FOOD stars — Innovative Food Product Development Cycle: Frame for Stepping Up Research Excellence of FINS

European Commission

Techniques for encapsulation of food ingredients

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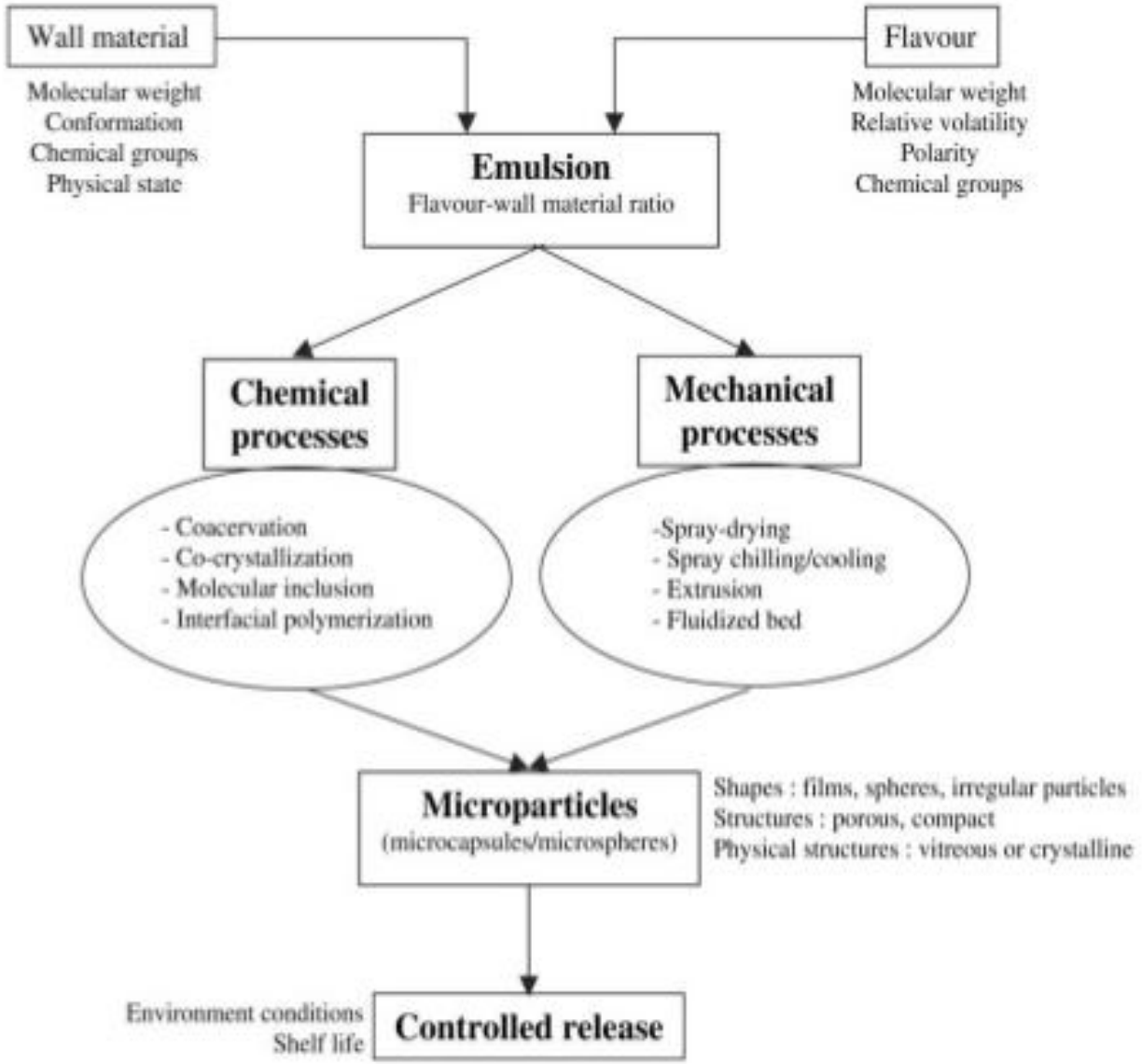
Overview of food encapsulation

