

Antioxidant, Pharmacological, Medical Properties and Chemical Content of *Rosa L.* Extracts

Shyryn Tolekova¹, Turegeldy Sharmanov², Yury Sinyavskiy³, Ramza Berzhanova⁴,
Ramazan Mammadov^{5,*}, Ozge Kilincarslan Aksoy⁶, Rusif Yusifli⁶

¹Kazakh Academy of Nutrition, Kazakh National University, Almaty, Kazakhstan

²Kazakhstan Academy of Nutrition, Almaty, Kazakhstan

³Department of Food Biotechnology, Almaty Technical University, Almaty, Kazakhstan

⁴Department of Biotechnology, Al-Farabi Kazakh National University, Almaty, Kazakhstan

⁵Molecular Biology and Genetics, Faculty of Science, Muğla Sıtkı Koçman University, Muğla, Turkey

⁶Department of Biology, Faculty of Art & Science, Pamukkale University, Denizli, Turkey

Abstract: Currently, increased attention is paid to plant raw materials as a source of biologically active substances. As a consequence of this great scientific interest is dog rose (lat. *Rosa*), a genus of wild plants of the Rosaceae family (Rosales) and it is widely used as a medicinal, vitamin source and food raw material. The species of *Rosa* genus have rich vitamin content and different chemical structures. Dog rose has medicinal value as a multivitamin remedy. Many works have been devoted to the study of the dynamics of the accumulation of vitamins depending on the forms and types of dog rose, geographic location, meteorological conditions, soil, fertilizer application and other environmental factors. The most economically valuable part of the dog rose is the pulp of the fruit. *Rosa* is used in official and traditional medicine. They also have anti-inflammatory, choleric, diuretic properties and a beneficial effect on carbohydrate metabolism and, they regulate the activity of the gastrointestinal tract, enhance tissue regeneration, the synthesis of hormones. In this review article, antioxidant, pharmacological, medical properties and chemical content of the *Rosa* genus has been discussed in detail.

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1. INTRODUCTION

Rosa L. is an upright broadleaf shrub, and its height reaches up to 1-2 m [1, 2]. Stems and branches are usually spiked. There are more than 120 species of wild rose in the world and they are widespread in temperate and subtropical zones of the Northern Hemisphere, and occasionally in the mountainous regions of the tropical belt [3, 4]. Some species of wild rose penetrate northward to the Arctic Circle, and southward to Ethiopia, Arabia, Northern India, and the Philippine Islands, and from North America to Mexico. Especially favorable conditions for its growth are in the region from the Mediterranean to the Himalayas and further in East Asia (Figure 1). These plants are resistant to harsh environmental conditions (rocky and sloping terrain, poor soil, lack of water) [5].

CONTACT: Ramazan Mammadov ✉ rmammad@yahoo.com 📧 Molecular Biology and Genetics, Faculty of Science, Muğla Sıtkı Koçman University, Muğla, Turkey

Pliny the Elder (23-79 AD) was the first person to describe the healing properties of *Rosa* when they saw and observed that French ethnic groups use for the treatment of dog bites. Because of this usage for treatment of dog bites, they gave "dog rose" name for it [6]. *Rosa* was also used by a German woman in Europe to make tea that could cure certain diseases. Because of their high content of vitamin C, "dog rose" became a main source of vitamin C in the UK during World War II, the government organized its enormous harvest [7]. Moreover, the great Iranian physician Avicenna (AD 980-1037) mentioned *Rosa* in his book "The Canon of Medicine" as alighol-kalb (most of the dog) and he indicated that it can treat ulcers, including mouth ulcers and strengthening of the gums [8]. An excellent source of vitamin C, rosehip is an effective medicinal plant for the treatment of gingivitis and swollen or bleeding gums [9-10], which are the main clinical manifestations of scurvy (vitamin C deficiency).

