UTILIZATION OF DAIRY INDUSTRY BY-PRODUCTS AS SUBSTRATES TO ENHANCE THE PRODUCTIVITY OF MICROALGAE PRODUCTION SYSTEMS

University of Minho
School of Engineering
Centre of Biological Engineering

Author* FERNANDES, BRUNO.
Supervisors: Vicente, António; Teixeira, José.
* brunofernandes@deb.uminho.pt

Fundação para a Ciência e a Tecnologia

Introduction

Microalgae

- Accumulate high amounts of lipids and starch, used to produce biodiesel and bioethanol.
- Mitigation of approximately 500 kg of CO_2 per 400 kg of microalgal biomass
- Traditional growth techniques, presents several drawbacks, with consequent limitation on algal productivity.

Cheese Whey (CW)

- By-product derived from cheese making process, which major components are lactose, proteins and lipids.
- Polluting waste stream - To make 1 kg of cheese, 10 L of whey is generated
- Biological treatment by conventional aerobic process is very expensive

Aim

Evaluate the possibility of using cheese whey (CW) or cheese whey hydrolysate (CWH) as carbon source for mixotrophic culture of *Chlorella vulgaris.*

Methods

The experiment consisted of 3 conditions, summarized in Table 1, each one performed in duplicate. All assays were performed in batch system, in 0.5 L flasks containing 400 mL of medium at 30 ºC and the pH was kept around 7.5.

Table 1 - Summary of culture conditions and respective carbon source

Growth Conditions	Carbon Source
Photoautotrophic	CO_2
Mixotrophic $_{CW}$	CO_2 + Cheese whey(1)
Mixotrophic $_{CWH}$	CO_2 + Cheese whey hydrolysate(2)

(1) Equivalent to 10 g L^{-1} lactose

(2) Equivalent to 5 g L^{-1} glucose + 5 g L^{-1} galactose

All the cultures were aerated with CO_2-enriched air (2% v/v CO_2) at a rate of 0.4 vvm and illuminated with continuous light (70 mmol m^{-2} s^{-1}).

The productivity of each cell in terms of different components (starch and lipids) was calculated using the equation:

$$P_{Component} = P_{max} \times F_{component}$$

where $P_{component}$ is the productivity of *Chlorella vulgaris* in term of one of the components in study (starch, lipids and proteins), P_{max} is the maximum biomass productivity and $F_{component}$ is the fraction of component (w w^{-1}) in the cell.

Results

Table 2 – Growth parameters for *Chlorella vulgaris* cultivated photoautotrophically and mixotrophically, with different carbon sources

Growth Conditions	Growth Parameters [1]		
	μ_{max} (d^{-1})	X_{max} (g L^{-1})	P_{max} (g L^{-1} d^{-1})
Photoautotrophic	0.13 ± 0.04 a	1.22 ± 0.12 a	0.103 ± 0.022 a
Mixotrophic $_{CW}$	0.13 ± 0.04 a	1.98 ± 0.43 b	0.316 ± 0.101 b
Mixotrophic $_{CWH}$	0.42 ± 0.16 a	3.58 ± 0.12 c	0.739 ± 0.035 c

[1] μ_{max} = max. specific growth rate (d^{-1}); X_{max} = max. biomass concentration (g L^{-1}); P_{max} = max. biomass productivity (g L^{-1} d^{-1}).

Table 3 – Consumption of the different organic carbon sources during mixotrophic growth of *Chlorella vulgaris*

Growth Conditions	Organic Carbon Source Consumption (%)		
	Glucose	Galactose	Lactose
Mixotrophic $_{CW}$	-	-	59.0 ± 9.8
Mixotrophic $_{CWH}$	100 ± 0.0	96.0 ± 0.2	-

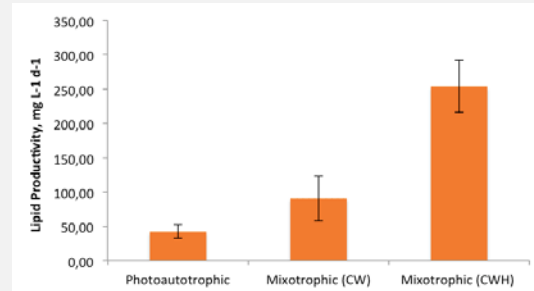

Figure 1 – Comparison of lipid productivity between photoautotrophic and mixotrophic growth of *Chlorella vulgaris*

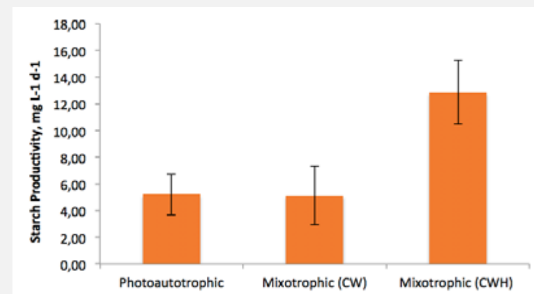

Figure 2 – Comparison of starch productivity between photoautotrophic and mixotrophic growth of *Chlorella vulgaris*

Conclusions

Biomass productivity and, inherently, the lipid and starch productivity was stimulated by CW and CWH, suggesting that this industrial by-product could be used as a low-cost supplement for the mixotrophic growth of *Chlorella vulgaris*.

Acknowledgements

This work was supported by Fundação para a Ciência e a Tecnologia through B. Fernandes grant SFRH/BD/44724/2008 and G. Dragone grant SFRH/BPD/44935/2008.