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ANALYSIS OF THE MOST IMPORTANT SECONDARY METABOLITES OF PRIMROSE ROOTS

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Abstract. *Primrose (Primula veris Huds.) is a perennial herbaceous plant which grows in Western and Southern Europe, Northwestern Africa, and most of southwestern Asia. It belongs to the Primulaceae family. Half of all species from this family belong to the genus Primula. Primrose is a low plant that grows up to 20 cm in height and flowers during early spring. It has an important role in phytotherapy. In traditional medicine, primrose root is used to thin thick bronchial secretions and facilitate expectoration. The secondary metabolites isolated from the roots of primrose have a pronounced biological and pharmacological potential. In order to determine the therapeutic effect, it is necessary to define the content of active compounds and monitor their content in the medicinal products obtained from the root of primrose. The aim of this paper is to review the current state of knowledge about analytical methods for the detection and determination of the content of secondary metabolites obtained from the roots of primrose. This review provides a detailed analysis of the current application of modern methods in the identification and determination of secondary metabolites of primrose root, based on data collected from peer-reviewed papers referenced in Science Direct, Scopus, Medline and Google Scholar databases. The search was performed based on the following keywords: "Primrose (Primula veris)", "Flavonoids", "Primrose (Primula veris) and Flavonoids", "Phytomedicine", "Primula veris and Phytomedicine", "Primula veris and Flavonoids and Phytomedicine". In the analyzed papers, the compounds with the most pronounced physiological effects were listed as: triterpene saponins and phenolic compounds, including flavonoids, phenolic acids and phenolic glycosides. In order to identify and determine the content of these compounds, the following methods were used in the works: spectrophotometric methods (estimation of the capacity of antioxidant activity using DPPH, CUPRAC test, FRAP test), thin-layer chromatography, high-performance liquid chromatography (HPLC), detection of evaporative light scattering, mass spectrometry (GC/ MS), Fourier-transform infrared spectroscopy (FTIR), nuclear magnetic resonance (NMR). HPLC is the most commonly used method for the determination of components from the primrose root. In the present review paper, the importance of secondary metabolites and other active components from the root of primrose is emphasized, as well as the need to apply adequate analytical methods for quick identification and accurate determination of individual ingredients. In addition, the conditions during the determination of the content of triterpene saponins and phenolic compounds are presented. The results presented in this paper serve as an important source of information for laboratory, pharmaceutical and medical professionals.*

Key words: *Primula, saponins, flavonoids, high-performance liquid chromatography*

Introduction

Primrose (*Primula veris* Huds.) is a perennial herbaceous plant from Western and Southern Europe, Northwestern Africa and Southwestern Asia. It belongs to the family Primulaceae, where almost half of all species belong to the genus *Primula*. It is a low plant that grows to a height of 20 cm, and flowers with characteristic yellow flowers during early spring. It is widespread in the mountainous regions of the country, and its habitat is sunny meadows. The medicinal part of the plant is the dried root (*Primulae radix*) and flower (*Primulae flos*). In addition to *Primula veris* and *Primula elatior* species, it is an officinal biological source of the mentioned herbal medicines. In the pharmacopoeia, the monograph of the root of primrose is divided into two parts. The first part is related to identification, where macroscopic and microscopic identification is described. The second part is related to thin-layer chromatography (TLC) as a method used to confirm that it is a saponin physiologically active substance of plant origin [1]. The roots of *P. veris* and *P. elatior* contain primulaverine and primeverine which are phenolic glycosides, while *P. veris* contains ten times more content than *P. elatior* [2]. *P. veris* and *P. elatior* are mainly used for the production of herbal teas and preparations of plant physiologically active substances, which are most often registered as supplements and stored. They indicate various pharmacological activities, for example, secretolytic, expectorant, anti-inflammatory, diuretic, antimicrobial, antifungal and sedative effects. According to the monograph of the European Medicines Agency (EMA), the flowers and root of primrose are used against cough, bronchitis and catarrh of the respiratory tract, and traditionally also for the treatment of nervousness, headache or rheumatism. Based on the EMA monographs and the European Pharmacopoeia, primrose preparations are produced exclusively from the plant species *P. veris* and *P. elatior*, which are considered to have the same values. Due to the developmental and morphological similarity between these species, it is difficult to distinguish them in natural locations, and after the drying process, the raw materials collected from them are indistinguishable [3]. In addition to its role in human health, it appears that primrose is an important plant species for natural habitats, because it can serve as an early indicator of ecosystem health and quality by quickly reacting to direct negative changes in the environment [4].