The value of *Rosa* was confirmed after the publishing of stamps with images of 23 species in 19 countries [11]. It should be noted that various parts of this plant have traditionally been used to treat various diseases. Its root, for example, has been used to treat cough *Rosa*, hemorrhoids, and dysuria. Its leaves are used in the treatment of colds, flu and cough, and its branches are useful in the treatment of urolithiasis. Also, its fruits were used to treat asthma, bronchitis and the common cold. Finally, its seeds have been used to treat osteoarthritis, rheumatism and gout [12].

A study conducted in 2010 on six plant species, including *Rosa* that was collected from Southern Europe, indicated that had excellent antioxidant properties, so it could be used as an alternative to synthetic antioxidants [13]. Since plants are among the rich sources of antioxidant compounds, the amount of antioxidant compounds in dietary plants, including various types of fruits, berries, vegetables, cereals, nuts and beans, has been investigated. The results showed that between different antioxidants in different food plants more than 1000 times *Rosa* hips, cherries, blackberries, strawberries, raspberries, sunflower seeds and pomegranates are the plants with the most antioxidants [14].

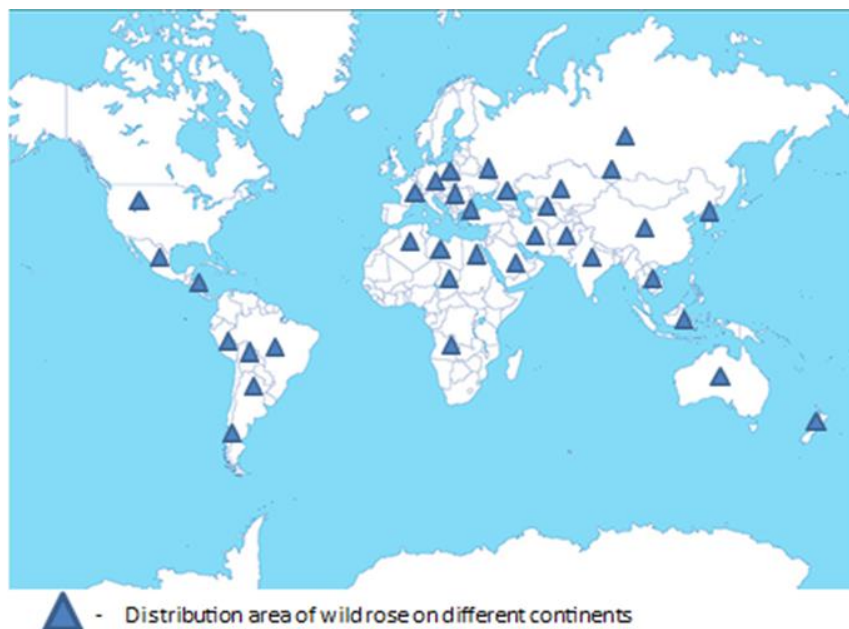


Figure 1. Habitats of all *Rosa* species around the world.

1.1. Plant Material and *In Vitro* Culture Conditions

The chemical composition of *Rosa* is well studied, including modern high-precision methods of analysis. Minerals of the plants are easily digestible form, they have high biological activity involving biochemical processes in the human body [15]. In the study of *Rosa* fruits by the mass spectrometry method revealed the presence of 16 mineral elements [16]. Shanina and Rubchevskaya [15] studied the mineral composition by the spectral method on a DFS-8 instrument and determined the presence of 28 elements. In the mineral composition of *Rosa* hips was determined by using the atomic absorption method [17, 18]. Data on the mineral composition of the wild rose fruits and leaves are presented in Table 1. It should be noted that, despite the different collection sites and different methods of analysis of plant raw materials, potassium and calcium are the prevailing mineral elements [15, 16, 18].

Table 1. Mineral elements of *Rosa* [40, 44].

