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Composition of Anthocyanins, Specific Sugars, and Organic Acids in Wild Edible Aromatic and Medicinal Vegetables

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Abstract: This study investigates the bioactive compound profiles of 12 wild edible plant species from the Amaranthaceae, Apiaceae, Asteraceae, Brassicaceae, Caryophyllaceae, Lamiaceae, Malvaceae, Polygonaceae, and Urticaceae families, consumed as aromatic and medicinal vegetables by local communities and forming part of the natural vegetation of Mount Ergan. The plants were collected and analyzed for their anthocyanin, organic acid, and sugar contents, using advanced liquid chromatography techniques. Statistically significant differences were observed between species for each compound analyzed, highlighting their diverse phytochemical profiles. *Malva neglecta*, *Brassica nigra*, and *Taraxacum phaleratum* exhibited the highest anthocyanin contents, suggesting their strong potential as natural antioxidant sources. Organic acid levels were notably elevated in *Polygonum cognatum*, *T. phaleratum*, *Urtica dioica*, and *M. neglecta*, which positions these species as promising candidates for use as natural acid regulators in food and pharmaceutical formulations. In terms of sugar content, *Chenopodium album*, *Mentha longifolia*, and *T. phaleratum* had the lowest levels, while *M. neglecta*, *Cirsium arvense*, *P. cognatum*, and *Tragopogon buphthalmoides* showed significantly higher concentrations, indicating potential applications in the development of natural sweeteners. This study's findings provide valuable insights into the phytochemical diversity of these wild plant species, emphasizing their potential utility in health nutrition, pharmaceuticals, and cosmetics. This study emphasizes the significance of investigating underexploited plant species for their bioactive chemicals and illustrates their potential contribution to the development of sustainable, natural product-based solutions for diverse industrial uses.

Keywords: Erzincan; organic acid; sugar; wild edible plants; anthocyanin pigments

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1. Introduction

The frequent application of chemicals, including fertilizers, hormones, and pesticides, in agriculture introduces foreign substances into crops, which may accumulate in food products. Additionally, the inclusion of artificial additives in food processing introduces synthetic substances into the final products, thus modifying their natural composition and possibly influencing their safety and nutritional value. Consuming such food may pose a risk of developing diseases (neurological and cardiovascular diseases, cancer, obesity, etc.) over time. Today, the increase in nutrition-related diseases has led people to seek healthy and natural nutrients [1]. In recent years, many consumers have become more interested in various edible wild plants for maintaining a healthy diet [2].

Edible wild plants have been one of the most important food sources for humans since ancient times. In addition to being used as food due to their nutritional properties, wild plant species have also been used for medicinal purposes. In the world and in Turkey, wild edible plants are currently consumed by people, especially in rural areas [3]. Wild plants have a great potential for use as a food source because of the protective effects provided by their bioactive compounds against diseases [4]. Current nutritional interventions propose the use of edible aromatic greens or plants as functional foods in addition to standard nutrition to prevent diseases [5]. Furthermore, the increasing demand for nutraceuticals and healthy functional foods has shifted the focus of research toward the determination of the chemical composition of wild plants [6]. Thus, studies on compounds having antioxidant, free radical prevention, and antiaging activities are of great importance.

Anthocyanins are a class of compounds that have high antioxidant activity and potential to produce favorable health consequences. Anthocyanins, an important class of water-soluble phenolic compounds, contain anthocyanidin bound to a sugar via a glycosidic bond [7,8]. In numerous studies, these compounds have been shown to be efficacious in improving cardiovascular functions and reducing the risk of diabetes, and have anticancer activity [9]. Anthocyanins accumulate in the cell vacuoles of different plant tissues such as leaves, stems, fruits, tubers, and rhizomes [10].

Organic acids are one of the major compounds that are present in plants in high concentrations. The biological activity of some organic acids has a positive effect on human health. Organic compounds, such as tartaric, malic, citric, and succinic acids, show antioxidant activity because of their metal-chelating properties [11,12]. These compounds are found in high amounts in fruits and vegetables. The amount of organic acids varies considerably according to the plant species and variety. Moreover, biotic and abiotic factors also affect the organic acid content. During the developmental stages of vegetables, the content of these acids decreases [1,13]. These acids also have a significant effect on the storage duration, taste, and aroma of vegetables. The influence of organic acids on flavor is associated with texture and acidity, which affects the perception of sweetness. Accordingly, organic acid content and sugar ratio are important indicators of the maturity of fruits and vegetables. Organic acids such as tartaric, malic, and citric acids have an alkalizing effect on the human body, thereby preventing the increase of harmful microflora populations. Additionally, the consumption of organic acids has a positive impact on metabolic processes by the stimulation of the digestive glands and bowel movements [14].

The available data on the composition of bioactive compounds of many wild edible plants that are not cultivated but consumed as vegetables by local populations are still insufficient. Although the scientific literature on wild edible vegetables is quite considerable, few studies have been conducted to determine the anthocyanin and organic acid profiles of wild plants with edible leaves. Therefore, it is important to contribute to the literature by presenting new data on the content of these compounds. With almost 10,000 species of plants, of which one-third is endemic, Turkey has one of the richest plant biodiversity worldwide because of its topographic features and wide range of climatic conditions. The Erzincan province, located in the Eastern Anatolia region, has a wide variety of edible wild plant species owing to its microclimate. In northeastern Turkey, the locals who live around Ergan Mountain are used to consuming wild herbs for both food and medicine. Nevertheless, prior research on these plants primarily focused on the taxonomy of flora [15] or other compounds of interest (polyphenols, hormones) [16]. The potential applications of these flora in the food industry have not been investigated. However, there is no study in the literature investigating the contents of anthocyanin, organic acid, and sugar in edible wild plants consumed as vegetables in the Erzincan province. Therefore, this study aims to determine the anthocyanin, organic acid, and sugar contents of 12 wild edible plant species belonging to nine different families collected from Mount Ergan in the Erzincan province and contribute important data in this field. This study's novelty is that it examined the anthocyanin, organic acid, and carbohydrate content of a few wild edible plants from the province of Erzincan for the first time in the literature.

2. Materials and Methods

2.1. Plant Material

In this study, 12 wild plant species belonging to Amaranthaceae, Apiaceae, Asteraceae, Brassicaceae, Caryophyllaceae, Lamiaceae, Malvaceae, Polygonaceae, and Urticaceae families, which grow naturally in the Ergan Mount location and are consumed as vegetables by the local people, were collected according to their consumption periods in March and May 2021. All species were recognized by a medicinal botany expert from Ataturk University and the University of Oradea. A specific specimen of each species was deposited at Yeditepe University. The edible portions of the plant specimens were collected and stored at −20 °C for further analysis. General details about the plant species, their family, scientific and local names, edible parts of the wild plants, and the altitude and geographic coordinates at which they grow are shown in Table 1.

Table 1. General information on the wild edible plant species.

