

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)

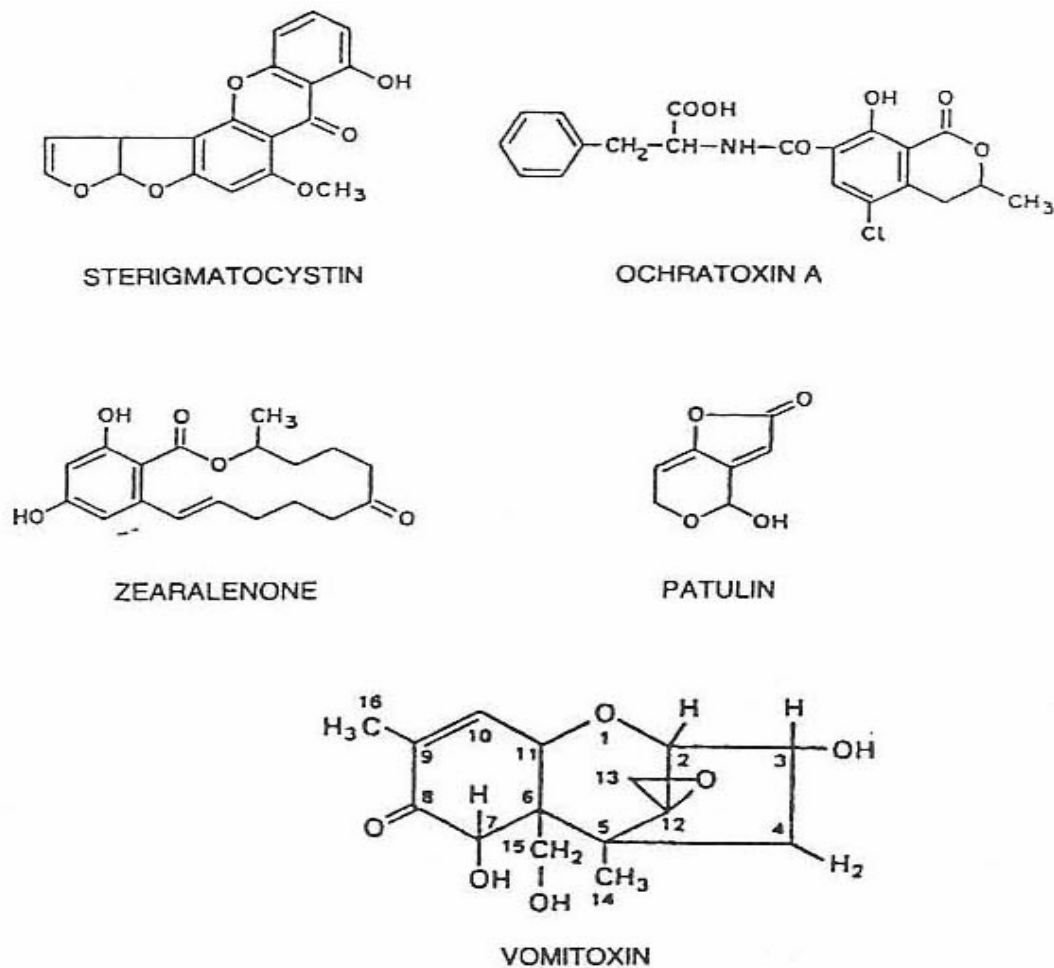


Figure 11-17 Chemical Structures of Sterigmatocystin, Ochratoxin A, Zearalenone, Deoxynivalenol (Vomitoxin), and Patulin. *Source:* From P.M. Scott, The Analysis of Foods for Aflatoxins and Other Fungal Toxins: A Review, *Can. Inst. Food Technol. J.*, Vol. 2, pp. 173-177, 1969; P.M. Scott et al., Effects of Experimental Flour Milling and Breadbaking on Retention of Deoxynivalenol (Vomitoxin) in Hard Red Spring Wheat, *Cereal Chem.*, Vol. 60, pp. 421-424, 1983.

