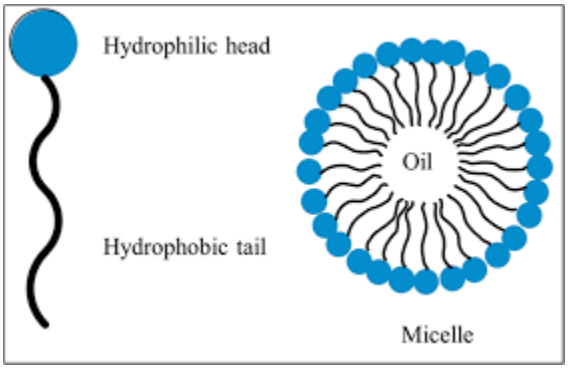
SAPONIN GLYCOSIDES

Saponins are a group of naturally occurring plant glycosides, characterized by their strong foam-forming properties in aqueous solution. The presence of saponins has been reported in more than 100 families of plants . Saponins are considered to be the main functional components of many plant drugs and folk medicines, as well as the main components of many pharmacological properties. Saponins have a major function in enhancing bidirectional immune regulation, reducing cholesterol and antitumor activity. Saponins glycosides have generally a hydrophobic tale and a hydrophilic head. This structure allows them to orient at water-oil interphase.



Chemical structure of Saponins

Saponins consist of an aglycone unit linked to one or more carbohydrate chains. The aglycone can be a triterpene or a steroid and can have a number of different substituents (–H, –COOH, –CH3). The number and type of carbohydrate moieties result in a considerable structural diversity of the saponins. Most carbohydrates in saponins are **hexoses** (i.e., glucose, galactose), **6-deoxyhexoses** (rhamnose),

pentoses (arabinose, xylose), uronic acid (glucoronic acid, the carbohydrate side-chain is usually attached to the 3 carbon of the sapogenin.

Classification

Saponins on hydrolysis yielde glycon (sugar) and aglycone (sapogenin).

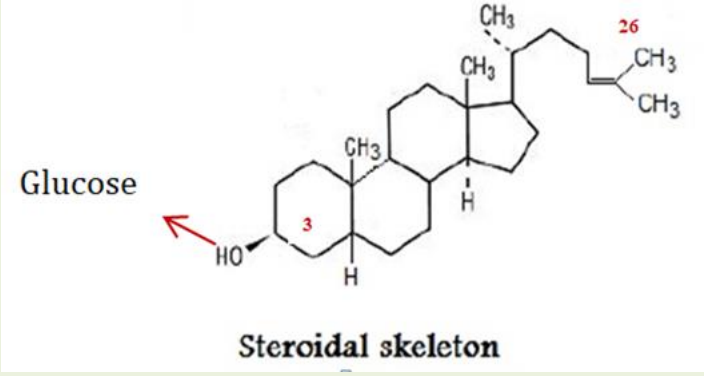
- According to the structure of the **aglycone**, saponins are classified as

1- **Steroidal tetracyclic** sapogenin
2- **Triterpenoid pentacyclic** sapogenin.

- According to the number of sugar chains in their structure as **mono**, **di**-, or **tridesmosidic**. Monodesmosidic saponins have a single sugar chain, normally attached at C-3. Bidesmosidic saponins have two sugar chains, often with one attached through an ether linkage at C-3 and one attached through an ester linkage at C26 or C-28 position.

Steroidal Saponins

- They are C-27 with 5 methyl groups.
- Less distributed in nature comparing to triterpenoidal saponins.
- The chemical structure of steroidal saponins is similar to that of many of the body hormones e.g. sex hormones, estrogen & cortisol, so they use as a starting material for synthesizing these compounds, and many plant containing them have a marked hormonal activity.



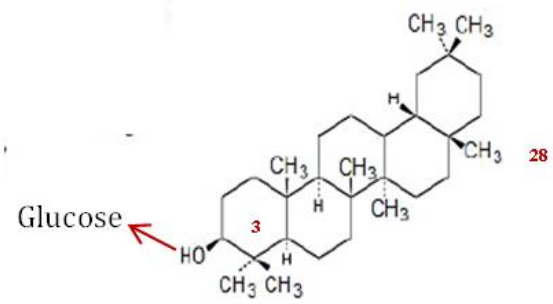
Steroidal skeleton

Triterpenoid Saponins

They are C-30 compounds with 8 methyl groups.

- Much more distributed in nature.
- Less hormonal activity.

