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Macroalgae as a source of biologically active compounds: types of biomass and possibilities of its use

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Macroalgae have a high content of bioactive compounds.

For commercial applications, the potential abundance of peptides, proteins, carbohydrates, vitamins, amino and fatty acids in freshwater *Cladophora glomerata* is one of its important properties. Thus, the obtainment of these compounds has attracted further interest in the use of freshwater macroalgae biomass in various fields.

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In summer in eutrophic and warm water of aquatic ecosystems frequently develop massive population of filamentous green algae forming a dense layer of algae biomass at the top of the water column.

= large biomass to the use

Freshwater macroalga
C. glomerata (photo M. Pikosz)

Major compounds in algal extracts belong to:

Compound	Function	Application
Polysaccharides	Components of cel wall (fucoidan, alginate, laminarin)	Provide strength, flexibility, prevent from desiccation
Polyphenols	Phenol rings in polyphenols act as electron traps to scavenge radicals.	Antimicrobial, antioxidant, antiviral compounds that protect algae from abiotic and biotic stress conditions
Protein, peptides, lipids, amino acids	The contents vary. Polyunsaturated fatty acids (PUFA) – higher level than in terrestrial plants.	Structural membrane lipids; importnat in human and livestock diet. Composed of glicerol, sugars, bases esterified with fatty acids.
Terpenoids and steroids	Carotenoids, xanthophyll, fucoxanthin, astaxanthin	Antioxidant, antivarial activity, UV protection
Vitamins	A, B1, B2, B6, B12, C, E, biotin, folic acid, pantothenic acid. Level depends on the season.	
Minerals	Zn, Mn, Cu – structural components of antioxidative enzymes.	

Michalak et al. 2015. Supercritical algal extracts: a source of biologically active compounds from nature. J. of Chemistry, 10.1155/2015/597140.

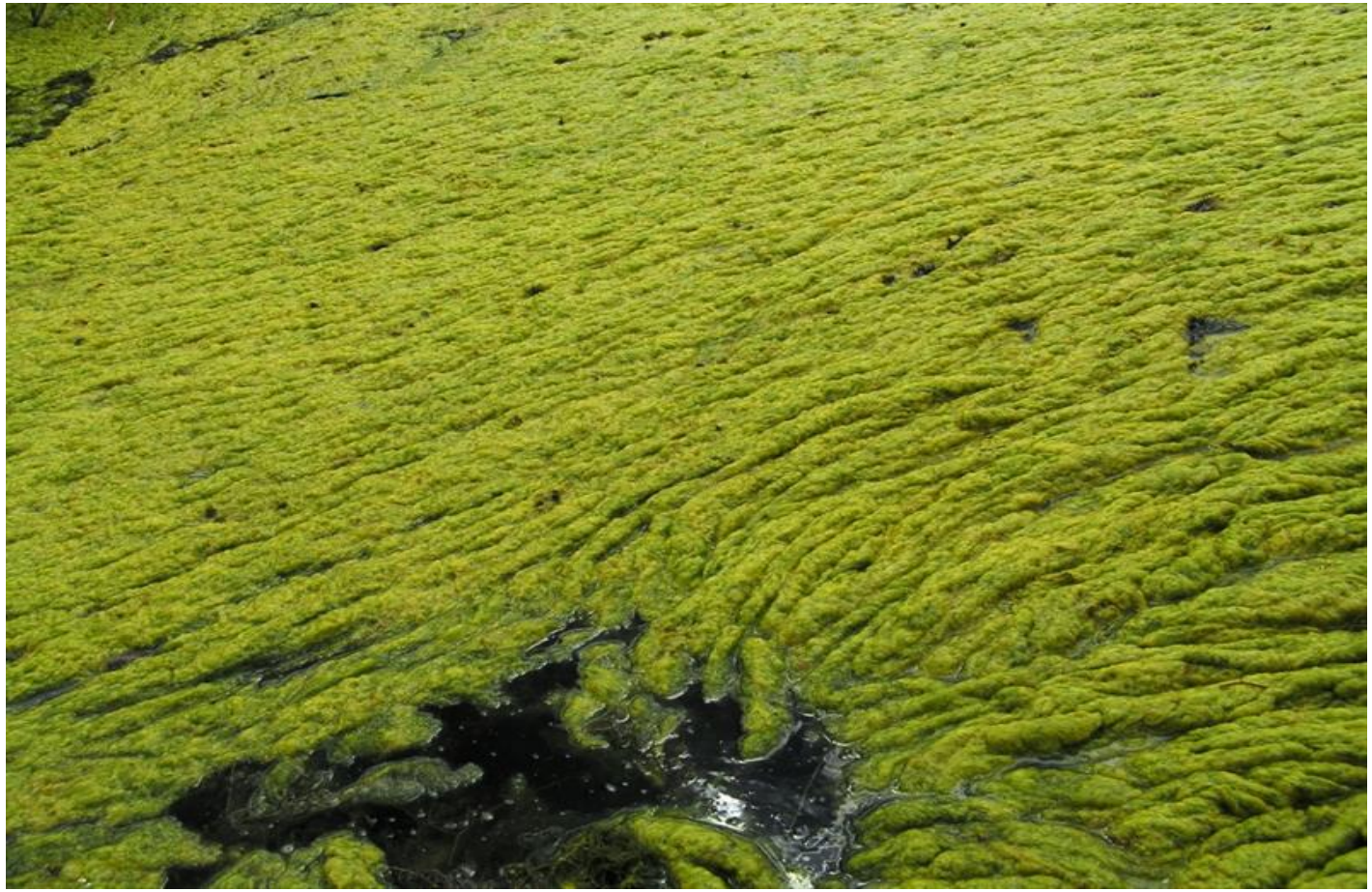
Factors affecting filamentous green algae development include

