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Optimal utilization of seafood side-streams through the design of new holistic process lines

RECOVERY OF BIOMOLECULES FROM LIQUID SIDE-STREAMS FROM MUSSEL PROCESSING

Mónica Gutiérrez, Bruno Iñarra, David San Martin & Carlos Bald

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Bio-based Industries Consortium

Horizon 2020 European Union Funding for Research & Innovation

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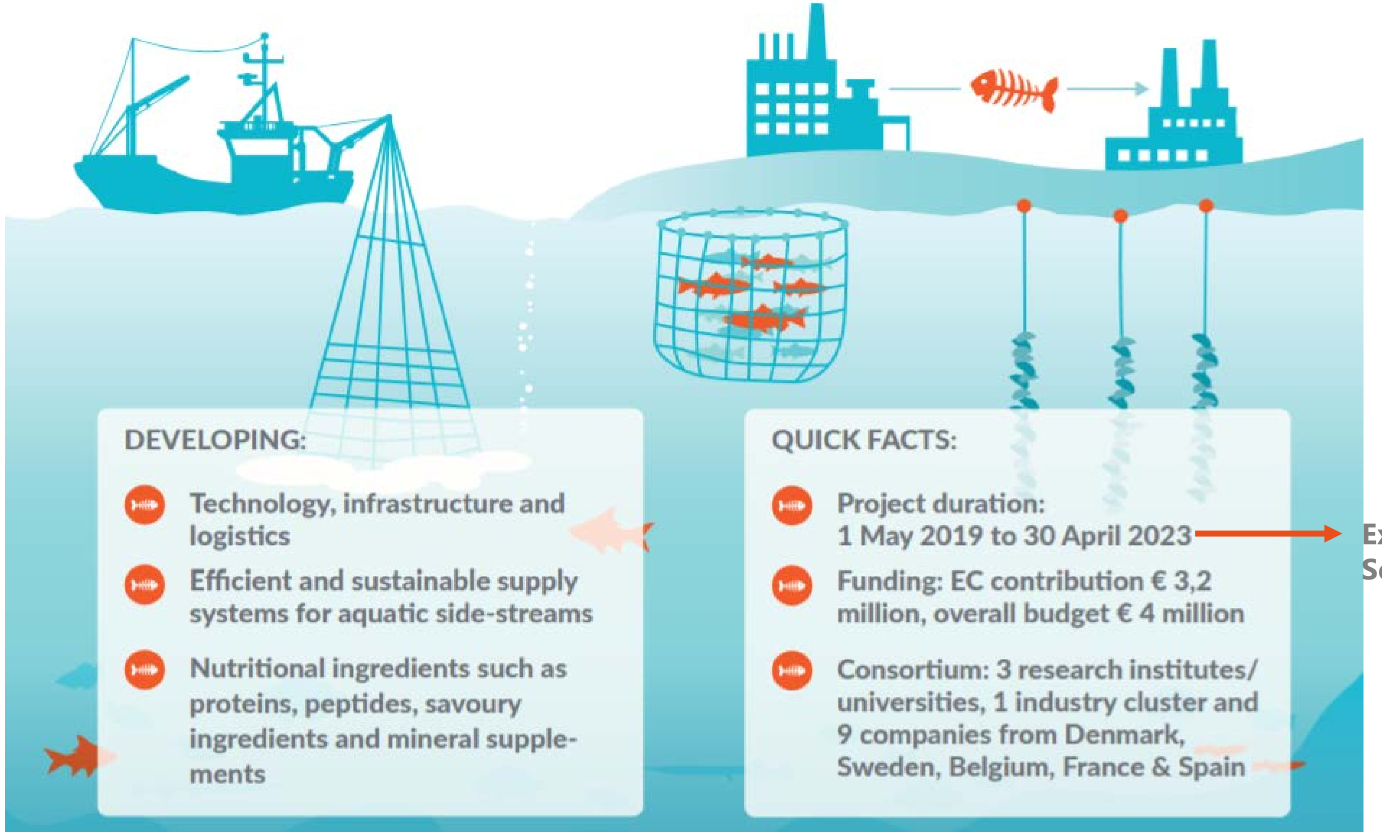

Extended until Sept 2023

COORDINATOR

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The context:
The current exploitation of the aquatic resources is hampered by inefficiency as up to 70 % end up as low-value products or waste, unsustainable considering the rising population.

