27-28 September 2016
Portugal

Seagriculture

5th international seaweed conference

Book of Abstracts

Hotel Meliá Ria, Aveiro, Portugal

September 27 & 28 2016

Benelux

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

AVEIRO
Câmara Municipal

Ilhavo
Câmara Municipal

Turismo Centro Portugal

HATCHERYFEED.COM
News and information about hatchery feed & nutrition

ALGAE WORLD NEWS
NEWS.ALGAEWORLD.ORG

aquafeed.com

EFTA
escola de formação profissional em turismo de aveiro

OLARIA EFTA
RESTAURANTE-BAR

Table of Contents

Preface advisory committee

Dear visitor,

Welcome to the 5th International Seaweed Conference ´Seagriculture´, in Aveiro, Portugal. We are happy to facilitate knowledge dispersion and exchange between such a diverse group of seaweed experts and enthusiasts!

On September 27 and 28, we all gather in the city of Aveiro, fondly nicknamed 'the Venice of Portugal' because of its many canals. Not to miss floating on these canals are the colorful *moliceiro* boats that give away the city's historical link with seaweed – the boats were previously used to harvest seaweed, now they are a main tourist attraction.

In a broader sense, Portugal is an excellent choice of host country, what with its extensive coast and ambitions for 'blue growth': growth related to the ocean economy, to take place primarily in blue energy, aquaculture, tourism, marine mineral resources and blue biotechnology. Sea agriculture would fit these blue growth ambitions, and with the country's vast coastline and favourable natural and geographical conditions, its potential is huge and largely unexploited.

But, the potential for seaweed cultivation is not limited to within Portuguese borders only. This year's program promises to integrate national, European, and global advances in research and industry over the course of six thematic sessions, (national) research pitches, and a roundtable discussion. In between the sessions, there is time to get to know the conference participants and their seaweed ventures – we are expecting a lot of familiar faces, but rest assured, the Seagriculture newcomers have real interesting stories to share as well!

Enjoy the conference, and your stay in Aveiro!

- The advisory committee

Welcome by the regional partners

From the University of Aveiro

“The University of Aveiro (UA) is among the most dynamic and innovative universities in the country. UA has a strong research profile, comprehensive but focussed predominantly on science and technology, and is a privileged partner to companies and other national and international organizations with which cooperates in numerous projects. UA has the highest scientific production and number of patents, per staff member, in Portugal, and it is ranked amongst the Top 100 (under 50 years old) by the Times Higher Education and in the Top 500 universities according to the Shanghai Ranking.

UA is highly committed to develop sustainable and cost-effective production systems for seaweeds, with emphasis on land-based modular integrated multi-trophic solutions. The valorisation of seaweed biomass is also a research priority at UA, namely through the development of origin certification/production tools, cleaner bio-refinery processes and the use of mass-spectrometry based approaches to unravel the true potential of seaweed bioactive molecules. ”

- Manuel António Assunção, Rector of the University of Aveiro

From the region ‘Centro do Portugal’

"The Centre of Portugal is a mixture of multiple resources and touristic products, in a wide and amazing variety of colours, sounds, smells and flavours.

Be enchanted with monasteries and sanctuaries, castles, beaches and pine forests, mountains, lagoons, caves and so much more…

Welcome to our region. Welcome to Aveiro and Ílhavo. We are waiting for you!"

Advisory committee

The advisory committee guides the topics of the conference, and ensures its quality. This year's advisory committee consists of the following members:

Helena Abreu
ALGAplus

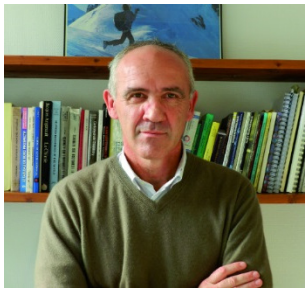
Willem Brandenburg

Bela Buck
Alfred Wegener Institute

Bernardete Castro
MTI-ICH

Floris Groenendijk
Wageningen UR

Paulien Hoftijzer
DLG Benelux



Jacques Mazoyer
Cargill

Birgit Schmidt-Puckhaber
DLG e.V.

Pi Nyvall Collén
Olmix Group

Isabel Sousa Pinto
CIIMAR – Porto University

Klaas Timmermans
NIOZ

Sponsors and partners

The area

Aveiro

50 Kilometers south of busy Porto lies the charming city of Aveiro, this year's conference venue. With most tourists flooding Portugal's Southern coasts, Aveiro is unjustly a much less frequented location.

Aveiro, or the 'Venice of Portugal', is the capital of the Ria, a broad laguna-like bay where the water of the Rio Vouga mixes with seawater. The city's many canals are home to the colorful 'moliceiro' boats – previously used to harvest seaweed, now a main tourist attraction.

General presumption is that Aveiro was founded during the reign of the Roman emperor Marcus Aurelius. The city was first named Aviarium, after the many bathing birds living around the lagoon. The 16th century brought wealth to Aveiro, as it developed a flourishing salt-, agricultural- and fishing industry. Unfortunately, prosperity did not last long: severe storms destroyed the connecting channel between the inlet and the sea, causing the salt and fishing industry to come to a halt. Quite some time elapsed before the Barra Nova was constructed in the 19th century. This connected Aveiro to the sea again, and allowed it to prosper once again.

What to see

Museu de Aveiro

The museum is housed in a former convent, dating back to 1463. Highlights include the Church of Jesus, a good example of Portuguese baroque, chapels and ancient choirs. The collection consists of paintings, sculptures, carvings, tiles, manuscripts, textiles and jewelry, all from the 15th to the 17th century

Av. de Santa Joana Princesa
3810–329 Aveiro
T +351 234 423 297
E maveiro@ipmuseus.pt
www.ipmuseus.pt
Opening hours:
Mo-fr: 10h00 | 17h30
Sa-Su and holidays:
10h00 | 17h30

Sé de Aveiro

Founded in 1423 as a Dominican convent, it is now a Roman Catholic cathedral seating the Diocese of Aveiro. Not to miss, as it's located on the town's square!

Praça do Milenário, 10
3810-064 Aveiro
T +351 234 422 182
Opening hours:
Everyday:
09h00 | 19h00

Igreja da Misericórdia

The church dates back to the Philippine period (1600). Noteworthy is the entrance, influenced by the Coimbran school, and the typical tiling

Rua Combatentes da Grande Guerra, 3
3810-087 Aveiro
T +351 234 426 732
E Scma.geral@scmaveiro.pt
www.scmaveiro.pt
Opening hours:
Mo-Fr: 09h00 | 17h30
Su: 11h30 | 12h30

Contemporary art museum

Housed in the beautiful Casa Major Pessoa, the Museu Arte Nova is the coolest new cultural stop in Aveiro. The first floor holds a roadmap for a walking tour of 28 iconic art nouveau buildings; the second floor holds an art gallery with work of artists and architects from the region. The top floor is for temporary exhibitions. Don't miss the Casa de Chá tearoom on the first floor!

Rua Barbosa Magalhães, 9/11
3800–200 Aveiro
T +351 234 406 485
E museucidade@cm-aveiro.pt
www.cm-aveiro.pt
Opening hours:
Museum
Tu-Fr: 09h30 – 12h30 and 14h00 – 18h00
Sa-Su: 14h00 – 18h00
Tea house:
Tu-Fr: 09h30 – 02h00
Sa-Su: 09h00 – 03h00

Eco-marine museum

Interested in finding out more about Aveiro's historical salt exploitation methods? This is the place to visit!

Marinha da Troncalhada
Cais das Pirâmides
3800 Aveiro
Guided tours via Museu de Cidade de Aveiro:
T +351 234 406 485
E museucidade@cm-aveiro.pt
www.cm-aveiro.pt
Opening hours:
Mo-Fr: 10h00-12h30 and 14h00-17h30
Sa-Sun: 10h00-12h30 and 14h00-17h30

Igreja da Vera Cruz

The two tiled panels on the white façade draw the attention of the visitor; inside, you'll find Portuguese baroque magic and exuberant gilded altarpieces.

Largo da Apresentação
3800-106 Aveiro
T +351 234 422 835
Opening hours:
Tu-Sa: 09h00 | 12h30 – 15h00 | 20h00
Su: 09h00 | 12h30 – 18h00 | 20h00

Ílhavo

Located in the Centre Region of Portugal, in a plain coastal area, Ílhavo was always deeply anchored between the Atlantic coast and “Ria de Aveiro” Lagoon.

Historically, the Cod fishery and the adjacent economical activities, in special the shipbuilding and repairs, have greatly contributed to its growth and development. Known as land of brave skippers, birthplace of captains, pilots and sailors, Ílhavo’s cod fishing epopee lived in the cold seas of the Greenland and of the Newfoundland, since the XVth century, and is deeply present in the collective memory. An excellent example is Maritime Museum of Ílhavo, including Museum Ship Santo André, which reflects the collective identity of its people and is one of the most visited museums in Portugal.

Nowadays, fishing, in both shallow and deep sea waters, plays an important role, along with the fish processing industry. Ílhavo assumes itself, in the present, as an innovative municipality and a strong organizer of its region.

Ílhavo’s tourism was born from the transformation of Costa Nova’s beach into a charming seaside resort, since the early nineteenth century. One of its main characteristic is the “palheiros” (typical wooden houses with colourful stripes), old warehouses for storing fishing gear, which were altered into vacation houses. Following in its footsteps is Barra’s beach, a cosmopolitan and still waters beach, which main attraction is the tallest Portuguese lighthouse.

Ílhavo is a privileged spot to practice nautical sports, mainly leisure sailing. The maritime ambassador of Ílhavo is the tall ship Santa Maria Manuela, cod-fishing gaff schooner that belonged to the White Fleet and that was recently restored. Its length overall is 68.64 metres and it usually sails with 11 latin sails.

You will also find Vista Alegre Museum, center of excellence for the creative industry of porcelain, distinguished by the rustic character of its workers quarters, started in 1824, and the Chapel of Nossa Senhora da Penha de França, national monument.

The venue

The conference venue is 4-star hotel 'Hotel Meliá Ria', in Aveiro. Located in the heart of Aveiro, next to the Cultural and Congress Centre and the train station, and a short distance from the city's historic centre, restaurants, shops, nightspots and fabulous beaches of Atlántico, Costa Nova and Barra, Hotel Meliá Ria is an excellent option for discovering and exploring Aveiro and its surroundings, thanks to its excellent location in the city centre, its complete and comfortable facilities and the quality of its services.

Hotel Meliá Ria
Cais da Fonte Nova, Lote 5,
3810-200 Aveiro, Portugal
Phone: +351 234 401 000
Contact person: Inês Ventura
ines.ventura@meliaportugal.com

Inside the venue

Seagriculture offers a lot of seaweed expertise, in a charming setting. Find your way around the venue with the simplified plan below!

The dinner venue

All Seagriculture attendees are invited to join the superb conference dinner, to take place in the old ceramic factory on Tuesday September 27th from 20:00 to 23:00. Let chefs Joe Best, Tony Martins and Gonçalo Santos amaze you with their skilfull incorporation of ALGAplus seaweeds in very gastronomic dishes!

Dinner is supported by the Tourist Board, and supported and served by students of the *Escola de formação profissional em turismo de Aveiro.*

Seagriculture 2016 conference program

Conference venue:
Hotel Meliá Ria
Cais da Fonte Nova, Lote 5,
3810-200 Aveiro, Portugal

Dinner location:
Old ceramic factory ´Jerónimo Pereira Campos´, located conveniently within walking distance of the conference venue.

Conference program day 1 – Tuesday September 27

09:00 – 10:00	**Welcome to Seagriculture 2016**
09:00 – 09:30	Opening Seagriculture 2016 *DLG Benelux and committee members* *President of the municipality of Aveiro, Eng. Ribau Esteves (with reservation)* *President of the municipality of Ilhavo, Eng. Fernando Caçoilo (with reservation)*
09:30 – 10:00	Key note: An overview of regional seaweed projects and aspirations for the future *Isabel Sousa Pinto*

10:00 – 11:00	**Session 1: Seaweed biology** *Seaweed species & strain selection to increase yield and to cater to specific demand* Chair: Balakrishnan Prithiviraj, Dalhousie University
10:00 – 10:15	1.1 Seaweed growth and biology *Philippe Potin, SB Roscoff/IDEALG*
10:15 – 10:30	1.2 Strain selection and culture possibilities for algal pigment applications: food, cosmetics and textiles *Juan Luis Gomez Pinchetti, Banco Español de Algas*
10:30 – 10:45	1.3 Novel strategies for preventing diseases in cultivated seaweeds *Claire Gachon, SAMS*

11:00 – 11:30	**Coffee / tea break**

11:30 – 12:45	**Session 2: Legislation and certification** *An update on current regulation in place for the various uses of seaweed aimed at the consumer, and an exploration of different seaweed certifications and the need for global standards* Chair: Willem Brandenburg
11:30 – 11:50	2.1 Standardization of aquatic biomass *Sander van den Burg, LEI/Wageningen UR*
11:50 – 12:10	2.2 Development of a joint MSC-ASC standard for seaweed eco-labelling *Dan Hoggarth, Marine Stewardship Council (MSC)*
12:10 – 12:30	2.3 Seaweed standards for food and cosmetics *Maud Benoit, CEVA*

12:45 – 13:15	**Slot for national research groups** • Íris Lopes *Lipid profile and lipogenic capacity of the seaweed Ulva Lactuca (chlorophyta): use as potential ingredient for fish aquaculture* • Loic Hiliou *Extractive extrusion of carrageenans from Mastocarpus stellatus: towards extrusion based biorefinery of seaweeds* • Patricia Diaz Rosales *From zebrafish to meagre: use of macroalgae as functional feeds* • Sónia Ventura *Development of technological tools and processes of purification to prepare enriched extracts of added-value bioactive compounds from macroalgae* • Cláudia Nunes *The potential of fucoidans for biomedical applications* • Cristina Rocha *Valorizing seaweeds potential aiming at bioplastics* • Elisabete da Costa *How to use lipidomic tools in red and green seaweeds signature and bioprospection?*
13:15 – 14:45	**Lunch and networking – Lunch kindly offered by U. Aveiro** • *Word of welcome by Prof. Paulo Vila Real, Vice-Rector of the University of Aveiro* • *Presentation by Prannie Rhatigan: Seaweeds, eat them, meet them, love them*
14:45 – 16:00	**Session 3: The economics of seaweed farming** *Financing the seaweed farm in different stages of development: from start-up to upscaling & practical business models* Chair: Miguel Herédia, OceanVision
14:45 – 15:05	3.1 Seaweed Aquaculture for Income Generation in Tropical Developing Countries *Randall Brummett, World Bank*
15:05 – 15:25	3.2 Technology exploitation in the seaweed field: examples and best practices *Ana Daniel, U. Aveiro*
15:25 – 15:45	3.3 Operational costs and capital expenditures of the largest seaweed cultivation farm in Europe *Olavur Gregersen, OceanRainforest*
16:00 – 16:15	**An introduction to the poster presenters** • Ingrid Bay-Larsen *Seaweed from traditional to commercial use – cross-disciplinary perspectives on using local protein sources in Arctic sheep husbandry* • Fleuriane Fernandes *Modification of the biochemical composition of the two Macroalgal species* Laminaria digitata *and* Ulva lactuca *via post-harvesting treatments.*
16:15 – 16:45	**Coffee break and time to visit the poster presentations**

16:45 – 18:00	**Session 4: The technology behind seaweed farming** *An exploration of cultivation techniques, the challenges and developments enabling large-scale seaweed farming* Chair: Jacques Mazoyer, Cargill
16:45 – 17:05	4.1 Mechanization of seaweed cultivation: The upcoming industrial revolution of sea agriculture *Bernardete Castro, IHC*
17:05 – 17:25	4.2 The move further offshore – challenges and opportunities for upscaling European seaweed farming *Frank Neumann, Seaweed Energy Solutions*
17:25 – 17:45	4.3 Landbased farming: Advantages and constraints *Helena Abreu, ALGAplus*

18:00 – 18:15	**Wrap up of conference day 1** *Sander van den Burg, LEI/Wageningen UR*

20:00 – 23:00	**Dinner in charming old ceramic factory, offered by Tourist Board and Municipalities** • *Opening by Mr. José Apólinario, Secretary of State of Fisheries* • *Speech by Dr. Pedro Machado, president of the Turismo do Centro Board (with reservation)* • *Dinner prepared by chefs Joe Best, Tony Martins and Gonçalo Santos. In collaboration with the escola de formação profissional em turismo de Aveiro*

Conference program day 2 – Wednesday September 28

09:00 – 10:15	**Session 5: Seaweed for high-end purposes** *The application of seaweed components in medicine, and functional foods* Chair: Isabel Sousa Pinto, CIIMAR
09:00 – 09:20	5.1 Health benefits of seaweeds *Balakrishnan Prithiviraj, Dalhousie University*
09:20 – 09:40	5.2 Ulvan, a Marine-Derived Sulfated Polysaccharide for Application in Regenerative Medicine *David Learmonth, Stemmatters*
09:40 – 10:00	5.3 Seaweed cultivation for bioactives, examples from the past and future prospects for the industry *Benoit Quéguineur, Algaia*

10:15 -10:45	**Coffee/tea break**

10:45 – 12:00	**Session 6: Large-scale seaweed production** *Towards standardizing the use of seaweed components in feed, food and plastics* Chair: Juan Luis Gómez Pinchetti, Banco Español de Algas
10:45 – 11:00	6.1 The ideal seaweed for carrageenans production *Jacques Mazoyer, Cargill*
11:00 – 11:15	6.2 Seaweed extracts for improving FEED use in animals *Pi Nyvall Collén, OLMIX group*
11:15 - 11:30	6.3 Upscaling Ulva for plastic production *Philippe Lavoisier, IDEAS international*
11:30 – 11:45	6.4 ZEEVIVO project – seaweed based proteins in fish feed *Tom Wijers, Van Hall Larenstein*

12:00 – 13:00	**Roundtable session 'How to match EU seaweed production with the expectations of the industry?'** *Chair: Philippe Potin* Includes participants: • Barbara Malmezat (Cargill) • Willem Brandenburg • Prof. Filomena Martins (Aveiro University) • Randall Brummett (the World Bank) • Nathalie Boulho (Olmix) • Benoit Queguineur (Algaia)

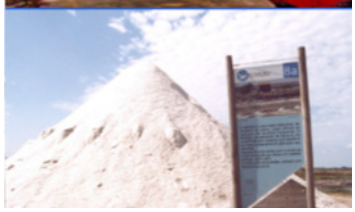
13:15 – 19:00	**Lunch and side visits** *Kindly supported by ALGAplus, the Municipality of Aveiro, the Municipality of Ilhavo and the Tourism Board.*

Side-visit planning

Check the colour code on your badge, and find your side-visit!

