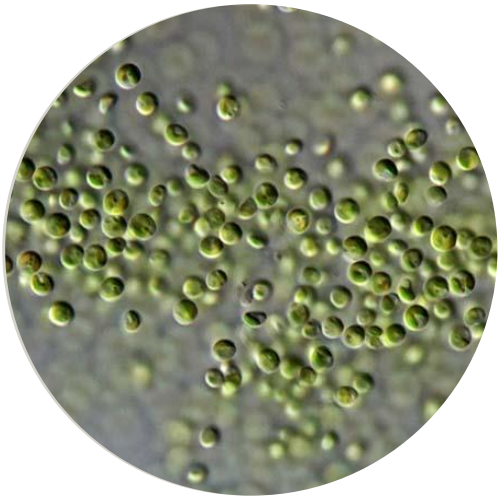
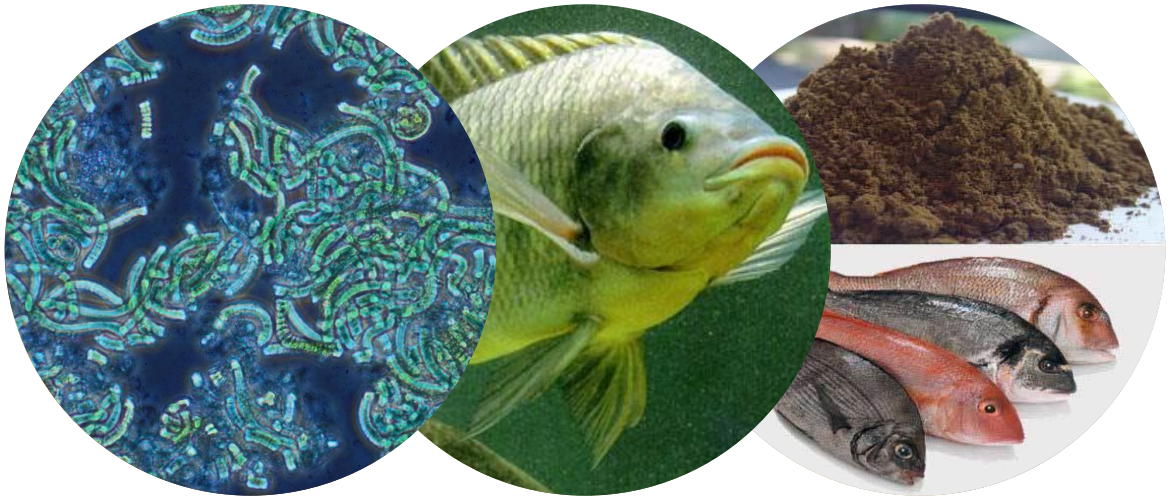
Novel proteins for fish:
Single cell proteins (algae/bacteria/yeast)

