Rósa Jónsdóttir

Biorefining of micro- and macroalgae

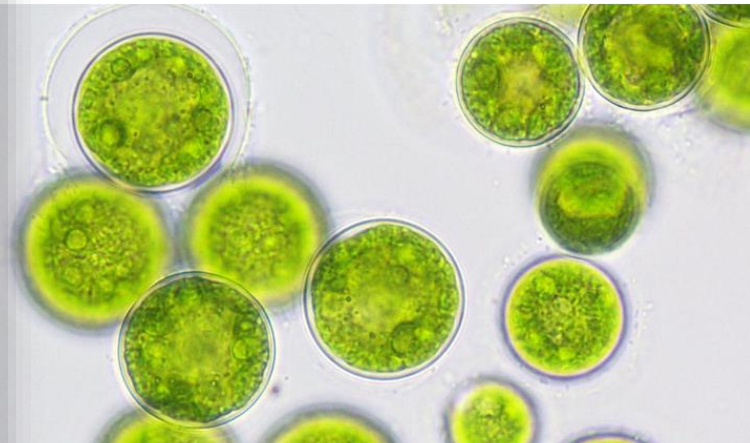
Circular Bioeconomy Days
25th 27th June 2019

Matís Food & Biotech

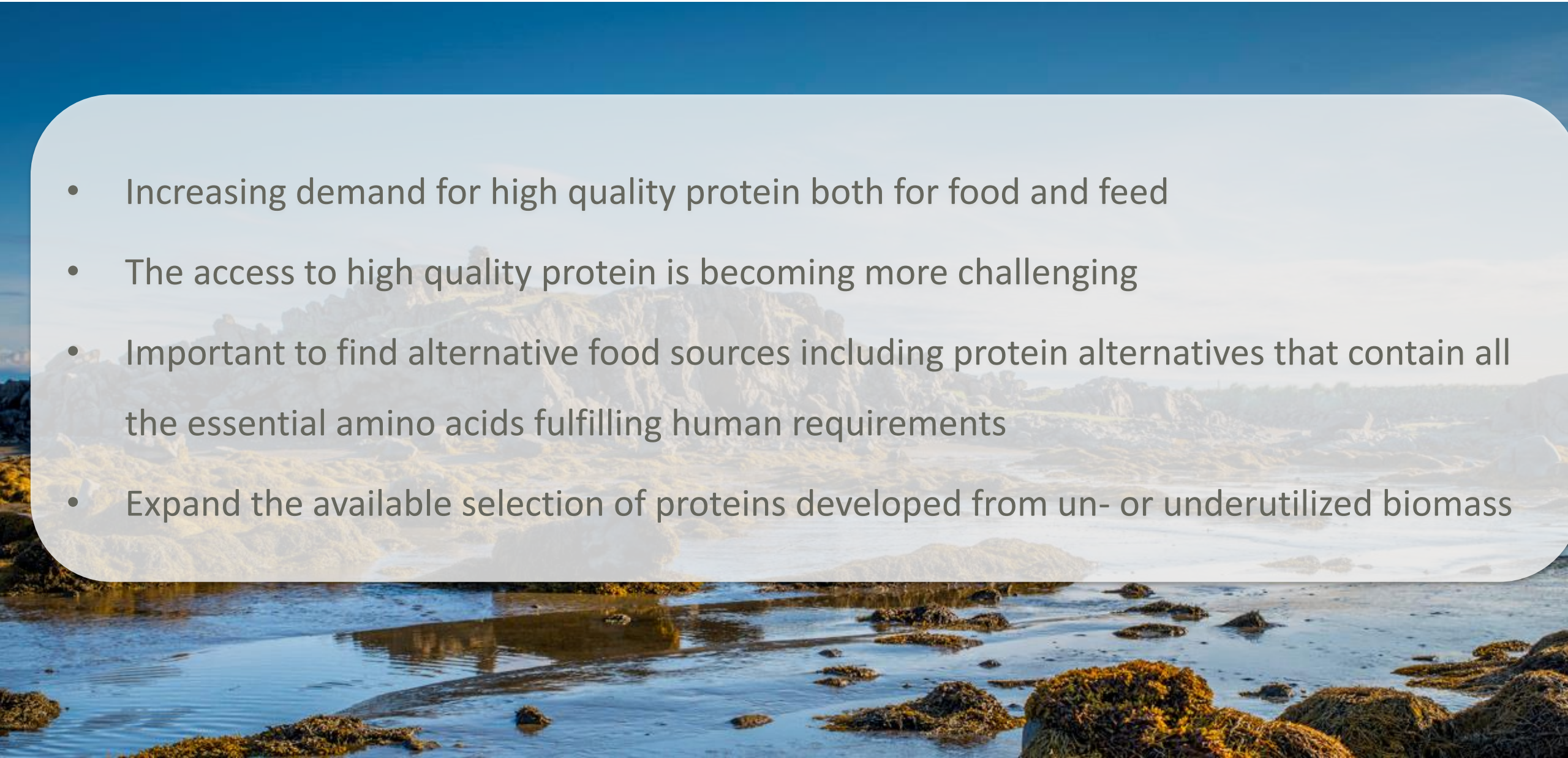
Find and define novel bioactive compounds and ingredients with subsequent development and marketing

