CHAPTER 2

EBUCEHİL (*Calligonum polygonoides* L. *subsp. comosum* (L' He'r.)

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1. INTRODUCTION

For both animal health and high animal production, the roughage included in the rations must be cheap and of high quality. This also ensures that animal husbandry is profitable and sustainable. In fact, approximately 70% of the costs in animal production go to feed expenses, and 78% of this goes to roughage expenses (Demiroğlu Topçu and Özkan, 2017; Bıçakçı and Açıkbaş, 2018; Harmanşah, 2018,). On the other hand, in Turkey, as in the world, areas within meadow-pasture and field agriculture are one of the most important sources from which roughage is supply. However, the amount of quality forage provided from these areas is not at the desired levels due to unconscious cultural practices and inadequate management-breeding efforts along with unsuitable environmental conditions. As a result, the desired animal product performances cannot be obtained from farm animals that are exposed to inadequate and unbalanced nutrition, or animal husbandry becomes unprofitable due to additional feed costs. For this reason, in order to ensure sustainable animal production and increase the quantity and quality of animal products, a search was made for cheap and high-quality roughage that can be an alternative to conventional feed sources to meet the the roughage deficit. In this sense, halophyte and xerophyte species that grow naturally in marginal areas (salty and arid) that have lost their productivity and can adapt to the conditions of that region have been seen as an important advantage (Kuria et al., 2005; El-Amier and Abdullah, 2015; Temel, 2015, 2018; 2019a, 2019b; Temel et al., 2015a; Abdullah et al., 2017; Paydaş et al., 2018; Temel and Sürmen, 2018; Altay and öztürk, 2020; Iqbal et al., 2022; Pirasteh-Anosheh et al., 2021; Pirasteh-Anosheh et al., 2023). In fact, thanks to their physiological and vegetative properties, xerophyte and halophyte species can grow in extreme environmental conditions and maintain their greenery throughout their vegetation period. As a result, these species, which can continue their productivity without suffering much loss of yield and quality, provide an important alternative forage material in the nutrition of ruminants.

The genus Calligonum, a member of the Polygonaceae family, is mostly distributed in deserts in the arid and semi-arid climate regions of the world (North Africa, Western and Central Asia, Southern Europe) and contains 153 species (Brandbyge, 1993; Kerven et al., 2004; Abdurahman et al., 2012; Vyas et al., 2012). One of these species is *Calligonum polygonoides* L. *subsp.*

comosum (L'Hér.). However, in Turkey as in the world, the pressure on this species (removal as fuel, overgrazing and extreme environmental conditions) is increasing day by day and as a result, the areas where it grows are narrowing and their density per unit area is decreasing (Tadevosyan, 2001; Altundağ, 2009; Gültekin, 2011). Like other species in the same genus, this species, which forms a habitat only in the Iğdır-Aralık wind erosion area (13.542 ha) in Türkiye, offers important ecological and social benefits by developing in marginal areas where many cultivated plants cannot grow. For example, they play an important role in retaining sand dunes, increasing soil fertility and erosion control with their strong roots and wide-spreading canopies. The local community also uses its branches and thick roots as fuel (Tao, 2000; Gyssels et al., 2005; Altundağ, 2009; Gültekin, 2011; Oktay, 2014; Artan and Temel, 2018; Afefe, 2020). However, it should be noted that these intensive removal and cutting practices increase the severity of erosion in the region. It also provides shelter and feeding habitat for wildlife.

