



Agricultural By-Products for Shelf Life Extension

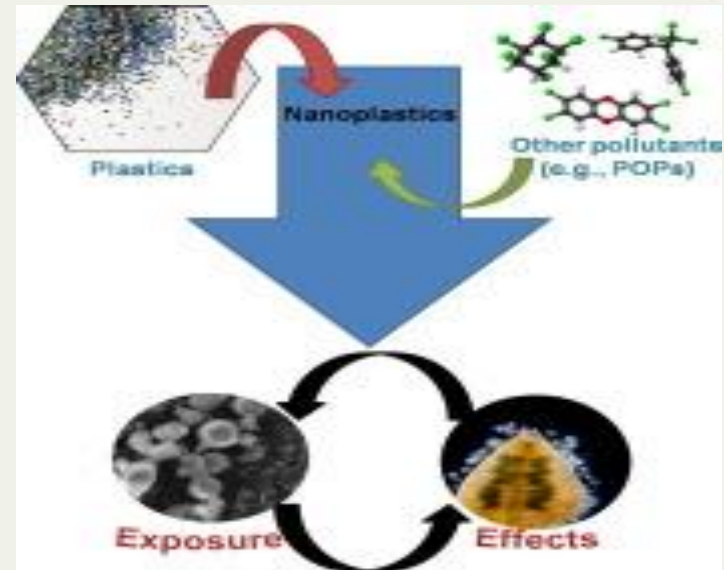
Prof Graham Bonwick
Institute for Agri-Food Research & Innovation
Newcastle University
graham.bonwick@newcastle.ac.uk

Packaging - Safety, Security & Sustainability



- Population growth and resource pressures - waste reduction
- Supply chains longer and more complex - integrity & fraud
- Consumers time-poor, disconnected and less 'food safety aware' - information

Packaging in the Media



Macro, micro and nano scale plastic impacts

Packaging & Consumers

- Packaging seen by the consumer as a problem, not a solution
- Perceptions influence purchasing activities



- Wide range of industry responses: - 'Plastic free aisles' /
- X% reduction by 20?? / single polymer use / recycled polymers /
- No plastic

Drivers - Legislation

EUROPEAN COMMISSION

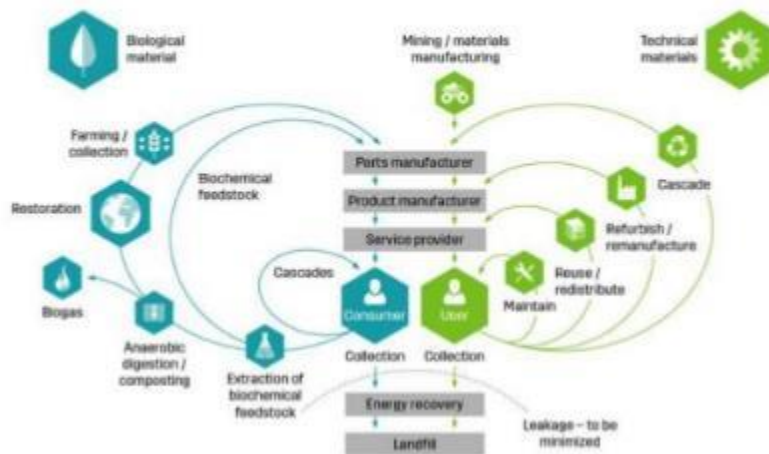
Brussels, 2.12.2015

COM(2015) 614 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Closing the loop - An EU action plan for the Circular Economy

