Оригинальная статья / Original article

https://doi.org/10.18619/2072-9146-2026-2-112-119
УДК: 633.88

Some peculiarities of Rosae sepala et pedunculi as prospective medicinal raw materials

Elena Yu. Babaeva[1]*, Anna V. Molchanova[2]

[1] All-Russian Scientific Research Institute of Medicinal and Aromatic Plants
7, Grina st., Moscow, Russia, 117216

[2] Federal State Budgetary Scientific Institution Federal Scientific Vegetable Center (FSBSI FSVC)
14, Selectsionnaya str., VNIISSOK, Odintsovo district, Moscow region, Russia, 143072

***Corresponding Author:** babaevaelena@mail.ru

Authors' Contribution: Babaeva E.Yu.: resources, investigation, formal analysis, writing – review & editing. Molchanova A.V.: investigation, formal analysis, writing – review & editing.

Acknowledgements. Authors express our gratitude to Cherdantsev A.V. and Kovalev N.I. for help with work.

Conflict of interest. The authors declare no conflict of interest.

For citations: Babaeva E.Yu., Molchanova A.V. Some peculiarities of Rosae sepala et pedunculi as prospective medicinal raw materials. *Vegetable crops of Russia.* 2026;(2):112-119. https://doi.org/10.18619/2072-9146-2026-2-112-119

Received: 31.01.2026
Accepted for publication: 05.03.2025
Published: 30.04.2026

ABSTRACT

Relevance. During the industrial processing of rosehip fruits, sepals and peduncles are separated and discarded as waste in accordance with regulatory documentation requirements. Following the principle of comprehensive use of the medicinal raw materials, it seems promising to study them. **The aim** of our study was a comparative research of some pharmacognostic and phytochemical characteristics of sepals and peduncles in comparison with the hypanthia for several species of the genus *Rosa*: *R. majalis* Herrm., *R. rugosa* Thunb., *R. acicularis* Lindl., and *R. mollis* Smith.

Materials and methods. Gravimetric methods were used to determine: the mass fraction of sepals in cynarrhodia, desiccation dynamics, dry matter and moisture content. Titrimetric methods were employed to determine: ascorbic acid content, monosaccharide content, the total content of antioxidants in alcohol extract and the total content of water-soluble antioxidants. The content of polyphenolic compounds was determined by spectrophotometry. Statistical calculations were performed in Microsoft Excel using Student's and Fisher's tests, with a critical significance level of 0.05.

Results. The study revealed that cynarrhodia dried 7.2 times longer than sepals with peduncles. The sepals desiccation coefficient was on average 1.68 times lower than that of cynarrhodia. The moisture content of hypanthia and sepals did not differ among species. The sepals moisture content was on average 2.2 times higher than that of hypanthia. The maximum total content of water-soluble antioxidants was found in the *R. majalis* sepals and hypanthia: 111.85 and 88.62 mg-eq ascorbic acid/g, respectively; the antioxidants in the alcoholic extract on average in the *R. majalis* and *R. rugosa* sepals were 68.26 and 73.76 mg-eq gallic acid/g, respectively. The greatest accumulation of ascorbic acid was noted in the *R. majalis* and *R. acicularis* sepals and hypanthia: 79.20 and 260.04 mg%; 83.60 and 231.00 mg%, respectively. The content of polyphenolic compounds in sepals and hypanthia did not differ significantly among species. High content of monosaccharides was noted in the *R. mollis* sepals and hypanthia: 5.79±0.37% and 7.14±0.06%, respectively.

KEYWORDS:
Rosehip, sepals and peduncles, hypanthia, desiccation coefficient, moisture content, ascorbic acid, water-soluble antioxidants, antioxidants in alcohol extract, polyphenolic compounds, monosaccharides.

Е.Ю. Бабаева[1]*, А.В. Молчанова[2]

[1] Всероссийский научно-исследовательский институт лекарственных и ароматических растений
117216, Россия, Москва, ул. Грина, д. 7, стр. 1

[2] Федеральное государственное бюджетное научное учреждение "Федеральный научный центр овощеводства" (ФГБНУ ФНЦО)
143072, Россия, Московская область, Одинцовский район,
п. ВНИИССОК, ул. Селекционная, д.14

***Автор для переписки:** babaevaelena@mail.ru

Вклад авторов: Бабаева Е.Ю.: ресурсы, проведение исследования, формальный анализ, создание рукописи и ее редактирование. Молчанова А.В.: проведение исследования, формальный анализ, создание рукописи и ее редактирование.

Благодарности. Авторы выражают благодарность А.В. Черданцеву и Н.И. Ковалеву за помощь в работе.

Конфликт интересов. Авторы заявляют об отсутствии конфликта интересов.

Для цитирования: Babaeva E.Yu., Molchanova A.V. Some peculiarities of Rosae sepala et pedunculi as prospective medicinal raw materials. *Vegetable crops of Russia.* 2026;(2):112-119. https://doi.org/10.18619/2072-9146-2026-2-112-119

Поступила в редакцию: 31.01.2026
Принята к печати: 05.03.2025
Опубликована: 30.04.2026

Некоторые особенности чашелистиков и плодоножек шиповника как перспективного лекарственного сырья

РЕЗЮМЕ

Актуальность. При промышленной обработке плодов шиповника по требованиям нормативной документации чашелистики и плодоножки отделяют и отбрасывают. Согласно принципу комплексного использования лекарственного растительного сырья, представляется перспективным их изучение. Цель исследования – рассмотрение некоторых фармакогностических и фитохимических характеристик чашелистиков с плодоножками в сравнительном аспекте с гипантиями видов: *Rosa majalis* Herrm., *Rosa rugosa* Thunb., *Rosa acicularis* Lindl., *Rosa mollis* Smith. Также изучали чашелистики с плодоножками – отходы промышленных партий плодов шиповника.

