

Industrial micro algae production in Austria – current state and future perspectives

*Silvia Fluch, PhD, COO
ecoduna/eparella*



The stage is set

- Why Microalgae
- The ecoduna story
- Micro algae culturing 2018
- From Pigments to Oils
- From fine chemicals to bulk products
- Quality, productivity, cost
- Demand and availability
- Challenges and future prospects



Microalgae will change the world

A microscopic view of several spherical microalgae cells. The cells have a thin, translucent outer layer and a dense, dark green interior filled with chloroplasts. Some cells show a distinct reddish-brown color, possibly due to carotenoids or other pigments. The background is a light gray, showing other smaller cells and structures.

Gow 10x faster than any crop

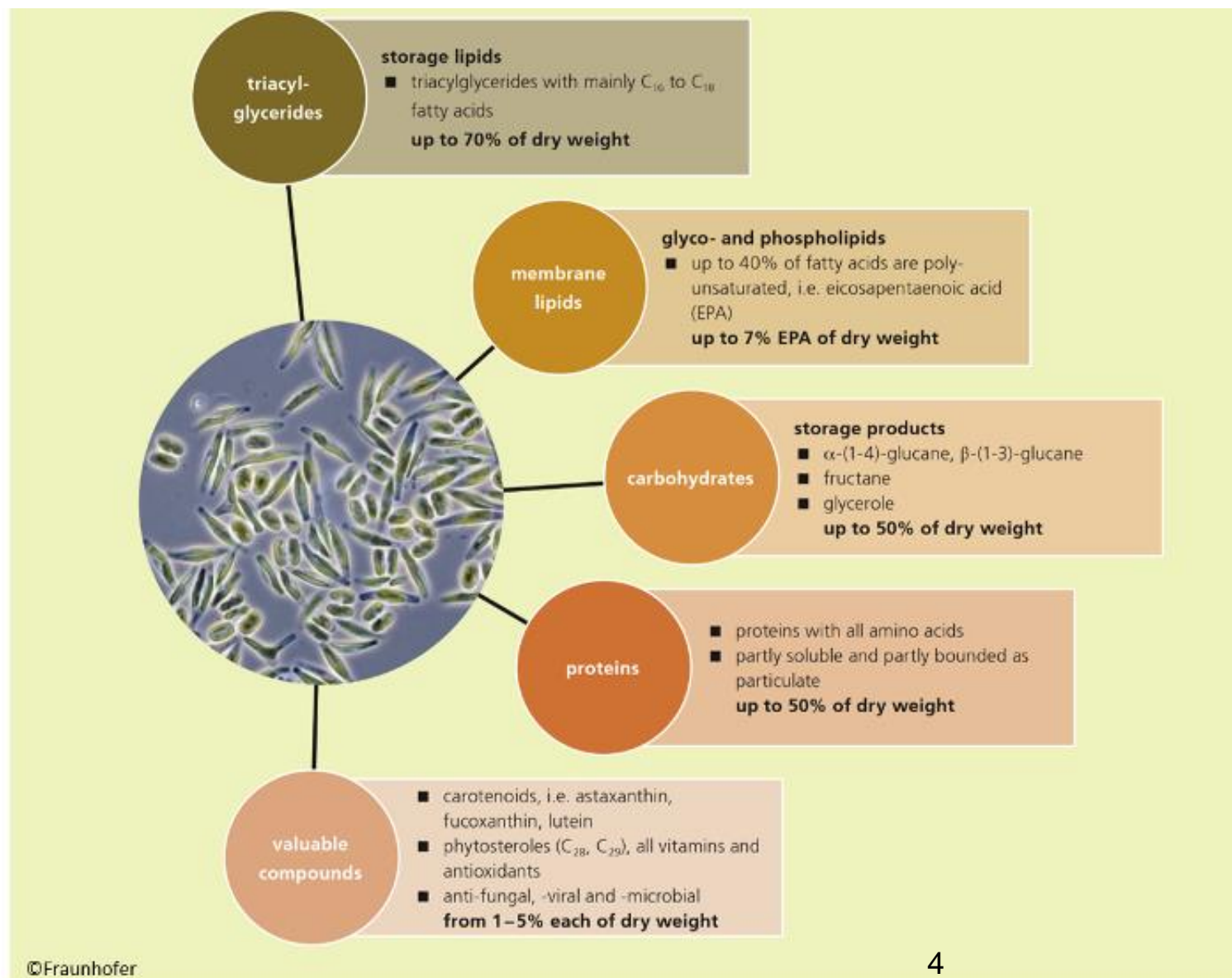
Food
Feed
Fertilizer
Nutraceuticals
Cosmetics
Pharmaceutical products

Biorefinery

Colourants
Antioxidants
Pigments
Fatty Acids
Proteins

Waste water cleaning
Phycoremediation
CO₂ from flue gas
Hydrothermal liquefaction
Energy

