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# Improvement of anaerobic digestion of lignocellulosic biomass by coupling fungal and chemical pretreatments

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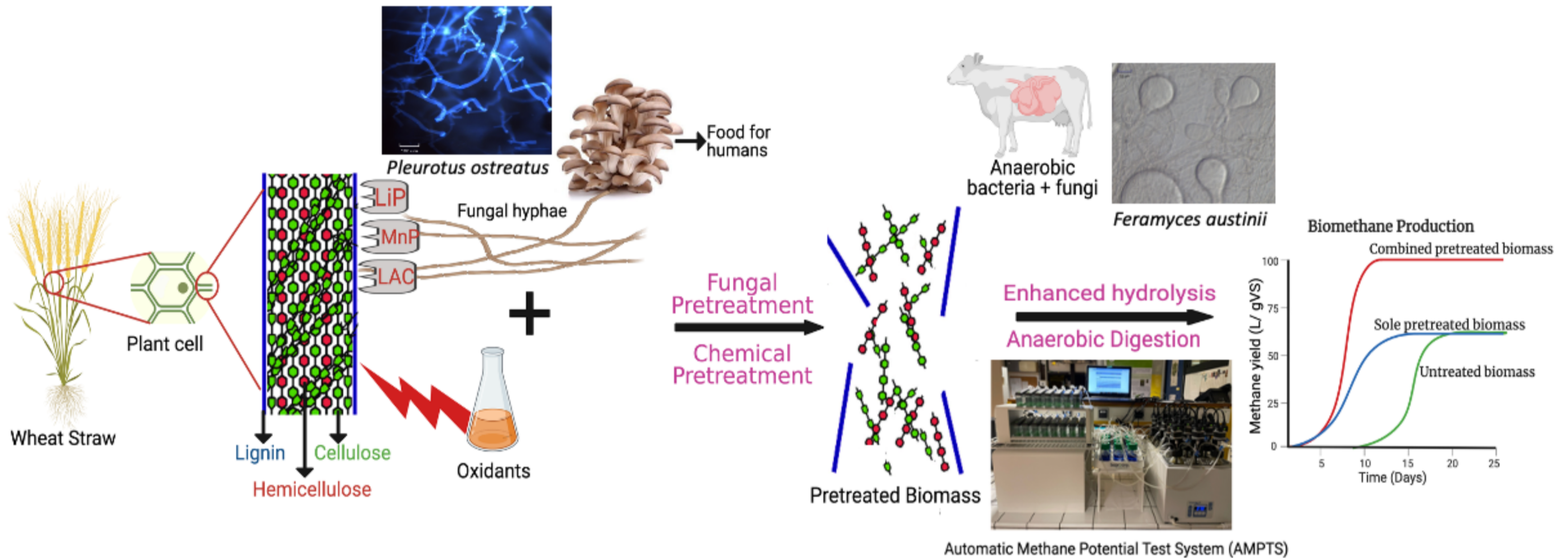
## INTRODUCTION

Biogas production from lignocellulosic biomass has not been scaled up efficiently despite its high methane potential. This is due to the recalcitrance of the complex lignocellulosic biomass structure which is majorly caused by lignin. Pretreatment, which is an expensive step, is essential for the disruption of lignin and for increasing the accessibility of microbes to cellulose and hemicellulose. Based on the biomass and the downstream process, the appropriate pretreatment steps need to be chosen. Combining different pretreatments helps to lower the severity of the drawbacks of the individual strategies<sup>(1)</sup>.

## OBJECTIVE

Aim of this project is to develop an economically feasible and environmentally benign combined pretreatment strategy to improve the biogas production from wheat straw.

## METHODOLOGY



### Biological: Fungal Pretreatment

#### Aerobic Fungi (*Pleurotus ostreatus* - Oyster Mushroom)

Interest in using mycelium residues after harvesting of oyster mushrooms  
 White rot fungi (WRF) - Ligninolytic properties

#### Anaerobic Fungi (*Feromyces austinii* - Neocallimastigomycota)

Present in the digestive system of various animals  
 Produces plant carbohydrate hydrolysing enzymes

#### Chemical: Oxidant Pretreatment ( $\text{Fe}^{2+}$ and $\text{H}_2\text{O}_2$ )

and/or Mimics the Fenton reaction-induced biomass decay by WRF  
 Facilitates delignification  
 Increases enzymatic digestibility