WaSeaBi Objective:
Ensure that side-streams from aquaculture, fisheries and aquatic processing industries can be exploited for production of new products and ingredients. By **developing storage solutions, sorting technologies and decision tools** that will secure an efficient, sustainable supply system f

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6 different side-streams:

Representing typical **aquaculture, fisheries and aquatic processing industries** in Europe:

Side-stream	Potential use
Solid side-stream from Cod industry	Food ingredient
Brine from salted Cod	Protein for reinjection/in-house use
Solids & process water from herring	Food ingredients
Salmon solids, mackerel, by-catches	Food & Feed ingredients
Mussel cooking water	Food ingredients (Savoury compounds)
Mussel shells	Food & Feed ingredients (mineral supplements)

WaSeaBi will take a whole chain perspective to succeed with **high quality production of**:

- Bioactive peptides for nutraceutical, food and feed application
- Protein-based food ingredients
- Savory ingredients and mineral supplements for food and feed

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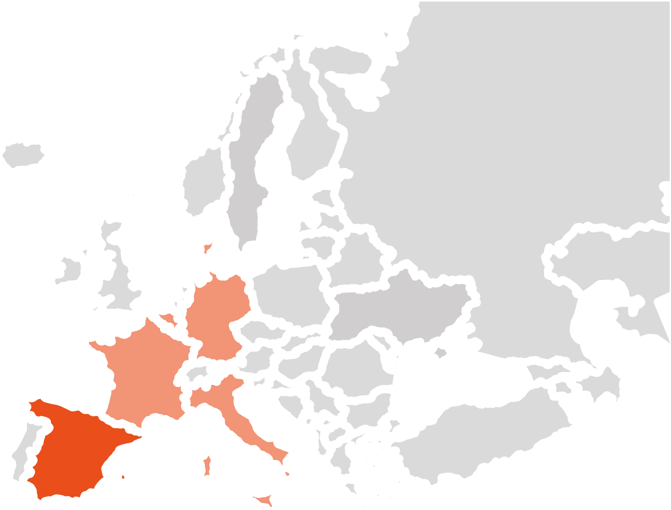
Some facts about mussel production:

- The European Union is the **second largest producer** after China (EUFOMA 2019)
- In the north-West of Spain, the **annual production** of mussels is 200 000 tonnes (35 % of the world) (Bello 2012)
- The industrial thermal treatment of mussels generates between **300 and 400 L/t wastewaters** that are continuously disposed into the sea without previous treatment (Prieto 2015)



Objectives:

- Optimization of direct concentration of high value molecules
- Estabilization of high molecules extracts
- Evaluate the use of this concentrates for sauvory compounds uses

- Bello P.M *et al.* Material Flow Analysis in a cooked mussel processing industry. Journal of Food Engineering 113 (2012) 100–117.
- EUMOFA. Case study: Fresh mussel in the EU (2019) Publications Office of the European Union, www.eumofa.eu, doi:10.2771/862.
- Prieto M.A., *et al.* (2015) "An environmental management industrial solution for the treatment and reuse of mussel wastewaters. Sci. Tot. Environ. 538 117–128.

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Steps for biomolecules recovery:

- Optimization of direct concentration of high value molecules
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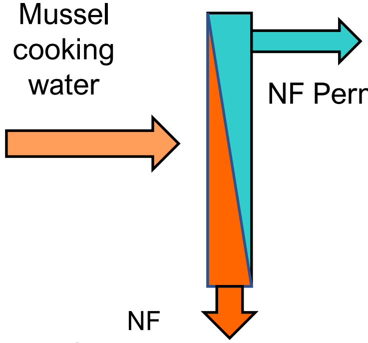
Concentration techniques:

