

Hydrothermal Liquefaction of Macroalgae *Alaria esculenta* for Possible Application as Source of Biofuel

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Introduction

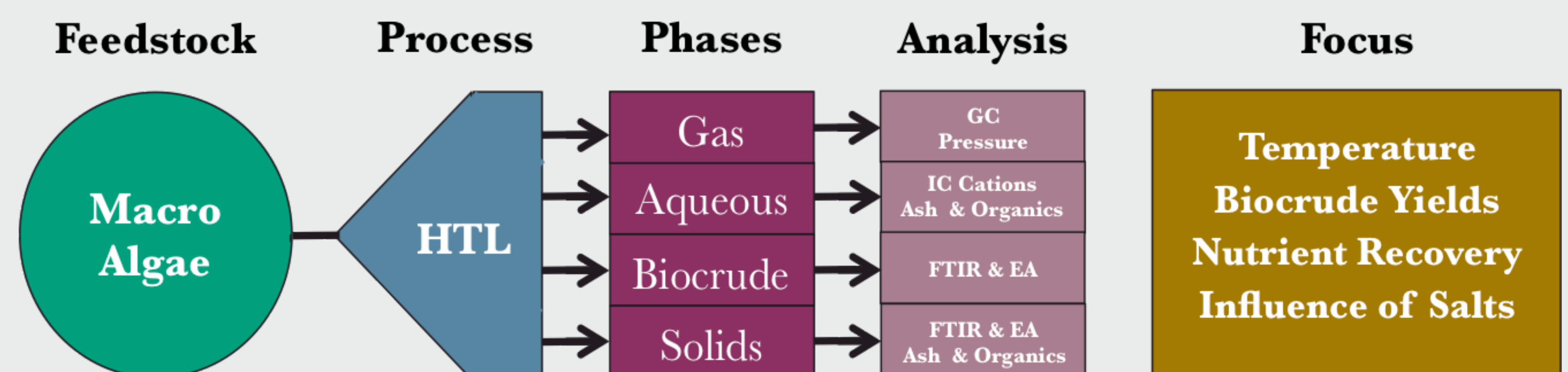
Macroalgae for Biofuel

- High biomass productivity
- High water content
- Traditional thermochemical methods are not energy efficient
- Interesting feedstock for hydrothermal processing

Motivation

- Assessing the effect of marine salts and temperature in HTL of macroalgae
- Recovery of nutrients

Methods and Process Conditions



Temperature	330 - 370 °C	Reaction Time	15 min	Initial Pressure	20 bar N ₂
Biomass : Water	1 : 10	Heating Rate	18 °C/min	Slurry Loading	70 Vol-%
Gas Loading	30 Vol-%	Solvent	Water	Reactor Volume	10 mL

