Item 3: Food Science and Technology Extended Study
Use of Food Additives and International Numbering System
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Food and Nutritional Sciences
The Chinese University of Hong Kong
Outlines

• Definition of food additives
• Classification of food additives according to International Numbering System (INS)
• Functions of food additives
• Uses of food additives: their applications and types
• Toxicological aspects of food additives
Additive means any substance, not commonly regarded or used as food, which is added to, or used in or on, food at any stage to affect its keeping qualities, texture, consistency, appearance, taste, odor, alkalinity or acidity, or to serve any other technological function in relation to food, and includes processing aids in so far as they are added to, or used in or on, food as aforesaid, but does not include:
Definition of Food Additives

Hong Kong Laws
Chapter 132 Subsidiary Legislation
Food and Drugs (Composition and Labelling) Regulations

a) Vitamins, minerals or other nutrients in so far as they are used solely for the purpose of fortifying or enriching food or of restoring the constituents of food;

b) Herbs or spices when used as seasoning;

c) Hops;

d) Salt;

e) Yeast or yeast extracts;

f) The total products of any hydrolysis or autolysis of food protein
Definition of Food Additives

Hong Kong Laws
Chapter 132 Subsidiary Legislation
Food and Drugs (Composition and Labelling) Regulations

g) Starter cultures;
h) Malt or malt extract;
i) Any substance which is present in food solely as a result of its addition to animal, bird or fish feeding stuffs or its use in a process or treatment carried out in crop husbandry, animal husbandry, veterinary medicine or storage (including any pesticide, fumigant, sprout depressant or veterinary medicine); or

j) Air or water
Processing aids

- Any substance or material, not including apparatus or utensils, and not consumed as a food ingredient by itself, intentionally used in the processing of raw materials, foods or its ingredients, to fulfill a certain technological purpose during treatment or processing and which may result in the non-intentional but avoidable presence of residues or derivatives in the final product.

- Examples: Extraction solvents, filtering aids, freezing agents
Definition of Food Additives

• “Food additive” means any substance not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products becoming a component of or otherwise affecting the characteristics of such foods. The term does not include “contaminants” or substances added to food for maintaining or improving nutritional qualities.
Definition of Food Additives
U.S. Food Additives Amendment (1958)

• **Definition**
  - Any substance, the intended use of which may reasonably be expected to result, directly (intentional) or indirectly (unintentional), in its becoming a component or otherwise affecting the characteristics of any food

• **Exemptions**
  - Generally recognized as safe substances (GRAS)
  - Prior sanctioned or approved substances
  - Pesticide chemicals
  - Color additives
Exemptions in U.S. Food Additives Amendment

- **GRAS**: substances for which use in food has a proven track record of safety based either on a history of use before 1958 or on published scientific evidence, and that need not be approved by the FDA prior to being used.
- **Prior-sanctioned**: substances that were assumed to be safe by either the FDA or the U.S. Department of Agriculture before 1958, to be used in specific food.
- **Color additives**: dyes that are used in foods, drugs, cosmetics and medical devices and must be approved by the FDA before they are used.
Category of Ingredients granted with GRAS status
(21 Code of Federal Regulation CFR Part 182)
• Spices and other natural seasonings and flavorings
• Essential oils and natural extractives
• Synthetic flavoring substances
• Substances migrating from cotton fabrics and paperboard products
• Adjuvants for pesticide chemicals
• Other individual ingredients
Classification of Food Additives

- European Union (EU) categories of food additives
- Joint FAO/WHO Expert Committee on Food Additives (JECFA) functional uses
- Codex Alimentarius International Numbering System (INS) classes/subclasses
International Numbering System (INS) for Food Additives

- Codex Committee on Food Additives and Contaminants (CCFAC)
- An agreed international numerical system for identifying food additives in ingredient lists, replacing specific names and complex chemical structure
- Based on EU (formerly EEC) system
- No implication of toxicological approval by Codex
- Not including flavors, chewing gum bases, dietetic and nutritive additives
- Twenty-three class titles based on technological functions
- Open nature of the list subject to the inclusion of additional additives or removal of existing ones
# Functional Classes of Food Additives in International Numbering System (INS)

