Imperial College London

THESSALONIKI 2021

27 June 2021

Pretreatment of Lignocellulosic Biomass using Tannery Wastewater for Solid State Anaerobic Digestion

A. B. Yazid, S. Grimes, S. R. Smith

Department of Civil and Environmental Engineering,
Skempton Building, Exhibition Road, SW7 2AZ, London
aby108@ic.ac.uk

Imperial College London

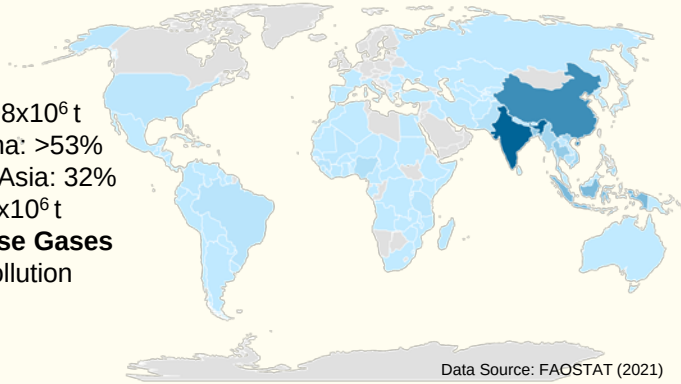
Kano City,

90% of Nigeria's tanning
Tannery Wastewater
$1x10^6$ m^3y^{-1}
Untreated, discharged
Water pollution crisis
Beamhouse 80%

Rice Paddy Burning (2018)

2018

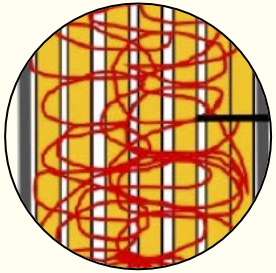
Globally: $108x10^6$ t
India & China: >53%
South East Asia: 32%
Nigeria: $1.8x10^6$ t
Green House Gases
Local Air Pollution



Data Source: FAOSTAT (2021)

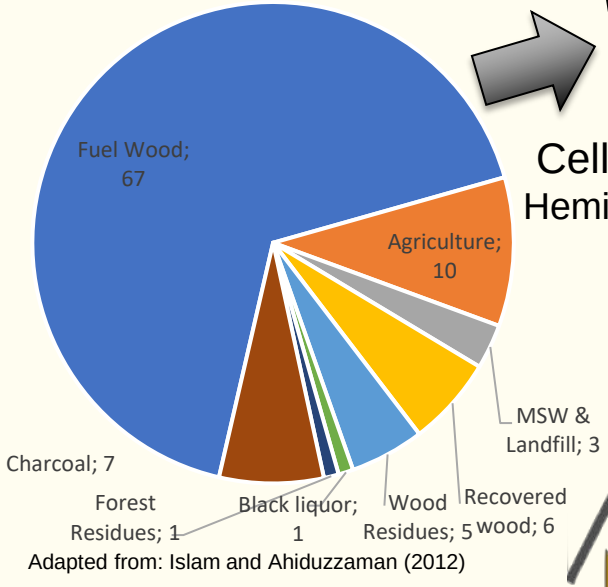
Photo Credit: Dr. Atinderpal Singh, 2019

Imperial College London



Tannery Beamhouse

Lime ($Ca(OH)_2$) source
>12,000 mgl^{-1}, pH 12,
Low cost alkaline pretreatment,
Co-digestion effects
COD > 10,000 mgl^{-1}
Nitrogen resource



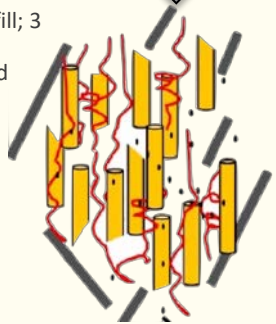
Adapted from: Islam and Ahiduzzaman (2012)

