Volume 14, Issue 2, Page 82-91, 2025 https://doi.org/10.46810/tdfd.1481031 Research Article

BİNGÖL UNIVERSITY

Türk Doğa ve Fen Dergisi
Turkish Journal of Nature and Science
www.dergipark.gov.tr/tdfd

Macro and Micro Nutritional Content and Physiochemical Soil Properties of Some Naturel Medicinal and Aromatic Plants

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(Received: 09.05.2024, Accepted: 16.04.2025, Online Publication: 27.06.2025)

Keywords
Burnetrose,
Darkplantain,
Patience dock,
Sea-buckthorn,
Natural,
Physical-chemica
soil properties

Abstract: Medicinal and aromatic plants have been consumed for food and health. In the research; it is aimed to determine the micro and macro plant nutrient content and physicochemical soil properties of the fruits and leaves of some plants that are naturally found in the Kop Pass region and are generally consumed as medicinal plants. According to the results of the physicochemical analysis of the soil samples taken from the root depths of the plants (0-40 cm), the soils are generally mildly acid to slightly alkaline, unsalted, clayey to heavy clayey soils, medium to good organic matter, medium to high in lime content, very high in phosphorus and potassium was found to be high and sufficient. According to the results of fruit and leaf analyzes of the plants (*Elaeagnus rhamnoides*, *Rosa spinosissima*, *Plantago atrata* and *Rumex patientia*) samples taken from their natural habitats, the highest NPK content is 0.34%-0.59%-1.44% in the leaves of the plantain and the lowest NPK content is % in the rosehip leaves. It was determined as 0.14-0.19%-0.67%. Regarding the plant's nutrient content, the leaf parts valued higher than the fruit parts in terms of macro (Ca, Mg) and micro (Fe, Cu, Mn, Zn) plant nutrients.

Bazı Doğal Tıbbi ve Aromatik Bitkilerin Makro ve Mikro Besin İçerikleri ve Fizyokimyasal Toprak Özellikleri

Anahtar Kelimeler
Kuşburnu,
Yabani İğde,
Sinir otu,
Labada,
Doğal,
Fiziksel-kimyasal
toprak özellikleri

Öz: Tıbbi ve aromatik bitkiler gıda ve sağlık amacıyla tüketilmektedir. Araştırmada; Kop Geçidi bölgesinde doğal olarak bulunan ve genellikle tıbbi bitki olarak tüketilen bazı bitkilerin meyve ve yapraklarının mikro ve makro bitki besin maddesi içeriği ile fizikokimyasal toprak özelliklerinin belirlenmesi amaçlanmaktadır. Bitkilerin kök derinliklerinden (0-40 cm) alınan toprak örneklerinin fizikokimyasal analiz sonuçlarına göre topraklar genel olarak hafif asitli-hafif alkali, tuzsuz, killi-ağır killi topraklar, orta-iyi organik madde içerikli topraklardır, kireç içeriğinin orta ila yüksek, fosfor ve potasyum içeriğinin çok yüksek ve yeterli olduğu tespit edilmiştir. Doğal ortamlarından alınan bitki (*Elaeagnus rhamnoides*, *Rosa spinosissima*, *Plantago atrata* ve *Rumex Patientia*) örneklerinin meyve ve yaprak analizleri sonuçlarına göre en yüksek NPK içeriğini %0.,34-%0.59-%1.44 ile sinirotu, en düşük NPK içeriğini ise %0.14-0.19-%0.67 ile kuşburnu yaprakları almıştır. Besin maddeleri içeriğine bakıldığında makro (Ca, Mg) ve mikro (Fe, Cu, Mn, Zn) bitki besin maddeleri açısından yaprak kısımlarının meyve kısımlarından daha yüksek değere sahip olduğu belirlenmiştir.

1. INTRODUCTION

Located in three phytogeographic zones and fauna variety, Türkiye has an important place in different climatic and ecological conditions and rich in natural flora diversity used for food and health purposes. Natural plants found in the vegetation of the North East Anatolia Region in the Iran-Turan (Irano-Turanian) flora group constitute the vegetation of the Eastern Anatolia and the Black Sea Passage [1; 2]. Erzurum and Bayburt provinces that make up our study area are rich in biological diversity and medicinal plants. According to WHO, the number of medicinal and aromatic plants used globally is around 20 thousand, and four thousand of these are widely used. A significant portion of the medication used for treatment is naturally sourced medicine. While the increasing world population's food deficit is attempted to be met by carrying out alternative agricultural activities such as traditional or organic agriculture, mountain plants are also used for health purposes. The demand for herbal products has significantly increased over the past few decades, with a variety of end uses including flavours, colourants, essential oils, sweeteners, antioxidants, and nutraceuticals [3].

The value chain for medicinal and aromatic plants is complex, involving numerous industries in both primary and secondary processing of products and services. Native medicinal and aromatic plants have been utilised in the Mediterranean region for nutritional purposes or for the treatment of various illnesses and disorders in both people and animals since antiquity due to their complex phytochemical components and associated therapeutic characteristics. Ex situ conservation of medicinal and aromatic plants currently offers documented plant material for genetic advancement and comparative chemodiversity studies, enables the sustainable use of medicinal and aromatic plants for low-input multipurpose cultivation schemes in arid lands and challenging soils, permits their exploitation for human use and/or for animal feeds, and ensures the potential to meet the needs and aspirations of both present and future generations [4].

