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

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Background

Lignocellulosic Biomass

Current Disposal

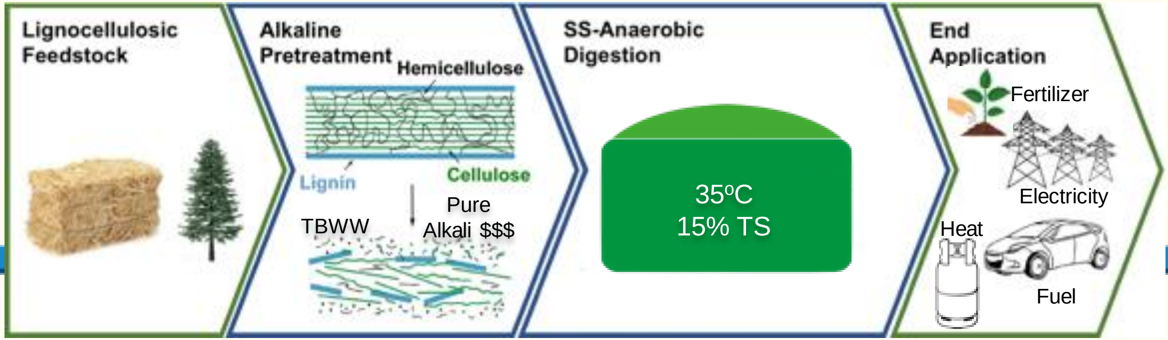
- Agricultural wastes, crop residues.
- Most abundant material 180 x 10^9 ty^{-1}
- Carbon source: 2nd Generation biofuel
- Disposed by burning locally
- 108x10^6 t rice paddy burnt in 2018
- India & China, South East Asia: 85%
- Nigeria: 1.8x10^6 t

Kano Nigeria

Beamhouse Wastewater

- 90% of Nigeria's tanning
- 1x106 m3y-1 Tannery Wastewater
- Untreated, discharged, water pollution
- Soaking, **Beamhouse**, Tanning
- >50%, Lime ($Ca(OH)_2$) source
- Alkalinity >12,000 mgl-1, pH 12,
- **Low cost alkaline pretreatment**

Input Chemicals	Tanning Process	Wastewaters	TBWW Content	
H_2O	Soaking	Soaking (23%)	$Ca(OH)_2$ Na_2CO_3 $CaCO_3$ NH_4OH NaOH NH_4	alkalinity source
$Ca(OH)_2$ & Na_2S	Liming	Beamhouse (54%)		
Na_2CO_3 & NaOH	Re-liming			
NH_4Cl or $(NH_4)_2SO_4$	De-liming			
NH_4Cl or $(NH_4)_2SO_4$	Pickling		**H_2S $CaSO_4$ Na_2SO_4 Na_2S**	sulphide source
$Cr_2(SO_4)_3$, $NaHCO_3$ & HCOONa	Tanning	Tanning(23%)		



AIM: Determine how to optimise tannery beamhouse wastewater for pretreatment of lignocellulosic biomass for solid state mesophilic AD.

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Materials & Methods

TBWW

$FeCl_3$

Rice Straw

Rumen Content Inoculum F/I = 0.25

Alkalinity (HMSO, 1981)
Sulphide (HMSO, 1983)
TS and VS (APHA, 2005)
NDF (BS, 2006)
ADF and ADL (BS, 2008)

$$A = [HCO_3] + 2[CO_3] + \sum[X^-] + ([OH-] - [H^+])$$

$$2FeCl_3 + H_2S \rightarrow 2FeCl_2 + S + 2HCl$$

100% 50% 25% $FeCl_3$ Concentrations

Volume of sample	100.0	ml
H_2S Concentration	2499.2	mg/l
H_2S mass	249.9	mg
H_2S molar mass	34.1	g/mol
H_2S mols	0.0073	mol
$FeCl_3$ mols	0.0147	mol
$FeCl_3$ molar mass	162.2	g/mol
$FeCl_3$ mass	2377.5	mg