Lignocellulosic Biomass

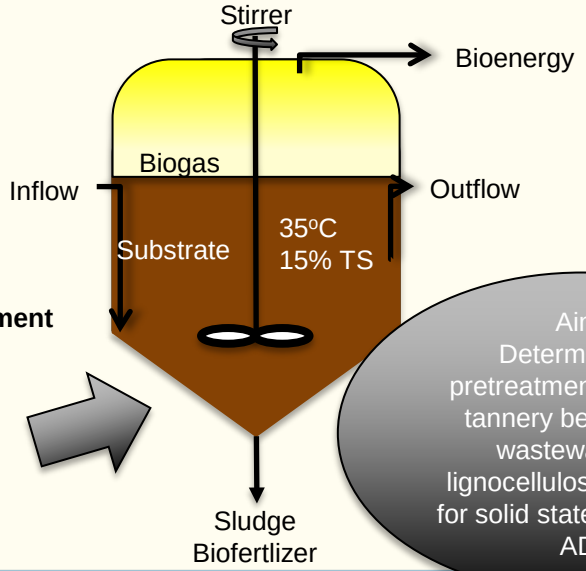
180×10^9 ty^{-1}

Cellulose (35% - 45%)
Hemicellulose (20% - 31%)
Lignin (12% - 30%).

Pretreatment: Chemical, physical, biological



Alkaline Pretreatment
Depolymerization
Solubilization
Delignification
Saponification
Solvation
Expensive £££££



Aim:
Determine the pretreatment effects of tannery beamhouse wastewater on lignocellulosic biomass for solid state mesophilic AD.

Imperial College London

Experimental Strategy

Wheat Straw (WS)

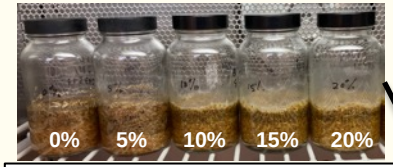
Sugar Cane Bagasse

Rice Straw

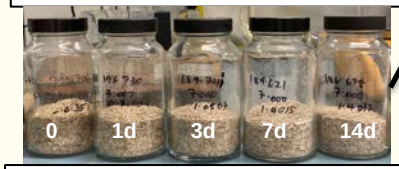
Corn Stover

Phase 1

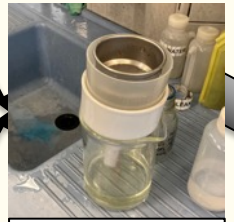
$Ca(OH)_2$ Pretreatments
Controlled experiments
Alkaline loading rate?
Pretreatment time?
35ºC incubation



$Ca(OH)_2$ g^{-1} DS WS – **7d**

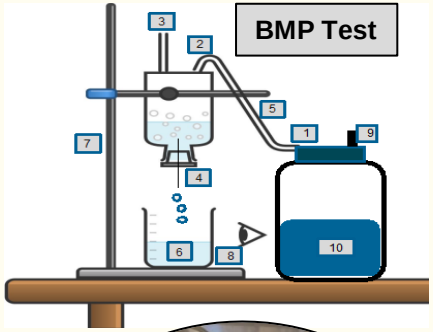


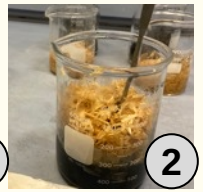
5% $Ca(OH)_2$ g^{-1} DS WS – Varying time

