



Lecture 62:

Phytonutrients

Part 2

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Flavonoids:

Flavonoids are color-providing pigments and are categorized into seven subtypes:

- flavonols
- flavones
- flavonones
- dihydroflavonols
- isoflavonones
- stilbenoids
- Anthocyanins

Flavonoids are famous as “Vitamin P”.

Subtypes:

- Over 4000 flavonoids have been isolated and the most common flavonoids are **quercetin**, quercetrin, rutin, hesperidin, myricetin, butin, luteolin, **apigenin**, **naringenin**, fustin, eriocitrin, eriodictyl, delphinidins, catechin, epicatechin, gallocatechin, rhamnetin, and kaempferol, cyanidin.

Food Sources:

- **Fruits:** acai berry, apple, bilberry, blueberry, cranberry, elderberry, figs, grapefruit, grapes, guava, kiwi, logan berry, nectarine, passion fruit, peach, olive, pear, persimmon, pitaya, pomegranate, raspberry, sea buckthorn, strawberry, and tamarillo.



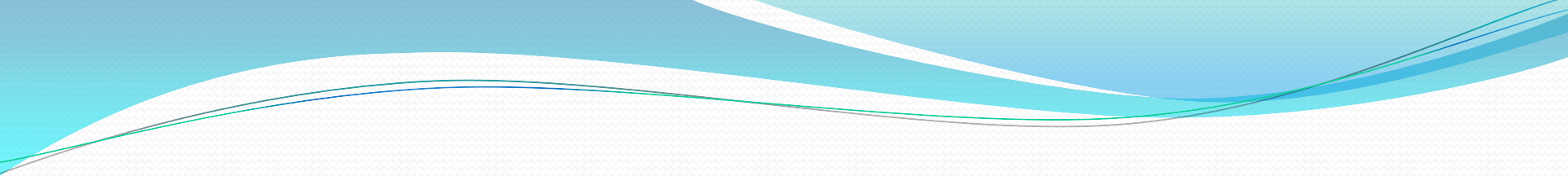
Berries are excellent sources of flavonoids.

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- **Vegetables:** artichoke, basil, beets, bell pepper, broccoli, Brussels sprouts, cabbage, cauliflower, celery, chard, corn, coriander, cucumber, dill, eggplant, garlic, green beans, green peas, kale, leek, lettuce, onion, parsley, parsnip, potatoes, pumpkin, radicchio, radish, rhubarb, spinach, sweet potatoes and tomatoes.

Health Benefits:

- **a)** Are potent antioxidants.
- **b)** Show anti-inflammatory effects.
- **c)** Have anti-cancer properties.
- **d)** May help reduce blood sugar level (quercetin has an anti-diabetic effect by enhancing insulin production).
- **e)** May improve blood flow (epicatechin).
- **f)** Strengthen walls of the vessels

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- **g)** May alleviate allergies.
 - **h)** May stimulate neurogenesis in multiple sclerosis (apigenin and luteolin).
 - **i)** Enhance immune system.
 - **j)** Help reduce bad cholesterol.
 - **k)** May demonstrate activity against HIV (quercetin).
 - **l)** Enhance the absorption of vitamin C, improve its functions, and protect it from oxidation.

Furanocoumarins:

- Furanocoumarins are a group of organic compounds produced by certain plants as a defence mechanism to protect themselves from external organisms.
- The importance of furanocoumarins is their interactions with metabolism of some medications.
- They cause enzyme inhibition, which means they block the liver enzyme **cytochrome P₄₅₀**, interfering with metabolism of some medications.