CIRCULAR ECONOMY INTERACTIVE SYSTEM¹⁾



¹⁾ Ellen MacArthur Foundation



Natural Solutions - Agri-Food By-Products

Category insight



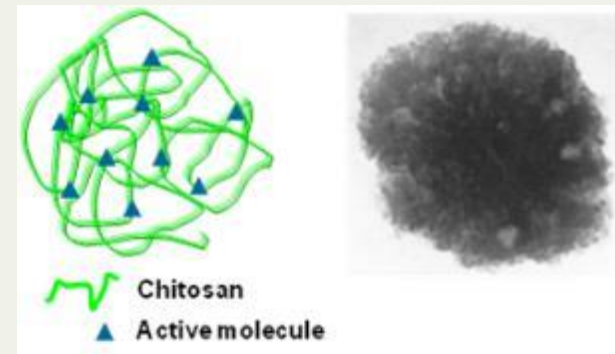
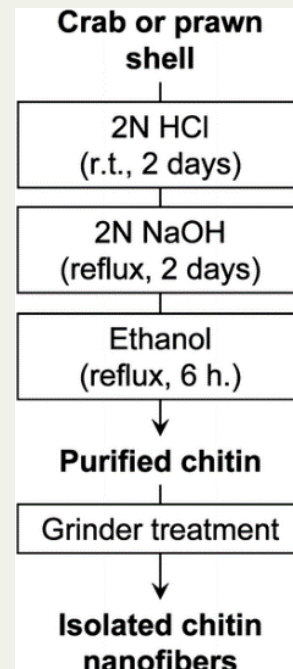
PACKING TOMATOES IN TOMATOES

Waitrose is trialling new technology that it says could save 3.5 million plastic trays from being recycled every year. Michael Barker reports

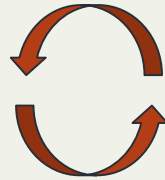
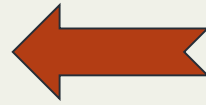
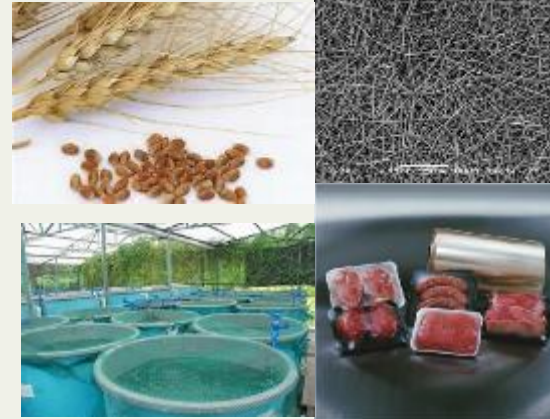
Tomato leaf and recycled cardboard pulp

Natural Materials - Chitosan

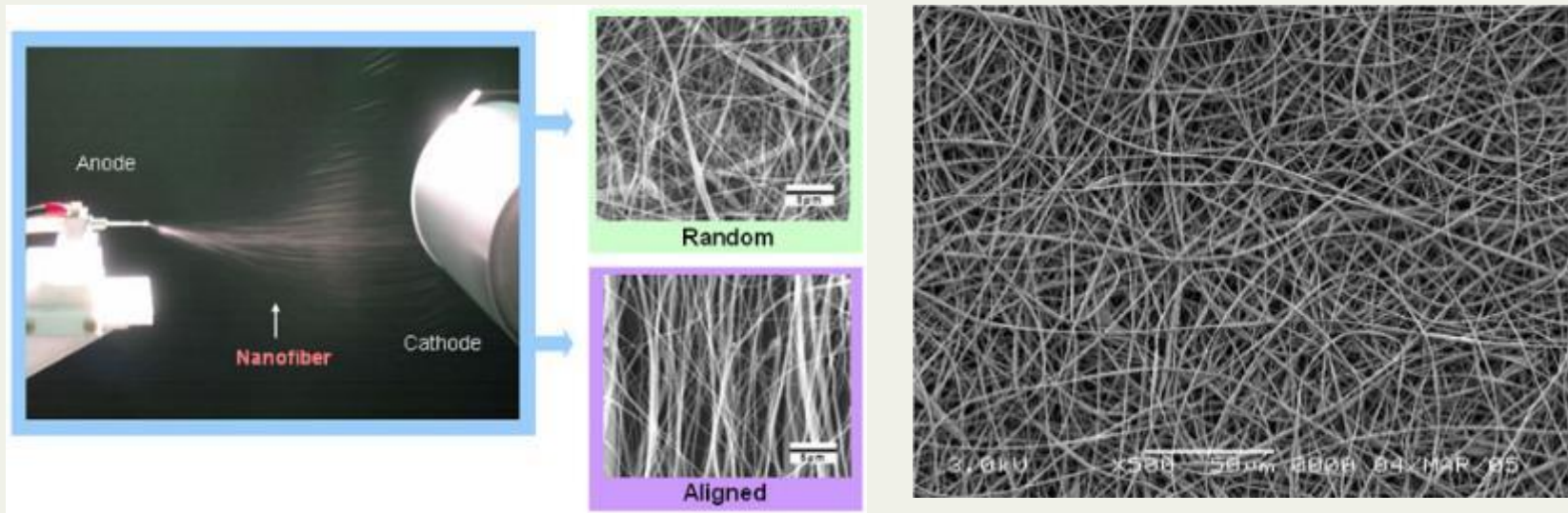
- Traditionally derived from processing crustacean by-products
- Has various applications due to its **biodegradable** and **nontoxic** properties
- **Chitosan nanoparticles** are found to be more effective against pathogens
- *High surface charge density – microbial membrane damage*



