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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

A Preliminary Study on The Chemical Structure of *Vicia sativa* L. Accessions Collected From Natural Flora of European Part of Turkey

Türkiye'nin Avrupa Yakası Doğal Florasından Toplanan *Vicia sativa* L. Aksesyonlarının Kimyasal İçeriği Üzerine Bir Ön Araştırma

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Abstract

The objective of this study was to determine chemical composition of 24 common vetch (*Vicia sativa* L.) accessions, collected from natural flora in European part of Turkey. The field experiment was carried out in the 2015-2016 growing season at field experimental area of Tekirdag Namık Kemal University, Agricultural Faculty, Field Crops Department in Tekirdag/Turkey. In this study, chemical structure (nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), copper (Cu), zinc (Zn), iron (Fe), and manganese (Mn) content) of common vetch accessions were determined on hay. Chemical composition content was statistically significantly different (P≤0.01) between accessions. According to the results obtained from field experiments, N, P, K, Ca, Mg, Cu, Zn, Fe, and Mn content of common vetch accessions varied between 0.95–3.14 %, 0.84–3.65 %, 0.22–2.44 %, 0.89–2.85 %, 0.23–0.74 %, 0.15–7.80 ppm, 0.10–5.30 ppm, 43.00–2295.20 ppm, 3.08–17.50 ppm, respectively. A wide variation was observed among common vetch accessions used in the study for N, P, K, Ca, Mg, Cu, Zn, Fe, and Mn content. Tetany and Ca/P rates of accessions changed from 0.13 - 1.54 and 0.28 - 2.19, respectively. The tetany and Ca/P rates of common vetch accessions are within suitable values for animal feeding. Ca/P ratio is above the limit value only in accessions 15-2 and 14O04. According to the correlation analysis, N was positively and significantly correlated with P, K, Mg, Cu and Fe. Similarly, P was positively and significantly correlated with N, K and Fe. Magnesium was positively and significantly correlated with N, Ca, Cu, Fe and Mn. Iron was positively and significantly correlated with N, P, Ca, Mg and Cu. As a result, accession 15K17 and 33 were identified as common vetch accessions with high mineral nutrition content.

Keywords: *Vicia sativa* L., Nitrogen, Phosphorus, Micro nutrients, Tetany

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Öz

Bu araştırmada, Türkiye'nin Avrupa bölümünden toplanan 24 yaygın fiğ (*Vicia sativa* L.) aksesyonunun kimyasal kompozisyonun belirlemesi amaçlanmıştır. Tarla denemesi, Türkiye'nin Tekirdağ ilinde Tekirdağ Namık Kemal Üniversitesi, Ziraat Fakültesi, Tarla Bitkileri Bölümü, Araştırma ve Deneme Alanı'nda 2015-2016 yetiştirme döneminde yürütülmüştür. Bu araştırmada yaygın fiğ aksesyonlarının kimyasal kompozisyonları (azot (N), fosfor (P), potasyum (K), kalsiyum (Ca), magnezyum (Mg), bakır (Cu), çinko (Zn), demir (Fe), mangan (Mn) içerikleri) kuru ot üzerinden belirlenmiştir. Kimyasal kompozisyon içerikleri aksesyonlar arasında istatistiki olarak önemli derecede farklı bulunmuştur ($P \leq 0.01$). Tarla çalışmasından elde edilen sonuçlara göre, N, P, K, Ca, Mg, Cu, Zn, Fe, ve Mn içerikleri sırasıyla 0.95–3.14 %, 0.84–3.65 %, 0.22–2.44 %, 0.89–2.85 %, 0.23–0.74 %, 0.15–7.80 ppm, 0.10–5.30 ppm, 43.00–2295.20 ppm, 3.08–17.50 ppm, arasında değişmiştir. Çalışmada kullanılan yaygın fiğ aksesyonlarında N, P, K, Ca, Mg, Cu, Zn, Fe, ve Mn içerikleri bakımından geniş bir varyasyon belirlenmiştir. Tetani ve Ca/P oranları sırasıyla 0.13 – 1.54 ve 0.28 – 2.19 arasında değişmiştir. Yaygın fiğ aksesyonlarının tetani ve Ca/P oranları hayvan besleme için elverişli değerlerdedir. Sadece 15-2 ve 14O04 nolu aksesyonlarda Ca/P oranı limit değerler üzerindedir. Korelasyon analizi sonuçlarına göre, N içeriği P, K, Mg, Cu ve Fe içeriği ile pozitif ve önemli korelasyon göstermiştir. Benzer olarak, P içeriği, N, K ve Fe içerikleri ile pozitif ve önemli ilişkiye sahip olmuştur. Mg içeriği N, Ca, Cu, Fe ve Mn içerikleri ile pozitif ve önemli ilişkilidir. Fe içeriği N, P, Ca, Mg ve Cu içerikleri ile pozitif ve önemli korelasyon göstermiştir. Sonuç olarak, 15K17 ve 33 nolu aksesyonlar yüksek mineral besin içeriğine sahip yaygın fiğ aksesyonları olarak tespit edilmiştir.

