European Commission

European Climate, Infrastructure and Environment Executive Agency

Study to support a Sustainable EU Algae Industry

2024-2025

This study explored algae's potential to:

- Replace fish-based aquafeed with algae-based feed
- Produce biofertilisers and biostimulants
- Treat (waste)water
- Help mitigate climate change
- Contribute to sustainable food and feed systems

The study also investigated wild seaweed harvesting and beach cast collection across the EU.

Wild harvesting and beach cast collection

130k tonnes Wild algae harvested in the EU annually

1.17 million tonnes Total amount of beach cast in the EU

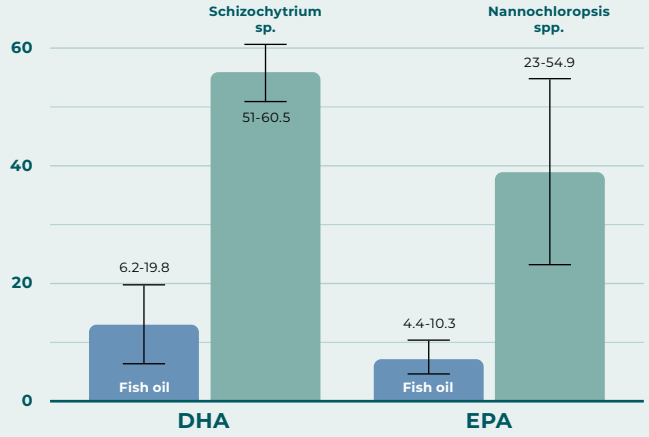
132.7k tonnes Of beach cast collected annually across 12 EU countries

Algae as feed

Using algae to replace fish-based aquafeed:

- Both micro- and macroalgae can be used for bioactive compounds/ functional additives (e.g., pigments)
- **Main advantages:** similar to fish-based feed in efficiency, fish growth and fish health, improved fish quality, fewer contaminants, more stable supply, improved environmental sustainability
  - DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid) in microalgae can be higher than some fish species

EPA and DHA in selected fish species and algae [mg/g dry weight]



up to 79% Reduction in dioxin-like PCBs when switching to algae oil[2]

up to 70% Reduction in dioxins and furans when switching to algae oil[1]

up to 60% Microalgae protein content with suitable amino acid profile

30-40% lower Environmental impacts are context specific. One algae producer concluded that their algae-based Omega-3 DHA has a carbon footprint 30-40% lower than traditional fish oil[3]

5% Algal inclusion could reduce the current forage fish dependency ratio (FFDR) by 32% (salmonids) and 26% (marine finfish)

- **Challenges:** higher production cost (approx. 10% higher), environmental performance depends on the specific production factors (e.g., size of facility, use of circular approaches)
- **Outlook:** 120k tonnes of fish-based ingredients could be replaced by 85k tonnes of algae ingredients by 2030

Where are underwater seaweed forests located in Europe? Check out this map, which was developed during the study.

Credits: iStock

CLICK HERE FOR A MORE DETAILED MAP

Credits: Roheline Vihmavari

Algae as fertiliser and water bioremediation solution

Using algae as a fertilising product (also suitable for organic farming):

- **Key species:** All species could be used as they are nutrient-rich and contain potentially crop stimulating molecules. The species best suited for the local growing conditions should be chosen.
- **Main advantages:**
  - Can reduce nutrient leaching and eutrophication risks
  - Algae-based biostimulants are promising new generation products that can improve plant health
  - Nutrient removal potential of algae from eutrophicated waters: 150 kgN/km²/y and 30 kgP/km²/y
- **Challenges:**
  - High cost; low production volumes
  - Missing field data for several types of applications
- Approx. 20% incorporation into mineral fertilisers offers benefits while mitigating the challenges

Harnessing valuable circular nutrients from industrial liquid side streams and wastewaters by recovering them into microalgae biomass holds significant potential to bridge both the economic and supply gap in fertiliser production. This approach may also be compatible with organic farming practices in some effluents:

Most suitable effluents

Urban wastewater

Best suited for small communities with stable and suitable weather conditions

Economically viable if biomass can be sold or valorised

Legal status of sewage sludge limits uses as fertilising product

Horticulture effluent

Possible to implement in hydroponics facilities and existing greenhouses

Potential presence of pesticides and pathogens

Effluents for organic certification

Treated or untreated winery and brewery effluents

Seasonally available

Treatment of effluents for removing the COD (sugars) before use is optional, as microalgae can convert sugars to biomass

Plant-based digestate

High yearly availability; typically co-located in industrial symbiosis setups.

