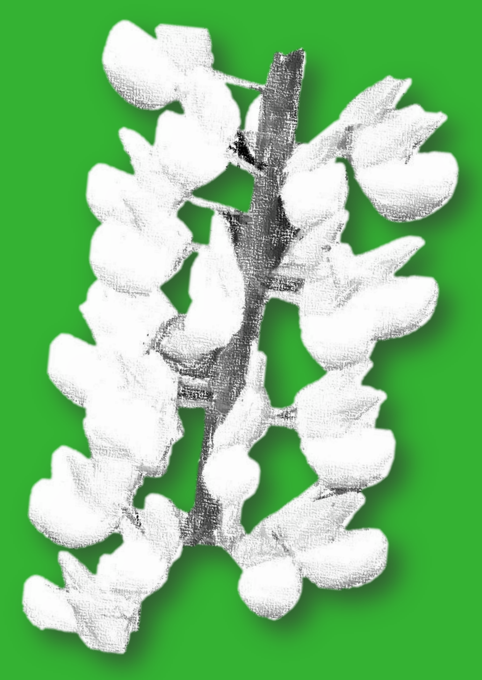
Sustainability assessment of fractionation processes of lupin seeds



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The objective is…

…to assess the impact of producing protein-enriched fractions using dry, wet and aqueous fractionation.

Which is achieved by evaluating…

… the mass of solvents used, water consumption, energy consumption, exergy losses and chemical exergy efficiency of the fractionation processes (Figure 1).

