Mixotrophic cultivation of *C. vulgaris* using sweet sorghum bagasse to reduce cost and enhance sustainability

Algae Biomass Summit 2020

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Introduction

- Mixotrophy is a strategy to enhance the growth rate and product yield in microalgae.
- It is the synergy between autotrophy and heterotrophy.
- However, sustainable mixotrophic cultivation of microalgae requires uninterrupted supply of organic carbon.
- Recovering waste carbon from agro-industrial waste could serve as organic carbon supply.
- Sweet sorghum is a low-cost non-food energy crop that can simultaneously produces sugar juice and bagasse.
- Sweet sorghum bagasse (SSB) is rich in cellulosic and hemicellulosic sugars (glucose and xylose) that can be obtained via pretreatment and enzymatic hydrolysis and then can be fed to algae.

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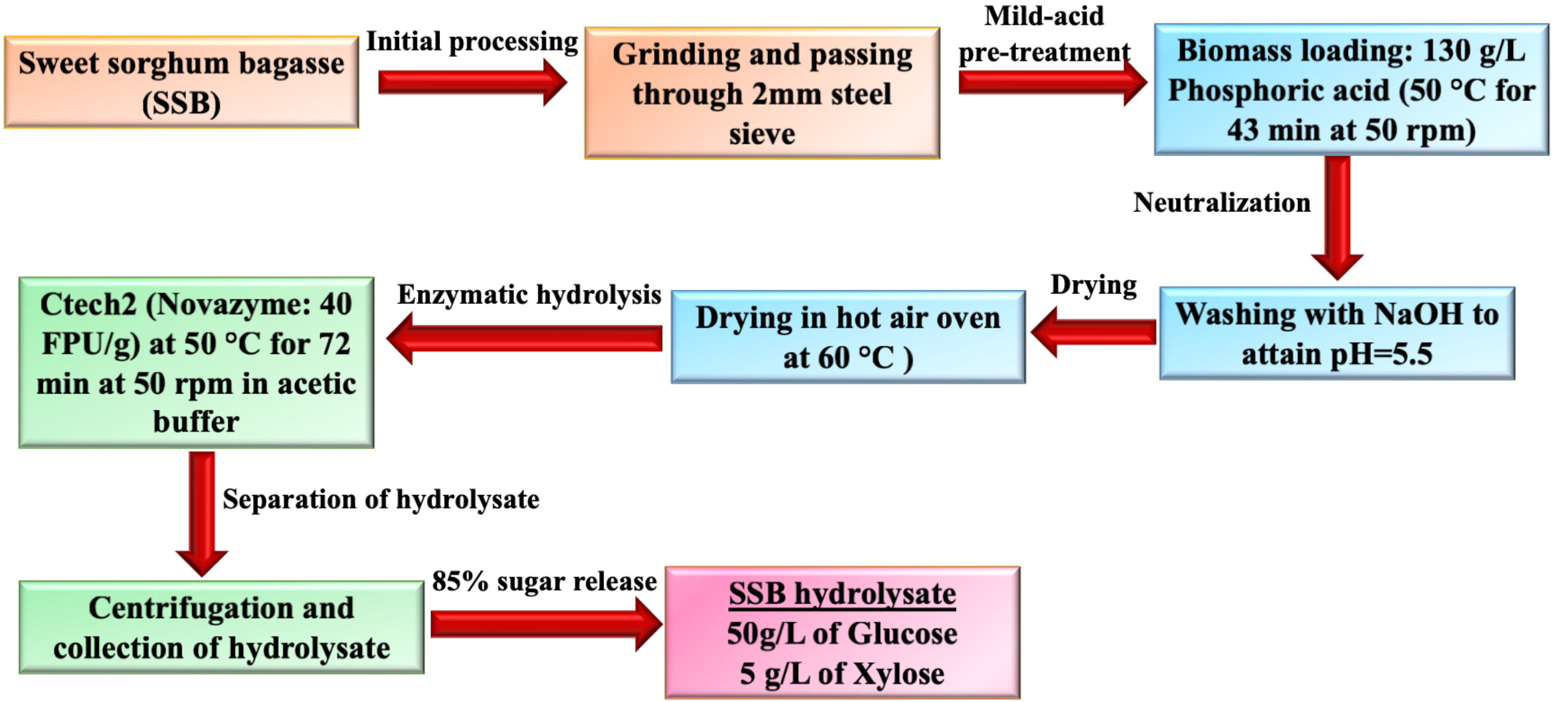
SSB conversion to sugars