5th June 2022
Johan Schrama





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Introduction

- Protein ingredients
  - Diversification
  - Variability in nutrients

Fishmeal

Poultry by-product meal

Soybean protein concentrate

Methanotroph

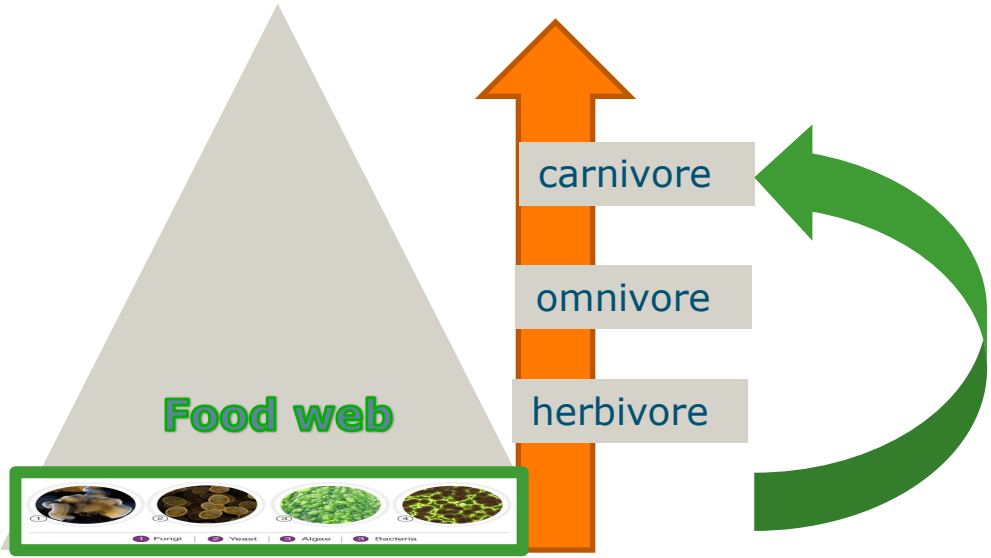
Type of single cell ingredients

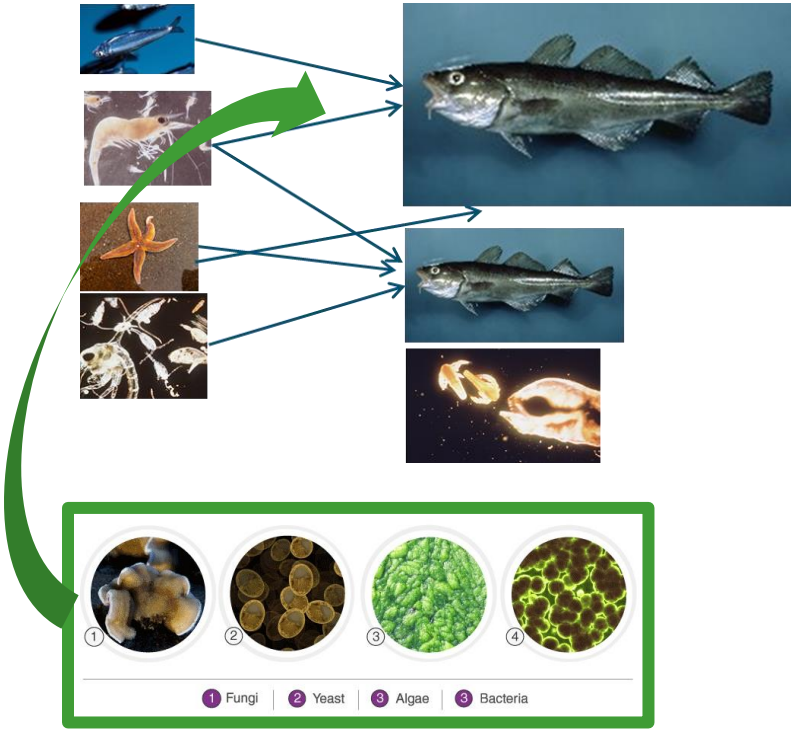
Table 1. Major groups of microalgae, yeasts and bacteria used as single-cell protein (SCP) or single-cell oil (SCO) source ingredients in aquaculture feeds.

Group	(Super)Phylum	Class	Genus	Species	Application	Data Source
Microalgae	Chlorophyta	Trebouxiophyceae	*Chlorella*	*vulgaris*	SCP	[50]
		Chlorophyceae	*Haematococcus*	*pluvialis*	Bioactive	[51]
	Heterokonta	Labyrinthulomycetes	*Schizochytrium*	*sp.*	SCO, SCP	[52,53]
		Eustigmatophyceae	*Nannochloropsis*	*gaditana*	SCP	[15]
		Coscinodiscophyceae	*Chaetoceros*	*muelleri*	SCO	[54]
		Coscinodiscophyceae	*Skeletonema*	*costatum*	SCO	[55]
		Bacillariophyceae	*Navicula*	*gregaria*	SCO	[55]
	Haptophyta	Pavlovophyceae	*Pavlova*	*lutheri*	SCO	[32,56]
		Prymnesiophyceae	*Isochrysis*	*galbana*	SCO, SCP	[32,57]
	Dinoflagellata	Dinophyceae	*Crypthecodinium*	*cohnii*	SCO	[20]
Fungal	Ascomycota	Saccharomycetes	*Saccharomyces*	*cerevisiae*	SCP	[41,58]
		Saccharomycetes	*Wikerhamomyces*	*anomalus*	SCP	[41,59]
		Saccharomycetes	*Candida*	*utilis*	SCP	[58]
		Saccharomycetes	*Kluyveromyces*	*marxianus*	SCP	[58]
	Mucoromycota	Mortierellales	*Mortierella*	*alpina*	SCO	[60]
Bacteria	Cyanobacteria	Cyanophyceae	*Spirulina*	*maxima*	SCP	[61]
	Proteobacteria	Gammaproteobacteria	*Methylococcus*	*capsulatus*	SCP	[62]
		Betaproteobacteria	*Methylophilus*	*methylotrophus*	SCP	[63]
		Alphaproteobacteria	*Methylobacterium*	*extorquens*	SCP	[64]

