The Research Council of Norway

MØREFORSKING

PROMAC

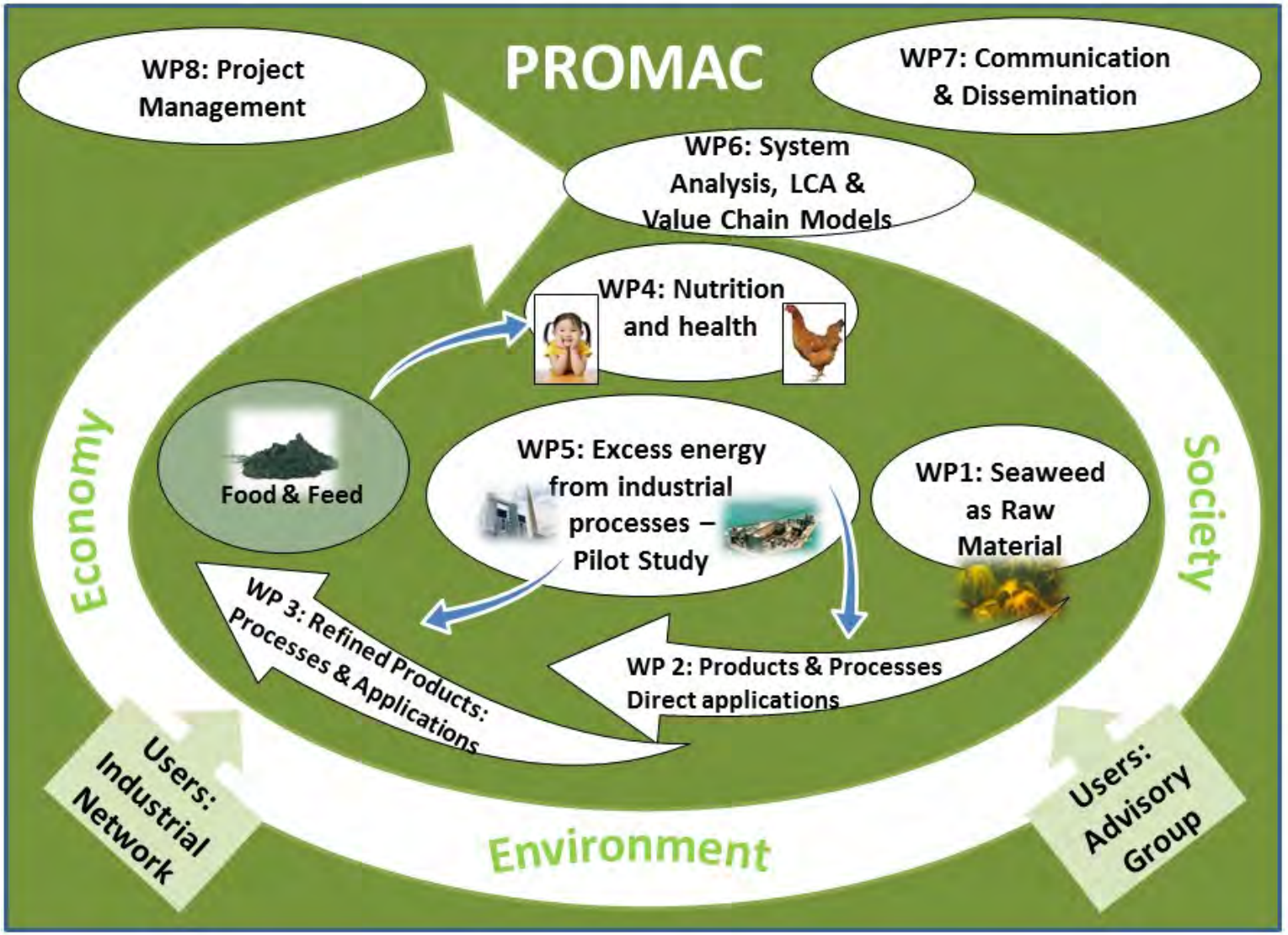
Potentially toxic compounds in seaweeds for human food

Pierrick Stévant
(Møreforsking Ålesund / NTNU)

