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Circular economy approaches to enhance the sustainability of supply chains in aquatic animal production

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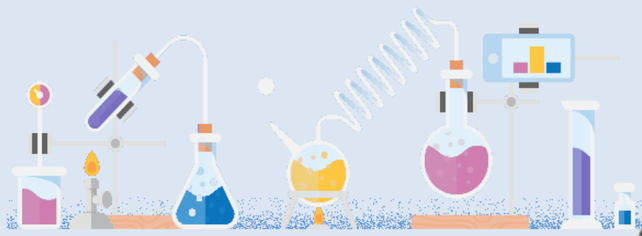
INTRODUCTION & AIM

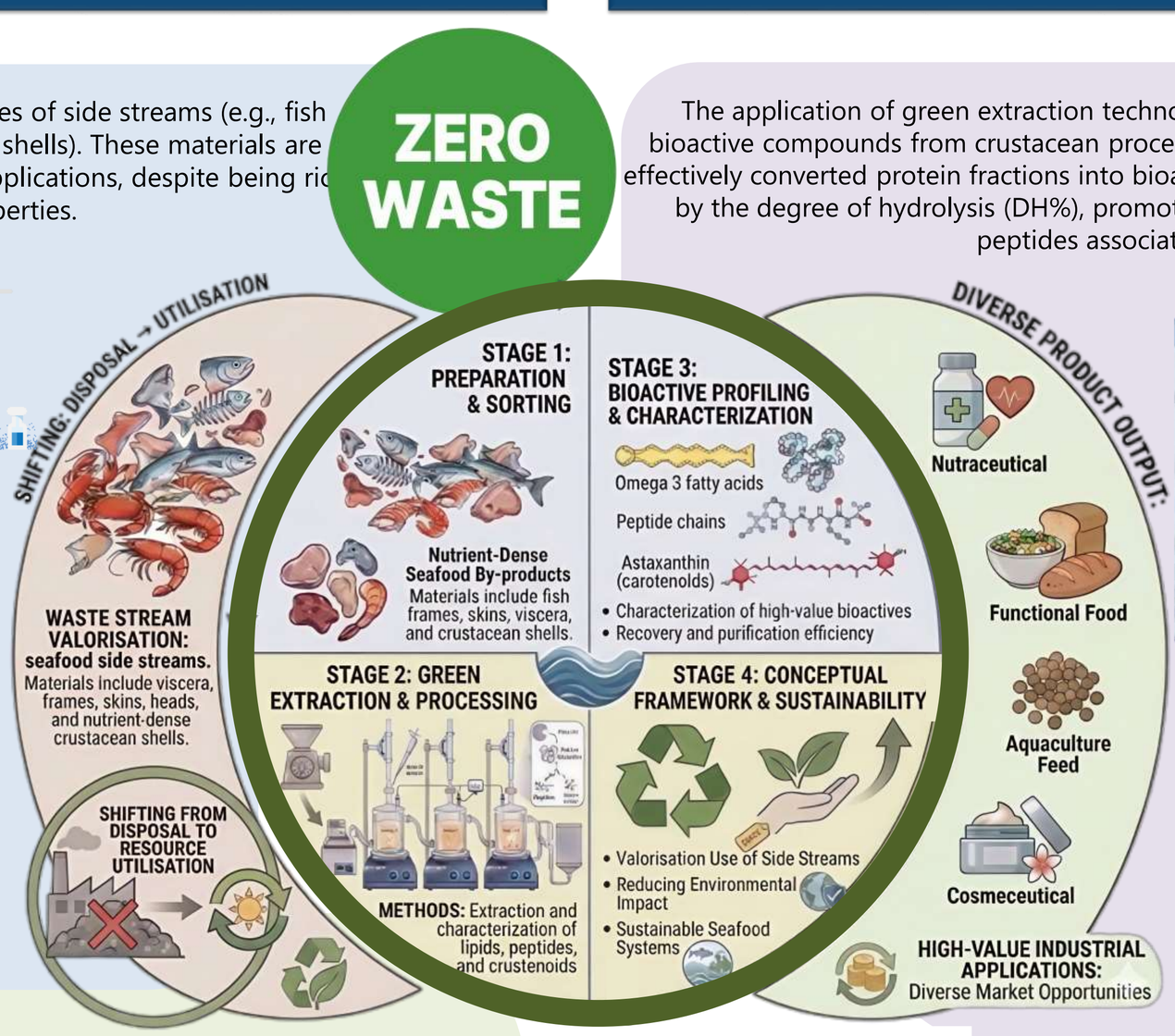
Seafood processing generates large quantities of side streams (e.g., fish viscera, heads, skins, frames, and crustacean shells). These materials are frequently discarded or used in low-value applications, despite being ric in bioactive compounds with functional properties.



