Hybrid Alternative Protein

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Plant protein product innovation

Leverage plant protein blends

Hybrid alternative protein – why?

Recent advance in hybrid alternative protein

- Associate Professor, University of Greenwich (2020 -)
  - Research group lead, Food Processing & Innovation
  - Head, Medway Food Innovation Centre (https://mfic.gre.ac.uk)
  - PI, Bezos Centre for Sustainable Protein
- Science & Technology Manager, Unilever (2011-2020)

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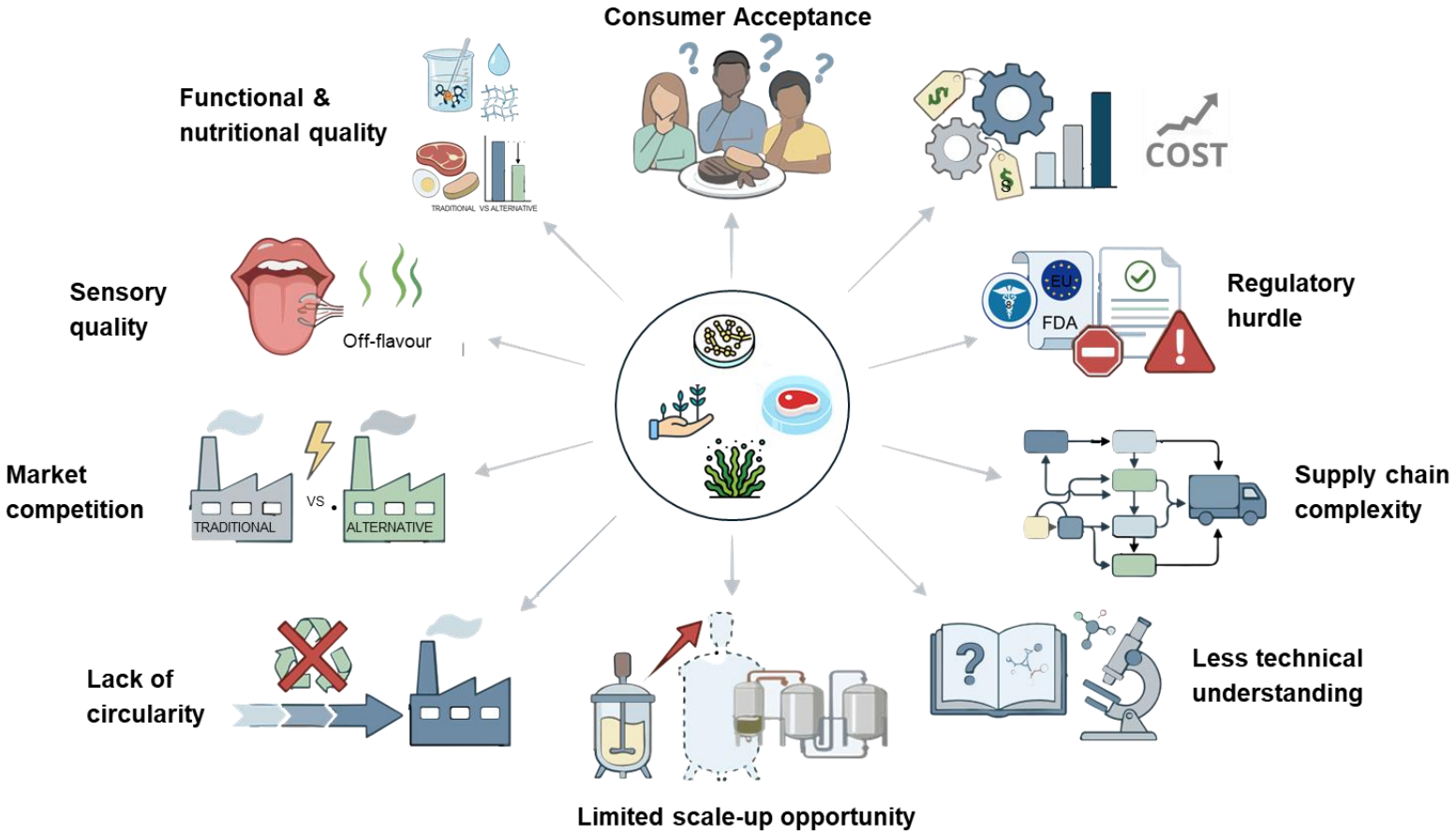
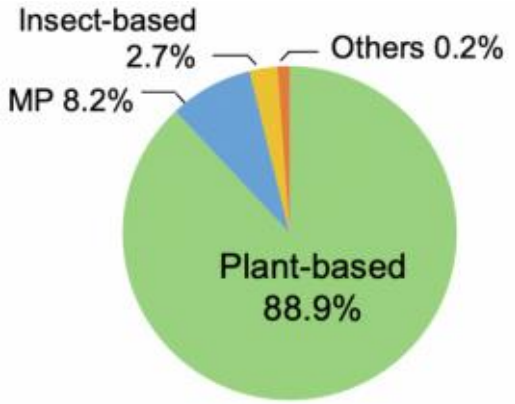
Alternative Protein: Challenges and Market Landscape

