



Microalgae food: Thinking sustainable, with a healthy taste

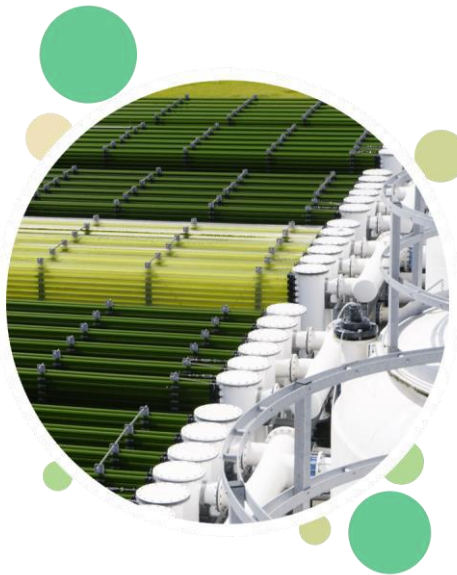
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Microalgae food: Thinking sustainable, with a healthy taste



SUMMARY

Alternative food sources

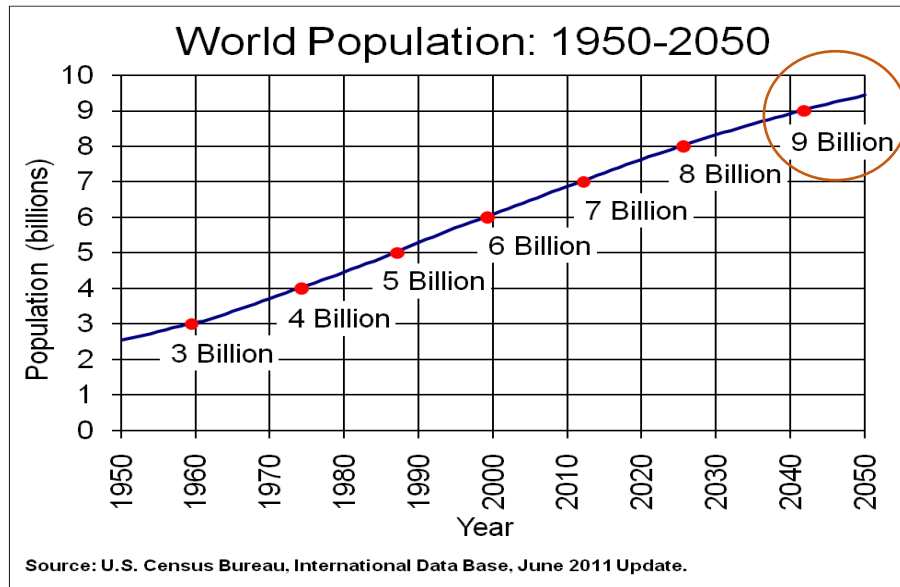
Food trends

Microalgae as important sources of bioactive compounds and macromolecules

Recent case studies

Strategy do engage the consumers?

In 2050 there will be 9 billion people on the planet!



Sharp population growth



Resource scarcity

Thomas Malthus (1798) - At that time he realized that the supply of food did not keep pace with population growth.

In the XXI century, food production is scarce and food prices assume significant increases



FAO estimates the production will have to rise by up to 70%, in order to have food available for all...

Efficiency of agricultural production systems
Scarcity of water resources and arable land
Climate change
Protein shortage





New perspective: healthy and sustainable food

MICROALGAE AS A SUSTAINABLE FOOD INGREDIENT

UNDER-EXPLOITED RESOURCES

CIRCULAR ECONOMY

valorisation of by-products

Microalgae biomass

Seaweed

other marine resources

(underutilized species used in food)

Insects

Microalgae - Food Innovation



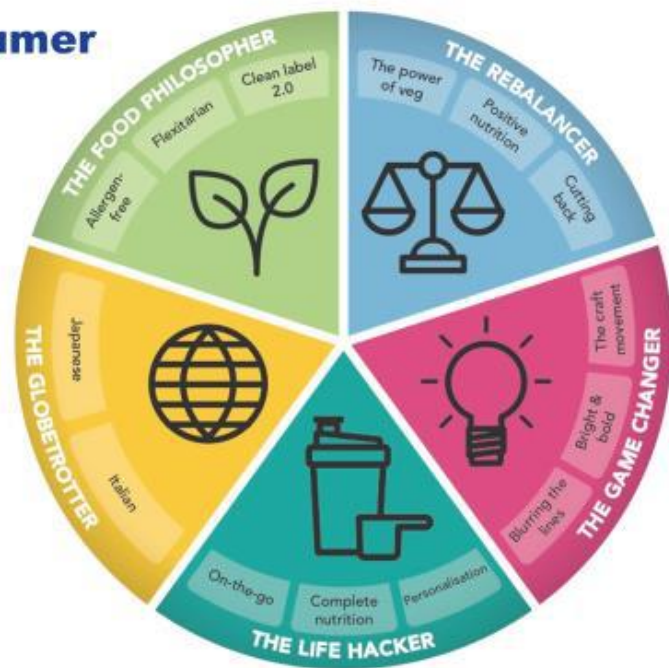
Chart 1.0: Top 10 Trends for 2021



https://grandeconsumo.com/10-tendencias-globais-de-consumo-para-2021/?utm_source=Newsletter+19%2F01%2F2021&utm_medium=email&utm_term=https%3A%2F%2Fgrandeconsumo.com%2F10-tendencias-globais-de-consumo-para-2021%2F&utm_content&utm_campaign=GC+News+19%2F01%2F2021#.YAh6YC0qLq0

2021 - almost 70% of the companies expect that consumers care more to sustainability than before Covid-19.

