Algae: Food for the Future Kitchen
Algae: Food for the Future

- Challenges for future food
- What are algae?
- Algae for food and feed
- Cultivating algae at scale
- Algae for a more circular future
Challenges for future food
What are algae?

- Incredibly diverse

- Conservative estimates suggest there are over **70,000 species** of microalgae (Guiry, 2012)

- Less than 50 currently used for commercial purposes (EABA, 2020)
Features of algae for food and feed

• High protein – balanced amino profile
• Essential fatty acids – omega-3s
• Many algae classified as GRAS – generally regarded as safe
• High vitamin and mineral content
What are “Vitamins” in organisms?

- Organic micronutrients that are required for growth
- Originally coined for ‘vital amine’, thiamine,
- Isolated from rice husks and cures beri-beri

Vitamin deficiency - consequences

- Vitamin A deficiency – blindness
- Folate (B9) deficiency – neural tube defects
- Thiamine (B1) deficiency – beri-beri, also lassitude & impaired mobility
Vitamin B12 in humans

Vitamin $B_{12}$, cobalamin (pernicious anaemia factor)
- Neuropathy and ‘malaise’
- Associated with cognitive impairment/decline

Source for human diet - animal products
- Not made by plants - only bacteria
- So strict vegetarians at risk of deficiency
- Reduced ability to absorb in elderly

Croft et al. (2005) Nature 438: 90-93
Croft et al. (2006) Eukaryotic Cell 5: 1175-1183
Algae need their vitamins – B12

- Nature’s most complex 1º metabolite
- Essential enzyme cofactor
- Only made by (subset) of bacteria
- Not made by plants or fungi
- Nor by algae – but many use and require it
Important Edible Algae – Sea Vegetables

- Porphyra (“laver”) and Pyropia (“nori”)
  - commercially important human foods based on high mineral, protein, and vitamin content

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Content mg per 100g dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$B_{12}$</td>
</tr>
<tr>
<td>Porphyra sp.$^1$</td>
<td>0.070</td>
</tr>
<tr>
<td>Liver$^2$</td>
<td>0.110</td>
</tr>
</tbody>
</table>


$^2$Wikipedia

$^3$provitamin A, ie β-carotene

2 µg/day is RDA for B12
Can algae provide bioavailable $B_{12}$?

**Increasing vitamin $B_{12}$ availability in India**

*Global Challenges Research Fund (GCRF) awards*

**Dietary intervention trials in Pune**

![Image of algae growth with edible bacteria]

![Image of Algal Biomass with high $B_{12}$ content]

**Algal growth with edible bacteria**

**Algal Biomass with high $B_{12}$ content**
Exploiting the mutualism to increase $B_{12}$ availability

- Sustainable natural production of vitamins for human consumption in long space missions

Adapted from https://www.melissafoundation.org/
• Don’t compete with traditional agriculture for land and potable/fresh water

• Fast growth rate (productivity - yield per unit time per unit area - may be 20x > land plants)

• Valuable compounds - vitamins, omega 3s, pigments (astaxanthin, beta carotene)

• Can be cultivated at industrial scale in photo-bioreactors
Algal Innovation Centre

- In Cambridge Botanic Garden

- Test facility to develop pipeline of algal-based solutions

- Autotrophic and Heterotrophic Growth – DEFRA licenced

http://www.camplants.group.cam.ac.uk/cambridge-bioenergy-initiative/algal-biotechnology-consortium-abc/aic
Circular photosynthesis- valorising waste

Using market/vegetable waste in Ghana

Crop waste

Anaerobic digestion

Digestate

Biogas

Animal feed

Algal growth

Algal biomass

Clean(er) water

Global Challenges Research Fund (GCRF) awards
Circular valorization aided by encapsulation

Dr David Aldridge  Dr David Willer

"Microencapsulated diets to improve bivalve shellfish aquaculture for global food security": https://www.sciencedirect.com/science/article/pii/S2211912418300336
Back to the future kitchen

Chlorella Colours

CHLORELLA Lime
CHLORELLA White
CHLORELLA Yellow

Join the revolution with our ground-breaking Chlorella Colours® platform
Back to the future kitchen

Microalgae biostimulant, bioprotectant for sustainable farming
Summary

- Algae, especially microalgae, are amazingly diverse

- Offer potential for many commercial exploitation

- Algae can be high in proteins, vitamins and other important nutritional compounds

- Algae, and their communities, may help provide more sustainable food sources in the future
Acknowledgements