Algae as a source of valuable compounds

- Food
- Nutraceuticals
- Cosmetics
- Feed

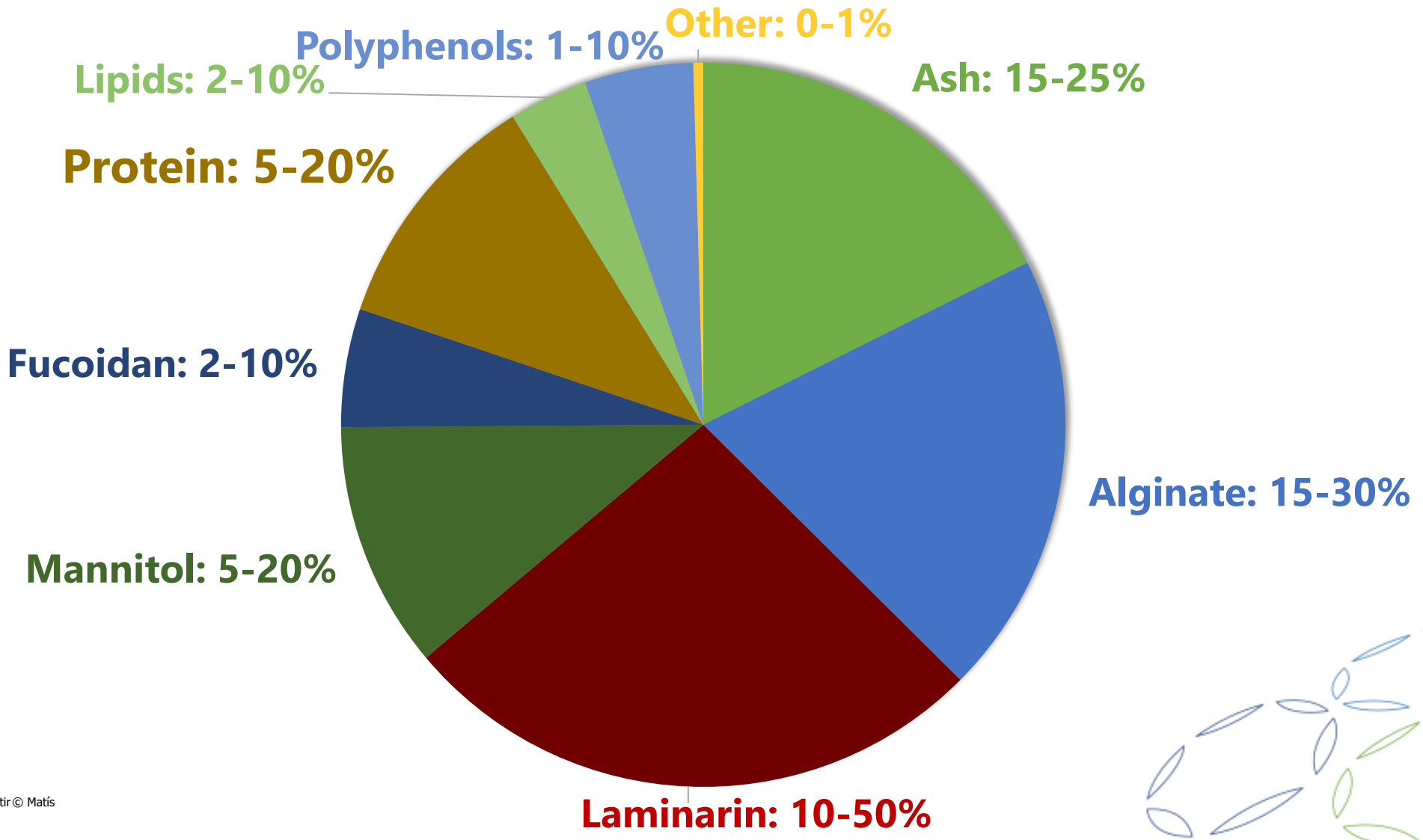


New protein sources from algae?



- Increasing demand for high quality protein both for food and feed
- The access to high quality protein is becoming more challenging
- Important to find alternative food sources including protein alternatives that contain all the essential amino acids fulfilling human requirements
- Expand the available selection of proteins developed from un- or underutilized biomass

