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FORAGE NUTRITIVE QUALITY AND SOME VITAMIN CONTENTS OF *DORYCNIUM GRAECUM* (L.) SER. AND *DORYCNIUM PENTAPHYLLUM* SCOP.

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Abstract
The research was conducted to determine some forage quality traits, macro and micro mineral, α-tocopherol, β-carotene and ergocalciferol content of Dorycnium graecum (L.) Ser. and Dorycnium pentaphyllum Scop. The samples were obtained in 2021 at end of flowering-beginning of pod binding stage, from the north side of the Ganos Mountain of Tekirdağ in Thrace-Türkiye, with a typical subtropical climate. The plant height (56.52 cm), number of stems (29.20 pcs), fresh above-ground biomass (172.00 g plant^{-1}), dry above-ground biomass (67.32 g plant^{-1}), crude ash (5.34%), P (0.27%), K (2.01%), Ca (1.52%), Zn (0.028 mg g-1), DDM (66.58%), DMI (2.84%), TDN (63.40%), Nel (0.652), Nem (0.704), Neg (0.377) of D. pentaphyllum were determined higher than D. graecum. The crude protein (17.10 %), ADF (29.09 %), NDF (43.26 %), Mg (0.31 %), Fe (0.24 mg g^{-1}), Cu (1.31 mg g^{-1}), Mo (0.192 mg g^{-1}), α-tocopherol (122.06 mg kg^{-1}), β-carotene (321.06 mg kg^{-1}), ergocalciferol (7.02 µg kg^{-1}) of D. graecum were found higher than D. pentaphyllum. According to the results of the characteristics examined in the research, both species can be evaluated in Tekirdağ, Thrace-Türkiye and similar ecological conditions.

Keywords: Mineral content, Morphological characters, Nutritive value

1. INTRODUCTION

Over the past few decades, the combined influences of climate change have led to a number of environmental challenges, including water scarcity, soil pollution, and higher levels of salinity in both soil and water. The reduction in the area of productive arable land, coupled with an increase in the global population, represents a significant threat to the sustainability of global agriculture. As these challenges persist, the stress experienced by plants intensifies, which in turn accelerates the extinction of species (Rejeb et al., 2014; Shokat and Groskinsky, 2019; Demiroğlu Topçu et al., 2024).

The name *Dorycnium* is derived from the Greek word *Dorycnion*, which later evolved into the current appellation. *Dorycnium* Miller. is a genus of about 12-13 species of herbaceous perennials and deciduous sub-shrubs. These are broadly classified as herbaceous perennials and deciduous sub-shrubs (Allen and Allen, 1981; Wills and Douglas, 1984; Slavik, 1995; Davies, 2005; Kocabaş and İlçim, 2016). *Dorycnium* species, which are hardly ever not affected by heavy frost events in winter, are defined as frost and drought-resistant, low-growing perennial legumes (Wills, 1983; Rys et al., 1988; Wills et al., 1989; Wills, 1994). *Dorycnium* species are commonly found in light, infertile and sandy soils and are widely distributed across the Mediterranean region, the Anatolia,

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from the Canary Islands to the Balkans, and Central and Southern Europe. (Allen and Allen, 1981). Futhermore, research has been conducted on the cultivation of certain species of *Dorycnium* as potential alternative forage crops (Lane et al., 2004). The greatest potential for *Dorycnium* species lies in their capacity to provide feed during the late summer and autumn months, a period when pasture availability is limited and livestock breeders have to rely on costly additional feedstuffs to maintain livestock (Bathgate and Pannell, 2002). On the other hand, several researchers reported condense tannens and hydrocynaic acid (HCN) are the limitations of the nutritive value of *Dorycnium* spp. (Plouver, 1974; Terril et al., 1992; Waghorn et al., 1998; Barroso et al., 2001; Gebrehiwot and Beuselinck, 2001; Waghorn and Molan, 2001; Waghorn et al., 2002). The contents of dorycnioside, catechin, D-pinitol, ß-sitosterol and stearic acid in *Dorycnium* species, along with the antioxidant activities were also determined.

The aim of this research was to determine the forage quality traits, including macro and micro mineral, α-tocopherol, β-carotene and ergocalciferol contents, of two species of *Dorycnium*, namely *D. graecum* (L.) Ser. and *D. pentaphyllum* Scop., in the region of Tekirdağ in Türkiye.

2. MATERIALS AND METHODS

The samples of species were collected in 2021 at end of flowering-beginning of pod binding stage, from Yenice village, Süleymanpaşa, Tekirdağ, the north side of the Ganos Mountain of Tekirdağ, Thrace, Türkiye. Tekirdağ has a 14.10 °C mean temperature, 580.00 mm total precipitation at long term period (1940-2023) with a typical subtropical climate. In 2021 the mean temperature and total rainfall were recorded 11.17 °C and 988.30 mm respectively (Anonymous, 2024a). The characteristics of the study were determined at 5 different plants for each species. Plant height was measured with a meter, number of stems were counted and stem diameter was determined with digital caliper. Plants harvested manually at end of flowering-beginning of pod binding stage and weighed for fresh above-ground biomass.

