Insights into biohydrogen production from organic wastes

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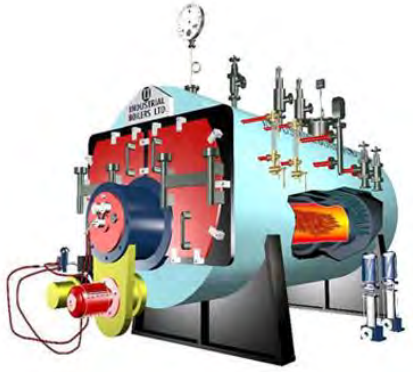


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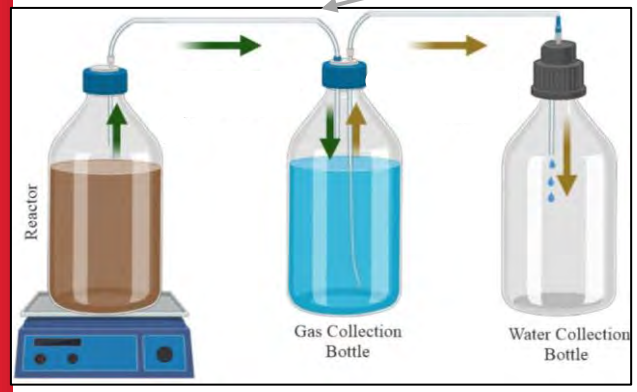
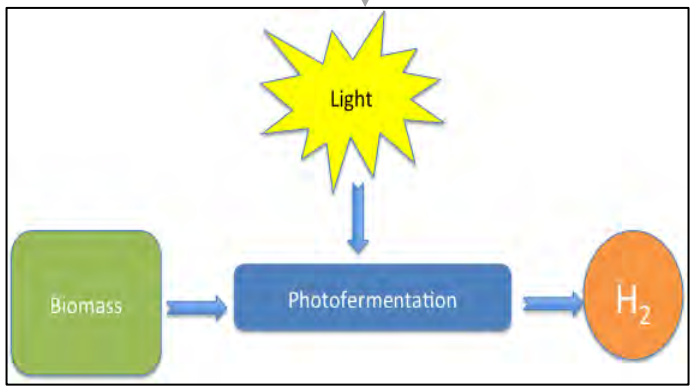
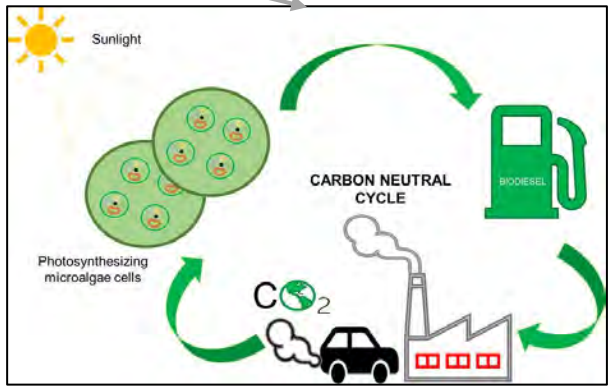
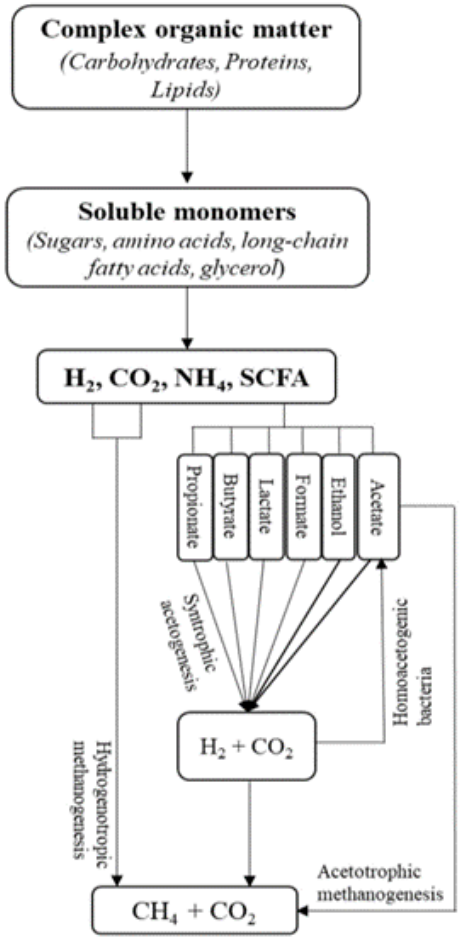
What is Bio-Hydrogen?







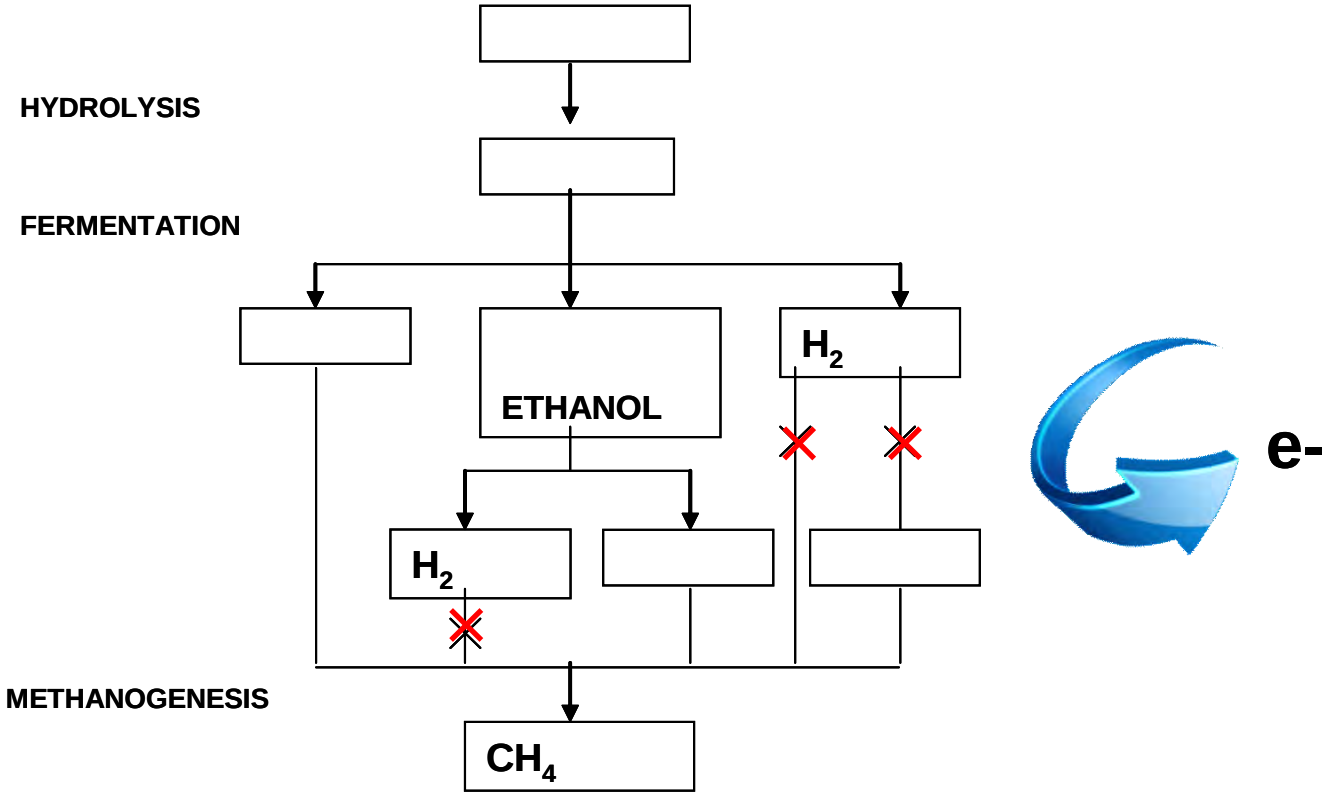
Key enzymes and dominant microbial taxa involved during anaerobic digestion of organic matter