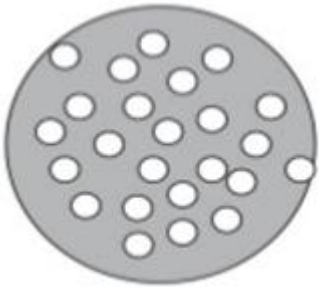


Theory of encapsulation technology

- **TYPES OF MICROPARTICLES**

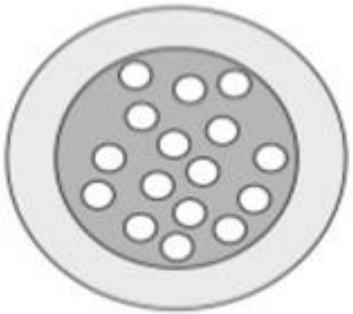
Reservoir or Microcapsule

- has a shell around the active agent
- is also called capsule, single-core, mono-core or core-shell type



Matrix or Microsphere

- active agent dispersed into the carrier
- active agents are in general present also at the surface



Coated matrix

- active agent dispersed into the carrier, but not at the surface (additional coating)

Theory of encapsulation technology

- **CARRIER MATERIALS**
- Food grade;
- Biodegradable;
- Stable during processing, storage and consumption;
- Different sources/types:
  - Carbohydrates (starch, cellulose, chitosan);
  - Proteins and peptides (gelatine, whey protein);
  - Lipid-based: (phospholipids, glycerolipids, waxes);
- Different origins:
  - Plant, marine and microbial/animal.

ARABIC GUM

CARRAGEENAN GUM

MODIFIED STARCH

CHITOSAN

Theory of encapsulation technology

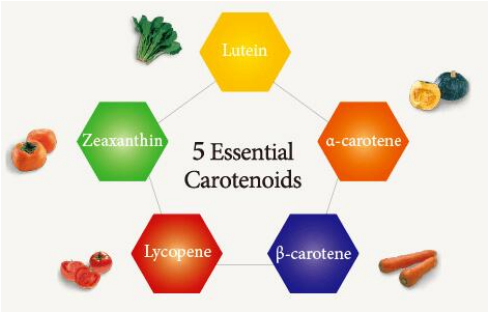
- **ACTIVE MATERIALS**

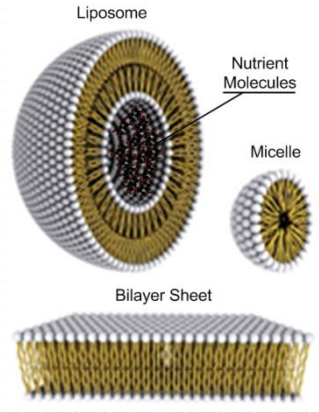
  - Pharmaceutical drugs
  - Living cells (microorganisms/probiotics, RNA, DNA)
  - Food ingredients and nutraceuticals
  - Enzymes
  - Food aromas and flavors
  - Spices, herbs
  - Essential oils
  - Sweeteners
  - Vitamins
  - Minerals
  - Pigments
  - Others

Linoleic acid

***Active/core materials may be liquids, gases or solids**

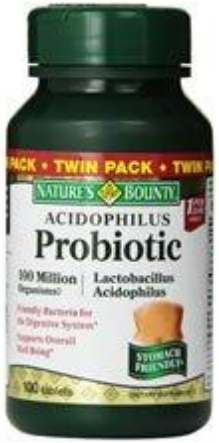
Food ingredients that require encapsulation