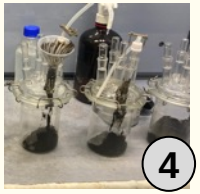


Washing

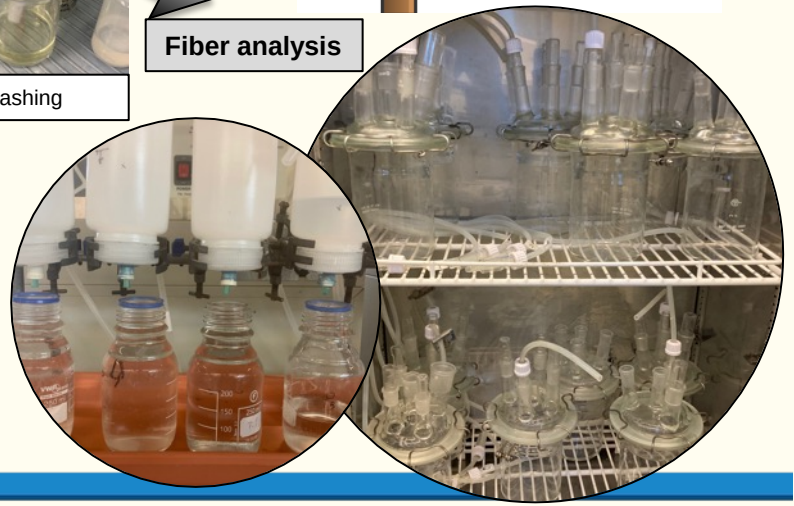
Fiber analysis





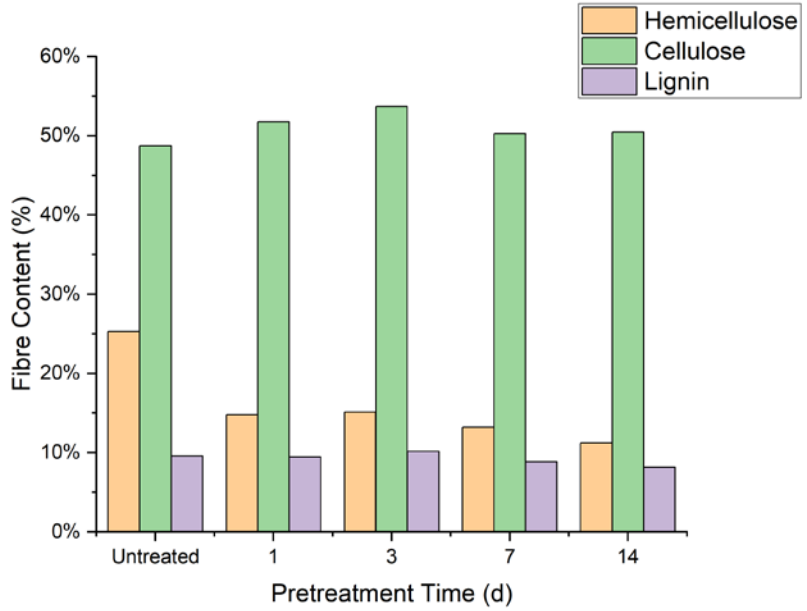


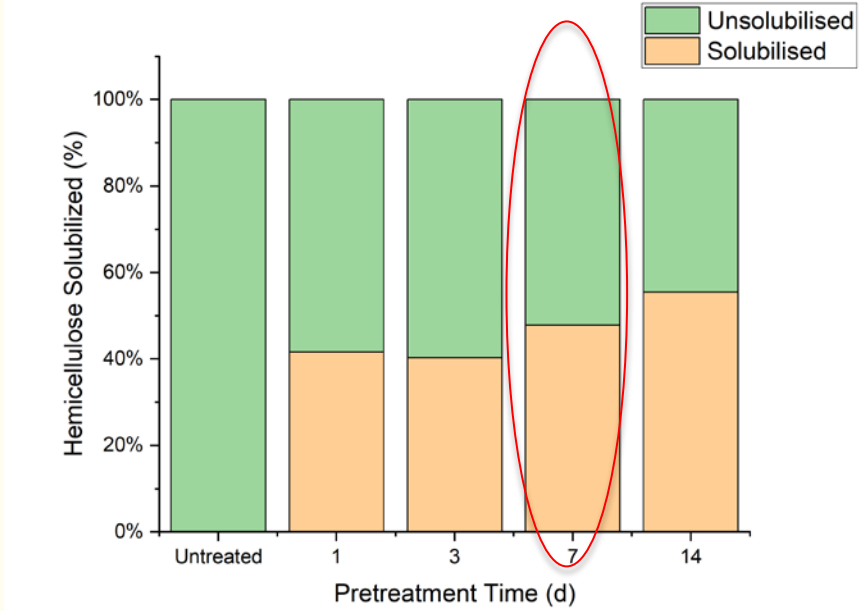
Biogas Yield/Composition



Imperial College London

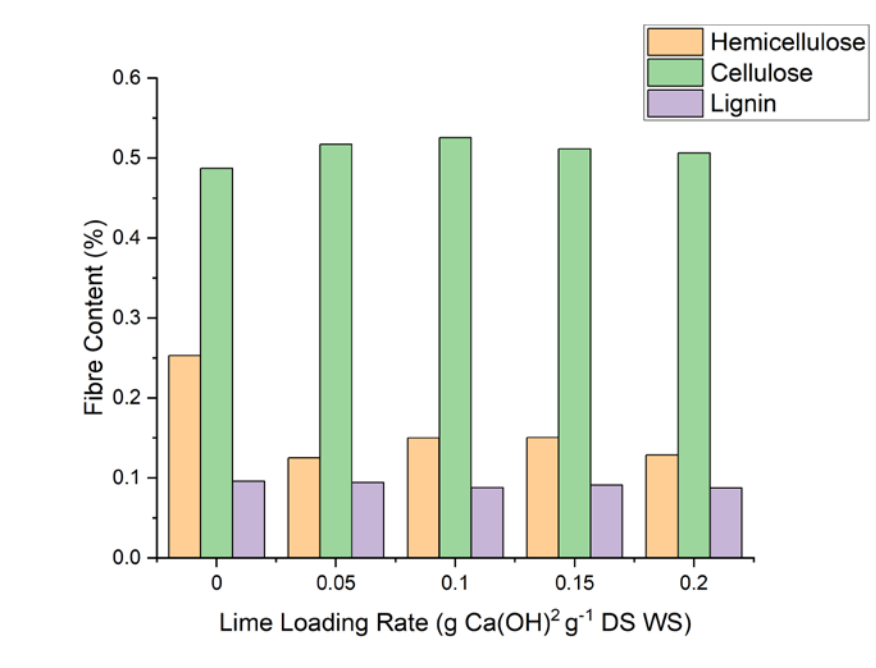
Results – Fibre Analysis

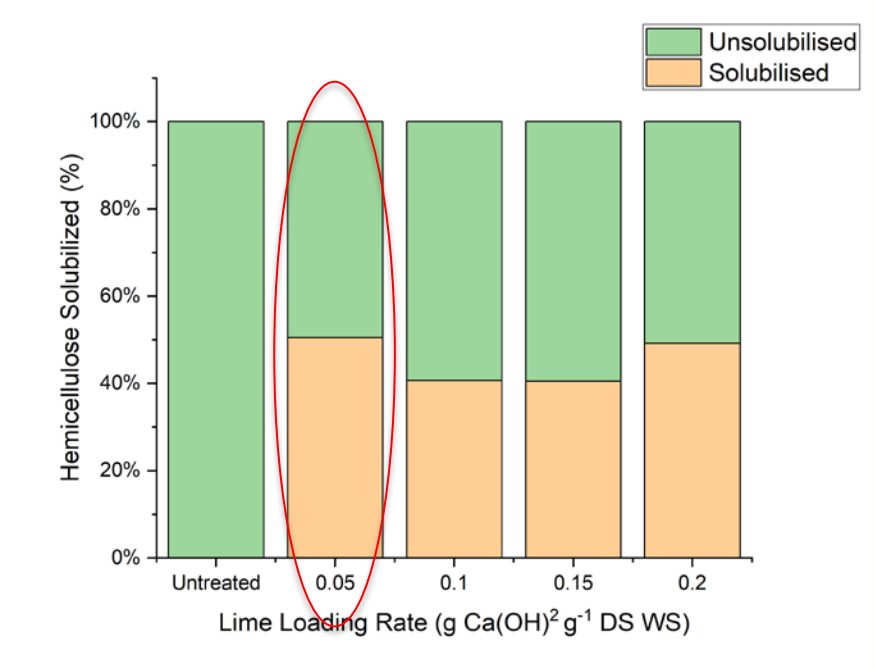




Imperial College London

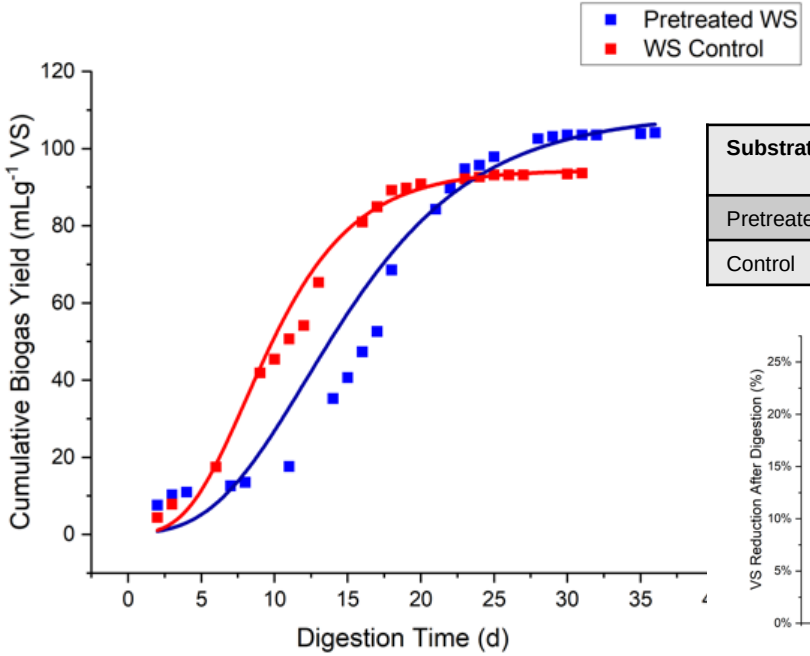
