

The use of sumac (*Rhus coriaria*) plant in value-added cosmetic, health and food products

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This study was conducted to determine the phenolic compound profile of *Rhus coriaria* L. (sumac) and to investigate the potential of these components for developing value-added products in the cosmetic, health, and food industries. Sumac, which holds an important place among medicinal and aromatic plants, possesses strong antioxidant, antimicrobial, and anti-inflammatory effects thanks to its rich content of phenolic acids, flavonoids, and organic compounds. In this study, the phenolic content of ethanol-water (80:20, v/v) extracts obtained from sumac fruit samples was analyzed using high-performance liquid chromatography (HPLC-DAD). A total of 10 phenolic compounds were identified as a result of the analysis. The compound with the highest concentration was gallic acid (5212.65 ng/μL), followed by ferulic acid (671.76 ng/μL), ascorbic acid (255.23 ng/μL), protocatechuic acid (111.67 ng/μL), and o-coumaric acid (81.76 ng/μL). Rutin, hesperidin, neohesperidin, vanillic acid, and p-coumaric acid were detected in lower concentrations. The results indicate that sumac extracts are among the natural antioxidant sources with high phenolic content. The presence of phenolic compounds reveals that the sumac plant plays an effective role in combating oxidative stress, cell regeneration, and suppressing microbial activity. Compounds such as gallic and ferulic acids, in particular, can be evaluated as natural active agents in the cosmetics industry due to their anti-aging, UV-protective, and collagen synthesis-supporting properties. Furthermore, sumac extracts can be used as natural preservatives and flavorings in food products; thanks to their antimicrobial properties, they extend shelf life and increase product stability. In the health sector, due to their antioxidant and metabolic balancing effects, they can be considered as a potential raw material in phytotherapeutic formulations. These findings demonstrate that *Rhus coriaria* is a rich source of phytochemicals in terms of biologically active components and can be a strategic raw material in sustainable production, natural cosmetic formulations, and functional food development processes. Considering Turkey's climatic advantages, the study also reveals the potential of sumac to create economic added value through domestic production.

Keywords: *Rhus coriaria*, phenolic compounds, HPLC-DAD, antioxidant activity, cosmetic applications, functional foods

INTRODUCTION

Medicinal and aromatic plants have been used for both nutritional and health purposes since the beginning of human history, and today they have strategic importance in terms of the global economy and industrial applications (Aras et al., 2024; Ekor et al., 2020). The demand for plant-based products is shaped by factors such as naturalness, sustainability, environmental awareness, and health consciousness. Accordingly, consumers prefer functional, natural, and safe products; this trend is increasingly highlighting the importance of plant-based raw materials in innovative product development processes, particularly in the cosmetics, health, and food sectors. (Başar et al., 2024; Bagheri et al., 2020). Sumac is a perennial plant belonging to the Anacardiaceae family and grows naturally in the Mediterranean, Middle Eastern, and Anatolian regions. Throughout history, sumac fruits have been used as a spice, a natural coloring agent, and for medicinal purposes. Ethnobotanical research reveals that sumac has a wide range of uses in traditional medicine due to its antioxidant, antimicrobial, anti-inflammatory, and metabolic regulatory properties (Al, 2015; Mehdizadeh et al., 2016). Sumac, thanks to its rich content of phenolic compounds, flavonoids, organic acids, and essential oils, possesses remarkable potential not only in traditional uses but also in modern industrial applications. These components support the plant's functional properties, contributing to its antioxidant, antimicrobial, anti-inflammatory, and free radical scavenging effects. Therefore, sumac is considered an important raw material for the development of value-added natural products in the pharmaceutical, cosmetic, and food industries. Recent phytochemical and pharmacological studies have shown that sumac extracts contain high levels of phenolic compounds, and these components play a decisive role in biological activities (Karadağ et al., 2024; Bagheri et al., 2020). These findings reveal that sumac can be a valuable natural resource not only in traditional medicine but also in modern biotechnological and industrial production processes. The aim of this study is to comprehensively examine the biologically active components of *Rhus coriaria* and their potential application areas in the pharmacological, cosmetic, health, and food industries. Furthermore, the potential for creating added value from sumac in terms of sustainable production, industrial application possibilities, and R&D studies is evaluated. In this context, the phenolic components of the sumac sample obtained in the study were determined using the HPLC-DAD method, the results were compared with existing literature data, and the industrial and biotechnological potential of the plant was revealed.