Материалы и методы. Определяли гравиметрическим методом: массовую долю чашелистиков в цинародии, динамику усушки, содержание сухого вещества, влажность. Титриметрическим методом: содержание аскорбиновой кислоты, моносахаридов, суммарное содержание антиоксидантов в спиртовом экстракте, суммарное содержание водорастворимых антиоксидантов. Спектрофотометрическим методом: содержание полифенольных соединений. Статистические расчеты проводили в программе Microsoft Excel по критериям Стьюдента и Фишера, критический уровень значимости принимали равным 0,05.

Результаты. Выявлено, что цинародии высыхали в 7,2 раза дольше чашелистиков с плодоножками. Коэффициент усушки чашелистиков был ниже, чем цинародиев, в среднем в 1,68 раза. Влажность гипантиев и чашелистиков по видам не различалась. Влажность чашелистиков была в среднем в 2,2 раза выше, чем гипантиев. Максимальное суммарное содержание водорастворимых антиоксидантов было выявлено в чашелистиках и гипантиях *R. majalis*: 111,85 и 88,62 мг-экв. аскорбиновой кислоты/г; антиоксидантов в спиртовом экстракте в среднем – в чашелистиках *R. majalis* и *R. rugosa* 68,26 и 73,76 мг-экв. галловой кислоты/г соответственно. Наибольшее накопление аскорбиновой кислоты отмечено в чашелистиках и гипантиях *R. majalis* и *R. acicularis*: 79,20 и 260,04 мг%; 83,60 и 231,00 мг% соответственно. Содержание полифенольных соединений в чашелистиках и гипантиях по видам достоверно не отличалось. Высокое содержание моносахаридов отмечено в чашелистиках и гипантиях *R. mollis*: 5,79±0,37% и 7,14±0,06% соответственно.

КЛЮЧЕВЫЕ СЛОВА: шиповник, чашелистики и плодоножки, гипантий, коэффициент усушки, влажность, аскорбиновая кислота, водорастворимые антиоксиданты, антиоксиданты в спиртовом экстракте, полифенольные соединения, моносахариды.

Introduction

Representatives of the Rosa genus are undoubted scientific interest and possess significant practical utility due to the various biologically active substances in all plant parts. The primary plant raw materials for plants of the Rosa genus are typically fruits and petals. Petals are usually used to obtain essential oil, and fruits are used as a multivitamin medicinal plant raw material [1]. Despite of abundant natural rosehips resources in our country, their harvesting is complicated by the fact that many species have low yields, and there is a decrease in the number of active harvesters needed for labor-intensive manual collection. Different *Rosa* species were studied and then introduced into industrial cultivation in Russia in the 1970s to better meet the needs of the medical and food industries. Varieties obtained as a result of breeding work with individual rose species (‘Krupnoplodny VNIVI’, ‘Yubileyny’) and from hybridization of different species (*R. majalis*, *R. rugosa*, *R. webbiana*, *R. acicularis*, *R. blanda*, *R. pimpinellifolia*, etc.) are used for establishing plantations. The annual demand of our country for rosehip fruits is estimated at 6-8 thousand tons, however, agriculture production satisfies less than half of this demand [2]. Currently, the etiology of many diseases is associated with the destructive free radicals action, and antioxidant drugs are used for their treatment. Antioxidants are compounds that prevent undesirable oxidation processes of vital matters and form a complex multicomponent system of high- and low-molecular-weight materials [3, 4]. Non-enzymatic components of antioxidant defense include polyphenols, carotenoids, tocopherols, ascorbate, and glutathione [5]. Antiradical properties of *R. rugosa* petals have been established [6]. High antioxidant activity of cell sap from *R. rugosa* Thunb. var. plena Regal flowers has also been demonstrated [7].

Rosehip is medicinal plant raw material, included in the Russian Pharmacopoeia [8]. The component composition and pharmacotherapeutic activity of rosehip preparations, included in Russian State Pharmacopoeia 15th edition (monograph 2.5.0106), are well known. A high antioxidant potential of rosehip fruits has been established [9, 10]. Alcoholic extracts from rosehip fruits exhibited higher antioxidant activity compared to aqueous extracts [11]. A significant share in the antioxidant status of plants is provided by polyphenolic compounds. Polyphenols appear to be the most important due to their high antioxidant activity and high anticarcinogenic properties. In addition to high antioxidant activity, such compounds also exhibit a synergistic effect with other natural antioxidants. This refers to vitamin C, tannins, carotenoids, etc. [12]. Thus, preparations based on various parts of rose plants are not only actively studied but also have the potential to expand their application in medical practice.

While fruits, petals, and rose essential oil have been thoroughly studied, the study of sepals attached to the fruits of various rose species is fragmentary and sporadic. For example, it has been shown that the extract from Rosa nutkana sepals has a very good antibacterial effect, and its combination with antibiotics is important in the treatment of acute purulent inflammation of the hair follicle (stye) [13].

One of the ways to increase the efficiency of phytochemical production is the development of technologies for the plant raw materials comprehensive use. Thus, Rose shoots obtained from rejuvenating pruning, as well as roots and rhizomes remaining after the liquidation of old plantations, can be used to obtain C- and P-vitamin products (as a feed additive) instead of being burned [14]. In production, when bringing rosehip to a standard state, sepals and peduncles are separated and discarded, as, according to regulatory documentation requirements, they are considered waste [8, 15]. It has been shown that during rosehip fruits processing, the proportion of waste can range from 6% to 10% of the mass of dry raw materials. With an average annual demand for rosehip fruits in the Russian Federation of about 7 thousand tons and pharmaceutical companies' demand being satisfied by 50%, approximately 280 tons of sepals and peduncles go to waste each year on average [16]. In this regard, it seems promising to study the mixture of rosehip sepals and peduncles from the perspective of the comprehensive fruit use elements.

The aim of the work was to study some pharmacognostic and phytochemical characteristics of sepals with peduncles and hypanthia of *Rosa majalis* Herrm., *Rosa rugosa* Thunb., *Rosa acicularis* Lindl., *Rosa mollis* Smith in a comparative aspect.

