

Carbon dioxide containing powder production - an innovative application to extend the shelf-life of cottage cheese

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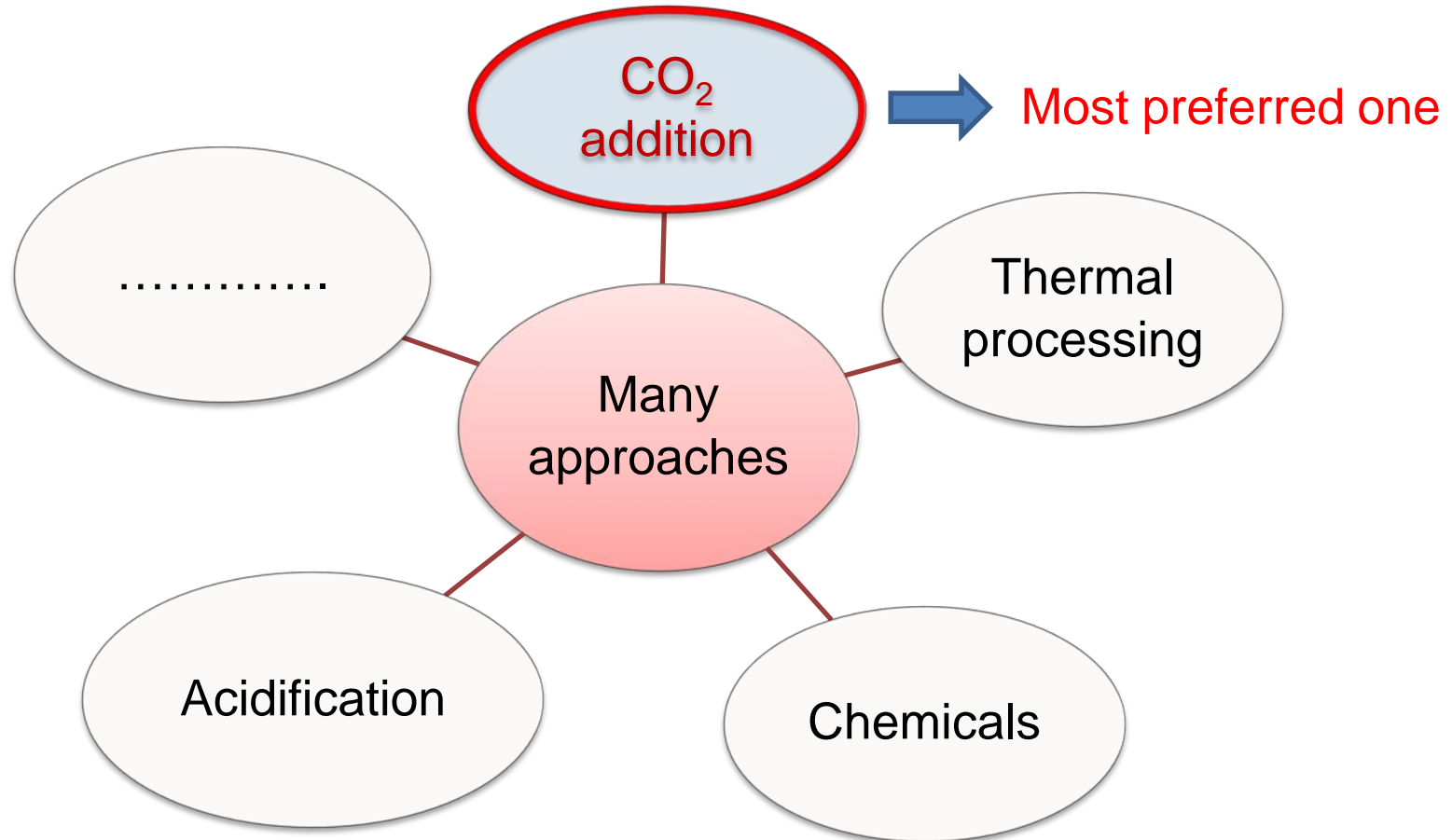


What is the shelf-life of non-sterile dairy products?