Treatment (mM)	Content	
	In Fruits	In Leaves
Macronutrients		
Potassium	7.05-12.17 g / kg [16]	5.80-5.82% [15]
Calcium	7.63-15.65% [15]	6.23-6.25% [15]
Magnesium	150-180 mg% [17]	11.60-11.61% [15]
Sodium	150-180 mg% [17]	4.64 * 4.69% [15]
Phosphorus	4.28-10.80 g / kg [16]	(1.71-1.711) 10-3% [15]
Trace elements		
Silicon	1,20-11,60 % [15]	1,160-1,28 % [15]
Manganese	24,91-50,70 mg/kg [16] (122,0-239,0) 10-3 % [15] 124-189 mkg/100 g [17] 0,37-0,59 mg % [16]	(65,0-200,0)*10-3% [15]
Copper	3,92-14,41 mg/kg [18] (22,87-47,80) 10-3 % [15] 0,1-0,15 mg/kg [17] 0,28-0,35 mg % [16]	(11,52-25,60)*10-3% [15]
Zinc	3,92-14,41 mg/kg [18] (22,87-47,80) 10-3 % [15] 0,1-0,15 mg/kg [17] 0,28-0,35 mg % [15]	(6,50-25,70)*10-3 % [15]
Nickel	1,01-2,42 mg/kg [16] 1,7-3,4 mkg/100 r [17] (4,58-7,17) 10-3 % [15]	(0,70-1,80)*10-3 % [15]
Cobalt	<0,003 mg/kg % [18] 0,48*10-3 % [15]	
Aluminum	0,13-3,48% [15]	1,06-1,75% [15]

1.2. Plant Material and *In Vitro* Culture Conditions

Rosa is considered as a raw material of multivitamin (Table 2). It is rich in a natural source of vitamin C, the content of which exceeds currants 10 times and lemon fruits fifty times [1]. At the same time, the biological role of vitamin C is manifested in the presence of organic acids and P-active compounds, which include anthocyanins, catechins, leucoanthocyanins and flavonols, which differ in chemical composition, but have a similar effect on the human body

[28]. Flavonoids act as antioxidants and inactivate free radicals in the presence of metals [29]. In the fruits of the plant of the genus *Rosa*, they are represented in particular by quercetin, hyperoside, astragalín, rutin, kaempferol-3-arabínoside, etc. [30].

Table 2. Vitamins and biological active substances of *Rosa* hips and leaves [40, 44].

Substance	Content	Substance	Content
Rosehips		Leaves	
Vitamin C	1007.63 - 1901.47 mg% [2, 20] 203.09-1082.69% mg [25] 498.96–947.69 mg% [12] 681–840% UHB * [3] 2483.65–3577.07 mg% DM ** [13]	Vitamin C	11,60-218,80 mg % [2]
Vitamin P	184.0 mg / kg [10]	Vitamin P	0,72-1,30 mg % [2]
Vitamin B1	0.73-0.90 mg% [2,6]	Vitamin B1	0,20-1,67 mg % [2]
Vitamin K	1.40-2.00 mg% [2,6]	Vitamin K	0,15-1,40 mg % [2]
Flavonoids	78-102 mg of EGC *** / g CB [3]	Flavonoids	0,10-0,45 mg ER****/ml [14]
Polyphenolic Substances	48.8 mg / kg [10] 4.80-5.90% [10]	Lycopene	0,03-0,005 mg/ml [14]
Flavonols	3.28-4.20% [12]	β-carotene	0,188-0,277 mg/ml [14]
Catechins	62-76 mg% [6]	Total amount phenolic compounds	5,41-8,63 mg EGK /ml [14]
Leucoanthocyanins	740-857 mg% [6]		
Anthocyanins	231-315 mg% [6]		
Tannins	877-1370 mg% [6]		
Chlorophyll	5.71-9.1% [20] 5.20-7.80 mg% 7.90-5.27 mg% SV [17]		

* FS - fresh substance; ** DS - dry substances; *** EGA - the equivalent of gallic acid, ER **** Equivalent routine.