2021 Consumer Trends



MICROALGAE BIOMASS in food...

Clean Label

The power of veg

Craft movement

On-the-go
Complete nutrition
Personalisation

The globetrotter
food from the world

Look for microalgae as a clean label ingredient



Cofinanciado por:
COMPETE 2020
INICIATIVA DE INOVAÇÃO, COMPETITIVIDADE E EMPREGO

Lisb@2020

PORTUGAL 2020

UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional

Close relationship with the food industry...



The importance of gluten-free market



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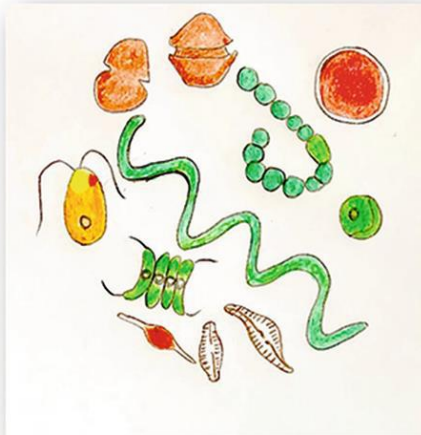


Bioactive compounds

Bioactive compounds

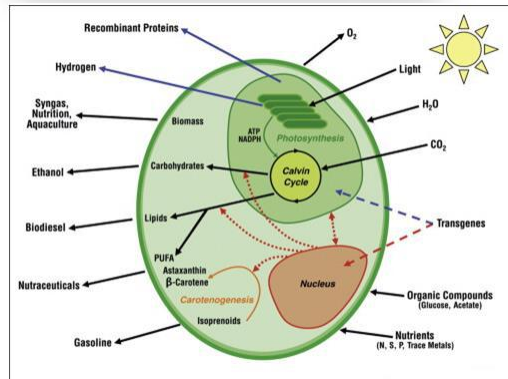
- Eicosapentaenoic acid (EPA)
- Docosahexaenoic acid (DHA)
- Sulphated polysaccharides
- Carotenoids
 - Astaxanthin
 - Fucoxanthin
 - β -carotene
 - Lutein
- C-phycoerythrin
- Novel metabolites
 - Cyanovirin-N
 - Apratoxin A
 - Tricophycin A
 - Calothrixin A
- Dinotoxins
 - Amphidinolides
 - Karlotoxins
 - Yessotoxin

Microalgae



Bioactivity

- Antibacterial
- Antiviral
- Anticancer
- Immunomodulatory
- Antiobesity
- Antidiabetic
- Anti-hyperlipidaemic
- Antioxidative



Macromolecules

Proteins and polysaccharides

Algal Research 2 (2013) 164–173

Contents lists available at SciVerse ScienceDirect

Algal Research

journal homepage: www.elsevier.com/locate/algal



Comparison of microalgal biomass profiles as novel functional ingredient for food products

Ana Paula Batista ^{a,b,*}, Luísa Gouveia ^b, Narcisa M. Bandarra ^c, José M. Franco ^d, Anabela Raymundo ^a

^a Núcleo de Investigação de Engenharia Alimentar e Biotecnologia (NIEAB), Instituto Piaget—ISEIT de Almada, Quinta da Arrénela de Cima, 2800-305 Almada, Portugal

^b Laboratório Nacional de Energia e Geologia (LNEG)—Unidade de Bioenergia, Estrada do Paço do Lumiar, Edifício G, 1649-038 Lisboa, Portugal

^c Divisão de Aquacultura e Valorização, Instituto Português do Mar e da Atmosfera, Av. Brasília 1449-006 Lisboa, Portugal

^d Universidad de Huelva, Facultad de Ciencias Experimentales, Dpto. Ingeniería Química, Campus de Excelencia Internacional Agroalimentario, c/i43, Campus del Carmen, 21071 Huelva, Spain

Microalgae present **varied nutritional profiles**, according to their origin and growth conditions, with different possibilities of incorporation into culinary preparations

RECENT CASE STUDIES

Staple foods

WHEAT BREAD



LWT - Food Science and Technology 89 (2018) 466–474



Contents lists available at ScienceDirect
LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Impact of *Chlorella vulgaris* on the rheology of wheat flour dough and bread texture



1 to 5 % w/w

Wheat bread – Up to 3% a positive impact on dough rheology was observed. For higher contents, a negative effect on dough rheology, bread texture and flavor was noticed.

Algal Research 45 (2020) 101749



Contents lists available at ScienceDirect

Algal Research

journal homepage: www.elsevier.com/locate/algal

Microalgal cell disruption: Effect on the bioactivity and rheology of wheat bread



M. Cristiana Nunes^{a,*}, Carla Graça^a, Sanja Vlaisavljević^b, Ana Tenreiro^c, Isabel Sousa^a, Anabela Raymundo^a



GLUTEN-FREE BREAD



Article

Tetraselmis chuii as a Sustainable and Healthy Ingredient to Produce Gluten-Free Bread: Impact on Structure, Colour and Bioactivity

Maria Cristiana Nunes ^{*}, Isabel Fernandes, Inês Vasco, Isabel Sousa and Anabela Raymundo

LEAF—Linking Landscape, Environment, Agriculture and Food, Instituto Superior de Agronomia, Universidade de Lisboa; Tapada da Ajuda, 1349-017 Lisbon, Portugal; icxfernandes@gmail.com (I.F.); inesfsvasco@gmail.com (I.V.); isabelsousa@isa.ulisboa.pt (I.S.); anabraymundo@isa.ulisboa.pt (A.R.)