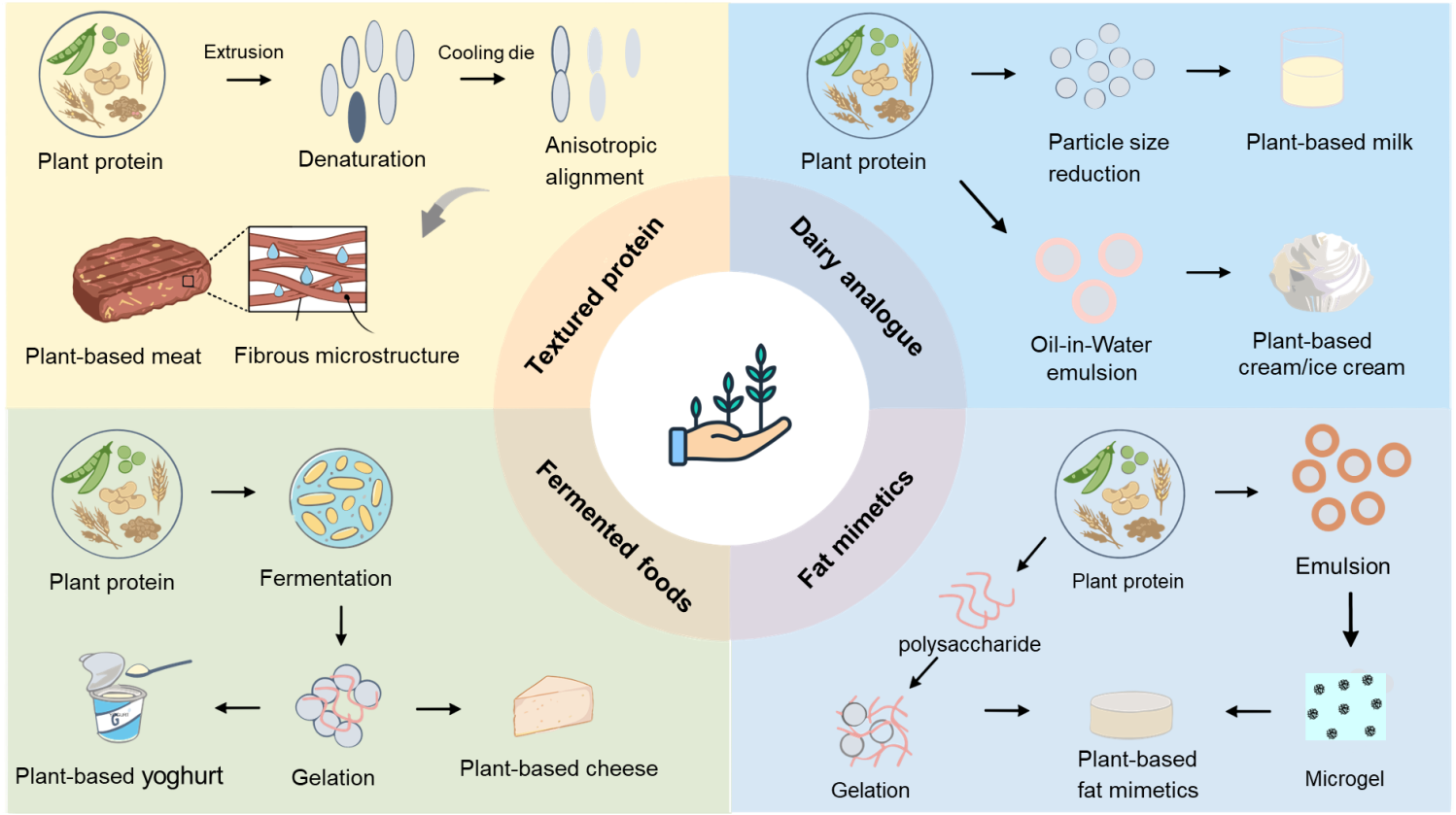




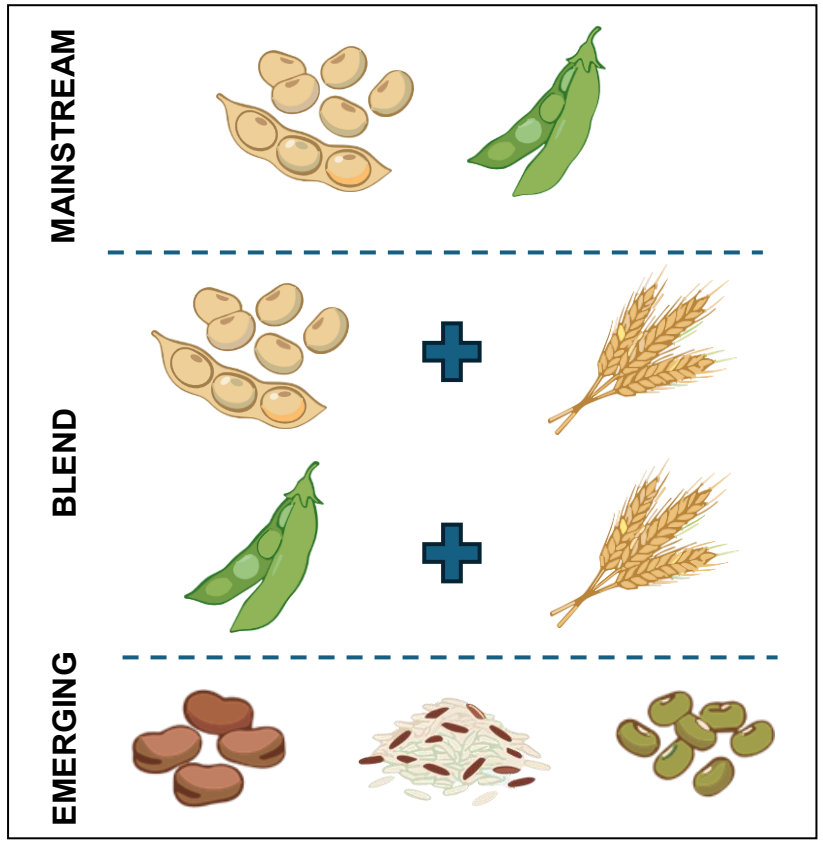
Malila, Y. et al., Nature Food (2024), 8, 53