Glencross et al. (2020)

Skipping trophic levels





Generally energy flow in food web:

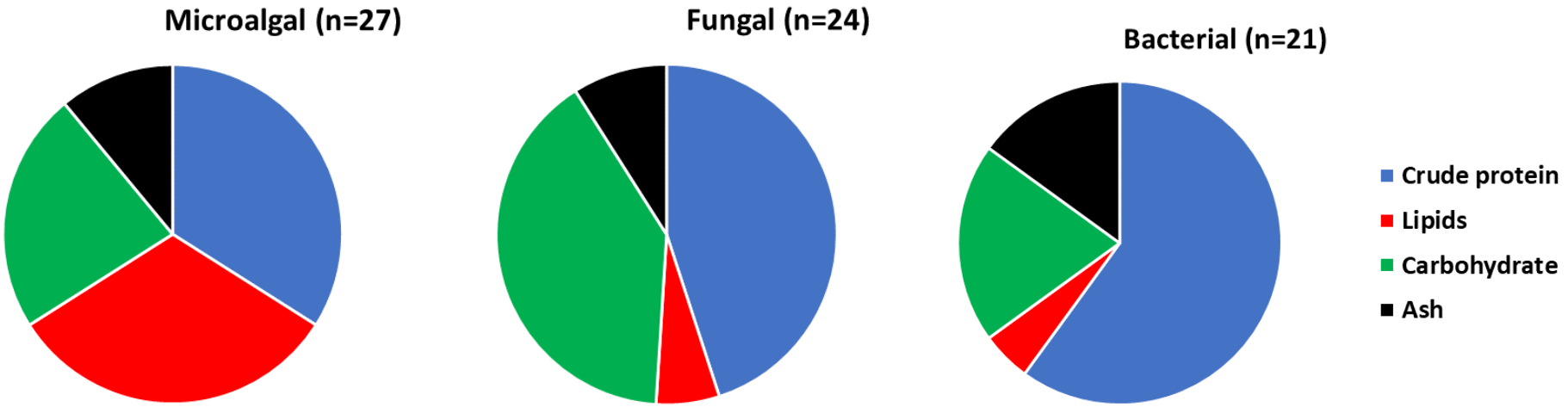
- Only 10% of the energy is transferred to the next trophic level

(Pauly &Christensen, 2005)

Origin of single cell protein (SCP):

Autotrophic ←→ Heterotrophic

Proximate composition of SCP (on DM basis)



CP
Mean: 34%
Range: 0-60%

CP
Mean: 45%
Range: 30-60%

CP
Mean: 60%
Range: <80%

Carbohydrate!!

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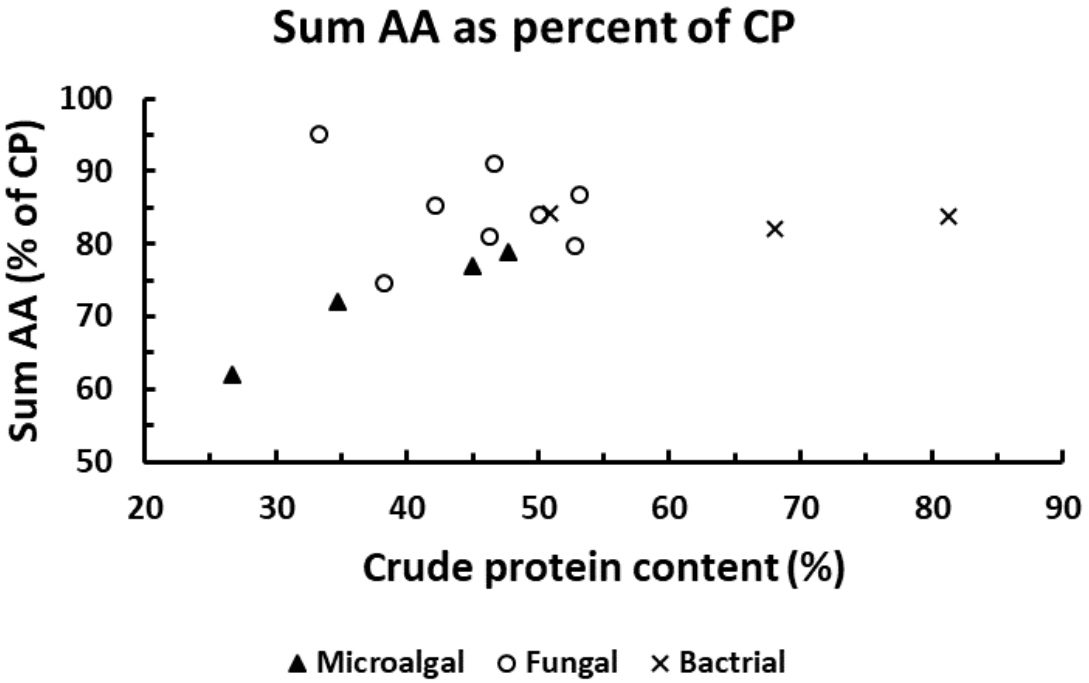
Glencross et al. (2020)

