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BASIC MAIN POLYPHENOLIC COMPOUNDS OF SOME PLANT SPECIES

Abstract. Data of some plant species containing polyphenolic compounds have been summarized. The dominant phenolic compounds of the investigated taxa were identified.The promising plant species for isolation of polyphenolic compounds as potential sources of original domestic pharmaceutical substances were determined.

Key words: polyphenolic compounds, flavonoids, glycosides, chalcones, *Asteraceae, Rosaceae, Salicaceae, Polygonáceae, Lamiáceae.*

Among the renewable sources of bioactive substances a special place belongs to plants traditionally used in folk and official medicine. There are some plant groups which are common or predominant in large areas and are interested for chemical and pharmacological studies.Plants of this kind are represented by the species of the following familiesin the territory of Kazakhstan:*Asteraceae* (*Compósitae*), *Salicaceae, Rosaceae, Polygonáceae, Lamiáceae* covering an extensive territory in the natural flora.

At present, researchers attention attracted to the phenolic compounds including flavonoids. Their interest in these substances is justified by their practical application in medicine.Flavonoids are referred tothe widespread plant metabolites. The elucidated structures of molecules have been described for over 8000 of flavonoids related to several dozens of structural types. A comprehensive study of flavonoids is done by scientists of major research centers of many countries in the world.The interest in these compounds is constantly growing due to the exclusively valuable properties of flavonoids such as antioxidant activity and related ability of many metabolites of this class toact as agents preventing or inhibiting tumors formation, strengthening blood vessels, protecting liver and a digestive tract, stimulating the brain and heart functions, making them biologically active additives (BAA) in medical and dietarynutrition [1-4].

The following plants served as objects of our research of polyphenolic compounds such as *Tanacétum vulgáre*L., *Helichrysum arenarium* L., *Crataégus*, *Populus balsamifera* L., *Origanum vulgaris* L., *Polygonum aviculare* L., *Bídens tripartíta* L., *Ajania fruticulosa* (Ledeb.) Poljak), *Hypericum perforatum* L., *Serratula coronata L.*, and *Carduus*.

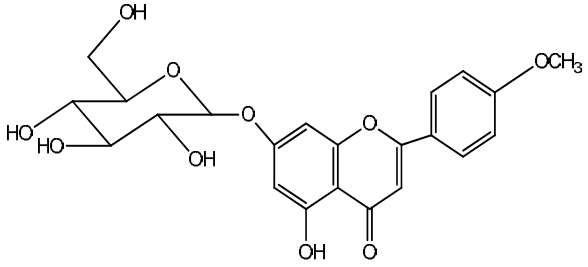
Tanacetum vulgare L. belongs to the widespreadherbs containing a wide range of biologically active substances: flavonoids, sesquiterpene lactones, essential oils. Flowers of *Tanacetum vulgare* L. are often used in various medicinal

forms as the vermicidal and choleretic agents.Flavonoids from flowers of *Tanacetum vulgare* L. are mainly represented by apigenin (5, 7,4'-trihydroxyflavone), acacetin (5,7-dihydroxy-4'-metoxyflavone), luteolin (5,7,3',4'-tetrahydroxyflavone), cynaroside (7-O-b-D-glucopiranoside of 5,7,3',4'-tetrahydroxyflavone), eupatilin (5.7-dihydroxy-6,3',4'-trimetoxyflavone), jaceidin (5,7,4'-trihydroxy-3,6,3'-trimetoxyflavone), jaceosidine (5,7,4'-trihydroxy-3',6-dimetoxyflavone), besides the major compound is acacetine-7-*O*-*β*-*D*-glucopiranoside (tilianin **1**) about the yield 0,2% from the air dry raw materials weight [5, 6]. Based on the sum of flavonoids from *Tanacetum vulgare* L. isolated by extraction with ethyl alcohol, the drug Tanaceholwas developed with acholeretic action. The yield of flavonoids amount is 3,1% of the air-dry raw materials. The content of active ingredients (sum of flavonoids and phenolcarboxylicacids) in the product was determined by spectrophotometer and is at least 55% in terms of luteolin [7].

