Additives
Most chemicals in our food are there naturally

• Intentional Additives = additives or ingredients added directly and intentionally for their beneficial effects – salt, sugar, processing aids, preservatives, vitamin and mineral supplements

• Unintentional Additives = get into food “by mistake”. Microbes and toxins, lubricants, detergents, drug/pesticide residues, environmental contaminants.
Exhibit 11–1 Toxic Chemicals in Foods

**NATURAL**

- normal components of natural food products
- natural contaminants of natural food products
  - microbiological origin: toxins
  - nonmicrobiological origin: toxicants (e.g., Hg, Se) consumed in feeds by animals used as food sources

**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
Risky “Additives” in decreasing order by risk

• Pathogenic microbes (bacteria, viruses, parasites)
• Naturally occurring toxins (aflatoxin, marine biotoxins, etc)
• Naturally occurring anti-nutritional factors
• Allergens
• Pesticide residues and their metabolites
• Drug residues and their metabolites
• Environmental contaminants (from pollution)
• Intentional additives (used at higher than approved levels)
Figure 11-18 Formation of Goitrin and Isothiocyanates from Glucosinolates in Cruciferous Products.

Figure 11-15 Chemical Structure of Some Polycyclic Aromatic Hydrocarbons
Aspartame – 7.5-13 mg/Kg/d presume 70 Kg person

• On can soda- 190 mg or 2.7 mg/Kg/day
• 5 cans per day – 13.5 mg
Categories and Functions of Intentional Ingredients

1. Add bioactive compounds
2. Maintain palatability and wholesomeness
3. Enhance appeal-sensory characteristics
4. Leavening agents
5. pH control
6. Processing aids
Add bioactive compounds

- Vitamins and minerals
- Bioactive agents (antioxidants, plant sterols)
- Stimulants
Figure 11-19 The Structure of Caffeine 1,3,7-Trimethylxanthine
2. Maintain palatability and wholesomeness

- *Antimicrobials* – nisin, benzoates, sorbate, salt
- *Antioxidants* – BHA, BHT, vitamin E, Vitamin C
- *Antibrowning agents* - sulfite, EDTA, acidulants
Table 11-1 Applications of Sorbates as Antimicrobial Agents

<table>
<thead>
<tr>
<th>Products</th>
<th>Levels (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy products: aged cheeses, processed cheeses, cottage cheese, cheese spreads, cheese dips, sour cream, yogurt</td>
<td>0.05–0.30</td>
</tr>
<tr>
<td>Bakery products: cakes, cake mixes, pies, fillings, mixes, icings, fudges, toppings, doughnuts</td>
<td>0.03–0.30</td>
</tr>
<tr>
<td>Vegetable products: fermented vegetables, pickles, olives, relishes, fresh salads</td>
<td>0.02–0.20</td>
</tr>
<tr>
<td>Fruit products: dried fruit, jams, jellies, juices, fruit salads, syrups, purees, concentrates</td>
<td>0.02–0.25</td>
</tr>
<tr>
<td>Beverages: still wines, carbonated and noncarbonated beverages, fruit drinks, low-calorie drinks</td>
<td>0.02–0.10</td>
</tr>
<tr>
<td>Food emulsions: mayonnaise, margarine, salad dressings</td>
<td>0.05–0.10</td>
</tr>
<tr>
<td>Meat and fish products: smoked and salted fish, dry sausages</td>
<td>0.05–0.30</td>
</tr>
<tr>
<td>Miscellaneous: dry sausage casings, semim腥t pet foods, confectionery</td>
<td>0.05–0.30</td>
</tr>
</tbody>
</table>

Figure 11–3 Chemical Structure of the Active Antioxidant Principles in Rosemary
3. Enhance appeal-sensory characteristics

- **Flavors** – spices, natural extracts, artificial flavors
- **Flavor enhancers** – MSG, protein hydrolysates, yeast autolysate, nucleic acids
- **Sweeteners** – sugar, artificial sweeteners, sugar alcohols
- **Colorants** – natural and artificial
- **Texturizing agents** – emulsifiers (lecithin, egg yolk), stabilizers (gums, starch),
- **Water binding agents** – humectants like sorbitol, sugar, milk powder
- **Thickeners** – gums
Figure 11–4 Chemical Structure of Sodium Saccharin, Sodium Cyclamate, Cyclohexylamine, and Acesulfame K
<table>
<thead>
<tr>
<th>Colorant</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthocyanins</td>
<td>Grape skins, elderberries</td>
</tr>
<tr>
<td>Betalains</td>
<td>Red beets, chard, cactus fruits, pokeberries, bougainvillea, amaranthus</td>
</tr>
<tr>
<td>Caramel</td>
<td>Modified sugar</td>
</tr>
<tr>
<td>Carotenoids</td>
<td></td>
</tr>
<tr>
<td>Anatto (bixin)</td>
<td>Seeds of <em>Bixa orellana</em></td>
</tr>
<tr>
<td>Canthaxanthin</td>
<td>Mushrooms, crustaceans, fish, seaweed</td>
</tr>
<tr>
<td>β-apocarotenal</td>
<td>Oranges, green vegetables</td>
</tr>
<tr>
<td>Chlorophylls</td>
<td>Green vegetables</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>Milk</td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Carmine (cochineal extract)</td>
<td><em>Coccus cati</em> insect</td>
</tr>
<tr>
<td>Turmeric (curcuma)</td>
<td><em>Curcuma longa</em></td>
</tr>
<tr>
<td>Crocetin, crocin</td>
<td>Saffron</td>
</tr>
</tbody>
</table>

