

Microencapsulation of ferrous sulfate by spray drying for further incorporation into a plant protein-based structured food

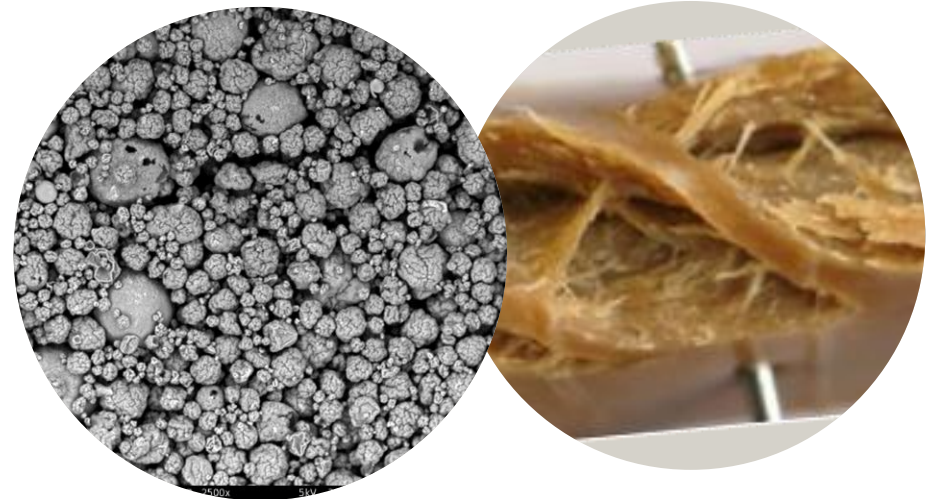
30th EFFoST - 2016
Vienna

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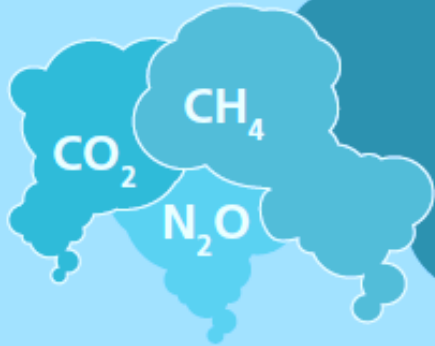