Anahtar Kelimeler: *Vicia sativa* L., Azot, Fosfor, Mikro besin elementleri, Tetani

1. Introduction

Thrace region is located on European part of Turkey between 26-29 East longitudes and 40-42 North latitudes. Tekirdag, Kirklareli, Edirne entirely and European sides of Canakkale and Istanbul provinces are located in Thrace region. The region is mostly characterized as a dry farming region; most of the crops were growing without irrigation like wheat and sunflower. Moderate hot and humid during summer with an average July temperate of 22.4 ℃. The winters are damp cloudy and wild. The average temperate is 3.9 ℃ with frosts and some snow. Long year (30 years) average Thrace region has annual rain for of 548 mm most of which false in late fall and winter. European part of Turkey is characterized by clay soils with varying percentages of loam, clay and sandy, the organic matter is low around the region because of intensive agricultural practices. Istranca Mountains are located along Thrace region in North West - South East direction from Bulgaria frontier to Istanbul. Thrace region is not high. It is average altitude approximately 180 meters. There are mainly two well-known mountain series. Istranca Mountain series located in the North of the region and Ganos Mountain series are located in the South. Also, the region has an important potential in regional agriculture production. The main source of income for Tekirdag, Edirne and Kirklareli population is agricultural production. Flora of Thrace region has provided the raw material for plant breeding especially. The rich plant genetic resources of the region have been negatively affected by intense agriculture and over grazing of natural pasture and meadows. Turkey is the center of many temperate legumes species (Maxted et al., 1991). The genus *Vicia* L. comprises approximately 190 species in the world and 64 species in Turkey (Erik and Tarıkahya, 2004; ILDIS, 1999; Gür and Tuna, 2016). This genus is primarily located in the Mediterranean regions (Kupicha, 1981). The genus *Vicia* has long been a subject of active research because it contains several species of economic importance, e.g., *V. faba*, *V. sativa*, *V. narbonensis*, *V. ervilla*, and *V. villosa*, many of which have been domesticated since the origin of agriculture (Gil and Cubero, 1993). Some vetch species currently use widely in agricultural systems of them. Of the numerous *Vicia* species, it is common vetch (*V. sativa* L.), Hungarian vetch (*V. pannonica* Crantz), Narbon vetch (*V. narbonensis* L.), and hairy vetch (*V. villosa* Roth) are the most important in Turkey. Common vetch seems most likely to have originated from southern Europe or South-west Asia (Maxted, 1995). In some of the Mediterranean countries, it is one of the most prominent types within the agriculture system. Common vetch is an important legume cultivated for feed grain and forage in the Mediterranean and Central Asia regions (Samarah and Ereifej, 2009). It is an annual legume, which is cultivated under rain fed conditions in the semi-arid regions of Turkey. The common vetch is a highly variable and polymorphic species containing both indigenous weeds and cultivated forms. It represents a wide range of morphological variation, which has caused considerable taxonomic uncertainty.

Vetches are legumes well adapted to winter growth in the Mediterranean environments throughout the world on a variety purposes such as dry matter, silage, grain feed and green manure (Acıkgoz, 2001; Sezmis and Macit, 2018). In the extensive Mediterranean production systems, fibrous feeds, particularly cereal straws and stubbles, are the most important diet ingredients for ruminants. Although quantitatively less important, legume straws can represent a valuable feed resource during summer for those animals having access to the site of grains threshing (Bruno-Soares et al., 2000). For quality feed, the plant must contain mineral substances at a certain level. In addition to the presence of mineral substances in the hay, its proportions are also important in terms of feed value (Yücel et al., 2014). Concentrations of most mineral nutrients showed a decreasing trend with advancing maturity. Maximum accumulation of N, P, Cu, and Zn was reached at the end of the period of rapid seed growth (Caballero et al., 1996). A mineral deficiency or excess in diet may affect the health of animals adversely. Tetany, an important disease of livestock, is caused by mineral imbalance in feeds (Turk et al., 2009). Grass tetany is characterized by low blood Mg in livestock resulting from low Mg content of feed or reduced absorption of Mg. Forages containing less than 0.20 % Mg and a “tetany ratio” [K/(Ca + Mg)] greater than 2.2 have higher risk of inducing grass tetany (Crawford et al., 1998). Grass tetany has occurred in ruminants grazing nearly all major cool-season grasses. Legumes generally contain higher concentrations of Ca and Mg and lower concentrations of K than do grasses. Therefore, the use of grass-legume mixtures rather than pure grass swards has been a recommended practice in some grass tetany areas (Mayland et al., 1990).