Circular Bioeconomy - Growth Opportunities



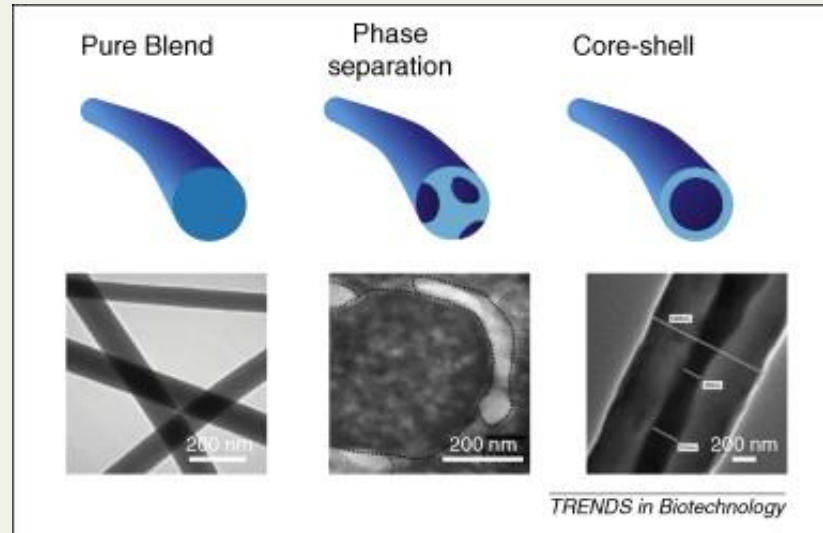
Electrospinning



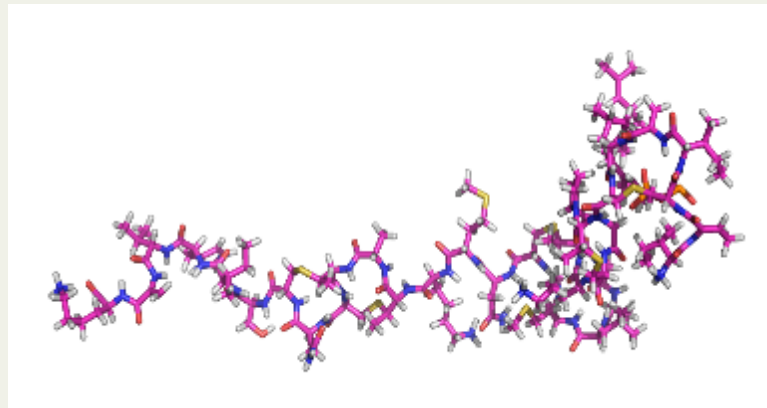
Polystyrene nanofibres - 85% open space, **antimicrobial**

- A simple and versatile manufacturing procedure compared with more complex nanostructure assembly methods.
- Applications to sensors, surface coatings, films

Structured Nanofibres



- Can be produced with co-spun encapsulated materials for controlled release

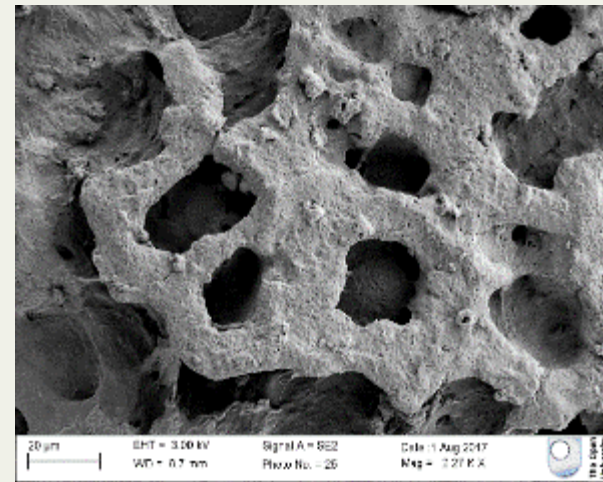
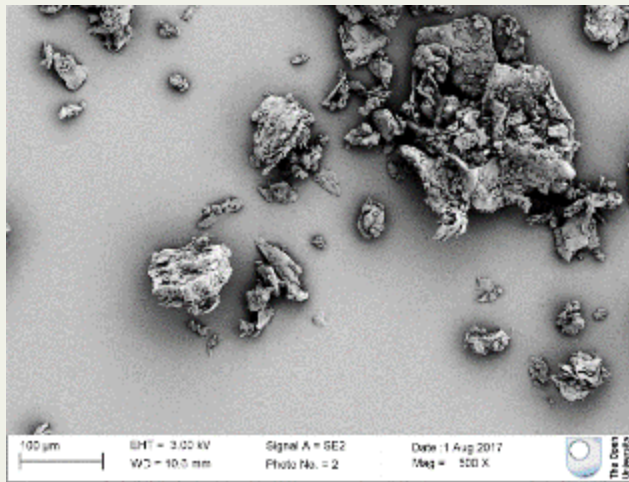