Results

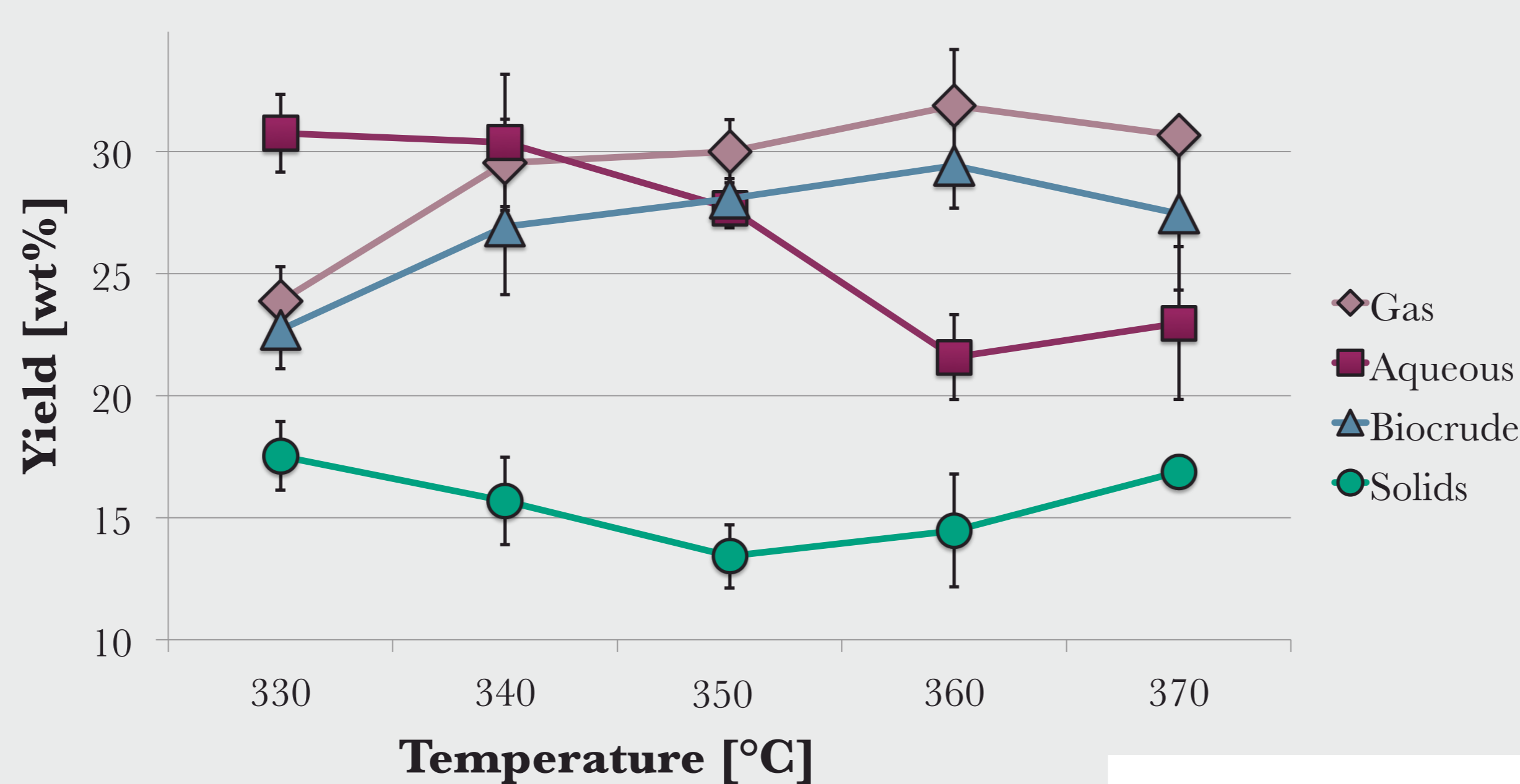
Feedstock Characterization

- *Alaria esculenta* was analysed before and after removing marine salts

	C [%]	H [%]	N [%]	S [%]	O [%] (calculated)	HHV [MJ/kg]
with salt	33.0	4.4	2.5	1.0	17.5	9.5
without salt	41.2	5.5	3.1	1.1	34.6	14.6
	Ash [%]		Salts [%]		Organics [%]	
with salt	9.9		31.7		58.5	
without salt	14.5		0.0		85.5	
	Ca ²⁺ [%]	K ⁺ [%]	Mg ²⁺ [%]	Na ⁺ [%]	PO ₄ ³⁻ [%]	Si [%]
with salt	1.3	6.9	1.0	4.3	0.5	0.4
without salt	1.7	2.1	1.1	1.3	0.3	0.1