The aim of this study was to determine chemical structures of some accessions of *Vicia sativa* L. collected from natural area in European part of Turkey.

2. Materials and Methods

2.1 Material

Common vetch (*Vicia sativa* L.) accessions were collected from European part of Turkey between March and July months in 2014 and 2015 years *(Table 1).*

Table 1. Collected site informations of common vetch (Vicia sativa L.) accessions

No	Location	Latitude	Longitude	Altitude
3-1, 3-2	Tekirdag (Kumbag district)	N 40°51'11.82"	E 27°27'12.96"	126
4-1	Tekirdag (Kumbag district)	N 40°51'3.84"	E 27°26'14.76"	126
6-5	Tekirdag (Marmara Ereglisi)	N 40°59'34.92"	E 27°57'14.10"	9
7-1, 7-3	Tekirdag (Marmara Ereglisi)	N 41° 2'7.08"	E 27°57'12.84"	25
10-6,10-7	Catalca	N 41° 9'23.64"	E 28°27'16.38"	61
15-2, 15-5, 15-6,	Catalca	N 41°21'11.52"	E 28°27'13.80"	136
17-6	Tekirdag (Köseilyas Village)	N 41° 0'7.74"	E 27°33'22.50"	83
33	Sarkoy	N 40°41'35.76"	E 27°17'29.70"	11
98-1	Malkara (Halic Village)	N 40°52'6.60"	E 26°46'37.40"	276
111-1	Gelibolu	N 40°17'54.90"	E 26°16'43.90"	14
116-1	Kirklareli (Organized industrial)	N 41°41'38.80"	E 27°19'20.20"	200
14N64	Edirne (Yenicekoy Village)	N 41°20'05.25"	E 26°44'18.49"	70
14O03, 14O04	Edirne (Trakya University)	N 41°38'50.33"	E 26°37'03.88"	67
14Y462	Edirne (Uzunkopru-Kırcasalih)	N 41°23'21.08"	E 26°47'96.39"	104
15K17	Kirklareli (Kocahıdır Village)	N 41°39'180"	E 26°54'429"	139
15K48	Kirklareli (Sergen Village)	N 41°43'46.00"	E 27°38'34.10"	139
15I01	Gelibolu (Ilgardere Village)	N 40°16'559"	E 26°29'062"	9

Collection sites were chosen to maximize the diversity of *Vicia* sp. sampled. At each site detailed passport data was recorded, both for the site and for each common vetch sampled. The taxonomic keys used during the mission were described by Maxted (1995), Davis and Plintman (1970) and Zohary and Heller (1984). A complete list of the locations of collected common vetch accessions is shown in *Table 1*.

2.2. Experimental design

The field experiment was carried out in the 2015-2016 growing season at field experimental area of Tekirdag Namık Kemal University, Agricultural Faculty, Field Crops Department in Tekirdag/Turkey (N 40º 59' 25.1", E 27º 34' 50.2", 15 m). Long-term average temperature, total rainfall and relative humidity were 11.7 °C, 529.7 mm and 80 %, respectively during growing period in Tekirdag *(Table 2).*

Table 2. Climatic data of October 2015 – June 2016 period and long-term average (1960 -2016)

	Mean temperature (°C)		Total precipitation (mm)		Relative humidity (%)	
Months	2015-2016 year	Long term	2015-2016 Year	Long term	2015-2016 Year	Long Term
October	16.4	15.7	83.7	90.0	80.1	80.5
November	13.8	11.3	48.5	62.5	80.7	84.0
December	7.3	7.2	0.7	82.5	79.9	83.6
January	5.6	5.2	70.7	62.1	80.0	84.0
February	9.7	5.7	68.4	64.9	85.5	81.4
March	10.4	8.0	30.6	57.4	80.3	80.7
April	15.6	12.2	22.9	41.5	72.2	78.2
May	17.9	17.6	28.1	33.8	74.4	75.1
June	23.6	22.2	35.0	35.0	72.2	72.6
Total			388.6	529.7		
Average	13.37	11.7			78.4	80.0

Total rainfall of experiment year was lower than that of long years with 388.6 mm. Therefore, average temperature in 2015-2016 was 13.37 ºC. This temperature over 1.67 °C from long-term average temperature. Relative humidity was 78.4 %. During the experiment period, the climate was hot and dry from the long-term average.