The development and production of aromatic and medicinal plants are closely tied to changes in the surrounding climate. Abiotic stressors, such as dryness, higher salt concentrations, temperature, ozone, UV rays, and heavy metal exposure, commonly limit the development and productivity of plants globally. Abiotic stresses change many metabolic processes and decrease CO2 uptake and diffusion, further inhibiting photosynthesis. Macro and micro plant nutrients make plants more beneficial for human health by changing plant morphology, anatomy, and chemical composition and increasing or decreasing plants' resistance and tolerance to diseases and pests [5]. The use of natural herbs for food and health purposes has necessitated identifying the differences in these plants' nutrient content in different locations and differences in their physical and chemical properties in the environment in which they grow.

This study was carried out to evaluate the nutritional elements of some natural plants consumed for health and food purposes in Erzurum and Bayburt provinces and the physico-chemical properties of the soils they grow. Physical and chemical soil analyzes were performed on soil samples taken from plant root depths. At the same time, macro and micro plant nutrient contents were investigated in fruit and leaf parts of plants taken from their natural habitats.

2. MATERIAL AND METHOD

The study was carried out between the years 2022-2023 in order to determine the differences between the physicochemical soil properties and the amount of macro and micro plant nutrients of some plants that are naturally found in Erzurum and Bayburt and consumed as health and food. Plant soils were taken from their natural habitat in triplicate. Plants used in the study are sea buckthorn (*Elaeagnus rhamnoides* L. A. Nelson), burnetrose (*Rosa spinosissima* L.), darkplantain (*Plantago atrata* Hoppe) and patiencedock (*Rumex patientia* L.). Soil samples were taken from plant root depths (0-40 cm) and brought to the laboratory by numbering. After the soil samples were air-dried, they were sieved through a 2mm sieve and made ready for analysis. In soil samples; in suspensions prepared for texture with the Bower method [6], 1 (example): 2.5 (water) ratio, soil reaction with a glass electrode pH meter [7], organic carbon determined by the modified Walkey Black method. The amount of organic matter was calculated by multiplying the content with a coefficient of 1.724 [8]. The lime content of the soil sample (mineral CO_2) was determined by Scheibler calcimeter, and from the obtained mineral CO_2 results, lime ($CaCO_3$) was determined as calcium carbonate equivalent by volumetric method [9]. The electrical conductivity values from the saturation paste extract were found to be mmhos cm-1 [10]. Total phosphorus content of soil samples was determined by ICP OES spectrophotometer (Perkin-Elmer, 2100 DV, ICP/OES, Shelton, CT 06484-4794, USA) in filters extracted with sodium bicarbonate, and potassium content was determined by flame photometer in filters extracted with ammonium easetate [11].

Plant samples were taken from their natural habitat in eightylicate (for each plants twentylicate), depending on the usage period (leaves in April, fruits in September-October). Plant samples were first dried at room temperature and then in an oven at 70 °C until they reached constant weight. Afterwards, the dried samples were ground in a Teflon blade mill with a thickness of approximately 2 mm and made ready for analysis [12]. The plant samples' total nitrogen content was determined by the micro Kjeldahl method after wet combustion with a mixture of sulfuric acid. After the plant samples were wet burned with a mixture of sulfuric acid, the total nitrogen content was determined by the Mikrokjeldahl method [13]. After wet burning with nitric perchloric acid mixture, macro and micro plant nutrients were determined by Perkin Elmer (Optima 2100) Model ICP – OES device [14]. Statistical analysis was performed in the JMP 5.0.1 program, with each subject separately according to the factorial arrangement in the random blocks. Soil and plant (fruit/leaf) were subjected to analysis of variance according to factorial experimental design in randomized blocks depending on locations, and differences between means were determined according to LSD (5%) multiple comparison test. The relationship between traits were visually demonstrated with graphics obtained from Genstat 12th Edition [15] and JumpPro-13 software.

3. RESULTS AND DISCUSSION

3.1. Physical and chemical properties of soil

The analysis of soils from the natural habitats of *E. rhamnoides, R. spinosissima, P. atrata and R. patientia* show that between the locations, lime, P and K were significant at 1%, the pH, EC, texture and OM were nonsignificant. It has been determined that lime and potassium have the highest value in Bayburt, and phosphorus in Erzurum. It was determined that EC, texture, lime contents were important at 1% and K content at 5% for plants, and pH and P averages were insignificant. In addition, the highest values for EC, lime, texture and K were determined by *P.atrata, E.rhamnoides and R.patientia*, respectively. When the location x plant interaction was examined, the EC, lime, and K values were significant at 1%, pH, soil texture, OM, and P values were insignificant (Table 1).

At the Erzurum location, the soils of *Elaeagnus rhamnoides* had highest EC (1.60 mmhos cm-1). In comparison, in the Bayburt location given by Rosa spinosissima with the lowest value of 0.60 mmhos cm-1. While the lime content in Erzurum location was 1.51% (*E. rhamnoides*), 1.00% (*P. atrata*), 0.70% (*R. spinosissima*) and 0.33% (R.patientia) the lime content was 42.23% (*P.atrata*), 40.87% (*R. patientia*), 11.14% (*E. rhamnoides*) and 2.32% (*R. spinosissima*) for the Bayburt location (Table 1). In terms of potassium values, E.rhamnoides, R.spinosissima, P.atrata and R.patientia in Erzurum location were at "sufficient" level, while for the Bayburt location, the potassium amount of E.rhamnoides and R.patientia was in the "excess" class, while the R.spinosissima and P.atrata soils were at the "sufficient" level (Table 2).