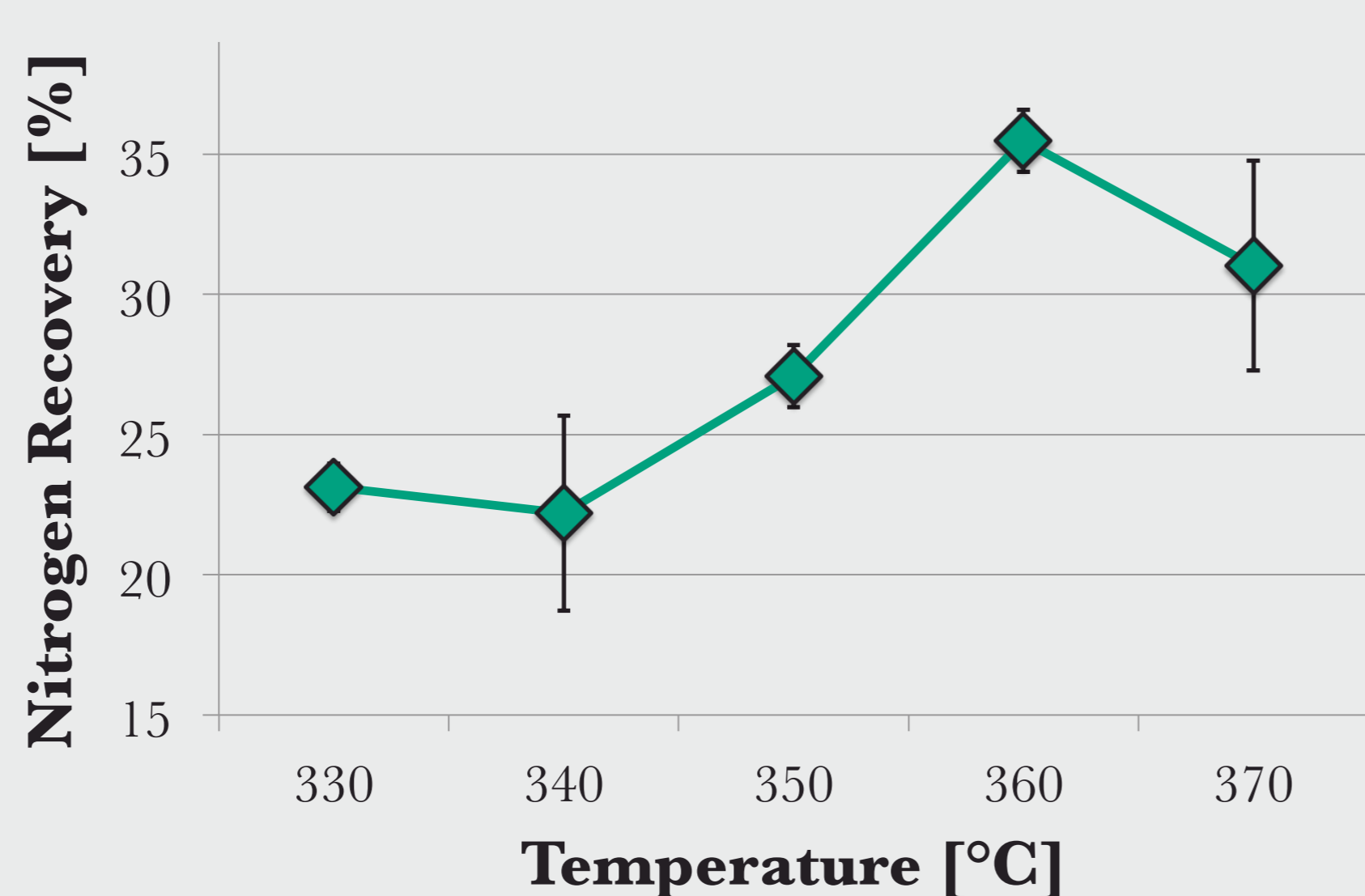
Mass Balances

- Total mass balance closures of >95 wt% were obtained
- The biocrude yield reaches its maximum of 29.42 wt% ± 1.74 wt% (StDev) at 360 °C