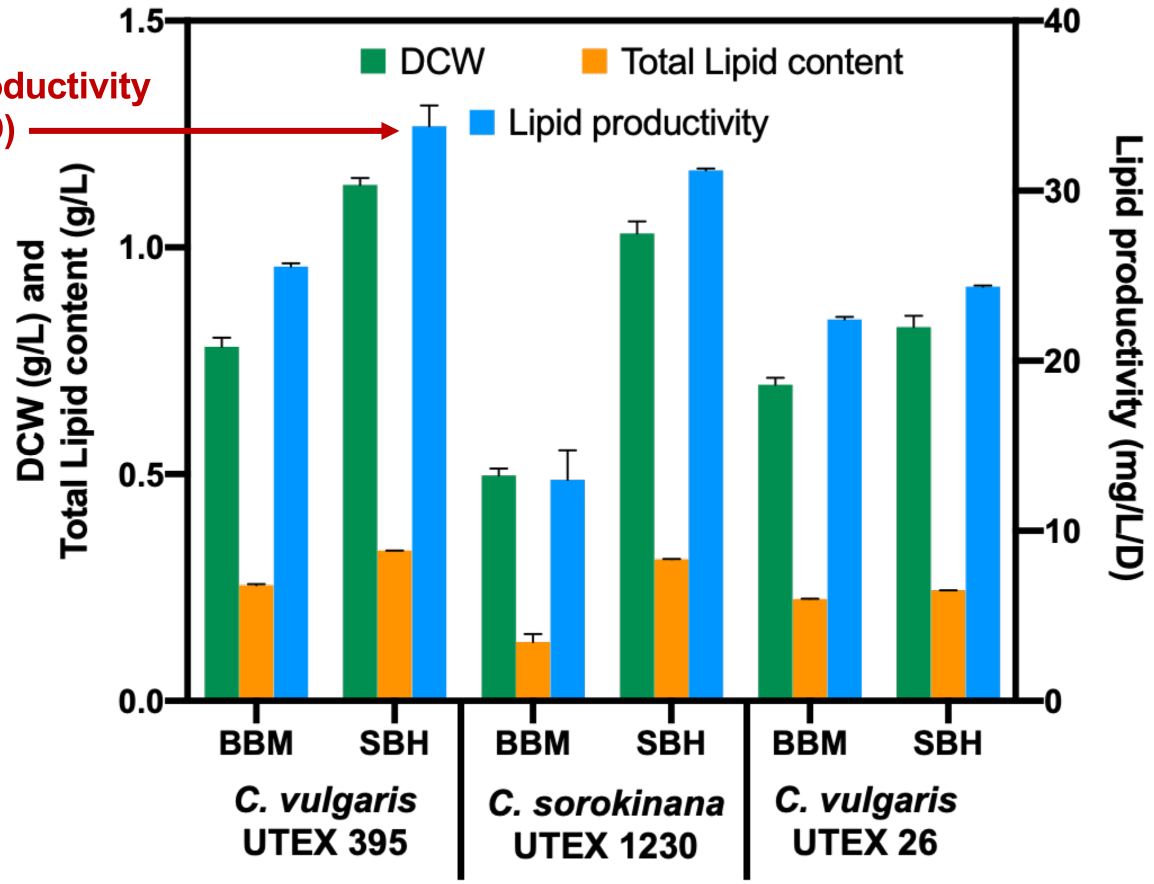


1. Initial processing 2. Pre-treatment 3. Enzymatic hydrolysis

E. Lo, L. Brabo-Catala, I. Dogaris, E.M. Ammar, G.P. Philippidis, Biochemical conversion of sweet sorghum bagasse to succinic acid, J. Biosci. Bioeng., 129 (2020), pp. 104-109.