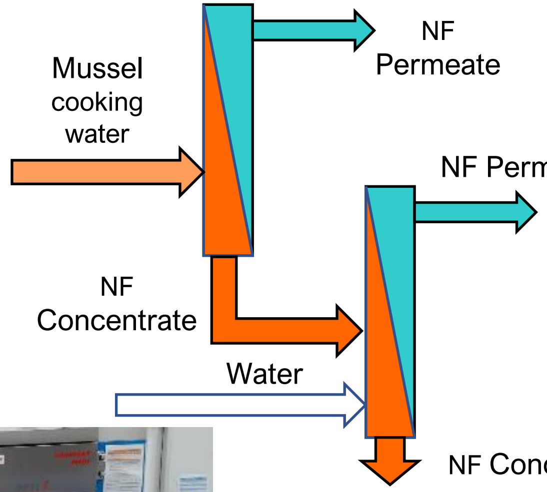
Vacuum evaporator (VE)

Lab vacuum evaporator (Buchi)

NanoFiltration (NF)



Diafiltration by NanoFiltration (Dia-NF)



Homogenization and heating reactor

Nanofiltration pilot plant

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Analytical and microbiological control:

Quantitative Composition

Protein
Ashes (%)
Humidity (%)
COD (mgO_2/l)
Chloride (mg/l)

Microbial composition

Salmonella spp (Inv/25 g)
Listeria monocytogenes (Inv/25 g)
Aerobios mesófilos (ufc/g)
Enterobacterias (ufc/g)
Escherichia coli (ufc/g)

Others

Protein content
Free Aa
Total Aa
Molecular weight distribution

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RESULTS

	Initial sample	VC Concentrate	NF concentrate	NF permeate	NF – Diaf concentrate	NF – Diaf permeate
Ashes (%)	2,38	**24,48**	2,40	2,42	1,20	2,20
Dry matter (%)	4,09	**39,66**	9,13	2,47	7,40	2,31
Protein (%)	1,14	**10,98**	4,85	0,14	4,68	0,12
Free Aa (%)	0,33	3,23	1,19	0,12	1,14	0,10
Chloride (g/l)	14,10	**138,18**	13,96	14,24	**7,12**	12,94
COD (mgO_2/l)	22200	224000	104800	2260	111000	2040