SIG Seaweed workshop, Trondheim 04.04.2017

The PROMAC PROJECT

- Research project funded by the **Norwegian Research Council,** 2015 – 2018, funding of 35mill. NOK (3.5 mill. €)
- Project leader: **Møreforsking Ålesund**
- Meeting recent strategic developments in EU:
  - Shift towards a **bio-economy**, including **marine** resources
  - From value chains to value cycles – **circular economy**
    - **From raw material to consumer/markets**
    - **Waste becomes resource**
- **Seaweeds as under-utilised marine raw-materials,** undergoing a (re)naissance in the western world
- Integrating **GREEN and BLUE sectors** (agriculture & aquaculture / fisheries)


PROMAC
WP8: Project Management
WP7: Communication & Dissemination
WP6: System Analysis, LCA & Value Chain Models
WP4: Nutrition and health
Food & Feed
WP5: Excess energy from industrial processes – Pilot Study
WP1: Seaweed as Raw Material
WP 3: Refined Products: Processes & Applications
WP 2: Products & Processes Direct applications
Economy
Society
Environment
Users: Industrial Network
Users: Advisory Group

PROMAC

The PROMAC Consortium

PROMAC

MØREFORSKING

SINTEF

NIBIO
NORSK INSTITUTT FOR BIØØKONOMI

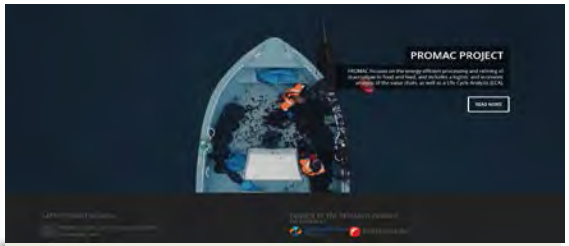
NTNU
Norwegian University of Science and Technology

NMBU
Norwegian University of Life Sciences

matis

ceva

SLU
SVERIGES LANTBRUKSUNIVERSITET



www.promac.no

The PROMAC Consortium

PROMAC

TAFJORD

Felleskjøpet

Firmenich

Hortimare

THE NORTHERN COMPANY

MARINOX

LEGASEA
Norwegian Biomarine Resources

Orkla Foods Norge

www.promac.no

Seaweeds in food

PROMAC

- Used extensively in Asia (kombu, wakame, nori, hijiki, ...) but little in Europe (Brittany, Ireland, Iceland)

- Increasing interest from the consumer for seaweed as food:
  - **Direct use** : sea vegetable, condiment, pesto, ...
  - Ingredient in the **food industry** and as **nutraceutical**

- Seaweeds contains bioactive compounds with **beneficial health effects**
- May also contain potentially toxic elements e.g. iAs, Cd and I
- Currently no specific regulation (EU, NO)

Nutritional value

PROMAC

	A. esculenta (winged kelp)	*S. latissima* (sugar kelp)	*P. palmata* (dulse)
Minerals (% DW)	**24.2**	**26.2**	**35.0**
Na/K	0.94	**0.56**	**0.25**
I (mg/kg DW)	213	**6568**	73.6
Cd (mg/kg DW)	**2.01**	0.22	0.061
Inorganic As (mg/kg DW)	0.22	0.16	0.18
Total carbohydrates (% DW)	**40.7**	**46.1**	24.6
Protein (% DW)	10.5	10.6	**17.9**
Polyphenols (% DW)	3.43	0.69	
Fucoxanthin (mg/kg DW)	**871**	431	

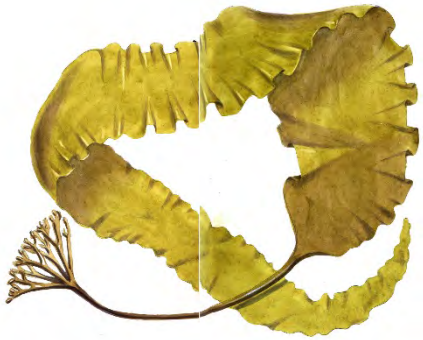
* Harvested in North-Brittany (FR) in May-June