## RESULTS

### Scanning electron microscopy

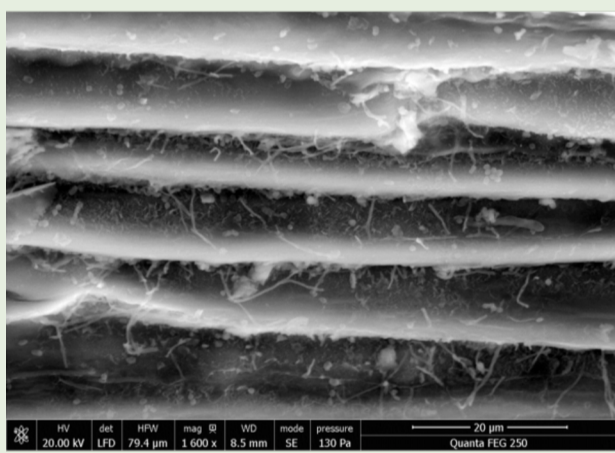


Fig. 1: Untreated wheat straw

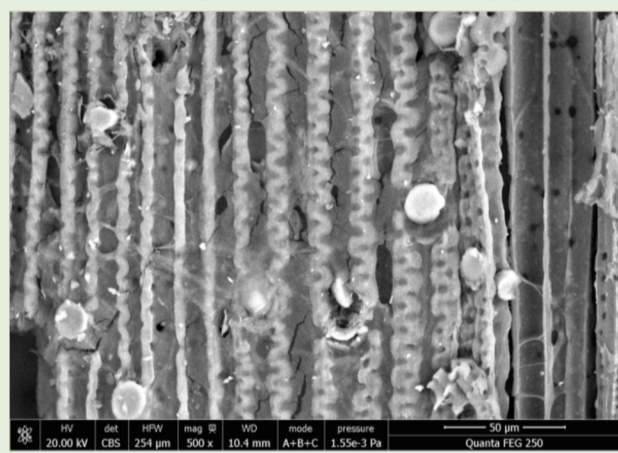


Fig. 2: Spent mushroom wheat straw (SMWS)

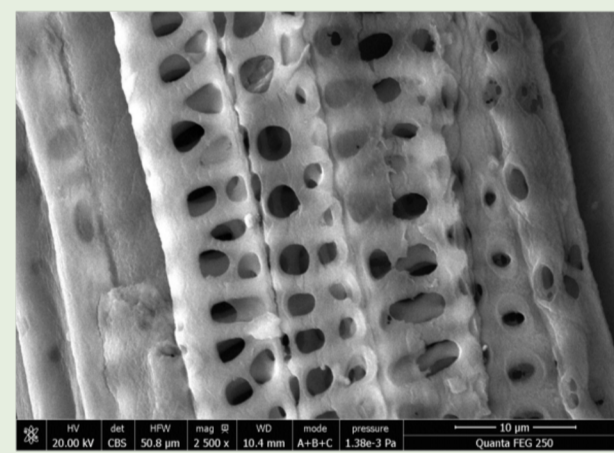


Fig. 3: Oxidant pretreated wheat straw

Scanning electron microscopy (SEM) helps to observe the structural changes in wheat straw. Untreated wheat straw has intact and smooth structure (Fig. 1). Complete structural modifications are seen in spent mushroom wheat straw generated after 2 rounds of harvests (Fig. 2). Pores caused by modification of lignin and hemicellulose content are observed in oxidant pretreated wheat straw (Fig. 3).

### Biomethane yield (Fig. 4):

2 cycles of harvest of mushrooms take about 14 days. The spent mushroom wheat straw generated produced 12% higher biomethane yield as compared to wheat straw just seeded with oyster mushroom mycelia. While oxidant pretreatment with 1.047 mM  $\text{Fe}^{2+}$  and 147.5 mM  $\text{H}_2\text{O}_2$  for 24 hours produced 15.71% increase in biomethane yield as compared to its control.