Tocopherols [31] were found in the rosehips, the antioxidant properties of which are based on the ability to form stable little-reactive radicals as a result of the cleavage of a hydrogen atom from a hydroxyl group upon interaction with active radicals [32]. Carotenoids

are represented mainly by lycopene, lutein and β -carotene [33, 34]. Their role is to bind singlet oxygen and inhibit the formation of free radicals, which helps to prevent the negative effect of the latter on the body [33, 35]. The number of carotenoids increases during the growing season, while the number of chlorophylls decreases [36]. Vitamin and mineral compositions of *Rosa* depends on many environmental factors, but the main ones are ecological and genetic. The ecological factor is the leading one; it is explained by the composition of the water, the nature of the microorganisms and the soil structure, the quality and quantity of the fertilizers applied [37, 38]. A huge role in this process is played by the soil, which contains mobile forms of mineral substances that are successfully absorbed by the plant and contribute to the normal course of the synthesis of vitamins and other important organic compounds. With an increase in the height of the growth of shrubs above sea level, the content of ascorbic acid, carotene, catechins, leucoanthocyanins, anthocyanins, and flavonols increases, but the content of tannins in fruits decreases [39]. At the same time, in addition to the rosehips, *Rosa* leaves have a rich chemical composition (Table 2). *Rosa* leaves occupy the second place in the content of ascorbic acid concerning the vegetative part of the plant [36]. In the leaves of wild rose, the presence of such biologically active substances as carotenoids, chlorophylls, tocopherols and flavonoids has been revealed [35, 40]. Ascorbic acid is found in significant amounts in products of plant origin (*Rosa* hips, primrose leaves, etc.) and it plays an important role in the vital activity of the organism. Due to the presence of a diene group in the molecule, ascorbic acid has strongly pronounced reducing (antioxidant) properties [41].

As a result of a phytochemical study (Table 3) of *Rosa* roots growing in the North Caucasus, the presence and content of biologically active compounds were determined: organic acids, water-soluble polysaccharides, pectinaceous substances, ascorbic acid, tannins and easily oxidizable substances, tannin, triterpenic saponins, amino acids. Arginine, glutamic acid, aspartic acid, and lysine predominate in the amino acid composition of *Rosa* roots. Defined macro- and microelement composition. The results indicate the promise of further research of raw materials and drug production [27].

The advantages of natural origin food and non-toxic antioxidants are obvious when compared with synthetic ones. It is known that non-toxic antioxidants are found in vegetable oils, plant extracts and other plant products [43]. Therefore, along with the study of the chemical composition, the authors widely studied the effect of the vegetative part of *Rosa*, containing natural antioxidants, on the mechanism of inhibition of oxidative processes [44]. The authors also confirm that the sugar or ascorbic acid content in the extract is responsible for the antioxidant activity of rose hips [45].

1.3. Medical Meaning of *Rosa*

For hundreds of years, *Rosa* raw materials used in scientific and traditional medicine. *Rosa* is a pharmacopoeial raw material that is used as a vitamin remedy. The oils prepared from the rosehips have wound-healing and choleric effects. A promising and important direction in the development of pharmacy is the comprehensive study and rational usage of the whole plant [46].

Ancient medicine defined the nature of *Rosa* as hot and dry in the II degree. It opens the blockage in the internal organs and cleans. The smell of *Rosa* strengthens the heart, brain, sense organs, the brain is hot, heals the cold of nerves. It kills worms in the ear and helps with ringing in the ears, and also it is good for toothache. When *Rosa* is applied to forehead, it can heal a headache [47].

Table 3. The content of biologically active compounds in *Rosa* genus roots [42].

Biologically active compounds	Analysis method	Metrological specifications
Free organic acids in terms of on apple acid	Alkalimetry	S = 0,0474342 SX = 0,0212138 X±ΔX = 8,06±0,047 ε = ±0,58%
Ascorbic Acid	Titrimetry	S = 0,0035637 SX = 0,0015938 ΔX = 0,0035417 X±ΔX = 0,262±0,0035 N=5 f=4
Tannin	HPLC	S=0,02645 SX = 0,011832 ΔX=0,0262942 X±ΔX =1,46±0,026 ε = ±1,80%.
Saponins	Gravimetry	S = 0,0238747 SX = 0,0106774 ΔX = 0,0237273 X±ΔX = 4,66±0,0237 ε = ±0,51%
Amino Acids in recalculated on alanine.	Spectrophotometry	S = 0,015379 SX = 0,006878 ΔX = 0,015284 X±ΔX = 3,788±0,015 ε = ±0,40%

