

Nutritional diversity of underutilized plant species collected from Aegean Region of Turkey

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Abstract

The objective of the present work was to evaluate variability for dry matter, protein and mineral N (nitrogen), P (phosphorus), K (potassium), Ca (calcium), Mg (magnesium) composition of nutritionally important and widely consumed wild edible plants in Aegean region of Turkey, and to assess their mineral diversity using multivariate analysis. The plant material comprises 17 edible plants collected from native found, the data were subject to analysis of variance, and a Pearson correlation test used to determine the correlations between dry matter, protein content and N, P, K, Ca, Mg composition. Principal component analysis was performed on the result of examine compositions and the factor loadings, eigenvalues and percentage of cumulative variance were calculated, the patterns of relationships among nutritive element were shown three-dimension scatter plot. Multivariate analysis revealed considerable variation for the most of concentration and explained 81.49% of total variation accounted for three PC axes. The data reveal that selected wild plant provide significant nutrition and exhibited great variability among the species. Although soil mineral concentration, availability, fertilization and environment may have influenced on nutrient accumulation in plant tissue, genetic variability is considerable influenced on mineral composition of plant.

Keywords: Minerals; Multivariate analysis; Nutritional value; Wild edible plants

1. Introduction

Wild edible plants have been used as a spice, vegetable or foodstuff, and several ethnobotanical studies underlined that wild vegetables constitute of wild food plants widely harvested and consume in the Mediterranean countries [1, 2, 3]. In many countries rural people traditionally consume wide range of leafy vegetables and several studies argue that wild edible plant conserve important nutrient and non-nutrient elements comparing to the cultivated species [4, 5], such as contain more vitamin C and pro-vitamin A. Furthermore, many neglected and underutilized species require less care are not affected by pesticide, well adapted to low input agriculture compared to the cultivated vegetables [6, 7]. In addition, edible plants are least expensive sources for number of nutrients and provide minerals, vitamins and essential fatty acids, and also observe flavor, odor which enhance taste and color in diets [8, 9, 10]. In addition, wild edible species are one of the important primary sources income for poor communities [11], some of them have been known as a functional food and contain physiologically active ingredients [12].

Wild edible species now considered as weeds found in agricultural fields, orchards, pastures, fallow lands vacant lots and roadsides [4]. They play an important role in food production, and consumption of wild edible species is increasing in many parts of the globe, however, widespread knowledge of edible wild plants does not provide much information on their nutritional significance and we need to focus on more research work on nutritional composition of wild edible plants due to their better nutritional value [5, 11, 13, 14, 15, 16]. Consumption of underutilized crops or wild edible

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plants effective way to reduce micronutrient deficiencies, and observe healthy diet particularly in poor people in developing countries. Dogan *et al.* [17] argue that wild plants have pivotal role by complementing staple foods for balanced diet by supplying trace elements, vitamins and minerals [18, 19, 20].

Turkey natural habitat and diverse ecological condition accompanied by wide range of plant diversity resulted numerous plant species can be traditionally used as food sources in Turkish cuisine [21, 22, 23, 24]. Ethnobotanical surveys reported that climatic differences, together with a high topographic and geological diversity present the richest flora across the Turkey. Number of examples from different region of the country indicate that diversity of edible species and consumption at an aggregated level. Consumption of these plants related with cultural diversity, and also number of species consumed as vegetables depend on knowledge of people who living in province. There are important regional differences in traditional wild edible plant consumption and green wild vegetables are frequently sold in local markets. Abak and Duzenli [25] pointed out nearly 40 wild plants consumed as a vegetable in Turkey. Tan *et al.* [26] surveyed Mediterranean region of Turkey and reported empirical evidence about wild edible plants and showed over ninety species consumed as vegetables. Dogan *et al.* [17, 23] informed 121 wild edible plants commonly consume in central Anatolia, 46 wild edible plant taxa belonging to 24 botanical families in Izmir where widely apply Mediterranean diet and those people consume large amount of wild edible plants in this region. Ertug [27] reported 143 wild edible plant are used as a food and beverage in South-western and the most of the plants used as a medicinals and all plant are edible category for animals. The consumption of non-cultivated plants are still important activities despite the socio-economic changes but there is still limited information of their natural production and its agronomic potential [13].