1.1. Chemical composition of sumac (*Rhus coriaria* L.): Sumac has a rich phytochemical profile, with its main components being phenolic acids, flavonoids, tannins, organic acids, and essential oils. The fruit and leaf parts of the plant contain particularly potent antioxidant compounds such as gallic acid, gallotannins, catechin, quercetin, myricetin, rutin, and naringin (Al, 2015; Mehdizadeh et al., 2016). Furthermore, organic acids such as malic acid, citric acid, and ascorbic acid support the plant's sour taste and antimicrobial effects. In the essential oil fraction, terpenoid compounds such as β -caryophyllene, limonene, α -pinene, and citral have been identified. This rich chemical composition gives sumac antioxidant, antimicrobial, anti-inflammatory, and free radical scavenging properties, thus making it a valuable natural ingredient in the health, food, and cosmetic industries.

1.2. Phenolic compounds and flavonoids of *Rhus coriaria* L.: Sumac is particularly rich in phenolic compounds and flavonoids. Fruit and leaf extracts contain compounds such as gallic acid, ellagic acid, tannins, quercetin, and kaempferol. These compounds are responsible for the plant's antioxidant, antimicrobial, and anti-inflammatory activities (Karadağ et al., 2021; Bagheri et al., 2020). The concentration of phenolic compounds varies depending on factors such as plant species, growing region, and harvest time.

Table 1. Uses of sumac in cosmetic, health and food products.				
Industry	Application	Functional Effect	Application Area	References
Cosmetic	Skin care products	Antioxidant, anti-aging, skin regenerating, anti-inflammatory	Antioxidant creams, serums and lotions (1–3% sumac extract)	Bagheri et al, 2020; Mehdizadeh et al, 2016
	Hair care products	Prevents hair loss, strengthens the scalp, prevents dandruff	Shampoo and hair tonic (1–2% sumac extract)	Bagheri et al, 2020
	Natural colorants & preservatives	Increases product stability thanks to phenolic compounds	Creams and lotions with 1–3% extract	Mehdizadeh et al, 2016
Healty	Phytotherapeutic applications	Antioxidant, anti-inflammatory, analgesic, metabolic support (blood sugar and hypertension)	Tea, capsules, tablets, ointments	Al, 2015; Bagheri et al, 2020
	Topical and aromatherapy	Wound healing, skin regenerating, soothing	Ointments, lotions, aromatherapy products	Bagheri et al, 2020
Food	Spices and flavorings	Provides natural taste and aroma	Salads, sauces, meals (0.5–1% spice addition)	Mehdizadeh et al, 2016
	Natural preservatives	Phenolic compounds prevent microbial spoilage	Baked goods, snack bars, functional foods	Bagheri et al, 2020
	Functional food	Antioxidant and biological activity enhancer	Tea, herbal supplements, natural extract products	Mehdizadeh et al, 2016
	Food safety	Use in accordance with EFSA/FDA toxicological limits	Standardized with toxicological tests	Mehdizadeh et al, 2016

1.3. Essential oils and terpenes of *Rhus coriaria* L.: The essential oils found in sumac fruits and leaves give the plant its characteristic aroma and biological activity. α -pinene, limonene, and β -caryophyllene are the main terpene components. These essential oils are used both as flavoring agents in the food and cosmetics industries and as antimicrobial and anti-inflammatory agents (Koçak et al., 2021; Mehdizadeh et al., 2016).

1.4. Vitamin and mineral composition of *Rhus coriaria* L.: *Rhus coriaria* L. is also an important herb in terms of vitamins and minerals. It is especially rich in vitamin C and vitamin K. Among the minerals, calcium, magnesium, iron, and potassium stand out. These components both increase the nutritional value of food products and contribute to functional health products (Zhang et al., 2023; Al, 2015).

1.5. Organic acids of *Rhus coriaria* L.: *Rhus coriaria* L. fruits contain organic acids such as malic acid, citric acid, and acetic acid. These acids function as acidity regulators and preservatives in food and health products. Additionally, along with phenolic compounds, they support antioxidant capacity, extending the shelf life of products (Karadag ve Doğan, 2024; Bagheri et al., 2020).

