CHAPTER 2

INTRODUCTION TO SAPONINS

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Saponins are generally known as non-volatile, surface-active compounds that are widely distributed in nature, occurring primarily in the plant kingdom (Lasztity et al., 1998, Oleszek, 2002 and Hostettmann and Marston, 2005). The name ‘saponin’ is derived from the Latin word *sapo*, which means ‘soap’, because saponin molecules form soap-like foams when shaken with water. They are structurally diverse molecules that are chemically referred to as triterpene and steroid glycosides. They consist of non-polar aglycones coupled with one or more monosaccharide moieties (Oleszek, 2002). This combination of polar and non-polar structural elements in their molecules explains their soap-like behaviour in aqueous solutions.

Saponins have a diverse range of properties, which include sweetness and bitterness (Grenby, 1991, Kitagawa, 2002 and Heng et al., 2006b), foaming and emulsifying properties (Price et al., 1987), pharmacological and medicinal properties (Attele et al., 1999), haemolytic properties (Oda et al., 2000 and Sparg et al., 2004), as well as antimicrobial, insecticidal, and molluscicidal activities (Sparg et al., 2004). Saponins have found wide applications in beverages and confectionery, as well as in cosmetics (Price et al., 1987, Petit et al., 1995 and Uematsu et al., 2000) and pharmaceutical products (Sparg et al., 2004).

Although in former times it may have been acceptable to classify compounds based on their physicochemical or biological properties, nowadays it is no longer customary and sensible in natural product chemistry. The structural diversity of compounds showing soap-like properties in aqueous solutions is enormous. Therefore, when the term “saponin” should continue to reflect some value in natural product classification, it
should be defined more precisely. This has become possible nowadays because the
knowledge on chemical structures of natural products (such as saponins) and their
biosynthetic pathways has grown tremendously. These advancements have stimulated the
classification of natural products based on the biosynthesis of their carbon skeletons
(Devon and Scott, 1972, Connolly and Hill, 1991 and Xu et al., 2004). Further
classification may be based on subsequent biosynthetic transformations of these main
carbon skeletons, such as minor rearrangements, typical oxidation, homologation, or
degradation patterns, leading to rearranged, seco, homo, or nor compounds.

Several reviews have been published over the last two decades, focussing on
biosynthesis, isolation, structural elucidation, and biological activities of saponins
(Kulshreshtha et al., 1972, Mahato et al., 1988, Mahato et al., 1992a, Mahato and Nandy,
2004).

Saponins are often subdivided into two main classes, the triterpenoid and the steroid
saponins (Abe et al., 1993), which are both derived from the 30 carbon atoms containing
precursor oxidosqualene (Haralampidis et al., 2002). The difference between the two
classes lies in the fact that the steroid saponins have three methyl groups removed (i.e.
they are molecules with 27 C-atoms), whereas in the triterpenoid saponins all 30 C-atoms
retained.

In a recent review (Vincken et al., 2007) the structures of saponins are classified based on
their carbon skeletons, the formation of which follows the main pathways for the
biosynthesis of triterpenes and steroids. In this way, 11 main classes of saponins were
Introduction to saponins distinguished: dammaranes, tirucallanes, lupanes, hopanes, oleananes, taraxasteranes, ursanes, cycloartanes, lanostanes, cucurbitanes, and steroids. The dammaranes, lupanes, hopanes, oleananes, ursanes, and steroids are further divided into 16 subclasses, because their carbon skeletons are subjected to fragmentation, homologation, and degradation reactions.

2.1 Introduction to triterpenoids:

Triterpenoids are ubiquitous non-steroidal secondary metabolites and have a carbon skeleton base on six isoprene units. They are derived from squalene and broadly classified as cyclic or acyclic structures. They are colourless crystalline, often high melting, optically active compounds. They possess acyclic, mono-, di-, tri-, tetra- or pentacyclic carbon skeletons. The important cyclic compounds are the tetracyclic (lanostane, euphane, cycloartane, etc.) and pentacyclic (\(\alpha\)-amyrin, \(\beta\)-amyrin, lupine, hopane, etc.). The pentacyclic triterpenoids, are dominant constituents. (Mohammed Ali, 2005).

2.2 Pentacyclic triterpenoids:

The true pentacyclic triterpeoids, \(\alpha\)-amyrin, \(\beta\)-amyrin, their derived acids and related compounds occur especially in waxy coating of leaves and fruits. They act as insect repellants and microbial attack. The pentacyclic triterpenes may be classified mainly into three groups:

(a) \(\beta\)-amyrin group, e.g., oleanane derived compounds

(b) \(\alpha\)-amyrin group, e.g., ursane-derived compounds, and

(c) lupeol system, e.g., lupane derived compounds
usually a hydroxyl group is located at C-3 position. The polyhydroxy β-amyrins possess hydroxyls in other position which may be from two to six in number. (Mohammed Ali, 2005).

2.3 Triterpenoid saponins:

They are naturally occurring sugar conjugates of triterpenes which form stable froth when shaken with water. The glycone part of these compounds are generally oligosaccharides, linear or branched, attached to a hydroxyl or a carboxyl group or both. The sides of attachment may be one (monodesmosides), two (bisdesmosides) or three (tridesmosides). These saponins possess the oleanane ring system, or more rarely ursane, dammarane, lupane, cycloartane, lanostane or serratene system. They respond positively to Liebermann-Burchard and Molisch’s test.

The carbohydrate group usually contains 1-6 monosaccharide units, the most common of these being glucose, galactose, rhamnose, arabinose, fructose, xylose, glucuronic acid and galactouronic acid. (Mohammed Ali, 2005)
2.2 References


