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MORPHOLOGICAL, CHEMICAL AND NUTRITIONAL PROPERTIES OF FORAGE PLANTS IN A NATURAL RANGELAND IN TURKEY

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Abstract

Plant length, main stem diameter, root crown diameter, dry weight of root per plant and forage yield per plant of 30 forage plants were examined as morphological characters. A wide range of variation within the same species was observed among morphological characters. Crude protein and crude ash ratios, K, Ca, Mg, P, S, Fe, Zn, Mn contents, K/(Ca+Mg), Ca/P and N/S ratios of the plants were examined. The crude protein and crude ash ratios of the plants ranged between 5.81 to 16.32%, 7.05 to 14.68%, respectively. K, P, Mg and Ca contents of plants ranged between 0.96 to 3.67, 0.17 to 0.49, 0.01 to 1.19 and 0.45 to 2.79%, respectively. The values for Fe, Zn and Mn contents of plants ranged between 132.4 - 815.2, 12.37 - 68.0 and 21.7 - 138.4 ppm, respectively. Ca/P, N/S and K/(Ca+Mg) ratios of plant samples were 1.17 - 10.38, 1.35 - 7.75 and 0.36 - 4.73, respectively.

Introduction

Turkey is rich regarding species, ecotype, genetic diversity and gene sources of plants (Davis 1985, Özgen *et al.* 1995). Besides leguminous and graminous, many plant species from other families are preferred by livestock in Turkey rangelands (Acar 1996, Özen and Kılıç 1996, Ayan 1997, Acar *et al.* 1999 a), but there is insufficient information about most of these plants.

Acar and Güncan (2002) determined the plant height, dry forage yield, stem diameters, crude protein ratios of *Convolvulus arvensis* L., *Plantago lanceolata* L. and *Malva neglegta* Wallr. in a research carried out in Konya-Turkey. High variation was observed in the same species regarding characters as mentioned above.

Tan and Yolcu (2001) reported that similar weedy species were rich in protein, ash, many kinds of minerals and had adequate level of K, Ca, Mg and P regarding daily necessities for livestock in a study on nine wild plant species.

More recent researches have revealed that the forage nutritive value of some weed species may be comparable to that of cultivated forages (Bosworth *et al.* 1985, Marten *et al.* 1987, Tan and Yolcu 2001, Acar and Güncan 2002). Dutt *et al.* (1982) reported that there was no decrease of feeding value of alfalfa and digestibility of forage in the contamination of alfalfa and dandelion (*Taraxacum officinale* Weber).

In New Zealand, the pasture seeded with a mixture of 18 to 26 species consisting of cool-season grasses and legumes along with several pasture herbs yielded more dry matter under sheep grazing than the pasture seeded with perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.) mixtures (Ruz-Jerez *et al.* 1991, Daly *et al.* 1996).

Jung *et al*. (1996) reported that crude protein ratio of chicory swards (*Cichorium intybus* L.) increased to 23% while growing alone and met dietary mineral requirement of lactating daily cows. Researchers reported that the mineral composition of forage chicory was comparable to or exceeded that of wild and red clover and perennial rye grass (Crush and Evans 1990, Reid *et al*. 1993).

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Palatability, defined as the selection or proportional choice by animals among two or more forages, is an important forage quality parameter. Despite high nutrient concentrations, low palatability may reduce forage feeding value (Marten *et al.* 1987). For instance, Marten and Anderson (1975) reported that common cocklebur (*Xanthium strumarium* L.) had IVDDM and CP concentrations of 88 and 24%, respectively while being highly unpalatably to sheep due to other chemical or physical characteristics. Acar *et al.* (1999 b) reported that although Amaranth species had high nutritious contents, they were not preferred by livestock. Instability of mineral matter ratios (Belesky *et al.* 2001) and some secondary phenolic components (Barry 1998) may reduce palatability.

