Single Cell Proteins production from effluents of candy industry

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Worldwide Proteins Demand

The human population has grown by around 250% over the past 60 years and we expect it to reach **10 billion by 2050**. We will hardly be able to meet this demand only thanks to agriculture, livestock and fish farming.

(Microbial Protein: A Valuable Component for Future, J.Singh).

In particular, in the last decade, there has been an increase in the consumption of proteins, from meat and dairy products. In 2050, demand is estimated to reach **1,200 million tons**.

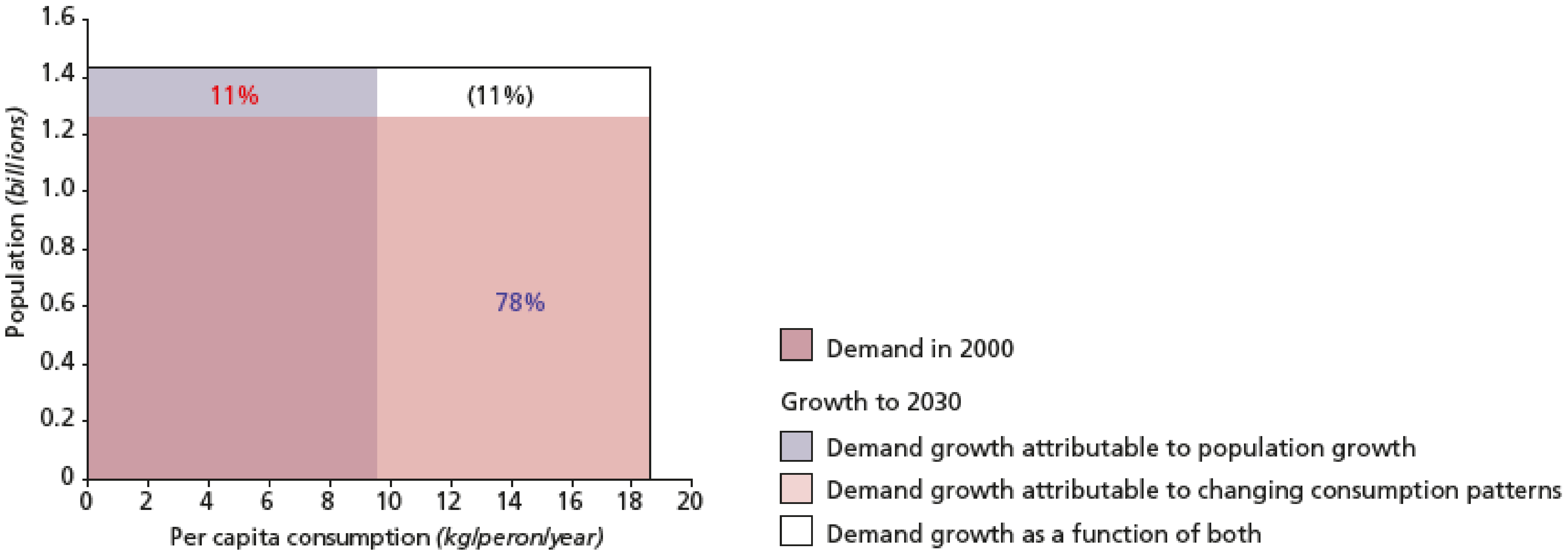
(Single Cell Protein –State of the Art, Industrial Landscape and Patents, A.Ritala)

Worldwide Proteins Demand

Demand increasing from 2010 al 2050	
Bovine meat	121%
Sheep meat	136%
Pork meat	105%
Chicken meat	173%
Dairy products	121%
Shrimps	190%
Salmon / Carp / Pangasius	140% - 190%

(FAO,2006c; World Population Prospects,2002)
(FISH to 2030, Prospects for Fisheries and Acquaculture)