The flowers of *Helichrysum arenarium* (L.) Moench.contain the sum of flavonoids (at least 20 compounds), belonging to different groups: flavones (apigenin, luteolin), flavonols (kaempferol, quercetin, and their glycosides, 3,5-dihydroxy-6,7,8-trimetoxyflavonol glycosides), chalcones (isosalipurposide **2**), flavanonsnaringenin, salipurposide (**3**), and their glucosides. Besides, the major polyphenolic compounds include chalconeisosalipurposide (**2**) and flavanonsalipurposide (**3**), but there is no agreement which of these components is a predominant one [8].

The preparation Flamin was developed based on the amount of pharmacologically active flavonoids from flowers of *Helichrysum arenarium* L. The main phenolic ingredient in the product Flamin is a chalconeisosalipurposide (**2**). When examining the chemical composition of *Helichrysum arenarium* L., naringin and its water-soluble derivatives prunin, quercetin, apigenin, naringenin, as well as apigenin-5-*O*-glucoside and isosalipurposide (**2**) were determined. It was established by the molecular absorption spectroscopy that the analyzed extract contains 73.48 mg of flavonoids in terms of rutin, or 17.94 mg in terms of quercetinper 1g of dry extract which is 20.99 and 5.13%, respectively [9].

Flavonoid apigenin was detected in the raw flowers of *Helichrysum arenarium* L. using the HPLC method, which content varies within a range from 0.1453± 0.0068% to 0.1657 ± 0.0085% based on the dried raw material [10].



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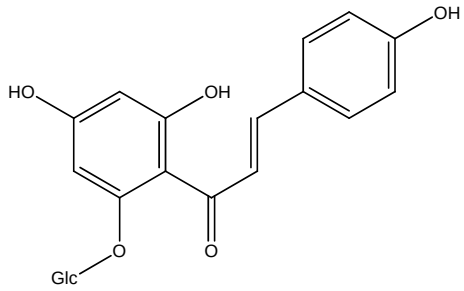

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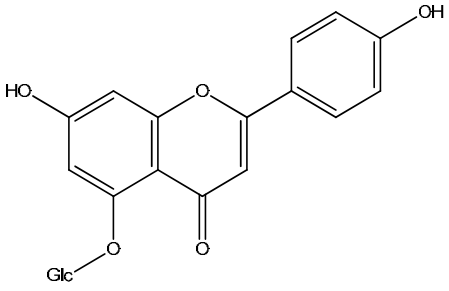


(3)

In plants of the genus *Crataégus*, biologically active substances are flavonoids, anthocyanins, triterpenoids, which are used to prepare decoctions, extracts, tinctures, and tablets. Among flavonoids which are found in the leaves, flowers, and fruits of *Crataégus* there are santin, 5-hydroxyaurantine, apigenin, kaempferol, quercetin, apigenin-7-glucoside, kaempferol-3-galactoside, hyperoside (quercetin-3-galactoside), vitexin (apigenin C-glycoside), vitexin-4'-rhamnoside, vitexin-4'-rutinoside and also (-) and (+) epicatechins [11]. C-glycosides dominate in the leaves of *Crataégus*, while biosides, di-and leucoanthocyanidins ofoligoglycosides, and other flavane derivatives are synthesized in flowers [12].From leaves, flowers and fruits of *Crataegus stevenij* Pojark. 7 flavonoids were isolated and characterized;moreover, the lipophilic flavonoid scutellarian 4'7-dimethyl ester had beenisolated for the first time [13]. The main component of a flavonoid fraction in all organs of *Crataegus stevenij* Pojark. is hyperoside (**4**). The total flavonoid content in fruits of *Crataegus stevenij* Pojark. is within the range from 0,057 to 0,085% [14], the minimum content of flavonoids is observed in leaves and flowers 0,89%and1,39%, respectively. The hyperoside content in flowers ranges from 0,6 to 0,9%, in fruits - from 0,028 to 0,04%, in shoots - from 0,25 to 0,39% [15].