Within the framework of the circular bioeconomy, the valorisation of seafood by-products is a strategy to improve resource efficiency and reduce waste.

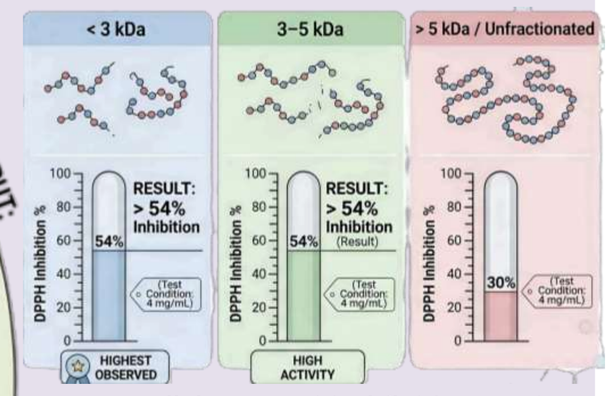
This study aimed to:

- Develop sustainable extraction approaches for crustacean by-products
- Recover bioactive compounds with potential functional properties
- Evaluate their antioxidant activity
- Assess their potential use in food, feed, nutraceutical, and cosmeceutical applications.



RESULTS & DISCUSSION

The application of green extraction technologies enabled the recovery of valuable bioactive compounds from crustacean processing side streams. Enzymatic hydrolysis effectively converted protein fractions into bioactive peptide hydrolysates, as indicated by the degree of hydrolysis (DH%), promoting the release of low molecular weight peptides associated with improved functional properties.



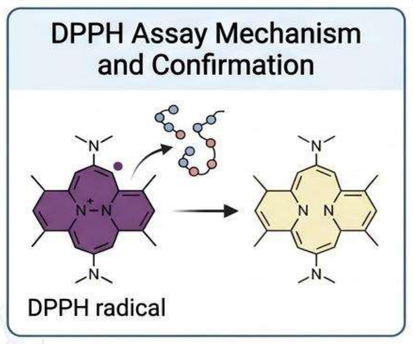
In parallel, supercritical fluid extraction (SFE) allowed the recovery of astaxanthin under mild operating conditions (~40 °C, 350 bar), producing extracts with high purity and reduced solvent residues compared to conventional extraction methods.

METHOD

Crustacean processing side streams were used as the primary raw materials.

Extraction procedures:
Bioactive peptides were obtained through enzymatic hydrolysis using Alcalase and Protamex, followed by thermal inactivation (90 °C, 5 min), centrifugation, and freeze-drying. Astaxanthin was recovered using supercritical CO_2 extraction (SFE) under controlled conditions (~40 °C, 350 bar).

Antioxidant Characterization
Protein hydrolysis was monitored through the degree of hydrolysis (DH%), while antioxidant activity was evaluated using the DPPH radical scavenging assay.