Potentially toxic elements in seweeds

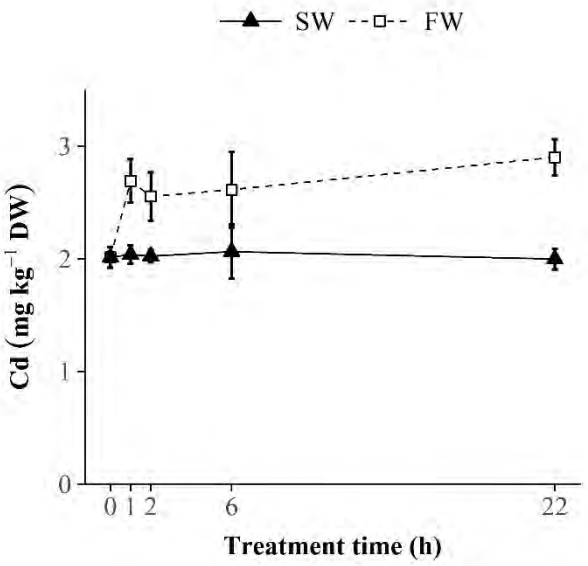
Potentially toxic elements	Limit values (mg kg^{-1} DW) France [a]	EU [b]
Inorganic arsenic (iAs)	**3.0**	
Lead (Pb)	**5.0**	**3.0**
Cadmium (Cd)	**0.5**	**3.0**
Mercury (Hg)	**0.1**	**0.1**
Tin (Sn)	**5.0**	
Iodine (I)	**2000**	

[a] Applies to “sea vegetables” (fresh) and condiments (dried) from seaweeds

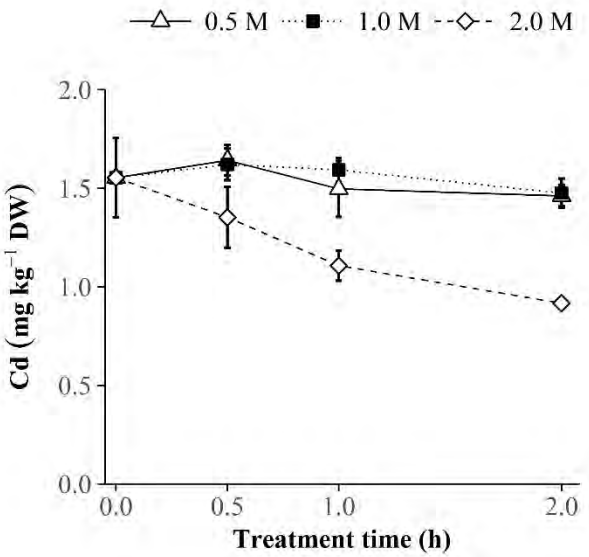
[b] Applies to food supplements (EU n°629/2008)



Treatments to reduce Cd & I



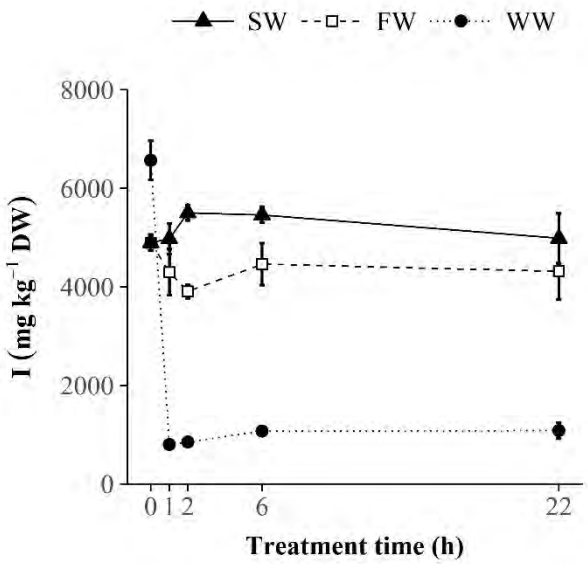
SW: seawater, **FW**: fresh water



0.5, 1.0, 2.0 M: NaCl concentration

- FW soaking treatment **failed to reduce Cd** in winged kelp
- High salinity treatment (in 2.0M NaCl) reduces Cd content
  - But strongly affects product quality (3-fold increase in Na)