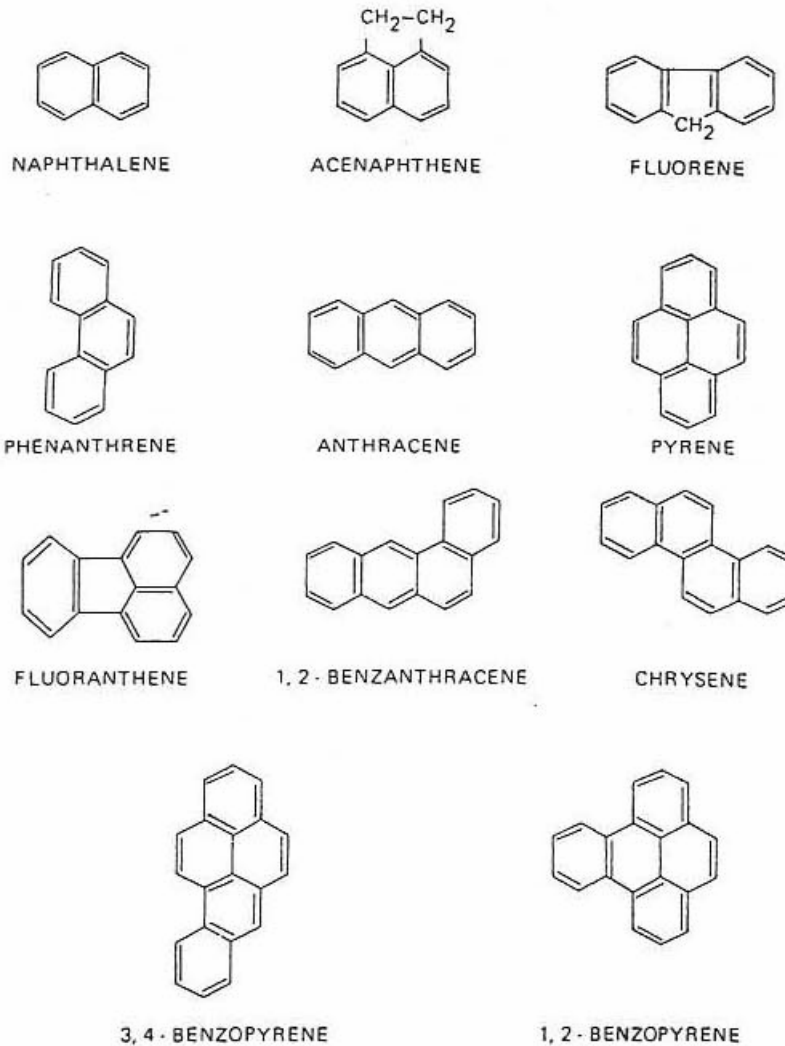


Figure 11-15 Chemical Structure of Some Polycyclic Aromatic Hydrocarbons

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

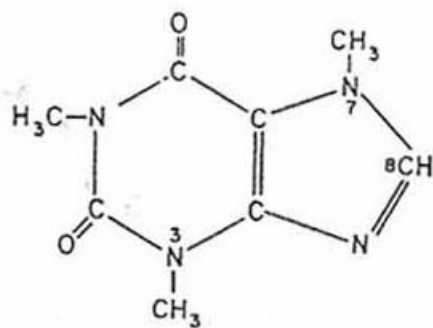


Figure 11–19 The Structure of Caffeine 1,3,7- Trimethylxanthine

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

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

Source: Reprinted with permission from J.N. Sofos and F.F. Busta, Sorbic Acid and Sorbates, in *Antimicrobials in Foods*, P.M. Davidson and A.L. Branen, eds., p. 62, 1993, by courtesy of Marcel Dekker, Inc.