On the other hand, like other halophyte and xerophyte species growing in extreme environmental conditions, Ebucehil shrub produces secondary compounds (terpenoid, steroid, glycoside, alkaloid, flavonoid and phenolic) as a protective measure in order to survive and maintain its vital functions properly. As a result, leaves, flower buds, succulent fruit, seeds, bark and flowers rich in these compounds are an excellent natural source of estrogenic, antimicrobial, cardioprotective, lipoxygenase-inhibiting, anti-ulcer, anti-inflammatory, hypoglycemic, cytotoxic and antioxidant. And these plant parts are widely preferred in the health and nutrition (food) sector (Singh et al., 1996; Samejo et al., 2011; Zouari et al., 2012; Samejo et al., 2013; Gomes et al.,, 2015; Ahmed et al., 2020; Berwal et al., 2021; Iqba et al., 2022). *Calligonum polygonoides*, which can maintain its greenness and productivity throughout the vegetation period in arid, semi-arid and desert conditions, also provides an important feed source for grazing animals due to its desired chemical, nutritional and mineral content (Bhandari, 1990; Koocheki and Mohalati, 1994; Goyal and Sharma, 2008; Abdurahman et al., 2012; Abdullah et al., 2013; Oktay and Temel, 2015a, 2015b; Temel ve Temel, 2018; Temel, 2019c; Alzarah, 2022).

2. SYSTEMATIC AND MORPHOLOGY

The genus Calligonum (Polygonaceae), which comes from the Greek words kalli "beautiful" and gony "knee joint", includes 153 species. One of these is *Calligonum polygonoides* L. *subsp. comosum* (L'He'r.). This species, known as "arta", "Phog", "Phogala" and "Phogaro" in the countries where it is distributed around the world, is known as Ebucehil shrub in Turkey. Ebucehil shrub is a perennial species with a slow growing and phanerophyte life form. It has a taproot system and sometimes an underground stem with a taproot system. Depending on the ecological conditions in which it grows and grazing pressure, its height varies between 0.85-3.0 m and the number of branches per tuft varies between 12-19 (Jussieu, 2001; Oktay, 2014; Temel and Temel, 2018) (Figure 1).

Kingdom	:Plantae
Phylum	:Tracheophyta
Class	:Magnoliopsida
Order	:Caryophyllales
Family	:Polygonaceae
Genus	:*Calligonum sp.*
Species	:*Calligonum polygonoides* L.
Subspecies	:*Calligonum polygonoides* L. *subsp. comosum* L' Her.
Synonym	:*Calligonum comosum* L'Hér.



Figure 1: Habitat, Plant Height and Crown Diameter of Tufts of Ebu Cehil shrub (Original)

While the young branches (shoots) formed during the vegetation period (April-August) are green in color and soft in structure, the old branches are in a hard structure, white to grayish-white, and sometimes light brown. In addition, young and old branches (shoots) are hairless, fragile, with swollen nodes and long internodes. Since there is a lot of branching, the canopy diameter of each tuft can be 2.70-3.90 m (Oktay and Temel, 2015b), sometimes up to 10 m (Burdak, 1982). In the Ebucehil shrub, leaves are usually absent or very small (8-16 mm long), sessile, distinct or united with short membranous ochreae (Fifure 2). For this reason, photosynthesis is carried out by green shoots (young branches) and the photosynthetic pathway they follow is C4.



Figure 2: Young and Old Shoots (Steam), Flower Buds, Flowers and Fruits (Original)

Bisexual flowers pedicellate, pedicel 3-8 mm long, slightly accrescent in fruit, articulate in the centre or near the base, Perianth segments 3-4 mm long, 2-3 mm broad, broadly oblong, white, reflexed in fruit. Pedicellate bisexual flowers, consisting of a 5-piece perianth 3-4 mm long and 2-3 mm broad, are mostly found in pairs or triplets (single or in loose clusters) in the axils where the leaf and branch joint. The flower pedicel is 3-8 mm long and hairless. Its white petals with green stripes are hairless. It has 10-18 stamens with filaments

that joint at the base and is dark red in color. The ovary is tetragonous. Flower buds form in mid-April. Flowering begins at the end of April and continues until the beginning of August (Table 1).