Side-visit 1 **Guided walking tour Aveiro + visit to Ecomuseum**

14:00 – 15:00	Guided walking tour in the city of Aveiro Supported by a technician of the Museum of Aveiro
15:00 – 16:00	Ride by Moliceiro boat with the Tourism Office and dropoff at the EcoMuseum
16:00 – 17:00	Guided tour in the EcoMuseum of salt ' Marinha da Trocalhada'
17:00	Dropoff in city center



Side-visit 2 **Visit to ALGAplus and the Maritime museum**

14:00 – 14:15	Bus to Maritime museum
14:15 – 15:45	Guided visit to the Maritime museum
15:45 – 16:00	Bus to ALGAplus production site
16:00 – 17:30	Visit to ALGAplus production site
17:30 – 17:45	Return to Hotel Melia Ria

Side-visit 3 **Visit to ALGAplus and the Vista Alegre museum**

13:30 – 13:45	Bus to ALGAplus production site
13:45 – 15:15	Visit to ALGAplus
15:15 – 15:30	Bus to Vista Alegre museum
15:30 – 16:45	Visit to Vista Alegre museum
16:45 – 17:00	Return to Hotel Melia Ria

List of attendees

Participant Company	Participants´ first name	Participants´ Lastname	Participant Country
ALGAplus	Helena	Abreu	Portugal
Nforsk	Ingrid	Bay-Larsen	Norway
University of Oslo	Marianne	Beck	Norway
CEVA	Maud	Benoit	France
Olmix	Nathalie	Boulho	France
Advisory Committee	Willem	Brandenburg	the Netherlands
World Bank	Randall	Brummett	USA
Municipality of Ílhavo	Fernando	Caçoilo	Portugal
University of Aveiro	Ricardo	Calado	Portugal
IHC MTI BV	Bernardete	Castro	the Netherlands
Aquasacrum Lda.	Miguel	Cintra	Portugal
University of Aveiro	Elisabete	Da Costa	Portugal
University of Aveiro	Ana	Daniel	Portugal
DLG Benelux	Christie	de Vrij	the Netherlands
CIIMAR	Patricia	Díaz-Rosales	Portugal
Stichting Zeeschelp	Marco	Dubbeldam	the Netherlands
Hortimare	Alexander	Ebbing	the Netherlands
Swansea University	Fleuriane	Fernandes	United Kingdom
CEAMSA	Cristina	Fernandez	Spain
Core Marine	Ben	Fitzgerald	Norway
Aquasacrum Lda.	Ricardo	Freire	Portugal
Scottish Marine Institute	Claire	Gachon	United Kingdom
CEAMSA	Angela	García	Spain
Ocean Rainforest	Olavur	Gregersen	Denmark
IMARES	Floris	Groenendijk	the Netherlands
Leroy Seafood	Jannicke	Hammer	Norway
WUR - BBP	Paulien	Harmsen	the Netherlands
Evalou aps	Evalou	Hauge	Denmark
MaBitec GmbH	Ulrich	Hees	Germany
North Seaweed BV	Carola	Helmendach	the Netherlands
Oceanvision, Business & Investment Advisory	Miguel	Heredia	Portugal
University of Minho	Loic	Hilliou	Portugal
	Beatrix	Hoecker	Germany
MSC - Marine Stewardship Council	Daniel	Hoggarth	United Kingdom
CEAMSA	María	Inmaculada Estévez	Spain
WUR - BBP	Astrid	Kemper	the Netherlands
Ministry of Economic Affairs	Yvonne	Koorengevel	the Netherlands
DLG Benelux	Suzanne	Kroeze	the Netherlands
Dutch Weed Burger	Mark	Kulsdom	the Netherlands
CEAMSA	Nicolaas	Lankhuizen	Spain

Participant Company	Participants´ first name	Participants´ Lastname	Participant Country
Savoie Technolac	Philippe	Lavoisier	France
Stemmatters	David	Learmonth	Portugal
University of Aveiro	Catarina	Lemos	Portugal
Cargill	Aurelie	Loaec	France
POM West-Vlaanderen	Lien	Loosvelt	Belgium
IMAR - University of Coimbra	Íris	Lopes	Portugal
Spanish Bank of Algae	Juan	Luis Gomez Pinchetti	Spain
Turismo do Centro	Pedro	Machado	Portugal
Cargill	Barbara	Malmezat	France
El Ulvario	Erik-Jan	Malta	Spain
University of Aveiro	Filomena	Martins	Portugal
Lab. of Applied Biotechnology	Hiba	Mawlawi	Lebanon
Cargill	Jacques	Mazoyer	France
Iranian National Institute for Oceanography	Neda	Mehdipour	Iran
CEAMSA	María	Moral	Spain
Seaweed Energy Solutions	Frank	Neumann	Portugal
Seaweed Energy Solutions	Luiza	Neves	Norway
University of Minho	Cláudia	Nunes	Portugal
Olmix	Pi	Nyvall Collén	France
Udaras	Máirtín	O´Cadhain	Ireland
Cartron Point Shellfish Ltd.	Freddie	O´Mahony	Ireland
This Is Seaweed	Paul	O'Connor	Ireland
ALGÓ Ehf	Gunnar	Ólafsson	Iceland
ALGAplus	Rui	Pereira	Portugal
SB Roscoff	Philippe	Potin	France
Dalhousie University	Balakrishnan	Prithiviraj	Canada
Algaia	Benoit	Quéguineur	Ireland
Irish Seaweed Kitchen	Prannie	Rhatigan	Ireland
Municipality of Aveiro	José	Ribau Esteves	Portugal
Nforsk	Camilla	Risvoll	Norway
University of Minho	Cristina	Rocha	Portugal
Dublin Institute of Technology	Emer	Shannon	Ireland
CIIMAR	Isabel	Sousa Pinto	Portugal
Leroy Seafood	Silje	Steinsund	Norway
Agroflux	Berend	Tillema	the Netherlands
CEAMSA	Sergio	Torras	Spain
LEI	Sander	van den Burg	the Netherlands
Seaweed Harvest Holland	John	van Leeuwen	the Netherlands
Stichting Noordzeeboerderij	Koen	van Swam	the Netherlands
CEAMSA	Ana Isabel	Vázquez	Spain
University of Aveiro	Sónia	Ventura	Portugal
EABA	Vítor	Verdelho	Portugal

Participant Company	Participants´ first name	Participants´ last name	Participant Country
University of Aveiro	Paulo	Vila Real	Portugal
BIM	Lucy	Watson	Ireland
Van Hall Larenstein	Tom	Wijers	the Netherlands

Trade show participants

Visit our trade show participants! We have the following companies lined up for you:

Evalou pattern & textile design
http://evalou.dk/
evalou@evalou.dk
Phone: 0045 20 78 86 12


University of Aveiro
Campus Universitário de Santiago,
3810-193 Aveiro, Portugal
https://www.ua.pt/
Phone: +351 234 370 200

Dutch Weed Burger
Distelweg 451,
1031 HD Amsterdam, the Netherlands
www.dutchweedburger.com
Phone: 00316 24857639

Ocean Rainforest
Mjólkargøta 20
FO - 180 Kaldbak, Faroe Islands
olavur@oceanrainforest.com
http://oceanrainforest.com

ALGAplus
Travessa Alexandre da Conceição s/n 3830-196
Ílhavo, Portugal
http://www.algaplus.pt/
Phone: (+351) 234 092 496 | 937 980 006
geral@algaplus.pt

Local partner booth
Municipality of Aveiro
Municipality of Ilhavo
Turismo do Centro

Poster presenters

At Seagriculture 2016, you can expect contributions by numerous Portuguese researchers, and international poster presenters!

Poster presenters

Name researcher	Institute	Abstract can be found on page
Neda Mehdipour *Absent: visa fell through*	Marine Science Research Center, Iranian National Institute for Oceanography and Atmospheric Science	20
Ingrid Bay-Larsen	Nordland Research Institute	22
Fleuriane Fernandes	MacroBioCrude Project, Swansea University	24

National researchers

Name researcher	Institute	Abstract can be found on page
Íris Lopes	University of Coimbra	26
Loic Hilliou	Universidade do Minho	27
Patricia Diaz Rosales	CIIMAR, U. Porto	30
Rita Cabrita *Absent*	ICBAS-Porto	28
Sónia Ventura	University of Aveiro	32
Cláudia Nunes	University of Aveiro	34
Cristina Rocha	U. Porto	36
Elisabete da Costa	University of Aveiro	37

Seasonal variations in the protein content and amino acid profiles of the Caspian Sea red seaweed, *Laurencia caspica* - absent

Author
Neda Mehdipour

Iranian National Institute for Oceanography and Atmospheric Science (INIOAS)

About the author
Neda Mehdipour
Faculty Member at INIOAS
@: neda.mehdipour@inio.ac.ir
Phone: +98 9122884418

Neda Mehdipour has completed her PhD degree in marine biology in 2010. Since then she has been working as a faculty member at Iranian National Institute for Oceanography and Atmospheric Science. Her primary research interests are Ecology and Biotechnology of Microalgae and Macroalgae, and in her current research position she uses methods including laboratory studies and field observations. As a project manager, she has conducted major projects including, “Seasonal Variations of Nutritional Value of Seaweed Species from the Southern Coasts of the Caspian Sea”, “Seasonal Distribution of Macroalgae along the Southern coasts of the Caspian Sea”, “Investigation of the history and evaluation of the algal bloom potential in the southern coasts of the Caspian Sea”. Further, she has experience with teaching undergraduate and graduate courses such as Advanced Marine Ecology, Marine Ecosystems and Marine Pollution, for which she received excellent feedback.

About the company/Institute
Iranian National Institute for Oceanography and Atmospheric Science
No. 3, Etemadzadeh St., Fatemi Ave., Tehran, Iran
1411813389
Phone: +98 21-66944873-5
http://www.inio.ac.ir

The Iranian National Center for Oceanography (INCO) was established in 1992 according to the agreement between the Ministry of Science, Research and Technology of Islamic Republic of Iran and UNESCO. In 19th March 2010, the Ministry of Science, Research and Technology approved the promotion of “Iranian National Center for Oceanography (INCO)” to “Iranian National Institute for Oceanography (INIO)” and on 8th June 2013, approved the promotion of Iranian National Institute for Oceanography (INIO) to the “Iranian National Institute for Oceanography and Atmospheric Science (INIOAS)”. It has organized many national, regional and international workshops, training courses and conferences in cooperation with the international organizations. The organizations, projects and networks which INIOAS is their national or regional coordinators are: “Intergovernmental Oceanographic Commission (IOC/UNESCO)”, “International Oceanographic

Data and Information Exchange (IODE)", "Global Ocean Observing System for Indian Ocean (IOGOOS)", "Global Coral Reef Monitoring Network (GCRMN)", "Indian Ocean Tsunami Warning System (IOTWS)". Furthermore, the Operational Center of International Oceanography Institute (IOI) in Iran is located in the Iranian National Institute for Oceanography and Atmospheric Science. This institute is also the national reference of "Inter-Islamic Science and Technology Network on Oceanography (INOC)".

Abstract

Seaweeds have potential value for the provision of biomass for food supplements. Nowadays, their demand is increasing especially for proteins as ingredients, and the amino acid profile for evaluation of the nutritional value of proteins. The year-round protein content and amino acid profile of the Caspian Sea red seaweed, Laurencia caspica, were determined in the present study. The pure protein content of the species varied significantly from 18.9±1.01 %DW to 24.5±1.31 %DW with the highest value in winter and the lowest in summer ($p<0.05$). A total of 16 amino acids including all essential amino acids and 7 non-essential amino acids were found to be present in the species tested. The Levels of essencial amino acids were higher than non-essential amino acids, and accounted between 50.9% and 55.7% of total amino acid content. Aspartic and Glutamic acids constituted together the large part of the amino acid fraction, while the amount of Histidine was the lowest in all seasons. Significant seasonal variations were recorded in the level of amino acids in different seasons ($p<0.05$).

Keywords: Seaweed, Protein content, Amino acid profiles, Laurencia caspica.

Seaweed from traditional to commercial use – cross-disciplinary perspectives on using local protein sources in Arctic sheep husbandry

Authors
Bay-Larsen, I., Vestrum, I., Lind, V., Risvoll, C., Novoa-Garrido, M. and Roleda, M.Y.

NORDLANDSFORSKNING
NORDLAND RESEARCH INSTITUTE

About the author
PhD Ingrid Bay-Larsen
Research Director
@: iby@nforsk.no
Phone: +474124 9314

Ingrid Bay-Larsen is Research Director at the Department for Environment and Society at Nordland Research Institute and has more than 15 years of experience from national and international projects on sustainable development in Northern areas. Her research interests connects to the sustainable governance of natural resources from both natural and social scientific perspectives. Area planning in coastal and terrestrial social-ecological systems have been main fields of interest. This includes the involvement of stakeholders in environmental planning, nature conservation and adaptation to climate change, as well as sustainable development of rural economies; agriculture (reindeer and sheep farming), aquaculture and mining industry. Currently she is involved in projects focusing on the interrelations between scientific and political sphere, and the role science and other forms of knowledge, have to ensure efficient and legitimate environmental decisions. She has also extensive experience from resilience of social-ecological systems, and how terrestrial ecosystem services and adaptive capacity in rural communities (primary industries) are affected by climatic and societal change, and from EU-projects focusing on remediation of contaminated ecosystems, including areas in use for food production.

About the company/Institute
Nordlands Research Institute
8049, Bodø
75411810
www.nordlandsforskning.no

Nordland Research Institute conduct research on topics related to sustainable development, innovation, entrepreneurship and the welfare state. Our thematic scope is extensive and cross-sectoral and iclude research and development projects in close co-operation with public and private clients. The institute participates in procurement and dissemination of scientific knowledge in multiple channels and arenas, and has been involved in the organising of a high number of scientific symposia, conferences, seminar series over the last years. The Department for Environmental and Society consist of 10 researchers of which 7 have PhD) representing anthropology, sociology, political sciences, geography, development studies, and engineering. The overarchin topic for the research group is the transition to low carbon society within bioeconomy (agriculture, aquaculture, sustainable tourism) as well as extractive industries (mining, oil and gas).

Abstract

Norwegian meat production is highly dependent on feed concentrate, based on imported soya. An increasing interest for locally produced feedstuff for ruminants is the background for the project "Legumes and seaweed as alternative protein sources for sheep" (Altpro) that was launched in 2014. The main objective of the project is to identify alternative protein sources, where locally available legumes and seaweeds seem to be the most suitable, sustainable and environmental friendly sources. Seaweeds as animal feed is not new; people living on coastal areas have traditionally fed their animals with seaweeds especially during lean feed seasons. Moreover, free-range ruminants had been observed to wilfully graze on beach-cast seaweeds. The use of seaweed as alternative protein source in animal feed, either as bulk ingredient or as extracted protein component, still requires basic studies (e.g. Tayyab et al., 2016). Moreover, the ecological impacts of using seaweed, either from wild harvest, monoculture or integrated multi-trophic aquaculture (IMTA), and the economics of extracting their protein in a commercial scale also requires further investigation. Alternatively, seaweed may be used as functional food ingredient that can be incorporated into animal feed, i.e. into the pellets, primarily for the various bioactive compounds that may have health benefits. In this paper the historical use of seaweed as animal feed, a practice that had been handed down through generations, and the farmers' perspectives toward large-scale use of seaweeds for animal feed were documented.