Plant Protein: Product Technologies

Innovation opportunities



Ingredients



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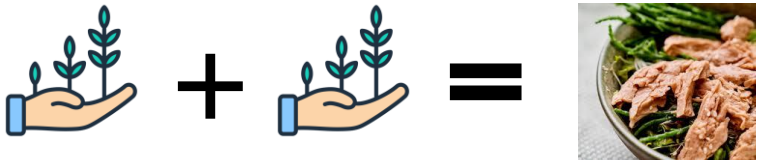
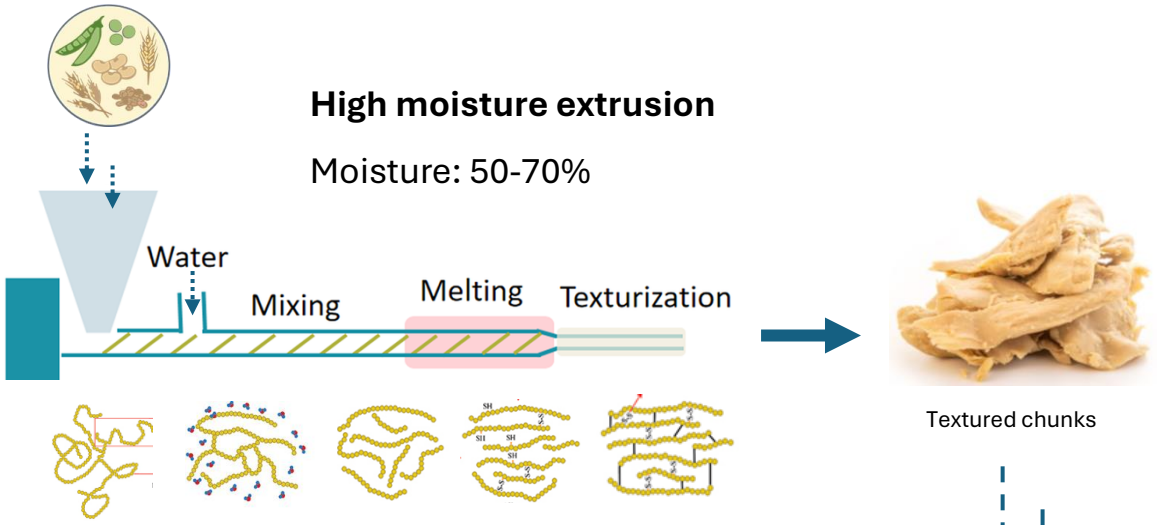
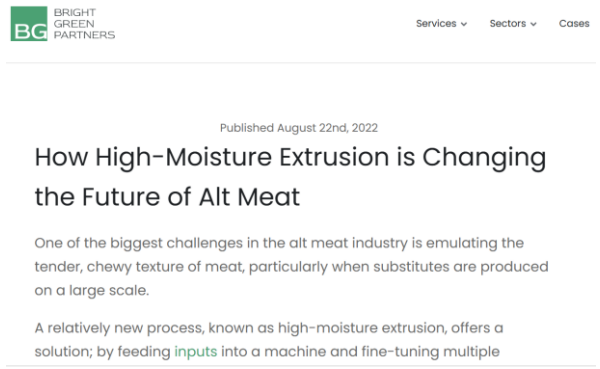
Textured Plant Protein Blend

Advantages of plant protein blend



- Ensure protein diversity
- Nutritional adequacy – complimentary AA profile
- Enhanced protein digestibility
- Superior texturization
- Improved functionalities





Munialo et al. Foods, 2025, 14(8), 1396
Sood et al. J Food Sc. 2026, 91, e70868

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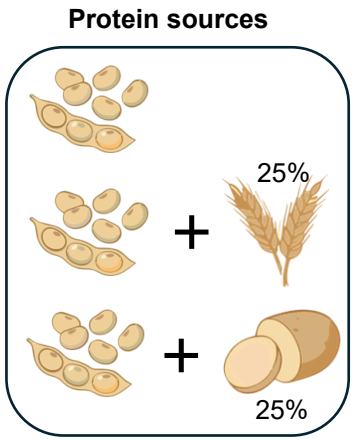
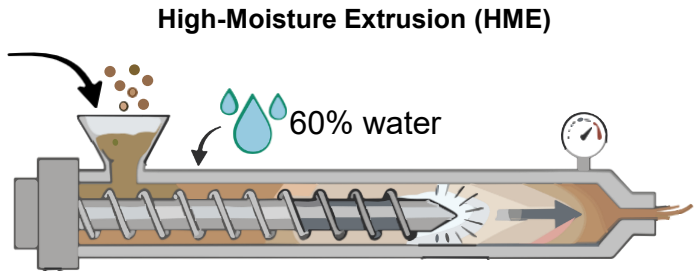
Gluten Free Plant-based Meat Alternatives

Knowledge gap

- How does gluten augment to texturization of faba bean protein
- Exploring potato protein (PPI) co-extrusion with faba bean protein
- Compare texturization - gluten (WG) versus potato (PPI)
  - PPI is high-quality protein but **what about texturizing capacity**!