Nowadays, a number of studies have been reported nutrition content of wild edible plants, their role in human nutrition, also high degree of variability reported in nutritional composition of edible plants in widely consumption countries [28, 29, 30]. Nutrient content of some wild edible plants in central black sea region of Turkey were evaluated and eight species shown large variability in terms of N, P, protein and dry matter composition [22]. Furthermore, not only the genetic differentiation among the species was reported also chemical and mineral composition of *Prangos ferulacea* (L.) and *Rheum ribes* depending on locations [10]. In addition, Coruh *et al.* [31] evaluate N, P K, Ca, Mg Na, Fe, Cu, Zn and Mn composition of widespread wild edible species (*Sinapis arvensis*, *Polygonum aviculare*, *Tragopogon aviculare*) and conclude that of examined minerals values depended on species or varieties and growing condition (soil and geographical condition). Significant variation was asses among 21 wild edible plant species, collected form Eastern Anatolia region of Turkey, and examined species showed valuable content of total antioxidant, vitamin C, and phenolic compound [32].

Multivariate statistical analysis is techniques have often been employed to facilitate understanding general distribution of the data leading to a reduction of the initial dimension of data sets and facilitating its interpretation and visualize genotypic differentiation among the species [33, 34, 35]. The principal component analysis has been applied to identify food analyses [36, 37, 38] elemental concentration and compositional profiling of the chili pepper [39], analytical strategy for the geographical identification of plant species [40] such as tomatoes [41], clementine [42], paprika [43], Tropea red onion [44].

The main objective of the present research was undertaken to evaluate nutritional composition widely consuming 17 wild edible leafy plants from Aegean region of Turkey, assess their mineral diversity, and relationships among minerals using multivariate analysis.

2. Material and methods

2.1. Experimental Set Up

The plant material native found as a weeds and widely distributed in the campus area of Ege University, Turkey, where the plants spontaneously grow and appear as natural populations. The collection site is Department Horticulture, Bornova, Izmir, Turkey, where collecting site is located at 38°28'N latitude, 27°15'E longitude and at an altitude of 25m above sea level. In order to reduce environmental and edaphic factors on the composition of the plant samples and to visualize genotypic differentiation among the species, the plant material collected from the a total 500 m² area where the soil is never cultivated, not use any chemicals such as fertilizer and pesticide in collection site. The nutritional composition analyses were carried out Soil Science and Plant Nutrition Department, Ege University.

2.2. Plant Material

In the present study a total 17 widely consume wild edible species in Aegean region of Turkey, were evaluate for edible parts of nutritional composition (Table 1). In the experiment *Lactuca serriola* L., *Capsella bursa-pastoris* L. Medik., *Malva sylvestris* L., *Papaver rhoeas* L., *Urtica dioica* L., *Erodium cicutarium* (L.) L' Herit., *Chondrilla juncea* L., *Stellaria media* L., *Rumex patientia* L., *Taraxanum officinale*, *Allium scorodoprasum* L. subsp. *rotundum*, *Plantago lagopus* L., *Sonchus asper* L. Hill. subsp. *glaucescens* (Jord.) Ball., *Daucus carota* L. subsp. *carota* (L.) Thel., *Sinapis arvensis* L., *Mentha pulegium* L., *Portulaca oleraceae* L. were collected at the same time in early spring when appear and suitable growing stage for consumption. Botanical identification of the species was achieved according to the Davis [45].

2.3. Chemical Analysis

A total thirty plant samples were collected by manually for each species and pooled to form a single sample. The edible parts of the plants were gently washed using distilled water and dried at room temperature in order to remove external moisture. They were placed in paper bags and oven-dried at 65°C for 24h. The dried plant samples were ground in a blender for composition determination and nutritional composition of each species analyzed in triplicate.