Soil test values of 0-20 and 20-40 cm soil levels at experimental field determined a pH of 6.25-6.52, 0.01-0.01 % lime, 1.6-1.5 ppm P_2O_5, 429-386 ppm Mg, 27-25 ppm Fe, 25-20 ppm Mn, 0.32-0.41 ppm Zn and 1.08-1.11 % organic matter, respectively *(Table 3)*. This analysis results shows soil of experimental field slightly acidic and low organic matter levels.

Table 3. Soil analysis of experimental area at Tekirdag, Turkey

Soil characteristics	0-20 cm	20-40 cm
Saturation with water (%)	40	41
pH	6.25	6.52
Lime (%)	0.01	0.01
Phosphorus (1.39-3.26) (ppm)	1.6	1.5
Calcium (1150-3500) (ppm)	2807	2406
Magnesium (160-480) (ppm)	429	386
Potassium (140-370) (ppm)	169	164
Iron (2-4.5) (ppm)	2.7	2.5
Manganese (14-50) (ppm)	25	20
Zinc (0.7-2.4) (ppm)	0.32	0.41
Organic matter (%)	1.08	1.11

Sowing was made by hand on 3 November 2015. Twenty seeds of each genotypes were sown into a single row (5 m) at 0.5 m intervals. The experiment was fertilized using 80 kg/ha P_2O_5 prior to saving and conducted under rain fed condition. Weeds were handling removed. Plants were harvested at 50 % flowering time. Fresh sample was taken from the harvested material, dried in the shade. Samples taken from dried plants were ground in a grinder. To determine the chemical content of the herb in ground samples, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), copper (Cu), zinc (Zn), iron (Fe), and manganese (Mn) analyzes were done. In wet-burned samples, Kjeldahl method were were used for N content (Akyıldız, 1984). Phosphorus analysis was determined according to vanadomolibdofosforik yellow color method (Akyıldız, 1984). Iron, copper, zinc, manganese, calcium, potassium and magnesium were analyzed with ICP-OES device (Allen et al., 1998). Tetany ratios (K/Ca + Mg) were calculated as Cherney et al. (2002).

2.3. Statistical analysis

Data were analysed using by SPSS for Windows V. 18. An analysis of variance was carried out according to Ramdomly Complete Block experimental design. Significant differences among the mean values were compared by TUKEY test ($P \leq 0.01$).

3. Results and Discussion

3.1. Chemical structure, tetany and Ca/P rates of Vicia sativa L. accessions

Results of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), copper (Cu), zinc (Zn), iron (Fe), manganese (Mn) contents, tetany and Ca/P rates of common vetch accessions presented in *Table 4* and *Table 5*.

Nitrogen, phosphorus, potassium, calcium, magnesium, copper, zinc, iron and manganese contents of common vetch accessions showed significant differences ($P \leq 0.01$). Similarly, tetany and Ca/P ratios were also determined to be statistically significant ($P \leq 0.01$).

Protein is an important nutrient supplied by forages. Understanding what protein analysis tells about the quantity and quality of the protein in the forage is important. The crude protein value includes true protein and

non-protein N compounds (Schroerder, 2018). Therefore, the N content of the forage crop is important. Nitrogen content of common vetch accessions ranged from 0.95 to 3.14 % *(Table 4)*. The highest N content was determined as 3.14 % in accession 15K17. This accession was followed by accessions 3-2, 7-1, 15-6 and 15K48 with 3.00, 2.62, 2.57 and 2.57 % N content, respectively. Since the high N content increases the protein ratio, these accessions with high N content can be selected for common vetch breeding studies. The lowest N content was obtained at 0.95 % with accession 15-2 and 15-5. N content of common vetch was determined as 3.57 % by Cabellero et al., (1996), and between 2.12 – 2.88 % by Celen et al. (2005). The results of Cabellero et al. (1996) are higher than our findings. Therefore, determined N values by Celen et al. (2005) is consistent with our findings.