<table>
<thead>
<tr>
<th>Functional Classes (for labelling purposes)</th>
<th>Definition</th>
<th>Sub-Classes (technological functions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acid (酸味剤)</td>
<td>Increases the acidity and/or imparts a sour taste to a food</td>
<td>Acidifier</td>
</tr>
<tr>
<td>2. Acidity regulator (酸度調節剤)</td>
<td>Alters or controls the acidity or alkalinity of a food</td>
<td>Acid, alkali, base, buffer, buffering agent, pH adjusting agent</td>
</tr>
<tr>
<td>3. Anticaking agent (抗結剤)</td>
<td>Reduces the tendency of particles of food to adhere to one another</td>
<td>Anticaking agent, anti-stick agent, drying agent, dusting powder, release agent</td>
</tr>
<tr>
<td>4. Antifoaming agent (消泡剤)</td>
<td>Prevents or reduces foaming</td>
<td>Antifoaming agent</td>
</tr>
<tr>
<td>5. Antioxidant (抗氧化剤)</td>
<td>Prolongs the shelf-life of foods by protecting against deterioration caused by oxidation, such as fat rancidity and colour changes</td>
<td>Antioxidant, antioxidant synergist, sequestrant</td>
</tr>
<tr>
<td>6. Bulking agents (增體剤)</td>
<td>A substance, other than air or water, which contributes to the bulk of a food without contributing significantly to its available energy value</td>
<td>Bulking agent, filler</td>
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Also used in Schedule 3 CAP 132W Food & Drugs (Comp. Label. Reg.) L.N. 85 of 2004
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<td>7. Color (色素)</td>
<td>Adds or restores color in a food</td>
<td>Color</td>
</tr>
<tr>
<td>8. Color retention Agent (護色劑)</td>
<td>Adds or restores color in a food</td>
<td>Color</td>
</tr>
<tr>
<td>9. Emulsifier (乳化劑)</td>
<td>Forms or maintains a uniform mixture of two or more immiscible phases such as oil and water in a food</td>
<td>Emulsifier, plasticizer, dispersing agent, surface active agent, surfactant, wetting agent</td>
</tr>
<tr>
<td>10. Emulsifying salt (乳化鹽)</td>
<td>Rearranges cheese proteins in the manufacture of processed cheese, in order to prevent fat separation</td>
<td>Melding salt, sequestrant</td>
</tr>
<tr>
<td>11. Firming agent (固化劑)</td>
<td>Makes or keeps tissues of fruit or vegetables firm and crisp, or interacts with gelling agents to produce or strengthen gel</td>
<td>Firming agent</td>
</tr>
<tr>
<td>12. Flavor enhancer (增味劑)</td>
<td>Enhances the existing taste and/or odor of a food</td>
<td>Flavor enhancer, flavor modifier, tenderizer</td>
</tr>
<tr>
<td>13. Flour treatment agent (麵粉處理劑)</td>
<td>A substance added to flour to improve its baking quality or color</td>
<td>Bleaching agent, dough improver, flour improver</td>
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<td>14. Foaming agent (發泡劑)</td>
<td>Makes it possible to form or maintain a uniform dispersion of a gaseous phase in a liquid or solid food</td>
<td>Whipping agent, aerating agent</td>
</tr>
<tr>
<td>15. Gelling agent (膠凝劑)</td>
<td>Gives a food texture through formation of a gel</td>
<td>Gelling agent</td>
</tr>
<tr>
<td>16. Glazing agent (上光劑)</td>
<td>A substance which, when applied to the external surface of a food, imparts a shiny appearance or provides a protective coating</td>
<td>Coating, sealing agent, polish</td>
</tr>
<tr>
<td>17. Humectant (水分保持劑)</td>
<td>Prevents foods from drying out by counteracting the effect of an wetting agent atmosphere having a low degree of humidity</td>
<td>Moisture/water retention agent, wetting agent</td>
</tr>
<tr>
<td>18. Preservative (防腐劑)</td>
<td>Prolongs the shelf-life of a food by protecting against deterioration caused by microorganisms</td>
<td>Antimicrobial preservative, antimycotic agent, bacteriophage control agent, chemosterilant/ wine maturing agent, disinfection agent</td>
</tr>
<tr>
<td>19. Propellant (推進劑)</td>
<td>A gas, other than air, which expels a good from a container</td>
<td>Propellant</td>
</tr>
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### Sub-Classes

- Whipping agent
- Aerating agent
- Coating
- Sealing agent
- Polish
- Moisture/water retention agent
- Wetting agent
- Antimicrobial preservative
- Antimycotic agent
- Bacteriophage control agent
- Chemosterilant
- Wine maturing agent
- Disinfection agent
- Propellant
### Functional Classes of Food Additives in International Numbering System (INS)*

