

CASCADE EXTRACTION OF COLLAGEN-BASED PROTEIN FROM ATLANTIC COD FILLETING SIDE STREAMS

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Introduction

Atlantic cod (*Gadus morhua*), part of the *Gadidae* family, makes up about 10% of all finfish caught globally, with an annual production of around 0.7 million tonnes. The main processing method is filleting, which yields only 33% of the fish's total weight as commercial product (Falch et al., 2005). The remaining side streams (head, backbone, and skin) are rich in collagen. Depending on the extraction conditions, collagen may be obtained as its native triple helix form, as gelatin, or as partially hydrolyzed peptides. Each fraction has distinct functional and biological properties, enabling a variety of industrial applications. In this study, we employed a rapid cascade extraction process using green technologies to sequentially recover native collagen, gelatin, and peptides from Atlantic cod skin, head, and backbone.

Materials and Methods

Skin, head, and backbone from Atlantic cod were provided by SINTEF (Norway). The cascade extraction (Figure 1) began with an alkaline pretreatment with aqueous NaOH to remove non-collagenous proteins. These proteins were then isolated through isoelectric precipitation and freeze-dried. Next, collagen was extracted with acetic acid by ultrasound. Collagen was isolated and freeze dried. The residual material from the native collagen extraction was mixed with hot distilled water (45-60 °C) and incubated to extract gelatin. Finally, the residue from head and backbone obtained from gelatin extraction was further extracted with subcritical water extraction at 170 °C. The yield was calculated relative to the initial mass of each side stream and hydroxyproline on a dry basis, and its chemical composition was characterized (AOAC, 2005, Cissell et al., 2017).

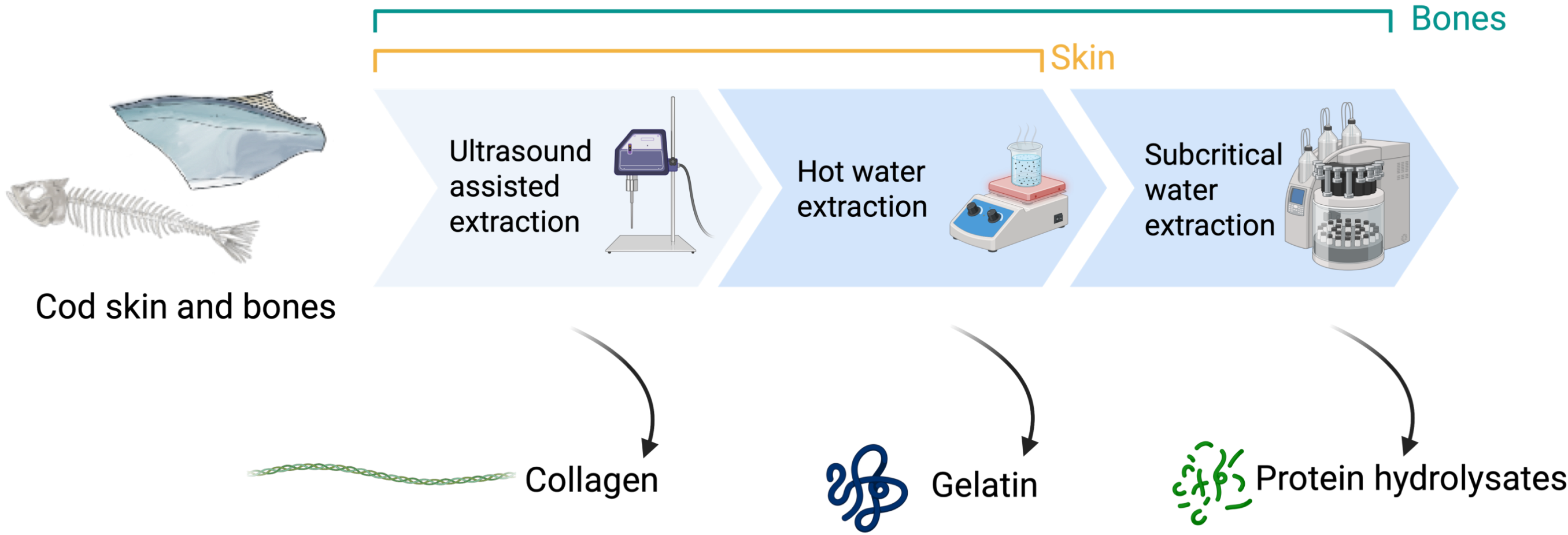


Figure 1. Cascade extraction procedure of Atlantic cod skin and bones.