Nisin - polycyclic peptide from *Lactococcus lactis*.

Effective against a wide range of Gram positive species including the food pathogen *Listeria monocytogenes*

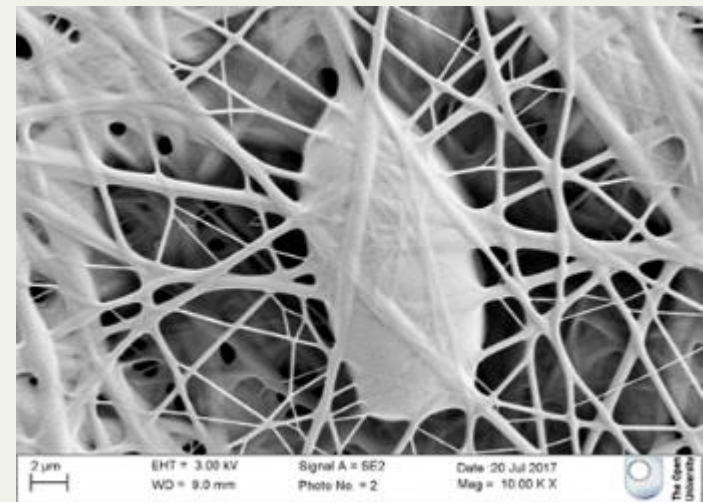
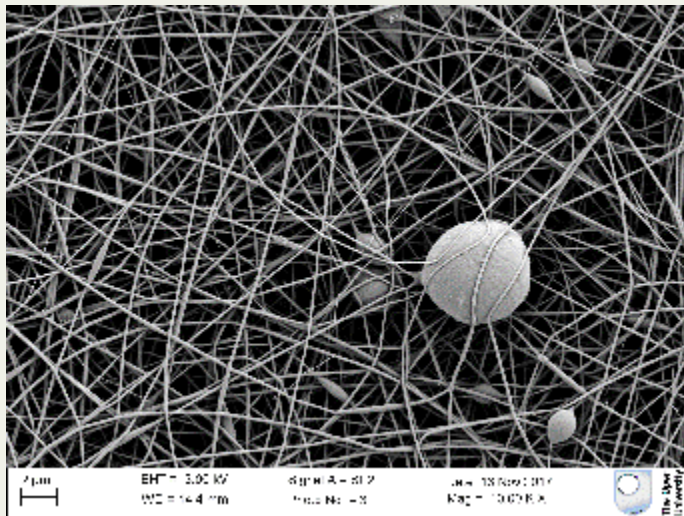
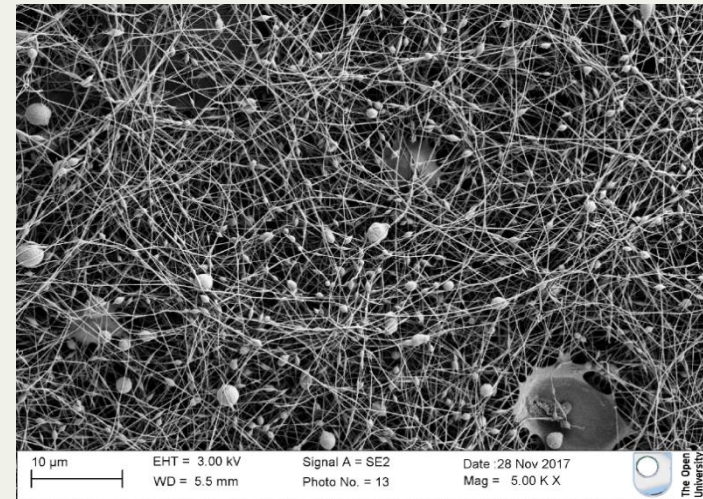
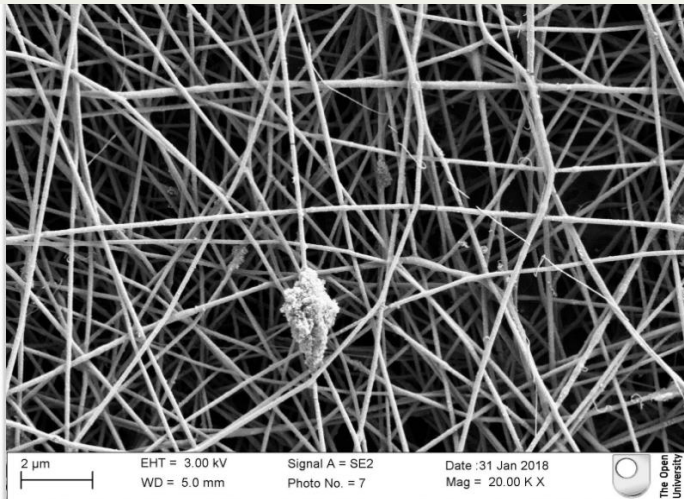
Agri-Food By-Product Valorisation