Table 1. Varyans analysis for soil properties according to mean of square

Sources of variation	pH	EC (mmhos cm-1)	Texture	OM (%)	Lime (%)	Salt (%)	P (%)	K (%)	N (%)
Location	1.5	0.0004	1.5	0.0338	3265.73**	0.0145**	2561**	8177.04**	0.00667*
Error-1	3.5783	0.3454	362.5	0.2463	0.0144	4.176	0.00042	5.20833	0.00042
Species	2.5456**	0.7671**	2242	2.7738**	619.901**	0.0073**	51**	650.863**	0.12645**
Location* Species	1.3611	0.5704**	205.5	0.8538**	645.143**	0.0089**	34.0704**	1243.72**	0.02963**
ERROR	0.4067	0.0071	62.5	0.0596	0.018	4.1676	0.000417	5.21	0.0004

Table 2. Physical and chemical properties of soils

Location	Plants	pH	OM (%)	P (%)	K (%)	EC (mmhos cm^{-1})	Clay (%)	Silt (%)	Sand (%)	Lime (%)
Erzurum	*E.rhamnoides*	5.30	2.30	0.030	0.011	1.60	46	30	24	1.5
	R.spinosissima	6.60	4.40	0.026	0.010	1.30	42	25	33	0.7
	P.atrata	7.40	3.70	0.019	0.008	1.47	48	32	20	1.0
	R.patientia	7.77	2.50	0.020	0.011	1.40	45	23	32	0.3
Bayburt	*E.rhamnoides*	7.20	2.80	0.032	0.263	1.30	45	30	25	11.1
	R.spinosissima	6.90	3.40	0.028	0.014	0.60	54	28	18	2.3
	P.atrata	7.27	4.30	0.019	0.017	2.10	60	25	15	42.2
	R.patientia	7.70	3.10	0.022	0.031	1.80	43	32	25	40.9

Soil texture, which determines the soil water and nutrient holding capacity, affec the rate of soil formation. Clay soils have high water and nutrient holding capacity, slow movement of water in the soil, and less aeration. This type of soil structure is resistant to water and wind erosion [16]. Since the structure of the plant soils that are the subject of the research is clayey, it is thought that they are rich in plant nutrients and resistant to water and wind erosion. It was stated that R.spinosissima, known as gara guşburni in the region,

grows on limestone or volcanic rocks on arid, rocky slopes at an altitude of 1200-2700 and has 7-11 oval leaflets. E.rhamnoides is a 10 m tall, thorny tree from the oleaster family, also known as sandthorn, sea-buckthorn, or xinjiang, used for anti-inflammatory intestinal diseases Erzurum and Bayburt [17]. It grows in sandy and rocky areas on wetlands in mountainous regions.

With its spinach-like structure, patience dock, or sorrel, a short plant rich in vitamins and minerals, the most known and used in the region, grows naturally in wetlands, on the edges of fields, and pastures. It has been stated that the plant is generally consumed as an anti-inflammatory and as food in the regions of this research [17; 18]. Plantago, known as broadleaf plantain, which grows in wetlands, compacted, degraded soil structure, is used as an anti-inflammatory and for wound treatments and nourishment purposes [19].

Soil pH affects the availability of nutrients and microorganism activities in the soil. The optimum pH value for plant growth is around 6.5-7.0. When the soil reaction (pH) rises from 7.5 to 8.0, the presence of elements such as Fe, Mn and Zn in the soil decreases and the plant cannot take up nutrients. When the pH value falls below 5.5-5.0, iron, manganese and aluminum elements accumulate in the soil in such a way that they have a toxic effect on the plant [20; 21]. As a result of the research, it is thought that the plant soils are between 5.30 and 7.70 and it is among the suitable values for plant growth, and therefore the availability of plant nutrients is not a problem.

Organic matter, which helps to increase the water holding capacity of the soil, ensures that the soil gains a good structure and that the plant nutrients become useful [16]. The results of the research determined that the amount of organic matter supports plant growth. In a study conducted on the extreme spreading area of the sea- buckthorns plant, it was stated that the plant grows in calcareous soil with a content of 164 mM - 520 mM EC, 0.66% - 3% organic matter, sandy-loam, and loam texture, 6.6-7.1 pH [22].

At the end of the examination of the natural environment soils of E.rhamnoides, R.spinosissima, P.atrata and R.patientia plants, the amount of organic matter was found between 2.30 and 4.40, and the electrical conductivity was between 0.60 and 2.10 (Figure 1).

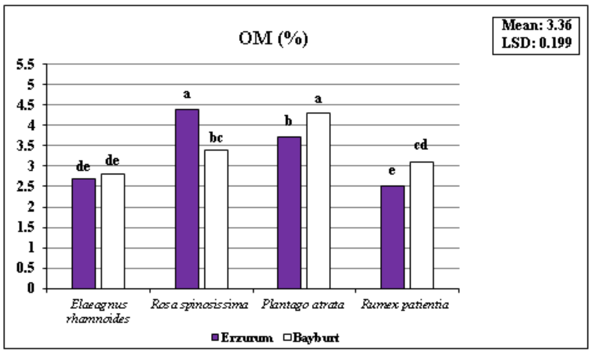

Figure 1. Interaction of location and species for OM (%)

According to Ramesh and colleagues [23], soil organic carbon is essential for the health of agro-ecosystems and is at the heart of the idea of sustainable soil health management. The amount of carbon stored in soils (in SOM) is at least three times that of the atmosphere or live plants. This substantial reservoir of organic carbon is sensitive to changes in the surrounding environment or climate. The ability of organic matter to endure is not due to the fundamental characteristics of the organic material itself, but rather to physicochemical and biological factors from the environment that lower the probability (and hence speed) of decomposition. In other words, the ability of soil organic carbon to persist is essentially an ecosystem feature rather than a molecular one. It is challenging to include the complexity of the soil system into a single conceptual model or to transform it into a manageable yet precise numerical model. The range of spatial patterns in soil spans many orders of magnitude (from nanometer minerals to football-sized soil clods), and there is interaction between solid, liquid, gas, and biological ones. The new information is still largely qualitative in nature. In many cases, it provides vital information and novel model structures, but does not provide information on how to parameterize them [24].