To address the increased demand in protein-rich substitute for soya for animal husbandry, knowledge on the potentials for largescale and sustainable cultivation and distribution of local resources containing high proteins is essential. Our project "Legumes and algae as alternative protein sources in fodder for sheep" (AltPro) is assessing the protein contents and digestibility as well as the social and managerial barriers and opportunities to (re)introduce local protein sources (e.g. seaweeds) in sheep farming. We present qualitative data i.e. interviews with sheep farmers in a coastal community in Northern Norway. The local respondents provide insights on the traditional and present use of seaweeds, and their attitudes toward future large-scale use of these resources. Specific to the northern communities, narrative analyses showed that positive attitudes were associated with the historical and present use of the coastal seaweed resources as feed. Conversely, negative attitudes were associated with the uncertainties related to environmental and ecological impacts, economic margins and the practicalities related to large-scale cultivation and distribution of local protein resources for sheep farming in northern Norway.

Modification of the biochemical composition of the two Macroalgal species *Laminaria digitata* and *Ulva lactuca* via post-harvesting treatments.

Authors
Fleuriane Fernandes, Claudio Fuentes-Grünewald, Hilary Redden, Kevin Flynn, Maria Scolamacchia

About the author
Fleuriane Fernandes
Research Assistant-MacroBioCrude Project
Centre for Sustainable Aquatic Research
Swansea university
Singleton park-Swansea, SA2 8PP
@: f.fernandes@swansea.ac.uk
Phone: +44 (0) 1792 295377

Fleuriane Fernandes is an aquaculture scientist, specialised in Macroalgae cultivation and ecophysiology. After achieving a master degree on aquaculture technics and fisheries in 2013, she worked in France on European and National projects all focusing on Algoculture development and optimization of existing processes. Since 2014, she has been working as a research assitant at Swansea University within the Center for Sustainable Aquatic Reasearch (CSAR) on the EPSRC (Engineering and Physical Sciences Research Council) funded MacroBioCrude project. Her research focuses on macroalgae cultivation from hatchery methods to the deployment at sea, macroalgae biochemistry and aquaculture systems and facilities. In 2016 she engineered and supervised the installation of one of the first Welsh seaweed farm which received positive feedback and publicity coverage.

About the company/Institute
Swansea University – Center for Sutainable Aquatic Research (CSAR)
Singleton park, SA2 8PP, Swansea
http://www.swansea.ac.uk/csar/
https://algaewales.wordpress.com/

The Centre for Sustainable Aquatic Research, CSAR, is a centre of excellence founded in 2003 with support from the European Union, Welsh Government, and Swansea University.Equipped with modern, fully programmable recirculating aquaculture systems, CSAR is designed for applied research on a diverse range of aquatic organisms, from temperate to tropical and marine to freshwater environments.In addition to its own experimental facilities, CSAR has direct access to comprehensive expertise and laboratories across the Swansea University campus, encompassing biochemistry, molecular biology, physiology, histo-pathology, water chemistry, systems engineering, bio-processing technologies and complex fluids processing. Areas of specialty are included within general overarching themes of: food and fuel security, low carbon technologies, climate change research and blue biotechnology. CSAR is extensively research active across the UK

and Europe, principally delivering research, development and technical assistance within industrial and academic consortia.
The CSAR team also provides information and advice to industry and governments, such as developing the aquaculture section of the Wales Fisheries Strategy (2008) and associated Implementation Plan, formation of the Welsh Aquaculture Producers' Association (WAPA) and input into microalgal biotechnology strategy documents

Abstract
Macroalgae have been proven to have many properties, notably thanks to their rich and diverse composition in Carbohydrates, Proteins and Lipids, allowing them to be used in many domains. The Macrobiocrude project (EPSRC funded) is looking into the utilisation of ensiled macroalgal biomass (anaerobic conservation of the biomass) for the manufacture of hydrocarbon, and a rich biochemical composition of the used biomass is a step towards processes efficiency and higher production yields. In this present study, the biochemical composition of the Brown macroalgae Laminaria digitata and the green macroalgae Ulva lactuca have been attempted to be modified through post-harvest treatments. These treatments constituted in an alteration of the natural abiotic environment of the macroalgae (increase in water salinity, temperature, nutrient supplementation or deprivation, modification of photoperiod) and were applied for a short period of time (1 to 2 weeks). The total carbohydrate, protein and lipid content of the altered biomass were measured by FTIR (Fourier Transformed InfraRed Spectroscopy). Results showed a significant ($p<0.01$) increase in total carbohydrate (2 times higher compared to control collected from the beach), protein (7 times higher) and lipid (5 times higher) for temperature and nutrient induced treatments in Laminaria digitata. Similar results were found in Ulva lactuca with a biochemical composition 2 times higher at the end of the experiment for nutrients addition post-harvest treatments and a long day photoperiod.

Key Words : Macroalgae, Total Carbohydrate, Protein and Lipid, Post-Harvest Treatment, FTIR

Lipid profile and lipogenic capacity of the seaweed *Ulva lactuca* (Chlorophyta): use as potential ingredient for fish aquaculture

Authors
Íris Lameiro Lopes, IMAR - Instituto do Mar, University of Coimbra; Leonel Pereira, Ivan Viegas

Íris Lameiro Lopes
Plant Biotechnology MSc Student
@: iris.l.lopes@gmail.com
Phone: 937597568

About the company/Institute
MARE - Marine and Environmental Sciences Centre
IMAR – Instituto do Mar
Department Life Sciences,
University of Coimbra
3004-517 Coimbra, Portugal

CFE – Center for Funtional Ecology
Department Life Sciences,
University of Coimbra
3000-456, Coimbra, Portugal

Abstract
Seaweeds are considered an alternative source for ingredients used in fish feed formulations, like fish meal, that are becoming increasingly unsustainable. Unlike fish, seaweeds are capable of synthetizing essential fatty acids, including omega 3 fatty acids (n-3) that need to be provided through their diet in order to ensure a healthy development. Ulva lactuca reveals an interesting qualitative lipid profile, having a high polyunsaturated fatty acids concentration, particularly n-3, when compared to saturated fatty acids and monosaturated fatty acids. This seaweed has a well-studied nutritional profile but its lipid synthesis and metabolism are still undeveloped topics.
Deuterium (2H) is a stable isotope of hydrogen (1H) that can be delivered as a tracer, by incorporation in seaweed tank water, as deuterated water (2H2O). Ulva lactuca discs were exposed to 10%-enriched 2H2O for 6 days, under different culture conditions followed by lipid extraction. The tracer incorporated into lipid metabolism allowing the determination of lipid metabolic fluxes particularly de novo lipogenesis (DNL), elongation and desaturation through 1H/2H nuclear magnetic resonance (NMR). In this work we developed a tool that not only allows determination of lipid rates in seaweeds, but can also detect changes in metabolism caused by environmental factors variations, such as temperature.

Extractive extrusion of carrageenans from Mastocarpus stellatus: towards extrusion based biorefinery of seaweeds

Author
Loic Hilliou

Universidade do Minho

Speaker details
Loic Hilliou
IPC/I3N
Dept. Polymer Engineering
Campus de Azurém
4800 - 058 Guimarães
@: loic@dep.uminho.pt
Phone: +351 253510320

About the company/Institute
Universidade do Minho
Largo do Paço
4704-553 Braga, Portugal
Phone: 253601100
@: gcii@reitoria.uminho.pt

Abstract
Hybrid carrageenans (HK) are polysaccharides with a statistical block copolymer structure, extracted from specific families of red seaweeds. HK is used as a natural texturizing agent in niche applications in foods and pharmaceutics. HK is isolated from seaweeds using batch extraction in alkali solutions. For Mastocarpus stellatus, a seaweed which can be effectively cultivated in an integrated multitrophic aquaculture system, an interplay between the seaweed chemistry and the chemical structure of HK was established [1]. Optimized extraction parameters showed to be efficient in tuning the chemical structure of HK and thus producing texturing agents with a palette of viscoelastic properties. Here we propose an alternative and eco-friendly route to the extraction of HK from Mastocarpus stellatus, based on extractive extrusion concepts. We will show preliminary results obtained with a prototype extrusion line dedicated to the biorefinery of seaweeds into polysaccharides and fillers for green plastic composites. HK alkaline conversion, extraction and separation from seaweeds is performed within minutes while water consumption is drastically reduced. The characteristics of HK produced with this new methods will also be presented.

[1] Hilliou, L. Hybrid carrageenans: isolation, chemical structure, and gel properties. (2014). Advances in food and nutrition research, 72: 17-43.

Seaweeds in ruminant feeding – only a poster

Authors
Cabrita, A.R.J., Maia, M.R.G., Sousa-Pinto, I., Azevedo, I.C., Correia, A., Vilanova, M., Fonseca, A.J.M.

Speaker details
Rita Cabrita, PhD
Assitant Professor, ICBAS/UP
@: arcabrita@icbas.up.pt
Phone: +351 911542123

Rita Cabrita is an assistant professor at Institute of Biomedical Sciences of Abel Salazar, University of Porto (ICBAS, UP) and a researcher of Laboratório Associado para a Química Verde, Rede de Química e Tecnologia (LAQV, REQUIMTE). Her research, in the area of animal nutrition and feeding, has been directed to the evaluation of alternative feed ingredients and feeding strategies for a higher nutrient efficiency use and for a reduction in the environmental impact of animal production.

About the company/Institute
ICBAS, LAQV, REQUIMTE, University of Porto
Rua de Jorge Viterbo Ferreira n.º 228
4050-313 Porto, Portugal
Phone: +351 220 428 000
https://sigarra.up.pt/icbas

At REQUIMTE, researchers exploit the basic principles of Green Chemistry and aim to contribute to the practice of Sustainable Chemistry. Research is presently focused in the following thematic areas of: (i) novel compounds from renewable sources; (ii) food quality and safety; (iii) analytical control and process automation; (iv) clean chemical processes; and (v) chemical biology and bioengineering. The Institute of Biomedical Sciences Abel Salazar (ICBAS) is an organic unit of the University of Porto with an university school structure and teaching center, scientific research, culture and service to the community. Scientific ICBAS areas are located within the Fundamental and Applied Biology, particularly in the areas of Health, Environment, Animal Production, Processing and Food Processing and Quality Control.

Abstract
Ruminants could be the most suitable farm animals to be fed on seaweeds as the rumen ecosystem might provide the animal the ability to use these feed resources by breaking down the complex polysaccharides. In the scope of a national project (EXPL/CVT-NUT/0286/2013 - FCOMP-01-0124-FEDER-041111), several studies were performed to ultimately identify seaweed species that can successfully constitute feed ingredients in ruminant diets. Eighteen common Portuguese seaweed species were analysed for their chemical composition, including a detailed mineral characterization (15 seaweeds). Generally, green species presented higher average contents of ash and crude fat,

red species were richer in crude protein and presented lower contents of acid detergent fiber, and acid detergent lignin, and brown seaweeds presented the lower dry matter digestibility values. However, wide differences were also observed among species within the same phylum. A large variability among species was also observed regarding their mineral profile but, compared to common animal feed ingredients, the studied seaweeds can be considered as good sources of calcium, magnesium, iron, iodine, copper, manganese, and selenium but are poor sources of phosphorous and zinc. For the first time, the effects of five seaweeds (Ulva sp., Laminaria ochroleuca, Saccharina latissima, Gigartina sp., and Gracilaria vermiculophylla) on gas and methane production and ruminal fermentation parameters when incubated in vitro with two substrates (meadow hay and corn silage) for 24 h were evaluated, the results revealing the potential of seaweeds to mitigate ruminal methane production and the importance of the basal diet. An in vivo study was also conducted with sheep fed diets with 25% inclusion of Ulva sp. and G. vermiculophylla. Both seaweeds presented lower dry matter digestibilitity than alfalfa hay, the organic matter digestibility of Ulva sp. being higher than that of G. vermiculophylla. The studied seaweeds presented low fiber and energy digestibilities which could compromise their use at high inclusion levels in ruminant diets. Dietary seaweed supplementation had no deleterious effect on the immune function of cells. Effects of G. vermiculophylla on the immunity status of growing ruminants is being studied. To take advantage of times of maximum biomasss yield and optimal nutritive value, seaweeds preservation is needed. A study was performed to assess the feasibility of ensiling preservation of G. vermiculophylla, Ulva sp. and S. latissima produced in a land-based tank without or with a lactic acid bacteria inoculant. The ensiling of S. latissima resulted in a marked lactic acid. Fermentation products from the ensilage of Ulva sp. and of G. vermiculophylla suggest the occurrence of a heterolactic fermentation or the promotion of heterofermentative bacteria and clostridia growth, respectively. Elemental composition of seaweeds was generally preserved by ensilage, but the in vitro digestibility of G. vermiculophylla was severely reduced.

Overall, this one-year project showed that seaweeds have potential as alternative sources in ruminant feeds with beneficial effects on rumen fermentation, their contribution for the dietary nutrient supply could decrease the external dependence of the European countries on massive feed imports from third countries, an important shortcoming of the animal production sector nowadays.

From zebrafish to meagre: use of macroalgae as functional feeds

Authors
Monteiro, M.[1]; Couto, A.[1]; Guedes, C.[2]; Azevedo, I.[2]; Amaro, H.[2]; Tavares, T.[3]; Costa, E.[4]; Domingues, M.R.[4]; Sousa-Pinto, I.[2]; Oliva-Teles, A.[1,5]; Díaz-Rosales, P.[1]

[1]Nutrition and Immunobiology group, Interdisciplinary Centre of Marine and Environmental Research, 4450-208 Matosinhos, Portugal.
[2]Coastal Biodiversity group, Interdisciplinary Centre of Marine and Environmental Research, 4450-208 Matosinhos, Portugal.
[3] LAQV/REQUIMTE - Department of Chemical Sciences, Faculty of Pharmacy, University of Porto, Rua de Jorge Viterbo Ferreira n.º 228, P-4050-313 Porto, Portugal; LEPABE - Laboratory of Engineering of Processes, Environment, Biotechnology and Energy, Rua Dr Roberto Frias, P-4200-264 Porto, Portugal
[4]Mass Spectrometry Centre, Department of Chemistry & QOPNA, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal.
[5]Nutrition and Immunobiology group, Faculty of Sciences, University of Porto, Rua do Campo Alegre 4169-007 Porto, Portugal

Speaker details
Dr. Patricia Díaz-Rosales
Postdoctoral researcher
@: prosales@ciimar.up.pt / pdiazrosales@gmail.com
Phone: +351 968 481 698

Patricia Díaz-Rosales graduated in Biology (2000) and obtained her PhD (2006) from the University of Malaga (Spain). The main topic of her thesis was investigate the role of bacterial virulence factors and the use of microalgae and probiotics as immunostimulants in Senegalese sole. Her first post-doctoral experience (2006-2008)- awarded an IntraEuropean Fellowship (Marie Curie)- was performed at the Scottish Fish Immunology Research Centre (University of Aberdeen, Scotland, UK), focusing on the study of trout cytoquines. Then, she got a three-year postdoctoral research contract (2010-2013), funded by the Spanish National Research Council (CSIC), at the Marine Research Institute (Vigo, Spain), where her main objectives were searching potential marker genes for resistance against viral/bacterial infections in turbot and the use of zebrafish as experimental animal model. Once the contract finished, P. Díaz-Rosales got a postdoctoral fellowship at the Interdisciplinary Centre of Marine and Environmental Research (CIIMAR, Portugal) at the Fish Nutrition and Immunobiology group. Currently, she is the principal investigator of a project funded by the National Funding Agency of the Portuguese Government (FCT, Fundação para a Ciência e a Tecnologia, Ministério da Educação e Ciência e Ensino Superior). Nutritional immunology has become her main research field, using zebrafish as experimental animal model to transference knowledge to farmed fish.

About the company/institute
Interdisciplinary Centre of Marine and Environmental Research (CIIMAR)
Novo Edifício do Terminal de Cruzeiros do Porto de Leixões. Avenida General Norton de Matos s/n

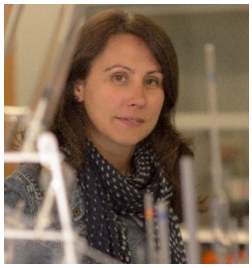
4450-208 Matosinhos, Portugal
Phone: (+351) 223 401 800
www.ciimar.up.pt

The CIIMAR – Interdisciplinary Centre of Marine and Environmental Research - is a multidisciplinary research institute whose mission is to develop high-quality research, promotes technological development and innovation and supports public policies in Marine and Environmental Sciences. At present, CIIMAR aggregates researchers from the University of Porto, the University of Madeira, the University of Azores, and the Portuguese Sea and Atmosphere Institute (IPMA). The research carried out at CIIMAR focuses on three thematic lines: Global Changes and Ecosystem Services, Aquaculture and Seafood Quality and Marine Biotechnology. Currently, the CIIMAR hosts 27 research groups, covering a wide range of scientific expertise and sharing a common vision: "Contribute to the Knowledge of the Ocean as a basis for the sustainable management and exploitation of resources". CIIMAR generates around 300 articles in SCI journals per year (60% in Q1), contributing to cross-cutting scientific themes and societal challenges at both regional/national and European levels.