Crude protein ←→ Sum amino acid (Sum AA)



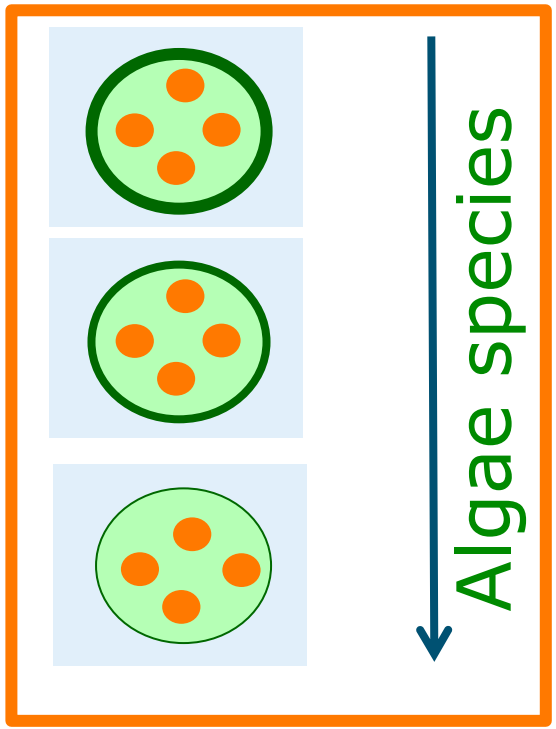
- CP biased
- Presence nucleotides
- Underestimation of carbohydrates
- AA patterns.....
  → not a problem
  → synthetic AA

Glencross et al. (2020)

Agboola et al. (2021)

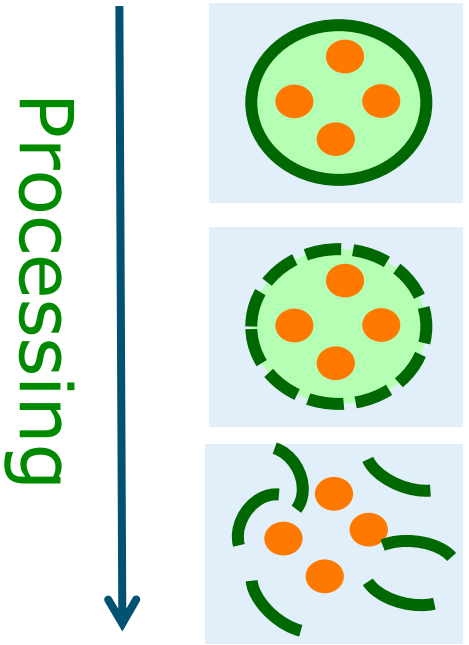
In vivo protein accessibility of SCP (microalgae)

Cell wall hardness



↑protein ADC?

Cell wall integrity?