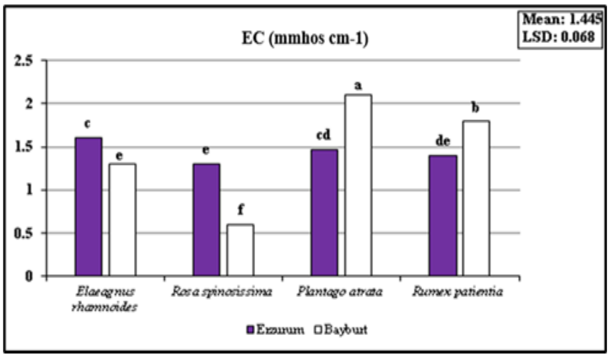

Figure 2. Interaction of location and species for EC (mmhos cm-1).

An important link between plants and soil can be seen in the interaction of location and species for EC (Figure 2), which may be partially sourced through rhizosphere respiration and biogeochemical processes. Rhizospheric microorganisms influence plant physiology by producing secondary metabolites in medicinal and aromatic plants, nitrogen fixation, nutrition uptake, and other beneficial outcomes [25]. Terpenes, alkaloids, flavonoids, carotenoids, plant hormones, carboxylic/organic acids, and fatty acids are just a few of the diverse group of compounds (phytochemicals) found in root exudates and extracts that play a crucial role in the development of plants as well as the control of the rhizosphere microbiota and soil characteristics [26]. These exudates and extracts may be sourcing from the studied medicinal and aromatic plant and/or neighbouring other native species exsisting in proximate location. Calcareous soil is a soil that contains free calcium carbonate. This type of soil is common in humid and semihumid regions as well as in arid and semiarid regions, especially if their parent material is $CaCO_3$-rich. The presence of $CaCO_3$ influences the availability of N, P, K, Mg, Zn, Cu, and Fe to plants as well as the induction of alkaline reactions in calcareous soils (Figure 3). Carbonates in soil assist in buffering the pH between 7.5 and 8.5. Apart from chemical influence, $CaCO_3$ in calcareous soil influences its physical properties as well [27].

The geographic variation is one element that is far from human control, because of different climatic conditions and edaphic factors that exist in each region [28]. Numerous medicinal plant species' chemical compositions are impacted by poorly drained soils [29]. Lychnophora ericoides [30] and Cryptomeria fortunei [31] of various origins can be used as examples of medicinal plant species where geographic variations in chemical compositions' quantity and quality as well as the existence of distinct chemotypes have been reported.

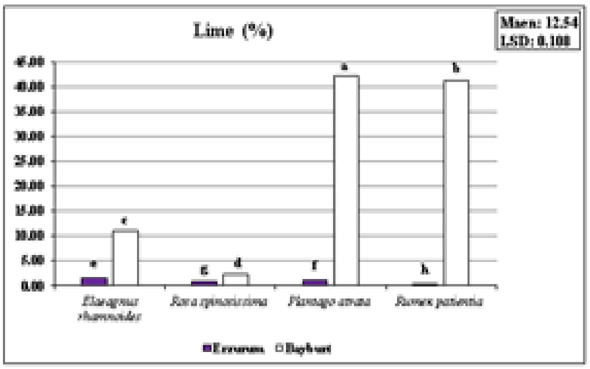

Figure 3. Interaction of location and species for lime (%)

3.2. Macro and micro nutrient contents of the plants

The effect of mineral substances on plant growth has been known for two thousand years. The amount of mineral substances that plants need to grow and develop is very limited. They take the necessary elements as well as the minerals that should not be taken. Fruit and leaf analysis of E.rhamnoides and R.spinosissima, show that P, Fe and Mn were significant at 1%, and K, Ca, Mg and Zn at 5%. At the same time, N and Cu were insignificant, and in plants, N, K, Ca, Mg, Fe, Cu, Mn, and Zn were found to be significant at 1%, whereas P was found to be insignificant. When the location x plant interaction was examined, it was found that Mn values were important at 1%, while N, P, K, Ca, Mg, Fe, Cu and Zn values were insignificant (Table 3; Table 4).

