

# Quantitative ethnobotanical analysis and pharmacological relevance of the genus *Rheum* L. in Türkiye

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## ABSTRACT

In the Eastern and Southeastern Anatolia regions of Türkiye, there is a rich diversity of medicinal plants used in traditional folk medicine. Species belonging to the genus *Rheum* L. (*R. ribes* L. and *R. telianum* Ilcim) hold a significant place in traditional healing practices. This study aims to comprehensively document the traditional uses of *Rheum* species, to evaluate their cultural importance quantitatively using ethnobotanical indices, and to contribute advanced molecular drug discovery. Fieldwork was conducted with 143 participants across seven high-altitude rural settlements in the provinces of Ağrı, Van, Şırnak, and Adıyaman, where plant samples were also collected. The collected data were analyzed using ethnobotanical criteria including Use Value (UV), Informant Consensus Factor (ICF), Cultural Importance Index (CI), and Relative Frequency of Citation (RFC). *R. ribes* emerged as particularly notable for its widespread use in antidiabetic, anticancer, and nutritional applications, with a high Use Value (UV = 0.71) and Relative Frequency of Citation (RFC = 0.76). A high Informant Consensus Factor (ICF > 0.99) among participants indicated a strong cultural foundation for its traditional use. The Cultural Importance Index (CI = 1.12) further supported the prominent role of *R. ribes*. The findings of this study demonstrate that species of the *Rheum* genus are used for therapeutic purposes in Türkiye. While

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regional diversity influences usage differences, the preservation, transmission, and quantitative compilation of traditional knowledge is of great importance from a modern pharmacological perspective.

**Keywords:** ethnobotany, herbal remedies, *Rheum ribes*, *Rheum telianum*, traditional knowledge

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## INTRODUCTION

The genus *Rheum* L. belongs to the family Polygonaceae and comprises taxa that are predominantly distributed across the temperate regions of Asia. In the flora of Türkiye, the genus is represented by a limited number of species, mainly the widely distributed and commonly known *R. ribes* L. and the endemic *R. telianum* İlçim, which was recently described as a new species. The therapeutic use of plants has a long-standing history in the ecosystems of the Middle East and Asia. Among these, species of the genus *Rheum* L. have held a central role in traditional medicine for centuries, serving both nutritional and medicinal functions while occupying a significant place in the cultural heritage of many communities. Global ethnobotanical research has extensively documented the diverse folk applications of *Rheum* species.

In 16th- and 17th-century Europe, *Rheum* species known as “rhubarb” were commonly cited in ethnobotanical texts for their purgative, gastrointestinal, antirheumatic, antipyretic, and dermatological properties. In particular, they were valued for their laxative and anti-rheumatic effects within the framework of traditional European medicine<sup>1</sup>. Decoctions prepared from *Rheum* roots were administered both medicinally and as dietary supplements. These historical uses later laid the groundwork for developments in modern phytotherapy<sup>2,3</sup>.

In Traditional Chinese Medicine (TCM), *Rheum* species hold a similarly prominent status. The root of *Rheum palmatum*, traditionally known as “Da Huang”, is extensively used in the treatment of gastrointestinal disorders, febrile illnesses, jaundice, and clarification<sup>3,4</sup>. Similarly, in the Kampo system of Japanese traditional medicine *Rheum* L. preparations are applied in the treatment of gastric cancers, although concerns regarding toxicity from long-term or improper use have also been noted<sup>5</sup>.

*Rheum* has been historically employed in traditional Chinese and Indian medicine for its purgative effects and presumed detoxification functions, and it remains a prominent subject of interest in contemporary pharmaceutical research and drug development<sup>5</sup>. In the Himalayan region, particularly among

indigenous populations, *Rheum* L. species such as *R. australe* D. Don are widely employed in traditional healthcare. The root parts are used to manage rheumatic pain, wounds, intestinal disturbances, toothaches, and febrile conditions<sup>6,7</sup>. These are typically processed by drying and powdering for use in decoctions or poultices. Ethnoveterinary practices have also recorded the use of *Rheum* preparations as general antidotes for livestock<sup>8</sup>. Additionally, herbal baths prepared by soaking rhizomes in water are traditionally used to reduce fever in infants<sup>9</sup>. Beyond medicinal uses, rhizomes of *R. australe* yield natural yellow dyes used in cosmetic formulations, as well as in coloring hair, textiles, wood, and even food products<sup>7</sup>. In Northern Pakistan, the leaves are also consumed as a dietary vegetable<sup>10</sup>.

In Türkiye (Table 1), ethnobotanical studies have identified *R. ribes* as one of the most widely used species, with its rhizomes and stalks applied to support digestion, regulate blood glucose, stimulate appetite, balance gastric acidity, and alleviate symptoms associated with osteoporosis, hypertension, diarrhea, and nausea<sup>11-23</sup>. Furthermore, vinegar prepared from the roots and stalks of *R. ribes* remains a traditional practice in various regions, and such formulations are commonly sold in local herbal markets (Figure 1).



**Figure 1.** Traditional modes of utilization of the medicinal plant *Rheum* (commonly known as ışgın) in local communities