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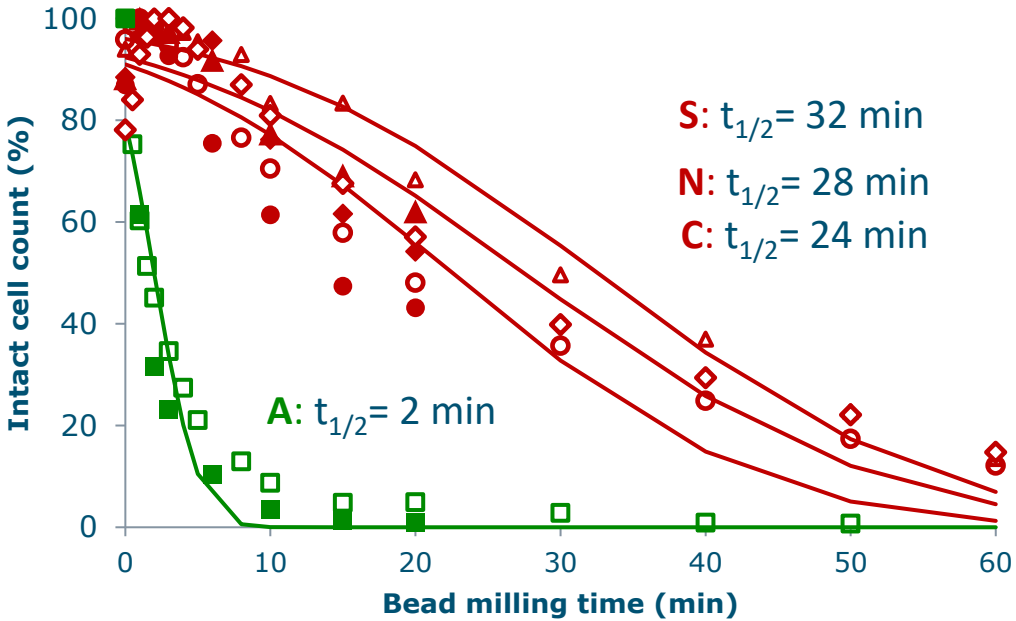
Cell wall hardness (microalgae & spirulina)



Differences in cell wall hardness between algae were quantified:

Spirulina <<< *C. vulgaris* ~ *N. gaditana* ~ *S. dimorphus*

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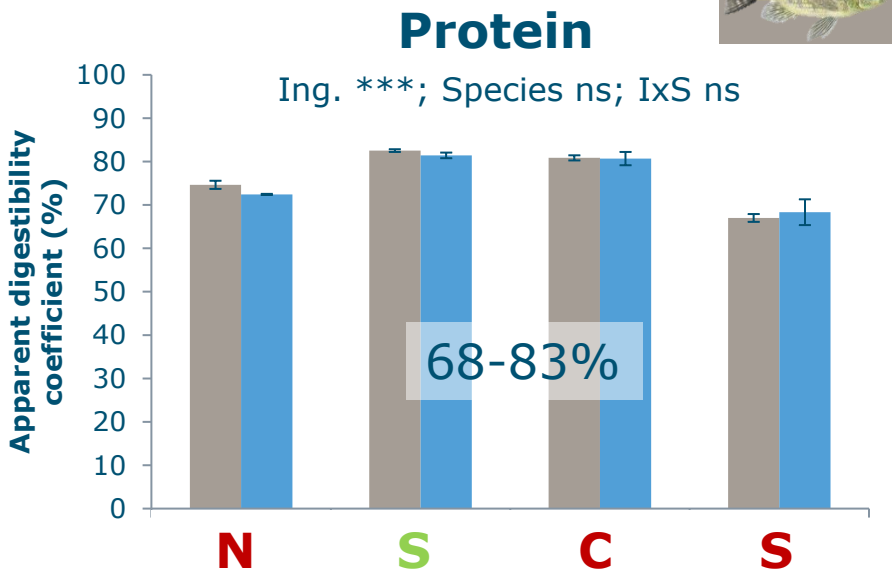
Teuling et al. (2017)

Cell wall hardness (microalgae & spirulina)



Differences in ADCs between "algae"

≠

differences in mechanical hardness of algae cell walls

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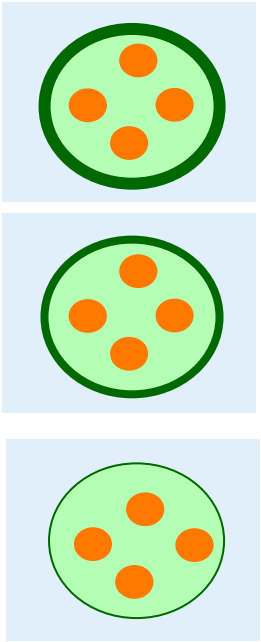
Teuling et al. (2017)

In vivo protein accessibility of SCP (microalgae)