Abstract
Meagre, Argyrosomus regius (Asso, 1801), has become an attractive candidate for diversification of aquaculture, due to its excellent biological characteristics. However, the expansion in meagre intensive culture is at risk from a range of common diseases. Thus, enhancing host defense mechanisms through the use of immunotherapeutic agents, from natural sources, has become increasingly important for the treatment and prophylaxis of farmed fish diseases. The present research project is intended to explore the potential of macroalgae to produce novel immunotherapeutics, using macroalgae bioactive compounds as functional ingredients in fish feeds. Macroalgae have been recognized as a valuable natural source of bioactive peptides with potential health-promoting and disease-preventing properties. Moreover, macroalgae present carotenoids and □□-glucan that have been proved to prevent problems linked to oxidative stress and to have immunostimulant properties, respectively; and a high content in polysaccharides, important bioactive compounds.
Different macroalgal extracts from Laminaria sp., Ulva sp. and Chondrus crispus, will be obtained, their active principles identified and their potential bioactivities tested in vitro in cells and zebrafish embryos. The most promising algal extracts will be characterized biochemically and used in zebrafish diets. Zebrafish is proposed as a model in fish nutrition trials that will allow more cost-effective and less time consuming studies. Finally, optimal diets supplemented with the most promising macroalgae species, will be formulated for meagre. The effect of macroalgae dietary administration will be studied at zootechnical and immune response levels.

Development of technological tools and processes of purification to prepare enriched extracts of added-value bioactive compounds from macroalgae

Authors
Ventura, Sonia



Speaker details
Dr. Sónia P. M. Ventura
Researcher
@: spventura@ua.pt
Phone: 00351370360

Sónia graduated in Chemical Engineering in 2007 by University of Aveiro (UA), Portugal. By the end of 2011 she completed her PhD in Chemical Engineering by UA. From 2011 until August of 2014 she was a post-doctoral researcher at CICECO, in a close collaboration between CESAM and CICECO, at UA. From September 1st 2014 to August 31th 2015 she was Assistant Professor in Biotechnology at the Chemistry Department (UA) and during this year she started her more recent reserach area included in the development of tools/processes to extract and purify bioactive compounds from marine sources. Recently she got a position of Assistant Researcher. Since 2007, she published more than 51 articles in international peer reviewed journals, has 1210 citations, and an h-index of 20. Sónia participated in 3 research projects and is now participating in one national project, and three international projects, including the european project GENIALG "GENetic diversity exploitation for Innovative macro-ALGal biorefinery". Sónia was nominated MC Substitute of the Cost Action EUALGAE. She also has two ongoing collaborations with industry in macroalgae (ALGAplus) and microalgae (Necton) cultivation and valorization.

About the company/Institute
Aveiro Institute of Materials (CICECO) & Chemistry Department, University of Aveiro
Campus Universitário de Santiago
3810-193, Aveiro
Phone: 00351370360
https://www.ua.pt/dqua/
http://www.ciceco.ua.pt/index.php?language=pt

The University of Aveiro (UA) is among the most dynamic/ innovative universities in the country. UA has a strong research profile contributing to the progression of science and technology, and a privileged partner to companies and other national and international organizations with which cooperate in numerous projects, providing important consultancy and services. CICECO-Aveiro Institute of Materials at University of Aveiro (UA) is the largest Portuguese institute including materials science and engineering areas and one of the most productive research Portuguese institutes in all scientific areas. Included in CICECO is our group acting in the line of Sustainability and Health. Our major research areas are the development of new products and processes based on non-conventional solvents (e.g. ionic liquids - ILs), biotechnology, and more recently in the use

of marine raw biomasses in order to extract and purify high value compounds to produce new bioproducts.

Abstract

Macroalgae (seaweed), are marine natural raw materials, rich in chemicals of economic/industrial interest, yet most are poorly explored or totally neglected. Phycobiliproteins, carotenoids and chlorophylls are the main pigments found in red, brown and green macroalgae, respectively, with a large range of applications, from food industry to pharmaceuticals, biomedical research and cosmetics to the energy field. However, the current extraction and purification processes applied in the recovery of pigments and other bioactive compounds from marine biomass need much improvement to make many reported processes economically viable, and also to enabling them to use fresh algae, since the water composing this biomass is one of the major limitations in the purification process. We are focused in the development and optimization of different tools and processes to create enriched extract/products based in the pigments and other added-value bioactive compounds from marine origin. These extracts, produced in a water or organic base, using common and/or alternative solvents (namely ionic liquids and surfactants), are tailor-made considering the purity levels required and the final applications focused.

Acknowledgements

This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, POCI-01-0145-FEDER-007679 (FCT Ref. UID/CTM/50011/2013), financed by national funds through the FCT/MEC and when appropriate co-financed by FEDER under the PT2020 Partnership Agreement. The authors are grateful for the financial support of the Portuguese Foundation for Science and Technology (FCT) for post-doctoral grant SFRH/BPD/79263/2011 of S.P.M. Ventura.

The potential of fucoidans for biomedical applications

Authors
Cláudia Nunes[1,2], Andreia S. Ferreira[2], Catarina Oliveira[3,4], Tiago H. Silva[3,4], Albino Martins[3,4], Nuno M. Neves[3,4], Rui L. Reis[3,4], and Manuel A. Coimbra[2]

[1]CICECO & [2]QOPNA, University of Aveiro, 3810-193 Aveiro, Portugal.
[3]3B´s Research Group - Biomaterials, Biodegradables and Biomimetics, University of Minho, Avepark - Parque de Ciência e Tecnologia, 4805-017 Barco GMR, Portugal
[4]ICVS/3B´s- PT Government Associated Laboratory, Braga/Guimarães, Portugal

Cláudia Nunes
1CICECO & 2QOPNA
University of Aveiro
3810-193 Aveiro, Portugal
@: claudianunes@ua.pt

About the company/Institute
University of Aveiro
Campus Universitário de Santiago,
3810-193 Aveiro, Portugal
Phone: +351 234 370 200

Abstract
Marine environments are rich in a wide variety of sulfated polysaccharides. Important biological activities, such as anticoagulant, antiviral, immunomodulatory and anti-inflammatory, have been assigned to these polysaccharides. Therefore, they are receiving growing interest for application in health-related fields [1]. However, the biological properties depend of several structural parameters, such as molecular weight, branching, and degree of sulfation [2]. Therefore, the relationship between structure and biological activity needs to be established.
In this study, the potential of fucoidan isolated from brown seaweed *Fucus vesiculosus* for therapeutic use has been evaluated, focusing in its antitumoral capacity, aiming to shed light on the structure-activity relationship (SAR) and the apparently contradictory results observed in the lab and on literature.
The performance as antitumoral agent was assessed over normal and breast cancer cell lines for different fucoidan extracts, which exhibited diverse cytotoxic effect. The chemical characterization of the fucoidan extracts disclosed similar sulfation content and sugars profile and despite the three fucoidan extracts present different molecular weights, complementary assays discarded also Mw as the key factor in the anti-tumor activity. A more detailed structural analysis revealed differences in fucoidans branching degree and sulfate position. Based on all these experimental data, we believe these last two properties are the ones influencing the most the cytotoxic effects of fucoidan extracts over the addressed cells.

This study revealed that fucoidan has high potential on advanced therapies for cancer, but the structural features should be accurately established towards the reproducibility of the reported biological activity.

References

[1]Silva TH, *et al.*, Biomatter. 2012, 2, 278.
[2]Jiao, G. *et al.*, Mar Drugs, 2011, *9*, 196.

Acknowledgements: The authors gratefully FCT, Portugal European Union, QREN, ERDF, and COMPETE for the financial support of the Research Units CICECO (POCI-01-0145-FEDER-007679, FCT UID/CTM/50011/2013) and QOPNA (FCT UID/QUI/00062/2013; FCOMP-01-0124-FEDER-037296) through national founds and when applicable co-financed by ERDF, within PT2020 Partnership Agreement, project EXPL/MAR-BIO/0165/2013, and grant (SFRH/BPD/100627/2014).

Valorizing seaweeds potential aiming at bioplastics

Author
Cristina M.R. Rocha, Helena Abreu, Freddie O'Mahony, Maud Benoit, Ana M. López Contreras, Julie Maguire

Universidade do Minho

Speaker details
Cristina M.R. Rocha
Invited Assistant Researcher
Centre of Biological Engineering, Universidade do Minho
Phone: +351 253 601 599
@: cmrochainv@gmail.com

About the company/Institute
Universidade do Minho
Largo do Paço
4704-553 Braga, Portugal
Phone: +351 253601100
@: gcii@reitoria.uminho.pt

Abstract
Currently, mainly non-biodegradable petroleum-based synthetic polymers are used to produce bioplastics, because of their availability, low cost and functionality. However, issues such as growing environmental concerns, petroleum shortage as well as increasing oil price instability caused by geopolitical conflicts, have boosted the search for alternative eco-friendly materials to replace plastics from petrochemical origin. Although there are many biopolymers under investigation to produce bioplastics, their application by the industry is hindered by very significant problems, which could be summarized in three issues: processability, functionality and sustainability.
Seaweeds are readily available, whether in the wild or from aquaculture cultivation. Furthermore, the increasing interest and spreading of integrated multitrophic aquaculture systems (IMTA) can also provide a new, more sustainable and significant source of seaweeds.
The main challenge addressed in the EU SeaBioPlas project[1] was the development of novel bioplastic solutions from seaweed-based ingredients fully biodegradable and compostable, including lactic acid from seaweed sugars and seaweed polymers. Several species of IMTA-produced seaweeds were used as feedstock. Different extraction and pretreatment protocols allowed the production of biopolymers with tailored chemical features to be used in films. Bioplastic-based films from renewable and sustainable sources could be produced with a wide range of properties, depending on the main biopolymer and additives.

[1] www.seabioblas.eu

How to use lipidomic tools in red and green seaweeds signature and bioprospection?

Codium tomentosum and *Gracilaria sp*. as showcases

Authors
Da Costa, Elisabete;
Melo, Tânia; Maciel, Elisabete; Lillebø, Ana; Calado, Ricardo; Domingues, Pedro; Abreu, M. Helena; Domingues, M. Rosário

universidade de aveiro
theoria poiesis praxis

About the author
Elisabete da Costa
Ph.D Student in Sustainable Chemistry
@: elisabetecosta@ua.pt
Phone: +351 966477592

Elisabete da Costa has graduated in Industrial Chemistry in the University of Coimbra and received her MSc in Instrumental Methods and Analytical Quality Control, at the University of Aveiro, in 2008. At present she is pursuing a Ph.D. in Sustainable Chemistry entitled High added value products from macroalgae: lipids as bioactive compounds under the supervision of Prof. Maria do Rosário Domingues and Dr. Helena Abreu (ALGAPlus company). She has started her career at the Portucel Soporcel Group between 2000-2009. This new stage in her scientific career started in 2010 after moving to the University of Aveiro (CICECO/QOPNA/Centre of Mass Spectrometry).
The most current research interests include the study of bioactive polar lipids fostering the valorization of marine seaweeds and microalgae to create opportunity for high-value products and applications:

- Lipidomic studies of seaweeds (chromatographic and mass spectrometry approaches);
- Evaluation of the biological functionality of algal lipids as added-value compounds with particular interest in therapeutic and nutraceutical features;
- New eco friendly methodologies in the extraction of bioactive compounds.

She published nine original papers, delivered eight invited oral communications, five poster communications in several national and international scientific meetings and has been a member and researcher in national and international projects and several workshops promoting Mass Spectrometry and Chemistry.

About the company/Institute
Marine Lipidomic Laboratory/University of Aveiro
Center of Mass Spectrometry, Department of Chemistry
Campus Universitário de Santiago
3810-193 Aveiro
Phone: +351 234 370 360
http://masspec.web.ua.pt/

Abstract

Polar lipids from seaweeds are an important reservoir of *n*-3 fatty acids and a source of glycolipids (GLs), phospholipids (PLs) and betaine lipids, accounting on essential functions for all living cells. They are considered high valuable novel-lipids with health benefits (e.g. antibacterial, antifungal, antiviral, antioxidative, anti-inflammatory, and antitumoral effects) yet to be fully exploited in applications related with nutraceutics and pharmaceutics, since the majority of these molecular structures remain unknown. Lipid composition depends on environmental and nutritional conditions, increasing the complexity and variety of the lipidome. Deciphering lipid signatures of seaweeds is a true challenge. The use of seaweeds cultivated on land-based integrated multitrophic aquaculture (IMTA) presents a sustainable solution to produce biomass under controlled conditions, ensuring the replicability and safety of the final product.

The lack of knowledge on seaweeds lipidome due to chemical diversity can be overcome by using advanced lipidomic approaches supported by modern research with MS-based techniques. The research of marine lipids at molecular level is emerging and Mass Spectrometry (MS)-based approaches are also considered an important tool to understand adaptations of the polar lipid profile to environmental and nutrition conditions [1].

In our laboratory, we have been working on decoding the full lipidome of seaweeds and in the bioprospection of their functionalities [2,3]. Our findings demonstrate the robustness of HILIC-MS and MS/MS modern lipidomics as a promising approach to profile the lipidome of seaweeds. Results achieved with the two studied seaweeds will be showcased: *Codium tomentosum* (Chlorophyta) and *Gracilaria* sp. (Rhodophyta) originating from a land-based IMTA system.

Total lipid extracts of *Codium* and *Gracilaria* unveiled phospholipids (PL), glycolipids (GL) and betaines molecular species. *Codium tomentosum* lipidome included 170 molecular species distributed over 43 GLs, 90 PLs and 38 betaine lipid compounds. In the case of *Gracilaria* sp. the lipidome comprised 140 molecular species distributed over 34 GLs, 88 PLs and 25 betaine lipids. Glycolipids included MGDG, DGDGs, SQDG and SQMG; phospholipids included PA, PC, LPC, PG, LPG and PI and betaine lipids included MGTS and DGTS classes. Interestingly, *Gracilaria* also comprised PE and IPC classes which were not recorded in *Codium* lipidome. These classes of lipids are potential biomarkers of interest to distinguish Rhodophyta.

The main polar lipids from seaweeds are glycerolipids, with a glycerol scaffold anchoring one or two fatty acids-linked at positions *sn*-1 and *sn*-2. In the case studies seaweeds, fatty acids uncover 14-, 16-, 18 and 20-carbons of saturated and unsaturated fatty acids (FA), and 18- and 20-carbon polyunsaturated FA (PUFA). *Codium tomentosum* preferably held 18:2*(n*-6), 18:3(*n*-3), 20:4(*n*-6), 20:5(*n*-3) and 22:6(*n*-3) PUFAs, meanwhile *Gracilaria* had PUFAs such as 18:2*(n*-6), 20:4(*n*-6) and 20:5(*n*-3). These findings highlight the difference between the lipidome of seaweeds from distinct phyla and encourage us to continue ongoing research.

Considering the potential health benefits of polar lipids, to date, lipid extracts from *Gracilaria* sp. were tested to evaluate their anti-inflammatory and antitumoral functionalities. These lipid extracts displayed anti-proliferative effect on T-47D human breast cancer and on 5637 urine bladder human cancer cell lines (IC_{50} of 12.2 and 12.9 µg/mL, respectively). The extracts also showed anti-inflammatory effects through the inhibition of the production of NO on macrophage RAW264.7 cells (IC_{50} 105 µg/mL). These results highlight the potential bioactivity of polar lipids from seaweeds that will be paramount for their valorization as high-end products.

The growing interest of new markets in the valorization of seaweeds as a source of added-value products, can promote seaweeds with bioactive properties originating from land-based IMTA systems as a premium resource in the landscape of blue biotechnology.

Acknowledgments

Elisabete da Costa thanks (SFRH/BD/52499/2014) and Tânia Melo (SFRH/BD/84691/2012) thanks their PhD grants, supported by funds from FCT. Thanks are due to University of Aveiro and FCT/MEC for the financial support to the QOPNA research project (FCT UID/QUI/00062/2013) and CESAM (UID/AMB/50017/2013), and through a post-doc grant to E. Maciel

(SFRH/BPD/104165/2014) through national funds. Thanks are due to Portuguese Mass Spectrometry Network (REDE/1504/REM/2005) and to ALGA+ for providing samples.