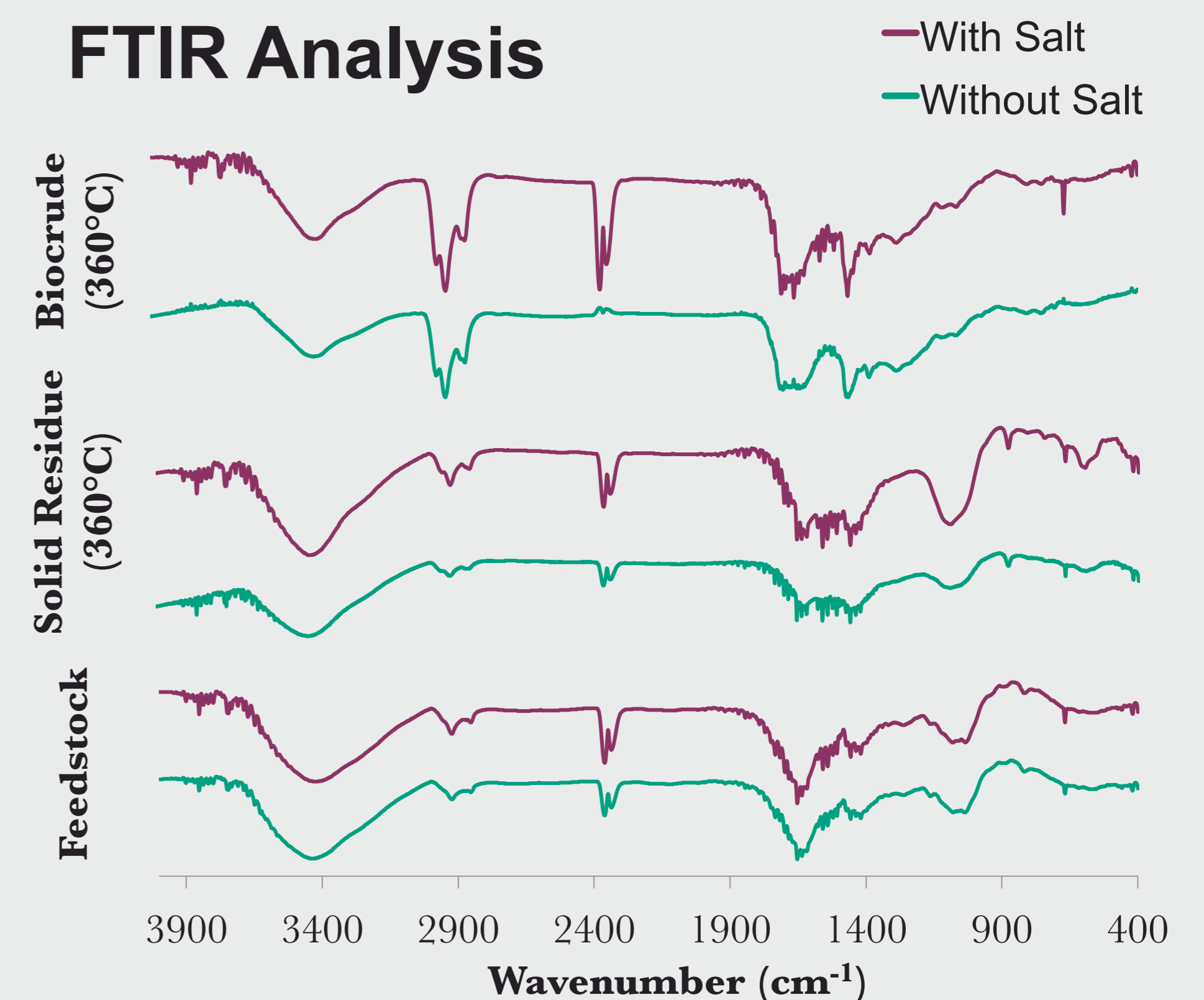


Nutrient Recovery

- The water phase exhibits potential for recovering nutrients
- Nitrogen is mainly recovered in the form of NH₄⁺



FTIR Analysis



- Similar FTIR spectra for solids and feedstock
- Biocrude spectra indicate the presence of nitrogen-compounds, ketones, aldehydes, aromatics, fats, alginates and polysaccharides
- 1200-900 cm⁻¹ weaker in salt based solid residue

Conclusion

- The highest biocrude yield for HTL of *Alaria esculenta* is 29.4 wt% (daf) at 360°C
- FTIR spectra suggest a catalytic effect of salts increasing the alginates and polysaccharides in the solid residue
- At 360°C a maximum of 35 wt% of nitrogen initially present in the macroalgae can be recovered in the aqueous phase

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