Objectives:

1. Establish the desiccation coefficient and trace the process of fruits and sepals desiccation dynamics.
2. To determine the moisture content and dry matter content of dried hypanthia and sepals.
3. Determine the content of the sum of water-soluble antioxidants, including ascorbic acid (AA), monosaccharides, antioxidants in an alcoholic extract, including polyphenolic compounds, in rosehip sepals and hypanthia.

Materials and Methods

The work was carried out under the research topic FGUU-2025-0001. Samples of rosehips with sepals (cynarrhodia), hypanthia, sepals with peduncles obtained from the unique scientific biocollection of the Botanical Garden of the Federal State Budgetary Scientific Institution All-Russian Scientific Research Institute of Medicinal and Aromatic Plants, Moscow (55.57° N, 37.55° E) were studied. Plants were from introduced populations, no agrotechnical practices were applied (Fig. 1 a, b, c, d). A mixture of sepals and peduncles, manually separated by us from fruits of various rosehip species industrial batches delivered to Krasnogorsklexredstva OJSC (in the following text – the mixture), was also investigated (Fig. 1 e). The work was conducted in 2022-2025.

Sepals are modified green leaves forming the outer part of the double perianth – the calyx [17]. Species from sections where taxa with fruits retaining sepals at the phase of full maturity are grouped, were studied:

Section Rugosae Chrshan. *Rosa rugosa* Thunb;

Section *Cinnamomeae* DC *Rosa acicularis* Lindl., *Rosa majalis* Herrm.

Additionally, we analyzed fruits and sepals of *Rosa mollis* Smith from the section *Caninae* DC [18]. This species is an exception among section representatives, as in most of them, sepals fall off as the fruits ripen and are absent on mature fruits. From the above, it follows that *R. canina* L., which has a wide range in the Russian Federation and is the type species of the section *Caninae*, was not considered by us [2, 19]. Main attention was paid to the study of pharmacopoeial species with the most extensive range in the Russian Federation, the fruits of which are predominantly found in industrial batches of rosehip fruits: *R. rugosa* and *R. majalis*. The fruits were harvested at the stage of technical maturity. The onset of the phase was determined according to the "Methodology for research during the introduction of medicinal and essential oil plants" [20]. The fruits were collected completely from five plants of each species. An experimental batch was obtained when combining fruits by species. Sepals and peduncles were separated from the fruits to obtain the prospective raw material Rosae sepala et pedunculi (since sepals predominated in it by quantity and mass, we hereafter refer to this raw material as Rosae sepala), as well as the hypanthium. The sepals proportion in the mass of the dried cynarrhodium was determined by gravimetric method in 20 repli-

Fig. 1a Rosa rugosa Thunb.

Fig. 1b Rosa mollis Smith

Fig. 1c Rosa majalis Herrm.

Fig. 1d Rosa acicularis Lindl.

Fig. 1e. Transport unit of an industrial batch of rosehip fruits
Рис. 1е. Транспортная единица промышленной партии плодов шиповника

cates. The dried raw material moisture content was determined according to pharmacopoeial monograph 1.5.3.0007 of the Russian State Pharmacopoeia XVth edition [21]. Determination of desiccation dynamics was carried out by gravimetric method daily in 20 replicates. Cynarrhodia and sepals were weighed separately at room temperature from the moment of collection until reaching constant mass of air-dry raw material. Then the desiccation coefficient was calculated. Dry matter content was determined by gravimetric method: fresh fruits and sepals were placed in a LabTech drying oven (Daihan LabTech Co, LTD) at 70°C until reaching constant mass of absolutely dry raw material [22]. Fresh plant parts were used to determine the content of AA, the amount of water-soluble antioxidants and monosaccharides. Dried raw material was taken for calculating the content of polyphenolic compounds and antioxidants in the alcoholic extract. Determination of the total water-soluble antioxidants content was carried out according to the method of Maximova et al. [23]. AA was used as the standard. Determination of the total antioxidants in the alcoholic extract content was established according to the method, modified by Golubkina by titrating a 0.01 N $KMnO_4$ solution with an ethanolic extract [12, 24]. Results were expressed in mg-equivalents of gallic acid (GA) per g of dry weight (d.w.). GA was used as the standard [25]. Monosaccharide content in rosehip sepals and hypanthia was analyzed by the cyanide method [26]. AA content was determined according to the methodology of Sapozhnikova, Dorofeeva [27]. The Folin-Ciocalteu colorimetric method was used on a Unico 2804 UV spectrophotometer (USA) to determine the level of polyphenolic compound accumulation. Analytical replication was 4-fold [12]. All reagents used were of analytical grade.

Data averaged over the years of research for the studied indicators are presented with the standard error of the mean indication. Data for each year of research are provided where possible. Statistical calculations were performed in Microsoft Excel using Student's and Fisher's tests, with a critical significance level of 0.05. The least significant difference (LSD) was calculated. This is a value indicating the boundary for limiting random deviations. It is obtained by multiplying the difference between means error by the t-criterion value at the accepted level of degrees freedom. Spearman's correlation analysis was also used to identify the relationships between quantitative traits. The variation coefficients for each biochemical indicator during analytical replicates, both for sepals and hypanthia, were below 10% (insignificant variability). Separation of mean values was carried out using Duncan's multiple range test (DMRT), considering a probability level of 0.05, using Excel. This is a post hoc test for measuring specific differences between pairs of means. Duncan's test is made in comparison between species [28].

Результаты и их обсуждение
Results and Discussion

The proportion of sepals in the total fruit mass was 8.32±0.47% for *R. majalis*, while for R. rugose it reached 16.05±0.54%, i.e., 1.83 times greater. We studied the desiccation dynamics of cynarrhodia and sepals (Table 1, Fig. 2, 3).

The transformation from fresh raw material to air-dry for sepals of species from sections Rugosae and *Cinnamomeae* showed no differences in duration. Sepals of *R. mollis* dried 18.2 % faster. A different pattern was revealed for cynarrhodia: the time interval from collection of fresh raw material to reaching air-dry mass exceeded that for sepals by 7.2 times. *R. acicularis* cynarrhodia underwent dehydration 1.86 times faster than the other studied species. The longest drying duration was for cynarrhodia of *R. rugosa*, which is associated with hypanthium thickness [29]. The same indicator can be linked to the *R. rugosa* cynarrhodia higher desiccation coefficient compared to other species. The sepals desiccation coefficient, as less hydrated organs, was lower than that of fruits for all studied species, on average by 1.68 times.