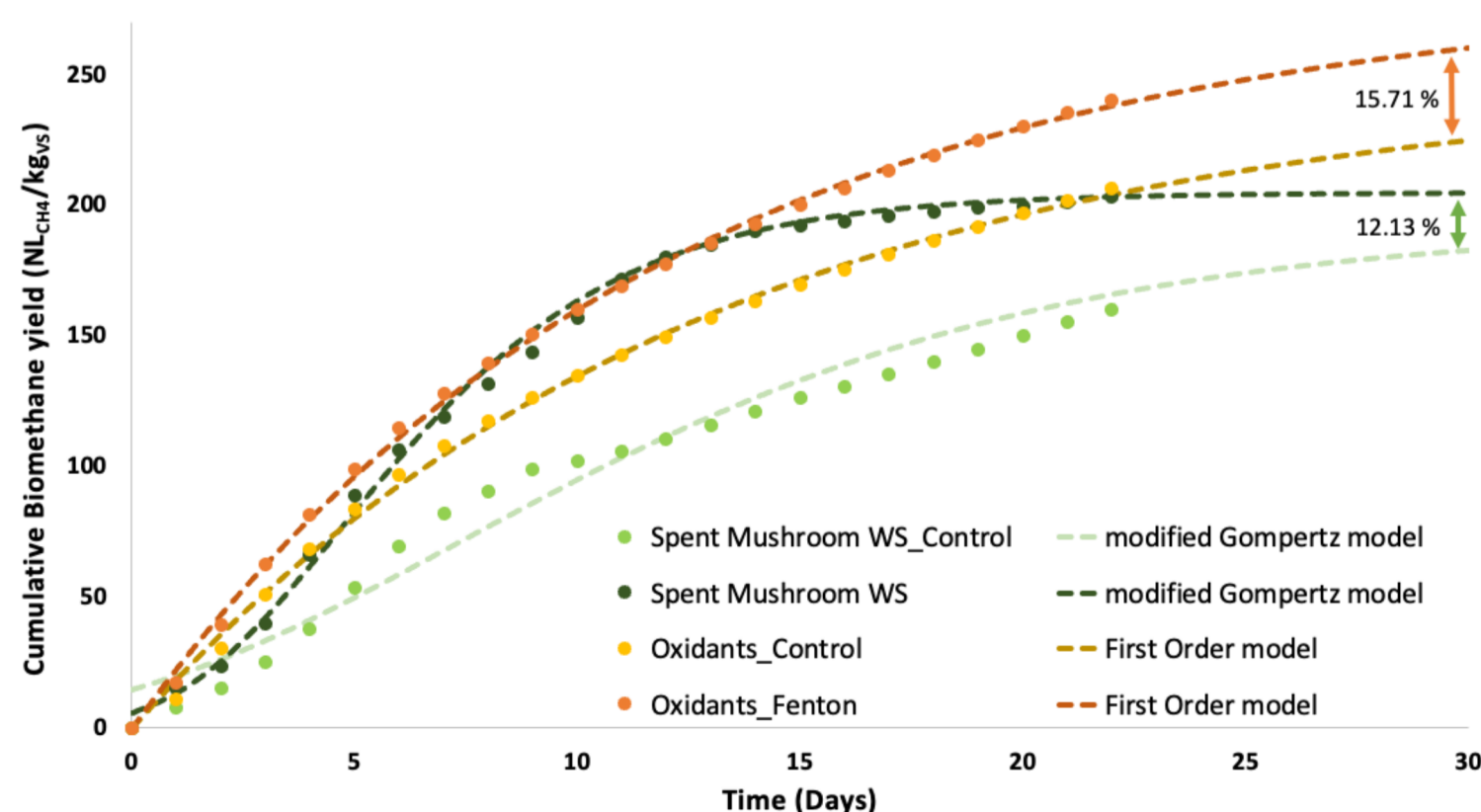


Fig. 4: Cumulative biomethane yield and kinetic modeling using First order and modified Gompertz equations

## CONCLUSION

Pretreatment has been viewed as the most expensive step in lignocellulosic biomass refineries. Oxidant pretreatment at very low concentration is effective to produce an increase in biomethane yield. It requires very less time as compared to biological pretreatment. For every kg of mushrooms produced, 3-5 kg of spent mushroom substrate is generated which is difficult to dispose due to presence of mycelium. Consequently, using spent mushroom substrate for biogas production is an effective alternative. Therefore, combining the two methods can improve substrate degradation and hence the biogas yields.

## ACKNOWLEDGEMENTS



## REFERENCE

<sup>(1)</sup> Meenakshisundaram, S., Fayeulle, A., Leonard, E., Ceballos, C. and Pauss, A., 2021. Fiber degradation and carbohydrate production by combined biological and chemical/physicochemical pretreatment methods of lignocellulosic biomass - A review. *Bioresource Technology*, 331, p.125053.

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