Cell wall hardness

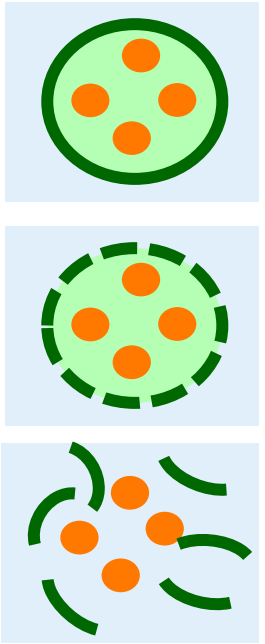


Algae species

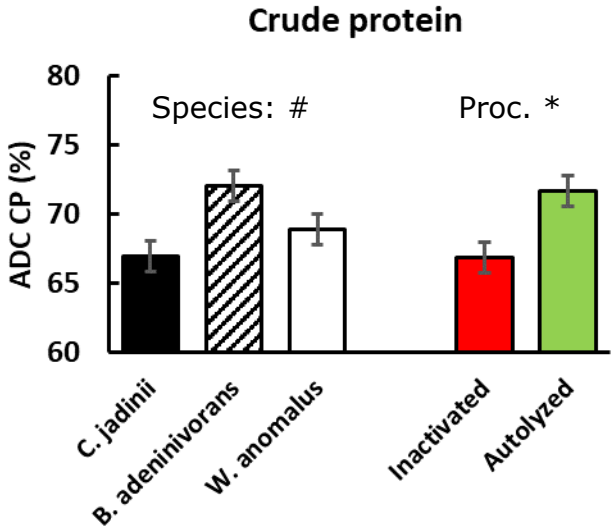
↑protein ADC?

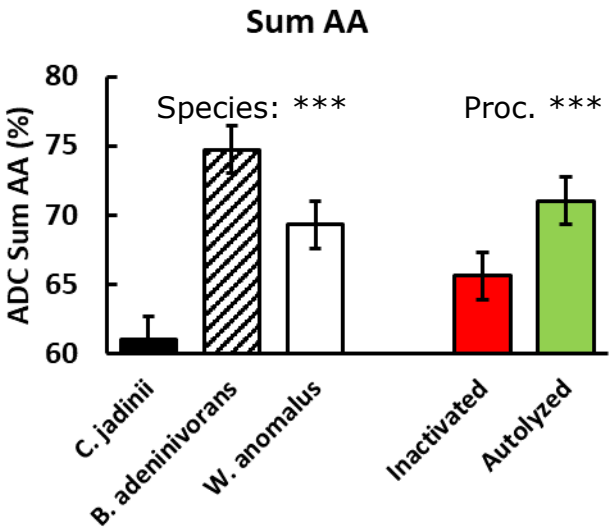
Cell wall integrity?

Processing



Processing yeast





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Agboola et al. (2022)

Cell wall integrity of SCP (*N. gaditana*)

- Untreated: (-) control

- Bead milling: (+) control

- Warm pasteurization

- Cold pasteurization (L60)