Pikosz & Messyasz 2016. Characteristics of Cladophora and coexisting filamentous algae.... Oceanol. & Hydrob. Studies, 45(2): 202-215.

Causes of macroalgal mass appearance

- ADAPTIVE FEATURES OF FILAMENTOUS GREEN ALGAE
- RAPID GROWTH OF ITS BIOMASS
- PHYSICO-CHEMICAL FACTORS
- EUTROPHICATION

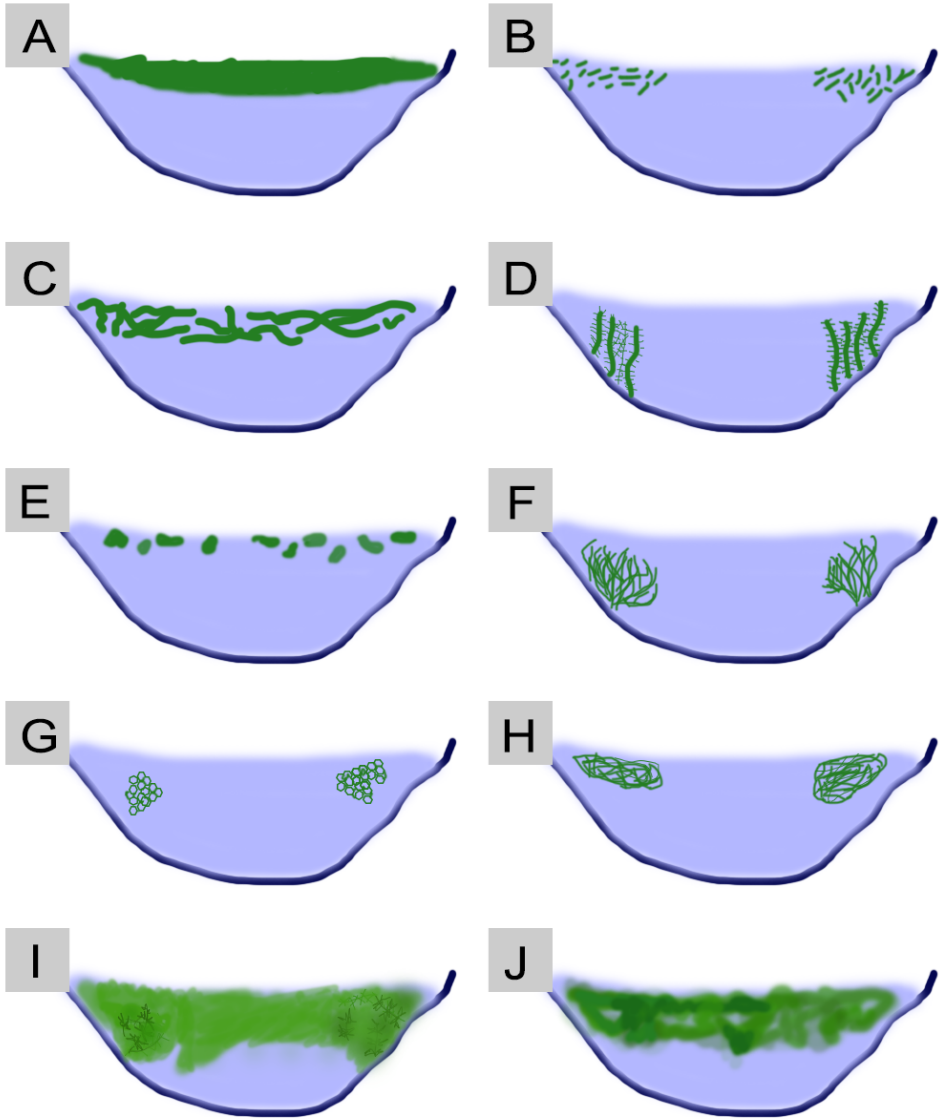
Effects of macroalgal mass appearance



Lake Oporzyńskie – July 2019

- SHADING
- NEGATIVE IMPACT ON THE OCCURRENCE OF OTHER ORGANISMS
- DECLINE IN OXYGEN CONDITIONS IN LAWER LAYERS OF WATER
- DISTURBANCE OF NUTRIENT COMPOUNDS CYCLE
  - INTAKE OF ELEMENTS
  - SECRETION OF MINERAL AND ORGANIC SUBSTANCES

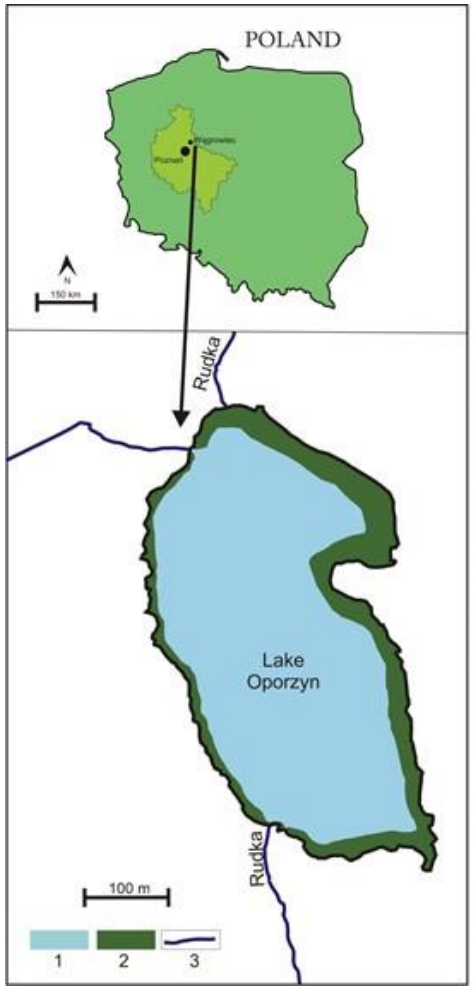
Characteristics of the mat structure



Macroalgae mat formations can be divided into:

- free-floating mats – taking shapes of flocs (B), mats or felts, tufts, clouds (E), net-like structures (G);
- attached to the bottom - upright growth forms (aligned), bush-like structures (F), solitary thalloid growth forms (D – stonworts);
- overgrowing the entire water column – includes both free floating and attached forms, also the forms that overgrow each element that can serve as a pillar e.g. submerged water plants.

Research area –the source of biomass



Oporzyn Lake

- location:
  Wielkopolska region
  near the town of Wągrowiec
- area: 17.5 ha (20.5 ha)
- average depth: 0.9 m
  maximum depth: 1.7 m
- visibility: 0.1 – 0.4 m
- pH 8.5 – 8.9
- flowing lake
- Trophic state: eutrophic

The maximum biomass is attained in May, June and early autumn.