Make a wish Micro Algae will deliver



Dunaliella salina/Lutein

- Best natural source of beta-carotene
- Largest production in Australia



[Hydrobiologia](#)

..... September 1984, Volume 116, [Issue 1](#), pp 115–121

The mass culture of *Dunaliella salina* for fine chemicals:
From laboratory to pilot plant

Authors

[Authors and affiliations](#)

L. J. Borowitzka, M. A. Borowitzka, T. P. Moulton

1978: Lab research – Roche Research of Marine Pharmacology

1987: construction of a 25ha plant & first sales

1997: Bought by Henkel/Cognis



January 2017, Austria

ecoduna 2010-2017: FAQs



Algae culture in Austria?
Ecoduna technology – ready to use?
Productivities to be expected
Artificial light?
Continuous production
Biofilm & contamination



Das Unternehmen (Geschichte)

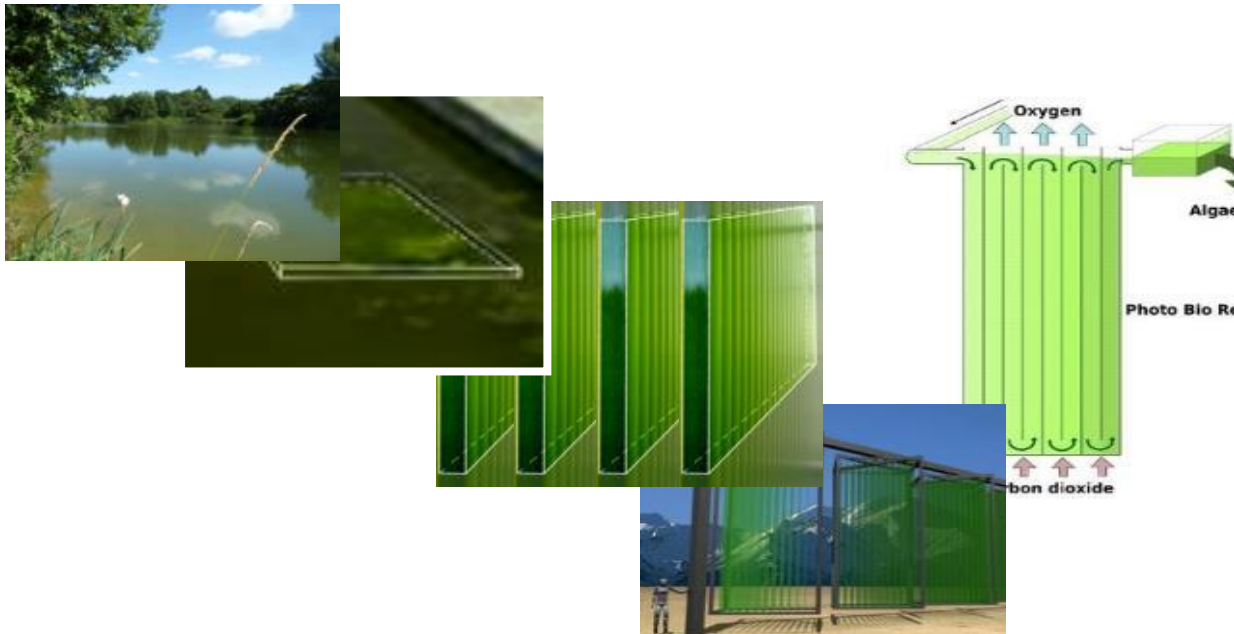
- 2007: the idea – ‘the hanging gardens’
- 2010: PHOBIOR (EC ECO-Innovation project)
 - Ecoduna founded & First financing by a group of enthusiasts
- 2011 & 2013 selling of plants in DK and DE
- 2012 R&D facility operational
- 2014 Energy Globe award
- 2015 Technology change & change of goal
- 2017 Start of construction for industrial production
- 2018 Start of industrial production plant

The ,hanging garden Technology‘ 2010



Concept:

- mimicking nature – 3D structure to optimize light capture
- Vertical flowing algae culture



2007-2015



- First trials 2007



Development steps



- First concept 2008

- First industrial plant 2018





USP

Proprietary technology

- Upright flowing algae
- Glass & Steel
- No cell stress by pumps
- Optimal nutrition state
- Low resource input
- Fully automated

benefits

- Sustainable
- Continuous
- Clean
- Energy saving
- Natural

- No Oxygen ,poisoning‘
- No CO₂ depletion
- Good Light penetration
- Good Culture stability
- Reduced Biofilm
- Closed system – controlled culture



Product/Technology

USP

- patented PBR technology
- Continuous and safe production of biomass
- Proprietary algae strains
- 6 years of pre-industrial experience
- Food safe – only glass and stainless steel