**Table 1.** Ethnobotanical uses and traditional applications of *Rheum* species in Türkiye based on published studies

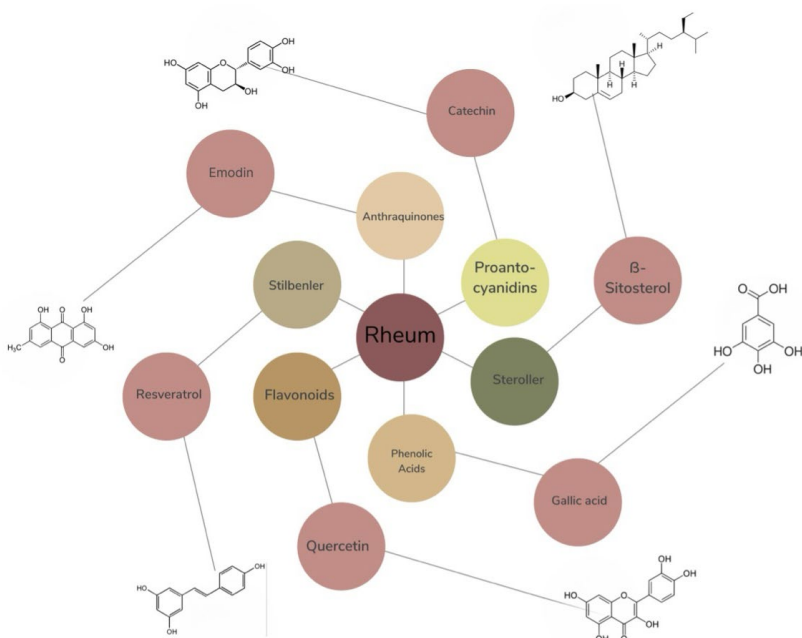
Region	Species	Local Name(s)	Plant Part Used	Preparation & Mode of Use	Traditional Purpose
Adıyaman	<i>R. ribes</i>	Rivis	Root	Decoction	Diabetes <sup>24</sup>
				Fresh eaten	
Ağrı	<i>R. ribes</i>	İşğın, yayla muzu, uçkun	Young stem, shoot, leaf	Consumed fresh / Raw	As vegetable or salad; antioxidant support <sup>23</sup>
Ağrı	<i>R. ribes</i>	İşğın	Root	Decoction; orally administered	Diabetes, peptic ulcer, kidney stones <sup>23,25,26</sup>
Bingöl	<i>R. ribes</i>	İşğın, yayla muzu, uçkun	Aerial parts & root, stem	Infusion; orally administered	Asthma, diabetes, kidney stones, heart disorders <sup>27,28</sup>
Bitlis	<i>R. ribes</i>	İşğın, yayla muzu, uçkun	Young stem, shoot, leaf	Consumed fresh / Raw	Salad, vegetable <sup>20</sup>
Bitlis	<i>R. ribes</i>	İşğın	Root	Decoction; orally administered	Diabetes, hemorrhoids, ulcers <sup>25,29</sup>
Elazığ	<i>R. ribes</i>	İşğın, yayla muzu, uçkun	Aerial part	Decoction	Urinary inflammations <sup>30,31</sup>
Erzincan		İşğın	Aerial part	Consumed fresh / Raw	Diabetes <sup>32</sup>
Erzurum	<i>R. ribes</i>	İşğın, yayla muzu, uçkun	Young stem, shoot, leaf	Consumed fresh / Raw	Salad, vegetable, antioxidant support <sup>33</sup>
Erzurum	<i>R. ribes</i>	İşğın	Root	Boiled; applied externally	Natural dye for wool, Diabetes <sup>34,35</sup>
Diyarbakır	<i>R. ribes</i>	İşğın	Root	Boiled	Diabetes <sup>36</sup>
Hakkâri	<i>R. ribes</i>	İşğın	Leaf, stem	Raw or boiled; used as fodder	Livestock feeding; ethnoveterinary use <sup>26,37</sup>
Malatya	<i>R. ribes</i>	İşğın	Fruit	Eaten fresh	Diabetes <sup>38</sup>
Muş	<i>R. ribes</i>	İşğın	Root	Decoction; externally applied	Natural dye for wool <sup>39</sup>
Tunceli	<i>R. ribes</i>	İşğın	Fruit	Eaten fresh	Salad vegetable <sup>40</sup>
			Stem	Peeling	Diabetes, hemorrhoids, carminative <sup>41</sup>
Van	<i>R. ribes</i>	İşğın	Root	Decoction; orally administered	Diabetes, hemorrhoids, ulcers <sup>25</sup>
Van	<i>R. ribes</i>	İşğın	Leaf, stem	Consumed raw or boiled; used as fodder	Livestock feed; folk veterinary practices <sup>26,37</sup>

Given the widespread ethnobotanical use of *Rheum* species, the differential accumulation of secondary metabolites in various plant organs particularly in the rhizomes, roots, and aerial parts—has been documented as a key contributor to their pharmacological effects<sup>6,42-45</sup>. The most prevalent bioactive compounds include anthraquinones (emodin, aloe-emodin, rhein), stilbenes (resveratrol, rhaponticin), and flavonoids (rutin, quercetin, luteolin), which play a pivotal role in defining the biological activity of these taxa. Anthraquinones, flavonoids, and stilbenes commonly found in *Rheum* species are associated with a wide range of biological activities, including antioxidant, anti-inflammatory, antimicrobial, and anticancer effects. These secondary metabolites are responsible for the pharmacological effects underlying the traditional uses of these species and are expected to guide future modern biological activity studies<sup>44-47</sup>.

In the Turkish flora, native *Rheum* species such as *R. ribes* L. and *R. telianum* Ilcim have been reported to possess high concentrations of phenolic acid derivatives, including gallic acid, ferulic acid, and protocatechuic acid. These compounds are particularly abundant in the root and leaf tissues. Furthermore, the detection of catechin and proanthocyanidin derivatives provides evidence supporting the strong antioxidant potential of *R. ribes*<sup>44,45,48</sup>(Figure 2).

In addition, the presence of sterols such as  $\beta$ -sitosterol and triacylglycerol in the root and seed parts enhances the therapeutic relevance of these species and underscores their value as promising sources for functional food development<sup>49,50</sup>.

Of particular note is *R. telianum*, a newly described species published in 2021, which has been found to contain high levels of flavonoids including rutin, vitexin, luteolin, and apigenin-6,8-di-C-glucoside. These findings suggest considerable phytopharmaceutical potential for this species and point to its value in future pharmacognostic and nutraceutical research<sup>48</sup>.



**Figure 2.** Phytochemical spectrum of the Genus *Rheum*: A literature-based synthesis

Recent literature emphasizes the considerable pharmacological potential of species belonging to the genus *Rheum* and their widespread use in traditional medicine systems<sup>44-51</sup>. Despite this growing interest, there is a noticeable lack of systematic and quantitative ethnobotanical studies focusing specifically on *R. ribes* and the recently identified *R. telianum* within the context of Türkiye.

The aim of this study is to document the traditional uses of *Rheum* L. species in selected regions of Türkiye and to record the medicinal applications attributed to different plant parts based on ethnobotanical field surveys. In addition, quantitative ethnobotanical indices were applied to systematically evaluate the cultural importance and use value of the recorded taxa.

## METHODOLOGY

### Study area

This study was conducted in the eastern part of Türkiye, covering both the Eastern Anatolia and Southeastern Anatolia regions, which span approximately 240,000 km<sup>2</sup> and lie between 38°–43° E longitudes and 37°–42° N latitudes<sup>52</sup>. These regions are characterized by remarkable topographical complexity, including high mountain ranges, expansive plateaus, deep valleys, and a mosaic of ecological zones, all of which contribute to a rich ethnobotanical landscape<sup>53</sup>.

Eastern Anatolia, the region with the highest average elevation in Türkiye, is defined by rugged geomorphology and prominent volcanic formations. Major peaks include Mount Ağrı (5,137 m), Süphan (4,058 m), Nemrut (3,050 m), and the Cilo and Tendürek ranges<sup>54</sup>. The dominant substrates are volcanic, comprising basaltic tuffs and andesitic rocks, with mineral-rich but organically poor soils<sup>55</sup>.