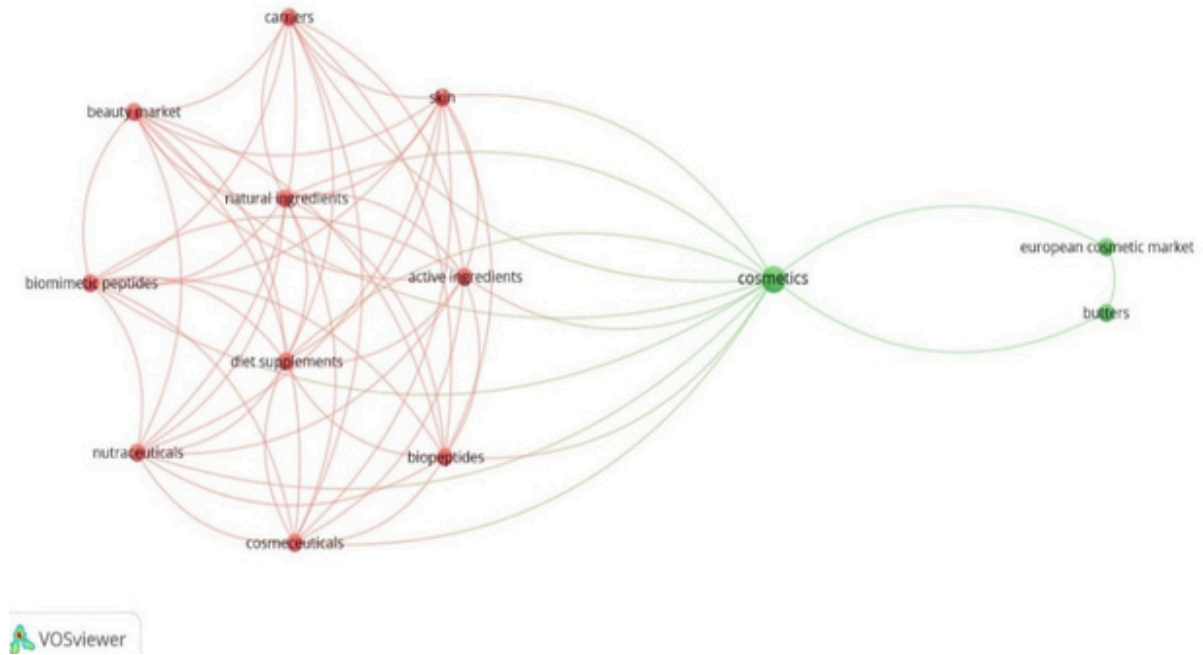


Fig. 1. Keywords used in academic studies regarding *Rhus coriaria* (Web of Science) (vosviewer).

