Oat protein-polysaccharide self-assemblies: multiscale characterisation towards sustainable material design and acceptance

J.McLauchlan[1] , A. I.I. Tyler[1] , C. Orfila[2] and A. Sarkar[1]

[1] Food Colloids and Bioprocessing Group, School of Food Science and Nutrition, Leeds, UK.

[2] Oatly, UK.

Presenter email: mmjam@leeds.ac.uk

THE ORIGINAL OATLY! · SOFI² CDT · UNIVERSITY OF LEEDS · UKRI Engineering and Physical Sciences Research Council

What's the problem?

In 2024, global warming values exceeded 1.5 °C for a full year[1]

This is the **climate tipping point** (irreversible damage to Earth's ecosystem)

Need to **reduce GHG emissions** by 43% by 2030 and to net zero by 2050[2]

... but how do we reach this target?

Look to nature and science!

Alternative proteins (plant-based, fermented or cultivated)

Why alternative proteins?[3]

1. Mitigate climate change

11–20% of GHG emissions are caused by animal agriculture

2. Increase food security

1/3 of all stale crops are fed to farm animals. **£3 billion** worth of feed and **£15 billion** worth of meat, fish and eggs in the UK are imported[4]

3. Fight antibiotic resistance

80% of antibiotics in the US are given to livestock

4. Help restore biodiversity

1/3 of Earth's arable land is used for animal agriculture

5. Improve animal welfare

Diseases from meat demand + unsustainable meat production

6. Reduce food waste

9:1 — 9 kcal of food are required to produce 1 kcal of chicken

The role of my research

- Proteins are **essential macronutrients** and are highly **satiating**
- However, plant proteins are often described as **'rough'** and **'gritty'** in texture
- Need to better understand **structure** and how it affects **performance**

Beyond porridge: unlocking the potential of oats[5]

- Starch
- **Protein**
- **Fibre (polysaccharide)**
- Vitamins/ minerals

... and more

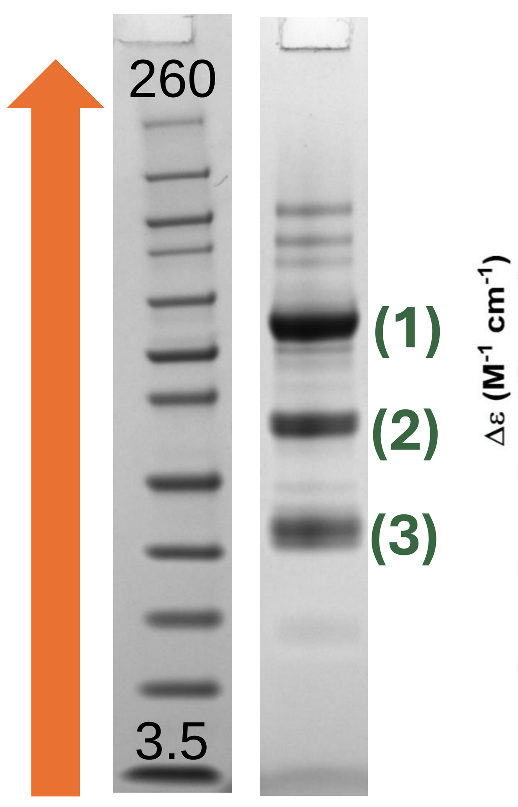
Research Question:

How does a naturally present polysaccharide (β-glucan) affect oat protein properties without energy intensive fractionation?

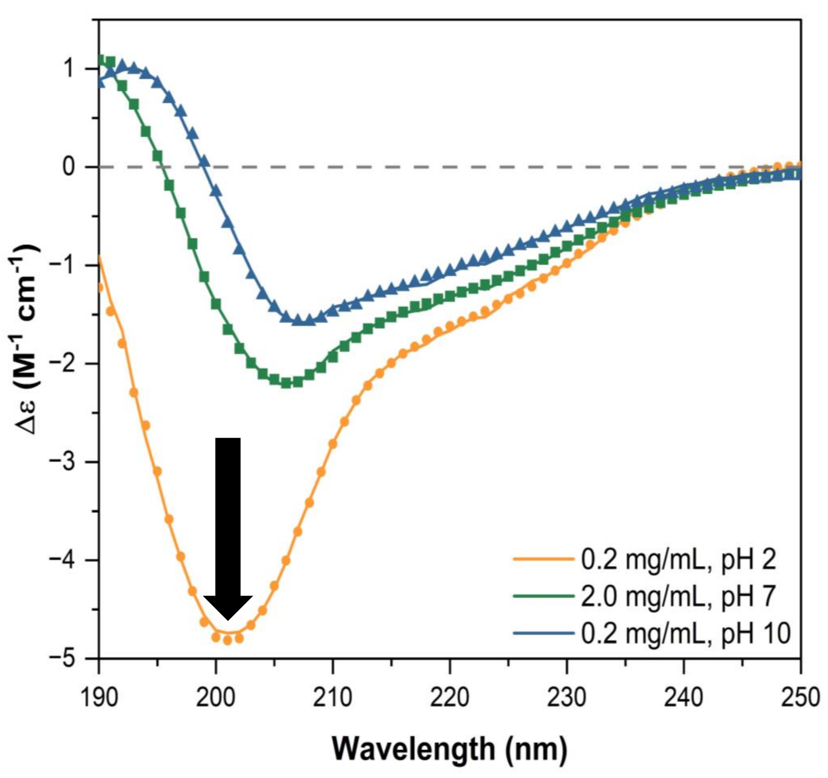
1. Composition and protein characterisation