Secondary metabolites from the roots and flowers of primrose

Primrose is an important medicinal plant that is traditionally used for its expectorant and anti-inflammatory properties, as well as a valuable horticultural plant of ornamental value and agro-nutritive interest (edible flowers and leaves) [5]. The roots and flowers of primrose are a source of pharmaceutical raw materials used for the production of expectorants and diuretic drugs due to their high content of triterpenes saponin and phenolic glycosides. Extracts, most often water-ethanol, from the roots of primrose are components of many herbal preparations, such as Bronchicum®, Pectosol®, Tussipect® and Sinupret® [4]. Primrose is used as a traditional herbal medicine as an expectorant for coughs associated with colds. The product is a traditional herbal medicine for use in the indicated indication only on the

basis of long-term use [6]. Valuable secondary metabolites produced in primrose roots can also be obtained from cultivated plants. In most *Primula species*, including *P.veris*, seed germination difficulties have been reported under greenhouse and field conditions. Seed germination in *P. veris* interferes with a number of factors, the most important of which is dormancy, which occurs at the level of the embryo, seed coat or seed coat, due to unfavorable environmental conditions during the year. From the point of view of phytochemistry, chemical synthesis of secondary metabolites is often not economically feasible due to very complex structures and stereospecificity. However, adventitious root culture is considered an efficient technique for the continuous production of biomass, and thus characteristic secondary metabolites, and tissue culture of some species of bitter gorse has been proposed as an alternative method in this context [4]. The main active compounds of the flowers and roots *of primrose* are triterpene saponins, as well as phenolic compounds, including flavonoids (about 3% in the flowers), phenolic acids and phenolic glycosides [3].

Saponins

Saponins are the active components of primrose that have an expectorant effect. They stimulate the gastric mucosa, which, due to the vagus reflex, leads to increased bronchial secretion and improves expectoration by diluting the sputum in the bronchi. Saponins are widely distributed in nature. They are mainly found in higher plants as secondary metabolites and their presence has been determined in almost 100 families. These glycoside-type compounds consist of a triterpene or steroidal aglycone known as sapogenin (hydrophobic part) and one or more sugar residues (hydrophilic part), which are linked by ester or ether bonds. Most triterpenoid saponin aglycones have a pentacyclic oleane, ursane, hopane or damaran type structure. While most aglycones of steroid saponins have a spirostane or furostane type structure. In plants, saponins are present in various organs (roots, rhizomes, stems, bark, leaves and seeds). Those that have a defensive role against bacteria, fungi, viruses, parasites and insects [7]. Glycosides and glycosidic esters of the oleanane type are among the most widespread groups of saponins. Despite their widespread presence, primulasaponins I, II (Figure 1) and sakurasosaponin have not previously been the subject of any clinical studies. However, they belong to the saponins which are of special medical interest [8]. According to the literature, the saponin content of the species *Primula* it can vary from 2% to 12%, and the optimal content has not yet been defined in monographs [1].