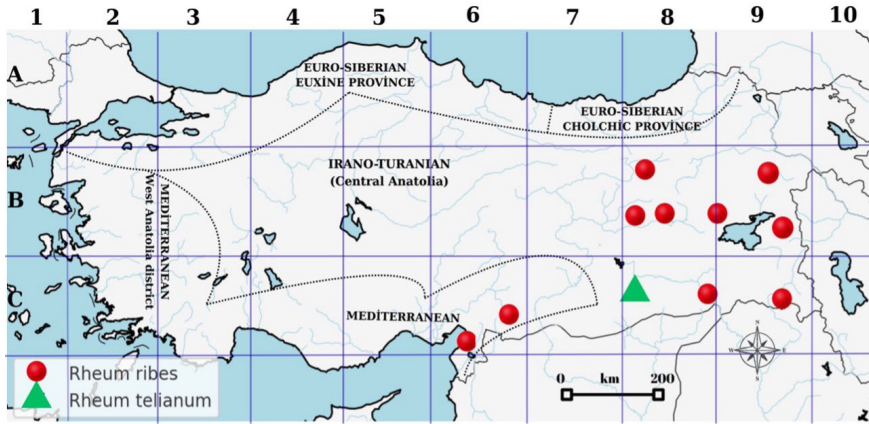
To the south, the Adıyaman region positioned along the southern fringes of the Taurus mountains is floristically and ethnomedicinally important due to its unique serpentine outcrops and ecotonal zones between steppe and forest ecosystems. These conditions foster high levels of endemism and habitat diversity.

Floristically, both regions fall within the Irano-Turanian phytogeographic zone and exhibit a highly diverse spectrum of plant life<sup>56,57</sup>. Taxa such as *Rheum* L., *Astragalus* L., *Centaurea* L., and *Salvia* L. are not only prevalent in the regional flora but are also commonly employed in traditional medicine and serve as frequent subjects of pharmacological interest<sup>58,59</sup>.

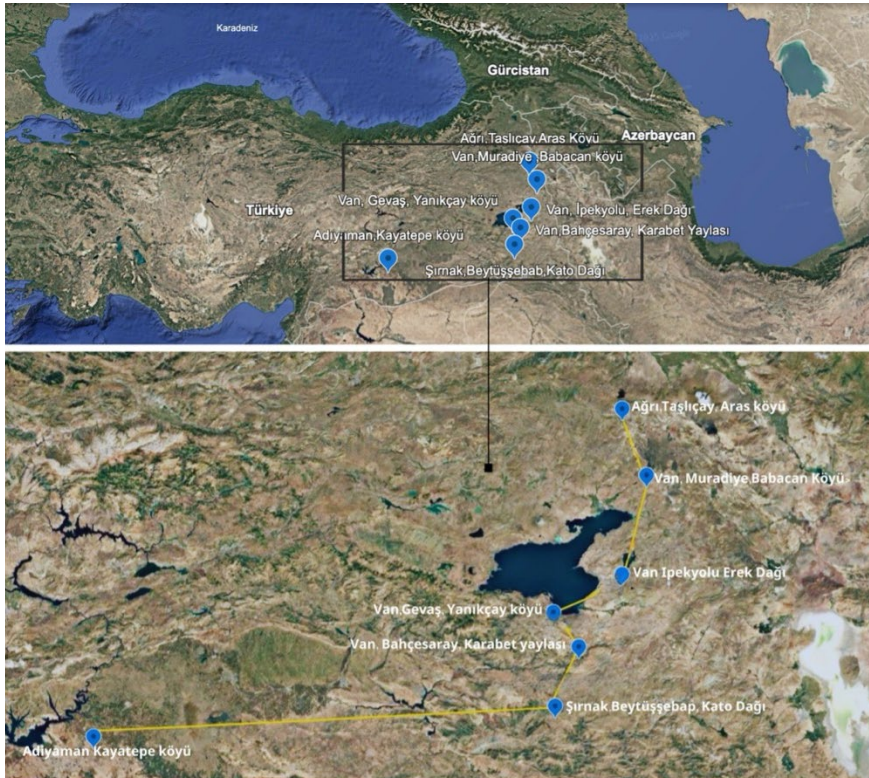
According to the TÜBİVES-2020 database, Eastern Anatolia alone hosts approximately 4,296 plant taxa. Southeastern Anatolia also supports hundreds of endemic and relict species. Collectively, these two regions contribute significantly to the overall floristic and ethnobotanical richness of Türkiye.

Ethnobotanical fieldwork was conducted between 2023 and 2025 in high-altitude rural settlements located in the eastern regions of Türkiye, specifically within the provinces of Ağrı, Adıyaman, Şırnak, Van and The selected sampling sites situated at elevations averaging around 2,000 meters above sea level included rocky slopes, subalpine valleys, and highland pastures. These areas were chosen based on the natural distribution of *Rheum* species and the presence of local informants actively involved in traditional medicinal practices. Figure 3 presents the geographical distribution map of *Rheum ribes* L. and *R. telianum* Ilcim in Türkiye.

In total, seven localities were surveyed. Geographical coordinates of each site were recorded using handheld GPS devices with an accuracy of  $\pm 5$  meters. Elevation data were corroborated using topographic maps and satellite imagery.



**Figure 3.** Phytogeographical distribution of *Rheum* species in Türkiye: *R. ribes* (●) and *R. telianum* (▲)



**Figure 4.** Geographical and satellite-based locations of the study sites

**Table 2.** Sampling localities and date information for *R. ribes* and *R. telianum* species

Taxon	Locality Details	ISTE Number	Collection Date
<i>R. ribes</i> L.	Ağrı: Taşlıçay, Aras Village; rocky hill slopes; 39.6362°N, 43.4086°E; 2580 m	ISTE 118906	18 July 2024
<i>R. ribes</i> L.	Van: Muradiye, Babacan Village; mountainous terrain, 100 m beyond the plateau; 38.9854°N, 43.7648°E; 2742 m	ISTE 118921	21 July 2024
<i>R. ribes</i> L.	Van: Gevaş, Yanıkçay Village; rocky hill slopes; 38.5012°N, 43.5617°E; 2450 m	ISTE 118916	23 July 2024
<i>R. ribes</i> L.	Van: Bahçesaray, Karabet Plateau; south-facing mountainous slopes; 38.1261°N, 42.8006°E; 2750 m	ISTE 118932	24 July 2024
<i>R. ribes</i> L.	Van: İpekyolu, Mount Ereğ; rocky hill slopes; 38.4636°N, 43.4557°E; 2650 m	ISTE: 118931	26 July 2024
<i>R. ribes</i> L.	Şırnak: Beytüşşebap, Mount Kato; southern summit slope; 37.6516°N, 43.2692°E; 2200 m	ISTE 118923	28 July 2024
<i>R. telianum</i> Ilcim	Adıyaman: Kayatepe (Rezip) Village; rocky serpentine soils; 37.8700°N, 38.2700°E; 1350 m	ISTE: 118911	23 June 2025