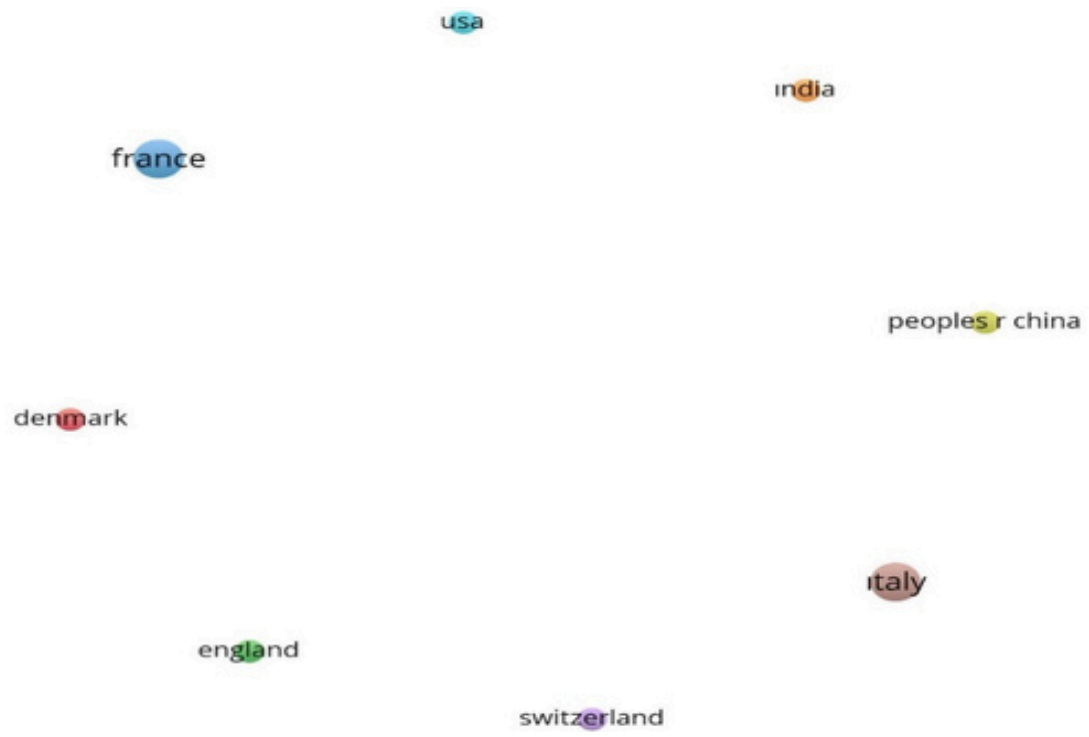


Fig. 2. Countries where *Rhus coriaria* is studied academically (Web of Science) (vosviewer).

Table 2. Moisturizing cream formula with *Rhus coriaria* L. extract.

Ingredients	% (w/w)	Function
Deionized Water	72.00	Solvent
Glycerin	5.00	Moisture retainer
Sumac Extract (EtOH–H ₂ O 80:20)	2.00	Antioxidant, skin regenerator
Stearyl Alcohol	3.00	Emulsifier and thickener
Cetyl Alcohol	2.00	Emulsifier, emollient
Glyceryl Stearate SE	4.00	Emulsifier
Caprylic/Capric Triglyceride	5.00	Carrier oil, emollient
Shea Butter	4.00	Skin nourishing oil
Dimethicone	1.00	Skin protector, emollient
Phenoxyethanol + Ethylhexylglycerin	0.80	Protective system
Fragrance	0.20	Fragrance
pH adjuster (Citric acid or NaOH)	1.00	pH regulator

1.6. Extraction methods of *Rhus coriaria* L.: The extraction of biologically active compounds from *Rhus coriaria* L. varies depending on the extraction method used. Common methods include ethanol, methanol, water, and supercritical CO₂ extraction. These methods affect both the phenolic and flavonoid yields and the stability of the resulting extract. Supercritical CO₂ extraction, in particular, allows for the production of a highly efficient and pure extract without leaving solvent residue (Karadağ ve Omarova, 2024; Mehdizadeh et al., 2016; Bagheri et al., 2020).

1.7. Diversity of chemical composition of *Rhus coriaria* L.: The chemical composition of *Rhus coriaria* L. is affected by environmental and agronomic factors such as species, ecological conditions, soil structure, climate, irrigation, and harvest time. Therefore, controlling the source material and determining quality parameters are critical for standardized extract production in industrial applications (Karadağ et al., 2025; Bagheri et al., 2020).

2. MATERIALS AND METHODS

2.1. *Rhus coriaria* plant material: The *Rhus coriaria* fruit sample used in this study was obtained from within the borders of Adiyaman province, Turkey. The collected fruits were separated under natural conditions, dried in the shade and in a well-ventilated environment at room temperature (20–25 °C), and ground into a homogeneous powder using a laboratory-type grinder. The ground sample was reduced to a particle size of 0.5–1 mm (or the sieve size used), and its moisture content was recorded using a moisture analyzer. The prepared powder sample was stored at -20°C in light-proof containers, protected from light and oxidation, before analysis (Karadağ, 2025).

2.2. Extract preparation: The solvent used in sample extraction was EtOH (ethanol). The extraction procedure was performed as follows: 2.00 g of ground sumac powder was taken and transferred to a 50 mL conical tube with 20.0 mL of 80% EtOH–H₂O (v/v) solution. The tube was extracted in an ultrasonic bath (35 kHz, 30 min), then centrifuged at 4,000 × g for 10 minutes, and the supernatant was passed through a 0.45 µm membrane filter to prepare it for HPLC analysis.