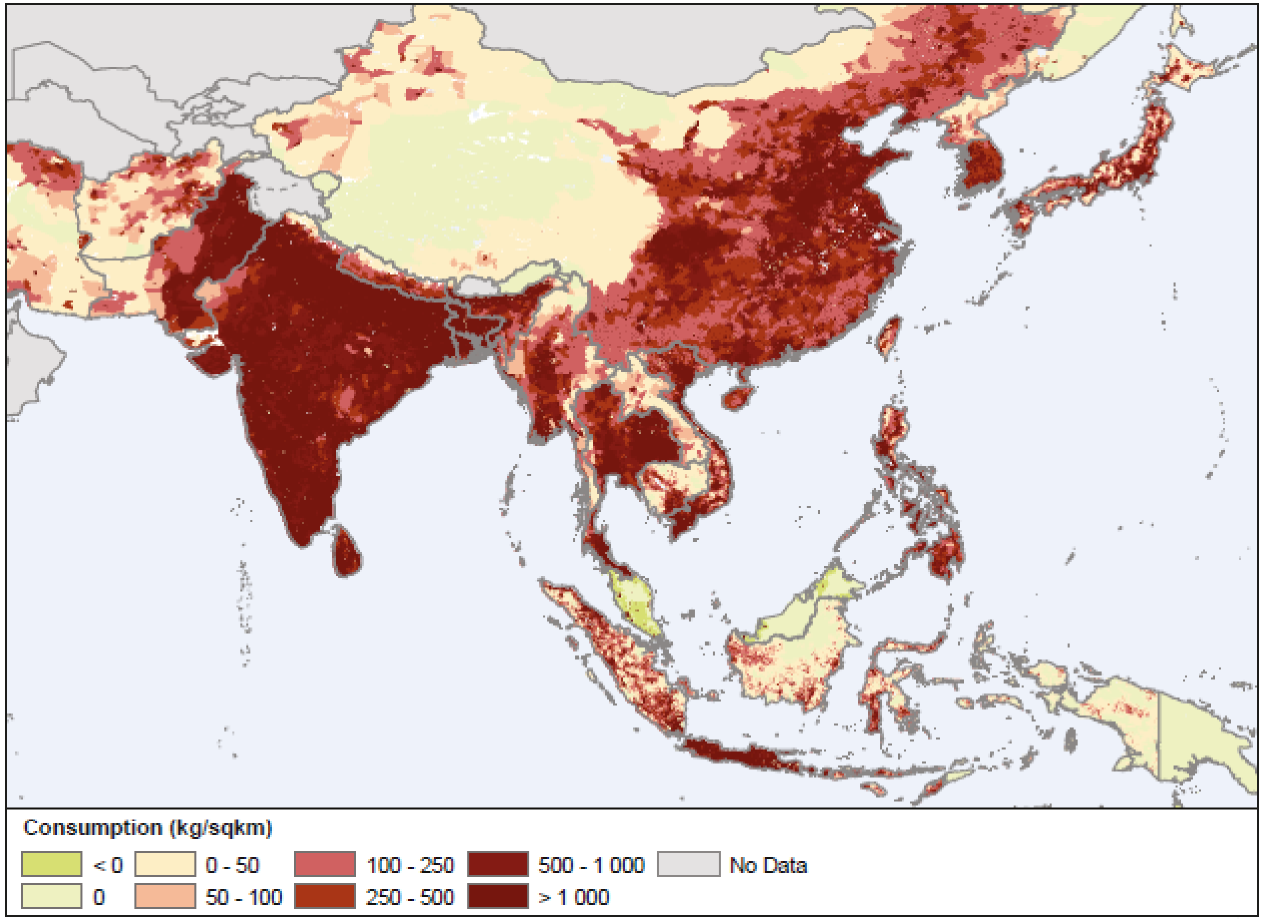
Worldwide Proteins Demand



The increasing of the proteins demand is mainly concentrated in Asia (2000-2030)

TABLE 4.7: Projected Changes in the Food Fish Consumption in China due to Accelerated Preference Shift

	2030 (000 TONS)		SCENARIO 4 RELATIVE TO BASELINE
	BASELINE	CHINA (SCENARIO 4)	
TARGETED SPECIES			
Shrimp	4,183	13,021	211%
Crustaceans	1,504	4,583	205%
Salmon	971	2,876	196%
Tuna	165	493	199%
Mollusks	17,695	36,201	105%



