Functional pea and lupine protein concentrates prepared with dry fractionation

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Background

Wet fractionation is the common route to isolate proteins from legumes. Major drawback of this process is the use of copious amounts of water and energy. Moreover, due to the harsh conditions, native functionality of proteins is lost. An alternative to wet fractionation is dry fractionation by fine milling and air classification[1]. During fine milling the larger starch granules are physically disentangled from the smaller protein-rich particles to allow optimal separation during air classification. In our research we investigated milling and air classification as an efficient route for production of protein pea and lupine concentrates in combination with functional analyses of protein concentrates

Dry fractionation by milling and air classification

Selective milling conditions were developed based on analysis of tissue morphology. Peas were milled to disentangle starch granules from the surrounding protein bodies. Millings were carried out using a multiprocessing unit (Fig. 1). Air classification yielded pea protein concentrates with protein contents up to 55% (w/dw) and a protein recovery of 77% (Fig. 2). Coarse milling (down to 100 µm) followed by air classification provided lupine protein concentrates with protein contents up to 59% (w/dw).

Figure 1. A Hosokawa Multi powder processing unit with impact, jet and pin milling facilities and air classification device is used to dry fractionate pea and lupine flours.

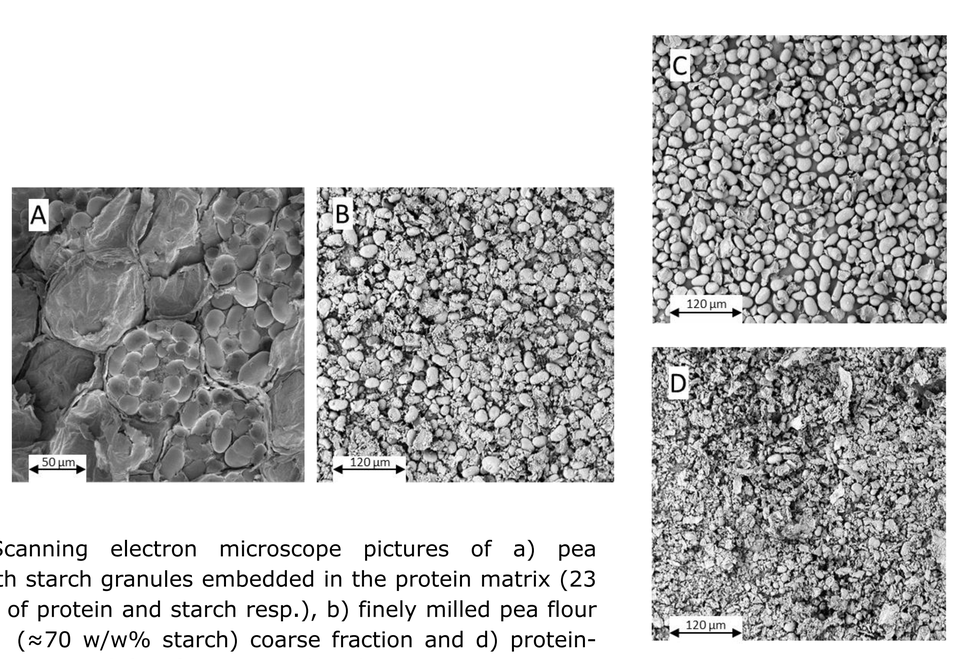

Figure 2. Scanning electron microscope pictures of a) pea cotyledon with starch granules embedded in the protein matrix (23 and 48 w/w% of protein and starch resp.), b) finely milled pea flour c) starch-rich (≈70 w/w% starch) coarse fraction and d) protein-rich (≈55 w/w% protein) fine fraction produced.