14.5%

of all anthropogenic GHG emissions come from livestock supply chains

It amounts to **7.1 gigatonnes CO₂-eq** per year

HUMAN - INDUCED GREENHOUSE GAS EMISSIONS



Transition towards a more plant-based diet



Environment



Human health

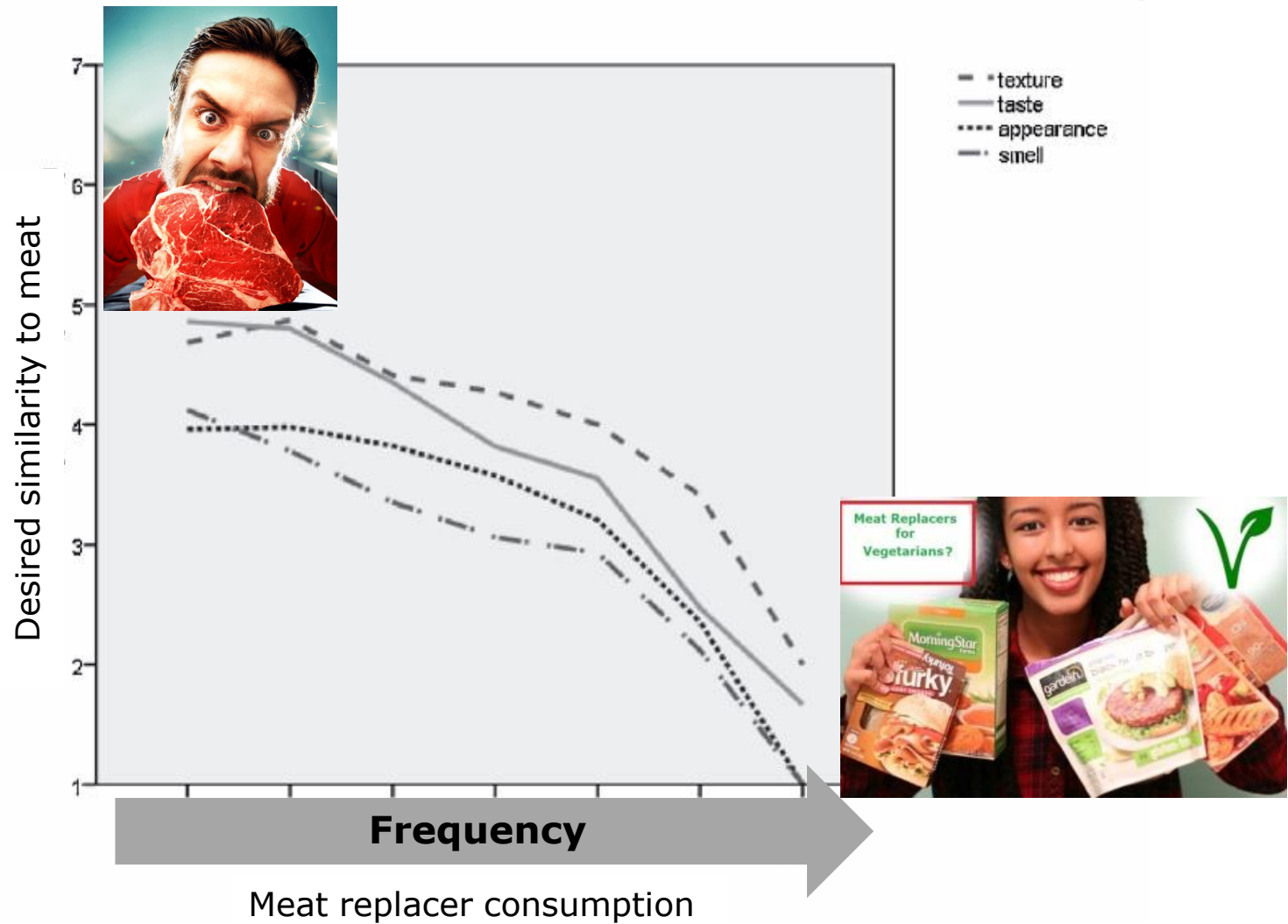


Animal welfare

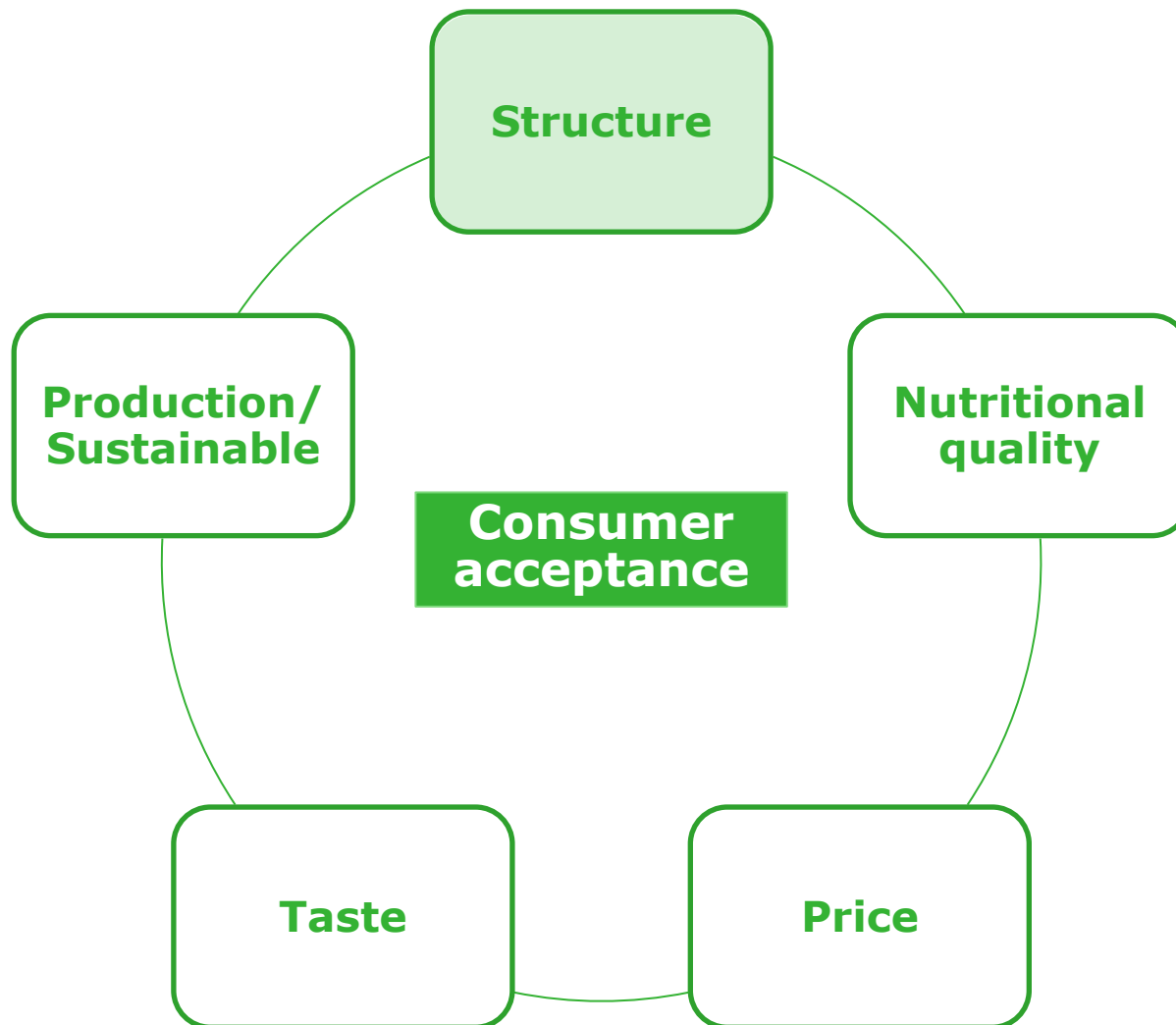
Meat



Plant-based meat replacer



Meat replacers: what is missing?