If wild plants are compared with cultivated forage crops, wild crops may have had some advantages (Özen *et al.* 1998, Tan and Yolcu 2001). Some wild plants are more resistant to negative environmental conditions (salinity, drought and cold), disease and pest damages (Jung *et al.* 1996, Tan and Yolcu 2001). Each wild plant species is rich regarding different macro and micro elements (Marten *et al.* 1987, Barry 1998, Islam and Adams 2000, Tan and Yolcu 2001). Some of them have high leaf ratio (Stordahl *et al.* 1999).

Our objective was to determine the nutritive values and different morphological characteristics of some wild plants growing naturally in our campus rangelands.

Material and Methods

This study was conducted between March and July 2004 in Ondokuz Mayis University (OMU), Kurupelit Campus rangeland protected since early 1970's. According to Davis's square system, the research area is in A6 square which is located at 41°21´ N latitude 36°15´ E longitude (Davis 1970). Irregular topography in 1300 h land has 150-300 m altitude, various soil types such as clay in the coastal area, greypodzolic and brown soil on hillsides, and different plant commu-nities such as forest, meadow, rangeland, bushy plant vegetation (Pamir and Erentöz 1974).

The soil pH is 6.85, and unsalty, moderate organic matter, Ca and Mg contents of the soil are 2.94, 0.53 and 0.77%, respectively. K content is 431.2 g/kg, P content is 12.25 g/kg. Fe, Zn and Mn contents are 24.77, 1.58 and 37.02 ppm, respectively. Mean annual temperature is 14.2°C, total annual precipitation is 670 mm, and the number of frost day is 18 (Anon. 2005).

Wild plant species in flowering time were picked up from the rangeland between March and July, 2004. Some properties of each wild plant sample, such as number of plant length, main stem diameter, root crown diameter, dry weight of root and stem, were determined. Classification of the plants were done according to Davis (1970) and the identification was by comparing plants kept at herbarium in the laboratory of biological science department in OMU.

Wild plants collected in the study area are: *Adonis annua* L., *Ammi visnaga* L., *Anagalis arvensis* L., *Anchusa azurea* Miller var. *azurea* Retz., *Bellis perennis* L., *Capsella bursa-pastoris* (L.) Medik., *Convolvulus arvensis* L., *Fumaria officinalis* L., *Galium verum* L. ssp. *verum*, *Geranium asphodeloides* Burm., *Geranium lucidum* L., *Lamium album* L., *L. purpureum* L., *Lapsana communis* ssp. *intermedia* Hayek., *Malva neglecta* Wallr., *Matricaria chamomilla* L., *Nepeta nuda* ssp. *grandiflora* (Dais) Gam., *Plantago lanceolata* L. *Ranunculus fragaria* L., *Raphanus raphanistrum* L., *Rumex crispus* L., *Sangiosorba minor* Scop., *Senecio vulgaris* L., *Silene vulgaris* (Moench) Gorcker var. *vulgaris*, *Sinapis arvensis* L., *Sonchus oleraceus* L.,

Stellaria holostea L., *Stellaria media* (L.) Vill. ssp. *media*, *Taraxacum officinale* L. and *Veronica filiformis* Smith.

Plant samples were dried to constant weight at 65°C in an oven for 24 h. After cooling and weighing, the samples were grounded for crude protein, crude ash and mineral content analyses. Crude protein content was calculated multiplying total nitrogen concentration by 6.25 (Kacar 1984); crude ash content was found ashing the plant samples at 550°C for 6 h (AOAC 1990); mineral contents (Ca, K, Mg, Mn, Fe and Zn) of the samples were also determined using Atomic Absorption Spectrophotometer after digesting the samples with $HClO_4$: HNO_3 (1 : 4) according to Kacar (1984). P and S were measured at 430 nm wave lengths using spectrophotometer.

The data obtained from this study to determine the morphological characters of wild plant growing naturally were evaluated by calculating mean and confidence limit for 0.05 probabilities (Little and Hills 1978, Tosun 1998).