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Control



Tc 1%



Tc 2%



Tc 4%



1, 2, 4 % w/w

Gluten-free bread – Bread with 4% *T. chuii* seems particularly interesting since a significant increase in the bioactivity, with a low impact on technological performance, but with lower sensory scores.



GLUTEN-FREE PASTA WITH SPIRULINA



Effect of *Arthrospira platensis* (spirulina) incorporation on the rheological and bioactive properties of gluten-free fresh pasta

Patrícia Fradinho^{a,*}, Alberto Niccolai^b, Rita Soares^a, Liliana Rodolfi^{b,c}, Natascia Biondi^b, Mario R. Tredici^{b,c}, Isabel Sousa^a, Anabela Raymundo^a

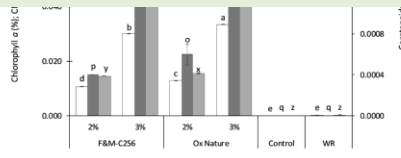
^a LEAF-Linking Landscape, Environment, Agriculture and Food, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

^b Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Piazzale delle Cascine 24, 50144 Florence, Italy

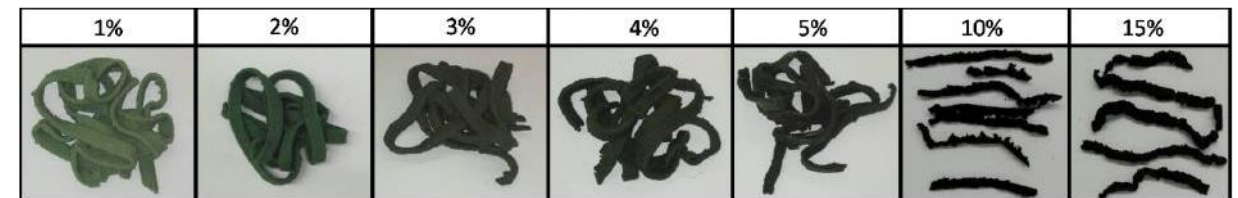
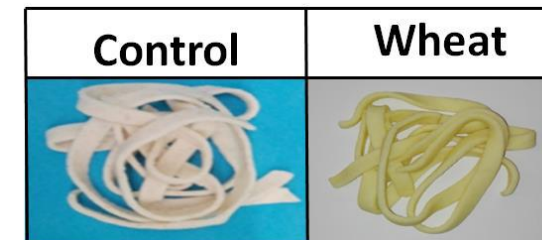
^c Fotosintetica & Microbiologica S.r.l., Via dei Della Robbia 54, 50132 Florence, Italy

Product with an attractive and innovative appearance.

Considerable **enhance the nutritional quality of pasta**, without affecting its cooking and texture quality properties, with a favourable sensory evaluation.



Rice flour(50%)
+
Psyllium gel (50%)



Arthrospira platensis



Microalge biomass to produce Bioactive biscuits

Algal Research 26 (2017) 161–171



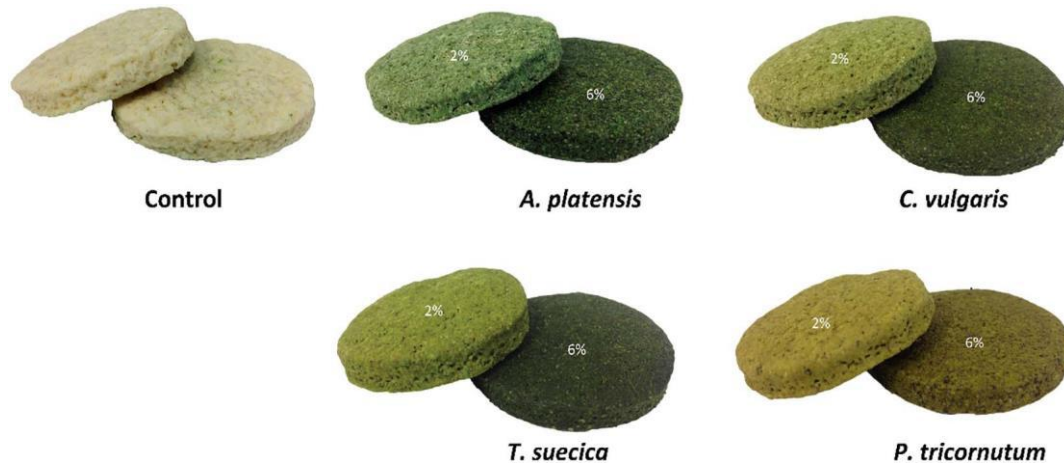
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Algal Research

journal homepage: www.elsevier.com/locate/algal

Microalgae biomass as an alternative ingredient in cookies: Sensory, physical and chemical properties, antioxidant activity and *in vitro* digestibility

Ana Paula Batista^{a,*}, Alberto Niccolai^b, Patrícia Fradinho^a, Solange Fragoso^a, Ivana Bursic^a, Liliana Rodolfi^{b,c}, Natascia Biondi^b, Mario R. Tredici^b, Isabel Sousa^a, Anabela Raymundo^a