References

[1] Maciel E., Leal M.C., Lillebo A.I., Domingues P., Domingues M.R., Calado R. **Bioprospecting of Marine Macrophytes Using MS-Based Lipidomics as a New Approach**, Mar. Drugs 14 (2016).

[2] E. da Costa, T. Melo, A.S.P. Moreira, E. Alves, P. Domingues, R. Calado, M.H. Abreu, M. R. Domingues, **Decoding bioactive polar lipid profile of the macroalgae *Codium tomentosum* from a sustainable IMTA system using a lipidomic approach**, Algal Res. 12 (2015).

[3] T. Melo, E. Alves, V. Azevedo, A.S. Martins, B. Neves, P. Domingues, R. Calado, M.H. Abreu, M. R. Domingues**, Lipidomics as a new approach for the bioprospecting of marine macroalgae-Unraveling the polar lipid and fatty acid composition of *Chondrus crispus***, Algal Res. 8 (2015).

*Glossary: monogalactosyl diacylglycerides (MGDG); digalactosyl diacylglycerides (DGDG); sulfoquinovosyl monoacylglyceride and sulfoquinovosyl diacylglycerides (SQMG and SQDG); phosphatidylcholines (PC) and lyso-PC (LPC); phosphatidylglycerols (PG) and lyso-PG (LPG); phosphatidylinositols (PI); phosphatic acid (PA); phosphatidylethanolamines (PE); inositephosphoceramides (IPC); monoacylglyceryl- and diacylglyceryl-N,N,N-trimethyl homoserines (MGTS and DGTS).

Session 1: Seaweed biology

Seaweed species & strain selection to increase yield and to cater to specific demand

Chair: Balakrishnan Prithiviraj

Presentation 1.2: Strain selection and culture possibilities for algal pigment applications: food, cosmetics and textiles

Authors
Gómez Pinchetti, J.L., Rodríguez Ramos, T., Vega Estévez, S., Rego, A.M., Abreu, M.H., Almeida Peña, C. and Martel Quintana, A.

BANCO ESPAÑOL DE ALGAS
marinebiotechnology.org

Dr. JUAN LUIS GÓMEZ PINCHETTI
Senior Lecturer at the Universidad de Las Palmas de Gran Canaria
Email: juan.gomez@ulpgc.es
(Mobile) phone number: +34 928 649298993

About the author
Juan Luis Gómez Pinchetti is a senior lecturer at the Faculty of Marine Science and Scientific Director at the Spanish Bank of Algae (ULPGC). PhD in Marine Science and Master in Applied Algology, he has got a wide experience in laboratory and pilot-scale cultivation of marine macroalgae, microalgae and cyanobacteria, at different laboratory- and pilot-scale photobioreactors, tanks and raceways. His research objectives include physiology, biochemistry, biomass transformation and applications of marine algal biomass under intensive cultivation and the development of biofiltration systems using algae. Nowadays he is chairman of the Spanish Phycologycal Society (SEF).

About the company/Institute
Banco Español de Algas (BEA) / Instituto de Oceanografía y Cambio Global (IOCAG) – Universidad de Las Palmas de Gran Canaria
Banco Español de Algas, Muelle de Taliarte s/n
Postal code + city: 35214 Telde
Direct telephone number: +34 928 133290
Website: www.bea.marinebiotechnology.org

The Spanish Bank of Algae (BEA) as a national centre for R+D+i of the University of Las Palmas G.C. (ULPGC) is recognized, by the World Intellectual Property Organization (WIPO), as an authorized culture collection for tropical, subtropical and extremophiles microalgae and cyanobacteria, particularly from the Macaronesian Region. Being a member of the European Culture Collection Organization (ECCO) and the World Federation of Culture Collections (WFCC), BEA is listed at the World Data Centre for Microorganisms (WFCC-MIRCEN). The Collection is accredited as an International Authority for the Deposit of Microorganisms, for the deposit of algae with the purposes of recognition of industrial property, in accordance with the Budapest Treaty. Nowadays, BEA holds 1690 living strains, as clonal or single cell isolates.
Under the frame of the “Marine Agronomy” concept, BEA main goal is to develop an important agro-industrial sector based upon Algal Biotechnology (algae cultivation and application developments) for the Canary Islands. Research objectives include work on physiology, biochemistry, biomass transformation and industrial applications of marine algal biomass under cultivation conditions, through recently financed research projects from the European commission such as FPVII-MIRACLES and LIFE-SEACOLORS or research agreements with companies for innovation programs.

Abstract
An increasing number of species, both of macro- and microalgae, are being cultured in different systems, scales and control degrees. Under controlled conditions, developments on species and strains selection based on growth characteristics, sustainable yields, biomass quality and security or traceability can be performed. In the last years, considering the possibility of wastewater nutrients and CO2 gases recycling have become key factors for the future success of industrial algae production, together with the concept of biorefinery (step-by-step biomass processing generating several final products of interest). As a recognized example, in the so-called "integrated multi-trophic aquaculture" systems (IMTA) algae are established as biofilters for dissolved nutrients (mainly nitrogen and phosphorus) generated by animals at higher trophic levels (fish or crustaceans) converting nutrients in biomass and O2, instead of being diluted to the environment.
Considering applications for biomass produced and transformed under these approaches, diversity of algal pigments, belonging to the groups of chlorophylls, carotenoids and phycobiliproteins, have reached an increased interest as far as new applications for industries like food and feed, biomedicine and cosmetics or textiles are searching for natural pigments obtained through sustainable and environmentally friendly processes.
To identify and select potential species of algae (macroalgae, microalgae and cyanobacteria) that can be used as raw material for the industry, different species and strains have been assayed at both laboratory and pilot scale to determine growth characteristics (biomass and/or pigment yields, growth rates) and pigment composition that might be useful for different industrial processes. Selection is carried out by considering both: (1) possibilities of being cultivated at pilot/industrial scale, performing consistent biomass yields in a sustainable way (year-round performance); and (2) pigments profile and accumulation characteristics under culture conditions (by studying possible effects of controlled parameters such as nutrients flow or light quality).
As an example, the main goal of the LIFE-SEACOLORS Project (www.seacolors.eu) is the demonstration and validation of obtaining natural pigments/dyes from algae, through sustainable and renewable biomass, for their application in the textile industry with the objective to replace synthetic dyes, pollutant and harmful for the environment. Under this principle, less contaminated wastewaters will be obtained due to the higher biodegradability of natural dyes, thus reducing water purification processes.
At the Spanish Bank of Algae (Canary Islands, Spain) and AlgaPlus (Aveiro, Portugal), the application of this approach have resulted in the selection of a group of macroalgae species and microalgae/cyanobacteria strains. Biomass, liquid crude extracts and freeze-dried pigments (phycobiliproteins – red and blue, carotenoids – orange and yellow or chlorophylls - green) are being assayed for dyeing performance. "Biomass waste" obtained after pigment extraction procedures is being recycled, under the biorefinery concept, both for residual pigments and secondary extracts with potential antioxidant activity.
In this presentation, some of these ideas, examples and results will be described.

Presentation 1.3: Novel strategies for preventing diseases in cultivated seaweeds

Authors
Gachon Claire, Strittmatter Martina, Badis Yacine, Murúa-Andrade Pedro Calmes Benoît, Bertrand Jacquemin, Valero Myriam, Vallet Marine, Prado Soizic, Elizabeth J. Cottier-Cook.

Speaker info
Dr Claire Gachon
Senior Lecturer in Molecular Phycology
Email: cmmg@sams.ac.uk
(Mobile) phone number: (+44) 1631 559 318

About the author
Claire Gachon is an algal pathologist, who investigates the ecology, physiology and genomics of algal diseases caused by protists. Initially focussed on the interaction between the intracellular pathogen Eurychasma dicksonii and the brown algal genome model Ectocarpus siliculosus, her research now encompasses a broad range of models, with an increasingly pronounced focus on applied topics; notably, this encompasses macroalgal breeding and disease management in the algal industry. Claire is fluent in biochemistry, molecular biology, genomics and bioinformatics. She has been participating to several seaweed genome projects, including Ectocarpus, Chondrus and Porphyra. Claire leads the NERC-funded GlobalSeaweed initiative and the Marie Curie ITN ALFF (the ALgal microbiome – Friends and Foes). She engages in community or community-building initiatives such as EMBRC and Unieuk and sits on various committees, such as the Council of the British Phycological Society and the New Phytologist Board of Advisors.

About the institute
Scottish Association for Marine Science
Scottish Marine Institute
PA37 1QA Oban
United Kingdom
claire.gachon@sams.ac.uk
Skype contact : claire.gachon
Tel: 0044 16 31 559 318
Fax 0044 16 31 559 001
http://www.sams.ac.uk/claire-gachon

Abstract

In any agricultural or aquaculture system, pests and pathogens typically reduce production yields by a fifth to a third; this also holds true for cultivated seaweeds. As seaweed cultivation develops and intensifies worldwide, the frequency and severity of disease outbreaks is increasing, for example on Gracilaria, Pyropia, eucheumatoids and kelps. Here, I will brush over different strategies developed in my group to describe and characterise hitherto unreported diseases of seaweeds and control pathogens in a cultivation context.

As a crucial prerequisite for the implementation of meaningful breeding strategies in brown algae, I will introduce our work on the mechanisms and heritability of disease resistance in Ectocarpus; we find that disease resistance is a phenotypically stable, quantitative, and heritable trait. Its fundamental mechanism is not only conserved against several pathogens but also across the entire brown algal lineage, thus providing proof-of-concept to breed for disease resistance in commercially important species.

To address the need for fast cost-effective tools fit for the quantitative phenotyping of numerous individuals, nephelometry will be described as a novel, non-invasive method for medium-throughput biomass measurement of macroalgae; application examples will be presented not only for disease diagnostic, but also for fertility and in vivo growth measurement.

I will also briefly introduce our work on commensal or beneficial microbes naturally associated to seaweeds that may counteract pathogens and be used as biocontrol agents and the outcome of a collaborative initiative undertaken in the framework of GlobalSeaweed, leading to recommendations for policy-makers.

Session 2: Legislation and certification

An update on current regulation in place for the various uses of seaweed aimed at the consumer, and an exploration of different seaweed certifications and the need for global standards

Chair: Willem Brandenburg

Presentation 2.1: Standardization of aquatic biomass

Author
van den Burg, Sander

Speaker info
Dr Ir. Sander van den Burg
Senior Researcher
Sander.vandenburg@wur.nl
+31 (0)70 335 8129

About the author
Sander van den Bur g is senior reseacher at LEI Wageningen UR. He is heavily involved in resaerch of seaweed production and use, focussing on the economic, environmental and legal aspects. In both the TripleP@sea and TO2 project, the economic feasibility of offshore seaweed cultivation was studied. The results are recently published in the Journal of Aquaculture Economics and Management. In SEABIOPLAS, the possibility to use seaweed for the production of bioplastics was examined, where LEI Wageningen studied the life-cycle environmentla impact. In projects such as MERMAID and MARIBE, particular attention goes out to the feasibility of seaweed production in offshore wind parks. Sander has a background in environmental sciences and a PhD from Wageningen University in Environmental Policy.

About the institute
LEI, Wageningen UR
P.O. Box 29703, NL-2502 LS The Hague, The Netherlands
Alexanderveld 5, NL-2585 DB The Hague, The Netherlands
www.wageningenur.nl/lei

LEI Wageningen UR is an internationally leading socio-economic research institute that offers governments and companies (socio)economic insights and integral advice for sound policies and better decision-making in an innovative way.The strength of LEI lies in developing new insights based on market intelligence (fact and evidence based information) and its integrated approach to issues. LEI has a nationally and internationally proven track record and extensive experience in setting up and carrying out policy analyses, including social cost/benefit analyses, impact evaluations, and future studies, as well as market and chain research, consumer research and the development of monitoring system for industry. LEI research relies on high-quality market and chain knowledge, a wide and international knowledge network, and unique data and models from the micro to the macro level. LEI stimulates sustainable economic development and the growth of companies or economies.

Abstract
This year, the European Commission issued a standardization request to the European Committee for Standardization (CEN) with a focus on algae and algae-based products and intermediates. This includes seaweeds, next to micro-algae and other aquatic biomass. The Working Group (WG 218) is created by the CEN/BT to develop a standardization work programme that at minimum shall address the subjects indicated in the EC's standardization request on algae and algae-based products or intermediates. This will be done in 2016.
To this end, various technical groups have been formed that work on the following subjects:

- Classification and analysis of algae-based biomas
- Algae-based products to be used for biofuel production
- Algae production and processing
- Quality characterisation of algal products to be used for non-energy applications

The standards developed by CEN – and its national counterparts – are not legal standards, they are voluntary standards that can be used by private actors to ease transactions. This means that support for the standards is important. Consequently, a variety of actor from different member states – both from public and private organisations – are involved in the working group.
The need for standards is assessed, given that on occasions, legel norms are in place and given the fact that the quality of characteristics of biomass are also discussed in other standards.
This presentation will not only give an overview of the developments in the BT/WG 218, it will contextualize these developments. To this end, the purpose of and rationale behind standardizastion will be discussed. Additionally, the presentation will touch upon experiences with standardization in the United States.

Presentation 2.2: Development of a joint MSC-ASC standard for seaweed eco-labelling

Authors
Hoggarth, D.D., P. Bianchi, S. Cansado, C. Lyons (MSC) and I. Pollard (ASC)

Speaker info
Dr Daniel D. Hoggarth
Head of Standards Governance, Marine Stewardship Council (MSC), London, UK
Email: dan.hoggarth@msc.org
Phone number: +44 207 246 8933

About the author
Dr Hoggarth has over 25 years' experience in a wide range of fishery management and stock assessment areas, including as a consultant based at MRAG Ltd, London, and independently both in the UK and overseas. He did his PhD in stock assessment at Imperial College, London, and is the author of over 20 scientific papers including two FAO Fisheries Technical Papers. He joined the MSC in 2007, to lead the Fisheries Team within the MSC Policy Unit, focused on technical oversight of the fishery assessments conducted by independent certifiers, and on the training of such certifiers towards consistent application of the MSC standard. He led a series of projects on the development of the MSC fisheries standard, including guidance on technical areas, and ensuring the wide accessibility of the program, including to developing world and small scale fisheries. Dr Hoggarth has recently moved to head the MSC Standards Governance Team, responsible for wider policy development processes (stakeholder consultations etc), consistency with international norms, and the quality assurance of assessments (including peer review processes). In this role, he also manages the MSC team responsible for development of the joint MSC-ASC seaweed standard.

About the institute
Marine Stewardship Council (MSC)
Address: Marine House, 1 Snow Hill, EC1A 2DH, London, UK
Phone number: +44 207 246 8933
Website: www.msc.org

The Marine Stewardship Council is an international non-profit organisation established to address the problem of unsustainable fishing and safeguard seafood supplies for the future. Our vision is for the world's oceans to be teeming with life – today, tomorrow and for generations to come. A sustainable seafood market is crucial to making this vision a reality. We use our blue MSC label and fishery certification program to contribute to the health of the world's oceans. We want to transform the seafood market by recognising and rewarding sustainable fishing practices and influencing the choices people make when buying seafood. We work with fisheries and businesses around the world to achieve this mission.

Abstract

With global seaweed production increasing alongside demand for certification, the Marine Stewardship Council (MSC) and Aquaculture Stewardship Council (ASC) are working together to create a joint standard for certifying seaweed operations. The Standard will apply globally to all locations and scales, including harvesting of wild populations and aquaculture production systems, both land-based and at-sea.

The current draft seaweed standard has been developed from MSC and ASC's existing standards and comprises five core principles: Principle 1, Harvesting and farming of seaweeds are conducted in a manner that does not lead to depletion of the exploited wild populations and, for those populations that are depleted, harvesting operations are conducted in a manner that demonstrably leads to their recovery; Principle 2, Harvesting and farming activities allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the activity depends; Principle 3: Harvesting and farming activities are subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable; Principle 4, Harvesting and farming activities operate in a socially responsible manner; and Principle 5, Harvesting and farming activities operate in a manner that minimizes impacts on other farms, activities and communities. The performance of the harvesting system or farm is scored against thirty-three Performance Indicators (PIs), each of which has one or more Scoring Issues (seventy in total).

The Seagriculture presentation will describe some of the details of these indicators, in addition to the assessment processes that will be required to acheive certification. Comparisons will also be made with other standards currently used in the seaweed sector, in relation to their scope, equivalence and assurance approaches. None of the other existing standards appear to cover the full breadth of issues included in the draft ASC-MSC standard. The new standard will enable producers to verify the good status and responsible management of their resources by using a credible, independent third-party assessment process. Certified harvesters and farms can be recognised and rewarded in the marketplace, with an assurance to consumers that their products come from well-managed and sustainable sources.

An initial public consultation on the draft standard and certification process was held in early 2016 (see improvements.msc.org/database/seaweed-standard). A second public consultation will be held early next year prior to an expected full release in July 2017.