Results and Discussion

Morphological characters: As morphological characters, plant length, main stem diameter, root crown diameter, dry weight of root and forage yield per plant were determined. Data concerning these properties are presented in Table 1.

Among the investigated species, *G. verum* ssp. *verum* had the longest plant length (100.06 cm) and *B. perennis* had the lowest plant length (14.46 cm). Plant length for other species ranged between 14.46 and 100.06 cm (Table 1).

Average plant length of *S. minor* (59.55 cm) was more than Acar *et al*. (1999 a)'s findings (31.4 - 46.8 cm). Further, average plant length of *M. neglecta* (62.24 cm) and *C. arvensis* (48.79 cm) were more than Acar and Güncan (2002)'s findings (50.4 and 31.0 cm, respectively); whereas plant length of *P. lanceolata* (42.20) was lesser than same researchers' value (59.7 cm).

Average stem diameters varied from 8.67 mm (*R. crispus*) to 0.62 mm (*V. filiformis*) (Table 1.) Stem diameter of *M. neglecta* (4.77 mm) was more than 3.44 mm found by Acar and Güncan (2002); while stem diameters of *C. arvensis* and *P. lanceolata* (1.55 and 2.22 mm, respectively) were less than same researchers' findings (3.1 and 5.7 mm).

Average root crown diameters of the 30 species ranged between 26.8 and 1.85 mm (Table 1). Thickness of the root crown diameter indicates that plant excessively branches out from root neck and this is important for saving soil and water (Tan and Yolcu 2001, Acar and Güncan 2002).

Chemical properties: Crude protein and ash content, K, Ca, Mg, P, S, Fe, Zn, Mn contents, K/(Ca+Mg), Ca/P and N/S ratios of wild plants growing naturally in the research area were examined. Crude protein ratios of the plants were between 5.81% (*S. media* spp. *media*) and 16.32% (*C. arvensis*) (Table 2).

Marten *et al*. (1987) reported protein ratios in wild plant species varied between 7.2 and 28.6% depending on locations, years and species in a research conducted in Minnesota. Tan and Yolcu (2001) reported the protein ratios of wild species between 9.79 and 19.66% in Erzurum-Turkey, while Acar and Güncan (2002) mentioned them between 6.15 and 17.70%.

Acar *et al*. (1999a) reported that average crude protein ratio of *S. minör* ranged between 5.6 and 5.7%. Obtained results are close to or slightly lower than some researchers' findings.

Crude protein ratios of plants increased due to nitrogen uptake following nitrogen fertilization (Marten *et al.* 1987).

Crude protein ratios of examined species were higher than the critic value (7%) reported by Espinoza *et al.* (1991) in forages except *S. media* ssp. *media*.

Crude ash ratios of examined species ranged between 7.05 (*L. communis* ssp. *intermedia*) and 14.68 % (*B. perennis*) (Table 2). Different researchers determined crude ash ratios of different plant species between 7.6 and 22.2% (Teutonica and Knorr 1985, Tan and Yolcu 2001).

K contents of plant species were between 0.96 (*M. neglecta)* and 3.67% (*L. purpureum*). K contents of all samples were less than the value (6.5 g/kg) recommended by NRC (1984) for cattle. But it should be considered that high K content may cause Mg deficiency (Loreda *et al.* 1986). High available K contents of soils in this study might have contributed to increase K contents of species.

Some researchers found that K contents of samples varied between 1.81 and 5.44% in different wild plant species (Marten *et al.* 1987, Tan and Yolcu 2001). K contents of the samples studied during this investigation were within these limits (Table 2).

Ca contents of the species ranged between 0.45% (*L. communis* ssp. *intermedia*) and 2.79% (*G. asphodeloides*). Ca contents in forages are recommended at least 3.1 g/kg for ruminants (NRC 1984). Some researchers reported that the Ca contents of samples varied between 0.79 and 2.54% in other plant families (Marten *et al.* 1987, Tan and Yolcu 2001).