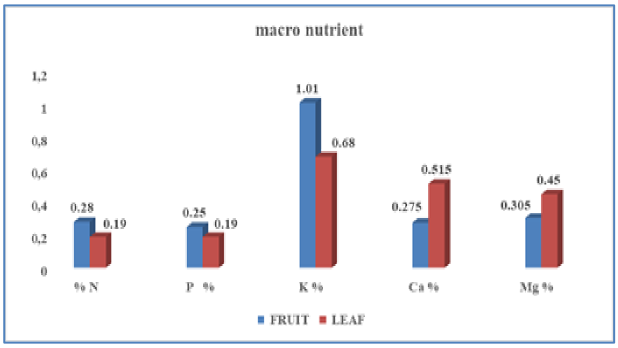

Figure 4. Average macronutrient content of *E. rhamnoides* and *R .spinosissima*

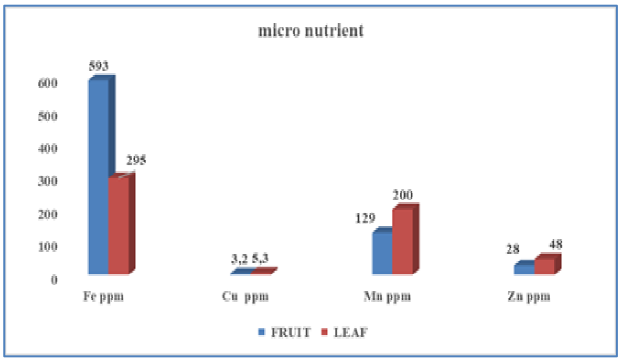

Figure 5. Average micronutrient content in *E. rhamnoides* and *R. spinosissima*

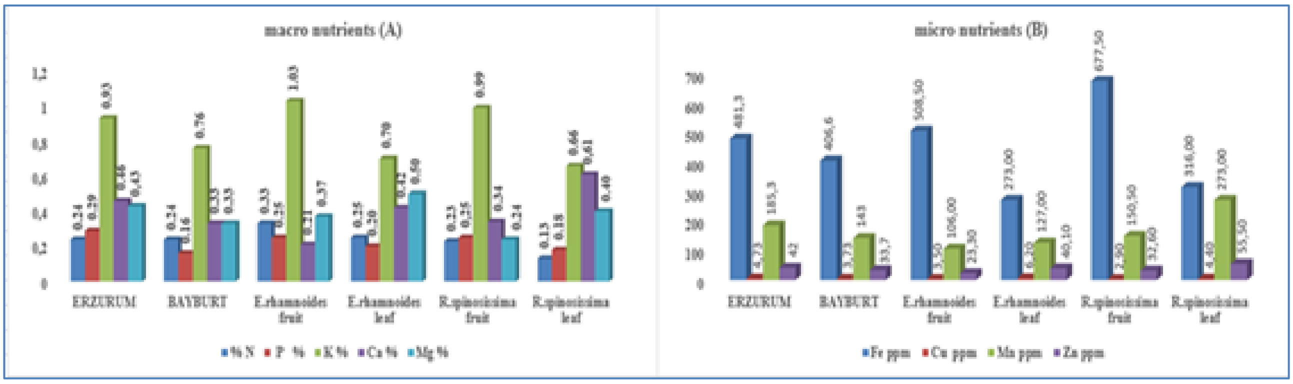

Figure 6. Plant macro and micronutrient contents

In the study, it was determined that Erzurum location gave better results, N (0.28%), P (0.25%), K (1.01%) and Fe (593 ppm) values were higher in fruits (Figure 4) and Ca (0.525%), Mg (0.465%), Cu (5.3 ppm), Mn (200 ppm), and Zn (45 ppm) nutrient contents in leaves (Figure 5). N, P, K are plant nutrients necessary for regular fruit formation and development and increase fruit quality among the plant nutrients. The researchers reported that the N% P% and K% contents differ in plants depending on the plant species, variety, age, and the plant sample taken [32]. In the study, nitrogen content in fruits and leaves was found to be between 0.33 and 0.13 the values (Figure 6). Nitrogen is the building block of protein and is the structural element of nucleic acid and chlorophyll molecule [20].

Table 3. Varyans analysis for fruit and leaf samples according to mean of square

	Sources of variation	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
Fruit	**Location**	0.00282**	0.11801**	0.0867*	0.07207**	0.0192**	15123**	0.0075**	660.083*	74.5008**
	Error-1	2.415	3.3355	0.01002	0.00099	0.00025	200	0.000	33.3333	0.58333
	Species	0.02466**	7.5455	0.00333	0.06601**	0.04813**	85683**	0.9075**	5084.08**	63.0208**
	Location*Species	0.00034*	0.00021	0.08333*	0.00908*	0.02803**	4800**	0.0675**	2494.08**	81.6408**
	ERROR	0.0025	0.00006	0.010008	0.000992	0.000333	100.0	1.1214	33.33	0.5833
Leaf	**Location**	0.00175*	0.0075**	0.1121*	0.07521**	0.0675*	18723**	11.4075**	12545.3**	1793.41*
	Error-1	0.00011	0.0001	0.0011	0.00333	0.00727	0.0000	1.1225	44.3333	146.417
	Species	0.0426*	0.0027**	0.0027	0.10268**	0.08333**	5547**	10.2675**	62496.3**	323.441*
	Location*Species	0.0001	2.634	0.0027	7.555**	0.02083	3	1.6875**	8965.33**	532.001
	ERROR	0.0001	4.257	0.0027	0.0008	0.002933	200.00	0.00250	74.3	138.083