Selection of microalgal strain

Maximum lipid productivity (34 mg/L/D)



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Optimizing key cultivation parameters

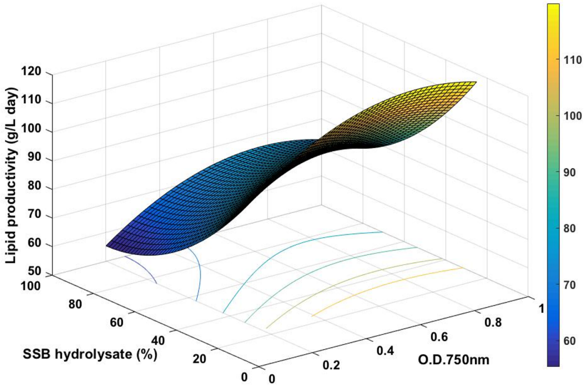
BBD Design		Coded level and concentration		
Parameter	Label	-1	0	1
$O.D._{750nm}$	OD	0.2	0.6	1
Salinity (%)	S	0	1.5	3
SSB Hydrolysate (%)	H	25	62.5	100

Maximized total lipid productivity (mg/L/D)

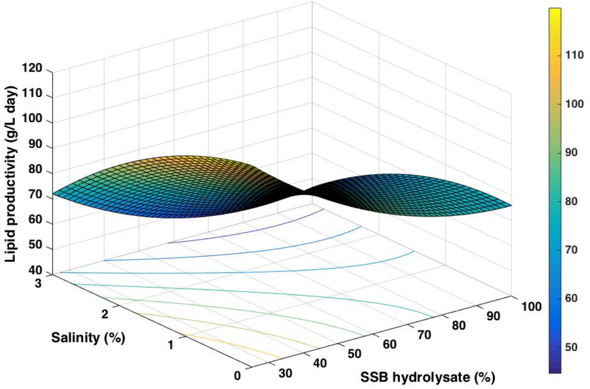
$$= 115.2 + 97.7[OD] - 1.534[H] - 12.47[S] - 61.9[OD]^2 + 0.00768[H]^2 - 3.77[S]^2 - 0.016[OD][H] + 7.31[OD][S] + 0.0821[H][S]$$

Optimized values:

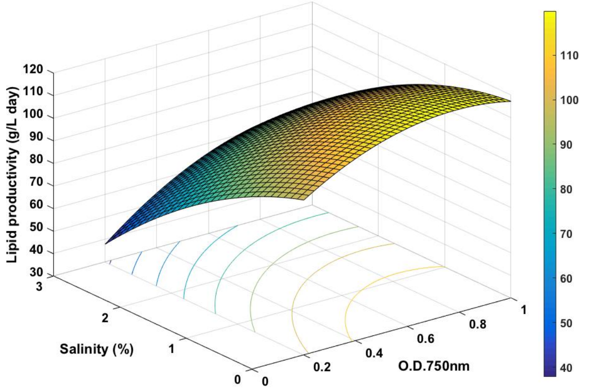
$O.D._{750nm}$ = 0.789, Salinity = 0 % and SSB hydrolysate = 25 %



Hydrolysate (%) vs O.D.

