Eksperimentell tareprosessering i SusKelpFood prosjektet

Oslo 15. august 2024

Dagbjørn Skipnes og Marthe Jordbrekk Blikra

Bidragsytere:
Tone Mari Rode, Torstein Skåra, Ingrid Maribu, Randi Sund og Mette Risa Vaka.

Nofima
Norwegian Institute of Food, Fisheries and Aquaculture Research

Oversikt over prosesseringsmetoder i SusKelpFood

PEF

Blansjering

Fermentering

Frysing og tining

Syrekonservering

Ultralyd
+ tørking

Mikrobølger
+ tørking

PEF

Blansjering

Fermentering

Frysing og tining

Syrekonservering

Ultralyd
+ tørking

Mikrobølger
+ tørking

Manglende data eller databehandling

PEF

Blansjering

Fermentering

Frysing og tining

Randi presenterer

Syrekonservering

Ultralyd
+ tørking

Mikrobølger
+ tørking

Manglende data eller databehandling

Presenteres her

PEF

Blansjering

Fermentering

Frysing og tining

Randi presenterer

Syrekonservering

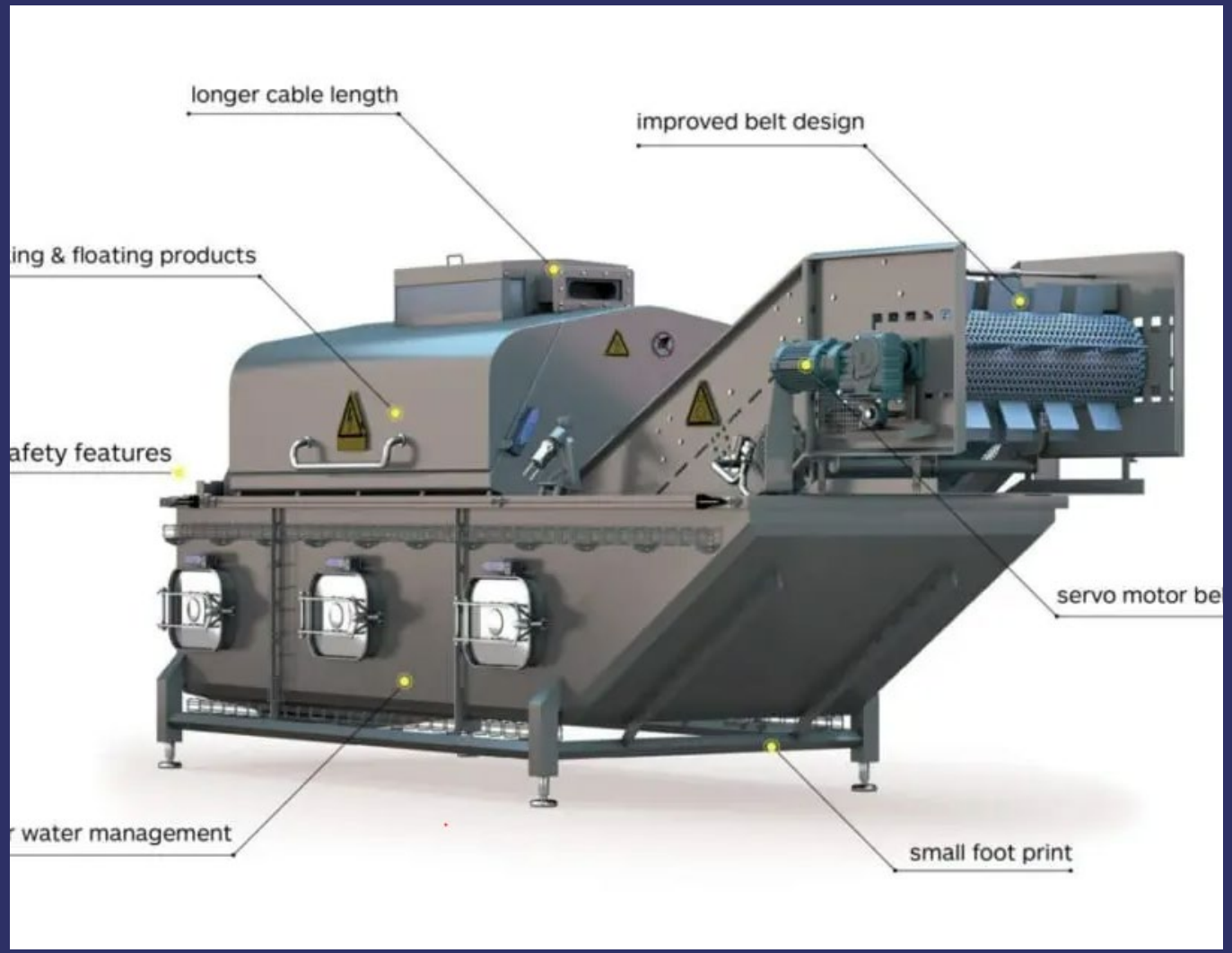
Ultralyd + tørking

Mikrobølger + tørking

Manglende data eller databehandling

PEF & blansjering

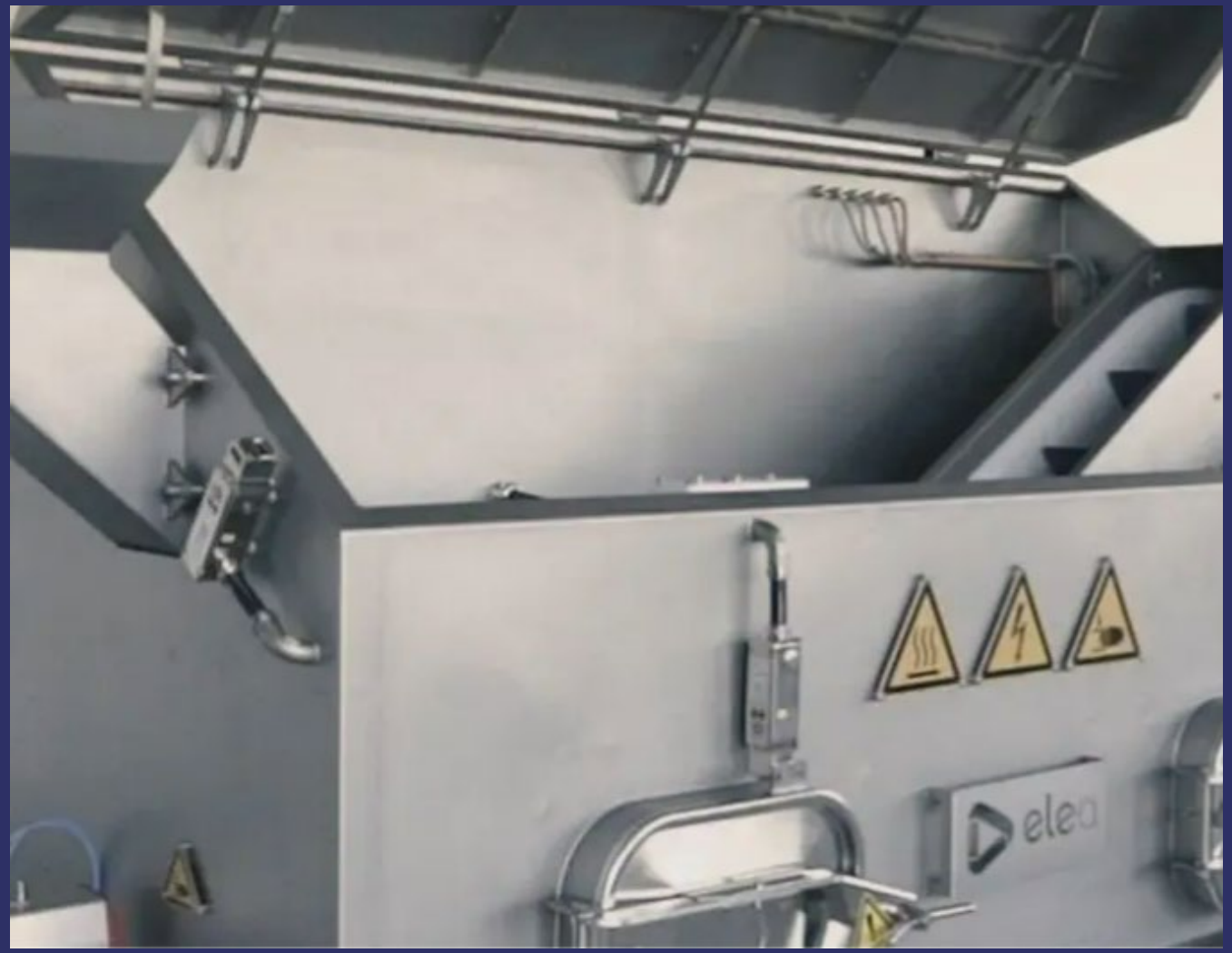
Are there PEF systems large enough for efficient kelp processing?