Biological activity of saponins

Saponins stand out from the group of glycosidic compounds as a special group due to three characteristics: 1) reduce the voltage on the contact surface of two immiscible phases (surfactants). Due to the reduction of surface tension, saponins also lead to hemolysis of erythrocytes. In cells, they bind to sterols found in membranes and increase membrane permeability. Because of this characteristic, extracts containing saponins are never administered intravenously; 2) Aqueous

solutions of saponin active substances by shaking copious amounts of foam; 3) in addition to the usual ether (glycosidic) bond, sugars can also be linked to the aglycone molecule by an ester bond. In relation to the properties of decoction of saponin extracts when shaken, it produces abundant and persistent foam, causes hemolysis of erythrocytes *in vitro*, poisons laboratory fish and earthworms, various monographs prescribe the determination of the number of foam, hemolytic action and fish index as quality parameters. The non-lethal part, the so-called aglycone, is responsible for its pharmacological effects [9]. After oral administration of therapeutic doses, saponins reflexly irritate the vagus nerves. This leads to increased secretion of mucus in the respiratory tract. Additionally, breathing and the cough center are irritated, resulting in more frequent coughing. However, higher doses of saponin can irritate the mucous membrane of the stomach and intestines, leading to vomiting, diarrhea and bleeding [10].

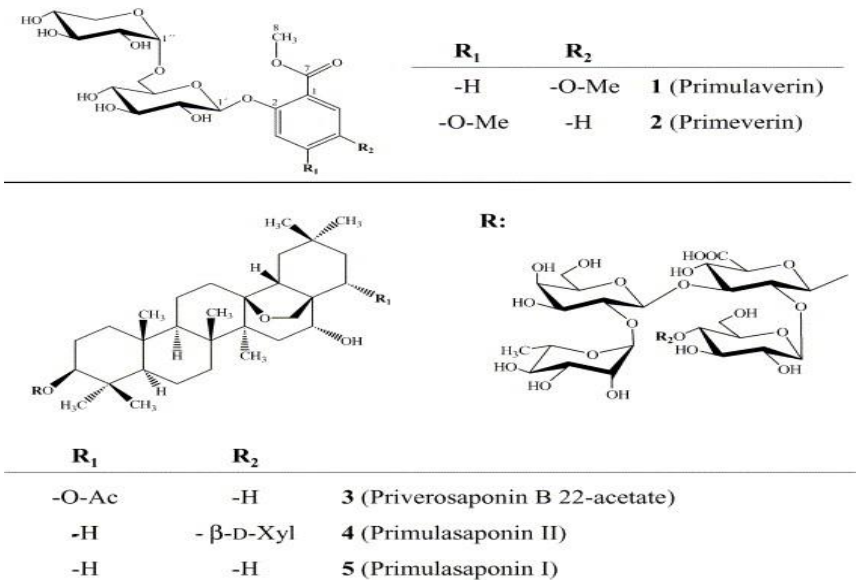

Figure 1. Structure of the most important compounds from the saponin group [18].

Flavonoids

Flavonoids are among the most studied secondary metabolites of plants. They are a prominent class plant metabolites which play a key role in the interactions of plants with their abiotic and biotic environment. Due to their variation among species and populations, flavonoids have been repeatedly used as a chemotaxonomic marker. However, even within the plant, qualitative and quantitative composition of flavonoids is very plastic and depends on the genotype of the plant, its developmental stage and the conditions of the environment in which it grows. These compounds can accumulate both in various organ tissues and in above-ground parts as an epicuticular secretion, where they perform a number of useful functions for the plant. The following are most represented in the root of primrose: apigenin, rutoside,

quercetagenin -3- gentiobioside, 3',4',5'- trimethoxyflavone and kaempferol -3-rutinoside. In addition to flavonoids from phenolic compounds, there are also specific phenolic glycosides primulaverine and primeverine (Figure 1), which can be significant from the aspect of quality control of *Primulae radix* as well as preparations of this herbal drug [11, 12].

Material and methods

During the research, this paper presents an overview of the detailed analysis of the current application of modern methods in the identification and determination of secondary metabolites of primrose root, based on data collected from peer-reviewed papers referenced in Science Direct, Scopus, Medline and Google Scholar databases. The search was performed based on the following keywords: "Primrose (Primula veris)", "Flavonoids", "Primrose (Primula veris)" AND "Flavonoids", "Phytomedicine", "Primula veris" AND "Phytomedicine", "Primula veris" AND "Flavonoids and Phytomedicine".