Other production systems

- Open ponds
- Raceway ponds
- Raceway cascades
- Plastic V-bags^c
- Green wall technology^c
- Horizontal closed stems^c
 - Plastic tubing
 - Glass tubes
- Flat panel

other providers of PBR Technology:

- ^c closed: IGV, Subitec, GF, A4F, Novagreen, Phytolutions;
- open: various developments



The correct choice - Bioprospecting



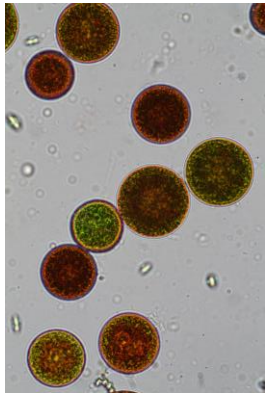
- Marine
- Fresh water
- Terrestrial
- Extremophiles:
 - Halophytic (*Dunaliella*)
 - Epiphytic (*Oedogonium*)
 - Epizoic (on/in animals i.e. *Zoochlorella* inside *Hydra*)
 - Symbiotic (*Azolla*)
 - Parasitic
 - Thermophytic (Hot springs)
 - Fluviatile (Waterfalls, Glaciers)



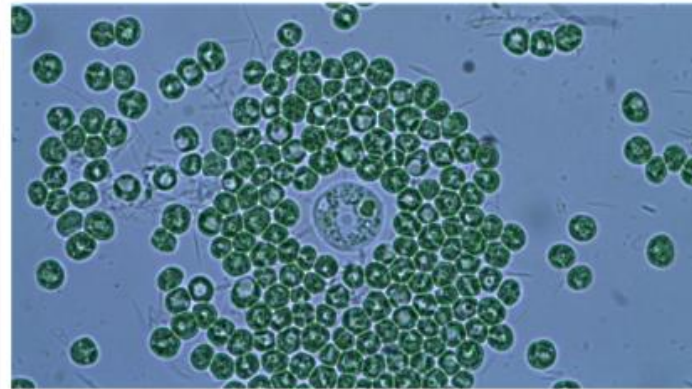
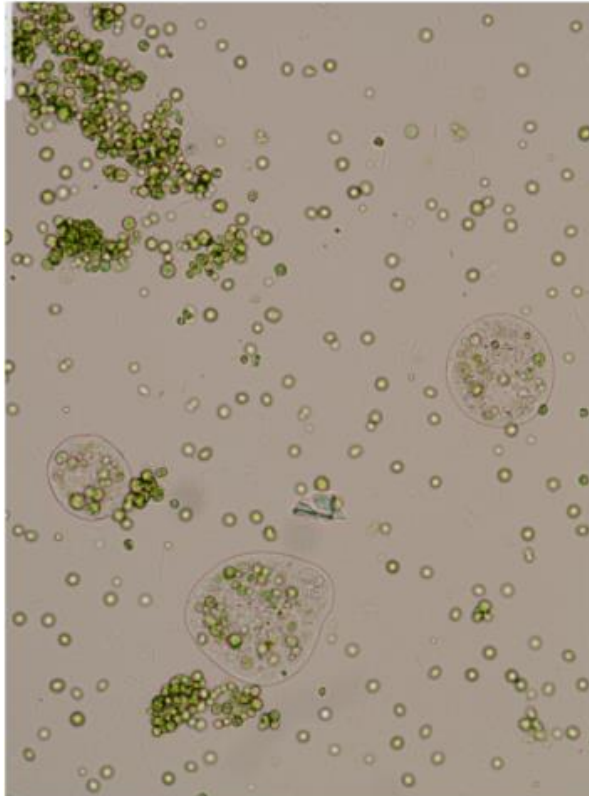
Bioprospecting:
Strain collections from different habitats offer manifold possibilities for