2.3. Preparation and Concentration: If necessary, the filtered extracts were slightly concentrated using a rotavapor (vacuum; <40 °C) to standardize the solvent volume of the solution. If the samples given for analysis were close to the saturation limit, they were diluted to the appropriate factor and homogenized before injection. All solutions were analyzed in dark glass bottles at +4 °C and within a maximum of 48 hours.

PRODUCTION STAGES

1. Phase A (water phase): Glycerin is dissolved in deionized water heated to 70–75 °C in a water bath.
2. Phase B (oil phase): In a separate container, stearyl alcohol, cetyl alcohol, glyceryl stearate SE, shea butter, and caprylic/capric triglyceride are mixed and melted at 70–75 °C.
3. Emulsification: The oil phase is slowly added to the water phase and mixed with a high-speed homogenizer (10,000 rpm, 5 min).
4. While the mixture is cooling to 40–45 °C, sumac extract (previously prepared with an 80% EtOH–H₂O mixture) is added.
5. Preservative, silicone, and perfume are added, and the pH is adjusted (pH 5.5).
6. When the cream reaches a homogenous structure after homogenization, it is packaged. Feature: High antioxidant effect, reduces free radical damage to the skin. It has a light, natural color (light pink tone due to sumac polyphenols).

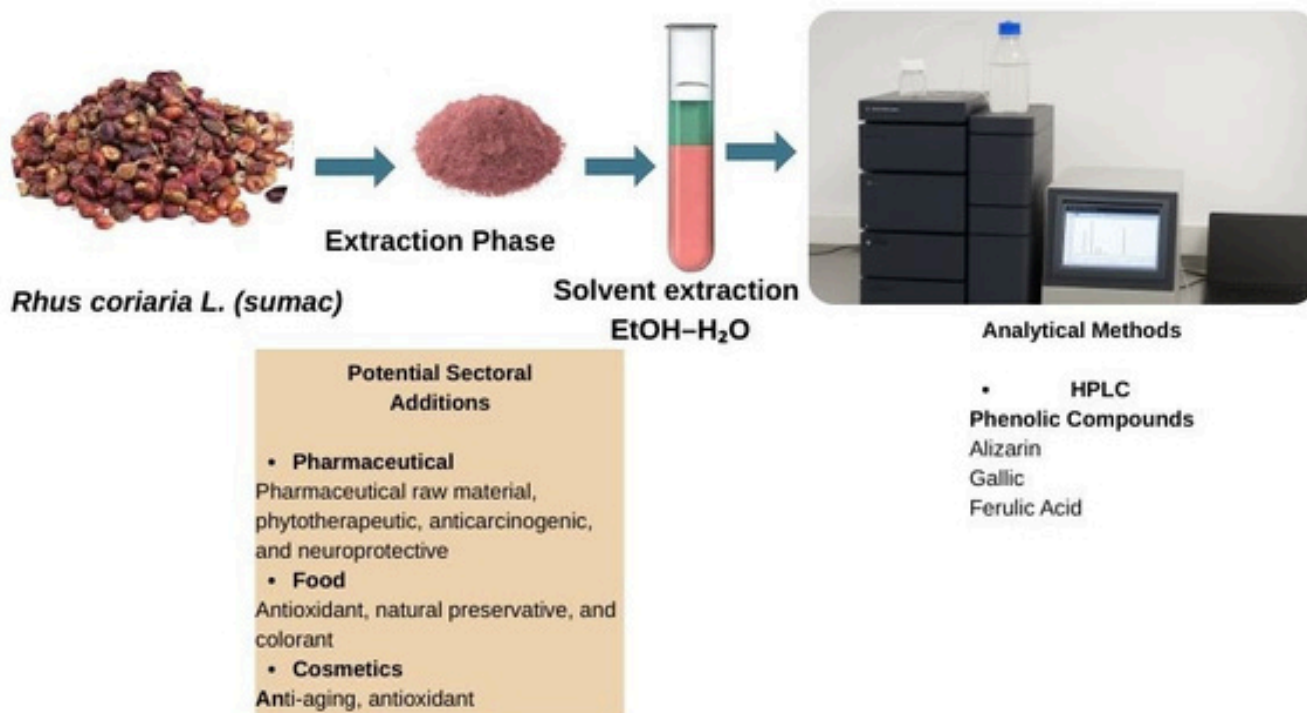


Fig. 3. The steps involved in preparing the cream from the sumac plant.