Since flowering continues for a long time during the vegetation period, it can provide an important nectar-pollen source to bees. The fruit, 12-17 mm long and 10-14 mm broad, is surrounded by numerous filiform bristles, 10-12 mm long, 2-3 times or more bilaterally branched. The fruits are light pink when newly formed, then dark red and bright brown when mature. The fruits matured between June and August depending on the climatic conditions, and most of them fall between mid july and early September (Table 1). The germination rates of seeds with a weight of 27-34 g per 1000 grains are between 60-77%. Additionally, seeds or fruits can be stored in sealed containers at 1-4 ^{0}C conditions for at least 5 years (Gültekin, 2011; Oktay and Temel, 2015b; Purohit and Kumar, 2020).

Table 1: The phenological Periods of Ebucehil Shrub (Oktay and Temel, 2015b)

	Months																							
	Emr	Mmr	Mre	Ea	Ma	Ae	Em	Mm	Me	Ej	Mj	Je	Ejl	Mjl	Jle	Eag	Mag	Age	Es	Ms	Se	Eo	Mo	Oe
Dp	+																							
Sbb		+																						
Sbp			+																					
Sb				+	+																			
Sp					+	+	+	+	+	+	+	+	+	+	+	+								
Bfb					+	+	+	+	+	+	+	+	+	+	+	+								
Fbp						+	+	+	+	+	+	+	+	+	+	+								
Bf							+	+	+	+	+	+	+	+	+	+								
Fp								+	+	+	+	+	+	+	+	+								
Ef									+	+	+	+	+	+	+	+	+							
Fs										+	+	+	+	+	+	+	+							
Bfr											+	+	+	+	+	+	+	+						
Frp												+	+	+	+	+	+	+						
Ff														+	+	+	+	+	+					
Esp																				+	+	+		
Tdp																								+

Dp: Dormant period	Sbp: Shoot bud period	Sp: Shoot period	Esp: End of shoot period
Bfb: Beginning of flower bud	Bf: Beginning of flowering	Ef: End of flower	Bfr: Beginning of fruit ripening
Sbb: Shoot bud beginning	Sb: Beginning of shoot	Fs: Fruit stage	Frp: Fruit ripening period
Fbp: Flower bud period	Fp: Flowering period	Ff: Fruit fall	Tdp: Transition to dormant period

Emr: Early March	Ea: Early April	Em: Early May	Ej: Early June
Mmr: Mid-March	Ma: Mid- April	Mm: Mid-May	Mj: Mid- June
Mre: End of March	Ae: End of April	Me: End of May	Je: End of June
Ejl: Early July	Eag: Early August	Es: Early September	Eo: Early October
Mjl: Mid- July	Mag: Mid- August	Ms: Mid- September	Mo: Mid- October
Jle: End of July	Age: End of August	Se: End of September	Oe: End of October

3. ADAPTATION

The genus *Calligonum* (Polygonaceae) is distributed mainly in China, Southern Europe, North Africa and Asia. *Calligonum polygonoides* L. *subsp. comosum* (L'He'r.), which is included in this genus, grows naturally on sandy, loamless, desert or semi-desert areas where arid climate prevails in Naxchivan, Syria, Iraq, Iran, Yemen, Azerbaijan, Mauritania, Palestine, Libya, Algeria, Bahrain, India, Tunisia, Egypt, Pakistan, Armenia and Kuwait in world, and is the dominant species of these areas (Koocheki and Mohalati, 1994; Khan, 1997; Abdurahman et al., 2012; Vyas et al., 2012; El-Amier and Abdullah, 2015; Kumar et al., 2015; Abdullah et al., 2017; Afefe, 2020; Dahiya, 2023). In Türkiye, it is distributed only in a narrow area (13,542 ha) on the slopes of Mount Ararat overlooking the Iğdır-Aralık plain, 30 km East-west and 4-5 km North-south (Davis, 1965-1985; Temel et al., 2017). This area is also the second largest wind erosion area in Turkey, and the wind speed can reach 102 km per hour. Its main distribution altitude is 800-1000 m. The average annual rainfall in the distribution area is between 100-300 mm. The average temperature is 12.9 ^{o}C, the highest and lowest temperatures are +42 ^{o}C and -30 ^{o}C, respectively. Relative humidity in the region is low and the annual evaporation rate is 1094 mm. These data show that the plant is quite resistant to drought and frost. Since the plant follows the C4 photosynthetic pathway, it can grow in intense light and high temperature conditions and use soil water and nitrogen more efficiently. It also reduces shoot development as a tolerance mechanism in drought conditions and accelerates the aging of adult shoots (Dhief et al., 2009). For this reason, their net photosynthetic production is higher and their