Treatments to reduce Cd & I



SW: seawater, **FW**: fresh water, **WW**: warm water

- FW soaking treatment **failed to reduce I** in sugar kelp
- Moderate soaking temperature (32°C) greatly reduces I in sugar kelp.
  - **But high losses of nutritional compounds** (minerals, polyphenols, pigments)

- Possible effects of storage treatments on the I content of kelps
- Difficulties to selectively reduce levels of potentially toxic compounds

Health risk estimation

Element	Species	Maximum concentration (mg kg^{-1} DW)	Daily dose for 3.3g consumption (mg day^{-1})	Daily dose for 12.5g consumption (mg day^{-1})	Daily dose from risk estimators (mg day^{-1})
Cd	*S. latissima*	0.27	0.0009	0.0034	0.025 [a]
	A. esculenta	2.01	**0.007**	0.025	
I	*S. latissima*	6568	21.7	82.1	1.0 [b]
	A. esculenta	213	0.7	12.7	
iAs	*S. latissima*	0.23	0.0008	0.0029	0.021 [b]
	A. Esculenta	0.22	0.0007	0.0027	

Data from the [a] EFSA and [b] World Health Organisation (WHO)

- **3.3g (DW)** defined as the average daily seaweed consumption in Japan
- Normal portion (3.3g) of winged kelp **do not contribute to high Cd intake**
- Eating sugar kelp **can contribute to high I intake**
- Low contribution of both winged and sugar kelp in iAs

Health risk estimation : Cd

PROMAC

- **Cd exposure quite low** in European population : 119 µg per week for a 70 kg-person (EFSA, 2012)
- TWI: 175 µg/week -> 56 µg margin
- Cd intake from daily ingestion of 3.3 g dried winged kelp **within the margin (low risk)**

- Cd bound to dietary fibers (alginate): presumably low bioavailability
- Daily consumption of 3.3 g dried seaweed rather unrealistic in EU

EFSA (2012). Cadmium dietary exposure in the European population. EFSA Journal 10(1): 2551-n/a.

Health risk estimation : I

- **High I intake** following 3.3 g daily consumption of sugar kelp
- Excess I generally excreted when I stores are replete
- Sensitive groups : I-deficient individuals, elderly, fetuses,... may develop thyroid complications
- I poisoning very rare
- Reported complications involved **excessive intakes over long-time**. Reversible effects

- EU population generally **I-deficient**.
- Moderate seaweed consumption can prevent I deficiency

Health risk estimation : iAs

- Levels **under the established limit** (3.0 mg/kg DW) in both kelps
- High levels reported in *Laminaria digitata* (up to 10-20 mg/kg DW) and hijiki (up to 70-90 mg/kg DW)

- High exposure to iAs among EU population (grains, rice, milk) (EFSA, 2014)
- Winged kelp and sugar kelp: not a major source of dietary iAs

Conclusion

- From health risk estimation, consumption of winged and sugar kelp **do not pose a threat to the consumer**
- Daily consumption of 3.3 g dried seaweeds in EU rather unrealistic. 1 to 2 meals per week more probable (Le Bras et al. 2014)
- Sensitive individuals should avoid eating large amounts sugar kelp
- Seaweed can be a **source of dietary iodine** in I-deficient populations

- Seaweed-based food supplements can accumulate potentially toxic compounds
- Product safety, labelling
- More occurrence data is needed regarding the **bioavailability** of potentially toxic elements from seaweeds

Le Bras, Q., Ritter, L., Fasquel, D., Lesueur, M., Lucas, S. and Gouin, S., (2014). Etude de la consommation des algues alimentaires en France. Programme Idealg Phase 1, Etude nationale: Les publications du Pôle halieutique AGROCAMPUS OUEST 35. 72p.

PROMAC Open seminar April 25th, Ålesund

Mer info : http://promac.no/

Pierrick Stévant

Hélène Marfaing

Arne Duincker

Joël Fleurence

Turid Rustad

Ingrid Sandbakken

Annelise Chapman