Collecting biomass ⇨ **Drying biomass** ⇨ **Grinding biomass**

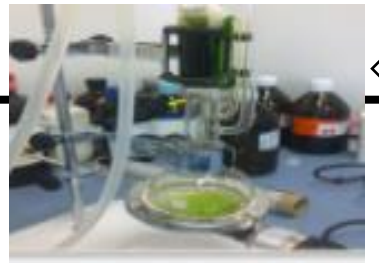
Further analyzes in laboratory ⇩

Macroalgae – from biomass to final product

SAMPLE COLLECTION
TAXONOMICAL IDENTIFICATION

CLEANING THALLI

DRYING



EXTRACTION

MINERALIZATION

MEASURMENT

MICRO-MACROELEMENTS → ICP-OES

PIGMENTS → SPECTROPHOTOMETRY

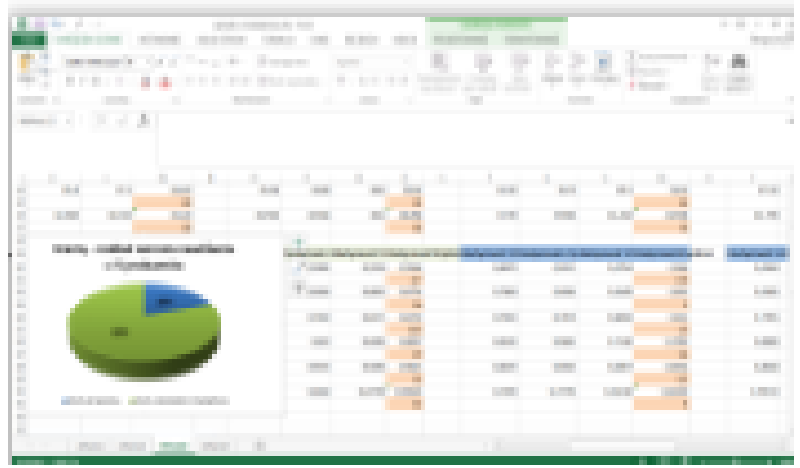