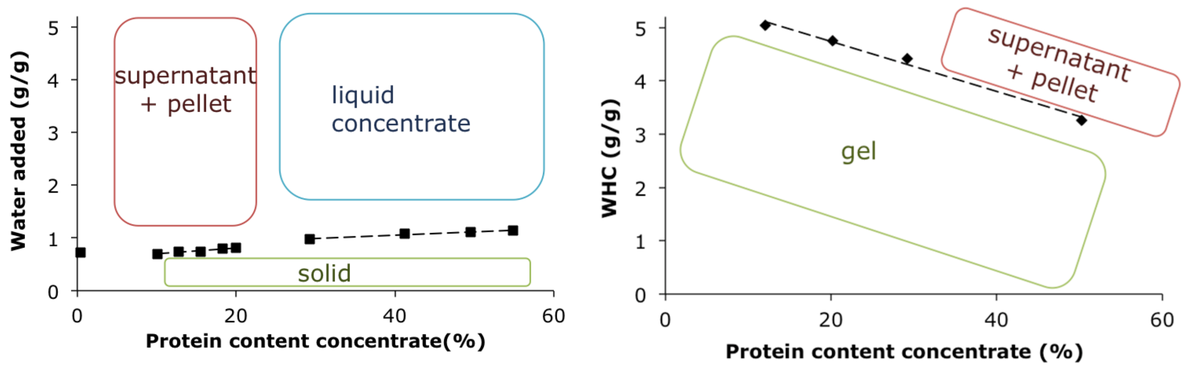

Figure 3. Left the state diagram of native pea flour with various protein percentages based on dry weight and Right the water holding capacity of denatured pea flour with various protein percentages based on dry weight.[2]

Functionality analyses

Pea and lupine pea protein concentrates were evaluated for their functional behaviour.

- A liquid concentrate comprising 26% (w/w) of protein could be prepared from dry pea protein concentrates thanks to the high solubility of pea protein in its native state. After heat treatment a gel with a high WHC of 4.8 g water (w/w) was obtained, which decreased with increasing protein content (Fig. 3).
- Native air classified lupine protein concentrate exhibits low viscosity, while after (in vitro) digestion the amount of proteins smaller than 3 kDa was higher in native and mildly heated protein concentrates compared to intensively heated protein concentrate (Fig. 4).

These results suggest promising development of liquid-like high protein formulations from air classified pea and lupine protein concentrates.

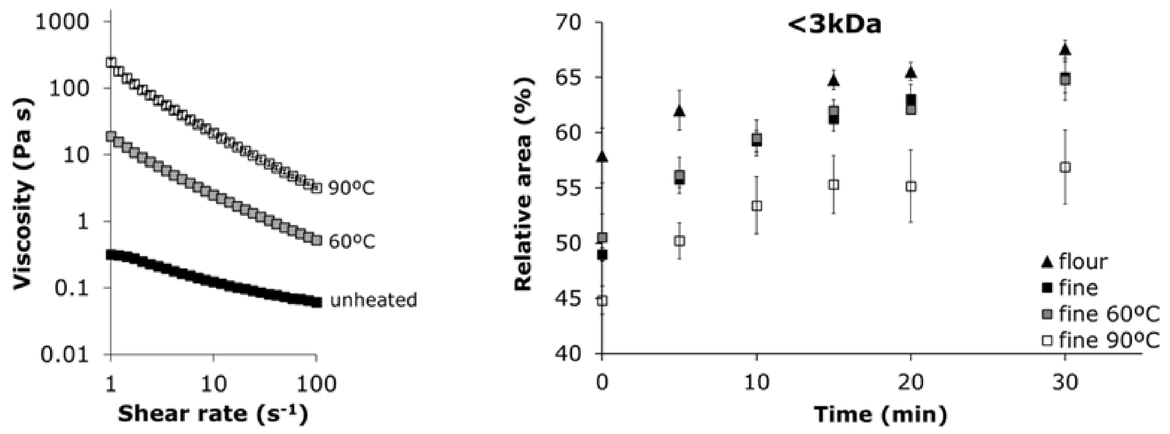

Figure 4. Left viscosity as function of the shear rate for the fine fraction, native and after a heat treatment. Right digestion of lupine flour, fine fraction and the fine fraction heated at 60ºC and 90ºC during 30 minutes expressed as percentage of the area under the chromatogram.

Conclusions

- Dry fractionation by milling and air classification yields enriched protein concentrates for pea and lupines that retain their native functionality.
- Functionality analyses of pea and lupine indicate promising application towards preparation of novel high protein foods.

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References

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2. Pelgrom, P. J. M., Vissers, et al. (2013). Food Research International, 53(1), 232-239.