# FDE 326- Food Chemistry II

## Prof. Dr. Aziz Tekin

| WEEK | TOPIC |
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| 8 | Phytochemicals |
| 9 | Toxic Compunds in Foods |
| 10 | Food Aromas |
| 11 | Food Additives |
| 12 | Food Contaminants |
| 13 | Food Contaminants |
| 14 | Chemical Compositions of Main Foods |

*References*


1- Food Chemistry (*Ed.* O.R. Fennema).Marcel Dekker (1996)
2- Fennema's Food Chemistry (*Ed.* S. Damodaran, K.Parkin, O.R. Fennema). CRC Press. (2007)
3- Food Chemistry (*Ed.* H.-D. Belitz, W. Grosch, P. Schieberle, and M.M. Burghagen). Springer (2004)
4- Advances in Food Biochemistry (*Ed. F. Yıldız*). Taylor and Francis (2010)
5- Food Safety and Toxicology, (*Ed.* J.D.Vries). CRC Press (1997)

# PHYTOCHEMICALS

Classification:

(1) Terpenes: Carotenoids*, limonoids, saponins, chromanols* (e.g. tocopherols).

(2) Phenolic compounds (polyphenols): phenolic acids, flavonoids, lignans

(3) Phytosterols and phytostanols: Exist in fats and oils and oil bearing materilas

(4) Organo sulfur compounds: Thiosulfunates, glucosinolates (Found mainly Cruciferae plant)

Among them, phenolics are the most important ones in foods

*: **Presented in vitamins and/or pigments section in this course**

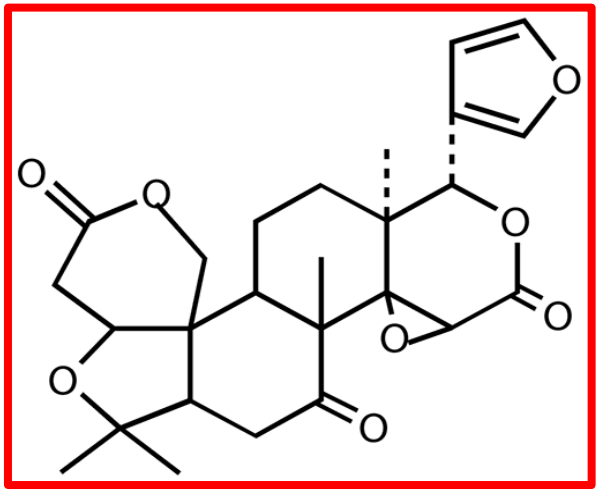
# • Terpenes:

**More than 25000 terpenes**

**Limonoids:** Limonoids having 26 carbons are oxidized triterpenes. Widesprad in citrus fruits, and responsible of bitterness of their juices and seeds that contain the highest ratio. Bitterness comes up when juice is heated or waited for several hours, which reduces the quality of the juice.

The common compound in this group is ***limonene***.

Its content reduces with maturation.

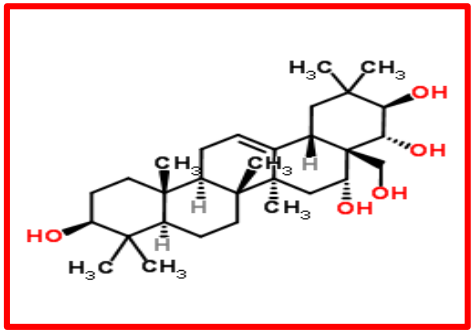


*Limonene*

**Saponins:** Structurally, they are glycosides, sugars attached to another organic molecule, usually a steroid or triterpene, a steroid building block. Saponins are both water and fat soluble, which gives them their useful soap properties.

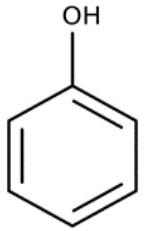
They are strongly bitter tasting, surface active agents (surfactants), which can cause intensive foaming activity in aqueous solutions. Saponins are only absorbed in small amounts, and their main effect is restricted to the intestinal tract.

While saponins are promoted commercially as dietary supplements and are used in traditional medicine, there is no high-quality clinical evidence that they have any beneficial effect on human health.