Subtypes:

The subtypes are:

- bergamottin
- dihydroxybergamottin
- bergapten
- isobergapten
- angelicin
- psoralen

Food Sources:

Fruits:

- **grapefruit** (bergamottin and dihydroxybergamottin)
- **Seville oranges** (bergamottin and dihydroxybergamottin)
- **pomelo** (bergamottin and dihydroxybergamottin)
- **fig** (psoralen)



Grapefruit is very high in furanocoumarines.
Image: Copyright©Depositphotos.com/Lukas Gojda

Vegetables:

- **celery (bergapten and psoralen)**
- **parsnips (isobergapten and psoralen)**
- **fennel seeds (psoralen)**
- **parsley (psoralen)**
- **wild carrot (psoralen)**

Health Benefits:

- **a)** Psoralen helps with treatment of certain skin disorders, such as psoriasis, eczema, alopecia and vitiligo.
- **b)** Bergapten may increase photosensitivity.
- **c)** For drug interactions, refer to “**lecture 53**”.

Indole – 3 – Carbinol:

- Indole-3-carbinol is not a sulfur-containing substance but released from the sulfur-containing compounds the “glucosinolates”.
- It breaks down in the body into diindolylmethane (DIM).

Food Sources:

- **Vegetables:** broccoli, cabbage, cauliflower, collard greens, Brussels sprouts, gai-lan, kale and mustard greens.



Broccoli, cauliflower, and cabbage are excellent sources of indole-3-carbinol.

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Health Benefits:

- **a)** Reduces risk of developing estrogen-related cancers by altering the metabolism of estrogen.
- **b)** Has an anti-viral, anti-bacterial, anti-androgenic, anti-inflammatory, and anti-cancer property.
- **c)** Shows activity against HPV (human papilloma virus) (DIM).
- **d)** May help people with systemic lupus erythematosus (SLE).

Isothiocyanates:

- Isothiocyanates are sulfur-containing substances (pigments) responsible for the **color of green** in some plants.
- They come from an enzymatic conversion of **glucosinolates**.

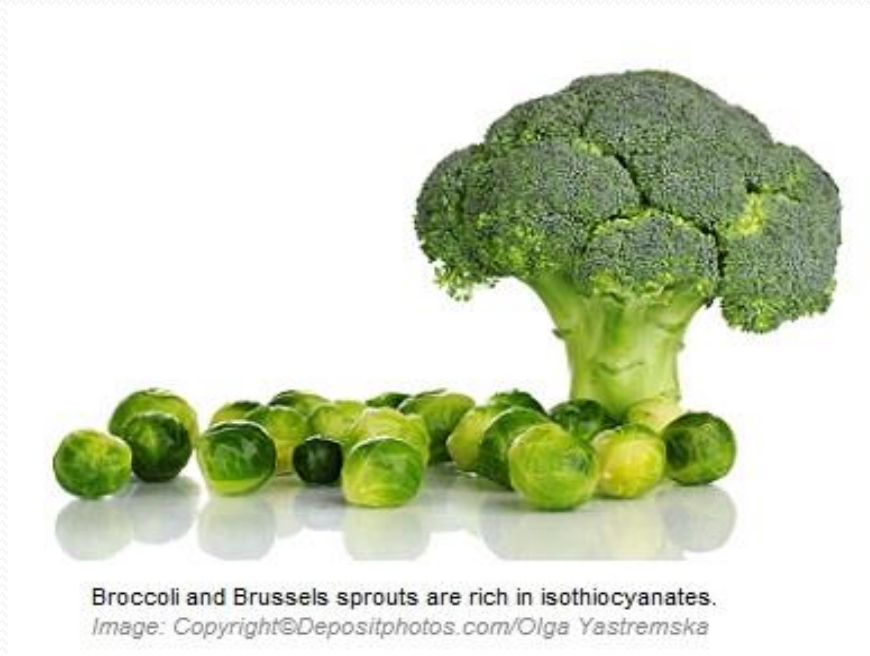
Subtypes:

Subclasses of isothiocyanates are:

- allyl isothiocyanate
- benzy isothiocyanate
- sulforaphane
- phenethyl isothiocyanate (PEITC)

Food Sources:

- **Vegetables:** arugula, Bok Choy, broccoli, Brussels sprout, cabbage, cauliflower, collards, gai-lan, kale, kohlrabi, leek, mustard greens, radish, spinach, turnip, turnip greens, and watercress.