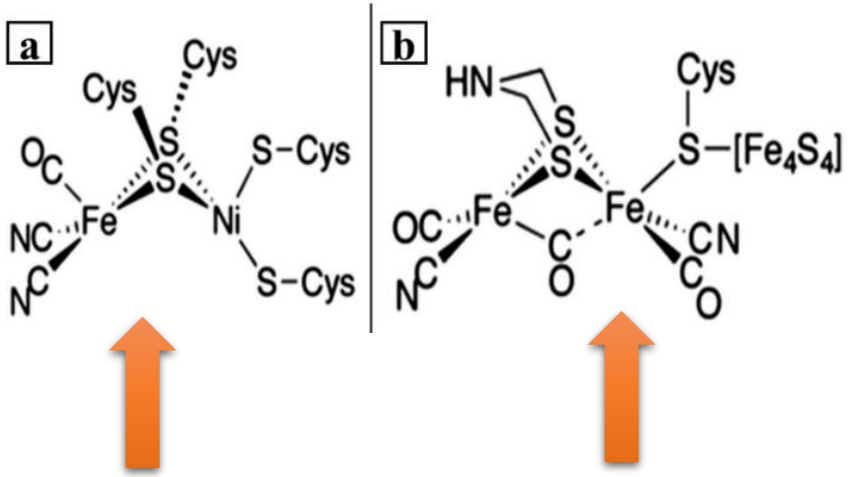
Action	Dominant taxa (genera)	Enzymes
Hydrolysis & Fermentation	*Clostridium, Bacteroides,*	Extracellular hydrolases (cellulose, xylanase, pectinase, amylase, lipase, and protease)
Acidogenesis	*Clostridium, Enterobacter, Klebsiella, Bacillus, Bifidobacterium*	Formic hydrogenase, Pyruvate oxidoreductase, Pyruvate formate-lyase, Ferredoxin oxidoreductase, Nickel-iron hydrogenases
Acetogenesis	*Smithllela, Syntrophobacter, Pelomaculum, Syntrophus, Syntrophomonas*	Formate dehydrogenases, Ferredoxin: NAD oxidoreductase, Hydrogenases
Methanogenesis	*Methanosaeta, Methanosarcina, Mathanobacterium, Mathanobrevibacter Methanospirillum Mathnoculleus,*	Hydrogenase, formate dehydrogenase, coenzyme F420-NADPH, oxidoreductase, NADPH diaphorase, and malate dehydrogenase