Table 4. Results of analysis properties of fruit and leaf samples

	Species	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
Fruit	*Elaeagnus rhamnoides*	0.33 a	0.25	1.03	0.21 b	0.39 a	508.5 b	3.45 a	111.00 b	28.30 b
	Rosa spinosissima	0.23 b	0.24	0.99	0.35 a	0.27 b	677.5 a	2.90 b	152.16 a	32.33 a
	Mean	0.275	0.0245	1.01	0.28	0.33	5.93.00	3.17	131.58	30.50
	LSD $_{(0.05)}$	0.002**	-	-	0.018**	0.010**	5.773**	6.118**	3.333**	0.440**
	Location									
	Erzurum	0.30 a	0.35 a	1.10 a	0.36 a	0.37 a	628.50 a	3.20 a	139.00 a	28.10 b
	Bayburt	0.26 b	0.15 b	0.93 b	0.20 b	0.29 b	557.50 b	3.15 b	124.16 b	33.08 a
	Mean	0.28	0.25	1.01	0.28	0.33	593.00	3.17	131.58	30.50
	LSD $_{(0.05)}$	0.002**	0.003**	0.057*	0.018**	0.009**	8.164**	1.115**	3.333*	0.440**
	CV (%)	**16.66**	3.22	9.90	10.71	3.03	1.68	3.31	4.38	2.48
Leaf	*Plantago atrata*	0.25 a	0.21 a	0.71	0.43 b	0.55 a	273.00 b	6.20 a	127.00 b	40.06 b
	Rumex patientia	0.13 b	0.18 b	0.68	0.62 a	0.38 b	316.00 a	4.35 b	271.33 a	50.45 a
	Mean	0.19	0.195	0.69	0.525	0.465	294.5	5.27	199.16	45.25
	LSD $_{(0.05)}$	0.006*	3.779**	-	5.756**	0.031**	8.164**	0.028**	4.977**	6.78*
	Location									
	Erzurum	0.18 b	0.22 a	0.79 a	0.60 a	0.54 a	334.00 a	6.25 a	231.50 a	57.48 a
	Bayburt	0.20 a	0.17 b	0.60 b	0.45 b	0.39 b	255.00 b	4.30 b	166.83 b	33.03 b
	Mean	0.19	0.195	0.69	0.525	0.465	294.50	5.27	199.16	45.25
	LSD $_{(0.05)}$	0.006*	0.005**	0.018**	0.028**	0.049*	0.149**	0.251**	3.844**	
	CV (%)	5.26	3.26	7.24	3.77	10.86	4.80	0.19	4.32	2.85

Increasing soil pH affects phosphorus availability. Phosphorus is an ATP building element and energy component. It accelerates plant root development, growth and maturation, renews plant cells and increases resistance against diseases [20; 32]. Phosphorus and Calcium play a role in the formation of bones and teeth in the human body and fulfill important functions for the body by participating in the structure of sugar phosphates, nucleotides, phosphoproteins and phospholipids [33]. Phosphorus content is transferred from leaves to seed and fruit towards vegetative development and accumulates in these parts. Potassium provides plant root development, plant health and resistance. Potassium is a mineral substance that takes part in important metabolic and physiological events such as maintaining osmotic pressure in our body, ensuring acid-base balance, muscle functions and transmission of nerve impulses [34]. At the same time, the potassium content of the plant leaves is higher. However, the amount of potassium in phloem is relatively high. The potassium content of young leaves, meristematic tissues, and fleshy fruits, where phloem is transported more, is higher because the substances dissolved in the phloem sap are carried up and down in the plant [32]. For these reasons, one can assume that the N, P and K contents are relatively higher in the plants fruit parts. In our study, phosphorus ratios in fruit were found between 0.25%-0.25% and potassium ratios between 1.03%-0.99% (Figure 4). Phosphorus ratios were found between 0.18%-0.20% in the leaves, while potassium ratios were found as 0.66%-0.70% (Figure 6). A study conducted on cornelian cherry fruits stated that K and P contents were high [35]. Magnesium is effective in metabolic events such as photosynthetic energy storage, protein synthesis, nucleotide formation and hydrolysis of many organic compounds in plants [36]. During the growth period of the plants, the ratio of K, Ca and Mg is high and the plant nutrients in the plant are at the highest rate at the beginning of growth [37]. It was stated that the Mg limit values were between 0.15-1.00% [32]. In light of the data obtained from our study, in the fruit-leaf analysis of burnetrose and sea-buckthorn, it was determined that % Mg values were 0.50-0.40 in leaves and 0.37-0.24 in fruits (Figure 4; Figure 5). Zinc plays a vital role in the plant's development and taste, being an extraordinary micronutrient element and a trace element found in all enzyme classes, even in trace amounts [38]. In the study, it was determined that Cu and Mn values gave the highest value in E.rhamnoides (6.2 ppm) and R.spinosissima (273 ppm) in location x plant interaction (Figure 8, Figure 9). Studies have shown that rosehip is a very important food rich in vitamins and minerals, and contains macro and micro minerals [39; 40]. In addition, there are potassium, calcium, magnesium, iron and phosphorus minerals in the content of sea buckthorn.

According to the leaf analysis results in Plantago atrata and Rumex patientia, where leaf parts are used extensively, it was determined that while K, Fe, and Zn were essential at 1% in the locations, other elements were insignificant. In terms of plants, N, P, Fe, Mn, and Zn were significant at 1%, Cu at 5%, and non-significant K, Ca, and Mg. When the location x plant interaction was examined, it was found that Fe and Zn were found to be 1%, Mg 5% significant N, P, K, Ca, Cu, and Mn non-significant.

