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Saponins – An Insecticidal Secondary Metabolite

*Yogapriya. A[1] and R. Muthu[2]
[1]Department of Entomology, Annamalai University, Chidambaram, Tamil Nadu, India.
[2]Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, TamilNadu

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Introduction:

Saponins are a group of secondary metabolic compounds produced by the plants. Generally they are heterosides of plant origin. Hetrosides are those that posses one or more sugar molecules in their structure (Chaieb, 2010). Triterpene glycosides, are bitter-tasting usually toxic plant-derived organic chemicals that have a foamy quality when agitated in water. They (saponins) are widely distributed but found particularly in soapwort (genus Saponaria), a flowering plant, and the soapbark tree (*Quillaja saponaria*) (Hostettmann and Marston, 1995) and these heterosides have defensive roles in plants (Appelbaum, 1969). Saponins are relatively big size molecules which contain sugars whose degradation is easier under certain conditions (pH slightly acid or basic, presence of hydrolysis enzymes). Saponins possess surface-active or detergent properties because the carbohydrate portion of the molecule is water-soluble, whereas the sapogenin is fat-soluble. The stability and strength of forage saponin foams are affected by pH, and this may have an effect on the development of bloat in ruminants.

Saponins are a class of plant glycosides in which water-soluble sugars are attached to either a lipophilic steroid or triterpenoid. This hydrophobic–hydrophilic asymmetry means that these compounds have the capacity to lower surface tension and are soap-like (Hofmann et al., 2003). Saponins are classified by the majority of the authors in two groups according to the nature of their aglycone (i) saponosides with steroidic aglycone, (ii) saponosides with triterpenic aglycone (Berger, 2001).

In aqueous solution, saponin molecules align themselves vertically on the surface with their hydrophobic ends oriented away from the water. This has the effect of reducing the surface tension of the water, causing it to foam. Saponins are both water and fat soluble, which gives them their useful soap properties.

It is evident that the rate of saponins degradation increased with an increase in temperature. The rate constant increased from 0.0085 min^{-1} at 80 °C to 0.0309 min^{-1} at 130 °C. This degradation leads to the loss of activity which enormously depends on the water-soluble sugar chains (Chaieb, 2005).

Role of saponins

Saponins serve a range of ecological roles including plant defence against disease and herbivores and possibly as allelopathic agents in competitive interactions between plants. Saponins are showing antibacterial as well as anticancer potential. In plants, saponins may serve as anti-feedants, and to protect the plant against microbes and fungi. Some plant saponins (e.g. from oat and spinach) may enhance nutrient absorption and aid in animal digestion (Foerster, 2006). Saponins have a cytotoxic (Haridas, et. al. 2001) haemolytic (Takechi, et. al. 2003) effects and are able of inhibiting the proteases activities (Wierenga and Hollingworth, 1992).

Sources of saponins

Saponins have historically been plant-derived, but they have also been isolated from marine organisms such as sea cucumber (Riguera, 1997). They derive their name from the soapwort plant (genus *Saponaria*, family Caryophyllaceae) (Liener, 1980), the root of which was used historically as a soap (Anonymous, 2008). Saponins are also found in the botanical family Sapindaceae, Aceraceae (maples), Hippocastanaceae, Cucurbitaceae, Apocynaceae (White Oleander, is a source of the potent cardiac toxin oleandrin) (Sigma aldrich, 2009).

Industrial uses of Saponins

They are used in soaps, medicinals, fire extinguishers, speciously as dietary supplements, for synthesis of steroids, and in carbonated beverages (the head on a mug of root beer). Some examples of these chemicals are glycyrrhizin, licorice flavoring; quillaia(alt. quillaja), a bark extract used in beverages; and squalene, a biological precursor to cholesterol that has been used as a vaccine adjuvant (Anonymous, 2008).

The amphipathic nature of saponins gives them activity as surfactants with potential ability to interact with cell membrane components, such as cholesterol and phospholipids, possibly making saponins useful for development of cosmetics and drugs (Lorent, 2014). Saponins have also been used as adjuvants in development of vaccines (Sun, 2009).

Saponins in Insect pest management.

In plants, saponins may serve as anti-feedants, and to protect the plant against microbes and fungi. Some plant saponins (e.g. from oat and spinach) may enhance nutrient absorption and aid in animal digestion. However, saponins are often bitter to taste, and so can reduce plant palatability (e.g., in livestock feeds), or even imbue them with life-threatening animal toxicity. Some saponins are toxic to cold-blooded organisms and insects at particular concentrations. Further research is needed to define the roles of these natural products in their host organisms, which have been described as "poorly understood" to date. (Forester, 2006). An inhibitory activity of the digestive proteases of saponins involved in the entomo-toxicity recorded (Barbouche, et. al. 2001). Saponins have a cytotoxic (Haridas, et. al. 2001) haemolytic (Takechi, et. al. 2003) effects and are able of inhibiting the proteases activities (Wierenga and Hollingworth, 1992).

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