Results and discussion

A crude plant extract is a very complex mixture that sometimes contains hundreds or thousands of different metabolites. The chemical nature of these constituents varies significantly within a given extract, and the variability of the physico-chemical as well as spectroscopic parameters of these compounds causes numerous problems in detection.

Thin Layer Chromatography (TLC)

Although an old technique, thin layer chromatography (TLC) finds a lot of application in the identification of physiologically active substances of plant origin. In TLC, the solid phase, the adsorbent, is deposited in a thin layer on solid, inert supports. The adsorbent should show extreme selectivity towards the substances to be separated so that the differences in the elution rate are large. For the separation of any mixture, some adsorbents can be too adsorbing or too weakly adsorbing. Table 1 lists the approximate order of chromatographic adsorbents, because it depends on the substance to be adsorbed and the solvent used for elution [13, 14].

Table 1. Chromatographic adsorbents

The strongest adsorbent	Aluminum oxide	Al_2O_3
	Activated charcoal	C
	Florisil	MgO/SiO_2 (anhydrous)
Least strong adsorbent	Silica gel	SiO_2

*source [13]

Thin-layer chromatography is a popular technique for the analysis of a wide range of organic and inorganic materials, due to its characteristic advantages such as

minimal sample clean-up, wide selection of mobile phases, flexibility in sample differentiation, large sample loading capacity and minimal cost [15]. After the macroscopic and microscopic identification of the physiologically active substances of *Primulae radix plant origin* in the pharmacopoeia, the method of thin-layer chromatography to confirm the identity is described. This test confirms whether it is a saponin active substance, and saponin escin is used as a standard. Since there may be falsification of physiologically active substance of plant origin *Primulae radix* , e.g. with the root of the non-saponin plant *Vincetoxicum hirundinaria* Medik, the TLC test confirms the identity of the plant matter, which can then be used in pharmacy. The main disadvantage of TLC is that it only shows the presence or absence of a compound, and that is why it is used to confirm the identity of the herbal raw material, while for the purposes of standardization of herbal medicinal preparations, most often the aqueous-ethanolic extract of burdock root, which is included in the composition of various herbal products, it is necessary to use other methods. For now, there is no requirement in the pharmacopoeia for the standardization of both the plant material and the corresponding extract, and there is a need for more detailed control, for the sake of efficiency and safety, especially since syrups obtained from the extract of primrose root are often used in pediatric age [1]. One representative TLC method for saponins determination in the *Primula* root is cited in Table 2.″

High Performance Liquid Chromatography (HPLC)

Performance Liquid Chromatography (*HPLC)* is an advanced form of liquid chromatography that is used to separate the complex mixture of molecules found in chemical and biological systems, in order to better recognize the role of individual molecules. In 1980, HPLC methods for testing bulk material appeared for the first time [13]. HPLC has become the main method in the United States Pharmacopoeia [16]. The HPLC method is used for analytical and preparative purposes. Like other chromatographic methods, it is based on the separation of the components of the mixture so that the required analyte can be detected. Separation of compounds from the mixture is done on the basis of their different distribution between two phases - stationary and mobile. The stationary phase is in the column in the form of particles between which the mobile phase passes. Compared to classical liquid chromatography, in the HPLC method the mobile phase flows through the column under high pressure, which shortens the duration of the method and improves the separation of the components of the mixture. The liquid sample is injected into a jet of solvent **(**mobile phase**)** flowing through a column filled with a separation medium (stationary phase). The sample components are separated from each other by the process differential migration as they pass through the column. As the strips exit the column, the flow carries them to one or more detectors that deliver the voltage response as a function of time [17]. The actual method is described in several scientific papers HPLC for the quantification of the most important phenolic compounds of the root and flower of the primrose. One representative HPLC method

for primverin and primulaverin E determination in the root of *P. veris* and *P. elatior* is cited in Table 2.

