How to select encapsulates for use in food products?

Klaas-Jan Zuidam

Flavour Generation & Delivery
Unilever Food & Health Research Institute,
Vlaardingen, The Netherlands

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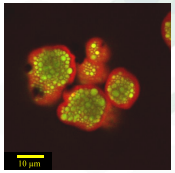
Unilever

agenda

- Consumer needs of food products
- Advantages & Disadvantages of encapsulates
- Requirements & Design of encapsulates
- World of food encapsulates
- Example: how to select fish oil encapsulates?



Unilever R&D organisation

- 6000 employees
- 900 million Euros (2.3% turnover; 2006)
- 6 Global Research centres
- 15 Global Product Development centres
- Regional & country centres

R&D in Unilever

R&D brings great ideas to life!

Using world-class science and technology to deliver nutrition, hygiene, and personal care through distinctive products that help people look good, feel good and get more out of life

Look Better	Be healthy for longer	Achieve more	Be free from health problems	Feel good daily	Give children a good start

Unilever Foods 'adds vitality to life'

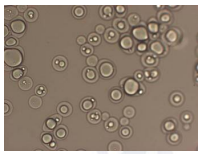
- Tasty
  - Optimal delivery of flavour
  - High quality & natural flavours
  - No malodour
- Healthy
  - Healthy ingredients
  - Less fat, less salt, less sugar
- Convenient
  - Easier handling
  - All in one
  - Delivering at the right time & place

Advantages of encapsulation

- superior handling of the active by conversion of liquid actives into a powder
- adjustable properties of active components (particle size, structure, oil- or water-soluble, colour)
- improved stability in final product and during processing
  - less evaporation of volatile actives
  - no degradation or reaction with other components in the food product such as oxygen or water
- creation of visible and textural effects (visual cues)
- off-taste masking
- controlled release (differentiation, release b right stimulus)

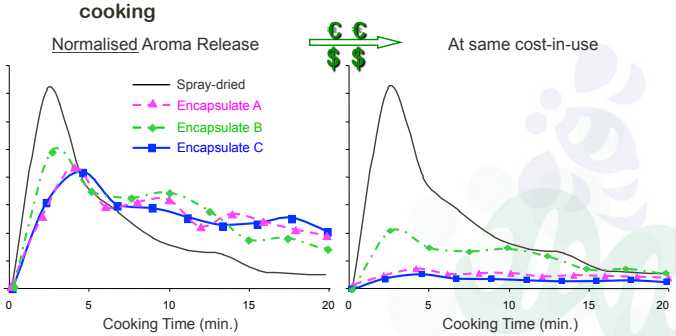
Disadvantages

- Additional costs
- Increase complexity
  - During production process
  - In supply chain
- Undesirable consumer notice
  - Visually
  - Feeling
- Stability challenges of encapsulates
  - Processing
  - Storage within the food products



Aroma release from encapsulates

A few technologies provide some prolonged release upon cooking



Undesirable consumer notice

small red "VitActiv-points" containing lutein and lycopene in Lätta Hoch

200-300 µm beads

visible beads in margarine

Challenges

- The benefits should overcome the negatives

→ **try to work without microencapsulation, "deliver" via proper design of food product.**

- Oil level
- Type and level of biopolymers
- Type and level of emulsifiers
- Viscosity
- Water content
- Packaging
- Etc.

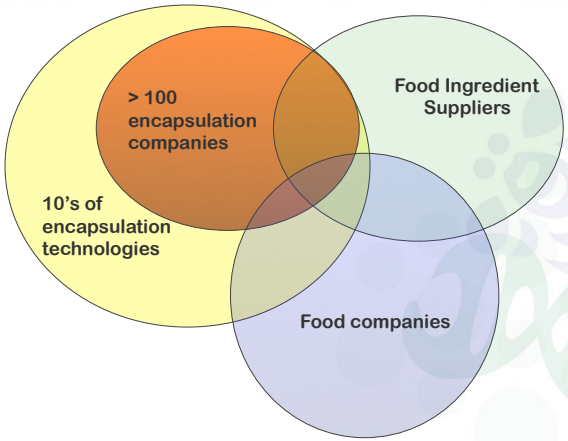
Requirements for encapsulates

- Physico-chemical characteristics of actives
  - particle size, water-solubility or not, etc.
- Process conditions of food products
- Storage of encapsulates
  - prior use
  - In food products
- Incorporation in food product
  - particle size
  - Density
- Trigger(s) and mechanism(s) of release
- Cost constraints

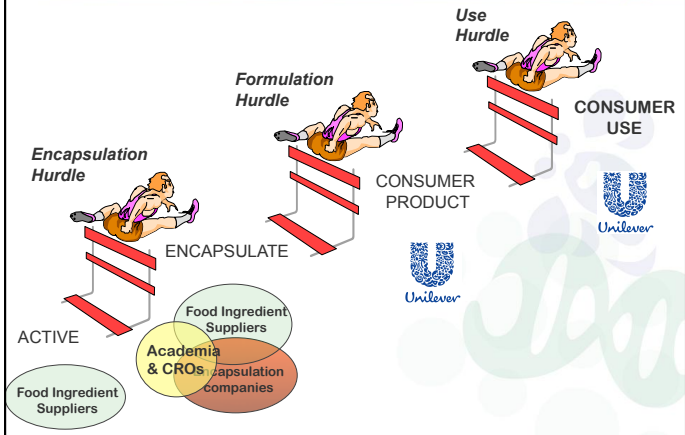
Design of encapsulates

- Coating
- Encapsulation process
- Loading
- Legal issues
  - Food grade, use of crosslinkers,
- Halal or Kosher status
- Freedom of use & IPR status
- Proper supply chain
  - Sufficient quantities
  - Constant quality
  - Right time