Crop Rotation – working with nature

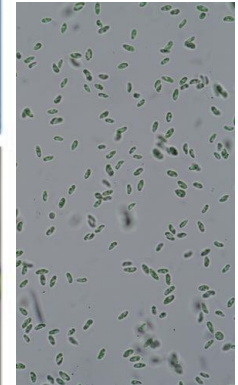
*Hämatococcus
pluvialis*



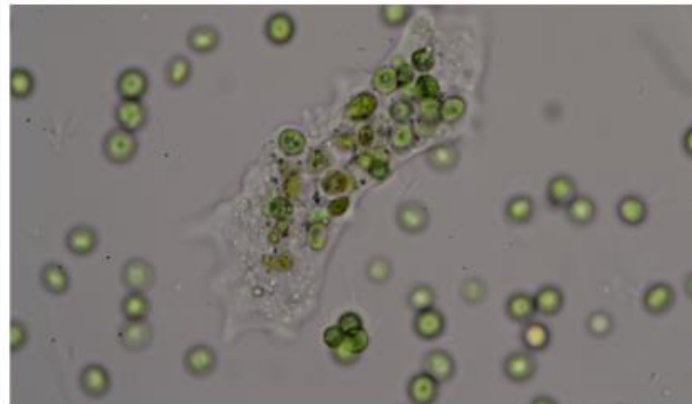
Astaxanthin



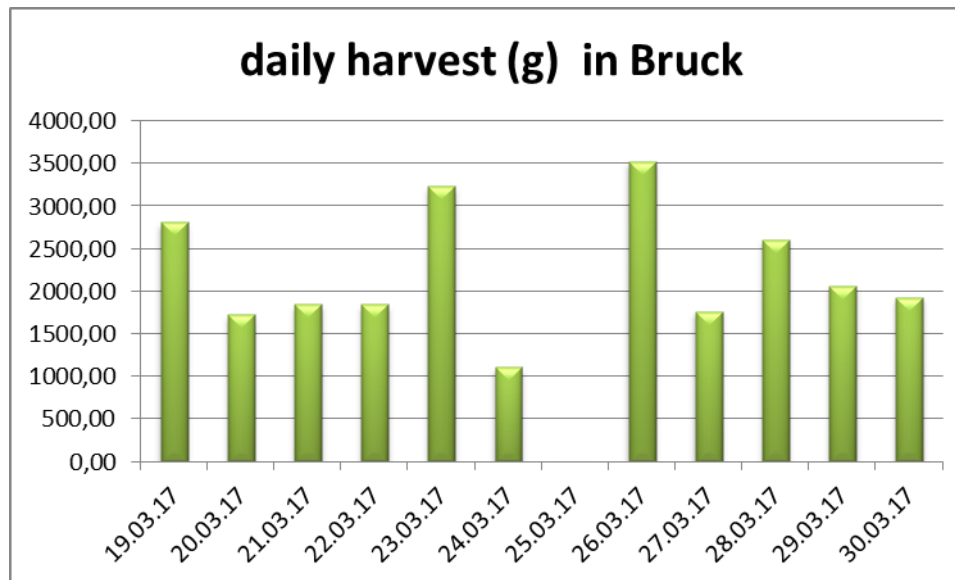
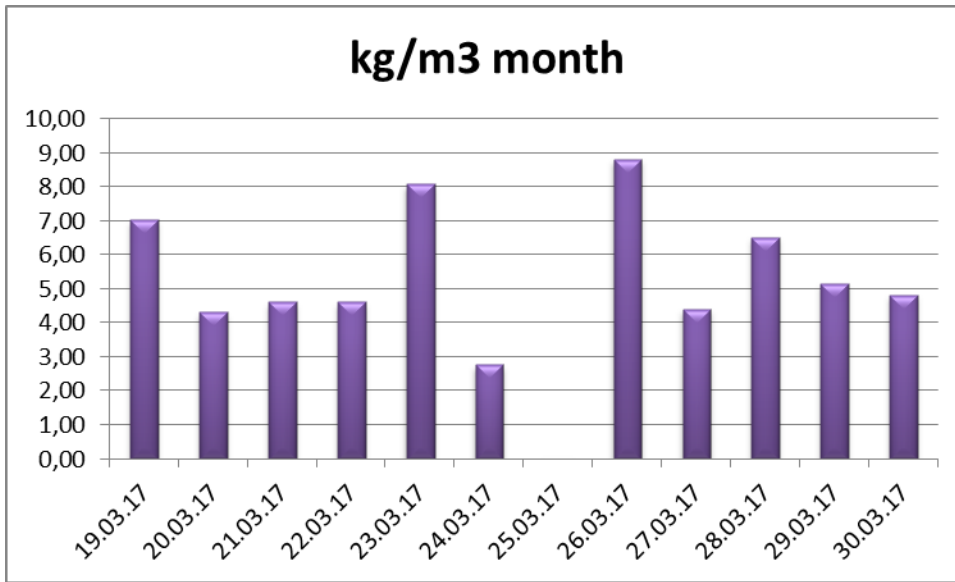
*anochloropsis/
monodopsis*



*Biomasse,
lipide, EPA*



Produktivität March 2017



Date	Daily growth OD	Daily growth g/L	g/m3 day	daily harvest (g) in Bruck
19.03.17	0	0	0	
20.03.17	1,17	0,23	234,28	
21.03.17	0,72	0,14		
22.03.17	0,77			
23.03.17				
24.03.17				

eparella
member of the ecduna group

Date	Daily growth OD	Daily growth g/L	g/m3 day	daily harvest (g) in Bruck
25.03.17	0,17	0,17	172,53	2070,37
26.03.17	0,81	0,16	161,23	1934,79

1ha: ca 100t dry biomass



Features & Certificates

- 100% clean cultures
- Algae from controlled lab strains
- Culturing in tap water in closed system
- No unspecific algae contamination
- Controlled food proof environment
- Daily internal QC batch analyses (microscope, mibi & DNA)
- Regular external chemical and microbial analyses
- HACCP certified
- Codex alimentarius