Simultaneous availability of CO_2 gas supply

Need for a proper dosing to avoid ammonia toxicity

Other potential effluent

Aquaculture effluent and manure-based digestate

Large volumes of effluent required

Best to implement as industrial symbiosis with an external algae producer

Potential presence of antibiotics and pathogens

Credits: iStock

Algae and climate change mitigation

Macroalgae contributes to climate mitigation via ocean-based sequestration: CO_2

902k km² Area of underwater seaweed forests

37.9 million tonnes Carbon stored in underwater seaweed forest biomass

23.5 million tonnes Annual carbon sequestration by natural seaweed forests

1.1 million tonnes Annual potential carbon sequestration by seaweed cultivation

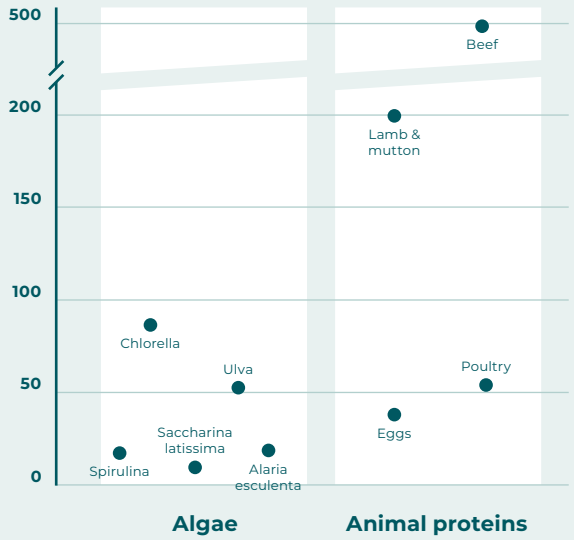
Restoring seaweed forests:

- **Advantages:**
  - Solution that can be implemented now, provided that MRV is improved
  - Benefits for biodiversity and resilience
- **Priority areas for restoration:**
  - The Iberian Peninsula (in particular the Bay of Biscay)
  - Parts of the Mediterranean
  - Opportunities for targeted restoration in the North Sea and British Isles

However! Cultivation for carbon sequestration (with biomass sinking) needs to be further investigated before being upscaled, particularly regarding environmental impacts and the development of a robust MRV framework for carbon credits.

Consuming algae instead of other protein sources can also reduce the GHG footprint of the food we consume:

Comparison CO_2eq. kg per kg protein produced



Further information

VIEW THE EXECUTIVE SUMMARY OF THE STUDY, ITS FINAL REPORT AND ANNEXES HERE

[1] Zatti et al. (2023) Full replacement of fish oil with algae oil in farmed Atlantic salmon (Salmo salar) – Debottlenecking omega 3. Aquaculture 574:739653. https://doi.org/10.1016/j.aquaculture.2023.739653

[2] Davis et al. (2021) Life cycle assessment of heterotrophic algae omega-3. Algal Research 60:102494. https://doi.org/10.1016/j.algal.2021.102494

[3] Davis et al., (2021) "Life cycle assessment of heterotrophic algae omega-3" Algal Research 60:102494, https://doi.org/10.1016/j.algal.2021.102494

Consortium partners

Trinomics · NORD University · s.Pro sustainable projects · Latvijas Hidroekoloģijas institūts · Ghent University · Møreforsking · Roheline Vihmavari OÜ · technopolis group

Read more in CINEA's report

European Climate, Infrastructure and Environment Executive Agency (CINEA)

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