adaptation to arid and infertile areas is better compared to C3 plants (Pearcy and Ehleringer, 1984).

Although the plant grows in clay and saline soils, it is mainly found on sandy and volcanic soils. Therefore, this species can easily grow in sandy areas where annual rainfall and soil fertility are low (because its water requirement is low). It also plays an important role in soil conservation by holding the dunes with its strong roots and branches that spread on a large area. As a matter of fact, in a study, the amount of soil accumulated by the Ebucehil shrub per tuft was determined as minimum 697.65 kg, maximum 5 082.53 kg and average 2 383.19 kg (Oktay, 2014). Since the Ebucehil shrub accumulates the sand dunes carried by erosion in the canopy, it forms tuft and spreads in natural vegetation in tufts. This also causes the Ebucehil shrub to have a large crown diameter on the soil surface and to increase its density per unit area.

In addition, it contributes significantly to the development and spread of other herbaceous and shrub species in the vegetation by positively improving the physical and chemical properties of the soil. Accordingly, it increases the species composition and density of the vegetation. As a matter of fact, in previous studies, it was reported that the Ebucehil shrub increased the water holding capacity, organic carbon, organic matter, lime, available nitrogen and phosphorus content of the soil under the canopy, and decreased the salinity content (Rathore et al., 2015; Artan and Temel, 2018; Mashizi and Sharafatmandrad, 2019; Abd-ElGawad vd., 2020; Ahmed et al., 2020b). For these reasons, it has been revealed that Ebucehil has a potential soil ameliorating factor and ecological importance. However, in the geographies where it grows, its density per unit area is decreasing day by day due to reasons such as intensive grazing of the plant by animals and its removal as fuel by local community. Similar pressure applies to other geographies where it grows, and it has been reported that this species is under threat (Dahiya, 2023). Considering that many species have no or low adaptation to such areas with extreme ecological conditions, it is of great importance to protect Calligonum polygonoides, which can adapt to these conditions, and to take propagation measures into consideration. In this way, marginal areas can be vegetated and natural vegetation can be developed. For propagation (planting), seeds, scions (branches/shoots), root shoots or dipping techniques can be preferred and used in planting sand dune areas. Although Ebucehil shrub is well adapted to desert

or semi-desert dune areas, measures such as windbreaks or shelterbelts that will stop or minimize dune movements must be taken into consideration for the formation of a healthy establishing in the first year (initially).

4. YIELD AND QUALITY

In order for a species to be recommended as an alternative feed material, the yield obtained per unit area must be high and the feed quality must be at the desired levels. A forage material with these properties can be provided with the known forage plant species and varieties under appropriate ecological conditions and correct agronomic practices. However, it is difficult or impossible to achieve this goal with known forage plant species in marginal areas where extreme ecological conditions prevail and the diversity of species that can be grown is limited. In this sense, species and varieties (especially shrub and tree formations) that grow in marginal areas and have the desired productivity and feed quality have been seen as an alternative solution to meet the required quality roughage needs (Gökkuş et al., 2011; Özaslan Parlak et al., 2011; Temel and Tan 2011a, 2011b; Kökten at al., 2012; Tan and Temel, 2012; Dökülgen and Temel, 2015, 2019, 2020). As a matter of fact, thanks to their superior properties, these formation types can provide important forage material to animals, especially in periods when herbaceous species turn yellow and their nutritional value decreases or there is no feed material to graze in the environment (habitat).