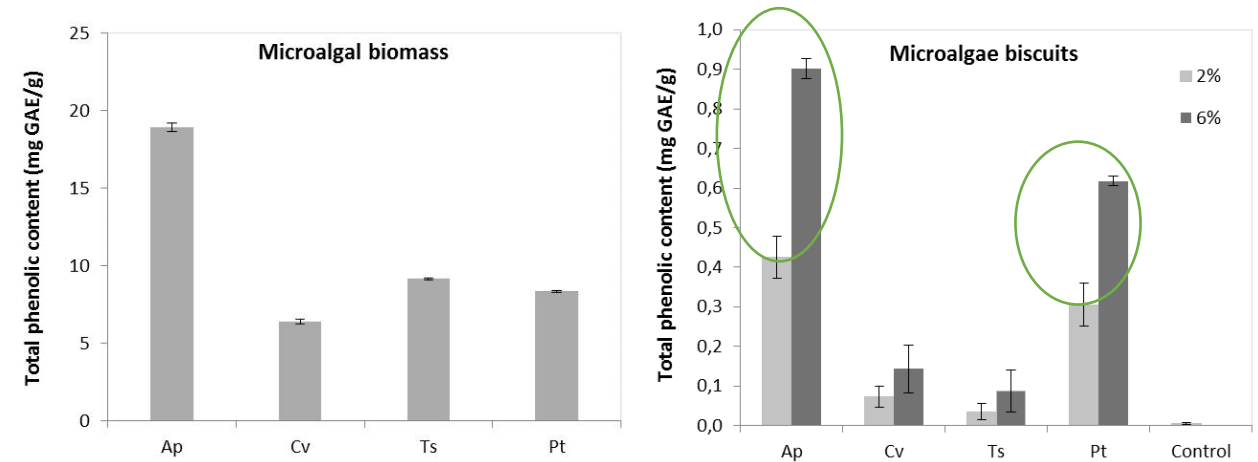
Cookies with *A. platensis* and *C. vulgaris* presented higher protein content compared to the control



Improvement of the nutritional profile



Total phenolic content
(expressed as gallic acid equivalents mg/g dry weight)



Microalgae - effective supplementation of phenolic compounds (practically absent in the control biscuit)

A. platensis with 6% (w/w) biscuit presented the highest phenolic content (0.90 mg GAE/g), followed by *P. tricornutum* 6% cookie (0.62 mg GAE/g).

A. platensis and *P. tricornutum* 2% cookies also showed much higher phenolic content than the chlorophyte algae (*C. vulgaris* and *T. suecica*), at the highest concentration



High thermal resistance



SABER QUE SABE BEM

Rita Falcão, Hector Hernnárez

*Chlorella vulgaris* smooth

Cream cheese



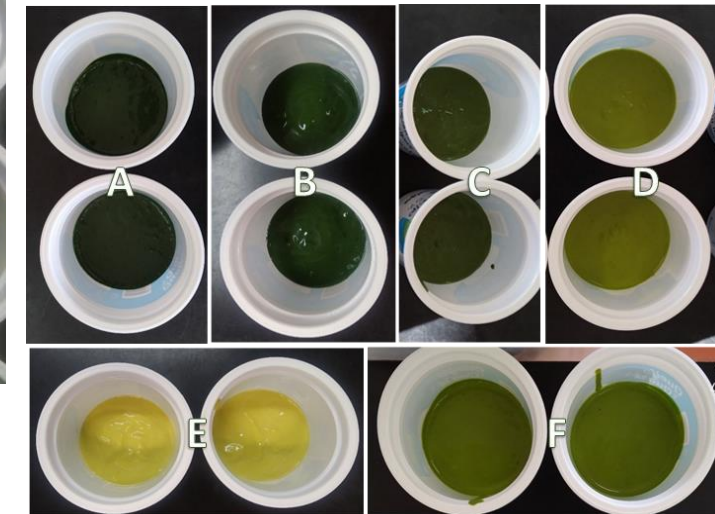
Cured cheese



Quark



A	Spirulina (Spiralgae)
B	Spirulina (AllMicroalgae)
C	Chlorella vulgaris 'BIO' (AllMicroalgae)
D	Chlorella vulgaris 'Smooth' (AllMicroalgae)
E	Chlorella vulgaris 'Honey' (AllMicroalgae)
F	Chlorella vulgaris (Phycom)



Green colour in traditional products...

3 and 5% incorporation



**Sharp increase in microalgae consumption
from domestic scale to industrial food production?...**



Are the consumers prepared?