The phenolic composition of *Crataegus* leaves was studied;four new monoterpene glycosides and a new phenolic glycoside pinnatifidanoside E were isolated and identified in the process [16].

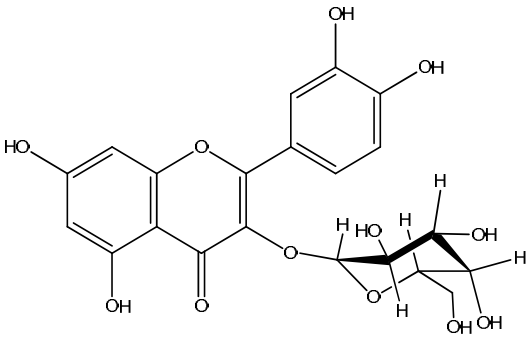
The fruits of two species *Crataegus monogyna*Jacq. And *Crataegus azarolus* L. were examined using the HPLC method. The phenolic composition of the investigated fruits showed some similarities and differences in the ratio of polyphenols between the two species. Twenty phenolic compounds were identified and distributed in four subclasses: four phenolic acids including three hydroxycinnamic acids and one hydroxybenzoic acid, eight flavonoids representing the most abundant subclass including six glucosylatedflavonols and two flavones; two anthocyaninswerepresent in the form of cyanidin glycosides with cyanidin-3-*O*-glucoside as the most common, and four flavanols. Epicatechinwas identified in all the fruit parts of both species [17].

Populus L. genus belongs to the family *Salicaceae* which is curious in its diversity, reserves, and distribution. *Populus* L. gemma are rich in the extractives

with a broad spectrum of biological activity. It was previously determined that ethanol is the most effective solvent to extract substances from *Populus* L. gemma both from the technological and economic perspectives. The share of alcohol-soluble substances averages from 35 to 45% of the raw material weight depending on atree development stage [18].

Phenol glucosides, phenolcarboxylic acids (caffeic, ferulic, hydroxycinnamic), flavonoids, tannins were found in *Populus* L.bark and gemma [5]. It is well known that *Populus* L. gemma feature the presence of flavanones, flavones, and flavonols [19-20]. Thus, in the gemma of P. *nigra* L., P. *trichocarga* Toor. ex Gray, P. g*randidentata* Michx. growing in Germany the following phenolic compounds were identified: p-hydroxyacetophenone, dimethyl caffeic acid, cinnamoylcinnamate, vanillin, and a number of flavonoids: chrysin, chrysin-7-methyl ester, apigenin, galangin, 7-methylgalangin, 7-methylkaempferol, quercetin, 7-methylquercetin,3,7-dimethyl quercetin, pinocembrin, 7-methylpinocembrin, 2,5-dihydroxy-7-methoxyflavanone and 2',6'-dihydroxy-4'-methoxychalcone [21].

In *Populus balsamifera* L. gemma, the content of the following compounds was determined: pinostrobin (**5**), pinocembrin (**6**), chrysin, tectochrysin, apigenin, kaempferol, quercetin, myricetin, galangin, izalpinin, isorhamnetin, rhamnetin, 2,6-dihydroxy-4'-methoxychalcone, and 4',6'-dihydroxychalcone. In the extract from *Populus balsamifera* L. gemma, theprotocatechuic, gallic, trans-cinnamic, p-coumaric, ferulic, and caffeic acids were also found. The dominant flavonoids of the *Populus balsamifera* L. gemma are pinostrobin (**5**) and pinocembrin (**6**) [22-23].