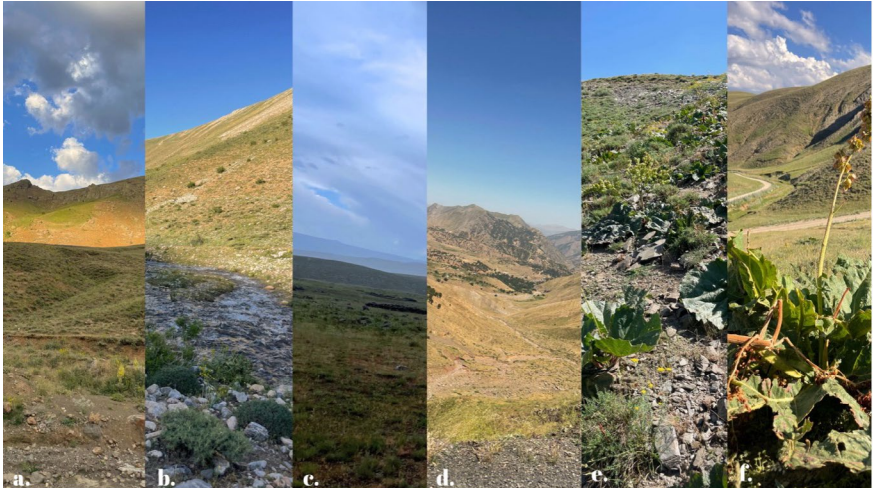
The ecological and cultural diversity of the study area provided a valuable framework for documenting and analyzing patterns of traditional knowledge related to *Rheum* species. Taxonomic identification of collected plant specimens was based on *Flora of Turkey and the East Aegean Islands*<sup>56</sup>, supplemented by recent taxonomic literature and field guides. The geographical and satellite-based locations of the study sites in Turkey are presented in Figure 4.

### Climatic and edaphic characteristics

The Eastern and Southeastern Anatolia regions of Türkiye are characterized by the harshest continental climate conditions in the country. These areas exhibit substantial annual temperature fluctuations, with winter temperatures dropping to as low as -25°C and summer temperatures rising to between 35°C and 40°C. Precipitation is largely concentrated in the winter and spring seasons, while the summers remain predominantly dry.

Humidity levels in the study area are generally low, ranging from 30% to 50%, particularly in valley floors and around Lake Van. Soils in Eastern Anatolia are largely of volcanic origin—young and mineral-rich but poor in organic matter. In contrast, serpentine and calcareous geological substrates dominate the Southeastern Anatolia region. These distinct edaphic conditions are key contributors to the region’s notable floristic diversity and endemism<sup>59,60</sup>.

Representative visual documentation of the habitat structure and soil profiles in selected sampling localities where *Rheum* species occur is provided in Figures 5 and 6.



**Figure 5.** Habitat images of *Rheum* species: (a) Yanıkçay, Van; (b) Taşlıçay, Ağrı; (c) Babacan, Van; (d) Bahçesaray, Van; (e) Erek, Van; (f) Beytüşşebap, Şırnak



**Figure 6.** Images of soil characteristics associated with *Rheum* species: (a) Yanıkçay, Van; (b) Taşlıçay, Ağrı; (c) Babacan, Van; (d) Bahçesaray, Van; (e) Erek, Van; (f) Beytüşşebap, Şırnak

## Data collection and interview procedures

Prior to data collection, all participants were informed about the purpose and scope of the study, and their participation was entirely voluntary. Anonymity and confidentiality were strictly maintained throughout the research process. Necessary official permissions and local institutional approvals (e.g., Gendarmerie Command, TAGEM) were secured prior to fieldwork initiation, in compliance with national research regulations. From June 2024 to July 2025, in-depth ethnobotanical interviews were conducted in the provinces of Van, Ağrı, Şırnak, and Adıyaman to document the traditional knowledge and uses of *Rheum* species. All responses were collected anonymously without recording any personally identifiable information.

Participants were recruited using a snowball sampling approach, with no predefined target sample size, and data collection continued until saturation was reached<sup>61</sup>. A stratified sampling design was adopted to account for provincial and elevational variations, ensuring representation from diverse socio-ecological contexts.

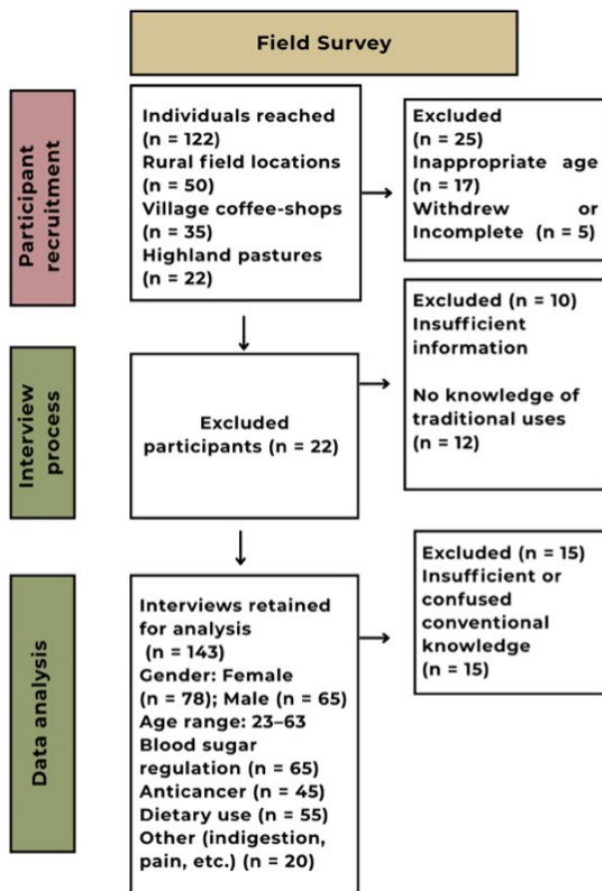
Data were collected using semi-structured questionnaires and ethnobotanical inventory forms. The questionnaire consisted of two main sections: Demographic and socioeconomic information, Knowledge and usage patterns of *Rheum* species.

The instrument was pre-tested with 143 participants to assess clarity, cultural sensitivity, and applicability. Based on feedback, minor revisions were made prior to full implementation. Interviews were conducted in Turkish, with Kurmanji (Kurdish) translation provided where necessary to ensure participant comprehension.

Botanical specimens of *Rheum* species were collected, pressed, and deposited in the ISTE Herbarium. Vernacular names reported during interviews were cross-validated with published sources to ensure accurate scientific classification<sup>62-64</sup>. The set of core ethnobotanical questions used in the semi-structured interviews is provided in Table 3. The flow diagram adapted for the ethnobotanical survey of *Rheum* species is presented in Figure 7.