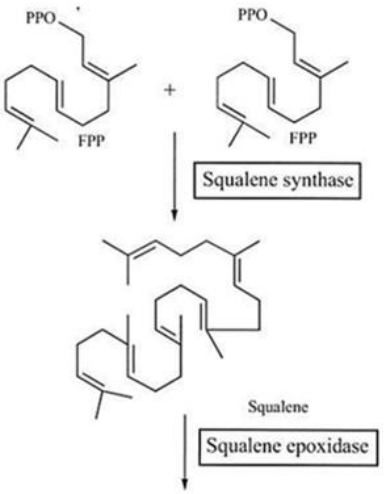
They have pharmacological properties

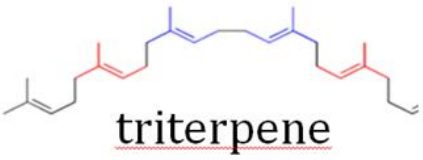


Tri-terpenoidal skeleton

Triterpenoid saponin biosynthesis

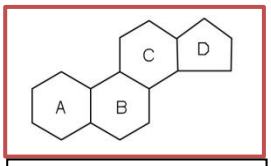
Stare with three isopentenyl pyrophosphate units(each containing five carbon atoms)are linked formed farnesyl pyrophosphate (FPP). Two FPPs are then connected by squalene synthetase resulting in squalene (containing 30 carbon atoms) which then it is oxidized to 2,3-oxidosqualene by squalene epoxidase . Squalene (triterpene) is akey branching point between triterpenoid and steroid saponin glycosides.



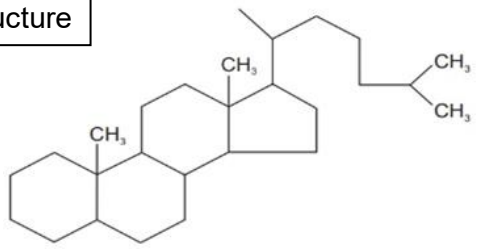


triterpene

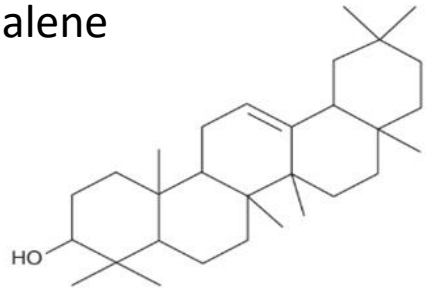
2,3-oxidosqualene



steroid structure



Tetracyclic triterpenoids
(Steroidal saponins)

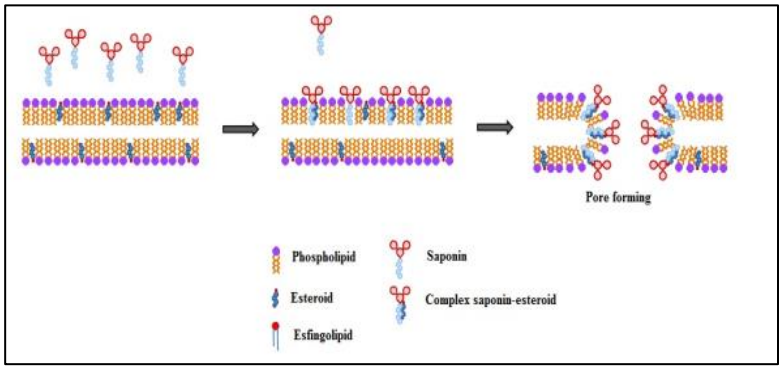


Pentacyclic triterpenoids

MEDICINAL USE FOR SAPONIN GLYCOSIDES

1-Antitumor activity of saponins : Apoptosis is morphologically characterized by cellular shrinkage, Saponins readily change the structure of membranes that contain a high amount of cholesterol. Especially the steroidal saponins, the spontaneous formation of complexes between saponins and cholesterol in the membranes is followed by association with a micelle, two-dimensional structure

within the membrane. The hydrophilic sugar chains are oriented towards the center of the micelle complex, leading to the formation of an aqueous pore that, in turn, would cause an increase in membrane permeability allowing the passage of ions and macromolecules across the lipid bilayer.