A better question: Are there commercial PEF systems that are so small that they may be used for kelp.

Left: Elea potato processing unit 100 t/h.

Currently no kelp producer in Norway operate in this range.



Smallest continous system of Elea.

May be run between 1 and 7.5 t/h

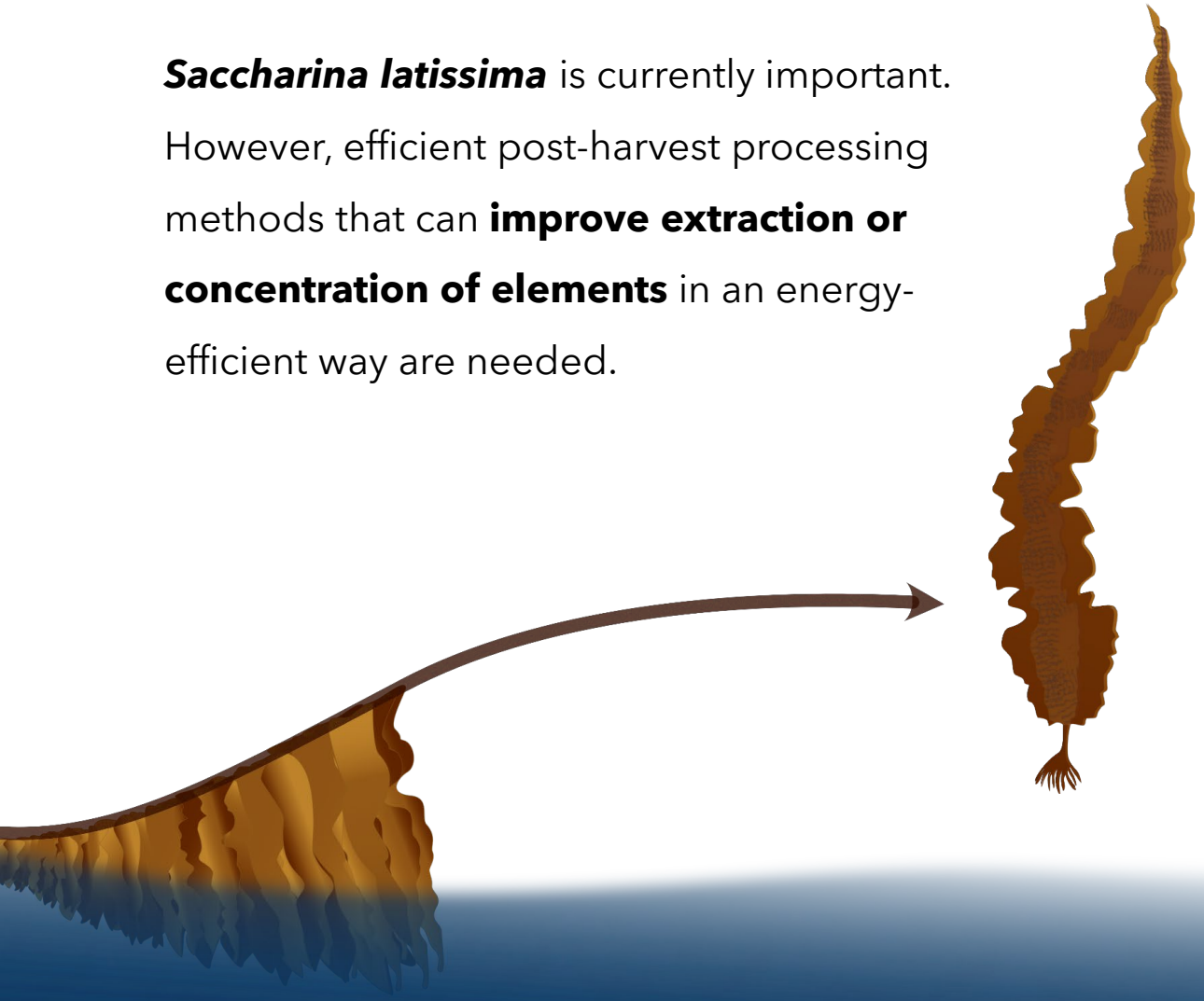
Large enough for processing a yearly produce in less than one week (running 8 h /day)