Shear-induced fibrous structure formation

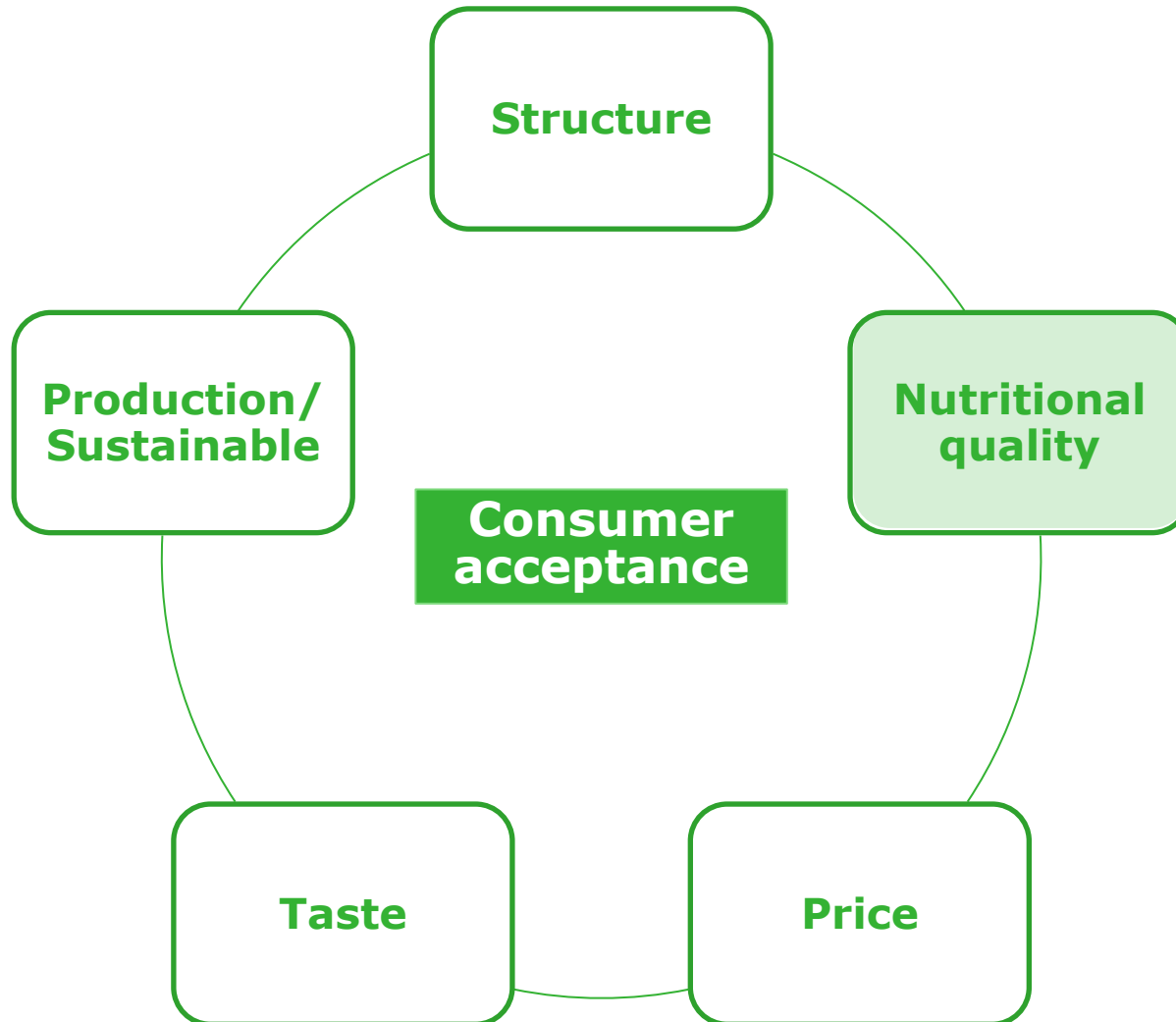


140 °C/30 rpm/15 min



SPC (44 wt%)

Meat replacers: what is missing?



Nutritional quality: adding nutrients

1. Choice of nutrient

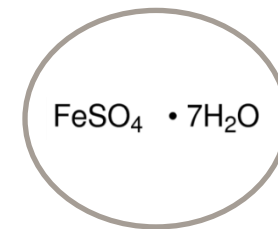
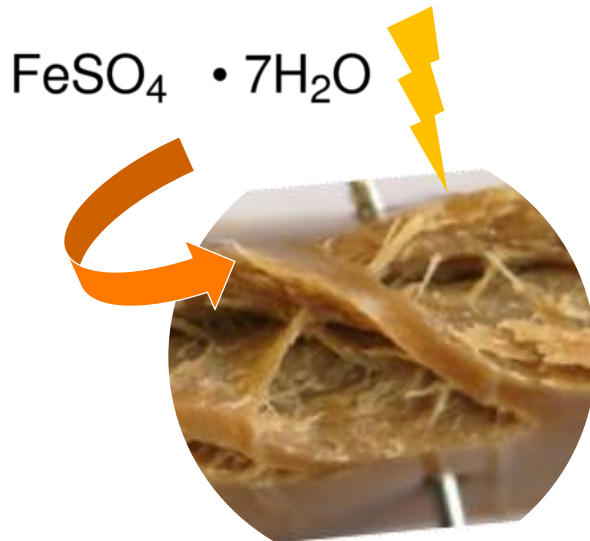