**Table 3.** Ethnobotanical question set used in the semi-structured interview form

<b>Question Content</b>	<b>Category</b>	<b>Description</b>
Are you familiar with this plant? Can you identify it from a photo/herbarium specimen?	Identification and recognition	Determines how the plant is recognized and identified directly
What is the source of the plant? (locally wild-harvested / cultivated / externally supplied)	Access and supply	Investigates methods of acquisition in terms of the sustainability of ethnobotanical knowledge transmission
What is the purpose of its use? (antidiabetic, anticancer, appetite stimulant, etc.)	Usage domain	Determines the therapeutic or functional purposes for which the plant is used
Which part of the plant is used? (root, leaf, rhizome, etc.)	Plant part used	Records which plant organs are utilized
How is it prepared? (decoction, infusion, etc.)	Preparation and application	Gathers information on how the plant is prepared and applied
What are the methods of access and supply? (collection season, habitat, price)	Ecological and economic access	Notes the seasonal and habitat-related context of collection, as well as economic aspects
Are there any known side effects or contraindications?	Safety information	Identifies potential risks and precautions based on ethnobotanical knowledge



**Figure 7.** Flow diagram adapted for the ethnobotanical survey of *Rheum* species

### Data analysis and ethnobotanical indices

Quantitative data analysis was conducted using widely accepted ethnobotanical indices to evaluate the cultural significance and local knowledge associated with *Rheum* species. The indices applied included Use Value (UV)<sup>65</sup>, Relative Frequency of Citation (RFC)<sup>66</sup>, Informant Consensus Factor (ICF)<sup>67</sup>, Fidelity Level (FL)<sup>68</sup>, Cultural Importance Index (CI), and Jaccard Similarity Index<sup>66</sup>. Reported ethnobotanical uses of *Rheum* species were classified into therapeutic and non-therapeutic categories, such as glycemic regulation (diabetes mellitus), oncological applications, nutritional/culinary uses, and miscellaneous categories. Descriptive statistics were utilized to summarize demographic and usage patterns, and ICF and FL values were calculated to assess the degree of agreement among informants for each use category.

Comparative analyses between different geographical localities (e.g., Van–Bahçesaray vs. Şırnak–Beytüşşebap) were also performed to identify spatial variations in traditional knowledge and usage patterns<sup>66,67</sup>. A comprehensive summary of these ethnobotanical indices is presented in Table 4.

**Table 4.** Descriptive indices used in statistical analysis

Index	Formula	Description
Information Diversity (ID) index	$ID = U_x$ (Use reports of species) / $U_t$ (Total use reports)	Measures the proportion of reported use cases by an individual informant relative to the total number of recorded uses. It reflects the breadth of knowledge distribution across participants
Information Evenness (IE) index	$IE = ID =$ (Informant diversity) / $ID_{max}$ = (Maximum informant diversity)	Assesses the uniformity of ethnobotanical knowledge among informants by comparing individual diversity scores to the maximum observed diversity
Use Diversity (UD) index	$UD = U_{cx}$ (Use reports of species x) / $U_{ct}$ (Total use reports)	Evaluates the relative importance and richness of different use categories for a species in relation to all reported categories
Use Evenness (UE) index	$UE = UD$ (Use diversity) / $UD_{max}$ (Maximum use diversity)	Indicates how evenly knowledge is distributed among various use categories, highlighting potential overemphasis or underrepresentation
Consensus on Use Type (CUT)	$(TU / U_t) / S$ (TU = Total use reports, U <sub>t</sub> = Total use reports, S = Number of species)	Quantifies the degree of agreement among informants on specific use types of a plant, normalized by species richness
Consensus on Plant Part (CPP)	$CPP = P_x$ (Plant parts of species x) / $P_t$ (Total plant parts)	Reflects the level of informant consensus regarding which part(s) of the plant (e.g., root, leaf, stem) is used for medicinal or culinary purposes
Consensus on Mode of Use (CMU)	$CMU = M_x$ (Medicinal uses of species x) / $M_t$ (Total medicinal uses)	Measures the extent of agreement on the method of application or preparation of the plant (e.g., decoction, infusion, raw)
Informant Consensus Factor (ICF)	$ICF = (Nur - N_t) / (Nur - 1)$ (Nur = Use reports, N <sub>t</sub> = Taxa)	Indicates the degree of consensus among informants for a particular use category. High ICF values suggest reliable and culturally validated plant uses
Fidelity Level (FL)	$(N_p/N) \times 100$ N <sub>p</sub> = Number of participants, N = Total number of participants	Indicates the proportion of informants who claim a specific use over all informants who cited the species

## Field data and participant profile

A comprehensive 20-day ethnobotanical field survey was conducted between 2024-2026 across seven distinct high-altitude localities within the Eastern Anatolia region of Türkiye. The study sites included: Van (Yanıkçay, Bahcesaray, Mount Ereğ), Ağrı (Taşlıçay), Şırnak (Beytüşşebap), and Adıyaman (Kayatepe). These locations were selected based on the natural distribution of *Rheum* species and the prevalence of traditional medicinal practices.

Among the recorded taxa, *R. ribes* was found to be the dominant species, locally referred to by vernacular names such as “ışgın”, “yayla muzı”, and “uçkun”. Conversely, *R. telianum* exhibited a more restricted distribution, being encountered exclusively in the Kayatepe locality of Adıyaman Province.

Ethnobotanical data were obtained from a total of 143 informants (78 women and 65 men), ranging in age from 23 to 63 years. Data collection methods included structured questionnaires and direct observational techniques. The sociodemographic attributes of the participants are summarized in Table 5. These demographic parameters were analyzed to assess patterns in the transmission and distribution of traditional ethnomedicinal knowledge.

**Table 5.** Sociodemographic profile of the participants (n=143)

Variables	Categories	Number of Participants (n)	Percentage (%)
Gender	Female	78	54.5
	Male	65	45.5
Age (years)	20-30	22	15.4
	31-40	34	23.8
	41-50	38	26.6
	51-60	31	21.7
	>60	18	12.5
Education level	Illiterate	29	20.3
	Primary school	41	28.7
	Secondary school	35	24.5
	High school	21	14.7
	University	17	11.8
Source of knowledge	Family/Ancestors	79	55.2
	Herbalists	22	15.4
	Personal experience	28	19.6
	Written sources	14	9.8
Treatment preference	Modern medicine	41	28.6
	Phytotherapy	63	44.1
	Both	39	27.3

## RESULTS and DISCUSSION

Field data collected for *R. ribes* and *R. telianum* were quantitatively assessed using internationally recognized ethnobotanical indices to evaluate their traditional uses. Reported applications were grouped into four main therapeutic domains: (i) anticancer uses, which are generally based on decoction preparations; (ii) glycemic regulation, also predominantly involving decoction-based applications; (iii) nutritional use, referring to the consumption of stem parts consumed raw or prepared in the form of salads or pickles; and (iv) other uses, which include applications prepared as infusions or decoctions, as well as the consumption of fresh plant parts in raw form. Descriptive statistics were applied, along with the computation of ICF and FL values for each use category<sup>66-67</sup>. The calculated values of the diversity of use and the ethnobotanical indices for *Rheum* species are presented in Table 6. Comparative assessments of usage patterns across different localities (e.g., Van-Bahçesaray, Ağrı-Taşlıçay, Şırnak-Beytüşşebap, Adıyaman-Kayatepe) were also performed.