Presentation 2.3: Seaweed standards for food and cosmetics

Authors
Benoit, M., Marfaing, H., Pierre, R.

Speaker info
Dr. Maud BENOIT
Project Manager, Algae product Innovation
Email: maud.benoit@ceva.fr
+33 2 96 22 93 50

About the author
PhD in green chemistry, with experience in applied industrial R&D in an international context at CEVA (Agro-Industrial Technical Institute for Algae, France) since 2012. Maud BENOIT is in charge of the set-up, management and transfer to the semi industrial scale of innovative R&D projects (private contracts and collaborative research) that integrate seaweed and microalgae as raw materials. She covers various fields of applications around the "blue bioeconomy": mainly in cosmetics area (surfactants, functional and active cosmetic ingredients) but also in biomaterials, agriculture, feed, food and energy industry.
Maud BENOIT is an expert in plant extraction and algae-based chemistry, with a special focus on biopolymers/carbohydrates and their applications, fractionation, purification and transformation by physicochemical routes. She managed more than 30 public or private projects in various topics (active cosmetic ingredients from tropical and local seaweeds, fermentation for PLA industry, transformation of cellulosic seaweed for bioethanol industry, active ingredients for aquaculture, surfactants for detergency area, seaweeds for plant health and crop protection…)
She is co-author of 11 publications.

About the institute
CEVA (Centre d'étude et de valorisation des algues)
Presqu'ile de Pen Lan BP3
22610 Pleubian
+33 2 96 22 93 50
www.ceva.fr

CEVA, located in Pleubian (Côtes d'Armor, Brittany, France), is a private research organization and a technical center of the ACTIA network, recognized as a national Agro-Industrial Technical Institute (ITAI) by the French Ministry of Agriculture, Food and Forestry. Located in a leading European region for the seaweed industry, CEVA is a very unique organization, fully devoted to sustainable industrial uses of algae.
CEVA encompasses all fields from algae biology to aquaculture, processing, chemistry and characterization. It was created in 1982 with the support of several public bodies and private companies involved in seaweed harvesting and transformation of algae into value-added products. Its first purpose was to answer local community concerns related to "green tides" (coastal

eutrophication) problems. From 1987 to nowadays, CEVA has expanded its action to providing R&D and technical transfer services to companies interested in developing industrial products based on algal biomass (macro and micro). In particular, CEVA ensures the transfer of scientific knowledge from the academic world to the industry field. In addition to providing R&D, technical assistance and consulting services to industries, CEVA participates in collaborative R&D projects, on a national, European and world-wide level.
In recent years, CEVA also played a very active role in the development of macroalgae cultivation in Europe, as well as promotion and broadening of its uses as a food ingredient.

Abstract
In a "green age" context, we see an ever increasing focus on marine biomass. Algae as raw material could constitute a carbon reservoir for numerous industrial applications since this biomass can largely exceed the productivity of terrestrial biomass (Corn, wheat), while preserving water and arable land.
In a European context, seaweed are mostly harvested for the colloids industry, along with a number of traditional applications in agriculture, feed, cosmetics and nutraceuticals, and an emerging human food market. However because of a lack of natural resources to answer emerging industrial developments, aquaculture should be the preferred option to reach high volumes.
Along with this attractiveness and ever increasing interest for seaweed emerges a need for standardization and traceability of the biomass to ensure stock quality. These requirements are currently being discussed in the context of the CEN Working Group on 'Algae and algae-based products' (CEN/BT WG 218).
Sustainability issues also arise, and can be illustrated by the project of certification process for environmentally sustainable and socially responsible seaweed production driven by the Marine Stewardship Council and Aquaculture Stewardship Council.
Nevertheless, a number of standards and regulations for seaweed, bio certification, and seaweed ingredients already exist and we will explore them.
From a food perspective, seaweed-based hydrocolloids are already well covered by additives standards and regulations. However, while most of European countries did not historically distinguish seaweeds from other food ingredients, French authorities started evaluating the safety of seaweed consumption in the 1980s. This ongoing process led to a "positive list" of 21 seaweed species allowed for human consumption, as well as a number of recommendations on contaminants (particularly heavy metals). Some species-specific concerns were also be raised, like the iodine level in certain brown seaweeds, for which specific processing strategies can be considered.
Additionally, we will also review the status of seaweed in the European Novel Food Catalogue, as well as in various European Food Supplements regulations.
From a cosmetic perspective, seaweed products do not necessarily differ from terrestrial plant-based ingredients. Nevertheless quality criteria are of utmost importance and general regulations for cosmetics and chemicals apply and can also significantly impact algae-based product development. Additionally, sustainability and fair sourcing practices are becoming essential. Some examples will be discussed (China IECIC list, specific national regulations on contaminants, Nagoya protocol).

Session 3: The economics of seaweed farming

Financing the seaweed farm in different stages of development : from start-up to upscaling and practical business models

Chair: Miguel Herédia

Introducing the Chairman of Session 3: Miguel Herédia

About the author
Miguel Herédia
Ocean Vision
Partner
@: mh@oceanvision.pt
Phone: +351 917 550 095

Miguel Heredia is a founding partner of Ocean Vision - Business and Investment Advisory, a consulting firm specialized in maritime affairs and blue economy.
With Ocean Vision, Miguel Heredia has been responsible for implementing several projects both for public and private clients, from business development and strategic plans for new business, investment analysis and prospecting for new businesses and markets, raising capital for companies in expansion phase and advice on the main strategic lines for the maritime economy development for public sector clients.
As a specialist in the maritime economy, Miguel Heredia has participated as a speaker at several conferences, seminars and televised debates, and has written in newspapers and magazines.
Miguel Herédia is member of the team that is setting up the Oceano Azul Foundation, a new Portuguese Foundation enterily dedicated to the ocean, focused on literacy, conservation and capacity building

Presentation 3.1: Seaweed Aquaculture for Income Generation in Tropical Developing Countries

Author
Brummett, R.

Speaker info
Randall Brummett, PhD
Senior Specialist – Aquaculture & Inland Fisheries
Environment and Natural Resources Department
World Bank
1818 H Street NW
Washington, DC 20433
USA
Phone: + 1 202 473 2853
Mob: +1 202 823 7641
@: rbrummett@worldbank.org

About the author
Randall Brummett is a fish biologist. Growing up on a houseboat on the Columbia River, he fell in love early with fish. After obtaining a PhD in fisheries at Auburn University, he spent 30 years in the Near East and Africa building fish farms, teaching aquaculture and fisheries biology, and undertaking a wide range of research and extension projects focusing on aquaculture, fish biodiversity and community based fisheries management systems. He joined the World Bank as a Senior Specialist in 2010 where his job is to develop a portfolio of investments in sustainable aquaculture and fisheries. He is currently working with a wide range of academic and policy teams on projects in Brazil, Mozambique, Jamaica, Vietnam, Ghana, Indonesia, Romania, Kazakhstan, the Philippines and Sri Lanka to explore ecosystem approaches to fisheries and aquaculture, environmental and disease management, the potential of recreational fisheries as a development intervention and the interaction between hydrological infrastructure and fisheries.

About the institute
Established in 1944, the World Bank Group is headquartered in Washington, D.C. We have more than 10,000 employees in more than 120 offices worldwide.
We provide low-interest loans, zero to low-interest credits, and grants to developing countries. These support a wide array of investments in such areas as education, health, public administration, infrastructure, financial and private sector development, agriculture, and environmental and natural resource management. Some of our projects are cofinanced with governments, other multilateral institutions, commercial banks, export credit agencies, and private sector investors.

We also provide or facilitate financing through trust fund partnerships with bilateral and multilateral donors. Many partners have asked the Bank to help manage initiatives that address needs across a wide range of sectors and developing regions.
We offer support to developing countries through policy advice, research and analysis, and technical assistance. Our analytical work often underpins World Bank financing and helps inform developing countries' own investments. In addition, we support capacity development in the countries we serve. We also sponsor, host, or participate in many conferences and forums on issues of development, often in collaboration with partners.
To ensure that countries can access the best global expertise and help generate cutting-edge knowledge, the Bank is constantly seeking to improve the way it shares its knowledge and engages with clients and the public at large.

Abstract
The expansion of seaweed farming in tropical developing countries could have large positive impacts on local poverty, ecosystem management and climate change mitigation. Being able to produce enough biomass and protein for the growing and increasingly wealthy human population with no new land and freshwater expropriation for agriculture would dramatically reduce humanity's ecological footprint relative to current trends and projections.
The growth of seaweed farming is constrained primarily by lack of proper marine spatial plans and appropriate financing. The current industry in the tropics is based on inshore areas where multiple conflicting users vie for space.
To grow large enough to have a global impact, floating rack systems of the type used in the northern hemisphere should be adapted to tropical conditions so they can be deployed further offshore. Such a system has been field tested under rigorous conditions and has the potential to generate 12 tons of dry seaweed per unit. Although not as productive as the best systems in the north, approximately 42 million of these simpler modular units occupying 950,000 km^2 could produce 500 million dry tons of seaweed at a total first sale value of $500 thousand million in current markets.
The need for technological improvements has consequent implications for scale of investment, which could be a hindrance to many potential seaweed growers, creating space for government engagement to support new smaller and medium-scale entrepreneurs.
Other opportunities for engagement by governments and international agencies committed to sustainable development include investments in transport infrastructure, storage facilities, food preparation and/or hydrocolloid extraction plants, applied research in solar drying and biogas technology *inter alia*, technical training and marine spatial planning.

Presentation 3.2: Technology exploitation in the seaweed field: examples and best practices

Author
Daniel, A.

Speaker info
Ana Daniel
@: anadaniel@ua.pt
Phone: +351966877660

About the author
Ana Daniel is professor at the University of Aveiro, Portugal, where she was appointed Graduate Discipline Coordinator of the Entrepreneurship at the Department of Economics, Management, Industrial Engineering and Tourism. Ana Daniel is also an experienced business development executive having served during 9 years as an Executive Director of the Technology Transfer Office of the largest research lab in Portugal in the field of materials, where she was responsible for the identification, capture and commercialization of intellectual property arising from the research activity, and the creation of several spin-off companies. She is currently Senior Expert of the EC for the SME Instrument program, and a member of the Investment Expert Group Assessing the Investment Potential of SMEs Emerging from EU R&I programmes.
As a researcher her main interests are on management issues related to technology transfer and technology valorization, innovation and social innovation and entrepreneurship. A number of publications have been produced in these areas, as well as several entrepreneurship prizes have been awarded due to her work in the development of technology-based spin-offs. She is/was also principal investigator of several national and European funded projects, reviewer of several scientific journals and member of the scientific board of the Portuguese conference in the field of entrepreneurship education.

About the institute
University of Aveiro
Campus Universitário Santiago
3800-193 Aveiro
Website: www.ua.pt

University of Aveiro (UAVR) was created in 1973 by Government Decree and, in 2009, became a public foundation operating under private law.
UAVR has transformed itself into one of the most dynamic and innovative universities in the country. With more than 15.000 students distributed for undergraduate, postgraduate and post-secondary

courses, UAVR has now 16 Academic Departments and 4 Polytechnic Schools which work together in an inter-disciplinary manner according to their academic and research affinities.

Abstract

Over the last decade, there has been a growing market demand for seaweed based products, since seaweed is a very valuable source for extraction of food (additives), pharmaceuticals, cosmetics, and it has high potential for biomass generation. In 2014, about 28.5 million tonnes of seaweeds and other algae were harvested for direct consumption or further processing (FAO, 2016). As a consequence, the value of the industry has been growing in the last 50 years and reached US$6.4 billion in 2014 (Cottier-Cook, 2016).

Although the traditional commercial applications of seaweed, there are many seaweed-based products being launched throughout the World. In this case, research and technology transfer are highly important.

This presentation will address the development of this industry from the point of view of technology transfer and valorisation, such as the number and type of patents filled per year and the creation of new spin-off companies in this field.

References

Cottier-Cook, E. (2016). *Policy brief: safeguarding the future of the global seaweed aquaculture industry*. Hamilton, Canada.

FAO (Food and Agriculture Organisation of the United Nations). (2016). *The state of the world fisheries and aquaculture 2010*. Rome.

Presentation 3.3: Operational costs and capital expenditures of the largest seaweed cultivation farm in Europe

Author
Gregersen, Olavur, Bak, Urd G.

Speaker info
Olavur Gregersen, M.Sc. Econ
Managing Dorector
@: olavur@oceanrainforest.com
Phone: +298 233080

About the author
Olavur Gregersen has a M.in Sc. Business Administration, Economics and International Trade and has been an entrepreneur since 1988. Since 2011 he has been Managing Director and main shareholder of Ocean Rainforest. He has more than 20 years of experience working with business development, marine management and economics. In addition, he has been an executive and non-executive director in several innovative companies and projects.

About the institute
Company/Institute name: Ocean Rainforest sp/f
Company/Institute address: Mjólkargøta 20
Postal code + city: FO-180 Kaldbak, Faroe Islands
Direct telephone number: +298 310700
Website: www.oceanrainforest.com

Ocean Rainforest Sp/F is a limited company located in the Faroe Islands engaged in the production of marine biomass from macroalgae in open ocean cultivation installations. Ocean Rainforest has 13.500 meter of seaweed lines in the Faroe Islands, where continuous current and stable sea temperature provide the perfect condition for seaweed farming. Ocean Rainforest has since 2010 developed and proven a scalable and sustainable method for cultivating seaweeds on the open ocean - thus moving this maritime resource away from a hunter-gathering style of procurement and into the realm of true aquaculture.
The mission of Ocean Rainforest is to be the most reliable provider of high quality seaweed cultivated in Europe. Our operation spans an unbroken chain from seeding, cultivation, harvesting, processing into a storage stable condition and sales to the business-to-business market.

Abstract
As a part of the Macro Value project results will be presented from the multiple partial-cutting harvests of Saccharina latissima cultivated on a commercial scale macroalgal cultivation rig (MACR)

from the period 2014-2016. The installation consists of six MACRs with a total capacity of 13.500 meters of growthline and an expected annual production of 100.000 kg. fresh weight (FW). This is presumably the largest commercial seaweed cultivation farm in Europe.
In order to show the underlying cost structure of macroalgal cultivation using the MACR we have attempted to formulate the cost functions. The yearly cost of investment in terms of capital expenditure (CAPEX) on a MACR can be subdivided into expenditure on the cultivation rig and on the growth lines, divided by the number of years over which the rig and the growth lines are depreciated. The operational expenditures (OPEX) involve cultivation offshore, monitoring, maintenance, and harvesting.
Four non-destructive harvests using a partial cutting method were carried out within a period of 16 months without re-seeding. An economic analysis of the important aspects of S. latissima cultivation showing the cost structure of the MACR was conducted. The cultivated macroalgae were sold as a high quality/premium price product to customers within the food and cosmetics industries, and this multiple harvest seems to be economic feasible in the Faroe Islands.
The approach of non-destructive multiple harvesting would decrease the need of seeding, hatchery phase, the lag phase of biomass increment and increase the yield and hereby commercial viability of seaweed cultivation.

Session 4: The technology behind seaweed farming

An exploration of cultivation techniques, the challenges and developments enabling large-scale seaweed farming

Chair: Jacques Mazoyer

Presentation 4.1: Mechanization of seaweed cultivation: the upcoming industrial revolution of sea agriculture

Authors
Castro, B., Lotman, R., Koevoets, J.

Speaker info
dr. ir. M. Bernardete G. Castro
Project Manager R&D
Email: mb.castro@ihcmti.com
Tel: +31(0)15 088 3658/+31(0)613848467

About the author
Bernardete Castro has a background on Mechanical Engineering and obtained her PhD on "Design for dustainable resource use". She has been working in several R&D projects with Royal IHC since 2006. She is currently project manager of the Seaweed Harvesting Technology project, that has the goal of developing mechanised technology for seaweed cultivation.

About the institute
IHC MTI, Royal IHC
Delftechpark 13
2628 XJ Delft
+31(0)15 088 2535
www.royalihc.com

IHC MTI is Royal IHC's knowledge and research centre. IHC MTI provides sustainable solutions for today's and tomorrow's problems from ocean floor to water surface. In this way we improve and extend IHC's product portfolio and the gained knowledge enables us to offer measuring and diagnostics and consultancy services to our customers. We work theoretically and practically on solutions for the industry validated in the in-house testing facilities and the facilities of our partners. We do this with respect to People, Planet and Profit; inspired by and in a corporate social responsible way.
IHC MTI is a member of the Royal IHC Group. Royal IHC is focused on the continuous development of design and construction activities for the specialist maritime sector. It is the global market leader for efficient dredging and mining vessels and equipment – with vast experience accumulated over decades – and a reliable supplier of custom-built ships and tools for offshore construction. Royal IHC is continuously following the developments in the maritime sector and looking for new growth maritime markets.