Table 1: Shelf-life of non-sterile dairy products without preservatives.

Dairy products	Shelf-life
Milk	1 week
Sweet (unsalted) butter	1-2 (refrigerator) or 8-12 months (freeze)
Cottage or cream cheese	1-2 weeks
Hard or semi-hard cheeses	Several weeks - months
Ice cream or frozen yogurt	2 weeks - 2 months (freeze)
Sour cream	2 weeks
Heavy cream or light cream	1 week

How can the shelf-life of dairy products be extended?



What is mechanism for inhibition of microbial growth by CO₂?



Displacement of oxygen

Lowering of pH

Direct effects on the metabolism of microorganisms

- Changes in membrane fluidity
- Reductions in intracellular pH
- Inhibition of metabolic pathways

How can CO₂ be delivered into dairy products?

- ❑ 500-2000 ppm
- ❑ Two common methods:
 - ✓ Modified atmosphere packaging (MAP)
 - Flushing of packaging headspace
 - Mixing with CO₂ pressurized ingredients
 - Etc.
 - ✓ Direct injection of CO₂

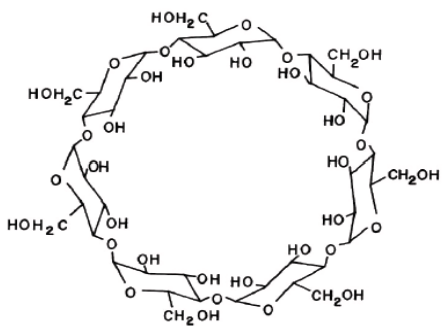
- ✓ Poor diffusion into (semi-) solid products (butter, cheese,...)
- ✓ Collapse of packaging



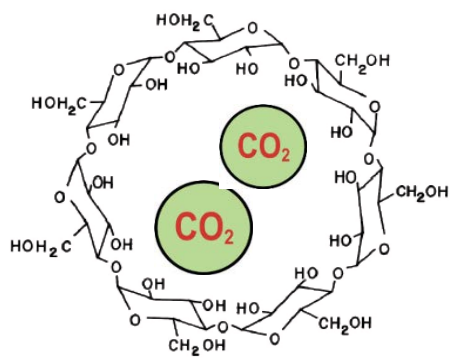
Effective ONLY for products in LIQUID STATE

How can CO₂ be delivered into COTTAGE CHEESES?

⇒ Convert CO₂ gas into CO₂ powder?



- Gas state
- Molecular size : 0.232 nm



Alpha-cyclodextrin (α-CD)

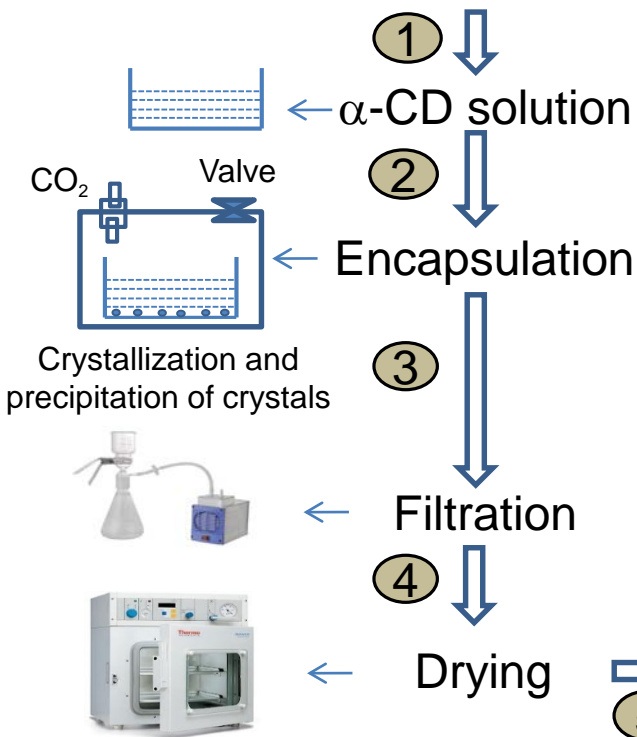
- Modified starch
- Solid state
- Pore size : 0.52 (φ) and 0.79 nm (H)
- GRAS (US),
natural food (Japan)
novel food (FSANZ)