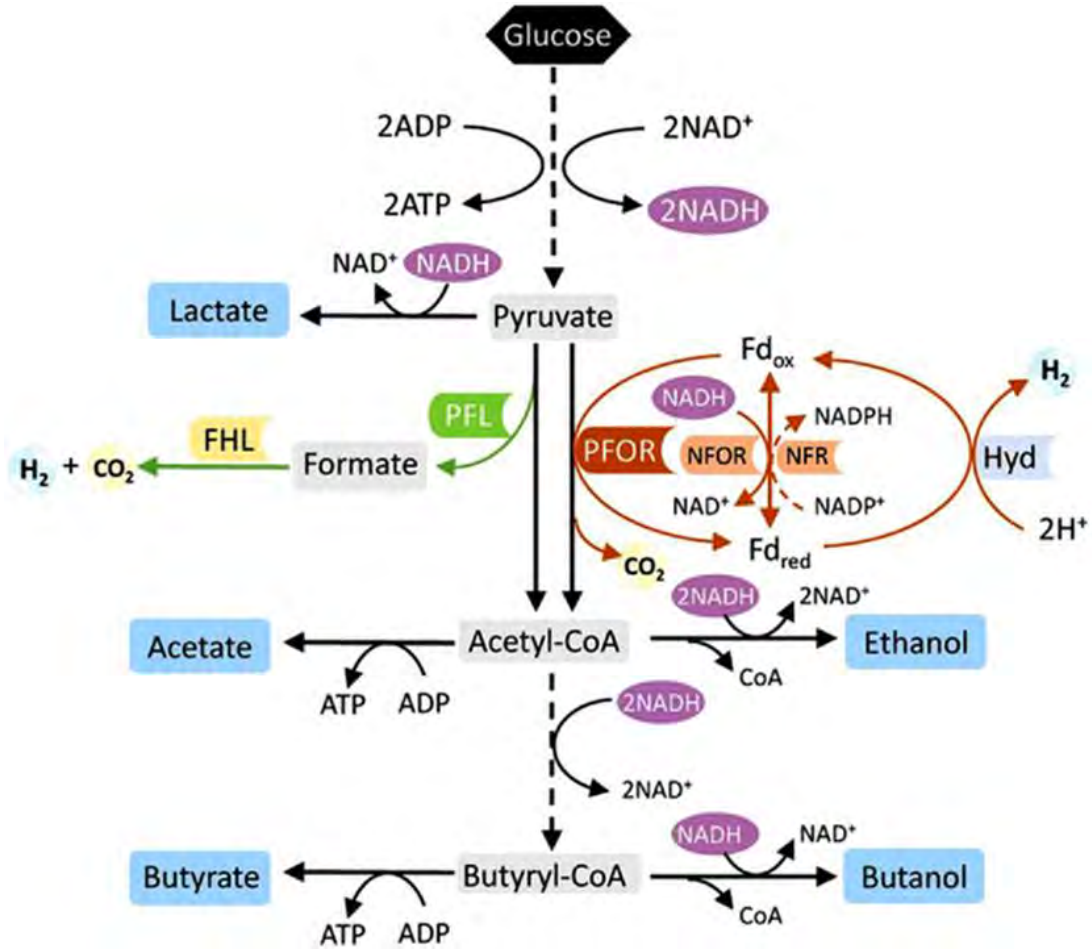
Hydrogen production

Anaerobic digestion


HYDROLYSIS
FERMENTATION
ETHANOL
H_2
H_2
METHANOGENESIS
CH_4
e-

Dark Fermentation





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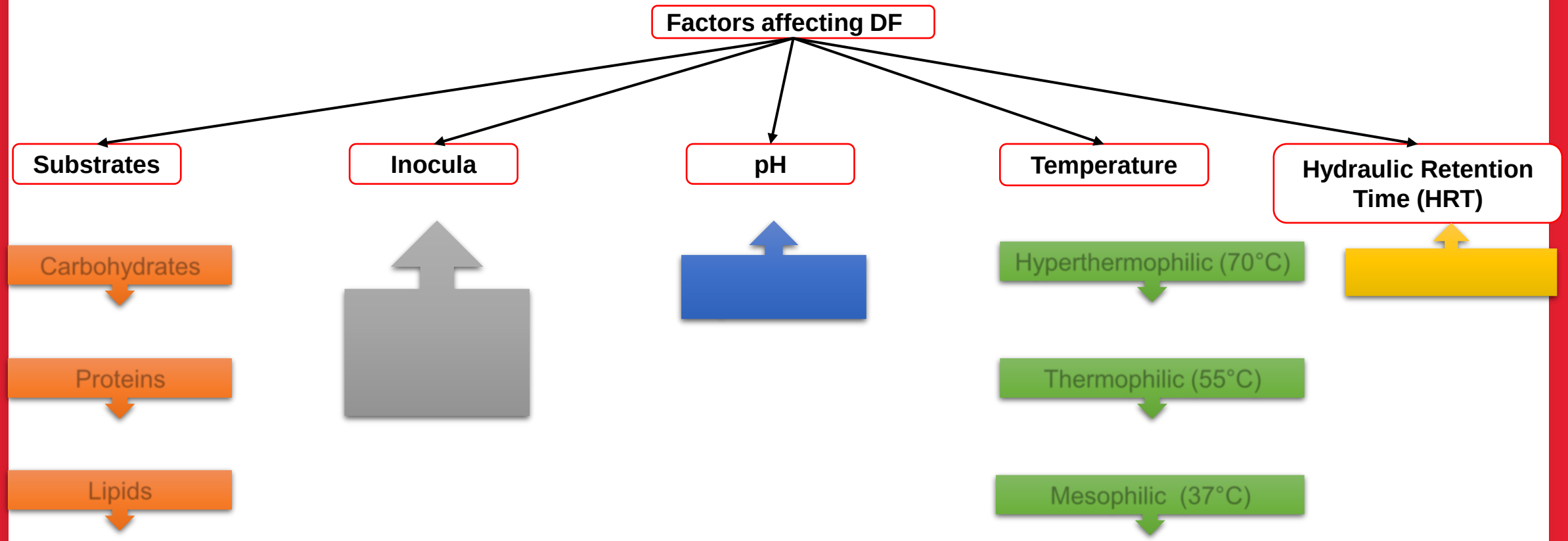
Dark Fermentation (DF)