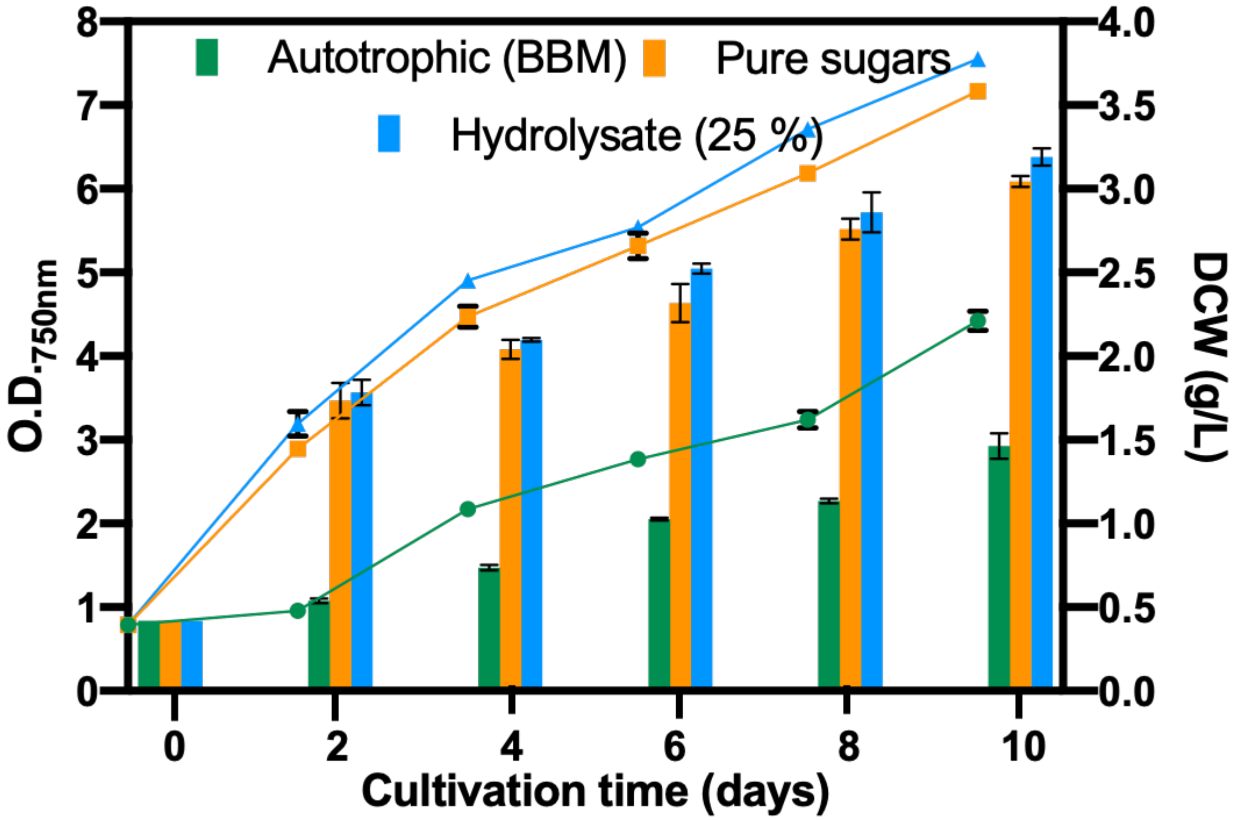


Salinity (%) vs Hydrolysate (%)



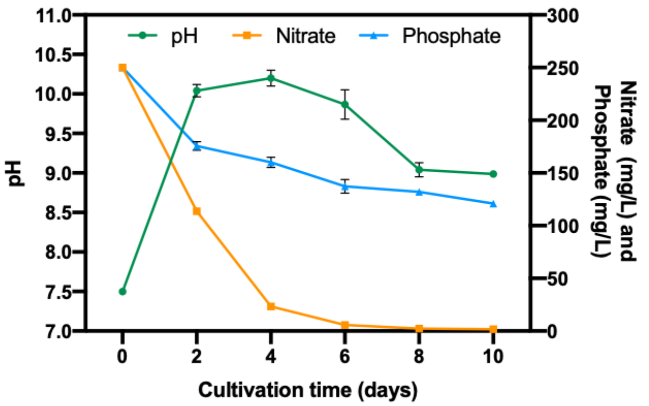
Salinity (%) vs O.D.