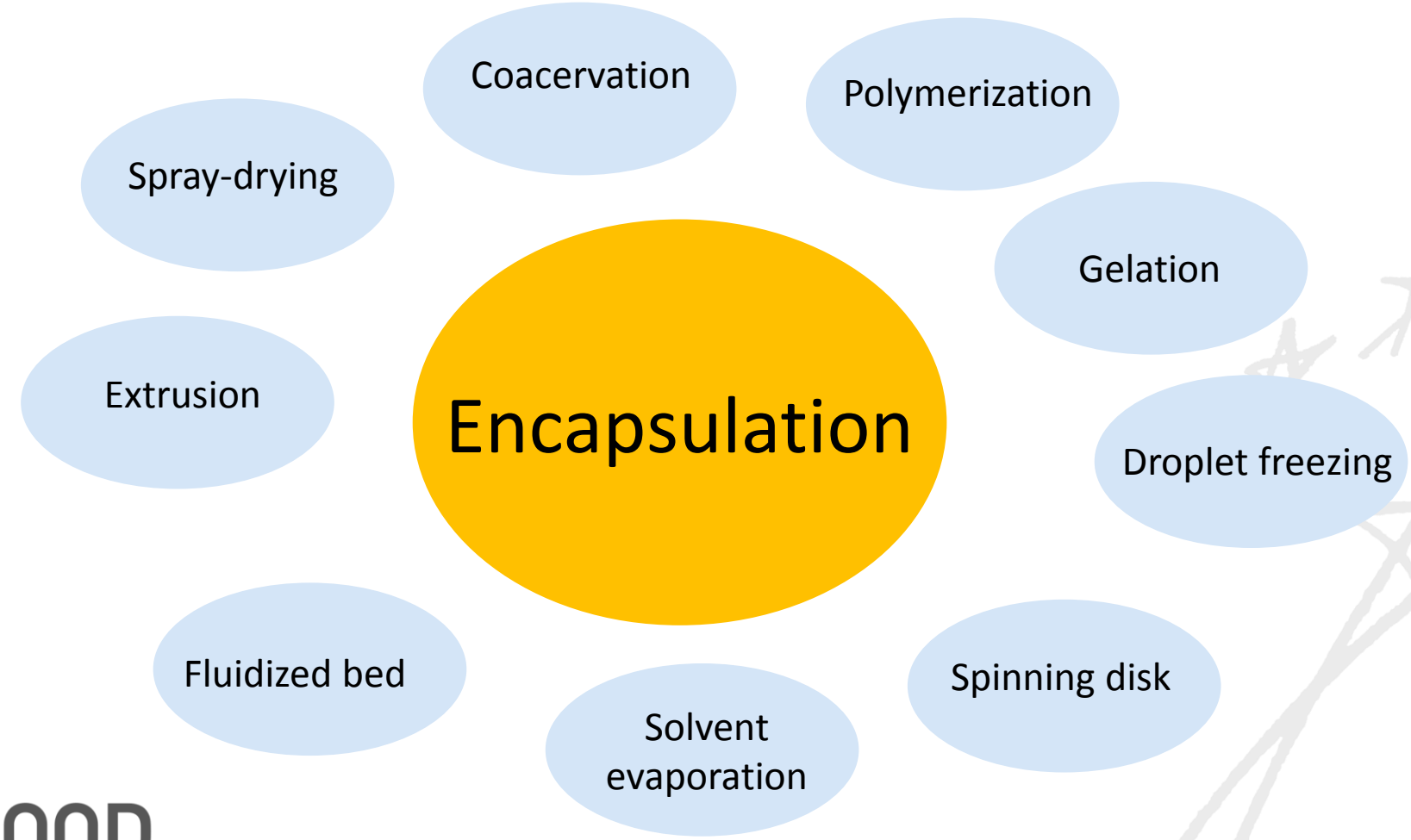
Type	Example	Reason
Flavors	Citrus oils	Allow incorporation in aqueous medium Facilitate storage and utilization Retard chemical degradation Control flavor release profile
Antimicrobials	Essential oils	Improve matrix compatibility Facilitate storage and utilization Retard chemical degradation Mask off-flavors Increase potency
Antioxidants	Carotenoids	Allow incorporation in aqueous medium Facilitate storage and utilization Retard chemical degradation Increase efficacy
Bioactive peptides	Cholecystokinin	Retard degradation in stomach Reduce bitterness and astringency Control release profile and bioactivity
Oligosaccharides and fibers	Chitosan	Avoid adverse ingredient interactions Improved product texture Control delivery in GI tract

Food ingredients that require encapsulation



Type	Example	Reason
Minerals	Iron	Avoid undesirable oxidative reactions Prevent precipitation Enhance bioavailability Reduce off flavors and astringency
Vitamins	Vitamin D	Allow incorporation in aqueous medium Improve ease of utilization Prevent chemical degradation Increase bioavailability
Bioactive lipids	ω-3 fatty acids	Allow incorporation in aqueous medium Improve ease of utilization Avoid chemical degradation (oxidation) Controlled delivery in GI tract
Probiotics	Lactic-acid bacteria	Increase bioavailability Avoid degradation in stomach Improve cell viability in product

