# The Effect of Poultry litter Biochar on *Saccharomyces cerevisiae* growth and Bioethanol Production

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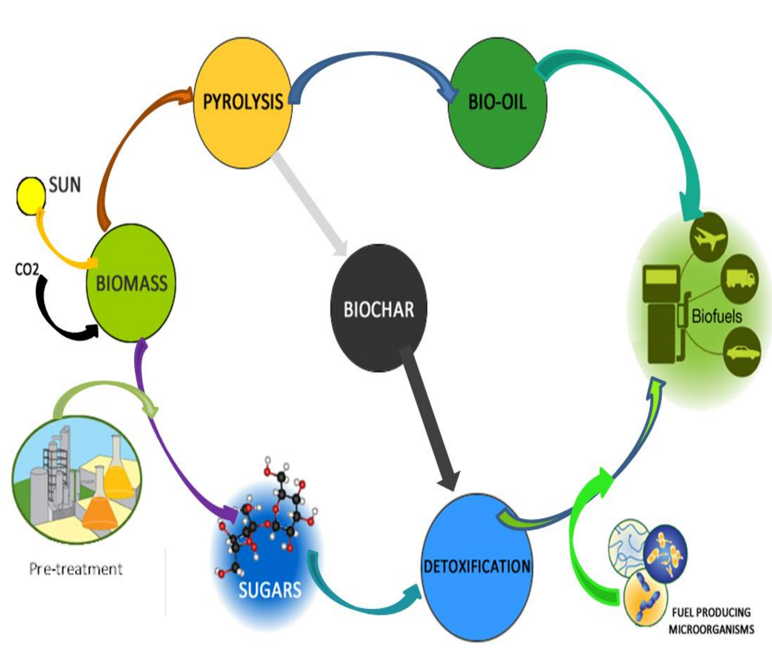
## Abstract

Studies have shown that poultry litter biochar produced during the pyrolysis of poultry litter biomass contains a high level of valuables nutrients such as: Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Iron, and Sodium (Agblevor et al…2009). Inhibitory compounds such as: furaldehydes, weak acids, and phenolics generated during the pretreatment of lignocellulosic biomass are found to be toxic to the fermenting microorganisms, therefore cause a low production of bioethanol. Biochar has been reported to have a high absorption capacity of chemicals and acid neutralization. In this work, we investigated the effect of poultry litter biochar on *Saccharomyces cerevisiae* growth, enzyme hydrolysis of steam exploded biomass, and bioethanol production. *S.cerevisiae* was cultivated in different batches of biochar broth, the enzyme hydrolysis of steam exploded poplar was performed, and the fermentation of the hydrolyzate was done. Results show that *S.cerevisiae* can grow on poultry litter biochar broth, and preliminary results also show that poultry litter biochar can improve enzyme hydrolysis and bioethanol production.

## Introduction

- Bioethanol produces fewer emissions than fossil fuels, generates no net , and compatible with current infrastructures.
- However increasing the yield of bioethanol and lowering it cost to compute with the petroleum fuels is a major challenge.
- Inhibiting compounds: furaldehydes, weak acids, and phenolic are too toxic for the yeast cells.
- Poultry litter Biochar can be a potential solution: a nutrient source for *S.cerevisiae*, and a potential lignocellulosic hydrolysate toxics removal.




Two methods of Biofuels production

## Objectives

To investigate the effect of poultry litter biochar:

- on the growth of *Saccharomyces cerevisiae,*
- on enzyme hydrolysis,
- and on bioethanol production.

## Materials and Methods

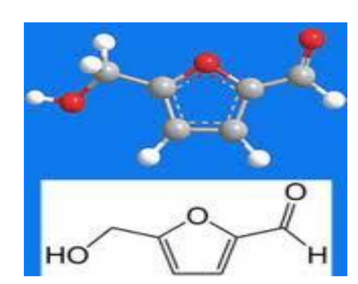
- The Beauty of Poultry litter Biochar

Poultry-litter Biochar

Poultry litter Biochar → C, H, N, S ,Cl ; K, P, Ca, Mg, Na, Fe

- Biochar as a nutrient source for microorganisms
  - Yeast *Saccharomyces cerevisiae* was cultivated in three different batches of biochar broths: 1g/l, 2g/l, and 3g/l
  - The flasks were incubated at $35^{o}$ C and 225 rpm for 24 hours
- Biochar as a toxic removal