As in other geographies of the world with marginal ecological conditions, the extreme climate and soil conditions prevailing in the Iğdır-Aralık wind erosion area significantly restrict the plant diversity and productivity of existing areas. Especially in summer and autumn, when herbaceous species are in dormant period, feed material cannot be produced in sufficient quantity and quality in the environment. This results in low animal products and unprofitable animal husbandry due to inadequate and unbalanced nutrition of grazed animals. For this reason, xrephyte and halophyte species that grow naturally in arid and infertile (dune) areas have been seen as an important advantage in closing the quality roughage gap and meeting the daily nutritional requirements of animals. (Temel et al., 2015; Keskin, 2018; Temel and Sürmen, 2018; Temel, 2015; 2019a, 2019b; Temel and Keskin, 2019a, 2019b). In this sense, the Ebucehil shrub, which grows widely in the wind erosion area with

dune soil structure and arid climate, maintains its greenness and productivity for a long time and provides an important alternative forage source for grazing animals in the region (Oktay and Temel, 2015b). However, depending on the animal species, the grazing plant parts and densities of each species vary. These differences may arise from the development periods, size, palatability and feed quality of the species. As a matter of fact, since there are no leaves in the Ebucehil shrub, the parts that are used as fodder material or grazed by animals are the young shoots formed during the vegetation period. On the other hand, since the plant is not tall enough, all accessible parts of the plant, especially its shoots, are grazed by cattle, sheep and goat during the vegetation period (from April to October) (Figure 3) and it is in the frequently preferred group (more than 76%) (Temel and Temel, 2018). Similar results were also revealed by Abdullah et al. (2017). Researchers have stated that Ebucehil shrub, which grows naturally in the arid pastures of the Cholistan desert, is a palatable species moderately preferred by free-grazing mixed herds (sheep, goat, cattle and camel) and has a good feed potential for ruminants. In addition, its flower buds, flowers and fruits are moderately palatable and are grazed by camels, cattle and sheep.



Figure 3: Ebucehil Shrub Being Grazed by Sheep and Cattle (Original)

Since the soils in the wind erosion area have a sand dune and volcanic sediment structure, their water holding capacity and productivity are very low. In addition, the annual rainfall in the region is low and the evaporation rate is very high. Accordingly, since the number and density of species growing in the wind erosion area is low, grazing pressure is concentrated on the Ebucehil shrub. In addition, the local community occasionally remove the Ebucehil shrub

and use it as fuel. As a result of all these, the development, height, density and yield per unit area of the Ebucehil shrub vary. As a matter of fact, in a study conducted in the region, it was reported that the fresh shoot yield per tuft of Ebucehil shrub varied between 19.17-67.13 kg, and the fresh herbage yield per decare ranged between 345.06-1208.34 kg. The average fresh herbage and dry hay yields of the plant were determined as 697.14 kg and 184.14 kg, respectively (Temel and Temel, 2018; Table 2). However, it is thought that the forage yield to be obtained from unit area during the year is higher. Because these values belong to the results obtained from a single harvest period. As a matter of fact, the Ebucehil shrub is constantly grazed during its vegetation and forms new shoots following grazing (Oktay and Temel, 2015b; Table 1).