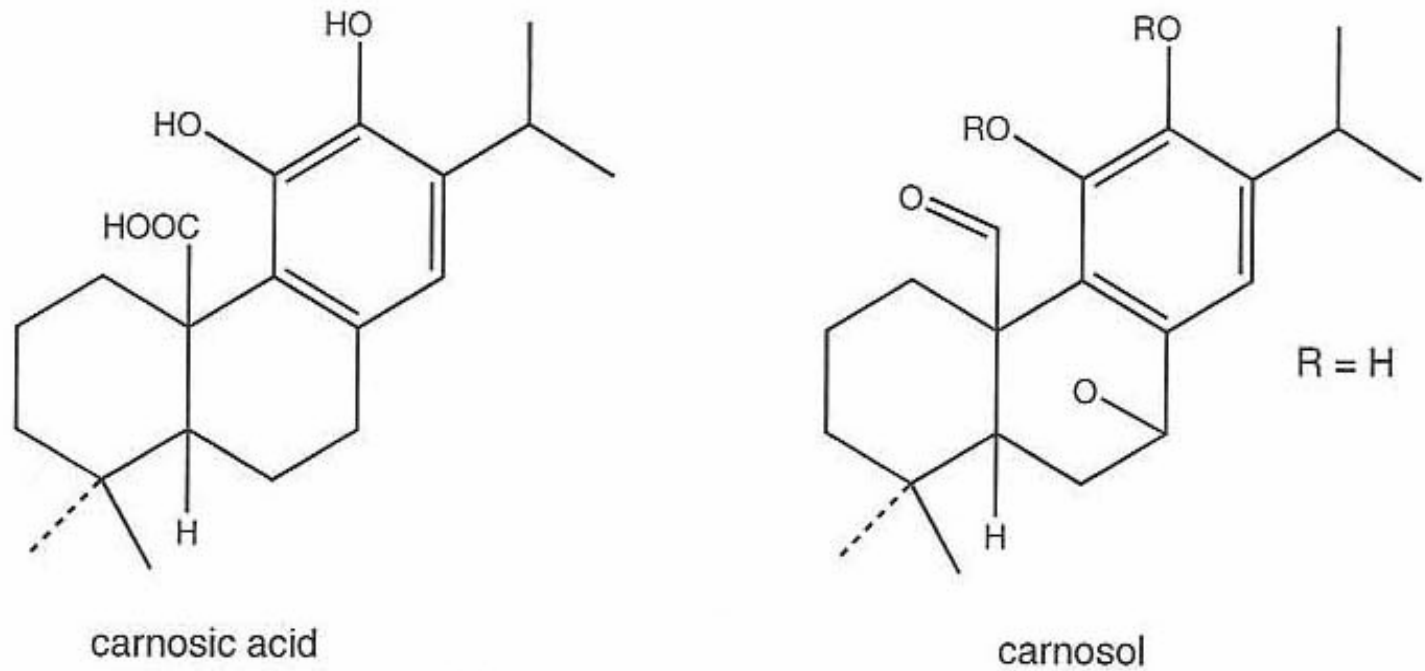
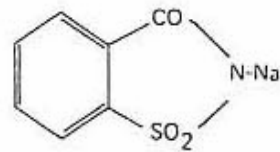


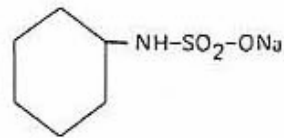
Figure 11-3 Chemical Structure of the Active Antioxidant Principles in Rosemary

3. Enhance appeal-sensory characteristics

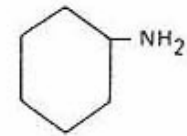
- *Flavors* –spices, natural extracts, artificial flavors
- *Flavor enhancers* – MSG, protein hydrolysates, yeast autolysate, nucleic acids
- *Sweetners* – sugar, artificial sweeteners, sugar alcohols
- *Colorants* – natural and artificial
- *Texturizing agents* – emulsifiers (lecithin, egg yolk), stabilizers (gums, starch),
- *Water binding agents* – humectants like sorbitol, sugar, milk powder
- *Thickeners* – gums



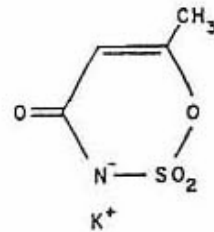
Na-Saccharin



Na-cyclamate



cyclohexylamine



Acesulfame K

Figure 11-4 Chemical Structure of Sodium Saccharin, Sodium Cyclamate, Cyclohexylamine, and Acesulfame K