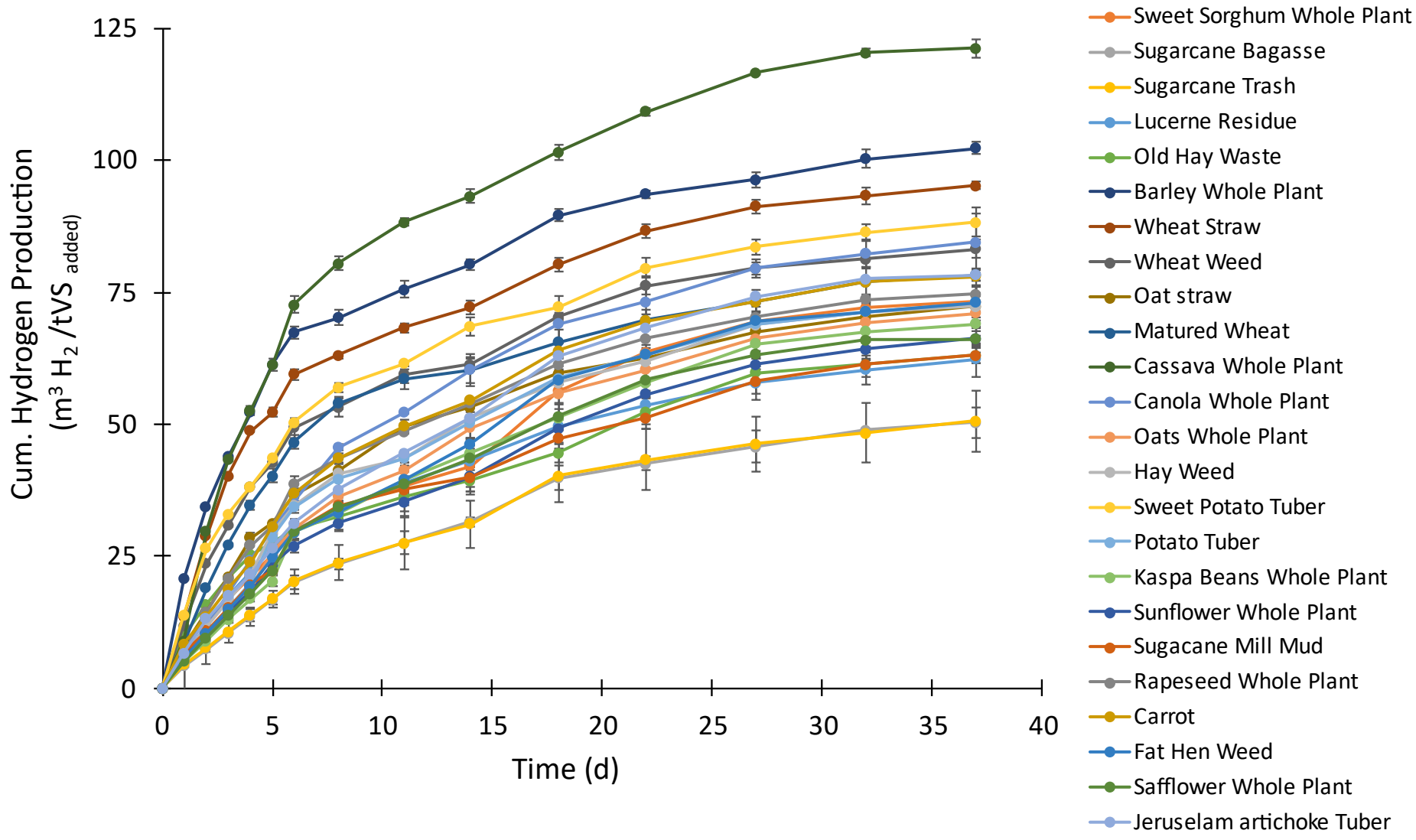


Biohydrogen potential of agricultural crops and residues

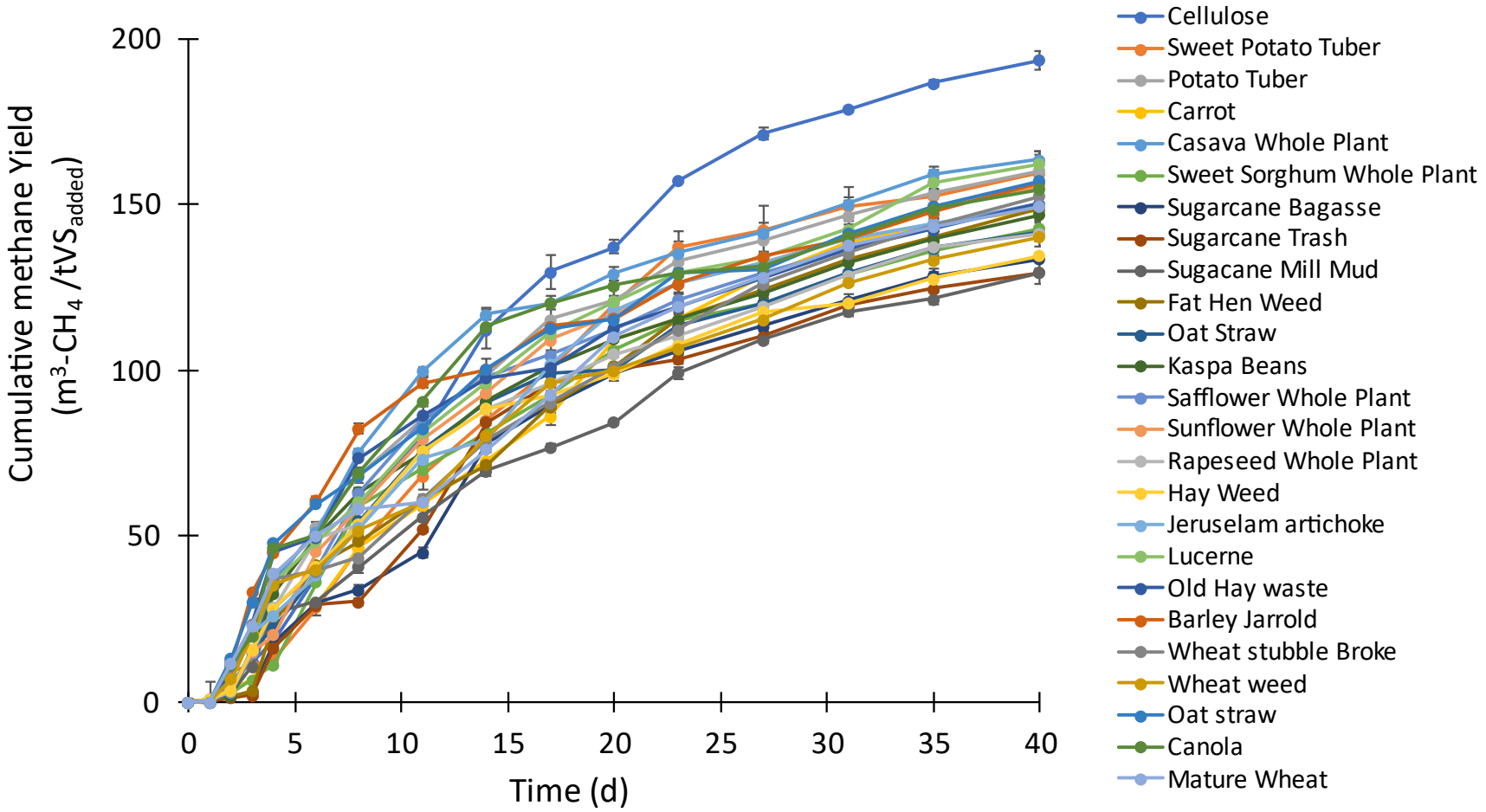
Batch experiments

Heat treated inoculum for H2 production

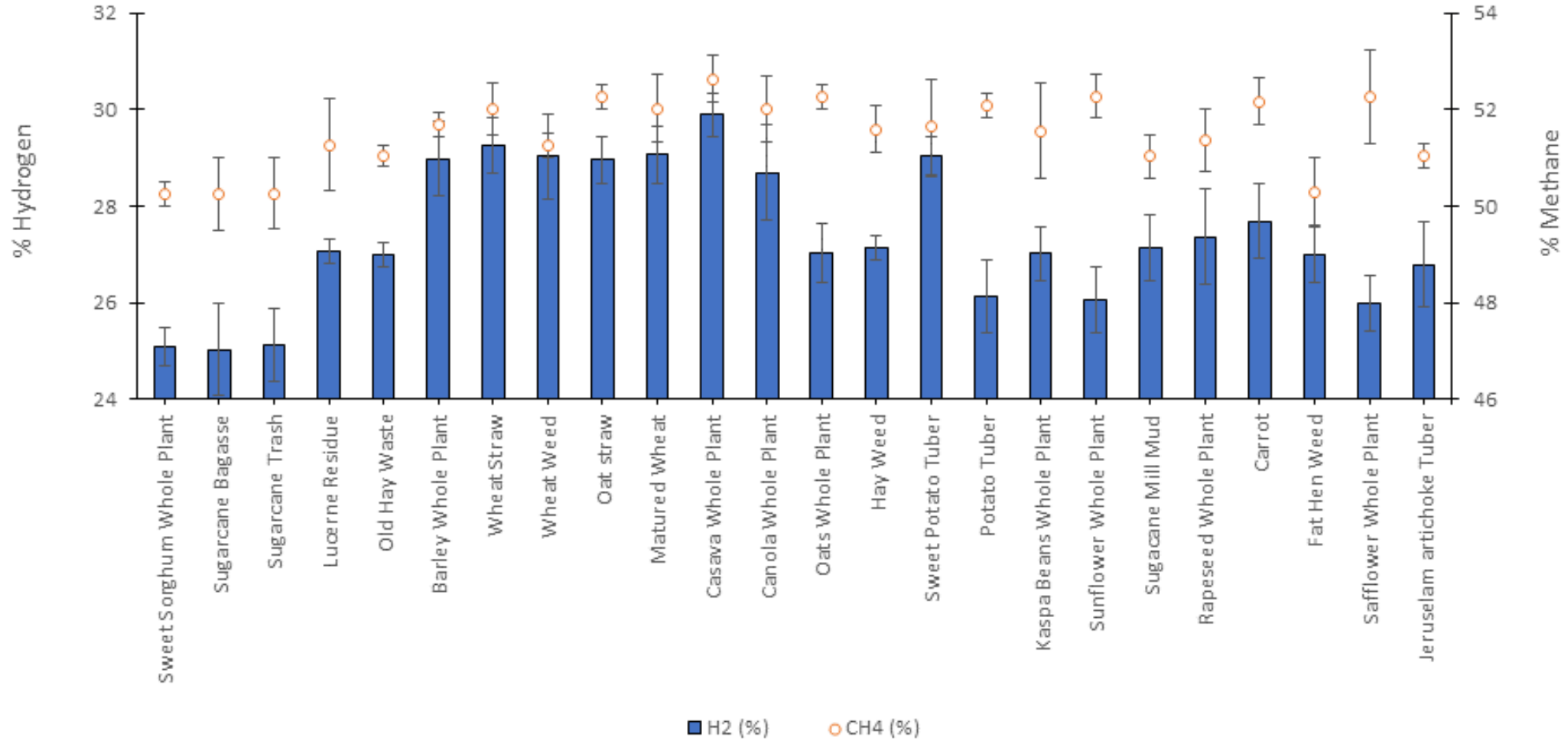