Exhibit 11-2 Color Additives Permitted for Food Use in the United States and Their Common Names

- FD&C red no. 3 (erythrosine)
- FD&C red no. 40 (allura red)
- FD&C orange B
- FD&C yellow no. 6 (sunset yellow)
- FD&C yellow no. 5 (tartrazine)
- FD&C green no. 3 (fast green)
- FD&C blue no. 1 (brillian blue)
- FD&C blue no. 2 (indigotine)
- Citrus red no. 2

4. Leavening agents

- Yeast
- Baking powder
5. pH control

- Acids – citric, lactic, malic, lemon juice, phosphoric
- Bases – phosphate salts
<table>
<thead>
<tr>
<th>Property</th>
<th>Acetic Acid</th>
<th>Adipic Acid</th>
<th>Citric Acid</th>
<th>Fumaric Acid</th>
<th>Gluconolactone</th>
<th>Lactic Acid</th>
<th>Malic Acid</th>
<th>Phosphoric Acid</th>
<th>Tartaric Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>CH₃COOH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empirical formula</td>
<td>C₂H₄O₂</td>
<td>C₆H₁₀O⁴</td>
<td>C₆H₈O₇</td>
<td>C₄H₄O₄</td>
<td>C₃H₁₀O₆</td>
<td>C₃H₆O₃</td>
<td>C₄H₆O₅</td>
<td>H₃PO₄</td>
<td>C₄H₆O₆</td>
</tr>
<tr>
<td>Physical form</td>
<td>Oily Liquid</td>
<td>Crystalline</td>
<td>Crystalline</td>
<td>Crystalline</td>
<td>Crystalline 85% Water Solution</td>
<td>Crystalline</td>
<td>Crystalline</td>
<td>85% Water Solution</td>
<td>Crystalline</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>60.05</td>
<td>146.14</td>
<td>192.12</td>
<td>116.07</td>
<td>178.14</td>
<td>90.08</td>
<td>134.09</td>
<td>82.00</td>
<td>150.09</td>
</tr>
<tr>
<td>Equivalent weight</td>
<td>60.05</td>
<td>73.07</td>
<td>64.04</td>
<td>58.04</td>
<td>178.14</td>
<td>90.08</td>
<td>67.05</td>
<td>27.33</td>
<td>75.05</td>
</tr>
<tr>
<td>Sol. in water (g/100 mL solv.)</td>
<td>∞</td>
<td>1.4</td>
<td>181.00</td>
<td>0.83</td>
<td>59.0</td>
<td>∞</td>
<td>144.0</td>
<td>∞</td>
<td>147.0</td>
</tr>
<tr>
<td>Ionization constants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$K_1$</td>
<td>$8 \times 10^{-5}$</td>
<td>$3.7 \times 10^{-5}$</td>
<td>$8.2 \times 10^{-4}$</td>
<td>$1 \times 10^{-3}$</td>
<td>$2.5 \times 10^{-4}$ (gluconic acid)</td>
<td>$1.37 \times 10^{-4}$</td>
<td>$4 \times 10^{-4}$</td>
<td>$7.52 \times 10^{-3}$</td>
<td>$1.04 \times 10^{-3}$</td>
</tr>
<tr>
<td>$K_2$</td>
<td>$2.4 \times 10^{-6}$</td>
<td>$1.77 \times 10^{-5}$</td>
<td>$3 \times 10^{-5}$</td>
<td>$9 \times 10^{-8}$</td>
<td>$6.23 \times 10^{-6}$</td>
<td>$5.55 \times 10^{-8}$</td>
<td>$3 \times 10^{-10}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$K_3$</td>
<td>$3.9 \times 10^{-6}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Processing aids

- Moisture control – phosphate salts,
- Filtration aids – diatomaceous earth
- Anticaking – silica gel, Ca phosphate
- Enzymes – filtration aid or clarification
- Emulsifiers and defoamers (lecithin, oils)