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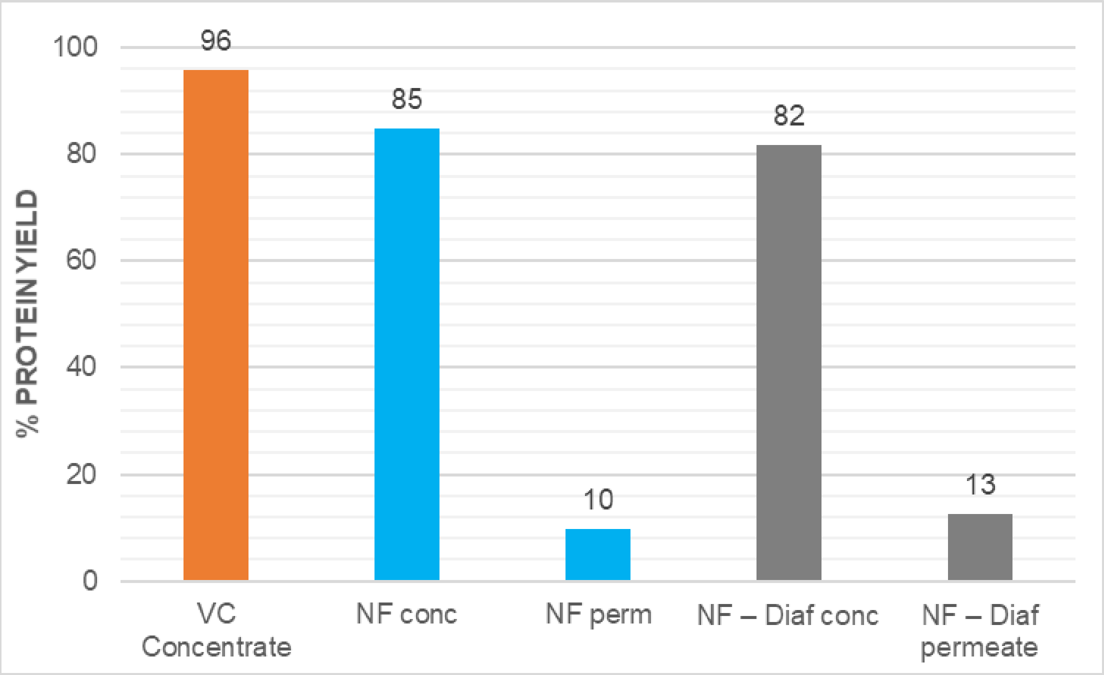
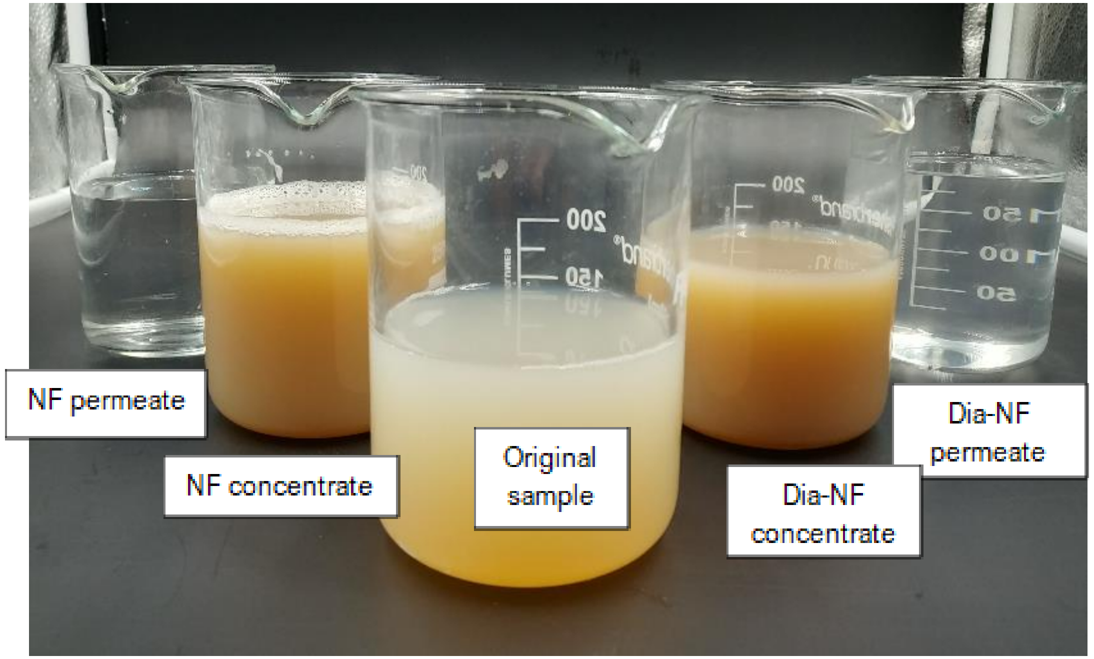
Optimization of direct concentration of high value molecules



