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Chemical characterization of microalgae

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Abstract

Microalgae contain interesting biomass components (such as lipids, proteins, carbohydrates and pigments) that, for example, can be used for the production of biofuels, bulk chemicals, feed and nutritional supplements. Here, we present the characterization of biomass components of the algal strains used in the MIRACLES-project: *Nannochloropsis gaditana*, *Phaeodactylum tricornutum*, *Isochrysis galbana* and *Scenedesmus obliquus*. For all freeze dried species the water content was lower than 5% (w/w). *P. tricornutum* contained the highest ash content followed by *I. galbana*. The fresh water algae *S. obliquus* contained the lowest amount of ash (Table 1). The amino acid composition of the algae was determined and the composition is more or less the same for all four species. *P. tricornutum*_has a higher amount of glycine and less leucine and lysine. *I. galbana* has more glycine, and asparagine/aspartic acid and less proline and glutamine/glutamic acid compared to *N. gaditana* and *S. obliquus* (Figure 1). From the total amount of amino acids the N-to-protein conversion factors were determined. The conversion factors for Kjeldahl are slightly higher than for DUMAS. (Table 2) The protein content ranged from 37 to 49 %(w/w) dry matter (Figure 2). Galactose and glucose were the most abundant carbohydrates in all species. Mannose is present in high amounts in *S. obliquus* and *P. tricornutum*. A relatively high amount of arabinose was present in *I. galbana* in comparison with the other species. The algae species have a different fatty acid composition. The omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are only both present in *I. galbana* and the concentration of DHA is 10 times higher as EPA. *N. gaditana* and *P. tricornutum* have the highest amount of EPA. No omega-3 fatty acids were determined in *S. obliquus* (Table 3).

Results

Table 1. Dry weight and ash content of different microalgae (% w/w).

Algae	Dry weight	Ash content 525 °C	Ash content 900 °C
Isochrysis galbana	95.61±0.05	12.80±0.00	10.19±0.00
Nannochloropsis gaditana	97.16±0.04	9.18±0.07	7.89±0.05
Phaeodactylum tricornutum	97.71±0.02	18.43±0.01	13.13±0.10
Scenedesmus obliquus	97.16±0.03	7.05±0.03	6.41±0.03

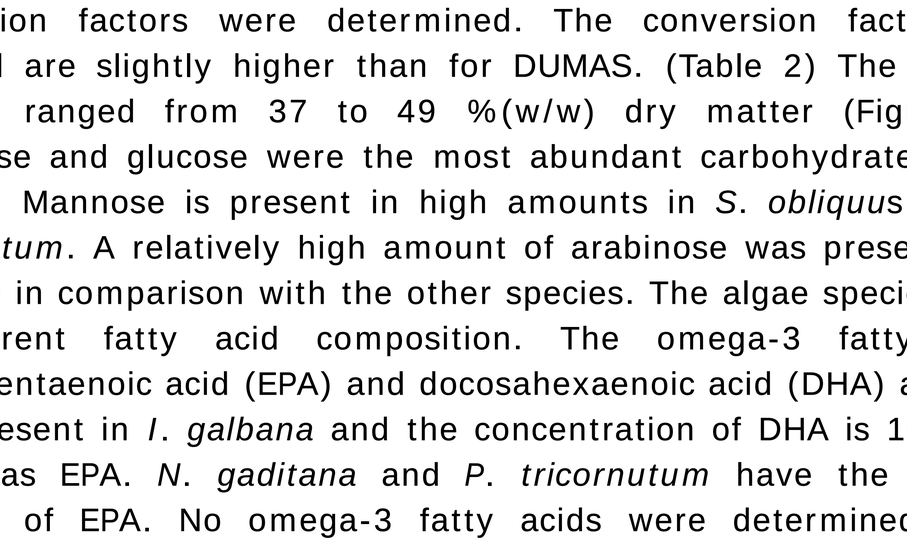

Figure 1. Amino acid composition (mol%) of different algae species.

