SAPONINS AND SOME BEST KNOWN SAPONIN CONTAINING MEDICINAL PLANTS

Nino Qurashvili
Professor, University of Georgia

RESUME

Saponin isolated from medicinal plants is a naturally occurring bioorganic molecule with high molecular weight and its aglycone (water non-soluble part) nucleus having 27 to 30 carbon atoms besides one or two sugar moieties (water soluble part) containing at least 6 or 12 carbon atoms respectively. The name 'saponin' comes from the Latin word 'sapo,' which means 'soap' as saponins show the unique properties of foaming and emulsifying agents.Steroidal and triterpenoid saponins can be used in many industrial applications including the preparation of steroid hormones in the pharmaceutical industry. Recently, the increase in demand of saponin applications was observed due to various biological, medicinal, and pharmaceutical actions.

Key Words: saponin, chemistry, medicinal plants, triterpenoid, steroidal saponin, alkaloidal saponin

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Since ancient times, bioactive medicinal plants are used in traditional or folk medicine for the treatment of various diseases. Recently using of phytochemicals is considered to be safer and congenial to the biology of the human body. (1)

There are estimated 250,000–500,000 species of plants on Earth. A relatively small percentage (1–10%) of these is consumed as food by both humans and animal species. It is possible that a greater number are used for medicinal purposes. People on all continents have long applied poultices and imbibed infusions of hundreds, if not thousands, of indigenous plants. Currently, antimicrobial plant extracts are of especial interest to chemists and microbiologists due to growing public awareness of the negative effects of the over-use of antibiotics and disinfectants (16)

Plants have the ability to synthesize an almost limitless array of substances. In many cases, these chemicals serve as plant-defense mechanisms against predation by microorganisms, insects, and herbivores. Some, such as terpenoids, give plants their flavors; others—quinones and tannins are responsible for plant pigmentation. Any part of the plant may contain active components. For instance, roots of ginseng plants contain active saponins and essential oils, while eucalyptus leaves are harvested for their essential oils and tannins. Some trees contain useful substances in their bark, leaves, and shoots (17) Some of the same herbs and spices used by humans to season food can yield useful medicinal compounds. Among different compounds derived from plants, saponins deserve a special mention. These chemicals may be considered as a part of plants' defense systems. They have been included in a large group of protective molecules found in plants named 'phytoanticipins' or 'phytoprotectants' (18).

Medicinal plants are the main source for the preparation and extraction of various modern drugs and pharmaceuticals like saponins, flavonoids, and alkaloids. Triterpenoid saponins are surface active glycosides of triterpenes that possess a wide, biologically active group of terpenoids and include a large chemical diversity of secondary metabolites with more than different 100 carbon skeletons identified from terrestrial, marine living organisms, and medicinal plants.(1) Triterpenoids as a saponin have its own characteristics like cause hemolysis of red blood cells (RBC's), form persistent froth if shaken with water, and it is soluble in water, alcohol and a mixture of both.

Saponins are a class of bioorganic compounds found in particular abundance in the plant kingdom. More specifically, they are naturally occurring glycosides described by the soap-like foaming, and consequently, they produce foams when shaken in aqueous solutions. Structurally saponins are having one or more hydrophilic glycoside sugar moieties combined with a lipophilic triterpene molecule.(2)

Saponins are naturally occurring bioorganic compounds having at least one glycosidic linkage (C-O-sugar bond) at C-3 between aglycone and a sugar chain. Hydrolysis of saponin molecule produces two portions, aglycone and a sugar moiety. Isolated amorphous solid saponins have a high molecular weight, and containing 27 to 30 carbon atoms in the non-saccharide portion. Figures 1 show the chemical structure of saponins in details including the following two chemically different partitions (see figure 1):

Literature shows that saponins exhibit a biological role and medicinal properties such as hemolytic factor(3) anti-inflammatory,(4) antibacterial,(5) antifungal,(6) antiviral,(7) insecticidal(8),anticancer,(9) cytotoxic(10) and molluscicidal action.(11) In addition, saponins are reported to exhibit cholesterol-lowering action in animals and human. (12,13).