Family	Species	Local Name	Edible Part	Geographical Coordinates (Altitude)
Amaranthaceae	*Chenopodium album* L. subsp. *album* var. *album*	Tel pancarı	Leaf, fresh stem, petiole	39°38.503′ N 039°31.878′ E (1232 m)
Apiaceae	*Falcaria vulgaris* Bernh.	Kazayağı	Leaf, fresh stem	39°38.699′ N 039°31.613′ E (1226 m)
Asteraceae	*Taraxacum phaleratum* G. Hagl. ex Rech.	Karahindiba	Leaf, fresh stem	39°38.579′ N 039°31.635′ E (1239 m)
Asteraceae	*Tragopogon buphthalmoides* (DC.) Boiss. var. *buphthalmoides*	Yemlik	Leaf	39°38.547′ N 039°31.857′ E (1225 m)
Asteraceae	*Cirsium arvense* (L.) Scop. subsp. *vestitum* (Wimmer & Grab.) Petrak	Keğaver	Leaf	39°38.815′ N 039°31.643′ E (1216 m)
Brassicaceae	*Brassica nigra* (L.) K. Koch	Eşek turpu	Leaf	39°38.324′ N 039°31.997′ E (1218 m)

Table 1. *Cont.*

Family	Species	Local Name	Edible Part	Geographical Coordinates (Altitude)
Caryophyllaceae	*Silene vulgaris* (Moench) Garcke var. *commutata* (Guss.) Coode & Cullen	Gelin parmağı	Leaf	39°38.803′ N 039°31.782′ E (1209 m)
Lamiaceae	*Mentha longifolia* (L.) Hudson subsp. *typhoides* (Briq.) Harley var. *typhoides*	Yabani nane	Leaf, fresh stem	39°38.328′ N 039°31.640′ E (1263 m)
Malvacea	*Malva neglecta* Wallr.	Ebegümeci	Leaf, petiole	39°38.431′ N 039°31.762′ E (1246 m)
Polygonaceae	*Rumex crispus* L.	Evelik	Leaf	39°38.627′ N 039°31.666′ E (1226 m)
Polygonaceae	*Polygonum cognatum* Meissn.	Madımak	Leaf, fresh stem, petiole	39°38.310′ N 039°31.875′ E (1231 m)
Urticaceae	*Urtica dioica* L.	Isırgan	Leaf, fresh stem, petiole	39°38.336′ N 039°31.604′ E (1264 m)

2.2. Anthocyanin Analysis

Anthocyanin extraction was carried out from the leaves of the plants according to the method reported by Assefa et al. [17]. To the 40 mg lyophilized and pulverized material, 5 mL of an extraction solution containing a mixture of methanol (50 v), ultrapure water (44 v), and formic acid (6 v) was added. The resulting mixture was agitated for 5 s. The mixture was then agitated in a shaker at a speed of 500 g for a duration of 20 min. The process involved centrifuging it at 4000× *g* for 10 min at 4 °C after it had been sonicated for 20 min in an ultrasonic bath. The resulting supernatants were filtered through a polytetrafluoroethylene filter and then submitted for HPLC analysis. HPLC analysis of anthocyanins was conducted with an Agilent 1260 system (Agilent Technologies, Sacramento, CA, USA) equipped with a diode array detector (DAD). Separation was conducted utilizing a C18 column (4.6 mm × 250 mm, 5 µm, CNW Technologies, Shanghai, China). The mobile phases consisted of eluent A (0.3% phosphoric acid in water) and eluent B (acetonitrile) at a flow rate of 1 mL min^{-1}. The linear gradient for phase B was as follows: 0–20 min, 5%; 20–30 min, 15%; 30–40 min, 25%; 40–48 min, 25%; 48–50 min, 5%. The injection volume was 10 µL. Anthocyanin components were detected at 520 nm and identified based on their retention times, UV–Vis spectra (λmax), and comparison with commercial standards (e.g., delphinidin-3-glucoside, delphinidin-3-O-glucoside chloride, cyanidin-3-O-glucosidechloride, petunidin-3-O-glucoside chloride, peonidin-3-O-glucoside chloride, and malvidin-3-O-glucoside chloride) and previously published literature. The results were expressed as mg/100 g dw.

2.3. Organic Acid Analysis

Organic acids were determined using ultrafast liquid chromatography (UFLC) equipped with DAD (Shimadzu, Kyoto, Japan), according to the method outlined by Barros et al. [18]. Each determined organic acid compound was identified and quantified by comparing the calibration curves specified in its commercial standards with the area of the peaks recorded at wavelengths between 215 nm and 245 nm, based on the absorption maxima of the respective organic acids The standards of organic acids (oxalic, propionic, tartaric, butyric, malonic, malic, lactic, citric, maleic, fumaric, succinic acids) were purchased from Sigma-Aldrich Chemicals Inc., Shangai, China). Plant samples (0.5 g) were homogenized using a pestle and mortar with 2.5 mL of deionized water. The homogenate was centrifuged at 10,000 rpm for 10 min at 4 °C. The resulting supernatant was stored at −18 °C for further analysis. One milliliter of the centrifuged liquid of the stock solution was filtered through a 0.45 µm Millipore size membrane filter and then injected in UFLC. The identification and quantification of acids were performed by injecting 20 µL stock solution to separate different acids on a Supelcogel TMC-610H column (30 cm × 7.8 mm, i.e., Supelco, Bellefonte, PA, USA) by using 0.01 M sulphuric acid as a mobile phase at a flow rate of 0.8 mL/min. The results were expressed in ng μL^{-1} of wild edible plant extract.

2.4. Free Sugar Analysis

Carbohydrate standards (sucrose, glucose, fructose, mannose, galactose, xylose, and arabinose) were purchased from Sigma-Aldrich (Shanghai, China). A total of 2 g of dried plant material was extracted with 20 mL of 80% (*v*/*v*) ethanol. The samples were sonicated for 2.5 h. Sugars in the wild edible plants were analyzed using an HPLC system (Agilent Technologies, 1100 series, USA), equipped with an isocratic pump, autosampler, and refractive index detector (RID, 1260 series), according to the method reported by Harada et al. [19]. Isocratic elution was carried out using a water/acetonitrile mixture (30:70, *v*/*v*) on a Purospher® Star NH2 column (250 × 4.6 mm, 5 µm; MerckMillipore, Darmstadt, Germany). The flow rate was 1 mL/min, with an injection volume of 10 µL. The RID and column oven were maintained at 40 °C during the analysis. The quantification of sugars was performed using the internal standard method. A known quantity of an internal standard (e.g., Erythritol) was added to each sample and calibration standard before the analysis. The results were expressed as g/100 g dry weight (dw).

2.5. Edibility Score (ES) Determination

The concentrations of 11 organic acids (oxalic acid, propionic acid, tartaric acid, butyric acid, malonic acid, malic acid, lactic acid, citric acid, maleic acid, fumaric acid, and succinic acid) and seven sugars (sucrose, glucose, fructose, mannose, galactose, xylose, and arabinose) were normalized using Equation (1):

$$C_{\text{normalized}} = \frac{C - Cminim}{Cmaxim - Cminim} \quad (1)$$

where, C—concentration of the organic acid/sugar in the edible plant; Cminim—the minimum level recorded for the organic acid/sugar in the edible plant; Cmaxim—the maximum level recorded for the organic acid/sugar in the edible plant.

Each organic acid was assigned a number based on its relevance to edibility. Positive numbers were assigned to acids that impart a pleasant taste, such as citric acid (2), malic acid (1.5), succinic and fumaric acids (1), and lactic, propionic, and tartric acids (0.5). Negative numbers were given to acids that may negatively influence taste, such as oxalic acid (−2), maleic acid (−1.5), and butyric and malonic (−1) acids. In the case of sugars, the following assigned number was used according to their sweetness index: 2 for sucrose, glucose, and fructose, 1 for mannose and galactose, and 0.5 for xylose and arabinose. The overall edibility score (ES) for organic acids/sugars (ES) was calculated according to Equations (2) and (3), respectively:

$$ES_{\text{ organic acid}} = \sum_{i=1}^{i=11} a\_i \times Cnormalized_{\text{i}} \quad (2)$$

$$\text{ES}_{\text{sugars}} = \sum_{i=1}^{i=7} a\_i \times Cnormalized_{\text{i}} \quad (3)$$

where ES is the edibility score and a_i—assigned number for each component.