- Agri-food by-products for production of nanofibers for food films and packaging coatings
- Chemical and enzyme treatment of by-products to enhance solubility for electrospinning
- Treatment to enhance porosity for bioactive release e.g. polyphenols



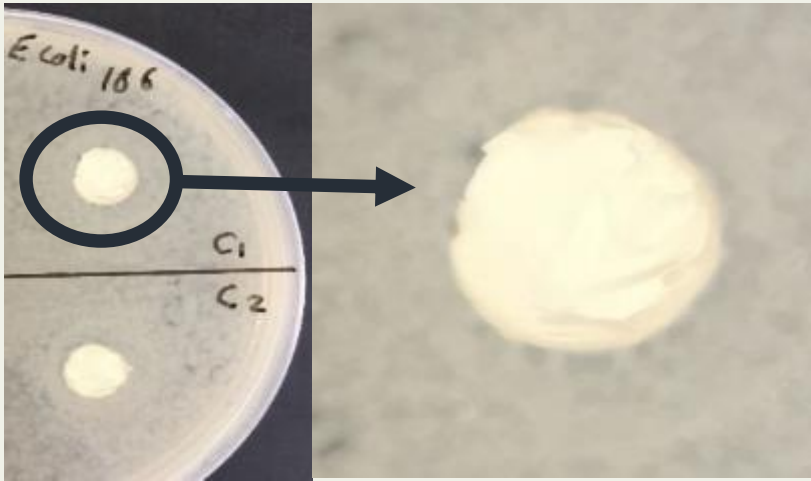
Milled tomato by-product treated to increase porosity

