

Barbara Moniuszko-Szajwaj

SAPONINS FROM THE ROOTS OF *SAPONARIA OFFICINALIS* L.
– CHEMICAL STRUCTURE, QUANTITATIVE DETERMINATION
AND BIOLOGICAL ACTIVITY

Keywords: *Saponaria officinalis* L., Caryophyllaceae, triterpenoid saponins, gypsogenic acid, quillaic acid, NMR

The aim of the study was to isolate triterpenoid saponins from the roots of common soapwort (*Saponaria officinalis* L.) and determine their full chemical structure; also to develop the UPLC-ESI-MS method for determining the content of individual triterpenoid saponins in the roots of soapwort and establish the change in the content and composition of saponins from the roots of soapworts from various locations; and finally to study selected biological activities of saponins from the roots of *S. officinalis*, such as allelopathic, antifungal and hemolytic activity.

The plant material in the form of ground soapwort roots, obtained from a commercial source (Herbapol Kraków S.A), was used to isolate saponins and study selected biological activities. Whereas, material obtained from natural positions was used to evaluate the composition and content of saponins in the roots of soapworts coming from different locations such as: Sochocin in the Masovian Province, the Warmian-Masurian Province, Jaworów in the Lviv Oblast, Mszaniec in the Tarnopol Oblast, from Zaklików in the Podkarpackie Province and Opatkowice, Łęka and Jaroszyn in the Lubelskie Province, as well as material from a two-year *S. officinalis* cultivation carried out on the IUNG-PIB experimental plot in Puławy.

19 saponins were isolated from the roots of soapwort (*S. officinalis*) using preparative chromatography techniques, the structure of which was determined by spectral methods, such as mass spectrometry and nuclear magnetic resonance (MS, NMR). It was found that 12 of the isolated saponins were glycosides of gypsogenic acid and its derivatives, and 7 were glycosides of quillaic acid. Eight saponins (3 with aglycone of gypsogenic acid and its derivatives and 5 of quillaic acid) turned out to be new compounds that had not been

described in the literature so far. In addition to the new saponins, the occurrence of dianchinenoside B and vaccaroside D was found in this plant for the first time.

The UPLC-ESI-MS method was developed for the quantitative determination of saponins in the soapwort material. The percentage content of saponins in the root of *S. officinalis* was 7.4% of the dry weight of the root. The dominant saponins in the soapwort root were new compounds No. **4**, (3-*O*- β -D-galactopyranosyl-(1 \rightarrow 2)-[β -D-xylopyranosyl-(1 \rightarrow 3)]- β -D-glucuronopyranosyl quillaic acid 28-*O*- β -D-glucopyranosyl-(1 \rightarrow 3)- β -D-xylopyranosyl-(1 \rightarrow 4)- α -L-rhamnopyranosyl-(1 \rightarrow 2)-[β -D-xylopyranosyl-(1 \rightarrow 3)]-(4-*O*-acetyl)- β -D-quinovopyranosyl-(1 \rightarrow 4)]- β -D-fucopyranoside and No. **7** (3-*O*- β -D-galactopyranosyl-(1 \rightarrow 2)-[β -D-xylopyranosyl-(1 \rightarrow 3)]- β -D-glucuronopyranosyl quillaic acid 28-*O*- β -D-glucopyranosyl-(1 \rightarrow 3)- β -D-xylopyranosyl-(1 \rightarrow 4)- α -L-rhamnopyranosyl-(1 \rightarrow 2)-[(4-*O*-acetyl)- β -D-quinovopyranosyl-(1 \rightarrow 4)]- β -D-fucopyranoside) and saponarioside A with a content of 12.10 mg/g, 9.23 mg/g and 7.48 mg/g of dry root weight, respectively. The percentage share of glycosides of quillaic acid was 64.81%, while the total share of gypsogenic acid and its derivatives amounted to 35.19%. The contents of saponins in extracts of soapwort plants from different locations were compared. It was found that soapwort roots differ in terms of qualitative and quantitative content of saponins depending on the position (saponin content ranged from 69.18 mg/g of dry matter for a plant originating from Zaklików up to 30.63 mg/g for a plant originating from Opatkowice).

Having examined the allelopathic activity, it turned out that saponins from soapwort root inhibit the germination and growth of lettuce, cress, white mustard and onions, and exert stronger inhibition action on the growth of roots rather than shoots.

Soapwort saponins inhibit the growth of pathogenic fungi of cereals *Gaemannomyces graminis* var. *tritici* and *Fusarium culmorum*; it turned out that the sensitivity of *F. culmorum* was much weaker compared to *G. graminis* var. *tritici*.

It has been shown that both the saponin fraction and the saponin fraction rich in glycosides of quillaic acid have a strong hemolytic effect on red blood cells. The comparison of both fractions showed that both gypsogenic and quillaic acid glycosides have similar hemolytic ability as well as the saponins from common soapwort have stronger hemolytic properties than medicagenic acid 3-glucoside.