Encapsulation methods



Choosing a microencapsulation method

Encapsulation process selection criteria:

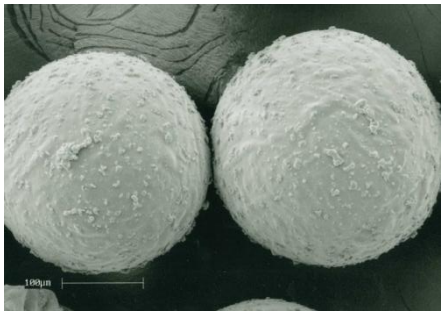
- Core and shell material properties
  - Gas/liquid/solid
  - Solubility
  - Viscosity/ surface tension
  - Density
  - Reactivity
- Capsule size and morphology
- Capsule payload
- Production capacity, scale-up potential and process cost
- Release profile and mechanism
- Product stability

The process need to be **TAILORED** according to the product

application

None of the existing technologies can be considered as a universally applicable process, as individual food components demonstrate extreme differences in molecular weight, polarity, solubility, stability, etc.

Encapsulation methods



- Physical X Chemical
  - **Physical encapsulation**

Physical methods include encapsulation by gravity-flow, centrifugal extrusion, spray-drying, spray-chilling, spinning disk and others. In general, a coating is applied to the active material and then is dried to obtain coated microparticles.

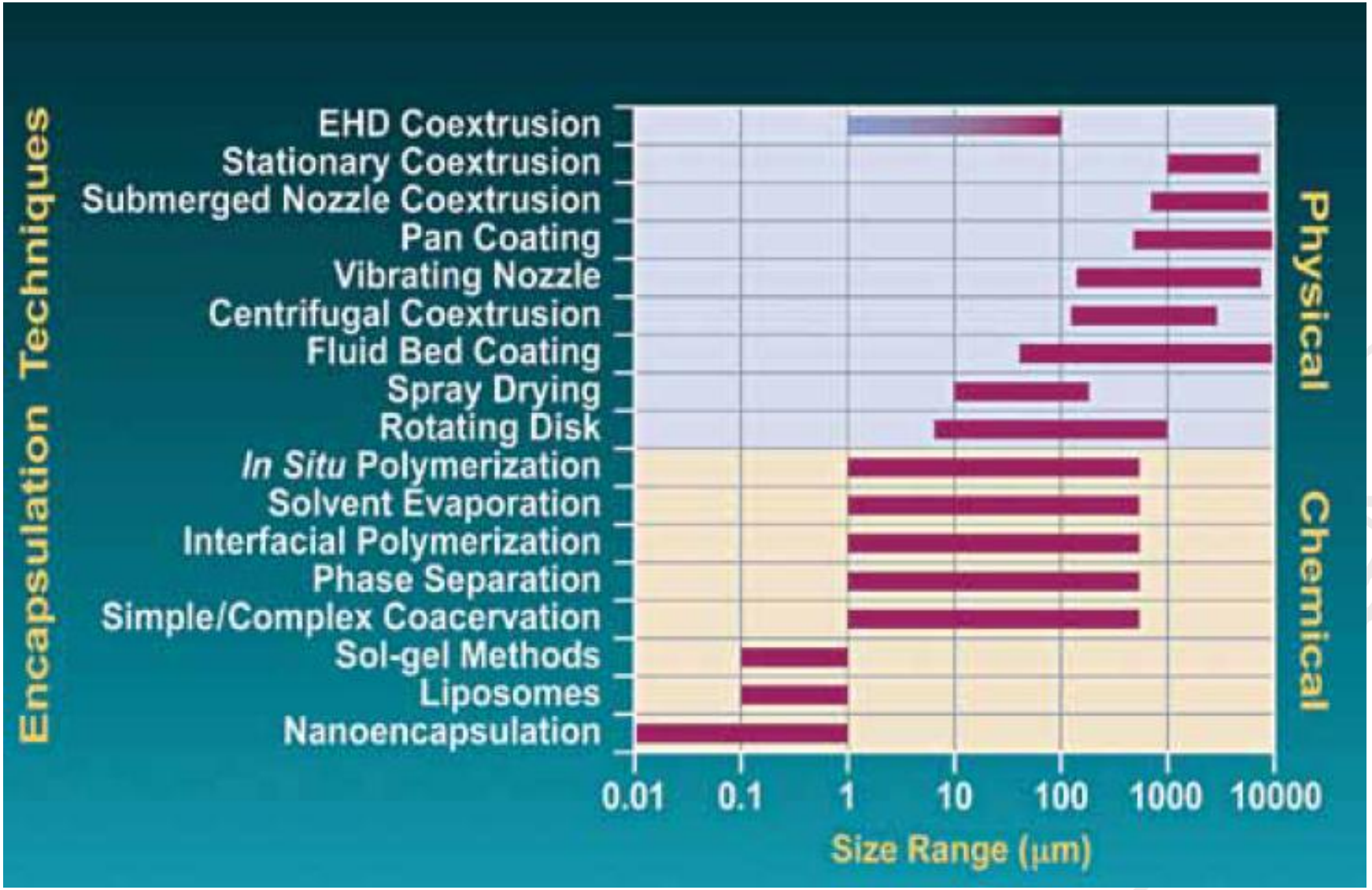
Physical Encapsulation Characteristics
- Particle sizes of 1-10,000 microns
- Material versatility
- Narrow size distribution
- Scalability and high production capacity
- Continuous production