Abstract
Seaweed cultivation is a growth market worldwide. Seaweed has multiple uses and is a promising resource to contribute to the societal challenges of food security and climate change in the future. However, the mechanisation of seaweed cultivation is essential for further growth, especially in

Europe or comparable regions with high labor costs. This development is comparable to the mechanisation of land based agriculture which started with the Industrial Revolution. The seaweed industry will make a similar transition from small scale artisanal cultivation to large scale fully mechansised farming, and we expect this to happen withing the timespan of a few decades. This is going to take place at sea, in the hostile marine environment, and it has to take place in a sustainable way.

IHC adressses this formidable challenge from its strenghts and maritime engineering background. Seaweed cultivation mechanisation knowledge is being developed and and combined with our profound understanding of marine engineering. This is necessary in order to realise equipment which fullfils its harvesting functionalities and survive the unforgiving sea environment. IHC MTI, the R&D centre of Royal IHC, has developed a first prototype harvesting machine and tested it to try out and understand harvesting principles and also to demonstrate the potential of mechanised harvesting. The initial prototype realises a cost reduction of 50% and harvesting time reduction of 90%, even at this early stage without impeding sustainability aspects. This presentation exhibits the results of the initial trials with the harvesting prototype. In addition we adress the next steps and technological challenges to achieve mechanised seaweed farming.

Presentation 4.2: The move further offshore - challenges and opportunities for up-scaling European seaweed farming

Author
Neumann, F.

Speaker info
Frank Neumann (Dipl.-Ing.)
Cultivation Technology
@: neumann.ses@seaweedenergysolutions.com
Phone : +351 933692004

About the author
Frank Neumann graduated as a Civil Engineer (Dipl.-Ing., Hydraulic Structures) from the University of Karlsruhe (KIT - Germany) in 1999, and has since then been based in Lisbon, Portugal. He had accumulated 12 years of ocean wave energy and coastal engineering experience, ultimately being appointed Associate Director of the Wave Energy Centre (www.wavec.org), which he helped to create. In 2011 he was also one of the Directors of the European Ocean Energy Association EU-OEA. Joining SES in 2012 as Marine Technology Manager, he initially worked on energy-scale and offshore seaweed cultivation visions. He took over responsibility for the design and installation of the 2014/15 Cultivation Pilot, and is now working on the improvement of farming techniques, harvest and deployment operations, as well as further exposed systems. Among his near-term priorities is to establish a commercial pilot-scale Kelp cultivation in Portugal.

About the institute
Seaweed Energy Solutions (SES) AS
Bynesveien 48
7018 Trondheim
Phone: +47 98646803
www.seaweedenergysolutions.com

SES was established in 2006 with a vision to enable large scale ocean farming of seaweed for the production of food, feed, biochemicals, energy and other valuable products. SES is a pioneer in seaweed cultivation in Europe with patented seaweed cultivation technology and extensive know-how across the seaweed value chain. In the season 2014/15, SES designed, built and successfully operated a 100-ton Pilot farm with the species Saccharina latissima in semi-exposed waters in Norway, proving the full cycle from spore creation to harvest of wet product on an industrially relevant scale. Part of the process has been the gradual development of up-scalable seeding, deployment and harvesting techniques, and since late 2015, the aspects of short-term buffering and processing have moved into the focus.
SES' goal is to be an innovative seaweed business developer and to using in-house developed technology, know-how and experience to realize seaweed opportunities worldwide.

Abstract
Although seaweed cultivation activities in Europe are still very small scale, key constrainst for the sector's future growth beside cost (mainly manpower) will be potential cultivation areas, for which a high demand exists once mass production starts. Offshore seaweed cultivation is expected to take significant space, in practice an annual harvest of several tens of tons per hectar sea surface is deemed realistic. Once the sector increases to volumes that covernot only human consumption but also feed applications, a significant pressure on protected sites will lead to the need of moving further offshore.
Starting from initially developing energy-scale seaweed cultivation concepts and open ocean farming visions, Seaweed Energy Solutions AS (SES) has shifted its focus on the food scale production, in order to establish a profitable product before scaling up with more mechanised farming methodologies. In the season 2014/15, a 100-ton Pilot farm with the species *Saccharina latissima* in semi-exposed waters in Norway was designed, built and successfully operated, proving the full cycle from spore creation to harvest of wet product on an industrially relevant scale. In the following season, the production was down-scaled to 20 tons due to the shift of focus to obtain a marketable, high value end product. In 2016, SES produced 20 tons of frozen and dried food-grade seaweed, which is the start of a gradual up-scaling and a significant step to get the (food) offshore seaweed industry started in Europe.
Knowing that soon other high-value components and feed (especially fish feed) are also very significant potential markets, and demand will increase significantly as soon as costs are brought down, SES has started to make cultivation trials in further and fully exposed areas in Portugal. In early 2016, growth and survivability tests were conducted with *Laminaria ochroleuca* in Southern Portugal, showing good growth but massive grazing, an issue that had been unknown from former experiences further north. Grazing is one of the potential issues to be considered in otherwise scarce environments, and an important factor will be to observe to what extent the impact of grazing decreases with increasing cultivation volumes.
This experience adds to a series of simple growth tests on vertical substrates in Póvoa de Varzim (North) and Peniche (Centre) in 2012, whih showed technical feasibility of cultivating *Saccharina latissima* in fully exposed seas. However the growth season was between January and June, and no major storms or extreme sea states occured during this period. Technical development will be required to ensure survivability in less favourable years.
Among other steps investigated is the possibility of designing advanced seaweed farms that enable protection mechanism in very high sea states. Such a vision is technically possible and is expected to be technially feasible and economically reasonable as soon as prime cultivation sites run out. As opposed to fish farms, seaweed does not require frequent (daily) operational intervention (e.g. feeding, desease control), which is why extreme sea survival is the only technical issue to solve.
This talk gives insight about SES' present considerations for exposed offshore farming.

Presentation 4.3: Land-based seaweed farming: advantages and constraints

Author
Abreu, H., Pereira, R., Ribeiro, A.

Speaker info
Helena Abreu, PhD
Co-founder and Director
@: htabreu@algaplus.pt
Phone: +351 938799423

About the author
Helena Abreu is one of the directors and co-founders of the company ALGAplus since 2012. She has a research background in seaweed ecophysiology and cultivation, with experience acquired in Portugal, Chile, USA and Ireland. Helena manages the R&D activities of ALGAplus and is also responsible for liaising with ALGA+™ customers.

About the institute
ALGAplus, Seaweed production and trade, Lda
IERA-Travessa Alexandre da Conceição
3830-196 Ílhavo Portugal
Phone: +351 234092496
www.algaplus.pt

ALGAplus is a seaweed aquaculture company operating in Portugal. Our differentiation lays in the production system, technical team and constant innovation applied to all axis of the activity.
Using a unique land-based system integrated with a fish farm, we manipulate specific production factors to attain high yields, constant supply and specific biomass traits. We offer high quality, certified and fully traceable Atlantic seaweeds and derived finished products, currently for the food and cosmetics B2B and B2C markets. *Ulva rigida* and *Porphyra dioica* are produced year-round and other species in a seasonal basis. Technical services as domestication of novel species and biomass customisation are provided to our industrial and R&D partners.

Abstract
Seaweeds can be farmed at sea or in land-based systems. Taking into account the species currently traded but mainly the valuable and unexploited Atlantic algal asset, there is a need to increase the number and production capacity of both those systems.
The demand for high quality, traceable, standardized, safe and sustainable products is generalized for all markets. Land-based seaweed farms may be the best option to comply with all those needs but are currently still scarce all over the world. In Europe, to our knowledge only a few are in operation. However, for Atlantic algae with high demand, like *Ulva* spp., *Palmaria palmata*, *Porphyra* spp., *Chondrus crispus*, land-based systems seem to be the best option due to the size, shape, biology and need of frequent maintenance of these species. Also, land-based operations are many times the only option to develop the production of “novel” algal species, select specific strains and

produce specific stages of the life history of important species. Another unique advantage of land-based systems is the possibility to manipulate specific production factors in order to balance biomass yields and chemical composition according to customer's needs.
The main constraints normally pointed to the implementation of land-based systems in Europe are related to the right of access to sea, implementation and operational costs and also the access to knowledge (much higher for seaweed systems at sea).
An overview of all these aspects will be given, focusing on idea that land-based seaweed farms are a way of restoring the coastal landscape for some European countries and contribute to meet the requirements of seaweed biomass produced in Europe, both from the industry and the final consumers.

Session 5: Seaweed for high-end purposes

The application of seaweed components in medicine and functional foods

Chair: Isabel Sousa Pinto

Presentation 5.1: Health benefits of seaweeds

Author
Prithiviraj, B.

Speaker info
Dr. Balakrishnan Prithiviraj
Associate Professor
Department of Environmental Sciences
Faculty of Agriculture
Dalhousie University
Email: bprithiviraj@dal.ca
Phone: +1-902-986-5720

About the author
Dr. Balakrishnan Prithiviraj is an Associate Professor at the department of Environmental Sciences, Dalhousie University, Nova Scotia, Canada. He had his training at the Banaras Hindu University, McGill University and Colorado State University. Dr. Prithiviraj research focuses on the use of seaweeds to improve plant, animal and human health. Using whole animal and cell culture models his laboratory is of the mechanism(s) of activity chemical components of seaweed.

About the institute
Company/Institute name: Dalhousie University
Company/Institute address: Faculty of Agriculture
Postal code + city: Truro, Nova Scotia B2N 5E3, Canada
Direct telephone number: +1-902-893-6643
Website: www.dal.ca/agriculture

Abstract
Seaweeds are rich untapped reservoir of health promoting bioactive compounds and has been considered as the next 'super food'. In the recent years there has been a renewed interest in the potential health benefits of seaweeds and chemical constituents within the seaweeds that imparts desirable health outcomes. We are investing health benefits of brown, red and green seaweeds using whole animal models (worm, rat and chicken) and animal cell culture models. Brown seaweed *Ascophyllum nodosum* and red seaweeds *Chondrus crispus*, *Palmairia palmata* and *Sarcodiotheca gaudichaudii* imparted tolerance against high temperature and oxidative stress and enhanced life span. These seaweeds also protected animal against pathogen infection by boosting immune system and also by reducing the virulence of pathogens. Chemical components of *C. crispus* reduced the progression of neuro-degenerative diseases like Alzheimer's disease and Parkinson's disease. Bioactivity guided fractionation of *C. crispus* yielded a fatty acid rich fraction that was most active against Alzheimer's disease. In this paper, I will also discuss on the prebiotic activity of seaweeds and their potential is reducing the use of antibiotics.

Presentation 5.2: Ulvan, a Marine-Derived Sulfated Polysaccharide for Application in Regenerative Medicine

Authors
Learmonth, DA. Correia C. and Sousa, RA

Speaker info
David A. Learmonth, Ph.D
RDI Director, Stemmatters
dalearmonth@stemmatters.com
253-540100

About the author
David Learmonth holds an honours degree in pure chemistry with specialisation in bioorganic and medicinal chemistry and a Ph.D in organic/medicinal chemistry, both from the University of Strathclyde, Scotland. Has over twenty years research and development and managerial experience in the pharmaceutical and biotechnology sectors within Portugal, contributing to the advancement of over a dozen new therapeutic entities into the preclinical and clinical development phases, including marketed drugs such the antiepileptic Zebinix™/Aptiom™ (EMA and FDA approved) and the antiparkinsonian Ongentys™ (EMA approved). Has proven expertise in drug discovery including drug design, medicinal chemistry, process development and validation, technical transfers, quality by design, manufacturing and regulatory affairs. David is first inventor and/or co-author of several hundred granted international patents, patent applications, original research articles, reviews and book chapters. Currently responsible for the design, synthesis, characterization and property optimization of functionally tailored biomaterials based on polysaccharides from natural and/or renewable sources, for application in innovative medical devices or advanced therapy medicinal products in the field of tissue engineering and regenerative medicine.

About the institute
Stemmatters, Biotecnologia e Medicina Regenerativa, SA
Parque de Ciência e Tecnologia Avepark, Zona Industrial da Gandra
4805-017, Barco, Guimarães
253-540100
www.stemmatters.com

Stemmatters originated from academic research at the University of Minho (3B's Research Group). Since its creation, Stemmatters has become a fully independent company, striving to create meaningful value from applied biomedical research. Our ambition is to pursue human benefit by developing novel products for clinical and translational research applications, while leveraging the increasing market appeal and societal relevance of regenerative medicine and biotherapeutics.
For its business operations, Stemmatters integrates complementary activities and operations covering research, development and manufacturing of medical devices and combination products. Stemmatters exploits and develops its core intellectual property alone or in collaboration with national and international institutions.

As a preclinical stage company, Stemmatters is currently developing game changing medical devices for regenerative medicine applications which offset current competitors and aim to revolutionize standard of care.

Abstract
Ulvan is a naturally sulphated, structurally unusual polysaccharide produced by the marine algae Ulva lactuca. Readily available in high and reproducible quality from a renewable, ecological and non-animal source through a robust and efficient extraction process, this fascinating molecule has been shown to exhibit pharmacological properties such as anti-oxidant, anti-inflammatory and anti-coagulant activity, often superior even to that of natural glycoaminoglycans (GAGs). Furthermore, ulvan possesses unprecedented stability towards in vivo degradation promoted enzymatically by hyaluronidase, collagenase and metalloproteinases. Ulvan, and some of its semi-synthetic derivatives form solutions with tunable viscosity when dissolved in physiologically relevant media at increasing concentrations. This combination of properties places ulvan as an attractive candidate for further development as a novel injectable viscosupplement for the management of osteoarthritis (OA), with potential to resolve the shortcomings associated with hyaluronic acid, the current gold standard therapy in OA. Furthermore, ulvan's core composition incorporates reactive sites, facilitating the synthesis of libraries of new chemical entities possessing specific biological and/or physicochemical attributes. This presentation will focus on Stemmatters' efforts to exploit ulvan as a standalone therapeutic agent and as a technological platform for the design of a new generation of biomaterials targeting applications in tissue engineering and regenerative medicine.

Presentation 5.3: Seaweed cultivation for bioactives, examples from the past and future prospect for the industry

Authors
Quéguineur, B.[1], Hennequart, F.[1]
[1] ALGAIA R&D Centre, 91 rue Edouard Branly, 50000 Saint-Lô

Speaker info
Benoit Quéguineur, PhD, MSc
Partnership Manager, Research and Innovation developer
@: benoit.queguineur@algaia.com
Phone: +33 7 68 39 99 59

About the author
Benoît Queguineur was educated between France, Spain and Ireland, and received his PhD in Marine Science entitled: "Phlorotannins, current and future implications for the seaweed industry" at the Irish Seaweed Research Group, Ryan Institute, National University of Ireland, Galway. His key area of expertise is Macroalgae Biotechnology, and during a postdoctoral project "Energetic Algae" (INTERREG IVb, FP7) he added large-scale cultivation to his seaweed skill set. In 2014, along with Franck Hennequart and Jeremy Brébion, he set up ALGANACT, the first commercial analytical and bioactivity lab dedicated to micro and macroalgae. In 2016, Alganact joined Eviagenics to become ALGAIA and Benoit is now in charge of collaborative projects and research and innovation developpement at ALGAIA. His other research interests include the aquaculture of edible seaweeds, the population dynamics study of carrageenophytes, the nutritional value of macroalgae, as well as various environmental surveys.
Dr Queguineur is a regular speaker and contributor to the International Seaweed Symposia, the European Algae Biomass Association Conferences and European Roundtables on Biofuel. He has numerous peer-reviewed publications and reports, including many pan-European projects.

About the institute
ALGAIA Headquarters
1 mail du Professeur Georges Mathé
94 800 Villejuif, FRANCE
Phone number : 01 49 59 97 00

ALGAIA R&D Centre
91 Rue Edouard Branly
50000 Saint Lô, FRANCE

ALGAIA is a company developing, producing and commercializing Natural Extracts, mostly made out of seaweed. ALGAIA offers a unique range of Natural and Sustainable products & solutions to the Agro-Nutrition, Personal Care and Pharmaceutical industries. Following the acquisition of Alganact SA, ALGAIA is also opening a Service Division for customers and partners willing to better understand the potential of their seaweed biomass or characterize their extracts. To learn more, please visit us at www.algaia.com

Abstract
Cultivation of macroalgae in the world aims at addressing the food, commodity and environmental issues. Commercial production and purification of potent bioactives from wild stocks remains challenging due to rights of access, individual variabilities, sites and seasonal variations. Some of those challenges can be overcome with cultivation. However, if in Asia cultivation of seaweed for food supply has been developed for many decades, those practices in the Western world are much more recent and still limited, mainly due to regulations and access to the sea. The current focus on such initiatives in Europe are oriented towards valorisation of high value bioactives. In the present work, we review the use of seaweed cultivation to produce molecules of commercial interest. We also discuss how seaweed cultivators benefit from monitoring the biochemical composition and in return how R&D projects can benefit from seaweed cultivation, through monitoring, selective breeding programmes, cultivation site knowledge (IMTA, environmental conditions, etc.).
We further suggest future prospects for the development of seaweed cultivation and insist on the importance of monitoring.