Table 1. Natural drying duration and desiccation coefficient of rosehip cynarrhodia and sepals
Таблица 1. Длительность естественной сушки и коэффициент усушки чашелистиков и плодов шиповника с чашелистиками

Species	Cynarrhodia		Sepals	
	Desiccation coefficient	Duration, days	Desiccation coefficient	Duration, days
Rosa majalis	2.22±0.04 b	43.50±1.32 B	1.36±0.01 b	6.75±0.28 A
Rosa rugosa	3.11±0.05 a	50.00±0.82 A	1.82±0.03 a	6.50±0.29 A
Rosa acicularis	3.06±0.03 a	25.25±0.75 C	1.72±0.03 a	6.25±0.25 AB
Rosa mollis	2.42±0.05 b	47.00±0.82 A	1.53±0.01 b	5.50±0.23 B

Values with the same letters are not statistically different according to Duncan's test at $p<0.05$

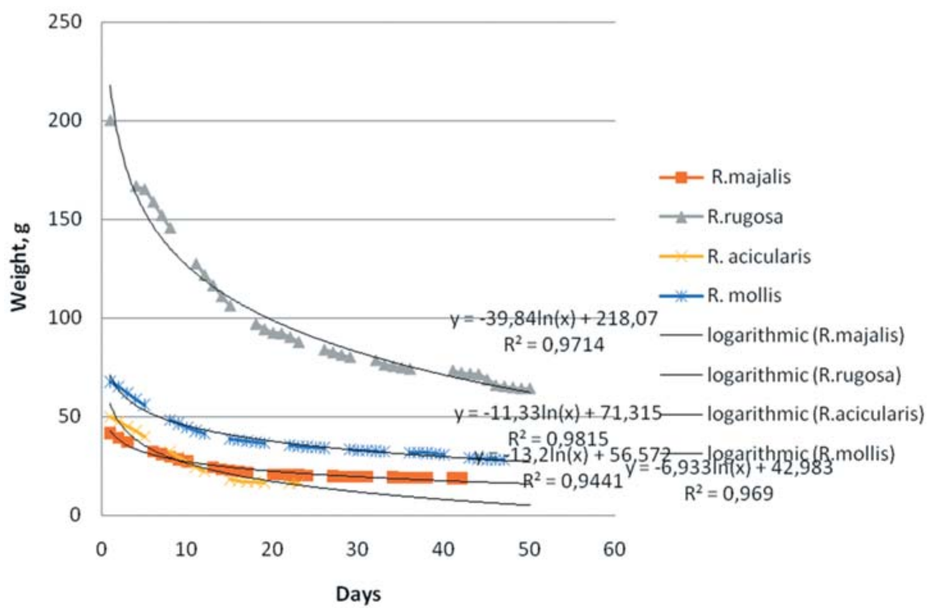

Fig. 2. Dynamics of cynarrhodia desiccation in rosehip
Рис. 2. Динамика усушки гипантиев шиповника

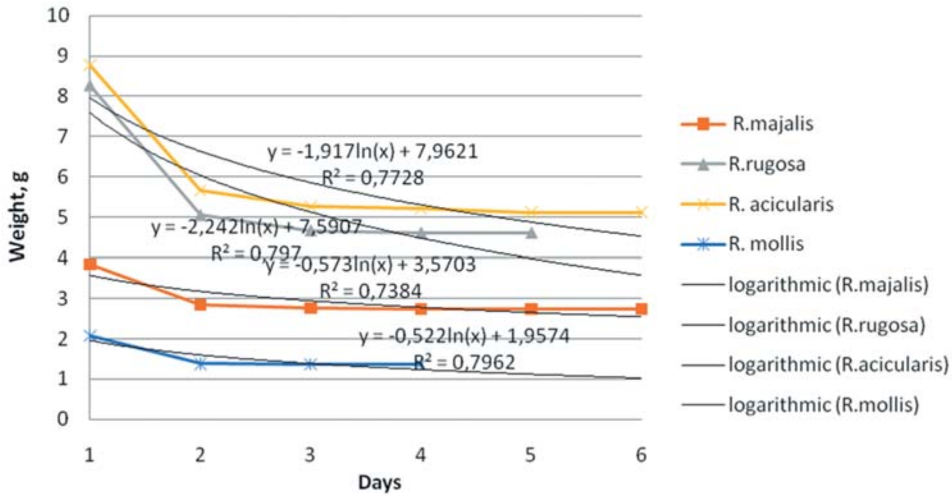

Fig. 3. Dynamics of cepals desiccation in rosehip
Рис. 3. Динамика усушки чашелистиков шиповника

The low desiccation coefficient of sepals compared to cynarrhodia correlated with significantly higher values of dry matter content in them (Table 2).

Table 2. Total dry content of rosehip hypanthia and sepals, %
Таблица 2. Содержание сухого вещества гипантиев и чашелистиков шиповника, %

Species	Hypanthia	Sepals
Rosa majalis	37.12±1.12 a	61.37±0.53 A
Rosa rugosa	26.80±0.83 b	49.96±0.62 B
Rosa acicularis	26.09±0.17 b	50.60±2.09 B
Rosa mollis	35.83±0.53 a	58.19±0.41 A

Values with the same letters are not statistically different according to Duncan's test at p<0.05

Maximum dry matter accumulation was distinguished in sepals of *R. majalis* and *R. mollis* – on average 18.89% higher than in sepals of *R. rugosa* and *R. acicularis*. A similar trend was identified for hypanthia and cynarrhodia. The total accumulation of dry matter by *R. majalis* and *R. mollis* cynarrhodia was 98.49% and 94.02% respectively, whereas in *R. rugosa* and *R. acicularis* it was 76.76% and 76.69%. This is possibly related to the number of achenes in the hypanthium or to individual species characteristics.