2. Type of iron

Compound	Solubility in gastric juice	Relative bioavailability	Order of preference for fortification	Stability in a product
Water soluble	↑	↑	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Ferrous sulfate</div>	↓
Ferrous sulfate				
Ferrous gluconate				
Poorly water soluble				
Ferrous fumarate				
Ferrous succinate				
Water insoluble			<div style="border: 1px solid black; padding: 5px; display: inline-block;">Encapsulated ferrous sulfate</div>	
Ferric pyrophosphate				
Elemental iron				

Nutritional quality: adding nutrients

3. Consequences of adding iron in a product



Encapsulation

✓ Protein oxidation

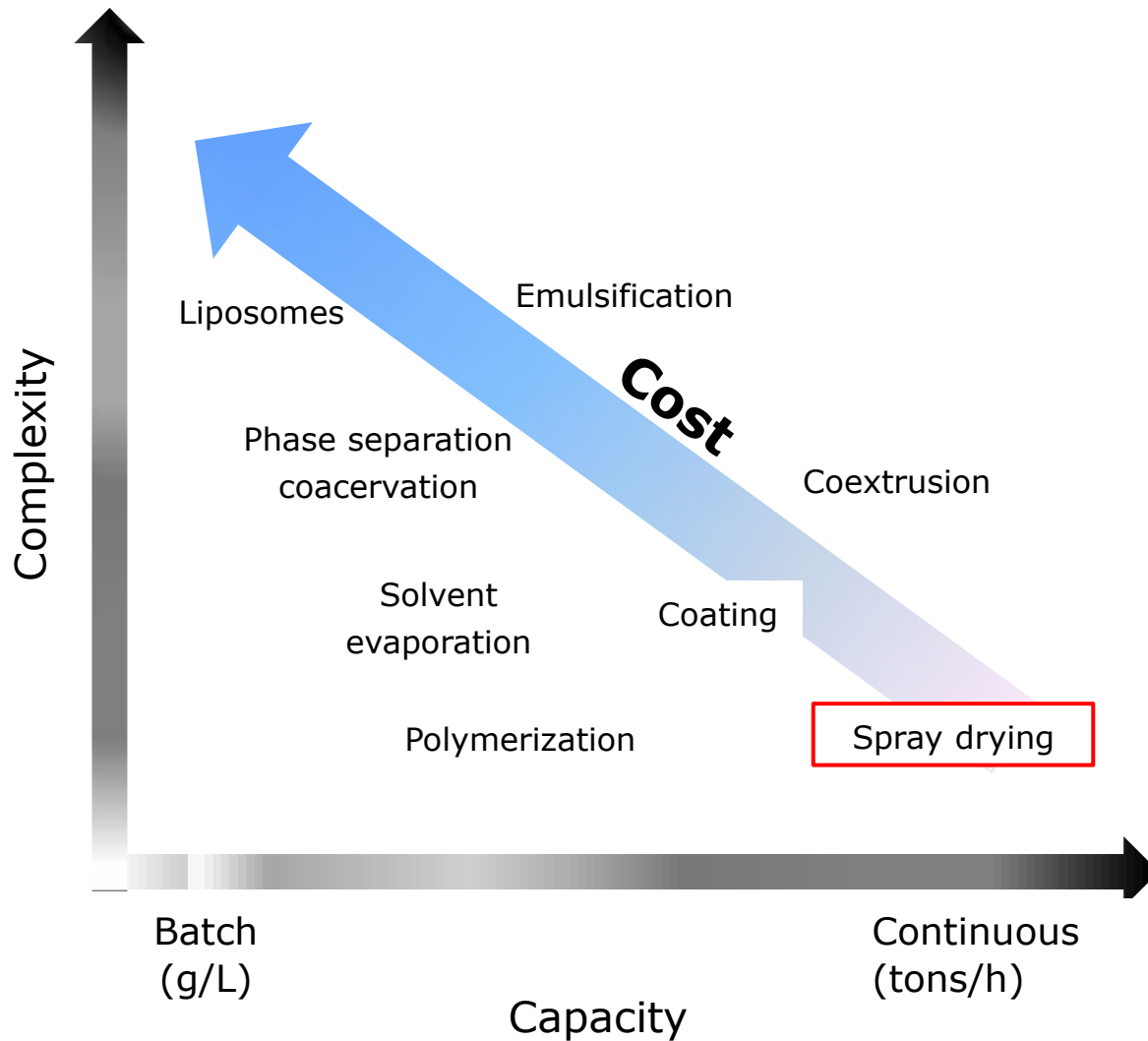
- ❖ Sensory defects: off-flavors, texture modification
- ❖ Loss in nutritional quality