The high ICF values indicate strong informant consensus, with anticancer uses showing the highest agreement compared to other categories, followed by glycemic regulation and nutritional uses. Such high agreement typically reflects long-term reliance on a species for specific health benefits and is considered a valuable indicator of potential pharmacological relevance<sup>67</sup>. In particular, strong cultural focus on anticancer and glycemic regulation uses aligns with previous research highlighting the bioactive potential of *Rheum* species in oxidative stress modulation and glucose metabolism<sup>69,70</sup>. Likewise, notable FL values for nutritional use reaffirm the traditional recognition of *R. ribes* as a seasonal food and functional dietary component, consistent with its documented role as an edible wild plant in Anatolia<sup>71</sup>.

The regional comparisons further suggest that ecological availability and local cultural practices may shape knowledge distribution, with some therapeutic uses being more dominant in specific locations. Similar spatial variability has been previously reported for culturally significant taxa across Anatolia, reflecting differences in accessibility and historical plant-use traditions<sup>20</sup>. Additionally, while *R. ribes* has a long-established ethnobotanical profile, the inclusion of *R. telianum*, a recently described species, provides pioneering insights that fill a notable literature gap regarding its traditional relevance<sup>72</sup>. The exceptionally high ICF value obtained in this study (ICF = 1.000), with the highest consensus observed for anticancer uses, indicates a remarkable level of agreement among informants regarding the main therapeutic purposes of *Rheum* species.

### **Use value (UV) and relative frequency of citation (RFC)**

The higher Use Value (UV) and Relative Frequency of Citation (RFC) recorded for *R. ribes* (UV = 0.71; RFC = 0.76) compared to *R. telianum* (UV = 0.52; RFC = 0.58) indicate that *R. ribes* is both more widely recognized and more frequently utilized among local communities. UV is considered a strong indicator of the practical relevance and versatility of a plant species within traditional knowledge systems, with higher values reflecting a greater number of culturally validated uses<sup>66</sup>. Similarly, a higher RFC confirms greater popularity and accessibility in ethnomedicinal practices<sup>67</sup>. These findings align with previous studies demonstrating that *R. ribes* has a well-documented history of nutritional and medicinal use across Eastern Anatolia, especially in relation to oxidative stress-related conditions such as diabetes and cancer<sup>69,70</sup>. In contrast, the lower UV and RFC values for *R. telianum* may be attributed to its relatively recent taxonomic recognition and limited ethnobotanical documentation<sup>72</sup> suggesting that traditional knowledge regarding this species is still emerging or is confined to specific cultural groups.

Recent phytochemical investigations support our finding that *R. ribes* enjoys higher use and recognition: A 2024 study showed marked variation among genotypes in phenolic and antioxidant content, underpinning the cultural and therapeutic versatility implied by its higher UV and RFC<sup>73</sup>. In contrast, for *R. telianum*, the 2025 study constitutes one of the first rigorous scientific profiles of the species and thus helps explain why its UV/RFC values remain lower it is simply less established in both research and traditional knowledge networks<sup>48</sup>.

### **Informant consensus factor (ICF)**

The exceptionally high ICF values obtained in this study (0.992 for anticancer, 0.991 for glycemic regulation, and 0.990 for nutritional uses) indicate a remarkable level of agreement among informants regarding the main therapeutic purposes of *Rheum* species. ICF is widely used to evaluate shared cultural knowledge, and values approaching 1.0 reflect well-established and actively transmitted traditional practices within the community<sup>66,67</sup>. The strong consensus observed for anticancer and glycemic regulation uses suggests that these applications are deeply rooted in local ethnomedicinal knowledge and may hold higher pharmacological relevance<sup>70</sup>. Moreover, the high agreement regarding the nutritional importance of *R. ribes* aligns with its extensive history as an edible wild plant in Anatolia<sup>71</sup>. Recent pharmacological evidence further supports these culturally validated uses: *R. ribes* has been shown to exert significant antioxidant activity and beneficial effects on glucose metabolism in clinical and experimental studies<sup>69,73,74</sup>. The strong consistency between

traditional knowledge and recent scientific findings emphasizes the relevance of *Rheum* species as candidates for further phytopharmacological research.

### **Fidelity level (FL) and traditional use relevance**

The Fidelity Level (FL) metric quantifies the percentage of informants who cite a specific use of a species out of all informants who mention the species. It serves as an indicator of how culturally specific and strongly validated a plant's use is in ethnomedicinal systems<sup>66</sup>. In our study, the FL values for *R. ribes* are 84% for anticancer use, 79% for glyceemic regulation, and 88% for nutritional use. These elevated values imply that the uses are not only widely recognized but are highly targeted: a substantial portion of the local informants associate *R. ribes* with specific therapeutic or dietary functions.

The high FL for nutritional use (88%) in particular signals that *R. ribes* is deeply integrated into local dietary traditions and that its edible status is broadly affirmed. This aligns with findings that *R. ribes* is consumed as a wild seasonal food in Anatolia and is recognized for its functional properties. The anticancer (84%) and glyceemic regulation (79%) FL values suggest that these therapeutic domains are also culturally entrenched. When such strong cultural consensus is evident, it strengthens the argument that the species' uses may correspond to bioactive properties worthy of pharmacological investigation.

The contemporary scientific literature reinforces these ethnobotanical findings. Ghafouri et al.<sup>74</sup> (2023) randomized controlled trial demonstrated that supplementation with aqueous and ethanolic extracts of *R. ribes* led to significant improvements in insulin resistance indices and apolipoprotein profiles in patients with type 2 diabetes. Yolbaş<sup>45</sup> (2024) chemical-analytical study showed that the shells of *R. ribes* contain a rich array of phenolic compounds (for example rutin, procyanidin B2) with measurable antioxidant activities. Additional research in Karatepe et al.<sup>75</sup> (2024) found high total phenolic content and antioxidant potential in *R. ribes* pulp enriched with eugenol, further demonstrating its functional-food potential. Collectively, these recent studies match the high FL values by showing that culturally validated uses of *R. ribes* have a plausible biochemical / pharmacological basis<sup>75</sup>.

Therefore, the strong FL results in our ethnobotanical survey should not be viewed solely as cultural curiosities but as pointers to plants with meaningful translational potential. The convergence of high cultural fidelity and modern bioactive evidence makes *R. ribes* a compelling candidate for further investigation—for example in isolated compound testing, mechanism-of-action studies for oxidative stress / glucose metabolism, and eventually standardisation of extracts for safe use.

The results indicate that middle-aged and elderly women were the primary knowledge holders concerning traditional uses of *Rheum* species. In contrast, male participants were more actively engaged in plant harvesting and preparation processes. No statistically significant correlation was observed between educational attainment and ethnobotanical knowledge levels, suggesting that medicinal plant knowledge in the region is predominantly preserved and transmitted through oral traditions rather than formal education systems.