The moisture content of rosehips dried hypanthia and sepals is presented in Table 3.

Table 3. Moisture content in rosehip hypanthia and sepals, %
Таблица 3. Содержание влажности гипантиев и чашелистиков шиповника, %

Species	Hypanthia	Sepals
Rosa majalis	4.62±0.005 a	9.76±0.21 A
Rosa rugosa	4.44±0.005 a	9.80±0.21 A
Rosa acicularis	4.57±0.005 a	9.79±0.22 A
Rosa mollis	4.49±0.005 a	9.77±0.22 A
Mixture	4.53±0.005 a	9.74±0.20 A

Values with the same letters are not statistically different according to Duncan's test at p<0.05

We did not observe significant differences for each part of the fruit regarding this indicator. The moisture content of sepals, as organs of leaf origin, was on average 2.2 times higher than the moisture content of hypanthia.

While data on the antioxidant activity for rosehips as the whole fruits exist [10], obtaining such results for sepals in particular is very promising (Table 4).

Table 4. Total content of water-soluble antioxidants n rosehip hypanthia and sepals (mg AAE/g)
Таблица 4. Суммарное содержание водорастворимых антиоксидантов в чашелистиках и гипантиях шиповника

Species	Plant organ	
	Hypanthia	**Sepals**
Rosa majalis	88.62	111.85
Rosa rugosa	41.10	91.93
Rosa acicularis	55.77	63.99
Rosa mollis	27.14	-*
LSD	LSD_{05}^{A}=4.33	LSD_{05}^{B} и ^{AB}=3.73

** Note: data was not obtained due to an inadequate quantity of material for analysis. Factor A – species, factor B – parts of plant*

Significant differences were noted in the accumulation of water-soluble antioxidants among Rose species and plant organs. The maximum total content of water-soluble antioxidants was found in Rosae majalis sepala. It exceeded the accumulation of water-soluble antioxidants in Rosae rugosae sepala by 21.67 % and in Rosae acicularis sepala by 74.79 %. Regarding the hypanthia, a similar pattern was observed: their maximum amount was found in *R. majalis*. These compounds accumulated less on average by a factor of 2.14 in other species. It can be noted that the content of water-soluble antioxidants in *R. majalis* sepala was 26.21 % greater than in hypanthia, in *R. rugosa* sepala – 2.24 times greater, and in *R. acicularis* sepala – 14.74 % greater. Thus, the ratio between the sum of water-soluble antioxidants in sepals and hypanthia is species-specific.

Table 5. Content of ascorbic acid in the sepals and hypanthia of rosehip, mg%
Таблица 5. Содержание аскорбиновой кислоты в чашелистиках и гипантиях шиповника, мг%

Species	Plant organ	
	Hypanthia	**Sepals**
Rosa majalis	260.04	79.20
Rosa rugosa	91.52	31.24
Rosa acicularis	231.00	83.60
Rosa mollis	126.72	36.96
LSD	LSD_{05}^{A}=5.22	LSD_{05}^{B} и ^{AB}=3.62

Note: factor A – species, factor B – parts of plant

AA is a component of water-soluble antioxidants. The content of AA in rosehip sepals and hypanthia was determined (Table 5).

Since fresh sepals and hypanthia were taken for analysis, considering the desiccation coefficient and cynarrhodium structure, the data correspond to the requirements of the Russian State Pharmacopoeia XVth edition, as well as results obtained in different regions of the Russian Federation (Saratov and Kemerovo regions) [8, 30]. The greatest accumulation of AA in hypanthia and sepals was noted for *R. majalis* and *R. acicularis*. In hypanthia, on average, 2.26 times more of this substance accumulated compared to *R. rugosa* and *R. mollis*, and in sepals the average excess was 2.38 times.

Monosaccharides are water-soluble substances. Their distribution between sepals and hypanthia was differed among species (Table 6).

Table 6. Monosaccharide content in rosehip hypanthia and sepals (% w/w)
Таблица 6. Содержание моносахаридов в чашелистиках и гипантиях шиповника

Species	Plant organ	
	Hypanthia	Sepals
Rosa majalis	5.28	2.60
Rosa rugosa	4.59	5.30
Rosa acicularis	4.78	5.17
Rosa mollis	7.14	5.79
LSD	LSD_{05}^{A}=0.44	LSD_{05}^{B} и ^{AB}=0.35

Note: factor A – species, factor B – parts of plant.

Significantly higher monosaccharide content was noted in *R. mollis* sepals. Accumulation of monosaccharides by *R. rugosa* and *R. acicularis* sepals was on average 0.55 absolute percentages points lower. The least amount of studied substances was noted in *R. majalis* sepals compared to the other three species: on average 2.09 times less. A similar pattern was identified for hypanthia. The excess accumulation of monosaccharides in *R. mollis* hypanthia compared to other species was 1.46 times on average. The ratio between the accumulation of these substances in hypanthia and sepals was 0.86 and 0.92 for R. rugose and *R. acicularis*, respectively. It was greater than one for the other two species: 2.05 for *R. majalis* and 1.23 for *R. mollis*. Species-specificity in monosaccharide accumulation by rosehip cynarrhodia can be noted. Oxidation of monosaccharides plays an important role in carbohydrate chemistry. This reaction is used in obtaining a number of compounds, including L-gulonic acid, from which AA is synthesized in plants [31]. Thus, AA is a derivative of monosaccharides. This explains the high monosaccharide content and low AA in *R. mollis* hypanthia and sepals and the inverse nature of the ratio in other species.

Table 7. Total antioxidants in alcoholic extracts of rosehip sepals (mg GAE/g d.w.)
Таблица 7. Суммарное содержание антиоксидантов в спиртовом экстракте в чашелистиках шиповника (мг-экв ГК/г)

Species	Years		
	2022	**2024**	**2025**
Rosa majalis	78.24	56.66	69.87
Rosa rugosa	82.09	55.50	83.70
Rosa acicularis	71.16	54.49	62.40
Rosa mollis	58.84	50.66	63.98
Mixture	58.22	62.66	68.96
LSD	LSD_{05}^{A}=2.14	LSD_{05}^{B} и ^{AB}=5.16	

Note: factor A – species, factor B – years.