Component	Concentration (mg/mL)
Protein	4.4 ± 0.1
β-glucan	0.59 ± 0.03

SDS-PAGE: protein identification



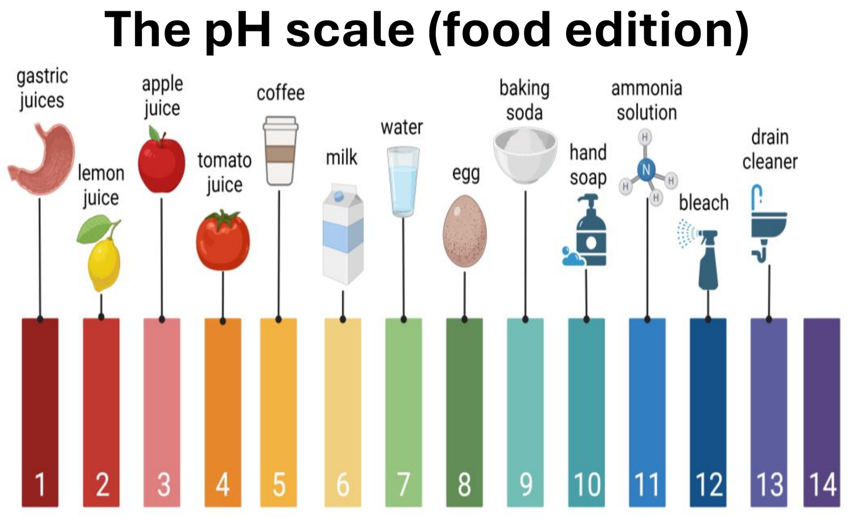
Circular dichroism spectroscopy: protein structure



- ✓ Identified major protein in oats and its components
- ✓ Structure behaviour matched previous oat protein data
- ✓ Some loss of structure in acidic conditions

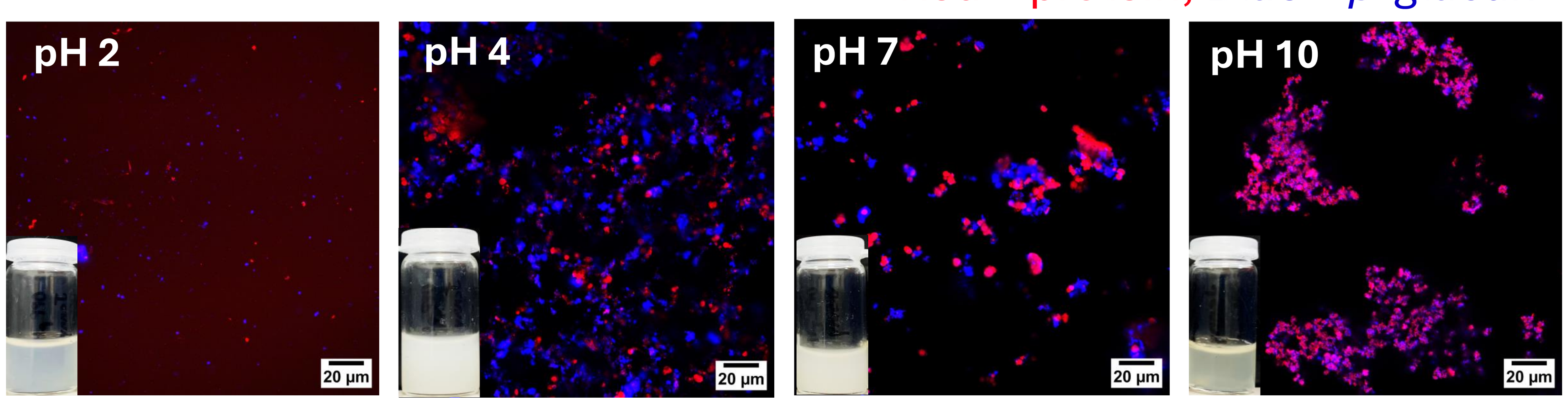
2. Imaging the material at relevant pH values

The pH scale (food edition)



- ✓ Used dyes to observe each component
- ✓ Interacting protein and β-glucan (especially at pH 10)
- ✓ Floc microstructure changes with pH – any influence on mouthfeel?