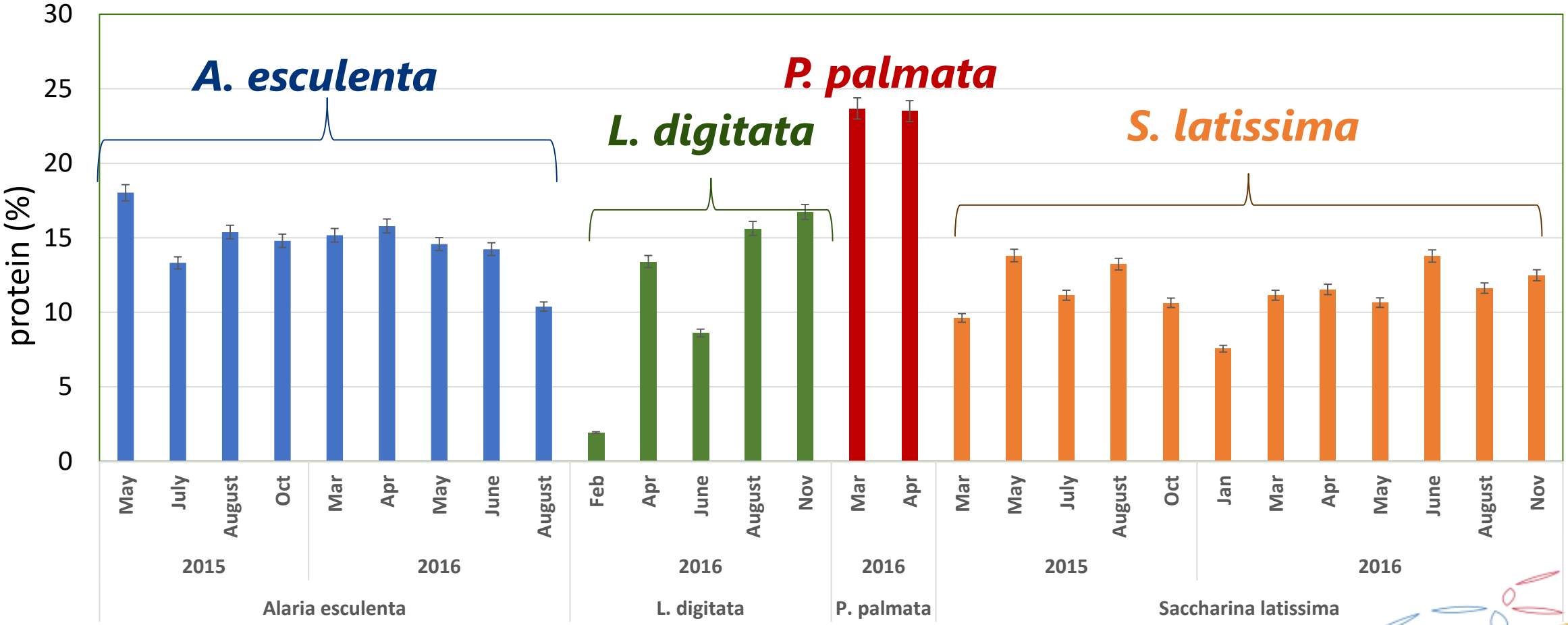
Chemical composition of brown macroalgae



Nordic Innovation

MacroValue

% Protein (N x 5.38)