Protein yield for the different concentration techniques tested



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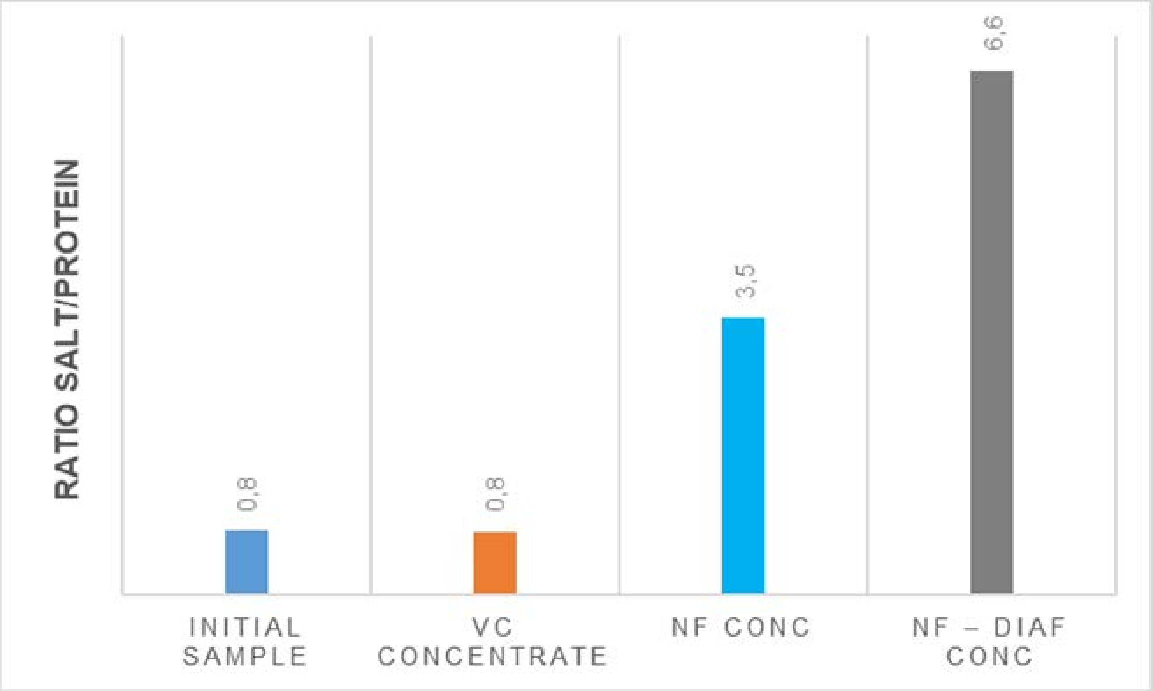