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<tr>
<th>Functional Class</th>
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<th>Sub-Classes</th>
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</thead>
<tbody>
<tr>
<td>20. Raising agent (膨脹劑)</td>
<td>A substance or combination of substances which liberate gas and thereby increase the volume of a dough</td>
<td>Leavening agent, raising agent</td>
</tr>
<tr>
<td>21. Stabilizer (穩定劑)</td>
<td>Makes it possible to maintain a uniform dispersion of two or more immiscible substances in a food</td>
<td>Binder, firming agent, moisture/water retention agent, foam stabilizer</td>
</tr>
<tr>
<td>22. Sweetener (甜味劑)</td>
<td>A non-sugar substance which imparts a sweet taste to a food</td>
<td>Sweetener, artificial sweetener, nutritive sweetener</td>
</tr>
<tr>
<td>23. Thickener (增稠劑)</td>
<td>Increases the viscosity of a food</td>
<td>Thickening agent, texturizer, bodying agent</td>
</tr>
</tbody>
</table>

* Identical with the functional classes of additive for the purpose of sub-paragraph (5) of Schedule 3 – Marking and Labeling of Prepackaged Foods in CAP 132W Food and Drugs (Composition and Labeling) Regulations of Hong Kong Laws (L.N. 85 of 2004)
E452 Polyphosphates
  (i) Sodium polyphosphates
  (ii) Potassium polyphosphates
  (iii) Sodium calcium polyphosphate
  (iv) Calcium polyphosphates

E621 Monosodium glutamate

E316 Sodium erythorbate

E129 Allura Red AC

E330 Citric acid

E250 Sodium nitrite

Food Additives in the European Union  http://www.foodlaw.rdg.ac.uk/additive.htm
E472e Mono- and diacetyl tartaric acid esters of mono- and diglycerides of fatty acids

E920 L-Cysteine

E282 Calcium propionate

E300 Ascorbic acid

Food Additives in the European Union
http://www.foodlaw.rdg.ac.uk/additive.htm
Purposes / functions of food additives

- To preserve \textit{product quality} in order to extend its storage life and improve safety
- To enhance \textit{sensory characteristics} of food including color, flavor, palatability and appearance
- To control \textit{product consistency}
- To improve or maintain \textit{nutritional value}
- To reduce wastage
- To enhance consumer acceptability
- To make the food more readily available
- To facilitate preparation of the food
Situations in which food additives should not be used

– To disguise faulty or inferior processes
– To conceal damage, spoilage, other inferiority
– To deceive the consumer
– If use entails substantial reduction in important nutrients
– If the desired effect can be obtained by economical, good manufacturing practices
– In amounts greater than the minimum necessary to achieve the desired effects
Related News:

Headline of “廣海鹹魚殺蟲劑「加工」” from Ming Pao, June 10, 2004

Headline of “廣東近半熟肉製品不合格” from Ming Pao Apr 28, 2005

Headline of “河北鹹蛋含致癌蘇丹紅” from Ming Pao, Nov 13, 2006
Natural food vs. Processed food

- Extraneous material/food additives
- Preservation/shelf life/freshness
- Food contamination
- Food quality
- Food variety/taste/products
- Nutrient fortification
- Convenience
Video presentation
Food Additives

by
Learning Seed

Synopsis
Food Additives takes a simple, factual look at the everyday trade-offs we make when we choose our food. It helps you to find out why mysterious chemicals are added, which are the most commonly used, and how you can make intelligent, informed decisions about the food you eat.
Applications and Types of Food Additives

To preserve product quality by

- Antimicrobial agents
- Antioxidants
**Functional Classes of Food Additives in International Numbering System (INS)**

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*Identical with the functional classes of additive for the purpose of sub-paragraph (5) of Schedule 3 – Marking and Labeling of Prepackaged Foods in CAP 132W Food and Drugs (Composition and Labeling) Regulations of Hong Kong Laws (L.N. 85 of 2004)
Definition *

- **Preservative** means any substance which is capable of inhibiting, retarding or arresting the process of fermentation, acidification or other deterioration of food of masking any of the evidence of putrefaction

- **Antioxidant** means any substance which delays, retards or prevent the development in food of rancidity or other flavour deterioration due to oxidation

*According to the Preservatives in Food Regulations, Cap. 132BD, HK Laws
Related News:

Headline of “四川泡菜防腐劑超標八成” from Ming Pao, May 14, 2004
Types and properties of antimicrobial substances used in the food processing industry.

