Anaerobic Digestion (AD) of Novel Wastes

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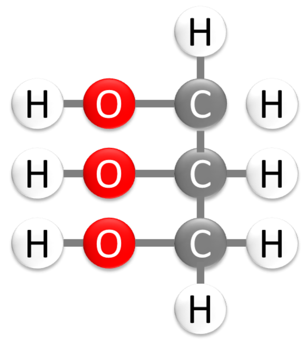
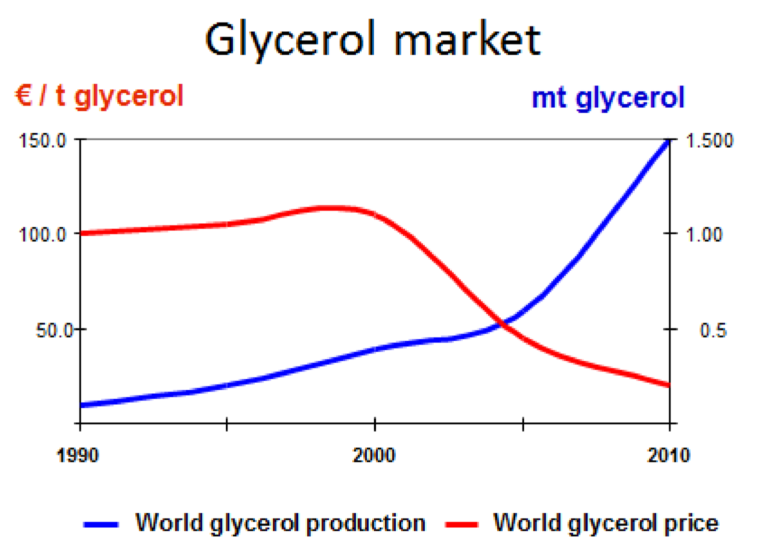
The Wastes

Glycerol



Oil + alcohol ⟶ Biodiesel + glycerol



The glycerol market has undergone radical changes, driven by very large supplies of crude glycerol arising from biodiesel production

The Problem Glycerol Quality

Unrefined glycerol from biodiesel production is only ~50% glycerol containing water, salts, unreacted alcohol, and unused catalyst. It is economically and energetically expensive to refine. Could AD be an alternative to refining for producing a biofuel from crude glycerol?

Crude & Refined Glycerol

Sargassum muticum Japanese wireweed

An invasive species to Great Britain that is causing considerable problems in certain areas of the Kent coast. The destruction of this seaweed is currently carried out at considerable financial and energy cost

	Moisture	Ash	C	H	O	N	S	HHV
	% total wt.			% dry weight				KJ g^{-1} dw
S. muticum	85.4	33.3	30.1	4.2	28.1	3.6	0.8	12.1

The theoretical yield of biogas, calculated from the chemical composition of macroalgae ($C_cH_hO_oN_nS_s$) using the "Buswell equation" can be high. .

	VS Empirical formula	Theoretical Methane Yield	
		L CH_4 g^{-1} VS	L CH_4 g^{-1} TS
S muticum	$C_1H_{1.66}O_{0.7}N_{0.1}S_{0.01}$	0.42	0.28

Could the anaerobic digestion of this invasive seaweed give it some value to encourage harvesting?

Assessment of Bio-methane potential of wastes

Methane potential bioassays were carried out using the Automated Methane Potential Test System (AMPTS), Bioprocess Control AB, Sweden, which consists of:

a) a water-bath with controlled temperature and 15 digestion bottles
b) 15 CO2 fixing bottles, each one connected to one of the 15 digestion bottles
c) A tipping cup volumetric gas measuring device connected to each fixing bottle

The Results

	Average CH_4 Yield	Actual yield as % Theoretical
	L CH_4 g^{-1} VS	
Crude Glycerol from Biodiesel Production	0.26	46%
Sargassum muticum	0.07	17%
50% Crude Glycerol & *S. muticum*	0.21	43%

Crude glycerol appears to be a suitable substrate for the production of biogas. The use of crude glycerol to produce biogas could be an alternative to costly refining to produce a fuels for compression ignition engines. However, as with other seaweeds, *S. muticum* appears to be particularly resistant to anaerobic fermentation. There is considerable conjecture about the reasons for the relatively low practical methane yields in seaweed compared to their theoretical potential.

Co-digestion appears to give a synergistic improvement in yields. One possible explanation could be an improvement in C:N ratio. It is often recommended that feedstocks have a C:N ratio of ~ 20:1. *S. muticum* has a C:N ratio of 8:1. The co-digestion of crude glycerol and *S. muticum* brings the C:N ratio closer to this suggested optimum for AD.

Considerable more research is required to ascertain the reasons for *S. muticum's* resistance to AD, improve methane yields and valorise control of this invasive seaweed

Part of this work was carried out by Ngomah Kien Temukum and Amrita Ratana for their MSc dissertations in Pharmaceutical Biotechnology and Biotechnology – Supervisor Birthe Nielsen – Mentor and initial project concept John Milledge