Table 2: Some Yield Characteristics of Ebucehil Shrub (Oktay and Temel, 2015a)

Characteristics	Minimum	Maximum	Mean
Fresh shoot yield per tuft (kg)	19.17	67.13	38.73
Dry shoot yield per tuft (kg)	5.49	16.20	10.23
Fresh shoot yield (kg da^{-1})	345.06	1208.34	697.14
Dry shoot yield (kg da^{-1})	98.82	291.6	184.14
Shoot length (cm)	45.10	68.25	58.65
Plant height (m)	1.20	2.25	15.88
Number of branches per tuft (number)	12.0	19.0	15.65

In order to obtain high quantity and quality animal products, it is of great importance to know the quality content as well as the amount of feed produced per unit area of the plants used as feed sources. Because animals provide the organic and inorganic nutrients that they need daily for survival and productivity through the feed they eat. Therefore, it is important that they obtain the nutrients needed for profitable livestock farming from the roughage they graze. In a study, some nutritional and chemical composition contents of Ebucehil shrub shoots were determined according to months during the vegetation period (Oktay and Temel, 2015a; Table 3).

Table 3: Nutrient and Chemical Composition of Ebucehil Shrub According to Months during Vegetation Period (Oktay and Temel, 2015)

Month	CP	NDF	ADF	ADL	DMD	DMI	DE	ME	RFV
	(%)						(Mcal kg^{-1})		
April	25.29	38.48	20.90	8.31	76.98	3.12	3.56	2.92	186.09
May	17.09	45.72	28.41	9.97	67.34	2.62	3.15	2.58	137.01
June	16.40	47.86	30.95	10.10	64.96	2.51	3.04	2.50	126.26
July	12.46	49.83	33.59	10.73	61.13	2.41	2.88	2.36	114.12
August	11.87	51.53	34.50	11.19	60.13	2.33	2.84	2.33	108.55
September	8.60	53.81	36.19	11.66	57.37	2.23	2.72	2.23	99.18
October	7.54	59.97	39.32	12.78	54.35	2.00	2.59	2.13	84.31
Mean	14.18	49.60	31.98	10.68	63.18	2.42	2.97	2.44	118.49

CP: Crude protein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, ADL: Acid detergent lignin, DMD: Dry matter digestibility, DMI: Dry matter intake, DE: Digestible energy, ME: Metabolic energy, RFV: Relative feed value

It can be said that this feed value of Ebucehil shrub is higher than many cultivated forage plant species, especially straw, which is used as a roughage source. According to 7-month average data, it was observed that Ebucehil shrub produced a feed material of good quality in terms of crude protein, NDF, DMI and RFV, and high quality in terms of ADF and DMD (Table 4). Although there has been a decrease in forage quality values with maturation, especially after June, the Ebucehil shrub constantly produces new (young) shoots following grazing. Accordingly, grazing animals have the opportunity to consume higher quality feed material for a long time. As a matter of fact, it has been shown that the Ebucehil shrub produces the best quality forage material in April, when it produces young shoots intensively, and the high quality forage material in May (Table 3; Table 4). When these data were compared with NRC (2007) values, it was seen that Ebucehil shrub has chemical and nutritional potential that can provide daily live weight gain in addition to the survival requirement of grazing ruminates without the need for a supplementary feeding. In addition, it has been reported that samples consisting of a mixture of leaves, shoots and flowers collected in the spring of the Ebucehil shrub, which grows naturally in the arid rangelands of the Pakistan-Cholistan desert, produce a medium quality feed material (Abdullah et al., 2017). As a result of this research, the dry matter ratio, crude protein, crude fiber, total ash, NDF, ADF, hemicellulose and lignin contents of the plant were determined as 93.64%, 11.54%, 23.37%, 9.48%,

43.67%, 33.67%, 10.00% and 8.80%, respectively. In another study (on the Deltaic Mediterranean coast of Egypt), they reported that naturally growing *Calligonum polygonoides* shoots had a content of 6.12% ash, 7.02% fiber, 1.88% fat, 18.94% protein, 4.58 mg/g glucose and 5.89 mg/g sucrose (El-Amier and Abdullah, 2015).