Red = protein; Blue = β-glucan

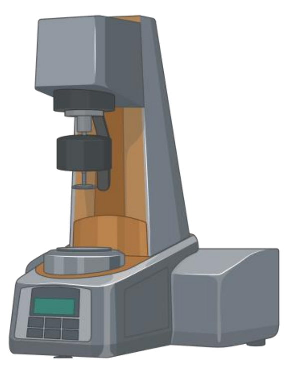


3. Moving forward with acceptability

How can we quantify mouthfeel (texture) in the lab?[6]

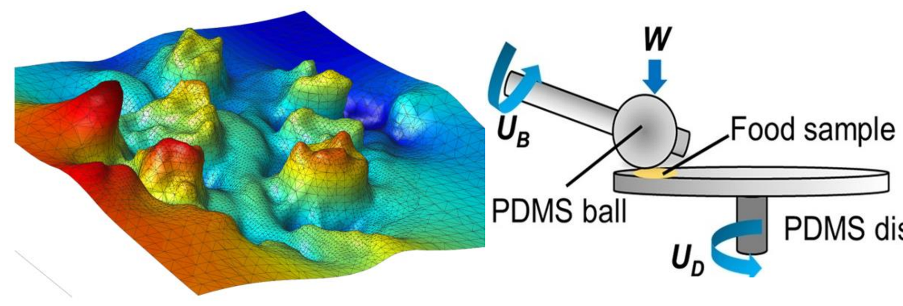
Rheology (viscosity/ thickness)

Good for initial perception of thickness

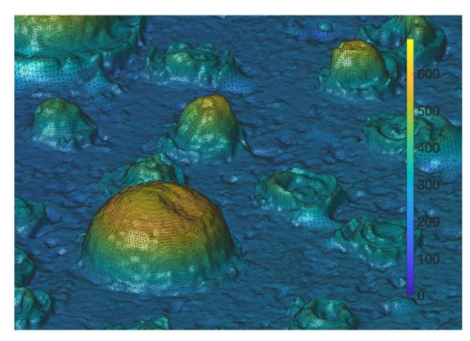


Water (low viscosity) vs. Honey (high viscosity)

Tribology (friction)



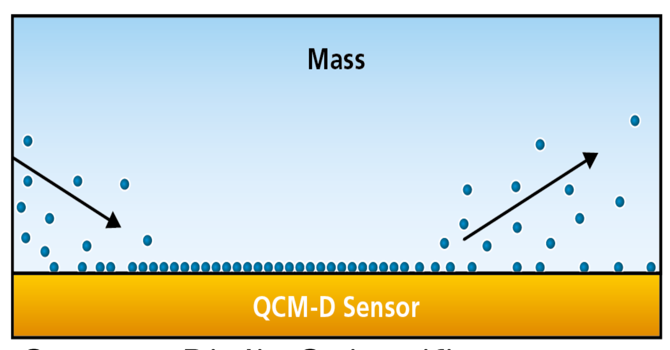
Real tongue surface[7]



3D printed tongue[7]

As food is ingested, contact with tongue and palate is crucial

QCM-D (adsorption onto surfaces)



Source: Biolin Scientific

How food interacts with tongue mimicking surfaces (+ with saliva)

- Film thickness
- Film properties

Key takeaway:

We have characterised an oat protein rich material with exciting tuneable properties

References

[1] Copernicus Climate Change Service (C3S), ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate, (accessed January 2025)

[2] J. D. Sachs et. al., *The Sustainable Development Goals Report 2023: Special Edition*, UN DESA, New York, 2023.

[3] The Good Food Institute, https://gfi.org/blog/alternative-proteins-are-a-solution-made-for-this-moment/, (Accessed January 2025).

[4] Department for Environment, Food & Rural Affairs (Defra) Report, DEFRA, London, 2023.

[5] J. McLauchlan et. al., *Food Hydrocolloids*, **2024**, **154**, **110139.**

[6] J. R. Stokes et. al., *Current Opinion in Colloid & Interface Science*, **2013**, **18**, **349-359.**

[7] E. Andablo-Reyes et. al., *ACS Applied Materials & Interfaces*, **2020**, **12**, **49371-49385.**

Images created in https://BioRender.com