To include the contributions of both organic acids and sugars, a combinate edibility score (CES) was calculated with the Equation (4):

$$\text{CES} = \alpha \cdot \text{ES}_{\text{organic acid}} + \beta \cdot \text{ES}_{\text{sugars}} \quad (4)$$

In this study, the factors α and β were considered equal importance, (α = β = 1).

2.6. Statistical Analysis

Results were presented as the mean ± standard deviation (SD). Variance analysis was conducted using SPSS 22.0, and T Duncan's multiple range tests were used to differentiate between means.

3. Results and Discussion

3.1. World Distribution and Morphological Characteristics of Wild Edible Plants

Due to its geographic location, temperature, water resources, and diverse geomorphology, Turkey exhibits remarkable biodiversity. Plant biodiversity is influenced by the number of endemic species and the variety of plant taxa found within an area.

The research was conducted in the Mount Ergan region of Erzincan province. Erzincan is situated in the northwestern part of the Eastern Anatolia Region. Erzincan province covers an area of 11,903 km², with the provincial center situated at an elevation of 1185 m above sea level. The village of Yaylabaşı, where the research was conducted, is positioned on the southern slopes of Mount Ergan in Erzincan province. Erzincan exhibits a continental climate. The annual mean temperature is 10.9 °C, with a maximum annual temperature of 40.6 °C and a minimum temperature of −31.2 °C. The yearly mean precipitation is 374.6 mm.

This research was conducted in the Ergan Mountains area of Erzincan province in 2021. In the preliminary phase of this study, field, and survey research were conducted first. The locations and heights of sites from where wild plant species were collected from their natural habitats were established. The attributes of the plants, including their leaves, stems, and flowers, utilized as vegetables were evaluated, and the consumption patterns in the region were established. Table 2 includes a brief description of the morphological traits of wild plant species and their culinary applications.

Table 2. The morphological characterization of wild edible plants and their food applications.

Edible Wild Species (Common Name)	Brief Morphological Characterization and Their Application in Food	Wild Edible Plant Images
Brassica nigra (L.) K. Koch (Eşek turpu)	In the region, it is called Eşek turpu, a tall-growing, annual, herbaceous wild plant belonging to the Brassicaceae family. The plant is harvested by cutting it at the root collar in April. The average plant height of the donkey radish plant was determined to be 26.24 cm, and the average leaf length was found to be 10.81 cm. It has been determined that the dry matter content is 11.99%. The leaf shape is lyrate, and the leaf blade is lobed and hairy. As a result of observations made in the region, it has been determined that the plant flowers in May, and its flower color is yellow. The plant is consumed by the local people in the region by boiling its fresh leaves to make salads, sautéing it with other herbs, and making yogurt with it. Fresh stems are peeled and consumed raw.	

Table 2. *Cont.*

Edible Wild Species (Common Name)	Brief Morphological Characterization and Their Application in Food	Wild Edible Plant Images
Chenopodium album L. subsp. *album* var. *album* (Tel pancarı)	It is an annual, herbaceous wild plant species belonging to the Amaranthaceae family. In face-to-face interviews with the local people, the plant is referred to as "tel pancarı" in the region because it resembles the small, thin state of the field crop beet when it comes out of the ground. In the region, it is harvested in April by cutting it with a knife at the root collar. During the harvest period, the average plant height was determined to be 87.72 cm. Leaf length has been determined to be 4.68 cm. The dry matter content was determined to be 10.62%. The leaf shape is lanceolate, and the leaf blade is entire and glabrous. It has been determined that it flowers in July–August. It has been determined that the flower color is green. It has been determined that the local people make a dish called "kavurma" from it. Additionally, it has been determined that dishes such as lapa, made from spinach, are consumed in the form of salads, yogurt, and gözleme.	
Cirsium arvense (L.) Scop. subsp. *vestitum* (Wimmer & Grab.) Petrak (Keğaver)	It is a perennial, herbaceous wild plant species belonging to the Asteraceae family. The plant, known as dandelion in the region, is harvested in March by cutting it at the root collar with a knife. The average plant height was determined to be 17.43 cm, and the average leaf length was found to be 11.54 cm. The dry matter content was determined to be 17.36%. The leaf shape is serrated, and the leaf blade is lobed and hairless. The dandelion, which has yellow flowers, blooms in April. In face-to-face interviews with the local people, it was found that the dandelion plant is consumed by the locals either raw as fresh leaves or cooked in salads, sautéed with mixed herbs, or as a dish. Additionally, dandelion tea is made from the fresh or dried leaves of the dandelion plant, and it is also utilized by the local people.	
Falcaria vulgaris Bernh. (Kazayağı)	It is a wild herbaceous plant species belonging to the Apiaceae family, which is commonly found in the region, grows upright, has a distinctive smell, and is called "kazayağı" by the local people because it resembles the feet of a goose. The average plant height of the kazayağı plant, which is collected by cutting it at soil level with a knife in April, has been determined to be 21.69 cm. The leaf length has been determined to be 8.43 cm. The dry matter content was determined to be 19.19%. The leaf shape is linear, and the leaf blade is entire and hairless. It has been determined that the flowers of the plant, which blooms in June-July, are small and white in color. In the region, it is consumed raw, roasted, as a mixed bulgur pilaf and soup, and as gözleme.	
Malva neglecta Wallr. (Ebegümeci)	It is a perennial, herbaceous wild plant species belonging to the Malvaceae family. The mallow plant is harvested by cutting it at the root collar in April. During the harvest period, the average plant height was determined to be 22.65 cm. The average leaf length has been determined to be 2.75 cm. The dry matter content has been determined to be 17.91%. The leaf shape is kidney-shaped, and the leaf blade is entire and hairy. It has been determined that the mallow plant, which has small flowers, blooms in May and June, and its flower color is white-pink. In oral interviews with the local people, it was found that it is used to make bulgur dishes, stews, pastries, and gözleme. It has also been determined that tea is made from its fresh or dried leaves.	

