

BioWALK4Biofuels project: Algae & biogas

Types and species

Algae is a large and diverse group of organisms consisting of tiny unicellular microalgae to large seaweeds. Algae, like the plants, typically live from photosynthesis capturing the energy from sunlight to build simple sugars from water and CO₂. Unlike the plants algae do not have roots, seeds or complex organs, and they can have very complex lifecycles.

Where the microalgae derive from at least 9 evolutionary different groups of organisms (Phylae), the macroalgae or seaweeds are only represented in three different groups: Green algae (Chlorophytes), red algae (Rhodophytes) and brown algae (Phaeophytes (Heteroconts)).

Depending on the particular species, seaweeds contain different types of valuable carbohydrates, proteins, oils, minerals and vitamins.

Globally, seaweeds are cultivated and harvested from natural resources to be used for food, feed and fertilizer in the order of 11 mio tonnes per year.

This project is concerned with the production of 2nd generation biofuel from macroalgae.

Five focus species have been selected based on their fast growth rate and promising biochemical composition for production of biogas. Three of these species are green algae and one is a red algae. All four species are pseudo-ephemeral and can be re-produced by protoplast technology.

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1. *Ulva lactuca* (green algae). *U. lactuca* (sea lettuce) has thin sheet-like fronds consisting of two layers of cells. It is a cosmopolitan species with a global distribution and growth rates up to 30% per day. It often is the cause of green tides in coastal areas with high nutrient loads. This species is utilised for human consumption and compost.



The largest production yield of up to 74 dry ton per hectare has been demonstrated in the US Aquatic Species Programme. Research has documented a methane yield from *U. lactuca* of between 77-560 ml per g volatile solids (VS). This is equivalent to the yield from cattle manure and land based energy crops, such as grass-clover. Direct combustion of *U. lactuca* biomass is problematic due to a high ash content and a high content of alkali metals in the ash.

2. *Chaetomorpha linum* (green algae). *C. linum* (spaghetti algae) is a filamentous green algae with a global distribution. It thrives in marine and brackish waters, where it often forms dense mats. *C. linum* has been proved to be useful as animal feed. A methane yield of 125-480 ml per g VS has been demonstrated from *C. linum*.



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3. Enteromorpha sp. Ulva sp. (green algae). This alga has short and slim delicate sheet or tube-like fronds. It has a global distribution and is used for human food in Asia, where it is harvested to prepare aonori. Enteromorpha is also sold as seaweed meal for feed and fertiliser. Yields of up to 28 dry g per m² per day are reported. This species has successfully been converted to bio-oil by hydrothermal liquefaction.



4. Gracilaria sp. (red algae). Gracilaria sp. is typically branched and forms up to 60 cm long bushes. It is found in warm and temperate waters, and is spreading rapidly as an invasive species in northern temperate regions. Gracilaria sp. is notable for its economic importance due to its high content of agar, but is also used as a food for humans and various species of shellfish. Various species within the genus are cultivated in the developing world, including Asia, South America, Africa and Oceania. Annual production yield is reported to be up to 127 dry ton per hectare. Methane yields of 83-540 ml per g VS are demonstrated.