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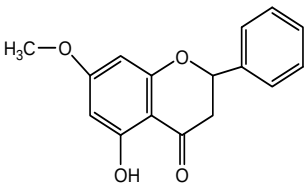

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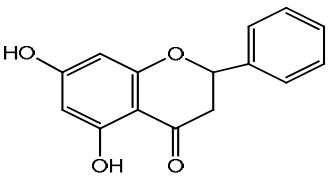

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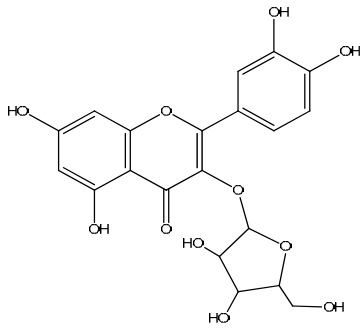
Plants of the genus *Origanum*are characterized by the presence of flavonoids (rutin, quercetin, luteolin, citrine, hesperidin, and their glycosides). The chemical composition of biologically active compounds (BAC) of *Origanum vulgaris* L. herb was studied which includes the essential oil components, triterpenoids, saponins, phenolcarboxylic acids, tannins, and flavonoids. Among the components of a polyphenol complex in *Origanum vulgaris* L. were noticed luteolin and its glycosides, cosmosyne (apigenin-7-glucoside), chrysin, and its glycosides, i.e. the flavonoid fraction of the plant is mainly represented by flavone derivatives. The total content of flavonoids in *Origanum vulgaris* L. samples varies in the range from 2,62 to 2,79% [24-27].

A promising source of polyphenolic compounds is *Polygonum aviculare* L. The aerial parts of *Polygonum aviculare* L. contain flavonoids (up to 9,4%), tannins, essential oils, carotene, vitamin C, vitamin K_1, saponins, coumarins (umbelliferone and scopoletin), anthraquinone glycosides. In the flowering plant about 30 glycosides of flavonoid nature were observed, which aglycons are rhamnetin, kaempferol, quercetin, and myricetin. The main flavonoid of *Polygonum aviculare* L. is considered avicularin (**7**) [28].

The chemical composition of *Polygonum aviculare* L. herb harvested during the flowering period was investigated. During the chemical composition analysis of flavonoids, 3 substances of a flavonoid character were identified and qualitatively determined: liquiritin (liquiritigenin4'-*O*-*β*-*D*-glucopyranoside), avicularin (quercetin 3-*α*-*L*-arabinofuranoside) (**7**), cinnaroside (luteolin-7-*O*-*β*-*D*-glucopyranoside). The latter ones, liquiritinand cynaroside, were isolated from *Polygonum aviculare* L. for the first time [29].

For *Bidens tripartita* L. antioxidant, antimicrobial, antifungal, hepatoprotective, immunostimulating, and hypotensive activities were established. These types of activity are associated with the presence of a series of phenolic compounds (flavones, chalcones, aurones), essential oils, and polyacetylenes in the herb [30, 31].

In research [32], the composition of the alcoholic extracts of *Bidens tripartita* L. is discussed where the main component of which is luteolin-*O*-7-glucopyranoside (cynaroside **8**). Luteolin and its glycosides were also defined in the



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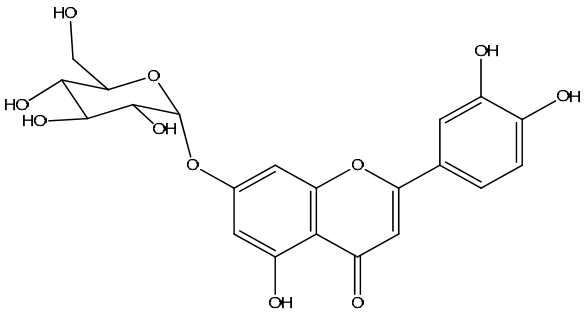


(8)

extract. The total amount of the above-mentioned compounds in extracts is about 55% of all identified components. About 20% of all compounds contenting the extract belong to hydroxycinnamic acids – the derivatives of caffeic and quinicacids, and the same amount to chalcones with hydroxyl groups in the 3'- and 4'-positions.