Table 2. *Cont.*

Edible Wild Species (Common Name)	Brief Morphological Characterization and Their Application in Food	Wild Edible Plant Images
Mentha longifolia (L.) Hudson subsp. *typhoides* (Briq.) Harley var. *typhoides* (Yabani nane)	It is a perennial, herbaceous wild plant species belonging to the Lamiaceae family, which grows upright and has a distinctive smell, commonly found in wet areas, streams, and riverbanks in the region. In the Ergan Mountain region, it is collected in April by cutting it at ground level or by plucking its leaves and stems as spring arrives and the stems have not thickened too much. During the harvesting period, the average plant height was determined to be 15.5 cm, and the leaf length was found to be 3.35 cm. The dry matter content was determined to be 22.66%. The leaf shape is linear, and the leaf blade is entire and quite hairy. As a result of phenological observations, it has been determined that the wild mint plant flowers in July–August, and its flower color is light purple. In face-to-face interviews with the local people, it was found that the wild mint plant is consumed fresh or dried to add flavor to soups and salads with or without yogurt, yogurt, appetizers, and dishes due to the pleasant scent of its fresh leaves and its aromatic taste. The wild mint plant is harvested before its stems begin to thicken and is consumed as a simple lemon salad. It has been determined that tea is made from its fresh or dried leaves and consumed.	
Polygonum cognatum Meissn. (Madımak)	It is a perennial, herbaceous wild plant species belonging to the Polygonaceae family, showing a horizontal growth habit. The madımak plant is harvested in the Ergan Mountain region in April by cutting the stems, which develop parallel to the soil surface, with a knife or by hand. During the harvest period, the average plant height was determined to be 122.66 cm, and the average leaf length was identified. It has been determined that the dry matter content is 23.53%. The leaf shape is elliptical, and the leaf blade is entire and glabrous. It has been determined that the plant, which blooms in May–June, has small white-pink flowers. It has been determined that the local people consume it raw, as a pilaf and rice dish, soup, salad, sauté, and yogurt, and use it as a filling for gözleme and börek.	
Rumex crispus L. (Evelik)	It is a species of perennial, herbaceous, wild plant that grows vertically and belongs to the Polygonaceae family. The harvesting of the evelik plant by locals takes place in April by cutting the leaves, leaf stems, and root collar or by breaking them off by hand. The average height of the Evelik plant during the harvesting period was determined to be 31.61 cm. The average leaf length was determined to be 17.54 cm. The dry matter ratio was determined to be 10.88%. The shape of the leaf is linear, and the leaf blade is entire and hairless. As a result of phenological observations, it has been established that the Evelik plant blooms in May-June, and its flowers are small and yellow. It has been established that the most common way for locals to consume the Evelik plant is by making a filling from its leaves and adding it to yogurt with garlic, using it as a pastry filling and for sautéing, making porridge, and making ayran soup from its fresh leaves.	

Table 2. *Cont.*

Edible Wild Species (Common Name)	Brief Morphological Characterization and Their Application in Food	Wild Edible Plant Images
Silene vulgaris (Moench) Garcke var. *commutata* (Guss.) Coode & Cullen (Gelin parmağı)	It is a perennial, herbaceous wild plant species belonging to the Caryophyllaceae family. The gelin parmağı plant is called "gelin parmağı" by the local people because of its beautiful appearance, with shiny, delicate, and sensitive leaves. The plant is collected by cutting it at soil level or by hand-picking. At the harvesting stage, the average plant height was determined to be 11.36 cm. The leaf length has been determined to be 5.86 cm. The dry matter content was determined to be 13.27%. The leaf shape is spoon-like, and the leaf blade is entire and hairless. The plant, which blooms in May-June, has white flowers. It is often consumed raw in the region. Additionally, it is used to make yogurt, salad, sauté, omelet, plain or mixed pilaf, soup, pastry, and gözleme. The fresh shoots are often consumed in the region by adding them to cottage cheese or yogurt.	
Taraxacum phaleratum G. Hagl. ex Rech. (Karahindiba)	It is a perennial, herbaceous wild plant species belonging to the Asteraceae family. Due to its abundant presence in the region and its rapid reproduction, the plant is referred to as "köygöçüren" by the local people. In the Ergan Mountain region, with the arrival of spring, the fresh shoots that emerge from the ground are cut and collected at soil level with the help of a knife in April. During the harvesting period, the average plant height was determined to be 13.75 cm. The leaf length has been determined to be 11.01 cm. It has been determined that the dry matter content is 12.43%. The leaf shape is elliptical, and the leaf blade is entire and hairy. It has been determined that the plant flowers in May–June and its flower color is light purple. It has been determined that a porridge dish, soup, sauté, and a yogurt salad made with boiled fresh shoots are prepared.	
Tragopogon buphthalmoides (DC.) Boiss. var. *buphthalmoides* (Yemlik)	Locally known as "yemlik", it is a tall-growing, perennial, herbaceous wild plant belonging to the Asteraceae family. In April, it is collected by cutting it with a knife or plucking it by hand at ground level. The average plant height has been determined to be 17.56 cm. Leaf length has been determined to be 13.34 cm. The dry matter content was determined to be 14.19%. The leaf shape is linear, the leaf blade is entire and glabrous. As a result of phenological observations conducted in the Ergan Mountain region, it has been determined that the flowers of the yemlik plant open at sunrise and close in the later hours when they are exposed to the sun. For this reason, the yemlik plant is also referred to as the flower that faces the sun in the region. Flowering in May-June, the fodder plant has yellow flowers. It is often consumed raw, but is also prepared as a salad with yogurt or lemon, a yogurt dish, soup, bulgur pilaf with forage herbs, a lightly soupy bulgur dish, and as a sauté.	

Table 2. *Cont.*

Edible Wild Species (Common Name)	Brief Morphological Characterization and Their Application in Food	Wild Edible Plant Images
Urtica dioica L. (Isırgan)	It is a perennial, herbaceous wild plant species that grows upright and belongs to the Urticaceae family. Harvesting is performed by cutting at the root collar. With the arrival of spring in the region, fresh shoots that emerge from the ground in April are consumed. The average plant height was found to be 27.93 cm. The average leaf length of the nettle plant has been determined to be 6.85 cm. The dry matter content was determined to be 15.8%. The leaf shape is deltoid, and the leaf blade is entire and hairy. In the region, the nettle plant blooms in May. It has been determined that it has small and light green flowers. Fresh shoots are used by the local people to make bulgur pilaf, nettle porridge with garlic yogurt, meat dishes, ayran soup (nettle ayran soup) or non-ayran soup, and scrambled eggs or plain sautéed dishes. The fresh shoots of the nettle plant are consumed by the local people either fresh or dried as tea.	

3.2. Anthocyanin Contents

As a result of the statistical analysis, it was determined that there were significant differences between the species in terms of anthocyanin content (Table 3). The highest delphinidin-3-glycoside contents were detected in *M. neglecta* Wallr. (33.99 mg/100 g dw), *U. dioica* L. (30.68 mg/100 g dw), and *P. cognatum* (28,21 mg/100 g dw) species, respectively. *C. album* L., with a value of 15.77 mg/100 g dw, was the species with the lowest content. The highest values of cyanidin-3-glycoside and petunidin-3-glycoside contents were determined in *T. phaleratum* species, and the lowest value was determined in *T. buphthalmoides* (DC.) Boiss. The highest value of peonidine-3-glycoside content was determined in *R. crispus* L (20.26 mg/100 g dw), and the lowest value was determined in *T. buphthalmoides* (6.22 mg/100 g dw) (Table 3). *M. neglecta* Wallr. (0.81 mg/100 g dw) had the highest Peonidin-3-acetyl glycoside content, whereas *P. cognatum* (0.78 mg/100 g dw) had the lowest. *P. cognatum* (0.09 mg/100 g dw) was the species with the lowest content. Malvidin-3-acetyl glycoside content was determined to have the highest in *Brassica nigra* (14.64 mg/100 g dw) and the lowest in *P. cognatum* (6.04 mg/100 g dw). The highest Malvidin-3-p-coumaryl glycoside content was determined in C. arvense (0.69 mg/100 g dw), *T. buphthalmoides* (0.67 mg/100 g dw), *B. nigra* (0.64 mg/100 g dw), and *M. neglecta* (0.64 mg/100 g dw) species, respectively. The lowest Malvidin-3-p-coumaryl glycoside content was determined in *P. cognatum* (0.19 mg/100 g dw), *M.longifolia* (0.21 mg/100 g dw), and *T. phaleratum* (0.21 mg/100 g dw) species, respectively (Table 3).