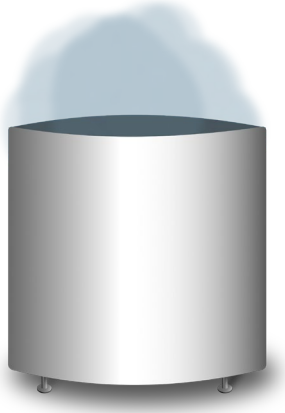
POWER SUPPLY

400/415 V, 50 Hz (3Phase/Ground), 32 A for B1 mini, 63A for B1.

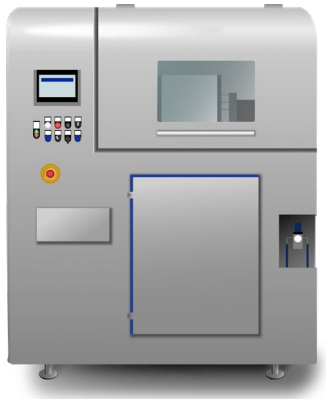
Background

Saccharina latissima is currently important. However, efficient post-harvest processing methods that can **improve extraction or concentration of elements** in an energy-efficient way are needed.





Blanching is currently the most used method for iodine reduction. However, this is a very energy-demanding process.



Pulsed electric field (PEF) has been shown to reduce iodine content in *S. latissima* and improve extraction of other elements

PEF parameters

- Seaweed 500.5 ± 0.3 g immersed in 5 L tap water
- Electrode voltage of 24 kV; electrode distance 24 cm
- Frequency 30 Hz;
- Pulse width of 6 us
- PEF1: Pulse count 200; Energy 2.7 ± 0.3 J/g
- PEF2: Pulse count 800; Energy 14.4 ± 1.0 J/g

LWT - Food Science and Technology 169 (2022) 114033

Contents lists available at ScienceDirect

LWT

journal homepage: www.elsevier.com/locate/lwt

On the use of pulsed electric field technology as a pretreatment to reduce the content of potentially toxic elements in dried *Saccharina latissima*

Marthe Jordbrekk Blikra *, Dagbjørn Skipnes, Torstein Skåra

Department of Processing Technology, Seafood Division, Nofima AS, P.O. Box 8034, NO-4068, Stavanger, Norway

On the use of pulsed electric field technology as a pretreatment to reduce the content of potentially toxic elements in dried Saccharina latissima - ScienceDirect

The content of PTEs (mg/kg dry sample) and the dry matter content (g/100 g wet weight) of samples of *Saccharina latissima*

Sample name	Data (mg/kg dry sample)				Limits (mg/kg)		
	Pos. control	PEF (1)	PEF (2)	Freeze-thawed	EU – food supplement*	EU – algae as food**	France***
Iodine[1]	4700 ± 600[a]	2700 ± 100[b]	2900 ± 300[b]	4400 ± 300[a]	none	none	2000
Arsenic[2]	71±7[a]	63±9[a]	63 ± 12[a]	65±1[a]	none	none	iAs: 3
Cadmium[2]	2.1 ± 0.5[a]	1.9 ± 0.1[a]	2.1 ± 0.5[a]	2.2 ± 0.3[a]	3.0	none	0.5
Mercury[2]	0.029 ± 0.003[a]	0.023 ± 0.002[b]	0.024 ± 0.001[b]	0.026 ± 0.004[ab]	0.1	0.01	0.1
Lead[2]	0.9 ± 0.6[a]	1.8 ± 1.1[a]	5±7[a]	1.4 ± 0.7[a]	3.0	none	5
Dry matter[1]	91.3 ± 0.2[a]	90.2 ± 0.3[b]	89.8 ± 0.2[b]	90.3 ± 0.4[b]			

