EPSRC CENTRE FOR INNOVATIVE MANUFACTURING IN Food

Dehydration of Hydrocolloids for Distributed Manufacturing

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Projects

- Innovative materials, products and processes
  - **Upgrading of Ingredients**
    - Clean label emulsifiers,
    - Novel routes to structure edible oils via oleogels,
    - Modulation of tomato fruit texture,
  - **New processing technologies**
    - Spontaneous emulsification,
    - Ice stabilisation in frozen drinks,
    - Drying mechanisms in food systems,
    - Protein-pectin complexes to stabilise functional emulsions,
    - Processing using micro-channel devices for the production of complex food emulsions,
    - Encapsulation and Release Approaches in Fluid Gel Microstructures,
    - Novel Drying Techniques,
    - Behaviour of foams and emulsion microstructures,
    - Behaviour of hydrocolloid and emulsion microstructure,
    - Particle stabilisation of emulsions
  - **Food manufacturing for healthy diets and lifestyles**
    - Redesign of biscuit manufacture;
    - Distributed manufacturing of food products,

Distributed Manufacturing by Infrastructure

- Decentralised production
- Reduced transport cost
- Smaller volumes can be produced
- Greater flexibility
- Meet regional variation

*Illustration from Getty Images

Distributed Manufacturing by Formulation

- Consumer produces final product
- Meet household variations
- Reduced transport cost
- Increased storage life
- Production waste reduced
- Mimic mass produced products

Hydrocolloids

- Commonly used as stabiliser and viscosity modifiers in soft solids, mimetic formulations and beverages
- Gel properties can be used to modify sensory properties such as texture, body and consistency
- High water content (<90 %)

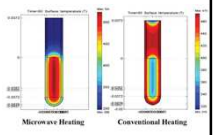
Research Aims

- Reduce water content of gels
  - Target = < 10 %
- Lower water activity of formulation
  - Target = 0.8 - 0.6 a_w
- Compare volumetric drying with freeze and air drying
- Assess differences in room temperature rehydration of gels dried by different techniques

Drying Techniques

- Equivalent pressures can be used
- Methods are time consuming
- Air drying and sublimation occurs initially at the surface - Microwave volumetric



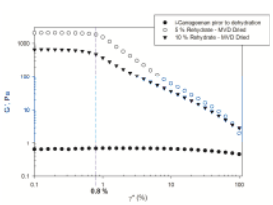
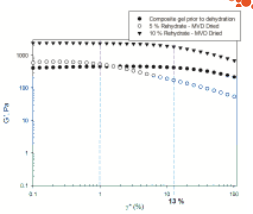


C. O. Kappe, *Angew. Chem., Int. Ed.*, 2004, **43**, 6250–6284

Microwave Vacuum Drying (MVD)

- Single mode microwave generator (2450 MHz) scalable to industrial frequencies (915 MHz)
- Capable of power application up to 2 kW
- Can operating at pressures between -97 and 1000 kPa
- Preferentially heats moisture not the gel resulting in less damage

Gel Properties - MVD

- i-carrageenan
- i-carrageenan /Methyl Cellulose

MVD - Composite gels

i-carrageenan Composite Gel

- Composite resistant to internal pressure

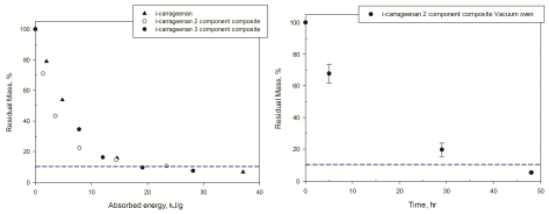
Dried Products

i-carrageenan

Composite Gel

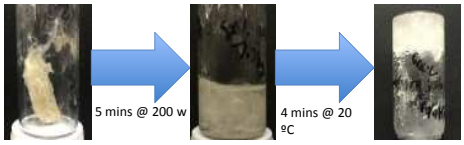
MVD Vacuum Oven Freeze drying

MVD Drying Rates



- Drying Temperature = 45°C
- Process Pressure = -80 kPa

Rehydration of Composite Gums - MVD



- Dehydration time = 300s (MVD)
- 91.6 % mass loss
- 0.84 a_w

Properties of MVD

- Direct heating ceases at around 6 %
  - Self limiting
- Efficiency reduces as sample dries
  - Suited to continuous processing
- Drying processes is very rapid compared to other techniques

Summary

- MVD viable route to dry ingredients which rapidly rehydrate on demand
- Drying times vastly decreased with MVD
  - 300 seconds to target (20 kJ/g)
- MVD allows high colour and structure retention
- Gel properties recovered at ambient temperatures

Moving Forward

- Investigated sheared composite gels
- Determine rehydration rate
- Investigate other novel drying routes
- Make comparisions to other standard tehniques

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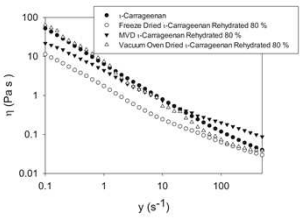
Thank you for listening

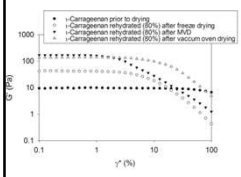
- Damage to the sturcture was seen in i-carra
- From gell with long lvr to rehydrate with shorter
- Mmc hold structure together alowing for drying and structure retention

Comparison of Viscosity Recovery by Technique

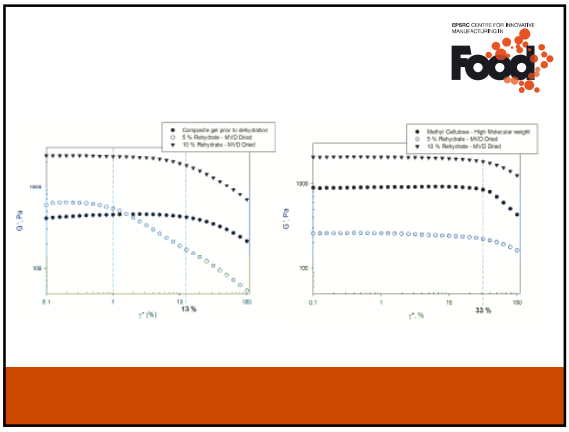


- Air and microwave drying exhibit similar recovery
- Freeze drying showed lower values

i-carrageenan Gel Properties



- On rehydration MVD treated gels exhibit equivalent linear viscoelastic region (LVR) to freeze drying
- Extended LVR seen in vacuum oven dried samples



Summary

- Water uptake higher for weak gels
- Drying times vastly decreased with MVD
  - 300 seconds to target (20 kJ/g)
- Gel properties rapidly recovered at ambient temperatures