Antioxidants in the alcoholic extract are represented by polyphenolic compounds, carotenoids, vitamin E, complex compounds of trace element ions, etc. (Table 7).

The accumulation of total antioxidants in the alcoholic extract in sepals differed among years. The lowest significant values were noted in 2024 for all variants except the mixture. The average content of total antioxidants in the alcoholic extract in sepals was equal in 2022 and 2025, amounting to 69.71 and 69.78 mg GAE/g. In 2024, it was 55.99 mg GAE/g. Differences in the content of the studied substances among species were also noted. We noted the maximum concentration of total antioxidants in the alcoholic extracts in 2022 and 2025 for *R. rugosa* sepals. *R. majalis* sepals accumulated total antioxidants in the alcoholic extract on average 8.06 % less across the years. The minimal amounts of total antioxidants in the alcoholic extract accumulated in 2022 in *R. mollis* sepals and the mixture. The decrease averaged 31.84 % compared to the other variants. Sepals of all species accumulated total antioxidants in the alcoholic extract in 2024 at an average of 54.33 mg GAE/g. The mixture contained significantly more of these compounds (by 15.33 %). The minimal amount of total antioxidants in the alcoholic extract was found in 2025 in *R. acicularis* and *R. mollis* sepals. The decrease compared to *R. rugosa* was 32.46 % on average. Approximately equal amounts of total antioxidants in the alcoholic extract were in *R. majalis* sepals and the mixture. There was 20.57 % less on average in them than in *R. rugosa* sepals.

The high antioxidant activity of polyphenolic compounds has been known for a long time [32]. These include aglycones of flavonoids and anthraquinone glycosides, tannins, coumarins, etc. [12]. In general, the low variability of polyphenolic compounds across years and species can be noted. The maximum accumulation of polyphenolic compounds in the mixture was noted in 2022, which on average exceeded the accumulation of polyphenolic compounds in the sepals of various rosehip species by 26.29 %. The content of polyphenolic compounds in sepals did not differ significantly among species (Table 8).

Table 8. Total polyphenols in rosehip sepals (mg GAE/g d.w.)
Таблица 8. Содержание полифенольных соединений в чашелистиках шиповника (мг-экв ГК/г сух. м.)

Species	Years		
	2022	**2024**	**2025**
Rosa majalis	21.32	26.25	28.00
Rosa rugosa	21.08	26.67	24.75
Rosa acicularis	22.98	26.29	25.53
Rosa mollis	20.55	25.83	24.48
Mixture	27.14	26.58	26.06
LSD	LSD_{05}^{A}=0.99	LSD_{05}^{B} и ^{AB}=0.60	

Note: factor A – species, factor B – years.

R. majalis sepals and the mixture were distinguished by a significantly higher concentration of polyphenolic compounds in 2025.

We calculated the content of other alcohol-soluble antioxidant compounds besides polyphenols (carotenoids, tocopherols, etc.) within the total antioxidants in the alcoholic extract (Table 9).

The patterns of non-polyphenolic substances accumulation in the sepals were closer to the patterns of the total antioxidants content in the alcoholic extract than to the amount of the polyphenolic compounds. The highest concentration of non-polyphenolic compounds was observed in *R. rugosa* sepals, amounting to 49.60 mg GAE/g on average across variants. Somewhat fewer non-polyphenolic compounds were contained in *R. majalis* sepals (43.07 mg

Table 9. Total non-polyphenolic substances in rosehip sepals (mg GAE/g d.w.)
Таблица 9. Содержание остаточных соединений в чашелистиках шиповника (мг-экв ГК/г сух. м.)

Species	Years		
	2022	2024	2025
Rosa majalis	56.93	30.41	41.88
Rosa rugosa	61.01	28.83	58.95
Rosa acicularis	48.18	28.20	36.88
Rosa mollis	38.30	24.83	39.50
Mixture	30.80	36.08	42.90
LSD	LSD_{05}^{A}=2.59	LSD_{05}^{B} и ^{AB}=2.06	

Note: factor A – species, factor B – years.

GAE/g). In the sepals of the other two species and the mixture of rosehips, these substances accumulated in an amount of 36.18 mg GAE/g on average. The minimal content of non-polyphenolic substances was noted in sepals in 2024 similar to the content of antioxidants in the alcoholic extract and polyphenolic compounds. On average, it was 29.67 mg GAE/g. The average content of non-polyphenolic substances was similar and amounted to 47.05 and 44.02 mg GAE/g in 2022 and 2025.

Spearman's coefficient was calculated between the content of polyphenolic compounds and residual substances in sepals (Table 10).

Table 10. Spearman's test (ρ Spearman) for assessing the relationship strength and direction between the content of polyphenolic compounds and residual substances in sepals
Таблица 10. Коэффициент корреляции Спирмена (ρ Спирмена) для оценки силы и направления взаимосвязи между содержанием полифенольных соединений и остаточных веществ в чашелистиках

Species	ρ	p	Status
Rosa majalis	-0.297	0.30300	Insignificant
Rosa rugosa	-0.957	0.000014	Significant
Rosa acicularis	-0.630	0.001675	Significant
Rosa mollis	-0.170	0.56200	Insignificant
Mixture	-0.415	0.08700	Insignificant

An assessment of the relationship strength revealed that for sepals of all studied rose species, as well as for the mixture, a negative correlation exists between the polyphenolic and residual compounds accumulation within the total antioxidants in the alcoholic extract. This means an inverse relationship: an increase in the level of polyphenolic compounds is accompanied by a decrease in residual substances within the sum of antioxidants. This correlation is very high, significant, almost linear for *R. rugosa* sepals. The correlation is high and significant for *R. acicularis* sepals. For *R. majalis* sepals and the mixture a moderate non-significant correlation was noted. For *R. mollis* sepals, it was low and non-significant.