FATTY ACIDS → GC-MS

AMINOACIDS → ION-EXCHANGE CHROMATOGRAPHY

Biological compounds analysis in Cladophora

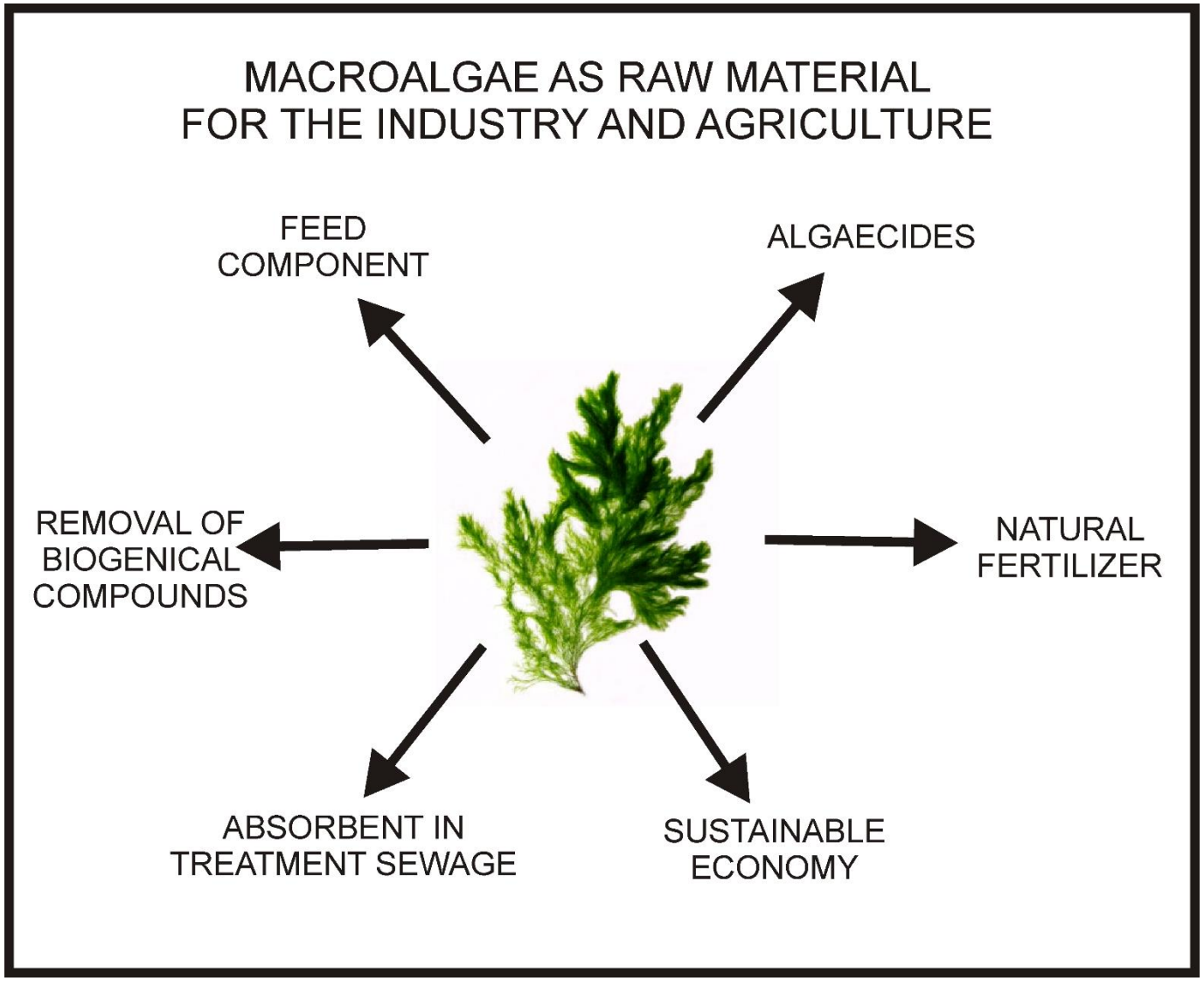
CREAM PREPARATIONS

APPLICATION STUDY



RESULTS

The usage of algal biomass can be successfully exploited:



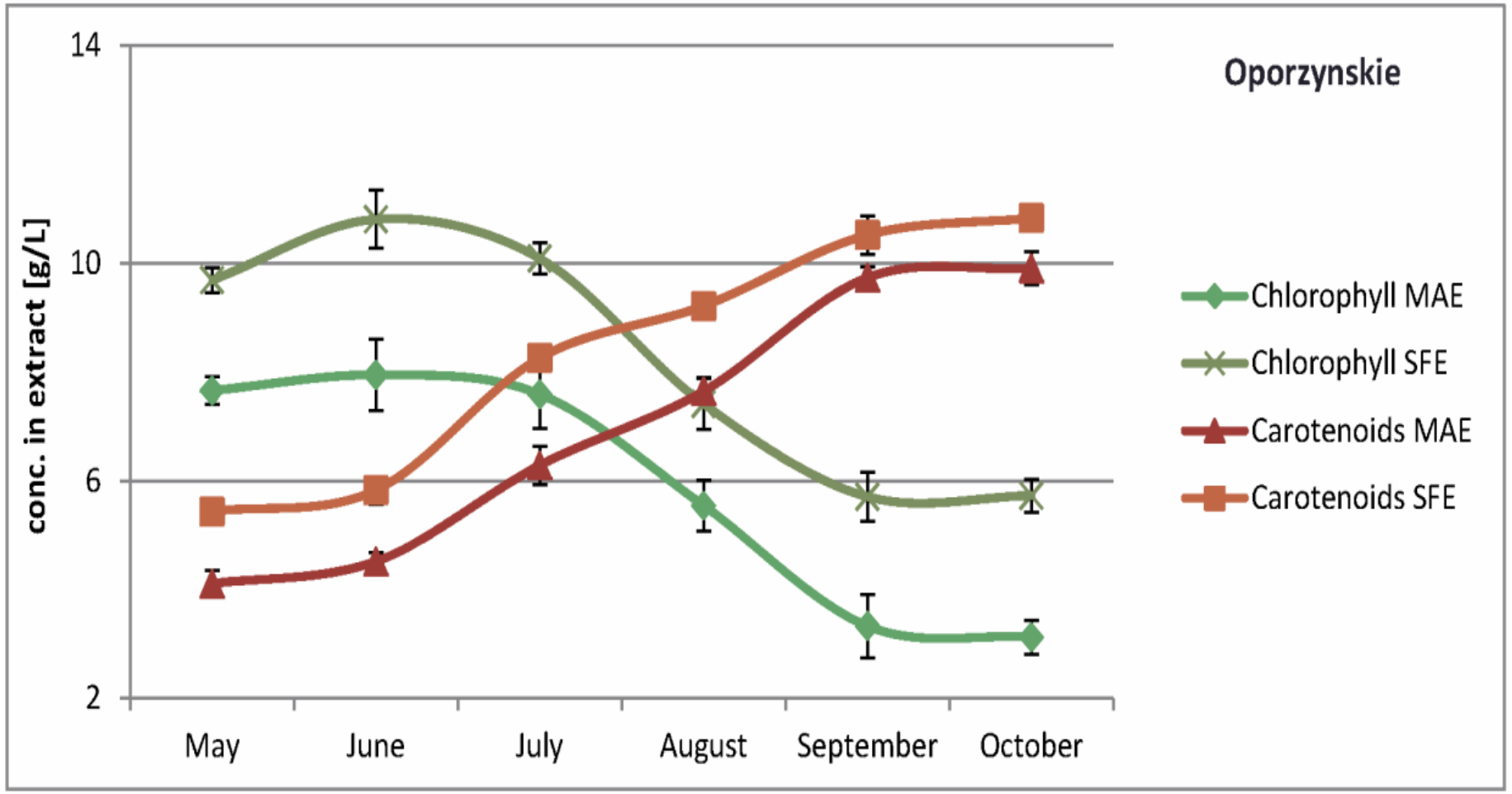
Chlorophylls and carotenoids in *C. glomerata* extracts