Agri-food waste for nanofiber films

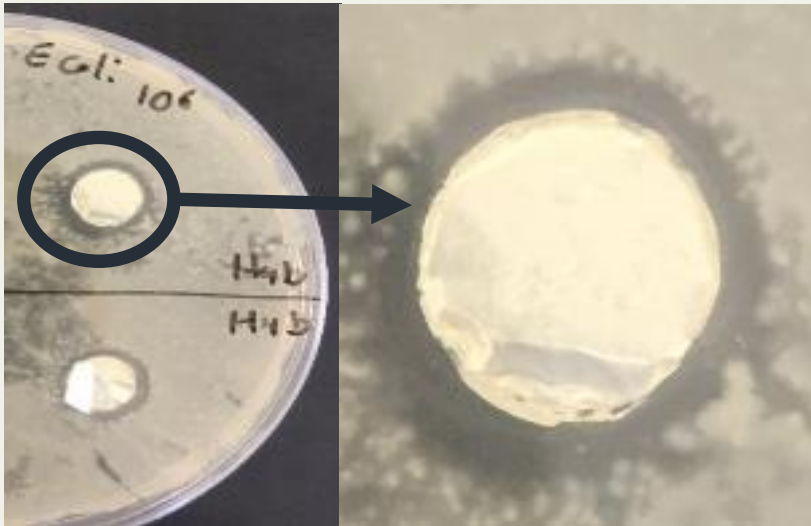


Nanofiber base materials - alginate, chitosan, PEO

Agri-food waste for nanofiber films

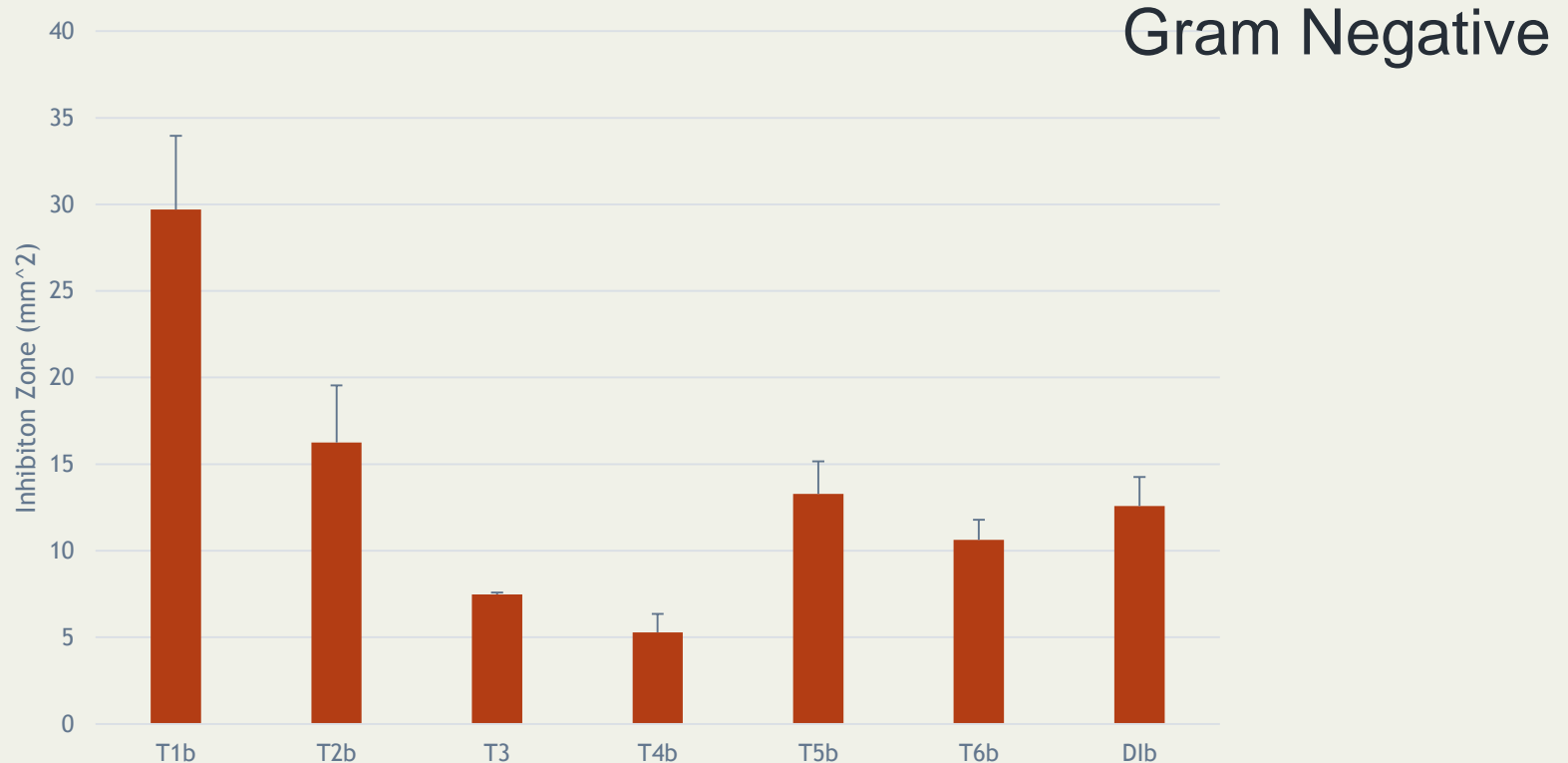


Control – uncoated Al foil disk
No inhibition of *E. coli* growth



Active packaging film –
E. coli growth inhibition by tomato material suitable for bioactive release embedded in a food grade edible alginate film.