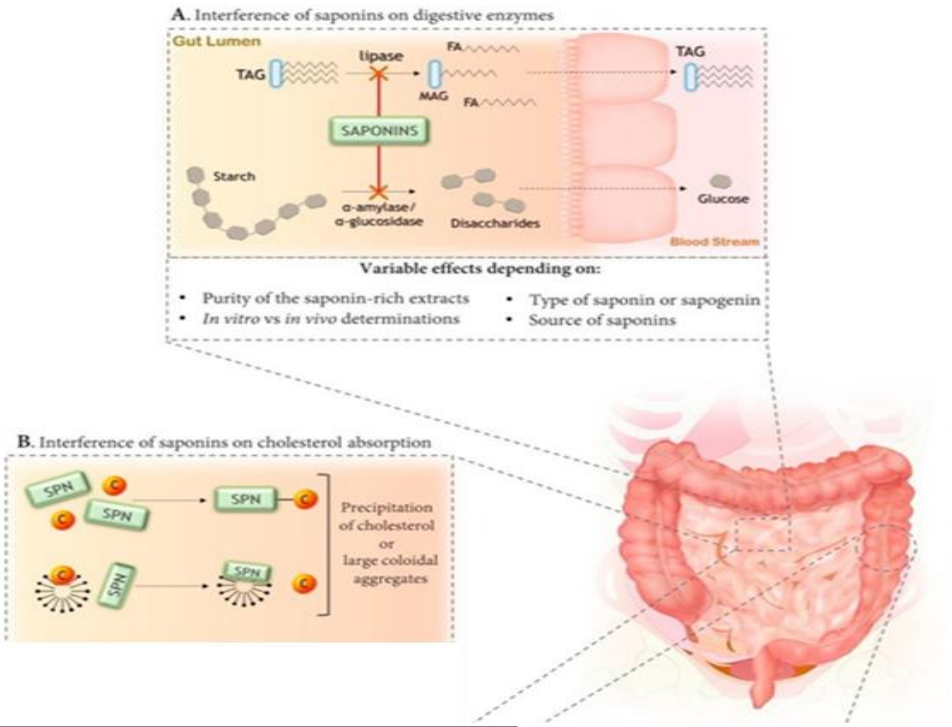


Model of the mechanism of action of saponins on the membranes

2- Have hypoglycemic and hypocholesterolemic properties::

Saponins they keep body blood sugar levels within normal limits and prevent insulin spikes. Furthermore, they inhibit the release of lipase, an enzyme that breaks down triacylglycerols (TAGs). As a result, your body will absorb less fat from food. Cholesterol is an essential component of the human body. Cholesterol functions in a variety of capacities including, but not limited to, stabilizing cell membranes and serving as precursor for bile acids, vitamin D, and steroid hormones. Every cell of the human body can synthesize cholesterol when needed, but cells cannot catabolize cholesterol by oxidative processes. Therefore, any excess cholesterol must be transported to the liver, secreted into bile (as cholesterol or bile acids), and eliminated from the body by the intestinal route. Cholesterol

accumulation in the bloodstream (hypercholesterolemia). Saponins inhibit digestive enzymes and interfere with the absorption of cholesterol as well as formation of an insoluble complex, thereby decreasing intestinal cholesterol absorption, producing an increase of sterols which are excreted along with feces.



Adverse effects of saponin glycosides

Saponin glycosides are toxic at highly doses over an extended period. Saponins are 10 to 1000 times less toxic orally than when given by intravenous injection. However, the absorption rate of saponins in the human gastrointestinal tract is very low, but the rare saponins of which glycosyl groups are hydrolyzed are more easily absorbed. The enzymes of gastrointestinal tract had no effect on the saponins, but they were hydrolyszed to their respective saponins by the cecal microflora. [Intestinal microorganisms are abundant in species, rich in enzymes, and mild in catalytic conditions which can catalyze reactions that are difficult to achieve by general chemical methods]. Natural saponins can

be hydrolyzed by physical (**heating**), chemical (**acidolysis**) and **microbial transformation**, The main way of microbial transformation is through the hydrolysis of saponin glycosyl groups, so as to transform natural saponins into rare saponins containing low sugar chains. Rare saponins and their derivatives show more valuable drug effects than natural saponins.