Liquid chromatography with mass spectrophotometry (LC – MS)

Mass spectrometry (MS) is an efficient analytical technique with a wide range of applications ranging from forensic, proteomic and metabolomic to clinical studies. With the development of various ionization techniques and mass analyzers, even demanding samples can be analyzed. In this way, mass spectrometry makes an important analytical tool in the field of characterization of bioactive molecules ranging from small metabolites to large macromolecular systems. MS is the only technique that offers a combination of high sensitivity with structural information.
LC-MS is a chemical technique that combines the physical separation capabilities of liquid chromatography with the analysis capabilities of MS. This is a powerful technique used in many applications. It has very high sensitivity and selectivity. In general, its application is aimed at the general detection and potential identification of chemicals in the presence of other chemicals. The preparative LC-MS system can be used for the quantification of the most important saponins and phenolic glycosides of the root and flower of primrose, rapid and mass purification of extracts of natural products and new molecular entities important for the food and pharmaceutical industries. LC-MS is the key analytical technique on which the new "-omics" technologies of proteomics, metabolomics and lipidomics are based. It provides both structural and quantitative data and can be used in a global or targeted manner, enabling the identification of thousands of proteins from tissues on the one hand, and the detection of biologically active metabolites at the levels of a few parts on the other. It can be expected that the continued incremental development of LC-MS, along with data handling routines, will soon bear fruit in the quest for a better understanding of human diseases, leading to new drug targets and therapies [18, 19] . The main problem of using LC-MS in the chemistry of natural products lies in the ionization of a very important series of compounds found in crude plant extracts [20]. One representative LC-MS method for saponins determination in the root of *P. veris* and *P. elatior* is cited in Table 2.

Nuclear Magnetic Resonance Spectroscopy (NMR)

Rapid detection of biologically active natural products is very important in phytochemical research of crude plant extracts. Since its invention in 1996, nuclear magnetic resonance (NMR) spectroscopy has been extensively used to elucidate and confirm the structure of target drug molecules [10]. In the last few years, various approaches have been presented that have found wide application, both in pharmaceutical and academic research. NMR has found its application in the analysis of plant extracts of *P.veris*, in quantitative analysis to determine the impurity of the drug, in the characterization of the composition of medicinal products and in the quantification of drugs in pharmaceutical formulations and biological fluids. Numerous works on the application of NMR in pharmacy have also been published

[21,22]. The recent introduction of HPLC combined with nuclear magnetic resonance (LC–NMR) represents a powerful complement to LC–UV–MS screening [23]. Table 2 provides a representative example of studding the primula solid extract using the NMR method.

Fourier transform infrared spectroscopy (FTIR)

Fourier transform infrared spectroscopy (FTIR) is suitable not only for differentiating different plant species, but also for differentiating different components within the plant. FTIR spectroscopic microscopy enables molecular imaging of complex botanical samples, and thus the detection and characterization of molecular components of biological tissue. This technique represents a powerful weapon in histological characterization and enables the investigation of the spatial distribution of proteins and small molecules within biological systems with high spatial resolution [24]. Table 2 provides a representative example of studding the *Primula* herbal extract using the FTIR method.

Presentation of analytical techniques for the determination of secondary metabolites of the root of primrose