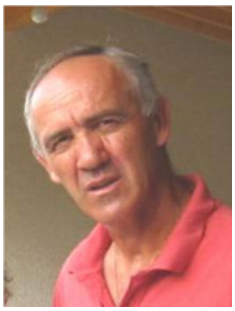
Session 6: Large-scale seaweed production

Towards standardizing the use of seaweed components in feed, food and plastics

Chair: Juan Luis Gómez Pinchetti

Presentation 6.1: The ideal seaweed for carrageenans production

Authors
Mazoyer J., Malmezat B., Jan S., Loaec A.



Speaker info
Mazoyer Jacques, PhD
Principal scientist
@: jacques_mazoyer@cargill.com
Phone : +33 6 74 96 20 85

About the author
After Organic and Mineral Chemical Engineer School, Jacques Mazoyer has obtained a Master degree and a PhD in polymer chemistry at the University Pierre et Marie Curie in Paris. He started his career in Hydrocolloids R&D for CECA in 1984.
He spent his career in Polysaccharides R&D focussing on raw material, processing,technologies and products development. Within his previous positions at Cargill Texturizing Solutions, he was in charge of "process and products development" teams, focusing on new and natural industrial polysaccharides. During this period he has made about 20 papers and 10 patents. More recently, he has a position of internal advisor for the Hydrocolloids R&D.
Over the last 10 years, he was in charge of a team and of projects on seaweed polysaccharides, like carrageenans and alginate.

About the institute
Cargill Texturizing Solution – Hydrocolloids
Baupte
50500 – Carentan
France
www.cargill.com

Cargill provides food, agriculture, financial and industrial products and services to the world. Together with farmers, customers, governments and communities, we help people thrive by applying our insights and 150 years of experience. We have 149,000 employees in 70 countries who are committed to feeding the world in a responsible way, reducing environmental impact and improving the communities where we live and work. For more information, visit Cargill.com and our News Center.

Abstract
This talk will aim at reviewing the most critical aspects of a red seaweed as a raw material for carrageenan production.
A short description of what is carrageenan in various aspects like, origin, regulation, process, application and market will be made and the links with the seaweed as a raw material will be proposed. The aim of this review is to point out what makes seaweed a good raw material for the

carrageenan production. Good, means as reliable, as sustainable and as profitable as possible within the whole supply chain. In this respect various criterias will be described like optimum content of carrageenan in the raw seaweed, like preserved / optimized content of carrageenan; like optimized costs of production, like sustainable and responsible supply chains and compliance with regulatory changes.

This will allow to define some criterias, mostly for EU, for a perfect seaweed for carragenan production which would make the seaweed business for carrageenan production viable on the long term.

Presentation 6.2: Seaweed extracts for improving FEED use in animals

Authors
Ras, M., Marzin, D., Nyvall-Collen, P.

Speaker info
Pi Nyvall Collén, Ph.D.
Position R&D Manager
@: pnyvallcollén@olmix.com
Phone: +33 6 33 61 30 46

About the author
Pi Nyvall Collén realized a master in Biology at the University of Uppsala, Sweden, followed by a thesis in Plant Physiology at Stockholm University, Sweden on starch metabolism in red algae. Seaweed have since been her organisms of choice. After a Post-doctorate period at the University of São Paulo, Brazil she arrived at the Roscoff Biological Station in 2001 where she studied different aspects of cell wall polysaccharides from brown, red and green algae as well as different algal or bacterial enzymes involved in their degradation or modification. Her experience in algae ranges from genomics, biochemistry, enzymology and physiology. She was hired as R&D manager of the Olmix group in October 2012 to coordinate the development of algal extracts and their development for plant, animal and human care.

About the institute
OLMIX group
ZA du Haut du Bois
56580 Bréhan - FRANCE
Phone: +33 (0)297 388 103
Fax: +33 (0)297 388 658
contact@olmix.com
www.olmix.com

In 20 years, OLMIX group has become one of the major global specialists in **marine biotechnology** and green chemistry. The company innovates in trace elements, transforming by-products into high-value ingredients. Its mission is to **make effective use of seaweed to promote sustainable food**.
As a pioneering biotechnology company in France, Olmix Group has always made a priority of investing in research and development. With an objective of helping to better feed 9 billion humans by 2050, the company has been inventing innovative solutions from marine bioresources for more than 20 years. Its technological advances, involving active ingredients, innovative processes and applications, have already led to 14 patents.
The three Olmix Group divisions: Plant Care, Animal Care and Human Care, innovate in pursuing the same objective: producing more with less, while improving food safety and respecting animals, people and the environment. They find their resources in algae, clays and trace elements.

Abstract

From an economic point of view, animal feed is the most costly expense when producing animal proteins. With the population growth and climate change, available resources for animal feed are likely to reduce and hence become more costly. It appears essential today to improve the conversion of animal feed in order to increase the uptake of nutrients and reduce feed intake. Seaweed as animal feed is not new, however innovation has led to the production of specific seaweed extracts which have potential applications in animal nutrition and health.

In France, green (Ulva sp.) and red (Solieria chordalis) seaweed are collected in large amounts on the north west atlantic coast. This harvesting is undertaken on natural populations which occur during regular green and red tides in the summer and winter respectiveley. This year-round resource has allowed the Olmix Group to develop a range of algo-based ingredients for the FEED sector. The global aim of these divers products are to make a better use of the feed.

A particular algo based product, which consists in assembling seaweed extracts (green and red) and micronized clay, has been proven efficient as a biocatalyst by favoring contact between substrate and enzyme as well as improving enzyme activity with co-factors. In order to measure the effect of this technology on digestibility performances, a collaborative study was initiated between the Olmix Group and the INRA (National Research Institut in Agronomy). Ileal digestibility trials were undertaken on pigs within this research institute. Measures of ileal digestibility (ID) are used routinely as estimates of protein digestibility of feed ingredients and hence of the bio-availibilty of amino-acids (AA).

A total of 5 pigs, which sustained an ileorectal anastomosis (removal of the colon), were fed with 3 different diets: a standard diet, a standard diet added with algae-clay product and a low protein and low energy diet. Each pig received successively each diet. Each diet was fed over one week: 4 days adaptation and 3 days measurements. All pigs were kept in individual cages and fed twice a day during the 3-week trial.

Results show that the algo-based additive in a standard diet improved the digestibility by 3% (apparent ileal digestive utilization coefficients measured on Dry matter, Organic matter). The energy utilization of the feed also increased by 3%. The bioavailability of proteins increased by 3.6% and the total AA by 3.1%. Threonine, Argenine, Lysine and Phenylalanine stand for the main AA responsible for this increase. Algae-clay additive in animal feed did improve the digestibility of proteins within a standard diet. The bioavailability of essential amino acids was increased which indicates a better use of the feed for nutrition and health.

Presentation 6.3: Bioplastics for packaging industry produced from macro algae - ULVA

Author
Lavoisier, P.

Speaker info
Philippe LAVOISIER
Position General manager
@: lavoisierph@wanadoo.fr
Phone : +33 616 400 707

About the author
Philippe LAVOISIER is a chemical engineer with more than 25 years experience in the plastic packaging industry. He first worked with 3M company in the USA for the development of new adhesive tapes using thin gauge plastic backing film; he then moved in engineering company for the supply of turn key plant for the production of traditionnal fuel based plastic films such as Polypropylene or polyester. In 1985, he created the IDEAS company for the sale of plastic films for packaging and started to work on biodegradable films that were sold all over europe. Starting 2010, Philippe developped technology based upon Macro algaes which are waste (ULVA) and showed feasability of making bioplastics without odor and color. Two patents were filed related to the technology to produce bioplastics with their formula, properties and application. Philippe has expertise in all kinds of bioplastics used in the plastic industry

About the institute
ERANOVA
SAVOIE TECHNOLAC – 17 rue du lac saint andre
BP 80298 – 73 375 LE BOURGET DU LAC CEDEX
Phone number + 33 616 400 707

ERANOVA's main activity is the development of bioplastics aimed at the packaging industry. ERANOVA has the know-how and technology to produce and extract algae starch that is a major component of bioplastics resins. ERANOVA uses mainly the waste macro algae that are collected on beaches and as a waste have no added value application and are not valorised, typically ULVA algaes. The company is building an industrial demonstrator to produce 20 times more biomass than corn (in T/hectare/year) and 13 times more starch than corn culture (in T dry/hectare/year) Company is also working to use other extracted components for various applications (fish food etc)

Abstract
Today, the plastic industry represents 311 million tons with an annual growth rate of 4%. This is mainly based on the fact that fossil resources are limited. These conventional plastics become a

problem when they end up in the environment – it has been shown recently that 269 millions tons is present in the oceans.
From early 2000, a lot of work has been done to develop bioplastics. Now, bioplastics show an annual growth rate of around 15% until 2020; the total volume will double in five years to reach nearly 8 million tons per year.
Currently, 33% of bioplastics produced are starch-based bioplastics with the starch coming from the agrofood industry (corn, wheat, etc.). These materials are either biodegradable, or compostable and their main application is for use as single-use plastic bags.
All categories of bioplastics are growing quite fast, leading bioplastics to drop in price from 10 times the price of conventional plastics, to 3-4 times the price of conventional plastic.
The key questions then are :

- Can we use a renewable material, not mainly dedicated to food ?
- Does this material have a higher renewability than land culture dedicated to food ?
- How are those bioplastics made in comparison with other bioplastics ?
- What key properties have to be focused on ?

ERANOVA obtains their raw material without any cost from municipalities; the algae is then put into raceways of a certain depth and with particular process conditions. We have succeeded to increase the percentage of Starch inside the ULVA collected drastically; levels of 40% have been reached. Simultaneously, the percentage of protein is decreasing.
From this “enriched” biomass, by patented process it has been possible to obtain an ALGAE EXTRACT containing more than 70% starch, Ulvane and minerals and very low levels of proteins.
Furthermore, it was found that the mechanical properties of bioplastics produced using GREEN algae extract are superior due to remaining minerals (resistance to corosion and abrasion plus +15% mechanical break resistance).
The objective is to show in real production conditions that we can produce 20 times more biomass than corn (in t/hectare/year) and 13 times more starch (in Dry T/hectare/year) without the use of any nutriments, fertilizers, or pesticides, and no extra water .
Definitely, ALGAE is a renewable ressource that can be used for Circular Economy since it is going back to Water, Co2 and biomass after biodegradation by mircoorganism .

Presentation 6.4: ZEEVIVO: Seaweed - based proteins in fish feed

Author
Wijers, T.

Speaker info
Tom Wijers, MSc
Researcher
Email: tom.wijers@hvhl.nl
0031 65 518 88 85

About the author
Tom Wijers is an enthousiastic marine biologist with expierence in aquatic biomass cultivation and biorefinary. After finishing his masters at the university of Groningen in 2013 he worked as a microalgae specialist for a company named Omega Green. Here he worked on a cost-efficient closed bioreactor for the culture of microalgae. In oktober 2015 he started at University of Applied Sciences Van Hall Larenstein as researcher, working for the ZEEVIVO project. Tom's focus is on the extraction and purification of proteins from seaweed.

About the institute
van Hall Larenstein
Agora 1
8934 CJ, Leeuwarden (the Netherlands)
0031 58 284 61 00
www.hvhl.nl

Van Hall Larenstein is a University of Applied Sciences. We train high-quality, ambitious and innovative professionals who contribute to a more sustainable world. The curricula of VHL University of Applied Sciences focus on the domains Delta Areas and Resources - Food and Dairy - Animal and Business.

Abstract
University of Applied Sciences VHL, NIOZ, IMARES, Danvos and Hortimare are working together in the ZEEVIVO (seaweed in fish feed) project. The rapidly growing aquaculture industry is dependent on fishmeal, a key component of fish feed. Fishmeal is produced from wild-caught fish, and this dependence limits the sustainable growth of the aquaculture industry. The fish feed industry is looking for alternative sources of protein; seaweed protein might be a sustainable alternative for fishmeal. In the ZEEVIVO project, research is being done to see if seaweed protein is a suitable fish meal replacer. The focus of this presentation will be on the bio-refinery research of ZEEVIVO. Small scale experiments have been conducted to determine the optimal pH, extraction time, pre-treatment, dilution rate and temperature for the extraction of proteins from seaweed-biomass. With these result the first large scale extraction experiments have been done on batches of 500 kilograms of fresh *Ulva lactuca* and *Saccharina latissima* in the spring of 2016. The seaweed was washed, chopped and dissolved in a liquid medium. Subsequently, the remaining solids were

separated from the liquid and with the help of membrane filtration the extracted proteins were purified and concentrated. Protein content, amino acid composition and protein functionality were measured to assess the bio-refinery process. Growth experiments on rainbow trout (*Oncorhynchus mykiss*) will be conducted in the coming years, to test if the produced protein is a suitable fish meal replacer. After completion of the ZEEVIVO project it is known which seaweed species and bio-refinery method result in the optimal raw material for fish feed. The ZEEVIVO project may have a global impact on our feed and food supply and aims to bring a sustainable aquaculture sector one step closer.

Roundtable session "How to match EU seaweed production with the expectations of the industry?"

Moderator: Philippe Potin (SB Roscoff)

Participants:

- **Barbara Malmezat (Cargill)**
- **Nathalie Boulho (Olmix)**
- **Willem Brandenburg**

- **Prof. Filomena Martins (Aveiro University)**
  Filomena Martins is associated professor at the University of Aveiro, responsable for several courses in the coastal and marine scientifc field at graduation and pros-graduation levels. She is member of the UA Sea Technology Platform Coordination Committee.

- **Randall Brummett (World Bank)**
  Randall Brummett is a fish biologist. After obtaining a PhD in fisheries at Auburn University, he spent 30 years in the Near East and Africa building fish farms, teaching aquaculture and fisheries biology, and undertaking a wide range of research and extension projects focusing on aquaculture, fish biodiversity and community based fisheries management systems. He joined the World Bank as a Senior Specialist in 2010 where his job is to develop a portfolio of investments in sustainable aquaculture and fisheries. He is currently working with a wide range of academic and policy teams on projects in Brazil, Mozambique, Jamaica, Vietnam, Ghana, Indonesia, Romania, Kazakhstan, the Philippines and Sri Lanka to explore ecosystem approaches to fisheries and aquaculture, environmental and disease management, the potential of recreational fisheries as a development intervention and the interaction between hydrological infrastructure and fisheries.

- **Benoit Quéquineur (Algaia)**

Benoît Queguineur was educated between France, Spain and Ireland, and received his PhD in Marine Science entitled: “Phlorotannins, current and future implications for the seaweed industry” at the Irish Seaweed Research Group, Ryan Institute, National University of Ireland, Galway. His key area of expertise is Macroalgae Biotechnology, and during a postdoctoral project “Energetic Algae” (INTERREG IVb, FP7) he added large-scale cultivation to his seaweed skill set. In 2014, along with Franck Hennequart and Jeremy Brébion, he set up ALGANACT, the first commercial analytical and bioactivity lab dedicated to micro and macroalgae. In 2016, Alganact joined Eviagenics to become ALGAIA and Benoit is now in charge of collaborative projects and research and innovation developpement at ALGAIA. His other research interests include the aquaculture of edible seaweeds, the population dynamics study of carrageenophytes, the nutritional value of macroalgae, as well as various environmental surveys.

Dr Queguineur is a regular speaker and contributor to the International Seaweed Symposia, the European Algae Biomass Association Conferences and European Roundtables on Biofuel. He has numerous peer-reviewed publications and reports, including many pan-European projects.

Acknowledgements

That's it! The fifth edition of Seagriculture has come and gone. We hope the conference was all that you hoped it would be, and that you have made new contacts, formed new ideas, or have just plainly had a good time.

This lustrum edition of Seagriculture would not have been possible without the help and support of numerous people and institutions. First of all, we want to thank all speakers and advisory committee members for having contributed their knowledge, and basically for forming the 'spine' of the conference. We have decorated it somewhat with a nice venue and the like, but in the end it comes down to the quality of the program – we are very grateful that the seaweed experts present have found time in their busy schedules to provide us with quality presentations, discussions and insights!

Next, we thank partners and sponsors: Cargill and the University of Aveiro have each contributed not only to the conference program, but have also supported the sustainability of the event with a monetary contribution. Local partners have been key in building the program: we relied on them for our side-visits and the exquisite conference dinner. For this, we have both the municipalities of Aveiro and Ílhavo to thank, the Tourist Board, the Tourism school of Aveiro, and of course ALGAplus and Helena Abreu in particular.

We thank all of you, the Seagriculture attendees, for your presence and your seaweed stories and hope we can check in with you next year, at Seagriculture 2017! All ideas, thoughts and suggestions are very welcome and can be directed at Suzanne Kroeze of DLG Benelux on s.kroeze@dlg.org.

See you next year, at Seagriculture 2017!

AlgaEurope 2016 – Save the date!