On the use of pulsed electric field technology as a pretreatment to reduce the content of potentially toxic elements in dried Saccharina latissima - ScienceDirect

Input energy required for processing of kelp and the associated iodine reduction

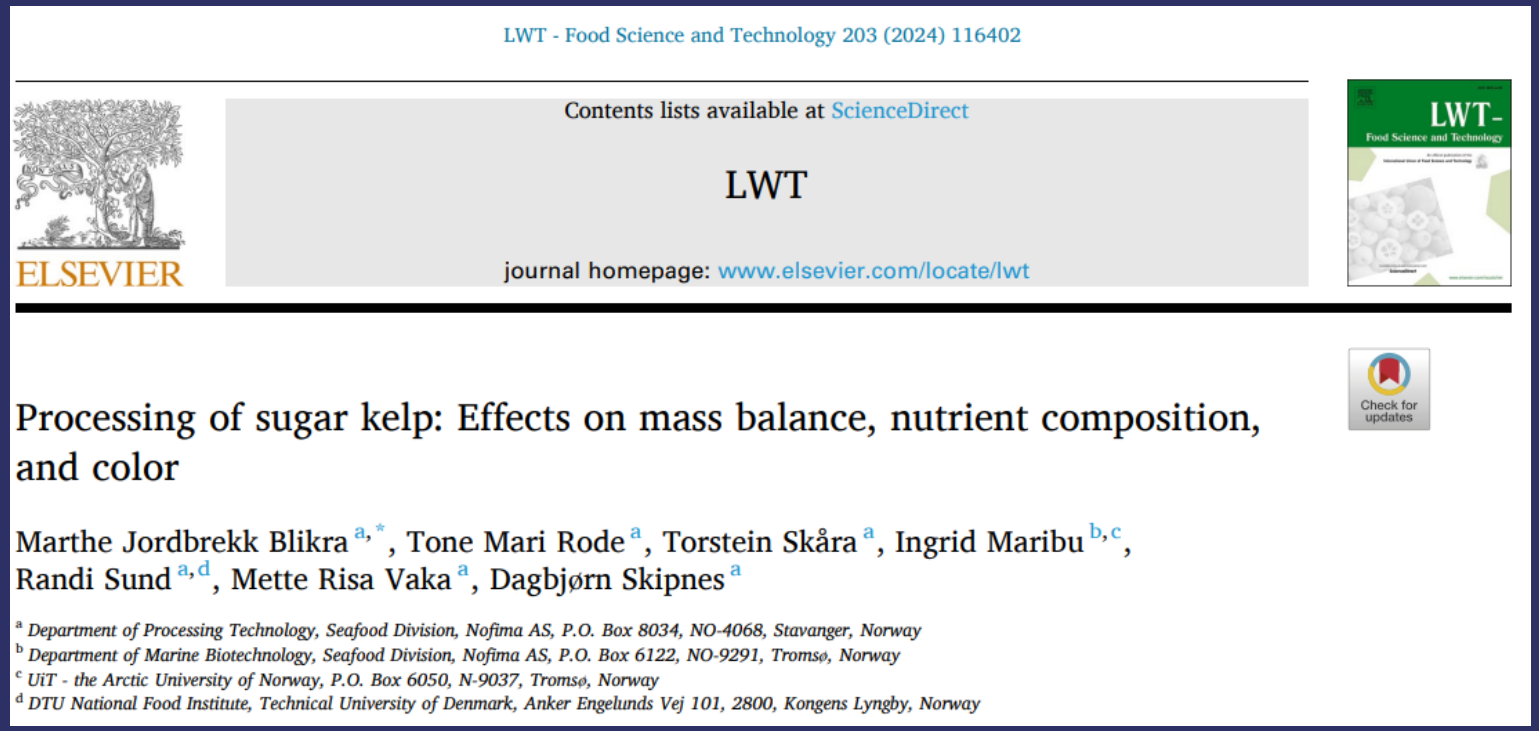
Treatment	Iodine reduction (%)	Temperature (°C)	Time	Water to kelp ratio	Input energy (kJ/kg)	Reference
Blanching	92	45	2 min	33	150	1
Boiling	38	95	15 min	3.8	340	2
Boiling	85	99	15 min	10	370	3
PEF - low	42	r.t.	~10 s	10	2.7	**This study**

References: 1:Nielsen et al. (2020); 2: Bruhn et al. (2019); 3: Blikra et al., 2021, Blikra et al., 2021.