  - **Chemical encapsulation**

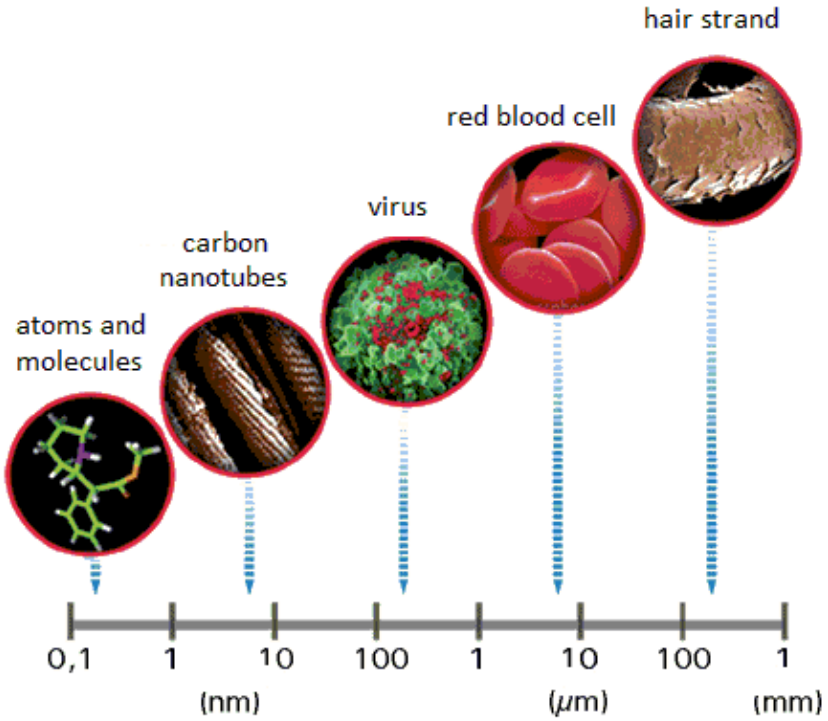
Chemical encapsulation methods include coacervation (simple and complex), *in situ* polymerization, interfacial polymerization, emulsion polymerization, layer-by-layer deposition, liposomes and others.

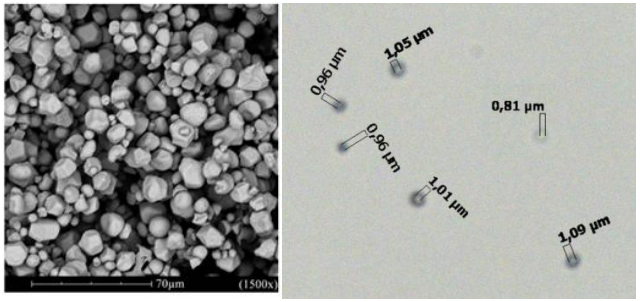
Chemical Encapsulation Characteristics
- Particle sizes of 0.1-500 microns
- High payload
- Uniform particle size distribution
- Scalability and high production capacity
- Batch production