The total amount of N in the leaf samples was determined by the modified Kjeldahl method [46]; and protein calculated using with N values, P with colorimetry in wet digested samples [47], K, Ca, with flame photometry (Eppendorf, Hamburg, Germany) and Mg, using atomic absorption spectrometry (SpectraAA220 FS; Varian, Mulgrave, VIC, Australia) [48]. Appropriate calibration controls (calibration curve method with commercial certified ICP (Inductively coupled plasma), multi element standard solution; Merck, Darmstadt, Germany) were applied to each set of measurements. N, P, K, Ca, Mg, concentrations were calculated on a dry-weight basis.

2.4. Data Collection and Statistical Analysis

Principal component analysis (PCA) was carried out for quantitative data and the total amount of variation was calculated as the sum of extracted eigen values. PCA reduces data and presents different manners for interpretation. PCA techniques can be used to reduce the information of a multidimensional data set in what can be displayed in a scatter plot with only two or three axes. The major part of variance of the data set comes to lie on the first, second and third axes [49]. In addition, the varimax factor rotations were applied in factor analyses in order to make the interpretation of the factors to be considered relevant and in order to maximize the loading of the variables in factors [50], using mathematics. Hierarchical cluster analysis used to classify examined content of samples into groups considering the values of a set of variables. Estimates of Euclidean dissimilarity coefficients were used to assess the relationships between samples according to the similarities examines distance between samples and data set, and it is the most applied cluster analysis method for environmental analysis [33] which was performed using unweighted pair-group average method [51]. Principal coordinate analyses (PCoA) were performed based on distance matrix, and three dimensional scatter plot was the prepared with the first three principal coordinated to visualize the relationship explained the examined nutritional content. The mean, maximum, minimum values and standard deviation of 8 traits were calculated. All data were processed using Statistica 7 software [52].

3. Results and discussion

3.1. Concentration of Analyzed Traits

The whole edible part of species was analyzed, dry matters, protein and mineral elements were found to vary depending on species as expected. According to the results, dry matter content of the wild edible species ranged between from 8.65% to 20.11% and the highest dry matter obtained from *U. dioica* L. species. These results are in agreement with those reported by other authors indicated dry matter composition ranged (7-29%) for different wild edible plants [28, 53], and Kibar and Temel [54] underlined that dry matter content varied from 13.90-20.27% and depending on species. Genetic structure of the species is main factor affecting dry matter content of the plant; in addition, ecological condition, edaphic factors, harvesting stage, and edible parts of plant influenced, additionally genotypic differentiation was reported for nutrient composition of several wild edible species collected from Turkey [14, 55, 22].

Table 1 Botanical name, family, common name and used parts of the examined wild edible species

Botanical name	Family	Common name	Part(s) used
<i>Lactuca serriola</i> L.	<i>Asteraceae</i>	Prickly lettuce, milk thistle	Fresh leaves and fresh shoots
<i>Capsella bursa-pastoris</i> (L.) Medik.	<i>Brassicaceae</i>	Shepherd's purse, caseweed	Fresh leaves and fresh shoots
<i>Malva sylvestris</i> L.	<i>Malvaceae</i>	Common mallow, tall mallow	Fresh leaves and shoots stem
<i>Papaver rhoeas</i> L.	<i>Papaveraceae</i>	Wild poppy, field poppy, common poppy	Leaves, shoots, petals and seeds sprout
<i>Urtica dioica</i> L.	<i>Urticaceae</i>	Stinging nettle, common nettle	Fresh tips and leaves
<i>Erodium cicutarium</i> (L.) L'Herit.	<i>Geraniaceae</i>	Common stork's bill, redstem filaree	Fresh leaves and shoots
<i>Chondrilla juncea</i> L.	<i>Asteraceae</i>	Skeleton weed, rush skeletonweed	Fresh leaves, shoots, roots
<i>Stellaria media</i> L.	<i>Caryophyllaceae</i>	Chickweed, chickenwort, craches	Young leaves stem
<i>Rumex patientia</i> L.	<i>Polygoaceae</i>	Patience dock, garden patience	Fresh leaves
<i>Taraxacum officinale</i> Web.	<i>Asteraceae</i>	Common dandelion, blowball	Fresh leaves
<i>Allium scorodoprasum</i> L. subsp. <i>rotundum</i> Stearn	<i>Liliaceae</i>	Wild leek, wild garlic	Fresh leaves and shoots
<i>Plantago lagopus</i> L.	<i>Plantaginaceae</i>	Hare's foot plantain	Fresh leaves
<i>Sonchus asper</i> L. Hill. subsp. <i>glaucescens</i> (Jord.) Ball.	<i>Asteraceae</i>	Prickly sow thistle	Fresh leaves and fresh shoots
<i>Daucus carota</i> L. subsp. <i>carota</i> (L.) Thel.	<i>Apiaceae</i>	Wild carrot, bird's nest	Young leaves
<i>Sinapis arvensis</i> L.	<i>Brassicaceae</i>	Wild mustard, charlock mustard	Fresh stem and leaves, older leaves, flowers, fruits, seeds sprout
<i>Mentha pulegium</i> L.	<i>Lamiaceae</i>	Pennyroyal, squaw mint	Leaves and stem
<i>Portulaca oleraceae</i> L.	<i>Portulacaceae</i>	Wild purslane, pursley, verdolaga	Stem and leaves