According to the study results, it was determined that the plant nutrients were between the limit values (Figure 6). It was determined that Erzurum location gives better results than Bayburt location. It was determined that N (0.34%), P (0.59%), K (1.44%), Ca (0.53%), Mg (0.45%), Cu (13 ppm) and Zn (33.4 ppm) mineral values highest were found in P.atrata, while Fe (1340 ppm) and Mn (82 ppm) values were highest in R.patientia (Figure 7; Figure 8). The high Fe content of R.patientia indicates that it can be recommended as a consumable food source in terms of eliminating Fe deficiency, which is common in the region. Iron is an indispensable mineral substance for life, used in electron transport, oxygen transport and storage, oxidative metabolism, cell growth and division, and catalysis of reactions essential for the body [41]. Iron is vital for the production of dry matter in the plant and is the main ingredient that makes up chlorophyll. It is involved in photosynthesis and related enzymatic reactions occurring in chlorophylls, so the development of young parts of the plant and dry matter production are closely related to the amount of iron [42].

In a study conducted in Sivas, the macro and micronutrients of the leaf parts of the naturally grown evelik / labada plant were examined, the nutrients in the leaves were determined as 2.59% for N, 0.360 for P, 6.85% and 0.66% for K. % for Mg and 0.48% for Ca, 225.8 mg/kg for Fe, 27.5 mg/kg for Zn, 30.4 mg/kg for Mn and 8.9 mg/kg for Cu [43]. When the plant x location interaction was examined, it was found that Mg (0.48%), Fe ppm (895 ppm), and Zn ppm (365 ppm) values were high in P.atrata in Erzurum location, while % Mg (0.42%) and Fe ppm (1805 ppm) values were high in R.patientia. Zn ppm (302 ppm) value was high in P.atrata in the Bayburt location (Figure 7; Figure 8; Figure 9; Figure 10). Fe limit values were10-1000 [32] and Zn limit values were 2-240 ppm [20].

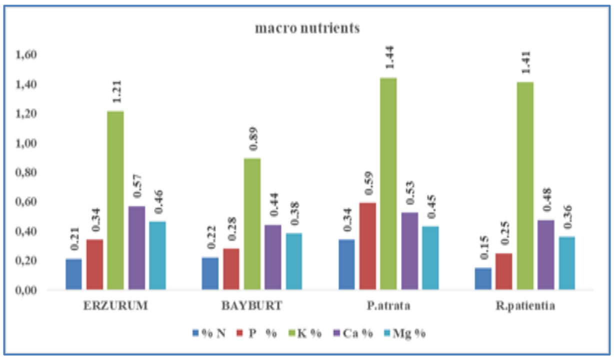

Figure 7. Macro nutrient content of leafy plants (*P. atrata* and R. *patientia*)

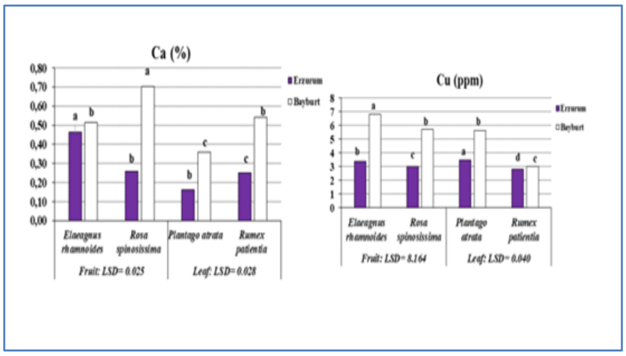

Figure 8. Interaction of location and species of fruit and leaf for Ca (%), Cu (ppm). Error bars indicate significant differences according to the LSD test at P≤0.05

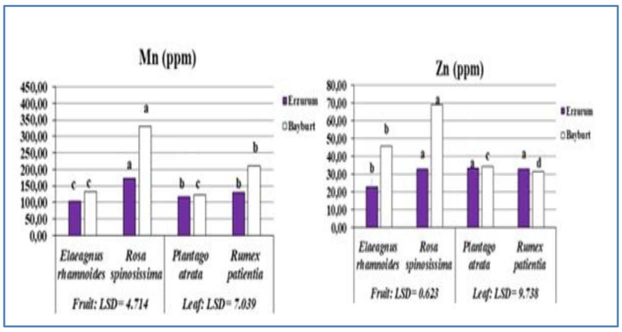

Figure 9. Interaction of location and species of fruit and leaf for Mn and Zn (ppm). Error bars indicate significant differences according to the LSD test at P≤0.05

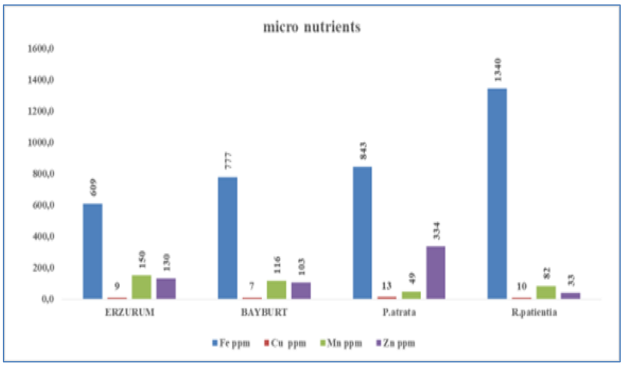

Figure 10. Micronutrient content of leafy plants (*P. atrata* and *R. patientia*)

Mg, Fe and Zn are nutritional elements effective in chlorophyll synthesis, plant water transmission, and leaf development, and their contents vary in the plant depending on the soil structure. In order to determine the mineral concentrations of Evelik/labada plants, 1.7% for N, 22.33 mg/100 g for P, 624 mg/100 g for K, 82.84 mg/ 100 g for Ca, in the study collected from natural areas in the Eastern Anatolia Region, It is stated that it is found as 36.47 mg/100 gr for Mg, 1.45 mg/100 gr for Na, 75.70 mg/100 gr for S [19]. Another study conducted with trees and shrubes in Nigeria stated that the Fe content was between 10.24 and 30.01 ppm [44]. In another study conducted on wild plants consumed as vegetables in the Aegean region, it was stated that the amounts of Fe and Zn were higher in plants in the wild form [45]. As a result of another study, it was stated by the researchers that the Zn amount was higher in spinach [46]. Ezeagu et al. [44], reported that the Zn content ranged from 9.9-67.2 ppm Cu content to between 6.6 and 20.7 ppm in a study conducted with trees and shrubs Mn content between 202-592 ppm. The results of our study show parallelism with other studies.