<table>
<thead>
<tr>
<th>Antimicrobial Compound</th>
<th>Effective Against</th>
<th>Some Food Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetic acid salt (sodium acetate)</td>
<td>bacteria, molds</td>
<td>bread; as vinegar in pickled products and mayonnaise</td>
</tr>
<tr>
<td>benzoic acid salt (sodium benzoate)</td>
<td>molds and yeasts</td>
<td>ketchup, jams, syrups, orange juice products, syrups</td>
</tr>
<tr>
<td>Na and Ca propionate</td>
<td>bacteria, molds</td>
<td>bread, cake, cheese foods</td>
</tr>
<tr>
<td>potassium sorbate</td>
<td>bacteria, molds</td>
<td>breads</td>
</tr>
<tr>
<td>salt (sodium chloride)</td>
<td>bacteria, yeast, molds</td>
<td>baked products, canned foods, meats</td>
</tr>
<tr>
<td>sodium nitrite</td>
<td><em>Clostridium</em></td>
<td>cured meat products</td>
</tr>
<tr>
<td>sodium benzoate</td>
<td>molds and yeasts</td>
<td>condiments, fruit juices</td>
</tr>
<tr>
<td>sugar (sucrose)</td>
<td>bacteria, yeast, mold</td>
<td>baked products, fruit preserves, meats</td>
</tr>
<tr>
<td>sulfite, sulfur dioxide (SO₂)</td>
<td>bacteria, yeast, mold</td>
<td>dried fruit, lemon juice, molasses, wines</td>
</tr>
</tbody>
</table>
Nitrites in food preservation

- Antimicrobial: inhibiting the growth and toxin production of *Clostridium botulinum* and other bacteria in cured meat products
- Mode of action to microflora: interferes with energy conservation by inhibiting oxygen uptake, oxidative phosphorylation, proton-dependent active transport, and inhibiting metabolic enzymes (e.g. cytochrome oxidase, glyceraldehyde-3-phosphate dehydrogenase and aldolase)
### Characteristics of Antimicrobial short-chain acid derivatives

<table>
<thead>
<tr>
<th>English</th>
<th>Chinese</th>
<th>Name</th>
<th>pKa</th>
<th>Undissociated acid form</th>
<th>Effective pH range</th>
<th>Target microbes</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzoic</td>
<td>苯甲酸</td>
<td>Acid</td>
<td>4.2</td>
<td><img src="image" alt="Benzoic Acid" /></td>
<td>2.5 – 4.0</td>
<td>bacteria</td>
<td>High-acid foods, fruit drinks, pickles, salad dressings, jams</td>
</tr>
<tr>
<td>Parabens</td>
<td>對羥基苯甲酸甲酯</td>
<td>Acidic &amp; alkaline</td>
<td>8.47</td>
<td><img src="image" alt="Parabens" /></td>
<td>Yeasts &amp; molds, gram positive bacteria</td>
<td>Fruit-cakes, soft drinks, fish products, flavor extracts</td>
<td></td>
</tr>
<tr>
<td>Sorbic</td>
<td>山梨酸</td>
<td>Acidic</td>
<td>4.8</td>
<td><img src="image" alt="Sorbic acid" /></td>
<td>Yeasts &amp; molds</td>
<td>Wine, fruit juice, dried fruit, cottage cheese, meat, fish products</td>
<td></td>
</tr>
</tbody>
</table>
Preservatives
Sulfur dioxide and sulfites

• **Antimicrobial** action: penetration of SO$_2$ across cell membrane to activate ATPase system, depleting ATP that resulted in cellular death

• Application as **preservatives** (in wines): preferential inhibition of molds and bacteria but not cultured yeast
Preservatives
Sulfur dioxide and sulfites

- Application as antioxidant: inhibition of nonenzymatic and enzymatic browning
Preservatives
Sulfur dioxide and sulfites

Discoloration of anthocyanin pigments by sulfur dioxide (reversible)

Figure 6–26 Reaction of Bisulfite with the Anthocyanin Carbonium Ion
<table>
<thead>
<tr>
<th>Antioxidant</th>
<th>Action/Characteristics</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDTA&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Slow oxidation by metals</td>
<td>Vegetable oil-containing foods</td>
</tr>
<tr>
<td>Citric acid</td>
<td>Chelate metals in meat</td>
<td>Meats</td>
</tr>
<tr>
<td>Phosphates</td>
<td>Complexes with metal ions</td>
<td>Meats</td>
</tr>
<tr>
<td>BHA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Survives baking and frying</td>
<td>Foods containing animal fats</td>
</tr>
<tr>
<td>BHT&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Survives baking and frying</td>
<td>Foods containing animal fats</td>
</tr>
<tr>
<td>TBHQ&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Survives frying temperature</td>
<td>Vegetable oil-containing foods</td>
</tr>
<tr>
<td>Propyl gallate</td>
<td>Heat sensitive</td>
<td>Vegetable oil-containing foods</td>
</tr>
<tr>
<td>Tocopherols</td>
<td>Can add with vitamin C, etc.</td>
<td>Foods containing animal fats</td>
</tr>
<tr>
<td>Rosemary</td>
<td>Delay free radical formation</td>
<td>Meats, irradiated ground beef</td>
</tr>
<tr>
<td>Thyme, oregano</td>
<td>Avoid warmed over-flavor</td>
<td>Comminuted poultry, meat, fish</td>
</tr>
<tr>
<td>Dried plums</td>
<td>Retard lipid oxidation</td>
<td>Sausage and other ground meat</td>
</tr>
<tr>
<td>Honey</td>
<td>Darker is more effective</td>
<td>Ground turkey</td>
</tr>
</tbody>
</table>