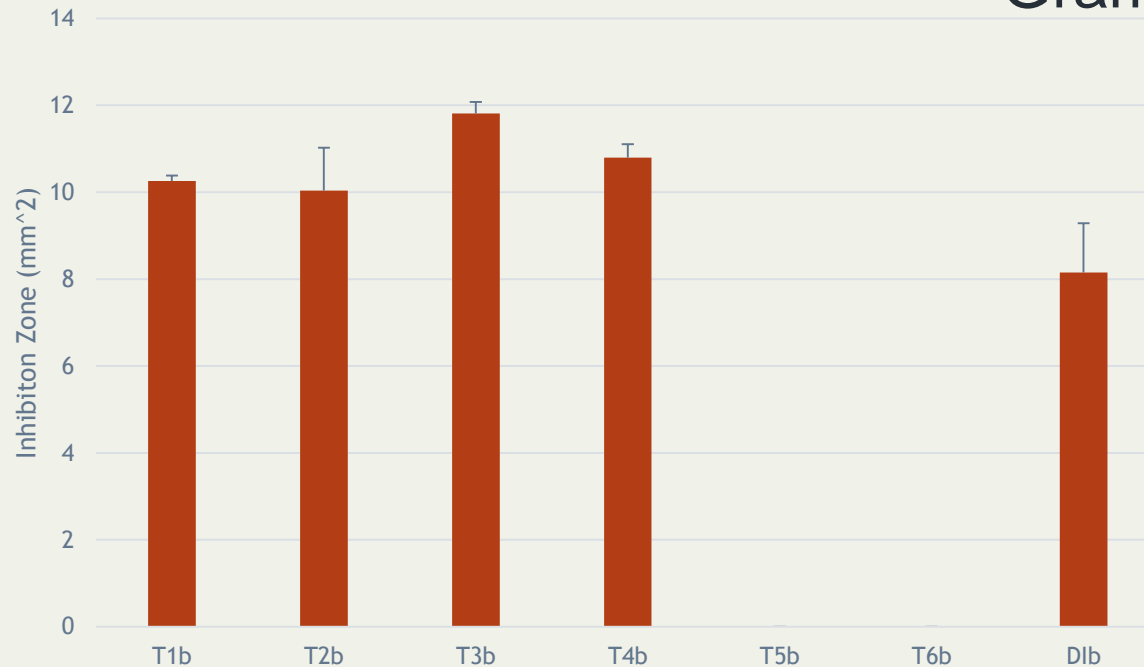
E. coli growth inhibition - tomato skin processing



Inhibition of *E.coli* K12 growth on Mueller-Hinton agar inoculated at 10^6 CFU/ml by PEO (6.8% w/w) / chitosan (0.8% w/w) nanofiber film with added tomato. Values are means \pm s.d., n=4. T1b: undigested dry tomato skin; T2b: Dry digested (24h) tomato skin; T3: Dry digested (48h) tomato skin; T4b: undigested wet tomato skin; T5b: wet digested (24h) tomato skin; T6b: wet digested (48h) tomato skin; DIb: (PEO 6.8% w/w, chitosan 0.8% w/w and distilled water).