According to the data obtained in the study, it was determined that Erzurum soils had slightly acid, salt-free, clayey, organic matter content at good, the lime content of the soils were very low, phosphorus and potassium content was medium and sufficient and that Bayburt soils were slightly alkaline, salt-free, clayey, good in organic matter, high lime content, high phosphorus content and sufficient potassium content. It was determined that macro-micro plant nutrients are on the border in Erzurum and Bayburt locations, but Zn (P. atrata / leaf) in Erzurum location is higher than the limit value of Zn (*P. atrata* / leaf) and Fe (*R. patientia* / leaf) in Bayburt location (Figure 8; Figure 9).

3.3. Principal component analysis for species

Principle component analysis in properties of Elaeagnus rhamnoides and Rosa spinosissima explained that PC-1 and PC-2 the diagonal line between PC-1 and PC-2 separates this species in terms of some traits. PC1 and PC2 showed variation in levels that 58.13% and 31.05%, respectively (Figure 11). Toncer et al. [47], repoted that total variation of Lippia citriodora of content of leaves and flowers was 80.39%.

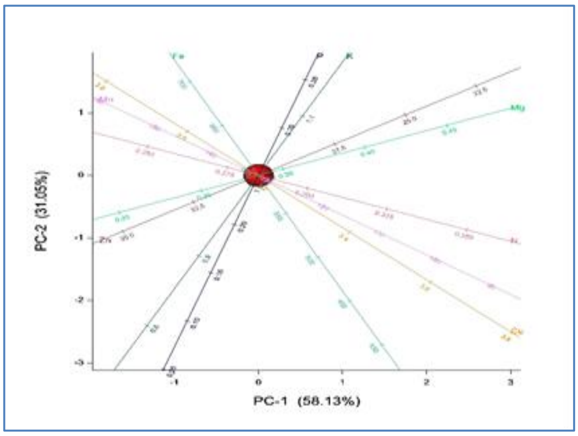

Figure 11. Principle component analysis for *E. rhamnoides* and *R. spinosissima*

The total variation in components was 89.18%. The diagonal indices form two groups; Group-1 had five indices: P, K, Mg, N and Cu. They formed narrow angles and were positively correlated each other. Group-2 included four indices: Ca, Fe, Mn and Zn. Ca, Fe and Mn formed narrow angles. These traits were negatively correlated with traits of other group (Figure 11). Principle component analysis in properties of Plantago atrata and Rumex patientia explained that PC-1 and PC-2 the diagonal line between PC-1 and PC-2 separates this species in terms of some traits. PC-1 and PC-2 showed variation in levels that 58.56% and 37.66%, respectively (Figure 12).

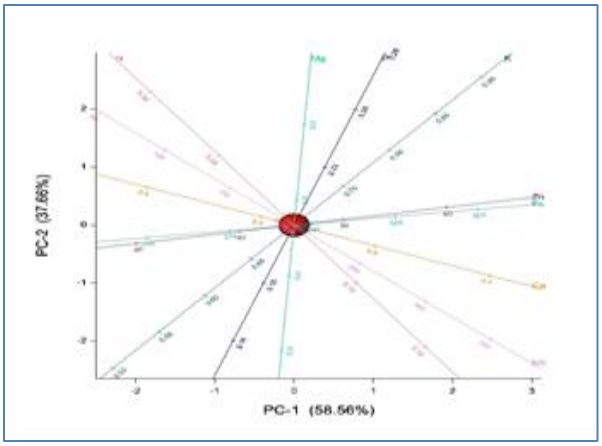

Figure 12. Principle component analysis for *P. atrata* and *R. patientia*

The total variation in components was 96.22%. The diagonal indices form two groups; Group-1 had eight indices: Mg, Cu, P, K, Zn, Fe, Ca and Mn. They formed narrow angles and were positively correlated each other. Group-2 included one indices (N). N value was negatively correlated with traits of other group (Figure 12). Principle component analysis are widely used to facilitate compare of traits among huge data populations [48]. Keefover Ring [49], stated that variation of component in aromatic plants was 91.00% (PC-1:79.1%, PC-2: 11.1%).

4. CONCLUSION

It was determined that the plant's mineral content leaves that the leaf parts valued higher than the fruit parts in terms of macro and micro plant nutrients. According to the results of the physicochemical analysis of the soil samples taken from the root depths of the plants (0-40 cm), the soils are generally mildly acid to slightly alkaline, unsalted, clayey to heavy clayey soils, medium to good organic matter, medium to high in lime content, very high in phosphorus and potassium was found to be high and sufficient.

Acknowledgement

Support was received from Karabük University Forest Engineering Department of Botany for the identification of plant species. Soil analyzes were carried out at the Erzincan Horticultural Research Institute, and plant analyzes were carried out at the East Anatolian High Tecnology Application and Research Center.

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