<sup>a</sup>Ethylenediaminetetraacetic acid  
<sup>b</sup>Butylated hydroxyanisole  
<sup>c</sup>Butylated hydroxytoluene  
<sup>d</sup>Tertiary-butylhydroquinone
Hydrolytic Rancidity

Formation of free fatty acids caused by either the reaction of lipid and water in the presence of a catalyst or by the action of lipases.
Oxidative rancidity

Complex lipid oxidation processes involving three phases: initiation, propagation, and termination

<table>
<thead>
<tr>
<th>Step</th>
<th>Reaction</th>
</tr>
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<tbody>
<tr>
<td>Initiation</td>
<td>RH $\rightarrow$ R$^<em>$ + H$^</em>$</td>
</tr>
<tr>
<td>Propagation</td>
<td>R$^<em>$ + O$_2$ $\rightarrow$ ROO$^</em>$</td>
</tr>
<tr>
<td></td>
<td>ROO$^<em>$ + RH $\rightarrow$ ROOH + R$^</em>$</td>
</tr>
<tr>
<td>Branching</td>
<td>ROOH $\rightarrow$ RO$^<em>$ + •OH $^{2\text{RH}}$ $\rightarrow$ 2R$^</em>$ + ROH + H$_2$O</td>
</tr>
<tr>
<td></td>
<td>(monomolecular decomposition)</td>
</tr>
<tr>
<td></td>
<td>2ROOH $\rightarrow$ ROO$^<em>$ + RO$^</em>$ + H$_2$O</td>
</tr>
<tr>
<td></td>
<td>(bimolecular decomposition)</td>
</tr>
<tr>
<td>Termination</td>
<td>ROO$^<em>$ + ROO$^</em>$ $\rightarrow$ ROOR + O$_2$</td>
</tr>
<tr>
<td></td>
<td>R$^<em>$ + R$^</em>$ $\rightarrow$ R - R</td>
</tr>
<tr>
<td></td>
<td>R$^<em>$ + ROO$^</em>$ $\rightarrow$ ROOR</td>
</tr>
</tbody>
</table>
Antioxidants (Phenolics)

**Figure 2-18** Structure of Propyl Gallate (PG), Butylated Hydroxyanisole (BHA), Butylated Hydroxy Toluene (BHT), and Tert-Butyl Hydroquinone (TBHQ)
Reaction mechanism of phenolic antioxidants
Citric acid as antioxidant

- Chelating agent to bind metal ions which act as catalyst in the oxidation of lipids
- Increases the effectiveness (synergistic action) with other antioxidants
- Helps to give a fresh taste sensation

\[
\begin{align*}
\text{HO-C-COOH} \\
\text{CH}_2 \\
\text{COOH}
\end{align*}
\]
Ascorbic acid (Vitamin C)  A multifunctional additive

- Nutritive additive: as vitamin C to fortified foods
- As reducing agent (nitrosamine)
- As antioxidant (lipid oxidation)
- As antioxidant (colour retention)
Ascorbic acid

- As a reducing agent to prevent the formation of N-nitrosamine (亞硝胺)

*Figure 9-25 Reaction Between Nitrous Acid and Ascorbic Acid. Source: From M.L. Liao and P.A. Seib, Selected Reactions of L-Ascorbic Acid Related to Foods, *Food Technol.*, Vol. 41, no. 11, pp. 104-107, 1987.*
Ascorbic acid (Color retention agent)

- As a reducing agent to prevent enzymic browning and discoloration in vegetables and fruit products by reduction of initial browning product back to the substrate and thus prevent melanin (brown pigment) formation.