Biochemical hydrogen potentials in batch assays



Biochemical methane potentials in batch assays



Hydrogen and methane content in the biogases



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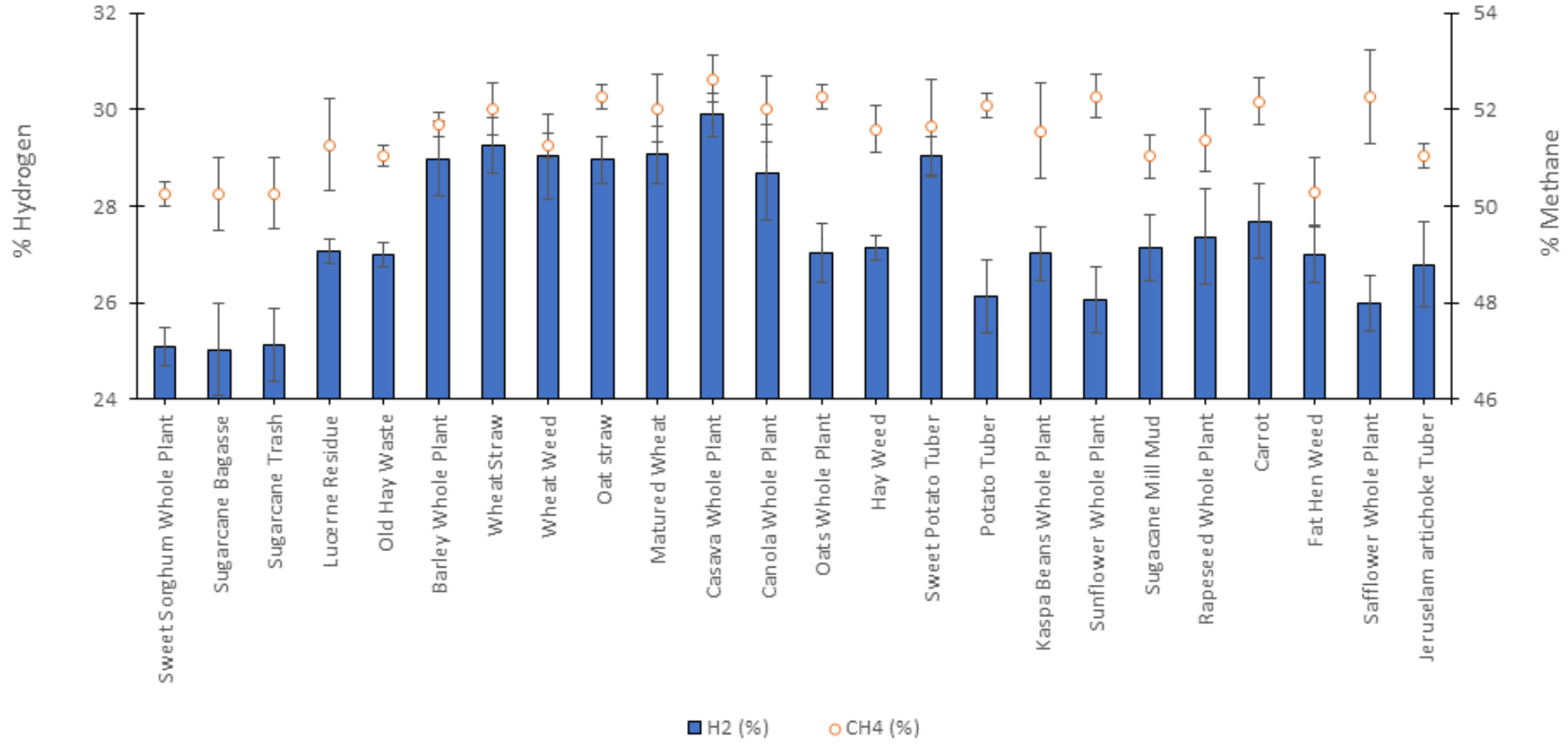