- Understand ***change in protein texture*** due to co-extrusion and assess conformation change
- Evaluate ***rheology*** to compare ***viscoelastic behaviour/ mechanical strength*** and ***taste*** of co-extrudates
- Identify ***protein-protein interactions*** affecting structure formation in co-extrudates

- Co-extruding gluten and potato protein with fava bean protein **under identical conditions**
- Enabling **isolation of protein-specific effects** on network formation, texture and sensory

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Texture Modulation, Protein Conformation and Surface Properties

E(FPI)

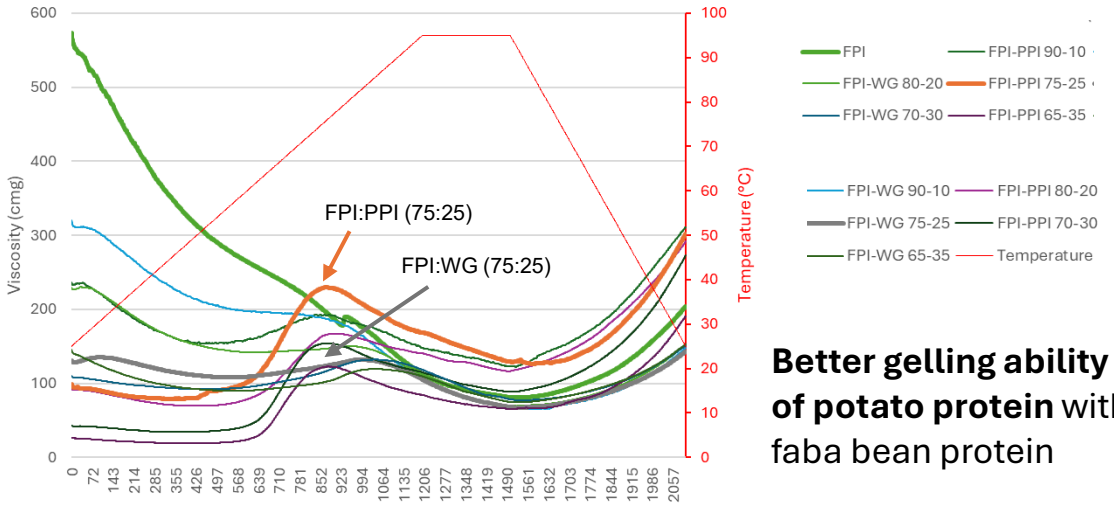
Faba bean protein only

E(FPI-WG)

with 25% gluten

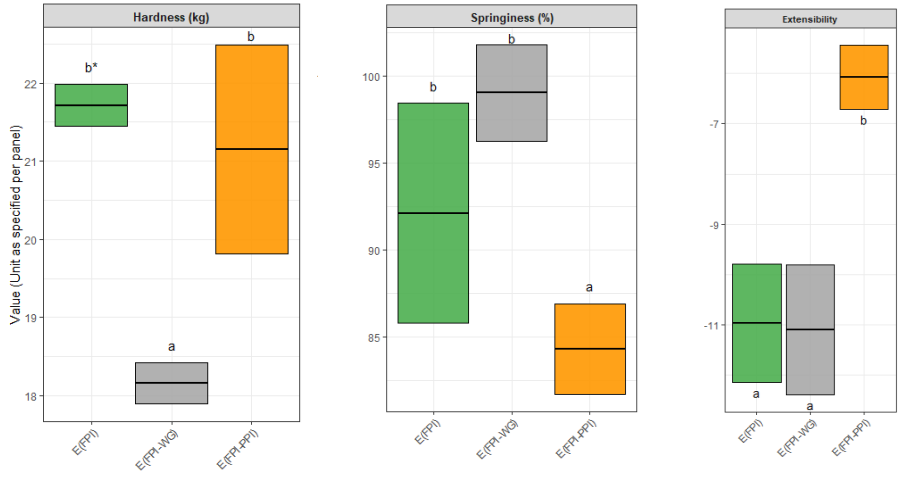
E(FPI-PPI)

with 25% potato protein



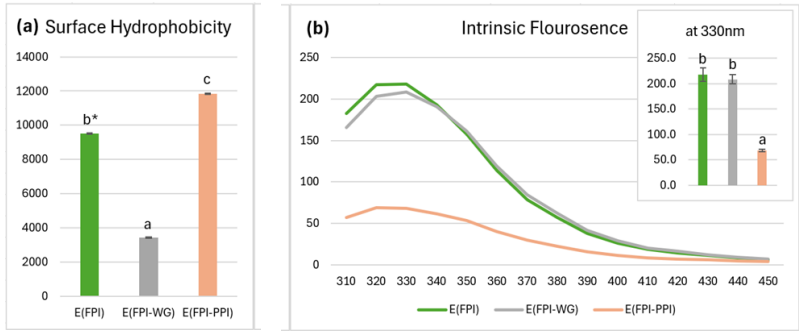
Better gelling ability of potato protein with faba bean protein

Texture effect (TPA and cutting test)



Gluten yields a **softer** and **elastic matrix**, but PPI leads to **improved hardness** with compliant **extensibility**

Surface hydrophobicity and protein conformation



HME leads to more **protein unfolding, aggregation** and **surface hydrophobicity** in E(FPI-PPI)