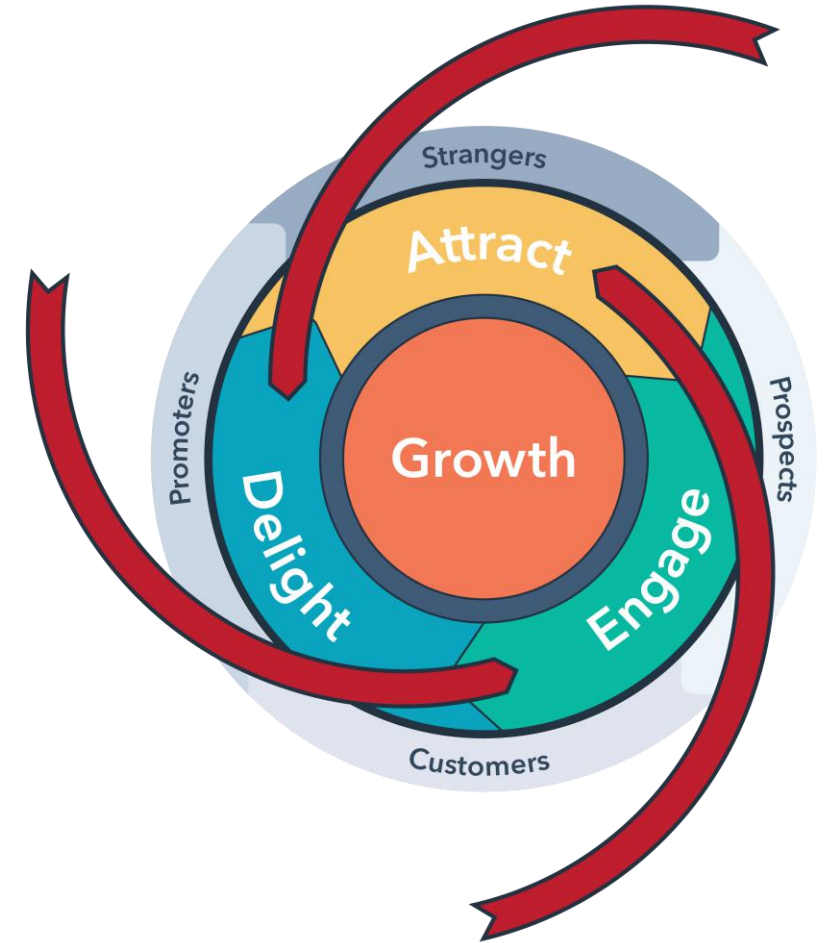
What can we do to engage the consumers...

TASTE, FLAVOUR, COLOUR?

TASTE, FLAVOUR, COLOUR...

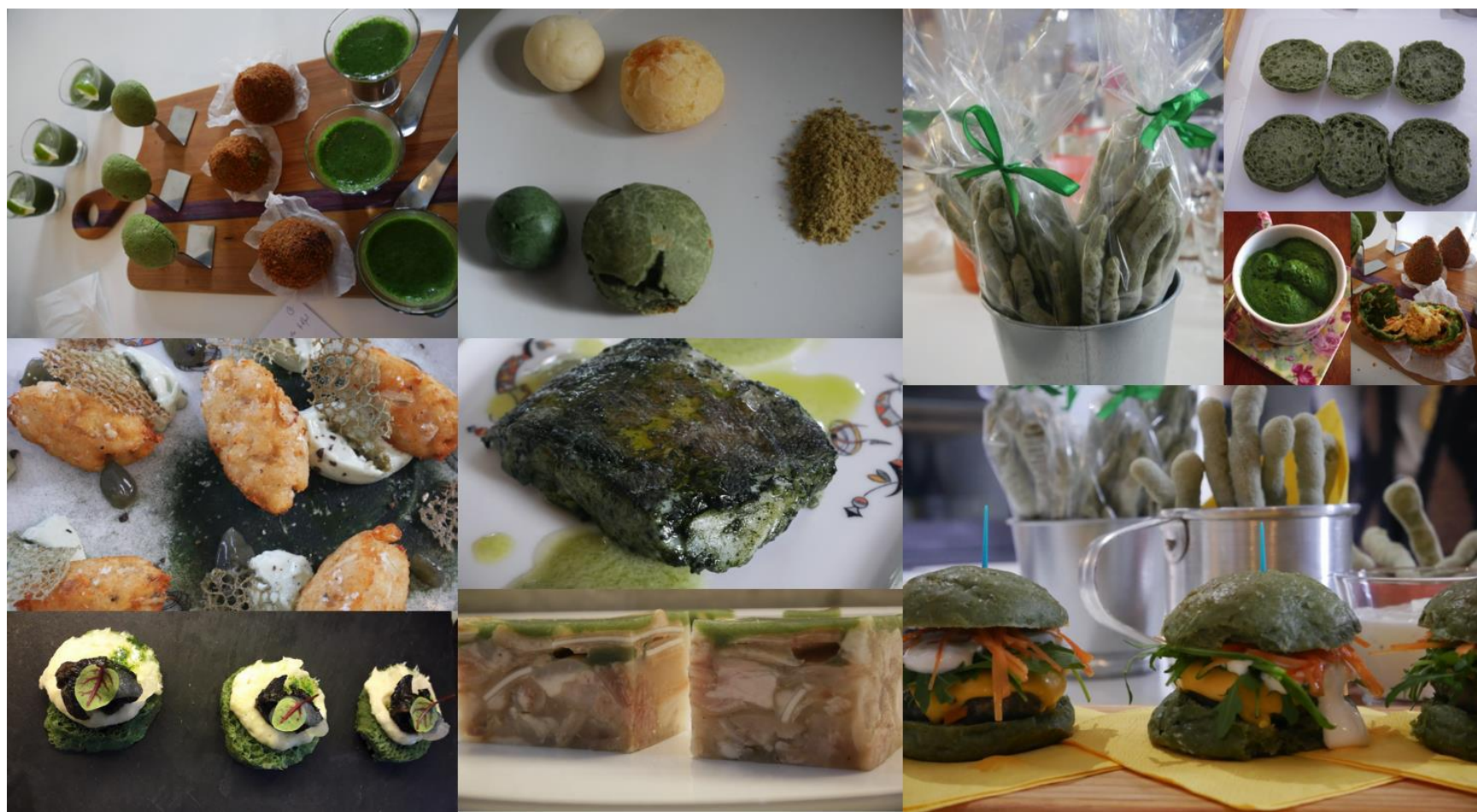
Strategy do engage the consumers?