Rosa is very popular in traditional medicine. Its boiled fruits are used as a choleric and fortifying agent. When *Rosa* juice is drunk with honey, it can act as a diaphoretic and it can remedy colds, hypertension, liver diseases. The local population of Central Asia prepares preserves of wild rose petals and they use it as a heart booster and a sedative. The boiled *Rosa* galls are used for treatment of gastric ulcer, duodenal ulcer, malaria, and pulmonary tuberculosis [48]. Jam of its flowers relaxes, heals the heartbeat. It is useful for tumors of the throat and tonsils. Treatment of wild rose flower petals eliminates the unpleasant smell of sweat in the bath. of the boiled rose hips treat stomach cancer. the boiled galls help to remedy the hemorrhoids, soothes pain and burning. Hippocrates used rosehip for treatment of gallbladder disease. Dioscorides also used it for abdominal pain. *Rosa* juice was used as a fixative and hemostatic agent [49, 50]. the boiled branches and leaves of *Rosa* are used for stomach pain, dysentery and boiled roots of it are drunk as a strong diuretic for urolithiasis. the grinded seeds of *Rosa*, with alum, are used for treatment of external wounds. The branches of the plant are burned, and a resinous substance is obtained. With this remedy, psoriasis is typically treated [51]. In Russian traditional medicine, *Rosa* tincture on vodka (1:10) is used in the treatment of diarrhea. *Rosa* liqueur (1 cup of fruit is drawn into the Sun with 1.5 cups of sugar in 3 cups of vodka, for 5 days) is drunk 15-20 grams each, after food as an anticonvulsant, painkiller [52]. In Chinese traditional medicine, the roots of the *Rosa* are used as an antihelminthic. In Tibetan traditional medicine, *Rosa* flowers are used for treatment of neurasthenia, atherosclerosis, and tuberculosis. In Mongolian traditional medicine, *Rosa* is used in the treatment of headaches,

dizziness, burning skin. In Bulgarian folk medicine, fruits, *Rosa* flowers are used as a choleric, sedative [53].

In modern scientific medicine, *Rosa* has also very widely usage. At First, all of its fruits are used as a source of vitamin C. 5-6 rosehips, fully provide a daily dose of this vitamin. Thanks to vitamin C and polyphenols, the rosehips of its leaves have a pronounced antioxidant and anti-inflammatory effect [54-57].

Experimental studies have revealed the immunomodulatory properties of *Rosa* extract [58, 59]. *Rosa* has been successfully applied to prevent morbidity among frequently ill children [60]. Its positive effects on diseases of the liver and gallbladder are noted. *Rosa* preparations normalize the secretion of the digestive tract, have a sedative, hemostatic effect [61].

Rosa is widely used for treatment of type II diabetes [62, 63]. *Rosa* hips have a hypolipidemic and hypoglycemic effect in diabetes mellitus [64]. Plant extracts inhibit the enzyme α amylase [65]. Prolonged intake of *Rosa* prevents cognitive impairment in diabetic patients [66].

Experimental studies have shown that rosehip extracts inhibit lipid accumulation in white adipose tissue, increases fatty acid oxidation processes in the liver and skeletal muscle, thereby preventing the development of obesity [67].

Randomized placebo-controlled studies have shown that taking *Rosa* for 12 weeks reduces the fatty lining of the abdomen, the body mass index in patients prone to obesity, and prevents the development of obesity [68]. Clinical, randomized, controlled studies have shown that the fruits, rosehips and seeds improve the condition of patients with osteoarthritis [69- 75].

Quercetin, isolated from *Rosa*, inhibited the activity of melanogenesis in melanoma cells [76, 77]. *Rosa* leaf extracts have an antiproliferative effect on leukemia [78], colon tumors [79]. Thanks to flavonoids and vitamin C, *Rosa* extracts have an antitumor effect [80]. The marked stimulating effect of *Rosa* on the secretion of the adrenal gland and thyroid gland. *Rosa* preparations stimulate the immune system, and therefore, it is advisable to prescribe them in infectious diseases [61].