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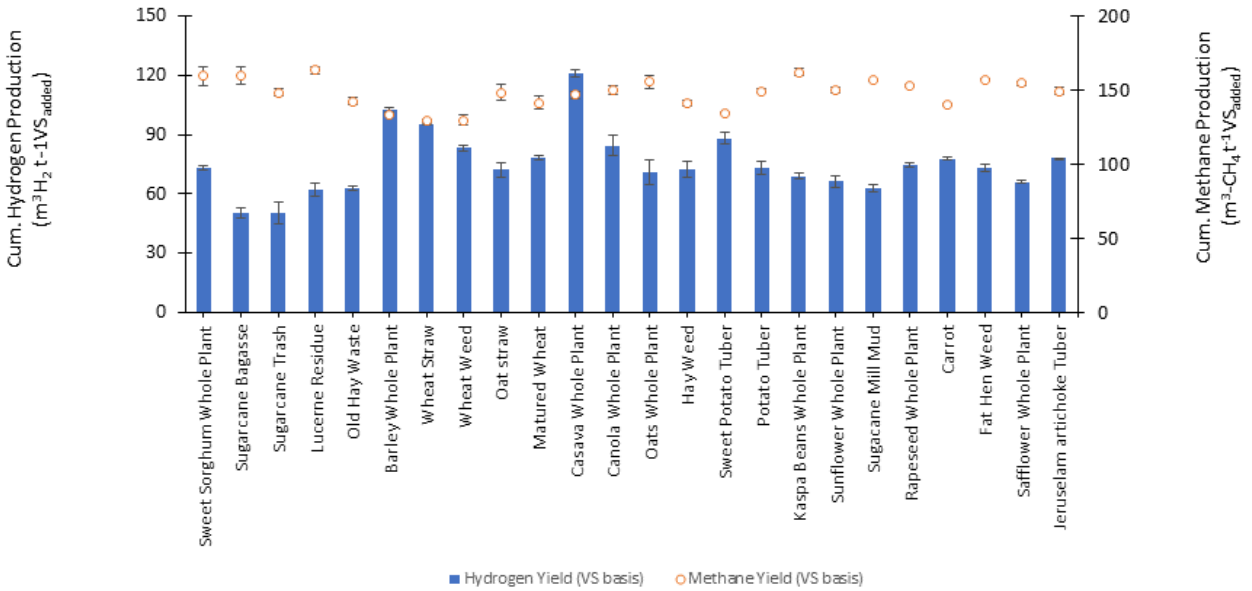
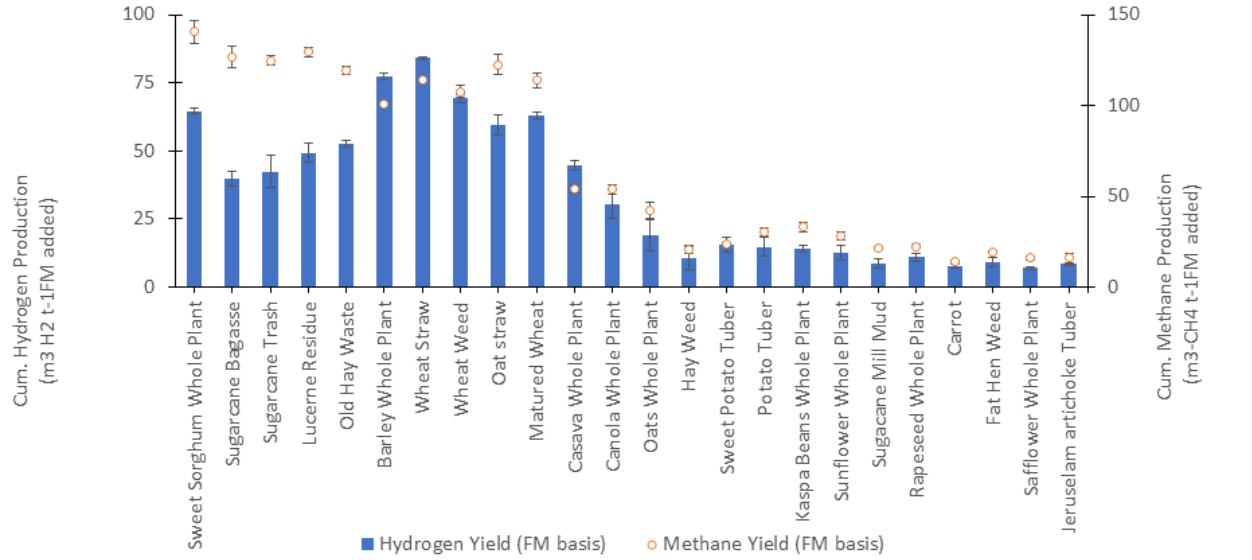
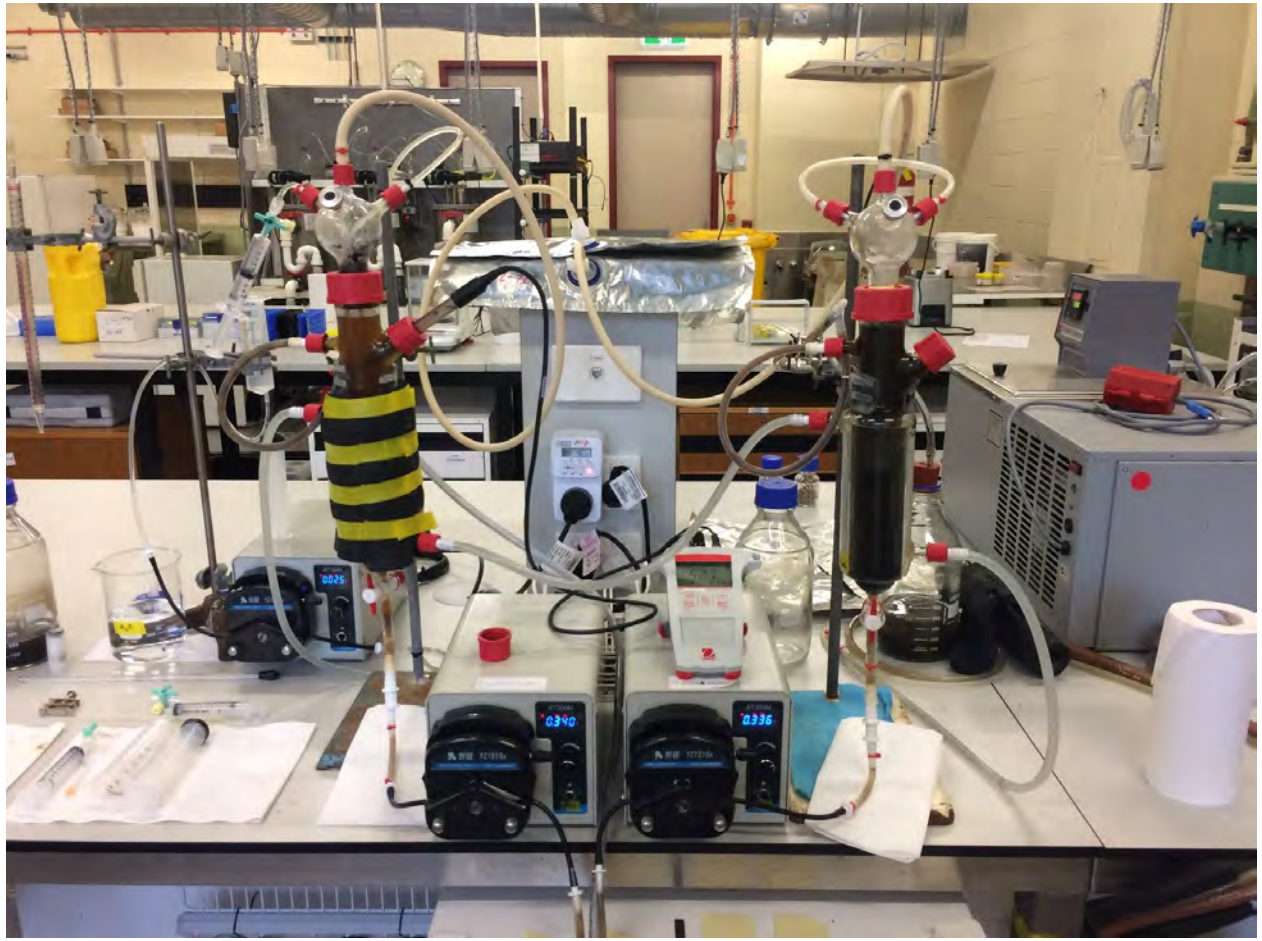
Biochemical biohydrogen and methane yields of energy crops and crop residues





