Principles of Food Science

by Janet D. Ward

Fourth Edition

G-W Publisher

The Goodheart-Willcox Co., Inc.
Tinley Park, Illinois
Chapter 14

• Phytochemicals:
• The Other Food Components
Objectives

• **List** at least eight groups of phytochemicals and give a food source for each group.

• **Identify** possible links between phytochemicals and disease prevention.

• **Describe** ways in which food processing can affect the phytochemicals in foods.

• **Plan** menus that are rich in phytochemicals.
Phytochemicals are a group of compounds originally produced by plants. These compounds help plants resist disease, pests, and extreme weather. They are found naturally in vegetables, fruits, grains, herbs, and spices. They give foods their colors and flavors.
Phytochemical Families: Allyl Sulfides

- **Allyl sulfides** are a group of compounds that contain sulfur and increase enzyme reactions.
- These sulfides:
  - may kill bacteria, fungi, and viruses.
  - are involved in enzyme reactions that rid the body of cancer-causing **carcinogens**.
  - are found in onions, garlic, leeks, and chives.
Phytochemical Families: Carotenoids

- **Carotenoids** act as antioxidants, changing harmful free radicals into harmless compounds
  - Many are used as precursors for vitamin A
  - They usually have a 40-carbon chain with a ring shape at either end
- Carotenoids are fat soluble
Phytochemical Families: Carotenoids

- Carotenoids appear to
  - reduce tissue damage that can lead to cancer cell formation
  - enhance the immune system
  - maintain healthy eye tissue and reduce the risk of age-related eye diseases

- The 2 subgroups are
  - carotenes
  - xanthophylls
Carotenes

- **Alpha-carotene** is in pumpkins and carrots
- **Beta-carotene** is found in dark green and yellow vegetables
- **Beta-cryptoxanthin** is in papayas, oranges, and tangerines
- **Lycopene** may reduce prostate cancer and
  - is found in tomato products, watermelon, guava, and red peppers
  - is not destroyed during cooking
Xanthophylls

- These compounds have a hydroxyl group
  - Lutein and zeaxanthin may help eyes filter out harmful blue light
- They are found in dark leafy greens
Phytochemical Families: Flavonoids

- **Flavonoids** are responsible for the flavor characteristics of foods
  - They may help fight cancer and reduce the risk of heart disease and stroke
  - *Quercetin* has antifungal, anti-inflammatory, antiviral, and antibacterial properties
  - They are found in dark chocolate, apples, blueberries, red onions, cranberries, and tea
Isoflavonoids

- **Isoflavones** are a subgroup of flavonoids found mainly in soy products and legumes
  - They have a hexagonal carbon ring structure
  - They are also called **phytoestrogens**, or plant hormones
  - Licorice, chickpeas, Chinese cabbage, bok choy, and many processed foods are sources
Phytochemical Families: Indoles

- **Indoles** are found in large amounts in broccoli, cabbage, kale, and cauliflower, the *cruciferous vegetables*

- The indoles
  - stimulate many enzymatic reactions such as the breakdown of estrogen
  - become more available when vegetables are cooked
Isothiocyanates are a subgroup of indoles that
- protect against cancer by affecting enzyme reactions
- are found in cruciferous vegetables
- are the source for the aromas in Brussel sprouts, cabbage, turnips, mustard greens, watercress, and radishes
Phytochemical Families: Phenolic Acids

- **Phenolic acids** or **phenols** are weak organic acids that have a hydroxyl group attached to an aromatic ring
  - Ellagic acid has been found to reduce damage to lungs from tobacco smoke and pollution
  - Berries, citrus fruits, tomatoes, carrots, whole grains, and nuts are sources
Phytochemical Families: Phenolic Acids

- **Polyphenols** are phenolic acids with more than one carbon ring
- This phytochemical family may reduce risk of some cancers and heart disease
  - They are found in tea, grape products, barley, rosemary, sunflower seeds, and apples
Phytochemical Families: Saponins

- **Saponins** are molecules formed from a sugar reacting with an alcohol
- This phytochemical family
  - appears to block DNA reproduction in cancer cells by interfering with enzyme reactions
  - forms a soapy foam with a bitter taste
  - is in spinach, potatoes, tomatoes, beans, soybeans, sugar beets, and legumes
Phytochemical Families: Terpenes