On the use of pulsed electric field technology as a pretreatment to reduce the content of potentially toxic elements in dried Saccharina latissima - ScienceDirect

PEF parameters

- Seaweed 900 g immersed in 1.8 L tap water
- Electrode voltage of 24 kV; electrode distance 24 cm
- Frequency 30 Hz;
- Pulse width of 6 us
- Pulse count 300; Energy 12.8 ± 0.5 J/g



LWT - Food Science and Technology 203 (2024) 116402

Contents lists available at ScienceDirect

LWT

journal homepage: www.elsevier.com/locate/lwt

Processing of sugar kelp: Effects on mass balance, nutrient composition, and color

Marthe Jordbrekk Blikra [a,*], Tone Mari Rode [a], Torstein Skåra [a], Ingrid Maribu [b,c], Randi Sund [a,d], Mette Risa Vaka [a], Dagbjørn Skipnes [a]

[a] Department of Processing Technology, Seafood Division, Nofima AS, P.O. Box 8034, NO-4068, Stavanger, Norway
[b] Department of Marine Biotechnology, Seafood Division, Nofima AS, P.O. Box 6122, NO-9291, Tromsø, Norway
[c] UiT - the Arctic University of Norway, P.O. Box 6050, N-9037, Tromsø, Norway
[d] DTU National Food Institute, Technical University of Denmark, Anker Engelunds Vej 101, 2800, Kongens Lyngby, Norway

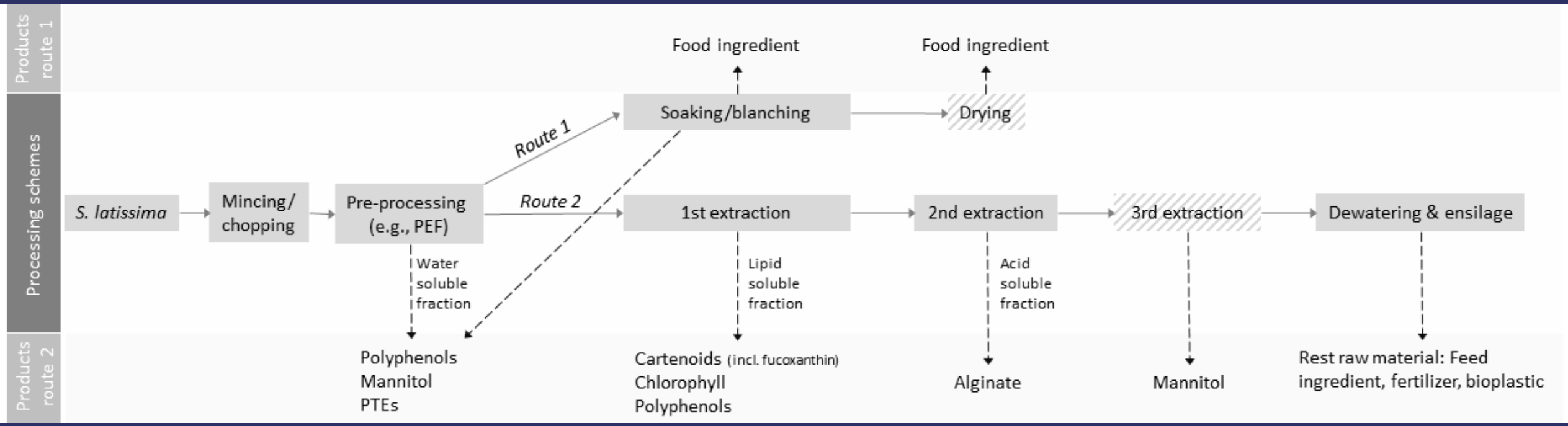
Processing of sugar kelp: Effects on mass balance, nutrient composition, and color - ScienceDirect

Main conclusions

- Combining PEF and soaking reduced iodine content -70%
  - without pre-heating
  - However, extraction of dry matter higher than compared to blanched only
- A processing scheme was suggested
  - A range of products suggested for
    - Liquid fraction
    - Solid fraction