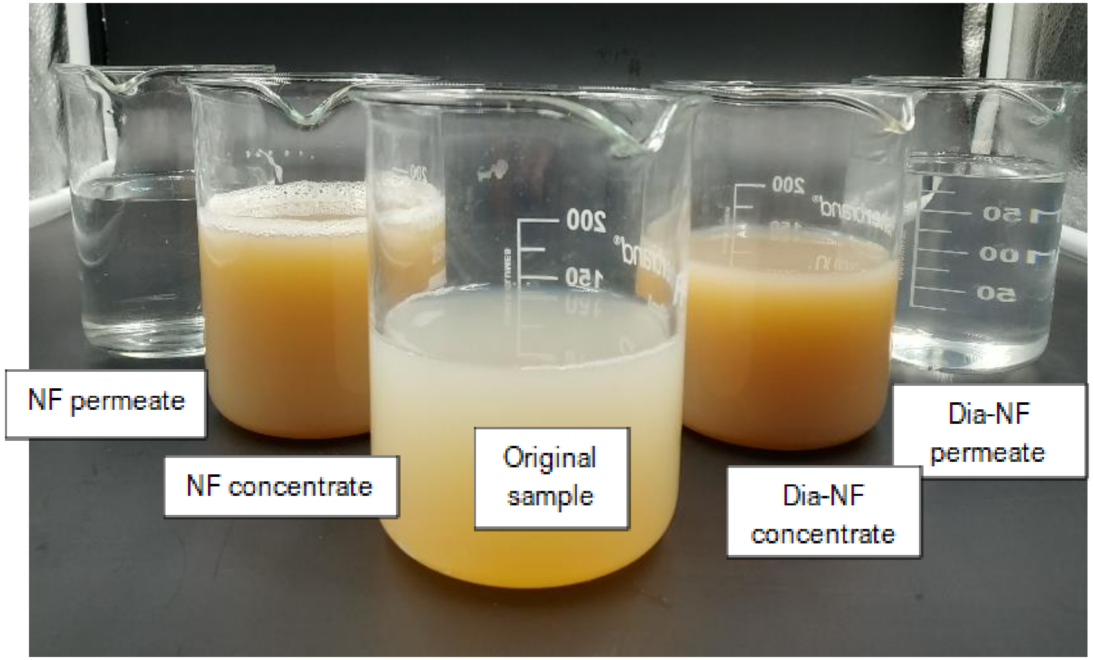

Protein/salt ratio of the different concentration techniques tested

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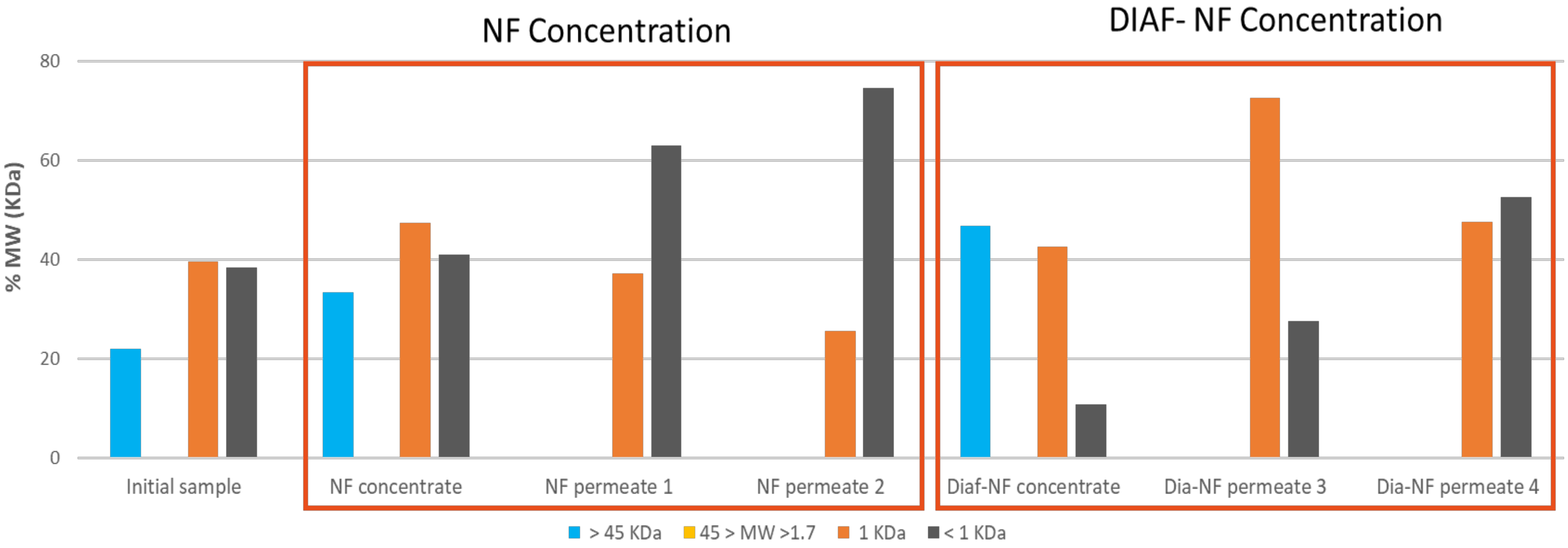

Molecular weight profile of NF and Diafiltration fractions

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Estabilization of high molecules extracts

Optimal Dryer parameters	Value
T inlet	165 °C
T outlet	68 °C
Pump rate	10 %
Aspirator rate	100 %
Spray air flow	25 mm