### **Cultural importance index (CI)**

CI reflects the extent of use and recognition of a species across use categories. The Cultural Importance Index (CI) is a quantitative metric that combines both the frequency of citation and the diversity of uses of a plant species within a community, thereby providing insight into how deeply embedded a species is in cultural practices. In this study the CI for *R. ribes* was recorded as 1.12, and for *R. telianum* as 0.86, which reinforces the interpretation that *R. ribes* not only has multifunctional uses but is also culturally deeply rooted in both therapeutic and dietary contexts. The higher CI value for *R. ribes* suggests that it is cited by more informants and for a greater variety of uses, consistent with observations in other ethnobotanical surveys where “the more versatile a plant, the more widespread its cultural importance.”<sup>66</sup> Recent investigations likewise support the reliability of CI as a proxy for cultural embeddedness: A 2023 study in Spain found that medicinal vascular plants with higher CI values were more likely to be prioritized for self-treatment practices, confirming the link between cultural salience and practical usage<sup>76</sup>. Moreover, a work on Egyptian endemic plants demonstrated the use of CI to evaluate plant species’ cultural value and found that species with  $CI > 1$  were typically those with well-reported multiple use-categories and frequent citations<sup>77</sup>. Within this framework, the CI value of 1.12 for *R. ribes* places it in the top tier of culturally significant species in the studied region. By contrast, the lower value for *R. telianum* (0.86) reflects a lesser degree of cultural penetration likely because it is more recently described and less culturally consolidated—thereby underlining the importance of cultural familiarity in ethnobotanical relevance.

### **Knowledge distribution indices: ID, IE, UD, UE**

Use Diversity (UD) and Use Evenness (UE) are important ethnobotanical metrics used to evaluate both the breadth of knowledge and the uniformity of knowledge distribution within a community<sup>78,79</sup>. In this study, *R. ribes* exhibited UD values of 0.362 for anticancer use, 0.336 for glycemic regulation, and 0.302 for nutritional purposes. The corresponding UE values were 1.00, 0.93, and

0.83, respectively. The perfect evenness observed for anticancer applications indicates that knowledge regarding this therapeutic role is shared broadly and consistently among informants, rather than being restricted to a small subgroup or specific locality.

High UE values are often interpreted as a sign of strong, actively transmitted traditional knowledge that remains resilient to sociocultural change<sup>80</sup>. The strong performance of anticancer and glycemic applications in both UD and UE supports the finding that these uses represent not only culturally significant practices but also widely accessible knowledge domains. Similar trends have been reported in recent ethnobotanical studies from the Mediterranean region, in which plants associated with chronic disease management exhibited the most evenly distributed knowledge due to frequent and long-term traditional reliance<sup>41</sup>.

Meanwhile, the slightly lower UE for nutritional use (0.83) may reflect variability in dietary traditions or seasonal consumption patterns across different subpopulations, a phenomenon also observed in studies of other wild edible plants in Türkiye<sup>81</sup>. Overall, the combined UD and UE values for *R. ribes* demonstrate that cancer-related and glycemic regulation knowledge is more homogeneously maintained across the region, suggesting a higher potential for sustained cultural continuity and strong community-level therapeutic reliance.

The Informant Diversity Index (ID) measures the variety of knowledge among informants specifically, how many different uses or items are known and shared by a set of informants. The Informant Evenness Index (IE) expresses how evenly that knowledge is distributed across informants<sup>82,83</sup>. In this study, the ID value of 0.022 indicates that the diversity of knowledge among informants is quite low, meaning only a small fraction of all possible uses or citations are held across the informant sample. Despite the low diversity, the IE value of 0.582 suggests that the limited knowledge present is moderately evenly distributed among the informants.

A low ID may reflect a situation where a few use-forms dominate the local knowledge or where usage categories are highly restricted. This can hint at a specialized or narrow ethnobotanical knowledge base, possibly due to ecological constraints, cultural specialization, or limited transmission of knowledge. Comparable findings were reported in quantitative ethnobotanical analyses where low ID values were associated with fewer use categories and relatively homogeneous use among informants<sup>82,84</sup>. On the other hand, IE values above the threshold of 0.5 are often interpreted as indicating fair homogeneity of

knowledge distribution meaning that no single informant or small subgroup monopolizes the knowledge set<sup>82</sup>. The IE of 0.582 thus suggests that while the breadth of knowledge is limited, it is not confined to only a few individuals; rather the known uses are dispersed across the community.

### **Consensus indices: CPP, CMU, CUT**

Consensus indices such as CPP (Consensus on Plant Part), CMU (Consensus on Mode of Use), and CUT (Consensus on Use Type) provide valuable insight into how consistently specific cultural practices are shared among informants<sup>65,85</sup>. In this study, the CPP values for *Rheum* species demonstrated a stronger agreement on the use of the stem (0.578) compared to the root (0.422), reflecting a wider recognition of stems in both dietary and medicinal contexts. Similarly, CMU values indicated a notable preference for raw consumption (0.64), followed by decoction (0.40), while infusion presented a lower frequency of agreement (0.16). These findings suggest that raw ingestion remains the principal cultural mode of utilization, whereas decoctions are more selectively applied in therapeutic uses, particularly aligning with reported practices in local pharmacopoeias across Anatolia. Nonetheless, when considered collectively with other strong ethnobotanical indices obtained in this study, including ICF, FL, RFC, and CI, the results reinforce the substantial cultural positioning of *R. ribes* and *R. telianum* as culturally validated medicinal and nutritional resources within Eastern Anatolia. The high consensus observed in anticancer and glycemic regulation categories is especially notable, since such convergence of knowledge implies accumulated empirical testing within the community and supports prioritization of these use claims for future pharmacological validation<sup>66-68</sup>. Overall, the robust agreement represented in consensus-based indices underscores the ethnomedicinal significance of *Rheum* species and highlights their strong potential for further evaluative biochemical and clinical research<sup>65-68,85</sup>.