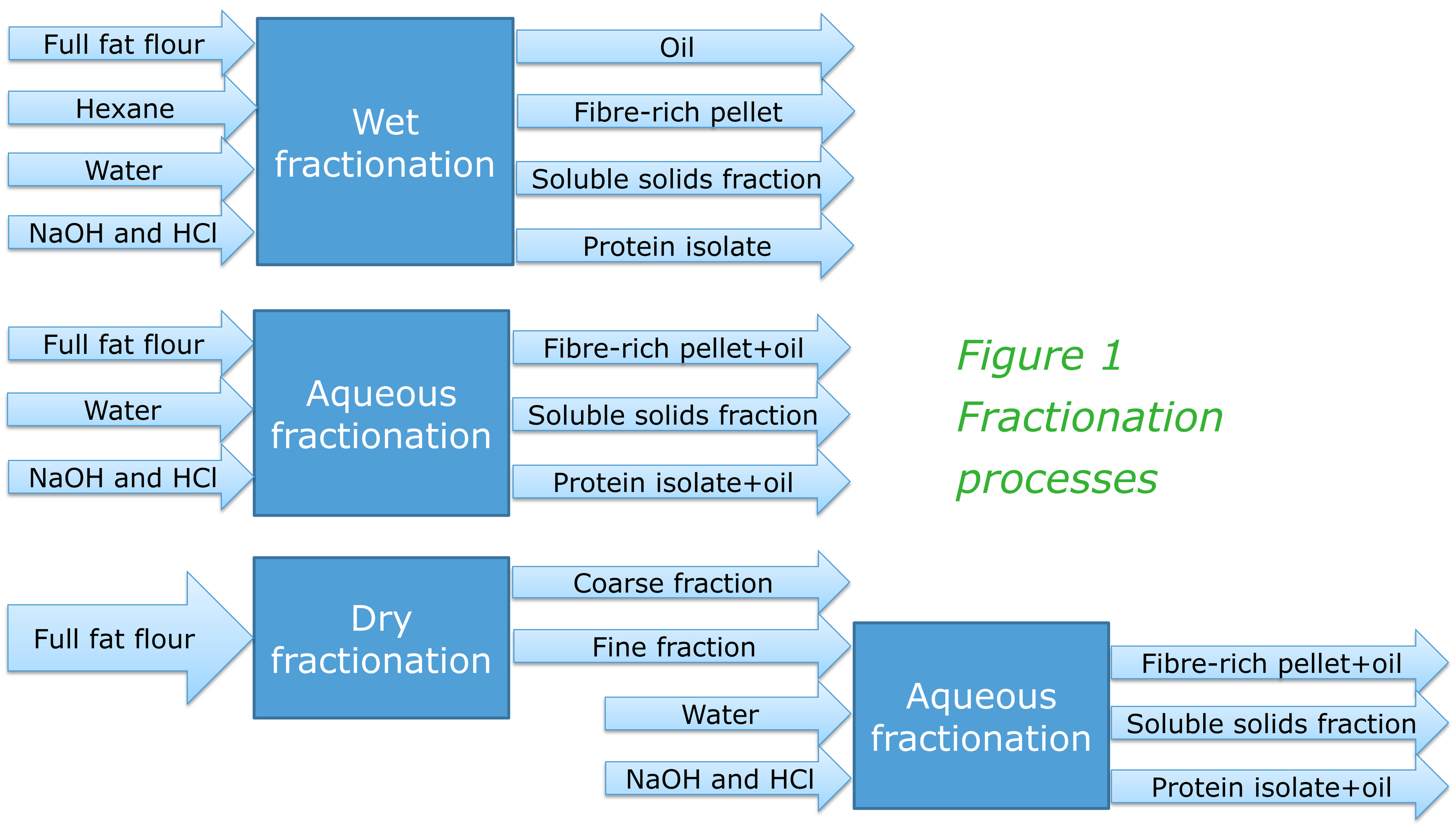


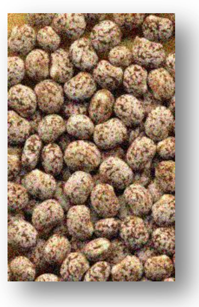
Figure 1 Fractionation processes

Results I

Oil extraction
The evaporation and condensation of *hexane* requires **13 MJ/kg** protein isolate.

Water consumption
Wet and aqueous fractionation require about **87 kg water/kg** protein isolate.

Drying
Drying of a protein isolate consumes about **6 MJ/kg** evaporated water.



Dry fractionation
Does not require water but yields protein-enriched flours with only **53.5% protein**.

Background

There is a need for milder fractionation alternatives that consume less solvents and energy. A milder wet fractionation method is aqueous fractionation, which omits an oil extraction step. Dry fractionation is a sustainable alternative for wet and aqueous fractionation, because it avoids the use of water and consumes less energy. Dry fractionation produces protein-enriched flours, that can be further enriched by wet fractionation techniques.