M. neglecta, *B. nigra*, and *T. phaleratum* stand out for their high anthocyanin levels, marking them as promising natural antioxidant sources, with potential applications in functional foods, nutraceuticals, and cosmetics.

Anthocyanins are natural pigments belonging to a subclass of polyphenols responsible for the coloration of fruits and vegetables, ranging from red to deep blue [20]. Therefore, studies on anthocyanin content have generally focused on colorful vegetables and fruits. However, there are also studies on the anthocyanin content of green leafy vegetables. Anthocyanin concentrations in lettuce types are influenced by shade conditions, development phases, and temperature regimes. Higher anthocyanin accumulation is favored by lower temperatures, whilst their synthesis is often decreased by warmer ones. This pertains to the influence of temperature on the regulation of genes associated with the anthocyanin biosynthesis pathway. In contrast, diminished light intensity due to shade inhibits anthocyanin synthesis. The synthesis of these pigments is favored by full sun exposure since light plays a crucial role in regulating them. Reduced temperatures, abundant sunlight, and optimal harvest timing can enhance anthocyanin concentrations [21]. Another study found that anthocyanin synthesis was greatly increased by high light intensity and UV radiation, particularly in red lettuce, since light is a key regulator of the biosynthetic pathway. As noted in the previous study, lower temperatures facilitate anthocyanin accumulation, whereas higher ones inhibit it. Moreover, nitrogen limitation induces increased anthocyanin concentrations, indicating the protective effects of these pigments during abiotic stress [22]. Purple-leaf tea varieties are another significant source of bioactive substances, including anthocyanins, which provide unique sensory qualities and health advantages [23].

Table 3. Anthocyanin contents (mg/100 g dw) of wild edible plant species.

Species	Delphinidin-3-glycoside	Cyanidin-3-glycoside	Petunidin-3-glycoside	Peonidine-3-glycoside	Peonidin-3-acetyl glycoside	Malvidin-3-acetyl glycoside	Malvidin-3-p-coumaryl glycoside
Brassica nigra	25.86 ± 1.13 [d]	15.21 ± 1.02 [abc]	15.35 ± 1.25 [d]	15.24 ± 0.36 [c]	0.78 ± 0.03 [a]	14.64 ± 1.27 [a]	0.64 ± 0.04 [a]
Chenopodium album	15.77 ± 0.32 [g]	10.98 ± 4.93 [fg]	14.51 ± 1.14 [de]	15.27 ± 0.22 [c]	0.49 ± 0.04 [b]	10.72 ± 9.81 [b]	0.36 ± 0.01 [b]
Cirsium arvense	19.93 ± 0.60 [f]	10.28 ± 1.03 [gh]	13.26 ± 1.57 [de]	12.17 ± 0.34 [d]	0.23 ± 0.02 [cd]	14.59 ± 1.68 [a]	0.69 ± 0.02 [a]
Falcaria vulgaris	25.52 ± 0.14 [d]	11.41 ± 0.25 [efg]	13.10 ± 1.43 [de]	14.86 ± 2.13 [c]	0.10 ± 0.01 [de]	7.69 ± 0.84 [c]	0.23 ± 0.04 [c]
Malva neglecta	33.99 ± 1.92 [a]	16.04 ± 0.35 [ab]	21.13 ± 1.95 [ab]	18.99 ± 0.55 [ab]	0.81 ± 0.05 [a]	14.42 ± 1.03 [a]	0.64 ± 0.03 [a]
Mentha longifolia	18.27 ± 0.44 [f]	12.73 ± 0.13 [def]	16.08 ± 1.32 [cd]	15.59 ± 1.36 [c]	0.32 ± 0.02 [c]	6.64 ± 0.58 [c]	0.21 ± 0.01 [c]
Polygonum cognatum	28.21 ± 1.52 [c]	14.16 ± 0.73 [bcd]	18.67 ± 1.63 [bc]	18.43 ± 1.55 [b]	0.09 ± 0.006 [e]	6.04 ± 0.46 [c]	0.19 ± 0.02 [c]
Rumex crispus	22.08 ± 1.93 [e]	12.34 ± 0.84 [defg]	20.17 ± 2.24 [ab]	20.26 ± 0.93 [a]	0.28 ± 0.02 [c]	10.10 ± 0.91 [b]	0.37 ± 0.03 [b]
Silene vulgaris	22.98 ± 1.51 [e]	13.52 ± 0.96 [cde]	14.57 ± 1.30 [de]	15.37 ± 1.78 [c]	0.35 ± 0.05 [c]	7.52 ± 0.23 [c]	0.25 ± 0.01 [bc]
Taraxacum phaleratum	24.97 ± 0.12 [d]	16.49 ± 0.35 [a]	22.71 ± 1.82 [a]	20.20 ± 1.92 [ab]	0.33 ± 0.01 c	6.59 ± 0.84 [c]	0.21 ± 0.01 [c]
Tragopogon buphthalmoides	15.45 ± 0.25 [g]	8.71 ± 0.08 [h]	11.57 ± 1.56 [e]	6.22 ± 0.54 [e]	0.22 ± 0.06 [cd]	14.15 ± 1.36 [a]	0.67 ± 0.04 [a]
Urtica dioica	30.68 ± 1.76 [b]	14.48 ± 1.02 [abcd]	20.50 ± 1.83 [ab]	19.45 ± 0.62 [ab]	0.11 ± 0.05 [de]	7.60 ± 0.45 [c]	0.25 ± 0.01 [bc]

Similar letters in same column are not significantly different from each other at $p \leq 0.01$.

In this study, the anthocyanin content varied depending on the different plant species tested. The variability of the results may be due to species differences, and ecological and climatic differences in which plants grow. Also, the amount and concentration of anthocyanins in plants can change under various stresses [24]. The distinct climatic conditions of Ergan Mountain significantly affect anthocyanin production in plants. Increasing altitude (more than 3000 m) results in increased UV-B exposure, which induces anthocyanin synthesis as a defensive response. Cool temperatures, especially at higher altitudes, stimulate anthocyanin biosynthesis. Moreover, significant diurnal temperature fluctuations enhance anthocyanin production. Intense sunshine at these elevations stimulates light-responsive pathways, while nutrient-deficient soils serve as mild stresses, inducing plants to synthesize secondary metabolites, such as anthocyanins. Anthocyanins are among the compounds that generally alleviate the symptoms and effects of stress against biotic and abiotic stress [25]. Recent research on *Vaccinium duclouxii* has shown that some glutathione S-transferases are increased in tissues with elevated anthocyanin levels, especially under stress conditions like high light intensity or cold temperatures. The authors demonstrated that the inhibition of glutathione S-transferase activity affects anthocyanin transport, resulting in reduced pigmentation, whereas higher expression leads to increased anthocyanin concentration [26]. Despite being a minor component in the human diet, researchers have highlighted that anthocyanins are important compounds for health [27]. Scientific studies have revealed that anthocyanins also have important biological activities, such as antioxidant [28], anti-inflammatory [29], and anticarcinogenic [30] effects. In a study conducted by Özen [31] on wild edible plants such as *Trachystemon orientalis*, *Vaccinium mrytillus*, *Rumex acetosella*, *Polygonum amphibium*, *Beta vulgaris,* and *Similax excelsa*, it was reported that the antioxidant activity of vegetables was due to the presence of anthocyanines. It has been reported that vegetables with higher cyanidin content have better antioxidant activity [32]. In our study, it was determined that the three species with the highest cyanidin content were *T.*

phaleratum, *M. neglecta,* and *B.nigra*, respectively. Studies indicate that regular consumption of edible vegetables rich in anthocyanins improves human health and quality of life.