- ISO, IFS under way

ecoduna: the next step 1ha

- Technology is ready (PBR, strains)
- Goal is selected
- Market entry done (contacts, Lols)
- **NOW: Generate Product**





ecoduna

FILM 4723

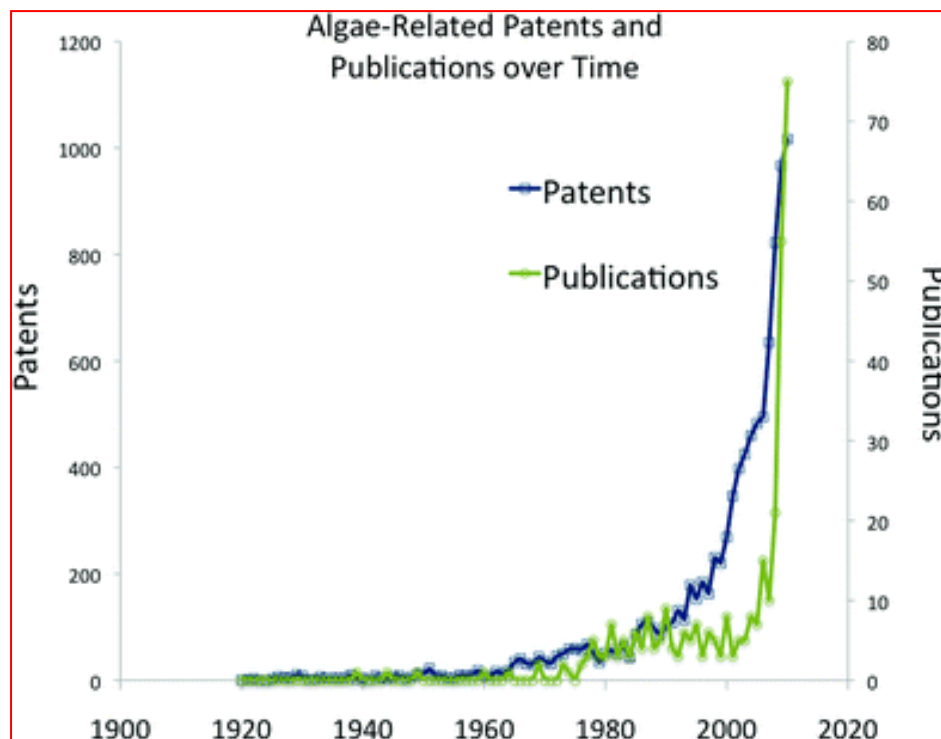


Product development

- The biomass is there – what next?



Novel Compounds and applications



Critical Reviews in Microbiology

<http://informahealthcare.com/mby>
ISSN: 1040-841X (print), 1549-7828 (electronic)

Crit Rev Microbiol, Early Online: 1-12
© 2015 Informa Healthcare USA, Inc. DOI: 10.3109/1040841X.2014.957640

informa
healthcare

REVIEW ARTICLE

Recent developments in therapeutic applications of Cyanobacteria

Rathinam Raja¹, Shanmugam Hemaiswarya¹, Venkatesan Ganesan², and Isabel S. Carvalho¹

¹Food Science Lab, Faculty of Sciences and Technology, University of Algarve, Faro, Portugal and ²AcmeProgen Biotech (India) Pvt. Ltd., Salem, India

Hindawi Publishing Corporation
Oxidative Medicine and Cellular Longevity
Volume 2014, Article ID 313570, 16 pages
<http://dx.doi.org/10.1155/2014/313570>



Review Article

Omega-3 Fatty Acids and Depression: Scientific Evidence and Biological Mechanisms

Review article

New drugs with antiprotozoal activity from marine algae: a review

Fábio A.E. Torres^{a,b,c}, Thais G. Passalacqua^{a,b,c}, Angela M.A. Velásquez^{a,b,c}, Rodriago A. de Souza^b, Pio Colepiccolo^d, Márcia A.S. Graminha^{a,c,*}



International Journal of Biological
Macromolecules

Available online 9 April 2017

In Press, Accepted Manuscript — Note to users



Isolation of fucoidan from *Sargassum polycystum* brown algae: Structural characterization, *in vitro* antioxidant and anticancer activity

Subramanian Palanisamy^a, Manoharan Vinosha^a, Thangapandi Marudhupandi^b, Periyannan Rajasekar^a,

marine drugs

Article

In Vitro Antioxidant Activities of Enzymatic Hydrolysate from *Schizochytrium* sp. and Its Hepatoprotective Effects on Acute Alcohol-Induced Liver Injury In Vivo

Xixi Cai^{1,2}, Ana Yan², Nanyan Fu¹ and Shaoyun Wang^{2,*}



Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: <http://www.elsevier.com/locate/clnu>