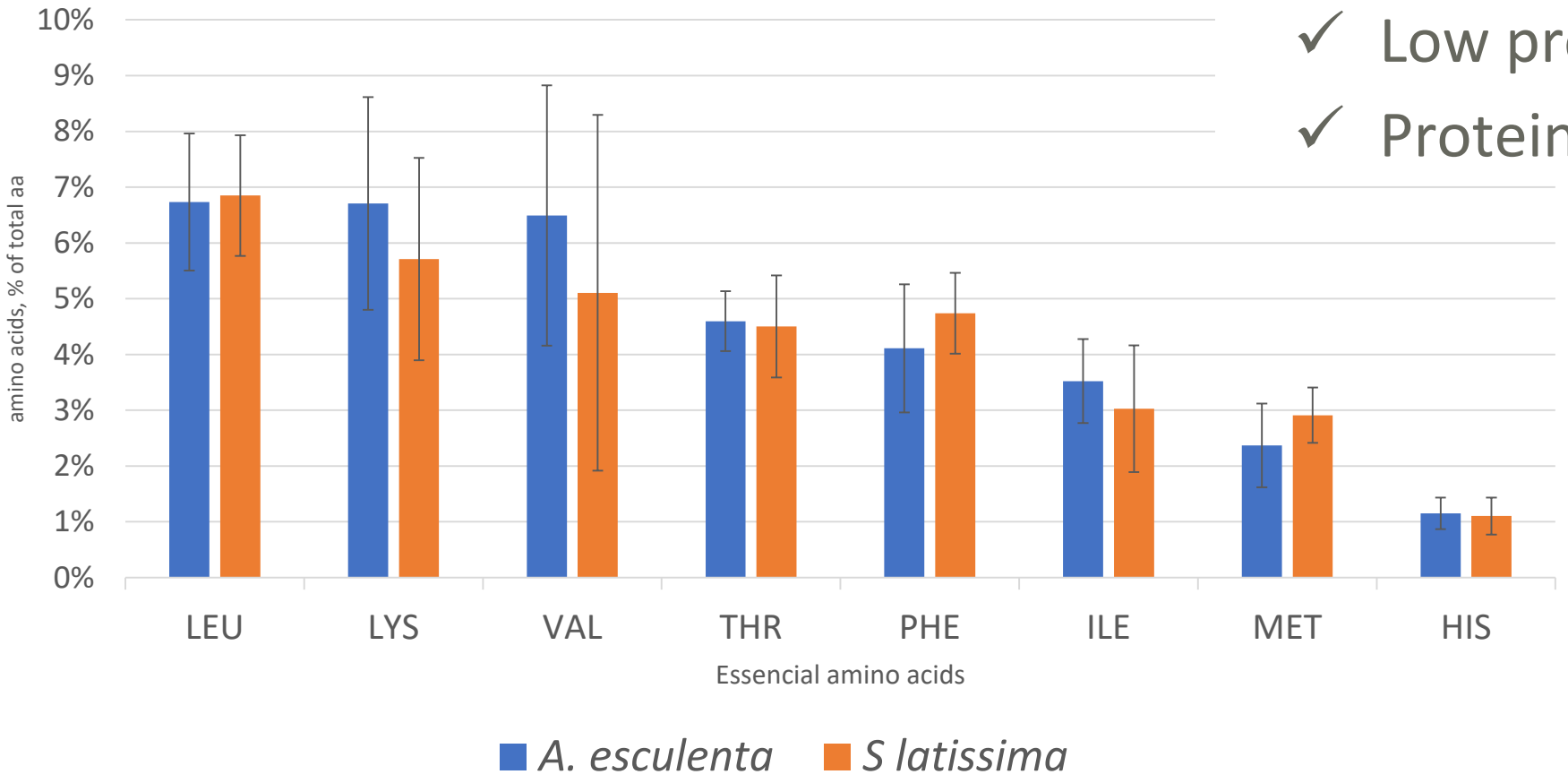


Species, year, month

Nordic Innovation

MacroValue

Essential amino acids, % of total amino acid content



- ✓ Low protein concentration
- ✓ Protein of high quality

Total EAA:

- **36%**
- **34%**

Urd et al. submitted 2019

Proteins from *Palmaria palmata*

- ✓ High protein content (up to 35%)
  - Comparable to high protein vegetables e.g. soybeans
- ✓ Main polysaccharide is xylan (34-35%)
- ✓ *P. palmata* has a rigid cell wall consisting mainly of β-(1→4)/β-(1→3)-D-xylans along with some fractions of cellulose and β-(1→4)-xylans
- ✓ Due to the strength of the cell wall, traditional protein extraction methods might give limited results