3.3. Organic Acid Contents

The organic acid contents of the species were examined, and statistically significant differences were found (Table 4). The highest quantity of oxalic acid and propionic acid was determined to be in *P. cognatum*, and the lowest quantity was in *M. neglecta. T. phaleratum* (79.06 ng μL^{-1}) had the highest tartaric acid content, whereas *T. buphthalmoides*. (31.93 ng μL^{-1}) had the lowest. Butyric acid content differed between the plant species, with the highest content measured in *U. dioica* (164.01 ng μL^{-1}) and the lowest in *P. cognatum* (77.54 ng μL^{-1}). The highest content of malonic acid was found in *U. dioica* (119.55 ng μL^{-1}), and the lowest content of malonic acid was in *C. album* (64.70 ng μL^{-1}) (Table 3). The highest quantity of malic acid was determined to be in *M. neglecta* (65.30 ng μL^{-1}), and the lowest quantity was in *T. buphthalmoides* (36.38 ng μL^{-1}). The highest content of lactic acid, citric acid, and maleic acid was found in *T. phaleratum* (93.63, 79.94, and 230.86 ng μL^{-1}, respectively), while the lowest content of lactic acid, citric acid, and maleic acid was in *T. buphthalmoides* (49.37, 37.39, and 36.70 ng μL^{-1}, respectively). The highest quantity of fumaric acid was obtained from *T. buphthalmoides* (70.01 ng μL^{-1}), and the lowest amount was obtained from *R. crispus* (27.95 ng μL^{-1}). The highest content of succinic acid was found in *P. cognatum* (167.75 ng μL^{-1}), and the lowest content of succinic acid was in *T. buphthalmoides* (75.87 ng μL^{-1}) (Table 4).

Table 4. Organic acid contents (ng μL^{-1}) of wild edible plant species.

Species	Oxalic Acid	Propionic Acid	Tartaric Acid	Butyric Acid	Malonic Acid	Malic Acid	Lactic Acid	Citric Acid	Maleic Acid	Fumaric Acid	Succinic Acid
Brassica nigra	130.11 ± 3.74 ^{cd}	116.18 ± 2.58 ^{bc}	50.12 ± 2.42 ^{def}	115.45 ± 8.25 ^{cde}	80.45 ± 6.52 ^{bc}	46.68 ± 2.22 ^{bc}	72.92 ± 2.18 ^{bc}	55.22 ± 2.51 ^{abcd}	156.53 ± 1.21 ^{b}	41.11 ± 2.02 ^{bc}	73.24 ± 4.310 ^{def}
Chenopodium album	105.19 ± 8.21 ^{e}	99.07 ± 5.52 ^{cd}	49.93 ± 3.38 ^{def}	82.68 ± 2.92 ^{f}	64.70 ± 5.85 ^{c}	38.78 ± 1.46 ^{bc}	62.38 ± 4.21 ^{cd}	53.26 ± 1.25 ^{bcde}	48.15 ± 2.76 ^{d}	31.52 ± 1.24 ^{de}	70.72 ± 2.92 ^{ef}
Cirsium arvense	112.76 ± 9.74 ^{de}	91.01 ± 6.28 ^{cd}	41.18 ± 3.98 ^{fg}	94.53 ± 1.27 ^{ef}	77.32 ± 5.24 ^{bc}	39.88 ± 1.87 ^{bc}	58.25 ± 2.67 ^{de}	44.11 ± 2.36 ^{cde}	67.98 ± 3.69 ^{d}	42.65 ± 1.18 ^{bc}	62.30 ± 4.08 ^{f}
Falcaria vulgaris	173.85 ± 5.63 ^{b}	102.99 ± 7.25 ^{c}	44.92 ± 2.25 ^{efg}	108.69 ± 4.48 ^{de}	76.89 ± 1.95 ^{bc}	45.05 ± 1.25 ^{bc}	66.53 ± 2.62 ^{cd}	40.86 ± 1.23 ^{de}	42.89 ± 1.28 ^{d}	44.46 ± 2.25 ^{b}	98.14 ± 2.87 ^{bcde}
Malva neglecta	178.13 ± 3.68 ^{b}	149.12 ± 3.58 ^{a}	65.89 ± 2.38 ^{abc}	172.12 ± 2.35 ^{a}	110.74 ± 2.14 ^{ab}	65.30 ± 2.82 ^{a}	90.87 ± 2.10 ^{a}	68.81 ± 3.99 ^{abc}	229.78 ± 2.17 ^{a}	38.11 ± 1.82 ^{bcd}	104.77 ± 1.51 ^{bc}
Mentha longifolia	118.63 ± 2.85 ^{de}	114.80 ± 7.54 ^{bc}	57.86 ± 3.71 ^{cde}	95.41 ± 39.27 ^{ef}	71.68 ± 2.25 ^{c}	43.74 ± 1.31 ^{bc}	72.28 ± 1.15 ^{bc}	61.72 ± 3.87 ^{abcd}	161.16 ± 6.05 ^{b}	34.15 ± 1.410 ^{cde}	76.09 ± 4.35 ^{cdef}
Polygonum cognatum	268.61 ± 8.95 ^{a}	155.44 ± 7.61 ^{a}	76.18 ± 4.98 ^{ab}	133.62 ± 42.57 ^{bc}	98.75 ± 2.78 ^{abc}	62.16 ± 1.22 ^{a}	91.59 ± 2.05 ^{a}	63.22 ± 4.01 ^{abcd}	116.10 ± 6.31 ^{bc}	40.34 ± 2.16 ^{bcd}	167.75 ± 6.28 ^{a}
Rumex crispus	145.39 ± 2.87 ^{c}	135.41 ± 4.58 ^{ab}	71.29 ± 4.35 ^{abc}	124.44 ± 8.58 ^{bcd}	96.66 ± 2.24 ^{abc}	54.77 ± 2.64 ^{ab}	82.78 ± 1.24 ^{ab}	70.68 ± 3.52 ^{ab}	50.47 ± 4.62 ^{d}	27.95 ± 1.58 ^{e}	102.13 ± 1.14 ^{bcd}
Silene vulgaris	121.25 ± 5.63 ^{de}	103.27 ± 3.65 ^{c}	44.55 ± 2.28 ^{efg}	107.58 ± 7.79 ^{de}	76.32 ± 1.60 ^{bc}	43.50 ± 1.28 ^{bc}	64.81 ± 1.57 ^{cd}	49.08 ± 1.99 ^{bcde}	77.79 ± 5.58 ^{cd}	36.84 ± 1.42 ^{bcde}	71.54 ± 2.02 ^{ef}
Taraxacum phalera-tum	166.67 ± 12.57 ^{b}	153.16 ± 2.87 ^{va}	79.06 ± 5.51 ^{a}	142.66 ± 10.58 ^{b}	101.26 ± 3.58 ^{abc}	62.79 ± 1.25 ^{a}	93.63 ± 2.30 ^{a}	79.94 ± 2.47 ^{a}	230.86 ± 11.56 ^{a}	31.66 ± 1.18 ^{de}	111.42 ± 1.57 ^{b}
Tragopogon buphthal-moides	106.62 ± 14.25 ^{e}	73.43 ± 7.27 ^{d}	31.93 ± 3.25 ^{g}	77.54 ± 72.54 ^{f}	67.47 ± 6.71 ^{c}	36.38 ± 1.65 ^{c}	49.37 ± 4.91 ^{e}	37.39 ± 2.01 ^{e}	36.70 ± 3.57 ^{d}	70.01 ± 7.98 ^{a}	45.84 ± 4.51 ^{f}
Urtica dioica	169.73 ± 12.78 ^{b}	134.61 ± 12.47 ^{ab}	63.40 ± 6.15 ^{bcd}	164.01 ± 14.89 ^{a}	119.55 ± 11.84 ^{a}	62.22 ± 4.87 ^{a}	82.02 ± 1.78 ^{ab}	62.11 ± 2.33 ^{abcd}	62.04 ± 1.14 ^{d}	35.06 ± 3.49 ^{cde}	104.64 ± 10.28 ^{bc}

Similar letters in same column are not significantly different from each other at $p \leq 0.01$.

