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POLYGONATUM MILL – AN INTENSIVELY STUDIED PERSPECTIVE PLANT GENUS

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მცენარე "POLYGONATUM MILL"-ის პერსპექტიული გვარის ინტენსიური შესწავლა

[1]აზერბაიჯანის სამედიცინო უნივერსიტეტი, ზოგადი და ტოქსიკოლოგიური ქიმიის დეპარტამენტი, ბაქო, აზერბაიჯანი; [2]თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი, სოციალური და კლინიკური ფარმაციის დეპარტამენტი

რეზიუმე

ნაშრომი წარმოადგენს განზოგადებულ მასალას Polygonatum Mill-ის სხვადასხვა სახეობის ქიმიური შემადგენლობის შესწავლის შესახებ. Polygonatum სახეობების ქიმიური შემადგენლობა შესწავლილია სხვადასხვა ქვეყნის მეცნიერების მიერ. ეს მცენარე მდიდარია ბიოლოგიურად აქტიური ნივთიერებებით, რომლებიც ძვირფასად ითვლება მედიცინისა და ფარმაციისათვის. ამ ნივთიერებების უმეტესობას ამჟამად აქტიურად იკვლევენ ფარმაკოლოგიური თვალსაზრისით მთელს მსოფლიოში. პოლიგონატუმის მრავალი სახეობის შემადგენლობაში გამოვლენილია ფლავანოიდები, კუმარინები, საპონინები, პოლისაქარიდები და სხვ. და შესწავლილია მათი ქიმიური სტრუქტურა. მაგრამ სტეროიდული საპონინები ითვლება მთავარ ბიოლოგიურად აქტიურ ნივთიერებად. შემაჯამებელი მონაცემები აჩვენებს, რომ პოლიგონატუმის სხვადასხვა სახეობის ბიოლოგიურად აქტიური ნივთიერებების შესწავლა არის ძალიან პერსპექტიული მიმართულება.

The genus Polygonatum Mill is currently one of the most intensively studied plant genus, distinguished by the diversity of its chemical composition and biological activity. The chemical composition of Polygonatum species has been studied by scientists from various countries.

Georgian scientists have determined a number of biologically active substances while studying two species of Polygonatum. Thus, the flavonoid content of P. glaberrimum and P. polyanthemum rhizomes was studied separately. 7 flavonoids - quercetin, isocversetin, hyperin, rutin, kempferol, astragalin and kempferol-3-O-α-D-arabinopyranoside were obtained from P. polyanthemum rhizome. The flavonoid content of P. glaberrimum rhizome is less rich in quality and quantity, only 4 types of flavonoids were found: quersetin, isoquersetin, kempferol, astragalin [6]. Later, when studying the chemical composition of the rhizome and main stem of P. polyanthemum, it was determined that it contains stilbens (aromatic hydrocarbons) and coumarins. 2 stilben and 2 coumarin were found. Coumarins have been identified as scopoletin (6-methoxy-7-hydroxycoumarin) and umbelliferon (7-hydroxycoumarin). Flavonoids, coumarins and stilbens from P. glaberrimum and P. polyanthemum were first obtained by these researchers [5].

Continuing to study the species of Polygonatum, Georgian scientists considered it important to first study the nature of the steroid sapogenins in the rhizomes of P. polyanthemum and P. glaberrimum. The sum of sapogenin was obtained by hydrolysis from raw materials taken separately from each plant. As a result of research, 4 substances were obtained from the sum of sapogenin of P. glaberrimum species: tigogenin, diosgenin, yamogenin and pennogenin, from P. polyanthemum species these 4 substances and in addition 5 substance - smilagenin. The study of steroid glycoside content of both plants was continued by researchers and individual saponins were obtained [2-4]. Azerbaijan scientists have studied the composition of steroid saponins and sapogenins in the species P. polyanthemum and P. glaberrimum, which are widespread in Azerbaijan. Steroid sapogenin - smilagenin was obtained from the rhizome of P. polyanthemum

[8]. Two steroidal saponins which aglycone part consist of diosgenin and pennogenin were obtained individually from the rhizome and berry of P.glaberrimum and their complete chemical structures were determined [7].