RS + S Free TBWW RS Control Inoculum Contr

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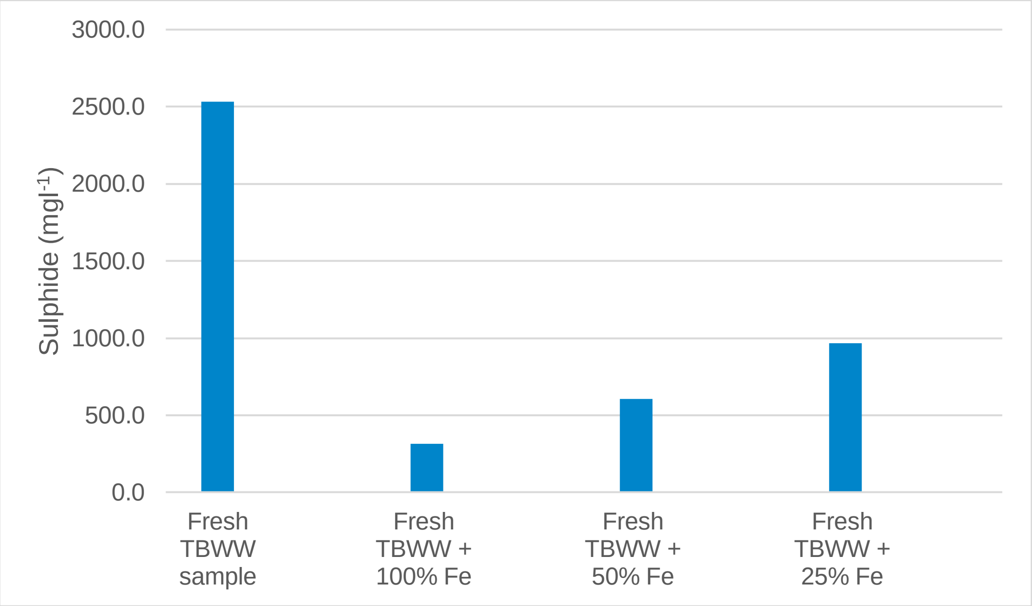
Results



	CaCO3 Alkalinity (mgl^{-1})	Alkaline loading rate (g CaCO3 g RS^{-1})
Fresh TBWW	32,711.7	32.7%
S-Free TBWW	12,197.9	12.2%
10% $Ca(OH)_2$	13,497.1	13.5%

$Fecl_3$ addition rate (%theoretical)	TS	VS
100	5.3%	58.9%
50	5.2%	66.6%
25	4.6%	64.8%

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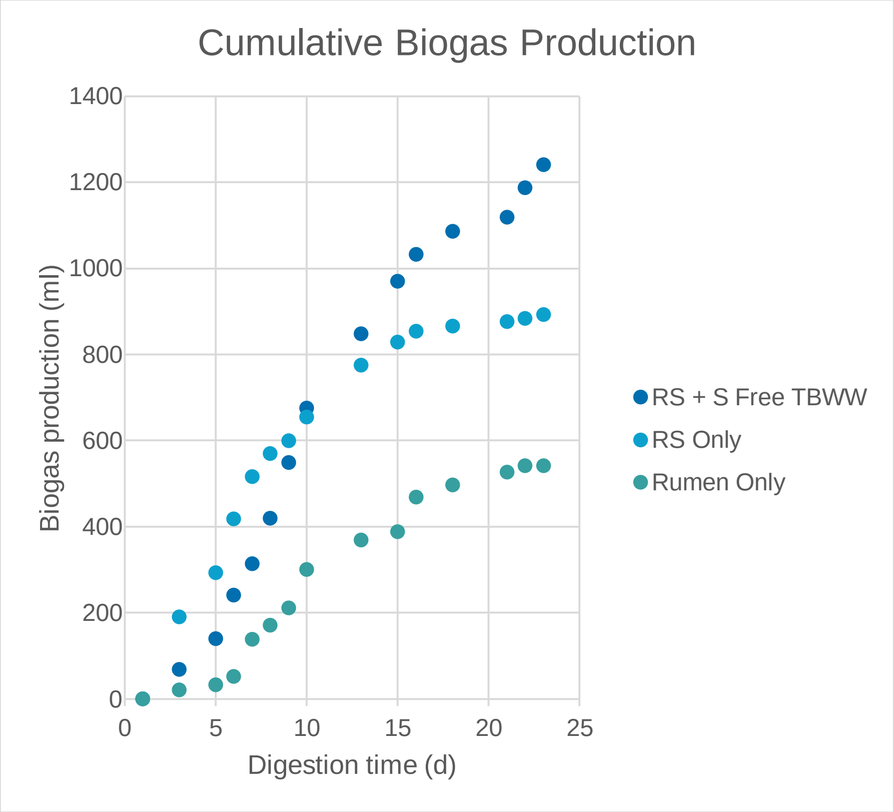
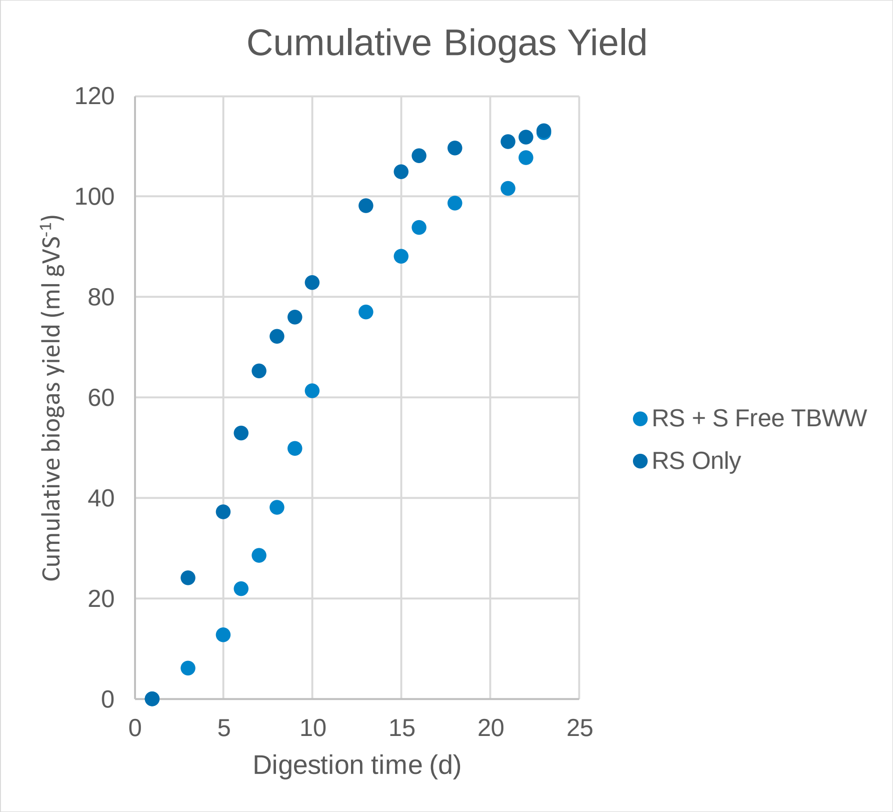
Results