Table 4. Chemical structure (N, Cu, Zn, Fe, Mn) of Vicia sativa L. accessions

Access. No	Nitrogen (N) (%)	Copper (Cu) (ppm)	Zinc (Zn) (ppm)	Iron (Fe) (ppm)	Manganese (Mn) (ppm)
3-1	1.52 cde	1.44 cd	1.82 b-e	219.60 fgh	16.80 ab
3-2	3.00 ab	7.50 a	0.71 d-g	414.91 fgh	9.91 a-g
4-1	1.24 cde	0.61 cd	0.10 g	373.40 fgh	6.33 efg
6-5	1.15 cde	0.62 cd	0.82 c-g	349.40 fgh	9.86 a-g
7-1	2.62 abc	1.44 cd	0.36 fg	1619.00 a-d	7.78 c-g
7-3	1.71 a-e	1.76 cd	1.34 b-f	71.00 h	16.02 abc
10-6	2.41 a-e	1.96 cd	1.64 b-e	1108.40 b-f	13.74 a-e
10-7	1.62 b-e	0.33 cd	0.35 fg	190.30 gh	7.02 d-g
15-2	0.95 e	0.80 cd	1.71 b-e	430.70 fgh	6.10 efg
15-5	0.95 e	0.42 cd	0.68 d-g	774.40 d-h	5.72 efg
15-6	2.57 a-d	4.75 b	2.02 bc	914.36 d-h	10.08 a-g
15-13	2.12 a-e	0.94 cd	1.48 b-f	735.60 d-h	9.87 a-g
17-6	1.22 cde	1.37 cd	1.51 b-f	570.15 e-h	9.33 a-g
33	1.57 b-e	2.20 c	1.34 b-f	1988.50 ab	15.00 a-d
98-1	1.05 e	2.14 cd	1.88 bcd	48.40 h	17.50 a
111-1	1.66 a-e	1.12 cd	1.52 b-f	1900.20 abc	11.94 a-f
116-1	2.05 a-e	0.15 d	1.87 bcd	519.50 e-h	4.84 fg
14N64	2.16 a-e	1.77 cd	2.16 b	918.60 d-h	11.31 a-g
14O03	1.71 a-e	0.60 cd	5.30 a	529.90 e-h	8.54 b-g
14O04	1.14 de	2.18 c	2.24 b	43.00 h	16.38 ab
14Y46	1.88 a-e	0.46 cd	1.14 b-g	1008.60 c-g	3.08 g
15K17	3.14 a	7.80 a	1.07 b-g	2295.20 a	7.82 c-g
15K48	2.57 a-d	1.56 cd	0.92 c-g	1043.00 c-g	11.96 a-f
15I01	1.62 b-e	1.86 cd	0.62 efg	1411.67 a-e	11.23 a-g
MSE	0.150	0.273	0.104	55362.239	4.828

Means bearing by same letter in column were not significantly different at the P≤0.01 level
MSE: Mean Squared Error

Copper (Cu) is an essential micronutrient for higher plant growth and metabolism. However, its high bioavailability in soils make it a potentially toxic substance causing inhibition of growth and oxidative injuries (Souguir et al., 2008). Copper content of common vetch accessions varied between 0.15 and 7.80 ppm *(Table 4)*. Copper content was obtained as the highest on accession 15K17 with 7.80 ppm among all accessions. This accession was followed by accessions 3-2 with 7.50 ppm Cu content. These two accessions differ significantly from the other accessions due to their Cu value which is quite higher than the other accessions. Caballero et al.,

(1996) determined the Cu content of common vetch as 7.3 ppm. This data is similar to the Cu content values of these two accessions. The lowest Cu content was found on accession 116-1 with 0.15 ppm. It is seen that there is a huge variation between the copper content of vetch accessions. Similarly, MacPhersson (2000) reported that there are differences between genotypes in terms of Cu concentration in subterraneum clover (*Trifolium subterraneum* L.) and some temperate grasses as perennial ryegrass (*Lolium perenne* L.) and orchard grass (*Dactylis glomerata* L.).

Zinc (Zn) content of common vetch accessions varied between 0.10 and 5.30 ppm *(Table 4).* The highest Zn content determined on accession 14O03 (5.30 ppm). The lowest Zn content was on accession 4-1 (0.10 ppm). Caballero et al., (1996) determined the Zn content of common vetch as 30.2 ppm.

Iron (Fe) is naturally well supplied by forages, and deficiencies of the element in grazing livestock are unlikely to occur normally but may result from blood loss due to heavy parasitic infestation or some other cause of haemorrhage. Legumes would generally contain more Fe than grasses (MacPherson, 2000). Iron content of common vetch accessions varied between 43.00 and 2295.20 ppm *(Table 4).* There is a high variation in Fe values of common vetch populations. The highest Fe content was determined as 2295.20 ppm in accession 15K17. This accession was followed by accessions 33 with 1988.50 ppm Fe content. The lowest Fe content was determined at 43.00 ppm with accession 14O04. Caballero et al. (1996) determined the Fe content of common vetch as 240 ppm.