Encapsulation
Mixing with cheese

How to produce CO₂ powder? - Conventional method

Liquid encapsulation

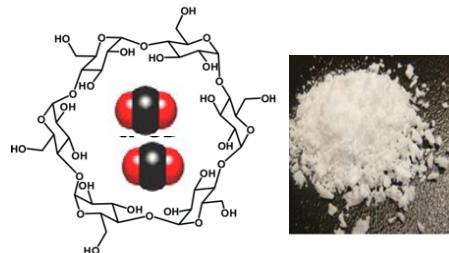


An alternative approach

Problems

1). Time consuming (several days)

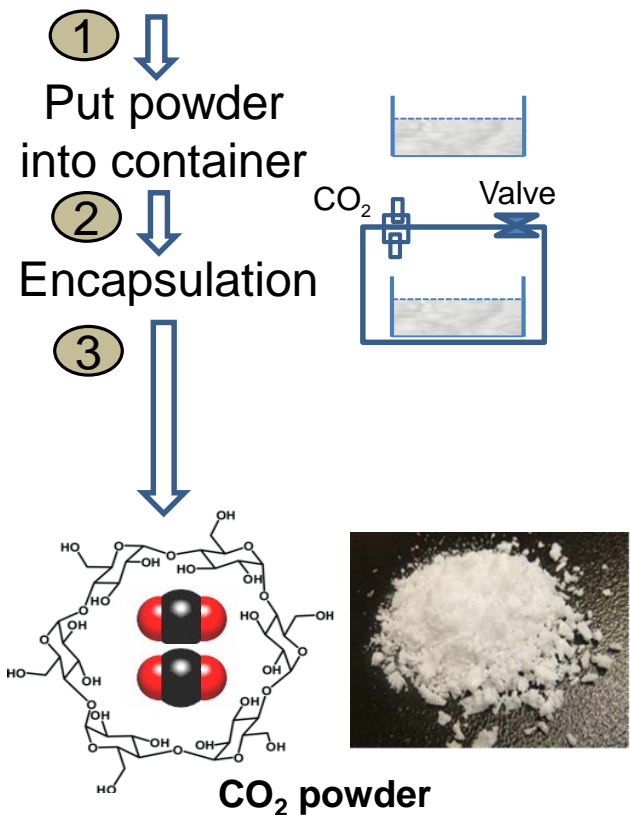
2). Low yield (< 50%)



CO₂ powder

How to produce CO₂ powder? - Innovative method

Solid encapsulation



Advantages

- 1). Fast (several hours)
- 2). High yield (100%)

Shortcomings

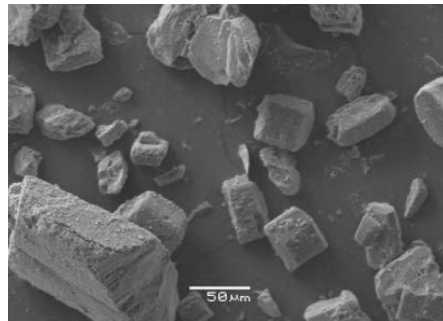
Commercial α -CD powder exists in crystalline form with high packed structure.

- 1). CO₂ adsorbs primarily on the particle surface.
- 2). It requires a long time to reach an encapsulation equilibrium.

Crystalline vs. amorphous α -CD powders



Crystalline α -CD powder (2)
(molecules - order arrangement)



Amorphous α -CD powder (1)
(molecules - random arrangement)