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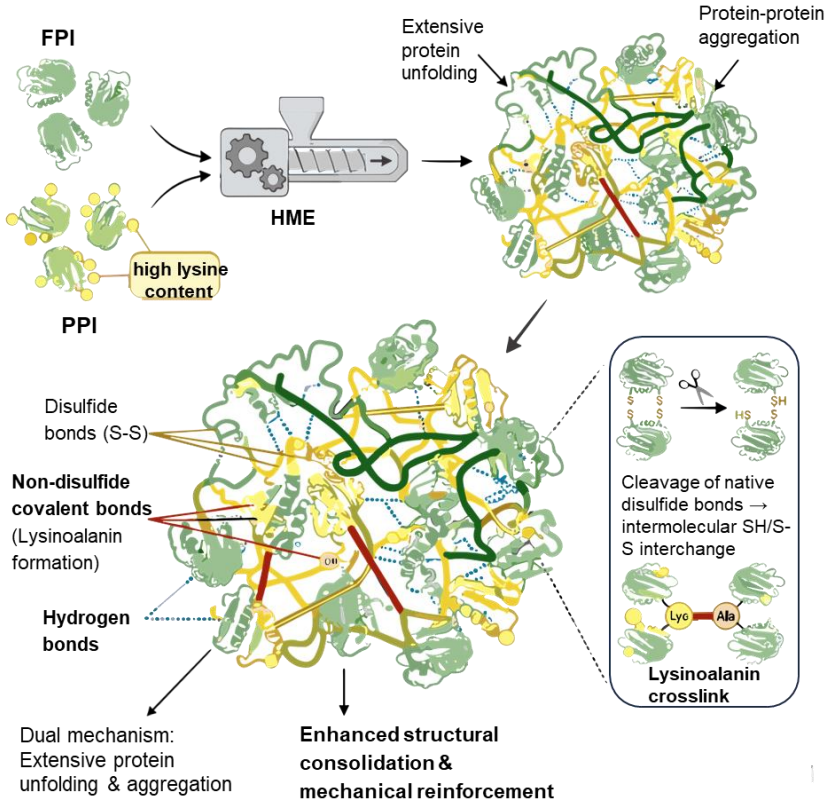
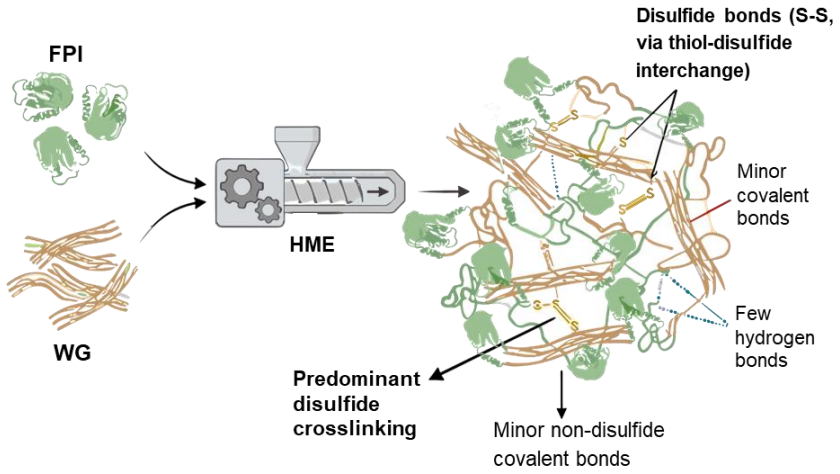
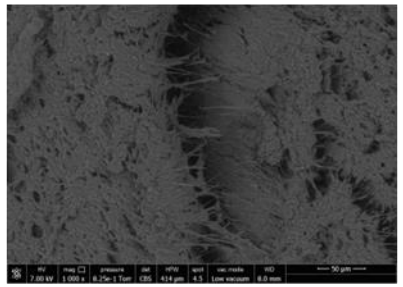
Protein-Protein Interaction, Visco-elasticity and Microstructure

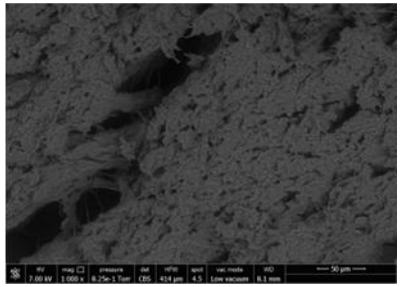




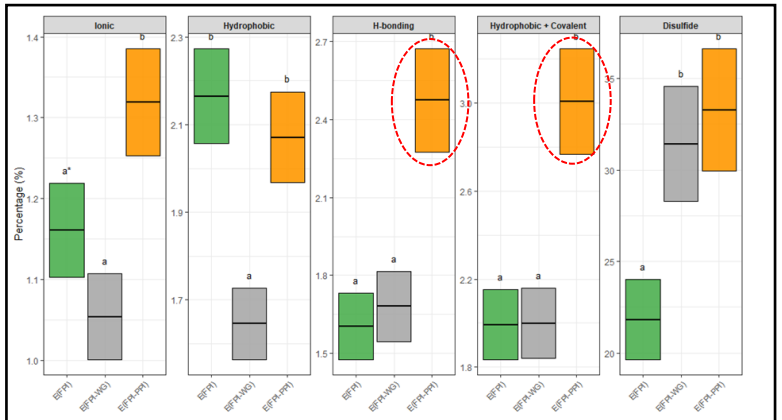
E(FPI-WG)



E(FPI-PPI)

