



Lessons learned from commercial scale urban Spirulina production

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Main Topics

Benefits of Spirulina

About EnerGaia and our technology

Lessons learned from commercial Spirulina production

Research needed to address key challenges

Benefits of Spirulina Algae



Benefits of Spirulina

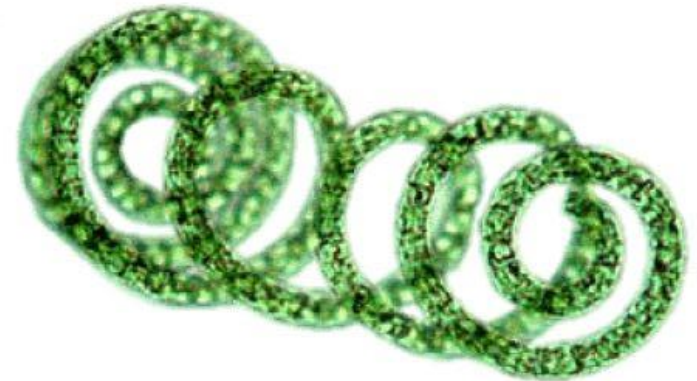


What is Spirulina?

Cyanobacteria which derives its name from the fact it looks like a spiral under the microscope. Grows best in 32 – 38 degC water.

Why is it special?

- Has the highest protein content of any natural food (60-65%) and is rich in antioxidants, minerals and vitamins with high absorption rates (> 80%).
- Large cell size (> 50 micron) makes it easy to harvest inexpensively
- Preference for highly alkaline environment (> 8.5 pH) reduces likelihood of contamination
- Long history of safe human consumption
- Not so difficult to grow



Benefits of Spirulina



Nutritional Benefits

Spirulina is a complete protein source, containing all eight essential amino acids plus an additional eight beneficial amino acids

Minerals contained in Spirulina include: Calcium, Iron, Magnesium, Potassium and Zinc

Contains Vitamins A, B, C and is a source beta-Carotene

A source of the anti-inflammatory γ -Linolenic acid or GLA

Simple sugar cell-wall making it easy to digest and absorb



Gen 2



Gen 3

Our technology and experience

- EnerGaia is a social enterprise based in Bangkok, Thailand
- More than 4-years of experience as a commercial Spirulina producer
- Innovative solution to solve cost vs. yield problem – Flexible system of linked bioreactors
- Currently 250,000 Liters of spirulina production volume – ***we are the largest closed-system Spirulina producer in the world***

If you would like to know more about us

<http://energaia.com/>

<http://www.aljazeera.com/programmes/earthrise/2014/12/rooftop-farming-20141216105542605874.html>

<http://www.theguardian.com/sustainable-business/2016/apr/07/spirulina-kale-thailand-urban-farming-environment-food>

Energaia Spirulina



System benefits

- Uses little space, flexible set up, easily scalable in small increments
- Controlled environment, eliminates contamination issues
- Little water usage
- Reduces CO2 emissions in the area it is located

Product benefits

Additionally, Energaia is the only company offering Spirulina in concentrated fresh paste form (70% water content, 4 week shelf life) as well as other innovative food products (Spirulina pastas, chocolate truffles, ice creams).

Our taste advantage allows for more creative uses in consumption.



Lessons learned applicable to MELiSSA



Production considerations

- The highest growth rates for Spirulina occur in water temperatures of 35 – 38 degC. Energy consumption for heating?
- Spirulina requires a highly alkaline environment (pH > 8.5). Typically maintained with NaHCO₃. Need to carry to space?
- The best Spirulina growth media (e.g. Zarrouck's) has more than 20 components. How to shift to available waste streams while maintaining productivity? And hygiene? And taste?
- Traditional Spirulina growth requires purging water from the system periodically. How to manage this efficiently in space?

Benefits of Spirulina



Spirulina is a highly concentrated super-food...

Nutritional Facts at a Glance

Here is something you may not have known...