In recent years, many biologically active substances have been obtained from P. sibiricum Delaroche - alkaloids, polysaccharides, steroids and triterpene saponins. Chinese scientists obtained 2 new alkaloids from the rhizome of P. sibiricum – polygonatin-1 and polygonatin-2, determined their structure by research and determined that these alkaloids should be indole derivatives [13]. In order to search for more potentially bioactive and new compounds, another group of Chinese scientists obtained 3 new triterpene saponins of the oleane type from the rhizome of the P. sibiricum plant and separately furostan saponins [11,16].

It is known that higher plants synthesize various biologically active substances. Among these substances, steroid compounds are of particular importance. Glycosides from spirostan and furostan form a group of steroid compounds. The aglycone part of these glycosides is a source of raw materials for various steroidal drugs. Steroid glycosides in species of different genus, including Polygonatum, have been chemically and pharmacologically studied by scientists from many countries: Azerbaijan, Georgia, Russia, Moldova, and China [1,3,8,9]. There are rich scientific literature informations on the presence of steroid saponins in many species of Polygonatum.

Russian researchers obtained 4 steroid saponins from P. stenophyllum and conventionally accepted them as polygonatosides A, B, C, D. The authors proved that the carbohydrate chain of polygonatosides B, C, D contained glucose, arabinose, rhamnose and that polygonatoside A contained only arabinose. These saponins accepted as new representatives of steroid compounds. Subsequent studies by these authors have shown that the sapogenin of these steroid saponins is 25 R-spirost-5-en-3β, 17α-diol-pennogenin. Pennogenin has synthetic opportunities – it can be used as a suitable raw material for the synthesis of many therapeutic steroids. Researchers have determined that the polygonatoside C itself is a mixture of glycosides C1 and C2, which are very difficult to separate from each other and have a very close degree of polarity. Finally, the authors were able to accurately determine the chemical structure of polygonatosides C1 and C2. C1 polygonatoside has been characterized as pennogenin-3-O-α-L-ramnopyranosyl (1→2)-[α-L-arabinofuranozyl(1→4)]-β-D-glucopyranoside, C2 polygonatoside pennogenin-3-O-α-L-ramnopyranosyl-(1→2)-[α-L-ramnopyranosyl (1→4)] - β-D-glucopyranoside [9].

Unlike Russian scientists, Moldovan scientists have studied steroid saponins of the leaves and underground part of another species – P. latifolium (Jacq.) Desf. The sum of steroid saponins was obtained from the underground part of this species and proved to consist of 9 substances. These substances are conventionally accepted as glycosides A, B, C, D, E, F, G, proto-E and proto-G. Studies have shown that substances B, proto-E and proto-G are furostanol. But glycosides A, C, D, E, F and G are spirostanol. A saponin A has been identified as trillin and saponin B as fungicide B. The aglycones of glycosides D, E, G are diosgenin; The aglycone of glycosides C and F is pennogenin. Subsequent studies have interpreted the results of determining the structure of E1 polygonatoside and E1 protopolygonatoside by conventionally accepting saponins of the same plant as polygonatosides. The chemical structure of both glycosides has been determined: E1 polygonatoside: 3-O- [β-D-glucopyranosyl (1→3) -O-β-D-glucopyranosyl- (1→4)-O-β-D-galactopyranosyl (1 → 3) -O-β-D-glucopyranoside] -diosgenin; The protopolygonatoside E1 is furostanol -26-O- β- D-glucopyranoside with the same carbohydrate chain in the position 3 [1,9].

The study of P. zanlanscianense rhizome in this direction was carried out by Chinese scientists, who were able to isolate the steroid saponins from the plant individually. The chemical composition of 4 new steroid saponins - polygonatosides has been identified. Their structure was

clarified based on the results of spectroscopic analysis, acid and enzymatic hydrolysis. These substances have been identified as isonarsogenin -α, -β, diossin, gracillin and parissaponin [12].