Alternatives to Animal Proteins

- **Raising edible insects as a protein source**

Drawbacks: they require pure substrates and have a low yield

- **Vegetable proteins**

Problematiche: they present a deficiency in some essential amino acids (Lys, Cys, Thr);

they are not always sustainable (consumption of 70% of global water and 40% of land, transport of non-seasonal fertilizers / vegetables)

- **Single Cell Proteins**

(FAO: Edible insects. Future prospects for food a nd feed security (2013))
(Plant protein in relation to human protein and amino acid nutrition, Vernon R Young)
(UNEP, Assesing the enviromental impacts of consumption and production)

SCP – Single Cell Protein

The Single Cell Proteins represent a proteic source derived from microorganisms (pure or mixed culture) yeasts, algae used as animal feed.

SCP interest is due to the possibility to use wastes streams as substrates for the microorganisms' growth.

SCP can be largely applied in aquaculture for fish growth. Fish are more efficient at converting protein from feed to bulk than livestock animals.

SCP from Candies production’s waste (CPW)

Yeast S.cerevisae has been adopted

for the SCP production

	sCOD (g/L)	TKN (g/L)	TP (g/L)	TS (%w/w)	TVS/TS (%)
Digestate	18.15	1.15	0.28	5,03	98,68
CPW	75.5	0.27	0.01	3.63	77.68

C:N
270:1

*Single cell protein from pineapple cannery effuent. (J.N. Nigam)

SCP from Candies production's waste (CPW)

Yeast S.cerevisae has been adopted for the SCP production

g/L	
Frctuose	4.00 ± 1.50
Glucose	11.00 ± 2.00
Maltose	2.40 ± 0.45
Sucrose	18.00 ± 4.30
Lactose	1.50 ± 0.20
Maltotriose	2.50 ± 0.15
Total Sugars	39.40 ± 5.35

*Single cell protein from pineapple cannery effuent. (J.N. Nigam)

Methods

- CPW and digestate were filtered at 0,2 µm
- Batch and countinous tests were conducted in mesophilic temperature (35 °C). Inlet feed: 75 gCOD/L and 2,4 g/L of dried inoculum (S. Cerevisae)
- Cells count: microscope following the Bürker chamber method
- Cell count was converted in biomass concentration*:

Cells count *5* 10^{-1}

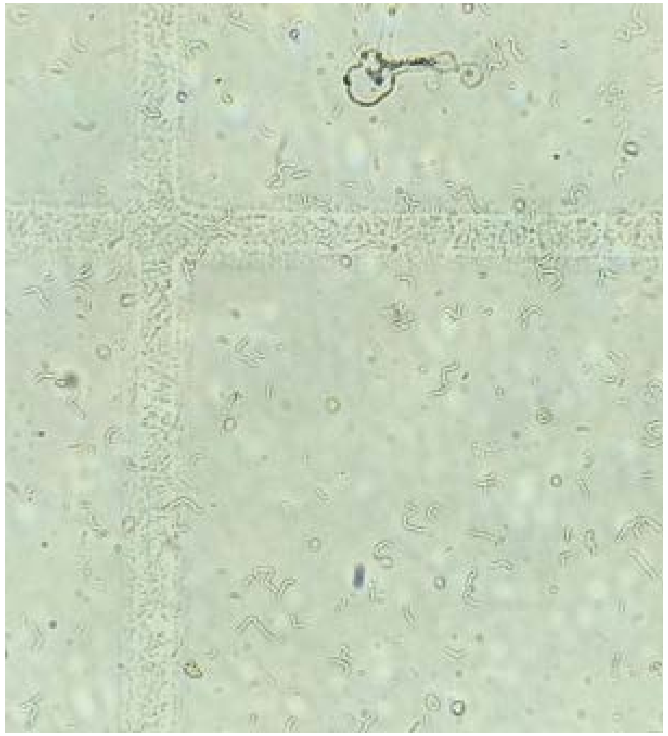
* Effect of the Strategy of Molasses Supplementation in Vinasse to High SCP Production and Rose Flavor Compound (J.M.Coimbra)

Batch tests

	Anaerobic	Aerobic
Duration (d)	7	7
Temperature (C°)	35	35
CPW (L)	0,7	0,7
Digestate (L)	0,017	0,017
Inoculum (g)	1,7 (2.4 g/L)	1,7 (2.4 g/L)