Cultivation results

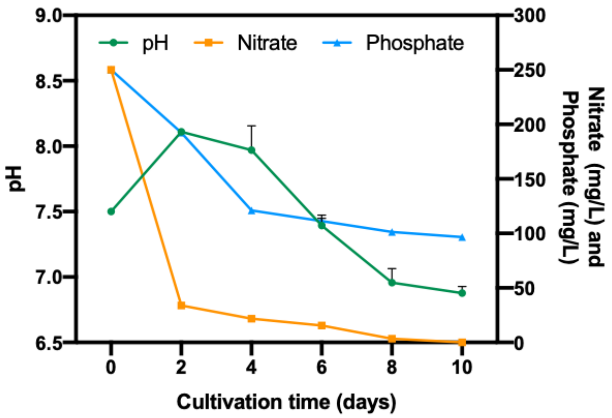


Changes in pH, nitrate, and phosphate

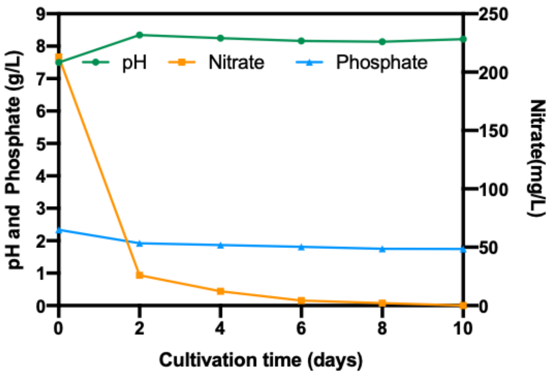
Autotrophic (BBM)