2.4. Analysis of phenolic compounds: The determination of phenolic compounds was performed using an Agilent brand HPLC system with a diode array detector (DAD). Detector settings were made at 300/200 nm wavelengths, with a reference value of 500/100 nm. Chromatographic analysis conditions were determined as follows: mobile phase: 83% (water containing 0.1% phosphoric acid) – 17% acetonitrile mixture, flow rate: 0.8 mL/min, column temperature: 30 °C, and injection volume: 10 µL. In the gradient system, the organic phase ratio was gradually increased between 0-40 minutes. Standards used for calibration included gallic acid, ferulic acid, rutin, hesperidin, o-coumaric acid, vanillic acid, protocatechuic acid, and ascorbic acid. The obtained data were evaluated using the external standard method, and the results were calculated in ng/µL (Koçak et al., 23021).

3. FINDINGS

According to HPLC-DAD analysis results, a total of ten different phenolic compounds were detected in the sumac sample. The compound with the highest concentration was gallic acid (5212.65 ng/µL), constituting approximately 81% of the total phenolic content. Gallic acid was followed by ferulic acid (671.76 ng/µL), ascorbic acid (255.23 ng/µL), protocatechuic acid (111.67 ng/µL), and o-coumaric acid (81.76 ng/µL), respectively. Lower concentrations of rutin (19.29 ng/µL), hesperidin (21.65 ng/µL), neohesperidin (14.72 ng/µL), vanillic acid (17.06 ng/µL), and p-coumaric acid (2.23 ng/µL) were also detected. The total phenolic content was calculated as 6414.70 ng/µL, indicating that sumac has a high antioxidant potential. The high levels of gallic and ferulic acids, in particular, support the idea that the plant may be effective in combating oxidative stress. The presence of these compounds reveals that sumac extracts are an important source of antioe.

Rhus coriaria L. extracts offer wound-healing, skin-renewing, and anti-aging effects in dermatological products. Furthermore, the aromatherapy properties of the essential oils are supported by stress-reducing and mentally relaxing effects. Therefore, sumac is preferred as a reliable and natural ingredient in both topical applications and aromatherapy products (Al, 2015; Mehdizadeh et al., 2016).

Rhus coriaria L. has the potential to develop high-value-added health products thanks to its biological activities and rich phytochemical profile. Phytotherapeutic and pharmaceutical products, formulated with naturally derived and functional compounds, can offer advantages in terms of consumer safety and efficacy. Sumac, thanks to both its biologically active components and versatile applications, has the potential to create high added value through an integrated chain encompassing agriculture, extraction, formulation, and marketing. The plant's economic and industrial potential stems from its use as a premium raw material in the cosmetics, health, and food sectors (Bagheri et al., 2020).

Table 3. Phenolic compounds detected in sumac (*Rhus coriaria* L.) sample.

No	Compound Name	Retention Time (min)	Amount (ng/μl)	Functional Property
1	Ascorbic acid	3.38	255.23	Antioxidant, source of Vitamin C
2	Gallic acid	4.31	5212.65	Powerful antioxidant, antimicrobial
3	Protocatechuic acid	5.72	111.67	Cell protective, antioxidant
4	Vanillic acid	9.72	17.06	Anti-inflammatory
5	p-Coumaric acid	17.11	2.23	Free radical scavenger
6	Rutin	18.93	19.29	Capillary protective, antioxidant
7	Ferulic acid	19.98	671.76	UV protective, skin regenerating
8	o-Coumaric acid	28.81	81.76	Antimicrobial
9	Neohesperidin	29.52	14.72	Vascular protective, antioxidant
10	Hesperidin	36.76	21.65	Skin regenerating, anti-inflammatory

