Seaweed residuals as fertilisers in agriculture

Ishita Ahuja and Anne-Kristin Løes

SIG Seaweed 5 Conference
Trondheim 27. november, 2019
OMRI Products List: About 140 products available as seaweed extracts/fertilisers in categories: Seaweed and Seaweed products/Fish products, liquid, stabilised, as per search on OMRI website, 25.11.2019.

- ASCO-SLE Liquid Seaweed Extract 0-0-6
  - Ruling Body: NOP
  - Status: Allowed
  - Product Code: aqu-2831
  - Classification: Crop Fertilizers and Soil Amendments
  - Category: Aquatic Plant Products, synthetically extracted
  - Company: OrganicOcean Inc.
  - Date Listed: 20-Dec-2011
  - Expiration: 01-Sep-2020

- Acadian Organic Liquid Seaweed Concentrate 0.1-0.0-5.0

- Actagro Elyxir Concentrated Foliar Solution 0-0-4

- Activ Liquid Seaweed Extract 0-0-5

- AgroKelp Fertilizante Orgánico Líquido Concentrado de Algas Marinas

- AgVerra AV Seaweed Extract

- Alga-Fusion Bioestimulante

- algabiol plant biostimulant fertilizante orgánico

- Algas Pacific NPKelp Seaweed Extract Liquid Organic Fertilizer

- Algas Pacific NPKelp Seaweed Extract Liquid Organic Fertilizer

OMRI determines which input products are allowed for use in organic production and processing, USDA and Canada - programs.

- Available as powder, cream, extracts or liquid fertilisers classified as Crop fertilisers and Soil Amendments.

- Most of them are from seaweeds only but some are blended with fish.

- Companies based in US, Canada, Mexico, China---and also Norway.
Some of the OMRI approved seaweed products

**GS Plant Foods:** Liquid Kelp is derived from *Ascophyllum nodosum*.

**BWF Banducci Inc.:** Super 6-1-1 Plus Kelp is a blended pelagic fish and seaweed high-nitrogen product.

**Trade Corporation International S.A.U.:** Phylgreen® Ascophyllum Nodosum Algae Pure Cold Extract Liquid Organic Fertilizer

**CATAWBA Enterprises:**

- **Fish Seaweed blend:** *A. nodosum* and the Humic & Fulvic Acids in Catawba Seaweed Blend
- **Seaweed powder:** *A. nodosum*, Humic & Fulvic Acids
Seaweeds - exploited through ages for fodder and fertiliser along Norwegian coast but lost value through modernisation of agriculture and production of mineral fertilisers.
Knotted wrack (*Ascophyllum nodosum*), collected along the coast of Norway, dried, grounded and extracted by acid/alkali to produce extracts - agriculture and animal feed.

This gives waste – we call it algae fibre - still has lot of nutrients.
Focus: How do we create a market for seaweed products and biomass to develop the seaweed industry?

So what's our aim: NORSØK studies-
Marine rest raw materials for fertilisers to organic agriculture (RESTOR)

- We initiated our work by getting Algae fibre from Algea AS.
### Algae fibre: nutritional parameters and heavy metals/trace elements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% DM</td>
<td>~22.5 - 30%</td>
</tr>
<tr>
<td>Organic C (% of DM)</td>
<td>31 - 32</td>
</tr>
<tr>
<td>Total N (% of DM)</td>
<td>1.2 - 1.5</td>
</tr>
<tr>
<td>P-Olsen (mg/100 g)</td>
<td>&gt; 25.0</td>
</tr>
<tr>
<td>Total P (g/kg DM)</td>
<td>2.3 – 3.6</td>
</tr>
<tr>
<td>Ca (g/kg DM)</td>
<td>48 - 68</td>
</tr>
<tr>
<td>K (g/kg DM)</td>
<td>74 - 130</td>
</tr>
<tr>
<td>Mg (g/kg DM)</td>
<td>11 - 25</td>
</tr>
<tr>
<td>S (g/kg DM)</td>
<td>11 - 15</td>
</tr>
<tr>
<td>pH</td>
<td>8.6 - 10</td>
</tr>
<tr>
<td>Cu</td>
<td>4 - 9.4</td>
</tr>
<tr>
<td>Zn (mg/kg DM)</td>
<td>82 - 110</td>
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<tr>
<td>Ni (mg/kg DM)</td>
<td>&lt; 1.5 - 4</td>
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<tr>
<td>Cd (mg/kg DM)</td>
<td>0.9 - 1.1</td>
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<tr>
<td>Pb (mg/kg DM)</td>
<td>&lt; 0.30</td>
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<tr>
<td>Hg (mg/kg DM)</td>
<td>0.08 - 0.3</td>
</tr>
<tr>
<td>Cr (mg/kg DM)</td>
<td>3.8 - 7</td>
</tr>
<tr>
<td>As (mg/kg DM)</td>
<td>27 - 33</td>
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</tbody>
</table>
Algae fibre as fertiliser

Pot experiment with Ryegrass

Field-pot experiment with Leek

Field-plot experiment with Oats
Pot experiment with ryegrass in 2018

First harvest

Dry matter yield: 0.41g 0.31g 0.43g

Soil Soil+Calcinit Soil+algae fibre

Second harvest

Dry matter yield: 0.46g 0.58g

Soil Soil+algae fibre
High pH in algae fibre, increased soil pH from 5.3 to 6.8, may be beneficial in acidic soil but may affect the uptake of plant nutrients where the uptake is affected by soil pH.