The data on phytochemical indicators of the mixture are closest to the results for *R. majalis* sepala. This is confirmed by the visual characteristics of the fruits corresponding to *R. majalis*. Thus, industrial rosehip batches delivered to Krasnogorsklexredstva OJSC during 2022-2024 mainly consisted of *R. majalis* fructus.

We can state the presence of biologically active compounds with a pronounced antioxidant action in rosehip sepals and peduncles. Further study of this production waste in silico and in vitro is necessary to assess the possibility of its use as a prospective medicinal raw materials, as well as a species component with cardioprotective, antiulcer, or other pharmacotherapeutic actions [33, 34].

Conclusion

Technological indicators of the prospective medicinal raw material "rosehip sepals" were studied in comparison with hypanthia: dynamics and duration of desiccation, desiccation coefficient, moisture content. A number of phytochemical parameters were established: content of water-soluble antioxidants and antioxidants in an alcoholic extract, ascorbic acid, polyphenolic compounds, monosaccharides. The maximum content of water-soluble antioxidants was found in the *R. majalis* sepals and hypanthia. The greatest accumulation of AA was distinguished in the sepals and hypanthia of *R. majalis* and *R. acicularis*. High monosaccharide content was noted in the *R. mollis* sepals. Peak accumulation of antioxidants in the alcoholic extract was noted in the sepals of *R. majalis* and *R. rugosa*. Low variability of polyphenolic compounds across years and species can be noted in general. It has been shown that rosehip sepals with peduncles contain diverse biologically active substances, the content of which is species-specific. Extracts from sepals with peduncles possess antioxidant activity. It has been established that rosehip sepals with peduncles can be a prospective medicinal raw material.

• Литература / References

1. Strelets V.D. Rose in Culture: Biological Characteristics. Vitamin Species and Varieties. Cultivation Technology. Moscow. Russian State Agrarian University- Moscow Agricultural Academy named after K.A. Timiryazev. 2009. 193 p. (in Russ.) https://elibrary.ru/sukxpd
2. Atlas of Russian medicinal plants Sidelnikov N.I. (ed.) Moscow. All-Russian Scientific Research Institute of Medicinal and Aromatic Plants. 2021. 646 p. ISBN: 978-5-87019-094-5 (in Russ.) https://www.elibrary.ru/dqvikr
3. Kasote D.M., Katuare S.S., Hegde M.V., Bae H. Significance of antioxidant potential of plants and its relevance to therapeutic applications. International Journal of Biological Sciences. 2015;(11):982-991. https://doi.org/10.7150/ijbs.12096
4. Wu Z., Liu S., Wang F., Du Y., Zou S. Comparative responses to silicon and selenium in relation to antioxidant enzyme system and the glutathione ascorbate cycle in flowering Chinese cabbage (Brassica campestris L. ssp. Chinensis var. utilis) under cadmium stress. *Environmental and Experimental Botany.* 2017;(133):1-11. https://doi.org/10.1016/j.envexpbot.2016.09.005
5. Kim Y.-H., Khan A.L., Waqas M., Lee I.-J. Silicon Regulates Antioxidant Activities of Crop Plants under Abiotic-Induced Oxidative Stress: A Review. *Frontiers Plant Science.* 2017;(8): 510. https://doi.org/10.3389/fpls.2017.00510
6. Nowak R,. Olech M., Pecio Ł., Oleszek W., Los R., Malm A., Rzymowska J. Cytotoxic, antioxidant, antimicrobial properties and chemical composition of rose petals. *Journal of the Science of Food and Agriculture.* 2014;(94):560-567. https://doi.org/10.1002/jsfa.6294
7. Ren G., Xue P., Sun X., Zhao G. Determination of the volatile and polyphenol constituents and the antimicrobial. antioxidant. and tyrosinase inhibitory activities of the bioactive compounds from the by-product of *Rosa rugosa* Thunb. var. plena Regal tea. *BMC Complementary and Alternative Medicine.* 2018;(18):307. https://doi.org/10.1186/s12906-018-2374-7
8. State Pharmacopoeia of the Russian Federation. 15th edition 2023. Pharmacopoeial article 2.5.0106 (in Russ.)

9. Um M., Han T.-H., Lee J.-W. Ultrasound-assisted extraction and antioxidant activity of phenolic and flavonoid compounds and ascorbic acid from rugosa rose (*Rosa rugosa* Thunb.) fruit. *Food Science Biotechnology*. 2018;27(2):375-382. https://doi.org/10.1007/s10068-017-0247-3

10. Aleksashina S.A., Makarova N.V., Demenina L.G. Antioxidant potential of wild rose. *Problems of Nutrition.* 2019;88(3):84-89. (in Russ.) https://doi.org/10.24411/0042-8833-2019-10033 https://www.elibrary.ru/djxepy

11. Cendrowski A., Kraśniewska K., Przybył J.L., Zielińska A., Kalisz S. Antibacterial and Antioxidant Activity of Extracts from Rose Fruits (*Rosa rugosa*). *Molecules.* 2020;(25):1365. https://doi.org/10.3390/molecules25061365

12. Golubkina N.A., Kekina E.G., Molchanova A.V., Antoshkina M.S., Nadezhkin S.M., Soldatenko A.V. Plant antioxidants and methods for their determination. Moscow. INFRA-M. 2020. 181. https://doi.org/10.12737/1045420 (in Russ.)

13. Eslami G., Taheri S., Abdol S., Ayatollahi M., Malek G., Fallah F., Pourkaveh B.. Comparison of Rosa Nutkana Sepal Extract with Synthetic Antibiotics for Treatment of Methicillin Resistant Staphylococcus Aureus Isolated from Patients with Sty. *Iranian journal of clinical infectious diseases.* 2011;(6):7-11.

14. Saibel O.L. The principle of integrated use of plant materials as a tool for resource-saving technologies for producing therapeutic and prophylactic agents. Issues in Biological, Medical and Pharmaceutical Chemistry. 2021;24(12):3-10. (in Russ.) https://doi.org/10.29296/25877313-2021-12-01 https://www.elibrary.ru/wzbsfw

15. Wild Medicinal Plants of Russia: Collection. Drying. Preparation of Raw Materials (Instructions) Moscow. All-Russian Scientific Research Institute of Medicinal and Aromatic Plants. 2015. 344 p. (in Russ.)

