Ten things the research says about processing brown kelp

Sugar kelp (Saccharina latissima), winged kelp (Alaria esculenta) and oarweed (Laminaria digitata)

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. **Blanching removes most of the iodine.** A short blanch cut iodine by 85 to 95 % in sugar kelp and by 80 to 92 % in winged kelp. Seawater at 80 °C for 2 min left 5 % of sugar kelp iodine, against 7 % in tap water. [Lab: Sletta et al. 2025, Foods]
2. **Load and water reuse change the result.** Going from 50 to 500 g of kelp per litre lowered iodine removal and dropped the water temperature by about 20 °C. The water served at least 10 batches of winged kelp, but sugar kelp results fell by the 5th reuse. [Lab: Sletta et al. 2025, Foods]
3. **Metals do not wash out.** Three rinses and 15 min of boiling removed 85 % of the iodine and 43 % of the arsenic, but not cadmium, lead or mercury. [Lab: Blikra et al. 2021, Foods]
4. **Heaters must recover fast.** Adding 511 g of kelp to 5 L of boiling water dropped it from 99.3 to 92.2 °C, and the return to 99 °C took about 7.4 min. [Lab: Blikra et al. 2021, Foods]
5. **Protein lines need a milder blanch.** Blanching at 45 °C kept protein yield and amino acids and gave an extract with 49 % less iodine. [Lab: Trigo et al. 2023, Food Chemistry]
6. **Untreated kelp presses poorly.** Untreated kelp gave up under 1 % of its water to a screw press in earlier studies. Air drying or an acid treatment before pressing raised dry matter. [Lab: Gallagher et al. 2018, Journal of Applied Phycology]
7. **Tough kelp and stones wear the cutters.** Oarweed needed a second pass through a mill set to 4 mm^2, holdfast stones nicked the blades, and common stainless steels do not resist hydrochloric acid. [Pilot: Adams et al. 2021, Journal of Marine Science and Engineering]
8. **Hot air suits nutrients, less so texture.** Air at 70 °C matched 25 °C and freeze-drying for nutrients in less time, but lowered rehydration. [Lab: Stévant et al. 2018, Journal of Applied Phycology]
9. **Storage buys time at a price.** Ensiling worked without an inoculant but cost 32 % of the crude protein. Formic acid preservation raised alginate yield by up to 40 %, and at 4 °C kept alginate at 350 to 500 kDa for up to 16 weeks. [Lab: Campbell et al. 2020, Animals; Lab: Nøkling-Eide et al. 2023, Algal Research]
10. **The cascade sets the economics.** A pilot cascade recovered 23.4 % (sugar kelp) and 26.3 % (winged kelp) of dry matter as four polysaccharides. In a modelled cascade, drying and process heat made up 37 to 70 % of the carbon footprint. [Lab and pilot: Birgersson et al. 2023, Algal Research; Model: Zhang and Thomsen 2021, Algal Research]

Questions to ask before you design a line

- What are the dry matter and temperature of the kelp at intake, and how many hours pass between harvest and the first process step?
- Which species and harvest months will the line run, and who tests iodine, cadmium and arsenic per batch?
- What iodine level must the product meet, and is it sold as food, feed or raw material for extraction?
- Will blanching use seawater or fresh water, at what load per litre, and how often is the water changed?
- What is the highest drying temperature the product tolerates for colour, texture and rehydration?
- How will kelp be held through harvest peaks: chilling, freezing, ensiling or acid?
- Which acids or chemicals touch the product, and which materials of construction follow from that?
- Where do blanch water, press juice and silage effluent go?

Sources

1. Sletta MS et al. (2025). Blanching of Two Commercial Norwegian Brown Algae for Reduction of Iodine and Other Compounds of Importance for Food Safety and Quality. Foods 14(23):4113. https://doi.org/10.3390/foods14234113 (open access, CC BY 4.0; scale: laboratory (500 g batches)).
2. Blikra MJ et al. (2021). Saccharina latissima Cultivated in Northern Norway: Reduction of Potentially Toxic Elements during Processing in Relation to Cultivation Depth. Foods 10(6):1290. https://doi.org/10.3390/foods10061290 (open access, CC BY 4.0; scale: laboratory (5 L pot)).

3. Trigo JP et al. (2023, online 2022). Mild blanching prior to pH-shift processing of Saccharina latissima retains protein extraction yields and amino acid levels of extracts while minimizing iodine content. Food Chemistry 404(Pt A):134576. https://doi.org/10.1016/j.foodchem.2022.134576 (open access, CC BY 4.0; scale: laboratory).
4. Gallagher JA et al. (2018). Species variation in the effects of dewatering treatment on macroalgae. Journal of Applied Phycology 30(4):2305-2316. https://doi.org/10.1007/s10811-018-1420-7 (open access, CC BY 4.0; scale: laboratory (40 to 50 g samples, small screw press)).
5. Adams JMM et al. (2021). Food-Grade Biorefinery Processing of Macroalgae at Scale: Considerations, Observations and Recommendations. Journal of Marine Science and Engineering 9(10):1082. https://doi.org/10.3390/jmse9101082 (open access, CC BY 4.0; scale: pilot (batches of 50 to 200 kg)).
6. Stévant P et al. (2018). Effects of drying on the nutrient content and physico-chemical and sensory characteristics of the edible kelp Saccharina latissima. Journal of Applied Phycology 30(4):2587-2599. https://doi.org/10.1007/s10811-018-1451-0 (publisher version closed; free accepted version: https://hdl.handle.net/11250/2494003; scale: laboratory).
7. Campbell M et al. (2020). The Effect of Ensiling on the Nutritional Composition and Fermentation Characteristics of Brown Seaweeds as a Ruminant Feed Ingredient. Animals (Basel) 10(6):1019. https://doi.org/10.3390/ani10061019 (open access, CC BY 4.0; scale: laboratory (lab silos)).
8. Nøkling-Eide K et al. (2023). Acid preservation of cultivated brown algae Saccharina latissima and Alaria esculenta and characterization of extracted alginate and cellulose. Algal Research 71:103057. https://doi.org/10.1016/j.algal.2023.103057 (open access, CC BY 4.0; scale: laboratory).
9. Birgersson PS et al. (2023). Sequential extraction and fractionation of four polysaccharides from cultivated brown algae Saccharina latissima and Alaria esculenta. Algal Research 69:102928. https://doi.org/10.1016/j.algal.2022.102928 (publisher version closed; free accepted version: https://hdl.handle.net/11250/3141439; scale: laboratory optimisation and a pilot-scale run).
10. Zhang X, Thomsen M (2021). Techno-economic and environmental assessment of novel biorefinery designs for sequential extraction of high-value biomolecules from brown macroalgae Laminaria digitata, Fucus vesiculosus, and Saccharina latissima. Algal Research 60:102499. https://doi.org/10.1016/j.algal.2021.102499 (open access, CC BY 4.0; scale: model (techno-economic and footprint assessment)).