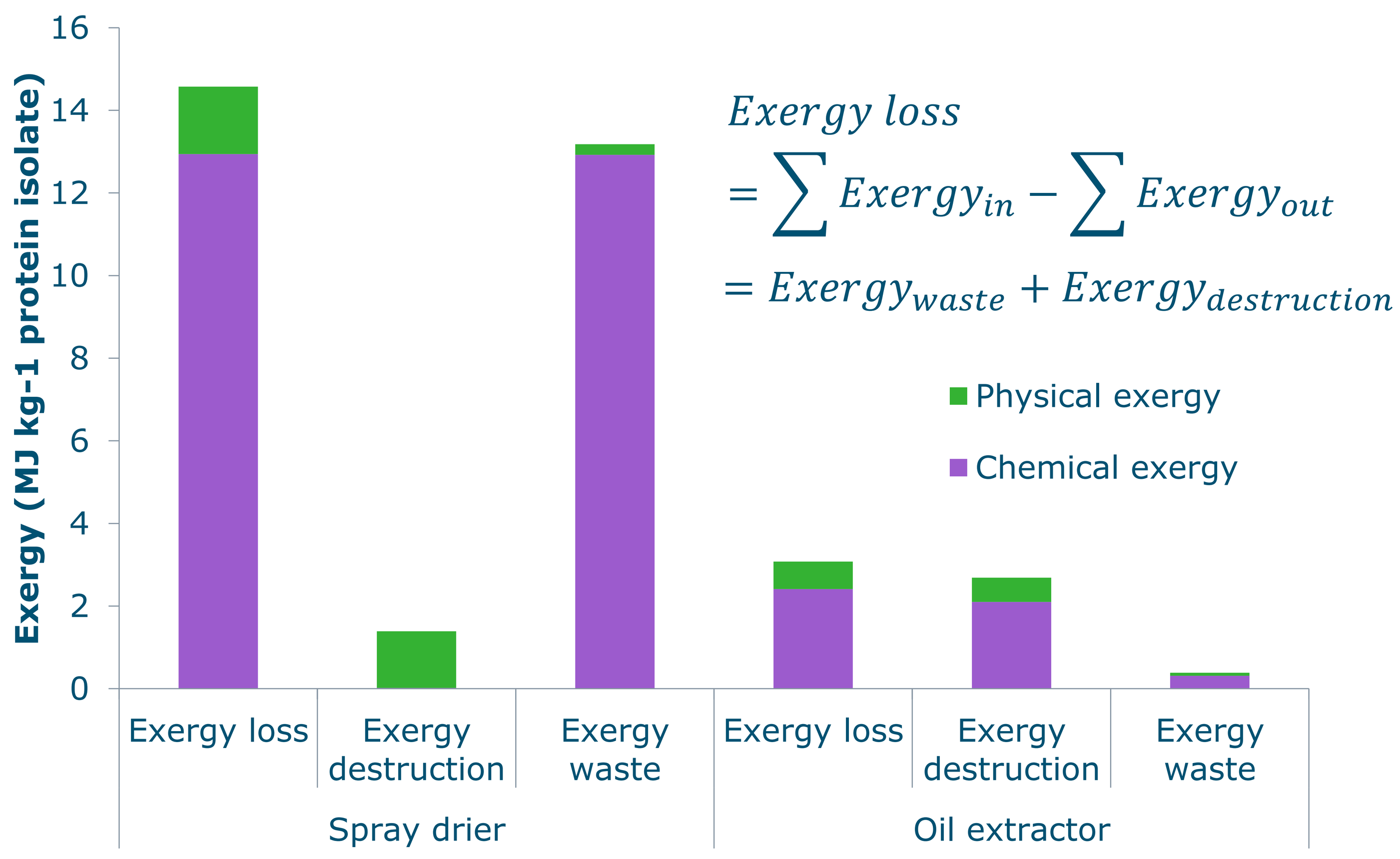
Conclusions

- Modern fractionation processes should focus on the ***full use of raw material***, using ***mild fractionation conditions*** and by putting less emphasis on purity
- ***Aqueous fractionation*** consumes less resources than traditional wet fractionation
- ***Combining dry and aqueous fractionation*** decreases water consumption of protein isolation

Results II

Omitting an oil extraction step and avoiding drying steps **reduces exergy losses** (Figure 2).

Figure 2 Exergy losses in the spray drier and oil extractor



$$Exergy\ loss = \sum Exergy_{in} - \sum Exergy_{out} = Exergy_{waste} + Exergy_{destruction}$$

Valorisation of waste streams increases the chemical exergy efficiency of all fractionation processes (Figure 3).

$$Chemical\ exergy\ efficiency = \frac{chemical\ exergy\ out\ of\ the\ process}{chemical\ exergy\ into\ the\ process}$$

Useful exergy out = the exergy of the fractions that are not wasted
Total exergy out = the sum of the exergy of all the fractions