Rich source of such antioxidants as carotenoids: β-carotene, lutein, zeaxanthin.

Soxhlet extraction

SFE – ultrasound assisted extractio

MAE – microwave assisted extractio

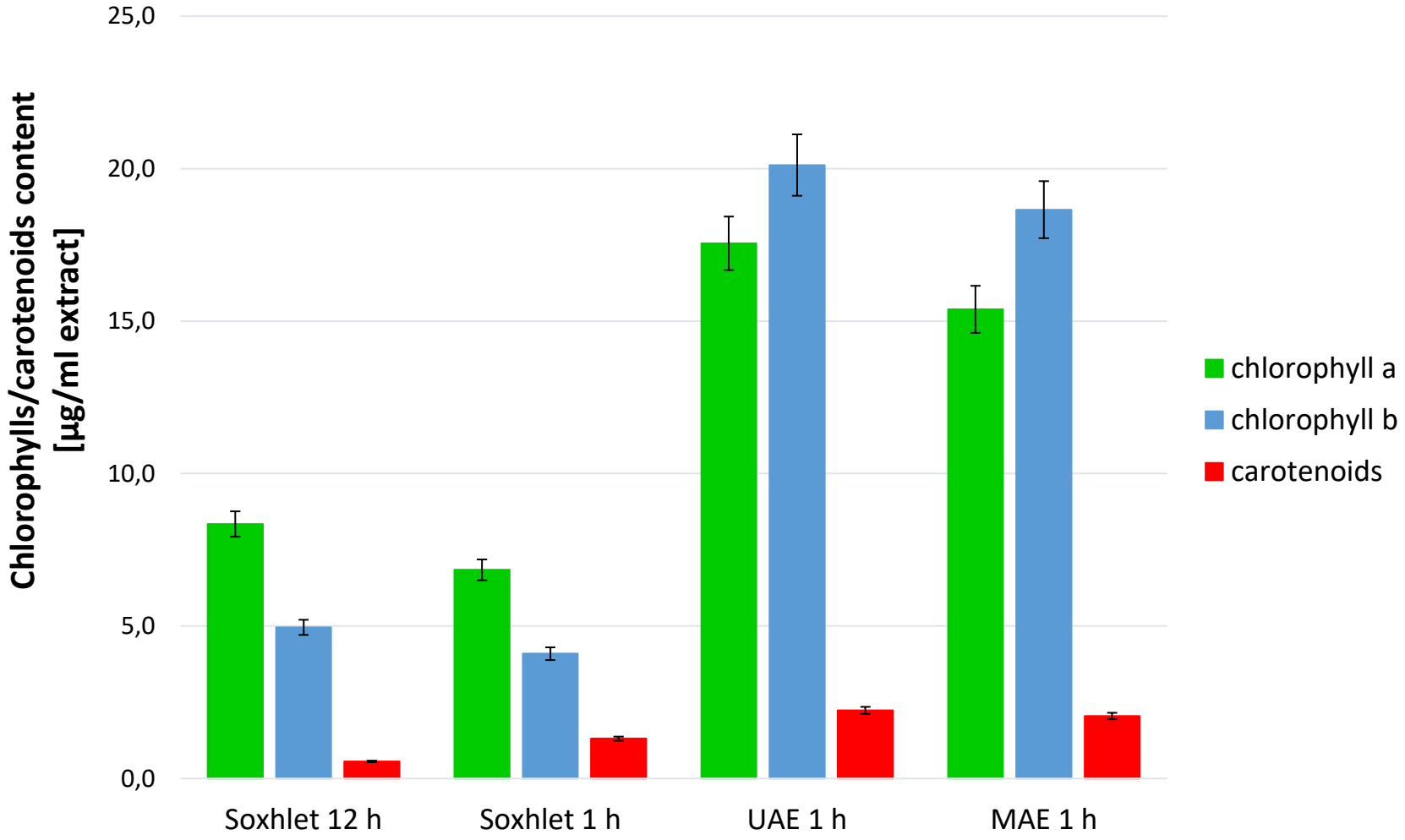


Chlorophylls and carotenoids in *C. glomerata* extracts

Soxhlet extraction

UEA – ultrasound assisted extraction