Figure 9-26 Reduction of Ortho-Quinone by Ascorbic Acid During Enzymic Browning. Source: From M.L. Liao and P.A. Seib, Selected Reactions of L-Ascorbic Acid Related to Foods, Food Technol., Vol. 41, no. 11, pp. 104–107, 1987.
Applications and Types of Food Additives

To enhance sensory characteristics by

• Colouring agents – natural and synthetic

• Flavouring agents
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* Identical with the functional classes of additive for the purpose of sub-paragraph (5) of Schedule 3 – Marking and Labeling of Prepackaged Foods in CAP 132W Food and Drugs (Composition and Labeling) Regulations of Hong Kong Laws (L.N. 85 of 2004)
<table>
<thead>
<tr>
<th>Name</th>
<th>EEC</th>
<th>United States</th>
<th>Canada</th>
<th>Japan</th>
<th>Hong Kong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythrosine</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Brilliant blue FCF</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Indigotine</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Tartrazine</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Quinoline yellow</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Allura red</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Sunset Yellow FCF</td>
<td>+</td>
<td>GRAS</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ponceau 4R</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Carmoisine</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Amaranth</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Red 2G</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Patent blue</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Green S</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Brown FK</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Chocolate brown HT</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Black PN</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

a +, Permitted for food use, (in some countries limited to specific foods); - prohibited for food use.
b No synthetic colorants permitted in Norway. c Permitted in Denmark, Ireland, Netherlands. d Not permitted in Finland.
e Not permitted in Portugal. f Permitted in Ireland only. g Not permitted in Sweden. h Permitted in Ireland and Netherlands

*Legislative amendment to remove Red 2G from the list of permitted colouring matter is underway in Hong Kong
Certified color dyes

Chemical structures: extensively conjugated system

Dye types: triphenylmethane, indigo, xanthine and azo compounds

Water solubility: applications in food with better uniformity

Fig. 4.18. Chemical structures of certified color dyes.
Certified color additives versus natural color pigments

- synthetic colors having higher coloring strength,
- stability and
- uniform standardization
Flavor enhancers

- Stimulate perception of a flavor already in food versus flavoring agents which are added to a substance to enhance flavor
- Umami as a unique primary taste/not a mixture of any of the four primary tastes (sweet, salty, sour and bitter)
- Glutamic acid as monosodium glutamate (MSG): D-form is inert and L-form is naturally occurring with flavor-enhancing effect; produced from hydrolysate of proteins contain 16% or more glutamic acid (e.g. wheat gluten 36%; casein 22%; corn gluten 24.5%) by either chemical (HCl) or wholly/partial enzymic hydrolysis
- 5’-nucleotides (5’-inosinate - IMP) produced by enzymic degradation of yeast RNA or manufacture of nucleosides by fermentation followed by chemical phosphorylation
- Other nucleotides include adenosine monophosphate (AMP), disodium 5’-guanylate (GMP), and disodium xanthylate (XMP)
Applications and Types of Food Additives

To control product consistency by

- Emulsifiers
- Stabilizers and thickeners
- pH control agents
- Anti-caking agents
# Functional Classes of Food Additives in International Numbering System (INS)*

<table>
<thead>
<tr>
<th>Functional Classes</th>
<th>Definition</th>
<th>Sub-Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Acidity regulator</td>
<td>Alters or controls the acidity or alkalinity of a food</td>
<td>Acid, alkali, base, buffer, buffering agent, pH adjusting agent</td>
</tr>
<tr>
<td>(酸度調節劑)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Emulsifier</td>
<td>Forms or maintains a uniform mixture of two or more immiscible phases such as oil and water in a food</td>
<td>Emulsifier, plasticizer, dispersing agent, surface active agent, surfactant, wetting agent</td>
</tr>
<tr>
<td>(乳化劑)</td>
<td>Rearranges cheese proteins in the manufacture of processed cheese, in order to prevent fat separation</td>
<td>Melding salt, sequestrant</td>
</tr>
<tr>
<td>10. Emulsifying salt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(乳化鹽)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Stabilizer</td>
<td>Makes it possible to maintain a uniform dispersion of two or more immiscible substances in a food</td>
<td>Binder, firming agent, moisture/water retention agent, foam stabilizer</td>
</tr>
<tr>
<td>(穩定劑)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Thickener</td>
<td>Increases the viscosity of a food</td>
<td>Thickening agent, texturizer, bodying agent</td>
</tr>
<tr>
<td>(增稠劑)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Identical with the functional classes of additive for the purpose of sub-paragraph (5) of Schedule 3 – Marking and Labeling of Prepackaged Foods in CAP 132W Food and Drugs (Composition and Labeling) Regulations of Hong Kong Laws (L.N. 85 of 2004)
## Selective Mineral Compounds Used as Food Additives