- **Terpenes** are responsible for the flavors of citrus fruits and many herbs and seasonings
  - They appear to block the formation of cancer cells and the development of tumors
  - Terpenes are in citrus peel (zest) and cherries
  - Best known is *taxol*, which can be produced in a laboratory and is used to treat ovarian cancer
Phytochemicals: Maintaining Food Colors

- Carotenoids are responsible for yellow, orange, and red pigments in fruits and vegetables
  - When carotenoids are present with chlorophyll, a green color is visible
- Carotenoids may become isomers when they change in chemical structure, but remain the same compound
Phytochemicals: Maintaining Food Colors

- Lycopene gives tomatoes their red color
  - It reduces the risk of cancers in reproductive tissue, enhances the immune system, and slows the aging process of certain body tissues
- Flavonoids in red cabbage change color as acids evaporate during cooking
  - Vinegar is therefore added to many recipes
Phytochemicals: Maintaining Food Colors

- Flavonoids change color in the presence of iron or tin
  - Foods high in flavonoids should be stored in glass, plastic, or stainless steel containers
- Tea turns cloudy when flavonoids bind with minerals in hard water
  - An acid such as lemon juice is added to dissolve these compounds
Phytochemicals: Maintaining Food Flavors

- Allyl sulfides are released when onions or garlic are chopped
  - Cooking results in a milder flavor
- Isothiocyanate flavor compounds in Brussels sprouts and cabbage strengthen after cooking
- The astringency of polyphenols affects the flavor of tea, grape juice, and wines
Phytochemicals: Maintaining Food Flavors

- **Tannins** are polyphenols that cloud liquids, especially beer and apple juice
  - Adding gelatin makes the tannins settle faster for filtering
Preserving Phytochemicals

- Fresh produce has a lower phytochemical content if picked before ripening
- Ways to maximize phytochemical content include
  - rapid freezing after harvest
  - developing new breeds of plants that form phytochemicals before harvest
Preserving Phytochemicals

- Additional research is needed to
  - develop produce with delayed spoiling characteristics
  - determine the impact of oxygen, acids, salts, light, and heat on each phytochemical
  - develop processing methods that maintain and increase phytochemical levels in food
Potential Health Benefits of Phytochemicals

- Research suggests that phytochemicals
  - stop development and/or growth of cancer cells
  - protect cell’s genetic material
  - have antibacterial, antifungal, anti-inflammatory, and antiviral properties
  - help the body fight off colds, influenza, and infections
  - reduce the risk of heart disease
Increasing Phytochemicals in Your Diet

- Nutrition powerhouses include
  - broccoli, cabbage, cauliflower, and kale
  - dark green vegetables such as spinach, watercress, collard greens, and parsley
  - white, green, and black tea
  - red and purple grapes or grape juice
  - garlic, onions, leeks, and chives
  - citrus fruits and tomatoes

continued
Increasing Phytochemicals in Your Diet

• The Dietary Guidelines recommend teens on a 2,000 kilocalorie per day eating plan consume 2 cups of fruit and 2½ cups of vegetables daily

• Add phytochemicals to your diet by
  - adding extra veggies to pizza and sandwiches
  - drinking tea with lemon instead of soda
  - choosing fruit for dessert instead of ice cream
Functional foods are food products with ingredients that are modified to provide health benefits beyond their traditional nutrients.

- These foods contain bioactive components such as phytochemicals.
- Examples include cholesterol-free eggs, calcium-enriched orange juice, and lycopene-rich tomatoes.

continued
New Directions for Food Science

- Food-specific health claims can appear on product labels if the claims are FDA approved.
- Depending on the claim, the food can be categorized as one of the following:
  - regular food, food additive, dietary supplement, drug, medical food, or a food for special dietary use.
Recap

• Phytochemicals are found in plants
• The phytochemical families based on chemical structure are
  - allyl sulfides, carotenoids, flavonoids, indoles, phenolic acids, saponins, and terpenes
• Phytochemicals may help fight
  - various types of cancer, heart disease, age-related eye diseases, and others
Phytochemicals may be impacted during food processing by factors such as:
- the presence of an acid or base
- freezing or cooking
- use of certain metals for storage or cooking
- mechanically altering the food as in cutting or chopping

continued
Recap

- Foods highest in phytochemicals include
  - soy products
  - broccoli and dark leafy greens
  - tea
  - red and purple grapes
  - onions, garlic, and chives
  - citrus fruits
  - tomatoes