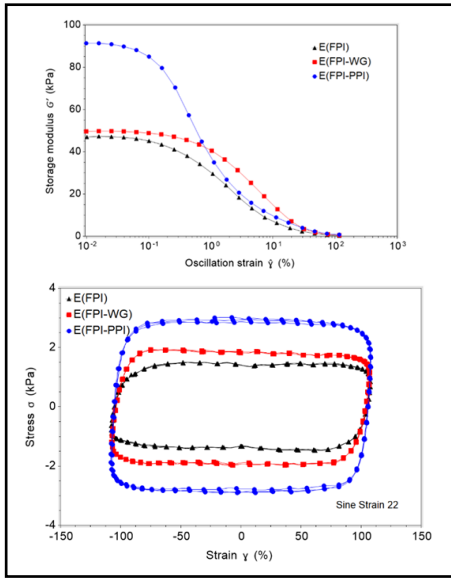


Protein-protein interactions



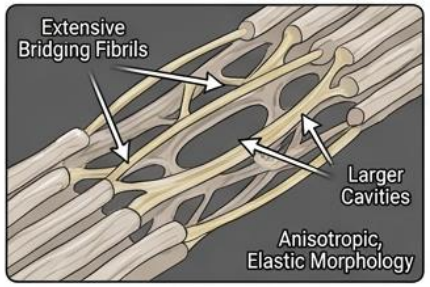
H-bonds and non-disulfide **covalent bonds** are more prominent in E(FPI-PPI)

Rheology (LAOS)

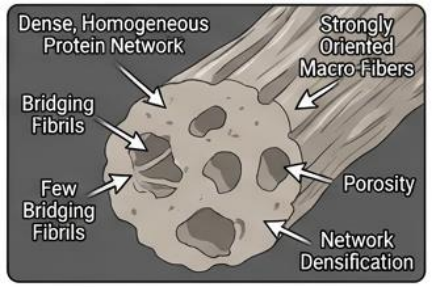


E(FPI-PPI) exhibits a **denser** and **cohesive network** compared to E(FPI-WG)

Gluten Versus Potato Protein: Texture and Sensory Impact

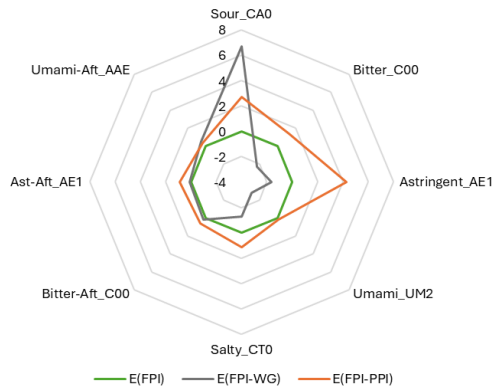


E(FPI-WG)



E(FPI-PPI)

Taste analysis (by e-tongue)



When co-extruded with faba bean protein, **gluten suppressed bitterness** and **astringency**, while **PPI intensified off-notes**

- **Divergent protein–protein interaction pathways** govern cross-link network formation led to texture
- **Potato protein drives deeper conformational restructuring and protein-protein network densification** which lead to superior mechanical properties in E(FPI-PPI)
- **Inverse relationship between fibril density and mechanical elasticity** underpins contrasting texture profiles in E(FPI-WG) versus E(FPI-PPI)
- **Sensory trade-off** between texture/protein network influence and taste quality