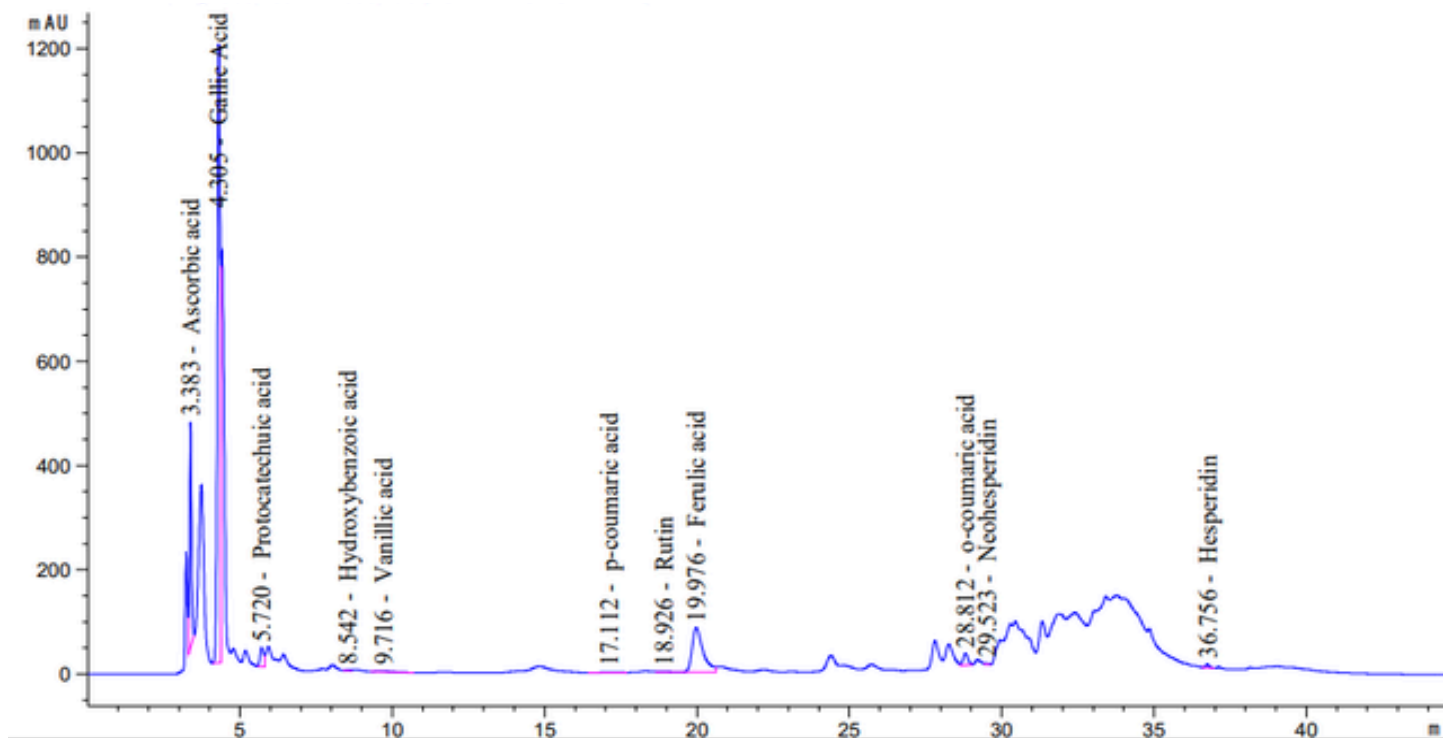


Fig. 4. Sumac (*Rhus coriaria*) HPLC phenolic chromatogram.

4. DISCUSSION

The results obtained are largely consistent with data reported in the literature (Bagheri et al, 2020; Mehdizadeh et al, 2016; Al-Snafi, 2015). Gallic acid, identified as the dominant compound in sumac extracts, is a potent antioxidant and antimicrobial agent, valued as a natural preservative in the food and cosmetic industries. Ferulic acid is a phenolic acid frequently used in cosmetic formulations due to its UV protection, collagen synthesis support, and skin elasticity enhancement properties. Furthermore, the presence of flavonoids such as rutin, hesperidin, and neohesperidin plays a role in the development of vascular protective, anti-inflammatory, and anti-aging effects. These compounds make significant contributions to maintaining skin health, supporting the circulatory system, and reducing free radical damage. The phenolic profile of sumac extracts demonstrates high antioxidant capacity and reveals its potential to reduce oxidative stress-induced cellular damage. Literature reports that *Rhus coriaria* extracts have antimicrobial effects against bacteria such as *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella* spp. (Bagheri et al, 2020). This supports the use of sumac extracts as a food preservative, cosmetic anti-aging agent, and phytotherapeutic component. In conclusion, the high phenolic content biological profile of the sumac plant indicates that it can be evaluated as a sustainable raw material in the development of natural preservatives, antioxidants, and therapeutic products. Furthermore, flavonoids such as rutin and hesperidin play a supportive role in preventing metabolic diseases through their effects that increase vascular elasticity and suppress inflammation. The results obtained indicate that sumac extracts can be considered a safe, natural, and effective component in both topical and oral applications.