Two-stage Reactor process (H2 and CH4 production)



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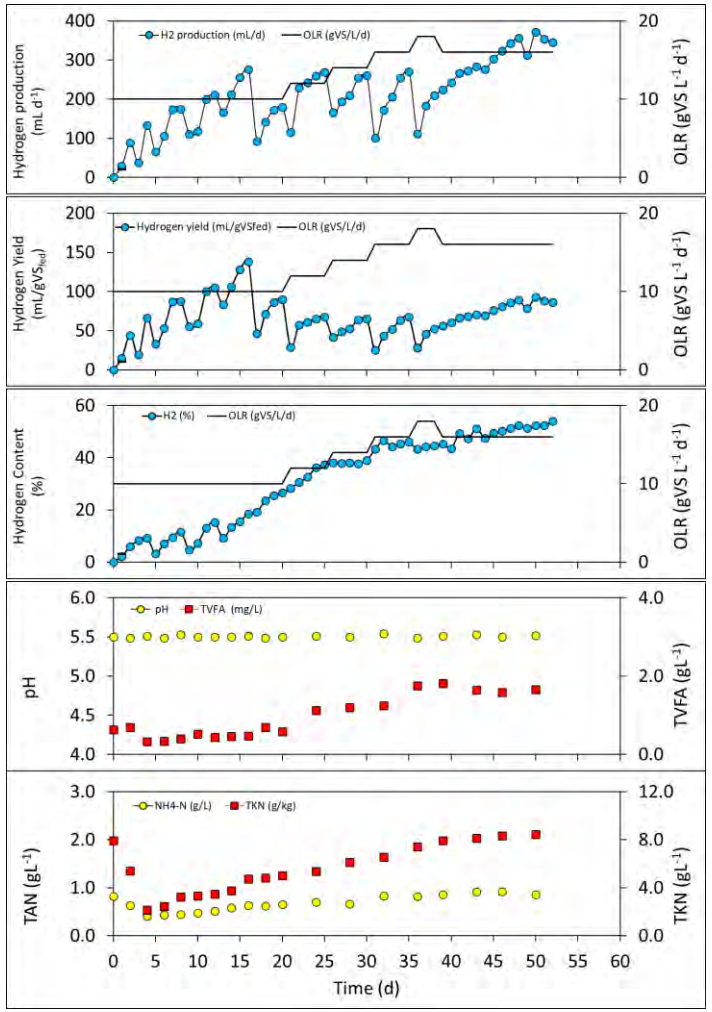
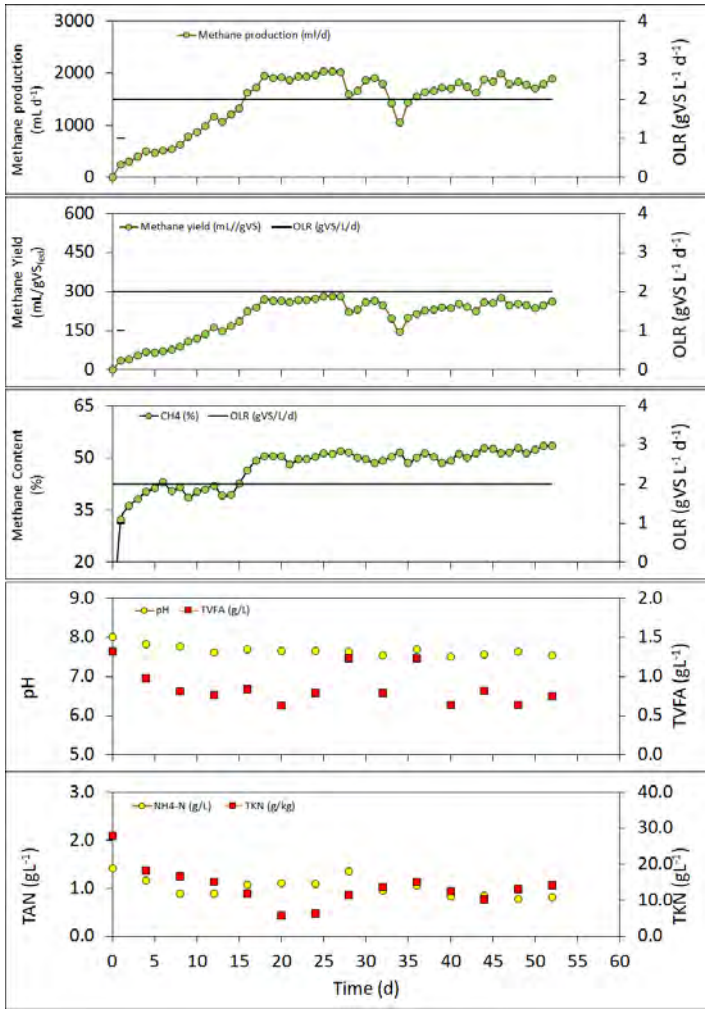