Humedad	6,4 % ± 0,3 %

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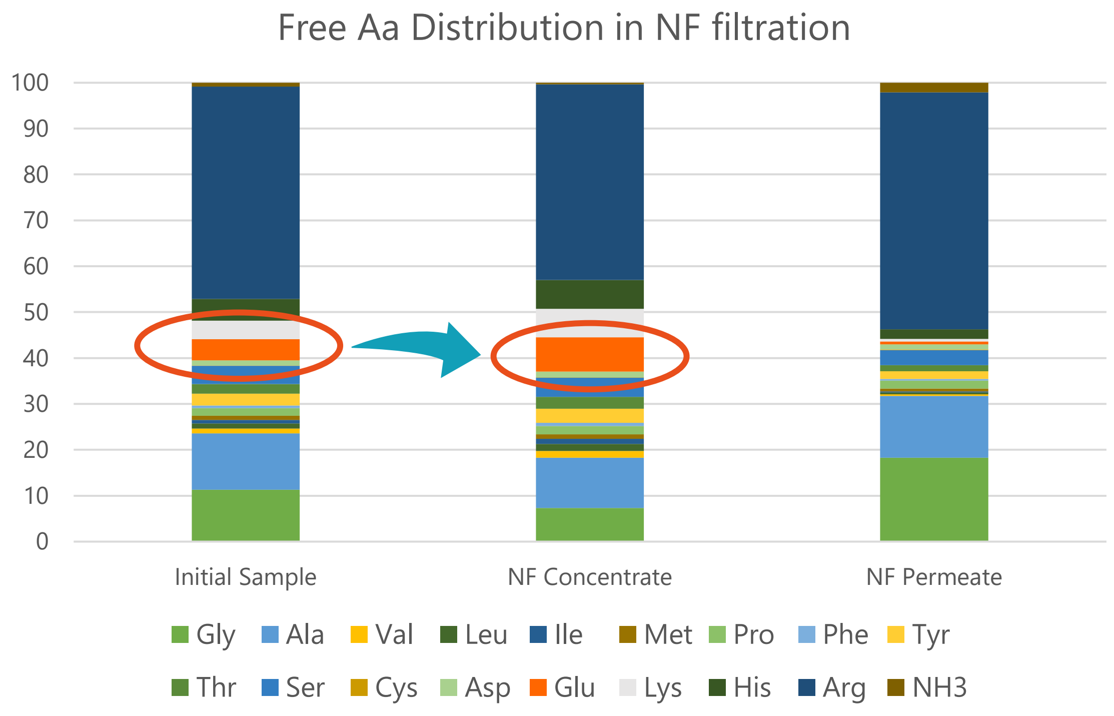
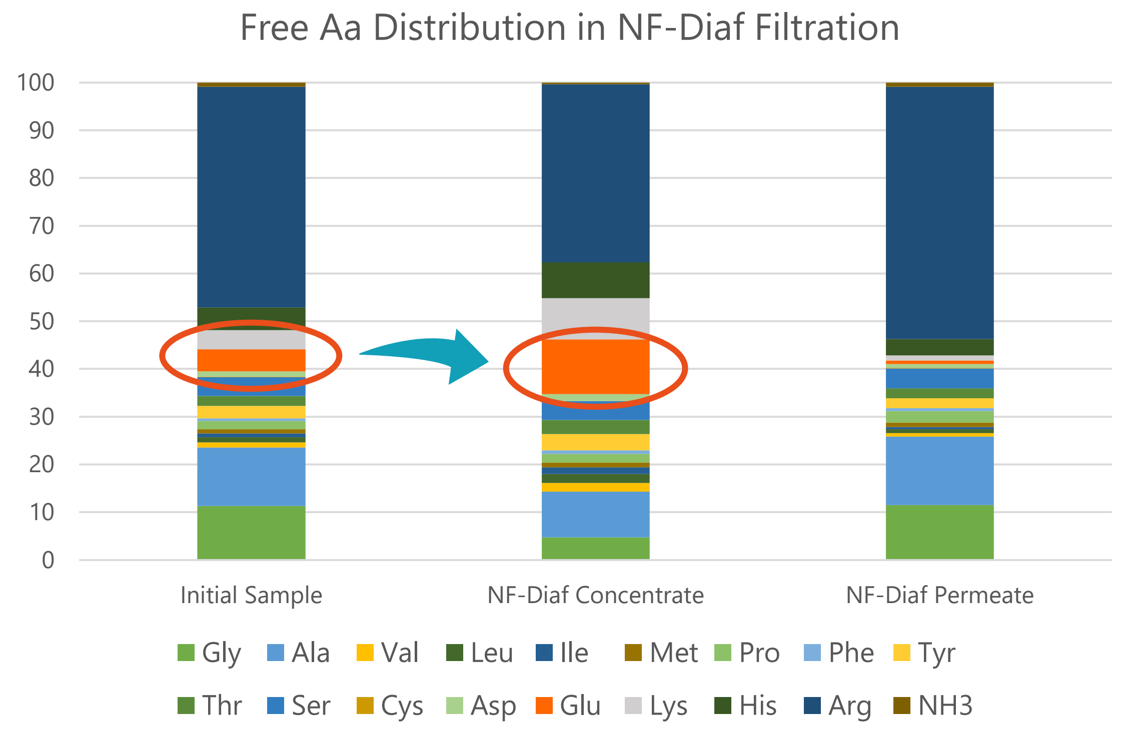
Evaluate the use of this concentrates for savoury compounds uses