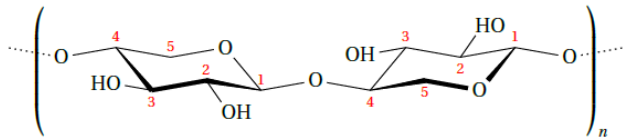


Figure 5 – β-(1,4)-D xylan

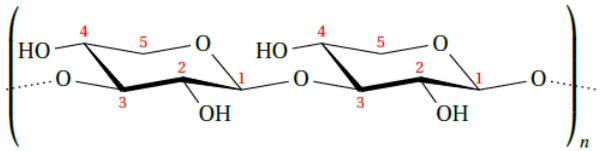


Figure 4 – β-(1,3)-D xylan

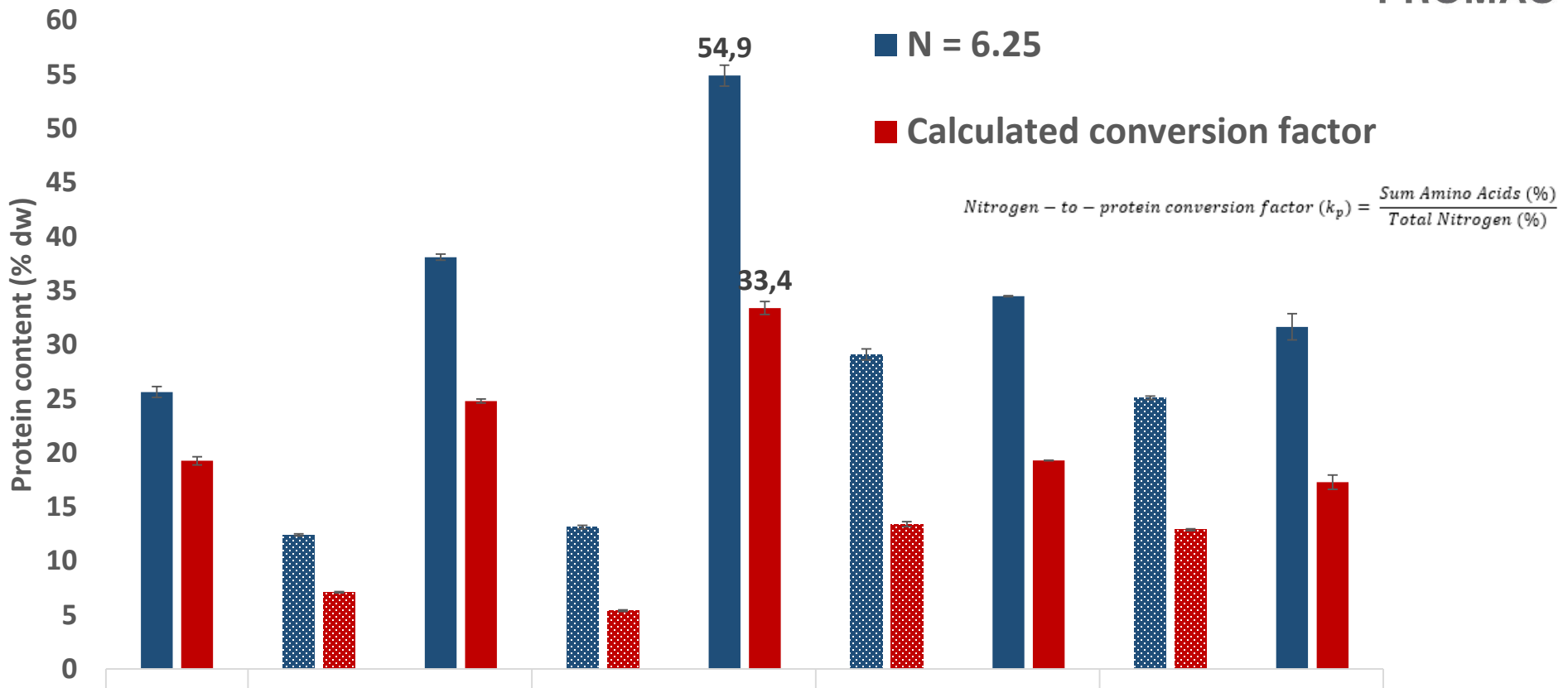
Objectives

Macroalgae as novel raw material for food and feed applications

- ✓ Develop fractionation processes for preparation of protein-rich products and extracts to be used as food, nutraceutical or feed ingredients
- ✓ Explore the use of enzymes (xylanase developed at Matís and protease) as processing tool
- ✓ Study protein yield, quality and the bioactivity of the different fractions

http://promac.no/

Protein content of *P. palmata*, untreated and enzymatically treated, using different N conversion factor



$$Nitrogen - to - protein\ conversion\ factor\ (k_p) = \frac{Sum\ Amino\ Acids\ (\%)}{Total\ Nitrogen\ (\%)}$$

Values are presented as % dry weight ± SD (n=4).

Conversion factor	4.7	3.6	4.1	2.5	3.8	2.9	3.5	3.2	3.4

Journal of Applied Phycology