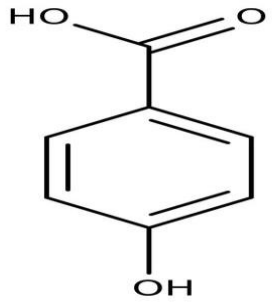
*Theasapogenol-B*

# PHENOLICS

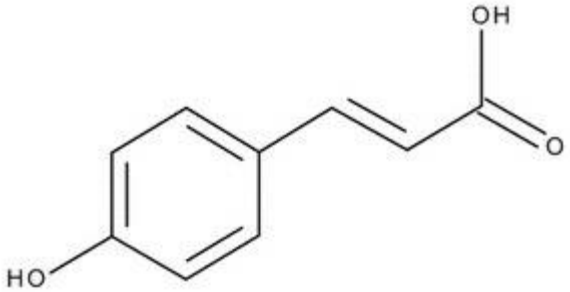



- $C_6$: Phenols
- $C_6C_1$: *Hydroxybenzoic (HBA) acids*
- $C_6C_2$: Acetophenons and phenyl acetic acids
- $C_6C_3$: *Hydroxycinnamic (HSA) acids*, cumarins, isocumarins, chromans
- $C_6C_4$: Napthoquinone
- $C_6C_1C_6$: Benzophenones, xanthons
- $C_6C_2C_6$: Stilbenes *(eg. resveratrol)* ve antrakinons
- $C_6C_3C_6$: *Flavonoids (Flavanons, flavonols, anthocyanidines, chalcones, flavon-3-ols, flavons, isoflavons, aurons)*
- $(C_6C_3)_n$: Lignans
- $(C_6C_3C_6)_n$: Proanthocyanidins (known as condenced tannins)

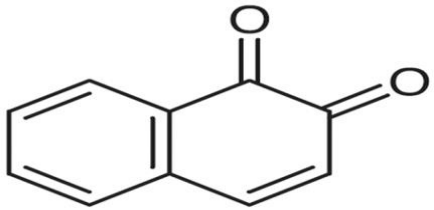
- Phenolic compunds are very common in the nature. Flavonoids and phenolic acids are present in all plants. More than 4.000 phenolics have been identified. They affect color and flavor, have antioxidan effect and also are substrates for browning reactions. They protect the plants against natural harmful agents and helps pollination.