Hot infusions of *Rosa* can be presented as a functional food for individuals with a high level of urates, and as a therapeutic agent for hyperoremic patients [81]. *Rosa* leaf extracts have antidiarrheal properties [82]. *Rosa* extracts prevent hepatic from tetrachloride methane damage [83].

Fruits harvested from various types of *Rosa*, belonging to the three sections, are used as medicinal plant raw materials: Cinnamomeae sections (high vitamin types) - May rosehip (brown rosehip) (*R. canina* (L.)), Acicular rosehip (*R. acicularis* Lindl.), Daurian rosehip (*R. davurica* Pall.), Begger's rosehip (*R. beggeriana* Schrenk), Fedchenko's rosehip (*R. fedtschenkoana* Regel), Kokand rosehip (*R. Kokanica* (Regel) Regel ex Juz.); Rugosae sections (high vitamin types) - wrinkled briar (*R. rugosa* Thunb.); and Caninae sections (low vitamin types) - canine briar (*R. canina* L.), briar shchitkon wasp (*R. corymbifera* Borkh.), dog rose small-flowered (*R. micrantha* Smith.), dog rose sand-loving (*R. psammophila* Chrshan.), dog rose felt (*R. tomentosa* Smith.), dog rose zangezura (*R. zangezura* P. Jarosch.) [84- 86].

The raw material is a whole, peeled from the sepals and peduncles false fruits of various shapes: from spherical, ovoid or oval to highly elongated spindle-shaped. The length of the fruit is 0.7 - 3 cm, diameter - 0.6 - 1.7 mm. At the top of the fruit there is a small round hole (in species of the Cinnamomeae section) or a pentagonal platform (in species of the Canina section). Fruits consist of overgrown, fleshy, when ripe juicy receptacle and numerous fruit-nuts enclosed in its cavity. The outer surface of the fruit is shiny, less often matte, more or less wrinkled. Inside, the fruit is covered with long, bristly hairs [87]. Nuts are small, oblong, with weakly expressed edges. The color of fruits is from orange-red to brownish-red, the nuts are

light yellow, sometimes brownish. The smell is absent. The taste is sour-sweet, slightly astringent [85]. There are differences in the preparation of high and low vitamin species. The types with high vitamin content are harvested in August-September. In the instructions for harvesting indicated that the harvesting of fruits should be completed before frost, since after frost during thawing, the content of ascorbic acid in the raw material is reduced. After harvesting fresh *Rosa* can be stored no more than 3 days [86]. When fruits of *Rosa* type with high vitamin content are dried, the various type dehydrators are used and the fruits exposure at 80-90 °C. It is considered that at this temperature, the fruit dries quickly without significant loss of ascorbic acid [86, 88].

The collection of low vitamin A species of *Rosa* is carried out throughout the autumn - from the moment of their full reddening to frosts. Fruits should not be harvested until they are completely reddened, since the immature raw materials contain insufficient organic acids and carotenoids [86]. To dry low vitamin A species of *Rosa*, both artificial and natural air drying can be used [86].

2. CONCLUSION

The chemical composition of the *Rosa* is quite rich, so broths, medical extracts and syrups are prepared from its dried fruits. *Rosa* is rich in many vitamins, minerals and tannins. It also has pectin, organic acids and sugar, which is easily digested. Due to the chemical composition of the rosehips, they contain useful for the body bioflavonoids with antioxidant action. They also help protect the body from aging and detoxify. *Rosa* is extremely useful, they allow a person to replenish stocks of missing vitamins, trace elements, essential acids and antioxidants. The simplest use of *Rosa* for the prevention of beriberi is a drink from its dried fruits.

Rosa is an excellent therapeutic and prophylactic agent. It is widely used in medicine, cosmetology and cooking. But when it is used it is worth remembering that everything is good in moderation. It is also necessary to take into account that the use of *Rosa* has a number of contraindications, therefore, you must first consult with your doctor.

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Orcid

Ramazan Mammadov  <https://orcid.org/0000-0003-2218-5336>

Ozge Kilincarslan Aksoy  <https://orcid.org/0000-0003-4944-1029>

Rusif Yusifli  <https://orcid.org/0000-0002-8429-5373>

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