16. Selivanova E.M., Babaeva E.Yu. Rosehip sepals are a promising medicinal plant material. *Current trends in health-preserving technologies.* Moscow. All-Russian Scientific Research Institute of Medicinal and Aromatic Plants. 2021:372-378. (in Russ.) https://doi.org/10.52101/9785870191027_2021_372 https://www.elibrary.ru/bvykwh

17. Korovkin O.A. Basic Terms and Concepts of the Higher Plants Morphology and Anatomy Moscow. Russian State Agrarian University-Moscow Agricultural Academy named after K.A. Timiryazev. 2015. 188 p. (in Russ.) https://www.elibrary.ru/bkpfpn

18. Flora of Eastern Europe. Tzvelev N.N. (ed.). Saint Petersburg. Saint Petersburg Chemical-Pharmaceutical Academy. 2001;(10):670. (in Russ.)

19. https://wfoplantlist.org/taxon/wfo-0001014409-2024-12?matched_id=wfo-0000984287&page=1 Date of access 04.03.2025

20. Tsitsilin A.N., Kovalev N.I., Korotkikh I.N. et al. Research Methodology for the Introduction of Medicinal and Essential Oil Plants. 2nd edition, revised and enlarged. Moscow. All-Russian Scientific Research Institute of Medicinal and Aromatic Plants. 2022. 64 p. (in Russ.)

21. State Pharmacopoeia of the Russian Federation. 15th edition 2023. General Pharmacopoeial article 1.5.3.0007 (in Russ.)

22. State Standard of the Russian Federation 31-640-2012. Feed. Methods for Determining Dry Matter Content. M. Standartinform. 2020. 12 p. (in Russ.)

23. Maximova T.V., Nikulina I.N., Pakhomov V.P., Shkarina E.I., Chumakova Z.V., Arzamastsev A.P. Method for determining antioxidant activity. Description of the invention for the patent of the Russian Federation. Moscow. Patent Russian Federation 2001. 2170930 C1 (in Russ.).

24. Trineeva O.V. Methods for determining the antioxidant activity of plant and synthetic origin in pharmacy (review). *Development and registration of drugs.* 2017;4(21):180-197. (in Russ.) https://www.elibrary.ru/ztwvex

25. Misin V.M., Klimenko I.V., Zhuravleva T.S. On the suitability of gallic acid as a standard sample of antioxidant composition. *Competence.* 2014;7(118):46-51. (in Russ.) https://www.elibrary.ru/snhhyf

26. Kidin V.V., Deryugin I.P., Kobzarenko V.I., Kulyukin A.N., Ladonin D.V. Agrochemistry Workshop. Moscow. Kolos. 2008. 302 p. (in Russ.)

27. Sapozhnikova E.V., Dorofeeva L.S. Determination of ascorbic acid content in colored plant extracts by the iodometric method. *Canning and vegetable growing industry.* 1966;(5):29-31. (in Russ.)

28. Glen S. "Duncan's Multiple Range Test (MRT)". 2023. Statistics How To.com: Elementary Statistics for the rest of us! https://www.statisticshowto.com/duncans-multiple-range-test/

29. Vinogradova Yu.K., Kuklina A.G. Variability of the morphometric traits *Rosa rugosa* Thunb. hypanthium of in the secondary range. *Bulletin of the Main Botanical Garden.* 2015;1(201):52-58. (in Russ.) https://www.elibrary.ru/tnjkqh

30. Matvienko U.A., Baldina A.A., Durnova N.A. Pharmacognostic analysis of *Rosa majalis* Herrm. (*R. cinnamomea* L.) and *Rosa rugosa* Thunb. fruits, growing in the Saratov region. *Gerbarium.* 2024;1(1):40-46. (in Russ.) https://doi.org/10.33380/3034-3925-2024-1-1-11 https://www.elibrary.ru/fmnvey

31. Bagirzade G.A. L-ascorbic acid (vitamin C). which boosts immunity and has an antioxidant effect. Synthesis with industrial components from D-glucose. Topical aspects of modern scientific research. CPN Publishing Group. Tokyo. 2024. P.67-77. (in Russ.)

32. Croft R.D. The chemistry and biological effects of flavonoids and phenolic acids. *Annals of the New York Academy of Sciences.* 1988;(4):435-442.

33. Lapin A.A., Ferubko E.V., Zelenkov V.N., Dargaeva T.D. Study of the antioxidant activity of herbal antiulcer species and its components. *Butlerov communications.* 2019;60(10):60-66. (in Russ.) https://www.elibrary.ru/cbridp

34. Potanina A.P., Khasanova S.R., Kudashkina N.V., Farkhutdinov R.R. Study of antioxidant activity of the "Cardiophyte" species using the chemiluminescence method. *Medical Bulletin of Bashkortostan.* 2013;8(5):75-77. (in Russ.) https://www.elibrary.ru/rpudtz

Об авторах:

Елена Юрьевна Бабаева – кандидат биол. наук,
в. н.с. лаборатории Ботанический сад ФГБНУ ВИЛАР,
https://orcid.org/0000-0002-4992-6926,
SPIN-код: 4230-0443, babaevaelena@mail.ru

Анна Владимировна Молчанова – к.с.-х.н., ст.н.с.
Лабораторно-аналитического отдела ФГБНУ ФНЦО,
https://orcid.org/0000-0002-7795-7463,
SPIN-код:4682-5853, автор для переписки, vovka_ks@rambler.ru

About the Authors:

Elena Yu. Babaeva – Cand. Sci. (Biology),
Leading Researcher Botanical Garden Laboratory,
https://orcid.org/0000-0002-4992-6926,
SPIN-code: 4230-0443, babaevaelena@mail.ru

Anna V. Molchanova – Cand. Sci. (Agriculture),
Senior Researcher of Analytical Department,
https://orcid.org/0000-0002-7795-7463,
SPIN-code: 4682-5853, Corresponding Author, vovka_ks@rambler.ru