Hydrogen Reactor



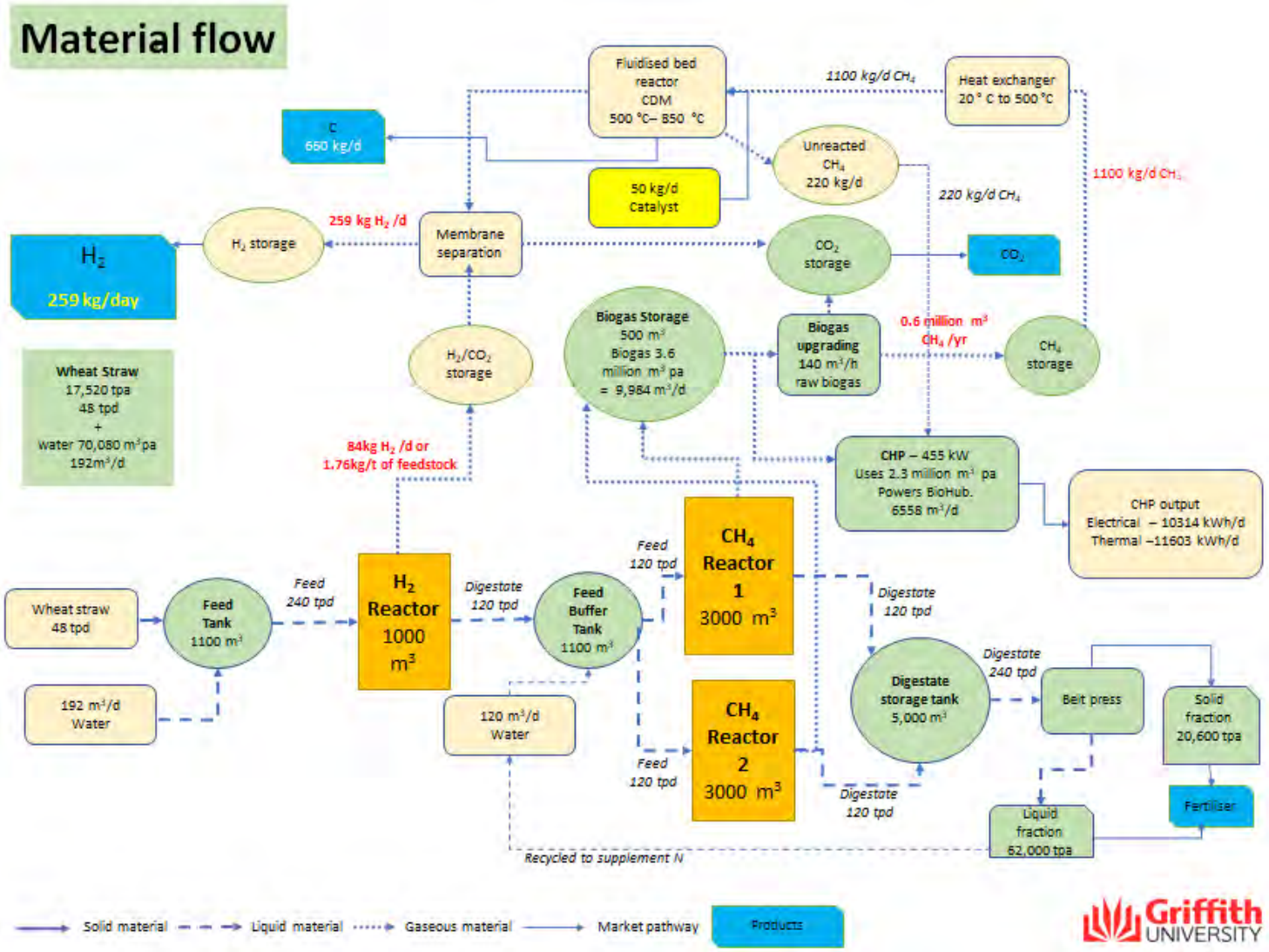
Methane Reactor

Two-stage Reactor process (H2 and CH4 production)

	Hydrogen reactor							Methane reactor	
Parameter									
OLR (gVS/l/d)	12	14	16	18	16	16	16	2	2
Day	24	29	34	37	39-42	43-46	47-50	18-27	37-52
Gas production (ml/d)	260	254	254	183	251	296	346	3880.9	3446.3
Hydrogen or methane yields (ml/gVS_{fed})	64.9	63.6	63.5	45.6	62.8	74.1	86.5	271.48	246.41
H2 or CH_4 content (%)	36.3	37.7	42.2	44.3	46.4	49.6	51.5	50.36	51.48
pH	5.51	5.54	5.54	5.51	5.51	5.53	5.52	7.66	7.56
TVFA (g/l)	1.12	1.2	1.25	1.82	1.82	1.67	1.66	0.71	0.71
TKN (g/kg)	5.37	6.12	6.56	7.92	7.92	8.12	8.45	6.08	12.51
NH_4-N (g/l)	0.7	0.66	0.83	0.86	0.86	0.92	0.86	1.10	0.81

Integration of two-stage AD process with CDM to produce 200 kg/d of H2

CDM: Catalytic decomposition of methane



Conclusion

Production of hydrogen (H_2) and methane (CH_4) is feasible

The two-stage H_2/CH_4 AD process improves overall process stability and energy yields than conventional one stage H_2 or CH_4 process

In the first stage, low pH and short hydraulic retention times, (HRTs) favour the fermentation of lignocellulosic residues into hydrogen and volatile fatty acids (VFAs) by enhancing the growth of H_2-producing bacteria.

In the second stage, neutral pH and longer HRTs are required for the growth of acetogens and methanogens for further conversion of VFAs to methane and carbon dioxide.

Thank you

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