Batch tests

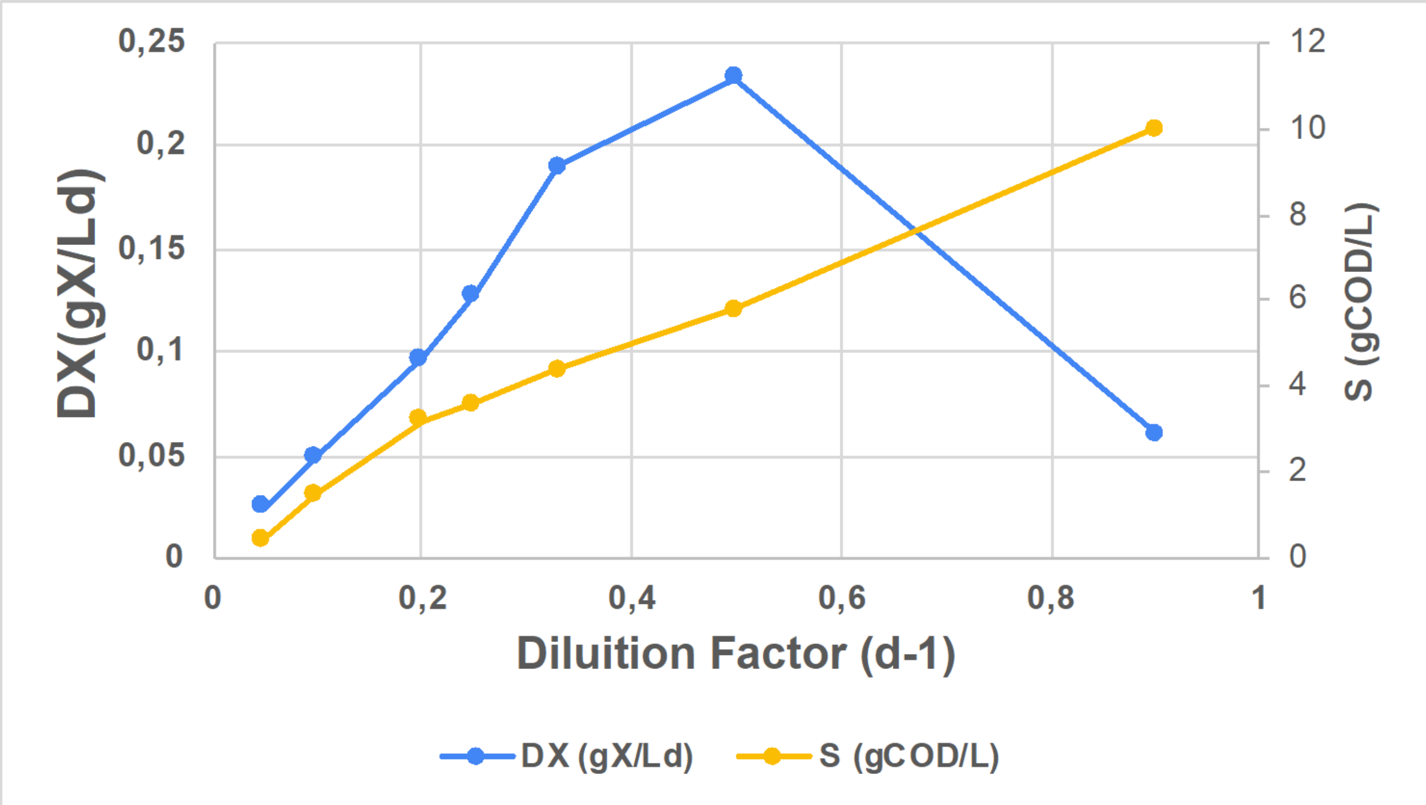
	Anaerobic	Aerobic
BIOMASS (g/L)	5,03	8,72
Cells count (*10^7)	2,4	3,9
TKN (g N/g biomassa, %)	3,02	6,66
% Crude Protein	18,86	41,65