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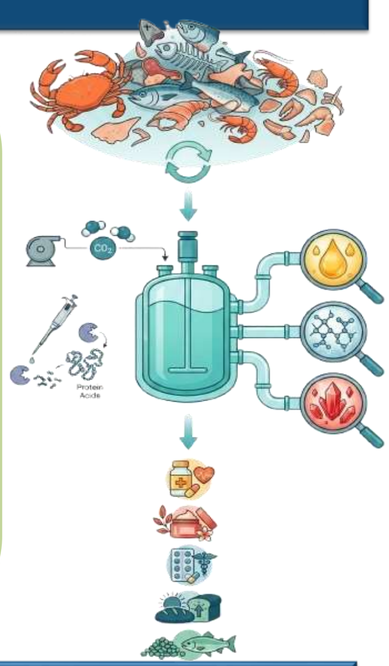
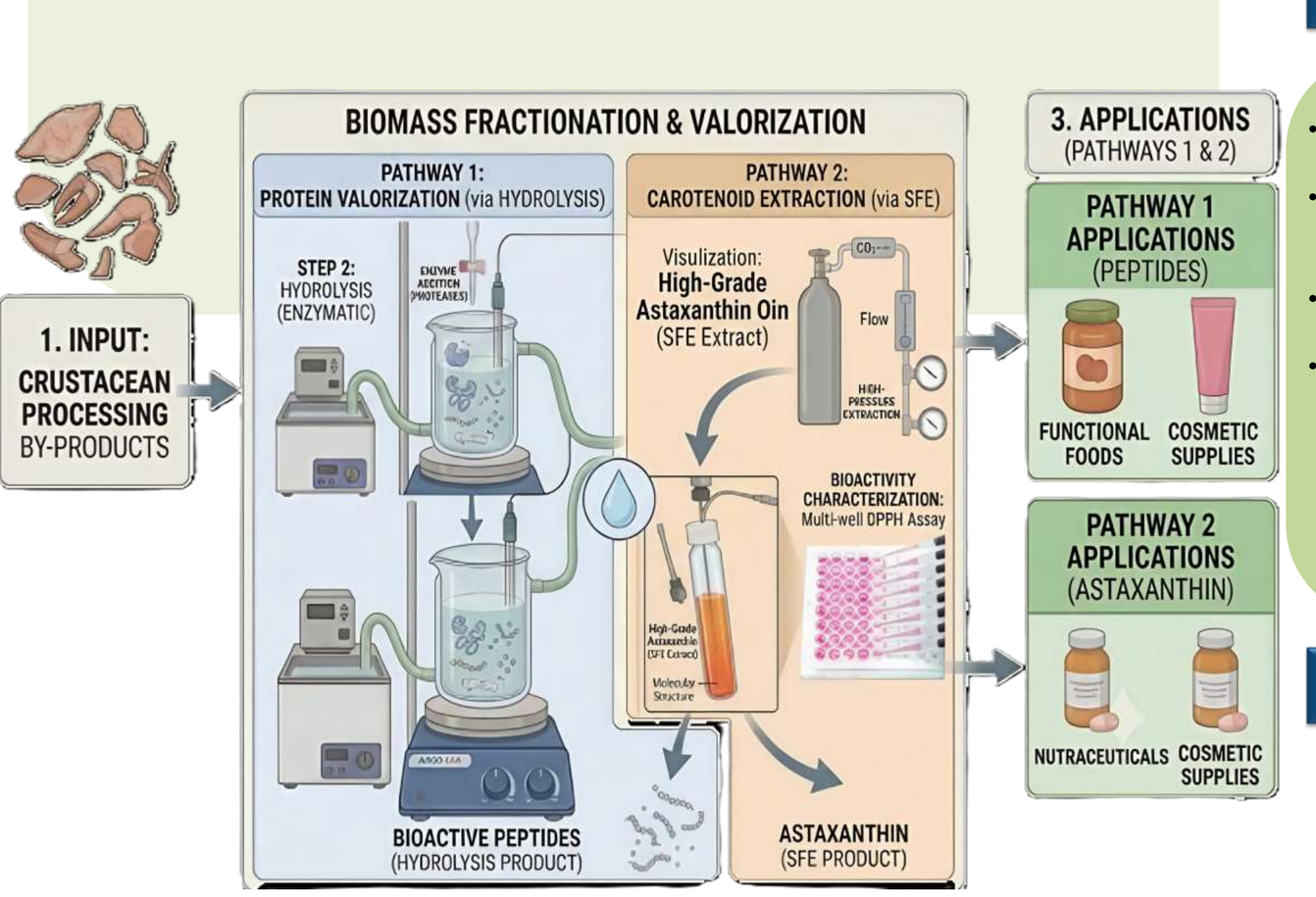
Highest activity observed in low molecular weight peptides (<3 kDa and 3-5 kDa).

Radical scavenging capacity exceeded 54% inhibition at 4 mg/mL.

CONCLUSION

- **Crustacean processing by-products** represent a valuable source of **bioactive compounds**.
- **Green extraction techniques** (enzymatic hydrolysis and supercritical CO_2 extraction) enabled the recovery of **peptide hydrolysates and astaxanthin** without toxic solvents.
- Recovered fractions exhibited **strong antioxidant activity**, supporting their potential as **functional ingredients**.
- Valorisation of these residues contributes to **waste reduction, improved resource efficiency, and the development of a circular marine bioeconomy**.





FUTURE WORK / REFERENCES

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Lanzoni, D., et al. (2026). Valorization of hemp, shrimp and blue crab co-products as culture media ingredients for cultured meat.
Messina, C., et al. Extraction of bioactive compounds from shrimp waste.
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