Manganese (Mn) content of common vetch accessions varied between 3.08 and 17.50 ppm *(Table 4).* The highest Mn content was determined as 17.50 ppm in accession 98-1. This accession was followed by accessions 3-1, 14O04, 7-3 and 33. The lowest Mn content was determined at accession 14Y46 with 3.08 ppm. Caballero et al., (1996) determined the Mn content of common vetch as 50.3 ppm.

Phosphorus (P), a required nutrient for all livestock, has numerous essential physiological functions in the body that include energy transfer (ATP), structure of bone, teeth, and membranes, and buffering pH changes in the rumen (Satter et al., 2005). Phosphorus content of common vetch accessions varied between 0.84 and 3.65 % (Table 5). The accession 7-1 was the highest P content among the accessions, with 3.65 %. This accession was followed by accessions 16-1, 15K17 and 10-7. The lowest P content was determined at accession 14O04, with 0.84 %. Phosphorus contents of *V. sativa* L. subsp. *sativa* and *V. sativa* L. subsp. *nigra* that collected from rangelands and farmlands in Iran were 0.087 % and 0.084 %, respectively (Badrzadeh et al., 2008). In the study conducted with a mixture of vetch and cereal under Erzurum conditions, the average values of P of pure vetch were determined as 0.203 % (Tan and Serin, 1996). P content of common vetch was determined as 0.50 - 0.61 % by Egritas and Onal Ascı (2015) and as 0.34 % by Caballero et al., (1996). These findings are lower than our data. These different findings may be due to the availability of phosphorus in the trial soils. However, there are also significant differences between populations in our trial. In this respect, its effect on genotypic characteristics should be considered.

Potassium (K) is essential for rumen microorganisms. The single most consistent effect of suboptimal K in the ration of ruminants is decreased feed intake (Armstrong, 1998). K content of common vetch accessions ranged from 0.22 to 2.44 % *(Table 5).* Potassium content was obtained as the highest on accession 6-5 with 2.44 % among all accessions. The lowest K content was found on accession 111-1 with 0.22 %. Badrzadeh et al., (2008) also reports potassium contents of *V. sativa* L. subsp. *sativa* and *V. sativa* L. subsp. *nigra* were 1.35 % and 1.34 %, respectively which is consistent with our results. Tan and Serin (1996) were determined as 3.54 % K which is higher than our results. Potassium content of common vetch was determined by Egritas and Onal Ascı (2015) as 1.29 – 1.43 % and Caballero et al. (1996) as 2.35 %. These results are similar to our findings.

Calcium (Ca) content of common vetch accessions varied between 0.89 and 2.85 % *(Table 5).* The highest Ca content determined on accession 33 (2.85 %). The lowest Ca content was on accession 15K48, with 0.89 %. Calcium content of *V. sativa* L. subsp. *sativa* and *V. sativa* L. subsp. *nigra* was 1.38 % (Badrzadeh et al., 2008). Cabellero et al., (1996) determined the Ca content of common vetch as 1.35 %. These results are within the limits of calcium content determined in this research. In another study, Tan and Serin (1996) found similar results (1.61 %), which are within the values we determined. Higher data than our finding were determined by Egritas and Onal Asci (2015) as 4.45 % and Celen et al. (2005) as 4.55-6.78 %.

Magnesium (Mg) is important that cows consume adequate quantities of dietary Mg to meet requirements for specific productive processes or functions. Blood Mg levels in cows normally range from 1.8 to 2.0 mg/dl and values near or slightly higher than 1.0 mg/dl reflect Mg deficiency (Mayland et al., 1990). At the same time, the high Mg content also reduces the tetany rate. For this reason, the Mg ratio in the forage crops is important. Magnesium content of common vetch accessions varied between 0.23 and 0.74 % in this research *(Table 5).* The accession 33 was the highest Mg content among the accessions, with 0.74 %. The lowest Mg content was determined at accession 4-1, with 0.23 %. Tan and Serin (1996) were determined as 0.35 % Mg for common vetch under Erzurum conditions. Magnesium content of common vetch was determined by Egritas and Onal Ascı (2015) as 0.46 – 0.51 % and as 0.37 % (Caballero et al., 1996). These results are similar to our findings.