Results

Table 2. Nitrogen-to-protein conversion factors of different algae species

Algae	Kjeldahl	DUMAS
Isochrysis galbana [1]	4.84±0.14	4.67±0.13
Nannochloropsis gaditana	4.84±0.17	4.63±0.16
Phaeodactylum tricornutum	3.95±0.06	3.68±0.06
Scenedesmus obliquus [2]	5.20±0.19	5.08±0.18

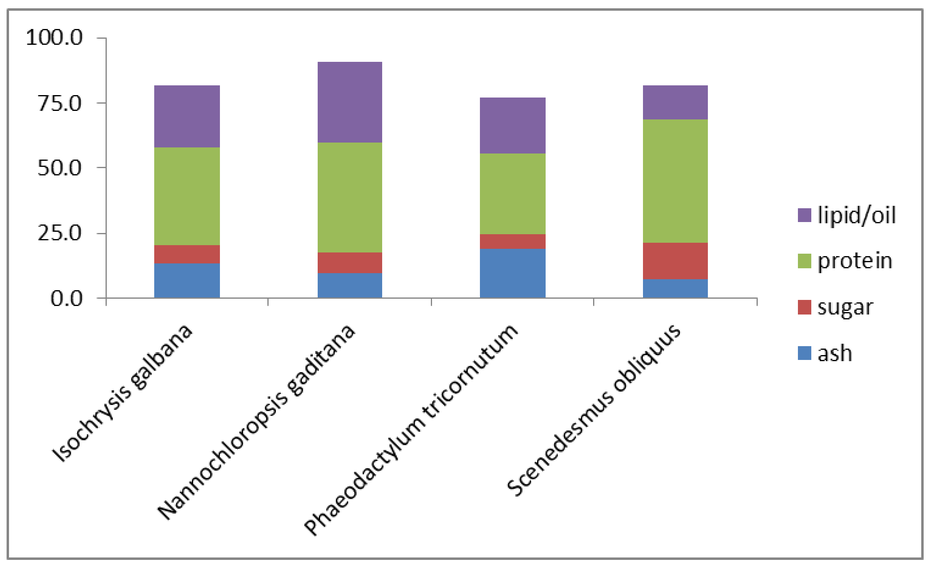

Figure 2. Ash, sugar, protein and lipid/oil content of different algae based on dry weight %(w/w).

Table 3. Fatty acid composition (% (w/w) dry matter) of different algae species. Standards for C16:4 and C18:4 were not available. Their presence (C16:4 in *Phaeodactylum tricornutum* and *Scenedesmus obliquus* and 18:4 in *Isochrysis galbana*) is based on elution time only.

	C14:0	C16:0	C16:1	C16:2	C16:3	C16:4	C18:0	C18:1	C18:2	C18:3	C18:4	C20:1	C20:3	C20:5	C22:6
Isochrysis galbana	1.67	1.31	0.59	0.00	0.00	0.00	0.53	2.12	0.92	1.13	1.27	0.59	0.00	0.08	1.24
Nannochloropsis gaditana	0.75	2.30	2.12	0.00	0.44	0.00	0.54	0.50	0.45	1.03	0.00	0.00	0.49	4.68	0.00
Phaeodactylum tricornutum	1.20	1.36	1.80	0.74	0.55	0.78	0.38	0.28	0.25	0.00	0.00	0.00	0.00	5.20	0.00
Scenedesmus obliquus	0.00	1.41	0.00	0.00	0.00	1.65	0.56	0.75	0.70	3.43	0.00	0.00	0.00	0.00	0.00

References

1. Gilbert-López B, Mendiola JA, Fontecha J, Van den Broek LAM, Sijtsma L, Cifuentes A, Hererrero M, Ibanez E (2015) Downstream processing of *Isochrysis galbana*: A step towards microalgal biorefinery. Green Chem 17:4599-4609.
2. Gilbert-López B, Mendiola JA, Van den Broek LAM, Houweling-Tan B, Sijtsma L, Cifuentes A, Herrero M, Ibáñez E (2017) Green compressed fluid technologies for downstream processing of *Scenedesmus obliquus* in a biorefinery approach. Algal Res 24:111-121.

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