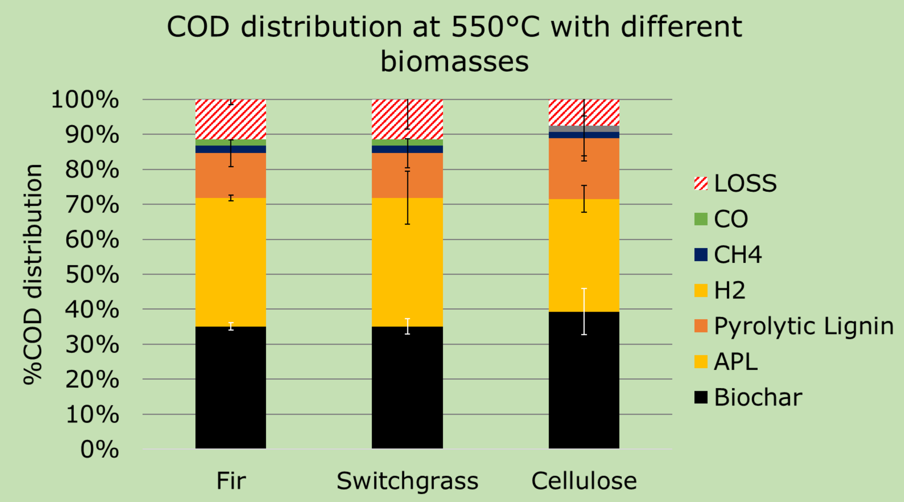
Differences Between Temperatures

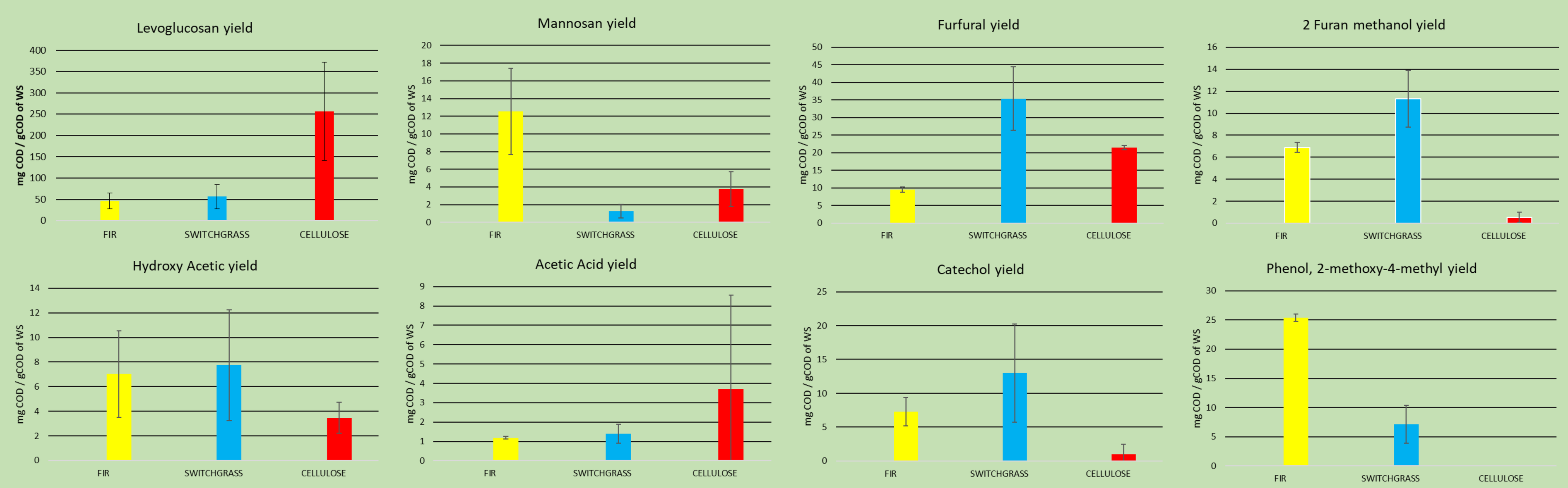


Yield of the target molecules choose in APL from pyrolysis Temperatures
(Response Factor considered 1)



Difference Between Biomass





Yield of the target molecules choose in APL from different biomass pyrolysis (Response Factor considered 1)

Results and Conclusions

Results indicate more than 50% of COD can be funnel into APL and syngas, even with a relatively simple pyrolysis system as the one use for these experiments. From the chemical characterization of APL of different biomass, cellulose, as expected, had the higher yield of easily fermentable compound, with minimal amount furans and absence of phenols. The higher amount of phenols was founded into Fir's APL, probably due to the high content of lignin. Switchgrass, on the other hand, contained more furans as compared to Fir, probably originated from hemicellulose.

From the experiments with different temperature, an increasing yield of APL was achieved increasing from 400 to 600°C. Higher temperatures revealed a stable trend of APL and Pyrolytic Lignin, however the yield of syngas started to increase, probably due by a partial gasification of biochar to form CO, CO_2 and H_2. Anhydrosugars yield increase with temperature, however, due to the high standard deviation, it is not clear if such increase in average amount is real. However, phenols, and in particular furans, showed a negative trend with the increase of temperatures.

Such results represents the base for further investigation, with the idea to determine how pre-treatments of biomass, or pyrolysis conditions, could affect the composition of APL. However, from this initial data it's clear that pyrolysis can convert more than 50% of the energy content into fraction potentially fermentable, representing a fast way to process a wide variety of wastes, to yield green platform chemicals that could be use to produce fuels, energy and materials.