World of Food encapsulates

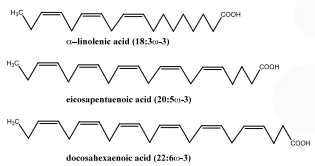


Food encapsulation business



Fish oil fortification

- We do not eat enough omega-3 fatty acids
  - Recommended dose is 0.4-1.0 g per day
  - The actual dose is 0.15 g per day
- Fortification of food with fish oil is an elegant way to fill this gap
  - Problem: Oxidation, resulting in fishy off-flavours



Prevention of fish oil oxidation

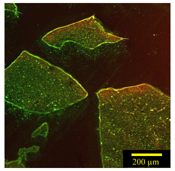
- High quality of fish oil and proper handling
- Reduce oxygen concentration
- Add antioxidants
- Lower the storage temperature
- Scavenge metal ions (iron or copper) by means of sequestrants in the water phase, if present
- Exclude light
- Design of food microstructure and composition.
  - oxidation in a water-in-oil emulsion might differ from an oil-in-water emulsion,
  - use of positively charged emulsifiers and thickeners of the interfacial layer of emulsions may repel metal ions
- Alternatively, encapsulation can reduce oxidation

N.J. Zuidam & C.M. Beindorff, CRS Newsletter 24(4), 22-24, 20

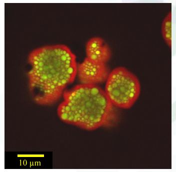
Fish oil microencapsulates

Microencapsulation may prevent off-flavour by:

- preventing contact between oxygen and fish oil,
- preventing contact between metal ions and fish oil,
- preventing direct exposure to light,
- trapping off-flavour



Duralife® from Firmenich



Meg-3® from ONC

Some fish oil microencapsulates on the market

Supplier	Trade name	Technology	Water soluble?	Expected price range
Arjuna, India	Zepufa	Spray-dried powder	yes	low
BASF, Germany	Dry n-3	Spray-dried gelatine/caseinate/sugar matrix with a starch coating.	yes	low
DSM, The Netherlands	Ropufa	Spray-dried cornstarch-coated matrix of gelatine and sucrose	yes	low
The Wright Group, USA	Supercoat Omega-3	Spray-dried starch/protein matrix	yes	low
National Starch, USA	Novomega	Spray-dried powder based on modified starch and soy protein	yes	low
Kievit, The Netherlands	Vana-Sana	Spray-dried powder produced by spraying on a moving belt	yes	low
National Starch, USA	Novomega	Spray-dried powder	yes	low
Nu-Mega, Australia	Driphorm	Spray-dried powder with Maillard products	yes	low
Wacker, Germany	OmegaDry	Complexation with γ-cyclodextrin in water, followed by vacuum drying	yes	middle
Firmenich, Suisse	Duralife	Melt injection with matrix based on maltodextrin and sugar	yes	middle
Ocean Nutrition Canada, Canada	Meg-3	Dried complex coacervates of gelatine and polyphosphate	No	middle
Kitii Corp,, Japan	Calshell	Calcium carbonate precipitation	only at low pH	high
Morishita Jintan, Japan		Submerged co-extrusion	yes	high
Denomega, Norway	Denomega GAT 100	Calcium alginate microspheres prepared via duplex emulsions and phase inversion	no	middle

Fish oil microencapsulates

Technology	Load (wt.% of dry weight)	Particle size (µm)	Water-soluble?	Expected price range
Spray-drying	1-60	10-400	Yes	Low
Melt injection	10-20	200-2000	Yes	Middle
Submerged co-extrusion	70-95	1000-5000	Yes	High
Complex coacervates	40-90	10-800	No	Middle
Microspheres	20-50	10-800	No	Middle
Calcium carbonate capsules	25-40	20	Only at low pH	High
γ-cyclodextrin + drying	15-40	≤100	yes	Middle?

Selection criteria of microencapsulates

- physico-chemical characteristics of the encapsulates
  - particle size, water-solubility or not, etc.
- costs
- stability during supply chain, processing and/or storage in a food product
  - may depends on the composition of the food matrix and packaging
- quality and safety of the fish oil
  - including the absence of off-flavours, pesticides, EPA/DHA ratio, and high EPA and DHA content
- bioavailability of the fish oil,
- commercial available quantity
- legal status
  - food grade and, e.g., the use of crosslinking agents
- optionally, availability in Halal or Kosher quality

N.J. Zuidam & C.M. Beindorff, CRS Newsletter 24(4), 22-24, 20

Conclusions

- Encapsulates might be used in food products
  - Benefits should overcome negatives
  - In general, encapsulation is not a first choice
    - only use them if proper food product design fails
- Three stages in the use of encapsulates
  - Encapsulation of the active
  - Incorporation of encapsulates in the consumer product
  - Proper release of active upon use
- Selection of the right encapsulates from the right supplier is a competitive edge for a food company like Unilever

Thanks to you for listening!

Acknowledgements:
Unilever colleagues & management