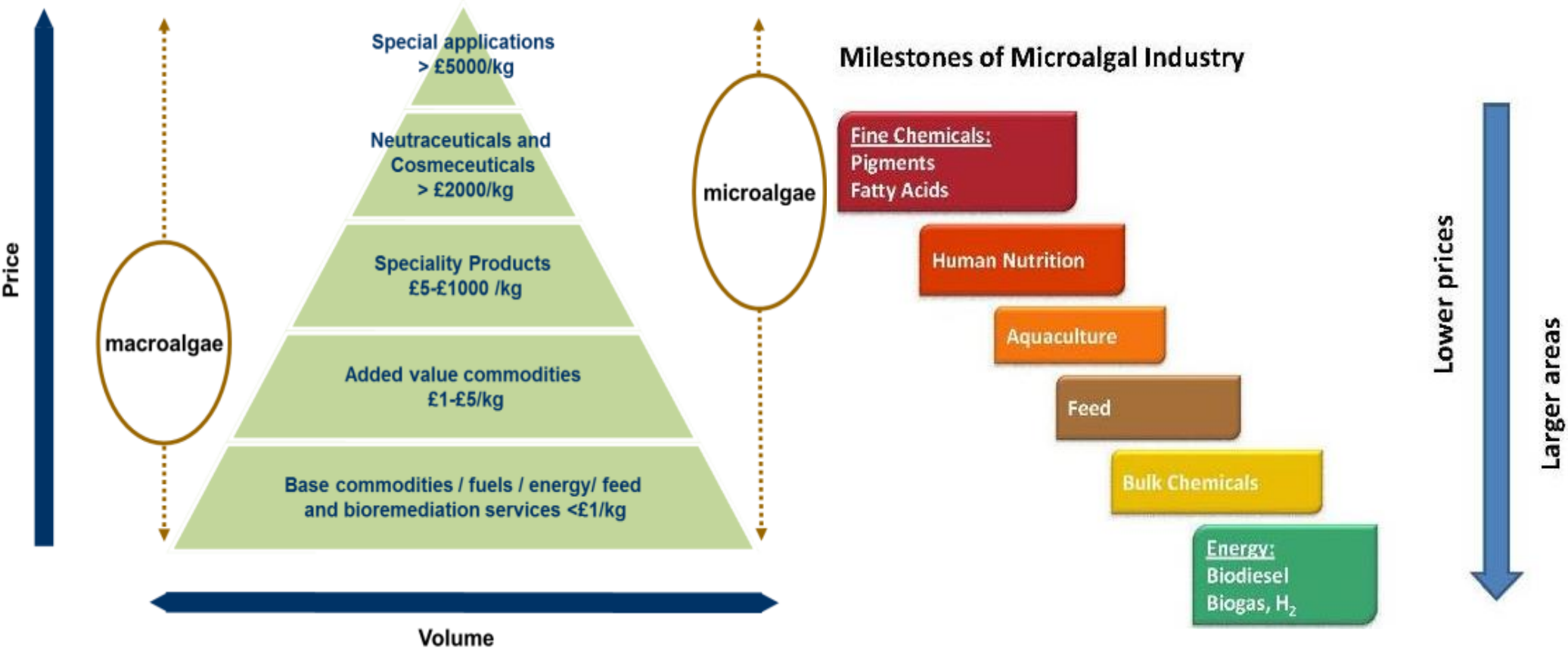


Meta-analyses

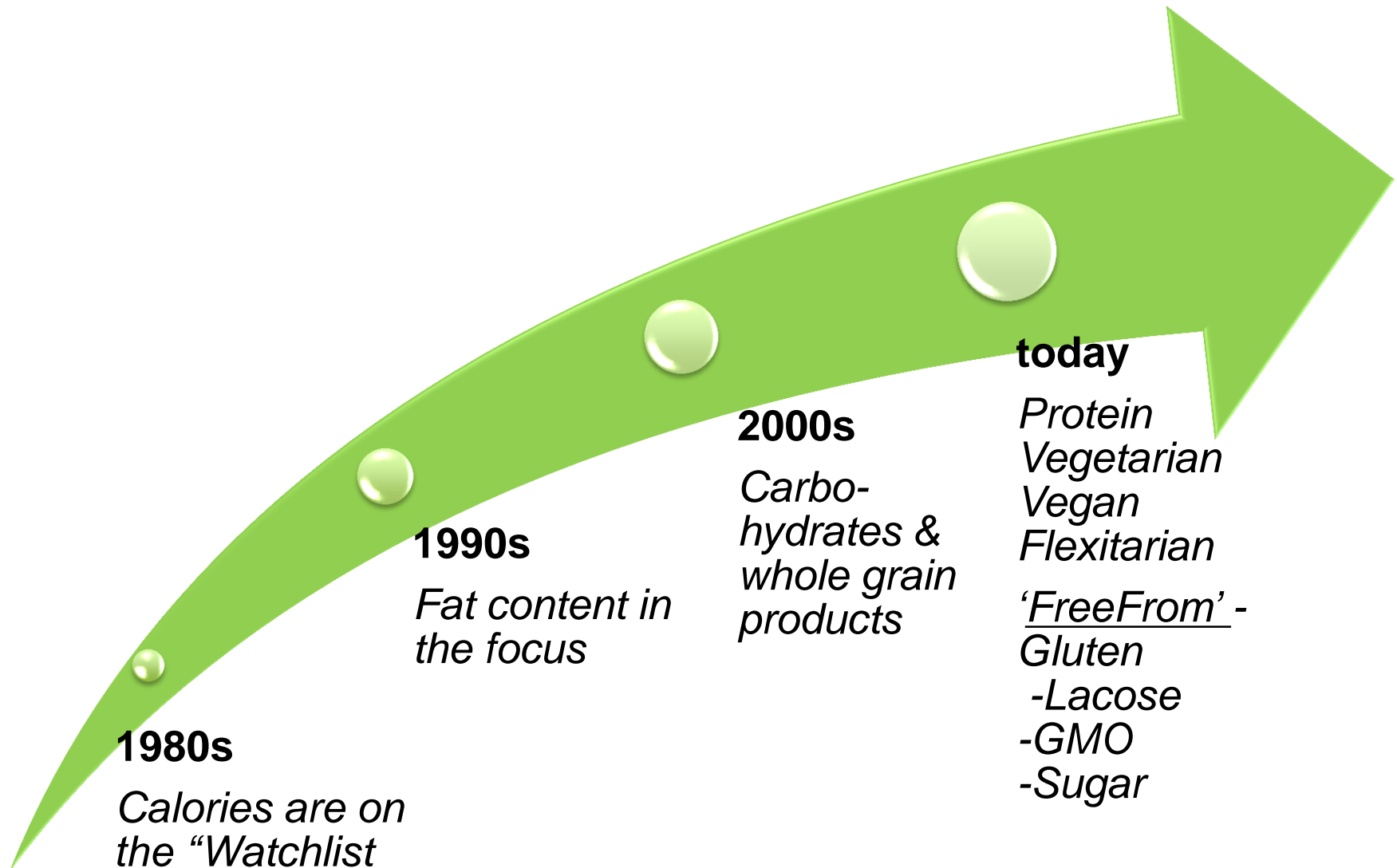
A systematic review and meta-analysis of the impact of Spirulina supplementation on plasma lipid concentrations

Maria-Corina Serban^a, Amirhossein Sahebkar^{b,c}, Simona Dragan^d, Gheorghe Stoichescu-Hogea^d, Sorin Ursoniu^e, Florina Andrica^f, Maciej Banach^{g,*}

