FUNCTIONAL INGREDIENTS AND INTENTIONAL FOOD ADDITIVES

FUNCTIONAL INGREDIENTS AND INTENTIONAL FOOD ADDITIVES

- When chemicals/biomaterials are added to food in bulk and represent a major fraction of the total, they are referred to as:
  - Ingredients

FUNCTIONAL INGREDIENTS AND INTENTIONAL FOOD ADDITIVES

- ...If they are a significant fraction, they are referred to as:
  - Functional ingredients

FUNCTIONAL INGREDIENTS AND INTENTIONAL FOOD ADDITIVES

- ... and if they are present in minor amounts, they are called:
  - Food additives
- The distinctions are admittedly somewhat arbitrary.

FUNCTIONAL INGREDIENTS AND INTENTIONAL FOOD ADDITIVES

- Reasons for adding chemicals/biomaterials to foods:
  - Quality improvement of sensory, physico-chemical, and microbial properties of foods
  - Safety enhancements
  - Nutritional enhancements

FUNCTIONAL INGREDIENTS

- Functionality in foods is usually defined as a particular structural, sensory or nutritional property that can be transferred from one commodity to another along with the molecules in that commodity that provide the property.

FUNCTIONAL INGREDIENTS

- Gelling agents
- Foaming agents
- Thickening agents

GELLING AGENTS

- Many foods are, at least during one period of their assembly, gels.
- Gels are semi-solids in which most of the mass of material is fluid and is supported by a 3-dimensional network of self-supporting matrix material.

GELLING AGENTS

- Gelling agents are typically proteins:
  - Gelatin
  - Egg white
  - Milk proteins
  - Modified soybean proteins

GELLING AGENTS

- ... or polysaccharides:
  - Starch
  - Pectins
  - Gums
- ... in which case, other components must also be added (e.g., calcium)

FOAMING AGENTS

- Foams are metastable systems composed of a continuous phase (e.g., liquid) and a discontinuous phase (e.g., air or gas), in which the gas is dispersed as bubbles in the liquid matrix

FOAMING AGENTS

- Egg white
- Wheat proteins
- Milk proteins
- Soy proteins

- ... stabilize foams by reducing surface tension at the interface between the two phases

Foams are a dispersion of bubbles within a liquid

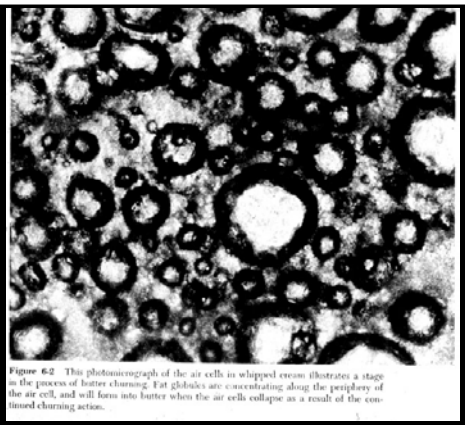

Figure 6-2 This photomicrograph of the air cells in whipped cream illustrates a stage in the process of butter churning. Fat globules are concentrating along the periphery of the air cell, and will form into butter when the air cells collapse as a result of the continued churning action.

FOAM CHARACTERISTICS

Foams are:

- Liquid spread over a bubble
- This requires reduced surface tension
- Dissolved molecules achieve this

FOAM CHARACTERISTICS

- Molecules in liquids attract each other
- At the liquid-air surface, they attract each other more than air molecules
- This is surface tension

EGG FOAMS

- Albumen proteins reduce surface tension
- When eggs are beaten, some proteins such as conalbumin, ovomucin, and globulin denature in the bubble wall

EGG FOAMS

- Protein network and viscosity stabilize (denaturation)

THICKENING AGENTS

- It is often highly desirable to restrict the flow of materials in foods (e.g., sauces, pastes, dressings)

THICKENING AGENTS

- Thickeners are "gels" with very low yield points and little elasticity:
  - Milk and soybean proteins
  - Starches, modified celluloses and gums

INTENTIONAL FOOD ADDITIVES

- Physical properties/Structure modifiers
- Biological properties/Structure and flavor modifiers
- Chemical properties modifiers

PHYSICAL PROPERTIES/STRUCTURE MODIFIERS

- Emulsifiers: ampiphilic (surface acting) molecules which orient themselves at the interface of dipersed oil droplets and provide a kinetic barrier to the coalescence of these otherwise thermodynamically unstable particles

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PHYSICAL PROPERTIES/STRUCTURE MODIFIERS

- Emulsifiers
  - Mono- and diglycerides
  - Polyglycerol esters
  - Sorbitan polyesters
  - Stearoyl lactylates
- ... among the most widely used food additives.