The elevated organic acid content in *P. cognatum*, *T. phaleratum*, *U. dioica*, and *M. neglecta* suggests their utility as natural acid regulators in food preservation and pharmaceutical formulations.

Organic acids are compounds that influence properties such as flavor, aroma, and appearance in vegetables. The most abundant organic acid in the species, in terms of ratio or amount, is oxalic acid, followed by propionic acid, butyric acid, and maleic acid [2]. In different studies, it has been determined that oxalic acid is the main acid [3,11,33]. Oxalic acid is an important acid in leafy vegetables and its toxicity is extremely low. However, oxalic acid may cause kidney stone formation because it reduces the bioavailability of calcium (transformation into an insoluble form). For this reason, excessive intake can pose a health risk [11]. In another study, it was recommended that the oxalic acid/Ca ratio in foods should not be more than 2.5 to prevent this toxic effect [33]. In the study conducted by Perreira et al. [34], they reported that the two most abundant organic acids in *Brassica napus* and *Brassica oleracea* species were oxalic and citric acid, respectively. In our study, the wild *Brassica nigra* species had maleic acid and oxalic acid as the most abundant organic acids, respectively. In another study involving similar plant species, such as Rumex and Taraxacum, the organic acid (oxalic, malic, and citric acid) contents of the plants highlighted the potential nutritional value of uncultivated vegetables as sources of organic acids [11].

Malic acid and citric acid contribute to the characteristic acidity of fruits, balancing the sweetness from soluble sugars [35]. Differences in results may be due to many reasons (such as species differences and ecological conditions). In this study, one of the organic acids detected in wild plant species is fumaric acid.

This organic acid is important due to its antioxidant and antimicrobial effects [18,36]. There is a high demand for citric acid consumption due to its low toxicity. Citric acid is a very important organic acid in the pharmaceutical and food industries due to its acidifying properties [37]. In this study, it was determined that the *Taraxacum phaleratum*, *Rumex crispus,* and *Malva neglecta* species had more citric acid content than the other species. There are also studies on the determination of organic acid content in Rumex species such as *R. induratus* [12], *R. papilaris,* and *R. pulcher* [4]. Organic acid contents such as oxalic, malic, citric, and fumaric acid were determined in *Taraxacum* sect. Ruderalia plant, which is a wild vegetable species [38]. While the fumaric acid content was similar to this study, it was observed that the other contents showed significant differences. Differences in the results may be due to reasons such as species differences and growing conditions.

3.4. Sugar Contents

As a result of the statistical analysis, it was determined that there were significant differences between the species in terms of sugar content (Table 5). The highest sucrose contents were detected in *M. neglecta* (8.26 g 100 g^{-1}). *F. vulgaris*, with a value of 0.72 g 100 g^{-1}, was the species with the lowest content. The highest quantity of glucose was determined in *C. arvense* and *T. buphthalmoides* (104.80 g 100 g^{-1}), and the lowest value was determined in *P. cognatum*. The highest value of fructose content was determined in *C. album* (92.59 g 100 g^{-1}), and the lowest value was determined in *P. cognatum* (54.65 g 100 g^{-1}). While *B. nigra* (9.84 g 100 g^{-1}) had the highest mannose content, *M. longifolia* (2.35 g 100 g^{-1}) had the lowest mannose content. *P. cognatum* was determined to have the highest galactose (7.6 g 100 g$-^{1}$) and arabinose (5.2 g 100 g^{-1}) content. The lowest quantity of galactose and arabinose was determined to be in *C. album* (0.43 g 100 g^{-1}) and *T. buphthalmoides* (1.87 g 100 g^{-1}), respectively. Xylose sugar was found to be the highest in *U. dioica* (5.36 g 100 g^{-1}), and the lowest in *C. album* (2.86 g 100 g^{-1}) (Table 5).

Table 5. Sugar contents (g 100 g^{-1} dw) of wild edible plant species.

Species	Sc	Gl	Fr	Ma	Gt	Xy	Ab
Brassica nigra	7.72 ± 0.64 ^{b}	88.03 ± 8.57 ^{b}	88.38 ± 2.35 ^{ab}	9.84 ± 0.22 ^{a}	3.94 ± 0.92 ^{d}	3.43 ± 0.01 ^{def}	2.63 ± 0.14 ^{de}
Chenopodium album	2.99 ± 0.21 ^{bc}	68.35 ± 2.81 ^{c}	92.59 ± 3.18 ^{a}	5.94 ± 0.11 ^{cd}	0.43 ± 0.03 ^{h}	2.86 ± 0.05 ^{f}	2.14 ± 0.09 ^{fg}
Cirsium arvense	3.66 ± 0.24 ^{abc}	64.80 ± 1.68 ^{a}	88.38 ± 1.79 ^{ab}	9.10 ± 0.29 ^{a}	3.19 ± 0.30 ^{f}	4.06 ± 0.09 ^{bcd}	2.11 ± 0.08 ^{fg}
Falcaria vulgaris	0.72 ± 0.031 ^{c}	49.82 ± 2.92 ^{d}	65.96 ± 1.67 ^{cd}	5.95 ± 0.21 ^{cd}	0.70 ± 0.06 ^{h}	3.59 ± 0.12 ^{cde}	3.41 ± 0.17 ^{b}
Malva neglecta	8.26 ± 0.79 ^{a}	72.38 ± 4.18 ^{c}	84.17 ± 3.45 ^{ab}	6.62 ± 0.31 ^{bc}	5.42 ± 0.13 ^{b}	4.32 ± 0.15 ^{b}	3.66 ± 0.02 ^{b}
Mentha longifolia	5.97 ± 0.54 ^{b}	44.55 ± 1.28 ^{d}	64.71 ± 2.28 ^{cd}	2.35 ± 0.09 ^{f}	3.56 ± 0.13 ^{e}	3.17 ± 0.10 ^{ef}	2.38 ± 0.01 ^{ef}
Polygonum cognatum	4.89 ± 0.38 ^{abc}	41.58 ± 1.09 ^{d}	54.65 ± 2.42 ^{d}	5.82 ± 0.26 ^{cd}	7.60 ± 0.22 ^{a}	4.08 ± 0.29 ^{bcd}	5.20 ± 0.19 ^{a}
Rumex crispus	3.20 ± 0.11 ^{bc}	66.11 ± 2.35 ^{c}	85.00 ± 3.48 ^{ab}	6.29 ± 0.10 ^{bc}	0.59 ± 0.02 ^{h}	4.48 ± 0.14 ^{b}	2.97 ± 0.15 ^{cd}
Silene vulgaris	0.91 ± 0.042 ^{c}	48.62 ± 1.89 ^{d}	71.68 ± 1.65 ^{bc}	3.73 ± 0.01 ^{ef}	0.48 ± 0.12 ^{h}	3.09 ± 0.07 ^{ef}	2.37 ± 0.15 ^{ef}