- 1) GASTRONOMIC SCIENCES
- 2) MICROALGAE TREATMENT – chemical and enzymatic
- 3) DIFERENT COLOURS...
- 4) FOOD EDUCATION PROGRAMS



1) The role of Gastronomic science to engage the consumers

Food of the world



1) The role of Gastronomic science to engage the consumers

Chlorella menu



By Cheff Sónia Oliveira



1) The role of Gastronomic science to engage the consumers

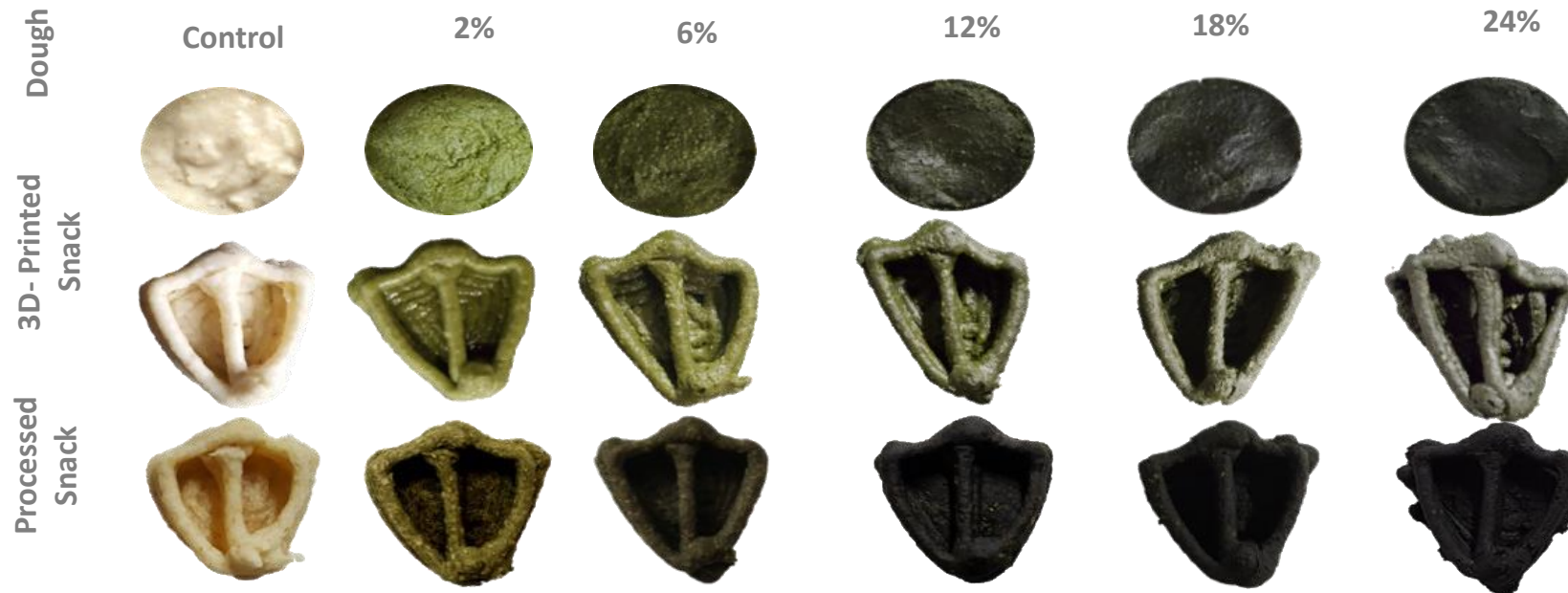
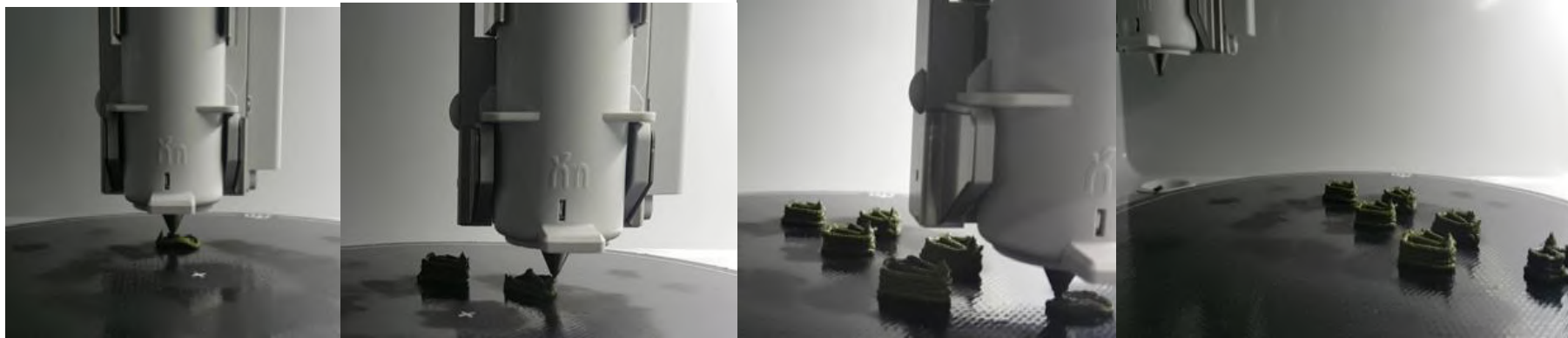
FOOD DESIGN