SPIRULINA (dried) 10g
1 tablespoon



=



BEEF 165g
Protein

BEEF 30g
Iron

BANANA 32g
Magnesium



MILK 10g
Calcium

... but it means we have to be careful not to exceed maximum RDA values for some minerals (Iron) and Vitamins

SPINACH 36g
Zinc



Research needed for space applications of Spirulina

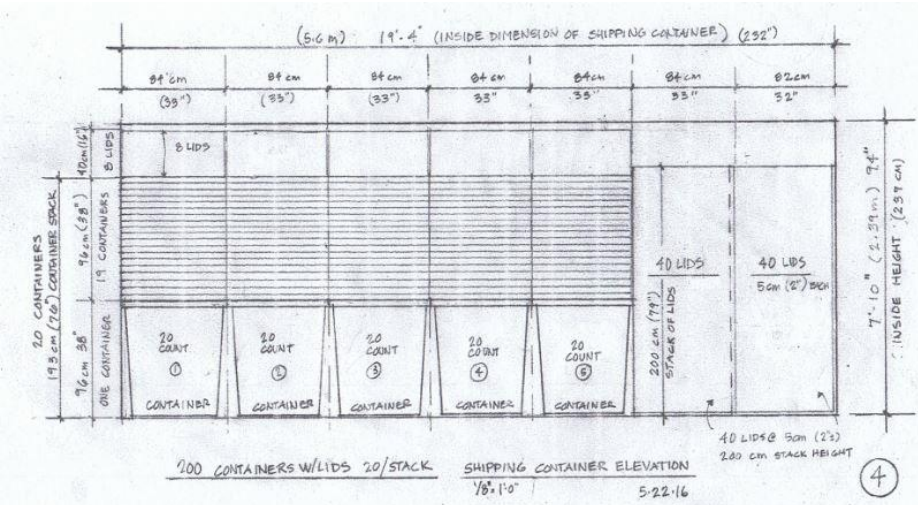
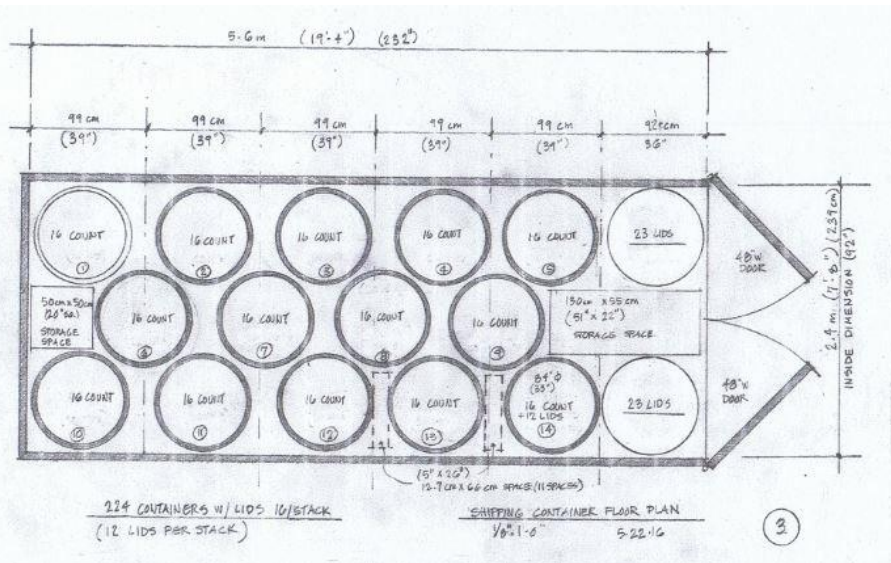
- Water temperature management system
- Growth media optimization with specifically available nutrient (waste) streams
- Efficient method to recycle purge water
- Maximum healthy Spirulina consumption levels
- Master culture management in space

Future Growth for EnerGaia



Terrestrial production kits

- Ship in standard 20ft sea containers
- All components for commercial production
- Easy to use for research pilots
- Can be used in developing world to combat malnutrition or for disaster relief





Stay Healthy,
Be Earthy.

Thank you