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Hybrid Alternative Protein

Limitations of individual protein sources

Plants

- Nutrition equivalency
- Functional limitation
- Off-taste/sensory

Microalgae

- Neophobia
- Cost
- Regulatory

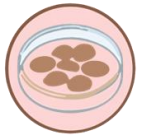
Mycoprotein

- Scalability
- Regulatory

Precision fermentation

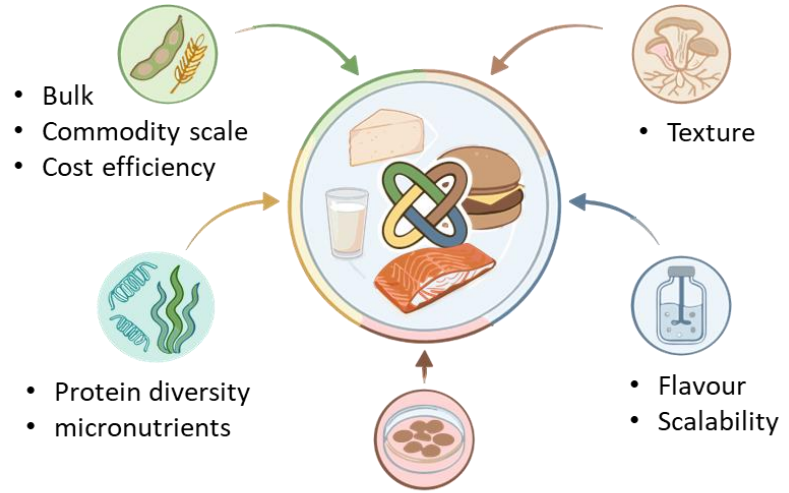
- Cost
- Regulatory

Cell culture



- Cost
- Consumer acceptance
- Regulatory

Hybrid strategy



More than the sum of their parts

Kaplan and McClements (2025) *Frontiers in Science*

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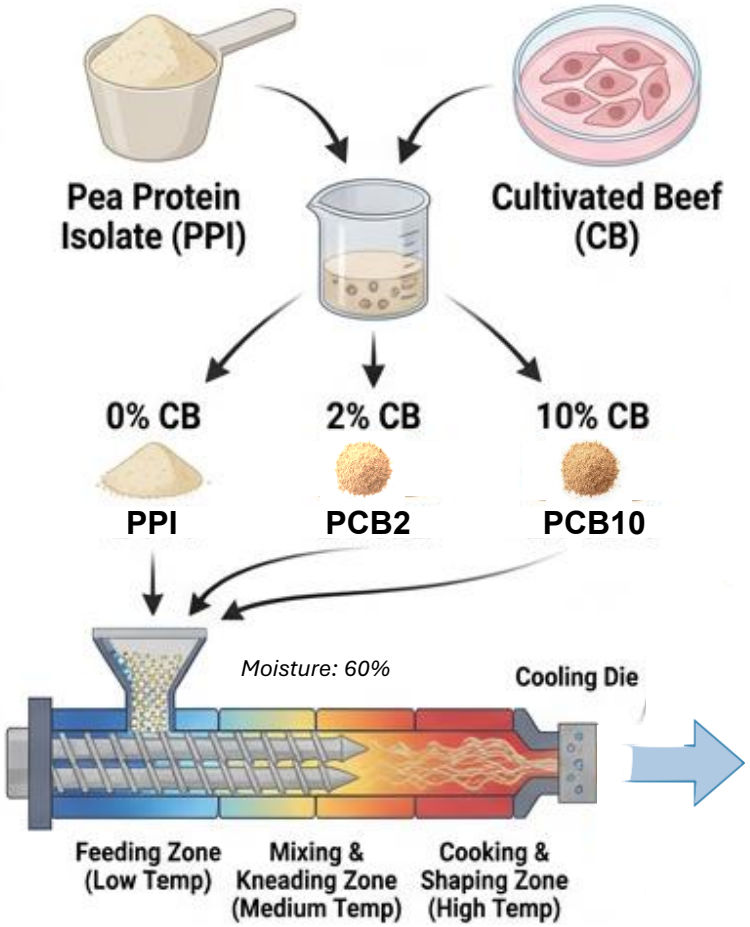
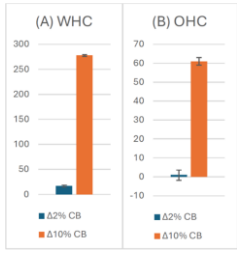
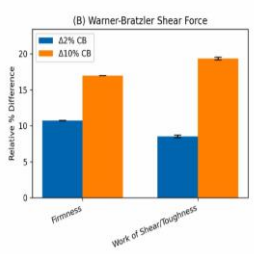
Recent Advance in Hybrid Alternative Protein

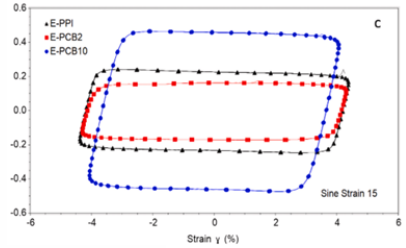
EXPERIMENTAL DESIGN



FUNCTIONAL & STRUCTURAL OUTCOME

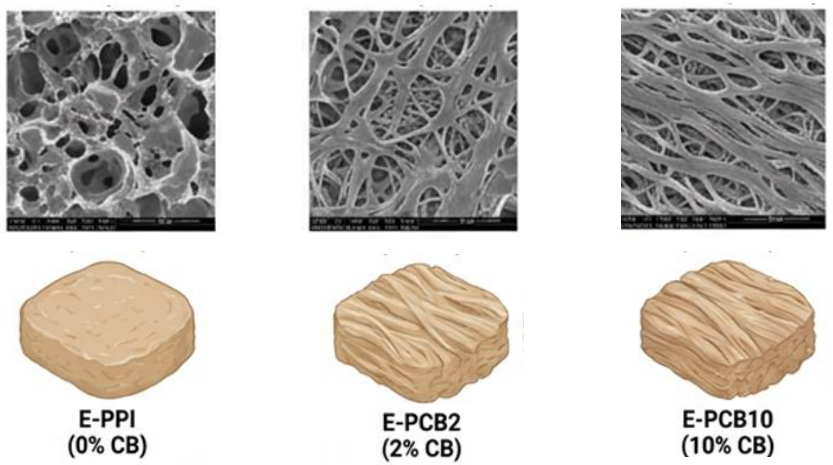




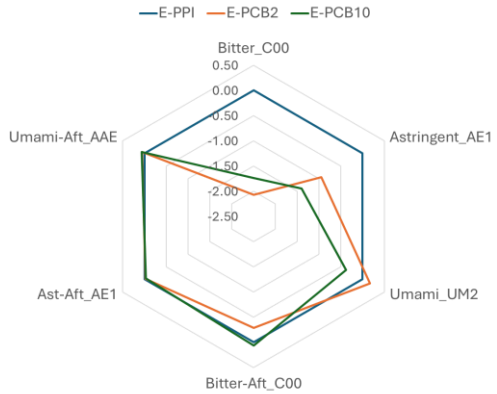


~16.7x & ~67x increase in water & oil holding

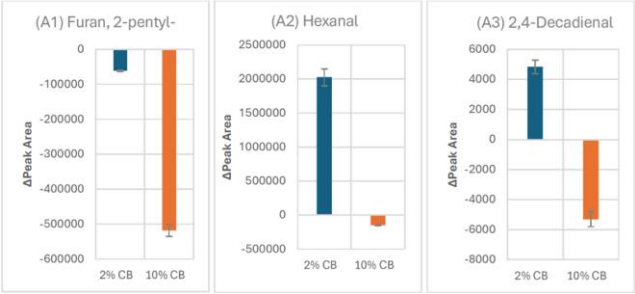
Improved texturization (from texture profile analysis) & mechanical strength (from LAOS)