Table 5. Chemical structure (P, K, Ca, Mg,), Tetany and Ca/P ratio of Vicia sativa L. accessions

Access. No	Phosphorus (P) (%)	Potassium (K) (%)	Calcium (Ca) (%)	Magnesium (Mg) (%)	Tetany (K/Ca+Mg)	Ca/P
3-1	2.56 a-g	1.53 b-e	1.58 b-g	0.39 bcd	0.78 b-f	0.62 bc
3-2	2.14 b-h	1.59 b-e	1.54 b-g	0.47 bcd	0.80 b-f	0.75 bc
4-1	3.05 a-d	1.79 a-d	0.95 fgh	0.23 d	1.54 a	0.31 c
6-5	1.42 f-i	2.44 a	1.58 b-g	0.39 bcd	1.26 ab	1.15 abc
7-1	3.65 a	1.86 abc	1.61 b-f	0.54 ab	0.86 b-e	0.44 c
7-3	2.04 c-i	1.85 abc	1.83 b-e	0.48 bc	0.80 b-h	0.90 abc
10-6	1.96 d-i	1.67 b-e	0.94 gh	0.46 bcd	1.24 ab	0.48 c
10-7	3.22 abc	1.65 b-e	1.12 fgh	0.35 bcd	1.13 a-d	0.35 c
15-2	0.94 hi	1.31 cde	1.86 bcd	0.28 cd	0.61 d-g	2.02 ab
15-5	1.34 ghi	1.04 e	1.19 e-h	0.37 bcd	0.67 c-g	0.89 abc
15-6	2.85 a-e	1.29 cde	2.07 bc	0.42 bcd	0.52 efg	0.73 bc
15-13	2.49 a-g	1.58 b-e	1.19 e-h	0.39 bcd	1.00 a-e	0.49 c
17-6	1.46 f-i	1.62 b-e	1.59 b-g	0.38 bcd	0.88 b-e	1.30 abc
33	2.94 a-d	1.05 e	2.85 a	0.74 a	0.29 fg	0.97abc
98-1	1.64 e-i	1.18 cde	1.01 fgh	0.34 bcd	0.88 b-e	0.62 bc
111-1	1.44 f-i	0.22 f	1.40 d-h	0.30 bcd	0.13 g	0.99 abc
116-1	3.61 a	1.66 b-e	1.00 fgh	0.32 bcd	1.26 ab	0.28 c
14N64	1.38 f-i	1.61 b-e	1.85 b-e	0.45 bcd	0.69 b-f	1.94 ab
14O03	2.29 b-g	1.14 de	1.49 c-h	0.39 bcd	0.62 d-g	0.65 bc
14O04	0.84 i	1.14 de	1.84 b-e	0.54 ab	0.48 efg	2.19 a
14Y46	2.15 b-h	1.49 b-e	1.89 bcd	0.47 bcd	0.63 d-g	0.98 abc
15K17	3.35 ab	2.04 ab	1.34 d-h	0.46 bcd	1.14 a-d	0.40 c
15K48	2.86 a-e	1.51 b-e	0.89 h	0.36 bcd	1.20 abc	0.31c
15I01	2.62 a-f	1.28 cde	2.21 ab	0.42 bcd	0.49 efg	0.84 abc
MSE	0.108	0.032	0.030	0.004	0.246	0.152

Means bearing by same letter in column were not significantly different at the P≤0.01 level
MSE: Mean Squared Error

Tetany, an important disease of livestock, is caused by mineral imbalance in feeds. The risk of tetany is increased at a K: (Ca+Mg) ratio of 2.2 or higher (Crawford et al., 1998). In this research, tetany rates of common vetch accessions changed from 0.13 and 1.54 *(Table 5).* Tetany rates of accession 4-1 was the highest among the accessions, with 1.54. This accession was followed by accessions 6-5, 116-1 and 10-6 with 1.26, 1.26, and 1.24, respectively. The lowest tetany rates were determined at accession 111-1, with 0.13. Tetany rates of common vetch accessions appear to be below the critical level. Tetany rate of all common vetch was determined as 0.20-

0.32 by Celen et al., (2005) and as 0.26-0.29 by Egritas and Onal Ascı (2015). Although these results are within the limits of our findings, they are well below the highest value of 1.54 (accession 4-1) in our data.

In general, a calcium/phosphorus (Ca/P) ratio of 2:1 is recommended. When it is higher than this rate, it causes milk fever in animals (Egritas and Onal Ascı, 2015). Calcium/phosphorus ratio of common vetch accessions varied between 0.28 and 2.19 *(Table 5).* Calcium/phosphorus ratio of accession 14O04 was the highest among the accessions, with 2.19. This accession was followed by accessions 15-2 and 14N64 with 2.02 and 1.94, respectively. The lowest Ca/P ratio was determined at accession 116-1, with 0.28. Calcium/phosphorus ratios of common vetch accessions are generally at a favorable level. But accession 15-2 and 14O04 are at risk limits with a ratio above 2. Calcium/phosphorus ratio of common vetch was determined as 7.26-8.80 by Egritas and Onal Ascı (2015). The results of these researchers are much higher than our data.