<table>
<thead>
<tr>
<th>Chemical Name of Compound and (INS)</th>
<th>Synonyms or Other Chemical Name</th>
<th>Functional Class and Comments</th>
<th>ADI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium alginate (404)</td>
<td>Calcium alginate</td>
<td>Thickening agent; stabilizer</td>
<td>“not specified”</td>
</tr>
<tr>
<td>Calcium ascorbate (302)</td>
<td>Calcium ascorbate dihydrate</td>
<td>Antioxidant</td>
<td>“not specified”</td>
</tr>
<tr>
<td>Calcium citrate (333)</td>
<td>Tricalcium citrate; tricalcium salt of beta hydroxytricarballylic acid</td>
<td>Acidity regulator; firming agent; sequestrant</td>
<td>“not specified”</td>
</tr>
<tr>
<td>Calcium hydrogen carbonate (170ii)</td>
<td>Calcium hydrogen carbonate</td>
<td>Surface colorant; anticaking agent; stabilizer</td>
<td>“not specified”</td>
</tr>
<tr>
<td>Sodium iron III-ethylenediamine tetraacetate trihydrate</td>
<td>Ferric sodium edeteate; sodium iron EDTA; sodium feredetate</td>
<td>Nutrient supplement (provisionally considered to be safe in food fortification programs</td>
<td>acceptable level of treatment</td>
</tr>
</tbody>
</table>
Food uses of phosphates

- Leavening acids
  \[ \text{Ca}(\text{H}_2\text{PO}_4)\text{H}_2\text{O} + \text{H}_2\text{O} \leftrightarrow \text{CaHPO}_4\cdot2\text{H}_2\text{O} + \text{H}_3\text{PO}_4 \]
- Flour conditioners
- Dough improvers
- pH adjusters (buffering and acidifying)
- Source of calcium for gelling control
- Mineral enrichment
- Anticaking/Free flow agent (tricalcium phosphate)
- Yeast food
Application of food additives in ice cream
Processes in manufacturing ice cream:
Stabilizers in Ice cream

- Maltodextrin, Cellulose Gel, Guar Gum

Level of general use

- Varies from 0.15-0.35%
  (More total solids, less for stabilizer)

Functions in ice cream

1. To stabilize the emulsion to prevent creaming of fat
2. To stabilize the air bubbles and to hold the flavorings
3. To provide some body and mouth-feel without being gummy
Effect of stabilizers on size of ice crystals in ice cream

![Bar graph showing the effect of stabilizers on ice crystal size over time. The x-axis represents time in weeks (0, 3, 2), and the y-axis represents maximum diameter in micrometers (µm). The graph compares control and stabilized samples, with error bars indicating variability.]
Effect of stabilizer on the re-crystallization of ice cream

With Stabilizer

Without Stabilizer
Emulsifiers in Ice cream

- Mono- and diglycerides

Level of general use

- Varies from 0.10-0.15%
  (High fat levels in a mix, less need for emulsifier)

Function in ice cream

Developing the appropriate fat structure and air distribution necessary for the smooth eating and good meltdown characteristics desired in ice cream
Action of Emulsifier

→ Decrease of interfacial tension

→ Increase the stability of emulsion
FAT STRUCTURE IN ICE CREAM

- Homogenized fat globules with appropriate membrane in ice cream mix.
- Freezing mix into ice cream.
- Fat globules "partially coalesce" or destabilize.
- Air bubble.
- Fat globules move to air interface during foaming of mix.

Resulting 3-dimensional structure of fat and air in ice cream.
Fat replacers in ice cream

- Cellulose Gel

Level of general use

- Depends on type of ice cream (High level in low-fat ice cream)

Function in ice cream

To replace fat content maintaining fat-like functional properties:

1. Creaminess
2. Fat-like mouth-feel
3. Stability
4. Texture modification
5. Increased viscosity
6. Glossy appearance of high fat emulsions
Body and Texture Defects

- Insufficient or poor stabilizer / emulsifier

1. Coarse/Icy Texture

2. Weak Body: Ice cream lacks "chewiness" and melts quickly into a watery liquid

3. Crumbly Body: A flaky or snowy characteristic

4. Fluffy Texture: A spongy characteristic

- Too much stabilizer

1. Gummy Body: This defect is the opposite of Crumbly in that it imparts a pasty or putty-like body
Toxicological aspects of food and food additives
Toxic Chemicals in Foods

• Natural
  – Normal components of natural food products
  – Natural contaminants of natural food products
    • Microbiological origin: toxins
    • Non-microbiological origin: toxicants (e.g. Hg, Se) consumed in feeds by animals used as food sources
Toxic Chemicals in Foods

• Man-made
  – Agricultural chemicals (e.g. pesticides, fertilizers)
  – Food additives
  – Chemicals derived from food packaging materials
  – Chemicals produced in processing of foods (e.g. by heat, ionizing radiation, smoking)
  – Inadvertent or accidental contaminants
    • Food preparation accidents or mistakes
    • Contamination from food utensils
    • Environmental pollution
    • Contamination during storage or transport
Recent incidents on the abusive use of additives and presence of contaminants in HK