Comparison between encapsulation methods



Size of encapsulated food ingredients





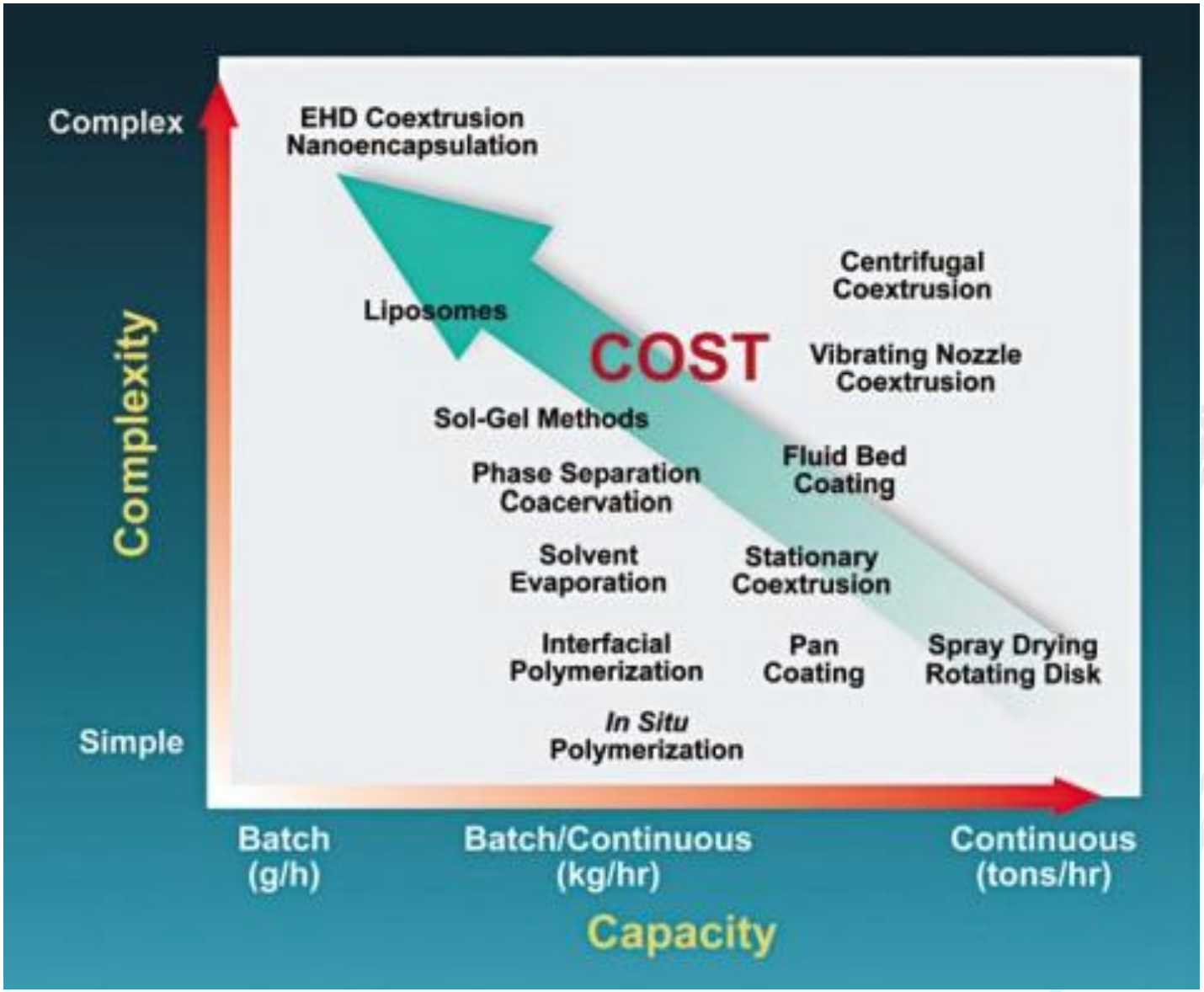
spray-drying

Orange essential oil (1.02 µm)

Particle size influences sensory perception (grittiness, roughness), viscosity and appearance of foods

Consumer acceptance!

Comparison between encapsulation methods



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European Commission

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