Table 4: Roughage Quality Standards for Farm Animals (Rivera and Parish, 2010)

Quality standard	CP	NDF	ADF	DMD	DMI	RFV
The best quality	>%19	<%40	<%31	>%65	>%3.0	≥151
High quality	%17-19	%40-46	%31-35	%62-65	%3.0-2.6	125-151
Good quality	%14-16	%47-53	%36-40	%58-61	%2.5-2.3	103-124
Medium quality	%11-13	%54-60	%41-42	%56-57	%2.2-2.0	87-102
Poor quality	%8-10	%61-65	%43-45	%53-55	%1.9-1.8	75-86
Very bad quality	≤%8	>%65	>%45	<%53	<%1.8	<75

CP: Crude protein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, DMD: Dry matter digestibility, DMI: Dry matter intake, RFV: Relative feed value

In addition to the healthy nutrition of animals, although nutrients such as protein, fat, carbohydrates and vitamins are important in providing high quantity and quality animal products, mineral requirements must also be met. Because minerals (macro and micro) have an important role in supporting the rumen activities of ruminants, increasing feed utilization efficiency, stimulating the neuromuscular systems and metabolite activities of animals. (Kutlu et al., 2005; Spears, 1994). However, mineral substances that play an important role in the metabolic activities of animals cannot be synthesized in the animal body (Kutlu et al., 2005) and the required minerals are mostly met by the plants that the animals graze (Gökkuş et al., 2013). Therefore, it is important to know the mineral composition contents of the plants that will be considered as feed sources and to have their mineral values at the desired levels. Mineral composition contents of plants may vary depending on the species of plants in the vegetation, their density, grazed plant parts, growing conditions and the grazing time of animals on these species. Depending on these, the mineral composition values that should be included in the daily rations of animals may be less or more than necessary. As a result, in case of deficiency or excess of minerals, it can have negative effects on the reproduction, development,

immune systems and productivity of animals (McDowell, 1992; Altıntaş, 2013).

As a matter of fact, it was reported that the mineral contents (P, K, Ca, Mg, Mn, Fe, Zn and Cu) of *Calligonum comosum* growing in the eastern province of Saudi Arabia varied according to months (January, February, March and April) and plant parts (whole plant, leaves, and stem) (Alzarah, 2021). In the current study, while nitrogen, phosphorus and potassium contents were found to be highest in the whole plant part, calcium, magnesium, manganese, zinc and copper elements were determined to be higher in the leaves compared to other plant parts. According to months, the highest nitrogen, potassium and zinc contents were recorded in March, but phosphorus, calcium, iron and copper contents in February. The lowest magnesium and highest manganese were determined in April. However, the results obtained from this study showed that mineral contents (except Zn and Mn) according to both months and plant parts were above the maximum tolerable levels of the animals (NRC, 2005). In another study conducted in a different geography, only shoot mineral contents of *Calligonum polygonoides* were determined (El-Amier and Abdullah, 2015). As a result of the study, it was seen that the P, Na, Fe, Cu, Mn and Zn contents of the shoots were at the tolerable levels of the animals and the K, Ca and Mg contents were above (NRC, 2005). Mineral contents of especially halophyte and xerophyte species growing in arid and saltine conditions are generally high. This is due to the fact that they remove large amounts of salt ions from the environment in which they grow and store them in their bodies. On the other hand, although not as much as halophyte and xerophyte species, grass and legume species that grow naturally in meadow-pasture areas can generally have higher mineral content than most cultivated forage plant species. In a study on the subject, the mineral contents of 12 legume and 8 grass forage plant species growing naturally in meadow-pasture areas were determined (Gürsoy and Macit, 2017). When the results obtained from this study were compared with NRC (2005) values, it was shown that some mineral substances could not meet the daily requirements of animals and some mineral substances were above the maximum tolerable levels of animals. However, it has been determined that the Ebucehil shrub, which grows naturally in extreme climate and soil conditions, can easily meet the daily mineral requirements of animals

and its mineral contents are below the maximum tolerable level (except Mg) for animals (Table 5; Table 6).