Oven drying for feed analysis at temperatures above 60°C can cause heat damage to protein, and this leads to increased fibre and lignin values (Reed and Van Soest, 1984; Tenikecier and Ates, 2018). To prevent this, the fresh samples were dried in an oven at 55°C for 48 hours, followed by an additional day of storage at room temperature (Ates, 2012; Tenikecier and Ates, 2019). Subsequently, the dry above-ground biomass was measured by weighing the samples, and they were ground to pieces of ≤1 mm in size and used for the further analyses. In accordance with the procedures by the Association of Official Analytical Chemists (AOAC, 2019), crude protein (CP, %) was determined. The contents of crude ash (CA), acid-detergent fibre (ADF), and neutral-detergent fibre (NDF) were found using the Weende and Van Soest methods (AOAC, 2019; Van Soest et al., 1991). The samples were subjected to wet ashing with nitric and perchloric acids and the phosphorus (P) content (%) was determined by spectrophotometrically. The contents of calcium (Ca, %), magnesium (Mg, %), potassium (K, %), iron (Fe, mg g^{-1}), copper (Cu, mg g^{-1}), zinc (Zn, mg g^{-1}), manganese (Mn, mg g^{-1}) and molybdenum (Mo, mg g^{-1}) were determined using an atomic absorption spectrophotometer (ICP-OES, inductively coupled plasma-optical emission spectrometer) (Isaac and Johnson JR, 1998). The following parameters were calculated using formulas adapted from fodder equations (Schroeder, 1994): digestible dry matter (DDM, %), dry matter intake (DMI, %), relative feed value (RFV, %), total digestible nutrients (TDN), net energy lactation (NEL), net energy maintenance (NEM), and net energy gain (NEG). The contents of vitamins (β-carotene, mg kg^{-1}; α-tocopherol, mg kg^{-1} and ergocalciferol, µg kg^{-1}) in the samples

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were found using slightly modified methods explained by Jensen et al. (1998), Jäpelt et al. (2011), Lindqvist et al. (2012), Ates et al. (2020) and Ates (2021). Each sample was analysed in duplicate. The data were analysed statistically using analysis of variance with TARIST software (Acikgoz et al., 2004) and treatment means were compared using the least significant difference (LSD) test with MSTAT-C software.

3. RESULTS AND DISCUSSIONS

The results of the study were given in Table 1. Plant height, number of stems, fresh above ground biomass, dry above-ground biomass, crude protein, crude ash, ADF, NDF, P, K, Ca, Mg, Fe, Cu, Zn, Mo, α-tocopherol, β-carotene, ergocalciferol, DDM, DMI, RFV, TDN, Nel, Nem, Neg were determined statistically significant at P<0.01, stem diameter and Mn were determined statistically non-significant.

Table 1. Some morphological and feeding quality characteristics, and vitamin contents of D. graecum (L.) Ser. and D. Pentaphyllum Scop.

Characters	*D. graecum* (L.) Ser.	*D. pentaphyllum* SCOP.	*Mean*	LSD
Plant Height (cm)	40.85b	56.52a	*46.68*	*14.26***
Number of Stems (pcs)	7.60b	29.20a	*18.40*	*7.50***
Stem Diameter (mm)	2.69	2.62	*2.65*	*ns*
Fresh Above Ground Biomass (g plant^{-1})	46.00b	172.00a	*109.00*	*21.22***
Dry Above Ground Biomass (g plant^{-1})	16.14b	67.32a	*41.73*	*14.75***
Crude Protein (%)	17.10a	16.55b	*16.82*	*0.22***
Crude Ash (%)	5.10b	5.34a	*5.22*	*0.22***
NDF (%)	43.26a	42.25b	*85.51*	*0.09***
ADF (%)	29.09a	28.66b	*28.87*	*0.35***
P (%)	0.25b	0.27a	*0.26*	*0.01***
K (%)	1.94b	2.01a	*1.97*	*0.03***
Ca (%)	1.49b	1.52a	*1.50*	*0.01***
Mg (%)	0.31a	0.29b	*0.30*	*0.01***
Fe (mg g^{-1})	0.24a	0.23b	*0.23*	*0.01**
Cu (mg g^{-1})	1.31a	1.28b	*1.29*	*0.02***
Zn (mg g^{-1})	0.027b	0.028a	*0.027*	*0.001**
Mn (mg g^{-1})	0.016	0.016	*0.016*	*ns*
Mo (mg g^{-1})	0.192a	0.190b	*0.191*	*0.002***
β caroten (mg kg^{-1})	321.06a	320.37b	*320.71*	*0.49**
α-tocopherol (mg kg^{-1})	122.06a	122.69b	*122.37*	*0.19***
Ergocalciferol (µg kg^{-1})	7.02a	6.69b	*6.85*	*0.03***
DDM (%)	66.24b	66.58a	*66.41*	*0.27***
DMI (%)	2.77b	2.84a	*2.80*	*0.01***
TDN	62.90b	63.40a	*63.15*	*0.40***
NEL	0.647b	0.652a	*0.649*	*0.004***
NEM	0.697b	0.704a	*0.700*	*0.005***
NEG	0.370b	0.377a	*0.373*	*0.005***
RFV	142.42b	146.59a	*144.50*	*0.52***