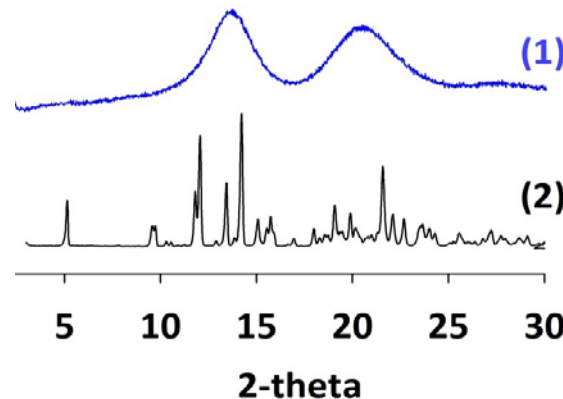
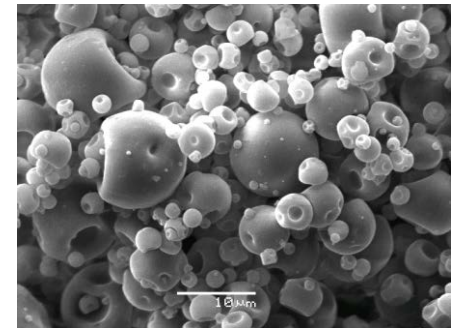


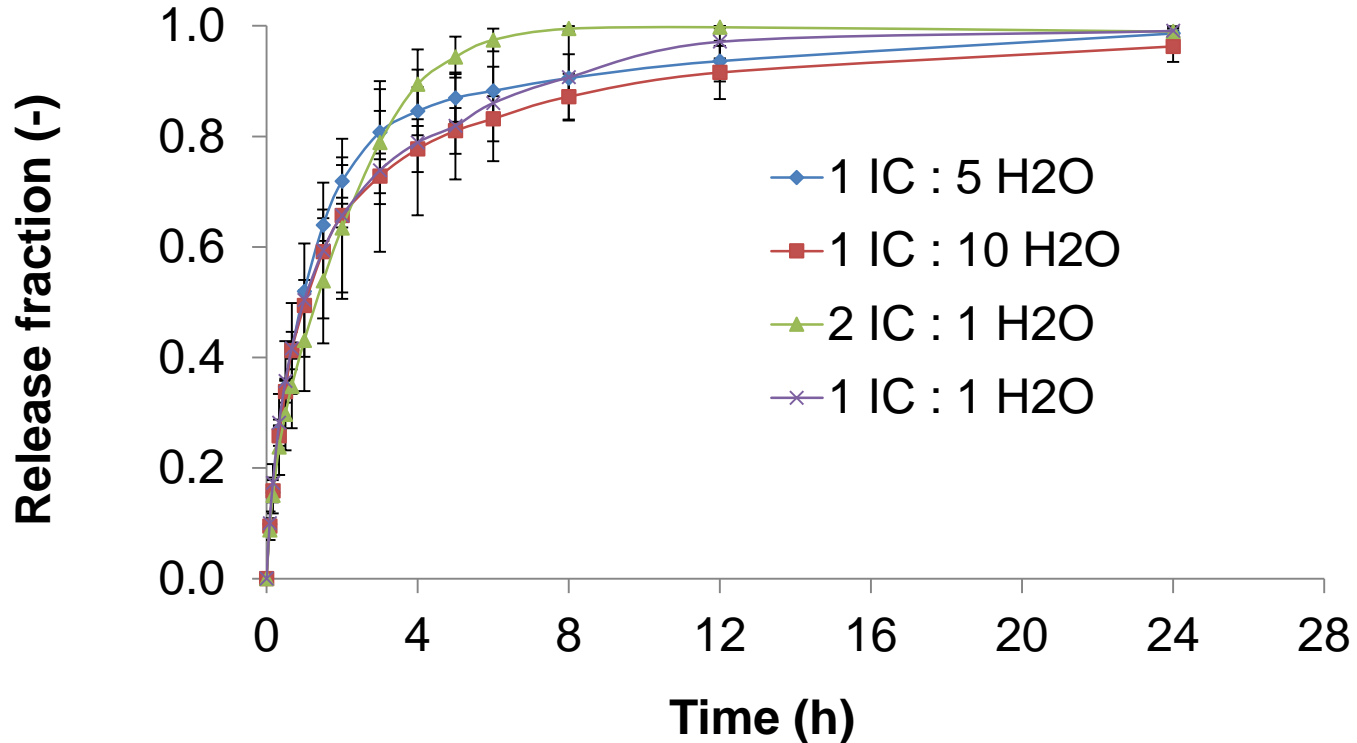
Fig. 1: X-ray diffraction patterns of commercial and spray-dried α -CDs.