The nitrogen concentration among the examined collection ranged between 2.02-4.79 mg 100 g⁻¹ and the highest N content observed in *C. bursa-pastoris* L. Medik. and the lowest N was found in *P. lagopus* L., similar trend was shown in protein composition which is calculated using with N concentration (Figure 1), and approximately equivalent to protein content, with some minor exceptions the level of protein in several examined species comparable with high amount protein containing pulses. The values obtained from examined species higher than the values reported for some other wild edible species. Ozbucak *et al.* [56] pointed out nitrogen content ranged between 1.1-4.2% in different edible wild plants and underlined that ecological such as temperature and light intensity and genetic factors play role in nitrogen contents of plants [57].

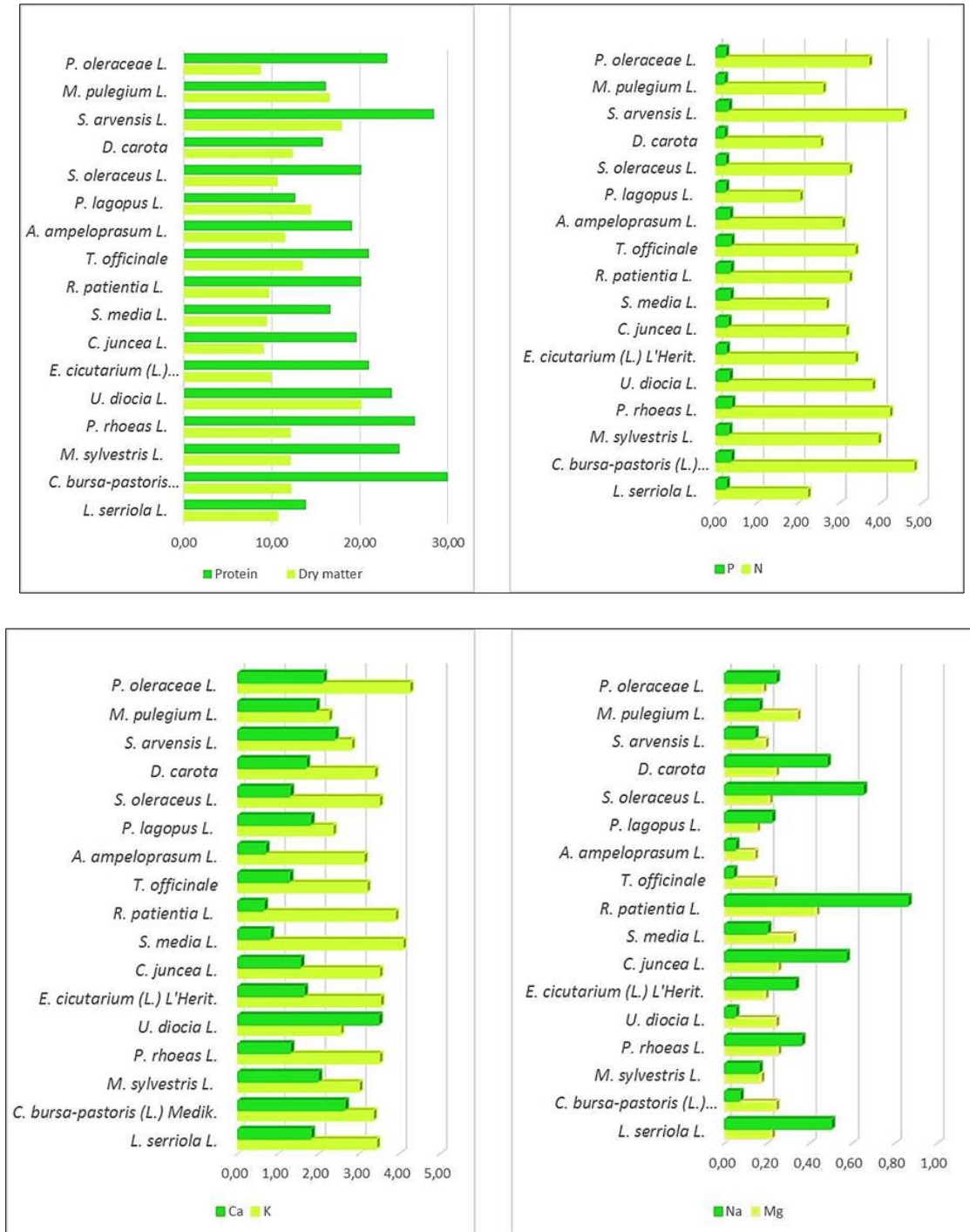


Figure 1 Nutritional composition of 17 wild edible plants

Turan *et al.* [5] determined nitrogen content ranged between 0.35-1.70% and the highest N values recorded in Polygonaceae family, and Yildirim *et al.* [14] assessed the range of nitrogen values (0.2-0.7%) and underlined the highest values received from *U. diocia* (L.). Kibar and Temel [54] investigated the mineral contents of *Bellevalia forniculata*, *Beta corolliflora*, *Caltha polypetala* and *Primula auriculata* species and reported that (0.08-0.69%), these four plant observed higher than commonly cultivated vegetables as lettuce, cabbage, spinach, pepper, broccoli and cauliflower.

In the present research phosphorous content ranged between 0.19-0.37 mg 100 g⁻¹, where *P. rhoeas* showed the highest P composition and Turan *et al.* [5] pointed out low variability among various wild edible plant species in terms for P composition, and ranged from 2.07 to 60.74 mg 100 g⁻¹. Several researches underlined that growth condition, species, geographical variation and analytical procedures resulted differences between the edible parts of the plant, but Renna *et al.* [58] highlighted the low influence of the harvesting sites on elements concentration in the wild edible plants and underlined significant differences among the examined species in terms for elements content.

The potassium content was considerably variable on the species and the highest K content was determined in *M. pulegium* L. 4.24 mg 100 g⁻¹, whereas the lowest content 2.24 mg 100 g⁻¹ obtained from *P. oleraceae*. The potassium content in the present work, in most cases, were different than reported elsewhere. Kibar and Temel [54] underlined that wide range of K composition (272-5579.1 mg 100 g⁻¹) was assess in many wild edible species collected from Turkey [5, 59, 31, 60, 61] and foreign countries [62, 63].