Steroids obtained from species of the genus Polygonatum so far can be divided into spirostan, furostan and cholestane groups. Oligosides contain more glucose, galactose, rhamnose and xylose. A number of saponins have lycetetraose in the third position. More than half of the spirostane saponins in the studied Polygonatum species are derivatives of smilagenin ((25R) -spirostan-3β-ol) and diosgenin (25R) -spirost -5-en-3β-ol). Smilagenin itself is obtained from the rhizomes of P. odoratum, and diosgenin is obtained from the rhizomes of P. odoratum, P. verticillatum, as well as the leaves of P. multiflorum. Diosgenin derivatives are obtained not only from P. odoratum rhizomes, but also from the underground part of P. sibiricum and P. latifolium rhizomes and leaves. In addition, glycosides of diosgenin have been identified in Far Eastern species (P. acuminatifolium, P. desoulavyi, P. humile, P. inflatum, P. involucratum, P. maximoviczii), the chemical structure of which has not been determined. Yamogenin tetraosides have been identified in P. sibiricum and P. odoratum rhizomes. The presence of glycosides of pennogenin in the rhizomes of P. stenophyllum was determined. Oligosides of septrumgenin and acyrogenin have been identified and isolated in P. orientale rhizomes. 3-O-lycotetraosides of sibiricogenin and neopraserigenin, as well as acetylated spirostanol-containing glycosides in the A ring, were obtained from P. sibiricum rhizome. (25S) spirost-5,14 diene-3β-ol-oligoside and spirost-5 en-3β, 4α-diol tetraoside, which differ in the chiral configuration of the aglycone, were identified in P. odoratum species. Furostanol glycosides have been identified in P. latifolium, P. odoratum and P. sibiricum. Thus, furost-5-en-3β, 22α, 29-triol tetraoiside and its 12-oxoderivative glycosides were found in P.odoratum. The structures of B polygonatoside and E` protopolygonatoside obtained from P. latifolium leaves and rhizomes were determined. Furostanol glycosides obtained from P. sibiricum differ from other saponins due to the presence of 22-alkyloxyderivative in the aglycone, with the exception of polygonoid B. The components of P. odoratum rhizomes are sterols: β sitosterol, daucosterol and stigmasterin [1,10,14,16].

Polysaccharides are another group of biologically active substances found in Polygonatum. The presence of polysaccharides in different species of Polygonatum has been determined and after isolation studied both phytochemically and pharmacologically [15, 20]. The polysaccharides in P. kianianum, depending on the different growth phases, have been extensively studied. These polysaccharides have been shown to have many pharmacological effects (antioxidant, anti-aging and antibacterial) [17]. In another study, the polysaccharides of the Polygonatum species were compared. In most of these 9 species, polysaccharides consist of pectins and fructans. Polysaccharides of P. macropodium are mainly composed of fructans [19]. The comparative polysaccharide content of P. sibiricum, P. cyrtonema, P. kingianum and P. odoratum species was studied using modern analysis methods. Polysaccharides of P. odoratum mainly consist of fructans, while the polysaccharides of the other 3 species are consist of pectin and fructans [18].

The diversity and richness of biologically active substances obtained from many species of Polygonatum indicate the perspective for further expansion of investigations of this plant.

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ИНТЕНСИВНОЕ ИЗУЧЕНИЕ ПЕРСПЕКТИВНОГО РОДА РАСТЕНИЙ «POLYGONATUM MILL».

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РЕЗЮМЕ

В работе представлен обобщенный материал по изучению химическому составу разных видов Polygonatum Mill. Химический состав видов Polygonatum изучен учеными разных стран. Это растение богато биологически активными веществами, которые считаются ценными для медицины и фармации. Многие из этих веществ в настоящее время активно изучаются с фармакологической

точки зрения учеными всего мира. Флаваноиды, кумарины, сапонины, полисахариды и др. определены в составе многих видов Polygonatum, изучено их химическое строение. Но основным биологически активным веществом считаются стероидные сапонины. Из сведений видно, что изучение биологически активных веществ у разных видов Polygonatum является очень перспективным направлением.

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SUMMARY

In the paper a generalized material on study chemical composition of the different species of Polygonatum Mill. has been presented. The chemical composition of Polygonatum species has been studied by scientists from different countries. This plant is rich in biologically active substances that are considered valuable for medicine and pharmacy. Many of these substances are currently being studied extensively from pharmacological aspect by scientists around the world. Flavanoids, coumarins, saponins, polysaccharides etc. are determined in the composition of many species of Polygonatum, their chemical structures were studied. But steroidal saponins are considered the main biologically active substance. It is clear from the summary information that the study of biologically active substances in different species of Polygonatum is a very perspective direction.

Key words: Polygonatum Mill., biological active substances, steroidal saponins