How much of CO₂ powder need for 1 kg cottage cheese?

- ❑ CO₂ in powder : 3-5 wt% or 30,000-50,000 ppm.
- ❑ 440 ppm CO₂ injected into cottage cheese cream dressing and package headspace significantly increase shelf-life (4-6 weeks) without affecting pH or flavour (Moir et al. 1993).
- ❑ Mixing of CO₂ powder with cottage cheese will release the gas from cyclodextrin and dissolve in water and fat phases.
- ❑ For 1 kg cottage cheese we need < 15 gram of CO₂ powder to achieve 500 ppm.

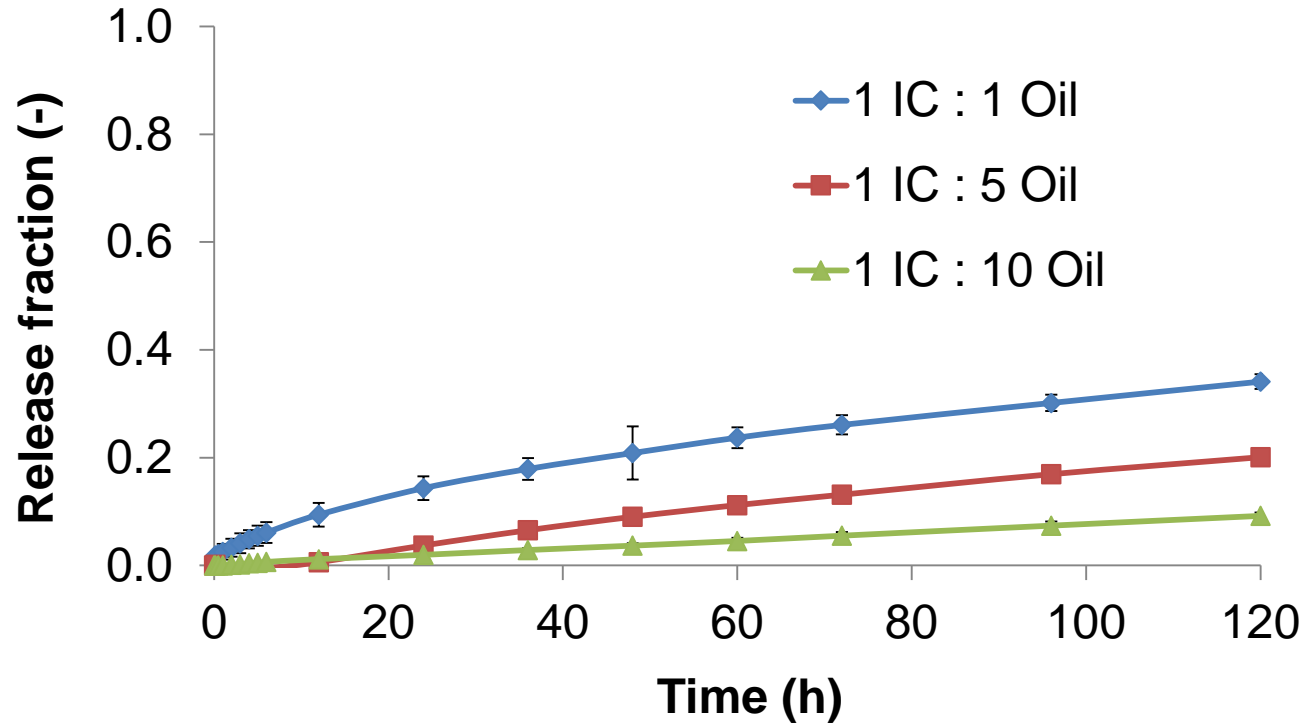
How much of CO₂ powder need for 1 kg cottage cheese?

Release of CO₂ in Water



How much of CO₂ powder need for 1 kg cottage cheese?

Release of CO₂ in Oil



**THANK YOU FOR
YOUR ATTENTION !!!**