✓ Metallic taste

✓ Side effects



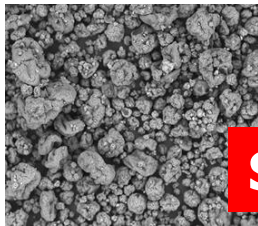
Encapsulation techniques



Challenges

**Iron
Encapsulation**

Fortification



Stability

Microparticles

Protein oxidation

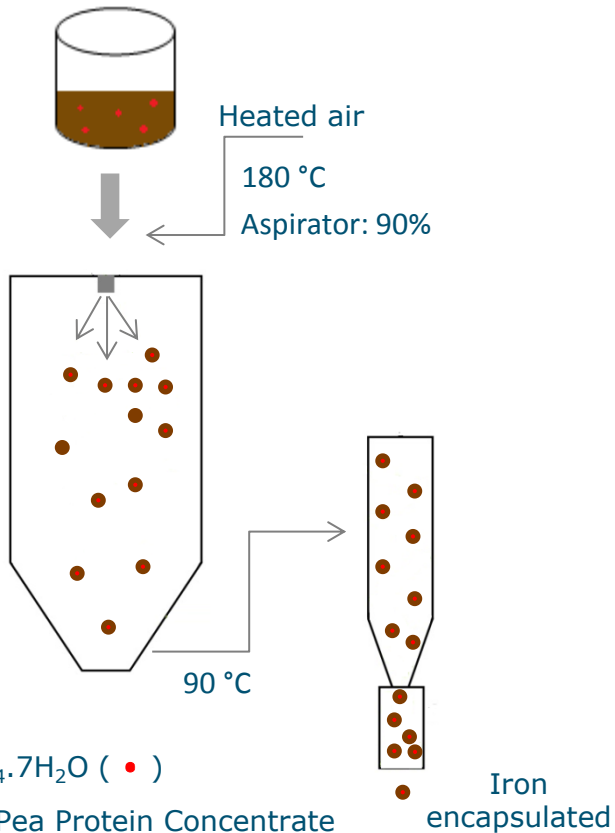
**Improving
nutritional
quality**



Iron encapsulation

Spray drying

Feed solution: PPC + iron



$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ (•)

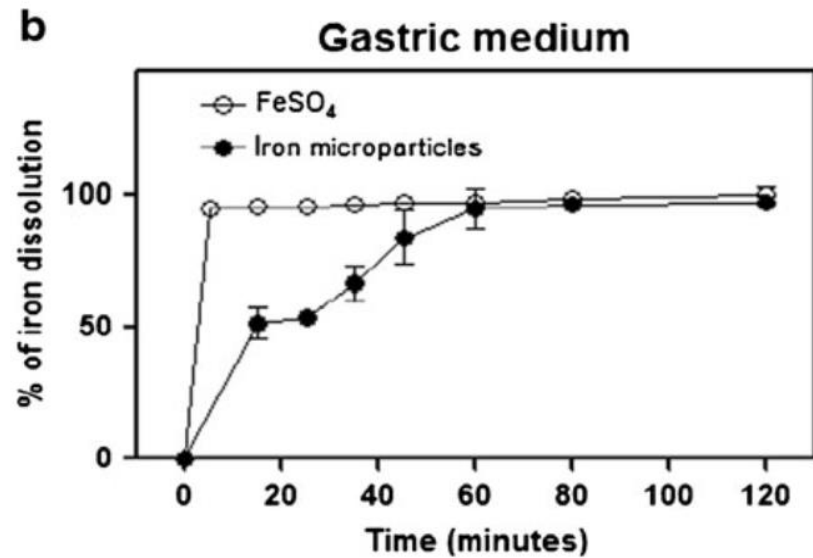
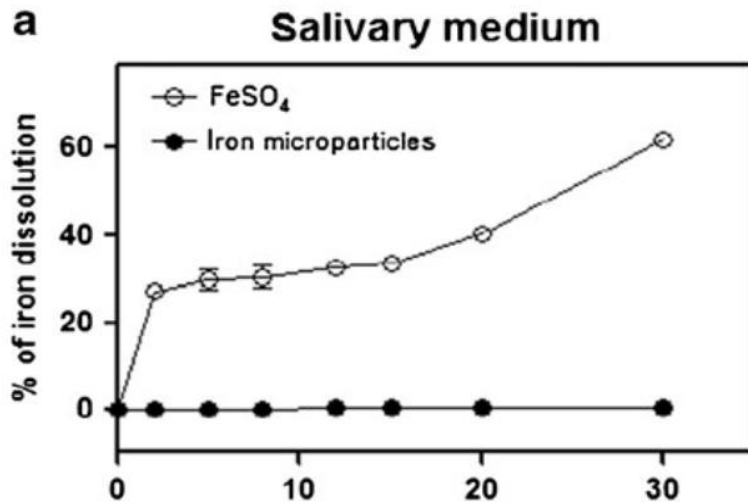
PPC: Pea Protein Concentrate