https://doi.org/10.1007/s10811-017-1351-8

PROMAC

CrossMark

Palmaria palmata as an alternative protein source: enzymatic protein extraction, amino acid composition, and nitrogen-to-protein conversion factor

Málfríður Bjarnadóttir[1,2] · Björn Viðar Aðalbjörnsson[1,2] · Anna Nilsson[1] · Rasa Slizyte[3] · Michael Y. Roleda[4] · Guðmundur Óli Hreggviðsson[1] · Ólafur H. Friðjónsson[1] · Rósa Jónsdóttir[1]

- ✓ *P. palmata* contains high protein content of good quality that can be extracted with good results using enzymatic treatment with xylanse
- ✓ Protein extract from *P. palmata* is high in essential amino acids and would therefore be suitable as food, feed and nutraceutical ingredient
- ✓ The results indicate that hydrolysis with protease can be a beneficial method to extract bioactive hydrolysates from *P. palmata*

Microalgae industry in Iceland

algalif Iceland inside™

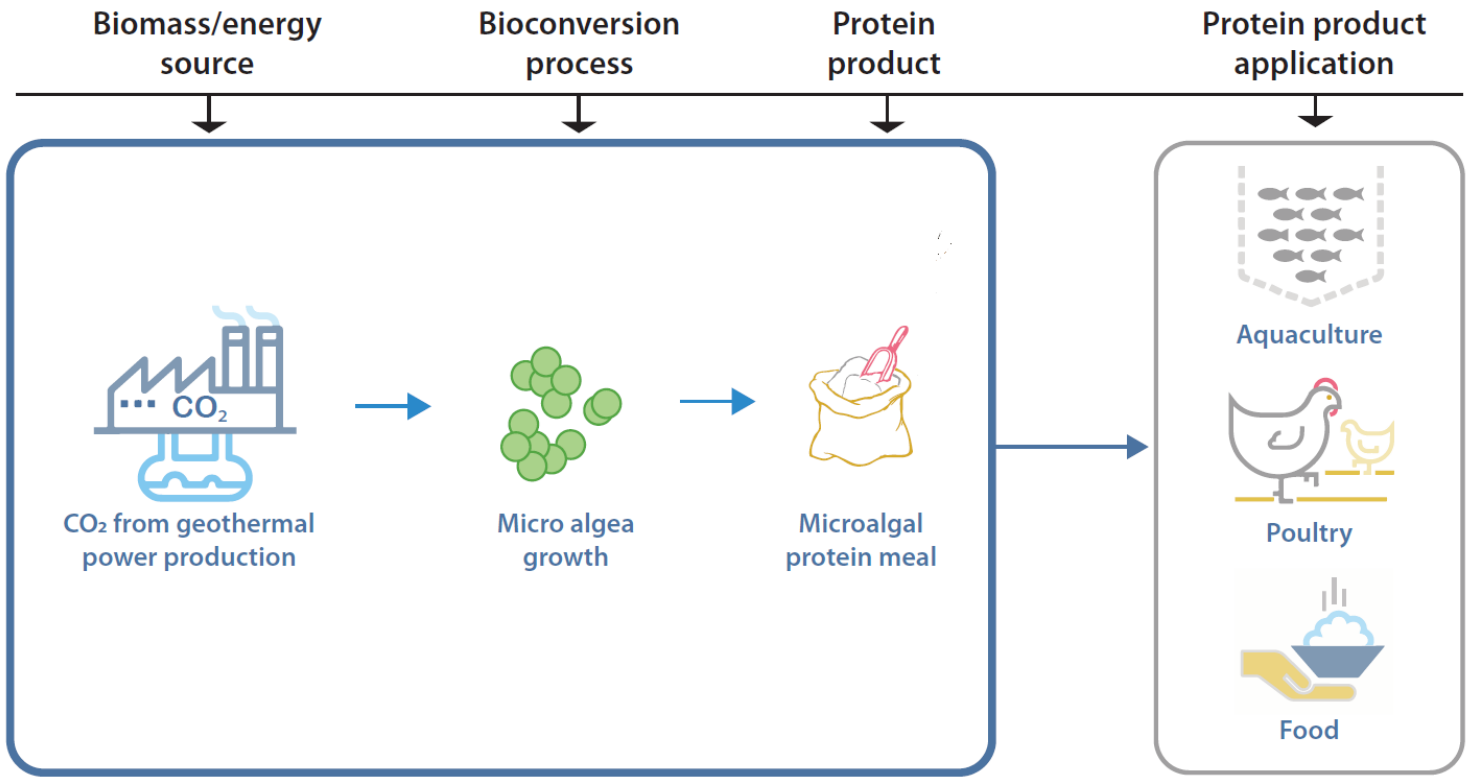
ALGAE INNOVATION
Aquaculture. Sustainability. Forward.