Table 11–5 Major Categories of Natural Food Colors and Their Sources

<i>Colorant</i>	<i>Sources</i>
Anthocyanins	Grape skins, elderberries
Betalains	Red beets, chard, cactus fruits, pokeberries, bougainvillea, amaranthus
Caramel	Modified sugar
Carotenoids	
Annatto (bixin)	Seeds of <i>Bixa orellana</i>
Canthaxanthin	Mushrooms, crustaceans, fish, seaweed
β -apocarotenal	Oranges, green vegetables
Chlorophylls	Green vegetables
Riboflavin	Milk
Others	
Carmine (cochineal extract)	<i>Coccus catti</i> insect
Turmeric (curcuma)	<i>Curcuma longa</i>
Crocin, crocin	Saffron

Source: Reprinted with permission from R.L. Newsome, Natural and Synthetic Coloring Agents, in *Food Additives*, A.L. Branen, P.M. Davidson, and S. Salminen, eds., p. 333, 1990, by courtesy of Marcel Dekker, Inc.

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 (brilliant blue)
- FD&C blue no. 2 (indigotine)
- Citrus red no. 2

Source: Reprinted with permission from R.L. Newsome, Natural and Synthetic Coloring Agents, in *Food Additives*, A.L. Branen, P.M. Davidson, and S. Salminen, eds., p. 344, 1990, by courtesy of Marcel Dekker, Inc.

4. Leavening agents

- Yeast
- Baking powder

5. pH control

- Acids – citric, lactic, malic, lemon juice, phosphoric
- Bases – phosphate salts

Table 11-4 Properties of Some Common Food Acids

Property	Acetic Acid	Adipic Acid	Citric Acid	Fumaric Acid	Glucono-Delta-Lactone	Lactic Acid	Malic Acid	Phosphoric Acid	Tartaric Acid
Structure	CH ₃ COOH	$\begin{array}{c} \text{COOH} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COOH} \end{array}$	$\begin{array}{c} \text{COOH} \\ \\ \text{CH}_2 \\ \\ \text{HO}-\text{C}-\text{COOH} \\ \\ \text{CH}_2 \\ \\ \text{COOH} \end{array}$	$\begin{array}{c} \text{HOOCCH} \\ \\ \text{HCCOOH} \end{array}$	$\begin{array}{c} \text{O}=\text{C} \\ \\ \text{HCOH} \\ \\ \text{HOCH} \\ \\ \text{HCOH} \\ \\ \text{HC} \\ \\ \text{CH}_2\text{OH} \end{array}$	$\begin{array}{c} \text{CH}_3 \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{COOH} \end{array}$	$\begin{array}{c} \text{COOH} \\ \\ \text{HO}-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{COOH} \end{array}$		$\begin{array}{c} \text{COOH} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{HO}-\text{C}-\text{H} \\ \\ \text{COOH} \end{array}$
Empirical formula	C ₂ H ₄ O ₂	C ₆ H ₁₀ O ₄	C ₆ H ₈ O ₇	C ₄ H ₄ O ₄	C ₆ H ₁₀ O ₆	C ₃ H ₆ O ₃	C ₄ H ₆ O ₅	H ₃ PO ₄	C ₄ H ₆ O ₆
Physical form	Oily Liquid	Crystalline	Crystalline	Crystalline	Crystalline	85% Water Solution	Crystalline	85% Water Solution	Crystalline
Molecular weight	60.05	146.14	192.12	116.07	178.14	90.08	134.09	82.00	150.09
Equivalent weight	60.05	73.07	64.04	58.04	178.14	90.08	67.05	27.33	75.05
Sol. in water (g/100 mL solv.)	∞	1.4	181.00	0.63	59.0	∞	144.0	∞	147.0
Ionization constants									
K ₁	8 × 10 ⁻⁵	3.7 × 10 ⁻⁵	8.2 × 10 ⁻⁴	1 × 10 ⁻³	2.5 × 10 ⁻⁴ (gluconic acid)	1.37 × 10 ⁻⁴	4 × 10 ⁻⁴	7.52 × 10 ⁻³	1.04 × 10 ⁻³
K ₂		2.4 × 10 ⁻⁶	1.77 × 10 ⁻⁵	3 × 10 ⁻⁵			9 × 10 ⁻⁶	6.23 × 10 ⁻⁸	5.55 × 10 ⁻⁵
K ₃			3.9 × 10 ⁻⁶					3 × 10 ⁻¹³	

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)