3D Printing



**New textures, new
shapes, surprise
factor!**

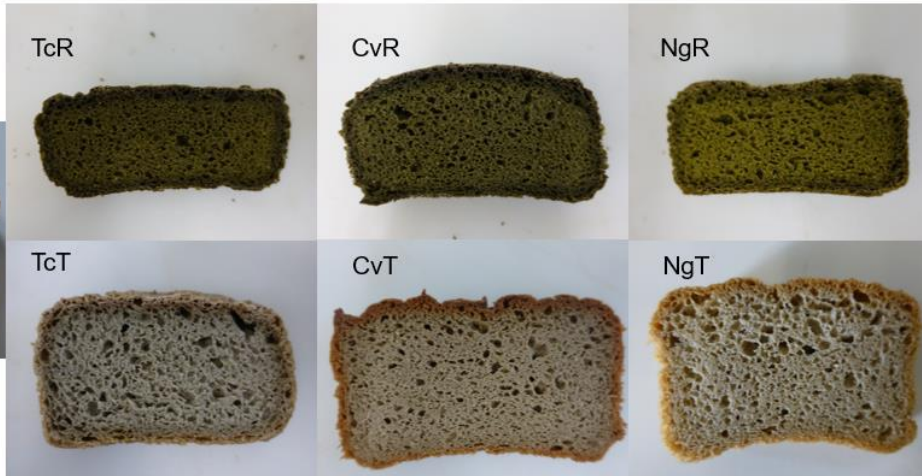
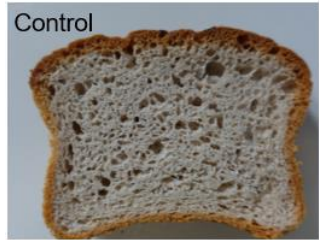
Higher incorporation levels...



2) MICROALGAE TREATMENT – chemical and enzymatic



A2F + AlgaeHealthyBread



4% microalgae biomass

Gluten-free bread

Waqas Qazi, Post-doc, NOFIMA
Inês Sousa MSc student, ISA

Gluten-free bread with the 4% replacement of microalgae's: Tetraselmis chuii (TcR), Tetraselmis chuii ethanol treated (TcT), Chlorella vulgaris (CvR), Chlorella vulgaris ethanol treated (CvT), Nannochloropsis gaditana (NgR) and Nannochloropsis gaditana ethanol treated (NgT).

Iceland
Liechtenstein
Norway grants

EEA submited

YUM ALGAE: enzYmes for improved sensory qUality of
MicroALGAE ingredients in foods
Bread + Cheese (NORCE)



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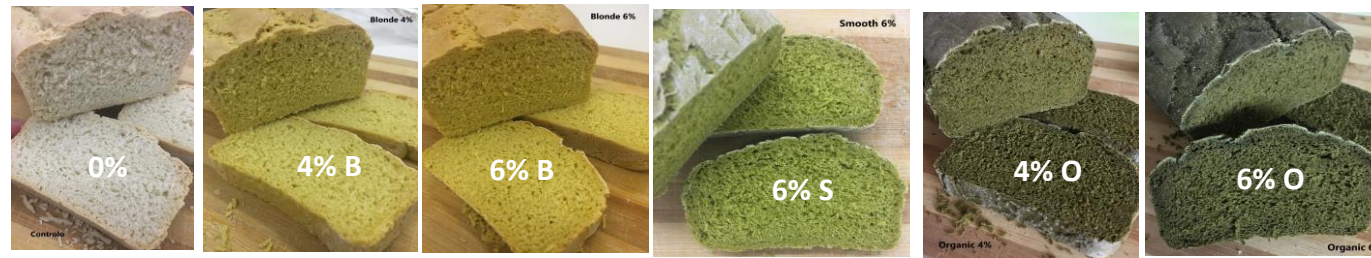