Processing of sugar kelp: Effects on mass balance, nutrient composition, and color - ScienceDirect

One of the suggested processing schemes for **full biomass utilization** of kelp



Processing of sugar kelp: Effects on mass balance, nutrient composition, and color - ScienceDirect

Blanching

- Treatment in water (or steam) at moderate to high temperatures for a short time (e.g., 30-100 °C for some seconds)
- Can be combined with MW, US, PEF, or ohmic heating

Picture shows blanching combined with US

Some effects of blanching

From the perspective of using the seaweed

- Improve mass transfer:
  - Quicker drying
  - Alters chemical content
    - Decrease content of salt and PTEs (iodine, arsenic)
    - Can increase content of sugars/carbohydrates
- Improves sensory characteristics
  - Color and texture incl. improved crunchiness
- Biochemical effects
  - Enzyme inactivation
  - Inhibiting degradation of fucoxanthin (40 °C)
  - Improve antioxidant activity (but total polyphenol content decrease)

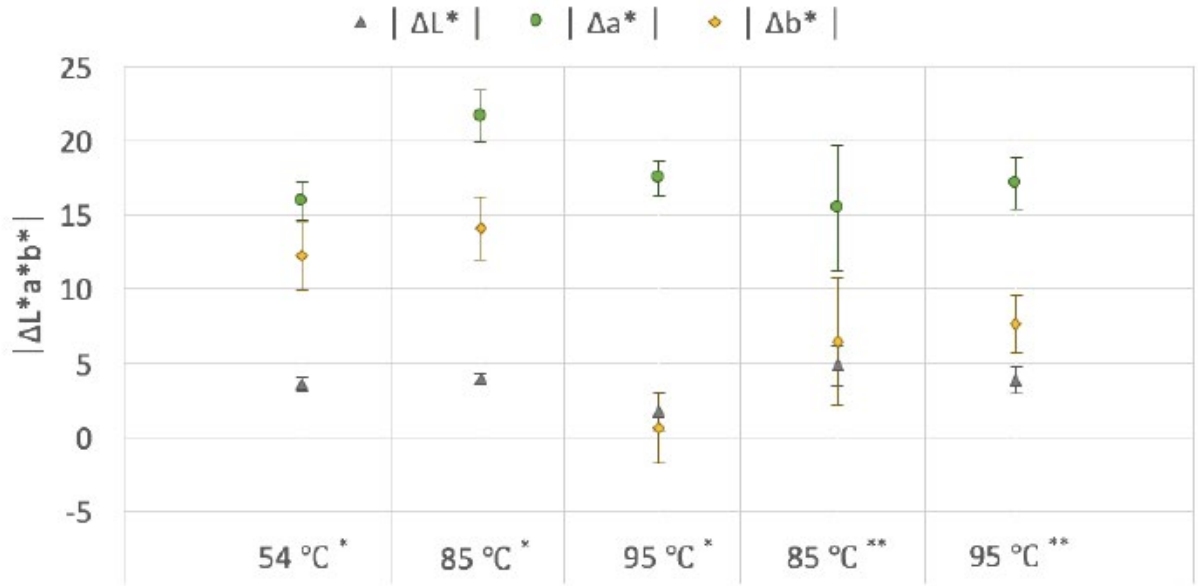
Relevant also from the perspective of using the extracts