4.1. Use in Cosmetic products: Sumac extract can be used as a powerful antioxidant agent in skin care. When included in formulations at a rate of 1–3%, it provides anti-aging, skin barrier strengthening, and anti-inflammatory effects. It also offers anti-dandruff and hair loss reduction effects in hair care products (1–2%).

4.2. Use in health products: Sumac can be used as an antioxidant, analgesic, and metabolic regulator in phytotherapeutic preparations (tea, capsules, ointment). Clinical studies report that sumac extracts show positive effects in lowering blood sugar and cholesterol levels (Karadag et al, 2024; Al, 2015).

4.3. Use in the food industry: In addition to its natural aroma and flavor-enhancing properties, sumac extends product shelf life by preventing microbial spoilage. Thanks to its phenolic compounds, it reduces the need for synthetic preservatives in food products. In functional foods (tea, bars, baked goods), sumac extract can be considered as an antioxidant additive.

4.4. Sustainable production and R&D potential: By-products (leaves, stems, bark) obtained from sumac production can be utilized through extraction, providing economic and environmental benefits. Furthermore, the use of green technologies such as supercritical CO₂ extraction allows for the production of high-purity extract without solvent residue. This is a significant advantage in terms of sustainable production on an industrial scale.

5. CONCLUSION AND RECOMMENDATIONS

This study revealed that the *Rhus coriaria* L. plant is quite rich in phenolic compounds, and that gallic acid and ferulic acid components, in particular, play a decisive role in biological activity. The findings show that sumac extracts have high antioxidant, antimicrobial, anti-inflammatory, and photoprotective effects, and that these properties can be evaluated in the cosmetic, health, and food industries.

Thanks to their natural and non-toxic structure, sumac extracts are an ideal component for anti-aging cosmetic products, functional foods, phytotherapeutic preparations, and natural preservative agents. These results show that it is possible to transform the plant into economic value within the framework of sustainable agriculture and green chemistry principles.

- **Standardization:** The phenolic compound profile of sumac extracts to be used on an industrial scale should be standardized, and component fluctuations between production batches should be minimized.
 - **Green Extraction Techniques:** Supercritical CO₂, ethanol, or water-based extraction methods should be popularized to support environmentally friendly production processes that do not leave solvent residues.
 - **Toxicological and Clinical Verification:** The safety of sumac extracts for use in food and cosmetic products should be verified through toxicological tests and clinical studies.
 - **University-Industry Collaboration:** The development of innovative sumac-based products should be encouraged through collaboration between R&D centers and the cosmetic/food industry.
 - **Sustainable Agricultural Practices:** Controlled production zones should be established, taking into account Turkey's climatic advantages, and sumac production should be planned in a way that contributes to the protection of agricultural biodiversity.
 - **Value-Added Product Development:** The utilization of by-products derived from sumac extracts (e.g., phenolic concentrates, essential oils, colorants) in food supplements, cosmetic formulations, and natural preservative systems should be encouraged.
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ETHICAL CONSIDERATIONS

This study did not involve human participants or experimental animals. The plant material (*Rhus coriaria* L.) used in the research was obtained from commercially available sources and/or collected in compliance with national and institutional regulations governing the collection and use of plant resources in Turkey. All experimental procedures were conducted in accordance with internationally accepted ethical standards for laboratory research, ensuring scientific integrity, data accuracy, and reproducibility. The authors confirm that no ethical approval was required for this study.

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CONFLICT OF INTEREST

The authors declare that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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