MAE – microwave assisted extraction



UAE and MAE extractions are the most effective for obtaining chlorophylls.

Phenolic compounds analysis

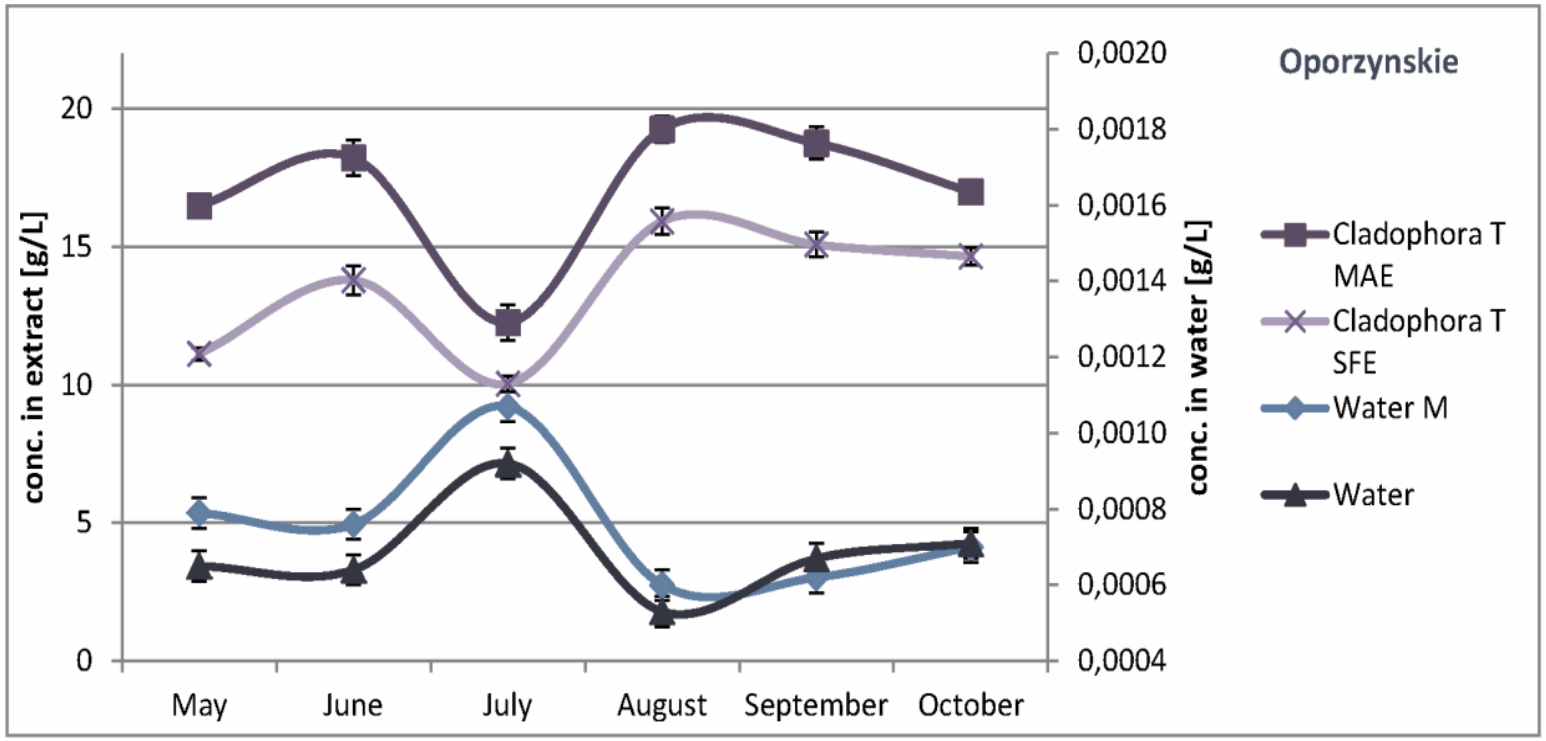
Total phenols content in algae extracts (Cladophora), water from the mat (Water M) and water from outside the mat (Water) in the period May-October - Lake Oporzynskie.