**Table 6.** Diversity of use and knowledge consensus indices of *Rheum* species

No	Index Code	Index Name	Formula	Calculated Value
1	ID	Informant Diversity Index	$ID = U_x / U_t$	0.022
2	IE	Informant Evenness Index	$IE = ID / ID_{max}$	0.582
3	UD	Use Diversity Index (Hypoglysemic)	$UD = 65 / 185$	0.351
4	UE	Use Evenness Index (Hypoglysemic)	$UE = 0.351 / 0.351$	1.000
3a	UD	Use Diversity Index (Anticancer)	$UD = 45 / 185$	0.243
4a	UE	Use Evenness Index (Anticancer)	$UE = 0.243 / 0.351$	0.692
3b	UD	Use Diversity Index (Nutritional)	$UD = 55 / 185$	0.297
4b	UE	Use Evenness Index (Nutritional)	$UE = 0.297 / 0.351$	0.846
3c	UD	Use Diversity Index (Other)	$UD = 20 / 185$	0.108
4c	UE	Use Evenness Index (Other)	$UE = 0.108 / 0.351$	0.307
5	CUT	Consensus on Use Type	$CUT = (95 / 185) / 4$	0.128
6	CPP	Consensus on Plant Part Used	$CPP = 175 / 185$	0.946
7	CMU	Consensus on Method of Use	$CMU = 174 / 185$	0.941
8	ICF	Informant Consensus Factor	$ICF = (104 - 1) / (104 - 1)$	1.000
9	UV	Use Value	$UV = \sum U / N$	1.48

### Regional distribution

The data revealed noteworthy geographic variation in the use categories of the two *R. ribes* and *R. telianum* across different study sites. In particular, anticancer applications were more frequently reported in the regions of Mount Ereğ (Van), Beytüşşebap (Şırnak) and Bahçesaray (Van), whereas uses related to glycemic regulation and nutrition predominated in Babacan village (Van) and Kayatepe village (Adıyaman). Such spatial heterogeneity in ethnobotanical usage aligns with findings from other studies showing that ecological, cultural and socio-economic factors shape plant-use patterns at local scales<sup>86,87</sup>. For example, Senkardes et al.<sup>86</sup> (2022) documented in Northern Turkey that geographical variation in ecological zones correlated with differences in medicinal plant use categories. The observed variation in our study suggests that the anticancer use of *Rheum* species may be more deeply embedded in highland or specific cultural settings (i.e., high consensus sites such as Mount Ereğ and Beytüşşebap), whereas the glycemic regulation and nutritional uses appear more strongly integrated into village-level subsistence contexts (Babacan, Kayatepe). These geographical trends highlight the importance of

mapping local cultural-ecological settings when interpreting ethnobotanical data and prioritising species for regional phytopharmacological evaluation.

### **Discussion on age and gender patterns in medicinal plant use**

Our data show distinct age- and gender-related patterns in the use of medicinal plants: glycemic-regulation uses were most commonly cited by participants aged 40-55 (45%), while anticancer uses predominated in the 45-60 age group (31%). Nutritional uses were recorded primarily in the 25-60 age range (38%), and “other” uses were most prevalent among individuals aged 30-45 (14%). These trends suggest that as individuals age, their plant usage tends to shift towards disease-specific applications, likely reflecting changes in health needs and accumulated experiential knowledge. Research in ethnobotany supports this age-gradient: for example, older adults often show higher usage of medicinal plants, although knowledge and usage do not always correlate directly with age<sup>88</sup>. In addition, women comprised 54.5% of our total participants, highlighting their central role in the transmission of traditional plant knowledge within the region. Multiple studies have found that women often possess greater knowledge of medicinal and edible plants, because of their roles in caregiving, food preparation, and household health management<sup>89</sup>. These demographic dimensions age and gender thus appear to shape both the knowledge base and use patterns of plants in our study area. For future research and for the design of community-based interventions, acknowledging these patterns is critical to understanding how medicinal-plant knowledge is maintained, transmitted, and applied across different subgroups.

### **Pharmacological and cross-cultural evaluation**

The traditional uses of *Rheum* species documented in Eastern Anatolia demonstrate remarkable parallels with ethnomedical practices across Central Asia, the Himalayas, and Traditional Chinese Medicine (TCM). These cross-regional similarities may reflect a shared historical medical heritage, likely facilitated through ancient trade routes such as the Silk Road.

This alignment is substantiated by the presence of bioactive phytochemicals in *Rheum* species particularly anthraquinones like emodin, rhein, and aloemodin which have been pharmacologically validated for anticancer, antioxidant, antimicrobial, and antidiabetic activities<sup>44,45,90-93</sup>. However, prolonged or high-dose consumption especially in raw forms may result in adverse effects such as calcium oxalate accumulation and gastrointestinal disturbances. These findings highlight the critical need for dose standardization and pharmacovigilance in modern phytotherapeutic applications.

This study confirms that *R. ribes* and *R. telianum* maintain significant cultural and therapeutic roles in the Eastern Anatolia Region. Local communities widely utilize these plants for anticancer, glycemic regulation, and nutritional purposes, and these traditional uses align with contemporary pharmacological evidence.

Ethnobotanical indices such as Use Value (UV = 0.71) and Relative Frequency of Citation (RFC = 0.76) further confirm that *R. ribes* are bioculturally prioritized resources for the local population.

The preservation and documentation of this traditional knowledge is essential, not only for sustaining community health and biocultural heritage, but also for advancing pharmaceutical research and biodiversity conservation. In this context, *Rheum* species stand out as some of the most prominent representatives of ethnobotanical continuity in the region.

Although *R. ribes* L. and *R. telianum* Ilcim have been used by local populations for generations, systematic and quantitative investigations remain scarce.

This study addresses this gap by not only documenting traditional knowledge but also integrating it with quantitative ethnobotanical indices such as Use Value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL) thereby contributing valuable insights to both ethnobotanical and pharmacological literature.

This study provides the first comprehensive and quantitative ethnobotanical assessment of *R. ribes* L. and *R. telianum* Ilcim in Eastern Anatolia, revealing their substantial cultural, nutritional and therapeutic importance. High ethnobotanical index values, including ICF, FL, RFC and CI, demonstrate strong community-wide consensus, particularly concerning anticancer and glycemic regulation uses. These culturally validated uses are further supported by contemporary pharmacological evidence highlighting the bioactive potential of *Rheum* species. The documented cross-regional parallels with Central Asian, Himalayan and TCM traditions suggest a deeply rooted historical continuity, likely fostered through ancient knowledge exchange networks such as the Silk Road.

Geographical, demographic, and knowledge-distribution analyses indicate that traditional plant use practices are shaped by local ecological conditions, age-related health requirements, and the active role of women in the transmission of ethnobotanical knowledge. The results show that *Rheum* species are predominantly consumed in raw form, while recorded therapeutic applications reflect their multifunctional use as both food and medicinal resources within

local communities. Differences in preparation methods and usage patterns further highlight the adaptive nature of traditional knowledge across regions. Overall, the findings demonstrate that *R. ribes* L. and *R. telianum* Ilcim continue to play an important role in everyday health practices in Eastern Anatolia, emphasizing their cultural relevance and sustained local use.

#### **STATEMENT OF ETHICS**

This study does not require any ethical permission.

#### **CONFLICT OF INTEREST STATEMENT**

The authors have no conflicts of interest to declare.

#### **AUTHOR CONTRIBUTIONS**

FS: Conceptualization, Fieldwork, Ethnobotanical data collection, data curation, formal analysis, visualization, writing original draft, writing review & editing, funding acquisition, fieldwork coordination.

MKA: Supervision, methodology, validation, resources, writing review & editing, funding acquisition, fieldwork coordination.

Both authors collaboratively carried out the ethnobotanical fieldwork and worked in close coordination throughout all stages of the study.

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