Results and discussion

Cascade extraction of collagen, gelatin and peptides

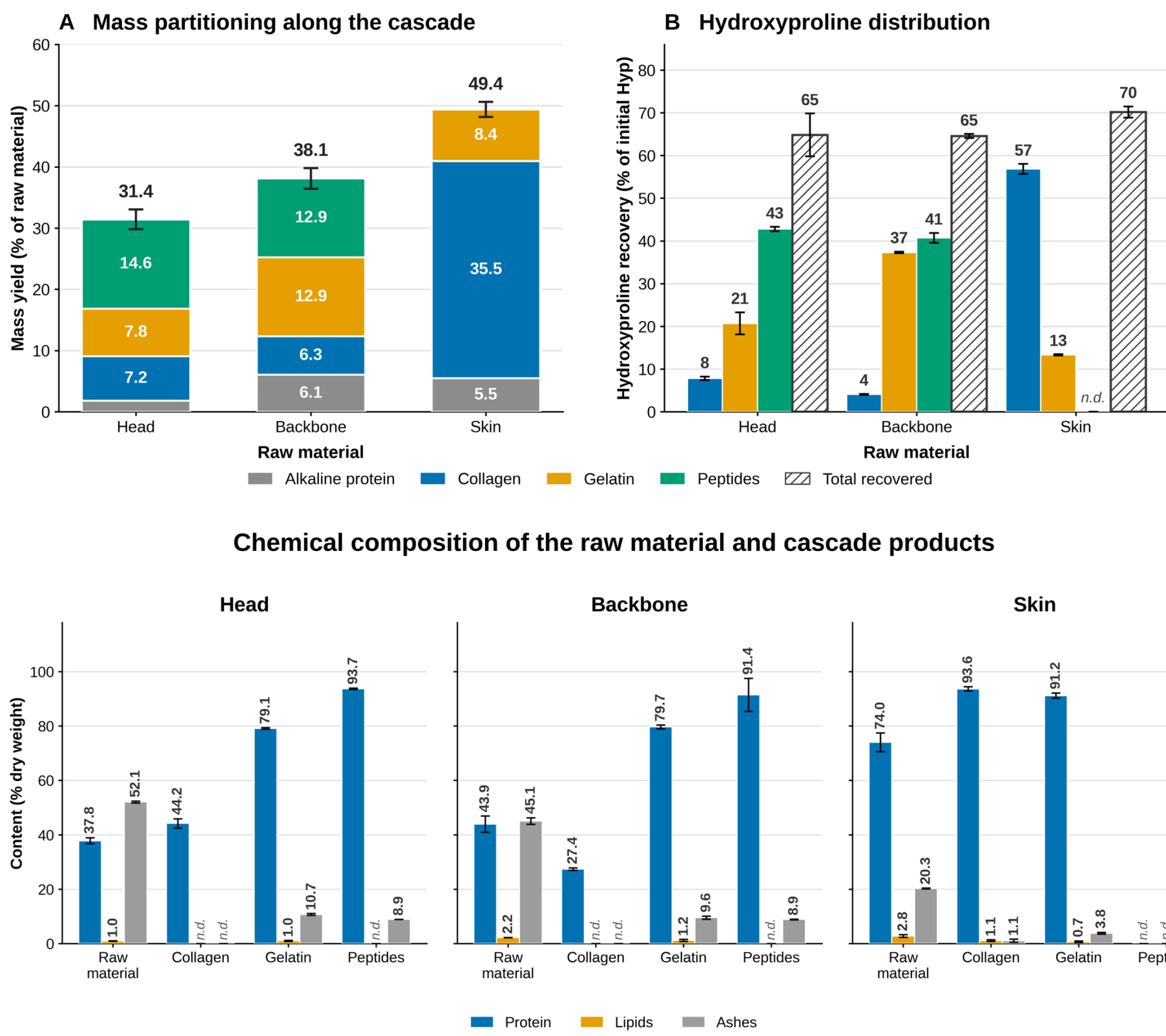


Figure 2. Cascade extraction of collagen, gelatin and peptides from fish head, backbone and skin. (A) Mass partitioning along the cascade. (B) Distribution of hydroxyproline among the collagen, gelatin and peptide fractions, expressed as a percentage of the hydroxyproline present in the raw material (C) Chemical composition (protein, lipids and ashes, % dry weight) of each raw material and of the products obtained from it. (D) Amino acid profile (residues per 1000 residues) of the raw materials and cascade products. Values in A–C are mean $\pm$ SD of two independent extractions; panel D corresponds to a single determination per sample. n.d., no data.

The cascade extraction process produced 50% collagen proteins from Atlantic cod skin. Although the total yield from the head and backbone was lower, minerals constitute nearly half of their dry weight, significantly reducing the organic matter available for extraction compared to the skin. The percentage of hydroxyproline recovered offers a clearer view of the collagen proteins extracted and remains consistent across all three tissues. The variations in protein levels in the collagen of the head, backbone, and skin are due to acid extraction of collagen, which partially solubilizes minerals present in the head and backbone. While this process reduces collagen purity, it facilitates the extraction of gelatin and peptides during cascade processing, as evidenced by higher protein recovery in these stages. The amino acid composition indicates a high initial presence of collagen's most abundant amino acids (Gly, Pro, and Hyp) both in the original and extracted materials. Overall, the process enables recovery of approximately 65-70% of total collagen protein from the skin, head, and backbone of Atlantic cod side streams within a total cascade extraction time of 160 minutes.

Conclusions

- Cascade extraction extracted 65-70% of total collagen protein (collagen, gelatin, and peptides) from Atlantic cod side streams.
- The extracted collagen protein materials generally have a crude protein content exceeding 80%.
- Both the initial material and the extracted collagen protein show an amino acid profile rich in Gly, Pro, and Hyp.
- Cascade extraction using green techniques (ultrasound, hot water, and subcritical water extraction) reduces the total extraction time to 160 minutes.

Acknowledgments

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References

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