Plants contain steroidal saponins

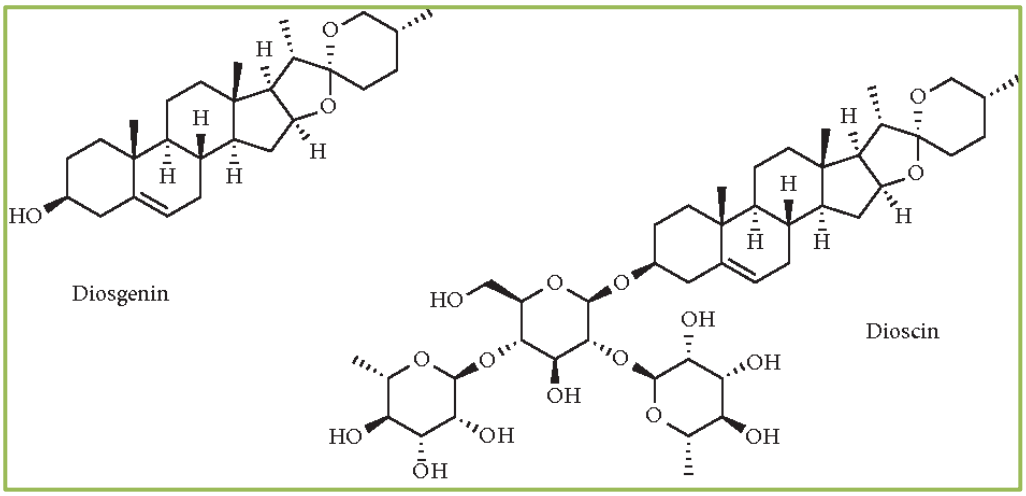
1-Fenugreek

seeds:Part use

Family :- **Fabaceae**

Trigonella foenum graecum

T. foenum graecum potential source of **diosgenin**, Diosgenin, a phytosteroid sapogenin, is the product of hydrolysis by acids, strong bases, or enzymes of saponin dioscin. Diosgenin is used for the commercial synthesis of cortisone, pregnenolone, progesterone, and other steroid products



2- yams

Parts use

Rhizomes &Roots

Family :- ***Dioscoreaceae***

Dioscorea villosa

The rhizomes and roots of several species of the genus *Dioscorea* (Family *Dioscoreaceae*), also commonly known as yams, contain steroidal saponins and were found to have a wide range of pharmacological activities. Reports have indicated that steroidal saponins yield diosgenin (the aglycon of the yam steroidal saponin) from hydrolysis of yam saponins. Diosgenin is used as an industrial starting material for the partial synthesis of steroidal-based drugs, e.g., progesterone and testosterone.

Plants contain triterpenoid saponins

1-Licorice

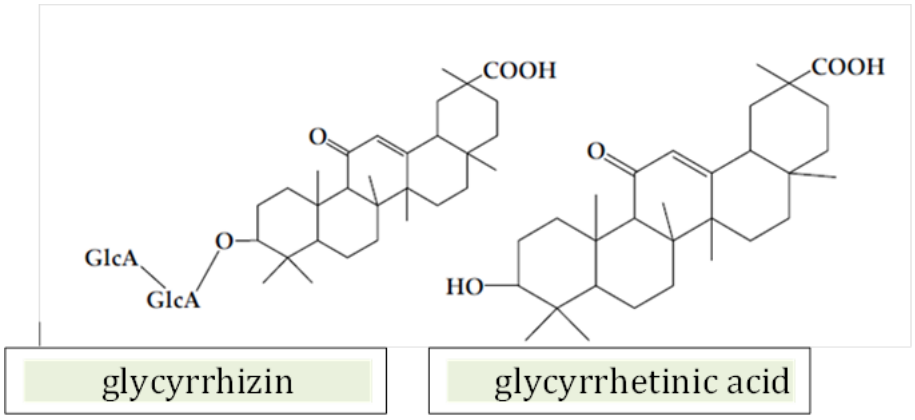
Part use

Roots

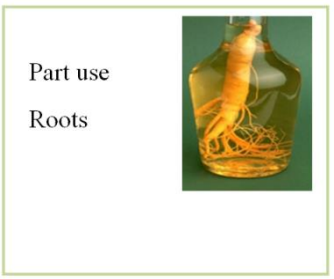
Family :- ***Leguminoseae***

Sp. Glycyrrhiza glabra

Glycyrrhiza (liquorice) plants. Liquorice is, one of the most popular medicinal plant which possesses a wide range of pharmacological properties and is used worldwide as a natural sweetener which is 50 times sweeter than sugar. The roots of G. glabra are rich in bioactivities like antiviral, anticancer, antiulcer, antidiabetic, anti-inflammatory, antioxidant. The active component of liquorice, (glycyrrhizin) named as Glycyrrhizic acid], which belongs to the pentacyclic triterpenoid saponins, Glycyrrhetinic acid [GA] is a hydrolytic product obtained from glycyrrhizin.



2-Panax



Family: - ***Araliaceae***
Panax ginseng

Ginseng is a perennial herbaceous plant belonging to the family Araliaceae, known as the “King of hundred herbs”. Ginseng has a wide history of clinical application in emergency treatment, cardiovascular disease, diabetes, liver, and stomach diseases. As the main active components of ginseng are **ginsenosides,** Direct absorbance of the natural ginsenosides is difficult and they first need to be transformed into secondary saponins by the metabolism of gastrointestinal flora before they can be readily absorbed and utilized in the blood, however, secondary saponins are rarely found in nature. Therefore, the biotransformation of ginsenosides into secondary saponins is a hotspot of current research.