3) Different colours: Heterotrophic production *Chlorella vulgaris*

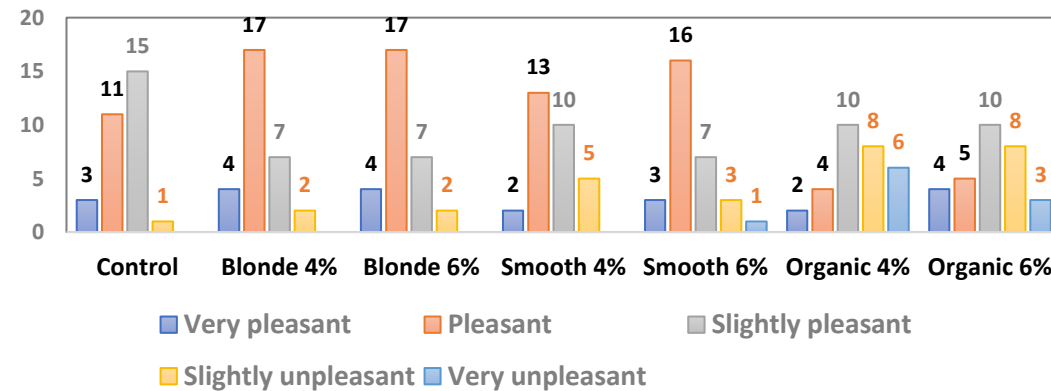


Wheat bread

Carolina Abelho MSc student, FCT/UNL



Global Appreciation

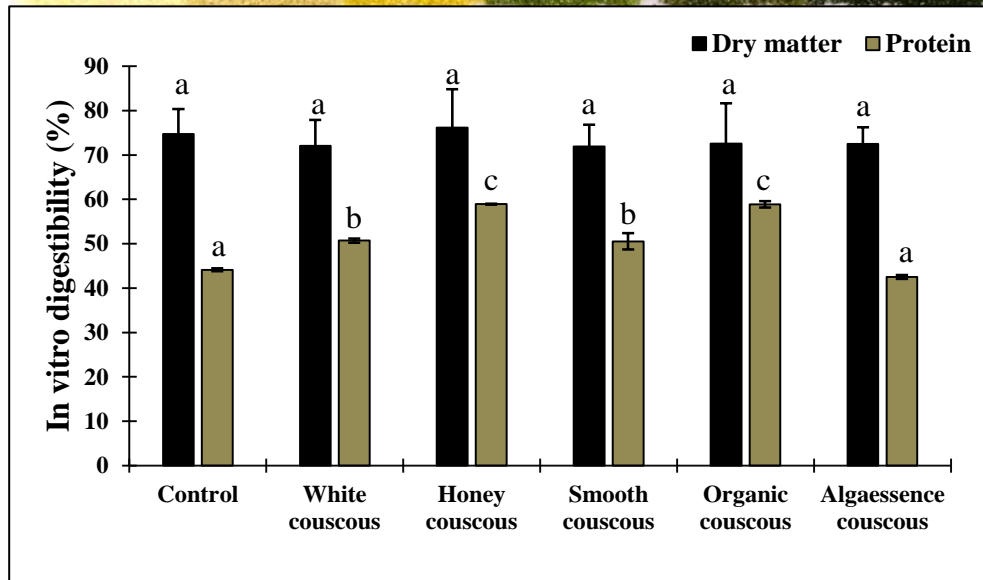


3) Different colours: Heterotrophic production *Chlorella vulgaris*

Couscous

Sheyma Khemiri, PhD student, INSAT Tunisia

6 % microalgae



Energetic healthy bars

Carolina Vala MSc student, ISA

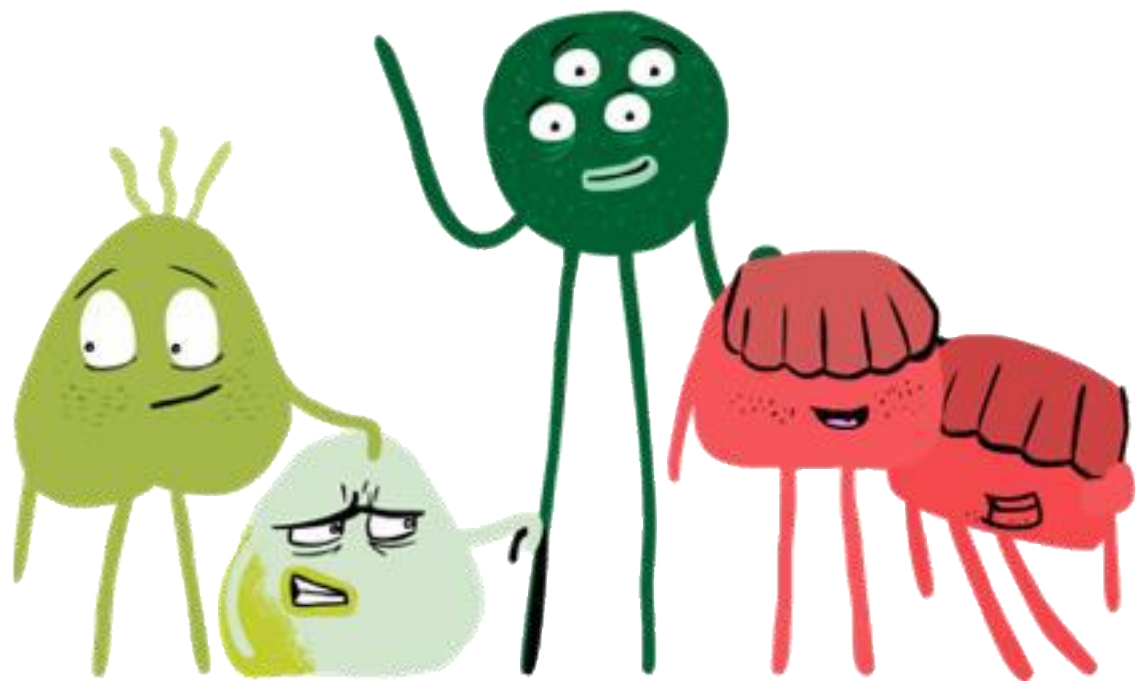


4 and 8 % microalgae

Nutritional claims (4% microalgae): “high fiber” and “source of protein, potassium, calcium, phosphorus, magnesium, iron, vitamin B6 and B12”.



4) FOOD EDUCATION PROGRAMS



Starting with the children ...

<https://www.facebook.com/algae2future/videos/451130295713073>



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Messages to take home...

WHY SHALL WE MICROALGAE?

Microalgae are an important source of bioactive compounds, that may benefit health beyond the role of basic nutrition - **BIOFORTIFICATION**

The use of whole microalgae as a food ingredient has a **high exploitation potential** for the production of value-added functional foods.

Microalgae can be considered **clean label** ingredients.

Different combinations of ingredients to take advantage of the flavour of the microalgae

Strategies to involve the consumer are welcome!