Continuous test

D (d-1)	**0,9**	**0,5**	**0,33**	**0,2**	**0,1**	**0,05**
In (L)	0,45	0,25	0,17	0,2	0,1	0,05
Out (L)	0,45	0,25	0,17	0,2	0,1	0,05
OLR (gCOD/Ld)	38,25	21,25	14,195	17	8,5	4,25
HRT (d)	**1,1**	**2**	**3**	**5**	**10**	**20**

Continuous test

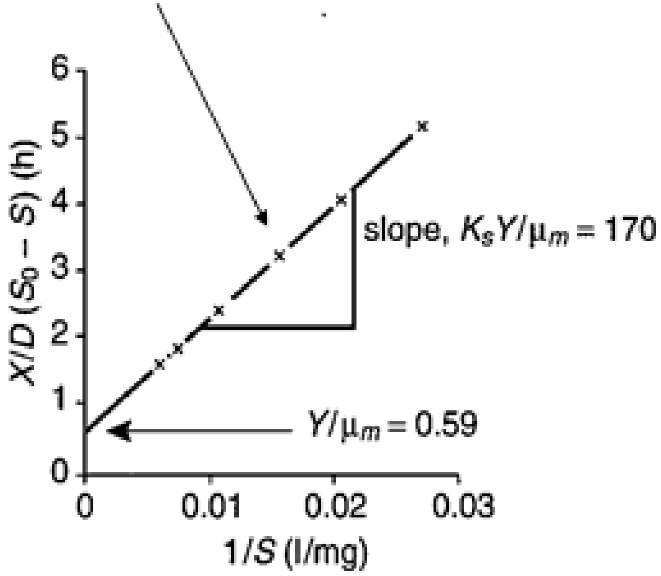


Continuous test

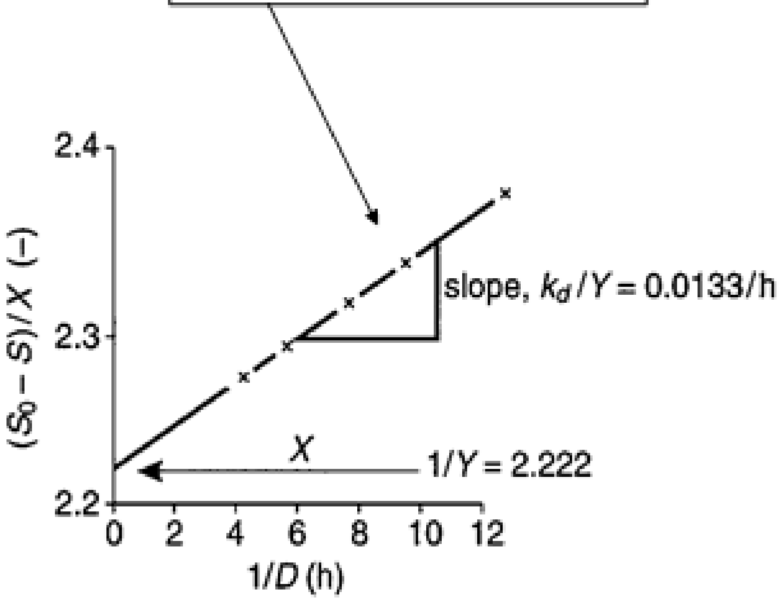
D (d-1)	0,05	0,1	0,2	0,25	0,33	0,5	0,9
Cells count (10^7)	0,08	0,995	0,973	1,025	1,15	0,933	0,135
TKN (%, w/w)	3,11	3,03	3,22	3,08	4,18	4,49	2,6
% Crude Proteins	19,42	19,57	20,11	19,25	26,09	28,06	16,28

Continuous test – Determination of the kinetical parameters

$$\frac{X}{D\cdot(S_0-S)}-\frac{Yk_S}{\mu_{max}}\frac{1}{S}+\frac{Y}{\mu_{max}}=0$$