**P≤0.01; ns: non-significant

The plant height (56.52 cm), number of stems (29.20 pcs), fresh above-ground biomass (172.00 g plant^{-1}), dry above-ground biomass (67.32 g plant^{-1}), crude ash (5.34%), P (0.27%), K (2.01%), Ca (1.52%), Zn (0.028 mg g^{-1}), DDM (66.58%), DMI (2.84%), TDN (63.40%), Nel (0.652), Nem (0.704), Neg (0.377) and RFV (146.59) of *D. pentaphyllum* were found higher than *D. graecum*.

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The plant height of *D. graecum* varies between 25-80 cm (Anonymous, 2024b). The results of the research indicate that the observed values fall within this range. The DDM was observed to be higher than the reported 63.47 %, while the DMI was determined to be lower by 2.83 % (Seydoşoğlu, 2019). Önal Aşçı and Acar (2018), Tenikecier and Ateş (2024) reported that the RFV index is a measure of the quality of a specific fodder. When the RFV of a forage declines, its quality depending on decreases. Avkıran and Ateş (2023) suggested that as above-ground biomass increases, both plant height and tetany ratio rise, while the contents of Ca, Mg, P and their ratios decrease in logarithmically.

The crude protein (17.10 %), ADF (29.09 %), NDF (43.26 %), Mg (0.31 %), Fe (0.24 mg g^{-1}), Cu (1.31 mg g^{-1}), Mo (0.192 mg g^{-1}), α-tocopherol (122.06 mg kg^{-1}), β-carotene (321.06 mg kg^{-1}), ergocalciferol (7.02 µg kg^{-1}) of *D. graecum* were determined higher than *D. pentaphyllum*. The findings of our analysis of NDF and ADF contents were determined to be accordance with those of previous researches (Geren, 2001; Kızılşimşek et al., 2023). Terrill et al. (1992) found that the total N content in *D. hirsutum*, *D. pentaphyllum* and *D. rectum* was 2.60, 3.57 and 3.25 (% in DM), respectively. In addition to, they reported that the in vitro dry matter digestibility of *D. hirsutum*, *D. pentaphyllum* and *D. rectum* was 73.0, 79.7 and 73.7 %, respectively. In another research, Douglas and Foote (1994) measured the DM production to be 0.31 DM ha^{-1}. Later, Douglas et al. (1996) reported that the average total nitrogen (N) content of *D. rectum* was 25 g N kg^{-1} of DM (2.5%). Reynolds (2000) suggested that the digestibility of feed may be affected by the concentration of CP in the diet. He also noted that the decline in CP content as plants mature is likely to leads to a reduction in metabolizable energy (ME). Davies and Lane (2003) reported that the CP content of *D. rectum*, *D. hirsutum* and *D. pentaphyllum* ranged from 5-18% of plant DM, with DM digestibility ranging from 45-67% and metabolizable energy of 6.2-9.6 MJ/kg/DM. Based on the findings of their investigation, *Dorycnium* spp. can provide a feed source for livestock in areas with low rainfall during late summer and early autumn, when conventional pastures typically experience regular forage shortages. Davies (2005) found that the CP of *D. pentaphyllum* ranged from 8.4 to 15.7 %, while the NDF content was between 32.0 and 42.5 %. Sardans et al. (2008) obtained the Mo content in the leaves and stems of *D. pentaphyllum* to be 0.118-0.329 mg g^{-1} and 0.214-0.343 mg g^{-1}, respectively. Futhermore, Bremner et al. (2009), Aliyazicioglu et al. (2019) and Demir et al. (2019) have noted that the *Dorycnium* genus exhibits a range of biological activities, including anti-inflammatory, antimicrobial, cytotoxic, and antioxidant features. Tenikecier and Ateş (2024) said that the forage legumes are better for ruminants and non-ruminants than grasses because they have more protein, minerals and vitamins and are less ashy.

4. CONCLUSIONS

The genus *Dorycnium* includes perennial leguminous plants that are frost and drought tolerant. These species are found on light, infertile, sandy soils and the greatest potential for *Dorycnium* is to provide forage in late summer and early autumn, when the ranges have low above-ground biomass. Futhermore, a significant benifits of these species under examination is its capacity to produce feed in adverse conditions, thereby helping as a late-season or alternative feed source during periods of regular forage shortages. According to study results, *D. graecum* emerges as a leading species, exhibiting high contents of CP, Mg, Fe, Cu, Mo and β-carotene, α-tocopherol and ergocalciferol. *D. pentaphyllum* has the highest levels of other characters examined in the research. When the results are evaluated as a whole, it can be concluded that both species are suitable for use as alternative forage crops in Tekirdağ, Türkiye and in similar conditions.

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