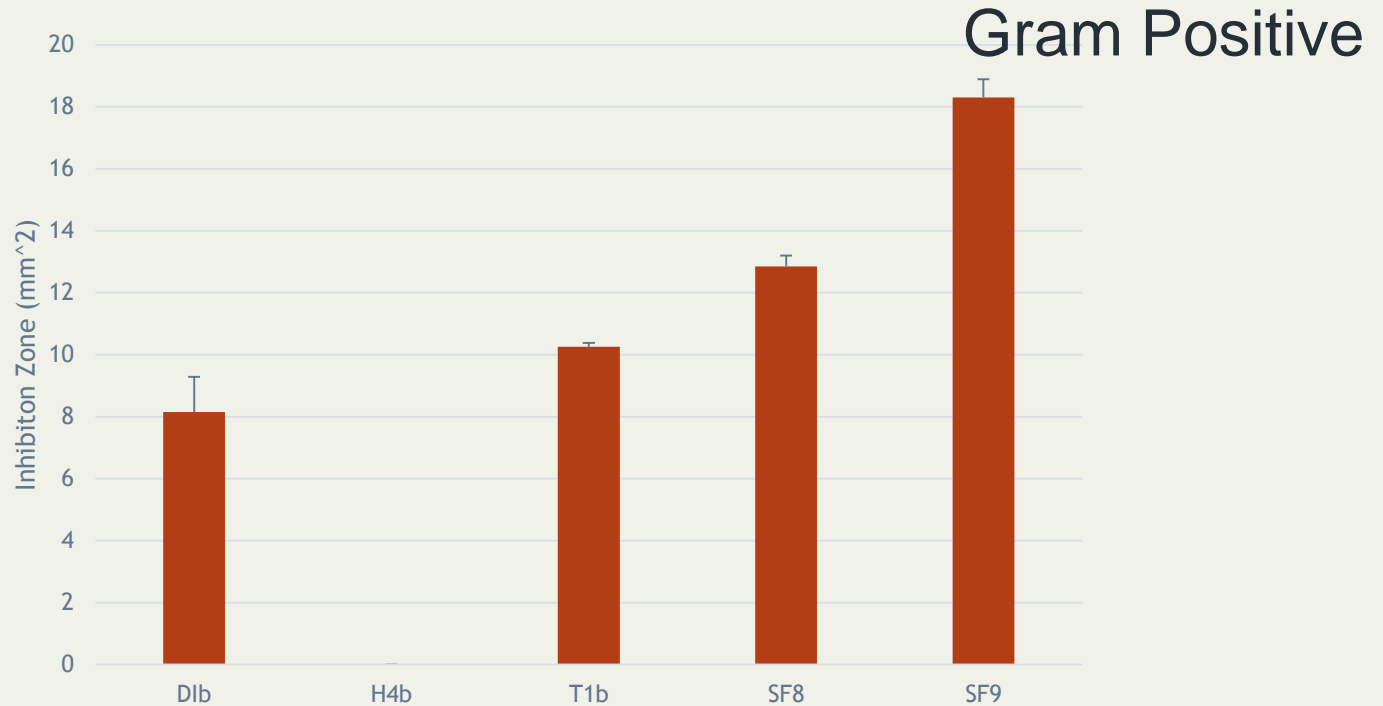
B. subtilis growth inhibition - tomato skin processing

Gram Positive



Inhibition of *B. subtilis* growth on Mueller-Hinton agar inoculated at 10^6 CFU/ml by PEO (6% w/w) / alginate (1.5% w/w) nanofiber film with added tomato. Values are means \pm s.d., n=4. T1b: undigested dry tomato skin; T2b: Dry digested (24h) tomato skin; T3b: Dry digested (48h) tomato skin; T4b: undigested wet tomato skin; T5b: wet digested (24h) tomato skin; T6b: wet digested (48h) tomato skin; D1b: (PEO 6.8% w/w, chitosan 0.8% w/w and distilled water).

B. subtilis growth inhibition - blend and inclusion



Inhibition of *B. subtilis* growth on Mueller-Hinton agar inoculated at 10^6 CFU/ml. Values are means \pm s.d., n=4. D1b: (PEO 6.8% w/w, chitosan 0.8% w/w and distilled water); H4b: (PEO 6.8% w/w, chitosan 0.8% w/w and wheat stem); T1b: (PEO 6.8% w/w, chitosan 0.8% w/w and tomato skin); SF8: (PEO 6% w/w, alginate 1.5% w/w); SF9: (PEO 6% w/w, alginate 1.5% w/w and tomato skin).

Proof of Concept - Next Steps

- Micronised cereal by-products as nanofiber feedstock
- Greener by-product processing – enzymes instead of chemicals
- Performance testing – anti-microbial and anti-oxidant properties
- Formulation modifications – electrospinning performance and film characteristics
- Shelf life extension – real foods packaged in nanofiber films

Agri-Food Waste Packaging - Safety

- Migration of contaminants and allergens
- Toxicity (*in vitro* / cytotoxicity)
- Biodegradation
- Consumer acceptance / perceptions



Collaborative research through IAFRI- 3 jointly funded PhD projects selected for 2018

Agri-Food Waste Packaging Safety



Collaboration with Fera Science Ltd

The UK National Reference Laboratory (NRL) for Materials and Articles in Contact with Food

Collaborative research through IAFRI- 3 jointly funded PhD projects selected for 2018

Non-targeted analysis



Biopolymer Packaging



Another opportunity to positively influence the customer?

Thank you for your attention!

September 2018

Postgraduate Certificate Food Packaging

FuturePack meeting - Fera Science Ltd, York