The Ca content varied from 0.64 to 3.47 mg 100 g⁻¹ being lowest *R. patientia* L. and highest in *U. diocia* L. Turan *et al.* [5] evaluate several Eastern Anatolian wild edible species collected from different site and result revealed that Ca values (27-830 mg 100 g⁻¹) depends on species and growing condition. Ozcan *et al.* [10] reported Ca composition of two edible plants (*R. ribes* and *P. ferulace*) ranged between 3.37-42.48 mg 100 g⁻¹ and argue that genetic differentiation among the species, and location influenced nutritional composition. Several studies reported wide range of Ca composition of wild edible plants and argue that genetically differences among the species accompanied by the environmental and edaphic factor affected mineral composition of plant tissue [5, 59, 31, 60, 54, 61]. Mg values of examined plant collection a very wide variability and are extended from 0.4 mg 100 g⁻¹ in *R. patientia* to 3.47 mg 100 g⁻¹ *U. diocia* L. species. The values reported by Turan *et al.* [5] assessed wide range of variability (30.33-293.08 mg 100 g⁻¹) among wild edible plants and these results are higher than the present work, but concordance with Kibar and Temel [54] reported that various wild edible plant varied from 30.33-864.3 mg 100 g⁻¹ [5, 59, 31, 60, 63, 61]. The variation in calcium and magnesium could be attributed to one or more factors of genetic, environmental or growth stage of the vegetable during collection [30]. Furthermore, wild edible plant contain higher Mg compared to some cultivated vegetables such as spinach, lettuce, cabbage, celery, broccoli, radish and celery [64, 54]. Na composition found in the range of 0.04-0.86 mg 100 g⁻¹ respectively, for *T. officinale* and *R. patientia* L., and mainly low Na values determined in the plant species Turan *et al.* [5] obtained Na values in the range of 1.09-59.32 mg 100 g⁻¹, Kibar and Temel [54] reported no statistical difference among four wild edible species.

Nowadays many underutilized vegetables usually provide only minor proportion of daily calories, they are observing high level of diversity in terms of nutrition and bioactive components [65]. Different vegetative parts of the wild edible plants can be used a food sources and significant differences reported edible part of the wild plants. Rao [66] stated that oil seed to be a good source of protein and fat. Sankhala *et al.* [67] evaluate less familiar leafy vegetables including *P. oleracea* in Udaipur region of India and variability reported in proximate composition, iron, calcium, beta-carotene, vitamin C and oxalic acid content. Kalidass and Mohan [68] investigate underutilized food legume and wide range of variability reported for mineral profile, vitamins, fatty acid and amino acid profiles of seed.

3.2. Correlation Analysis

In the present research a total seventy wild edible species were evaluate based on nutrition composition in edible parts and there were highly significant differences in all the investigated nutrition among species. The data contained in the present report provide an evidence of the potential examined nutritional values of the indigenous species. Simple correlations analysis of all examined trait shows the moderate to strong coefficients, and coefficients values range from 0 to 1 indicating weak to strong correlations between variables (Table 2). The data presented here show that dry matter positively correlated Ca, while negatively correlated K and Na. Protein is positively correlated with N, P, Ca content: N is positively correlated P and Ca. Potassium negatively correlated Ca, whereas positively N. Phosphorus positively correlated with protein and N content; also, Na is positively correlated with Mg while negatively correlated with Na composition.

Table 2 Pearson correlations coefficient of the nutritional status of examined wild edible species

	Dry matter	Protein	N	P	K	Ca	Mg
Protein	0.192						
N	0.192	1.00**					
P	-0.007	0.555*	0.555**				
K	-0.780**	0.104	0.104	0.200			
Ca	0.647**	0.405*	0.405*	-0.157	-0.447*		
Mg	-0.117	-0.112	-0.112	0.201	0.191	-0.270	
Na	-0.541*	-0.294	-0.294	-0.205	0.421*	-0.438*	0.474*

*Correlation is significant at the $P= 0.05$ level; **Correlation is significant at the $P= 0.01$ level

3.3. Principal Component Analysis

In order to evaluate mineral accumulation among species in a diversity context principal component analysis were applied by all eight variables. Multivariate analysis revealed considerable variation for the most of concentration. The principal component (PC) analysis explained 81.49% of total variation accounted for three PC axis (Table 3). The higher loading of the variable implies larger contribution of to the variation. The rotated loadings and communality for each variable were given in the table 3. The first PC axis accounting for 32.34% of the variations and mainly comprises protein, N and P compositions. The second PC explained 31.74% of total variations, concerned with dry matter, K, Ca, and Na. The third PC axis accounted for 17.41% of the total variations and concerned with Mg.

Table 3 Minimum (min), mean, maximum (max), standard deviation (SD), Eigen values proportion of variability, and minerals contributed to the principal components of wild edible species.