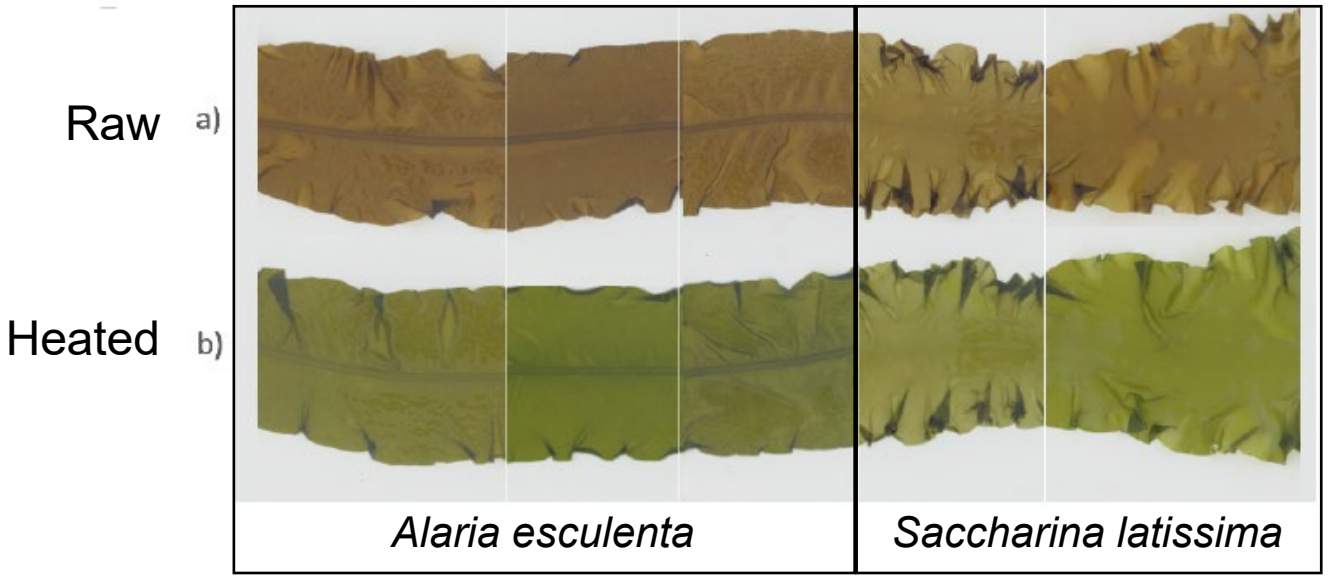
Based on Table 2, review by Zhu et al. 2021. https://www.sciencedirect.com/science/article/pii/S0308814621019555

Alaria esculenta & Saccharina latissima

Heat treatments:

- 54 ℃, 2 min
- 85 ℃, 5 s
- 95 ℃, 15 min





Blikra 2016. Master thesis.

Effects on PTE's

Sample	Iodine		Arsenic		Cadmium		Mercury		Lead	
	Conc.	Red.	Conc.	Red.	Conc.	Red.	Conc.	Red.	Conc.	Red.
Literature	2630–7977	–	28–120	–	0.2–4.6	–	0.01-0.06	–	0.1–1.1	–
Cont.	5200	–	72.3 ^{A}	–	1.60 ^{C}	–	0.0185 ^{A}	–	0.151 ^{A}	–
S10	4300 ^{B}	17	63.4 ^{AB}	12.4	1.83 ^{C}	−14.3	0.0217 ^{A}	−17.5	0.114 ^{A}	24.6
B45	500 ^{E}	90	60.6 ^{BC}	16.2	2.45 ^{B}	−53.0	0.0235 ^{A}	−27.2	0.109 ^{A}	27.9
B60	500 ^{E}	90	53.9 ^{BC}	25.4	2.30 ^{B}	−43.3	0.0245^{A}	−32.6	0.135^{A}	10.6
PEF	2600 ^{C}	50	73.3 ^{A}	−1.4	2.58 ^{B}	−60.7	0.0289 ^{A}	−56.5	0.145^{A}	3.8
PEF + S10	1600 ^{D}	69	57.9 ^{BC}	20.0	3.19 ^{A}	−99.2	0.0316^{A}	−71.3	0.177^{A}	−17.5
PEF + B45	300 ^{E}	94	50.9 ^{C}	29.6	3.15 ^{A}	−96.3	0.0311^{A}	−68.4	0.156^{A}	−3.3
PEF + B60	300 ^{E}	94	51.7 ^{C}	28.6	3.43 ^{A}	−114	0.0419^{A}	−126.9	0.176^{A}	−16.6
UL (iodine) and TWI (metals)	600 µg		Not establ.		2.5 µg/kg BW		1.6 µg/kg BW		Not establ.	

Further work

- Asessment of sensorial impact of PEF (about to be submitted)
- Study of how PEF impact micobial activity (ongoing)
- Determine the economic impact of reduced shear force (coming)
- Upscaling for industrial production (next season?)

Photo Ingrid Olesen (Nofima)