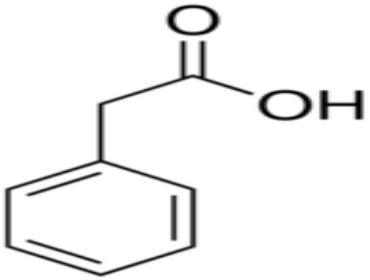

Hydroxybenzoic acid



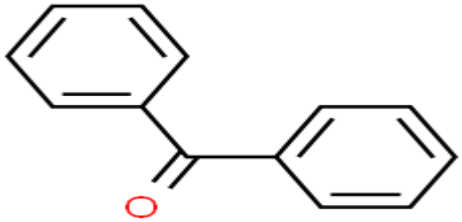

Hyroxycinnamic acid



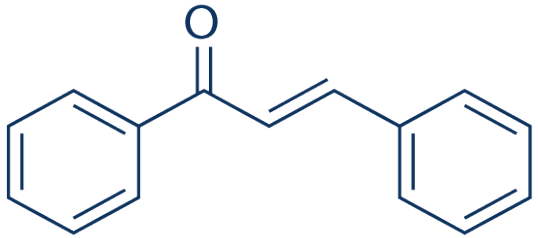

1,2 Naphtoquinone



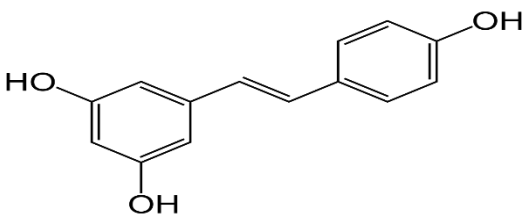

Phenyl acetic acid



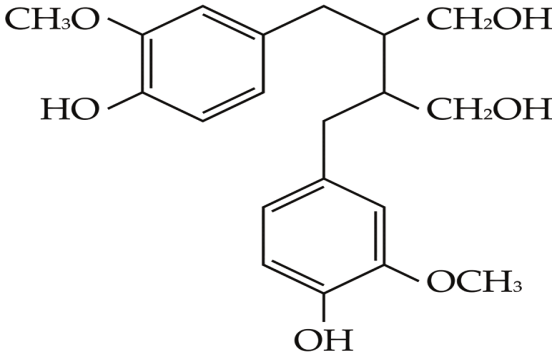

Benzophenone



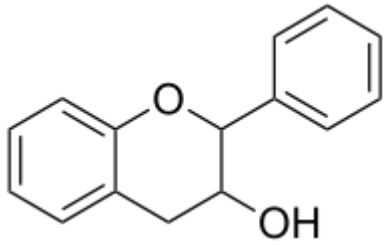

Chalcone



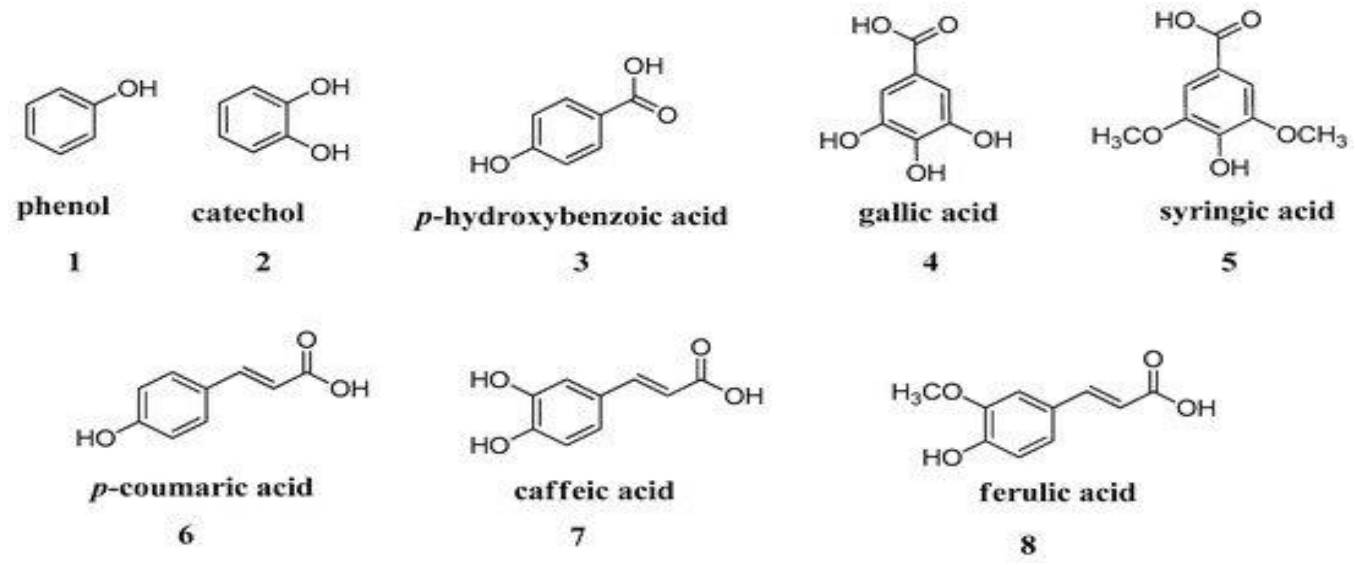

Resveratrol



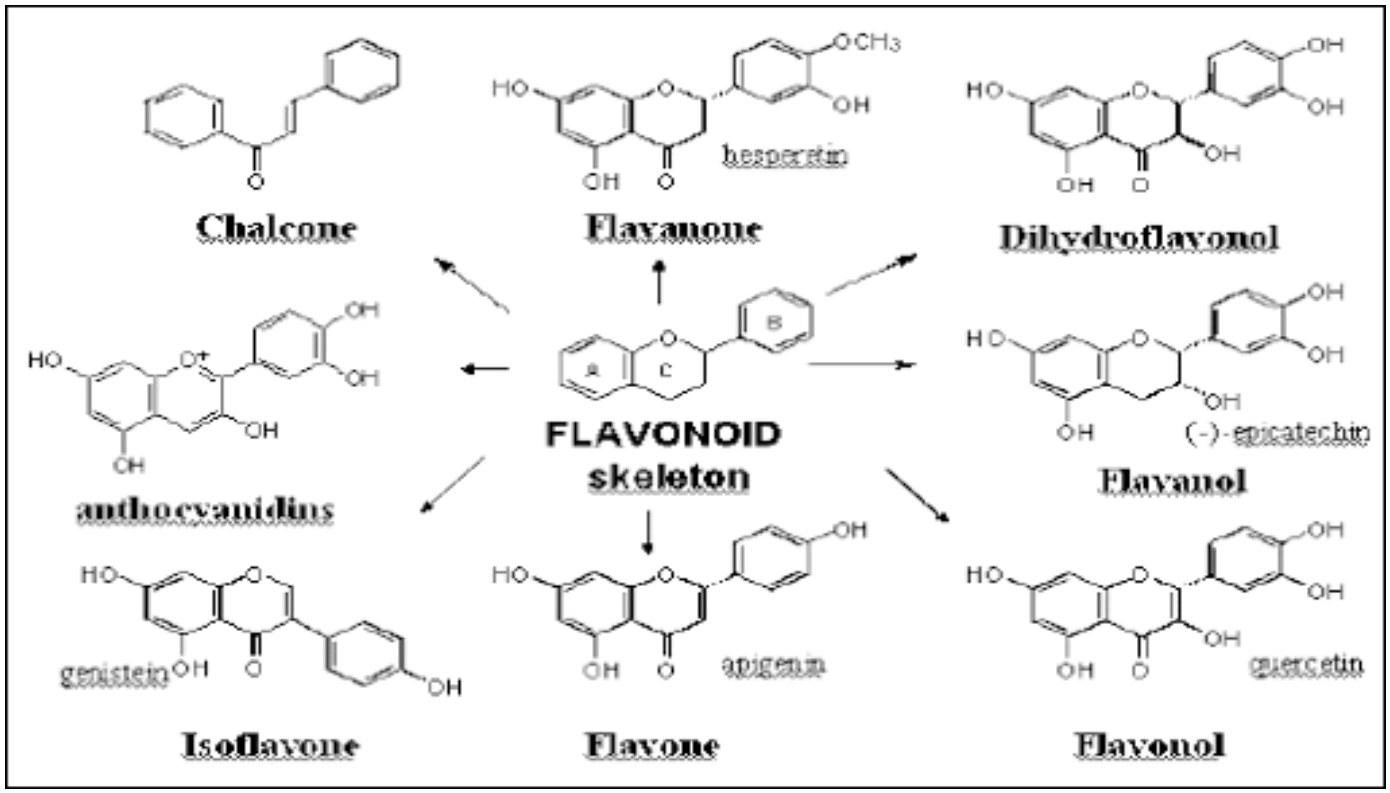

Lignan structure




Tannin

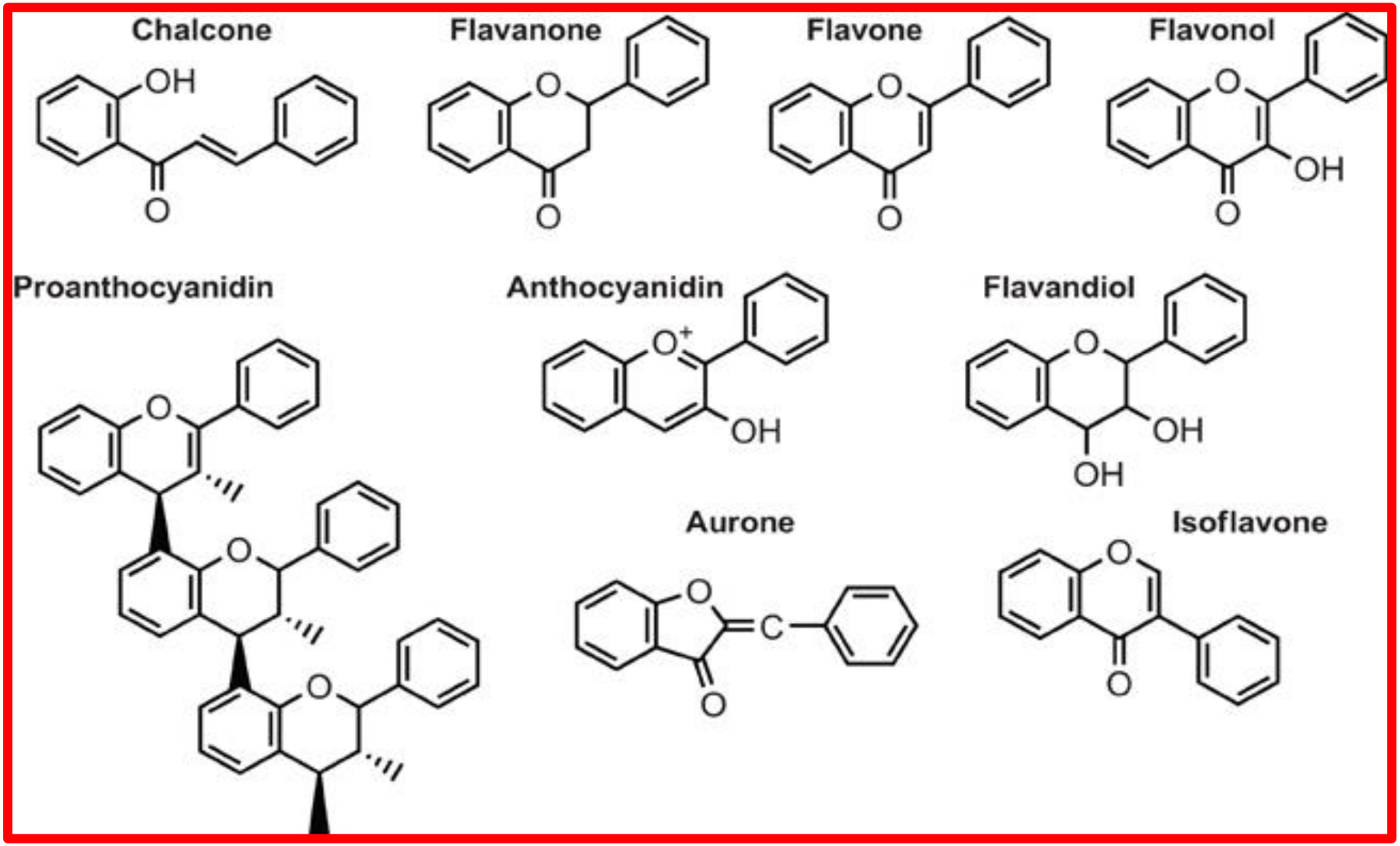



Simple phenols

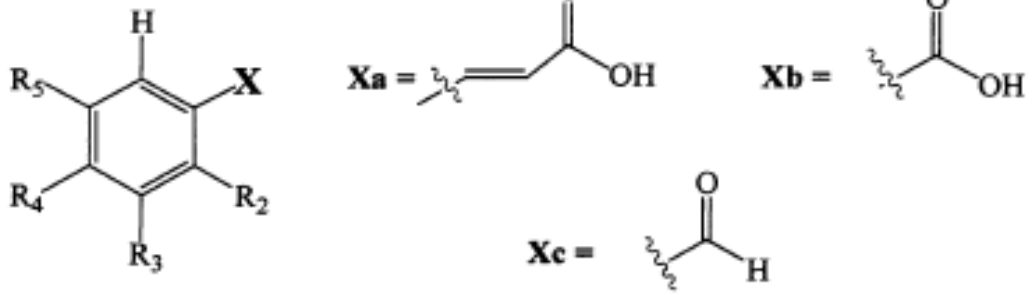



Flavonoids

# Chemical structures of flavonoids



# Chemical structures of phenolic acids




| Name | $R_2$ | $R_3$ | $R_4$ | $R_5$ | x |
|---|---|---|---|---|---|
| *Cinnamic acids* | | | | | |