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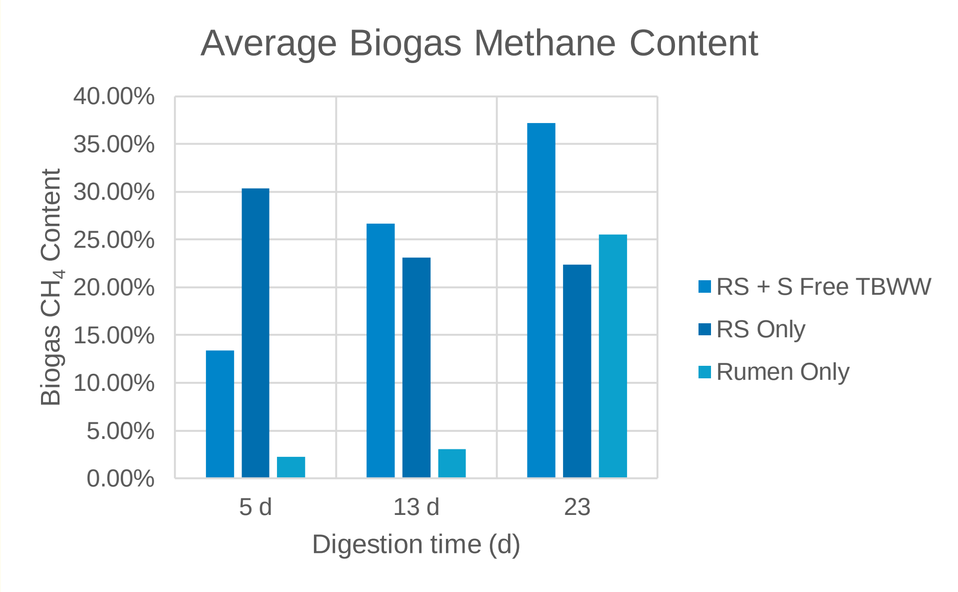
Results



Average Biogas Sulphide Content (ppm)	5 d	13 d	23 d
RS + S Free TBWW	12.00	5.67	593.00
RS Only	5.00	4.50	61.00
Rumen Only	5.00	4.50	46.00

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Conclusions

- $FeCl_3$ reduces sulphide in TBWW by up to 90%.
- Biogas production RS is increased by up to 10% through TBWW pretreatment.
- RS is digestible using rumen as inoculum.
- Sulphide even in low concentrations in TBWW reduces the rate of methanogenesis but does not cause complete inhibition
- Tannery beamhouse wastewater is a potential alkaline resource for increasing biogas yield of lignocellulosic biomass.
- *Next steps: Rerun experiments using TBWW with sulphide removed by drying.*

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Thank you for listening

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