Mg contents of samples were between 0.01% (*G. asphodeloides*) and 1.19% (*L. communis* ssp. *ıntermedia*) (Table 2). Mg contents of some species were below the recommended value (0.2%) by Tajeda *et al.* (1985), except eight species; whereas Mg contents of some plant species were higher than the value (0.1%) recommended by NRC (1996), except in three species.

K/(Ca+Mg) ratios of plant species ranged between 0.36 (*M. neglecta*) and 4.73 (*T. officinale*). It is recommended that K/(Ca+Mg) ratio of forages should be below 2.20 (Mayland and Grunes 1979, Kidambi *et al.* 1989). The K/ (Ca+Mg) ratios over 2.20 may cause grass tetany in especially cool seasons (Mayland and Grunes 1974). K/ (Ca+Mg) ratios of all species, except *N. nuda* ssp. *grandiflora* were below 2.20 (Table 2).

P contents of the grass species were between 0.49% (*M. neglecta*) and 0.17% (*V. filiformis*) (Table 2). It is reported that forages for cattle should contain P between 0.17 and 0.39% (NRC, 1996) and forages for sheep should have P between 0.16 - 0.38% (NRC 1984). The values of examined five species were higher than the recommended values; and those of other species were into the recommended limits (Table 2). When P content of forage is twice more than the recommended value, it may cause urinary calculi (Emerick 1988). P contents of different plant species were found between 0.18 and 0.52% (Marten *et al.* 1987, Tan and Yolcu 2001).

Ca/P contents of the plant species ranged between 1.17% (*R. crispus*) and 10.38% (*A. visnaga*). Ca/P ratios of all species, except *R. crispus* and *T. officinale*, were higher than 2.00 (Table 2). When Ca/P ratio is over 2.00, milk fever may be observed in animals or growing performance and effectiveness of forage-animal product transformation may decrease (Jacobson *et al.* 1972, Reid and Jung 1974).

N/S ratios of examined samples ranged between 1.35 (*S. media* ssp. *media*) and 7.75 (*R. crispus*) (Table 2). N/S ratios of all samples were below the recommended values (Table 2). Probably, nitrogen deficiency in plant tissues might cause this situation as they were collected from the untouched natural areas. High S content affects the Cu, Zn and Se availableness for sheep (Suttle 1974).

Average Fe contents of plant species were between 132.4 ppm (*S. arvensis*) and 815.2 ppm (*T. officinale*) (Table 2). Periguad (1970) and Lamand (1975) recommend that forages should contain at least 50 ppm Fe. During this investigation Fe contents of all samples were over the recommended value. It is reported that Fe deficiency is observed in areas having high nitrogen application rates (Rybak 1977 and Acar *et al.* 1993). Fe contents of samples were high as they were collected from the natural areas without nitrogen application.

Zn contents of plant species varied from 12.37 (*C. arvensis*) to 68.0 ppm (*S. holostea*). The least recommended values of this in forages are 10 ppm (Danbara *et al.* 1985), 50 ppm (Periguad 1970, Lamand 1975) and 30 ppm (NRC 1996) for ruminants. Zn contents of all samples were over the value recommended by Danbara *et al.* (1985). Zn deficiency causes sterility, anemia or immune system problems in animals (Hidiroglu and Knipfell 1984).

Mn contents of samples were between 21.7 (*L. communis* ssp. *intermedia*) and 138.4 ppm (*B. perennis*). Forages should contain approximately 50 ppm Mn in extensive stockbreeding. Mn contents of 18 species from the examined 30 species were over the recommended value, whereas Mn contents of 12 species were below the critic value. Excessive Mn causes appetite decreases in animals (Danbara *et al.* 1985).

The region in this study had many plant species from different families, growing naturally and grazed by animals. Many species had some advantages concerning growth characters or nutrients. In addition, a wide variation within same species was observed regarding investigated characters.

Results obtanined indicate that *R. crispus*, *C. arvensis*, *P. lanceolata*, *T. officinale*, *S. minor*, and *M. neglecta* are the most important species for forage uses in the rangaland under this investigation.

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