Concentrations of As in the algae fibre was high. Despite this, concentrations of As in ryegrass plants were below the limit of detection.

Algae fibre is high in K, which in combination with fish bones can give a more balanced NPK fertiliser, as fish bones have high N and P.

High K in algae fibre, may lead to luxury uptake, decreasing uptake of Ca and Mg with potentially negative health effects in animals, of particular concern especially in forage crops for dairy cows.
Effect of fish bones and algae fibre as fertilisers for ryegrass

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Ishita Ahuja og Anne-Kristin Læsø, NORSØK

https://orgprints.org/36439/
Field experiment with oats 2019: Application of algae fibre to soil
Field experiments: Experimental Design

Crops: Oats (160 kg N/haa) and leek (320 kg N/ha)

Treatments:
Control – No Nitrogen (N)
Mineral fertiliser: Calcinit (CaNO3)
«Grønn Øko» Green Organic (poultry manure) 8 % N
Fish bones 6 % N
Algae fibre 0.4 % N
Fish bone (70% N) + algae fibre (30% N)
People in action during harvesting of oats on 31st July
Field-plot experiment with oats: Main conclusions so far-----

- Algae fibre in combination with fish bones resulted in high yield.
- Algae fibre is high in K, which in combination with fish bones can give a more balanced NPK fertiliser, as fish bones have high N and P.
Field-pot experiment with leek (*Allium porrum*) plants

Leek plants on 27\textsuperscript{th} May

Leek plants on 3\textsuperscript{rd} September

Soil

Soil + algae + fibre

Soil + fish bones + algae fibre
Leek plants on 3rd September

Fresh yield per plant

Soil: 4.0 g
Soil + Green Organic: 9.8 g
Soil + algae fibre: 30.3 g
Soil + algae fibre + fish bones: 42.1 g
Algae fibre is high in K, which in combination with fish bones can give a more balanced NPK fertiliser, as fish bones have high N and P.

- Algae fibre showed better effect on leek plants due to long growth period.

Field-pot experiment with leek: Main conclusions so far:

![Bar chart showing dry matter yield with ES, ES+GO-N2, ES+FB-N2, ES+AF-N2, ES+AF+FB-N2 treatments. The ES+AF+FB-N2 treatment has a yield of 21.3 g.]
Acknowledgements

Marine rest raw materials for fertilisers to organic agriculture (RESTOR)

Pathways to phase-out contentious inputs from organic agriculture in Europe

Funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No [774340 — Organic-PLUS]).

Anne de Boer       Hanne Dahlen    Marius Bless          Morten Rørdam

Peggy Haugnes  Tatiana Rittl
Why not work together and generate a new fertiliser product from the seaweed processing waste?

Thank you for your attention

https://www.omri.org/ubersearch/results/seaweed
https://www.catawbrand.com/agriculture
http://tradecorp.mx/product/phylgreen/
http://www.bwfbanducci.com/
https://www.algebra.com/index.php/algeafert-solid-g
https://www.omri.org/ubersearch/results/algebra
https://www.aftenbladet.no/lokalt/i/jLxGw/hvorfor-saa-mye-tang-og-tare-paa-stranden
https://www.ntnu.edu/employees/sverre.m.myklestad
Seaweeds as fertilizer: Some bits from the Norwegian history

- **Myklebust** (Sunnmore); "Tang og tare er ansett som en meget god gjødning til eng, og hovedmassen blir brukt slik, men den blir også mye brukt til havre og bygg".

- **Sverre Myklestad**, in a report entitled *Noen Gjødslingsforsøk med Tang og Tare, Norsk Institutt for Tang- og Tareforskning*, writes that in a book "*Norges Naturlige Historie*" from 1752, bishop Pontoppidan described use of seaweed as fertiliser.

- Results from the studies using seaweed as fertiliser for potato, conducted by Dr. E. Solberg, Statens Landbrukskjemiske Kontrollstasjon i Trondheim (1901-1904), are discussed.

- **Myklestad 1963**, *Experiments with seaweed as supplemental fertiliser*, Norwegian Institute for Seaweed Research, Trondheim. Field experiments were carried out on turnips, odder beets and cauliflower in 1958-1960.
### Algae fibre: What about arsenic?

<table>
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<th>Class 0</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
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<tbody>
<tr>
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### QUALITY CLASSES:

- **Class 0**: may be applied according to crop demands on all types of land.
- **Class I**: may be used in amounts up to 40 tons of DW/ha of agricultural land over a period of 10 years, or applied as a top layer up to 5 cm on land not used for growing of food or feed crops.
- **Class II**: may be used in amounts up to 20 tons of DW/ha of agricultural land over a period of 10 years or applied as a top layer as described for class I products.
- **Class III**: may be used as a top layer as described for class I and II or used as a top layer up to 15 cm to cover waste deposits.

As Arsenic, B Boron, Cd Cadmium, Co Cobalt, Cr Chromium, Cu Copper, Fe Iron, Hg Mercury, Ni Nickel, Pb Lead, Mn Manganese, Mo Molybdenum, Zn Zinc.

**Soil conditioners in**

- **Class 0**: may be applied according to crop demands on all types of land.
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