Results – Fibre Analysis



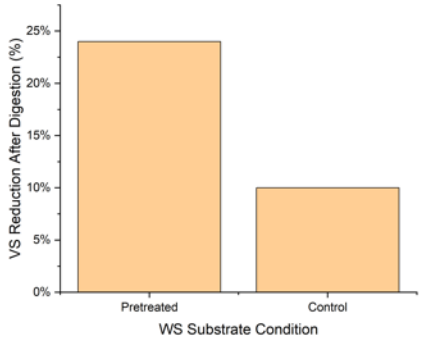


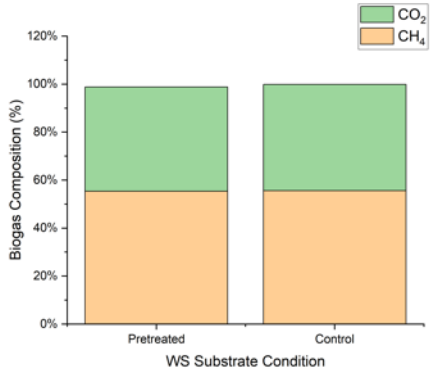
Imperial College London

Results – Biogas and volatile solids



Substrate Condition	Gompertz Model Calculated (mLg^{-1} VS)	R^2
Pretreated WS	108	0.9985
Control	94	0.9997





Imperial College London

Conclusions

- Optimum $Ca(OH)_2$ loading rate for WS pretreatment is 5% and optimum pretreatment time is 7 days.
- $Ca(OH)_2$ mainly affects hemicellulose fibres by breaking acetyl bonds. Cellulose and lignin fibre contents remain unchanged.
- Biogas yield increased by 10% with $Ca(OH)_2$ pretreatment.
- Tannery beamhouse wastewater is a potential alkaline resource for increasing biogas yield of lignocellulosic biomass.

Imperial College London

Acknowledgement

A. B. Yazid is supported by a PhD scholarship from the Islamic Development Bank.