| Cinnamic a. | -H | -H | -H | -H | a |
| o-coumaric a. | -OH | -H | -H | -H | a |
| p-coumaric a. | -H | -H | -OH | -H | a |
| m-coumaric a. | -H | -OH | -H | -H | a |
| Ferulic a. | -H | $-OCH_3$ | -OH | -H | a |
| Sinapic a. | -H | $-OCH_3$ | -OH | $-OCH_3$ | a |
| Caffeic a. | -H | -OH | -OH | -H | a |
| *Benzoic acids* | | | | | |
| Benzoic a. | -H | -H | -H | -H | b |
| Salicylic a. | -OH | -H | -H | -H | b |
| p-hydroxybenzoic a. | -H | -H | -OH | -H | b |
| Vanillic a. | -H | $-OCH_3$ | -OH | -H | b |
| Syringic a. | -H | $-OCH_3$ | -OH | $-OCH_3$ | b |
| Protocatechuic a. | -H | -OH | -OH | -H | b |
| Gentisic a. | -OH | -H | -H | -OH | b |
| Gallic a. | -OH | -OH | -OH | -OH | b |
| Veratric a. | -H | $-OCH_3$ | $-OCH_3$ | -H | b |
| *Aldehydes* | | | | | |
| Syringicaldehyde | -H | $-OCH_3$ | -OH | $-OCH_3$ | c |
| Vanillin | -H | $-OCH_3$ | -OH | -H | c |

- **Phytosterols and phytstanols:** Phytosterols are natural compounds structurally similar to mammalian cell-derived cholesterol. The best dietary sources of phytosterols are unrefined vegetable oils, seeds, cereals, nuts, and legumes. The most abundant plant sterols include sitosterol, campesterol, and stigmasterol. Stanols are saturated sterols, having no double bonds in the sterol ring structure. They are mostly present in the free form and less as fatty acid esters. They are used as a an important criteria for purity of vegetable oils because each vegetable oil has its unique sterol distribution.

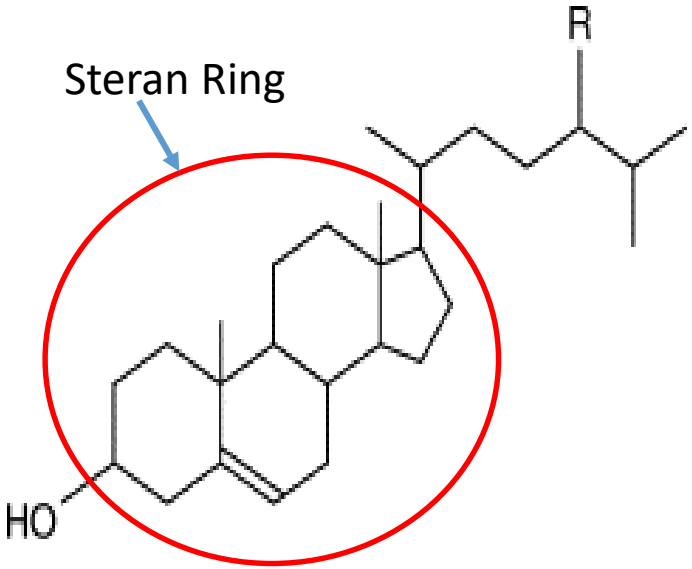
Plant sterol absorbtion is very low.

It has been estimated that humans absorb approximately 10 mg plant sterols per day.

Intestinal absorbtion of dietary cholesterol ranges in 20– 80%, while plant sterol absorption is 0.4–4%, and plant stanol absorption ranges in 0.02–0.3%.

A high intake of these compounds can also protect against atherosclerosis and decrease serum total cholesterol and LDL cholesterol levels. Mechanistically, phytosterols compete with cholesterol for micelle formation in intestinal lumen and inhibit cholesterol absorption.

Consumption of 2g per day reduces blood cholesterol 8-13%.




| | |
|---|---|
| Cholesterol | R = H |
| β-Sitosterol | R = – $C_2H_5$ |
| Stigmasterol | R = – $C_2H_5$ ; $\Delta^{22}$ |
| Campesterol | R = – $CH_3$ |
| $\Delta^5$-Avenasterol | R = CH – $CH_3$ |
| Brassicasterol | R = – $CH_3$ ; $\Delta^{22}$ |