Economical considerations



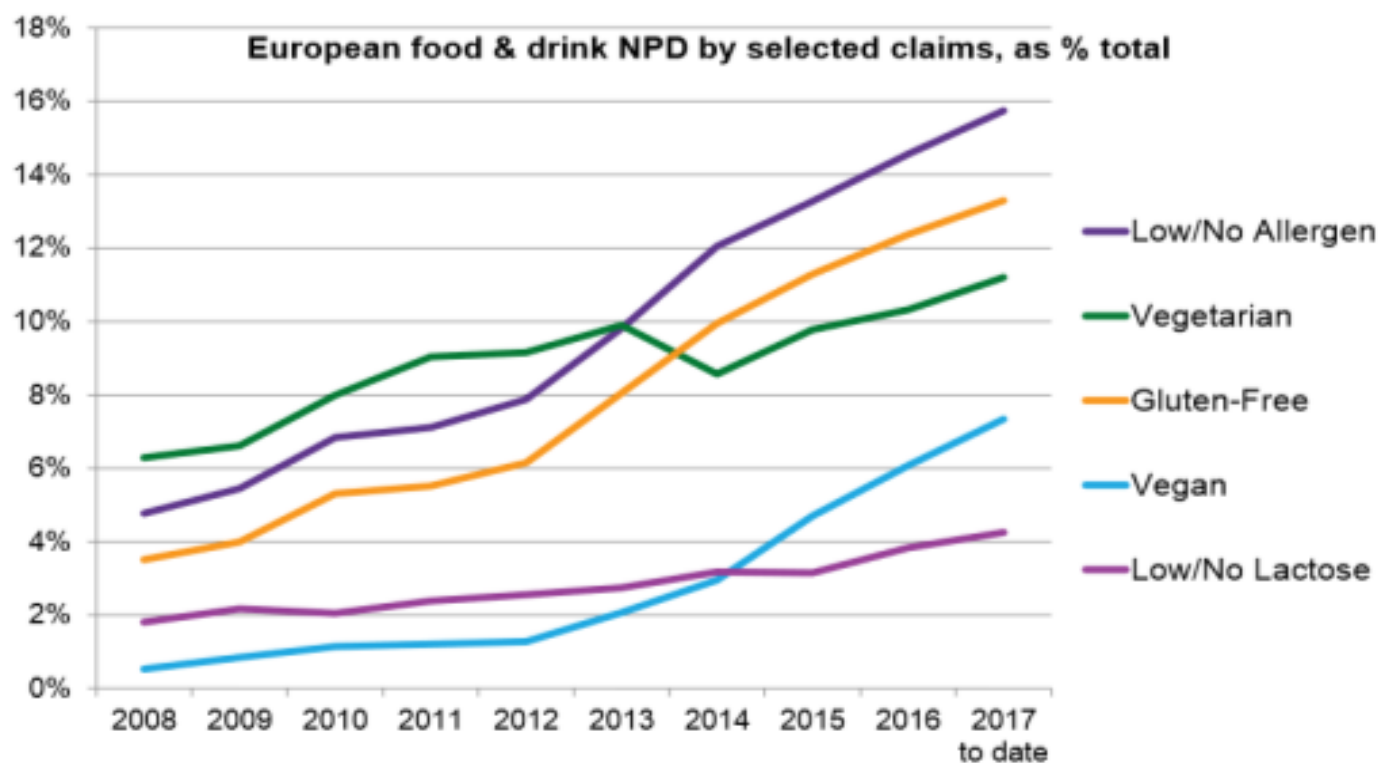
Changing food trends



Future food trends



And industry focus now is on free-from & healthy lifestyle foods



Product qualities

- Fresh
- Fresh/Frozen
- Powder
- Granulated product
- Extracts
- Tablets/Capsuls



Product examples

- Smoothies
- Algae chokolade
- Algaedrink (Helga)
- Energy-Bars
- VeganFood
- Bread spread
- Other drinks



Where is the problem?

- Prime
- Fish ta



Over

Ironmetal
tion

Use cultured algae as a sustainable source!!!

Vegan algae oil made by ecoduna



Extraction ssCO₂
Omega3 FA rich in EPA from
microalgae

ecoduna

Whole algae Omega 3 Oil

Description	Whole microalgae Oil from scCO ₂ extraction
Ingredients	Micro algae oil mixed with linseed oil (organic)
Origin	Made in Austria
Highlights	HACCP certified, Vegan; IFS & GMP in 2018

Organoleptic description

Appearance, consistency	Dark brown oil
Smell/taste	Fishy smell / typical algae taste

Fatty acid composition per g

Parameters	% of total lipids
C14:0	2,4
C16:0	8,9
C16:1	1,8
C18:0	4,8
C18:1	19,0
C18:2	13,8
C18:3	38,0
C20:1	2,0
C20:4	1,2
C20:5	6,7

Others

Allergens:	The algae powder is free of allergens. No additives.
Transport & storage:	Store at room temperature and in dry environment (<65% rel. humidity) Dark storage is recommended.
Best before date:	24 months after packaging date. Recommendation: Content should be consumed or processed further within 3 months after opening
The nutritional values are based on third party analyses. They are constantly determined & can change slightly from batch to batch. The product including packaging & labelling complies with the Austrian Food Safety & Consumer Protection Law (LMSVG 2006) & the EU-regulation 1169/2011.	

General Information

ecoduna cultivates some very potent Omega-3 algae strains, which are producing high quantities of PUFAs, especially EPA. EPA is an essential Omega3 fatty acid that is needed to protect the heart, prevent dementia, prevent thrombosis & cardiovascular diseases, reduce inflammation, protect eyes, help against depression & much more. Daily recommended intake of EPA % DHA is 200-400mg. In vegetable oil regarded as Omega-3

Grand challenges

- Understanding of products
- Readyness of markets & Customer education
- Organic production
- Demand is high – volumes currently can't be generated
- Seasonality of production in Europe / acceptance by markets
- Improved strains – increased productivity
- R&D results translated to industrial scale
- Pest management
- **Capex/Opex** reduction



Summary I



- **ecoduna** technology ready for industrial use
- We will use our own technology to tap the enormous potential of microalgae – demand is high
- Our target: vegan Omega 3 oil

BUT

- Market readiness
 - Development of new standards
 - Customer education – price vs quality
 - Novel food regulation for new products
 - Organic production (now: from agricultural standards)



Summary II

- Big market potential for micro algae
- High value products (FA, Amino Acids, Pigments) for Nutraceuticals and Pharma
- GMO for speciality products
- Standards need to be defined
- Customer education – away from legends
- Autotrophic/heterotrophic growth
- Demand is high – volumes currently can't be generated

We are just at the beginning!

Strong need for collaboration and R&D to fully understand and exploit microalgae





Thank you for your attention!



Eating fish? Start eating algae! | Silvia Fluch |
TEDxLinz

<https://www.youtube.com/watch?v=le9zwsD9Onw>