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Extracted protein from slaughterhouse side streams – new functional ingredients for meat products (#306)

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Introduction

Side streams from the meat industry are a potential source of high-quality proteins for human consumption. However, some side streams e.g. lungs, heart and spleen are not desirable for human consumption *per se*, and technical solutions for processing of such animal side streams are needed for better utilization of the proteins. A solution for better utilization is extraction of the proteins. When extracting proteins from a solid matrix, the first step is to solubilize the intracellular material. This can be done chemically, physically or biologically. Until now, the Danish meat industry has primarily attempted to upgrade the side streams through hydrolysis. During production of hydrolysates, the proteins lose their functionality and bitter peptides are often formed due to elevated temperatures and enzyme activity, which is not favourable for further application in meat products. It is important to maintain the functionality of the proteins in order to utilize these proteins as emulsifying or gelling agents in meat processing.

The overall aim was to develop a gentle extraction method (without elevated temperatures) for protein extraction from a solid slaughterhouse side stream matrix, suitable for industrial upscaling. The hypothesis was that extraction under 20°C without enzymes would maintain the functionality of side stream proteins, thus making them eligible as emulsifying or gelling agents for meat products.

Methods

Different methods for protein extraction were investigated at laboratory scale[1]: water extraction; salt extraction (0.1M KCl in EDTA-buffer); alkaline extractions (varying in pH (9-10.8), extraction time (1-24 h) and temperature (3-20°C)). See Table 1 for further details. Afterwards, acid precipitation at pH 5.03 was used for all extraction methods, besides water, to obtain the extracted protein in a solid phase.

Furthermore, the effect on extraction yield was evaluated with varying pH (9.0-10.5), an extraction time of 1 hour at 3°C and a ratio of 1:5. The protein content was evaluated using the Kjeltec-Tecator system, analysing the content of organically bound nitrogen. The protein content was calculated as %Nx6.25. The extraction efficiency was determined from the content of protein in extract [g]/protein in lung tissue [g]x100.

[1] At laboratory scale 100 g of lung tissue was used for each extraction

Results

Different cold extraction methods were evaluated in a screening trial (Figure 1). Alkaline extraction showed the greatest extraction efficiency compared to salt extraction. A positive correlation between pH and the extraction yield was found for alkaline extraction. Furthermore, elevated temperature or longer extraction time also resulted in an increased extraction yield.

Functionality was evaluated in the forms of water binding, foamability and gelling properties. The methods showed no significant differences in functionality (results not shown).

Alkaline extraction at high pH resulted in a greater extraction yield, although it is also expected to have a negative effect on the wearing of the upscaling equipment. Usually, the wearing of the equipment is determined by the number of cleaning circles, which are performed at pH 11. Using an extraction solvent of pH 11 would thereby halve the wearing of the equipment as it is expected to be cleaned between every extraction. Lowering the pH to 9.0 is therefore expected to be relevant due to the rentability of the process. However, the efficiency at pilot scale is still to be evaluated at varying pH in order to evaluate the rentability of the process.

Alkaline extraction at pH 9, for 1 h at 20°C and ratio 1:5, had an efficiency of 55%, which is comparable to water extraction (extraction efficiency of 53%). However, extraction at pH 9 will prevent unwanted bacterial growth during extraction, which is beneficial compared to water extraction in which there will be no control of bacterial hurdles.

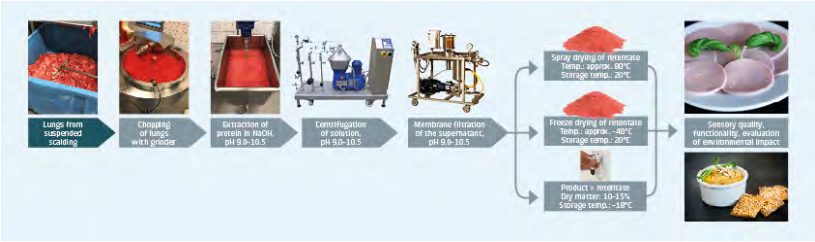
At laboratory scale, the precipitation step resulted in a loss of 50-60% of the extracted proteins (results not shown). Furthermore, handling of concentrated hydrochloric acids in large scale is not wanted. Upscaling the process to a pilot scale[1] has therefore focused on a method to avoid precipitation and concentrating the extracted proteins by membrane filtration. The effect of a drying step will be tested in the further work of the project (Figure 2).

[1] At pilot scale, 10 kg of lung tissue are used for each extraction

Conclusion

To conclude, alkaline extraction is a gentle method for extracting proteins from a solid matrix such as porcine side streams and shows great potential for upscaling of slaughterhouse side streams.

Notes



Flow chart that illustrates the processing of slaughterhouse side streams into functional ingredient

Extraction agent	Ratio[1]	Time [h]	Temperature [°C]	Extraction efficiency [%]
Water	1:13	1	4	53
KCl	1:5	1	20	49
Alkaline pH 10.8	1:5	24	4	67
Alkaline pH 10.5	1:5	1	3	55
Alkaline pH 10.0	1:5	1	3	52
Alkaline pH 9.5	1:5	1	3	48
Alkaline pH 9	1:5	1	3	47
Alkaline pH 9	1:5	1	20	55
Alkaline pH 9	1:5	24	5	52

[1]sample:solvent ratio

Extraction yield of the different extraction methods investigated

Notes