Iron
encapsulated

Iron encapsulation

Spray drying

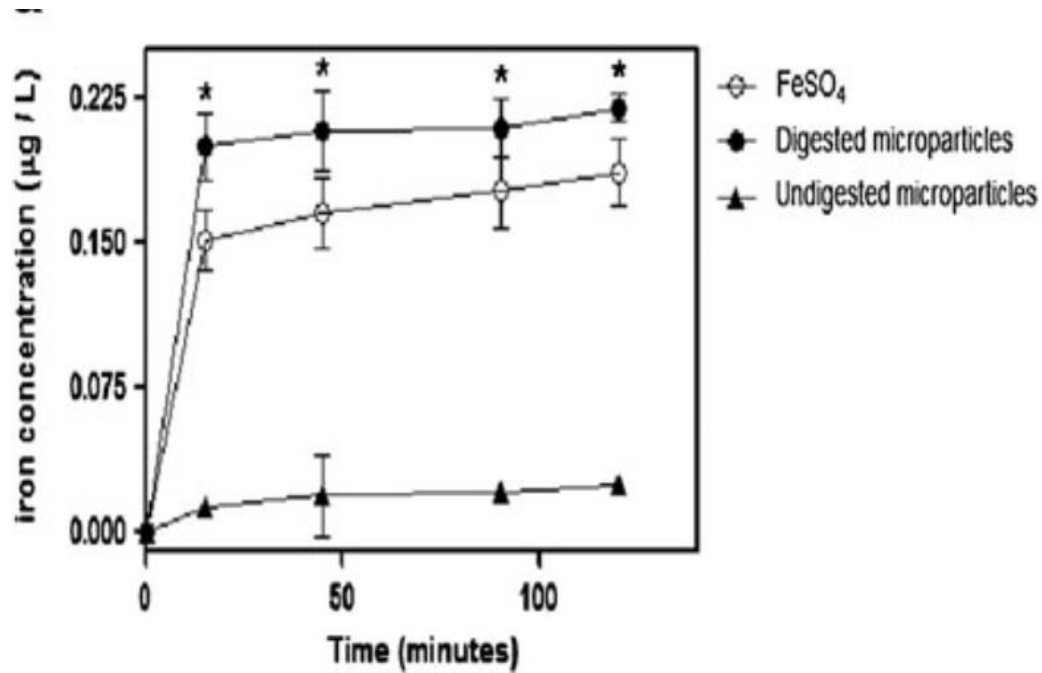
Why PPC as a matrix?



Iron encapsulation

Spray drying

Why PPC as a matrix?



Iron encapsulation

Spray drying



Why PPC as a matrix?



✓ **Fortification:**
Cooked black beans
(5,8 mg/100g)¹

Banana candy
(5,5 mg/100g)²

Acceptability > 70%



Masked the metallic taste

**Iron
encapsulation**

Spray drying

**Process
efficiency**

- ✓ Moisture content: $3,8 \pm 0,4\%$
- ✓ Yield: $38,8 \pm 7,9\%$

Yield (%): $\frac{\text{Total solids in the microparticles}}{\text{Total solids in the feed solution}} \times 100$

Iron encapsulation

Spray drying

Process efficiency

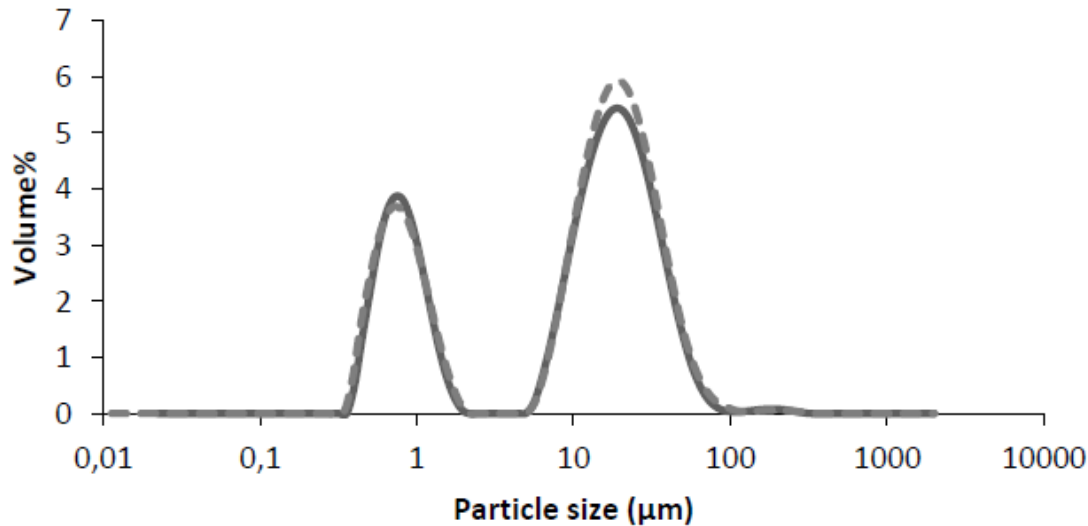
Characterization

Physical/Chemical

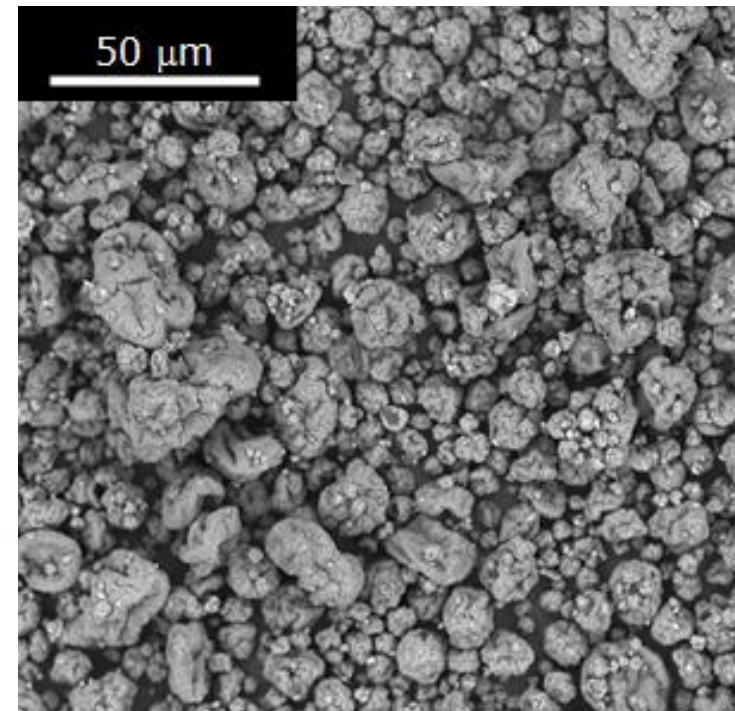
✓ Particle size (Mattersizer):