3.2. Correlation of chemical contents of common vetch.

The correlation coefficients among the chemical contents (N, P, K, Ca, Mg, Cu, Zn, Fe and Mn) of common vetch are presented in *Table 6.*

According to the results of the correlation analysis, there are significant correlations among some chemical contents of common vetch *(Table 6).*

Nitrogen was positively and significantly correlated with P (r = 0.562**), K (r = 0.283*), Mg (r = 0.301*), Cu (r = 0.519**) and Fe (r = 0.489**). However, it was negatively and significantly correlated with Mn (-0.241*).

Table 6. Correlation coefficients (r) among the chemical contents of common vetch accessions

	N	P	K	Ca	Mg	Cu	Zn	Fe	Mn
N	1.000								
P	0.562**	1.000							
K	0.283*	0.322**	1.000						
Ca	0.120	-0.115	-0.167	1.000					
Mg	0.301*	0.137	0.052	0.589**	1.000				
Cu	0.519**	0.121	0.132	0.141	0.249*	1.000			
Zn	-0.092	-0.254*	-0.297	0.129	0.017	-0.077	1.000		
Fe	0.489**	0.353**	-0.165	0.254*	0.374**	0.246*	-0.183	1.000	
Mn	-0.241*	-0.312**	-0.227	0.215	0.256*	0.188	0.219	-0.202	1.000

* p≤0.05, ** p≤0.01

Phosphorus content of common vetch accessions was positively and significantly correlated with N (r = 0.562**), K (r = 0.322**) and Fe (r = 0.353**). There was a negatively and significantly correlated with Zn (-0.254*) and Mn (r = -0.312**).

Potassium was positively and significantly correlated with N (r = 0.283*) and P (r = 0.322**). Potassium content was found to be positive and insignificantly correlated with Mg and Cu, while it was found to be negative and insignificantly correlated with Ca, Zn, Fe and Mn. Similarly, Yücel et al. (2014) determined a significant and positive relationship between K and P, and an insignificant and negative relationship between K and Ca.

Calcium was positively and significantly correlated with Mg (r = 0.589**) and Fe (r = 0.254*). Yücel et al. (2014) similarly determined a significant and positive relationship between Ca and Mg.

Magnesium was positively and significantly correlated with N (r = 0.301*), Ca (r = 0.589**), Cu (r = 0.249*), Fe (r = 0.374**) and Mn (r = 0.256*). There was a positively and non-significantly correlated with P (r = 0.137), K (r = 0.052) and Zn (r = 0.017). Yücel et al. (2014) similarly determined an insignificant and positive relationship between P and Mg.

Copper was positively and significantly correlated with N (r = 0.519**), Mg (r = 0.249*) and Fe (r = 0.246*).

Zinc was non-significant correlated with all characters except P that was negatively and significantly correlated with Zn (r = 0.254*).

Iron was positively and significantly correlated with N (r = 0.489**), P (r = 0.353**), Ca (r = 0.254*), Mg (r = 0.374**) and Cu (r = 0.246*).

Manganese was negatively and significantly correlated with N (r = -0.241*) and P (r = -0.312**), while it was positively and significantly correlated with Mg (r = 0.256*).

4. Conclusions

Nitrogen, phosphorus, potassium, calcium, magnesium, copper, zinc, iron and manganese contents of common vetch accessions showed significant differences (P≤0.01). N, P, K, Ca, Mg, Cu, Zn, Fe, and Mn content of common vetch accessions varied between 0.95 – 3.14 %, 0.84 – 3.65 %, 0.22 – 2.44 %, 0.89 – 2.85 %, 0.23 – 0.74 %, 0.15 – 7.80 ppm, 0.10 – 5.30 ppm, 43.00 – 2295.20 ppm, 3.08 – 17.50 ppm, respectively. There is a huge variation in chemical structure among common vetch accessions.

Tetany and Ca/P ratios were determined to be statistically significant (P≤0.01). Tetany rates of accessions changed from 0.13 to 1.54. Calcium/phosphorus rates also varied between 0.28 and 2.19. The tetany and Ca/P rates of common vetch accessions are within suitable values for animal feeding. Calcium/phosphorus ratio is above the limit value only in accession 15-2 and 14O04.

According to the results of the correlation analysis, there are significant correlations among some chemical contents of common vetch. Nitrogen was positively and significantly correlated with P, K, Mg, Cu and Fe. Phosphorus was positively and significantly correlated with N, K and Fe. Calcium was positively and significantly correlated with Mg and Fe.

As a result of in this study, accession 15K17 (high N, Cu, Fe, P and K content) and 33 (high Fe, Mn, Ca and Mg content) were identified as common vetch accessions with high mineral nutrition content.

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