Broccoli and Brussels sprouts are rich in isothiocyanates.

Image: Copyright©Depositphotos.com/Olga Yastremska

Health Benefits:

- **a)** Have anti-oxidative activities.
- **b)** Show anti-inflammatory and immunoprotective properties.
- **c)** Enhance liver detoxification.
- **d)** Induce apoptosis (programmed cell death; cell suicide) in certain cancers.
- **e)** Inhibit the growth of *Helicobacter Pylori* (sulforaphane).

Lactucin, Lactucopicrin, and Lactuerol:

- They are bitter-tasting terpenes in plants and active ingredients in **lactucarium**.
- Also known as “*lettuce opium*”, lactucarium is a milky liquid produced by certain plants and gives them their slightly bitter flavours.

Food Sources: lettuce and radicchio.

Health Benefits:

- a) Have analgesic and sedative effects.
- b) Used to help insomnia.



Lettuce and radicchio are high in lactucin, lactucopicrin and lactuerol.
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Limonoids:

- Limonoids are phytochemicals responsible for yellow to orange **color** and **taste** of certain fruits and vegetables.
- **Food Sources:** grapefruit, nectarine, oranges, tangerines, lemons, limes, pomelo, ugly fruit, and other citrus.



Citrus fruits are the best food sources of limonoids.
Image: Copyright©Depositphotos.com/Sergejs Bespalovs

Subtypes of limonoids are limonin, nomilin, nomilinic acid, azadirachtin, anthothecol, bussein, carapinic acid, cedrelone, fassinolide, entandrophragmin, gedunin, deacetyl gedunin, and khivorin.

Health Benefits:

- **a)** They show antiviral, antibacterial, antifungal, and antimalarial activities.
- **b)** Have anti-cancer properties especially against brain tumors, breast and colon cancers.
- **c)** Detoxify liver.

Mucilage:

- Mucilage is a glycoprotein released by most plants.
- Being chemically a subclass of hemicellulose, mucilage is a gelatinous substance and has a viscous and sticky consistency.

Food Sources:

- **Fruits:** jujube.
- **Vegetables:** aloe vera, chia seeds, flaxseeds, kelp, marshmallow, okra, psyllium, broadleaf plantain, and fenugreek.

Health Benefits:

- Mucilage has an anti-inflammatory activity in the gastrointestinal system by covering the mucous membranes and protecting them from getting irritated.

Phenolic Compounds:

- Phenolic compounds are a major class of polyphenols. These phytochemicals are derivatives of the phenolic acids.

Subtypes:

- Phenolic compounds differ from flavonoids, and they are hydroxybenzoic acid, hydroxycinnamic acid, coumarins, caffeic acid, chlorogenic acid, ferulic acid, eugenol, gallic acid, gentisic acid, vanillic acid, coumaric acid, sinapic acid, syringic acid, oleuropein, and elenoic acid.

Food Sources:

Fruits: acai berry, bilberry, cranberry, elderberry, goji berry, grapes, loganberry, mango, nectarine, olive, orange, pear, persimmon, pitaya, plum, pomegranate, quince, raspberry, sea buckthorn, strawberry, and tamarillo.



Berries are excellent sources of phenolic compounds.

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Vegetables:

**amaranth, beets, bell pepper, celery, corn,
coriander, eggplant, garlic, green peas, lettuce,
onion, parsley, potatoes, pumpkin, radish, rhubarb,
and spinach .**

Health Benefits:

- **a)** Are powerful antioxidants.
- **b)** Show anti-inflammatory activities.
- **c)** Demonstrate antibacterial and antiviral properties.
- **d)** Enhance immune system.
- **e)** Prevent from platelet aggregation.
- **f)** Improve HDL cholesterol level.
- **g)** Display cardioprotective activities.

Homework:

- 1) Describe the health benefits of flavonoids.
- 2) Describe the health benefits of indole-3-carbinol.