Waheed et al. (14) isolated a novel steroidal saponin glycoside from *Fagonia indica* that can induce

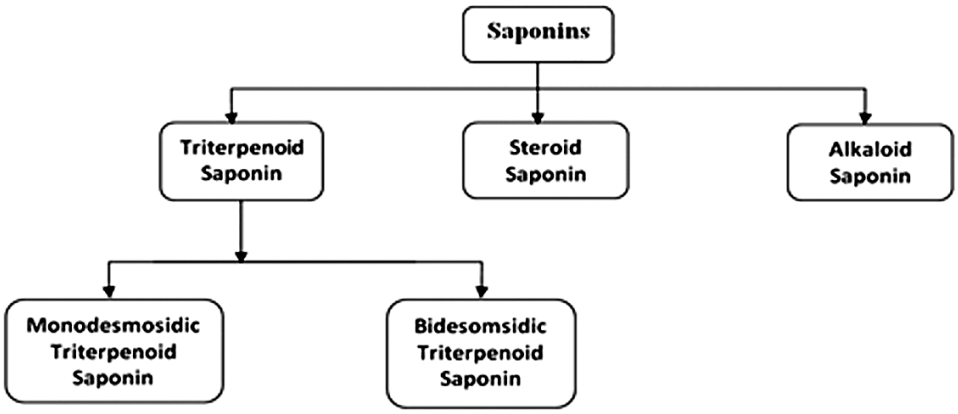

Figure 1 Categories of saponins.

cell-selective apoptosis or necrosis in cancer cells. Saponins were considered as a starting precursor for the semi-synthesis of steroidal drugs in the pharmaceutical industry. Sheng et al(15) reviewed the clinical significance of triterpenoid saponins in the prevention and treatment of metabolic and vascular disease.

The presence of saponins has been reported in more than 100 families of plants and in a few marine sources such as star fish and sea cucumber. Triterpene saponins are present in many taxonomic plant groups. In particular, they can be found in parts of dicotyledonous plants (*Dicotyledones*) such as the seeds of *Hippocastani*, roots and flowers of *Primulae*, leaves of *Hedrae*, roots of *Ginseng*, bark of *Quillaja*, roots of *Glycyrrbizae*, roots of *Senegae*, leaves of *Polygalae Amarae*, roots of *Saponariae*, seeds of *Glycine max* and leaves of *Herniariae*, Roots of *Tamus communis* (20). Legumes such as soybeans, beans and peas are rich sources of triterpenoid saponins. Steroidal saponins are typically found in members of the *Agavaceae*, *Alliaceae*, *Asparagaceae*, *Dioscoreaceae*, *Liliaceae*, *Amaryllidaceae*, *Bromeliaceae*, *Palmae* and *Scrophulariaceae* families and accumulate in abundance in crop plants such as yams, alliums, asparagus, fenugreek, yucca and ginseng. Diosgenin, the steroidal aglycone obtained by hydrolysis of dioscin, a saponin abundant in the tubers of *Dioscorea villosa* (wild yam), is the precursor for commercial synthesis of steroids such as cortisone, progesterone and pregnenolone. Steroidal glycoalkaloids are commonly found in members of the *Solanaceae* family including tomato, potato, aubergines and capsicum (19). Cereals and grasses are generally deficient in saponins, with some notable exceptions, such as the *Avena* species (oats) which accumulates both triterpenoid and steroidal saponins.

This article discusses some of the better known saponins containing medicinal plants.

Tamus communis is a species of flowering plant in the yam family Dioscoreaceae and is commonly known as black bryony, lady's-seal or black bindweed (21). It is a climbing herbaceous plant growing to 2–4 m tall, with stems that twine anticlockwise (22). The leaves are spirally arranged, heart-shaped, up to 10 cm long and 8 cm broad, with a petiole up to 5 cm long. It is dioecious, with separate male and female plants. The flowers are individually inconspicuous, greenish-yellow, 3–6 mm diameter, with six petals; the male flowers produced in slender 5–10 cm racemes, the female flowers in shorter clusters. The fruit is a bright red berry, 1 cm diameter. Its fairly large tuber is, like the rest of the plant, poisonous.

Figure 2. Tamus communis Figure

3. Tamus communis with ripe fruit

Figure 4. Roots of Tamus communis

Tamus communis roots contain 8-10 % of spirostan and furostan type steroid saponins that are mainly diosgenin substitutes. The content of diosgenin varies from 0.89 to 1.6 % according to the plant vegetation period (23).