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Emulsion

A suspension of one liquid in another

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Dispersed phase=
Droplets

Continuous phase=
Between the droplets

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Surface tension keeps liquids in bulk mass and in separate layers

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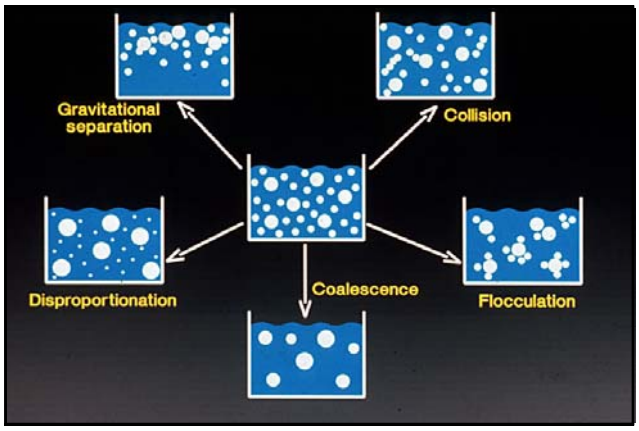
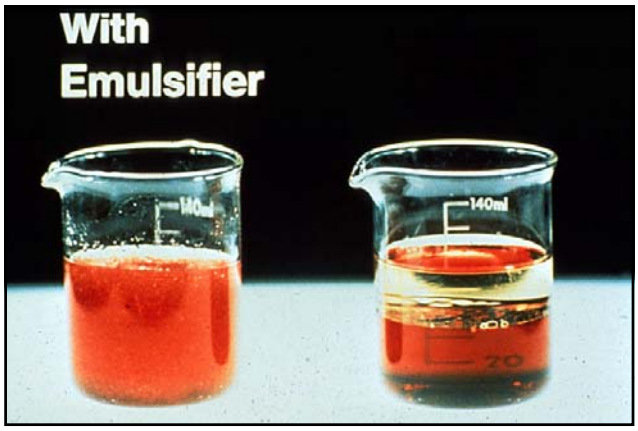


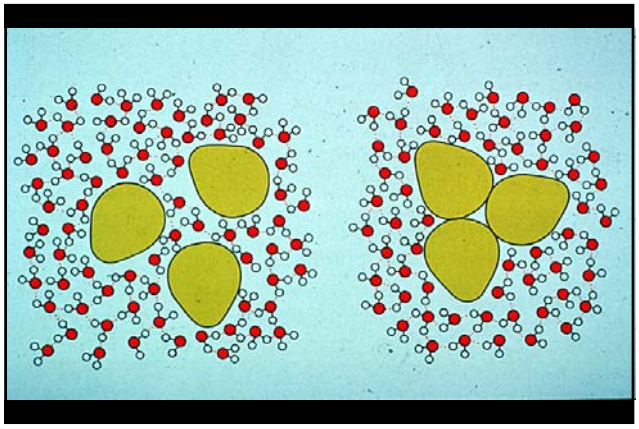


EMULSION

- Emulsifiers are chemical bridges

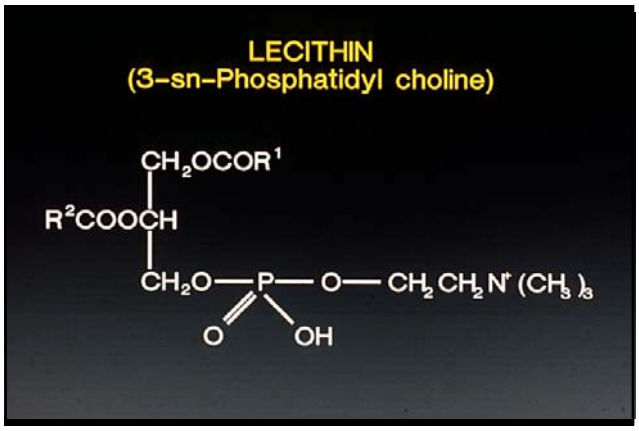
EMULSION

- Locates at water-oil surface
- Reduces surface tension
- Boosts negative charges
- Promotes stability of oil droplet



EGG YOLK EMULSIFIERS INCLUDE

- Proteins
- Cholesterol
- Fatty Acids
- Lecithin



PHYSICAL PROPERTIES/STRUCTURE MODIFIERS

- Antifoaming agents: highly surface active, they serve to interrupt the necessary network on the surface of air bubbles and effectively collapse an undesirable foam.