Table 5. *Cont.*

Species	Sc	Gl	Fr	Ma	Gt	Xy	Ab
Taraxacum phaleratum	6.56 ± 0.61 b	44.55 ± 1.51 d	64.7146.47 cd	3.41 ± 0.02 ef	4.90 ± 0.14 c	4.00 ± 0.19 bcd	3.30 ± 0,27 bc
Tragopogon buphthalmoides	4.52 ± 0.32 abc	104.80 ± 6.43 a	88.38 ± 4.1 ab	7.58 ± 0.25 b	2.87 ± 0.05 g	4.22 ± 0.12 bc	1.87 ± 0.78 g
Urtica dioica	0.97 ± 0.01 c	48.62 ± 1.79 d	71.68 ± 3.05 bc	4.52 ± 0.22 de	0.66 ± 0.01 h	5.36 ± 0.22 a	3.29 ± 0.10 bc

Sc: sucrose, Gl: glucose, Fr: fructose, Ma: mannose, Gt: galactose Xy: xylose, Ab: arabinose. Similar letters in same column are not significantly different from each other at $p \leq 0.01$.

The sugar content analysis reveals *M. neglecta*, *C. arvense*, *P. cognatum*, and *T. buphthalmoides* as potential candidates for developing natural sweeteners or energy-enriched products, while *C. album*, *M. longifolia*, and *T. phaleratum* may appeal to low-sugar dietary needs.

Soluble sugars contribute to plant growth, and stress responses [39], including drought, salinity, cold, and herbicides [40]. At the same time, sugars are one of the elements of taste and flavor in plants [41]. There are similar studies investigating the sugar composition in edible wild vegetables [6]. In the research conducted by Gibson et al. [39] on the *Taraxacum* sect. Ruderalia species, the sugar content (sucrose, glucose, and fructose) differed from that of *Taraxacum phaleratum* used in our study. It is thought that the different ecologies and species caused this difference. Previous studies showed that the differences in the content of plants are influenced by genomic background and environmental conditions [42–45].

3.5. Edibility Score of Wild Plant Species

The edibility score of the plants was determined based on the levels of organic acids and carbohydrates, with the results shown in Figure 1.

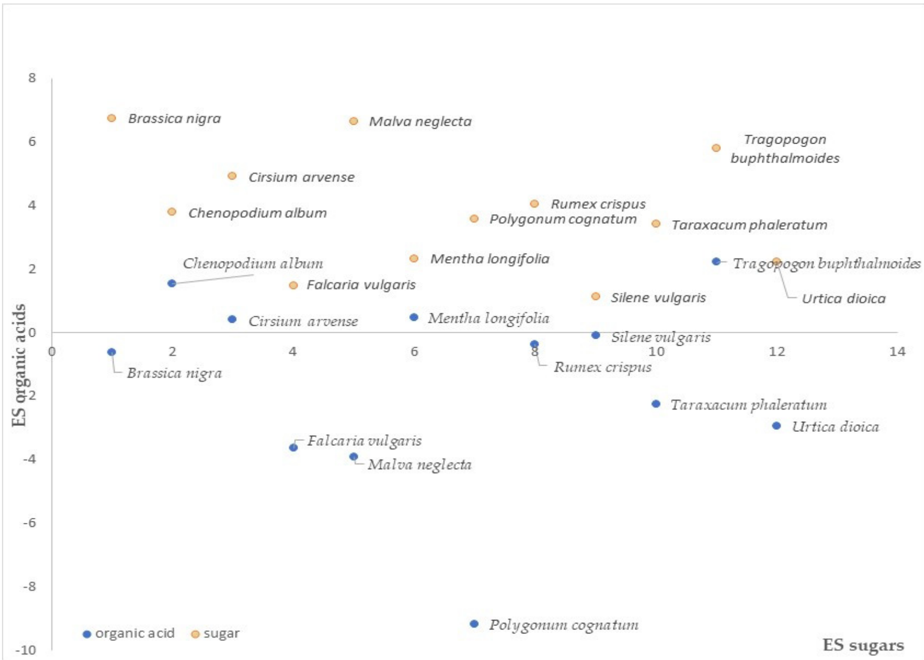

Figure 1. Edibility score of 12 wild plant species from natural vegetation on Mount Ergan according to the levels of organic acids and sugars. The blue circle represents the organic acid ES, and the orange circle represents the ES score in terms of sugars.

T. buphthalmoides exhibits a high edible organic acid score of 2.22, followed by *C. album*, *M. longifolia,* and *C. arvense*, with scores of 1.53, 0.47, and 0.41, respectively (Figure 1), making it the most suitable for consumption. The other wild plants recorded negative scores, which suggests that they are less palatable in terms of taste. The lowest score of −9.19

was recorded for *P. cognatum* (Figure 1), which exhibited the highest quantities of oxalic, propionic, and succinic acid (Table 4) compared to the other edible plants investigated.

Conversely, the edibility assessment based on sugar content resulted in a different grouping for edible plants. The highest score was attributed to *B. nigra*, followed by *M. neglecta*, *T. buphthalmoides,* and *C. arvense*, with respective values of 6.75, 6.65, 5.81, and 4.92 (Figure 1). Table 3 indicates that *M. neglecta* had the highest sugar concentration, although the above-mentioned wild plants also had high fructose and glucose concentrations. The minimum sugar ES value was recorded for *S. vulgaris* (1.12), with the lowest level of sugar. Therefore, *T. buphthalmoides* ranked first with a score of 8.03, followed by *C. arvense* and *B. nigra*, which scored 6.28 and 6.12, respectively.

The release of organic acids in the oral cavity influences flavor perception during the mastication of food, according to the interrelated nature of flavor and taste [46]. Organic acids not only modulate flavor but are also involved in plant metabolism and provide nutritional value. The sour perception of organic acid is influenced by its chemical structure, dissociation constant, and anion concentration. Increased carboxyl groups reduce acidity intensity. Citric acid (tricarboxylic acid) has a lower intensity of sour perception than malic acid (a dicarboxylic acid) or lactic acid (a monocarboxylic acid). Research [46] indicates that the perception of acidity from organic acids is affected by both their content and molecular structure, as well as the presence of other flavor chemicals. Understanding these attributes is essential for food composition and taste improvement.

On the other hand, the sugar–acid ratio is a critical determinant affecting flavor, quality, and harvest timing of plants [35]. In our study, the highest value of the sugar–acid ratio was recorded in *T. buphthalmoides* (0.339), followed by *C. arvense* and *C. album*, with ratios of 0.294 and 0.248, respectively.

4. Conclusions

This study highlights the phytochemical diversity of 12 wild edible plant species from the natural vegetation of Mount Ergan, focusing on their anthocyanin, organic acid, and sugar profiles. The results demonstrate significant variability in bioactive compound content across species, underscoring their potential as valuable natural resources for various industrial applications.

This research contributes to the growing body of knowledge on underutilized wild plants, advocating for their sustainable use and integration into health, food, and cosmetic industries. Future studies should explore the bioavailability and efficacy of these compounds, as well as investigate sustainable harvesting practices to ensure the preservation of these valuable natural resources in different regions of Erzincan province.

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