Various analytical techniques and appropriate analytical methods play an important role in the analysis of secondary metabolites of the primrose root. Müller et al. [18] described the first liquid chromatographic method suitable for the simultaneous determination of bioactive compounds, saponins and phenolic glycosides, present in *Primula elatior* and *Primula veris*, together with NMR data of primulaverine and primeverine. Saponins were detected by evaporative light scattering detection (ELSD), while phenolic glycosides were monitored by UV at 210 nm. Table 2 shows the method validation parameters, which include: repeatability ($\sigma_{rel} \leq 4.5\%$), precision (intra- and inter-day variation $\leq 5.0\%$), accuracy (recovery $\geq$ 97.1%) and sensitivity (LOD $\leq$ 22ng (UV) and $\leq$ 38ng (ELSD) on column, respectively). *P.veris* and *P.elatior* can be easily distinguished by the saponin pattern. Bączek et al. [3] successfully determined with the method of high-performance liquid hormatography that the content of phenolic glycosides (primverine and primulaverine) is ten times higher in *P.veris* compared to *P.elatior*. The method of thin-layer chromatography enables the simultaneous qualitative and quantitative determination of saponins from different plant extracts with high specificity, but quickly and cheaply, with high throughput and low consumption of reagents, providing new methods for the analysis of saponins in the food industry [14]. Latyapova et al. [23] used NMR for the first time to isolate the substance 3′,4′methylenedioxy-5′-methoxyflavone from bitter gourd. Bahar et al. [25] analyzed the antioxidant activity of primrose flowers using three different spectrophotometric methods, including 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging activity, iron reducing antioxidant power (FRAP) and copper reducing antioxidant capacity (CUPRAC). In addition to the differentiation of different plant species, FTIR is also suitable for the differentiation of different components within the plant [26].

Table 2. Presentation of analytical techniques for the determination of secondary metabolites of the root of primrose

METHOD	MATERIAL	REPEATABILITY	KEY RESULTS	REFERENCES
LC – MS: separation on Synergi 4 μm ; mobile phase 5% acetonitrile in methanol along with 0.025% TFA	Root of *P. veris* and *P.elatior*	Repeatability: $\sigma_{rel} \leq$ 4.5%, Accuracy: intra- and inter-day variations ≤ 5.0%, Accuracy: recovery ≥ 97.1% Sensitivity: LOD ≤ 22 ng (UV) and ≤ 38 ng (ELSD) on column, respectively)	Saponins in the root of *P.veris* 14.9% The most dominant phenolic glycoside: primverine (0.64 – 1.2%)	https://doi.org/10.1016/j.chroma.2005.10.067
HPLC: separated binary gradient of deionized water adjusted to pH 3 with phosphoric acid (Sigma-Aldrich); mobile phase A and ACN; mobile phase B was used as follows: 0.01 min, 18% B; 2.50 min, 20% B; 2.51 min, 95% B; 3.50 min, 95% B; 3.54 min, 18% B, 5 min, stop	Root of *P. veris* and *P. elatior*	PRIMVERIN Accuracy: 1.18 % Sensitivity: 7.95 μg/L PRIMULAVERINE: Accuracy: 0.96% Sensitivity: 38.39 μg/L	The content of both compounds was ten times higher in *P. veris* (1183.32 and 536.16 mg/100 g DW) than in *P.elatior* (110.31 and 74.40 mg/100 g DW)	https://doi.org/10.1155/2017/2871579
TLC: stationary phase – silica gel; Mobile phase – was designed using seed extract to test eight different mobile phases (ethyl	*Primula* root	Accuracy: 0.75%	Saponins 4.96%	https://doi.org/10.1016/j.lwt.2024.116139

acetate:methanol:water) in the ratio 4:1:0.6, 4:1:0.7, 4:1:0.8, 4 : 1: 0.9, 5 : 1: 0.8, 4 : 1.2: 0.8, 4 : 1.3: 0.8, 4 : 1.4: 0.8				
NMR	*Primula* solid extract	Nucleus sensitivity ^{1}H (0.1% ethylbenzene , $CDCl_3$)	Substance 3′,4′methylenedioxy-5′-methoxyflavone was isolated for the first time from primrose.	https://doi.org/10.1016/j.phymed.2018.09.015
CUPRAC test	Primula *flower*		16.68 ±0.42	https://doi.org/10.1016/j.ijgfs.2022.100618
FRAP test			8.79 ±0.40	
DPPH test			76.52 ±2.94	
FTIR	*Primula* herbal extract		5.3396 ±0.0943	http://dx.doi.org/10.3390/separations9090260

Conclusion

Primrose is one of the people's favorite plants, and it also plays an important role in phytotherapy. The main active compounds of the flowers and roots *of the primrose* are triterpene saponins, as well as phenolic compounds, including flavonoids, phenolic acids and phenolic glycosides. The paper emphasizes the importance of secondary metabolites and other active components from the roots of the primrose, as well as the need to apply adequate analytical methods for quick identification and accurate determination of individual ingredients. In addition, the conditions during the determination of the content of triterpene saponins and phenolic compounds are presented. The results presented in this paper serve as an important source of information both for experts in laboratories and for pharmaceutical and medical experts.