Chromatogram (280 nm):

quinic acid $[M-H]^-$ 191.0

Gallic acid $[M-H]^-$ 169.0

P-coumaric acid $[M-H]^-$ 163.0



Microwave-assisted extraction (MAE); Supercritical fluid extraction (SFE)

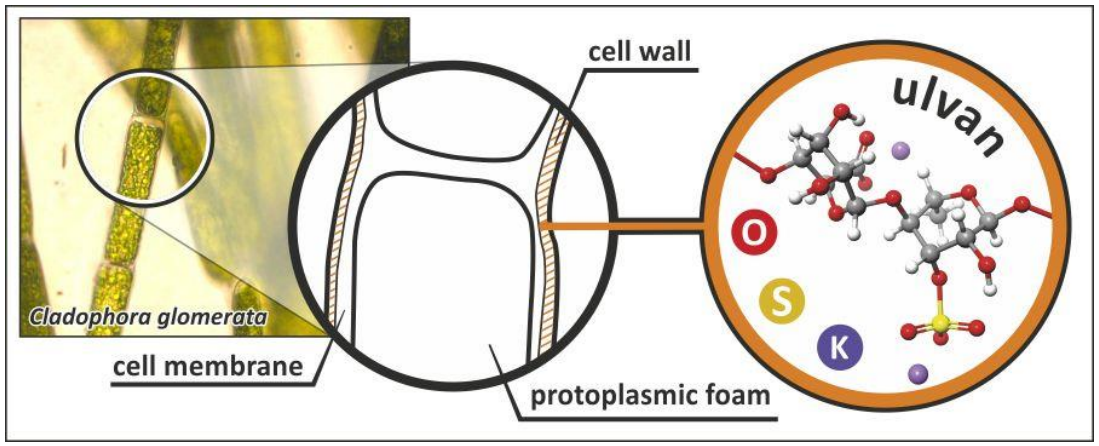
Sulfated polysaccharides

SPs – *sulfated polysaccharides*

Carrageenans and alginates

Fucoidans

Ulvans



anionic polysaccharides, contain a sulphate group, come from cell walls, where constitute a building material

8-29% of algae dry matter

Ingredients: glucose, xylose, rhamnose, mannose, arabinose, galactose, uronic acids

Conclusions

- Freshwater green macroalga *C. glomerata* was found as a source of various bioactive compounds:
  - Fatty acids;
  - Carotenoids;
  - Phenolic compounds;
  - Sulfated polysaccharides
- Extracts from the alga possess antioxidant properties
- Extracts added to cosmetics increased skin hydration and elasticity
- Biomass of *C. glomerata can* be used as a new cosmetic raw material

Freshwater green macroalga
Cladophora glomerata

THANK YOU
FOR YOUR ATTENTION