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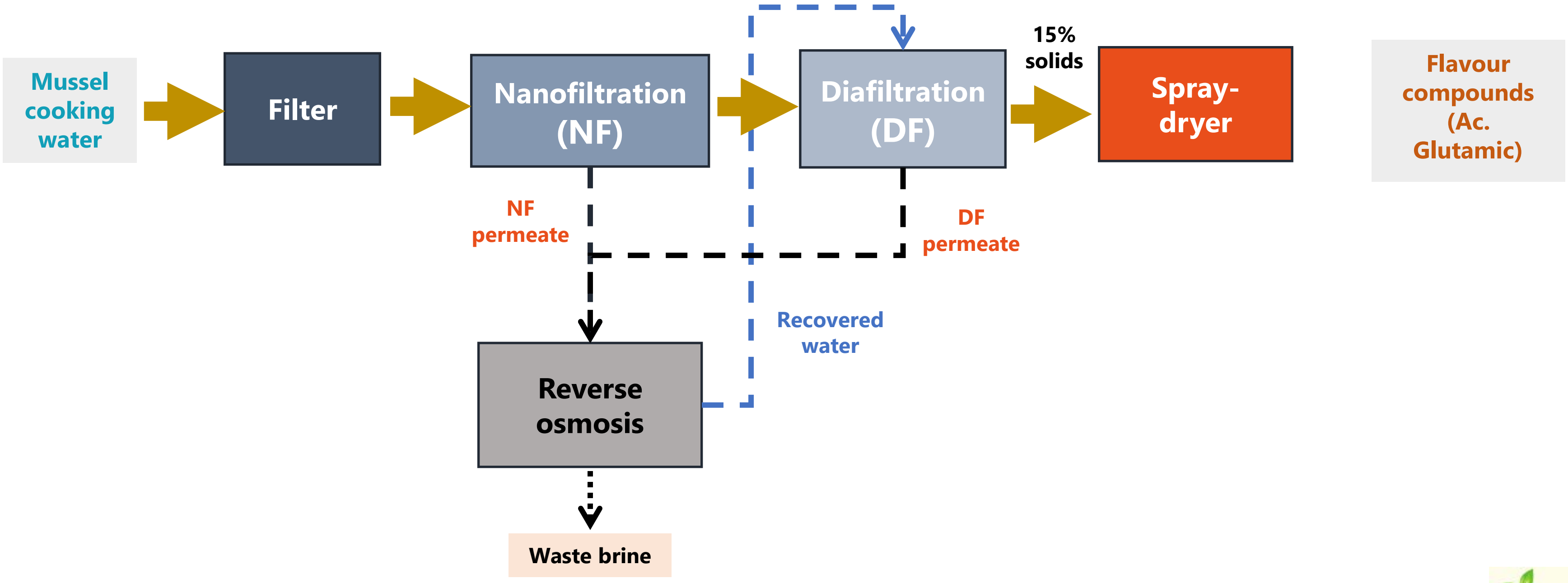
Conclusions

- Different separation techniques had been tested: NF and Diafiltration-NF membrane filtration and vacuum evaporation
- The best concentration system for protein concentration was the vacuum technology, that concentrate proteins almost 10 times
- The problem of vacuum concentration is the high value of salt in the solution, so that, it is necessary to find a technique to remove NaCl
- Both NF techniques yielded lower result in protein recovery, due to the permeation of small molecular weight proteins (≤ 0.1 KDa)
- The resulting NF permeate still had an organic load in the final effluent, but reduced enough to be discharged within the regulatory frame

Conclusions

- The best option for biomolecule recovery from mussel cooking waters was the next:



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THANK YOU

ANY QUESTION?

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