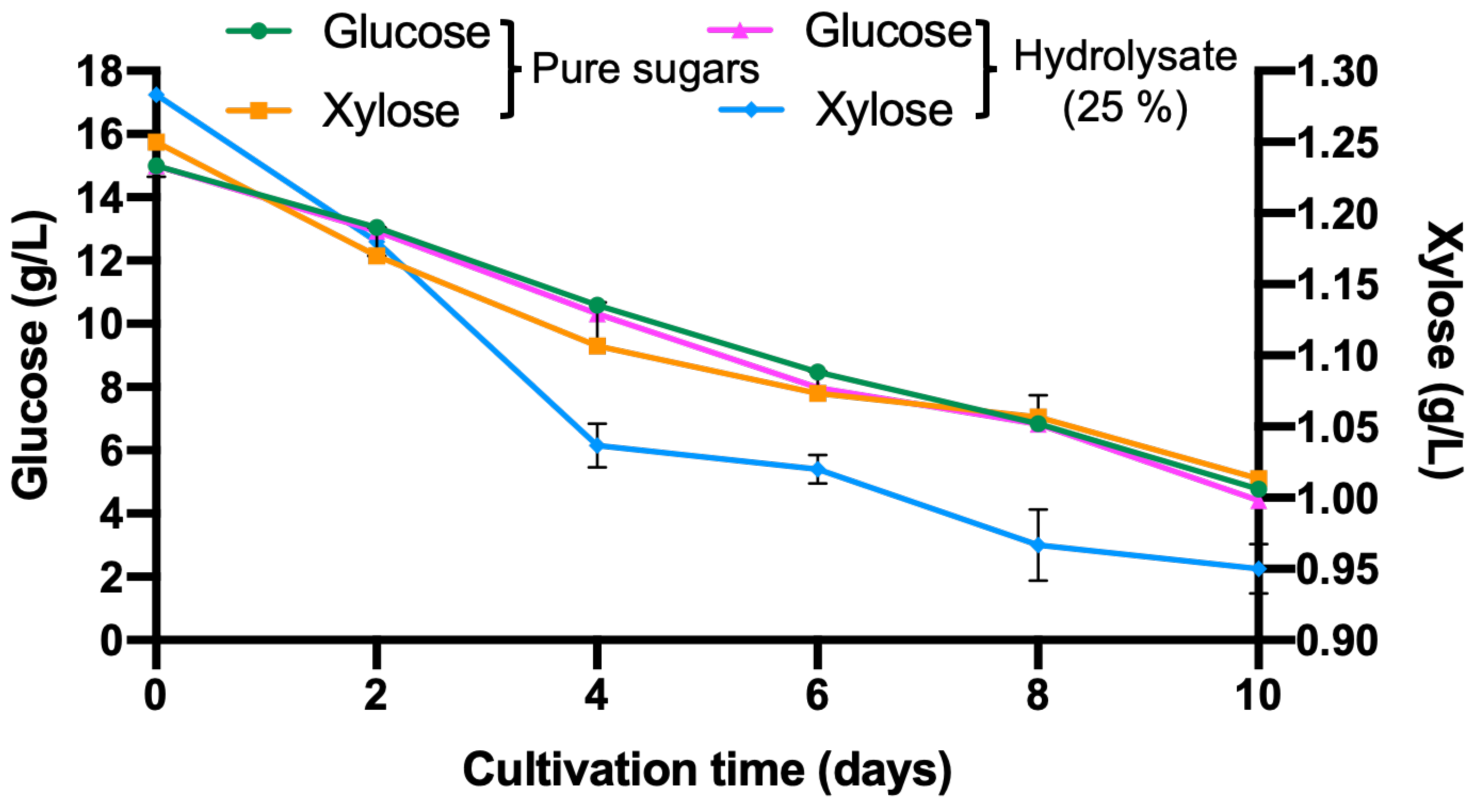
Pure sugars



Hydrolysate (25 %)



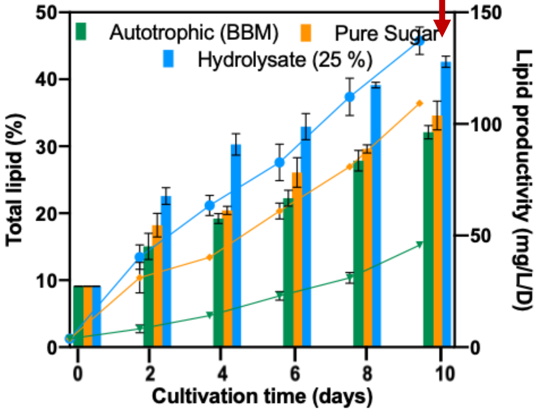
Sugar consumption



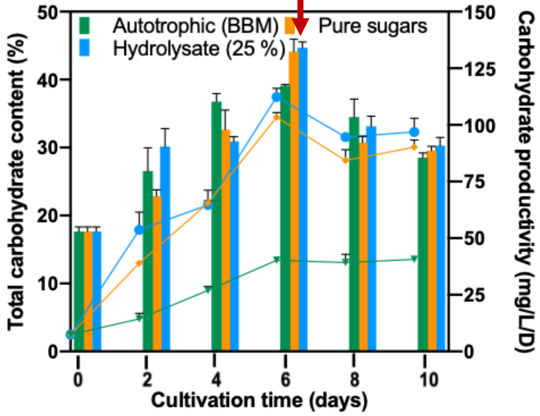
Changes in cellular composition

Maximum lipid productivity (136 mg/L/D)

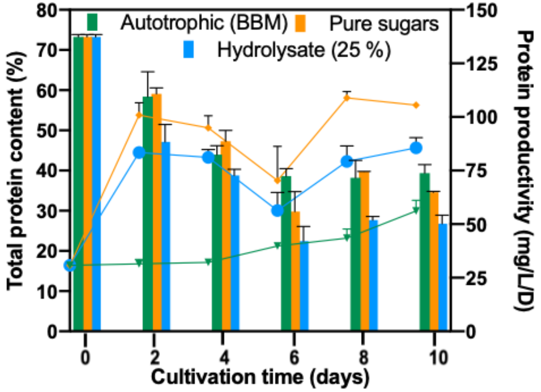
Maximum carbohydrate productivity (112 mg/L/D)