KEY natura

NEXTGEN PROTEINS

European Commission

Optimise and validate the production of proteins from microalgae, single cells and insects and demonstrate their suitability as alternative sustainable sources in food and feed value chains



matis

ALGAEINNOVATION
Aquaculture. Sustainability. Forward.

Possible health benefits

Proteins – crucial in feeding the world

Essential Amino acids

Phlorotannins

Antioxidant, anti-diabetes, antibacterial, anti-inflammatory

Laminaran/Laminarin

Anti-viral, antibacterial, reduces cholesterol, lowering blood pressure, stimulates immune system

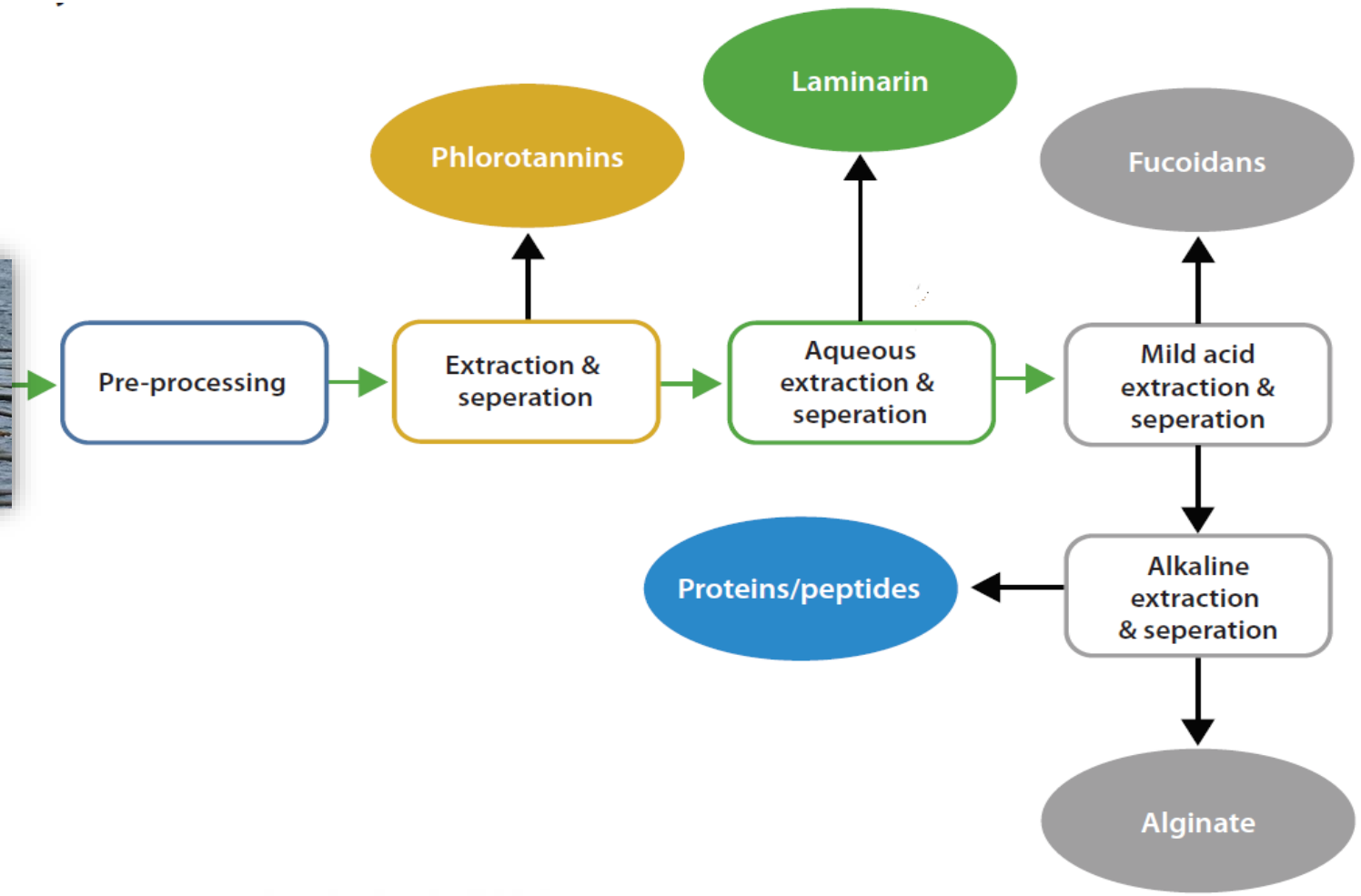
Fucoidan

Anti-coagulant, anti-arteriosclerosis, anti-inflammatory, anti-oxidant, stimulation of immune system, anti-bacterial

Løvstad Holdt & Kraan, 2011

Stepwise Biorefining of Brown Seaweed

S. latissima
A. esculenta

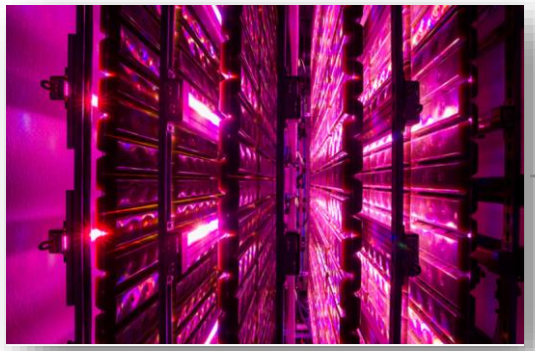


End products

- ✓ Cosmetics
- ✓ Nutraceuticals
- ✓ Functional food ingredients
- ✓ Medical products
- ✓ Biobased material

Rósa Jónsdóttir © Matís

Biorefining of microalgae



Cell disruption → Drying → Supercritical fluid extraction → 

Supercritical fluid extraction → Side stream

Side stream → **Lipids Carbohydrates**

Side stream → **Protein, 20%**

NEXTGEN PROTEINS

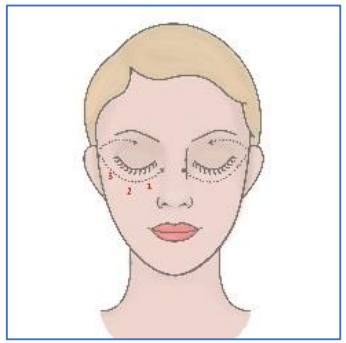
Biorefining

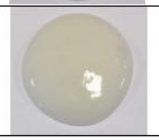
Fucoidans in cosmetic products
S. latissima and *A. esculenta*

Applications tested in end products

- Cosmetics
- Nutraceuticals
- Functional food ingredients
- Medical products
- Biobased material

- ✓ Good qualities in day and eye cream bases
- ✓ No effects on odour
- ✓ No separation from creams
- ✓ Significant colour change
- ✓ pH was relatively stable
- ✓ Changes is viscosity



Photographic images	0,1%	0,5%
Initial		
2 weeks		
1 month		
2 months		

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Seaweed bioactive ingredients *F. vesiculosus*

Successful product development

- new product line of rye products
- encapsulated seaweed extract
  - Iodine and metals below limits
  - Verification of bioactivity (TPC, antioxidant activity and α-glucosidase activity) for up to 18 months at RT





Seaweed bioactive ingredients (with verified in-vivo bioactivities)

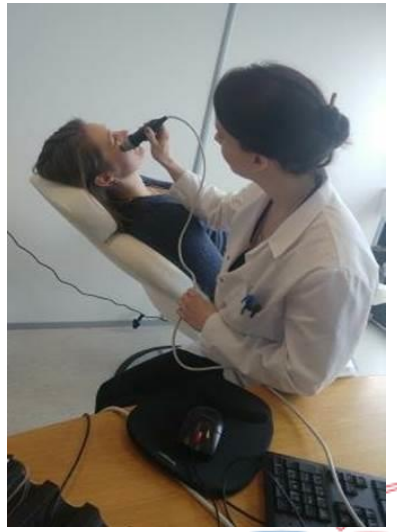
- ✓ A significant improvement of glucose metabolism

Medical Press Open Access
International Journal of Food Sciences and Nutrition Research
Research