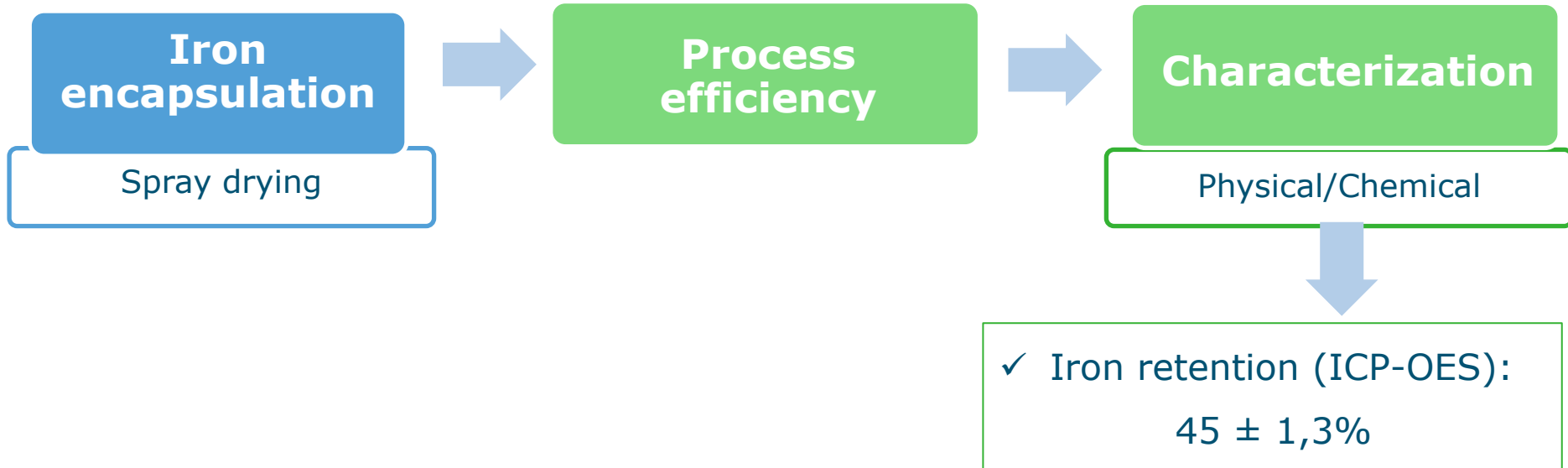
$D_{4,3}: 16,4 \pm 0,1 \mu\text{m}$

✓ Morphology (SEM)