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ANALIZA NAJVAŽNIJIH SEKUNDARNIH METABOLITA KORIJENA JAGORČEVINE

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Sažetak. *Jagorčevina (Primula veris Huds.) je višegodišnja zeljasta biljka koja raste u zapadnoj i južnoj Evropi, sjeverozapadnoj Africi i dijelovima jugozapadne Azije. Ona spada u porodicu Primulaceae. Polovina svih vrsta iz ove porodice pripada rodu Primula. Jagorčevina je niska biljka koja raste u visinu do 20 cm i cvjeta tokom ranog proljeća. Ona ima važnu ulogu u fitoterapiji. U tradicionalnoj medicini korijen jagorčevine je korišten za razređenje gustog bronhijalnog sekreta i olakšavanje iskašljavanja. Sekundarni metaboliti izolovani iz korijena jagorčevine imaju naglašen biološki i farmakološki potencijal. Za utvrđivanje terapijskog efekta potrebno je definisati sadržaj aktivnih jedinjenja i pratiti njihov sadržaj u ljekovitim proizvodima dobijenim iz korijena jagorčevine. Cilj ovog rada odnosi se na pregled trenutog stanja znanja o analitičkim metodama za detekciju i određivanje sadržaja sekundarnih metabolita dobijenih iz korijena jagorčevine. Ovaj pregled pruža detaljnu analizu trenutne primjene savremenih metoda u identifikaciji i određivanju sekundarnih metabolita korijena jagorčevine, a na osnovu podataka prikupljenih iz recenziranih radova referisanih u bazama Science Direct, Scopus, Medline i Google Scholar. Pretraživanje je izvršeno na osnovu sljedećih ključnih riječi: „Primrose (Primula veris)", "Flavonoids", „Primrose (Primula veris) and Flavonoids", „Phytomedicine", „Primula veris and Phytomedicine", „Primula veris and Flavonoids and Phytomedicine".*

U analiziranim radovima kao jedinjena sa najizraženijim fiziološkim djelovanjem navedeni su: triterpenski saponini i fenolna jedinjenja, uključujući flavonoide, fenolne kiseline i fenolne glikozide. Za identifikaciju i utvrđivanje sadržaja ovih jedinjenja u radovima su korištene: spektrofotometrijske metode (procjena kapaciteta antioksidativne aktivnosti pomoću DPPH, CUPRAC test, FRAP test), tankoslojna hromatografija, tečna hromatografija visokih preformansi (HPLC), detekcija evaporativnog raspršenja svjetlosti, masena spektrometrija (GC/MS), Fourier-transformska infracrvena spektroskopija (FTIR), nuklearna magnetna rezonancija (NMR). HPLC je najčešće korištena metoda za određivanje sastojaka iz korijena jagorčevine.

U ovom preglednom radu naglašena je važnost sekundarnih metabolita i drugih aktivnih komponenti iz korijena jagorčevine, te potreba za primjenom adekvatnih analitičkih metoda za brzu identifikaciju i tačno određivanje pojedinih sastojaka. Pored toga, prikazani su uslovi tokom određivanja sadržaja triterpenskih saponina i fenolnih jedinjenja. Rezultati prikazani u ovom radu služe kao važan izvor informacija za stručnjake u laboratorijama, farmaceutske i medicinske stručnjake.

Ključne riječi: *Primula, saponini, flavonoidi, tečna hromatografija visokih perfomansi*