$$\frac{(S_0-S)}{X}=\frac{1}{D}\cdot\frac{k_d}{Y}-\frac{1}{Y}$$



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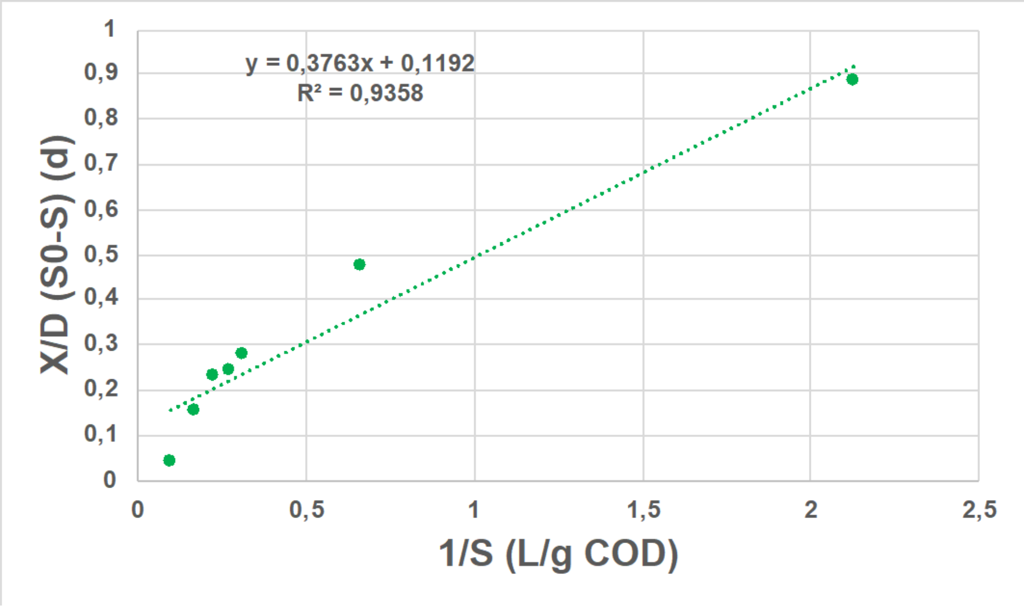

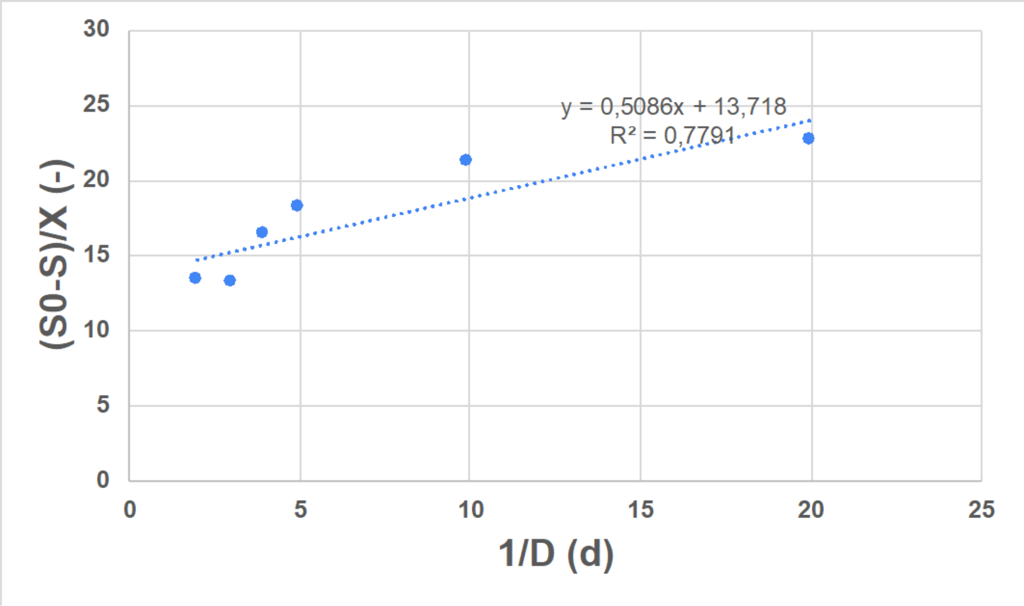

Y	1.28
Kd	0.03
µ max (1/h)	0.45
Ks (g/L)	3.16

Next Steps

- Individuation of the optimal OLR;
- Analysis of the amino acid profile of the produced biomass. By this way it will possible to verify the quality of the amino acids present in the SCP;
- Use of the produced SCP for aquaculture scope.

Thanks for your kind attention