					PC axis		
Eigenvalues					2.59	2.54	1.39
Explained proportion of variation					32.34	31.74	17.41
Cumulative proportion of variation					32.34	64.09	81.50
					Eigen values		
Properties	Min	Mean	Max	SD	1	2	3
Protein	12.63	29.94	20.7	4.76	0.947	0.118	-0.166
N	2.02	4.79	3.32	0.76	0.947	0.118	-0.166
P	0.19	0.37	0.28	0.06	0.773	-0.097	0.261
Dry matter	8.65	20.11	12.54	3.21	0.091	0.953	-0.006
K	2.24	4.24	3.28	0.55	0.239	-0.883	0.037
Ca	0.64	3.47	1.70	0.70	0.239	0.709	-0.313
Na	0.04	0.86	0.29	0.23	-0.267	-0.551	0.509
Mg	0.14	0.43	0.23	0.07	0.047	-0.088	0.955

3.4. Cluster and Principal Coordinate Analysis

The hierarchical agglomerative clustering performed for nutritional composition and the classified into the clusters (Figure 2). Nutritional composition of the examined species is reflected by cluster analysis and divided into the three main clusters.

Cluster analysis allowed these data to be integrated to evaluate which qualitative variables (considered simultaneously) contributed the most to the differences among the groups (i.e., species). Disciglio *et al.* [69] evaluate the protein, mineral levels (such as nitrates P, K, Ca, Mg, Na) polyphenol content and the antioxidant activity of the main wild herbaceous food species consumed in Foggia Province, Italy and the cluster analysis of all the qualitative characteristics of the species identified into five clusters.

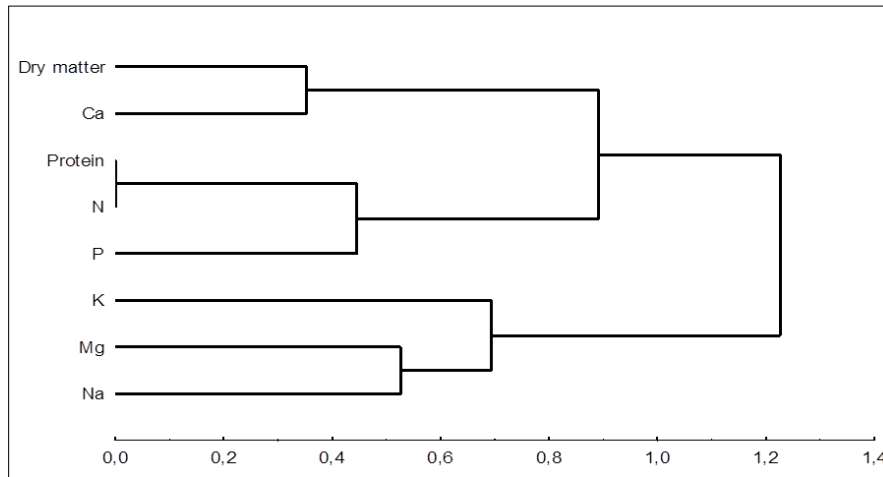


Figure 2 Dendrogram based on dissimilarity matrix constructed from nutritional composition of 17 wild edible plants using unweighted pair-group average method

In order to demonstrate relationships of investigated minerals factor analysis was applied, and the first three principal co-ordinates are given 3D (dimension) scatter plot (Figure 3). Mineral elements separate their corresponding value of explained proportion of variation in the scatter plot. Multivariate analysis was not widely applied to assessment diversity context in the mineral concentration among wild edible plant.

The results of experiments revealed that the first three principal components were highly valid to classify the examined species and separating mineral accumulations. Disciglio *et al.* [69] underlined that the dry matter content, the chloride, phosphorus, potassium, and fluoride levels and the protein content effectively differentiated between many of these examined 11 wild edible plant groups covering *S. arvensis* L. and *P. oleracea* L.