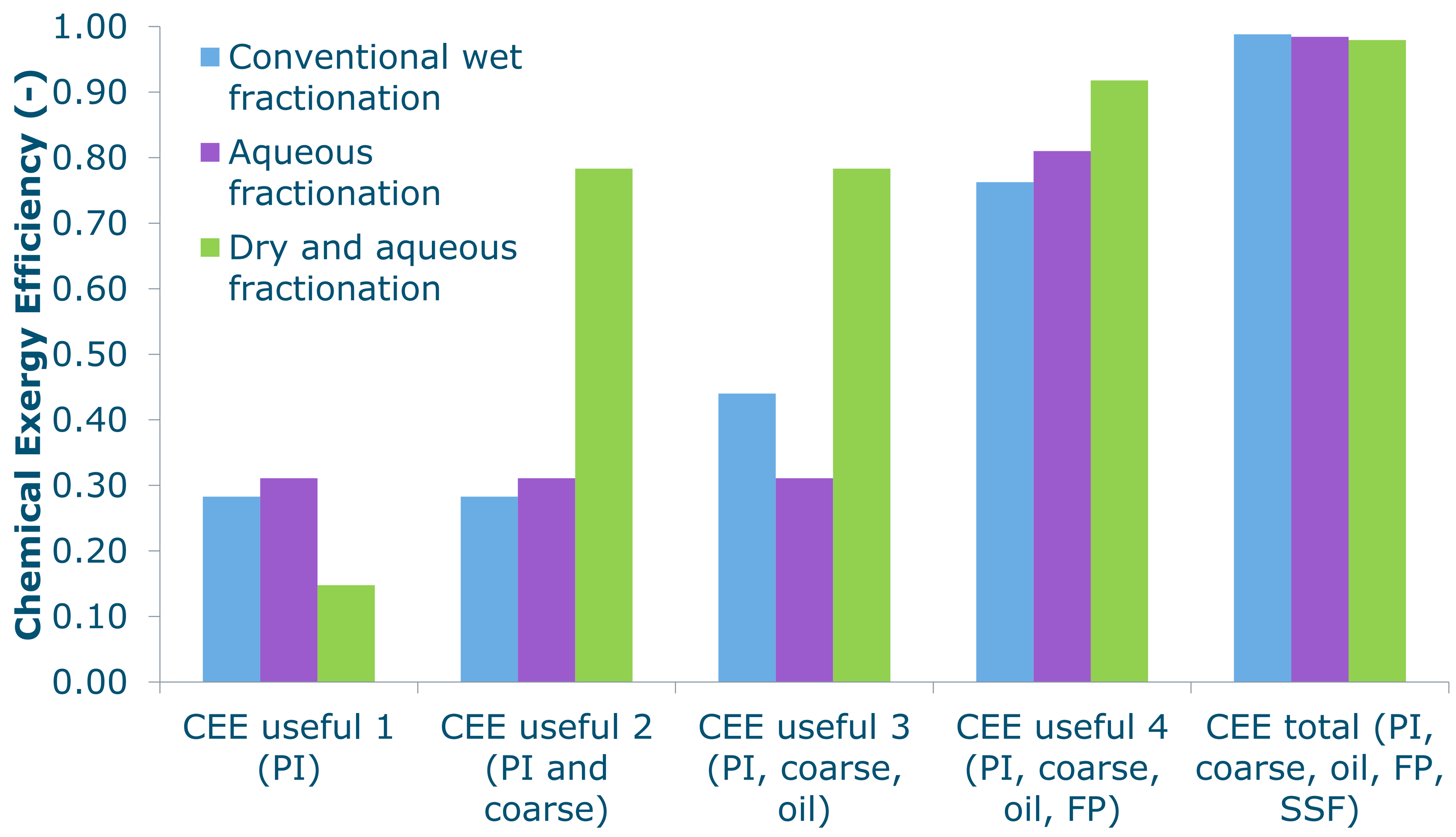


Figure 3 Chemical exergy effciency of conventional wet, aqueous and dry fractionation processes. PI = protein isolate, FP = fibre-rich pellet, SSF = soluble solids fraction.

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Acknowledgements

The authors thank Suzanne Overbeek and Francisco Rossier for their contribution to the calculations and discussions and The PEAS Foundation and ISPT for financial and project support.