Table 5: Some Mineral Values of Ebucehil Shrub according to Months during the Vegetation Period (Temel, 2019)

Month	P	K	Ca	Mg	Na	Fe	Cu	Zn	Mn
			(%)				(ppm)		
April	0.33	1.68	1.81	0.99	0.30	190.43	2.31	26.20	37.97
May	0.49	1.83	1.52	0.87	0.20	138.30	2.35	25.90	41.37
June	0.54	2.03	1.49	0.82	0.21	125.66	2.47	29.33	34.16
July	0.53	1.84	1.33	0.81	0.24	111.30	2.67	28.03	35.60
August	0.63	1.93	1.37	0.79	0.22	115.16	2.43	31.83	34.63
September	0.59	1.98	1.39	0.74	0.23	100.97	2.00	24.77	41.12
October	0.47	1.45	1.32	0.65	0.25	99.73	2.70	28.60	45.56
Mean	0.51	1.82	1.46	0.81	0.24	125.93	2.42	27.85	38.63

In this study, during the 7-month vegetation period, it was reported that P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn contents of Ebucehil shrub varied between 0.33-0.63%, 1.45-2.03%, 1.32-1.82%, 0.65-0.99%, 0.20-0.30%, 99.73-190.43 ppm, 2.00-2.70 ppm, 24.77-31.83 ppm and 34.16-45.56 ppm, respectively. In addition, it was determined that Ca, Na, Mg and Fe contents were relatively higher in the early development period, and P and K contents were relatively higher in the late development period (Temel, 2019c).

Table 6: Maximum Tolerable Levels of Minerals in the Rations (% or mg/kg of the DM) of Animals according to İndexes Of Animal Health (NRC, 2005)

	P	K	Ca	Mg	Na	Mn	Cu	Zn	Fe
			(%)				(ppm)		
Cattle	0.70	2.00	1.50	0.60	4.50	2000	40	500	500
Sheep	0.60	2.00	1.50	0.60	4.00	2000	15	300	500

In addition to having the desired nutritional, chemical and mineral content, Ebucehil shrub is also rich in secondary compounds such as carotenoids, tannins, terpenoids, steroids, glycosides, alkaloids, flavonoids and phenolics. These compounds have a great impact on the usefulness of other

feedstuffs eaten by animals, animal health, rumen microbial population, and the quantity and quality of animal products. As a matter of fact, studies have shown that these compounds have estrogenic (Ahmed et al., 2015), anticarcinogenic (Sak, 2014), antimicrobial (Riadh et al., 2011; Alkhalifah, 2013; Khan et al., 2015; Al-Hammouri et al., 2018), cardioprotectiv (Abushouk et al., 2017), lipoxygenase-inhibiting (Yawer et al., 2007), antiosteoporotic (Sabry et al. 2013), anti-ulcer, anti-inflammatory (Liu et al., 2001; Shalabi et al., 2015), hypoglycemic (El-Hawary and Kholief 1990; Abdo et al., 2015), antihelmentic (Degheidy et al. 2013), cytotoxic and antioxidant (Badria et al. 2007; Ahmed et al., 2020) activity. However, it should not be forgotten that when these compounds are included in high amounts in the diet of animals or when animals are fed with plants containing these compounds for a long time, these secondary compounds may inhibit the growth of the animal and disrupt its normal metabolism.

As a result, it has been observed that the Ebucehil shrub growing in arid and infertile conditions to which most species cannot adapt is an important alternative forage source for grazing animals because it has the desired feed quality characteristics. Although feed quality values decrease with maturation, it is at a level that can meet the needs of ruminants without the need for supplementary feeding during the vegetation period. In addition, when most herbaceous species growing in marginal areas dried out or entered the dormant period, the Ebucehil bush can produce a significant amount of feed material, and this should be seen as an important advantage in terms of meeting the daily feed requirement of the animals grazing in the region. It is also thought that the Ebucehil shrub can make important contributions to the profitable and sustainable of the animal husbandry.

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