Tamus communis has been used against inflamations due to saponins content. In addition, it restores mucosal surface, cleans blood and increases elasticity of blood vessels. Since the 11th century, Tamus communis roots has intensively been used in Georgian folk medicine for treatment of pains caused by rheumatoid arthritis.(24).

Calendula officinalis (Asteraceae) is well-known medicinal plant. It is also popular in gardens as a decorative annual species. Traditionally, it has been used topically for many eruptive skin diseases and abrasions, as well as for gastric and menstrual discomfort, as a plant with antiseptic, mild diaphoretic and antispasmodic properties. Calendula contains significant amounts of oleananesaponins, which form two distinct series of related compounds, called 'glucosides' and 'glucuronides' according to the structure of the respective precursor. Extracts from marigold flowers are still used in ointments, cosmetic creams and hair-shampoos (25).

Figure 5. Marigold, Calendula officinalis

In Southern Europe, the region around the Mediterranean Sea is rich in grapes. Saponin glycosides in red wine are known as heart protective, due to their LDL cholesterol-lowering and HDL cholesterol-increasing effects. The saponins in red wine also help prevent clumping of red blood cells. Many of plant species rich in saponins are used traditionally in Greece for making herbal teas, as flavorings and seasonings and have been tested for various pharmacological activities (26).

The Glycyrrhiza genus (Leguminosaefamily) consists of about 30 species and is widely distributed all over the world. In China, three species G. uralensis, G. glabra and G. inflata are officially used as licorice and recorded in Chinese Pharmacopoeia. Biological studies showed that licorice has a variety of biological effects, such as antioxidant, antiviral, anti-cancer, antidepressant, anti-inflammatory, anti-carcinogenesis, hepatoprotective and neuroprotective bioactivities (27,28).

Glycyrrhiza glabra or Licorice is a perennial, temperate-zone herb or subshrub 3 to 7 feet high, with a long, cylindrical, branched, flexible, and burrowing rootstock with runners. The parts used are the dried runners and roots, which are collected in the fall. It is used for treatment of gastritis and ulcer diseases.

Figure 6. Glycyrrhiza glabra

Licorice root consists of the dried rhizome and roots of Glycyrrhiza glabraThe name is derived from the Greek glykos (sweet) and rhiza (root). The crude drug contains two types of active principles: glycyrrhizin and the flavonoids: liquiritin and isoliquiritin. Licorice root preparations are contraindicated by cholastatic liver disorders, cirrhosis of the liver, hypertension, hypokalemia, severe renal failure, and pregnancy. Orally administered glycyrrhizin is believed to relive gastric inflammation by its inhibition of prostaglandin synthesis and lipoxygenase. Because of the mineralocorticoid-like action of glycyrrhizin, the average daily dose should not exceed 5-15 g of dried herb (equivalent to 200-600 mg glycyrrhizin) and the course of treatment should not exceed 4-6 weeks. Higher dosage or longer use could lead to adverse effects consisting of sodium and water retention, blood pressure elavation, potassium loss and edema (29).

The important source of natural medicines is Panax genus. Three valuable Panax species P. ginseng, P. quinquefolius, and P. notoginseng are of great interest to medicine and food industry, and they are widely used in healthcare products, foods and food additives. Ginseng root and its preparations have been used more than 2000 years. Ir is native to Korea and China but today is extremely rare in the wild.

Panax ginseng is a perennial herb (family Araliaceae) with fleshy, pale yellow, often multibranched roots that have an aromatic odor and a bittersweet taste.

Figure 7. Panax ginseng fruits and root

The root plant takes about 6 years to mature, the stem reaching a height of 60-80 cm. Ginseng powders and extracts are made from the dried roots which contain 2-3 % glycosidal saponins known as ginsenosides (29).

To the end of 2012, at least 289 saponins were reported from eleven different Panax species (30). Most of them are glycosides of triterpenoid aglycones (31). Ginseng has been used as a herbal medicine in China for thousands of years due to its wide pharmacological properties, such as anticancer, antidiabetic, antifatigue, anti-ageing, hepatoprotective and neuroprotective (32). It was also documented that P. notoginseng saponins suppress radiation-induced osteoporosis by regulating bone formation and resorption (33).

Having analysed folk medical books and scientific reseraches on saponins and saponin containing plants, we concluded that the latter can successfully be used for treament of pains caused by arthritis as well as many other ailments and folk medicin receipts must be consumed together with synthesized medications.

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