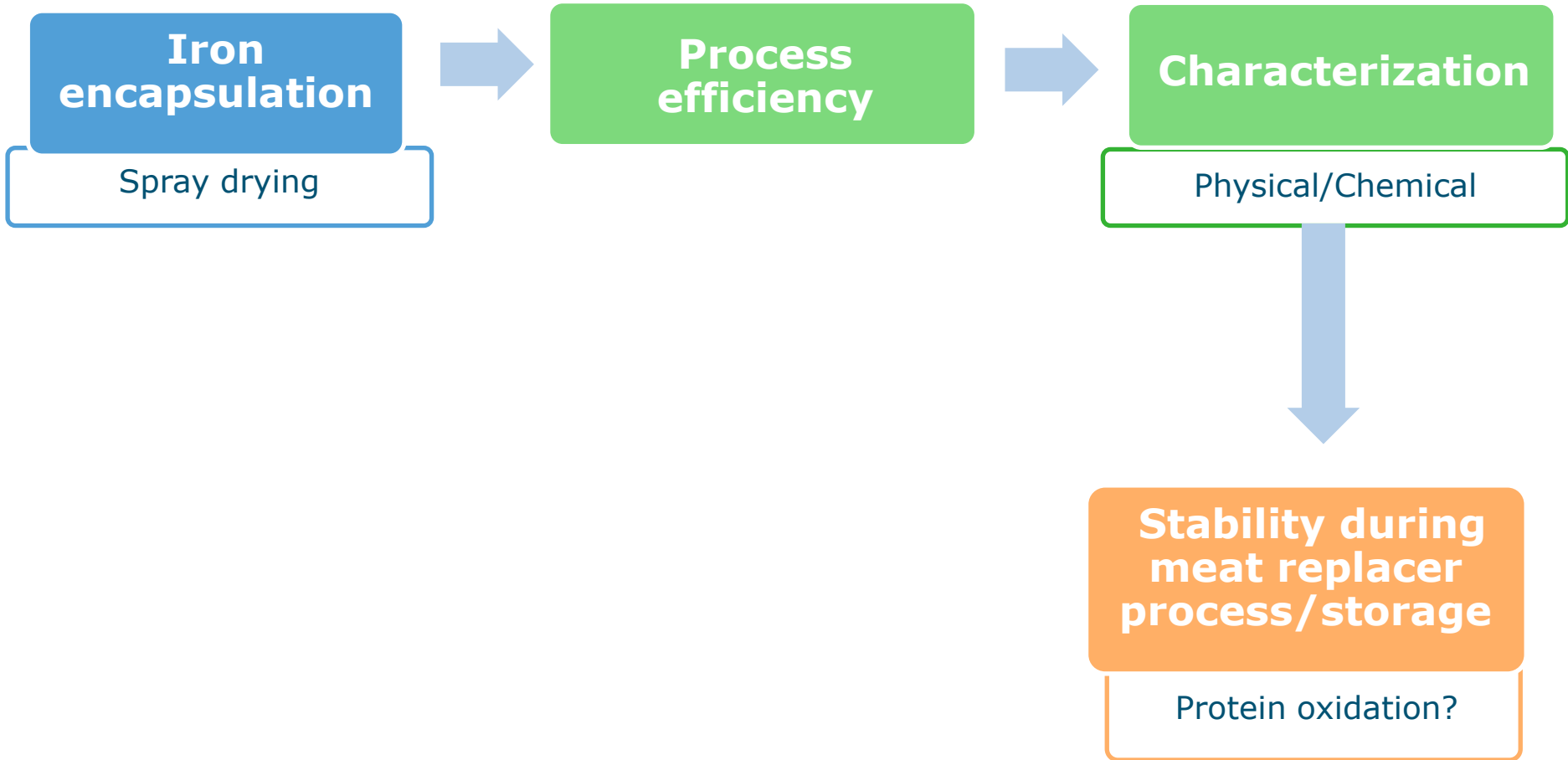


— after 1 day
- - after 30 days





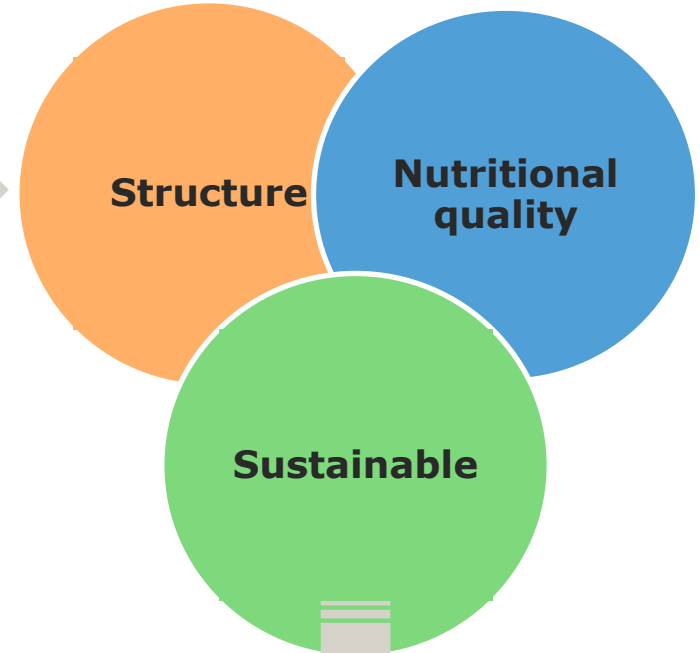
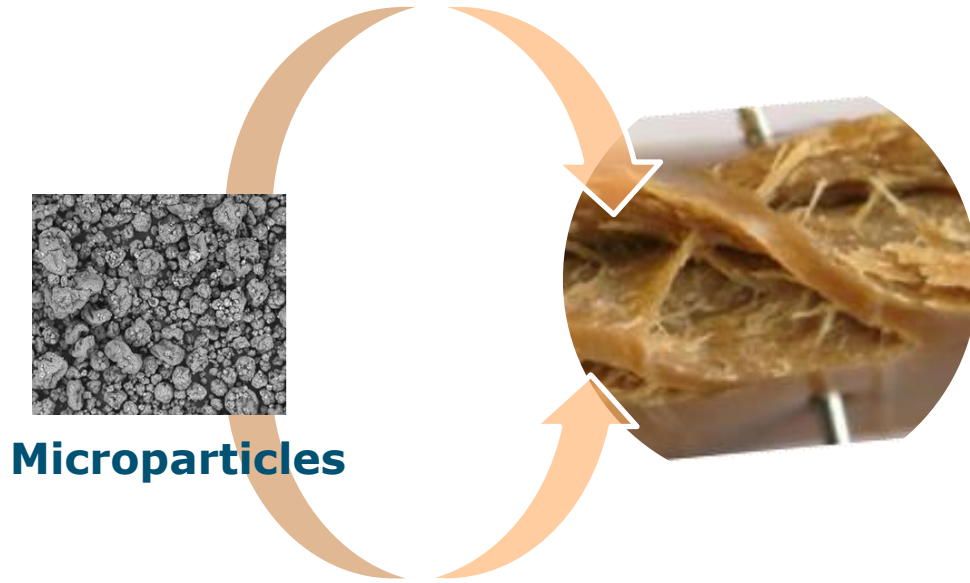
Iron retention (%): $\frac{\text{Iron content in the microparticles (g per 100 g solids)}}{\text{Iron content in feed solution (g per 100 g solids)}} \times 100$



Iron Encapsulation

Fortification

Product design



Improving nutritional quality

Thank you!

Any questions?

Acknowledgements

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