Total Lipid

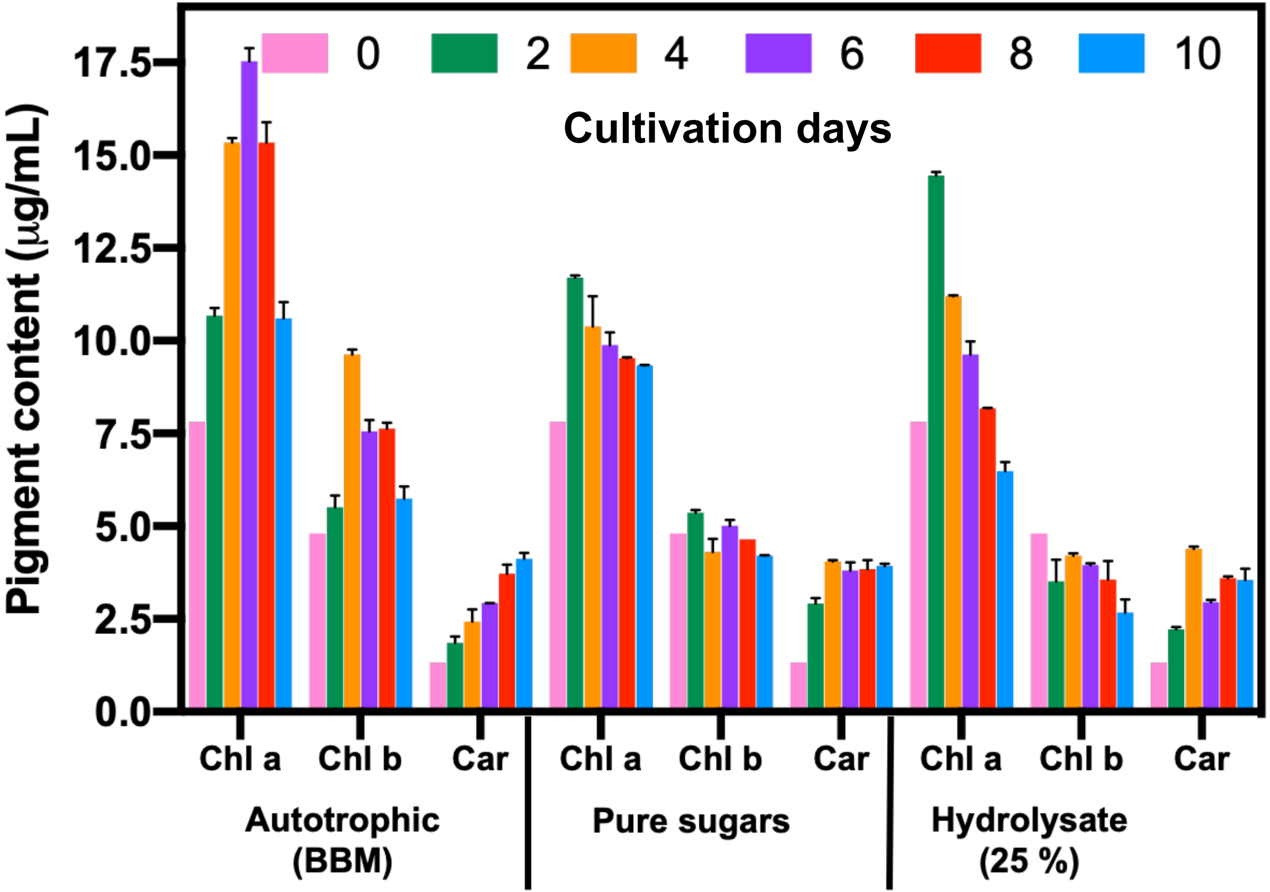


Total Carbohydrate

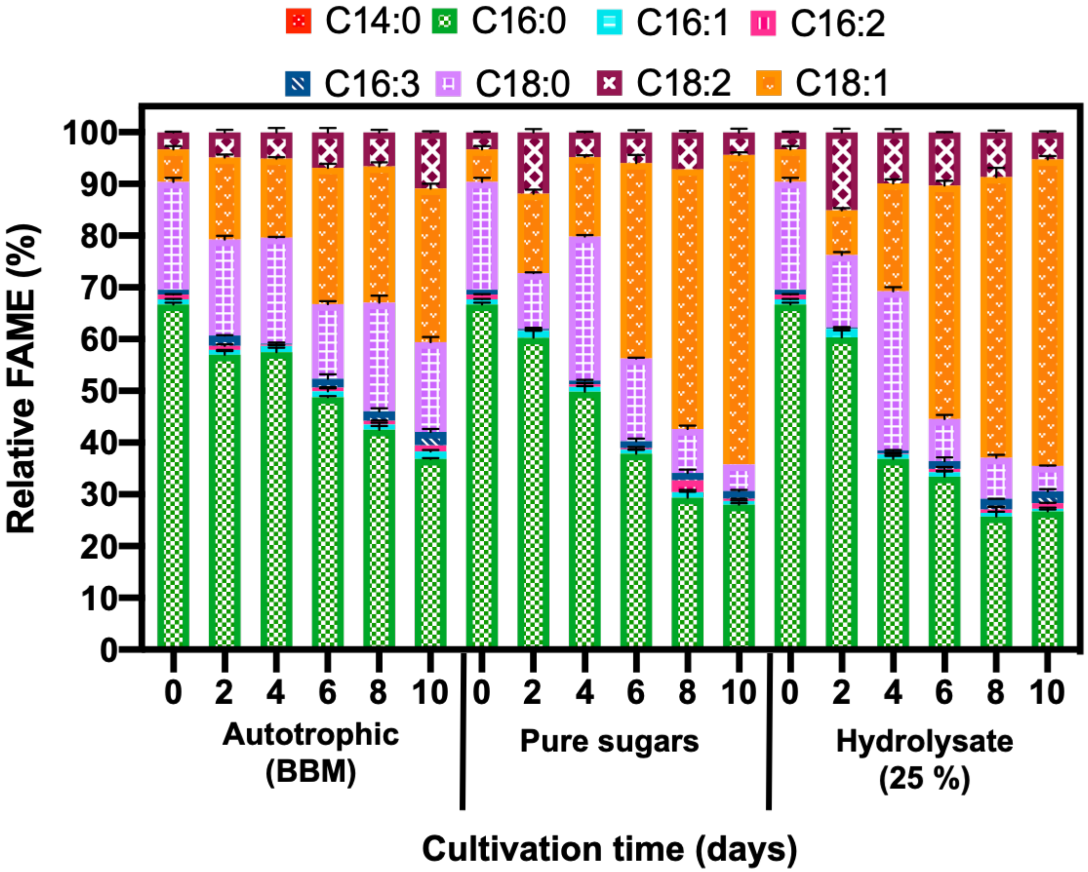


Total Protein

Changes in photosynthetic pigments



Temporal changes in FAME profile



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Conclusions and Future directions

- Mixotrophic cultivation of *Chlorella vulgaris* using sweet sorghum bagasse (SSB), a low-cost renewable agricultural residue
- SSB hydrolysate boosted both lipid and carbohydrate productivity.
- Microalgae metabolism switches from protein synthesis to carbohydrate accumulation during initial nitrogen deprivation.
- However, prolonged nitrogen deprivation triggers lipid accumulation in the microalgae.
- Variations in FAME composition were observed with decrease in SFA and increase in MUFA and PUFA during growth.
- Future studies will focus on scale-up studies in PBR and deciphering the molecular mechanism for glucose uptake by *C. vulgaris* under mixotrophic and heterotrophic conditions.

Thank you

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