Ten things the research says about processing Ulva (sea lettuce)

Ulva fenestrata, Ulva lactuca, Ulva rigida and other Ulva species

These ten points come from peer-reviewed studies summarised in the SIRPUTIS research library. Each figure is taken from the paper named in brackets, with the scale of the study (Lab, Pilot, Field, Survey or Model). They are our reading of the literature, not results of SIRPUTIS tests, and conditions in a real plant will differ.

1. **Harvest early for protein.** Crude protein fell from 20.79 % of dry weight on 1 April to 4.67 % in mid June, while lead rose from 13 to 368 µg/kg fresh weight. [Field: Steinhagen et al. 2022, Frontiers in Marine Science]
2. **Fresh Ulva keeps days, not weeks.** Shelf life was 6 days at 16 °C and up to 10 days at 4 °C, with about 8 to 9 % drip loss by the end of storage. [Lab: Sánchez-García et al. 2021, Foods]
3. **Washing is a product step.** A fresh-water wash gave a salt yield of up to 29 % and 36 % of the biomass of two Ulva species and raised protein by 11 to 24 %. [Lab: Magnusson et al. 2016, Algal Research]
4. **Cut before you shear.** Hand pre-cutting to 1 x 1 cm raised the maximum protein yield to 48 %, in a dilute suspension of 10.7 g of biomass per kg. A short high-speed cutting stage before slower shearing used 79 to 86 % less energy, but still 11 kWh/kg dry weight or more, above the 4.8 kWh/kg held in the biomass. [Lab: Postma et al. 2018, Journal of Applied Phycology]
5. **Do not dry before a wet extraction.** In preliminary tests, fresh Ulva gave a 15.9 % soluble protein yield, against 5.6 % after mild pre-drying. [Lab: Postma et al. 2018, Journal of Applied Phycology]
6. **A press starts the cascade.** Mechanical pressing alone recovered 5.0 % of the protein; pressing and then alkaline extraction of the pulp recovered 23.9 %, because the pulp protein precipitated better. [Lab: Juul et al. 2022, Food and Bioproducts Processing]
7. **Drying temperature is a product choice.** Drying took about 15 h at 25 °C, which gave the most chlorophyll and lutein. Yellowing was strongest at 60 °C, where ulvan recovery tended to rise, to a mean of 37 %. [Lab: Silva et al. 2019, Marine Drugs]
8. **Hot blanching costs vitamin B12.** Blanching at 60 °C for 3 min cut B12 by 45 %, while a 3 min soak in 16 °C fresh water had no effect and oven-drying kept B12 through 4.8 months. [Lab: Trigo et al. 2025, Food Chemistry]
9. **Hot water can replace acid.** Heating dried, milled Ulva in water up to 160 °C recovered 23 % of the ulvan without acid, and the residue had about double the methane potential of untreated biomass. The authors suggest the route for wet Ulva but did not test it. [Lab: Rodríguez-Iglesias et al. 2024, Science of the Total Environment]
10. **Lower in toxic elements at one site, but with limits.** Ulva had the lowest toxic-element levels of four species from one site, but its sulphur load suggests at most 5 to 10 % in an animal diet. [Survey: Jönsson and Nordberg Karlsson 2023, Journal of Applied Phycology; Lab: Bikker et al. 2016, Journal of Applied Phycology]

Questions to ask before you design a line

- Is the Ulva grown at sea or on land, in which harvest window, and what protein level do you need?
- How many hours pass from harvest to chilling, and at what temperature is the biomass held?
- Is the salt removed in washing a product or a waste stream, and how much fresh water is available?
- What is the end product: green food, protein, ulvan or feed? That sets the drying temperature and the pretreatment.
- How much fouling and epiphyte load must washing and sorting handle late in the season?
- Who tests lead and arsenic per batch?
- How much energy per kg of product can the disruption step afford?

Sources

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2. Sánchez-García F et al. (2021). Freshness Quality and Shelf Life Evaluation of the Seaweed Ulva rigida through Physical, Chemical, Microbiological, and Sensory Methods. Foods 10(1):181. https://doi.org/10.3390/foods10010181 (open access, CC BY 4.0; scale: laboratory (chilled storage)).

3. Magnusson M et al. (2016). Seaweed salt from Ulva: A novel first step in a cascading biorefinery model. Algal Research 16:308-316. https://doi.org/10.1016/j.algal.2016.03.018 (closed access; abstract free at the publisher; scale: laboratory).
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5. Juul L et al. (2022). Combining pressing and alkaline extraction to increase protein yield from Ulva fenestrata biomass. Food and Bioproducts Processing 134:80-85. https://doi.org/10.1016/j.fbp.2022.05.006 (open access, CC BY 4.0; scale: laboratory).
6. Silva AFR et al. (2019). Effect of Oven-Drying on the Recovery of Valuable Compounds from Ulva rigida, Gracilaria sp. and Fucus vesiculosus. Marine Drugs 17(2):90. https://doi.org/10.3390/md17020090 (open access, CC BY 4.0; scale: laboratory).
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9. Jönsson M, Nordberg Karlsson E (2023, issue 2024). Chemical food safety of seaweed: Species, spatial and thallus dependent variation of potentially toxic elements (PTEs) and techniques for their removal. Journal of Applied Phycology 36(2):765-781. https://doi.org/10.1007/s10811-023-03131-8 (open access, CC BY 4.0; scale: field sampling and analysis).
10. Bikker P et al. (2016). Biorefinery of the green seaweed Ulva lactuca to produce animal feed, chemicals and biofuels. Journal of Applied Phycology 28(6):3511-3525. https://doi.org/10.1007/s10811-016-0842-3 (open access, CC BY 4.0; scale: laboratory).