SENSORY BENEFITS

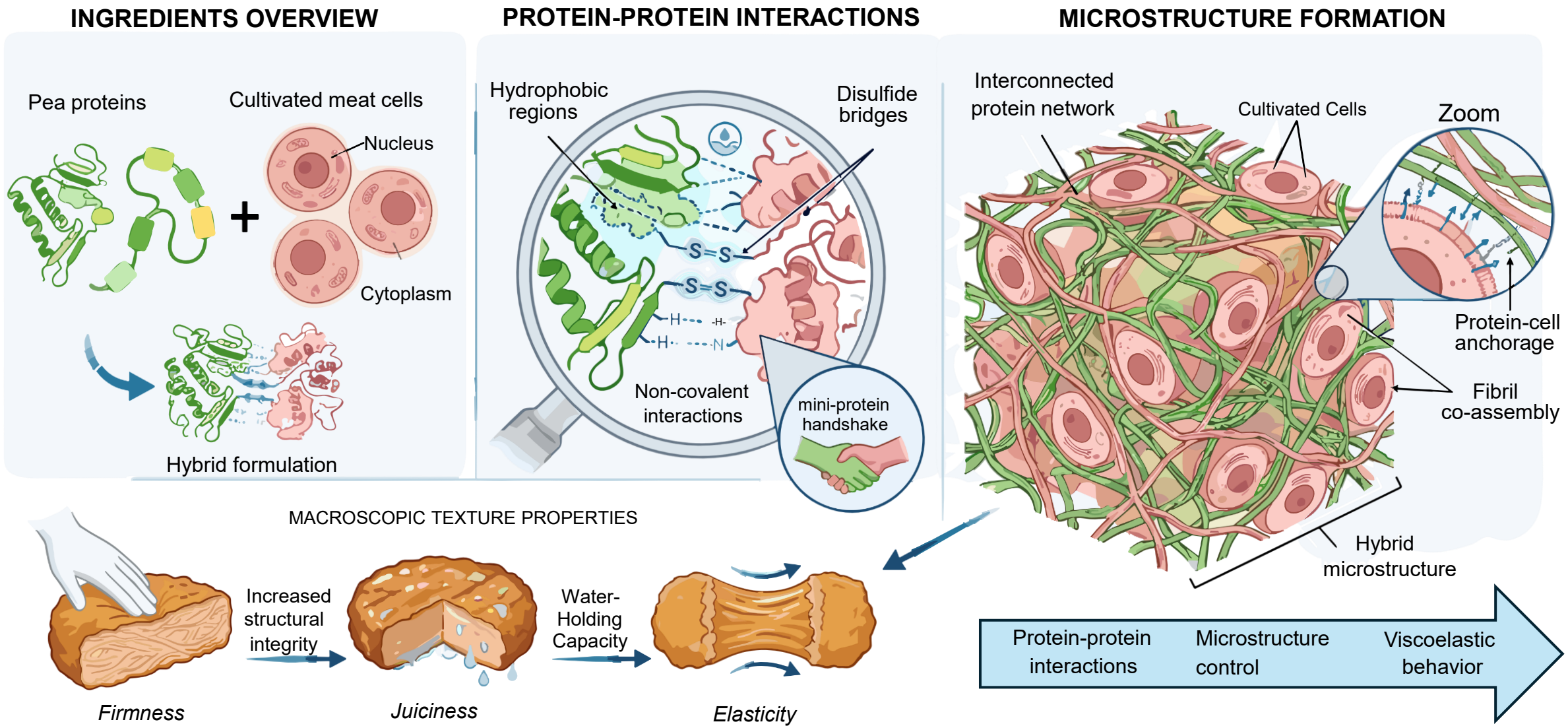


- **Less bitterness and astringency**
- **Reduction of off-flavours**



Baeghbali et al. Food Hydrocolloids, 2026, 172, 112154

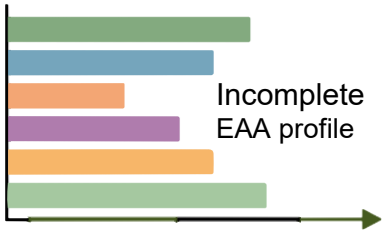
Hybrid Alternative Protein: Microstructure Control



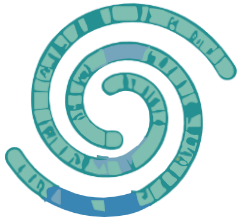
Nutritional Advantages of Plant - Algae Blend

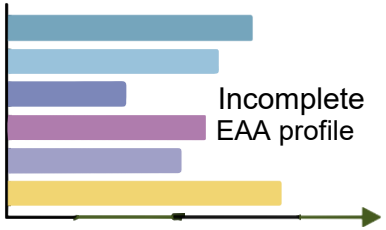
Alternative protein sources → **Formation of Hybrid alternative protein** → **Nutritional advantage**

Protein source A
(Legume)



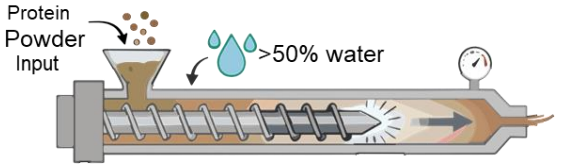
Protein source B
(Microalgae)



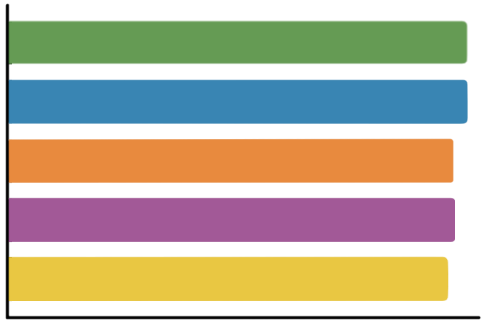


Hybridization:

Co-processing
alternative proteins

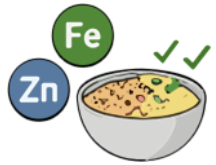


Complete EAA Profile of A+B



Enhanced
bioactive
peptides

Improved
digestibility



Natural
fortification of
micronutrients

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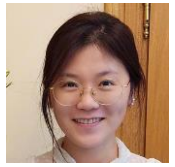
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