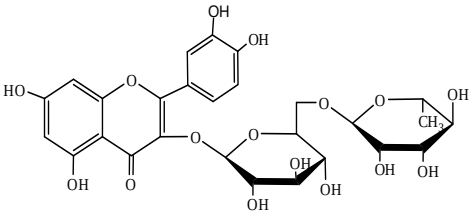
From the above-ground parts of *Bidens tripartita* L. fourteen phenolic compounds were isolated (butein, 3,2',4'-trihydroxy-4-methoxychalcone, 4'-*O*-*D*-glucopyranosyl-2'-3-dihydroxy-4-methoxychalcone, okanin, okanin4'-*O*-*D*-glucopyranoside, okanin4'-*O*-(6''-*O*-acetyl-*D*-glucopyranoside), bidenoside, luteolin, diosmetin, luteoside, achilarin, quercetagetin 3,6,3'-trimethyl ether, sulfuretin, 6,7,3',4'-tetrahydroxyauron), and two polyacetylenes [33].

As known, *Hypericum perforatum* L. herb has a complex chemical composition represented by flavonoids (rutin, hyperoside, bisapigenin, quercetin, luteolin, kaempferol, myricetin), anthracene derivatives (hypericin, pseudohypericin), and essential oils [34]. The following phenolic compounds were isolated from *Hypericum perforatum* L.: rutin, hyperoside, quercetin, 6,8'-diquertcetin, 3,8'-bisapigenin, phenylpropanoid, and a chlorogenic acid. Moreover, 3,8'-bisapigenin and 6,8'-diquertcetin have been isolated for the first time [35]. A comparative phytochemical study of samples of *Hypericum perforatum* L. and *Hypericum maculatum* Grantz was performed using the HPLC method. It has been established that the predominant flavonoid in *Hypericum maculatum* Grantz herb is hyperoside, and in *Hypericumperforatum* L. is rutin (**9**). Quercetin is observed in both species; however, the content of this component is low. The flavonoid bisapigeninis found only in *Hypericum perforatum* L. [36].

During the study of a phenolic composition of *Ajania fruticulosa* (Ledeb.) Poljak., oxyflavones 5,3',4'-trioxy-3,6,7-trimethoxy flavone, artemisetin (**10**), axillarin, phenolcarboxylic, chlorogenic and caffeic acids were identified [37, 38].

Serratula coronata L. is a promising source of ecdysteroids,its aerial parts also contain the phenolic compounds (apigenin, rutin, quercetin, luteolin), tannins, coumarins, essential oils, sesquiterpene lactones, and carotenoids. The majority of flavonoids in the above-ground part of *Serratula coronata* L. is concentrated in the leaves and ranges from 14,87 to 18,50%, much less in the inflorescences (4,18-5,88%), and a minimum amount in the stems (2,61-3,44%) in terms of rutin. The predominant flavonoid (aglycon) of the aerial part of the plant is 3-methylquercetin (**11**), which content in the inflorescences ranges from 10,4 to 11,9%, in leaves from 2,5 to 5,1%, and in stems – from 1,2 to 2,9% (in terms of the flavonoids total).

The quantitative content of phenolic compounds in *Serratula coronata* L. was studied. During the compositional analysis of flavonoids, 3 substances of a flavonoid nature were determined and identified, they were: apigenin (5,7,4'-trihydroxyflavone), 3-methylquercetin (5,7,3',4'-trihydroxy-3-methoxyflavone **11**), isokaempferide(5,7,4'-trihydroxy-3-methoxyflavone) [39].