• Heavy metals in dried oysters (Jan 2008 18th Issue)
• Sulphur dioxide in meat (Dec 2007 17th Issue)
• Trans fat in foods (Nov 2007 16th Issue)
• Preservatives in dried fruits and pickled vegetables (Oct 2007 15th Issue)
• Leanness-enhancing agents (ractopamine) in pork (Sep 2007 14th Issue)
• Organic contaminants (DDT, PCBs, and PBDEs) in local mussels (Sep 2007 14th Issue)
• Sudan dye in rice dumplings (Jul 2007 12th Issue)
• Paralytic shellfish poisoning (PSP toxins) (Jun 2007 11th Issue)
• Arsenic in dried squid snacks (May 2007 10th Issue) and fish (*Cololabis saira*) (Oct 2006 3rd Issue)
• Cadmium in dried oysters (Mar 2007 8th Issue)
• Oilfish consumption and oily diarrhoea (Feb 2007 7th Issue)
• Formaldehyde in food (Jan 2007 6th Issue)
• Non-permitted sweetener (Stevioside) used in snack food (Jan 2007 6th Issue)
• Veterinary drug residues (Nitrofurans) in marine fish (Dec 2006 5th Issue)
• Synthetic dye for industrial use (Malachite Green) in freshwater fish (Dec 2006 5th Issue)
• Pesticide residues (Endosulfan) in live eels (Sep 2006 2nd Issue)

Reference: Food Safety Focus, Centre for Food Safety
Application of the Carry-Over Principles of Food Additives

The presence of an additive in food is generally permitted if:

- The additive is permitted in the raw materials or other ingredients by an applicable Codex Standard or under any other acceptable provision which takes into account the safety aspects of food additives;
- The amount of the additive in the raw materials or other ingredients does not exceed the maximum amount so permitted;
- The food into which the additive is carried over does not contain the food additive in greater quantity than would be introduced by the use of the ingredients under proper technological conditions or manufacturing practice;
- The food additive carried over is present at a level which is non-functional, i.e., at a level significantly less than that normally required to achieve an efficient technological function in its own right in the food.
Toxicological terms (1)

ADI (Acceptable Daily intake)
• acceptable daily intake; estimate of the amount of a substance in food or drinking water, expressed on a body weight basis, for a standard human weight of 60 kg, that can be ingested daily over a lifetime without appreciable risk for health.

Toxicological terms (2)

• ADI “not specified”
  – A term applicable to a food substance of very low toxicity which, on the basis of the available data (chemical, biochemical, toxicological, and other), the total dietary intake of the substance arising from its use at the levels necessary to achieve the desired effect and from its acceptable background in food does not, in the opinion of JECFA, represent a hazard to health. For that reason, and for reasons stated in individual evaluations, the establishment of an acceptable daily intake expressed in numerical form is not deemed necessary. An additive meeting this criterion must be used within the bounds of good manufacturing practice (GMP), i.e., it should be technologically efficacious and should be used at the lowest level necessary to achieve this effect, it should not conceal inferior food quality or adulteration, and it should not create a nutritional imbalance.
Future Development on Additives

• Food safety: not only an issue of protection, but also maintenance and promotion of health (e.g. antioxidants, dietary fiber)

• Measuring intake of additives (calculation vs. direct/biomarker/metabolite studies)

• Reducing the level of additives (preservatives/colors/sweeteners) requires special processing/packaging/instructions to consumers
Reference Materials (overseas)

- Code of Federal Regulations 21. Food and Drug Administration Parts 100-199 (Revised annually)
  http://www.gpoaccess.gov/cfr/index.html

- Codex Alimentarius
  http://www.codexalimentarius.net/web/members.jsp?lang=EN

- Compendium of Food Additives Specifications FAO Food and Nutrition Paper 52 and addenda 1 to 8.

- EU Directives
  http://www.ciaa.be

- Food Additives in the European Union
  http://www.foodlaw.rdg.ac.uk/additive.htm

- Joint Expert Committee on Food Additives (JECFA)

- Scientific Committee on Food.
  http://europa.eu.int/comm/food/fs/sc/scf/index_en.html
Reference Materials (local)

- Centre for Food Safety, FEHD, HKSAR Government
  http://www.cfs.gov.hk
- Hong Kong Laws Chapter 132 PUBLIC HEALTH AND MUNICIPAL SERVICES ORDINANCE
- Choice Magazine and Consumer Council
  http://choice.yp.com.hk
  http://www.consumer.org.hk