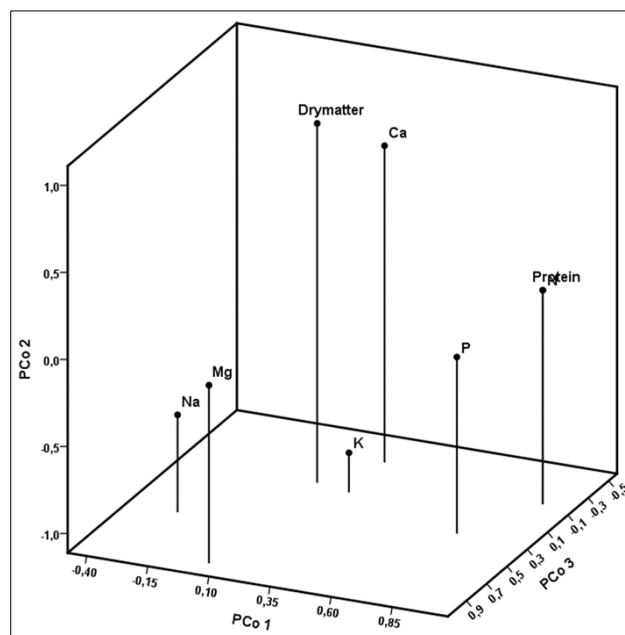


Figure 3 Patterns of relationships among wild edible species due to the first three principal co-ordinates

Plants or their products have been used as a food source, medicine, production of materials or magic rituals from ancient times and many wild plants became cultivated species in ancient Greece [70]. However, with development of modern agriculture people focused more on domesticated cultivars and gave less attention to wild species. Ethnobotanical studies showed that more than 30,000 plant species can be classified as an edible, and from this amount about 7,000 species have been used for human diet [71]. Nowadays, ethnobotanical studies revealed that the information on the traditional knowledge of wild edible plants is disappearing today; furthermore, in this century most of the human 80% of total dietary energy intake obtained from twelve domesticated species eight from cereals and four from tubers [72].

A large number of wild edible plants are consumed as foods in various different areas of the Mediterranean Basin, and consumed in a variety of ways, the high percentage of wild edible plants consumed as raw in salad. Nowadays in most countries, selling of green wild vegetables often sold in Mediterranean countries mainly in Italy, Greece, Croatia, Spain and Turkey. In the last decade, there has been a return to natural food, however new generations are not familiar with wild edible plants and most of the traditional knowledge of wild food plants is disappearing and in most cases, survives only with the elderly [73, 74]. Apart from the traditional consumption, some of the important wild edible plants could be collected for commercial purposes; wild food plants re-discovered and re-created by many restaurants tend to use many wild species in their kitchen [75]. In addition to the economic importance of underutilized wild edible plants has been increased and research underlined that they possess high nutritional value compared with the cultivated species. In latest years' researchers, more focus on nutritional composition of the widely consumed fruit and vegetables, and plant breeders take into consideration improving nutritional status of edible part of the cultivated species.

In this context, wild edible plants are present valuable nutrient sources for alternative nutrition for achieving a balanced human diet. Unlike the domesticated cultivated species that may require higher input for production wild edible plants can easily be found from gardens, farmlands or other habitats. Furthermore, most of the wild edible species are adapted to marginal agro-climatic conditions, and some of them can be selected and developed as future crops [30]. Focusing on wild edible species is an effective way to reduce micro and macronutrient deficiency and improve food security.

4. Conclusion

The present study's analytical investigations were carried out to ascertain dry matter, protein, N, P, K, Ca, Mg and Na content of widely consumed wild edible species in the Aegean region of Turkey. The results show that among the examined species *C. bursa-pastoris* L. Medik., and *S. arvensis* showed higher values for protein content, *U. dioica* was rich in Ca, *P. oleraceae* L. and *S. media* good sources for K, *R. patientia* contain high amount of Mg. The current work is underlined that examined wild edible plant species contain large amount of mineral element, also exhibited great variability and the fact that most of the wild plants are perceived as highly useful for future exploitation of health foods. Despite wild edible species observe high nutritional value, health benefit compound and important source for people further research needed for evaluation of agronomic potential.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared that there is no conflict of interests regarding the publication of this paper.

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