***In Vitro and In Vivo* Effects of Seaweed Extract on Carbohydrate Digestion and Availability**

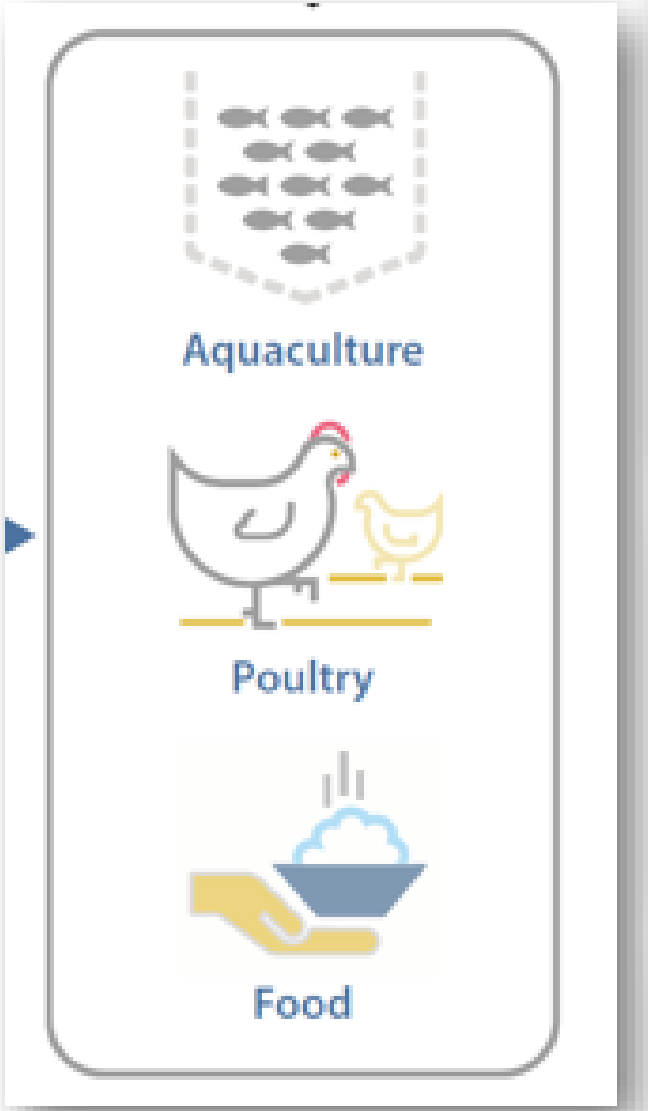
Sveinsdottir K[1], Ingadottir B[1], Elidottir AS[2], Geirsdottir OG[2,3], Jonsson PV[3], Ramel A[1,2,3*]

- ✓ Positive impact on the skin of the participants



The results obtained made the next steps possible:

- ✓ Marketing, commercialisation and increased value of the end products



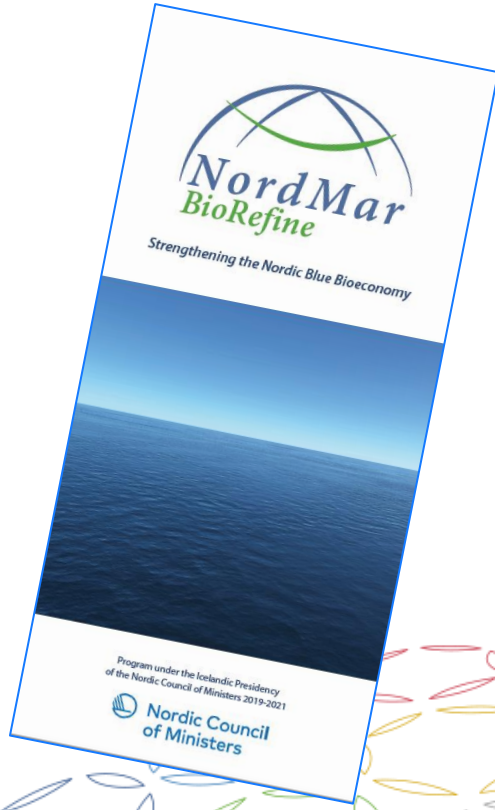
Biorefining of micro- and macroalgae
Challenges

- ✓ Sustainable resource exploitation
- ✓ Novel processing technologies
- ✓ Optimization of bioprocessing
- ✓ Product development and confirmation of benefits via *in-vivo* testing (human studies)
- ✓ Formulation of new products requires case by case approach
- ✓ New proteins for food is a niche-type market
- ✓ Legislation and regulation
- ✓ Marketing
- ✓ Need of open access biorefineries or scale-up facilities

NordMar BioRefine

To strengthen the Nordic blue bioeconomy and taking important steps towards the establishment of a Nordic open access blue biorefinery

- ✓ A feasibility study on key open access blue biorefinery facilities for R&D purposes will be performed.
- ✓ The aim is to identify which facilities will best serve value creation and improved resource efficiency of Nordic blue biomass.
- ✓ An operational model will be designed, including necessary investments, operational cost, collaborative model etc.



https://bluebioportal.com/

ACKNOWLEDGMENTS

The Research Council of Norway

European Commission

Nordic Innovation

Nordic Council of Ministers

MarineBiotech

Technology Development Fund

eurostars™

AVS rannsóknasjóður í sjávarútvegi

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