Lignocellulose Biomass → Pretreatment → Enzyme Hydrolysis → Fermentation → BioEthanol

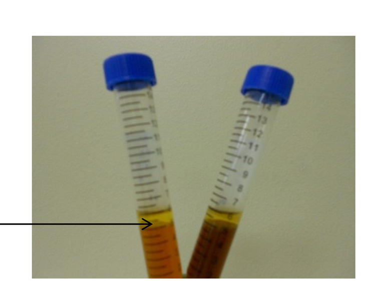



HMF (acs.org)

- *Trichoderma reesie* and CTec2 were used to hydrolyze the steam exploded poplar

$$C_6H_{12}O_6 \xrightarrow{Yeast} 2C_2H_5OH + 2CO_2$$

- Liquid liquid extraction



Upper layer

Fermentation broth

- Ethanol was analyzed by Gas chromatography

## Results

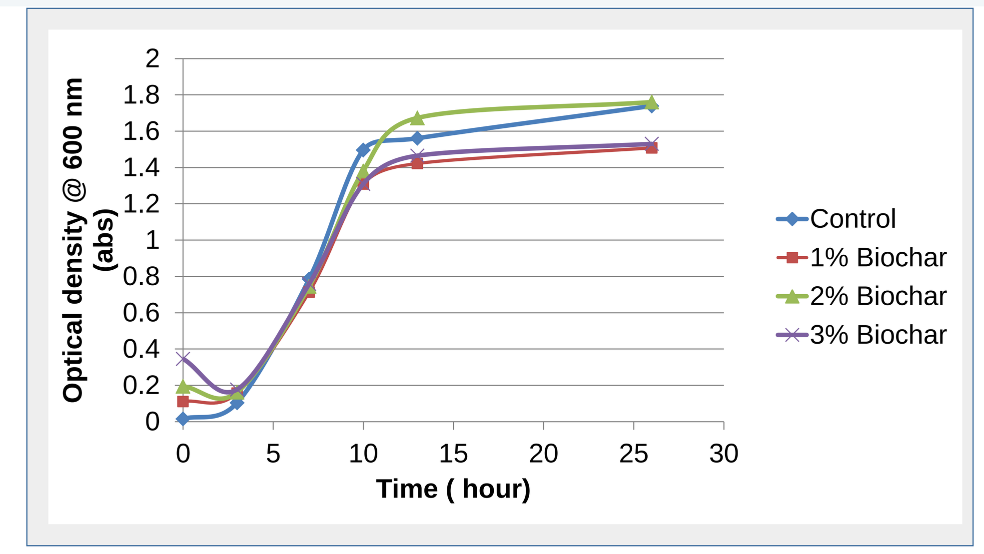



**Figure1**: Growth curve of *S. cerevisiae* in biochar broth

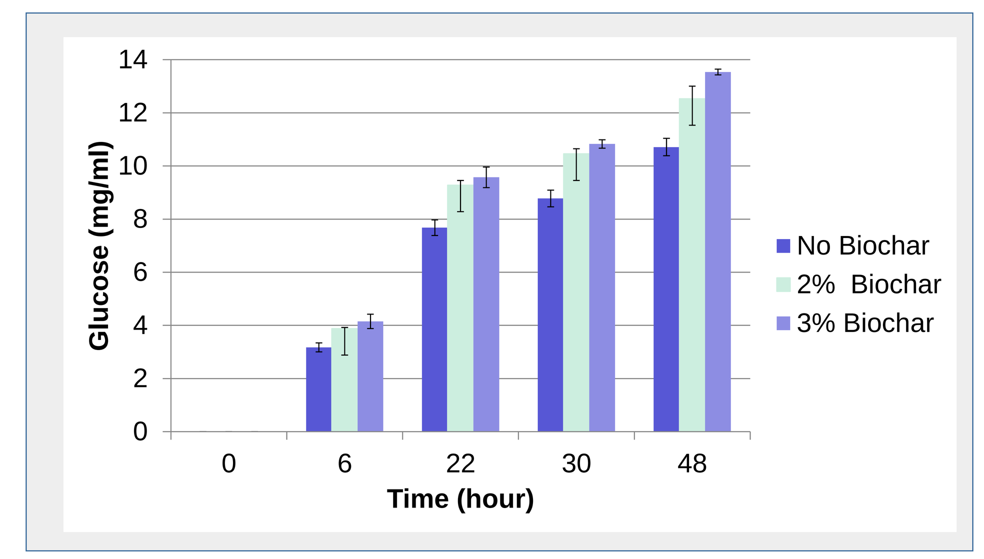



**Figure2**: Glucose concentration with *T.reesei* 3% w/w (g enzyme/g cellulose) loading

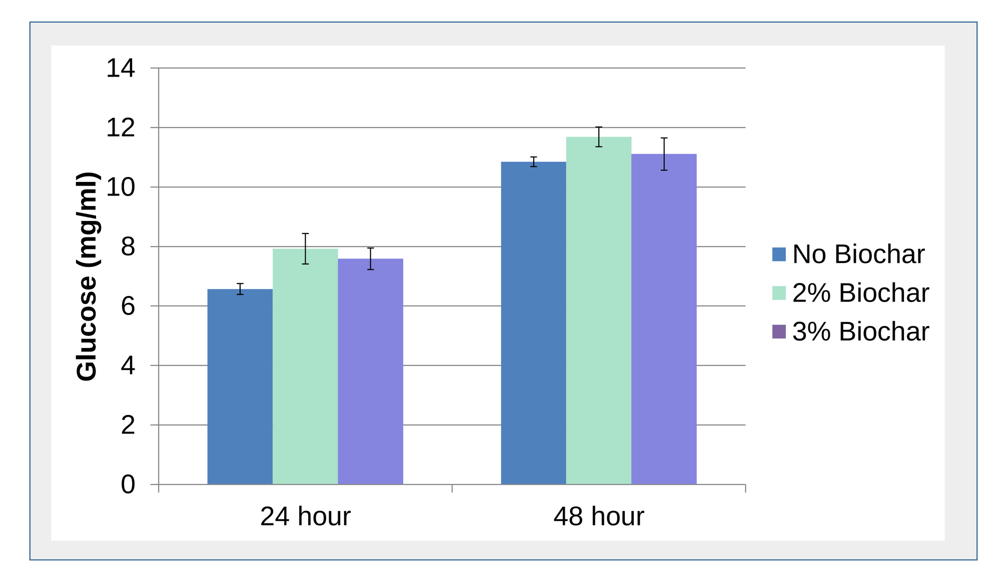



**Figure2**: Glucose concentration with *CTec 2* 3% w/w (g enzyme/g cellulose) loading

| | Average ethanol (% v/v) | | |
|---|---|---|---|
| Time (hour) | No Biochar | 2% Biochar | 3% Biochar |
| 24 | 0.752 | 0.906 | 0.753 |
| 48 | 1.195 | 1.237 | 1.545 |

**Table 1**: Ethanol produced ( % v/v)

## Results cont'd

- The plot shows that 2% biochar may be the optimal concentration of biochar that gives the best yeast growth.
- The highest glucose concentration was 25% (w/w) using *Trichoderma reesei* at 3% biochar broth, and 20% (w/w) using *CTec2* at 2% biochar broth.