- Freezing → thawing

Roller drying

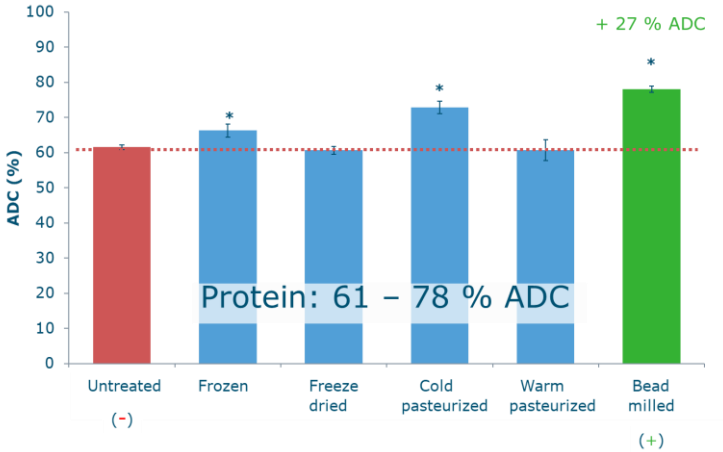
- Freezing

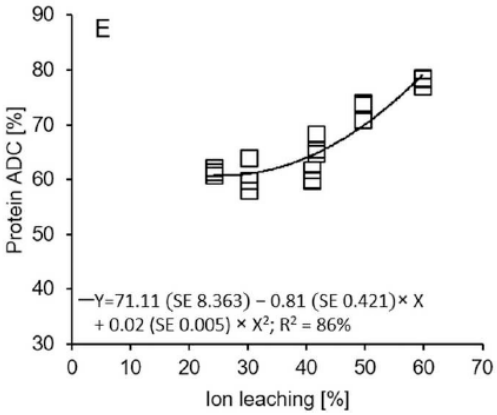
Freeze drying

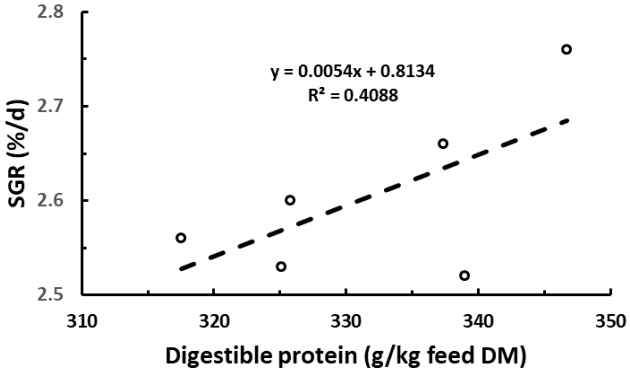
Similar gross composition; similar protein composition

Teuling et al. (2019)

Cell wall integrity of SCP (*N. gaditana*)

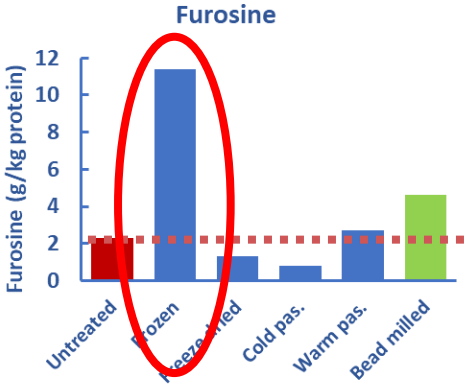


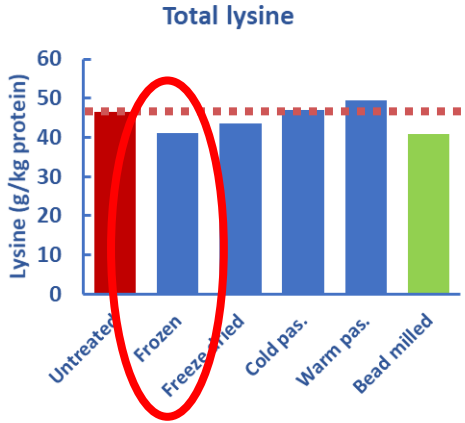


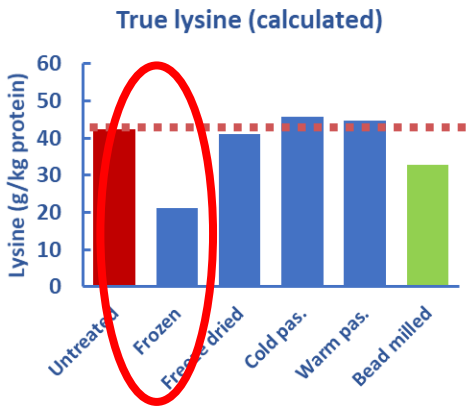


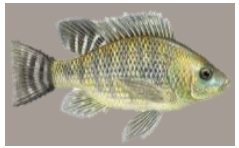
Teuling et al. (2019)

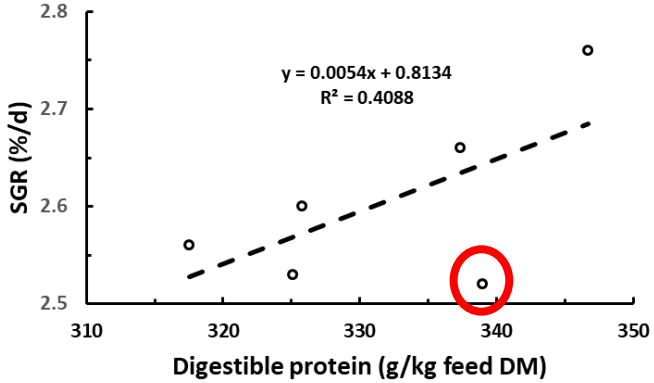
Processing → protein quality (*N. gaditana*)











Teuling et al. (2019)

Conclusions

Pros:

- .....
- .....
- .....

Cons:

- .....
- .....
- .....

Thank you

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