PHYSICAL PROPERTIES/STRUCTURE MODIFIERS

- Antifoaming agents
  - Medium chain fatty acids
  - Silicone oxide

PHYSICAL PROPERTIES/STRUCTURE MODIFIERS

- Leavening agents: used for the direct formation of gas within certain foods (through chemical reactions)


LEAVENING AGENTS

- Steam is produced when the free water in a dough is heated
- Air is incorporated into a mixture as a result of creaming, beating or mixing in the ingredients
- CO_2 may be produced by yeast or as a result of chemical reactions between an acid and a base (or with heat)

LEAVENING AGENTS

$NaCHO_3$ (baking soda) $\xrightarrow{\text{Heat}}$ Na_2CO_3 (washing soda) $+ CO_2 + H_2O$

NH_4HCO_3 (ammonium bicarbonate) $\xrightarrow{\text{Heat}}$ $NH_3 + CO_2 + H_2O$

LEAVENING AGENTS

In solution, baking soda reacts with acid to yield carbon dioxide

$$Na^+HCO_3^- + H^+X^- \longrightarrow NA^+X^- + H_2CO_3$$

$$H_2CO_3 \longrightarrow CO_2 + H_2O$$

LEAVENING AGENTS

Food acids that may react with baking soda include:

- lactic acid (sour milk)
- acetic acid (vinegar)
- gluconic acid (honey)
- aconitic acid (molasses)

LEAVENING AGENTS

- Baking powder = baking soda + acid
- Single acting, quick BP: acid = phosphate or tartrate (cream of tartar)
- Double acting, slow BP: acid = monocalcium phosphate or sodium aluminum phosphate

BIOLOGICAL PROPERTIES/ STRUCTURE & FLAVOR MODIFIERS

- Enzymes used as catalysts to tenderize meat, hydrolyze starch, cause milk caseins to gel, and bleach unwanted pigments...
  - Papain, pepsin
  - Rennin, chymosin
  - Amylases
  - Lipases, lipoxygenases

CHEMICAL PROPERTIES MODIFIERS

- Chelating agents (sequestrants)
  - Form complexes with metallic and alkaline ions
  - Antioxidant synergists by removing metal ions that catalyze oxidation
  - Polycarboxilic acids, polyphosphoric acids, and macromolecules (natural)
  - EDTA (ethylenediamine tetraacetic acid)

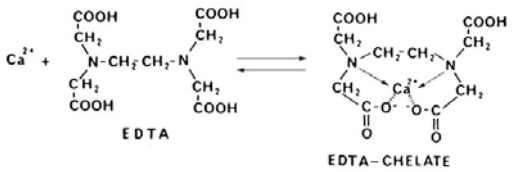


FIGURE 6 Schematic representation of chelation of calcium by EDTA.

CHEMICAL PROPERTIES MODIFIERS

- Antioxidants
  - In many foods, the presence of polyunsaturated fatty acids can render the product highly susceptible to lipid oxidation and rancidity
  - Antioxidants do not eliminate this oxidation but substantially prolong the lag time before oxidation begins

CHEMICAL PROPERTIES MODIFIERS

- Antioxidants
  - Tocopherols
  - BHA (butylated hydroxy anisole)
  - BHT (butylated hydroxy toluene)
  - Propyl gallate
  - Ascorbate
  - Ascorbyl palmitate

CHEMICAL PROPERTIES MODIFIERS

- Coloring/color controlling agents
  - Natural (carotenoids, anthocyanins,..)
  - Artificial (Indigo Carmine, Food Green, Erythrosine, Quinoline Yellow, Patent Blue,...)
  - Nitrate/nitrite, magnesium chloride