- Ethanol produced was approximately 1%, 1.2% , and 1.5% (v/v) respectively for no biochar, 2%, and 3% biochar broth.

## Conclusion

- Yeast *S.cerevisiae* can grow on Poultry litter Biochar broth, hence poultry litter biochar can be used in any other fermentation process.
- The addition of poultry litter biochar had a positive effect on the enzyme hydrolysis of poplar however the glucose produced will depend on the biochar concentration and the cellulase type.
- Ethanol produced was very low but there was an increased from without biochar to with biochar.
- Poultry litter biochar can be consider a method to improve the economical success of lignocellulosic bioethanol.

## References

1. F.A. Agblevor, et . al. (2010) W. Management 298-307
2. Chelsae Wingreen, Foster A. Agblevor
3. Ellen R. Gaber, et. al. (2010)
4. W.Parawira and M.Tekere. Informa Healthcare 2011. 0738-8551
5. Hisashi M. et. al. (2003) En. And M. Technology 32. 396-400
6. Necdet K. et. al. (2011)
7. Bruno O. Dias, et. al.(2010).J.of Bio.Technology **101** 1239–1246.
8. Ayhan Demirbas. (2009) Springer 978-1-84882010-4
9. Michael L. Shuler/F. Kargi. 2nd edition. (2002) 0-13-081905-5

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