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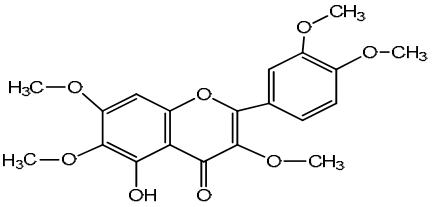

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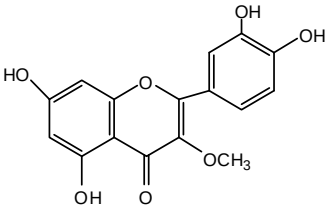

(11)

In *Carduus* herb, saponins, coumarins, sesquiterpene lactones, and flavonoids (silymirin, sidichristin, and silidionin) were found [4].

The ethanol extracts of four *Carduus* species (*Carduus argyroa* Biv., *Carduus nutans* subsp. macrocephalus (Desf.) Nyman, *Carduus pycnocephalus* L., *Carduus cephalanthus* Viv.) were studied by HPLC; it was revealed that the phenolic compounds kaempferol-3-*O*-glucoside, kaempferol-3-*O*-rhamnoside, luteolin, apigenin, kaempferol, diosmetin, and tricin are present in all samples. The diosmetin derivatives were found only in *C.cephalanthus* and *C. pycnocephalus*, whereas luteolin*O*-arabinosylglucoside, apigenin*O*-rhamnosylglucoside and apigenin-7-*O*-glucoside were present only in *C. argyroa* and *C. nutans* subspecies [40].

The methanol extract of *Carduus* was studied using HPLC, and eight flavonoids and flavonoid glycosides were detected. It was revealed that among all identified flavonoids luteolin and apigeninhave the highest content [41].

From *Carduus pycnocephalus*L.the following flavonoid compounds were isolated and identified: apigenin, kaempferol, diosmetin, and their glycosides [42].

Thus, as a result of integrating data on the composition of polyphenolic compounds of some plant species of the families *Asteraceae* (*Compositae*), *Salicaceae*, *Rosaceae*, *Polygonáceae*, and *Lamiáceae* the promising flavonoid plants have been identified. The provided information helps evaluate the qualitative composition of polyphenolic compounds in plants and determine their major components.The promising sources for production of biologically active flavonoids (apigenin, tilianine, isosalipurposide, hyperoside, pinostrobin, pinocembrin, and avicularin) are *Helichrysum arenarium* L., *Polygonum aviculare* L., *Bídens tripartíta* L., *Populus balsamifera* L. gemma, *Tanacétum vulgáre* L., *Crataégussanguinea* Pall.

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Резюме

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ОСНОВНЫЕ ПОЛИФЕНОЛЬНЫЕ СОЕДИНЕНИЯ
НЕКОТОРЫХ ВИДОВ РАСТЕНИЙ

Обобщены данные по полифенольным соединениям некоторых видов растений. При этом определены доминирующие фенольные соединения изучаемых таксонов. Выявлены перспективные виды растений для выделения полифенольных соединений – потенциальных источников оригинальных лекарственных веществ.

Ключевые слова: полифенольные соединения, флавоноиды, гликозиды, халконы, *Asteraceae, Salicaceae, Rosaceae, Polygonáceae, Lamiáceae.*

Резюме

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ӨСІМДІКТЕРДІҢ КЕЙБІР ТҮРЛЕРІНІҢ
НЕГІЗГІ ПОЛИФЕНОЛДЫ ҚОСЫЛЫСТАРЫ

Өсімдіктердің кейбір түрлерінің полифенолды қосылыстары туралы мәліметтер жинақталды. Сонымен қоса зерттелген таксондардағы басым фенолды қосылыстар анықталды. Бірегей дәрілік заттардың ықтимал көздері болып табылатын полифенолды қосылыстарды бөліп алу үшін қолданылатын келешекті өсімдік-түрлері анықталды.

Түйін сөздер: полифенолды қосылыстар, флавоноидтар, гликозидтер, халкондар, *Asteraceae, Salicaceae, Rosaceae, Polygonáceae, Lamiáceae.*